Grammatemes and Coreference in the PDT 2.0

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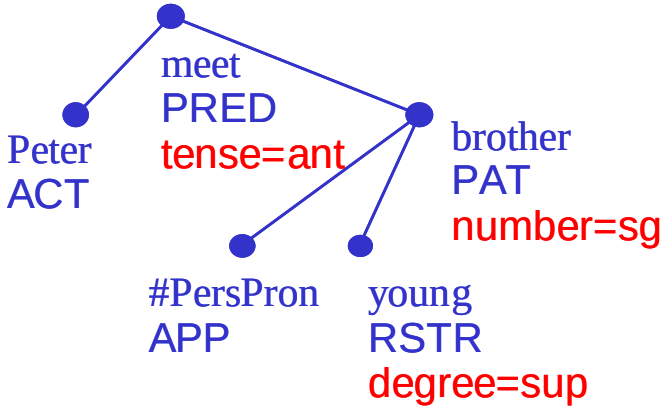
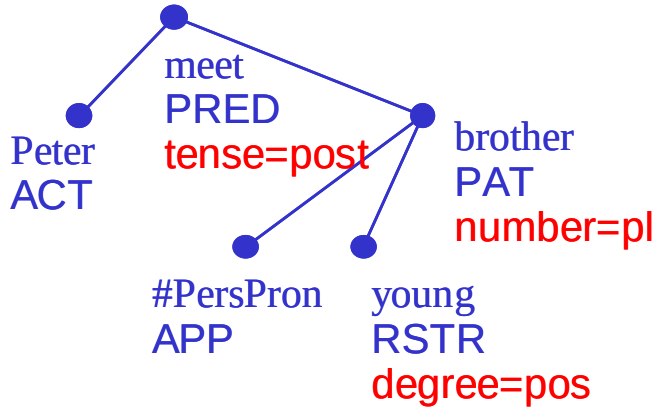
What is a "grammateme"? (1)

Peter met her youngest brother.



Peter will meet her young brothers.



- the same t-lemmas, the same tree topology, the same functors, but the original sentences are obviously not synonymous and must be distinguished at the t-layer (must obtain different t-trees) !
- the difference is in grammatemes ~ t-node attribute-value pairs representing morphological meanings (semantically indispensable morphological categories)
- e.g. number for nouns, tense for verbs, degree for adjectives, deontic/verb/sentence modality ...

What is a "grammateme"? (2)

- grammatemes are not just straightforward counterparts of surface morphological categories (as stored in m-layer tags) !
- some morphological categories are only imposed by grammar and thus are not semantically relevant
  - gender, number or case of an adjective in a noun group come from agreement with the noun (e.g. in Czech or German), not from semantics
  - similarly, person is not a grammateme of verbs, as it is only induced by subject-verb agreement

What is a "grammateme"? (3)

- on the surface, grammatemes can be expressed both inflectionally and analytically
- info about grammatemes can be distributed over more than one m-layer token
  - comparative of adjectives in English (*more interesting*)
  - future tense of imperfectives in Czech (*budu chodit…/ I will go…*)

Complete list of grammateme attributes used in PDT 2.0

1. **gram/number** - number of semantic nouns
2. **gram/gender** - gender of semantic nouns
3. **gram/person** - person of pronominal semantic nouns
4. **gram/politeness** -basic vs. polite/esteemed form, relevant for pronominal semantic nouns
5. **gram/indeftype** (type of indefiniteness of pro-forms)
6. **gram/numertype** (type of numeric expression)
7. **gram/negation** - negation of semantic nouns, adjectives, and adverbs (not of verbs)
8. **gram/degcmp** - degree of comparison of semantic adjectives and adverbs
9. **gram/tense** - tense of verbs
10. **gram/aspect** - aspect of verbs
11. **gram/verbmod** - basic verb modality (indicative, imperative, conditional)
12. **gram/deontmod** - deontic modality expressed by modal verbs
13. **gram/dispmod** - dispositional modality (specific for Czech)
14. **gram/resultative** - resultativeness of verbs
15. **gram/iterativeness** - iterativeness of verbs
16. **sentmod** - sentence modality (enunciative, exclamative, desiderative, imperative, interrogative)

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Grammateme number

- values:
  - sg - singular
  - pl - plural
  - nr - not recognized

- m-layer/t-layer asymmetry:
  - pluralia tantum: *jedny dveře/ dvoje dveře* (one door, two doors) - only the plural form exists at the m-layer, but sg/pl should be disambiguated at the t-layer
  - polite form: *"Viděl jste to, Petře?"* (Did you see it, Petr?) - complex verb form containing an auxiliary verb in plural at the m-layer, but at the t-layer the grammateme number (filled in the reconstructed #PersPron node) is equal to singular

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Grammateme tense

- relative tense of verbs (with respect to the tense of the governing clause)
- values:
  - sim - simultaneous
  - ant - anterior
  - post - posterior
  - nil - absent (with infinitives)
  - nr - not recognized
- m-layer means for expressing tense=post in Czech:
  - inflection with perfectives (*uvařím* - I will cook)
  - auxiliary verb *být* with imperfectives (*budu zpívat* - I will sing)
  - prefix *po-*/*pů-* with a limited set of verbs (*pojedu* - I will go)

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Grammateme indeftype (I)

- pro-form - a word used to replace or substitute other words, phrases, clauses...
- pronouns (pro-nouns), pro-adjectives, pro-numerals, pro-adverbs
- there are many semantically significant analogies present in the pro-forms systems, but usually not explicitly distinguished in the POS tag sets
- example of such parallelism:
  - nobody/never/nowhere... vs. everybody/always/everywhere...
- grammateme indeftype (type of indefiniteness) dedicated for all indefinite pro-forms
- to capture the parallelisms, each group of pro-forms is represented with t_lemma identical with the relative form: *někde->kde (nowhere->where), kdokoli->kdo (whoever->who), nikdy->kdy (never->when)*

Grammateme indeftype (II)

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t-lemma:	*kdo*	*co*	*který*	*jaký*
value of the grammateme **indeftype**:				
relat	*kdo*	*co*	*který, jenž*	*jaký*
indef1	*někdo*	*něco*	*některý*	*nějaký*
indef2	*kdosi, kdos*	*cosi, cos*	*kterýsi*	*jakýsi*
indef3	*kdokoli(v)*	*cokoli(v)…*	*kterýkoli(v)*	*jakýkoli(v)*
indef4	*ledakdo, leckdo…*	*ledaco, lecco…*	*leckterý, ledakterý*	*lecjaký, ledajaký*
indef5	*kdekdo*	*kdeco*	*kdekterý*	*kdejaký*
indef6	*málokdo, kdovíkdo…*	*máloco…*	*málokterý…*	*všelijaký…*
inter	*kdo, kdopak…*	*co, copak…*	*který, kterýpak*	*jaký, jakýpak*
negat	*nikdo*	*nic*	*žádný*	*nijaký*
total1	*všechen*	*všechen, všechno, vše*	–	–
total2	–	–	*každý*	–

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Grammateme indeftype (III)

- indefinite, negative, interrogative, and relative pronouns and other pro-forms are unproductive classes with (at least to a certain extent) transparent derivational relations also in other languages

- preliminary sketch of several English and German pronouns classified by indeftype

	English	English	German	German
Lemma	*who*	*what*	*wer*	*was*
indefype:				
relat	who	what	wer	was
indef1	someone	something	jemand	etwas
indef2	-	-	irgendjemand	irgendetwas
indef3	whoever	whatever	-	-
inter	who	what	wer	was
negat	nobody	nothing	niemand	nichts
total1	all	everything	alle	alles
total2	each	each	jeder	jedes

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Typing of t-nodes

- unlike t_lemmas and functors, grammateme attributes are not relevant for all t-nodes
  - obviously, no tense for *dog*, no degree of comparison for *(he) waits*, etc.
- question: how to formally declare presence/absence of a certain grammateme in a certain t-node ? → the need for node typing
- our solution: two-level hierarchy of node types
  - 1st level: 8 coarse-grained types of nodes
  - 2nd level: 19 more specific subtypes, corresponding to detailed semantic parts of speech

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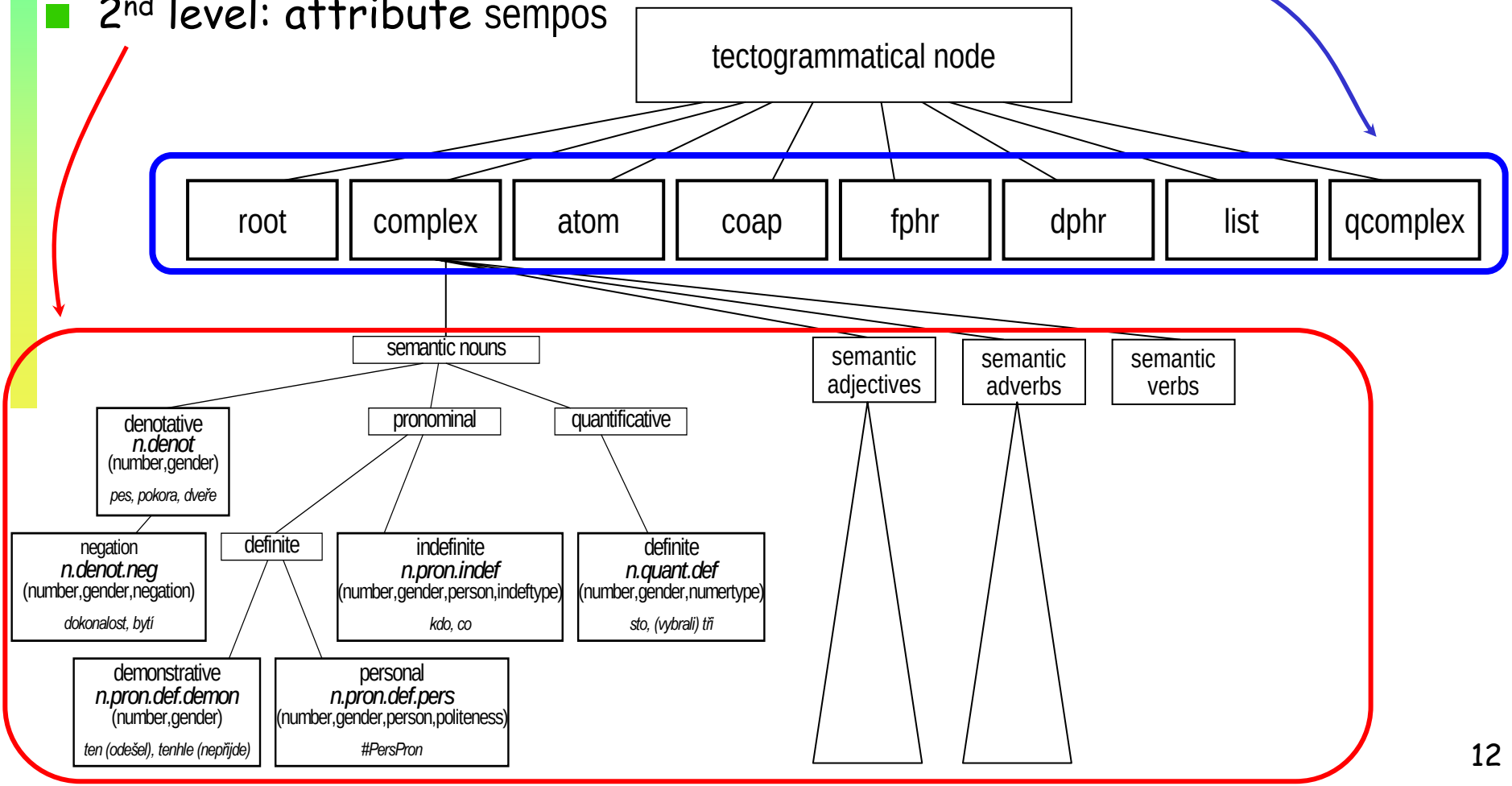
Two-level hierarchy of t-node types

- 1st level: attribute nodetype
- 2nd level: attribute sempos



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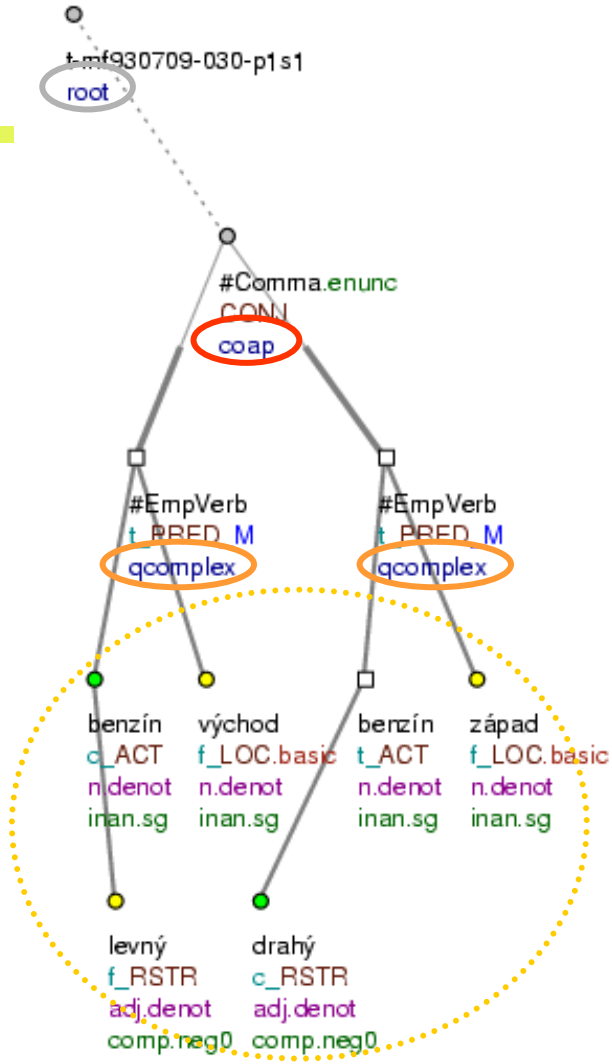
First level of the hierarchy: attribute nodetype

- 8 nodetype values:

  root | complex | qcomplex | list | atom | coap | dphr | fphr

- fully automatic annotation - use of
  - the tree structure → root
  - t-attributes
    - t-lemma → qcomplex | list
    - functor → atom | coap | dphr | fphr
  - otherwise → complex



Levnější benzín na Východě, dražší na Západě
Cheaper gasoline in the East, more expensive one in the West

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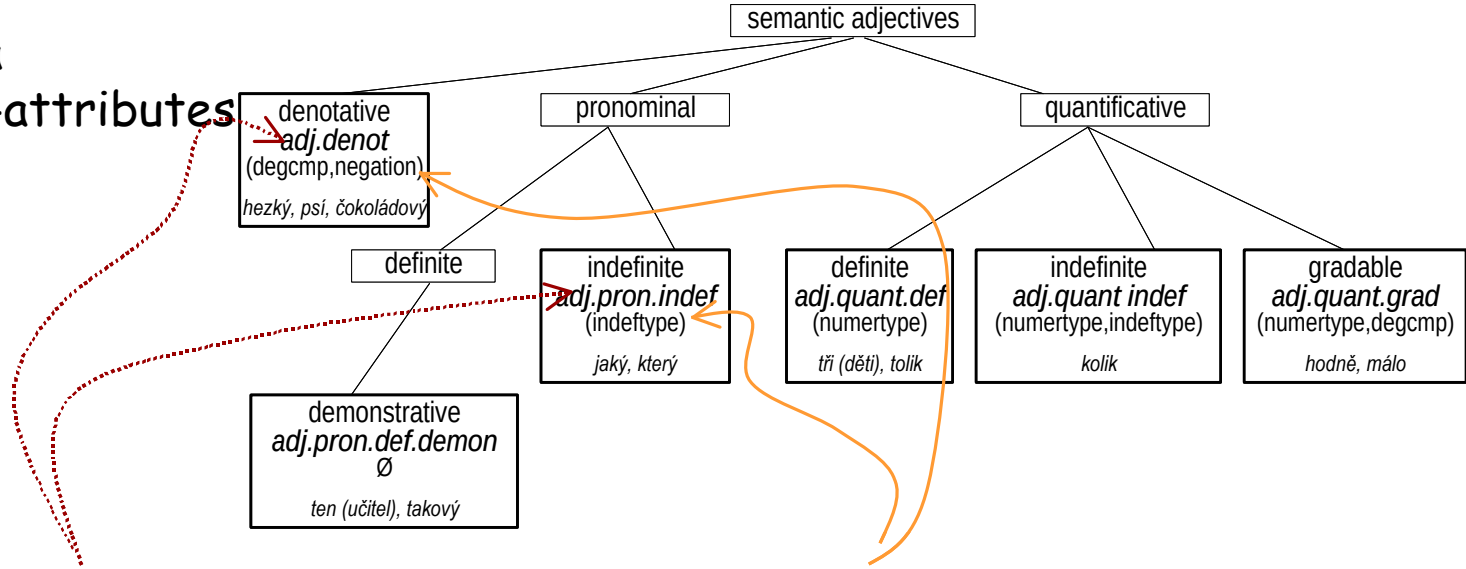
Second level of the hierarchy: attribute sempos

- sempos relevant only for nodetype=complex t-nodes
- 19 values of the attribute sempos:
  - n. ... | adj. ... | adv. ... | v. ...
- fully automatic annotation – use of
  - m-tag
  - t-lemma
  - other t-attributes



- sempos value delimits the set of relevant grammatemes

M-layer POS tags vs. sempos

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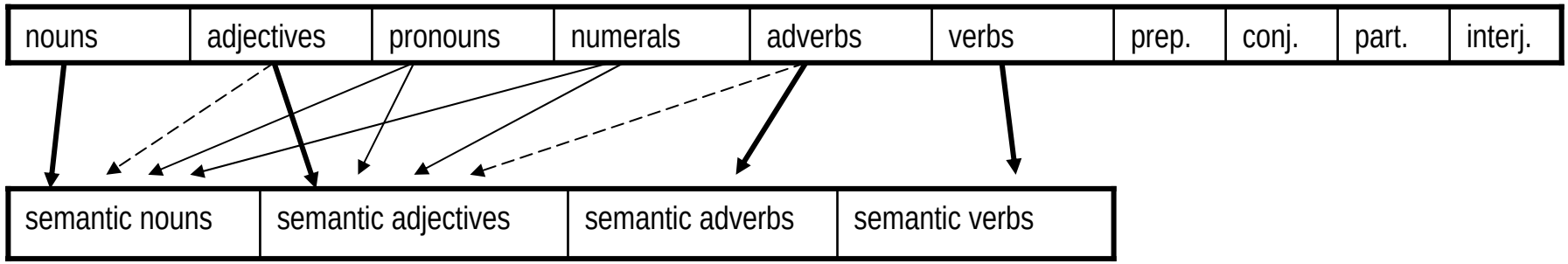

"prototypical" relations between semantic and "traditional" parts of speech

distribution of pronouns and numerals into semantic parts of speech

classification following the derivational information

- Examples of asymmetry:
  - m-layer possessive adjectives (e.g. *matčin*/mother's) converted to semantic nouns (*matka*/mother)
  - m-layer deadjectival adverbs (*pěkně*/nicely) converted to semantic adjectives (*pěkný*/nice)

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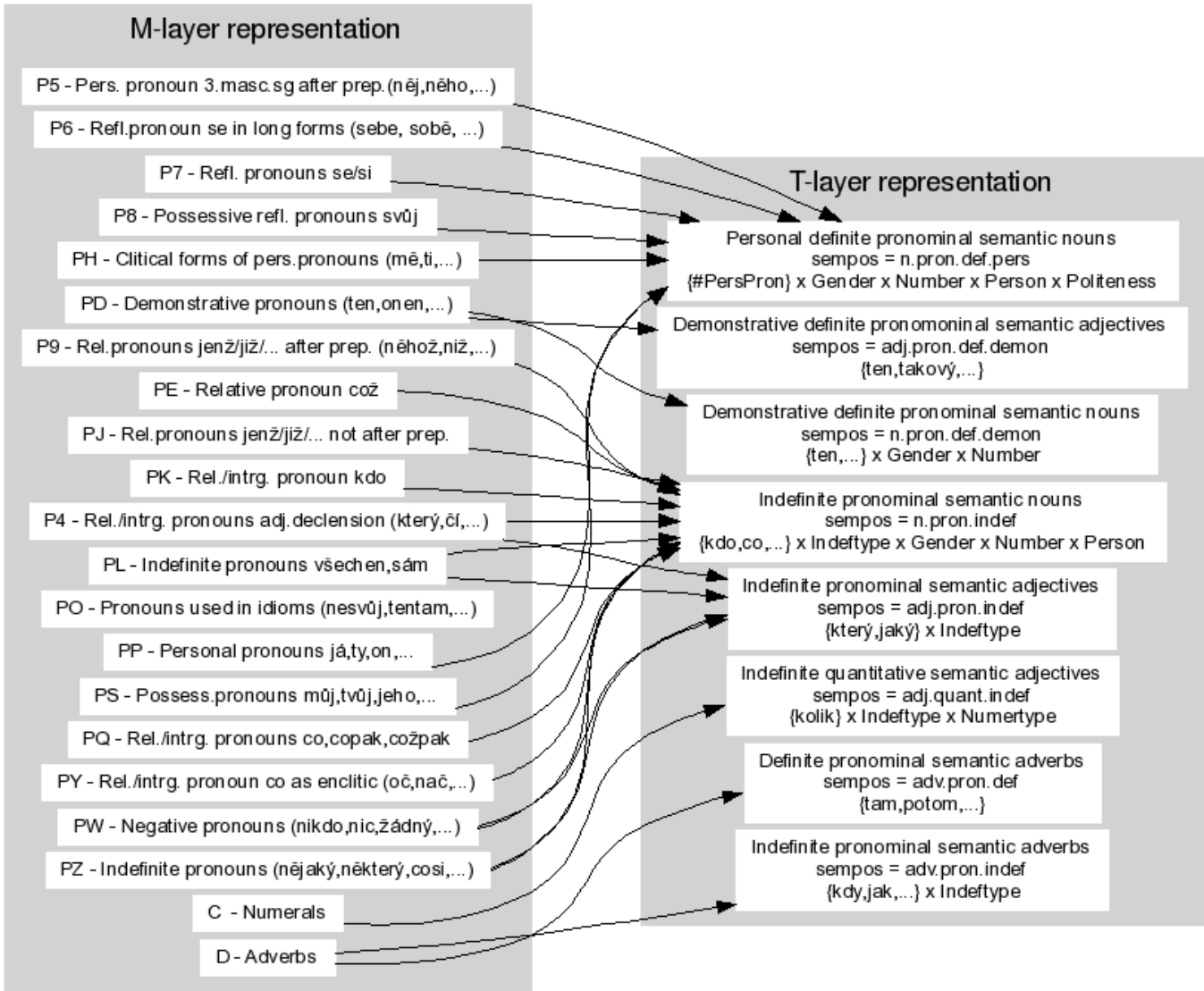
Pro-forms: m-layer tags vs. t-layer sempos



Grammatemes: Annotation process

- implementation: 2000 Perl LOCs in the ntred environment
- + 2000 lines of linguistic rules
- extensive usage of m-layer and a-layer manual annotation => mostly automatic annotation possible
- only 5 man-months of human annotation needed
- grammatemes available in all tectogrammatical trees of PDT 2.0

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Grammatemes - summary

- grammateme attributes
  - component of the tectogrammatical layer
  - semantically indispensable morphological categories
  - i.e., not those imposed by agreement or other grammatical rules
  - e.g. number with nouns, tense with verbs, but not number with verbs
  - t-nodes types determine which grammatemes must be present

Part II
Coreference

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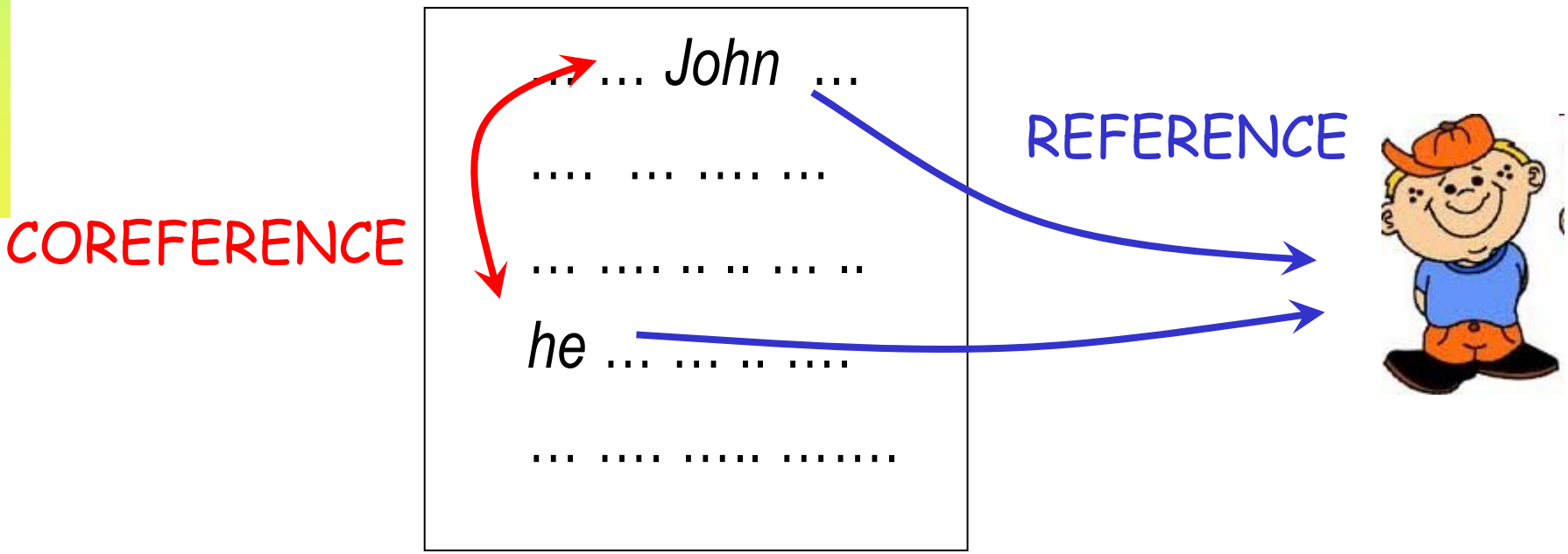
What is coreference?

- multiple expressions in a sentence or document can refer to the same thing



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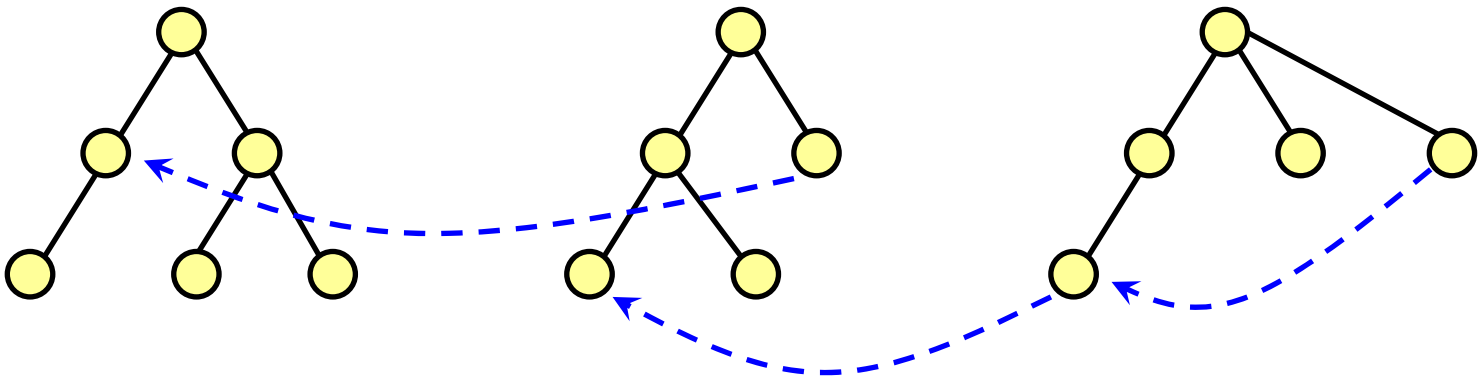
Coreference in PDT

- links between tectogrammatical nodes
- technically: pointer from an anaphor t-node to its antecedent t-node
- links can form chains



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Two types of coreference

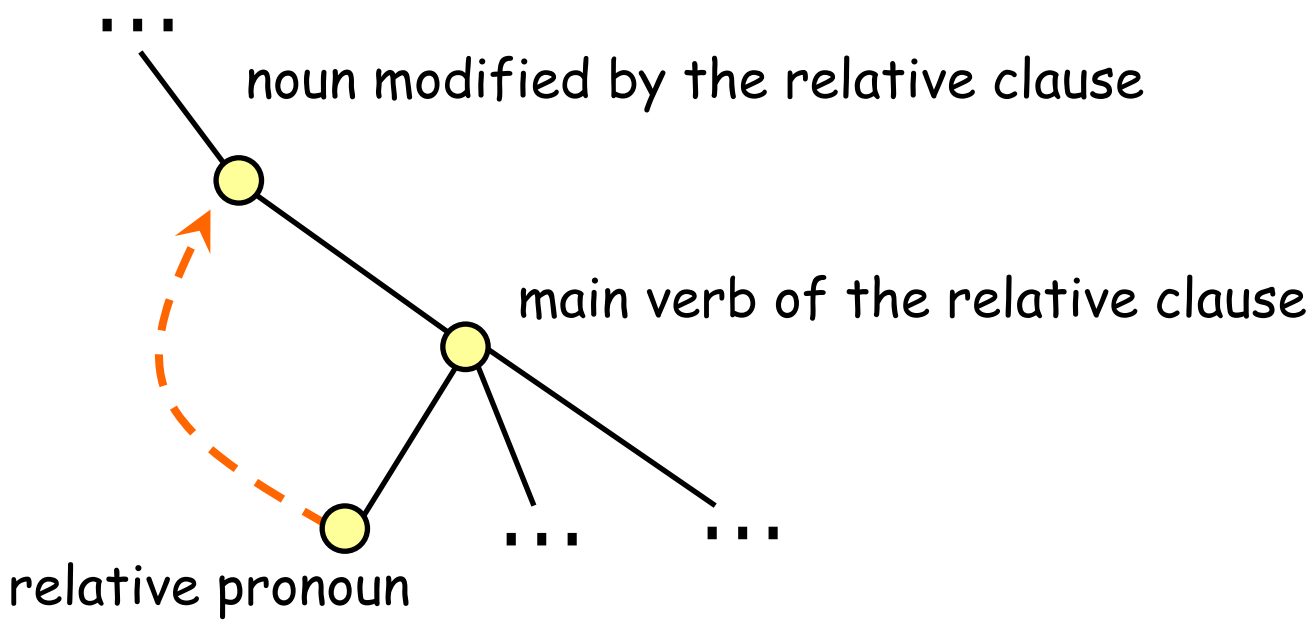
- according to Functional Generative Description, two types of coreference distinguished:

- **grammatical** coreference
  - (partially) determined by grammar rules

- **textual** coreference
  - determined only by text meaning

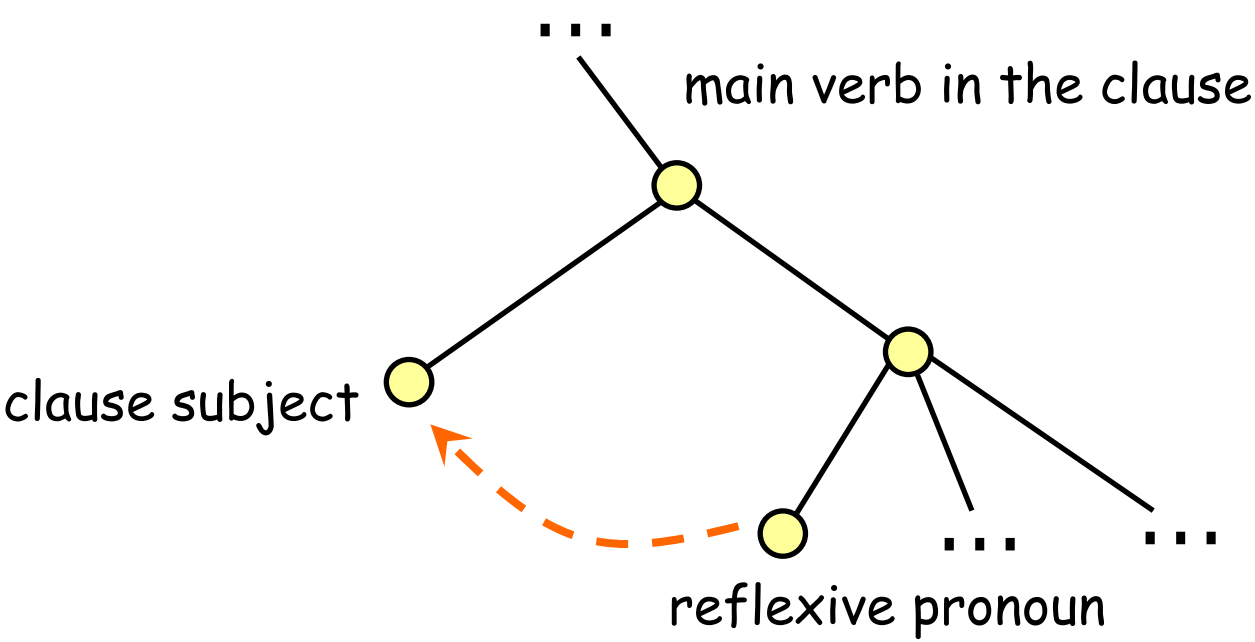
Grammatical coreference (1)

- relative pronouns
- *"The man, who…", "The man, whose …"*
- typical local configuration:



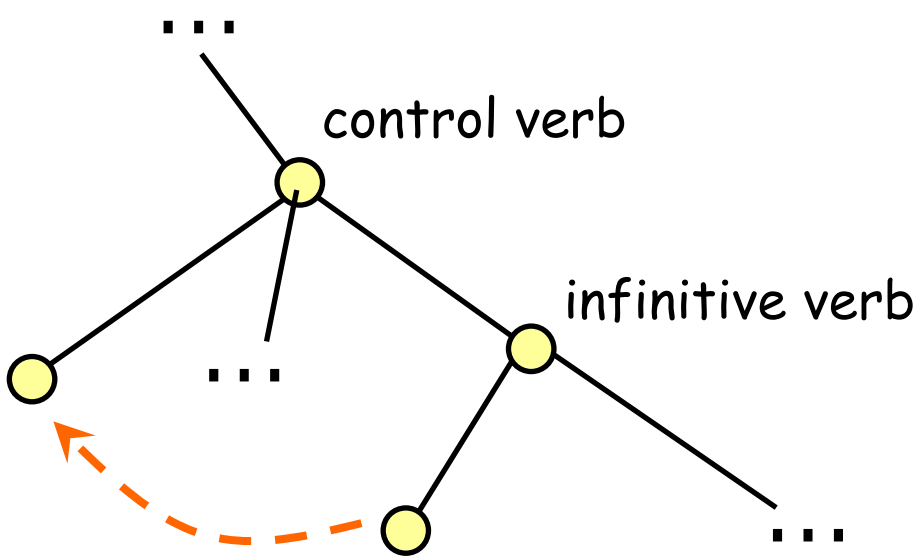
Grammatical coreference (2)

- reflexive pronouns
- in Czech, pronouns referring to clause subject have reflexive form
- typical local configuration:



Grammatical coreference (3)

- reconstructed (surface-unexpressed) actor of infinitive verbs
- *"He started to sing." "They asked him to come."*
- typical local configuration:



#Cor.ACT - reconstructed coreferential actor

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Textual coreference

- anaphors:
  - personal pronouns
  - possessive pronouns
  - reconstructed pronouns (pro-drop)

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Special cases

- multiple antecedent:
  - two or more parallel links from a plural anaphor (*Peter and Paul … they…*)
- cataphora
  - left-to-right links
- segm – vague reference to the previous context
- exoph - exophora

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Annotated data

- manually annotated coreference in 50,000 sentences
- around 45,000 coreference links

Coreference - summary

- coreference in PDT 2.0
  - t-layer component
  - one of the largest manually annotated coreference resources
  - two types of coreference links
    - grammatical coreference
    - textual coreference
  - anaphors:
    - pronouns (personal, possessive, relative, reflexive)
    - reconstructed nodes (pro-drops,actants of infinitive verbs,...)