erc TreeGraSP

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Language modeling with tree-adjoining grammars

Grammar implementation for LTAG

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[a] and some slides by Timm Lichte

Outline

Overview

What is grammar implementation?

Two ways of tree template implementation

- Metarules
- Metagrammars

Getting XMG 2

Last sessions

Mon:	Motivation and the basic TAG
Tue:	Linguistic applications and using LTAG: syntax
Wed:	Linguistic applications and using LTAG: semantics

The following sessions

Wed:	Introduction to grammar engineering and XMG
Thu:	Grammar implementation with XMG
Fri:	Parsing TAG

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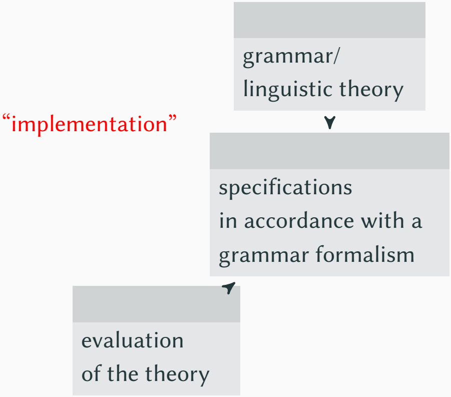
Two kinds of grammar implementation



grammar/
linguistic theory

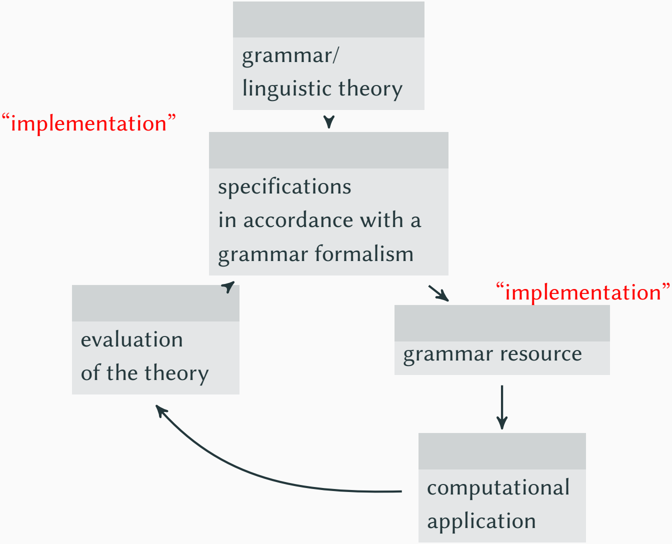
“implementation”

specifications
in accordance with a
grammar formalism

evaluation
of the theory

As is frequently pointed out but cannot be overemphasized, an important goal of formalization in linguistics is to enable subsequent researchers to see the defects of an analysis as clearly as its merits; only then can progress be made efficiently. (Dowty 1979: 322)

Two kinds of grammar implementation



grammar/ linguistic theory

“implementation”

specifications in accordance with a grammar formalism

evaluation of the theory

“implementation”

grammar resource

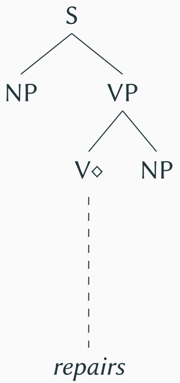
computational application

What kind of grammar resource?

tree template

lexical insertion

anchor



The implementation task for LTAG

General task

Implement a large-coverage LTAG, as the XTAG grammar.

Subtasks:

1. Generate unlexicalized trees (= tree templates)
2. Generate a database of lexical anchors (= lexicon)
3. Connect the tree templates with the lexicon (= lexical insertion)

Two ways of grammar implementation with TAG

Two existing toolkits:

XTAG tools[13]

1. implementation tools

   ⇒ **metarule approach**

2. editor/viewer for MorphDB and SynDB
3. parser

XMG + lexConverter + TuLiPA

1. XMG : eXtensible MetaGrammar[5]

   ⇒ **metagrammar approach**

2. lexConverter (LEX2ALL)
3. TuLiPA: Tübingen Linguistic Parsing Architecture[8]

Two ways of grammar implementation with TAG

Two existing toolkits:

XTAG tools[13]

1. implementation tools
   - ⇒ **metarule approach**
2. editor/viewer for MorphDB and SynDB
3. parser

XMG 2 + ~~lexConverter~~ + TuLiPA

1. XMG 2: eXtensible MetaGrammar[5]
   - ⇒ **metagrammar approach for grammar and lexicon**
2. ~~lexConverter (LEX2ALL)~~
3. TuLiPA: Tübingen Linguistic Parsing Architecture[8]

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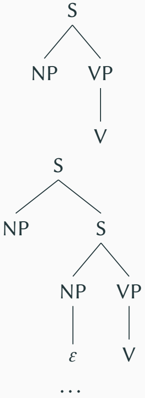
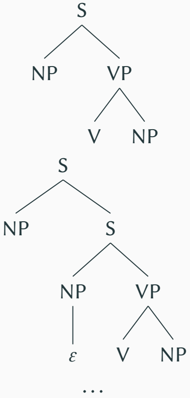
The situation

12 templates for intransitive verbs



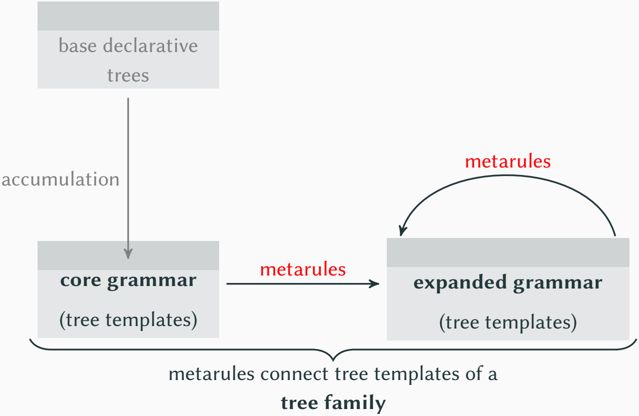
39 tree templates for transitive verbs



XTAG defines a set of 1008 unrelated tree templates.

Metarules for LTAG

Idea from GPSG[7], later applied to XTAG[1,2,9]



base declarative trees

accumulation

metarules

core grammar

(tree templates)

metarules

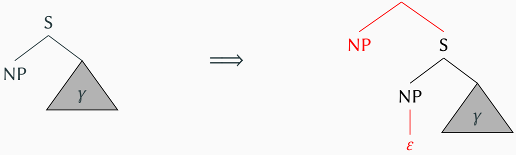
expanded grammar

(tree templates)

metarules connect tree templates of a **tree family**

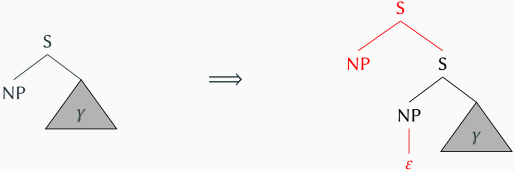
Metarules for LTAG: Example

extraction:

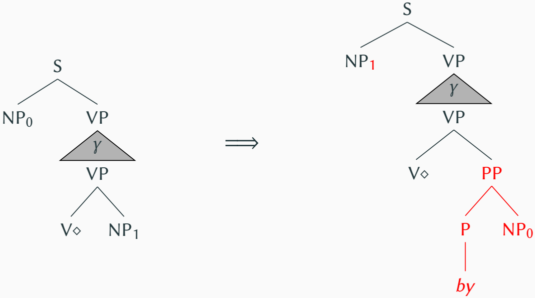


Metarules for LTAG: Example

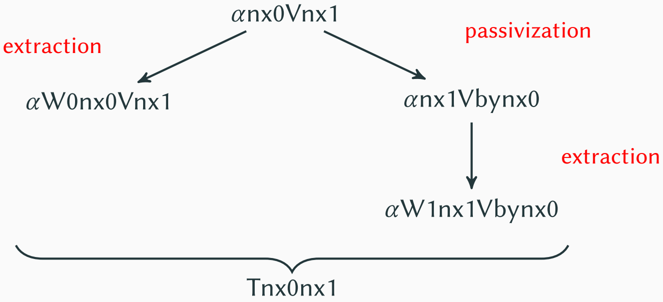
extraction:



passivization:



Metarules for LTAG: Example



αnx0Vnx1

extraction

passivization

αW0nx0Vnx1

αnx1Vbynx0

extraction

αW1nx1Vbynx0

Tnx0nx1

Metarules for LTAG: Problems[1]

Metarules are very powerful:

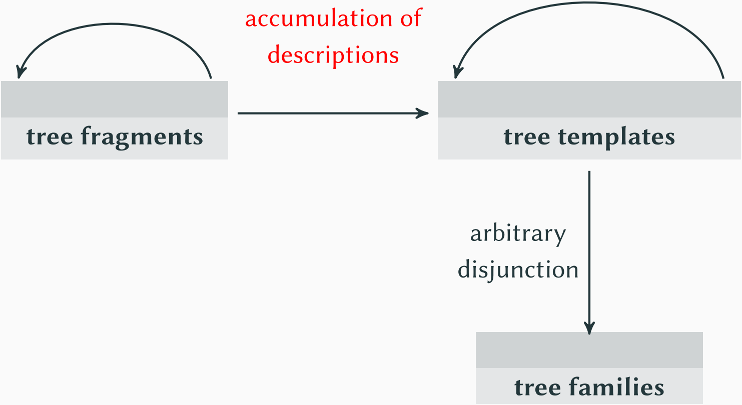
- deletion, copying, recursive application, metavariables over trees
- order sensitive
- in the unrestricted case: undecidable[11]

Restrictions (GPSG):[10]

- finite closure: apply every metarule at most once
  - ⇒ still NP-complete
- biclosure: apply at most two metarules in a row
  - ⇒ insufficient for LTAG metarules[1]
- explicit rule ordering (by means of finite state automata)[9]

Metagrammars for LTAG

Candito (1996)[4,5,12]



accumulation of descriptions

tree fragments

tree templates

arbitrary disjunction

tree families

Metagrammars

- Observation: too many trees, but a lot of redundancies
- Idea: instead of trees, consider (reusable) tree fragments
- Trees obtained by assembling tree fragments
- No transformations → accumulation of descriptions
- Monotonic, not order sensitive

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Getting XMG 2

Getting XMG 2

Everything you need is on the website:

`https://xmg.phil.hhu.de`

Three options for using XMG 2, see the documentation:

`https://github.com/spetitjean/XMG-2/wiki`

- Follow the steps (Ubuntu), or
- Install VirtualBox and get the XMG 2 image, or
- Use the online compiler(s): `https://xmg.phil.hhu.de/index.php/upload/workbench`

[1] Becker, Tilman. 1994. *Hytag: a new type of tree adjoining grammars for hybrid syntactic representations of free word order languages*. Universität des Saarlandes dissertation. `http://www.dfki.de/~becker/becker.diss.ps.gz`.

[2] Becker, Tilman. 2000. Patterns in metarules for TAG. In Anne Abeillé & Owen Rambow (eds.), *Tree Adjoining Grammars: Formalisms, linguistic analyses and processing* (CSLI Lecture Notes 107), 331–342. Stanford, CA: CSLI Publications.

[3] Candito, Marie-Hélène. 1996. A principle-based hierarchical representation of LTAGs. In *Proceedings of the 16th international Conference on Computational Linguistics (COLING 96)*. Copenhagen. `http://aclweb.org/anthology-new/C/C96/C96-1034.pdf`.

[4] Crabbé, Benoît. 2005. *Représentation informatique de grammaires d'arbres fortement lexicalisées: Le cas de la grammaire d'arbres adjoints*. Université Nancy 2 dissertation.

[5] Crabbé, Benoit, Denys Duchier, Claire Gardent, Joseph Le Roux & Yannick Parmentier. 2013. XMG: eXtensible MetaGrammar. *Computational Linguistics* 39(3). 1–66. `http://hal.archives-ouvertes.fr/hal-00768224/en/`.

[6] Dowty, David R. 1979. *Word meaning and Montague Grammar*. Reprinted 1991 by Kluwer Academic Publishers. Dordrecht: D. Reidel Publishing Company.

[7] Gazdar, Gerald. 1981. Unbounded dependencies and coordinated structure. *Linguistic Inquiry* 12. 155–182.

[8] Parmentier, Yannick, Laura Kallmeyer, Wolfgang Maier, Timm Lichte & Johannes Dellert. 2008. TuLiPA: A syntax-semantics parsing environment for mildly context-sensitive formalisms. In *Proceedings of the ninth international workshop on Tree Adjoining Grammars and related formalisms (TAG+9)*, 121–128. Tübingen, Germany.

[9] Prolo, Carlos A. 2002. Generating the XTAG English grammar using metarules. In *Proceedings of the 19th international Conference on Computational Linguistics (COLING 2002)*, 814–820. Taipei. Taiwan.

[10] Ristad, Eric Sven. 1987. Revised General Phrase Structure Grammar. In *Proceedings of the 25th annual meeting of the Association for Computational Linguistics*, 243–250. Stanford, CA. `http://www.aclweb.org/anthology/P87-1034`.

[11] Uszkoreit, Hans & Stanley Peters. 1987. On some formal properties of metarules. English. In Walter J. Savitch, Emmon Bach, William Marsh & Gila Safran-Naveh (eds.), *The formal complexity of natural language* (Studies in Linguistics and Philosophy 33), 227–250. Dordrecht, The Netherlands: D. Reidel Publishing. http://dx.doi.org/10.1007/978-94-009-3401-6_9.

[12] Xia, Fei. 2001. *Automatic grammar generation from two different perspectives*. University of Pennsylvania dissertation. http://faculty.washington.edu/fxia/papers_from_penn/thesis.pdf.

[13] XTAG Research Group. 2001. *A Lexicalized Tree Adjoining Grammar for English*. Tech. rep. Philadelphia, PA: Institute for Research in Cognitive Science, University of Pennsylvania.