Looking for Errors

A Declarative Formalism for Resource-Adaptive Language Checking

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Overview

- Main aim:
  - provide tools for rapid development of grammar and controlled language checkers
- Outline:
  - Background:
    Phenomenon-based language checking
  - Integration of backend NLP components
  - Declarative error specification
  - Development environment

Background

- Phenomenon-based language checking
  - Based on the notion of “triggers”
    - Identification of candidates (as cheaply as possible)
    - Confirmation by focussed deeper processing
  - Specific rules for specific error types
- Motivation:
  - Scarce distribution of grammar errors
  - Use appropriate technology (resource-adaptive)
  - Controlled languages always client-specific & positively defined formal grammars unavailable

Multiple NLP Backends I

- Combine virtues of different backend technologies, e.g.
  - Speed
  - Robustness
  - Precision
- Flexible combination of different types of linguistic resources
- Overall robustness independent of individual backend components (resource-independent)

Multiple NLP Backends II

- Tokenisation
- Morphological Analysis (MULTEXT mmorph)
- Probabilistic POS Tagging (TnT; Brants 1999)
- Probabilistic NP Chunking (Skut/Brants 1998)
- Topological Parsing (Braun et al. 2000)
- Deep NLP (work in progress)

Declarative Specification

- Permits tight integration of multiple backends (descriptions of linguistic objects)
- Facilitates division of labour between linguistic tasks and engineering aspects
  - Quickly respond to client-specific demands
  - Individual checking components benefit from global optimisations
- Formalism reflects basic checking architecture

Specification Formalism I

- Token enriched with multiple annotations (token, lemma, part-of-speech, morphology)
- Word-level annotations represented as feature structures
- FS-pattern matching
- Bottom-up integration of (partial) parsing

Specification Formalism II

- #ERROR mWn
- #OBJS

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@dat_obj ::= [POS "^(ART|ADJA)$"
MORPH.READING.INFLECTION.case "dat"];
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- #RULES

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TRIGGER(70) ==
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- Object definitions
- Rules

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- Object definitions
- Rules
  - Trigger (determine error candidates)

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- Object definitions
- Rules
  - Trigger
  - Negative evidence (discard false alarms)

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- Object definitions
- Rules
  - Trigger
  - Negative evidence
  - Positive evidence (confirm error candidates)

Specification Formalism III

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- Resources
- Expressiveness

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  - Token (robust)
- Expressiveness

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  - POS tags (robust)
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- Resources
  - Token (robust)
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  - Morphological analysis
- Expressiveness
  - regular expressions over feature values

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- Resources
  - Token (robust)
  - POS tags (robust)
  - Morphological analysis
- Expressiveness
  - regular expressions over feature values
  - negation/disjunction over feature structures

Specification Formalism IV

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- Rules

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- Rules
  - Weighted with confidence measure

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  - Regexps over feature structures (LHS)

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- Rules
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  - Regexps over feature structures (LHS)
  - Match assigned to named variables (RHS)

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- Rules
  - Weighted with confidence measure
  - Regexps over feature structures (LHS)
  - Match assigned to named variables (RHS)
    - assignment by local coindexation (^)

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- Rules
  - Weighted with confidence measure
  - Regexps over feature structures
  - Match assigned to named variables (RHS)
  - Evidence rules may target named variables

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- Rules
  - Weighted with confidence measure
  - Regexps over feature structures
  - Match assigned to named variables (RHS)
  - Evidence rules may target named variables
    - interface between trigger and validation rules

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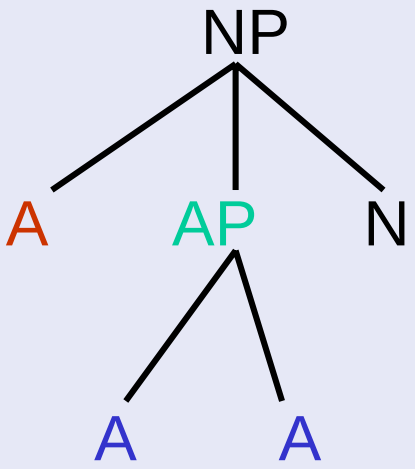
- Rules
  - Weighted with confidence measure
  - Regexps over feature structures
  - Match assigned to named variables
  - Evidence rules may target named variables
  - Relational constraints

Tree constraints I

- Currently:
  - NP/PP chunks: `cin`, `cancestor`, `cpath`
  - Sentence topology: `sin`, `sancestor`, `spath`
- Set of 3 constraints per tree backend:
  - *X*`in`(*Node*,*NT-pattern*)
    determine minimal (lowest) NT node dominating *Node* that matches the regexp in *NT-pattern*
  - *X*`ancestor`(*Terminal1,Terminal2,NT-pattern*)
    determine minimal node dominating both *Terminal1* and *Terminal2* that matches the regexp in *NT-pattern*
  - *X*`path`(*Terminal*,*NT-Node, NT-pattern*)
    restrict the path from *Terminal* to *NT-Node* to contain a node matching the regexp in *NT-pattern*

Tree constraints II

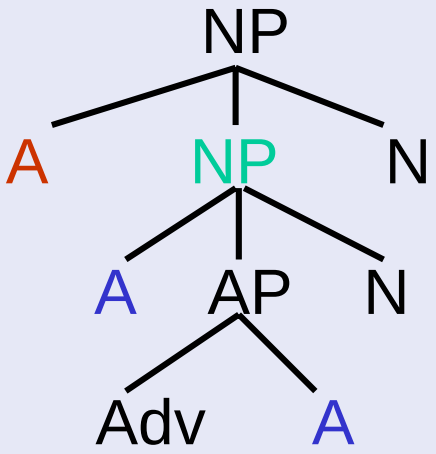



```
@adj ::= [POS "^A$"];

@adj^1 []* @adj^2
  && cin(^1,""^3)
  && cin(^2,^3);
```

- Standard tree configurations
  - Immediate sisterhood
  - Domain-locality (extended sisterhood)
  - Government
  - C-command
  - C-command & bounding nodes

Tree constraints II

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  && cin(^1,"NP"^3)
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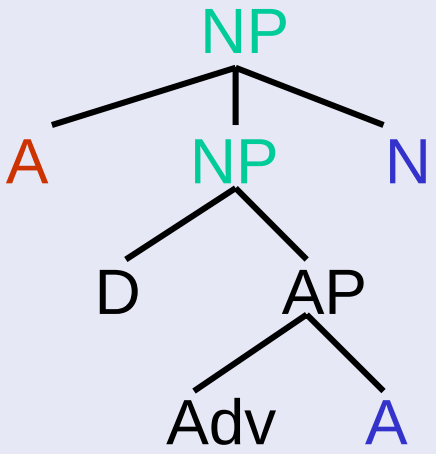


```
@adj ::= [POS “^A$“];
@noun ::= [POS “^N$“];

@adj^1 []* @noun^2
  && cin(^1,“NP“^3)
  && cin(^2,“NP“^4)
  && cin(^3,^4);
```

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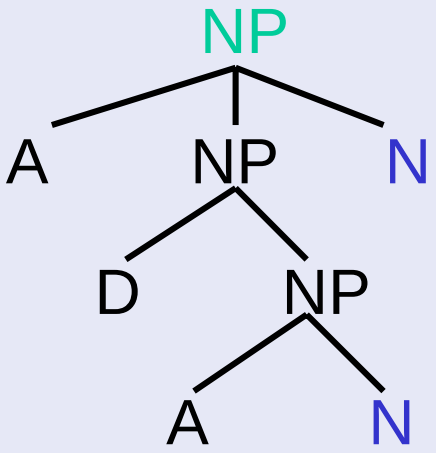


```
@noun ::= [POS “^N$“];

@noun^1 []* @noun^2
  && cin(^2,“NP“^3)
  && cancestor(^1,^2,^3);
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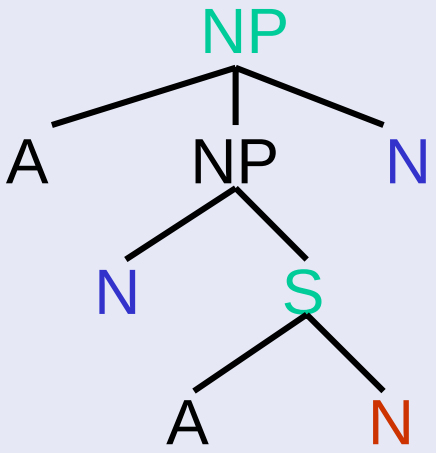


```
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@noun^1 []* @noun^2
  && cin(^2,“NP“^3)
  && cancestor(^1,^2,^3)
  && -cpath(^1,^3,“^S$“);
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Example error

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- „meines Wissens nach"
  - Erroneous blend:
    „meines Wissens (gen)"
    „meinem Wissen nach (dat)"
  - „nach" can be pre-/postposition (selecting dative case)

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  MORPH.READING.INFLECTION.case "dat"];

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  NEG_EV(30) ==
  &&cin($nach,"^PP$"^1) && cin($dat,^1);

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- „meines Wissens nach"
  - Erroneous blend:
    „meines Wissens (gen)"
    „meinem Wissen nach (dat)"
  - „nach" can be pre-/postposition
  - Error:
    findet [meines Wissens nach]$_{PP}$
    [vor dem Essen]$_{PP}$ statt
  - False Alarm:
    findet [meines Wissens]$_{NP}$
    [nach dem Essen]$_{PP}$ statt

Example error

- #ERROR mWn
- #OBJS
  @poss ::= [TOK "^[MmDdSs]eines]";
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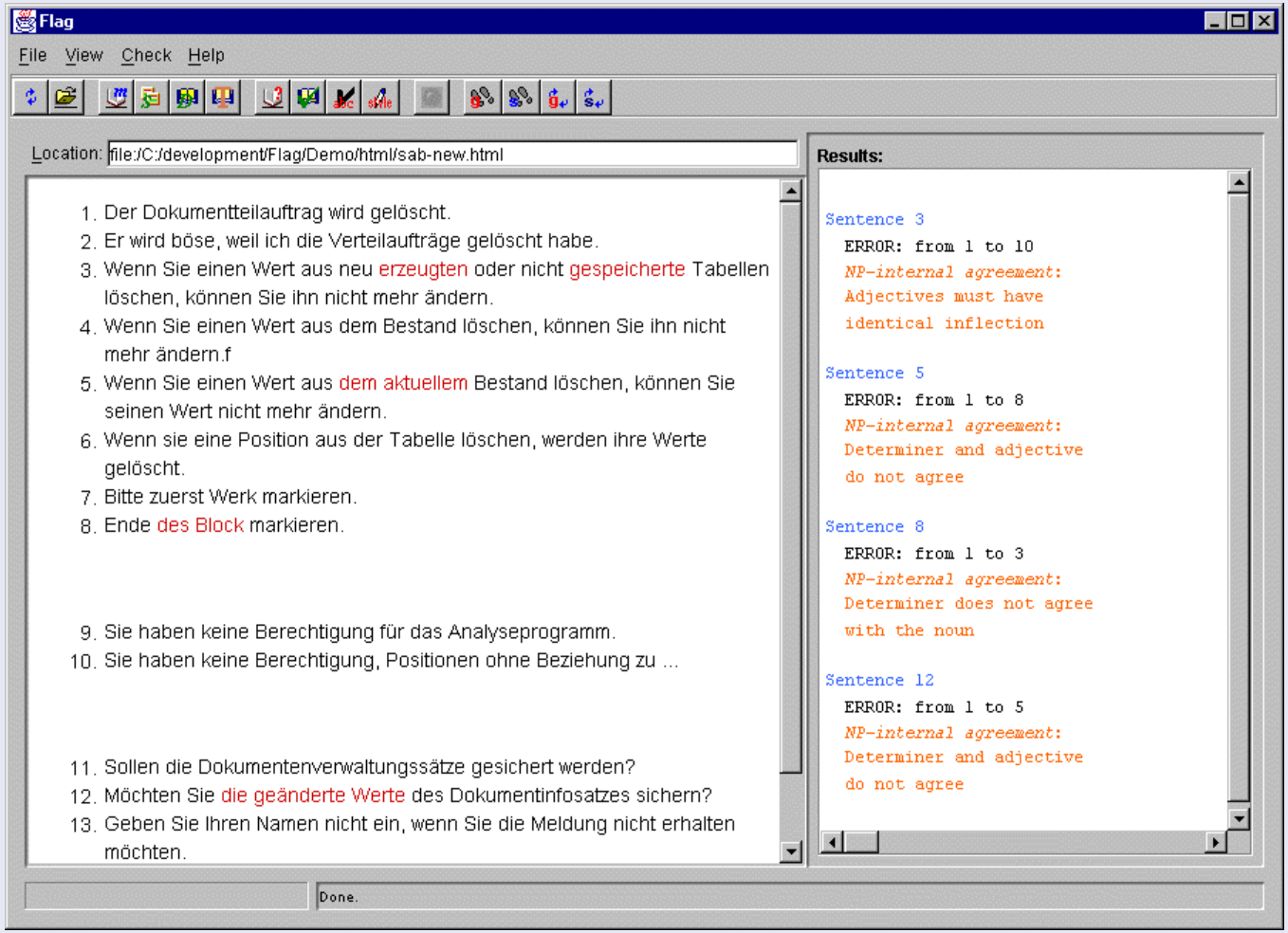
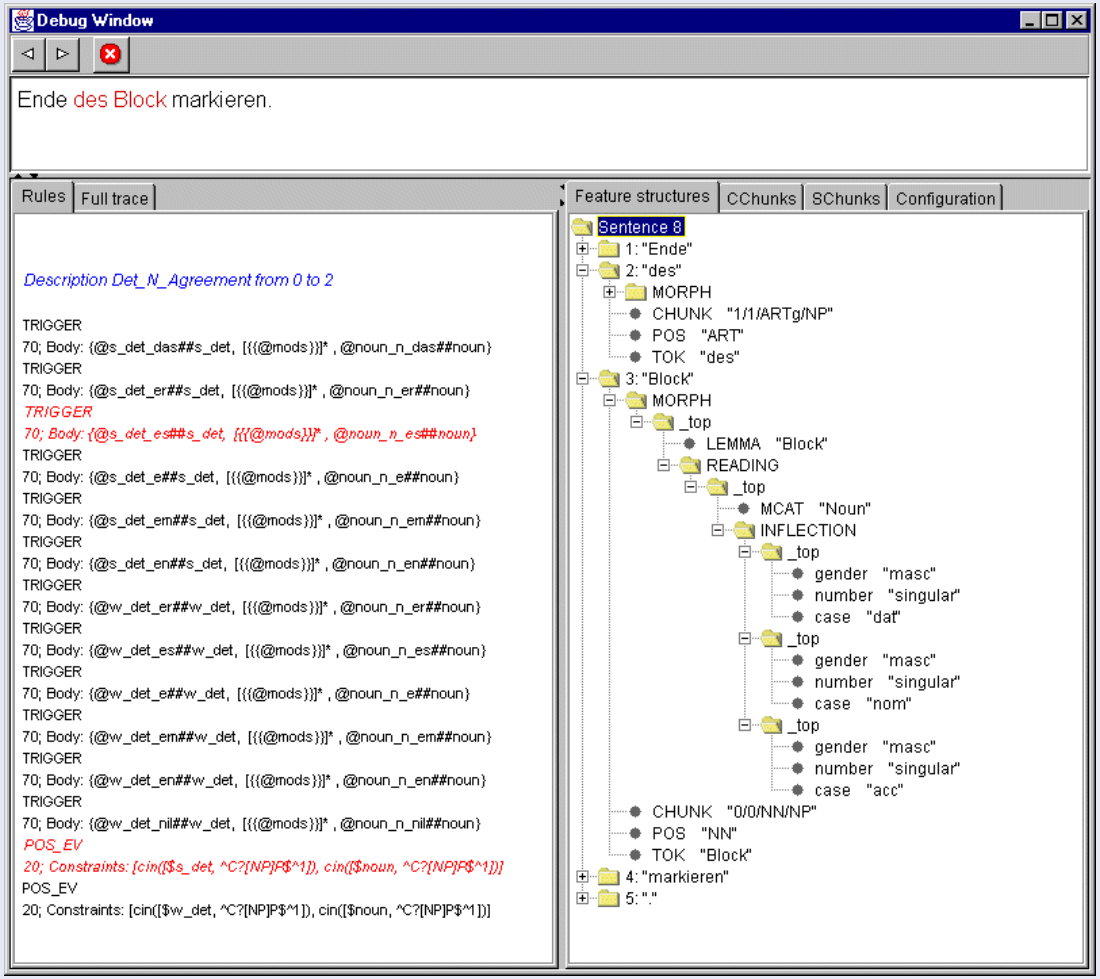
Development environment I

- Integrated environment on Unix and Windows



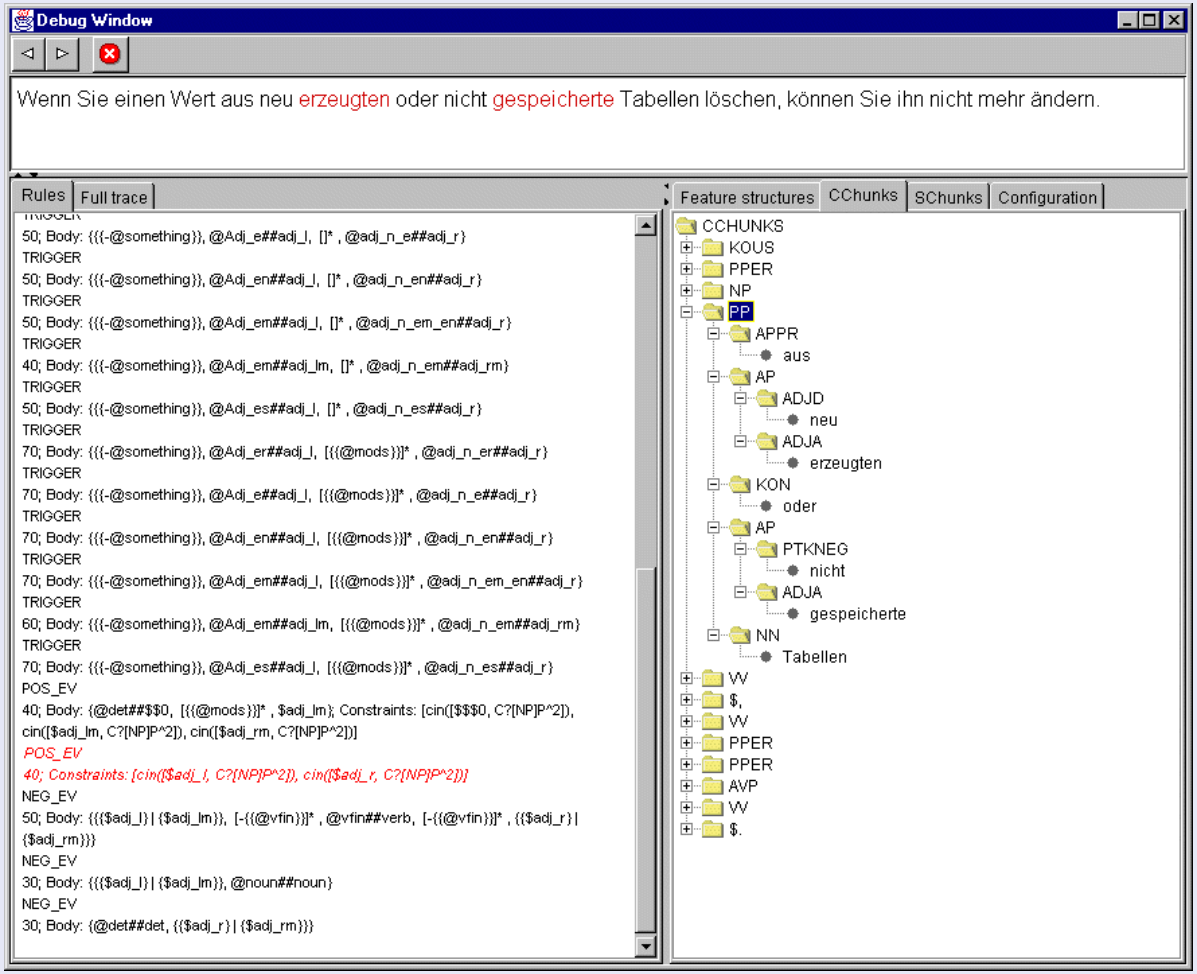
Development environment II

- Rule trace & feature browser
  - Position of a match highlighted
  - Successful rules highlighted
  - Browser for lexical resources:
    - Token
    - POS
    - Morphology



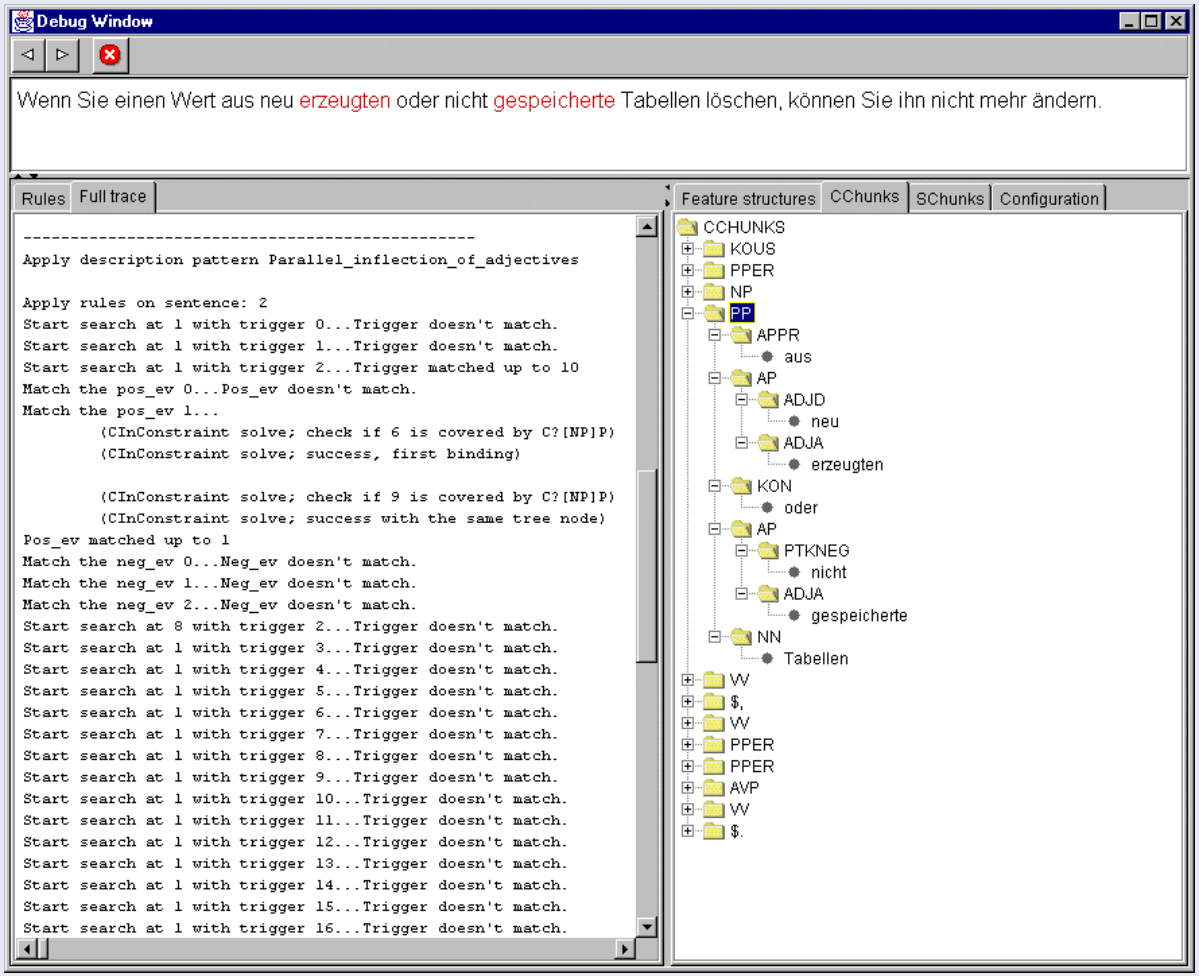
Development environment III

- Rule trace & chunk browser
  - NP chunks
  - Sentence topology



Development environment IV

- Full trace & chunk browser
  - Variable binding
  - Constraint resolution



Future work

- Integrate additional lexical resources into rule formalism, e.g.
  - Semantic ontologies
  - Terminological databases
- Provide path equations as constraints
  - permitting the representation of DAGs
  - specialisation of previous matches
- Integrate deep NLP (project Whiteboard)
- Optimise pattern matching engine

Conclusion

- Phenomenon-based approach to checking
  - Cheap identification of error candidates
  - Focussed processing for error confirmation
  - Resource-adaptivity
- Separation of error specification and underlying NLP components
  - customisable
  - extendible