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für Künstliche
Intelligenz GmbH

Document

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**DFKI-Publications:
The First Four Years**

1990 - 1993

Josua Boon (Ed.)

January 1994

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Deutsches Forschungszentrum für Künstliche Intelligenz

The German Research Center for Artificial Intelligence (Deutsches Forschungszentrum für Künstliche Intelligenz, DFKI) with sites in Kaiserslautern and Saarbrücken is a non-profit organization which was founded in 1988. The shareholder companies are Atlas Elektronik, Daimler-Benz, Fraunhofer Gesellschaft, GMD, IBM, Insiders, Mannesmann-Kienzle, SEMA Group, and Siemens. Research projects conducted at the DFKI are funded by the German Ministry for Research and Technology, by the shareholder companies, or by other industrial contracts.

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- Programming Systems
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- Document Analysis and Office Automation.

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From its beginning, the DFKI has provided an attractive working environment for AI researchers from Germany and from all over the world. The goal is to have a staff of about 100 researchers at the end of the building-up phase.

Dr. Dr. D. Ruland
Director

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Preface

Since late 1989, the DFKI is publishing its research results in the three publication series "Research Report", "Technical Memo", and "Document". By now, the number of publications as well as the demand for them has grown to a large extent. The document on hand contains abstracts of all DFKI-publications so far. This publication activity represents the DFKI's strive for participation in knowledge transfer into the academic community.

The three different publication series are to meet different requirements on the publication's content.

A "Research Report" represents an original paper on the level of a contribution to a technical conference or a technical journal.

Reports published as "Technical Memo" are original papers of current interest representing the actual state of a research work which still would have to be developed further before acceptance by a conference or journal.

Whereas the two former publication series are meant for a wider circulation, in general "Document" stands for a publication of more limited distribution, or of documentary character such as proceedings or manuals.

Currently, the 255 DFKI-publications divide themselves in 151 "Research Reports", 31 "Technical Memos", and 73 "Documents". Mainly they are written in English, some however are published in German.

In order to further the circulation of DFKI-publications and to make them available to a larger readership in a more efficient way, our goal is to make the three publication series available via anonymous ftp. Some of the reports are already obtainable. Otherwise, the printed versions of the DFKI-publications or the list of all published papers so far are available. The sources of supply are mentioned on page 16. The reports are distributed free of charge except if otherwise indicated.

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Editor

DFKI-Publications: The First Four Years

1990 - 1993

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Contents:

Brief Survey of Publications	2
Author Index	12
Project Index	14
Publishing Statistics	15
Research Reports	16
Technical Memos	63
Documents	72

Brief Survey of Publications

DFKI Research Reports

RR-90-01

Franz Baader:

Terminological Cycles in KL-ONE-based Knowledge Representation Languages

RR-90-02

Hans-Jürgen Bürckert:

A Resolution Principle for Clauses with Constraints

RR-90-03

Andreas Dengel, Nelson M. Mattos:

Integration of Document Representation, Processing and Management

RR-90-04

Bernhard Hollunder, Werner Nutt:

Subsumption Algorithms for Concept Languages

RR-90-05

Franz Baader:

A Formal Definition for the Expressive Power of Knowledge Representation Languages

RR-90-06

Bernhard Hollunder:

Hybrid Inferences in KL-ONE-based Knowledge Representation Systems

RR-90-07

Elisabeth André, Thomas Rist:

Wissensbasierte Informationspräsentation:

Zwei Beiträge zum Fachgespräch Graphik und KI:

1. Ein planbasierter Ansatz zur Synthese illustrierter Dokumente
2. Wissensbasierte Perspektivenwahl für die automatische Erzeugung von 3D-Objektdarstellungen

RR-90-08

Andreas Dengel:

A Step Towards Understanding Paper Documents

RR-90-09

Susanne Biundo:

Plan Generation Using a Method of Deductive Program Synthesis

RR-90-10

Franz Baader, Hans-Jürgen Bürckert, Bernhard Hollunder, Werner Nutt, Jörg H. Siekmann:
Concept Logics

RR-90-11

Elisabeth André, Thomas Rist:

Towards a Plan-Based Synthesis of Illustrated Documents

RR-90-12

Harold Boley:

Declarative Operations on Nets

RR-90-13

Franz Baader:

Augmenting Concept Languages by Transitive Closure of Roles: An Alternative to Terminological Cycles

RR-90-14

Franz Schmalhofer, Otto Kühn, Gabriele Schmidt:

Integrated Knowledge Acquisition from Text, Previously Solved Cases, and Expert Memories

RR-90-15

Harald Trost:

The Application of Two-level Morphology to Non-concatenative German Morphology

RR-90-16

Franz Baader, Werner Nutt:

Adding Homomorphisms to Commutative/Monoidal Theories, or: How Algebra Can Help in Equational Unification

RR-90-17

Stephan Busemann:

Generalisierte Phasenstrukturgrammatiken und ihre Verwendung zur maschinellen Sprachverarbeitung

RR-91-01

Franz Baader, Hans-Jürgen Bürckert, Bernhard Nebel, Werner Nutt, Gert Smolka:

On the Expressivity of Feature Logics with Negation, Functional Uncertainty, and Sort Equations

RR-91-02

Francesco Donini, Bernhard Hollunder, Maurizio Lenzerini, Alberto Marchetti Spaccamela, Daniele Nardi, Werner Nutt:

The Complexity of Existential Quantification in Concept Languages

RR-91-03

B.Hollunder, Franz Baader:

Qualifying Number Restrictions in Concept Languages

RR-91-04

Harald Trost:

X2MORF: A Morphological Component Based on Augmented Two-Level Morphology

RR-91-05

Wolfgang Wahlster, Elisabeth André, Winfried Graf, Thomas Rist:

Designing Illustrated Texts: How Language Production is Influenced by Graphics Generation.

RR-91-06

Elisabeth André, Thomas Rist: Synthesizing Illustrated Documents: A Plan-Based Approach

RR-91-07

Günter Neumann, Wolfgang Finkler:
A Head-Driven Approach to Incremental
and Parallel Generation of Syntactic Structures

RR-91-08

*Wolfgang Wahlster, Elisabeth André,
Som Bandyopadhyay, Winfried Graf, Thomas Rist:*
WIP: The Coordinated Generation of Multimodal
Presentations from a Common Representation

RR-91-09

*Hans-Jürgen Bürckert, Jürgen Müller,
Achim Schupeta:* RATMAN and its
Relation to Other Multi-Agent Testbeds

RR-91-10

Franz Baader, Philipp Hanschke:
A Scheme for Integrating
Concrete Domains into Concept Languages

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Bernhard Nebel:
Belief Revision and Default Reasoning:
Syntax-Based Approaches

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J. Mark Gawron, John Nerbonne, Stanley Peters:
The Absorption Principle and E-Type Anaphora

RR-91-13

Gert Smolka:
Residuation and Guarded Rules
for Constraint Logic Programming

RR-91-14

Peter Breuer, Jürgen Müller:
A Two Level Representation for Spatial Relations—
Part I

RR-91-15

Bernhard Nebel, Gert Smolka:
Attributive Description
Formalisms ... and the Rest of the World

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Stephan Busemann:
Using Pattern-Action Rules for the Generation of
GPSG Structures from Separate Semantic
Representations

RR-91-17

Andreas Dengel, Nelson M. Mattos:
The Use of Abstraction Concepts for
Representing and Structuring Documents

RR-91-18

*John Nerbonne, Klaus Netter, Abdel Kader Diagne,
Ludwig Dickmann, Judith Klein:*
A Diagnostic Tool for German Syntax

RR-91-19

Munindar P. Singh:
On the Commitments and
Precommitments of Limited Agents

RR-91-20

Christoph Klauck, Ansgar Bernardi, Ralf Legleitner
FEAT-Rep: Representing Features in CAD/CAM

RR-91-21

Klaus Netter:
Clause Union and Verb
Raising Phenomena in German

RR-91-22

Andreas Dengel:
Self-Adapting Structuring
and Representation of Space

RR-91-23

*Michael Richter, Ansgar Bernardi,
Christoph Klauck, Ralf Legleitner:*
Akquisition und Repräsentation von technischem
Wissen für Planungsaufgaben im Bereich der
Fertigungstechnik

RR-91-24

Jochen Heinsohn:
A Hybrid Approach for Modeling
Uncertainty in Terminological Logics

RR-91-25

Karin Harbusch, Wolfgang Finkler, Anne Schauder:
Incremental Syntax
Generation with Tree Adjoining Grammars

RR-91-26

*M. Bauer, S. Biundo, D. Dengler,
M. Hecking, J. Koehler, G. Merziger:*
Integrated Plan Generation and Recognition
—A Logic-Based Approach—

RR-91-27

*A. Bernardi, H. Boley, Ph. Hanschke,
K. Hinkelmann, Ch. Klauck, O. Kühn,
R. Legleitner, M. Meyer, M. M. Richter,
F. Schmalhofer, G. Schmidt, W. Sommer:*
ARC-TEC: Acquisition, Representation
and Compilation of Technical Knowledge

RR-91-28

Rolf Backofen, Harald Trost, Hans Uszkoreit:
Linking Typed Feature Formalisms and
Terminological Knowledge Representation
Languages in Natural Language Front-Ends

RR-91-29

Hans Uszkoreit:
Strategies for Adding Control
Information to Declarative Grammars

RR-91-30

Dan Flickinger, John Nerbonne:
Inheritance and Complementation:
A Case Study of Easy Adjectives and Related Nouns

RR-91-31

H.-U. Krieger, J. Nerbonne:
Feature-Based Inheritance
Networks for Computational Lexicons

RR-91-32

Rolf Backofen, Lutz Euler, Günther Görz:
Towards the Integration of Functions, Relations
and Types in an AI Programming Language

RR-91-33

Franz Baader, Klaus Schulz:
Unification in the Union of Disjoint Equational
Theories: Combining Decision Procedures

RR-91-34

Bernhard Nebel, Christer Bäckström:
On the Computational Complexity of
Temporal Projection and some related Problems

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Winfried Graf, Wolfgang Maaß:
Constraint-basierte Verarbeitung graphischen Wissens

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Werner Nutt:
Unification in Monoidal Theories is
Solving Linear Equations over Semirings

RR-92-02

*Andreas Dengel, Rainer Bleisinger, Rainer Hoch,
Frank Hönes, Frank Fein, Michael Malburg:*
 Π ODA: The Paper Interface to ODA

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Harold Boley:
Extended Logic-plus-Functional Programming

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John Nerbonne:
Feature-Based Lexicons:
An Example and a Comparison to DATR

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*Ansgar Bernardi, Christoph Klauck,
Ralf Legleitner, Michael Schulte, Rainer Stark:*
Feature based Integration of CAD and CAPP

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Achim Schupetea:
Main Topics of DAI: A Review

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Michael Beetz:
Decision-theoretic Transformational Planning

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Gabriele Merziger:
Approaches to Abductive Reasoning—An Overview

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Perspektiven zur Kombination von automatischem
Animationsdesign und planbasierter Hilfe

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M. Bauer:
An Interval-based Temporal
Logic in a Multivalued Setting

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Susane Biundo, Dietmar Dengler, Jana Koehler:
Deductive Planning and Plan Reuse
in a Command Language Environment

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Markus A. Thies, Frank Berger:
Planbasierte graphische Hilfe in
objektorientierten Benutzungsoberflächen

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Intelligent User Support in Graphical User Interfaces:
Thomas Fehrlé, Markus A. Thies
1. InCome: A System to Navigate through
Interactions and Plans
Markus A. Thies, Frank Berger
2. Plan-Based Graphical Help in Object-
Oriented User Interfaces

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Winfried Graf:
Constraint-Based Graphical
Layout of Multimodal Presentations

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*Jochen Heinsohn, Daniel Kudenko,
Bernhard Nebel, Hans-Jürgen Profilich:*
An Empirical Analysis of
Terminological Representation Systems

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Hassan Aït-Kaci, Andreas Podelski, Gert Smolka:
A Feature-based Constraint System
for Logic Programming with Entailment

RR-92-18

John Nerbonne:
Constraint-Based Semantics

RR-92-19

Ralf Legleitner, Ansgar Bernardi, Christoph Klauck
PIM: Planning In Manufacturing
using Skeletal Plans and Features

RR-92-20

John Nerbonne:
Representing Grammar, Meaning and Knowledge

RR-92-21

Jörg-Peter Mohren, Jürgen Müller
Representing Spatial Relations (Part II)
—The Geometrical Approach

RR-92-22

Jörg Würtz:
Unifying Cycles

RR-92-23

Gert Smolka, Ralf Treinen:
Records for Logic Programming

RR-92-24

Gabriele Schmidt:
Knowledge Acquisition
from Text in a Complex Domain

RR-92-25

*Franz Schmalhofer,
Ralf Bergmann, Otto Kühn, Gabriele Schmidt:*
Using integrated knowledge acquisition to prepare sophisticated expert plans for their re-use in novel situations

RR-92-26

*Franz Schmalhofer,
Thomas Reinartz, Bidjan Tschaischian:*
Intelligent documentation as a catalyst for developing cooperative knowledge-based systems

RR-92-27

Franz Schmalhofer, Jörg Thoben:
The model-based construction of a case-oriented expert system

RR-92-29

Zhaohur Wu, Ansgar Bernardi, Christoph Klauck:
Skeletal Plans Reuse: A Restricted Conceptual Graph Classification Approach

RR-92-30

Rolf Backofen, Gert Smolka
A Complete and Recursive Feature Theory

RR-92-31

Wolfgang Wahlster
Automatic Design of Multimodal Presentations

RR-92-32

Rainer Hoch, Michael Malburg:
Designing a Structured Lexicon for Document Image Analysis

RR-92-33

Franz Baader:
Unification Theory

RR-92-34

Philipp Hanschke:
Terminological Reasoning and Partial Inductive Definitions

RR-92-35

Manfred Meyer:
Using Hierarchical Constraint Satisfaction for Lathe-Tool Selection in a CIM Environment

RR-92-36

Franz Baader, Philipp Hanschke:
Extensions of Concept Languages for a Mechanical Engineering Application

RR-92-37

Philipp Hanschke:
Specifying Role Interaction in Concept Languages

RR-92-38

Philipp Hanschke, Manfred Meyer:
An Alternative to H-Subsumption Based on Terminological Reasoning

RR-92-40

Philipp Hanschke, Knut Hinkelmann:
Combining Terminological and Rule-based Reasoning for Abstraction Processes

RR-92-41

Andreas Lux:
A Multi-Agent Approach towards Group Scheduling

RR-92-42

John Nerbonne:
A Feature-Based Syntax/Semantics Interface

RR-92-43

Christoph Klauck, Jakob Mauss:
A Heuristic driven Parser for Attributed Node Labeled Graph Grammars and its Application to Feature Recognition in CIM

RR-92-44

Thomas Rist, Elisabeth André:
Incorporating Graphics Design and Realization into the Multimodal Presentation System WIP

RR-92-45

Elisabeth André, Thomas Rist:
The Design of Illustrated Documents as a Planning Task

RR-92-46

Elisabeth André, Wolfgang Finkler, Winfried Graf, Thomas Rist, Anne Schauder, Wolfgang Wahlster:
WIP: The Automatic Synthesis of Multimodal Presentations

RR-92-47

Frank Bomarius:
A Multi-Agent Approach towards Modeling Urban Traffic Scenarios

RR-92-48

Bernhard Nebel, Jana Koehler:
Plan Modifications versus Plan Generation: A Complexity-Theoretic Perspective

RR-92-49

Christoph Klauck, Ralf Legleitner, Ansgar Bernardi:
Heuristic Classification for Automated CAPP

RR-92-50

Stephan Busemann:
Generierung natürlicher Sprache

RR-92-51

Hans-Jürgen Bürckert, Werner Nutt:
On Abduction and Answer Generation through Constrained Resolution

RR-92-52

Mathias Bauer, Susanne Biundo, Dietmar Dengler, Jana Koehler, Gabriele Paul:
PHI
—A Logic-Based Tool for Intelligent Help Systems

- RR-92-53**
Werner Stephan, Susanne Biundo:
 A New Logical Framework for Deductive Planning
- RR-92-54**
Harold Boley:
 A Direkt Semantic Characterization of RELFUN
- RR-92-55**
*John Nerbonne, Joachim Laubsch,
 Abdel Kader Diagne, Stephan Oepen:*
 Natural Language
 Semantics and Compiler Technology
- RR-92-56**
Armin Laux:
 Integrating a Modal Logic of
 Knowledge into Terminological Logics
- RR-92-58**
Franz Baader, Bernhard Hollunder:
 How to Prefer More Specific
 Defaults in Terminological Default Logic
- RR-92-59**
Karl Schlechta and David Makinson:
 On Principles and Problems of Defeasible Inheritance
- RR-92-60**
Karl Schlechta:
 Defaults, Preorder Semantics and Circumscription
- RR-93-01**
Bernhard Hollunder:
 An Alternative Proof Method for Possibilistic
 Logic and its Application to Terminological Logics
- RR-93-02**
*Wolfgang Wahlster, Elisabeth André, Wolfgang
 Finkler, Hans-Jürgen Profitlich, Thomas Rist:*
 Plan-based Integration
 of Natural Language and Graphics Generation
- RR-93-03**
*Franz Baader, Bernhard Hollunder, Bernhard Nebel,
 Hans-Jürgen Profitlich, Enrico Franconi:*
 An Empirical Analysis of Optimization Techniques
 for Terminological Representation Systems
- RR-93-04**
Christoph Klauck, Johannes Schwagereit:
 GGD: Graph Grammar
 Developer for features in CAD/CAM
- RR-93-05**
Franz Baader, Klaus Schulz:
 Combination Techniques
 and Decision Problems for Disunification
- RR-93-06**
*Hans-Jürgen Bürckert,
 Bernhard Hollunder, Armin Laux:*
 On Skolemization in Constrained Logics
- RR-93-07**
*Hans-Jürgen Bürckert,
 Bernhard Hollunder, Armin Laux:*
 Concept Logics with Function Symbols
- RR-93-08**
*Harold Boley, Philipp Hanschke,
 Knut Hinkelmann, Manfred Meyer:*
 COLAB: A Hybrid Knowledge
 Representation and Compilation Laboratory
- RR-93-09**
Philipp Hanschke, Jörg Würtz:
 Satisfiability of the Smallest Binary Program
- RR-93-10**
*Martin Buchheit,
 Francesco M. Donini, Andrea Schaerf:*
 Decidable Reasoning in
 Terminological Knowledge Representation Systems
- RR-93-11**
Bernhard Nebel, Hans-Jürgen Bürckert:
 Reasoning about Temporal Relations: A Maximal
 Tractable Subclass of Allen's Interval Algebra
- RR-93-12**
Pierre Sablayrolles:
 A Two-Level Semantics
 for French Expressions of Motion
- RR-93-13**
Franz Baader, Karl Schlechta:
 A Semantics for Open Normal
 Defaults via a Modified Preferential Approach
- RR-93-14**
Joachim Niehren, Andreas Podelski, Ralf Treinen:
 Equational and
 Membership Constraints for Infinite Trees
- RR-93-15**
*Frank Berger, Thomas Fehrlé, Kristof Klöckner,
 Volker Schölles, Markus A. Thies, Wolfgang Wahlster:*
 PLUS—Plan-based User Support: Final Project Report
- RR-93-16**
Gert Smolka, Martin Henz, Jörg Würtz:
 Object-Oriented
 Concurrent Constraint Programming in Oz
- RR-93-17**
Rolf Backofen:
 Regular Path Expressions in Feature Logic
- RR-93-18**
Klaus Schild:
 Terminological Cycles
 and the Propositional μ -Calculus
- RR-93-20**
Franz Baader, Bernhard Hollunder:
 Embedding Defaults into Terminological
 Knowledge Representation Formalisms

RR-93-22

Manfred Meyer, Jörg Müller:
Weak Looking-Ahead and its
Application in Computer-Aided Process Planning

RR-93-23

Andreas Dengel, Ottmar Lutz:
Comparative Study of Connectionist Simulators

RR-93-24

Rainer Hoch, Andreas Dengel:
Document Highlighting—
Message Classification in Printed Business Letters

RR-93-25

Klaus Fischer, Norbert Kuhn:
A DAI Approach
to Modeling the Transportation Domain

RR-93-26

Jörg P. Müller, Markus Fischel:
The Agent Architecture InterRAP:
Concept and Application

RR-93-27

Hans-Ulrich Krieger:
Derivation Without Lexical Rules

RR-93-28

Hans-Ulrich Krieger, John Nerbonne, Hannes Pirker:
Feature-Based Allomorphy

RR-93-29

Armin Laux:
Representing Belief in
Multi-Agent Worlds via Terminological Logics

RR-93-30

Stephen P. Spackman, Elizabeth A. Hinkelman:
Corporate Agents

RR-93-31

Elizabeth A. Hinkelman, Stephen P. Spackman:
Abductive Speech Act Recognition,
Corporate Agents and the COSMA System

RR-93-32

David R. Traum, Elizabeth A. Hinkelman:
Conversation Acts
in Task-Oriented Spoken Dialogue

RR-93-33

Bernhard Nebel, Jana Koehler:
Plan Reuse versus Plan Generation:
A Theoretical and Empirical Analysis

RR-93-34

Wolfgang Wahlster:
VerbMobil—Translation of Face-To-Face Dialogs

RR-93-35

Harold Boley, François Bry, Ulrich Geske (Eds.):
Neuere Entwicklungen der deklarativen
KI-Programmierung — *Proceedings*

RR-93-36

*Michael M. Richter, Bernd Bachmann, Ansgar Bernardi,
Christoph Klauck, Ralf Legleitner, Gabriele Schmidt:*
Von IDA bis IMCOD:
Expertensysteme im CIM-Umfeld

RR-93-38

Stephan Baumann:
Document Recognition of
Printed Scores and Transformation into MIDI

RR-93-40

*Francesco M. Donini, Maurizio Lenzerini,
Daniele Nardi, Werner Nutt, Andrea Schaefer:*
Queries, Rules and Definitions as
Epistemic Statements in Concept Languages

RR-93-41

Winfried H. Graf:
LAYLAB: A Constraint-Based
Layout Manager for Multimedia Presentations

RR-93-42

Hubert Comon, Ralf Treinen:
The First-Order Theory of
Lexicographic Path Orderings is Undecidable

RR-93-43

M. Bauer, G. Paul:
Logic-based Plan
Recognition for Intelligent Help Systems

RR-93-44

*Martin Buchheit,
Manfred A. Jeusfeld, Werner Nutt, Martin Staudt:*
Subsumption between
Queries to Object-Oriented Databases

RR-93-45

Rainer Hoch:
On Virtual Partitioning of Large Dictionaries for
Contextual Post-Processing to Improve Character
Recognition

RR-93-46

Philipp Hanschke:
A Declarative Integration of Terminological,
Constraint-based, Data-driven, and Goal-directed
Reasoning

RR-93-48

Franz Baader, Martin Buchheit, Bernhard Hollunder:
Cardinality Restrictions on Concepts

DFKI Technical Memos

TM-89-01

Susan Holbach-Weber:
Connectionist Models and Figurative Speech

TM-90-01

Som Bandyopadhyay:
Towards an Understanding of
Coherence in Multimodal Discourse

TM-90-02*Jay C. Weber:*

The Myth of Domain-Independent Persistence

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Plan Schemata in Planning Formalisms**TM-91-02***Knut Hinkelmann:*Bidirectional Reasoning of Horn Clause Programs:
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for COoperative Schedule Management

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into DAGs by Heuristic Classification

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D-89-01

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Constraint Logic Programming System based on
PROLOG with Corouting

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*Harold Boley, Klaus Elsbernd,
Hans-Günther Hein, Thomas Krause:*
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eines Arbeitsplanerstellungssystems für Drehteile

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TEC-REP: Repräsentation von
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tion der relational-funktionalen Sprache RELFUN

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Learning of Natural Language and Ontology

D-91-10

Donald R. Steiner, Jürgen Müller (Eds.):
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Workshop on "Modeling Autonomous Agents and
Multi-Agent Worlds"

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Distributed Truth Maintenance

D-91-12

Bernd Bachmann:
Hier_{Con}—a Knowledge Representation
System with Typed Hierarchies and Constraints

D-91-13

International Workshop on Terminological Logics
*Organizers: Bernhard Nebel, Christof Peltason,
Kai von Luck*

D-91-14

*Erich Achilles, Bernhard Hollunder,
Armin Laux, Jörg-Peter Mohren:*
KRIS: Knowledge Representation and Inference System
- Benutzerhandbuch -

D-91-15

*Harold Boley, Philipp Hanschke, Martin Harm,
Knut Hinkelmann, Thomas Labisch, Manfred Meyer,
Jörg Müller, Thomas Oltzen, Michael Sintek,
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Model Transforming CAD-like Geometries into
Abstract NC Programs

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bei der Fertigung rotationssymmetrischer Drehteile

D-91-17

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Hinblick auf ihre Eignung für die Arbeitsplanung

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Maschinenbau als eine Begriffsbildungsaufgabe

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D-92-01

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-Benutzeranleitung-

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kumenten am Beispiel des Layout-Managers in WIP

D-92-03

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Dudung Soetopo, Winfried Graf:*
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von Text-Bild-Kombinationen in multimodalen
Dokumenten

D-92-04

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zu Verbreitung und Koordination

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Werkstücken in der Terminologie der Featuresprache

D-92-07

Susanne Biundo, Franz Schmalhofer (Eds.):
Proceedings of the DFKI Workshop on Planning

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DFKI Workshop on
Taxonomic Reasoning Proceedings

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integrativen Wissensakquisitionsmethode des ARC-
TEC-Projektes

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attributierte Graph-Grammatiken

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Möglichkeiten der Wissensmodellierung
für technische Diagnose-Expertensysteme

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Otto Kühn, Franz Schmalhofer, Gabriele Schmidt:
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Drehteile: eine Bildergalerie)

D-92-13

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An Investigation of the Applicability of
Terminological Reasoning to Application-
Independent Software-Analysis

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Johannes Schwagereit:
Integration von Graph-Grammatiken und Taxo-
nomien zur Repräsentation von Features in CIM

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Workshop on User Modeling, Proceedings

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automatisierten Diagnose technischer Systeme

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der Dokument-analyse zur Fokussierung und
Klassifizierung von Geschäftsbriefen

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Natural Language with Tree Adjoining Grammars

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Languages Applied to PROLOG Code Generation

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Prolog-artigen Syntax von RELFUN

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mit Hilfe des Constraint-Systems CONTAX
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Reasoning with Constraint Handling Rules
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DFKI Wissenschaftlich-Technischer Jahresbericht
1992
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PPP: Personalized Plan-Based Presenter
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Design & KI
- D-93-20**
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einen hybriden Wissensrepräsentationsformalismus
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am Beispiel Terminologischer Logiken
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Benutzungsoberflächen mit Tcl/Tk und Common Lisp
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zu Funktionsverbgefügen und Relativsätzen
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Textwissen
INFOCOM - Eine interaktive Formalisierungskomponente
- D-93-27**
*Rolf Backofen, Hans-Ulrich Krieger,
Stephen P. Spackman, Hans Uszkoreit (Eds.):*
Report of theEAGLES Workshop on
Implemented Formalisms at DFKI, Saarbrücken

Author Index

- | | | | |
|------------------------|--|--------------------------|--|
| Abecker, Andreas; | 92 | Gawron, J. Mark; | 25 |
| Achilles, Erich; | 77 | Geske, Ulrich; | 60 |
| Ait-Kaci, Hassan; | 37 | Globig, Christoph; | 70 |
| André, Elisabeth; | 18; 19; 23; 24; 45; 46;
50; 83; 88 | Gores, Klaus-Peter; | 87; 88 |
| Baader, Franz; | 16; 17; 19; 20; 21; 22;
24; 31; 42; 43; 49; 50;
51; 54; 55; 63; 64; 65 | Görz, Günther; | 31 |
| Bachmann, Bernd; | 61; 76; 91 | Graf, Winfried; | 23; 24; 32; 35; 37; 46;
62; 79; 83; 88 |
| Backofen, Rolf; | 30; 31; 41; 55; 93 | Hanschke, Philipp; | 24; 29; 43; 44; 52; 63;
77; 87 |
| Bäckström, Christer; | 32 | Harbusch, Karin; | 29; 67; 87 |
| Bandyopadhyay, Som; | 24; 64 | Harm, Martin; | 77; 86 |
| Bauer, M.; | 29; 35; 62 | Hecking, M.; | 29 |
| Bauer, Mathias; | 47 | Hein, Hans-Günther; | 72; 74 |
| Baumann, Stephan; | 61 | Heinsohn, Jochen; | 29; 37; 65; 80; 88 |
| Becker, Andreas; | 74; 78 | Henz, Martin; | 55 |
| Becker, Kerstin; | 81 | Herbig, Bernhard; | 91 |
| Becker, Klaus; | 68; 84 | Herfert, Michael; | 85; 89 |
| Beetz, Michael; | 35 | Hinkelman, Elizabeth A.; | 59; 60; 89 |
| Berger, Frank; | 36; 54 | Hinkelmann, Knut; | 29; 44; 52; 65; 68; 77;
86; 89 |
| Bergmann, Ralf; | 40 | Hoch, Rainer; | 33; 42; 56; 62; 68; 84;
89 |
| Bernardi, Ansgar; | 27; 28; 29; 34; 38; 41;
47; 61; 73; 75; 91 | Hölbach-Weber, Susan; | 63 |
| Birk, Andreas; | 71 | Hollunder, Bernhard; | 17; 18; 19; 22; 49; 50;
51; 52; 55; 63; 64; 65;
77; 80 |
| Biundo, Susanne; | 19; 29; 36; 47; 48; 80 | Hönes, Frank; | 33 |
| Bleisinger, Rainer; | 33; 66; 68; 72; 87; 88 | Höper, Hans Werner; | 80 |
| Boley, Harold; | 20; 29; 33; 48; 52; 60;
66; 71; 74; 77; 89 | Horstmann, Thilo C.; | 76 |
| Bomarius, Frank; | 46 | Jeusfeld, Manfred A.; | 62 |
| Breuer, Peter; | 25 | Jung, Christoph; | 89 |
| Bry, François; | 60 | Kamp, Gerd; | 75 |
| Buchheit, Martin; | 53; 62; 63; 86 | Kass, Bob; | 83 |
| Buhrmann, Ulrich; | 71 | Kieninger, Thomas; | 89 |
| Bürckert, Hans-Jürgen; | 16; 19; 22; 24; 47; 51;
52; 53; 65; 92 | Kilger, Anne; | 70 |
| Buschauer, Béla; | 67 | Klauck, Christoph; | 27; 28; 29; 34; 38; 41;
45; 47; 51; 61; 68; 73;
75; 91 |
| Busemann, Stephan; | 21; 26; 47; 87 | Klein, Judith; | 27; 80 |
| Bussmann, Stefan; | 68; 79 | Klößner, Kristof; | 54 |
| Cohen, Robin; | 83 | Koehler, Jana; | 29; 36; 46; 47; 60 |
| Comon, Hubert; | 62 | Köhler, Jana; | 65 |
| Dengel, Andreas; | 17; 19; 26; 28; 33; 56;
66; 68 | Krause, Thomas; | 74; 76 |
| Dengler, Dietmar; | 29; 36; 47 | Kremer, Christof; | 71 |
| Diagne, Abdel Kader; | 27; 48 | Krenn, Brigitte; | 92 |
| Dickmann, Ludwig; | 27; 80 | Krieger, Hans-Ulrich; | 31; 58; 89; 93 |
| Dittrich, Stefan; | 84 | Kudenko, Daniel; | 37 |
| Donini, Francesco M.; | 53; 61 | Kuhn, Norbert; | 57 |
| Donini, Francesco; | 22 | Kühn, Otto; | 20; 29; 40; 66; 70; 71;
82 |
| Drollinger, Dennis; | 91 | Labisch, Thomas; | 77; 86 |
| Elsbernd, Klaus; | 74; 89 | Laubsch, Joachim; | 48 |
| Engelkamp, Judith; | 83 | Laufkötter, Gernod; | 81; 87 |
| Euler, Lutz; | 31 | Laux, Armin; | 49; 51; 52; 59; 77; 89 |
| Fehrle, Thomas; | 36; 54 | Laux, Robert; | 90 |
| Fein, Frank; | 33 | Legleitner, Ralf; | 27; 28; 29; 34; 38; 47;
61; 73; 75 |
| Finkler, Wolfgang; | 24; 29; 46; 50 | Lenzerini, Maurizio; | 22; 61 |
| Fischer, Klaus; | 57 | Linster, Marc; | 66 |
| Flickinger, Dan; | 30 | | |
| Franconi, Enrico; | 50 | | |
| Frühwirth, Thom; | 87 | | |

- Luck, Kai von; 77
 Lutz, Ottmar; 56
 Lux, Andreas; 44
 Maaß, Wolfgang; 32; 79
 Makinson, David; 49
 Malburg, Michael; 33; 42; 72
 Mattos, Nelson M.; 17; 26
 Mauss, Jakob; 45; 81
 Merziger, Gabriele; 29; 35
 Meyer, Manfred; 29; 43; 44; 52; 56; 77;
 90
 Mohren, Jörg-Peter; 39; 77
 Müller, Jörg P.; 56; 57; 70; 74; 77
 Müller, Jürgen; 24; 25; 39; 65; 70; 76;
 85; 88
 Nardi, Daniele; 22; 61
 Nebel, Bernhard; 22; 25; 26; 32; 37; 46;
 50; 53; 60; 65; 77; 88
 Nerbonne, John; 25; 27; 30; 31; 34; 38;
 45; 48; 58
 Netter, Klaus; 27; 28
 Neumann, Günter; 24
 Niehren, Joachim; 54
 Nutt, Werner; 17; 19; 21; 22; 32; 47;
 61; 62; 65; 92
 Oepen, Stephan; 48
 Oltzen, Thomas; 77
 Paris, Cécile; 83
 Paul, Gabriele; 47; 62
 Peine, Holger; 82
 Peltason, Christof; 77
 Peters, Frank; 87; 93
 Peters, Stanley; 25
 Pierre, Sablayrolles; 53; 71
 Pirker, Hannes; 58
 Pischel, Markus; 57; 70
 Podelski, Andreas; 37; 54
 Poller, Peter; 67
 Powers, David; 76
 Profitlich, Hans-Jürgen; 37; 50; 65; 88
 Reeker, Lary; 76
 Reinartz, Thomas; 40; 77; 78
 Richter, Michael M.; 28; 29; 61
 Rist, Thomas; 18; 19; 23; 24; 45; 46;
 50; 88
 Schaerf, Andrea; 53; 61
 Schäfer, Ulrich; 89
 Schauder, Anne; 29; 46; 67; 85
 Scheidhauer, Ralf; 70
 Schiffmann, Thomas; 79
 Schild, Klaus; 55
 Schlechta, Karl; 49; 54
 Schmalhofer, Franz; 20; 29; 40; 41; 70; 77;
 80; 82
 Schmidt, Gabriele; 20; 29; 40; 61; 66; 82;
 87; 91
 Schölles, Volker; 54
 Schulte, Michael; 34
 Schulz, Klaus; 31; 51
 Schupeta, Achim; 24; 34; 69; 71
 Schwagereit, Johannes; 51; 68; 83
 Seul, Georg; 73
 Siekmann, Jörg H.; 19
 Singh, Mona; 69
 Singh, Munindar P.; 27; 67
 Sintek, Michael; 72; 74; 77; 89
 Smolka, Gert; 22; 25; 26; 37; 39; 41;
 55
 Soetopo, Dudung; 79
 Sommer, W.; 29
 Spaccamela, Alberto M.; 22
 Spackman, Stephen P.; 59; 93
 Stark, Rainer; 34
 Staudt, Martin; 62
 Stein, Johannes; 66
 Stein, Werner; 74; 77; 85; 89
 Steiner, Donald; 76; 85
 Steinle, Frank; 77
 Stephan, Werner; 48
 Thies, Markus A.; 35; 36; 54
 Thoben, Jörg; 41; 70; 77
 Tolzmann, Enno; 86
 Traum, David R.; 60
 Treinen, Ralf; 39; 54; 62
 Trost, Harald; 21; 23; 30
 Tschaitshian, Bidjan; 40
 Uszkoreit, Hans; 30; 93
 Volk, Martin; 92
 Vonerden, Markus; 89
 Wahlster, Wolfgang; 23; 24; 42; 46; 50; 54;
 60; 83; 88
 Wazinski, Peter; 67; 78
 Weber, Jay C.; 64; 66
 Wu, Zhaohui; 41
 Würtz, Jörg; 39; 52; 55
 Zhang, Lijuan; 69

Project Index

This index relates publications to the project(s) in which they had been prepared.

AKA-MOD

(Modeling of Cooperating Agents)

RR-91-14, 19

RR-92-06, 07, 21

RR-93-13, 22, 25, 26

TM-91-06, 08, 09, 15

TM-92-02, 03, 04

TM-93-02

D-91-10

D-92-01, 25

D-93-06

AKA-TACOS

(Taxonomies and Common Sense)

RR-92-51, 56, 58, 59, 60

RR-93-01, 03, 05, 06, 07, 11, 12, 18, 20, 29,
40, 44, 48

D-93-25

AKA-WINO

(Logical Foundations of Knowledge Representation
and Processing)

RR-90-01, 02, 04, 05, 06, 10, 13, 15, 16

RR-91-01, 02, 03, 09, 10, 14, 19, 33

RR-92-01, 33, 36

TM-90-03, 04

TM-91-06, 08, 09

D-90-02

D-91-14

D-92-08, 13

ALV / WIDAN / PEP

(Automatic Reading and Understanding)

(Knowledge Based Document Analysis)

(Personal Electronic Paper)

RR-90-03, 08

RR-91-17, 22

RR-92-02, 32

RR-93-23, 24, 38, 45

TM-91-05, 14

D-92-19, 28

D-93-07, 08

ARC-TEC / IMCOD / VEGA

(Acquisition, Representation and Compilation of
Technical Knowledge)

(Intelligent Manager for Comprehensive Design)

(Knowledge Validation and Exploration by Global
Analysis)

RR-90-12, 14

RR-91-10, 20, 23, 27

RR-92-03, 05, 19, 24, 25, 26, 27, 28, 29, 34,
35, 36, 37, 38, 40, 43, 49, 54

RR-93-04, 08, 09, 22, 35, 36, 46

TM-91-02, 03, 04, 12, 13

TM-92-01, 05, 06

TM-93-01, 03, 04, 05

D-90-03, 04, 05, 06

D-91-01, 02, 03, 06, 07, 08, 12, 15, 16, 17, 18

D-92-06, 07, 09, 10, 11, 12, 14, 18, 22, 23,
26, 27

D-93-01, 02, 11, 12, 14, 15, 16, 20, 21, 22, 26

ASL

(Architecture for Speech and Language System)

RR-93-17

D-93-27

COMPULOG

(Computational Logic)

RR-93-10

DISCO

(Natural Language Dialog System for Cooperating
Agents)

RR-90-17

RR-91-04, 07, 12, 16, 18, 21, 28, 29, 30, 31,
32

RR-92-04, 18, 20, 42, 50, 55

RR-93-27, 28, 30, 31, 32

D-92-04

D-93-03, 09, 10, 24, 27

HYDRA

(Constraint-Based Computation and Deduction)

RR-91-13, 15

RR-92-17, 22, 23, 30

RR-93-09, 14, 16, 42

KIK / TEAMWARE

(AI and Communications)

(Cooperation in Distributed Human-Machine
Teams)

RR-92-41, 47

D-91-09, 10, 11

D-92-24

PHI

(Plan-Based Help Systems)

RR-90-09, 26

RR-92-08, 10, 11, 48, 52, 53

RR-93-15, 33, 43

TM-91-01

D-92-07

PLUS

(Plan-Based User Support)

RR-92-09, 13, 14

VERBMOBIL

(Translation of Face to Face Dialog)

RR-93-34

D-92-16

WIP

(Knowledge-Based Presentation of Information)

RR-90-07, 11
 RR-91-07, 08, 11, 24, 25, 34, 35
 RR-92-09, 15, 16, 31, 44, 45, 46, 48
 RR-93-02, 03, 33, 41
 TM-90-01
 TM-91-10, 11
 TM-92-08
 D-91-13, 19
 D-92-02, 03, 08, 17, 21
 D-93-03, 05

Publishing Statistics

The following table shows the development of publication activity over the years 1989 to 1993.

	Research Reports	Technical Memos	Documents	Σ
1989	—	1	1	2
1990	17	4	6	27
1991	35	14	18	67
1992	56	7	26	89
1993	43	5	22	70
Σ	151	31	73	255



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Terminological Cycles in KL-ONE-based Knowledge Representation Languages

33 pages

Abstract: Cyclic definitions are often prohibited in terminological knowledge representation languages, because, from a theoretical point of view, their semantics is not clear and, from a practical point of view, existing inference algorithms may go astray in the presence of cycles. In this paper we consider terminological cycles in a very small KL-ONE-based language. For this language, the effect of the three types of semantics introduced by Nebel (1987, 1989, 1989a) can be completely described with the help of finite automata. These descriptions provide a rather intuitive understanding of terminologies with cyclic definitions and give insight into the essential features of the respective semantics. In addition, one obtains algorithms and complexity results for subsumption determination. The results of this paper may help to decide what kind of semantics is most appropriate for cyclic definitions, not only for this small language, but also for extended languages. As it stands, the greatest fixed-point semantics comes off best. The characterization of this semantics is easy and has an obvious intuitive interpretation. Furthermore, important constructs—such as value-restriction with respect to the transitive or reflexive-transitive closure of a role—can easily be expressed.

RR-90-02

Hans-Jürgen Bürckert

A Resolution Principle for Clauses with Constraints

25 pages

Abstract: We introduce a general scheme for handling clauses whose variables are constrained by an underlying constraint theory. In general, constraints can be seen as quantifier restrictions as they filter out the values that can be assigned to the variables of a clause (or an arbitrary formulae with restricted universal or existential quantifier) in any of the models of the constraint theory. We present a resolution principle for clauses with constraints, where unification is replaced by testing constraints for satisfiability over the constraint theory. We show that this constrained resolution is sound and complete in that a set of clauses with constraints is unsatisfiable over the constraint theory if we can deduce a constrained empty clause for each model of the constraint theory, such that the empty clauses constraint is satisfiable in that model. We show also that we cannot require a better result in general, but we discuss certain tractable cases, where we need at most finitely many such empty clauses or even better only one of them as it is known in classical resolution, sorted resolution or resolution with theory unification.

RR-90-03*Andreas Dengel, Nelson M. Mattos***Integration of Document Representation, Processing and Management**

18 pages

Abstract: This paper describes a way for document representation and proposes an approach towards an integrated document processing and management system. The approach has the intention to capture essentially freely structured documents, like those typically used in the office domain. The document analysis system ANASTASIL is capable to reveal the structure of complex paper documents, as well as logical objects within it, like receiver, footnote, date. Moreover, it facilitates the handling of the containing information. Analyzed documents are stored by the management system KRISYS that is connected to several different subsequent services. The described integrated system can be considered as an ideal extension of the human clerk, making his tasks in information processing easier. The symbolic representation of the analysis results allow an easy transformation in a given international standard, e.g., ODA/ODIF or SGML, and to interchange it via global network.

RR-90-04*Bernhard Hollunder, Werner Nutt***Subsumption Algorithms for Concept Languages**

34 pages

Abstract: We investigate the subsumption problem in logic-based knowledge representation languages of the KL-ONE family and give decision procedures. All our languages contain as a kernel the logical connectives conjunction, disjunction, and negation for concepts, as well as role quantification. The algorithms are rule-based and can be understood as variants of tableaux calculus with a special control strategy. In the first part of the paper, we add number restrictions and conjunction of roles to the kernel language. We show that subsumption in this language is decidable, and we investigate sublanguages for which the problem of deciding subsumption is PSPACE-complete. In the second part, we amalgamate the kernel language with feature descriptions as used in computational linguistics. We show that feature descriptions do not increase the complexity of the subsumption problem.

RR-90-05*Franz Baader***A Formal Definition for the Expressive Power of Knowledge Representation Languages**

22 pages

Abstract: The notions "expressive power" or "expressiveness" of knowledge representation languages (KR-languages) can be found in most papers on knowledge representation; but these terms are usually just used in an intuitive sense. The papers contain only informal descriptions of what is meant by expressiveness. There are several reasons which speak in favour of a formal definition of expressiveness: For example, if we want to show that certain expressions in one language *cannot* be expressed in another language, we need a strict formalism which can be used in mathematical proofs. Though we shall only consider KL-ONE-based KR-language in our motivation and in the examples, the definition of expressive power which will be given in this paper can be used for all KR-languages with model-theoretic semantics. This definition will shed a new light on the tradeoff between expressiveness of a representation language and its computational tractability. There are KR-languages with identical expressive power, but different complexity results for reasoning. Sometimes, the tradeoff lies between convenience and computational tractability. The paper contains several examples which demonstrate how the definition of expressive power can be used in positive proofs—that is, proofs where it is shown that one language can be expressed by another language—as well as for negative proofs—which show that a given language cannot be expressed by the other language.

RR-90-06*Bernhard Hollunder***Hybrid Inferences in KL-ONE-based Knowledge Representation Systems**

21 pages

Abstract: We investigate algorithms for hybrid inferences in KL-ONE-based knowledge representation systems. Those systems employ two kinds of formalisms: the terminological and the assertional formalism. The terminological formalism consists of a concept description language to define concepts and relations between concepts for describing a terminology. On the other hand, the assertional formalism allows to introduce objects, which are instances of concepts and relations of a terminology. We present algorithms for hybrid inferences such as

- determining subsumption between concepts
- checking the consistency of such a knowledge base
- computing the most specialized concepts an object is instance of
- computing all objects that are instances of a certain concept.

RR-90-07*Elisabeth André, Thomas Rist***Wissensbasierte Informationspräsentation:****Zwei Beiträge zum Fachgespräch Graphik und KI**

1. Ein planbasierter Ansatz zur Synthese illustrierter Dokumente
2. Wissensbasierte Perspektivenwahl für die automatische Erzeugung von 3D-Objektdarstellungen

24 Seiten

Zusammenfassung: Teil 1: Obwohl die Erzeugung multimodaler Dokumente in der KI-Forschung zunehmendes Interesse findet, werden in den meisten Systemen Text- und Graphik weitgehend unabhängig voneinander aufgebaut und stehen daher beziehungslos nebeneinander. In dieser Arbeit wird von der Überlegung ausgegangen, daß nicht nur die Erzeugung von Texten, sondern auch die Erzeugung multimodaler Dokumente als kommunikative Handlung zur Erreichung von Zielen aufgefaßt werden kann. Für die Realisierung eines Systems, das selbstständig illustrierte Dokumente erstellt, bietet sich daher ein planbasierter Ansatz an. Es wird zunächst gezeigt, daß die in der Textlinguistik gebräuchliche Unterscheidung zwischen Haupt- und Nebenhandlungen auch für Text-Bild-Kombinationen geeignet ist. Von dieser Unterscheidung ausgehend werden Strategien formuliert, die sich sowohl auf die Erzeugung von Text als auch auf den Aufbau von Bildern beziehen. Die gemeinsame Planung von Text und Bild wird als grundlegende Voraussetzung angesehen, die beiden Modi in einem Dokument aufeinander abzustimmen.

Teil 2: Aus welcher Perspektive ein Objekt gezeigt werden soll, ist eine der elementaren Fragen, die sich bei der automatischen Erzeugung von 3D-Darstellungen stellt, die aber in den wenigen Systemen, die graphische Objektdarstellungen selbstständig planen, bisher vernachlässigt wurde. Ziel der vorliegenden Arbeit ist es, aufzuzeigen, wie sich Wissen über Objekte und Darstellungstechniken verwenden läßt, um die Menge der möglichen Perspektiven, aus denen ein Objekt gesehen und gezeigt werden kann, sinnvoll einzuschränken. Als Grundlage zur Perspektivenwahl schlagen wir ein Bezugssystem vor, das eine Einteilung der Perspektiven in 26 Klassen nahelegt und das darüberhinaus Vorteile bietet, wenn gewählte Perspektiven natürlichsprachlich zu beschreiben sind. Anschließend führen wir einige für die Perspektivenwahl relevante Kriterien an. Diese Kriterien werden dann zur Formulierung von Regeln herangezogen, die wir dazu verwenden, um in einer konkreten Präsentationssituation eine geeignete Perspektive zu bestimmen.

RR-90-08

Andreas Dengel

A Step Towards Understanding Paper Documents

25 pages

Abstract: This report focuses on analysis steps necessary for a paper document processing. It is divided in three major parts: a document image preprocessing, a knowledge-based geometric classification of the image, and a expectation-driven text recognition. It first illustrates the several low level image processing procedures providing the physical document structure of a scanned document image. Furthermore, it describes a knowledge-based approach, developed for the identification of logical objects (e.g., sender or the footnote of a letter) in a document image. The logical identifiers provide a context-restricted consideration of the containing text. While using specific logical dictionaries, a expectation-driven text recognition is possible to identify text parts of specific interest. The system has been implemented for the analysis of single-sided business letters in Common Lisp on a SUN 3/60 Workstation. It is running for a large population of different letters. The report also illustrates and discusses examples of typical results obtained by the system.

RR-90-09

Susanne Biundo

Plan Generation Using a Method of Deductive Program Synthesis

17 pages

Abstract: In this paper we introduce a planning approach based on a method of deductive program synthesis. The program synthesis system we rely upon takes first-order specifications and from these derives recursive programs automatically. It uses a set of transformation rules whose applications are guided by an overall strategy. Additionally several heuristics are involved which considerably reduce the search space. We show by means of an example taken from the blocks world how even recursive *plans* can be obtained with this method. Some modifications of the synthesis strategy and heuristics are discussed, which are necessary to obtain a powerful and automatic planning system. Finally it is shown how subplans can be introduced and generated separately.

RR-90-10

Franz Baader, Hans-Jürgen Bürckert, Bernhard Hollunder, Werner Nutt, Jörg H. Siekmann

Concept Logics

26 pages

Abstract: Concept languages (as used in BACK, KL-ONE, KRYPTON, LOOM) are employed as knowledge representation formalisms in Artificial Intelligence. Their main purpose is to represent the generic concepts and the taxonomical hierarchies of the domain to be modeled. This paper addresses the combination of the fast taxonomical reasoning algorithms (e.g. subsumption, the classifier etc.) that come with these languages and reasoning in first order predicate logic. The interface between these two different modes of reasoning is accomplished by a new rule of inference, called *constrained resolution*. Correctness, completeness as well as the decidability of the constraints (in a restricted constraint language) are shown.

RR-90-11

Elisabeth André, Thomas Rist

Towards a Plan-Based Synthesis of Illustrated Documents

14 pages

Abstract: A major drawback of existing systems for the synthesis of multimodal documents is that they generate textual and graphical parts mostly independently of each other. Consequently, the relation between text and graphics remains opaque in such documents. This report starts from the assumption that not only the generation of text, but also the generation of multimodal documents can be considered as a communicative act in the achievement of certain goals. A plan-based approach seems adequate for the realization of a system able to automatically generate illustrated documents. First, we show that the distinction between main and subsidiary acts proposed by textlinguists is also suitable for text-picture-combinations. Starting from this distinction, we formulate strategies which relate both to text and picture production. The joint planning of text and pictures is regarded as a fundamental prerequisite for the coordination of different modes.

RR-90-12

Harold Boley

Declarative Operations on Nets

43 pages

Abstract: To increase the expressiveness of knowledge representations, the graph-theoretical basis of semantic networks is reconsidered. Directed labeled graphs are generalized to directed recursive labelnode hypergraphs, which permit a most natural representation of multi-level structures and n-ary relationships. This net formalism is embedded into the relational/functional programming language RELFUN. Operations on (generalized) graphs are specified in a declarative fashion to enhance readability and maintainability. For this, nets are represented as nested RELFUN terms kept in a normal form by rules associated directly with their constructors. These rules rely on equational axioms postulated in the formal definition of the generalized graphs as a constructor algebra. Certain kinds of sharing in net diagrams are mirrored by binding common subterms to logical variables. A package of declarative transformations on net terms is developed. It includes generalized set operations, structure-reducing operations, and extended path searching. The generation of parts lists is given as an application in mechanical engineering. Finally, imperative net storage and retrieval operations are discussed.

RR-90-13

*Franz Baader*Augmenting Concept Languages by Transitive Closure of Roles:
An Alternative to Terminological Cycles

40 pages

Abstract: In Baader (1990a,1990b), we have considered different types of semantics for terminological cycles in the concept language \mathcal{FLQ} which allows only conjunction of concepts and value restrictions. It turned out that greatest fixed-point semantics (gfp-semantics) seems to be most appropriate for cycles in this language. In the present paper we shall show that the concept defining facilities of \mathcal{FLQ} with cyclic definitions and GFP-semantics can also be obtained in a different way. One may replace cycles by role definitions involving union, composition, and transitive closure of roles. This proposes a way of retaining, in an extended language, the pleasant features of GFP-semantics for \mathcal{FLQ} with cyclic definitions without running into the troubles caused by cycles in larger languages. Starting with the language \mathcal{ALC} of Schmidt-Schauß&Smolka (1988)—which allows negation, conjunction and disjunction of concepts as well as value restrictions and exists-in restrictions—we shall disallow cyclic concept definitions, but instead shall add the possibility of role definitions involving union, composition, and transitive closure of roles. In contrast to other terminological KR-systems which incorporate the transitive closure operator for roles, we shall be able to give a sound and complete algorithm for concept subsumption. Surprisingly, this algorithm can also be used to decide subsumption with respect to concept equations, i.e., arbitrary equational axioms of the form $C = D$ where C and D are concept terms. This is so because concept terms of our extended language can be used to encode finite sets of concept equations.

RR-90-14

*Franz Schmalhofer, Otto Kühn, Gabriele Schmidt*Integrated Knowledge Acquisition from Text, Previously Solved Cases, and
Expert Memories

20 pages

Abstract: Within the model-based knowledge engineering framework, an integrated knowledge acquisition method was developed for a complex real-world domain with different traces of expertise. By having an expert constructively explain the previously solved cases with more general information from other traces of expertise (text, expert memories) a model-centered knowledge base is constructed. The proposed method allows for an early knowledge verification where the relevance, sufficiency, redundancy, and consistency of knowledge are already assessed at an informal level. The early knowledge verification efficiently prepares the consecutive knowledge formalization. Through a cognitively adequate model of expertise and the explanation-oriented knowledge elicitation procedures, user friendly second generation expert systems may be developed.

RR-90-15

Harald Trost

The Application of Two-level Morphology to Non-concatenative German Morphology

13 pages

Abstract: In this paper I describe a hybrid system for morphological analysis and synthesis. This system consists of two parts. The treatment of morphonology and non-concatenative morphology is based on the two-level approach proposed by Koskenniemi (1983). For the concatenative part of morphosyntax (i.e. affixation) a grammar based on feature-unification is made use of. Both parts rely on a morph lexicon.

Combinations of two-level morphology with feature-based morphosyntactic grammars have already been proposed by several authors (c.f. Bear 1988a, Carson 1988, Görz & Paulus 1988, Schiller & Steffens 1989) to overcome the shortcomings of the continuation-classes originally proposed by Koskenniemi (1983) and Karttunen (1983) for the description of morphosyntax. But up to now no linguistically satisfying solution has been proposed for the treatment of non-concatenative morphology in such a framework. In this paper I describe an extension to the model which will allow for the description of such phenomena. Namely it is proposed to restrict the applicability of two-level rules by providing them with filters in the form of feature structures. It is demonstrated how a well-known problem of German morphology, so-called "Umlautung", can be described in this approach in a linguistically motivated and efficient way.

RR-90-16

Franz Baader, Werner Nutt

Adding Homomorphisms to Commutative/Monoidal Theories, or: How Algebra Can Help in Equational Unification

25 pages

Abstract: Two approaches to equational unification can be distinguished. The syntactic approach relies heavily on the syntactic structure of the identities that define the equational theory. The semantic approach exploits the structure of the algebras that satisfy the theory. With this paper we pursue the semantic approach to unification. We consider the class of theories for which solving unification problems is equivalent to solving systems of linear equations over a semiring. This class has been introduced by the authors independently of each other as commutative theories (Baader) and monoidal theories (Nutt). The class encompasses important examples like the theories of abelian monoids, idempotent abelian monoids, and abelian groups. We identify a large subclass of commutative/monoidal theories that are of unification type zero by studying equations over the corresponding semiring. As a second result, we show with methods from linear algebra that unitary and finitary commutative/monoidal theories do not change their unification type when they are augmented by a finite monoid of homomorphisms, and how algorithms for the extended theory can be obtained from algorithms for the basic theory. The two results illustrate how using algebraic machinery can lead to general results and elegant proofs in unification theory.

RR-90-17

Stephan Busemann

Generalisierte Phasenstrukturgrammatiken und ihre Verwendung zur maschinellen Sprachverarbeitung

114 Seiten

Zusammenfassung: Der vorliegende Artikel setzt sich mit der Syntaxtheorie der Generalisierten Phasenstruktur-Grammatiken (GPSG) auseinander, gibt eine neue formale Definition des aktuellen Formalismus aus und zeigt die mit diesem Formalismus verbundenen Probleme auf. Darüber hinaus wird begründet, warum der Formalismus nicht effizient implementierbar ist. Es wird eine konstruktive Version von GPSG vorgeschlagen, die für die maschinelle Sprachverarbeitung (Parsing und Generierung) geeignet ist. Der Artikel kann gleichzeitig als eine Grundlage für Lehrveranstaltungen über GPSG dienen.

Abstract: This article describes the syntax theory of Generalized Phrase Structure Grammar (GPSG), introduces a new formal definition and reveals the problems connected with this formalism. Moreover it is shown why the formalism cannot be implemented. A constructive version of GPSG is suggested that is suitable for parsing and generation. This report may also serve as a basis for lectures about GPSG.

RR-91-01*Franz Baader, Hans-Jürgen Bürckert, Bernhard Nebel, Werner Nutt, Gert Smolka***On the Expressivity of Feature Logics with Negation, Functional Uncertainty, and Sort Equations**

20 pages

Abstract: Feature logics are the logical basis for so-called unification grammars studied in computational linguistics. We investigate the expressivity of feature terms with complements and the functional uncertainty construct needed for the description of long-distance dependencies and obtain the following results: satisfiability of feature terms is undecidable, sort equations can be internalized, consistency of sort equations is decidable if there is at least one atom, and consistency of sort equations is undecidable if there is no atom.

RR-91-02*Francesco Donini, Bernhard Hollunder, Maurizio Lenzerini, Alberto Marchetti Spaccamela, Daniele Nardi, Werner Nutt***The Complexity of Existential Quantification in Concept Languages**

22 pages

Abstract: Much of the research on concept languages, also called terminological languages, has focused on the computational complexity of subsumption. The intractability results can be divided into two groups. First, it has been shown that extending the basic language \mathcal{FL} with constructs containing some form of logical disjunction leads to co-NP-hard subsumption problems. Second, adding negation to \mathcal{FL} makes subsumption PSPACE-complete. The main result of this paper is that extending \mathcal{FL} with unrestricted existential quantification makes subsumption NP-complete. This is the first proof of intractability for a concept language containing no construct expressing disjunction—whether explicitly or implicitly. Unrestricted existential quantification is therefore, alongside disjunction, a source of computational complexity in concept languages.

RR-91-03*Bernhard Hollunder, Franz Baader***Qualifying Number Restrictions in Concept Languages**

34 pages

Abstract: We investigate the subsumption problem in logic-based knowledge representation languages of the KL-ONE family. The language presented in this paper provides the constructs for conjunction, disjunction, and negation of concepts, as well as qualifying number restrictions. The latter ones generalize the well-known role quantifications (such as value restrictions) and ordinary number restrictions, which are present in almost all KL-ONE based systems. Until now, only little attempts were made to integrate qualifying number restrictions into concept languages. It turns out that all known subsumption algorithms which try to handle these constructs are incomplete, and thus detecting only few subsumption relations between concepts. We present a subsumption algorithm for our language which is sound and complete. Subsequently we discuss why the subsumption problem in this language is rather hard from a computational point of view. This leads to an idea of how to recognize concepts which cause tractable problems.

RR-91-04*Harald Trost***X2MORF: A Morphological Component Based on Augmented Two-Level Morphology**

19 pages

Abstract: In this paper I describe X2MORF, a language-independent morphological component for the recognition and generation of word forms based on a lexicon of morphs. The approach is an extension of two-level morphology. The extensions are motivated by linguistic examples which call into question an underlying assumption of standard two-level morphology, namely the independence of morphophonology and morphology as exemplified by two-level rules and continuation classes. Accordingly, I propose a model which allows for interaction between the two parts. Instead of using continuation classes, word formation is described in a feature-based unification grammar. Two-level rules are provided with a morphological context in the form of feature structures. Information contained in the lexicon and the word formation grammar guides the application of two-level rules by matching the morphological context against the morphs. I present an efficient implementation of this model where rules are compiled into automata (as in the standard model) and where processing of the feature-based grammar is enhanced using an automaton derived from that grammar as a filter.

RR-91-05*Wolfgang Wahlster, Elisabeth André, Winfried Graf, Thomas Rist***Designing Illustrated Texts:****How Language Production is Influenced by Graphics Generation.**

17 pages

Abstract: Multimodal interfaces combining, e.g., natural language and graphics take advantage of both the individual strength of each communication mode and the fact that several modes can be employed in parallel, e.g., in the text-picture combinations of illustrated documents. It is an important goal of this research not simply to merge the verbalization results of a natural language generator and the visualization results of a knowledge-based graphics generator, but to carefully coordinate graphics and text in such a way that they complement each other. We describe the architecture of the knowledge-based presentation system WIP which guarantees a design process with a large degree of freedom that can be used to tailor the presentation to suit the specific context. In WIP, decisions of the language generator may influence graphics generation and graphical constraints may sometimes force decisions in the language production process. In this paper, we focus on the influence of graphical constraints on text generation. In particular, we describe the generation of cross-modal references, the revision of text due to graphical constraints and the clarification of graphics through text.

RR-91-06*Elisabeth André, Thomas Rist***Synthesizing Illustrated Documents: A Plan-Based Approach**

13 pages

Abstract: The aim of our work is to develop a system able to generate documents in which text and pictures are smoothly integrated. Such tailoring requires knowledge concerning the functions of textual and pictorial document parts and the relations between them. We start from the assumption that not only the generation of text, but also the generation of multimodal documents can be considered as a sequence of communicative acts which aim to achieve certain goals. Based on textlinguistic work, the structure of an illustrated document is described by the hierarchical order of communicative acts and the relations between them. In view of the generation of text-picture combinations, we have examined relations which frequently occur between text passages and pictures, or between the parts of a picture. For the automated generation of illustrated documents, we propose a plan-based approach. To represent knowledge about presentation techniques, we have designed presentation strategies which relate to both text and picture production. Finally, we show by example how a document fragment is synthesized.

RR-91-07*Günter Neumann, Wolfgang Finkler*

A Head-Driven Approach to Incremental and Parallel Generation of Syntactic Structures

13 pages

Abstract: This paper describes the construction of syntactic structures within an incremental multi-level and parallel generation system. Incremental and parallel generation imposes special requirements on syntactic description and processing. A head-driven grammar represented in a unification-based formalism is introduced which satisfies these demands. Further the basic mechanisms for parallel processing of syntactic segments are presented.

RR-91-08*Wolfgang Wahlster, Elisabeth André, Som Bandyopadhyay, Winfried Graf, Thomas Rist*

WIP: The Coordinated Generation of Multimodal Presentations from a Common Representation

23 pages

Abstract: The task of the knowledge-based presentation system WIP is the generation of a variety of multimodal documents from an input consisting of a formal description of the communicative intent of a planned presentation. WIP generates illustrated texts that are customized for the intended audience and situation. We present the architecture of WIP and introduce as its major components the presentation planner, the layout manager, the text generator and the graphics generator. An extended notion of coherence for multimodal documents is introduced that can be used to constrain the presentation planning process. The paper focuses on the coordination of contents planning and layout that is necessary to produce a coherent illustrated text. In particular, we discuss layout revisions after contents planning and the influence of layout constraints on text generation. We show that in WIP the design of a multimodal document is viewed as a non-monotonic planning process that includes various revisions of preliminary results in order to achieve a coherent output with an optimal media mix.

RR-91-09*Hans-Jürgen Bürckert, Jürgen Müller, Achim Schupeta*

RATMAN and its Relation to Other Multi-Agent Testbeds

31 pages

Abstract: RATMAN (Rational Agents Testbed for Multi Agent Networks) is a workbench for the definition and testing of *rational* agents in multi-agent environments. The special feature of RATMAN is the specification of such agents with hierarchical knowledge bases comprising all knowledge levels from sensoric knowledge to learning capabilities. In all levels only knowledge representation languages have to be used which are based on logic. On each knowledge level the designer may choose the granularity of knowledge for the agent to be designed and moreover he may decide whether the agent should have a certain skill at all. Thus it will be possible to construct a society of very heterogeneous agents from expert systems on one side of the spectrum to simple reactive agents on the other side. Since the aim of such a testbed is to get more insight in the behavior of intelligent agents' cooperating actions, RATMAN is providing a set of statistical and documentational features. In the second part other approaches to multi-agents environments are presented. AF, MACE, AGORA and MAGES are first characterized by their main features. Then their specialities are discussed and finally the boarders with respect to RATMAN are considered.

RR-91-10*Franz Baader, Philipp Hanschke*

A Scheme for Integrating Concrete Domains into Concept Languages

31 pages

Abstract: A drawback which concept languages based on KL-ONE have is that all the terminological knowledge has to be defined on an abstract logical level. In many applications, one would like to be able to refer to concrete domains and predicates on these domains when defining concepts. Examples for such concrete domains are the integers, the real numbers, or also non-arithmetic domains, and predicates could be equality, inequality, or more complex predicates.

In the present paper we shall propose a scheme for integrating such concrete domains into concept languages rather than describing a particular extension by some specific concrete domain. We shall define a terminological and an assertional language, and consider the important inference problems such as subsumption, instantiation, and consistency. The formal semantics as well as the reasoning algorithms are given on the scheme level. In contrast to existing KL-ONE based systems, these algorithms will be not only sound but also complete. They generate subtasks which have to be solved by a special purpose reasoner of the concrete domain.

RR-91-11

*Bernhard Nebel***Belief Revision and Default Reasoning: Syntax-Based Approaches**

31 pages

Abstract: Belief revision leads to temporal nonmonotonicity, i.e., the set of beliefs does not grow monotonically with time. Default reasoning leads to logical nonmonotonicity, i.e., the set of consequences does not grow monotonically with the set of premises. The connection between these forms of nonmonotonicity will be studied in this paper focusing on syntax-based approaches. It is shown that a general form of syntax-based belief revision corresponds to a special kind of partial meet revision in the sense of variants of logics for default reasoning. Additionally, the computational complexity of the membership problem in revised belief sets and of the equivalent problem of derivability in default logics is analyzed, which turns out to be located at the lower end of the polynomial hierarchy.

RR-91-12

*J. Mark Gawron, John Nerbonne, Stanley Peters***The Absorption Principle and E-Type Anaphora**

33 pages

Abstract: The Absorption Principle is a principle of situation theory which restricts the kinds of parametric information which is available. In particular it rules out abstraction over variable occurrences in parametric restrictions (unless the parameter itself is included). In *Anaphora and Quantification in Situation Semantics*, Gawron and Peters showed that the Absorption Principle has intuitively correct consequences in applications to quantificational and anaphoric semantics, but Sem, Saebo, Verne and Vestre (1990) point out cases of incorrect consequences. The present paper provides an analysis of the problematic cases in which the Absorption Principle is maintained. A key part of the analysis is the postulation that anaphors may have quantified NPs as antecedents, a position which has been vigorously advocated by Evans (1980). As a consequence, anaphors of this type are called 'E-Type'. We argue that the pronoun 'it' in the following discourse must be analyzed as E-Type:

Tom has exactly one car. It is red.

We provide an analysis of E-Type anaphora with the following properties: (i) the type of the anaphor is derived from the conservative scope of its antecedent; (ii) its semantics is provided by a choice function; and (iii) there is a pragmatic condition that the choice function not be controlled either by speaker or hearer in the discourse. We demonstrate how this accounts for a wide range of facts, including apparently varying quantificational force.

RR-91-13

*Gert Smolka***Residuation and Guarded Rules for Constraint Logic Programming**

17 pages

Abstract: A major difficulty with logic programming is combinatorial explosion: since goals are solved with possibly indeterminate (i.e., branching) reductions, the resulting search trees may grow wildly. Constraint logic programming systems try to avoid combinatorial explosion by building in strong determinate (i.e., non-branching) reduction in the form of constraint simplification. In this paper we present two concepts, residuation and guarded rules, for further strengthening determinate reduction. Both concepts apply to constraint logic programming in general and yield an operational semantics that coincides with the declarative semantics. Residuation is a control strategy giving priority to determinate reductions. Guarded rules are logical consequences of programs adding otherwise unavailable determinate reductions.

RR-91-14

*Peter Breuer, Jürgen Müller***A Two Level Representation for Spatial Relations, Part I**

27 pages

Abstract: A model to represent spatial relations is presented. It is used for the definition of common sense knowledge of rational agents in a multi-agent-scenario. The main idea is, that it is structured in two levels: the representation of relations may be accomplished in terms of predicate logic at one level or in expressions of Cartesian coordinates at the other. Hence reasoning is possible with common rules of deduction as well as via exact calculations of the positions.

Here we give an overview on the whole structure and then investigate in the the definition of a set of spatial relations at the "Logical Level". Finally special features like the handling of the context and the problem of multiple views are discussed.

RR-91-15*Bernhard Nebel, Gert Smolka***Attributive Description Formalisms ... and the Rest of the World**

20 pages

Abstract: Research in knowledge representation has led to the development of so-called terminological logics, which have the purpose to support the representation of the conceptual and terminological part of Artificial Intelligence applications. Independently, in Computational Linguistics so-called feature logics have been developed, which are aimed at representing the semantic and syntactic information natural language sentences convey. Since both of these logics rely mainly on attributes as the primary notational primitives for representing knowledge, they can be jointly characterized as attributive description formalisms.

Although the intended applications for terminological logics and feature logics are not identical, and the computational services of systems based on the respective formalisms are quite different for this reason, the logical foundations turn out to be very similar — as we pointed out elsewhere. In this paper, we will show how attributive description formalisms relate to "the rest of the world." Recently, a number of formal results in the area of attributive description formalisms have been obtained by exploiting other research fields, such as formal language theory, automata theory, and modal logics. This connection between different fields of formal research will be highlighted in the sequel.

RR-91-16*Stephan Busemann***Using Pattern-Action Rules for the Generation of GPSG Structures from Separate Semantic Representations**

18 pages

Abstract: In many tactical NL generators the semantic input structure is taken for granted. In this paper, a new approach to multilingual, tactical generation is presented that keeps the syntax separate from the semantics. This allows for the system to be directly adapted to application-dependent representations. In the case at hand, the semantics is specifically designed for sentence-semantic transfer in a machine translation system. The syntax formalism used is Generalized Phrase Structure Grammar (GPSG). The mapping from semantic onto syntactic structures is performed by a set of pattern-action rules. Each rule matches a piece of the input structure and guides the GPSG structure-building process by telling it which syntax rule(s) to apply. The scope of each pattern-action rule is strictly local, the actions are primitive, and rules can not call each other. These restrictions render the production rule approach both highly modular and transparent.

RR-91-17*Andreas Dengel, Nelson M. Mattos***The Use of Abstraction Concepts for Representing and Structuring Documents**

17 pages

Abstract: Due to the amount of documents available in modern offices, it is necessary to provide a multitude of methods for the structuring of knowledge, i.e., abstraction concepts. In order to achieve their uniform representation, such concepts should be considered in an integrated fashion to allow concise descriptions free of redundancy. In this paper, we present our approach towards an integration of methods of knowledge structuring. For this purpose, our view of abstraction concepts is briefly introduced using examples of the document world and compared with some existing systems. The main focus of this paper is to show the applicability of an integration of these abstraction concepts as well as their built-in reasoning facilities in supporting document processing and management.

RR-91-18

*John Nerbonne, Klaus Netter, Abdel Kader Diagne, Ludwig Dickmann, Judith Klein***A Diagnostic Tool for German Syntax**

20 pages

Abstract: In this paper we describe an effort to construct a catalogue of syntactic data, exemplifying the major syntactic patterns of German. The purpose of the corpus is to support the diagnosis of errors in the syntactic components of natural language processing (NLP) systems. Two secondary aims are the evaluation of NLP systems components and the support of theoretical and empirical work on German syntax.

The data consist of artificially and systematically constructed expressions, including also negative (ungrammatical) examples. The data are organized into a relational data base and annotated with some basic information about the phenomena illustrated and the internal structure of the sample sentences. The organization of the data supports selected systematic testing of specific areas of syntax, but also serves the purpose of a linguistic data base.

The paper first gives some general motivation for the necessity of syntactic precision in some areas of NLP and discusses the potential contribution of a syntactic data base to the field of component evaluation. The second part of the paper describes the set up and control methods applied in the construction of the sentence suite and annotations to the examples. We illustrate the approach with the example of verbal government. The section also contains a description of the abstract data model, the design of the data base and the query language used to access the data. The final sections compare our work to existing approaches and sketch some future extensions.

We invite other research groups to participate in our effort, so that the diagnostics tool can eventually become public domain.

RR-91-19

*Munindar P. Singh***On the Commitments and Precommitments of Limited Agents**

15 pages

Abstract: Rationality is an important concept in Artificial Intelligence and Philosophy. When artificial systems are considered to be intelligent or autonomous, it is almost obligatory to attribute intentions and beliefs to them. The currently dominant view of intentions sees them as involving commitments on the part of the agents who have them. But the notion of commitment seems to clash with the notion of rationality. It is argued that this need not be so. Commitments are only appropriate for agents with a limited capacity to reason. A treatment of commitment has been previously proposed that reconciles them with rationality. Here further motivations for the commitments of limited agents are discussed. This analysis is extended to account for the so-called precommitments, which have been excluded by others as introducing too much complexity.

RR-91-20

*Christoph Klauck, Ansgar Bernardi, Ralf Legleitner***FEAT-Rep: Representing Features in CAD/CAM**

48 pages

Abstract: When CAD/CAM experts view a workpiece, they perceive it in terms of their own expertise. These terms, called *features*, which are build upon a *syntax* (geometry) and a *semantic* (e.g. skeletal plans in manufacturing or functional relations in design), provide an abstraction mechanism to facilitate the creation, manufacturing and analysis of workpieces. Our goal is to enable experts to represent their own *feature-language* via a *feature-grammar* in the computer to build *feature-based* systems e.g. CAPP systems. The application of formal language terminology to the feature definitions facilitates the use of well-known formal language methods in conjunction with our flexible knowledge representation formalism FEAT-REP which will be presented in this paper.

RR-91-21

Klaus Netter

Clause Union and Verb Raising Phenomena in German

38 pages

Abstract: In this paper we discuss a class of constructions in German syntax which have been known as *coherent infinitive*, *clause union* or *verb raising* constructions. These data run against the predictions of strictly configurational theories by apparently having a syntactic structure where the subcategorization frames of two or more verbal heads are merged into one. Thus, in addition to a fully bi-clausal structure with two clearly separated verbal heads, we also have to envisage the case where a verb is apparently raised from an embedded to form a verb cluster together with its governing verb, while the sets of their arguments are merged into a single set, representing the case of clause union. In addition, there are constructions where there is no evidence for clause union, but where one could nevertheless argue for the formation of a verb cluster.

We investigate these data by looking at a series of constructions which bear evidence on the issue. Among these are *extraposition*, which appears a reliable test for nonobligatory verb raising; *subjectless constructions*, which are possible only as the complements of so-called raising verbs but not of control verbs; *S-bar-Pronominalization*, which seems to be limited to equi-verbs; *scrambling* and *long reflexivization*, which we can take as evidence for clause union; the *scope of adjuncts and negation* which argues in favour of verb raising, but does not necessarily presuppose clause union; and finally certain *topicalization* phenomena which appear to violate almost any of the generalizations set up so far by configurational theories.

RR-91-22

Andreas Dengel

Self-Adapting Structuring and Representation of Space

27 pages

Abstract: The objective of this report is to propose a syntactic formalism for space representation. Beside the well known advantages of hierarchical data structure, the underlying approach has the additional strength of self-adapting to a spatial structure at hand. The formalism is called *puzzletree* because its generation results in a number of blocks which in a certain order — like a puzzle — reconstruct the original space. The strength of the approach does not lie only in providing a compact representation of space (e.g. high compression), but also in attaining an ideal basis for further knowledge-based modeling and recognition of objects. The approach may be applied to any higher-dimensioned space (e.g. images, volumes). The report concentrates on the principles of *puzzletrees* by explaining the underlying heuristic for their generation with respect to 2D spaces, i.e. images, but also schemes their application to volume data. Furthermore, the paper outlines the use of *puzzletrees* to facilitate higher-level operations like image segmentation or object recognition. Finally, results are shown and a comparison to conventional region quadrees is done.

RR-91-23

Michael M. Richter, Ansgar Bernardi, Christoph Klauck, Ralf Legleitner

Akquisition und Repräsentation von technischem Wissen für Planungsaufgaben im Bereich der Fertigungstechnik

24 Seiten

Zusammenfassung: Im Bereich der Fertigungstechnik kann eine Fülle von Planungsaufgaben identifiziert werden, die für eine Bearbeitung mit Methoden der KI geeignet erscheinen. Das Projekt ARC-TEC am DFKI wendet die KADS-Methode zur systematischen Entwicklung von Expertensystemen an und erstellt Tools für alle Phasen dieser Entwicklung. Die Brauchbarkeit der entwickelten Methoden und Tools wird am Beispiel der Erstellung von Arbeitsplänen für die Drehbearbeitung demonstriert. Besonderes Augenmerk gilt dabei der expliziten Repräsentation des konkreten Expertenwissens und der Bearbeitung des gegebenen Problems in einer der Vorgehensweise des Experten möglichst naheliegenden Weise.

Abstract: In the area of production engineering many planning tasks can be found which seem well-suited to be tackled using AI-methodologies. The ARC-TEC project of the DFKI uses the model based KADS approach for a systematic development of expert systems and provides tools to support the different phases of this development. The generation of work plans for manufacturing by turning is used as an example to demonstrate the applicability of the different tools and methodologies. Special focus is upon the explicit representation of the concrete experts knowledge and the problem solving strategy which closely follows the way an expert solves the problem.

RR-91-24
Jochen Heinsohn

A Hybrid Approach for Modeling Uncertainty in Terminological Logics

22 pages

Abstract: This paper proposes a probabilistic extension of terminological logics. The extension maintains the original performance of drawing inferences in a hierarchy of terminological definitions. It enlarges the range of applicability to real world domains determined not only by definitional but also by uncertain knowledge. First, we introduce the propositionally complete terminological language *ALC*. On the basis of the language construct "probabilistic implication" it is shown how statistical information on concept dependencies can be represented. To guarantee (terminological and probabilistic) consistency, several requirements have to be met. Moreover, these requirements allow one to infer implicitly existent probabilistic relationships and their quantitative computation. By explicitly introducing restrictions for the ranges derived by instantiating the consistency requirements, *exceptions* can also be handled. In the categorical cases this corresponds to the overriding of properties in nonmonotonic inheritance networks. Consequently, our model applies to domains where both term descriptions and non-categorical relations between term extensions have to be represented.

RR-91-25
Karin Harbusch, Wolfgang Finkler, Anne Schauder

Incremental Syntax Generation with Tree Adjoining Grammars

16 pages

Abstract: With the increasing capacity of AI systems the design of human-computer interfaces has become a favorite research topic in AI. In this paper we focus on aspects of the output of a computer. The architecture of a sentence generation component — embedded in the WIP system — is described. The main emphasis is laid on the motivation for the incremental style of processing and the encoding of adequate linguistic units as rules of a Lexicalized Tree Adjoining Grammar with Unification.

RR-91-26
M. Bauer, S. Biundo, D. Dengler, M. Hecking, J. Koehler, G. Merziger

Integrated Plan Generation and Recognition - A Logic-Based Approach -

17 pages

Abstract: The work we present in this paper is settled within the field of intelligent help systems. Intelligent help systems aim at supporting users of application systems by the achievements of qualified experts. In order to provide such qualified support our approach is based on the integration of plan generation and plan recognition components. Plan recognition in this context serves to identify the users goals and so forms the basis for an active user support. The planning component dynamically generates plans which are proposed for the user to reach her goal. We introduce a logic-based approach where plan generation and plan recognition is done on a common logical basis and both components work in some kind of cross-talk.

RR-91-27
*A. Bernardi, H. Boley, Ph. Hanschke, K. Hinkelmann, Ch. Klauck, O. Kühn,
 R. Legleitner, M. Meyer, M. M. Richter, F. Schmalhofer, G. Schmidt, W. Sommer*

ARC-TEC:

Acquisition, Representation and Compilation of Technical Knowledge

18 pages

Abstract: A global description of an expert system shell for the domain of mechanical engineering is presented. The ARC-TEC project constitutes an AI approach to realize the CIM idea. Along with conceptual solutions, it provides a continuous sequence of software tools for the acquisition, representation and compilation of technical knowledge. The shell combines the KADS knowledge-acquisition methodology, the KL-ONE representation theory and the WAM compilation technology. For its evaluation a prototypical expert system for production planning is developed. A central part of the system is a knowledge base formalizing the relevant aspects of common sense in mechanical engineering. Thus, ARC-TEC is less general than the CYC project but broader than specific expert systems for planning or diagnosis.

RR-91-28

Rolf Backofen, Harald Trost, Hans Uszkoreit

Linking Typed Feature Formalisms and Terminological Knowledge Representation Languages in Natural Language Front-Ends

11 pages

Abstract: In this Paper we describe an interface between typed formalisms and terminological languages like KL-ONE. The definition of such an interface is motivated by the needs of natural language front-ends to AI-systems where information must be transmitted from the front-end to the back-end system and vice versa.

We show some minor extensions to the feature formalism allow for a syntactic description of individual concepts in terms of typed feature structures. Namely, we propose to include intervals and a special kind of sets. Partial consistency checks can be made on these concepts descriptions during the unification of feature terms. Type checking on these special involves calling the classifier of the terminological language. The final consistency check is performed only when transferring these concept description into structures of the A-Box of the terminological language.

RR-91-29

Hans Uszkoreit

Strategies for Adding Control Information to Declarative Grammars

17 pages

Abstract: Strategies are proposed for combining different kinds of constraints in declarative grammars with a detachable layer of control information. The added control information is the basis for parametrized dynamically *controlled linguistic deduction*, a form of linguistic processing that permits the implementation of plausible linguistic performance models without giving up the declarative formulation of linguistic competence. The information can be used by the linguistic processor for ordering the sequence in which conjuncts and disjuncts are processed, for mixing depth-first and breadth-first search, for cutting off undesired derivations, and for constraint-relaxation.

RR-91-30

Dan Flickinger, John Nerbonne

Inheritance and Complementation:

A Case Study of *Easy* Adjectives and Related Nouns.

39 pages

Abstract: Mechanisms for representing lexically the bulk of syntactic and semantic information for a language have been under active development, as is evident in the recent studies contained in this volume. Our study serves to highlight some of the most useful tools available for structured lexical representation, in particular, (multiple) inheritance, default specification, and lexical rules. It then illustrates the value of these mechanisms in illuminating one corner of the lexicon involving an unusual kind of complementation among a group of adjectives exemplified by *easy*. The virtues of the structured lexicon are its succinctness and its tendency to highlight significant clusters of linguistic properties. From its succinctness follow two practical advantages, namely its ease of maintenance and modifiability. In order to suggest how important these may be practically, we extend the analysis of adjectival complementation in several directions. These further illustrate how the use of inheritance in lexical representation permits exact and explicit characterizations of phenomena in the language under study. We demonstrate how the use of the mechanisms employed in the analysis of *easy* enable us to give a unified account of related phenomena featuring nouns like *pleasure*, and even the adverbs (adjectival specifiers) *too* and *enough*. Along the way we motivate some elaborations of the Head-Driven Phrase Structure Grammar (HPSG) framework in which we couch our analysis, and offer several avenues for further study of this part of the English lexicon.

RR-91-31

*H.-U. Krieger, J. Nerbonne***Feature-Based Inheritance Networks for Computational Lexicons**

11 pages

Abstract: The virtues of viewing the lexicon as an inheritance network are its succinctness and its tendency to highlight significant clusters of linguistic properties. From its succinctness follow two practical advantages, namely its ease of maintenance and modification. In this paper we present a feature-based foundation for lexical inheritance. We argue that the feature-based foundation is both more economical and expressively more powerful than non-feature-based systems. It is more economical because it employs only mechanisms already assumed to be present elsewhere in the grammar (viz., in the feature system), and it is more expressive because feature systems are more expressive than other mechanisms used in expressing lexical inheritance (cf. DATR). The lexicon furthermore allows the use of default unification, based on the ideas of default unification, defined by Bouma.

These claims are buttressed in sections sketching the opportunities for lexical description in feature-based lexicons in two central lexical topics, inflection and derivation. Briefly, we argue that the central notion of paradigm may be defined in feature structures, and that it may be more satisfactorily (in fact, immediately) linked to the syntactic information in this fashion. Our discussion of derivation is more programmatic; but here, too, we argue that feature structures of a suitably rich sort provide a foundation for the definition of lexical rules.

We illustrate theoretical claims in application to German lexis. This work is currently under implementation in a natural language understanding effort (DISCO) at the German Artificial Intelligence Center (Deutsches Forschungszentrum für Künstliche Intelligenz).

RR-91-32

*Rolf Backofen, Lutz Euler, Günther Görz***Towards the Integration of Functions, Relations and Types in an AI Programming Language**

14 pages

Abstract: This paper describes the design and implementation of the programming language PC-Life. This language integrates the functional and the Logic-oriented programming style and feature types supporting inheritance. This combination yields a language particularly suited to knowledge representation, especially for application in computational linguistics.

RR-91-33

*Franz Baader, Klaus Schulz***Unification in the Union of Disjoint Equational Theories:
Combining Decision Procedures**

33 pages

Abstract: Most of the work on the combination of unification algorithms for the union of disjoint equational theories has been restricted to algorithms which compute finite complete sets of unifiers. Thus the developed combination methods usually cannot be used to combine decision procedures, i.e., algorithms which just decide solvability of unification problems without computing unifiers. In this paper we describe a combination algorithm for decision procedures which works for arbitrary equational theories, provided that solvability of so-called unification problems with constant restrictions—a slight generalization of unification problems with constants—is decidable for these theories. As a consequence of this new method, we can for example show that general A -unifiability, i.e., solvability of A -unification problems with free function symbols, is decidable. Here A stands for the equational theory of one associative function symbol.

Our method can also be used to combine algorithms which compute finite complete sets of unifiers. Manfred Schmidt-Schauß' combination result, the until now most general result in this direction, can be obtained as a consequence of this fact. We also get the new result that unification in the union of disjoint equational theories is finitary, if general unification—i.e., unification of terms with additional free function symbols—is finitary in the single theories.

RR-91-34

*Bernhard Nebel, Christer Bäckström***On the Computational Complexity of Temporal Projection and some related Problems**

35 pages

Abstract: One kind of temporal reasoning is *temporal projection* - the computation of the consequences for a set of events. This problem is related to a number of other temporal reasoning tasks such as story understanding, plan validation, and *planning*. We show that one particular simple case of temporal projection on partially ordered events turns out to be harder than previously conjectured. However, given the restrictions of this problem, planning and story understanding are easy. Additionally, we show that plan validation, one of the intended applications of temporal projection, is tractable for an even larger class of plans. The incomplete decision procedure for the temporal projection problem that has been proposed by other authors, however, fails to be complete in the case where we have shown plan validation to be tractable.

RR-91-35

*Winfried Graf, Wolfgang Maaß***Constraint-basierte Verarbeitung graphischen Wissens**

14 Seiten

Zusammenfassung: Bei der Entwicklung neuerer intelligenter Benutzerschnittstellen, die wie im Beispiel des multimodalen Präsentationssystems WIP natürliche Sprache und Graphik kombinieren, spielt insbesondere die wissensbasierte Gestaltung des Layouts multimodaler Dokumente eine wichtige Rolle. Am Beispiel des Layout-Managers in WIP soll gezeigt werden, wie aufgrund der von einem Präsentationsplaner spezifizierten semantischen und pragmatischen Relationen, die von den media-spezifischen Generatoren erzeugten Graphik- und Textfragmente in einem Dokument automatische arrangiert werden können. Dabei wird das Layoutproblem als Constraint-Satisfaction-Problem behandelt. Es wird hier gezeigt, wie der Constraint-Ansatz sowohl zur Repräsentation von graphischem Wissen, als auch zur Berechnung der Platzierung der Layoutobjekte auf einem Design-Grid verwendet werden kann. So werden semantische Kohärenzrelationen wie etwa *'sequencee'* oder *'contrast'* durch entsprechende Design-Constraints reflektiert, die perzeptuelle Kriterien (Alignierung, Gruppierung, Symmetrie, etc.) spezifizieren. Zur Realisierung wird in WIP ein mehrschichtiger inkrementeller Constraint-Solver mit lokaler Propagierung verwendet, der es erlaubt, Constraints dynamisch zu generieren.

RR-92-01

*Werner Nutt***Unification in Monoidal Theories is Solving Linear Equations over Semirings**

57 pages

Abstract: Although for numerous equational theories unification algorithms have been developed there is still a lack of general methods. In this paper we apply algebraic techniques to the study of a whole class of theories, which we call monoidal. Our approach leads to general results on the structure of unification algorithms and the unification type of such theories.

An equational theory is monoidal if it contains a binary operation which is associative and commutative, an identity for the binary operation, and an arbitrary number of unary symbols which are homomorphisms for the binary operation and the identity. Monoidal theories axiomatize varieties of abelian monoids. Examples are the theories of abelian monoids AC, idempotent abelian monoids ACI, and abelian groups.

To every monoidal theory we associate a semiring. Intuitively, semirings are rings without subtraction. We show that every unification problem in a monoidal theory can be translated into a system of linear equations over the corresponding semiring. More specifically, problems without free constants are translated into homogeneous equations. For problems with free constants inhomogeneous equations have to be solved in addition.

Exploiting the correspondence between unification and linear algebra we give algebraic characterizations of the unification type of a theory. In particular, we show that with respect to unification without constants monoidal theories are either unitary or nullary. Applying Hilbert's Basis Theorem we prove that theories of groups with commuting homomorphisms are unitary with respect to unification with and without constants.

RR-92-02

*Andreas Dengel, Rainer Bleisinger,
Rainer Hoch, Frank Hönes, Frank Fein, Michael Malburg*

Π ODA: The Paper Interface to ODA

53 pages

Abstract: In the past, many people have proclaimed the vision of the paperless office, but today offices consume more paper documents than ever before. As computer technology becomes more and more important in daily practice of modern offices, intelligent systems bridging the gap between printed documents and electronic ones, called paper-computer-interfaces, are required.

In this report our model-based document analysis system Π ODA is discussed in detail. Basic ideas of the ODA standard for electronic representation of office documents are the foundation of our document model. Moreover, different knowledge sources essential for the analysis of business letters are incorporated into the Π ODA model. The system comprises all important analysis tasks. Initially, *layout extraction* includes a necessary low-level image processing and segmentation to investigate the layout structure of a given document. While *logical labeling* identifies the logical structure of a business letter, *text recognition* explores the captured text of logical objects in an expectation-driven manner. By this way, word hypotheses are generated and verified using a dictionary. Finally, a *partial text analysis* component syntactically checks well-structured text objects, primarily the recipient of a letter.

As output, Π ODA produces an ODA conforming symbolic representation of a document originally being captured on paper. Now, the document is available for any further automatic processing such as filing, retrieval or distribution.

The inherent modularity of our system, however, allows a reuse of knowledge sources and constituents of the architecture in other document classes such as forms or cheques. Additionally, Π ODA is an open and flexible system: improved and new analysis methods can be integrated easy without modifying the overall system architecture.

RR-92-03

Harold Boley

Extended Logic-plus-Functional Programming

28 pages

Abstract: Extensions of logic and functional programming are integrated in RELFUN. Its valued clauses comprise Horn clauses ('true'-valued) and clauses with a distinguished 'foot' premise (returning arbitrary values). Both the logic and functional components permit LISP-like varying-arity and higher-order operators. The DATAFUN sublanguage of the functional component is shown to be preferable to relational encodings of functions in DATALOG. RELFUN permits non-ground, non-deterministic functions, hence certain functions can be inverted using an 'is'-primitive generalizing that of PROLOG. For function nestings a strict call-by-value strategy is employed. The reduction of these extensions to a relational sublanguage is discussed and their WAM compilation is sketched. Three examples ('serialise', 'wang', and 'eval') demonstrate the relational/functional style in use. The list expressions of RELFUN's LISP implementation are presented in an extended PROLOG-like syntax.

RR-92-04*John Nerbonne***Feature-Based Lexicons: An Example and a Comparison to DATR**

15 pages

Abstract: A FEATURE-BASED lexicon is especially sensible for natural language processing systems which are feature-based. Feature-based lexicons offer the advantages: (i) having a maximally transparent (empty) interface to feature-based grammars and processors; (ii) supplying exactly the EXPRESSIVE CAPABILITY exploited in these systems; and (iii) providing concise, transparent, and elegant specification possibilities for various lexical relationships, including both inflection and derivation. The development of TYPED feature description languages allows the use of INHERITANCE in lexical description, and recent work explores the use of DEFAULT INHERITANCE as a means of easing lexical development.

TDL is the implementation of a TYPE DESCRIPTION LANGUAGE based on HPSG feature logics. It is employed for both lexical and grammatical specification. As a lexical specification tool, it not only realizes these advantages, but it also separates a linguistic and a computational view of lexical contents and supplies a development environment for lexicon engineering.

The most important competitor for feature-based lexical work is the very competent special purpose tool DATR, whose interface to feature-based systems is, however, inherently problematic. It is argued that feature-based systems (such as TDL) and DATR look compatible because of their common mathematical interpretation as graph description languages for directed graphs, but that this masks radically different modeling conventions for the graphs themselves.

The development of TDL is continuing at the German Artificial Intelligence Center (Deutsches Forschungszentrum für Künstliche Intelligenz - DFKI) in the natural language understanding project DISCO.

RR-92-05*Ansgar Bernardi, Christoph Klauck, Ralf Legleitner, Michael Schulte, Rainer Stark***Feature based Integration of CAD and CAPP**

19 pages

Abstract: To integrate CAD systems with other applications in the CIM world, two principal approaches are currently under development. The feature based CAD systems provide higher level primitives which support not only the generation of the drawing but also serve as basic input for other CIM components. Another approach enables any CIM component to recognize the higher level entities used in CAD systems out of a lower level data exchange format, which might be the internal representation of such systems as well as some standard data exchange format. In this paper the authors examine both approaches in more detail. First a conceptual model of CAD and - as an example of another CIM component - of CAPP is represented. Comparing these two models the authors investigate the possible integrations on the different levels and provide a concise terminology and advantages and disadvantages of the different approaches.

RR-92-06*Achim Schupeta***Main Topics of DAI: A Review**

38 pages

Abstract: A new branch of artificial intelligence, distributed AI, has developed in the last years. Topic is the cooperation of AI-systems which are distributed among different autonomous agents. The thereby occurring problems extend the traditional AI spectrum and are presented along the major DAI-relevant topics: Knowledge representation, task-decomposition and -allocation, interaction and communication, cooperation, coordination and coherence, organizational models, agent's modelling of other agents and conflict resolution strategies (e.g. negotiation). First we try to describe the role of DAI within AI. Then every subsection will take up one special aspect, illuminate the occurring problems and give links to solutions proposed in literature. Interlaced into this structure are sketchy descriptions of a few very prominent and influential DAI systems. In particular we present the Contract Net Protocol, the Distributed Vehicle Monitoring Testbed, the Air Traffic Control problem and the Blackboard Architecture.

RR-92-07

*Michael Beetz***Decision-theoretic Transformational Planning**

22 pages

Abstract: In this paper we develop decision-theoretic transformational planning as a novel computational theory for planning reactive behavior under hard time constraints. The theory is based on three main paradigms: transformational planning, decision theory, and time-dependent computations. Knowledge about goals and the robot control language is accessed through transformation rules that define semantic relationships between constructs in the plan representation language and associations between goals and canned plans. The computational theory deals with uncertainty by applying decision-theoretic methods to control the planning process. The tradeoffs between planning and acting are weighed by applying time-dependent algorithms for testing the applicability and utility of transformation rules with respect to the current situation and the preferences of the robot.

RR-92-08

*Gabriele Merziger***Approaches to Abductive Reasoning - An Overview -**

46 pages

Abstract: Abduction is a form of non-monotonic reasoning that has gained increasing interest in the last few years. The key idea behind it can be represented by the following inference rule

$$\frac{f \rightarrow \omega, \omega}{f}$$

i.e., from an occurrence of w and the rule " f implies w ", infer an occurrence of f as a *plausible* hypothesis or explanation for w . Thus, in contrast to deduction, abduction is as well as induction a form of "defeasible" inference, i.e., the formulae sanctioned are plausible and submitted to verification.

In this paper, a formal description of current approaches is given. The underlying reasoning process is treated independently and divided into two parts. This includes a description of *methods for hypotheses generation* and *methods for finding the best explanations* among a set of possible ones. Furthermore, the complexity of the abductive task is surveyed in connection with its relationship to default reasoning. We conclude with the presentation of applications of the discussed approaches focusing on plan recognition and plan generation.

RR-92-09

*Winfried Graf, Markus A. Thies***Perspektiven zur Kombination von automatischem Animationsdesign und planbasierter Hilfe**

15 Seiten

Abstract: Aktuelle Themen auf dem Gebiet der intelligenten Benutzerschnittstellen behandeln derzeit die automatische Planung multimodaler Präsentationen. Hierbei stand bisher im wesentlichen die koordinierte Generierung von Text und Graphik im Vordergrund. In Zukunft wird hier aufgrund der Komplexität der zu präsentierenden Information zunehmend auch die Einbeziehung realistischer animierter 3D-Graphiken gefordert sein. Einen anderen wichtigen Forschungsschwerpunkt bildet der Einsatz graphischer Ausgabekomponenten für planbasierte Hilfesysteme.

Die vorliegende Arbeit hat zum Ziel zunächst einen Überblick über den derzeitigen Stand der Forschung in diesen beiden Bereichen zu geben, als auch neue Anforderungen an die automatische Animationsgenerierung und an Systeme zur planbasierten graphischen Hilfe zu formulieren. Anschließend wollen wir, basierend auf Ergebnissen und Erfahrungen aus WIP und PLUS, Perspektiven für eine mögliche Weiterentwicklung und Integration von Techniken der Animationsplanung und graphischen Hilfe präsentieren.

RR-92-10

*M. Bauer***An Interval-based Temporal Logic in a Multivalued Setting**

17 pages

Abstract: We describe the embedding of the semantic notions and modal operators of a first-order temporal logic based on time intervals in a multivalued setting. Truth values will be realized as functions from time intervals to "ordinary" truth values like t and f . The main emphasis lies on the realization of the various modal operators contained in the temporal logic as operations on the functional truth values. We show that it is possible to obtain an efficient system sufficient for tasks in the area of diagnostic reasoning.

RR-92-11

*Susanne Biundo, Dietmar Dengler, Jana Koehler***Deductive Planning and Plan Reuse in a Command Language Environment**

13 pages

Abstract: In this paper we introduce a deductive planning system currently being developed as the kernel of an intelligent help system. It consists of a deductive planner and a plan reuse component and with that provides planning from first as well as planning from second principles. Both components rely upon an interval-based temporal logic. The deductive formalisms realizing plan formation from formal specifications and the reuse of already existing plans respectively are presented and demonstrated by examples taken from an operating system's domain.

RR-92-13

*Markus A. Thies, Frank Berger***Planbasierte graphische Hilfe in objektorientierten Benutzungsoberflächen**

13 Seiten

Zusammenfassung: Wir stellen das System PLUS vor, ein planbasiertes graphisches Hilfesystem für Applikationen mit einer objektorientierten Benutzerschnittstelle. Es werden die Hilfekomponente *InCome+*, die *Animationskomponente* und der graphik-orientierte Planeditor *PlanEdit+* beschrieben. *PlanEdit+* ermöglicht den interaktiven Aufbau der hierarchischen Planbasis, die die Grundlage für den Planerkennungsprozeß bildet. Eine zentrale Komponente der graphischen Hilfe in unserem System stellt das Modul *InCome+* dar, das den Interaktionskontext des Benutzers visualisiert und darüberhinaus weitere Features wie semantische Undo- und Redo-Möglichkeiten und einen kontext-sensitiven Tutor zur Verfügung stellt. Als wesentliche Erweiterung der graphischen Benutzerunterstützung wird innerhalb von PLUS die Präsentation animierter Hilfe integriert. Es werden Benutzeraktionen simuliert, indem eine Animation über die aktuelle Benutzerschnittstelle gelagert wird. Die Animationssequenz wird im Kontext der aktuell vom Benutzer verfolgten Aufgabe generiert.

RR-92-14

Intelligent User Support in Graphical User Interfaces:

1. **InCome: A System to Navigate through Interactions and Plans**
Thomas Fehrle, Markus A. Thies
2. **Plan-Based Graphical Help in Object-Oriented User Interfaces**
Markus A. Thies, Frank Berger

22 pages

Abstract: 1. This paper presents a frontend to an intelligent help system based on plans called InCome (Interaction Control Manager). It visualizes user actions previously executed in a specific application as a graph structure and enables the user to navigate through this structure. A higher level of abstraction on performed user actions shows the dialog history, the interaction context and reachable goals. Finally, the user is able to act on the application via InCome by performing undo mechanisms as well as specifying user goals inferred already by the help system.

2. This paper describes the system PLUS, a plan-based help system for applications offering an object-oriented user interface. Our plan recognition process is based on a predefined static hierarchical plan base, that is modelled using a goal plan language. This language is designed to especially cope with the problems arising when plan recognition is performed in a graphical user interface environment whose interaction is based on a user-directed dialog by means of direct manipulation—so-called Direct Manipulation User Interfaces. The plan hierarchy is entered using the interactive graphics-oriented plan editor *PlanEdit+*. The plan recognition module *PlanRecognizer+* builds a dynamic plan base by mapping user actions to plans stored in the static plan base. The dynamic plan base contains hypotheses about tasks the user is pursuing at the moment. These plan hypotheses serve as a basis to offer various kinds of assistance to the user. A central component of our graphical help is the module *InCome+*. *InCome+* visualizes user actions previously executed in an application as a graph structure and enables the user to navigate through this structure. A higher level of abstraction on performed actions shows the dialog history, the interaction context, and reachable goals. *InCome+* offers special features like task-oriented undo und redo facilities and a context-sensitive tutor. As a substantial extension of the graphical user assistance, we integrate the presentation of animated help within PLUS. Animation sequences are generated in the context of the tasks the user is currently working on.

RR-92-15

*Winfried Graf***Constraint-Based Graphical Layout of Multimodal Presentations**

23 pages

Abstract: When developing advanced multimodal interfaces, combining the characteristics of different modalities such as natural language, graphics, animation, virtual realities, etc., the question of automatically designing the graphical layout of such presentations in an appropriate format becomes increasingly important. So, to communicate information to the user in an expressive and effective way, a knowledge-based layout component has to be integrated into the architecture of an intelligent presentation system. In order to achieve a coherent output, it must be able to reflect certain semantic and pragmatic relations specified by a presentation planner to arrange the visual appearance of a mixture of textual and graphic fragments delivered by mode-specific generators.

In this paper we will illustrate by the example of *LayLab*, the layout manager of the multimodal presentation system WIP, how the complex positioning problem for multimodal information can be treated as a constraint satisfaction problem. The design of an aesthetically pleasing layout is characterized as a combination of a general search problem in a finite discrete search space and an optimization problem. Therefore, we have integrated two dedicated constraint solvers, an incremental hierarchy solver and a finite domain solver, in a layered constraint solver model *CLAY*, which is triggered from a common metalevel by rules and defaults. The underlying constraint language is able to encode graphical design knowledge expressed by semantic/pragmatic, geometrical/topological, and temporal relations. Furthermore, this mechanism allows one to prioritize the constraints as well as to handle constraint solving over finite domains. As graphical constraints frequently have only local effects, they are incrementally generated by the system on the fly. Ultimately, we will illustrate the functionality of *LayLab* by some snapshots of an example run.

RR-92-16

*Jochen Heinsohn, Daniel Kudenko, Bernhard Nebel, Hans-Jürgen Profitlich***An Empirical Analysis of Terminological Representation Systems**

38 pages

Abstract: The family of terminological representation systems has its roots in the representation system KL-ONE. Since the development of this system more than a dozen similar representation systems have been developed by various research groups. These systems vary along a number of dimensions. In this paper, we present the results of an empirical analysis of six such systems. Surprisingly, the systems turned out to be quite diverse leading to problems when transporting knowledge bases from one system to another. Additionally, the runtime performance between different systems and knowledge bases varied more than we expected. Finally, our empirical runtime performance results give an idea of what runtime performance to expect from such representation systems. These findings complement previously reported analytical results about the computational complexity of reasoning in such systems.

RR-92-17

*Hassan Ait-Kaci, Andreas Podelski, Gert Smolka***A Feature-based Constraint System for Logic Programming with Entailment**

23 pages

Abstract: This paper presents the constraint system *FT*, which we feel is an intriguing alternative to Herbrand both theoretically and practically. As does Herbrand, *FT* provides a universal data structure based on trees. However, the trees of *FT* (called feature trees) are more general than the trees of Herbrand (called constructor trees), and the constraints of *FT* are finer grained and of different expressivity. The basic notion of *FT* are functional attributes called features, which provide for record-like descriptions of data avoiding the overspecification intrinsic in Herbrand's constructor-based descriptions. The feature tree structure fixes an algebraic semantics for *FT*. We will also establish a logical semantics, which is given by three axiom schemes fixing the first-order theory *FT*.

FT is a constraint system for logic programming, providing a test for unsatisfiability, and a test for entailment between constraints, which is needed for advanced control mechanisms.

The two major technical contributions of this paper are (1) an incremental entailment simplification system that is proved to be sound and complete, and (2) a proof showing that *FT* satisfies the so-called "independence of negative constraints".

RR-92-18

*John Nerbonne***Constraint-Based Semantics**

21 pages

Abstract: Montague's famous characterization of the homomorphic relation between syntax and semantics naturally gives way in computational applications to CONSTRAINT-BASED formulations. This was originally motivated by the close harmony it provides with syntax, which is universally processed in a constraint-based fashion. Employing the same processing discipline in syntax and semantics allows that their processing (and indeed other processing) can be as tightly coupled as one wishes—indeed, there needn't be any fundamental distinction between them at all. In this paper, we point out several advantages of the constraint-based view of semantics processing over standard views. These include (i) the opportunity to incorporate nonsyntactic constraints on semantics, such as those arising from phonology and context; (ii) the opportunity to formulate principles which generalize over syntax and semantics, such as those found in HEAD-DRIVEN PHRASE STRUCTURE GRAMMAR; (iii) a characterization of semantic ambiguity, which in turn provides a framework in which to describe disambiguation, and (iv) the opportunity to underspecify meanings in a way difficult to reconcile with other views. The last point is illustrated with an application to scope ambiguity in which a scheme is developed which underspecifies scope but eschews auxiliary levels of logical form.

RR-92-19

*Ralf Legleitner, Ansgar Bernardi, Christoph Klauck***PIM: Planning In Manufacturing using Skeletal Plans and Features**

17 pages

Abstract: In order to create a production plan from product model data, a human expert thinks in a special terminology with respect to the given work piece and its production plan: He recognizes certain features and associates fragments of a production plan. By combining these skeletal plans he generates the complete production plan.

We present a set of representation formalisms suitable for the modelling of this approach. When an expert's knowledge has been represented using these formalisms, the generation of a production plan can be achieved by a sequence of abstraction, selection and refinement. This is demonstrated in the CAPP-system PIM, which is currently developed as a prototype.

The close modelling of the knowledge of the concrete expert (or the accumulated know-how of a concrete factory) facilitate the development of planning systems which are especially tailored to the concrete manufacturing environment and optimally use the expert's knowledge and should also lead to improved acceptance of the system.

RR-92-20

*John Nerbonne***Representing Grammar, Meaning and Knowledge**

18 pages

Abstract: Among the expertises relevant for successful natural language understanding are grammar, meaning and background knowledge, all of which must be represented in order to decode messages from text (or speech). The present paper is a sketch of one cooperation of grammar and meaning representations—with some remarks about knowledge representation—which allows that the representations involved be heterogeneous even while cooperating closely. The modules cooperate in what might be called a PLURALIST fashion, with few assumptions about the representations involved. In point of fact, the proposal is compatible with state-of-the-art representations from all three areas.

The paper proceeds from the nearly universal assumption that the grammar formalism is feature-based and insufficiently expressive for use in meaning representation. It then demonstrates how feature formalisms may be employed as a semantic metalanguage in order that semantic constraints may be expressed in a single formalism with grammatical constraints. This allows a tight coupling of syntax and semantics, the incorporation of nonsyntactic constraints (e.g., from knowledge representation) and the opportunity to underspecify meanings in novel ways—including, e.g., ways which distinguish ambiguity and underspecification (vagueness).

We retain scepticism vis-à-vis more ASSIMILATIONIST proposals for the interaction of these—i.e., proposals which foresee common formalisms for grammar, meaning and knowledge representation. While such proposals rightfully claim to allow for closer integration, they fail to account for the motivations which distinguish formalisms—elaborate expressive strength in the case of semantic representations, monotonic (and preferably decidable) computation in the case of grammar formalisms, and the characterization of taxonomic reasoning in the case of knowledge representation.

RR-92-21

*Jörg-Peter Mohren, Jürgen Müller***Representing Spatial Relations (Part II) -The Geometrical Approach**

25 pages

Abstract: The representation and analysis of spatial relations is a tough problem in AI and Cognitive Science and is hence heavily discussed in the literature. Our general approach to this problem is to use a two-level representation where the relations may either be defined on a logical/propositional level or in terms of a three dimensional model of co-ordinates. Here we occupy ourselves with an approach to analyze spatial relations on the depictional level, i.e. on a representation of spatial scenes by space co-ordinates.

First we describe a representation formalism for spatial objects, based on boundary representations. Coming from that, we introduce a method for testing the applicability of spatial relations between two or more objects. The degree of applicability of a spatial relation results from the deviation of the object to be located from an 'ideal position' which is specified by the reference object(s) and various influences by spatial properties of the regarded objects like size or shape, where the deviation results from trigonometrical computations.

RR-92-22

*Jörg Würtz***Unifying Cycles**

24 pages

Abstract: Two-literal clauses of the form $L \leftarrow R$ occur quite frequently in logic programs, deductive databases, and—disguised as an equation—in term rewriting systems. These clauses define a cycle if the atoms L and R are weakly unifiable, i.e., if L unifies with a new variant of R . The obvious problem with cycles is to control the number of iterations through the cycle. In this paper we consider the cycle unification problem of unifying two literals G and F modulo a cycle. We review the state of the art of cycle unification and give new results for a special type of cycles called unifying cycles, i.e., cycles $L \leftarrow R$ for which there exists a substitution σ such that $\sigma L = \sigma R$. Altogether, these results show how the deductive process can be efficiently controlled for special classes of cycles without losing completeness.

RR-92-23

*Gert Smolka, Ralf Treinen***Records for Logic Programming**

38 pages

Abstract: CFT is a new constraint system providing records as logical data structure for constraint (logic) programming. It can be seen as a generalization of the rational tree system employed in Prolog II, where finer-grained constraints are used, and where subtrees are identified by keywords rather than by position.

CFT is defined by a first-order structure consisting of so-called feature trees. Feature trees generalize the ordinary trees corresponding to first-order terms by having their edges labeled with field names called features. The mathematical semantics given by the feature tree structure is complemented with a logical semantics given by five axiom schemes, which we conjecture to comprise a complete axiomatization of the feature tree structure.

We present a decision method for CFT, which decides entailment and dis entailment between possibly existentially quantified constraints. Since CFT satisfies the independence property, our decision method can also be employed for checking the satisfiability of conjunctions of positive and negative constraints. This includes quantified negative constraints such as $\forall y \forall z (x \neq f(y,z))$.

The paper also presents an idealized abstract machine processing negative and positive constraints incrementally. We argue that an optimized version of the machine can decide satisfiability and entailment in quasi-linear time.

RR-92-24*Gabriele Schmidt***Knowledge Acquisition from Text in a Complex Domain**

20 pages

Abstract: Complex real world domains can be characterized by a large amount of data, their interactions and that the knowledge must often be related to concrete problems. Therefore, the available descriptions of real world domains do not easily lend themselves to an adequate representation. The knowledge which is relevant for solving a given problem must be extracted from such descriptions with the help of the knowledge acquisition process. Such a process must adequately relate the acquired knowledge to the given problem.

An integrated knowledge acquisition framework is developed to relate the acquired knowledge to real world problems. The interactive knowledge acquisition tool COKAM+ is one of three acquisition tools within this integrated framework. It extracts the knowledge from text, provides a documentation of the knowledge and structures it with respect to problems. All these preparations can serve to represent the obtained knowledge adequately.

RR-92-25*Franz Schmalhofer, Ralf Bergmann, Otto Kühn, Gabriele Schmidt***Using integrated knowledge acquisition to prepare sophisticated expert plans for their re-use in novel situations**

12 pages

Abstract: Plans which were constructed by human experts and have been repeatedly executed to the complete satisfaction of some customer in a complex real world domain contain very valuable planning knowledge. In order to make this compiled knowledge re-usable for novel situations, a specific integrated knowledge acquisition method has been developed: First, a domain theory is established from documentation materials or texts, which is then used as the foundation for explaining how the plan achieves the planning goal. Secondly, hierarchically structured problem class definitions are obtained from the practitioners' highlevel problem conceptualizations. The descriptions of these problem classes also provide operability criteria for the various levels in the hierarchy. A skeletal plan is then constructed for each problem class with an explanation-based learning procedure. These skeletal plans consist of a sequence of general plan elements, so that each plan element can be independently refined. The skeletal plan thus accounts for the interactions between the various concrete operations of the plan at a general level. The complexity of the planning problem is thereby factored in a domain-specific way and the compiled knowledge of sophisticated expert plans can be re-used in novel situations.

RR-92-26*Franz Schmalhofer, Thomas Reinartz, Bidjan Tschaischian***Intelligent documentation as a catalyst for developing cooperative knowledge-based systems**

16 pages

Abstract: In the long run, the development of cooperative knowledge-based systems for complex real world domains such as production planning in mechanical engineering should yield significant economic returns. However, large investments have already been made into the conventional technology. Intelligent documentation, which abstracts the current practice of the industry, is suggested as a stepping stone for developing such knowledge-based systems. A set of coordinated knowledge acquisition tools has been developed by which intelligent documents are constructed as an intermediate product, which by itself is already useful. Within the frame of the conventional technology, the task- and domain specific hypertext structures allow the reuse of production plans while simultaneously starting the development process for knowledge based systems.

RR-92-27

*Franz Schmalhofer, Jörg Thoben***The model-based construction of a case-oriented expert system**

18 pages

Abstract: Second generation expert systems should be based upon an expert's high level understanding of the application domain and upon specific real world experiences. By having an expert categorize different types of relevant experiences and their components, hierarchies of abstract problems and operator classes are determined on the basis of the expert's accumulated problem solving experiences. The expert's global understanding of the domain is integrated with the experiences by a model of expertise. This model postulates problem classes at different levels of abstractions and associated skeletal plans. During a consultation with the expert system previously unseen types of input may be used to delineate a new problem. The application of the expert system can thus be situated in changing environments and contexts. With increasing dissimilarity between the cases that were analyzed during knowledge acquisition and the specific problem that is processed at the time of the application of the system, its performance gracefully degrades by supplying a more and more abstract skeletal plan. More specifically, the search space which is represented by the skeletal plan increases until the competence of the system is exceeded. This paper describes how such a case-oriented expert system is developed for production planning in mechanical engineering.

RR-92-29

*Zhaohui Wu, Ansgar Bernardi, Christoph Klauck***Skeletal Plans Reuse: A Restricted Conceptual Graph Classification Approach**

13 pages

Abstract: In order to reuse the existing skeletal plans in the manufacturing process planning system *PIM*, in this paper, we propose a plan reuse framework, in which Restricted Conceptual Graphs are used as the internal representations of these skeletal plans and reusing these skeletal plans is approached by retrieving the most specific general candidate and effectively modifying. A similarity metrics about Restricted Conceptual Graphs is given for guarding the effective retrieval. Two applications of this proposed framework are described in this paper.

RR-92-30

*Rolf Backofen, Gert Smolka***A Complete and Recursive Feature Theory**

32 pages

Abstract: Various feature descriptions are being employed in logic programming languages and constrained-based grammar formalisms. The common notational primitive of these descriptions are functional attributes called features. The descriptions considered in this paper are the possibly quantified first-order formulae obtained from a signature of binary and unary predicates called features and sorts, respectively. We establish a first-order theory *FT* by means of three axiom schemes, show its completeness, and construct three elementarily equivalent models.

One of the models consists of so-called feature graphs, a data structure common in computational linguistics. The other two models consist of so-called feature trees, a record-like data structure generalizing the trees corresponding to first-order terms.

Our completeness proof exhibits a terminating simplification system deciding validity and satisfiability of possibly quantified feature descriptions.

RR-92-31

Wolfgang Wahlster

Automatic Design of Multimodal Presentations

17 pages

Abstract: We describe our attempt to integrate multiple AI components such as planning, knowledge representation, natural language generation, and graphics generation into a functioning prototype called WIP that plans and coordinates multimodal presentations in which all material is generated by the system. WIP allows the generation of alternate presentations of the same content taking into account various contextual factors such as the user's degree of expertise and preferences for a particular output medium or mode. The current prototype of WIP generates multimodal explanations and instructions for assembling, using, maintaining or repairing physical devices. This paper introduces the task, the functionality and the architecture of the WIP system. We show that in WIP the design of a multimodal document is viewed as a non-monotonic process that includes various revisions of preliminary results, massive replanning and plan repairs, and many negotiations between design and realization components in order to achieve an optimal division of work between text and graphics. We describe how the plan-based approach to presentation design can be exploited so that graphics generation influences the production of text and vice versa. Finally, we discuss the generation of cross-modal expressions that establish referential relationships between text and graphics elements.

RR-92-32

Rainer Hoch, Michael Malburg

Designing a Structured Lexicon for Document Image Analysis

11 pages

Abstract: This paper presents a structured, multi-level architecture of a lexicon which is a central component of our knowledge-based document analysis system. Our system has the task to transform incoming business letters into an equivalent electronic representation automatically. Moreover, partial text analysis and understanding of a letter's body and relevant parts are initiated to enrich the conceptual knowledge about the actual document (e.g., by a classification). In such an application domain, a well-designed lexicon has to consider requirements of both, text recognition and text analysis. For that purpose, we propose an appropriate lexicon architecture and the internal structure of corresponding lexical entries being a prerequisite for successful higher-level interpretations of documents.

RR-92-33

Franz Baader

Unification Theory

22 pages

Abstract: The purpose of this paper is not to give an overview of the state of art in unification theory. It is intended to be a short introduction into the area of equational unification which should give the reader a feeling for what unification theory might be about. The basic notions such as complete and minimal complete sets of unifiers, and unification types of equational theories are introduced and illustrated by examples. Then we shall describe the original motivations for considering unification (in the empty theory) in resolution theorem proving and term rewriting. Starting with Robinson's first unification algorithm it will be sketched how more efficient unification algorithms can be derived. We shall then explain the reasons which lead to the introduction of unification in non-empty theories into the above mentioned areas theorem proving and term rewriting. For theory unification it makes a difference whether single equations or systems of equations are considered. In addition, one has to be careful with regard to the signature over which the terms of the unification problems can be built. This leads to the distinction between elementary unification, unification with constants, and general unification (where arbitrary free function symbols may occur). Going from elementary unification to general unification is an instance of the so-called combination problem for equational theories which can be formulated as follows: Let E, F be equational theories over disjoint signatures. How can unification algorithms for E, F be combined to a unification algorithm for the theory $E \cup F$.

RR-92-34

Philipp Hanschke

Terminological Reasoning and Partial Inductive Definitions

23 pages

Abstract: There are two motivations for this paper:

1) In terminological systems in the tradition of KL-ONE the taxonomic and conceptual knowledge of a particular problem domain can be represented by so called concepts. The intensional definitions of these concepts can be analyzed and checked for plausibility using certain reasoning services (e.g. subsumption) that make the user conscious of some of the consequences of his definitions. A hybrid knowledge base can then rely on these checked definitions. In this paper a terminological formalism is embedded into the formalism of partial inductive definitions (PID) such that a flexible environment for experimenting with this kind of hybrid systems and the terminological formalism itself is obtained.

2) Terminological formalisms provide (terminating) decision procedures for their reasoning services dealing with a restricted kind of quantification. Mapping these algorithms to PID improves the understanding of control and explicit quantification in PID

RR-92-35

Manfred Meyer

Using Hierarchical Constraint Satisfaction for Lathe-Tool Selection in a CIM Environment

18 pages

Abstract: In this paper we shall discuss how to treat the automatic selection of appropriate lathe tools in a computer-aided production planning (CAPP) application as a constraint satisfaction problem (CSP) over hierarchically structured finite domains. Conceptually it is straightforward to formulate lathe-tool selection in terms of a CSP, however the choice of constraint and domain representations and of the order in which the constraints are applied is nontrivial if a computationally tractable system design is to be achieved.

Since the domains appearing in technical applications often can be modeled as a hierarchy, we investigate how constraint satisfaction algorithms can make use of this hierarchical structure. Moreover, many real-life problems are formulated in a way that no optimal solution can be found which satisfies all the given constraints.

Therefore, in order to bring AI technology into real-world applications, it becomes very important to be able to cope with conflicting constraints and to relax the given CSP until a (suboptimal) solution can be found. For these reasons, the constraint system CONTAX has been developed, which incorporates an extended hierarchical arc-consistency algorithm together with discrete constraint relaxation and has been used to implement the lathe-tool selection module of the ARC-TEC planning system.

RR-92-36

Franz Baader, Philipp Hanschke

Extensions of Concept Languages for a Mechanical Engineering Application

15 pages

Abstract: We shall consider an application in mechanical engineering, and shall show that the adequate modeling of the terminology of this problem domain in a conventional concept language poses two main representation problems. The first requires access to concrete domains, such as real numbers, while the second asks for a construct which can be used to represent sequences of varying length. As shown in recent papers by the authors there exist extended concept languages—equipped with sound and complete reasoning algorithms—that satisfy the respective representation demands separately.

The main result presented in this paper is that the combination of both extensions leads to undecidable terminological inference problems. In particular, the important subsumption problem is undecidable. It should be noted that the need for these extensions is not particular to the considered problem domain; similar representation demands are likely to occur in other non-toy applications.

RR-92-37*Philipp Hanschke***Specifying Role Interaction in Concept Languages**

26 pages

Abstract: The KL-ONE concept language provides role-value maps (RVMs) as a concept forming operator that compares *sets* of role fillers. This is a useful means to specify structural properties of concepts. Recently, it has been shown that concept languages providing RVMs together with some other common concept-forming operators induce an undecidable subsumption problem. Thus, RVMs have been restricted to chainings of *functional* roles as, for example, in CLASSIC.

Although this restricted RVM is still a useful operator, one would like to have additional means to specify interaction of general roles. The present paper investigates two concept languages for that purpose. The first one provides concept forming operators that generalize the restricted RVM in a different direction. Unfortunately, it turns out that this language also has an undecidable subsumption problem. The second formalism allows to specify structural properties w.r.t. roles without using general equality and is equipped with (complete) decision procedures for its associated reasoning problems.

RR-92-38*Philipp Hanschke, Manfred Meyer***An Alternative to H-Subsumption Based on Terminological Reasoning**

9 pages

Abstract: Clause subsumption and rule ordering are long-standing research topics in machine learning (ML). Since logical implication can be reduced to rule-subsumption, the general subsumption problem for Horn clauses is undecidable (Plotkin, 1971). In this paper we suggest an alternative knowledge-representation formalism for ML that is based on a terminological logic. It provides a decidable rule-ordering which is at least as powerful as H-subsumption.

RR-92-40*Philipp Hanschke, Knut Hinkelmann***Combining Terminological and Rule-based Reasoning for Abstraction Processes**

17 pages

Abstract: Terminological reasoning systems directly support the abstraction mechanisms generalization and classification. But they do not bother about aggregation and have some problems with reasoning demands such as concrete domains, sequences of finite but unbounded size and derived attributes. The paper demonstrates the relevance of these issues in an analysis of a mechanical engineering application and suggests an integration of a forward-chaining rule system with a terminological logic as a solution to these problems.

RR-92-41*Andreas Lux***A Multi-Agent Approach towards Group Scheduling**

32 pages

Abstract: Thanks to rapid improvements in computer and communication technology the network of national and international business relationships is becoming more and more dense. Intelligent cooperation mechanisms are a necessary prerequisite for efficient cooperation. This report examines an everyday cooperative scenario, scheduling and management of appointments, from the point of intelligent computer support. The example is chosen to clarify our approach towards a formal model to describe cooperative processes. It shows the suitability of the approach to quickly design and implement typical cooperative scenarios. Especially, the integration of different existing calendar tools within the general cooperation model provides a clear advantage over existing approaches.

RR-92-42

John Nerbonne

A Feature-Based Syntax/Semantics Interface

19 pages

Abstract: Syntax/Semantics interfaces using unification-based or feature-based formalisms are increasingly common in the existing computational linguistics literature. The primary reason for attempting to specify a syntax/semantics interface in feature structures is that it harmonizes so well with the way in which syntax is now normally described; this close harmony means that syntactic and semantic processing (and indeed other processing, see below) can be as tightly coupled as one wishes—indeed, there need not be any fundamental distinction between them at all. In this paper, we first point out several advantages of the unification-based view of the syntax/semantics interface over standard views. These include (i) a more flexible relation to nonsyntactic constraints on semantics; (ii) a characterization of semantic ambiguity, which in turn provides a framework in which to describe disambiguation, and (iii) the opportunity to underspecify meanings in a way difficult to reconcile with other views. The last point is illustrated with an application to the notorious scope ambiguity problem.

RR-92-43

Christoph Klauck, Jakob Mauss

A Heuristic driven Parser for Attributed Node Labeled Graph Grammars and its Application to Feature Recognition in CIM

17 pages

Abstract: To integrate CA*-systems with other applications in the CIM world, one principal approach currently under development is the feature recognition process based on graph grammars. It enables any CIM component to recognize the higher-level entities - the so-called *features* - used in this component out of a lower-data exchange format, which might be the internal representation of a CAD system as well as some standard data exchange format. In this paper we present a 'made-to-measure' parsing algorithm for feature recognition. The heuristic driven chart based bottom up parser analyzes attributed node labeled graphs (representing workpieces) with a (feature-)specific attributed node labeled graph grammar (representing the feature definitions) yielding a high level (qualitative) description of the workpiece in terms of features.

RR-92-44

Thomas Rist, Elisabeth André

Incorporating Graphics Design and Realization into the Multimodal Presentation System WIP

15 pages

Abstract: Recently, there has been increasing interest in the design of user interfaces that take advantage of graphics when presenting information. Since it is impossible to anticipate the needs and requirements of each potential user in an infinite number of presentation situations, it is more reasonable to automatically design graphics on the fly in a context-sensitive way. In this paper, we present components for graphics design and graphics realization as parts of the multimodal presentation system WIP. After a short overview of WIP, we introduce our basic assumptions about how to describe surface aspects and the meaning of complex graphics. We then describe the graphics realization component and sketch the graphics design process. By means of a generation example we show how graphics design is interleaved with graphics realization.

RR-92-45

Elisabeth André, Thomas Rist

The Design of Illustrated Documents as a Planning Task

21 pages

Abstract: Not only the generation of text, but also the generation of multimodal documents can be considered as a sequence of communicative acts which aim to achieve certain goals. For the realization of a system able to automatically generate illustrated documents, a plan-based approach seems adequate. To represent knowledge about how to present information, we have designed presentation strategies which relate to both text and picture production. These strategies are considered as operators of a planning system. However, a conventional hierarchical planner for determining the contents and the rhetorical structure of a document has proven inappropriate to handle the various dependencies between content determination, mode selection and content realization. To overcome these problems, a new planning scheme has been developed that supports data transfer between the content planner and the mode-specific generation components and allows for revising an initial document structure.

RR-92-46

*Elisabeth André, Wolfgang Finkler, Winfried Graf, Thomas Rist, Anne Schauder, Wolfgang Wahlster***WIP: The Automatic Synthesis of Multimodal Presentations**

19 pages

Abstract: Due to the growing complexity of information that has to be communicated by current AI systems, there comes an increasing need for building advanced intelligent user interfaces that take advantage of a coordinated combination of different modalities, e.g., natural language, graphics, and animation, to produce situated and user-adaptive presentations. A deeper understanding of the basic principles underlying multimodal communication requires theoretical work on computational models as well as practical work on concrete systems. In this article, we describe the system WIP, an implemented prototype of a knowledge-based presentation system that generates illustrated texts that are customized for the intended audience and situation. We present the architecture of WIP and introduce as its major components the presentation planner, the layout manager, and the generators for text and graphics. To achieve a coherent output with an optimal media mix, the single components have to be interleaved. The interplay of the presentation planner, the text and the graphics generator will be demonstrated by means of a system run. In particular, we show how a text-picture combination containing a crossmodal referring expression is generated by the system.

RR-92-47

*Frank Bomarius***A Multi-Agent Approach towards Modeling Urban Traffic Scenarios**

24 pages

Abstract: This paper investigates the use of the multi-agent paradigm in modeling urban traffic scenarios. It demonstrates that vehicles, pedestrians, traffic-lights, car-parks and even streets can be considered agents in a heterogeneous multi-agent system. Different types of agents in such scenarios will be identified, characterized and constructed by virtue of a general agent model.

The various kinds of relationships and interactions, generally called cooperations between these agents will be modeled; some examples sketch the major issues developed in this paper.

RR-92-48

*Bernhard Nebel, Jana Koehler***Plan Modifications versus Plan Generation: A Complexity-Theoretic Perspective**

15 pages

Abstract: The ability of a planner to modify a plan is considered as a valuable tool for improving efficiency of planning by avoiding the repetition of the same planning effort. From a computational complexity point of view, however, it is by no means obvious that modifying a plan is computationally as easy as planning from scratch if the modification has to follow the principle of "conservatism", i.e., to reuse as much of the old plan as possible. Indeed, considering propositional STRIPS planning, it turns out that conservative plan modification is as hard as planning and can sometimes be harder than plan generation. Furthermore, this holds even if we consider modification problems where the old and the new goal specification are similar. We put these results into perspective and discuss the relationship to existing plan modification systems. Although sometimes claimed otherwise, these systems do not address the modification problem, but use a non-conservative form of plan modification as a heuristic technique.

RR-92-49

*Christoph Klauck, Ralf Legleitner, Ansgar Bernardi***Heuristic Classification for Automated CAPP**

15 pages

Abstract: In order to create a process plan from a workpiece description, a human expert thinks in a special terminology with respect to the given workpiece. The steps of human thinking during the generation process of a process plan are following the principles of heuristic classification: First using feature recognition an abstraction process is realized yielding a high level (qualitative) description of the current workpiece in terms of features. To these features certain (more or less) abstract (partial) process plans—the so-called skeletal plans—are associated. In the refinement step these skeletal plans are merged together to one complete process plan. In this paper we present a set of domain-oriented higher level representation formalisms for features and skeletal plans suitable for the modeling of this approach. When an expert's (process planner's) knowledge has been represented using these formalisms, the generation of a process plan can be achieved by heuristic classification. This is demonstrated in the CAPP-system PIM, which is currently implemented as a prototype.

RR-92-50

*Stephan Busemann***Generierung natürlicher Sprache**

61 Seiten

Zusammenfassung: Dieser Aufsatz beschreibt das interdisziplinäre Forschungsgebiet Generierung natürlicher Sprache und gibt einen Überblick über den gegenwärtigen Stand der Kunst. Behandelt werden Ansätze aus der Psycholinguistik, Planungs- und Entscheidungsverfahren aus der sprachverarbeitenden KI und Verfahren auf der Grundlage moderner Grammatikformalismen. Die jeweiligen Forschungsziele und -methoden werden dargestellt.

Abstract: This report describes the interdisciplinary research field of natural language generation and gives an overview of the current state of the art. The paper presents psycholinguistic approaches, AI planning and decision-making processes, and generators based on modern grammar formalisms. For each case, the research goals and methods are described.

RR-92-51

*Hans-Jürgen Bürckert, Werner Nutt***On Abduction and Answer Generation through Constrained Resolution**

20 pages

Abstract: Recently, extensions of constrained logic programming and constrained resolution for theorem proving have been introduced, that consider constraints, which are interpreted under an open world assumption. We discuss relationships between applications of these approaches for query answering in knowledge base systems on the one hand and abduction-based hypothetical reasoning on the other hand. We show both that constrained resolution can be used as an operationalization of (some limited form of) abduction and that abduction is the logical status of an answer generation process through constrained resolution, i.e., it is an abductive but not a deductive form of reasoning.

RR-92-52

*Mathias Bauer, Susanne Biundo, Dietmar Dengler, Jana Koehler, Gabriele Paul***PHI—A Logic-Based Tool for Intelligent Help Systems**

14 pages

Abstract: We introduce a system which improves the performance of intelligent help systems by supplying them with plan generation and plan recognition components. Both components work in close mutual cooperation. We demonstrate two modes of cross-talk between them, one where plan recognition is done on the basis of abstract plans provided by the planner and the other where optimal plans are generated based on recognition results. The examples which are presented are taken from an operating system domain, namely from the UNIX mail domain.

Our system is completely logic-based. Relying on a common logical framework—the interval-based modal temporal logic LLP which we have developed—both components are implemented as special purpose inference procedures. Plan generation from first and second principles is provided and carried out deductively, whereas plan recognition follows a new abductive approach for modal logics. The plan recognizer is additionally supplied with a probabilistic reasoner as a means to adjust the help provided for user-specific characteristics.

RR-92-53

*Werner Stephan, Susanne Biundo***A New Logical Framework for Deductive Planning**

15 pages

Abstract: In this paper we present a logical framework for defining consistent axiomatizations of planning domains. A language to define basic actions and structured plans is embedded in a logic. This allows general properties of a whole planning scenario to be proved as well as plans to be formed deductively. In particular, frame assertions and domain constraints as invariants of the basic actions can be formulated and proved. Even for complex plans most frame assertions are obtained by purely syntactic analysis. In such cases the formal proof can be generated in a uniform way. The formalism we introduce is especially useful when treating recursive plans.

A tactical theorem prover, the *Karlsruhe Interactive Verifier KIV* is used to implement this logical framework.

RR-92-54

*Harold Boley***A Direkt Semantic Characterization of RELFUN**

30 pages

Abstract: This paper attempts a direct semantic formalization of first-order relational-functional languages (the characteristic RELFUN subset) in terms of a generalized model concept. Function-defining conditional equations (or, footed clauses) and active call-by-value expressions (in clause premises) are integrated into first-order theories. Herbrand models are accommodated to relational-functional programs by not only containing ground atoms but also ground molecules, i.e. specific function applications paired with values. Extending SLD-resolution toward innermost conditional narrowing of relational-functional clauses, SLV-resolution is introduced, which, e.g., flattens active expressions. The Tp-operator is generalized analogously, e.g. by unnesting ground-clause premises. Soundness and completeness proofs for SLV-resolution naturally extend the corresponding results in logic programming.

RR-92-55

*John Nerbonne, Joachim Laubsch, Abdel Kader Diagne, Stephan Oepen***Natural Language Semantics and Compiler Technology**

17 pages

Abstract: This paper recommends an approach to the implementation of semantic representation languages (SRLs) which exploits a parallelism between SRLs and programming languages (PLs). The design requirements of SRLs for natural language are similar to those of PLs in their goals. First, in both cases we seek modules in which both the surface representation (print form) and the underlying data structures are important. This requirement highlights the need for general tools allowing the printing and reading of expressions (data structures). Second, these modules need to cooperate with foreign modules, so that the importance of interface technology (compilation) is paramount; and third, both compilers and semantic modules need "inferential" facilities for transforming (simplifying) complex expressions in order to ease subsequent processing.

But the most important parallel is the need in both fields for tools which are useful in combination with a variety of concrete languages—general purpose parsers, printers, simplifiers (transformation facilities) and compilers. This arises in PL technology from (among other things) the need for experimentation in language design, which is again parallel to the case of SRLs.

Using a compiler-based approach, we have implemented *NLL*, a public domain software package for computational natural language semantics. Several interfaces exist both for grammar modules and for applications, using a variety of interface technologies, including especially compilation. We review here a variety of *NLL*, applications, focusing on COSMA, an NL interface to a distributed appointment manager.

RR-92-56

Armin Laux

Integrating a Modal Logic of Knowledge into Terminological Logics

34 pages

Abstract: If we want of group of autonomous agents to act and to cooperate in a world, each of them needs knowledge about this world, about the knowledge of other agents, and about his own knowledge. To describe such knowledge we introduce the language \mathcal{ALCK} which extends the concept language \mathcal{ALC} by a new operator Δ_i . Thereby, $\Delta_i\phi$ is to be read as "agent i knows ϕ ". This knowledge operator is interpreted in terms of possible worlds. That means, besides the real world, agents can imagine a number of other worlds to be possible. An agent is then said to know a fact ϕ if ϕ is true in all worlds he considers possible.

In this paper we use an axiomatization of the knowledge operator which has been proposed by Moore. Thereby, knowledge of agents is interpreted such that (i) agents are able to reason on the basis of their knowledge, (ii) anything that is known by an agent is true, and (iii) if an agent knows something then he knows that he knows it. We will give tableaux-based algorithms for deciding whether a set of \mathcal{ALCK} sentences is satisfiable, and whether such a set entails a given \mathcal{ALCK} sentence.

RR-92-58

Franz Baader, Bernhard Hollunder:

How to Prefer More Specific Defaults in Terminological Default Logic

31 pages

Abstract: In a recent paper we have proposed terminological default logic as a formalism which combines both means for structured representation of classes and objects, and for default inheritance of properties. The major drawback which terminological default logic inherits from general default logic is that it does not take precedence of more specific defaults over more general ones into account. This behaviour has already been criticized in the general context of default logic, but it is all the more problematic in the terminological case where the emphasis lies on the hierarchical organization of concepts.

The present paper addresses the problem of modifying terminological default logic such that more specific defaults are preferred. It turns out that the existing approaches for expressing priorities between defaults do not seem to be appropriate for this purpose. Therefore we shall consider an alternative approach for dealing with prioritization in the framework of Reiter's default logic. The formalism is presented in the general setting of default logic where priorities are given by an arbitrary partial ordering on the defaults. We shall exhibit some interesting properties of the new formalism, compare it with existing approaches, and describe an algorithm for computing extensions.

RR-92-59

Karl Schlechta, David Makinson

On Principles and Problems of Defeasible Inheritance

13 pages

Abstract: We have two aims here: First, to discuss some basic principles underlying different approaches to Defeasible Inheritance; second, to examine problems of these approaches as they already appear in quite simple diagrams. We build upon, but go beyond, the discussion in the joint paper of Touretzky, Horty, and Thomason: A Clash of Intuitions.

RR-92-60

Karl Schlechta

Defaults, Preorder Semantics and Circumscription

19 pages

Abstract: We examine questions related to translating defaults into circumscription. Imielinski has examined the concept of preorder semantics as an abstraction from specific systems of circumscription. We give precise definitions, characterize preorder semantics syntactically and examine the translatability of one default into preorder semantics. Finally, we give a rather bleak outlook on the translation of defaults into circumscription.

RR-93-01*Bernhard Hollunder*

An Alternative Proof Method for Possibilistic Logic and its Application to Terminological Logics

25 pages

Abstract: Possibilistic logic, an extension of first-order logic, deals with uncertainty that can be estimated in terms of possibility and necessity measures. Syntactically, this means that a first-order formula is equipped with a possibility degree or a necessity degree that expresses to what extent the formula is possibly or necessarily true. Possibilistic resolution, an extension of the well-known resolution principle, yields a calculus for possibilistic logic which respects the semantics developed for possibilistic logic.

A drawback, which possibilistic resolution inherits from classical resolution, is that it may not terminate if applied to formulas belonging to decidable fragments of first-order logic. Therefore we propose an alternative proof method for possibilistic logic. The main feature of this method is that it completely abstracts from a concrete calculus but uses as basic operation a test for classical entailment. If this test is decidable for some fragment of first-order logic then possibilistic reasoning is also decidable for this fragment.

We then instantiate possibilistic logic with a terminological logic, which is a decidable subclass of first-order logic but nevertheless much more expressive than propositional logic. This yields an extension of terminological logics towards the representation of uncertain knowledge which is satisfactory from a semantic as well as algorithmic point of view.

RR-93-02*Wolfgang Wahlster, Elisabeth André, Wolfgang Finkler, Hans-Jürgen Profitlich, Thomas Rist*

Plan-based Integration of Natural Language and Graphics Generation

50 pages

Abstract: Multimodal interfaces combining natural language and graphics take advantage of both the individual strength of each communication mode and the fact that several modes can be employed in parallel. The central claim of this paper is that the generation of a multimodal presentation can be considered as an incremental planning process that aims to achieve a given communicative goal. We describe the multimodal presentation system WIP which allows the generation of alternate presentations of the same content taking into account various contextual factors. We discuss how the plan-based approach to presentation design can be exploited so that graphics generation influences the production of text and vice versa. We show that well-known concepts from the area of natural language processing like speech acts, anaphora, and rhetorical relations take on an extended meaning in the context of multimodal communication. Finally, we discuss two detailed examples illustrating and reinforcing our theoretical claims.

RR-93-03*Franz Baader, Bernhard Hollunder, Bernhard Nebel, Hans-Jürgen Profitlich, Enrico Franconi*

An Empirical Analysis of Optimization Techniques for Terminological Representation Systems

28 pages

Abstract: We consider different methods of optimizing the classification process of terminological representation systems, and evaluate their effect on three different types of test data. Though these techniques can probably be found in many existing systems, until now there has been no coherent description of these techniques and their impact on the performance of a system. One goal of this paper is to make such a description available for future implementors of terminological systems. Building the optimizations that came off best into the KRIS system greatly enhanced its efficiency.

RR-93-04

*Christoph Klauck, Johannes Schwagerei***GGD: Graph Grammar Developer for features in CAD/CAM**

13 pages

Abstract: To integrate CA*-systems with other applications in the world of CIM, one principal approach currently under development is based on feature representation. It enables any CIM component to recognize the higher-level entities—the so-called *features*—out of a lower-data exchange format, which might be the internal representation of a CAD system as well as some standard data exchange format. In this paper we present a 'made-to-measure' editor for representing features in the higher-level domain specific representation language FEAT-REP - a representation language based on a (feature-) specific attributed node labeled graph grammar. This intelligent tool, shortly called GGD, supports the knowledge engineer during the representation process by structuring the knowledge base using a conceptual language and by verifying several characteristics of the features.

RR-93-05

*Franz Baader, Klaus Schulz***Combination Techniques and Decision Problems for Disunification**

29 pages

Abstract: Previous work on combination techniques considered the question of how to combine unification algorithms for disjoint equational theories E_1, \dots, E_n in order to obtain a unification algorithm for the union $E_1 \cup \dots \cup E_n$ of the theories. Here we want to show that variants of this method may be used to decide solvability and ground solvability of disunification problems in $E_1 \cup \dots \cup E_n$. Our first result says that solvability of disunification problems in the free algebra of the combined theory $E_1 \cup \dots \cup E_n$ is decidable if solvability of disunification problems with linear constant restrictions in the free algebras of the theories E_i ($i = 1, \dots, n$) is decidable. In order to decide ground solvability (i.e., solvability in the initial algebra) of disunification problems in $E_1 \cup \dots \cup E_n$ we have to consider a new kind of subproblem for the particular theories E_i , namely solvability (in the free algebra) of disunification problems with linear constant restriction under the additional constraint that values of variables are not E_i -equivalent to variables. The correspondence between ground solvability and this new kind of solvability holds, (1) if one theory E_i is the free theory with at least one function symbol and one constant, or (2) if the initial algebras of all theories E_i are infinite. Our results can be used to show that the existential fragment of the theory of the (ground) term algebra modulo associativity of a finite number of function symbols is decidable; the same result follows for function symbols which are associative and commutative, or associative, commutative and idempotent.

RR-93-06

*Hans-Jürgen Bürckert, Bernhard Hollunder, Armin Laux***On Skolemization in Constrained Logics**

40 pages

Abstract: First-order logics allows one to quantify over all elements of the universe. However, it is often more natural to quantify only over those elements which satisfy a certain condition. Constrained logics provide this possibility by introducing restricted quantifiers $\forall_{X:R} F$ and $\exists_{X:R} F$ where X is a set of variables, and which can be read as " F holds for all elements satisfying the restriction R " and " F holds if there exist elements which satisfy R ", respectively.

In order to test unsatisfiability of a set of such formulas using an extended resolution principle, one needs a procedure which transforms them into a set of constrained clauses. Such a procedure causes more problems than the classical transformation of first-order formulas into a set of clauses. This is due to the fact that quantification over the empty set may occur. Especially, a modified Skolemization procedure has to be used in order to remove restricted existential quantifiers.

In this paper we will give a procedure that transforms formulas with restricted quantifiers into a set of clauses with constraints preserving unsatisfiability. Since restrictions may be given by sorts this procedure can, e.g., be applied to sorted logics where empty sorts may occur. The obtained clauses are of the form $C \parallel R$ where C is an ordinary clause and R is a restriction, and which can be read as " C holds if R holds". They can be tested on unsatisfiability via constrained resolution. Finally, we introduce so-called constraint unification which can be used for optimization of constrained resolution if certain conditions are satisfied.

RR-93-07

*Hans-Jürgen Bürckert, Bernhard Hollunder, Armin Laux***Concept Logics with Function Symbols**

36 pages

Abstract: Constrained resolution allows the incorporation of domain specific problem solving methods into the classical resolution principle. Firstly, the domain specific knowledge is represented by a restriction theory. One then starts with formulas containing so-called restricted quantifiers, written as $\forall_{X,R} F$ and $\exists_{X,R} F$, where X is a set of variables and the restriction R is used to encode domain specific knowledge by filtering out some assignments to the variables in X . Formulas with restricted quantifiers can be translated into clauses which consist of a (classical) clause together with a restriction. In order to attain a refutation procedure which is based on such clauses one needs algorithms to decide satisfiability and validity of restrictions w.r.t. the given restriction theory.

Recently, concept logics have been proposed where the restriction theory is defined by terminological logics. However, in this approach problems have been assumed to be given as sets of clauses with restrictions and not in terms of formulas with restricted quantifiers. For this special case algorithms to decide satisfiability and validity of restrictions have been given.

In this paper we will show that things become much more complex if problems are given as sets of formulas with restricted quantifiers. The reason for this is due to the fact that Skolem function symbols are introduced when translating such formulas into clauses with restrictions. While we will give a procedure to decide satisfiability of restrictions containing function symbols, validity of such restrictions turns out to be undecidable. Nevertheless, we present an application of concept logics with function symbols, namely their use for generating (partial) answers to queries.

RR-93-08

*Harold Boley, Philipp Hanschke, Knut Hinkelmann, Manfred Meyer***COLAB: A Hybrid Knowledge Representation and Compilation Laboratory**

64 pages

Abstract: Knowledge bases for real-world domains such as mechanical engineering require expressive and efficient representation and processing tools. We pursue a declarative-compile approach to knowledge engineering.

While Horn logic (as implemented in PROLOG) is well-suited for representing relational clauses, other kinds of declarative knowledge call for hybrid extensions: functional dependencies and higher-order knowledge should be modeled directly. Forward (bottom-up) reasoning should be integrated with backward (top-down) reasoning. Constraint propagation should be used wherever possible instead of search-intensive resolution. Taxonomic knowledge should be classified into an intuitive subsumption hierarchy.

Our LISP-based tools provide direct translators of these declarative representations into abstract machines such as an extended Warren Abstract Machine (WAM) and specialized inference engines that are interfaced to each other. More importantly, we provide source-to-source transformers between various knowledge types, both for user convenience and machine efficiency.

These formalisms with their translators and transformers have been developed as part of COLAB, a compilation laboratory for studying what we call, respectively, 'vertical' and 'horizontal' compilation of knowledge, as well as for exploring the synergetic collaboration of the knowledge representation formalisms.

A case study in the realm of mechanical engineering has been an important driving force behind the development of COLAB. It will be used as the source of examples throughout the paper when discussing the enhanced formalisms, the hybrid representation architecture, and the compilers.

RR-93-09

*Philipp Hanschke, Jörg Würtz***Satisfiability of the Smallest Binary Program**

8 pages

Abstract: Recursivity is well known to be a crucial and important concept in programming theory. The simplest scheme of recursion in the context of logic programming is the binary Horn clause $P(l_1, \dots, l_n) :- P(r_1, \dots, r_n)$. The decidability of the satisfiability problem of programs consisting of such a rule, a fact and a goal—called smallest binary program—has been a goal of research for some time. In this paper the undecidability of the smallest binary program is shown by a simple reduction of the Post Correspondence Problem.

RR-93-10

*Martin Buchheit, Francesco M. Donini, Andrea Schaerf***Decidable Reasoning in Terminological Knowledge Representation Systems**

35 pages

Abstract: Terminological Knowledge Representation Systems (TKRS) are tools for designing and using knowledge bases that make use of terminological languages (or concept languages). We analyze from a theoretical point of view a TKRS whose capabilities go beyond the ones of presently available TKRS. The new features studied, all of practical interest, can be summarized in three main points. First, we consider a highly expressive terminological language, called *ALCNR*, including general complements of concepts, number restrictions and role conjunction. Second, we allow to express inclusion statements between general concepts, and terminological cycles as a particular case. Third, we prove the decidability of a number of desirable TKRS-*deduction services* (like satisfiability-, subsumption- and instance checking) through a sound, complete and terminating calculus for reasoning in *ALCNR*-knowledge bases. Our calculus extends the general technique of constraint systems and can be easily turned into a procedure using exponential space. As a byproduct of the proof, we get also the result that inclusion statements in *ALCNR* can be simulated by terminological cycles, if descriptive semantics is adopted.

RR-93-11

*Bernhard Nebel, Hans-Jürgen Bürckert***Reasoning about Temporal Relations:****A Maximal Tractable Subclass of Allen's Interval Algebra**

28 pages

Abstract: We introduce a new subclass of Allen's interval algebra we call "ORD-Horn subclass", which is a strict superset of the "pointisable subclass". We prove that reasoning in the ORD-Horn subclass is a polynomial-time problem and show that the path-consistency method is sufficient for deciding satisfiability. Further, using an extensive machine-generated case analysis, we show that the ORD-Horn subclass is a maximal tractable subclass of the full algebra. In fact, it is the unique greatest tractable subclass amongst the subclasses that contain all basic relations.

RR-93-12

*Pierre Sablayrolles***A Two-Level Semantics for French Expressions of Motion**

51 pages

Abstract: Developing suitable representations for formalizing time and space knowledge has always been of a great importance in Artificial Intelligence (AI) and cognitive science. We here present a new way to conjoin these two problems. From the linguistic study of motion (which is the best concept available to associate space and time at the lexical and phrase levels), realized by Laur (1991), we construct a system to represent the spatio-temporal semantics of motion. This linguistic analysis consists of a semantic classification of the French motion verbs and spatial prepositions and of the elaboration of compositional rules between the semantic classes of these verbs and these prepositions. Our system, based on a two-level semantics representation, allows to formally represent the results drawn by the linguistic part and to perform some kind of natural spatio-temporal reasoning.

RR-93-13

*Franz Baader, Karl Schlechta***A Semantics for Open Normal Defaults via a Modified Preferential Approach**

25 pages

Abstract: We present a new approach for handling open normal defaults that makes it possible

- (1) to derive existentially quantified formulae from other existentially quantified formulae by default,
- (2) to derive universally quantified formulae by default, and
- (3) to treat cardinality formulae analogously to other formulae.

This was not the case for previous approaches. Reiter uses Skolemization in his treatment of open defaults to achieve the first goal, but this has the unpleasant side-effect that logically equivalent facts may lead to different default consequences. In addition, Reiter's approach does not comply with our second requirement. Lifschitz's main motivation for his approach was to satisfy this second demand. However, to achieve this goal he has to violate the third requirement, and the first condition is also not observed. Differing from these two previous approaches, we will not view open defaults as schemata for certain instantiated defaults. Instead they will be used to define a preference relation on models. But unlike the usual approaches to preferential semantics we shall not always take the minimal models to construct our semantics. Due to this new treatment of preference relations the resulting nonmonotonic consequence operator has "nice" proof-theoretic properties such as cumulativity.

RR-93-14

*Joachim Niehren, Andreas Podelski, Ralf Treinen***Equational and Membership Constraints for Infinite Trees**

33 pages

Abstract: We present a new constraint system with equational and membership constraints over infinite trees. It provides for complete and correct satisfiability and entailment tests and is therefore suitable for the use in concurrent constraint programming systems which are based on cyclic data structures.

Our set defining devices are *greatest fixpoint solutions* of regular systems of equations with a deterministic form of union. As the main technical particularity of the algorithms we present a novel memorization technique. We believe that both satisfiability and entailment tests can be implemented in an efficient and incremental manner.

RR-93-15

*Frank Berger, Thomas Fehrle, Kristof Klöckner, Volker Schölles, Markus A. Thies, Wolfgang Wahlster***PLUS - Plan-based User Support Final Project Report**

33 pages

Abstract: This paper presents the results of the project PLUS (Plan-based User Support). The overall objective of PLUS was the design and the implementation of a plan-based help system for applications that provide a graphical and direct-manipulative interface.

The design of graphical user interfaces is based on the principle that *"the user is always in control"*. This means that the user is responsible for performing his tasks according to his own strategy. This leads to a great degree of flexibility in task execution as opposed, for instance, to menu-oriented user interfaces. Usually, neither a definite sequence of interactions nor a fixed number of actions are required to accomplish a specific task. In addition, modeless user interfaces allow the user to work on different tasks in parallel and to arbitrarily switch between them.

Within the project PLUS we developed various help strategies, including graphical representation of the current interaction context, tutoring modes, and animated help, to support novice and occasional users during their work with applications that provide graphical user interfaces.

RR-93-16

*Gert Smolka, Martin Henz, Jörg Würtz***Object-Oriented Concurrent Constraint Programming in Oz**

17 pages

Abstract: Oz is an experimental higher-order concurrent constraint programming system under development at DFKI. It combines ideas from logic and concurrent programming in a simple yet expressive language. From logic programming Oz inherits logic variables and logic data structures, which provide for a programming style where partial information about the values of variables is imposed concurrently and incrementally. A novel feature of Oz is that it accommodates higher-order programming without sacrificing that denotation and equality of variables are captured by first-order logic. Another new feature of Oz is constraint communication, a new form of asynchronous communication exploiting logic variables. This avoids the problems of stream communication, the conventional communication mechanism employed in concurrent logic programming. Constraint communication can be seen as providing a minimal form of state fully compatible with logic data structures.

Based on constraint communication and higher-order programming, Oz readily supports a variety of object-oriented programming styles including multiple inheritance.

RR-93-17

*Rolf Backofen***Regular Path Expressions in Feature Logic**

37 pages

Abstract: We examine the existential fragment of a feature logic, which is extended by regular path expressions. A regular path expression is a subterm relation, where the allowed paths for the subterms are restricted to any given regular language. We will prove that satisfiability is decidable. This is achieved by setting up a quasi-terminating rule system.

RR-93-18

*Klaus Schild***Terminological Cycles and the Propositional m-Calculus**

32 pages

Abstract: We investigate terminological cycles in the terminological standard logic \mathcal{ALC} with the only restriction that recursively defined concepts must occur in their definition positively. This restriction, called syntactic monotonicity, ensures the existence of least and greatest fixpoint models. It turns out that as far as syntactically monotone terminologies of \mathcal{ALC} are concerned, the descriptive semantics as well as the least and greatest fixpoint semantics do not differ in the computational complexity of the corresponding subsumption relation. In fact, we prove that in each case subsumption is complete for deterministic exponential time. We then show that the expressive power of finite sets of syntactically monotone terminologies of \mathcal{ALC} is the very same for the least and the greatest fixpoint semantics and, moreover, in both cases they are *strictly* stronger in expressive power than \mathcal{ALC} augmented by regular role expressions. These results are obtained by a direct correspondence to the so-called propositional m-calculus which allows to express least and greatest fixpoints explicitly. We propose \mathcal{ALC} augmented by the fixpoint operators of the m-calculus as a unifying framework for all three kinds of semantics.

RR-93-20

*Franz Baader, Bernhard Hollunder***Embedding Defaults into Terminological Knowledge Representation Formalisms**

34 pages

Abstract: We consider the problem of integrating Reiter's default logic into terminological representation systems. It turns out that such an integration is less straightforward than we expected, considering the fact that the terminological language is a decidable sublanguage of first-order logic. Semantically, one has the unpleasant effect that the consequences of a terminological default theory may be rather unintuitive, and may even vary with the syntactic structure of equivalent concept expressions. This is due to the unsatisfactory treatment of open defaults via Skolemization in Reiter's semantics. On the algorithmic side, we show that this treatment may lead to an undecidable default consequence relation, even though our base language is decidable, and we have only finitely many (open) defaults. Because of these problems, we then consider a restricted semantics for open defaults in our terminological default theories: default rules are only applied to individuals that are explicitly present in the knowledge base. In this semantics it is possible to compute all extensions of a finite terminological default theory, which means that this type of default reasoning is decidable.

RR-93-22*Manfred Meyer, Jörg Müller***Weak Looking-Ahead and its Application in Computer-Aided Process Planning**

17 pages

Abstract: Constraint logic programming has been shown to be a very useful tool for knowledge representation and problem-solving in different areas. Finite Domain extensions of PROLOG together with efficient consistency techniques such as forward-checking and looking-ahead make it possible to solve many discrete combinatorial problems within a short development time.

In this paper we present the weak looking-ahead strategy (WLA), a new consistency technique on finite domains combining the computational efficiency of forward-checking with the pruning power of looking-ahead. Moreover, incorporating weak looking-ahead into PROLOG's SLD resolution gives a sound and complete inference rule whereas standard looking-ahead itself has been shown to be incomplete. Finally, we will show how to use weak looking-ahead in a real-world application to obtain an early search-space pruning while avoiding the control overhead involved by standard looking-ahead.

RR-93-23*Andreas Dengel, Ottmar Lutzy***Comparative Study of Connectionist Simulators**

20 pages

Abstract: This paper presents practical experiences and results we obtained while working with simulators for artificial neural network, i.e. a comparison of the simulators' functionality and performance is described. The selected simulators are free of charge for research and education. The simulators in test were: (a) PlaNet, Version 5.6 from the University of Colorado at Boulder, USA, (b) Pygmalion, Version 2.0, from the Computer Science Department of the University College London, Great Britain, (c) the Rochester Connectionist Simulator (RCS), Version 4.2 from the University of Rochester, NY, USA and (d) the SNNS (Stuttgart Neural Net Simulator), Versions 1.3 and 2.0 from the University of Stuttgart, Germany. The functionality test focusses on special features concerning the establishment and training of connectionist networks as well as facilities of their application. By exemplarily evaluating the simulators' performance, we attempted to establish one and the same type of back-propagation network for optical character recognition (OCR). A respective quality statement is made by comparing the number of cycles needed for training and the recognition rate of the individual simulators.

RR-93-24*Rainer Hoch, Andreas Dengel***Document Highlighting — Message Classification in Printed Business Letters**

17 pages

Abstract: This paper presents the INFOCLAS system applying statistical methods of information retrieval primarily for the classification of German business letters into corresponding message types such as order, offer, confirmation, etc. INFOCLAS is a first step towards understanding of documents. Actually, it is composed of three modules: the central indexer (extraction and weighting of indexing terms), the classifier (classification of business letters into given types) and the focuser (highlighting relevant letter parts). The system employs several knowledge sources including a database of about 100 letters, word frequency statistics for German, message type specific words, morphological knowledge as well as the underlying document model. As output, the system evaluates a set of weighted hypotheses about the type of letter at hand, or highlights relevant text (text focus), respectively. Classification of documents allows the automatic distribution or archiving of letters and is also an excellent starting point for higher-level document analysis.

RR-93-25

Klaus Fischer, Norbert Kuhn

A DAI Approach to Modeling the Transportation Domain

93 pages

Abstract: A central problem in the study of autonomous cooperating systems is that of how to establish mechanisms for controlling the interactions between different parts (which are called agents) of the system. One way to integrate such mechanisms into a *Multi-Agent System* is to exploit the technique of cooperation or negotiation protocols. In a protocol we distinguish two essential layers: the communication layer specifying the possible flow of messages between different agents, and the decision layer, which controls the selection of a message (speech-act) that the agent sends in a specific situation.

In this report we first give a short introduction of our agent model InteRRap which provides the basis for the modeling of the different scenarios considered in the AKA-Mod project at the DFKI. The techniques we will discuss in the following are located in the plan based component and in the cooperation component of this model. The domain of application is the MARS scenario (Modeling a Multi-Agent Scenario for Shipping Companies) which implements a group of shipping companies whose goal it is to deliver a set of dynamically given orders, satisfying a set of given time and/or cost constraints. The complexity of the orders may exceed the capacities of a single company. Therefore, cooperation between companies is required in order to achieve the goal in a satisfactory way. This domain is of considerable interest for studies with economical background as well as for research projects.

We give a short summary of results from economical studies that are concerned with the real-world situation in Germany in the transportation domain. They show the need for the development of new techniques from the field of computer science to tackle the problems therein. Then, an overview on related research is presented. Two approaches are discussed in more detail: the first one being based on OR-techniques and a second one being based on the concept of partial intelligent agents attempting to integrate techniques from OR and DAI. Both approaches are concerned with the situation in a single company. However, our purpose to handle the case of distributed shipping companies requires additional mechanisms, e.g. to cope with the problems of task allocation and task decomposition in multi-agent systems.

Mechanisms for distributed task decomposition and task allocation processes in multi-agent systems belong to the core of our studies. Therefore, we will first discuss techniques for these problems in a general setting and then describe their implementations in the MARS system. In this description, particular emphasis is placed on the cooperation within a shipping company. Here, one company agent has to allocate a set of orders to its truck agents. The truck agents support the company agents by giving cost estimations based on their route planning facility. Thus, this procedure provides the basis for the decisions of the company agents and is discussed in very detail.

Finally, we present results from a series of benchmark tests. The test sets have also been run with OR-based implementations and thus, give us the opportunity to compare our implementation against these approaches.

RR-93-26

Jörg P. Müller, Markus Pischel

The Agent Architecture InteRRaP: Concept and Application

99 pages

Abstract: One of the basic questions of research in Distributed Artificial Intelligence (DAI) is how agents have to be structured and organized, and what functionalities they need in order to be able to act and to interact in a dynamic environment. To cope with this question is the purpose of models and architectures for autonomous and intelligent agents. In the first part of this report, InteRRaP, an agent architecture for multi-agent systems is presented. The basic idea is to combine the use of patterns of behaviour with planning facilities in order to be able to exploit the advantages both of the reactive, behaviour-based and of the deliberate, plan-based paradigm. Patterns of behaviour allow an agent to react flexibly to changes in its environment. What is considered necessary for the performance of more sophisticated tasks is the ability of devising plans deliberately. A further important feature of the model is that it explicitly represents knowledge and strategies for cooperation. This makes it suitable for describing high-level interaction among autonomous agents. In the second part of the report, the loading-dock domain is presented, which has been the first application the InteRRaP agent model has been tested with. An automated loading-dock is described where the agent society consists of forklifts which have to load and unload trucks in a shared, dynamic environment.

RR-93-27

*Hans-Ulrich Krieger***Derivation Without Lexical Rules**

33 pages

Abstract: In Krieger and Nerbonne (1992) we showed how to get rid of LEXICAL RULES for DERIVATION, as they are explicated by Pollard and Sag (1987) in HPSG I, Ch. 8.2. We proposed a treatment of derivation NOT by means of traditional lexical rules but instead in terms of PRINCIPLES, RULES, and LEXICAL ENTRIES entirely in the spirit of HPSG, together with unification-based inheritance of a very sophisticated kind. One major disadvantage of this approach was the employment of complex functions in certain principles. In this paper I first extend the old approach and then show how to eliminate these functional dependencies in the domain of derivational morphology by going back to simpler ones like *cons*, *first*, and *rest*. But this simplification is only achieved if we assume more complex feature structures than the ones described in Krieger and Nerbonne (e.g., by introducing two different SUBCAT features) and by proposing modified versions of the old Constituent Order Principle and the Subcategorization Principle for morphology. In addition, I postulate a hierarchy of affixes which is cross-classified, for instance, according to the effects these affixes contribute to the subcategorization information of a compound word.

The structure of the paper is as follows. We start with a very short introduction about the residence of word-formation rules in modern feature-based theories. After that we present our approach to derivational morphology which is distinguished in that it gives up the notion of lexical rule as a single entity (operator). We describe the structure of affixes and words (e.g., which attributes are appropriate?) and introduce the relevant principles and the rule schema of our approach to derivational morphology. The section shows how to reduce functional dependencies to a minimum at the cost of the size of our feature structures. We also present a technique which allows us to state relational dependencies as they are called by HPSG in a functional manner. In the next section we show how the whole treatment works by applying it to tough phenomena from prefixation and suffixation. The section presents many examples, which might serve as a *how* guide to a practitioner. After that we explain the idea which will lead us to the affix hierarchy. We will see that the affix hierarchy is inspired by the work of HPSG on structured lexicons (i.e., by the hierarchy of lexical types). A lot of examples will again be given throughout this section. We finish the paper by summarizing our approach and by saying a few words about the topics which we will tackle next.

RR-93-28

*Hans-Ulrich Krieger, John Nerbonne, Hannes Pirker***Feature-Based Allomorphy**

8 pages

Abstract: Morphotactics and allomorphy are usually modeled in different components, leading to interface problems. To describe both uniformly, we define finite automate (FA) for allomorphy in the same feature description language used for morphotactics. Nonphonologically conditioned allomorphy is problematic in FA models but submits readily to treatment in a uniform formalism.

RR-93-29

Armin Laux

Representing Belief in Multi-Agent Worlds via Terminological Logics

35 pages

Abstract: In multi-agent systems a group of autonomous intelligent systems, called agents, acts and cooperates in a world in order to achieve certain goals. Such systems are in general assumed to have no central control structure and hence each agent can only perform actions that are based on his local knowledge and on his local beliefs. In the literature knowledge of agents is mostly represented under the view that knowledge is true belief. On the other hand, if agents are acting in a (real) world their knowledge often is obtained by perception and communication, and hence typically is not true. Thus, the use of belief—where agents may have false beliefs—seems more appropriate than the use of knowledge in multi-agent systems.

Terminological logics provide a well-investigated and decidable fragment of first-order logics that is much more expressive than propositional logic and well suited to describe a world agents are acting in. However, knowledge or belief of agents can only be represented in a very limited way. In this paper we investigate how terminological logics can be extended in such a way that belief of agents can be represented in an adequate manner. We therefore exemplarily extend the concept language \mathcal{ALC} by a modal operator Δ , which is indexed by agents. Thereby, $\Delta_i\phi$ represents the fact "agent i believes ϕ ". This belief operator will be interpreted in terms of possible worlds using the well-known modal logic KD45.

This extended language \mathcal{ALCB} provides a uniform formalism to describe both, a world agents are acting in and the beliefs agents have about this world and about their own and other agents' beliefs. Thus, it can be seen as a two-dimensional extension of \mathcal{ALC} which allows both, reasoning about objective facts that hold in the world and reasoning on the level of possible worlds. We will give sound and complete algorithms to check consistency of the represented beliefs and to decide whether an \mathcal{ALCB} -sentence is logically entailed by the beliefs of agents. Hence, when acting in a world agents can use beliefs which are explicitly represented as well as implicit beliefs that are entailed by their knowledge base.

RR-93-30

Stephen P. Spackman, Elizabeth A. Hinkelman

Corporate Agents

14 pages

Abstract: The logic of belief and intention in situations with multiple agents is increasingly well understood, but current formal approaches appear to face problems in applications where the number of agents greatly exceeds two. We provide an informal development of *Corporate Agents*, an intensional approximation of individual and group states which treats groups symmetrically with autonomous agents. *Corporate Charters*, constraints derived from typical patterns of information flow, replace detailed reasoning about the propagation of attitudes in most contexts.

The approximation to an ideal logical formulation is not tight, but the model appears to function well in information-poor environments and fails in ways related to characteristic human errors. It may therefore be particularly appropriate to application in the area of natural language discourse.

RR-93-31

Elizabeth A. Hinkelman, Stephen P. Spackman

Abductive Speech Act Recognition, Corporate Agents and the COSMA System

34 pages

Abstract: This chapter presents an overview of the DISCO project's solutions to several problems in natural language pragmatics. Its central focus is on relating utterances to intentions through speech act recognition. Subproblems include the incorporation of linguistic cues into the speech act recognition process, precise and efficient multiagent belief attribution models (*Corporate Agents*), and speech act representation and processing using Corporate Agents. These ideas are being tested within the COSMA appointment scheduling system, one application of the DISCO natural language interface. Abductive speech act processing in this environment is not far from realizing its potential for fully bidirectional implementation.

RR-93-32

*David R. Traum, Elizabeth A. Hinkelman***Conversation Acts in Task-Oriented Spoken Dialogue**

28 pages

Abstract: A linguistic form's compositional, timeless meaning can be surrounded or even contradicted by various social, aesthetic, or analogistic companion meanings. This paper addresses a series of problems in the structure of spoken language discourse, including *turn-taking* and *grounding*. It views these processes as composed of fine-grained actions, which resemble speech acts both in resulting from a computational mechanism of planning and in having a rich relationship to the specific linguistic features which serve to indicate their presence.

The resulting notion of *Conversation Acts* is more general than speech act theory, encompassing not only the traditional speech acts but turn-taking, grounding, and higher-level *argumentation* acts as well. Furthermore, the traditional speech acts in this scheme become fully joint actions, whose successful performance requires full listener participation.

This paper presents a detailed analysis of spoken language dialogue. It shows the role of each class of conversation acts in discourse structure, and discusses how members of each class can be recognized in conversation. Conversation acts, it will be seen, better account for the success of conversation than speech act theory alone.

RR-93-33

*Bernhard Nebel, Jana Koehler***Plan Reuse versus Plan Generation: A Theoretical and Empirical Analysis**

33 pages

Abstract: The ability of a planner to reuse parts of old plans is hypothesized to be a valuable tool for improving efficiency of planning by avoiding the repetition of the same planning effort. We test this hypothesis from an analytical and empirical point of view. A comparative worst-case complexity analysis of generation and reuse under different assumptions reveals that it is not possible to achieve a provable efficiency gain of reuse over generation. Further, assuming "conservative" plan modification, plan reuse can actually be strictly more difficult than plan generation. While these results do not imply that there won't be an efficiency gain in the "average case", retrieval of a good plan may present a serious bottleneck for plan reuse systems, as we will show. Finally, we present the results of an empirical study of three different plan reuse systems, which leads us to the conclusion that the utility of plan-reuse techniques is limited and that these limits have not been determined yet.

RR-93-34

*Wolfgang Wahlster***Verbmobil Translation of Face-To-Face Dialogs**

10 pages

Abstract: Verbmobil is a long-term project on the translation of spontaneous language in negotiation dialogs. We describe the goals of the project, the chosen discourse domains and the initial project schedule. We discuss some of the distinguishing features of Verbmobil and introduce the notion of translation on demand and variable depth of processing in speech translation. Finally, the role of anytime modules for efficient dialog translation in close to real time is described.

RR-93-35

*Harold Boley, François Bry, Ulrich Geske (Eds.)***Neuere Entwicklungen der deklarativen KI-Programmierung — *Proceedings***

150 Seiten

Note: This document is available only for a nominal charge of 25 DM (or 15 US-\$).

Abstract: The field of declarative AI programming is briefly characterized. Its recent developments in Germany are reflected by a workshop as part of the scientific congress KI-93 at the Berlin Humboldt University. Three tutorials introduce to the state of the art in deductive databases, the programming language Gödel, and the evolution of knowledge bases. Eleven contributed papers treat knowledge revision/program transformation, types, constraints, and type-constraint combinations.

RR-93-36

Michael M. Richter, Bernd Bachmann, Ansgar Bernardi, Christoph Klauck, Ralf Legleitner, Gabriele Schmidt

Von IDA bis IMCOD: Expertensysteme im CIM-Umfeld

13 Seiten

Zusammenfassung: Kürzer werdende Produktzyklen bei höher werdenden Qualitätsansprüchen erfordern flexiblere und intelligentere Systeme für komplexere Aufgaben. Die im Sinne der CIM-Idee fortschreitende Integration unterschiedlicher Aufgabenbereiche und ihrer jeweiligen Systeme stellt hohe Anforderungen an die Informationstechnologie. Die Künstliche Intelligenz und speziell die Expertensystemforschung liefern hier erfolgversprechende Ansätze und Perspektiven. Die Systeme MOLTKE und IDA stehen als Beispiele für einzelne Expertensysteme in den Bereichen Diagnose und Konfiguration. Die Ergebnisse des ARC-TEC Projekts erreichen zwischen Konstruktion und Planung bereits eine stärkere Integration. Das Projekt IMCOD untersucht schließlich Ansätze, die Möglichkeiten der Verbindung verschiedener Systeme mit beschränkten Kompetenzbereichen, um einen besseren Produktentwurf zu erzielen.

Abstract: The shortness in product cycles with increasing quality demands requires more flexible and more intelligent systems for very complex tasks. The proceeding integration of the many different task areas within the CIM-idea and their individual systems requests high demands to the information technology. AI, especially expert system research, provides a successful approach and perspectives. The examples for single expert systems in diagnostics and configuration are the systems MOLTKE and IDA. The results of the ARC-TEC projects already reach a strong integration of construction and planning. The project IMCOD finally surveys the possibility of connecting different systems with limited competence areas to obtain better products.

RR-93-38

Stephan Baumann

Document Recognition of Printed Scores and Transformation into MIDI

24 pages

Abstract: The processing of printed music pieces on paper images is an interesting application to analyse printed information by a computer. The music notation presented on paper should be recognized and reproduced. Numerous methods of image processing and knowledge-based procedures are necessary. The DOREMIDI System allows the processing of simple piano music pieces for two hands characterized by the following steps:

- Scanning paper images
- Processing of binary image data into basic components
- Knowledge-based analysis and symbolic representation of a musical score
- Visual and acoustic reproduction of the results.

DOREMIDI has been realised on a Macintosh II, using Common-Lisp (Clos) programming language. The user interface is equivalent to the common Macintosh-interface, which enables in an uncomplicated way to use windows and menus. A keyboard presents the results of the acoustical reproduction.

RR-93-40

Francesco M. Donini, Maurizio Lenzerini, Daniele Nardi, Werner Nutt, Andrea Schaerf

Queries, Rules and Definitions as Epistemic Statements in Concept Languages

23 pages

Abstract: Concept languages have been studied in order to give a formal account of the basic features of frame-based languages. The focus of research in concept languages was initially on the semantical reconstruction of frame-based systems and the computational complexity of reasoning. More recently, attention has been paid to the formalization of other aspects of frame-based languages, such as non-monotonic reasoning and procedural rules, which are necessary in order to bring concept languages closer to implemented systems. In this paper we discuss the above issues in the framework of concept languages enriched with an epistemic operator. In particular, we show that the epistemic operator both introduces novel features in the language, such as sophisticated query formulation and closed world reasoning, and makes it possible to provide a formal account for some aspects of the existing systems, such as rules and definitions, that cannot be characterized in a standard first-order framework.

RR-93-41

*Winfried H. Graf***LAYLAB: A Constraint-Based Layout Manager for Multimedia Presentations**

9 pages

Abstract: When developing advanced intelligent user interfaces composing text, graphics, animation, hypermedia etc., the question of automatically designing the graphical layout of such multimedia presentations in an appropriate format plays a crucial role. This paper introduces the task, the functionality and the architecture of the constraint-based multimedia layout manager LayLab.

RR-93-42

*Hubert Comon, Ralf Treinen***The First-Order Theory of Lexicographic Path Orderings is Undecidable**

9 pages

Abstract: We show, under some assumption on the signature, that the $\forall^*\exists^*$ fragment of the theory of any lexicographic path ordering is undecidable. This applies to partial and to total precedences. Our result implies in particular that the simplification rule of ordered completion is undecidable.

RR-93-43

*M. Bauer, G. Paul***Logic-based Plan Recognition for Intelligent Help Systems**

15 pages

Abstract: Intelligent help systems aim at providing optimal help to the users of complex software application systems. In this context plan recognition is essential for a cooperative system behavior in that it allows to predict the user's future actions, to determine suboptimal action sequences or even serves as a basis for user-adapted tutoring or learning components. In this paper a new approach to incremental plan recognition based on a *modal temporal logic* is described. This logic allows for an abstract representation of plans including control structures such as loops and conditionals which makes it particularly well-suited for the above-mentioned tasks in command-language environments. There are two distinct phases: With a generalized *abductive reasoning* mechanism the set of valid plan hypotheses is determined in each recognition step. A *probabilistic selection*, based on Dempster-Shafer Theory, then serves to determine the "best" hypotheses in order to be able to provide help whenever required.

RR-93-44

*Martin Buchheit, Manfred A. Jeusfeld, Werner Nutt, Martin Staudt***Subsumption between Queries to Object-Oriented Databases**

36 pages

Abstract: Most work on query optimization in relational and object-oriented databases has concentrated on tuning algebraic expressions and the physical access to the database contents. The attention to semantic query optimization, however, has been restricted due to its inherent complexity. We take a second look at semantic query optimization in object-oriented databases and find that reasoning techniques for concept languages developed in Artificial Intelligence apply to this problem because concept languages have been tailored for efficiency and their semantics is compatible with class and query definitions in object-oriented databases. We propose a query optimizer that recognizes subset relationships between a query and a view (a simpler query whose answer is stored) in polynomial time.

RR-93-45

*Rainer Hoch***On Virtual Partitioning of Large Dictionaries for Contextual Post-Processing to Improve Character Recognition**

21 pages

Abstract: This paper presents a new approach to the partitioning of large dictionaries by virtual views. The basic idea is that additional knowledge sources of text recognition and text analysis are employed for fast dictionary look-up in order to prune search space through static or dynamic views. The heart of the system is a redundant hashing technique which involves a set of hash functions dealing with noisy input efficiently. Currently, the system is composed of two main system components: the dictionary generator and the dictionary controller. While the dictionary generator initially builds the system by using profiles and source dictionaries, the controller allows the flexible integration of different search heuristics. Results prove that our system achieves a respectable speed-up of dictionary access time.

RR-93-46*Philipp Hanschke***A Declarative Integration of Terminological, Constraint-based, Data-driven, and Goal-directed Reasoning**

81 pages

Abstract: The paper settles a research branch in the realm of logic-oriented, hybrid knowledge representation. Terminological knowledge representation and reasoning can now be utilized for more realistic applications as an integral component of a computationally complete, declarative hybrid knowledge representation formalism with integrated special-purpose reasoners of concrete domains such as real-closed fields or finite-domain constraints. The paper presents technical results exploring the impact of "role interaction" on the decidability of the subsumption problem of terminological logics. In particular, decision procedures are presented for common reasoning problems in an expressive terminological logic that is parametrized by a concrete domain. A refined minimal belief logic which avoids certain problems concerning the non-propositional case (which occurred surprisingly), is the basis of the model-theoretic semantics of a very general generic rule formalism integrating goal-directed (i.e., top-down) and data-driven (i.e., bottom-up) reasoning in a declarative manner. A mechanical engineering application (production planning of lathes) is used to demonstrate how the theoretical results can be employed in realistic applications.

RR-93-48*Franz Baader, Martin Buchheit, Bernhard Hollunder***Cardinality Restrictions on Concepts**

20 pages

Abstract: The concept description formalisms of existing terminological systems allow the user to express local cardinality restrictions on the fillers of a particular role. It is not possible, however, to introduce global restrictions on the number of instances of a given concept. The paper argues that such cardinality restrictions on concepts are of importance in applications such as configuration of technical systems, an application domain of terminological systems that is currently gaining in interest. It shows that including such restrictions into the description language leaves the important inference problems such as instance testing decidable. The algorithm combines and simplifies the ideas developed for the treatment of qualifying number restrictions and of general terminological axioms.

DFKI Technical Memos**TM-89-01***Susan Holbach-Weber***Connectionist Models and Figurative Speech**

27 pages

Abstract: This paper contains an introduction to connectionist models. Then we focus on the question of how novel figurative usages of descriptive adjectives may be interpreted in a structured connectionist model of conceptual combination. The suggestion is that inferences drawn from an adjective's use in familiar contexts form the basis for all possible interpretations of the adjective in a novel context. The more plausible of the possibilities, it is speculated, are reinforced by some form of one-shot learning, rendering the interpretative process obsolete after only one (memorable) encounter with a novel figure of speech.

TM-90-01

Som Bandyopadhyay

Towards an Understanding of Coherence in Multimodal Discourse

18 pages

Abstract: An understanding of coherence is attempted in a multimodal framework where the presentation of information is composed of both text and picture segments (or, audio-visuals in general). Coherence is characterised at three levels: coherence at the syntactic level which concerns the linking mechanism of the adjacent discourse segments at the surface level in order to make the presentation valid; coherence at the semantic level which concerns the linking of discourse segments through some semantic ties in order to generate a wellformed thematic organisation; and, coherence at the pragmatic level which concerns effective presentation through the linking of the discourse with the addressees' preexisting conceptual framework by making it compatible with the addressees' interpretive ability, and linking the discourse with the purpose and situation by selecting a proper discourse typology. A set of generalised coherence relations are defined and explained in the context of picture-sequence and multimodal presentation of information.

TM-90-02

Jay C. Weber

The Myth of Domain-Independent Persistence

18 pages

Abstract: The *frame problem* can be reduced to the problem of inferring the non-existence of causes for change. This paper concerns how these non-existence inferences are made, and shows how many popular approaches lack generality because they rely on a domain-independent assumption of occurrence omniscience. Also, this paper shows how to represent and use appropriate domain-dependent knowledge in three successively more expressive versions, where the causal theories are deductive, non-monotonic, and statistical.

TM-90-03

*Franz Baader, Bernhard Hollunder**KRIS* : Knowledge Representation and Inference System

-System Description-

15 pages

Abstract: The knowledge representation system KL-ONE first appeared in 1977. Until then many systems based on the idea of KL-ONE have been built. The formal model-theoretic semantics which has been introduced for KL-ONE languages provides means for investigating soundness and completeness of inference algorithms. It turned out that almost all implemented KL-ONE systems such as BACK, KL-TWO, LOOM, NIKL, SB-ONE use sound but incomplete algorithms. Until recently, sound *and* complete algorithms for the basic reasoning facilities in these systems such as consistency checking, subsumption checking (classification) and realization were only known for rather trivial languages. However, in the last two years concept languages (term subsumption languages) have been thoroughly investigated. As a result of these investigations it is now possible to provide sound and complete algorithms for relatively large concept languages.

In this paper we describe *KRIS* which is an implemented prototype of a KL-ONE system where all reasoning facilities are realized by sound and complete algorithms. This system can be used to investigate the behaviour of sound and complete algorithms in practical applications (and not just in toy examples). Hopefully, this may shed a new light on the usefulness of complete algorithms for practical applications, even if their worst case complexity is NP or worse. *KRIS* provides a very expressive concept language, an assertional language, and sound and complete algorithms for reasoning. We have chosen the concept language such that it contains most of the constructs used in KL-ONE systems with the obvious restriction that the interesting inferences such as consistency checking, subsumption checking, and realization are decidable. The assertional language is similar to languages normally used in such systems. The reasoning component of *KRIS* depends on sound and complete algorithms for reasoning facilities such as consistency checking, subsumption checking, retrieval, and querying.

TM-90-04

*Franz Baader, Hans-Jürgen Bürckert, Jochen Heinsohn,
Bernhard Hollunder, Jürgen Müller, Bernhard Nebel, Werner Nutt, Hans-Jürgen Profitlich*

Terminological Knowledge Representation: A Proposal for a Terminological Logic

7 pages

Abstract: This paper contains a proposal for a terminological logic. The formalisms for representing knowledge as well as the needed inferences are described.

TM-91-01

Jana Köhler

Approaches to the Reuse of Plan Schemata in Planning Formalisms

52 pages

Abstract: Planning in complex domains is normally a resource and time consuming process when it is purely based on first principles. Once a plan is generated it represents problem solving knowledge. It implicitly describes knowledge used by the planning system to achieve a given goal state from a particular initial state. In classical planning systems, this knowledge is often lost after the plan has been successfully executed. If such a planner has to solve the same problem again, it will spend the same planning effort to solve it and is not capable of "learning" from its "experience."

Therefore it seems to be useful to save generated plans for a later reuse and thus, extending the problem solving knowledge possessed by the planner. The planning knowledge can now be applied to find out whether a problem can be solved by adapting an already existing plan.

The aim of this paper is to analyze the problem of plan reuse and to describe the state of the art based on a variety of approaches which might contribute to a solution of the problem. It describes the main problems and results that could be of some relevance for the integration of plan reuse into a deductive planning formalism.

As a result, this description of the state of the art leads to a deeper insight into the complex problem of plan reuse, but also shows that the problem itself is still far from being solved.

TM-91-02

Knut Hinkelmann

Bidirectional Reasoning of Horn Clause Programs: Transformation and Compilation

20 pages

Abstract: A compilative approach for forward reasoning of horn rules in Prolog is presented. Pure horn rules—given as Prolog clauses—are to be used for forward and backward reasoning. These rules are translated into Prolog clauses, denoting one forward reasoning step. Forward chaining is triggered by an initial fact, from which the consequences are derived. Premises of forward rules are verified by Prolog's backward proof procedure using the original clauses. Thus, without any changes to the Prolog interpreter integrated bidirectional reasoning of the original horn rules is possible. Breadth-first and depth-first reasoning strategies with enumeration and collection of conclusions are implemented. In order to translate forward clauses into WAM operations several improvements are introduced. To avoid inefficient changes of program code derived facts are recorded in a special storage area called retain stack. Subsumption of a new conclusion by previously derived facts is tested by a built-in procedure. As a reasonable application of this kind of forward reasoning its use is demonstrated for integrity constraint checking.

TM-91-03*Otto Kühn, Marc Linster, Gabriele Schmidt***Clamping, COKAM, KADS, and OMOS:****The Construction and Operationalization of a KADS Conceptual Model**

20 pages

Abstract: For a simplified version of the clamping tool selection problem in mechanical engineering, the knowledge acquisition tool COKAM is applied to obtain an informal knowledge base and explanation structures from technical documents and previously solved cases. The output of COKAM is used to construct a three layered KADS conceptual model which is then transformed into an operational model in the language OMOS. The OMOS formalization allows to verify the informal KADS conceptual model and to check the completeness of the domain knowledge. The results of this analysis are utilized in the next knowledge elicitation session with COKAM.

TM-91-04*Harold Boley (Ed.)***A Sampler of Relational/Functional Definitions**

(Second, Revised Edition)

12 pages

Abstract: This is a collection of annotated RELFUN definitions showing principles and applications of relational/functional specification. It consists of concise declarative programs (often invertible) selected on the basis of didactic considerations. The knowledge they encode is mostly derived from the domain of mechanical engineering. The definitions solve problems in solid geometry, feature parsing, workpiece normalization, chemistry, etc.. All examples can be run directly in RELFUN.

TM-91-05*Jay C. Weber, Andreas Dengel, Rainer Bleisinger***Theoretical Consideration of Goal Recognition Aspects for Understanding Information in Business Letters**

10 pages

Abstract: Businesses are drowning in information—paper forms, e-mail, phone-calls and other media do struggle the speed of managers in handling and processing information. Traditional computer systems do not support business flow because of their inflexibility and their lack in understanding information. A sophisticated understanding of the meaning of a business letter requires an understanding of why the sender wrote it. This paper describes some ideas to use goal recognition techniques as one possibility, or method to initiate information understanding. It brings together two areas of cognition: goal recognition and document understanding. To do so, it gives an overview of the application of goal recognition techniques to the discovery of the overall purpose of a letter and a coherent explanation of how the individual sentences are meant to achieve that purpose.

TM-91-06*Johannes Stein***Aspects of Cooperating Agents**

22 pages

Abstract: An overview on aspects about cooperating agents is presented. As multiagent systems are various, we start with a classification of multiagent systems which is particularly influenced by an article from Decker, Durfee, and Lesser [Decker& 89]. In the following, the aspects of communication, planning, and negotiation are examined. On the occasion of communication, the discussion is split into: no communication—simple protocols—artificial languages. The planning aspect is broken into sections: from classical to multiagent planning—a general multiagent planning theory—intention—intention-directed multiagent planning. Finally, a summary of Brigitte and Hassan Lâasri and Victor Lesser's negotiation theory will be presented.

TM-91-08

*Munindar P. Singh***Social and Psychological Commitments in Multiagent Systems**

11 pages

Abstract: Commitment is a central concept in Artificial Intelligence (AI). At least two kinds of commitments can be identified that have been used in AI—the internal or *psychological* and the external or *social*. While the former has been explicit in AI theory, the latter has often been ignored (though it is given more importance in other disciplines, and indeed even in AI practice). The many roles of social commitment in AI are discussed within. It is argued that while social and psychological commitments are related, they must not be conflated with each other. In particular, thinking directly in terms of social commitments helps us avoid the infelicities of traditional theories of group action and intention.

TM-91-09

*Munindar P. Singh***On the Semantics of Protocols Among Distributed Intelligent Agents**

18 pages

Abstract: The continuing expansion of distributed intelligent systems makes new demands on theories of communication in Computer Science. It is customary to describe the individual nodes or agents in an intelligent system in terms of higher-level concepts such as intentions, know-how and beliefs. However, current theories of the communication among such agents provide no form of a formal or rigorous semantics for the messages exchanged at a corresponding level of abstraction—they either concern themselves with implementational details or address what is, for artificial systems, an irrelevant aspect of the problem. A recent theory of communication that gives the objective model-theoretic semantics for speech acts is applied to this problem. This allows important properties of protocols to be formalized abstractly, i.e., at the level of the application, not the implementation. Further constraints on "good" designs can also be stated, which simplify the requirements imposed on the member agents. The resulting theory not only provides some insights into designing distributed intelligent systems, but also helps in their validation. As an example, it is applied to a logical reconstruction of the classical Contract Net protocol.

TM-91-10

*Béla Buschauer, Peter Poller, Anne Schauder, Karin Harbusch***Tree Adjoining Grammars mit Unifikation**

149 pages

Abstract: Tree Adjoining Grammars (TAGs) - as used in the parsing algorithm of Harbusch - can be improved with respect to compactness and transparency for the task of grammar design. We have combined the two formalisms Tree Adjoining Grammar and Unification in order to benefit from their respective advantages. Our approach is contrasted with the approach of Vijay-Shanker.

TM-91-11

*Peter Wazinski***Generating Spatial Descriptions for Cross-modal References**

21 pages

Abstract: We present a localisation component that supports the generation of cross-modal deictic expressions in the knowledge-based presentation system WIP. We deal with relative localisations (e.g., "The object to the left of object X."), absolute localisations (e.g., "The object in the upper left part of the picture.") and corner localisations (e.g., "The object in the lower right corner of the picture"). In addition, we distinguish two localisation granularities, one less detailed (e.g., "the object to the left of object X.") and one more detailed (e.g., "the object above and to the left of object X."). We consider corner localisations to be similar to absolute localisations and in turn absolute localisations to be specialisations of relative localisations. This allows us to compute all three localisation types with one generic localisation procedure. As elementary localisations are derived from previously computed composite localisations, we can cope with both localisation granularities in a computationally efficient way. Based on these primary localisation procedures, we discuss how objects can be localised among several other objects. Finally we introduce group localisations (e.g., "The object to left of the group of other objects.") and show how to deal with them.

TM-91-12

Klaus Becker, Christoph Klauck, Johannes Schwagereit

FEAT-PATR:

Eine Erweiterung des D-PATR zur Feature-Erkennung in CAD/CAM

33 Seiten

Zusammenfassung: In diesem Papier wird aufgezeigt, wie der im Bereich der natürlichsprachlichen Systeme bekannte unifikationsbasierte Grammatikformalismus D-PATR [Kartt86] erweitert werden kann, um im Bereich CAD/CAM zur geometrischen Interpretation von Werkstücken herangezogen werden zu können. Das resultierende System FEAT-PATR demonstriert zum einen die Nützlichkeit einer Analogie zwischen (formalen) Sprachen und der geometrischen Interpretation von Werkstücken und zum anderen die Schwächen bestehender Grammatikformalismen für String-Grammatiken zur geometrischen Interpretation von Werkstücken.

TM-91-13

Knut Hinkelmann

Forward Logic Evaluation: Developing a Compiler from a Partially Evaluated Meta Interpreter

16 pages

Abstract: Pure horn logic does not prescribe any inference strategy. Clauses could be applied in forward and backward direction. This paper presents a translation of rules into forward clauses which simulate a forward chaining deduction if executed by Prolog's resolution procedure. Premises of forward rules are verified by Prolog's backward proof procedure using the original clauses. Thus, without any changes to the Prolog interpreter integrated bidirectional reasoning of horn rules is possible. The translation is obtained from a meta interpreter for forward reasoning written in horn logic. Data-driven partial evaluation of this meta interpreter wrt the original horn clauses results in a forward program. The approach is applied to the problem of recognizing production-specific features from a product model. A product model contains geometrical, topological, and technological information collected during the design phase. From these data features giving valuable hints about manufacturing are derived.

TM-91-14

Rainer Bleisinger, Rainer Hoch, Andreas Dengel

ODA-based modeling for document analysis

14 pages

Abstract: This article proposes the document model of a hybrid knowledge-based document analysis system for business letters. The model combines requirements of object-oriented representation of both, documents as well as knowledge necessary for analysis tasks, and is based on the ODA platform. Model-driven document analysis increases the flexibility of a system because several analysis specialists can be used in co-operation to assist each other and to improve the results of analysis. The inherent modularity of the system allows for a reuse of knowledge sources and integral constituents of the architecture in other document classes such as forms or cheques.

TM-91-15

*Stefan Bussmann*Prototypical Concept Formation
An Alternative Approach to Knowledge Representation

28 pages

Abstract: This paper describes an approach for representing and forming natural categories. We will first show classical concept formation to be inadequate and discuss experimental results of cognitive science which led to the development of prototype theory. The basic idea is to represent concepts by their most typical members instead of giving a precise definition. The core of prototype theory, as validated results, points out only properties of human concept formation, but does not imply a concrete model. Thus, we will introduce our approach to prototypical concept formation and discuss its implementation.

TM-92-01

Lijuan Zhang

Entwurf und Implementierung eines Compilers zur Transformation von Werkstückrepräsentationen

34 Seiten

Zusammenfassung: Im Projekt ARC-TEC werden innerhalb der anwendungsorientierten Grundlagenforschung KI-Methoden entwickelt oder weiterentwickelt und mit anderen Techniken der Informatik verzahnt. Ergebnis des ARC-TEC Projektes ist eine domänenspezifische Shell für ein Teilgebiet der Fertigungstechnik und eine oder mehrere exemplarische Anwendungen dieser Shell. Daneben werden Schnittstellen zu konventionellen Modellierungstools, wie z.B. STEP oder CLDATA erstellt.

In dieser Arbeit wird die Entwicklung und Implementierung einer Schnittstelle zu dem Konstruktionssystem, fertigungsgerecht entwickelt am Lehrstuhl von Prof. Meerkamm, Universität Erlangen, dokumentiert.

Abstract: In the ARC-TEC project, AI methods are developed within the application oriented principle research work and are linked together with other technics of Computer Science. The result of the ARC-TEC project is a domain specific shell for a subarea of manufacturing and one or more exemplary applications of this shell. Besides this interfaces to conventional modeling tools via e.g. STEP and CLDATA are generated.

In this Technical Memo the development and implementation of an interface to the Konstruktionssystem Fertigungsgerecht, developed at the chair of Prof. Meerkamm University of Erlangen, is documented.

TM-92-02

Achim Schupeta

Organizing Communication and Introspection in a Multi-Agent Blocksworld

32 pages

Abstract: The implementation of a simple blocksworld-scenario simulation-program is described. The blocksworld is modeled according to the multi-agent paradigm of distributed artificial intelligence. Each block is viewed as an agent. The agents have capabilities like to move, to communicate, to plan or to gain a small amount of introspective knowledge which are necessary to transform the initial scene of a problem into the goal scene. The structure of the system is oriented along the ideas of the specification of RATMAN described in (BMS91). RATMAN was reduced to its two central modules and their concepts were implemented with means as simple as possible. The result was a system, that allows to experimentally develop concepts for communication, planning and introspection, that are (for this simple toy-domain) sufficient to solve the problems without any global problem solver, but by the cooperative behavior in the society of agents

TM-92-03

Mona Singh

A Cognitive Analysis of Event Structure

21 pages

Abstract: Events occupy a central place in natural language. Accordingly, an understanding of them is crucial if one is to have any kind of a theoretically well-motivated account of natural language understanding and generation. It is proposed here that speakers create a cognitive structure for each discourse and process it as they introduce sentences into the discourse. The structure for each sentence depends systematically on its tense, aspect and the situation type; its effect on the discourse also depends on the structures of the sentences that precede it. It is also argued that the perfective aspect introduces the structure of the given event in its entirety. The progressive, by contrast, introduces only the core of the structure of the given event excluding, in particular, its preparatory processes and resultant state. Similarly, the perfect and the perfective can be distinguished on the basis of the temporal schemata they introduce. While the perfective presents the event as complete, the perfect presents it as complete and closed; i.e., the perfect prevents succeeding discourse from being interpreted as falling during the given event. This is surprising since the perfect is otherwise simply the combination of the perfective and a tense. This paper also provides a key motivation for distinguishing between the preparatory processes and the preliminary stages of an event. This observation, which is crucial in distinguishing between the perfective and the progressive has not been made in the literature.

TM-92-04

*Jürgen Müller, Jörg Müller, Markus Pischel, Ralf Scheidhauer***On the Representation of Temporal Knowledge**

61 pages

Abstract: The growing interest in an adequate modelling of time in Artificial Intelligence has given rise to the research discipline of *Temporal Reasoning (TR)*. Due to different views, different approaches towards TR such as PL1, modal logics or Allen's interval logic have been investigated. It was realized at an early stage that each of these approaches has some strong points whereas it suffers from certain drawbacks. Thus recently, a number of research activities have emerged aiming at a combination of the classical paradigms for representing time.

In the first part of this paper, we present an overview of the most important approaches to the integration of temporal knowledge into logic programming. In the second part, we present the CRONOLOG temporal logic programming language which has been developed to cover the quintessence of the approaches presented before. The third part of the paper describes TRAM, which it is an extension of CRONOLOG to a temporal knowledge representation system. Using TRAM it is possible to represent knowledge depending on time and to reason about this knowledge. TRAM has been conceptually based on a combination of modal logics with Allen's interval logic. We present the *Extended Modal Logics (EML)* which establishes the theoretical framework for TRAM. We define an *operational semantics* and a *horizontal compilation scheme* for TRAM.

TM-92-05

*Franz Schmalhofer, Christoph Globig, Jörg Thoben***The refitting of plans by a human expert**

10 pages

Abstract: During the course of the development of a Case-Oriented Expert System for situated applications additional cases were needed. The required cases were obtained by having a human expert refit old solutions to new problems and the structural relations between source and target cases were analyzed: A higher degree of reuse of the old cases was found when the expert could apply derivational reasoning and a uniform design rationale (i.e. the solution of the source was generated by the expert himself) than when the expert could only analyze structural relationships (i.e. the source solution was constructed by some one else). Except with very obvious cases, it was also found, that different experts perceive different cases as the most similar source to a given target problem. The results also indicate for user-situated applications of expert systems.

TM-92-06

*Otto Kühn, Franz Schmalhofer***Hierarchical skeletal plan refinement: Task- and inference structures**

14 pages

Abstract: This paper presents the task- and inference structure for skeletal plan refinement which was developed for lathe production planning, the application domain of the ARC-TEC project. Two inference structures are discussed: a global inference structure which was developed in the first phase of knowledge acquisition and a more detailed inference structure which builds on the hierarchical organization of the skeletal plans. The described models are evaluated with respect to their cognitive adequacy and their scope of application. The benefits and limitations of the KADS knowledge acquisition methodology are discussed with respect to the development of the two models.

TM-92-08

*Anne Kilger***Realization of Tree Adjoining Grammars with Unification**

27 pages

Abstract: The syntactic generator of the WIP system is based on the representation formalism 'Tree Adjoining Grammars' (TAGs). We have extended the formalism by associating elementary rules of the grammar (trees) with feature structures, leading to 'Tree Adjoining Grammars with Unification' (UTAGs). The extended formalism facilitates a compact and adequate representation of complex syntactic features. The contradiction between the monotonic operation of unification and the combination operation for trees—adjunction—that is nonmonotonic in a way can be solved by several approaches to realization. Two of them are presented in this work and compared with respect to the restrictions that are given by the system, i.e., the adequacy of the realization for incremental and parallel generation. It can be shown that UTAGs are subsumed by FTAGs (Feature Structure based TAGs) that have been defined by Vijay-Shanker and Joshi. That is why the results for realization can be applied to both UTAGs and a restricted version of FTAGs.

TM-93-01

Otto Kühn, Andreas Birk

Reconstructive Integrated Explanation of Lathe Production Plans

20 pages

Abstract: A Reconstructive Explanation tool has been developed and implemented within an integrated knowledge acquisition framework. This tool (RIETO) employs both a formal and an informal knowledge base to construct explanations for individual lathe production plans. RIETO adopts a reconstructive explanation approach [WickThompson92] which does not rely on the problem solving trace constructed by the inference component of the system. Instead it reconstructs possible lines of reasoning which may provide justifications for those aspects of the solution which are questioned by the user. The explanation tool can thus bring to bear all pertinent information which was captured during knowledge acquisition, even if it was not used for actually solving the problem. RIETO can answer 'why?' and 'why not?' questions about different aspects of the production plan, can give justifications for rules and provide all information about a particular topic (e.g. the selection of cutting materials) which is pertinent to the context in which the question is asked by the user.

TM-93-02

Pierre Sablayrolles, Achim Schupeta

Conflict Resolving Negotiation for COoperative Schedule Management Agents (COSMA)

21 pages

Abstract: A five component negotiation model which structures the interaction of agents along different levels of increasing complexity is investigated: The lowest level introduces the possible *message types*. The *protocol level* links those messages together to create communicational contexts. The *decision layer* needs some criteria to rank and compare different scheduling proposals. The usage of those criteria implements the *negotiation strategy* of the strategic level. As an outline we sketch how a *cooperation level* emerges within the agent society and enforces cooperative behavior of the agents.

The model is presented at the problem of appointment scheduling, because it is an inherently distributed problem which necessarily involves communication, negotiation, and cooperation mechanisms to resolve possible conflicts. COSMA agents (COoperative Schedule Management Agents) are designed to act as personal assistants to maintain their user's calendar. They are provided with competence to negotiate about the scheduling of appointments with other users. After describing the message types, the negotiation protocol is presented. The decision criteria are derived from a time model based on the association of time intervals and preferences. The negotiation strategies are guided by a local time file, the priority of a meeting and the results of earlier negotiations, which is encoded in a simple partner model maintained by the agents. An example finally shows the overall behavior of the agent society and will reveal and answer several questions about the technical details.

TM-93-03

Harold Boley, Ulrich Buhrmann, Christof Kremer

Konzeption einer deklarativen Wissensbasis über recyclingrelevante Materialien

11 pages

Abstract: For economic decision processes, recycling of products and production waste is getting more important. In future the integration of recycling-relevant data in information structures of companies should be supported by knowledge-based methods. We present the conception of a knowledge base for recycling-oriented product and production planning (RPPP). Then we take a detailed look at the fundamental materials module. We examine which evolution techniques are appropriate for the maintenance of such knowledge bases. In particular, we study the validation of existing materials and the exploration of new ones with regard to their recyclability.

TM-93-04

Hans-Günther Hein

Propagation Techniques in WAM-based Architectures — The FIDO-III Approach

105 pages

Abstract: In this paper we develop techniques to implement finite domain constraints into the Warren Abstract Machine (WAM) to solve large combinatorial problems efficiently. The WAM is the de facto standard model for compiling PROLOG. The FIDO system (Finite Domain) provides the same functionality as the finite domain part of CHIP.

The extension includes the integration of several new variable types (suspended variables, domain variables and suspended domain variables) into the WAM. The 'firing conditions' are lookahead and forward control schemes known from CHIP. We have developed a constraint model where the constraint is divided into constraint initialization code, constraint testing code and constraint body. Furthermore, we supply a deeply integrated WAM builtin to realize the first fail principle. Besides the summary of the important theoretical results, the specification of the compilation process in the WAM Compilation Scheme is given.

We also present a simple graphical analysis method to estimate the computational burden of lookahead and forward constraints.

The work is an instance of exploring finite domain consistency techniques in logic programming belonging to the FIDO lab within the ARC-TEC project.

TM-93-05

Michael Sintek

Indexing PROLOG Procedures into DAGs by Heuristic Classification

64 pages

Abstract: This paper first gives an overview of standard PROLOG indexing and then shows, in a step-by-step manner, how it can be improved by slightly extending the WAM indexing instruction set to allow indexing on multiple arguments. Heuristics are described that overcome the difficulty of computing the indexing WAM code. In order to become independent from a concrete WAM instruction set, an abstract graphical representation based on DAGs (called DAXes) is introduced.

The paper includes a COMMON LISP listing of the main heuristics implemented; the algorithms were developed for RELFUN, a relational-plus-functional language, but can easily be used in arbitrary PROLOG implementations.

DFKI Documents

D-89-01

Michael H. Malburg, Rainer Bleisinger

HYPERBIS: ein betriebliches Hypermedia-Informationssystem

43 Seiten

Zusammenfassung: Hypermediasysteme finden in jüngster Zeit immer größere Beachtung, was sich in vielen Konferenz- und Workshopveranstaltungen niederschlägt. In diesem Bericht wird die Entwicklung eines betrieblichen Informationssystems unter Verwendung eines Hypermediasystems betrachtet. Die verfolgte Absicht dieses Ansatzes war es, möglichst viele Informationen des DFKI, insbesondere der bestehenden Organisation, des beschäftigten Personals, der durchgeführten Projekte und der benutzten Räumlichkeiten, in einheitlicher Weise auf einem Rechner zu verwalten und bei unterschiedlichen Gelegenheiten wirkungsvoll zu präsentieren. Das System HYPERBIS wird einerseits aus entwicklungstechnischer Sicht und andererseits aus Benutzersicht beschrieben. Zum einen werden die teilweise schwierige Akquisition und Analyse von Informationen über das DFKI sowie die anschließende Abbildung in die Hypermediastrukturen diskutiert. Zum anderen werden ausführlich die komfortable Benutzerschnittstelle und die hilfreichen Wartungsfunktionen erklärt.

D-90-01

DFKI Wissenschaftlich-Technischer Jahresbericht 1989

45 Seiten

Zusammenfassung: Dieses Dokument enthält den Wissenschaftlich-Technischen Jahresbericht 1989 des Deutschen Forschungszentrums für Künstliche Intelligenz.

D-90-02*Georg Seul***Logisches Programmieren mit Feature - Typen**

107 Seiten

Zusammenfassung: Diese Arbeit integriert Feature-Typen in eine logische Programmiersprache mit polymorpher Typdisziplin und Untersorten. Während die Typisierung die Erkennung vieler Programmierfehler zur Compile-Zeit ermöglicht, stellen Feature-Typen abstrakte Zugriffsfunktionen und einen Vererbungsmechanismus zur Verfügung. Es wird zunächst gezeigt, wie die Semantik und die allgemeinen operationalen Methoden (Interpreter, Typ-Checker) einer polymorphen Sortenlogik mit Feature-Typen aussehen können. Die logische Programmiersprache TEL verfügt bereits über ein polymorphes Typkonzept mit Untersorten. Wir beschreiben den Entwurf und die Implementierung einer Erweiterung von TEL um Feature-Typen. Es stellt sich heraus, daß die Einbettung von Feature-Typen in das Modulkonzept von TEL interessante Möglichkeiten im Sinne des *information hiding* bietet.

D-90-03*Ansgar Bernardi, Christoph Klauck, Ralf Legleitner***Abschlußbericht des Arbeitspaketes PROD**

36 Seiten

Zusammenfassung: In dieser Studie wird eine Übersicht über konventionelle Produktmodelle im Bereich des Maschinenbaus gegeben. Es werden Datenstrukturierungs- und speicherungsaspekte diskutiert. Die Erkenntnisse sollen eine Grundlage für die Erstellung eines integrierten wissensbasierten Produktmodelles werden.

D-90-04*Ansgar Bernardi, Christoph Klauck, Ralf Legleitner***STEP: Überblick über eine zukünftige Schnittstelle zum Produktdatenaustausch**

69 Seiten

Zusammenfassung: STEP (*Standard for the Exchange of Product Model Data*) ist ein von der ISO entwickeltes Standardformat zur Abbildung produktdefinierender Daten (ISO TC 184/SC 4, NAM 96.4) im Gesamtkomplex der CIM-Techniken (*Computer Integrated Manufacturing*), der 1993 weltweiter Standard werden soll. In diesem Bericht wird ein Überblick über den derzeitigen Entwicklungsstand von STEP gegeben. Dabei werden die bereits weitgehend stabilen Teile detailliert beschrieben.

D-90-05*Ansgar Bernardi, Christoph Klauck, Ralf Legleitner***Formalismus zur Repräsentation von Geometrie- und Technologieinformationen als Teil eines Wissensbasierten Produktmodells**

66 Seiten

Zusammenfassung: Im Projektteil R von ARC-TEC ist unter anderem das Integrierte Wissensbasierte Produktmodell (IWP) zu erstellen. Mit Hilfe der unter diesem Begriff zusammengefassten Formalismen soll es möglich sein, ein Werkstück so vollständig zu beschreiben, daß auf dieser Basis die im Rahmen des Gesamtprojekts auftretenden Aufgaben (Konfiguration, Arbeitsplanung, Qualitätssicherung) gelöst werden können. Das IWP umfasst neben Elementen zur Beschreibung des Fertigungsumfeldes (Werkzeugmaschinen, Werkzeuge, Spannmittel usw.) und der speziellen Elemente der Aufgabe (etwa Arbeitspläne ...) eine vollständige Repräsentation des Werkstücks. Hierzu werden Geometrie, Funktionselemente, technologische Information, Bemaßung, arbeitstechnische Bereiche ("Features"), aber auch der intendierte Einsatz und die Historie des Produkts usw. abgebildet. Der in diesem Dokument vorgestellte Entwurf befaßt sich ausschließlich mit der Repräsentation des Werkstücks und beschreibt einen Formalismus zur Repräsentation der Geometrie eines Werkstücks, der um Elemente zur Darstellung von Funktionselementen, technologischen Informationen usw. erweitert wurde.

D-90-06*Andreas Becker***The Window Tool Kit**

66 pages

Abstract: The window toolkit presented in this document realizes a uniform graphical interface for Apple Macintosh and X Windows systems using Common Lisp. Two implementations exist: The Allegro Window Toolkit runs on Macintosh using Allegro Common Lisp. The X Window Toolkit is based on Common Lisp and the Common Lisp-X Windows interface CLX. As far as graphic is concerned, Common Lisp programs relying on this toolkit are compatible w.r.t. X Windows systems and Macintosh and may be exchanged freely. The Window Toolkit includes functions for the generation, management and handling of graphical objects, e. g. windows, menus, bitmaps. Output of text using several fonts and drawing of primitive geometric entities, e.g. circles and lines, is also supported.

D-91-01*Werner Stein, Michael Sintek***Relfun/X - An Experimental Prolog Implementation of Relfun**

48 pages

Abstract: Relfun/X is an experimental implementation of Relfun, a relational and functional language developed by Harold Boley at Kaiserslautern University. It is totally implemented in Prolog; additionally, the Relfun/X programs are compiled into Prolog programs (i.e. "consulted" analogously to the ordinary consulting scheme of Prolog). While Relfun/X does not provide all the features of the Lisp-based Relfun implementation, it is the first running version supporting Relfun's multi-footed clauses.

D-91-02*Jörg P. Müller***Design and Implementation of a Finite Domain Constraint Logic Programming System based on PROLOG with Coroutinging**

127 pages

Abstract: Many problems in Artificial Intelligence can be regarded as constraint solving problems (CSPs). Due to its relational, declarative and nondeterministic form, logic programming offers a convenient way for *solving* CSPs. Unfortunately, logic programming languages such as e. g. PROLOG tend to be inefficient for *solving* CSPs because of their poor control facilities. One current way of remedying this is the Constraint Logic Programming approach: By integrating a domain concept for logic variables, and consistency techniques such as forward checking or looking-ahead into PROLOG, the search space can be restricted in an *a priori* manner. Thus, a more efficient control strategies can be realized, preserving the 'clean' dual PROLOG semantics. In the paper, a horizontal compilation approach towards a CLP system is presented. A PROLOG system providing a delay mechanism is used in order to achieve the control behaviour described above.

D-91-03*Harold Boley, Klaus Elsbernd, Hans-Günther Hein, Thomas Krause***RFM Manual: Compiling RELFUN into the Relational/Functional Machine (Second, Revised Edition)**

38 pages

Abstract: RELFUN's classifier produces a declarative clause language; its code generator optimizes target code for an underlying WAM emulator, called NyWAM. The parts are glued together by RELFUN's user interface. All intermediate steps use explicit LISP S-expression representations, which can be displayed. The software is part of a LISP-based compilation laboratory for relational/functional languages.

D-91-04**DFKI Wissenschaftlich-Technischer Jahresbericht 1990**

93 Seiten

Zusammenfassung: Dieses Dokument enthält den Wissenschaftlich-Technischen Jahresbericht 1990 des Deutschen Forschungszentrums für Künstliche Intelligenz.

D-91-06

Gerd Kamp

Entwurf, vergleichende Bewertung und Integration eines Arbeitsplanerstellungssystems für Drehteile

130 Seiten

Zusammenfassung: In letzter Zeit werden verstärkt Anstrengungen zur Automatisierung der Arbeitsplanung unternommen. Insbesondere sollen wissensbasierte Methoden helfen, bisher offene Probleme zu lösen. So entstanden eine Reihe von Prototypen zur Arbeitsplanerstellung, über die in zahlreichen Veröffentlichungen berichtet wurde.

Nach einer Einführung in die Begriffswelt und Problematik der Arbeitsplanerstellung werden im ersten Teil dieser Arbeit eine Anzahl dieser Systeme untersucht und verglichen. Daraus werden Anforderungen abgeleitet, die ein System zur Arbeitsplanerstellung erfüllen sollen, aber teilweise noch nicht vorhanden sind.

Im zweiten Teil wird das Konzept eines Systems entwickelt, das versucht diesen Anforderungen gerecht zu werden. Eine Anforderung ist die Möglichkeit des Anschlusses externer Programme (wie z.B. CAD-Systemen und Datenbanken) an das Arbeitsplanungssystem.

Die Entwicklung und Implementierung einer Client-Server Architektur zur Verwirklichung dieser Schnittstelle zu externen Programmen ist Inhalt des dritten Teiles der Arbeit.

D-91-07

Ansgar Bernardi, Christoph Klauck, Ralf Legleitner

TEC-REP: Repräsentation von Geometrie- und Technologieinformationen

70 Seiten

Zusammenfassung: Im Projektteil R von ARC-TEC ist unter anderem das Integrierte Wissensbasierte Produktmodell (IWP) zu erstellen. Mit Hilfe der unter diesem Begriff zusammengefaßten Formalismen soll es möglich sein, ein Werkstück so vollständig zu beschreiben, daß auf dieser Basis die im Rahmen des Gesamtprojekts auftretenden Aufgaben (Konfiguration, Arbeitsplanung, Qualitätssicherung) gelöst werden können. Das IWP umfaßt neben Elementen zur Beschreibung des Fertigungsumfeldes (Werkzeugmaschinen, Werkzeuge, Spannmittel usw.) und der speziellen Elemente der Aufgabe (etwa Arbeitspläne ...) eine vollständige Repräsentation des Werkstücks. Hierzu werden Geometrie, Funktionselemente, technologische Information, Bemaßung, arbeitstechnische Bereiche ("Features"), aber auch der intendierte Einsatz und die Historie des Produkts usw. abgebildet. Der in diesem Dokument vorgestellte Entwurf TEC-REP befaßt sich ausschließlich mit der Repräsentation des Werkstücks und beschreibt einen Formalismus zur Repräsentation der Geometrie eines Werkstücks, der um Elemente zur Darstellung von Funktionselementen, technologischen Informationen usw. erweitert wurde.

Dieses Dokument ist eine verbesserte und erweiterte Auflage des Dokumentes D-90-05.

Abstract: A goal of ARC-TEC part R is the development of the integrated knowledge-based product model (Integriertes Wissensbasiertes Produktmodell IWP). The formalisms summarized under this name shall facilitate a complete representation of product information to serve as a base for the solution of all ARC-TEC tasks (configuration, work plans, quality assurance). The IWP includes descriptions of the shop floor (machine tools, tools ...), the application-specific representation tasks (e. g. work plans), and a complete representation of the work piece. The latter describes the geometry, functional elements, technological information, measurements, and features of a work piece together with its history and intended use.

This document shows the geometry representation formalism TEC-REP which has been augmented by constructs for the description of functional elements, technological information, measurements and so on as part of the final work piece representation.

This document is a corrected and extended version of the document D-90-05.

D-91-08

*Thomas Krause***Globale Datenflußanalyse und horizontale Compilation der relational-funktionalen Sprache RELFUN**

137 Seiten

Abstract: The compilation of the relational-functional language RELFUN is enhanced by source-level (horizontal) preprocessing. A horizontal compiler transforms the language into a normal-form kernel. This includes right-hand-side propagation, static unification, sharing, pre-evaluation, and reordering. The transformations are specified as a collection of term-rewriting systems plus a control algorithm. Building on the PROLOG mode interpreter of Saumya K. Debray, a global mode or data-flow analyzer for RELFUN call patterns is developed. All compiler enhancements described are running in LISP.

D-91-09

*David Powers, Lary Reeker (Eds.)***Proceedings MLNLO'91 -****Machine Learning of Natural Language and Ontology**

211 pages

Note: This document is available only for a nominal charge of 25 DM (or 15 US-\$).

Abstract: This document contains 40 workingpapers presented at the AAAI Spring Symposium on Maschine Learning of Natural Language and Ontology, March 26-28, 1991, Stanford University.

D-91-10

*Donald R. Steiner, Jürgen Müller (Eds.)***MAAMAW'91: Pre-Proceedings of the 3rd European Workshop on "Modeling Autonomous Agents and Multi-Agent Worlds"**

246 pages

Note: This document is available only for a nominal charge of 25 DM (or 15 US-\$).

Abstract: This document contains papers presented on the Third European Workshop on Modeling Autonomous Agents and Multi Agent Worlds, 5-7 August, 1991, Kaiserslautern, Germany.

D-91-11

*Thilo C. Horstmann***Distributed Truth Maintenance**

61 pages

Abstract: Distributed AI systems are intended to fill the gap between classical AI and distributed computer science. Such networks of different problem solvers are required for naturally distributed problems, and for tasks which exhaust the recourse of an individual node. To guarantee a certain degree of consistency in a distributed AI system, it is necessary to inspect the beliefs of both single nodes and the whole net. This task is performed by Distributed Truth Maintenance Systems. Based on classical TMS theories, distributed truth maintenance extends the conventional case to incorporate reason maintenance in DAI scenarios.

D-91-12

*Bernd Bachmann***HieraC_{ON} - a Knowledge Representation System with Typed Hierarchies and Constraints**

75 pages

Abstract: Universal constraint processing algorithms over finite domains lacks the ability to exploit possible internal structures of these domains. This report reveals how typed hierarchies can be used not only to support specialized local propagation algorithms but also to provide heuristics for constraint relaxation. In order to prove the feasibility of the approach the configuration task for computer systems is modeled as an enhanced constraint satisfaction problem (CSP) where specific requirements of the configuration task are mapped into the layout of the constraint network and into a constraint typology with various kinds of constraints, which are definable over the typed hierarchy.

D-91-13

International Workshop on Terminological Logics

Organizers: Bernhard Nebel, Christof Peltason, Kai von Luck

131 pages

Abstract: This document contains papers presented on the International Workshop on Terminological Logics, Schloß Dagstuhl, Germany, May 6-8, 1991.

D-91-14

*Erich Achilles, Bernhard Hollunder, Armin Laux, Jörg-Peter Mohren**KRIS : Knowledge Representation and Inference System*

- Benutzerhandbuch -

28 Seiten

Zusammenfassung: Dieses Dokument gibt eine Einführung in das Arbeiten mit dem KRIS-System. KRIS ist ein Wissensrepräsentationssystem der KL-ONE Familie, welches in der Projektgruppe WINO am DFKI entwickelt und implementiert worden ist. KRIS stellt dem Benutzer eine mächtige Konzeptsprache für die Definition von Terminologien zur Verfügung; die assertionale Sprache ist vergleichbar mit denen anderer KL-ONE Systeme. Im Unterschied zu allen anderen KL-ONE Systemen sind die typischen Inferenzen wie z.B. Subsumtion, Konsistenztest etc. durch korrekte und *vollständige* Algorithmen realisiert.

D-91-15

Harold Boley, Philipp Hanschke, Martin Harm, Knut Hinkelmann, Thomas Labisch, Manfred Meyer, Jörg Müller, Thomas Oltzen, Michael Sintek, Werner Stein, Frank Steinle

mCAD2NC: A Declarative Lathe-Worplanning Model Transforming CAD-like Geometries into Abstract NC Programs

100 pages

Abstract: mCAD2NC is a knowledge-based system generating workplans for idealized lathe CNC machines. It transforms CAD-like geometries of rotational-symmetric workpieces into abstract NC programs, using declarative term representations for all processing steps. The system has been developed using COLAB, a hybrid-knowledge compilation laboratory which integrates the power of forward and backward reasoning (incl. functional programming), constraint propagation, and taxonomic classification. The focus of this work is on exemplifying techniques of the hybrid, declarative COLAB formalisms for the central subtasks of CAD-to-NC transformations.

D-91-16

Jörg Thoben, Franz Schmalhofer, Thomas Reinartz

Wiederholungs-, Varianten- und Neuplanung bei der Fertigung rotationssymmetrischer Drehteile

134 Seiten

Zusammenfassung: Diese Arbeit beschreibt eine empirische Studie zum Planungsverhalten menschlicher Experten bei der Fertigungsplanung im Maschinenbau. Im Rahmen der Studie wurden zwei Teiluntersuchungen durchgeführt. In der ersten Untersuchung waren eine Reihe von Planungsaufgaben für die Herstellung eines Werkstückes (definiert durch die Geometrie und den Werkstoff) in einer bestimmten Werkstatt (Drehmaschine) zu bearbeiten. Dabei wurden verschiedene Geometrien, Werkstoffe und Drehmaschinen einbezogen. Es wurde gezeigt, daß Experten bei der Fertigungsplanung zunächst eine erste Lösung auf einem abstrakteren Niveau, die als Planskelett (skeletal plan) bezeichnet wird, erarbeiten. Bei der Erstellung solcher wird auf bereits vorliegende Lösungen zurückgegriffen, die gegebenenfalls modifiziert werden. In einer zusammenfassenden Strukturierung der Variantenplanungen konnten verschiedene Vorgehensweisen bei der Übertragung vorhandener Planskelette auf neue Fertigungsaufgaben unterschieden werden. In der zweiten Untersuchung war im Paarvergleich von Planungsaufgaben einzuschätzen, wie ähnlich deren resultierende Fertigungspläne sind. Dabei sollte Aufschluß darüber gewonnen werden, wie das Ähnlichkeitsurteil von den Faktoren Geometrie, Werkstoff und Drehmaschine abhängt.

D-91-17

Andreas Becker

Analyse der Planungsverfahren der KI im Hinblick auf ihre Eignung für die Arbeitsplanung

86 Seiten

Zusammenfassung: In dieser Arbeit werden Planungsverfahren der Künstlichen Intelligenz auf ihre Anwendbarkeit im Gebiet des Computer Aided Process Planning CAPP untersucht. Nach einem Überblick über das komplexe Gebiet der KI-basierten Arbeitsplanung werden die vorgestellten Verfahren vor dem Hintergrund des CAPP ausführlich bewertet. Schließlich wird die Implementierung eines Skelettplan-basierten Verfahrens vorgestellt, das als Teil des Prototyps PIM im Rahmen des ARC-TEC Projekts entwickelt wurde.

Abstract: In this document, AI-based planning mechanisms are investigated with respect to their usability in the domain of Computer Aided Process Planning CAPP. An overview of the complex area of AI-based process planning is provided and the described mechanisms are evaluated. Finally the implementation of a skeletal-plan based system is presented which was developed as part of the prototype PIM of the ARC-TEC project.

D-91-18

Thomas Reinartz

Definition von Problemklassen im Maschinenbau als eine Begriffsbildungsaufgabe

107 Seiten

Zusammenfassung: Experten bilden, zum Beispiel im Bereich des Maschinenbaus, zu einer Menge von Problemstellungen ihrer Domäne Problemklassen. Die Erstellung solcher Problemklassen kann als Aufgabe der menschlichen Begriffsbildung angesehen werden. Gemeinsam mit den Begriffen der Problemklassen werden allgemeine Lösungsstrategien, die auf theoretischem Wissen der Domäne basieren, entwickelt und mit dem zugehörigen Begriff assoziiert, so daß die Begriffe die Lösung neuer Problemstellungen leiten. Eine Aufgabe der Wissensakquisition besteht bei der Entwicklung eines Expertensystems in der Erhebung dieser Begriffe. Dazu betrachtet man Ergebnisse der allgemeinen menschlichen Begriffsbildung aus der Kognition und versucht diese auf den Bereich des Maschinenbaus zu übertragen. Ausgehend von diesen Ergebnissen kann eine Wissensakquisitionsmethode zur Erhebung der Begriffe entwickelt werden. Die Erhebung dient nicht nur der Aufzeichnung der Begriffe, sondern einer Strukturierung und einer aufbereiteten Repräsentation. Die aufbereitete Repräsentation kann durch eine schrittweise Formalisierung in eine formale Wissensbasis übersetzt werden, die ein Expertensystem automatisch verwenden kann. Das im Akquisitionsteil des ARC-TEC-Projektes entwickelte Erhebungsverfahren CECoS wird im Zusammenhang mit der Begriffsbildungsaufgabe der Problemklassen diskutiert und erweitert. Eine Beispielanwendung ausgehend von 60 typischen Fertigungsproblemen bis hin zu Implementierungsversuchen der formalen Repräsentation der Problemklassen in einem taxonomischen Wissensrepräsentationssystem soll die Methoden der integrierten Wissensakquisition überprüfen und beurteilen.

D-91-19

Peter Wazinski

Objektlokalisierung in graphischen Darstellungen

110 Seiten

Zusammenfassung: Es wird eine Lokalisationskomponente für das wissensbasierte Präsentationssystem WIP vorgestellt. Die behandelten Lokalisationsphänomene umfassen relative Lokalisationen (z.B. "Das Objekt links von Objekt X."), absolute Lokalisationen (z.B. "Das Objekt links oben im Bild.") und 'Ecke'-Lokalisationen (z.B. "Das Objekt in der linken oberen Ecke des Bildes."). Desweiteren wird zwischen zwei Lokalisationsgranularitäten unterschieden: zwischen zusammengesetzten Lokalisationen (z.B. "Das Objekt links oben im Bild.") und elementaren Lokalisationen (z.B. "Das Objekt links oben im Bild."): 'Ecke'-Lokalisationen werden wie absolute Lokalisationen behandelt. Absolute Lokalisationen wiederum werden als Spezialfälle der relativen Lokalisationen angesehen. Diese Vorgehensweise ermöglicht es, alle drei Lokalisationstypen durch eine generische Lokalisationsprozedur zu berechnen. Die Berechnung der beiden Lokalisationsgranularitäten erfolgt, indem elementare Lokalisationen aus den zuvor berechneten zusammengesetzten Lokalisationen abgeleitet werden. Darüber hinaus wird gezeigt, wie Objekte auf der Grundlage der beschriebenen Lokalisationsverfahren auch innerhalb einer komplexen Objektkonfiguration lokalisiert werden können. Schließlich wird diskutiert, wie Informationen über die hierarchische Struktur von Objekten in Form sogenannter Gruppenlokalisierungen zu berücksichtigen sind.

D-92-01*Stefan Bussmann***Simulation Environment for Multi-Agent Worlds - Benutzeranleitung**

50 Seiten

Zusammenfassung: Es wird ein Programmsystem, SEMAW Version 1.1, beschrieben, daß zur Simulation von Multi-Agenten Szenarien auf einer sequentiellen Maschine dient. Es stellt ein Agentenmodell, sowie Mechanismen zur Kommunikation und Simulation des Szenarios zur Verfügung. Diese Anleitung gibt dem Benutzer eine Einführung in die Konzepte von SEMAW. Sie beschreibt die Handhabung der Menüs, die Programmierung der Agenten und des Szenarios. Als Beispiel wird die Implementation eines Szenarios (Tower of Hanoi) vorgeführt.

D-92-02*Wolfgang Maaß***Constraint-basierte Platzierung in multimodalen Dokumenten am Beispiel des Layout-Managers in WIP**

111 Seiten

Zusammenfassung: Bei innovativen intelligenten Benutzerschnittstellen, wie im Beispiel des multimodalen Präsentationssystems WIP, spielt insbesondere die automatische Platzierung von Graphiken und Texten eine wichtige Rolle. Das komplexe Platzierungsproblem läßt sich dabei als Constraint-Satisfaction-Problem auffassen. Zu dessen Lösung haben wir das System CLAY, welches ein integraler Bestandteil des Layout-Managers von WIP ist, entwickelt. Das Constraint-Solver-Modell CLAY, basierend auf der Kopplung zweier dedizierter Constraint-Solver, erlaubt die effiziente Verarbeitung komplexer graphischer Beziehungen, wie sie besonders im funktionalen Layout vorherrschen. CLAY stellt einen effizienten und flexiblen Mechanismus zur deklarativen Spezifikation und Lösung graphischer Gestaltungsprobleme dar. In dieser Arbeit werden dem Constraint-Solver-Modell zugrundeliegende abstrakte Algorithmen sowie den Constraint-Definitionssprachen vorgestellt und an Hand von Beispielen illustriert.

D-92-03*Wolfgang Maaß, Thomas Schiffmann, Dudung Soetopo, Winfried Graf***LAYLAB: Ein System zur automatischen Platzierung von Text-Bild-Kombinationen in multimodalen Dokumenten**

41 Seiten

Zusammenfassung: Im Bereich der intelligenten Benutzerschnittstellen besteht derzeit, bedingt durch die wachsende Komplexität der von wissensbasierten Anwendungssystemen zu übermittelnden Information, ein zunehmender Bedarf an Werkzeugen zur flexiblen und effizienten Informationspräsentation. Neben Sprache spielt beim Design von (elektronischen) Dokumenten die Verwendung von graphischen Darstellungen sowie eine Kombinationen dieser beiden Medien zur Informationsvermittlung eine entscheidende Rolle. Während heute in der Regel solche Graphiken noch manuell erstellt werden, z.B. mittels interaktiver 3D-Graphikeditoren, bestand die Aufgabe in diesem Fortgeschrittenenpraktikum darin, Graphiken in Abhängigkeit von bestimmten Generierungsparametern wie Präsentationsziel, Präsentationssituation, Zielgruppe, Ausgabemedium, etc. automatisch zu erzeugen. Eine zentrale Rolle spielte dabei die Repräsentation von Wissen über die Verwendung von Graphik. Zum einen sollte Wissen über Objekte und Darstellungstechniken in den Entwurfsprozeß einfließen, zum anderen war der Bildinhalt zu repräsentieren, um beispielsweise darauf natürlichsprachlich Bezug nehmen zu können. In dieser Arbeitsgruppe stand die Entwicklung einer automatischen Platzierungskomponente zur Gestaltung des Layouts von multimodalen Dokumenten im Vordergrund, während sich zwei weitere Gruppen mit der wissensbasierten Anwendung spezieller Graphiktechniken (z.B. Explosion, Aufriß, Annotation) befaßten. Die vorliegende Arbeit beschreibt die prototypische Implementierung des Systems *LayLab*, einem Experimentiersystem zum automatischen Layout multimodaler Präsentationen, das im Kontext des WIP-Projektes entwickelt wurde. Als Programmierungsumgebung standen hierzu Symbolics Lisp-Maschinen und Apple MacIvory Workstations zur Verfügung. Bei der Entwicklung konnte auf einen Lisp-basierten interaktiven 3D-Graphikeditor (S-Geometry) sowie die objektorientierte Symbolics Fensterumgebung zurückgegriffen werden.

D-92-04*Judith Klein, Ludwig Dickmann***DiTo-Datenbank - Datendokumentation zu Verbrektion und Koordination**

55 Seiten

Zusammenfassung: In dieser Arbeit werden die Daten eines Testwerkzeugs für die Fehlerdiagnose bei Syntaxkomponenten natürlichsprachlicher Systeme vorgestellt. Mit unserem Diagnostik-Tool unternehmen wir den Versuch, einen Datenkatalog zu erstellen, der die wesentlichen Phänomene deutscher Syntax erfaßt, um die Fehlerdiagnose zu unterstützen. Bisher beinhaltet der Datenkatalog die Bereiche *Verbrektion* und *Koordination*. Wir arbeiten mit anderen Gruppen zusammen, die weitere Syntaxthemen entsprechend den Richtlinien unseres Ansatzes erarbeiten. Damit ausgewählte Syntaxgebiete separat abgetestet werden können, sind die Daten in einer relationalen Datenbank organisiert.

In den Teildokumentationen zu den einzelnen Syntaxgebieten werden zunächst die behandelten Phänomene skizzenhaft beschrieben. Dann wird die der Datensammlung zugrundeliegende Systematik erläutert. Anschließend wird gezeigt, wie die Daten in der relationalen Datenbank organisiert sind. Die Dokumentationen enden mit einem Ausblick auf mögliche Erweiterungen der Datenbank

Abstract: In this paper we present the data of a testing tool for the error diagnosis in NLP systems. Our diagnostic tool is an effort to construct a catalogue of syntactic data exemplifying the major syntactic patterns of German. Its aim is to support the diagnosis of errors. Up to now, the catalogue contains the areas *verbal government* and *coordination*. We cooperate with other groups that work on further syntactic phenomena according to the ideas of DiTo. To allow systematic testing of specific syntax areas the data are organised into a relational database.

In the documentation of the special syntax areas, the phenomena are sketched first. Then we describe the methodology the data collection is based on. Next we show how the data are organised into the relational database. Finally we say something about possible extentions of the data base.

D-92-06*Hans Werner Höper***Systematik zur Beschreibung von Werkstücken in der Terminologie der Featuresprache**

392 Seiten

Zusammenfassung: Die vorliegende Arbeit dient dem Bereitstellen von Wissen über Werkstückbeschreibungen durch Features. Die hier ermittelten Featuredefinitionen sind Input für das im R-Teil des ARC-TEC Projektes entwickelte PIM System. Innerhalb dieser Arbeit wurde beispielhaft eine Beschreibungssprache für einfache Werkstücke (2 1/2 D) entwickelt, in der fertigungstechnisch wichtige Bereiche als sogenannte Features beschrieben werden können. Dazu wurden Featurenamen und Featuregrammatiken zur Erkennung der Features gefunden. Weiterhin wurden die grundlegenden Bearbeitungsstrategien für die gefundenen Features skizziert. Konkret wurden Grammatiken für die Repräsentation von fertigungstechnischen Features für die Außen-Drehbearbeitung von Wellenteilen in der vom R-Teil des ARC-TEC-Projektes entwickelten Feature-Repräsentationssprache aufgeschrieben.

D-92-07*Susanne Biundo, Franz Schmalhofer (Eds.)***Proceedings of the DFKI Workshop on Planning**

65 pages

Abstract: This document contains the contributions to the DFKI-Workshop on Planning held at Kaiserslautern in February 1992.

D-92-08*Jochen Heinsohn, Bernhard Hollunder (Eds.)***DFKI Workshop on Taxonomic Reasoning****Proceedings**

56 pages

Abstract: This document contains 9 workingpapers presented at the DFKI Workshop on Taxonomic Reasoning, Saarbrücken, February 26, 1992.

D-92-09

*Gernod P. Laufkötter***Implementierungsmöglichkeiten der integrativen Wissensakquisitionsmethode des ARC-TEC-Projektes**

86 Seiten

Zusammenfassung: Die Implementation der Wissensakquisitionsmethode des ARC-TEC-Projektes als Software-System soll einerseits ihre Verifikation durch den Einsatz als rechnergestütztes Tool ermöglichen. Sie muß andererseits dem experimentellen Charakter der Anwendung durch hohe Flexibilität und Änderungs-/Erweiterungsfreudigkeit Rechnung tragen. Um beide Anforderungen zu erfüllen, werden hier verschiedenere Möglichkeiten zur Implementation der ARC-TEC-Methode unter Berücksichtigung vorhandener Hard- und Software-Ressourcen untersucht. Ziel dabei ist es nicht, völlig unterschiedliche, inkompatible Implementationsmöglichkeiten zu vergleichen. Vielmehr wird ein portables Basissystem postuliert, das in aufeinander aufbauenden Varianten an Kapazität und Effizienz, aber auch an Entwicklungsaufwand zunimmt.

D-92-10

*Jakob Mauss***Ein heuristisch gesteuerter Chart-Parser für attributierte Graph-Grammatiken**

87 Seiten

Zusammenfassung: Um eine enge Kopplung der CA*-Komponenten in einem CIM-System zu erreichen, sind vor allem geeignete Schnittstellen zwischen diesen Komponenten zu definieren. Ein Ansatz, der dazu derzeit untersucht wird, basiert auf sogenannten Feature-Sprachen und deren Repräsentation durch Graph-Grammatiken. In dieser Arbeit wird ein solcher Graph-Grammatik-Formalismus definiert, vor allem aber ein Graph-Parser dafür angegeben und dessen Anwendung auf das Feature-Erkennungsproblem in CIM-Systemen demonstriert. Der vorgestellte heuristisch steuerbare, bottom-up Chart-Parser ermöglicht die Analyse attributierter Graphen, die *Werkstücke repräsentieren, mittels einer gegebenen Graph-Grammatik, die die Feature-Sprache (das Konzeptwissen) eines menschlichen Maschinenbau-Experten repräsentiert.* Die Ausgabe des Parsers ist eine qualitative Beschreibung des Werkstücks in der jeweiligen Feature-Sprache in Gestalt eines sogenannten Feature-Baums.

Abstract: To integrate CA*-systems with other applications in the CIM world, one principal approach currently under development is the feature recognition process based on graph grammars. It enables any CIM component to recognize the higher-level entities—the so-called features—used in this component out of a lower-data exchange format, which might be the internal representation of a CAD system as well as some standard data exchange format. In this paper we present a 'made-to-measure' parsing algorithm for feature recognition. The heuristic driven chart based bottom up parser analyzes attributed node labeled graphs (representing workpieces) with a (feature-)specific attributed node labeled graph grammar (representing the feature definitions) yielding a high level (qualitative) description of the workpiece in terms of features.

D-92-11

*Kerstin Becker***Möglichkeiten der Wissensmodellierung für technische Diagnose-Expertensysteme**

92 Seiten

Zusammenfassung: Diese Arbeit beschäftigt sich mit den Möglichkeiten, die man zur Modellierung technischen Diagnosewissens hat. Ausgehend von den Formen, in denen Diagnosewissen beim menschlichen Experten vorliegt, werden fünf Hauptmodellierungsarten vorgestellt: heuristisches, kausales, fallbasiertes, statistisches Wissen und Wissen in Form von Entscheidungsbäumen und Entscheidungstabellen. Nachdem diese verschiedenen Wissensarten beschrieben wurden, werden einige bereits existierende Diagnose-Expertensysteme vorgestellt, die vorwiegend auf nur einer Wissensform basieren. In der anschließenden Wertung werden die Vor- und Nachteile der verschiedenen Wissensmodellierungsarten genannt und aus ihnen heraus eine Alternative in Form eines Hybrids motiviert. Es wird ein Vorschlag gemacht, in welchen Gebieten welche Wissensform geeignet ist. Abschließend wird der Hybrid MOLTKE 3 vorgestellt.

Abstract: This work deals with possibilities to model technical knowledge for diagnosis. Starting with forms diagnostic knowledge resides in human experts, five major kinds of modelling are presented: heuristic, causal, case-based, statistic, and as decision-trees or decision-tables structured knowledge. After the description of these different kinds of knowledge some concrete, already existing expertsystems for diagnosis are presented mainly basing on just one kind of knowledge. In the following judgement the advantages and disadvantages of the different kinds of modelling knowledge are enumerated and an alternative in form of a hybrid is motivated. A proposition is made, in which domains which form of knowledge is suitable. Finally the hybrid MOLTKE 3 is presented.

D-92-12*Otto Kühn, Franz Schmalhofer, Gabriele Schmidt***Integrated Knowledge Acquisition for Lathe Production Planning: a Picture Gallery (Integrierte Wissensakquisition zur Fertigungsplanung für Drehteile: eine Bildergalerie)**

27 pages

Abstract: This picture gallery illustrates the application of the integrated knowledge acquisition procedure which was developed in the ARC-TEC project. Guided by a model of expertise, the knowledge for lathe production planning is acquired from texts, previously solved cases, and expert memories. Three coordinated tools support the elicitation, documentation, verification and formalization of the relevant knowledge.

Zusammenfassung: Diese Bildergalerie veranschaulicht den Einsatz der im ARC-TEC Projekt entwickelten integrativen Wissensakquisitionsmethode. Geleitet durch ein Modell der Expertise, wird das Wissen zur Fertigungsplanung für Drehteile aus Texten, Fallsammlungen und Expertenurteilen akquiriert. Drei aufeinander abgestimmte Tools unterstützen die Erhebung, Dokumentation, Überprüfung und Formalisierung des relevanten Wissens.

D-92-13*Holger Peine***An Investigation of the Applicability of Terminological Reasoning to Application-Independent Software-Analysis**

55 pages

Abstract: This work is a first investigation of an observation noted as possibly promising: "The problem of application-independent recognition of given elements from the architecture of an unknown software system to be analyzed can be conceived as a special case of the classification problem in a terminological reasoning system if supplied with a suitably defined taxonomy for software-elements."

This problem, however, has been solved in certain terminological reasoning systems (TRSs). To the end of investigating this idea, the availability of a TRS was necessary (provided at DFKI by virtue of the KRIS-system) as well as stating clearly the envisaged application independent software-elements, followed by a concept taxonomy expressible in KRIS and delivering the desired results. Furthermore, a tool had to be developed to analyze software (i.e., the source code) and generate the input information for the taxonomy from that.

Stating application-independent complete and correct conditions for the role of an element within a software system turned out to be feasible for only a few basic concepts, because software employs at least up to now too few standardized concepts. The translation of the feasible concepts to KRIS resulted in problems of the expressive power of TRSs that were recognized as fundamental. The root of this problem spawned a new language construction for KRIS. Under the assumption of this new construction, a taxonomy of software-elements was formulated. However, as the incorporation of this construct, while recognized as feasible, would exceed the scope of this work and is therefore still to come, it has not been possible so far to test the formulated taxonomy. Hoping this will become possible in the future, the tool for input generation was developed nonetheless. The chosen programming language to be processed is C, as there was an initial tool already available for it. Thus the concluding judgment of this investigation is still to come.

D-92-14

Johannes Schwagereit

Integration von Graph-Grammatiken und Taxonomien zur Repräsentation von Features in CIM

98 Seiten

Zusammenfassung: Die Komplexität und die wirtschaftliche Bedeutung der Arbeitsplanung im Maschinenbau hatte bereits eine Vielzahl von Ansätzen zur Folge, diese computerunterstützt durchzuführen. In dieser Arbeit wird von einer *Feature-basierten Arbeitsplanung* ausgegangen, wie sie im ARC-TEC--Projekt verwendet wird. Grundidee ist die Identifikation von Werkstückbereichen, den *Feature*, aus denen nach dem Prinzip der heuristischen Klassifikation Informationen für die Arbeitsplanung resultieren.

Um die Beschreibung eines Werkstücks durch Feature zu ermöglichen, werden im ARC-TEC--Projekt unter anderem *attribuierte Graph-Grammatiken* verwendet. Mit diesen lassen sich die Charakteristika der Feature sehr gut wiedergeben.

Der Repräsentation der Feature kommt dabei eine wichtige Rolle zu. Daher wurde, aufbauend auf der Diskussion der theoretischen Grundlagen, in dieser Arbeit ein maßgeschneidertes System entwickelt, in dem die Definitionen der Feature eingegeben, dargestellt und effizient verwaltet werden können. Ein wichtiger Teil dieses Systems sind Werkzeuge, die die Entwicklung einer Graph-Grammatik unterstützen, unter anderem eine komfortable Benutzeroberfläche. Zu den Aufgaben des Systems gehören auch Tests der semantischen und syntaktischen Korrektheit der Feature, die Berechnung von Hierarchien, die einen effizienten Einsatz der Feature ermöglichen sowie die Bereitstellung von Schnittstellen, die anderen Programmen den Zugriff auf die Repräsentation erlauben.

D-92-15

DFKI Wissenschaftlich-Technischer Jahresbericht 1991

130 Seiten

Zusammenfassung: Dieses Dokument enthält den Wissenschaftlich-Technischen Jahresbericht 1991 des Deutschen Forschungszentrums für Künstliche Intelligenz.

D-92-16

Judith Engelkamp (Hrsg.)

Verzeichnis von Softwarekomponenten für natürlichsprachliche Systeme

189 Seiten

Zusammenfassung: Dieses Dokument enthält die Ergebnisse der vom BMFT (Bundesministerium für Forschung und Technologie) in Auftrag gegebenen Umfrage zu existierenden Softwarekomponenten im Bereich der Verarbeitung natürlicher Sprache im März 1992.

D-92-17

*Elisabeth André, Robin Cohen, Winfried Graf,
Bob Kass, Cécile Paris, Wolfgang Wahlster (Eds.)*

UM92: Third International Workshop on User Modeling Proceedings

254 pages

Note: This document is available only for a nominal charge of 25 DM (or 15 US-\$).

Abstract: This document contains workingpapers presented at the International Conference and Research Center for Computer Science (IBFI) at Schloß Dagstuhl in Wadern (Germany), August 9 – 13, 1992.

D-92-18

*Klaus Becker***Verfahren der automatisierten Diagnose technischer Systeme**

109 Seiten

Abstract: This thesis deals with the introduction and judgement of different kinds of methods of diagnosis for technical systems. Theoretical concepts as well as practical realizations are discussed with regard to their suitability for technical diagnosis.

Diagnosis systems can be divided into the following categories: heuristic, model-based, case-based, statistic, decision-trees and decision-tables. Most industrial applications are heuristic diagnosis systems. But especially for technical application areas model-based methods seem to be suitable.

No method of diagnosis is absolutely suited to every application area. Therefore, for every new application it is necessary to decide, which method of diagnosis to choose. In many cases different methods of diagnosis are melted together in order to take advantage of the advantages of any single method and to avoid the disadvantages.

After the presentation of theoretical concepts and practical realizations the thesis closes with a small practical part: To verify some theoretical results a small system for diagnosing faults of the turning process has been implemented. Additionally, it has been examined, whether a general domain theory serving as a base for the construction, was useful.

D-92-19

*Stefan Dittrich, Rainer Hoch***Automatische, Deskriptor-basierte Unterstützung der Dokumentanalyse zur Fokussierung und Klassifizierung von Geschäftsbriefen**

107 Seiten

Zusammenfassung: Die vorliegende Arbeit wurde im Rahmen des ALV-Projekts (Automatisches Lesen und Verstehen) am Deutschen Forschungszentrum für Künstliche Intelligenz (DFKI) erstellt. Ziel des ALV-Projektes ist die Entwicklung einer intelligenten Schnittstelle zwischen Papier und Rechner (paper-computer interface). Hierbei soll durch Nachahmung des menschlichen Leseverhaltens ein Schritt in Richtung papierloses Büro ausgeführt werden. Exemplarisch werden in ALV Geschäftsbriefe als Domäne untersucht. Teilgebiete innerhalb des ALV-Projekts sind Layoutextraktion, Logical Labeling, Texterkennung und Textanalyse.

Diese Arbeit fällt in den Bereich der Textanalyse. Die Aufgabenstellung bestand darin, mittels der vorkommenden Wörter (im Briefftext) die Art des Briefes sowie erste Hinweise über die Intention des Briefautors zu ermitteln. Derartige Informationen können von anderen Experten zur weiteren Verarbeitung, Verteilung und Archivierung der Briefe genutzt werden. Das innerhalb einer Diplomarbeit entwickelte und implementierte INFOCLAS-System versucht deshalb auf der Basis statistischer Verfahren und Methodiken aus dem Information Retrieval folgende Funktionalität bereitzustellen:

- i) Extrahierung und Gewichtung von bedeutungstragenden Wörtern;
- ii) Ermittlung der Kernaussage (Fokus) eines Geschäftsbriefs;
- iii) Klassifizierung eines Geschäftsbriefs in vordefinierte Nachrichtentypen.

Die dafür entwickelten Module Indexierer, Fokussierer und Klassifizierer benutzen - neben Konzepten aus dem Information Retrieval - eine Datenbasis, die eine Sammlung von Geschäftsbriefen enthält, sowie spezifische Wortlisten, die die modellierten Briefklassen repräsentieren. Als weiteres Hilfsmittel dient ein morphologisches Werkzeug zur grammatikalischen Analyse der Wörter. Mit diesen Wissensquellen werden Hypothesen über die Briefklasse und die Kernaussage des Briefinhalts aufgestellt.

Abstract: In this documentation existing techniques of information retrieval (IR) are compared and evaluated for their application in document analysis and understanding. Moreover, we have developed a system called INFOCLAS which uses appropriate statistical methods of IR, primarily for the classification of German business letters into corresponding message types such as order, offer, confirmation, inquiry, and advertisement. INFOCLAS is a first step towards understanding of business letters. Actually, it comprises three modules: the central indexer (extraction and weighting of indexing terms), the classifier (classification of business letters into given types) and the focuser (highlighting relevant parts of the letter). INFOCLAS integrates several knowledge sources including a database of about 120 letters, word frequency statistics for German, message type specific words, morphological knowledge as well as the underlying document model (layout and logical structure). As output, the system computes a set of weighted hypotheses about the type of letter at hand. A classification of documents allows the automatic distribution or archiving of letters and is also an excellent starting point for higher-level document analysis.

D-92-21

Anne Schauder

Incremental Syntactic Generation of Natural Language with Tree Adjoining Grammars

57 pages

Abstract: This document combines the basic ideas of my master's thesis - which has been developed within the WIP project - with new results from my work as a member of WIP, as far as they concern the integration and further development of the implemented system. ISGT (in German Inkrementeller Syntaktischer Generierer natürlicher Sprache mit TAGs) is a syntactic component for a text generation system and is based on Tree Adjoining Grammars. It is lexically guided and consists of two levels of syntactic processing: A component that computes the hierarchical structure of the sentence under construction (*hierarchical level*) and a component that computes the word position and utters the sentence (*positional level*). The central aim of this work has been to design a syntactic generator that computes sentences in an *incremental fashion*. The realization of the incremental syntactic generator has been supported by a distributed parallel model that is used to speed up the computation of single parts of the sentence.

D-92-22

Werner Stein

Indexing Principles for Relational Languages Applied to PROLOG Code Generation

80 pages

Abstract: In this paper we propose an extensible, flexible, multi-argument indexing technique for relational languages. We present a compiler producing indexing header code for a PROLOG emulator based on the Warren Abstract Machine. We will show that our technique combines positive aspects of relational database methods and other existing WAM-based indexing schemes. All the indexing concepts introduced are implemented in LISP for the relational-functional programming language RELFUN.

D-92-23

Michael Herfert

Parzen und Generieren der Prolog-artigen Syntax von RELFUN

51 Seiten

Abstract: This paper describes a parser for recognizing and a pretty-printer for generating the prolog-like syntax of RELFUN. It also describes how to link the new modules into the RELFUN-system and the implications on its commands.

D-92-24

Jürgen Müller, Donald Steiner (Hrsg.)

Kooperierende Agenten

78 Seiten

Zusammenfassung: Das vorliegende Dokument gibt eine Übersicht über die Aktivitäten des DFKI im Arbeitsbereich "Kooperierende Systeme". Es werden die laufenden *Projekte* des Bereichs allgemein vorgestellt. Die *Systeme* (Entwicklungsumgebungen) der einzelnen Projekte werden eingeführt und *Anwendungen* unter Benutzung verschiedener Kooperationstechniken beschrieben. Ferner werden *Techniken* auf theoretischer Basis abgehandelt.

Abstract: The document in hand displays an overview of the DFKI activities in the field of "Cooperating Systems". Current *projects* within the field will be presented. The *systems* and tools of the different projects will be introduced and the *applications* will be described with a special view on the different cooperation techniques. Eventually some specific *techniques* will be discussed on a more theoretical level.

D-92-25*Martin Buchheit***Klassische Kommunikations- und Koordinationsmodelle**

31 Seiten

Zusammenfassung: Bei der Betrachtung von Multi-Agenten-Systemen (MAS) als Teilbereich der Verteilten Künstlichen Intelligenz treten Probleme zutage, die der klassischen Informatik nicht unbekannt sind. Im folgenden werden bekannte klassische Verfahren zur Kommunikation und Koordination in Verteilten Systemen wie sie in Verteilten Betriebssystemen, in Verteilten Programmiersprachen und in Verteilten Datenbanksystemen zur Anwendung kommen, vorgestellt. Die Verwendbarkeit dieser Methoden im Rahmen der Aufgabenstellung des Projektes AKA-MOD wird allgemein untersucht und am Beispiel eines dort verwendeten Szenarios von Transportunternehmen, des sog. Speditions-Szenarios, veranschaulicht.

D-92-26*Enno Tolzmann***Realisierung eines Werkzeugauswahlmoduls mit Hilfe des Constraint-Systems CONTAX**

28 Seiten

Zusammenfassung: Das Modul *werkzeug-konfig* dient zur Werkzeugauswahl bei der Drehbearbeitung mit Schneidstoffen aus Hartmetall aufgrund gegebener Geometrie- und Technologieinformationen. Als Werkzeug der Wissensrepräsentation wurde das Constraint-System CONTAX verwendet, das die Darstellung von Expertenwissen in Form von gewichteten Constraints über hierarchisch strukturierten endlichen Datentypen ermöglicht und einen Inferenzmechanismus zur Constraintpropagierung mit diskreter Constraintrelaxierung zur Verfügung stellt. In dieser Arbeit werden die wichtigsten Phasen bei der Implementierung des Werkzeugauswahlmoduls, bestehend aus Festlegung des Einsatzbereichs, Spezifikation der Ein-/Ausgabedaten, Wahl der Wissensrepräsentation und Formalisierung des Expertenwissens beschrieben. Danach wird das Constraint-System CONTAX vorgestellt, eine Funktionsbeschreibung des Programms gegeben und werden spezielle Implementierungsfragen erläutert. Abschließend wird die Leistungsfähigkeit des Programms unter den Aspekten Ergebnisgüte und Antwortzeit diskutiert.

D-92-27*Martin Harm, Knut Hinkelmann, Thomas Labisch***Integrating Top-down and Bottom-up Reasoning in COLAB**

40 pages

Abstract: The knowledge compilation laboratory COLAB integrates declarative knowledge representation formalisms, providing source-to-source and source-to-code compilers of various knowledge types. Its architecture separates taxonomical and assertional knowledge. The assertional component consists of a constraint system and a rule system, which supports bottom-up and top-down reasoning of Horn clauses. Two approaches for forward reasoning have been implemented. The first set-oriented approach uses a fixpoint computation. It allows top-down verification of selected premises. Goal-directed bottom-up reasoning is achieved by a magic-set transformation of the rules with respect to a goal. The second tuple-oriented approach reasons forward to derive the consequences of an explicitly given set of facts. This is achieved by a transformation of the rules to top-down executable Horn clauses. The paper gives an overview of the various forward reasoning approaches, their compilation into an abstract machine and their integration into the COLAB shell.

D-92-28

Klaus-Peter Gores, Rainer Bleisinger

Ein Modell zur Repräsentation von Nachrichtentypen

56 Seiten

Zusammenfassung: In diesem Papier stellen wir einen Formalismus vor, mit dem eine computergerechte Repräsentation verschiedener Klassen von Geschäftsbriefen möglich ist. Der Ausgangspunkt dieser Bemühungen ist das Projekt ALV (Automatisches Lesen und Verstehen), dessen Ziel das partielle Erkennen einer eingeschränkten Menge von Geschäftsbriefen ist. Für die verschiedenen Klassen von Geschäftsbriefen werden sogenannte Nachrichtentypen entwickelt, die sich aus einzelnen Bausteinen, den Nachrichtenelementen zusammensetzen. Diese werden durch eine modifizierte Conceptual Dependency-Notation definiert. Durch die hierarchische und modulare Definition kann eine breite Anzahl von Geschäftsbriefen modelliert werden. Die Zielrichtung des hier vorgestellten Modells liegt neben der effizienten Modellierung der Nachrichtentypen in der Bearbeitung durch ein Verfahren zur erwartungsgesteuerten Textanalyse in ALV. Um dies zu ermöglichen, wurden zahlreiche Steuerungselemente in das Nachrichtenmodell aufgenommen.

D-93-01

Philipp Hanschke, Thom Frühwirth

Terminological Reasoning with Constraint Handling Rules

12 pages

Abstract: Constraint handling rules (CHRs) are a flexible means to implement 'user-defined' constraints on top of existing host languages (like Prolog and Lisp). Recently, M. Schmidt-Schauß and G. Smolka proposed a new methodology for constructing sound and complete inference algorithms for terminological knowledge representation formalisms in the tradition of KL-ONE. We propose CHRs as a flexible implementation language for the consistency test of assertions, which is the basis for all terminological reasoning services.

The implementation results in a natural combination of three layers: (1) a constraint layer that reasons in wellunderstood domains such as rationals or finite domains, (2) a terminological layer providing a tailored, validated vocabulary on which (3) the application layer can rely. The flexibility of the approach will be illustrated by extending the formalism, its implementation and an application example (solving configuration problems) with attributes, a new quantifier and concrete domains.

D-93-02

Gabriele Schmidt, Frank Peters, Gernod Laufkötter

User Manual of COKAM+

23 pages

Abstract: This document contains the user manual of COKAM+.

D-93-03

Stephan Busemann, Karin Harbusch(Eds.)

DFKI Workshop on Natural Language Systems: Reusability and Modularity - Proceedings

74 pages

Abstract: This document contains 10 workingpapers presented at the workshop held at Saarbrücken, October 23, 1992.

D-93-04

DFKI Wissenschaftlich-Technischer Jahresbericht 1992

194 Seiten

Zusammenfassung: Dieses Dokument enthält den Wissenschaftlich-Technischen Jahresbericht 1991 des Deutschen Forschungszentrums für Künstliche Intelligenz.

D-93-05*Elisabeth André, Winfried Graf, Jochen Heinsohn, Bernhard Nebel, Hans-Jürgen Profitlich, Thomas Rist, Wolfgang Wahlster***PPP: Personalized Plan-Based Presenter**

70 pages

Abstract: The aim of the project 'Personalized Plan-Based Presenter' (PPP) is to explore and develop innovative presentation techniques for future intelligent user interfaces. The central issues of the project are: 1. Planning multimedia presentation acts, 2. Interactive multimedia presentations, 3. Monitoring the effectiveness of a presentation, 4. Providing a firm representation foundation. Presentation design can be viewed as a relatively unexplored area of common-sense reasoning. Unlike most research on common-sense reasoning to date, the PPP project does not deal with metadomain research on general design principles, but focuses on formal methods capturing some of the reasoning in the design space of presentations for specific and realistic domains. The development of an interactive, multimedia presentation system requires efforts from various research areas such as planning, knowledge representation, constraint processing, natural language, and knowledge-based graphics generation.

D-93-06*Jürgen Müller (Hrsg.)***Beiträge zum Gründungsworkshop der Fachgruppe Verteilte Künstliche Intelligenz, Saarbrücken, 29. - 30. April 1993**

235 Seiten

Note: This document is available only for a nominal charge of 25 DM (or 15 US-\$).

Zusammenfassung: Das vorliegende Dokument enthält die Fachbeiträge des Gründungsworkshops der Fachgruppe 1.1.6 „Verteilte Künstliche Intelligenz“ in der Gesellschaft für Informatik.

Abstract: The document contains the papers of the founding workshop of the special interest group on "Distributed Artificial Intelligence" of the German Society for Computer Science.

D-93-07*Klaus-Peter Gores, Rainer Bleisinger***Ein erwartungsgesteuerter Koordinator zur partiellen Textanalyse**

53 Seiten

Zusammenfassung: In diesem Papier wird die koordinierende Komponente eines Systems zur erwartungsgesteuerten Textanalyse auf der eingeschränkten Domäne deutscher Geschäftsbriefdokumente vorgestellt. Dazu wurden wesentliche Konzepte und Datenstrukturen zur Modellierung der Domäne, das Nachrichtenmodell, entwickelt (siehe [Gores & Bleisinger 92]). Mit diesem Nachrichtenmodell steuert die Komponente die Textextraktion der Informationen eines vorliegenden Briefdokumentes. Sie wird in ihrer Arbeit von Spezialisten, sogenannten Substantiierern, unterstützt, die auf dem Text arbeiten. Dazu muß intensiver Nutzen von den Informationen eines Lexikons gemacht werden. Die Repräsentation des Ergebnisses erfolgt in einer Form, die eine weitere Verarbeitung, wie die semantische Interpretation und eine darauf aufbauende Generierung neuer Aktionen begünstigt.

D-93-08

Thomas Kieninger, Rainer Hoch

Ein Generator mit Anfragesystem für strukturierte Wörterbücher zur Unterstützung von Texterkennung und Textanalyse

125 Seiten

Abstract: This document describes the implementation of a structured dictionary for document analysis allowing access to lexical data by two distinct methods. On the one hand, there is a technique called three-fold hashing which automatically selects the best of three provided hash functions according to the quality of recognition results. For this kind of access a regular expression can be specified dealing with noisy input. In addition, the system provides a concept of (lexical) views for pruning search space, i.e., additional knowledge sources are used for fast accessing the dictionary. On the other hand, complex queries over the members of a view can be initiated based on a special filter concept. The realization of such views is a major topic of our dictionary system. Furthermore, we differentiate between two main components of the system: the dictionary generator and the dictionary controller (run time system).

D-93-09

Hans-Ulrich Krieger, Ulrich Schäfer

TDL ExtraLight User's Guide

35 pages

Abstract: This paper serves as a user's guide to the first version of the description language *TDL* used for the specification of linguistic knowledge in the DISCO project of the DFKI.

D-93-10

Elizabeth Hinkelman, Markus Vonerden, Christoph Jung

Natural Language Software Registry (Second Edition)

174 pages

Abstract: The Natural Language Software Registry is a concise summary of the capabilities and sources of language processing software available to researchers. It comprises academic, commercial, and proprietary software, with theory, specifications, and terms on which it can be acquired clearly indicated.

This second edition, containing nearly one hundred software descriptions, owes much to the participants of the 1992 survey of natural language processing software conducted for the German Ministry for Research and Technology by DFKI and directed by Prof. Wolfgang Wahlster. The Registry now distinguishes among several levels of linguistic analysis, with a full section for natural language generation. It encompasses as well large systems that perform several levels of analysis, linguistic development tools, and selected applications of natural language processing technology.

D-93-11

Knut Hinkelmann, Armin Laux (Eds.)

DFKI Workshop on Knowledge Representation Techniques — Proceedings

88 pages

Abstract: This Document contains papers presented at the DFKI Workshop on Knowledge Representation Techniques in Kaiserslautern, Germany, July 8, 1993.

D-93-12

Harold Boley, Klaus Elsbernd, Michael Herfert, Michael Sintek, Werner Stein

RELFUN Guide: Programming with Relations and Functions Made Easy

86 pages

Abstract: A practical description of relational/functional programming in RELFUN is given. The language constructs are introduced by a tutorial dialog. Builtins, primitives, and commands are explained. Examples are given on all aspects relevant to using the language.

D-93-14

Manfred Meyer (Ed.)

Constraint Processing –

Proceedings of the International Workshop at CSAM'93, July 20-21, 1993

264 pages

Note: This document is available only for a nominal charge of 25 DM (or 15 US-\$).

Abstract: The Workshop on Constraint Processing at CSAM'93 was aimed at exchanging, comparing and contrasting research results in all areas of constraint processing regarded as a general paradigm of computation. Papers have been submitted by authors working on various aspects of constraint processing at different sites in Austria, England, France, Germany, Netherlands, Russia, Slovenia, Switzerland, and the United States. The two-days workshop was held as a separate track of sessions within the International Congress on Computer Systems and Applied Mathematics (CSAM'93) organized by the Center of Modern Communications of St. Petersburg State University and held at the Educational Center in St. Petersburg, Russia, on July 19-23, 1993. These proceedings contain extended versions of the invited talk and all papers accepted for presentation at the workshop. They cover a wide range of topics in the area of constraint processing including concurrent constraint languages, constraints and knowledge representation, constraint logic programming, constraint maintenance algorithms, modelling with constraints, constraint-satisfaction techniques, constraints for temporal reasoning, theoretical foundations of constraint networks, implementation techniques, constraints and databases, distributed constraint satisfaction, and applications of constraint processing techniques to space planning problems, exams planning problems, and job scheduling problems.

D-93-15

Robert Laux

Untersuchung maschineller Lernverfahren und heuristischer Methoden im Hinblick auf deren Kombination zur Unterstützung eines Chart-Parsers

86 Seiten

Abstract: Die schlechte Komplexität von Graph-Parsern für allgemeine Graphgrammatiken (NP-Vollständigkeit) legt die Verwendung von Heuristiken nahe. Aufgabe dieser Arbeit war es, zur Unterstützung des chart-basierten Graph-Parser GraPaKL (für die Graphgrammatikklasse NRCFGG) eine Heuristikkomponente, die das benötigte Kontrollwissen durch ein Lernverfahren akquiriert, zu entwickeln. Dazu wurden zunächst verschiedene Repräsentationsarten von Kontrollwissen sowie verschiedene Lernverfahren zur Akquisition des Kontrollwissens diskutiert und festgestellt, daß sich die Repräsentation des Kontrollwissens in Form einer Bewertungsfunktion in Kombination mit dem konnektionistischen Lernverfahren Backpropagation am besten eignet. Die entwickelte Heuristikkomponente besteht aus zwei Modulen, dem Bewertungs- und dem Lernmodul. Das Bewertungsmodul steuert den Parser, indem es mittels einer Bewertungsfunktion Prioritäten an die Alternativen in der Agenda vergibt. Aufgrund der Tatsache, daß die Güte der Alternativen wesentlich vom Zustand des Parsers abhängt, setzt sich die Bewertungsfunktion aus zwei Teilen zusammen: einem statischen, d.h. vom aktuellen Zustand des Parsers unabhängigen, als auch einem dynamischen, also vom Parserzustand abhängigen Teil. Dabei kommt der dynamischen, situationsabhängigen Teilbewertung die Rolle der Primärsteuerung zu. Die dynamische Teilbewertungsfunktion wird durch das Lernmodul akquiriert. Der Benutzer bzw. Experte präsentiert Beispielparse, mit denen das Lernmodul die Bewertungsfunktion entsprechend verändert. Der Benutzer kann somit GraPaKL nur mittelbar, und zwar über das Lernmodul (durch die Präsentation von Beispielparsen) steuern; die konkrete Bewertungsfunktion bleibt dem Benutzer verborgen. Bemerkenswert ist, daß die Architektur der Heuristikkomponente unabhängig von der zugrundeliegenden Graphgrammatik (Domäne) ist. Darüberhinaus läßt sie sich durchaus auch auf agenda-basierte Chart-Parser für Stringgrammatiken übertragen. In (provisorischen) experimentellen Untersuchungen konnte die prinzipielle Eignung einerseits der Konzeption der Bewertungsfunktion und andererseits der Wahl des Lernverfahrens aufgezeigt werden. Ein systematisches Training mit verschiedenen Netzarchitekturen und Parameterkonstellationen konnte im Rahmen dieser Arbeit nicht durchgeführt werden, da dies aufwendige Testreihen erfordert hätte.

D-93-16*Bernd Bachmann, Ansgar Bernardi, Christoph Klauck, Gabriele Schmidt***Design & KI**

74 Seiten

Zusammenfassung: In diesem Bericht werden die wichtigsten Begriffe aus dem Bereich des (Produkt)Designs aus dem Blickwinkel der Künstlichen Intelligenz untersucht. Der Schwerpunkt liegt dabei nicht so sehr auf den technischen Details von existierenden Designsystemen als vielmehr in der Untersuchung der wesentlichen Konzepte wie Designmodelle, Modelle des wissensbasierten Designs, innovatives Design, etc. auf einem informellen Level, die der grundsätzlichen Beschreibung des Vorgehens eines Experten beim Design genügen.

Abstract: In this document the crucial terms in the field of product design from the viewpoint of artificial intelligence are going to be investigated. We put the emphasis rather on the investigation of the principal concepts, e.g. design model, models of knowledge based design, inovative design, etc., then on the technical details of existing design systems. All issues were kept on an informal level that is suitable to describe the principle approach of a human design expert.

D-93-20*Bernhard Herbig***Eine homogene Implementierungsebene für einen hybriden Wissensrepräsentationsformalismus**

97 Seiten

Zusammenfassung: Im Bereich des Constraint Logic Programming gibt es einen Ansatz, Constraint Formalismen explizit über sogenannte "Constraint Simplification Rules" zu implementieren. Daran anlehnend wird eine formale Grundlage geschaffen, die es erlaubt, Regeln zum Ersetzen und Erweitern von Basismengen zu definieren. Beim Versuch, mit Hilfe solcher Regeln den Inferenzmechanismus terminologischer Sprachen - den Konsistenztest für A-Boxen- zu implementieren, stößt man an die Grenzen des Formalismus. Die klare Formalisierung ermöglicht es aber, den Regelformalismus adäquat zu erweitern. Die Handhabung dieser Erweiterung wird an einer Reihe von ganz verschiedenen Beispielen demonstriert: der Konsistenztest für A-Boxen, logische Programme, lokale Konsistenz, Unifikation, Erfüllbarkeit von Ungleichungen. Ferner wird ein Abarbeitungsmechanismus definiert, dessen Implementation in COMMON LISP im Anhang vorgestellt wird.

D-93-21*Dennis Drollinger***Intelligentes Backtracking in Inferenzsystemen am Beispiel Terminologischer Logiken**

53 Seiten

Zusammenfassung: In der KI beschäftigt man sich zunehmend mit Terminologischen Logiken. Diese gehen auf einen logikbasierten Formalismus für Semantische Netze zurück, der von R. Brachman unter dem Name KL-ONE eingeführt wurde. In KL-ONE-basierten Systemen wird zwischen terminologischem und assertionalem Wissen unterschieden, indem für jede Komponente ein eigener Formalismus zur Verfügung steht. In der sogenannten TBOX wird das konzeptuelle Wissen beschrieben, während in der ABOX Instanzen von Konzepten gebildet werden können, die über Relationen miteinander verknüpft werden.

In den letzten Jahren lag der Schwerpunkt der Forschung im Bereich Terminologischer Logiken auf der Entwicklung vollständiger und effizienter Algorithmen für die Klassifikation, die den zentralen Inferenzdienst des TBOX-Reasoning darstellt. Heute kann man sagen, daß die Leistungsfähigkeit implementierter Systeme bezüglich des TBOX-Reasoning durchaus den Anforderungen genügt.

In den meisten Applikationen stellt jedoch das ABOX-Reasoning, die für den Einsatz als Tool oder Stand-Alone-System wesentlichen Inferenzdienste, zur Verfügung. Die bisher entwickelten vollständigen Algorithmen für das ABOX-Reasoning sind jedoch zu ineffizient, um sie in praktisch verwendbaren Systemen einsetzen zu können. Ursache dieser Ineffizienz ist die naive Behandlung der Disjunktionen, weshalb eine intelligente Behandlung dieser notwendig erscheint.

In der vorliegenden Arbeit wurde ein Verfahren entwickelt, das durch die Verwaltung von Abhängigkeiten und durch geeignete Kontrollmechanismen eine intelligente Backtrackingstrategie realisiert.

D-93-22

Andreas Abecker

Implementierung graphischer Benutzungsoberflächen mit Tcl/Tk und Common Lisp

44 Seiten

Zusammenfassung: Es wird das Programmiersystem Tcl/Tk als sinnvolles Hilfsmittel für die Implementierung graphischer Benutzungsoberflächen für LISP-Anwendungen vorgestellt. Dazu wird auf die Kopplung zwischen LISP und Tcl/Tk eingegangen und einiges an nützlichen LISP-Funktionen für die Benutzung dieser Kopplung zur Verfügung gestellt. Als Anwendungsbeispiel wird ein Taxonomiebrowser für die im terminologischen Wissensrepräsentationssystem TAXON erstellten Begriffshierarchien implementiert.

Abstract: The Programming system Tcl/TK is presented as aid for the implementation of graphic user interfaces for LISP-applications. To that the coupling between LISP and Tcl/Tk is considered and useful LISP-functions for the use of this coupling is provided. As example for an application, a browser for the conceptual hirachies of the knowledge representation system TAXON is implemented.

D-93-24

Brigitte Krenn, Martin Volk

DiTo-Datenbank: Datendokumentation zu Funktionsverbgefügen und Relativsätzen

66 Seiten

Zusammenfassung: In dieser Arbeit werden die DiTo-Daten zu *Funktionsverbgefügen* und *Relativsätzen* beschrieben. DiTo ist ein am DFKI entwickeltes Testwerkzeug für die Fehlerdiagnose der Syntaxkomponenten natürlichsprachlicher Systeme. Mit diesem Tool, das zum Ziel hat, möglichst alle wesentlichen Phänomene deutscher Syntax anhand von Testdaten zu repräsentieren, kann die Fehlerdiagnose bei Testläufen natürlichsprachlicher System systematisch unterstützt werden. Bisher beinhaltet der Datenkatalog die Bereiche *Verbrektion, Satzkoordination, Funktionsverbgefüge und Relativsätze*. Wir arbeiten mit anderen Gruppen zusammen, die weitere Syntaxthemen entsprechend den Richtlinien unseres Ansatzes erarbeiten. Damit ausgewählte Syntaxgebiete separat abgetestet werden können, sind die Daten in einer relationalen Datenbank organisiert.

In den Teildokumentationen zu den beiden hier behandelten Syntaxgebieten werden die Phänomene zuerst skizzenhaft beschrieben. Dann wird die der Datensammlung zugrundeliegende Systematik erläutert. Anschließend wird gezeigt, wie die Daten in der relationalen Datenbank organisiert sind.

Abstract: In this paper we describe DiTo-data for *fixed verbal structures* and *relative clauses*. DiTo is a diagnostic tool for errors within the syntactic component of NLP systems. The DiTo project is an effort to construct a catalogue of data exemplifying the major syntactic patterns of German. Presently, the catalogue adresses *verbal government, coordination, fixed verbal structures and relativ clauses*. We cooperate with other groups that work on further syntactic phenomena according to the ideas of DiTo. To allow systematic testing of specific syntax areas, the data are organised into a relational database.

In this document, the phenomena are sketched first. Then we describe the methodology the data collection is based on. Finally, we show how the data are organised into the relational database.

D-93-25

Hans-Jürgen Bürckert, Werner Nutt (Eds.)

Modeling Epistemic Propositions

118 pages

Note: This document is available only for a nominal charge of 25 DM (or 15 US-\$).

Abstract: Thes document contains the papers presented at the Workshop "Modeling Epistemic Propositions" which has been held in Berlin at the 17th German Conference on Artificial Intelligence, September 1993.

D-93-26

Frank Peters

Unterstützung des Experten bei der Formalisierung von Textwissen
INFOCOM - Eine interaktive Formalisierungskomponente

58 Seiten

Zusammenfassung: Ein in der Wissensakquisition grundlegendes Problem ist das Formalisieren informalen Wissens. Für die Lösung dieses Problems bieten sich verschiedene Wege an, die sich nicht zuletzt durch den Grad ihrer Automatisierung unterscheiden. In dieser Arbeit soll das System INFOCOM vorgestellt werden, welches einen Experten der zu bearbeitenden Domäne beim formalisieren von Textwissen unterstützt. Der Vorgang des Formalisierens ist in verschiedene Phasen unterteilt, die zum einen automatisch durch einen regelgesteuerten Füllalgorithmus, zum anderen manuell im interaktiven Dialog mit dem Experten durchgeführt werden. Ein Wissensingenieur hat die Aufgabe, den Füllalgorithmus durch Eingabe von Regelsystemen zu konfigurieren und den Experten bei seiner Arbeit zu unterstützen.

Abstract: A fundamental problem with knowledge acquisition is the formalisation of informal knowledge. In order to solve this problem there are various ways which, last but not least, differ by the degree of their automatic control. In this document the system INFOCOM is to be presented which supports domain-experts while formalising text-knowledge. The process of formalisation is divided into different phases which are executed automatically by a rule-controlled filling-algorithm on the one hand and manually through an interactive dialog with the expert on the other hand. The task of the knowledge engineer is the configuration of the filling-algorithm by creating rule-systems. In addition to this, he has to support the work of the expert.

D-93-27

Rolf Backofen, Hans-Ulrich Krieger, Stephen P. Spackman, Hans Uszkoreit (Eds.)

Report of theEAGLES Workshop on Implemented Formalisms at DFKI,
Saarbrücken

110 pages

Abstract: This document contains the contributions to the EAGLES Workshop on Implemented Formalisms at DFKI, Saarbrücken, March 1-3, 1993.

DFKl-Publications: The First Four Years
1990 - 1993
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