Towards a Conversion of the Prague Dependency Treebank Data to the Uniform Meaning Representation

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Supported by the LUSyD project (GAČR, no. 20-16819X) and the LINDAT/CLARIAH-CZ project (MŠMT, no. LM2023062); partially supported by CUNI (GAUK, project no. 104924, and SVV, project no. 260 698).

Motivation and Goal

Meaning representation

- intriguing theoretical problem
- its practical implications for applications
  - interlingua for machine translation
  - a basis for knowledge representation and knowledge systems
- a sound and reliable basis for logical inference

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LLM dominates the field, BUT

- problems with hallucinating
- tend to fabricate information

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Goal:

- compare 2 meaning representations
  - based on different theoretical assumptions, with different linguistic traditions, with different focuses
- a substantially deeper understanding of language semantics

Two Meaning Representations at a Glance

PDT-MR

- theory: Functional Generative Description
  (esp. Sgall et al, 1967; 1986; 2020)
- data and tools: treebank (esp. Hajič et al., 2020)
  Czech (~130k sentences); English (~55k); Latin (~5k)
- dependency-oriented formalism
- covers:
  - deep and surface syntax (argument structure)
  - meaning-relevant morphology (tense, modality)
  - coreference annotation
  - information structure and discourse relations

UMR

- semantics, abstracting away from syntax
  (esp. van Gysel et al, 2018; Bonn et al, 2013)
- typological perspective
- limited data, no supporting infrastructure
  6 languages (~ 2k sentences)
- (directed) (acyclic) graphs
- covers:
  - argument structure
  - multiword expressions, named entities
  - enhanced info on aspect, modality, temporality
  - coreference

focus on **meaning as structured** by **the given language** more-or-less **directly reflects the text**

broad **sem. interpretation** of the text for cross-lingual applications

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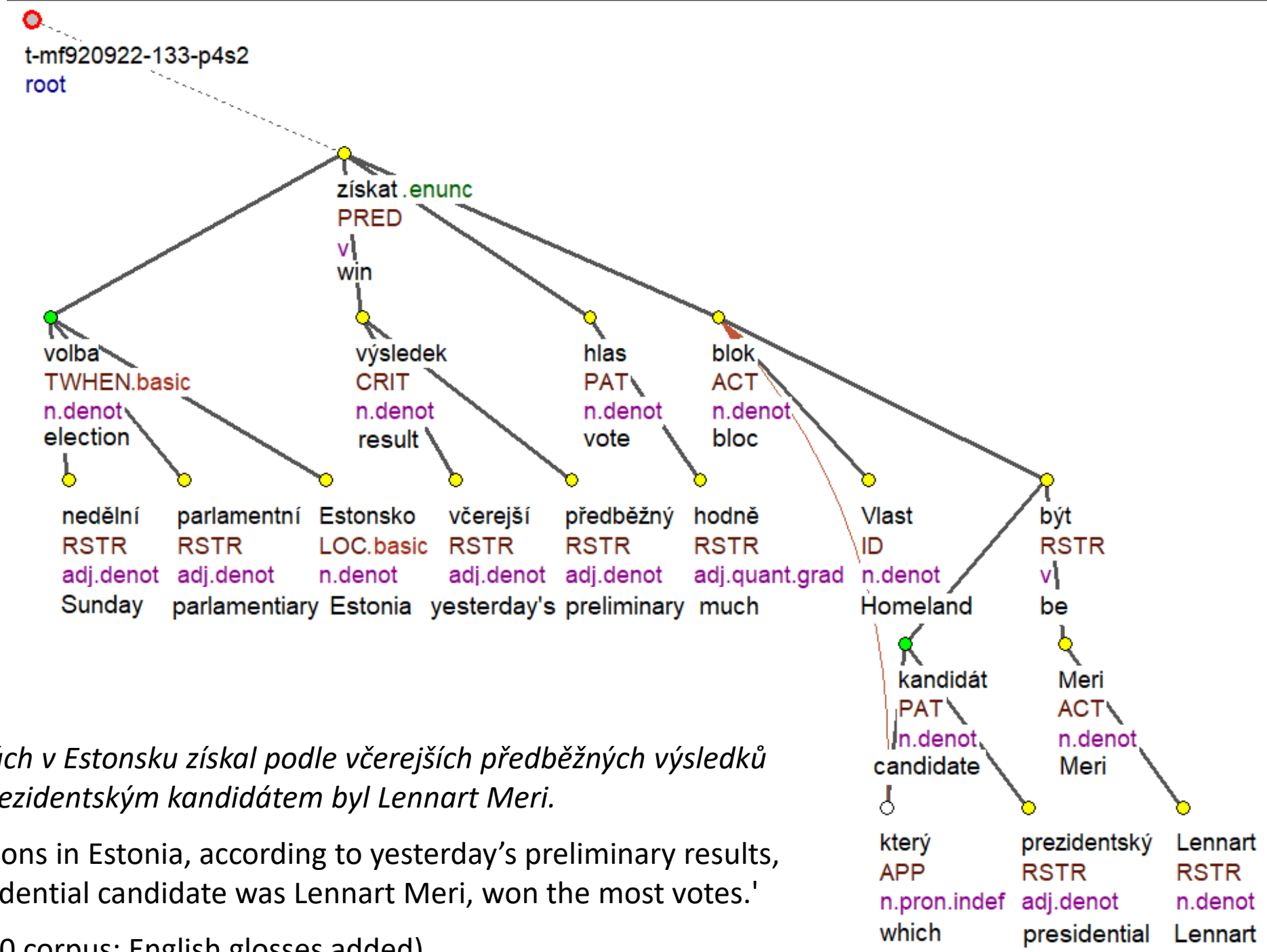
PDT-MR



V nedělních parlamentních volbách v Estonsku získal podle včerejších předběžných výsledků nejvíce hlasů blok Vlast, jehož prezidentským kandidátem byl Lennart Meri.

'In Sunday's parliamentary elections in Estonia, according to yesterday's preliminary results, the Homeland bloc, whose presidential candidate was Lennart Meri, won the most votes.'

(borrowed from the PDiT-EDA 1.0 corpus; English glosses added).

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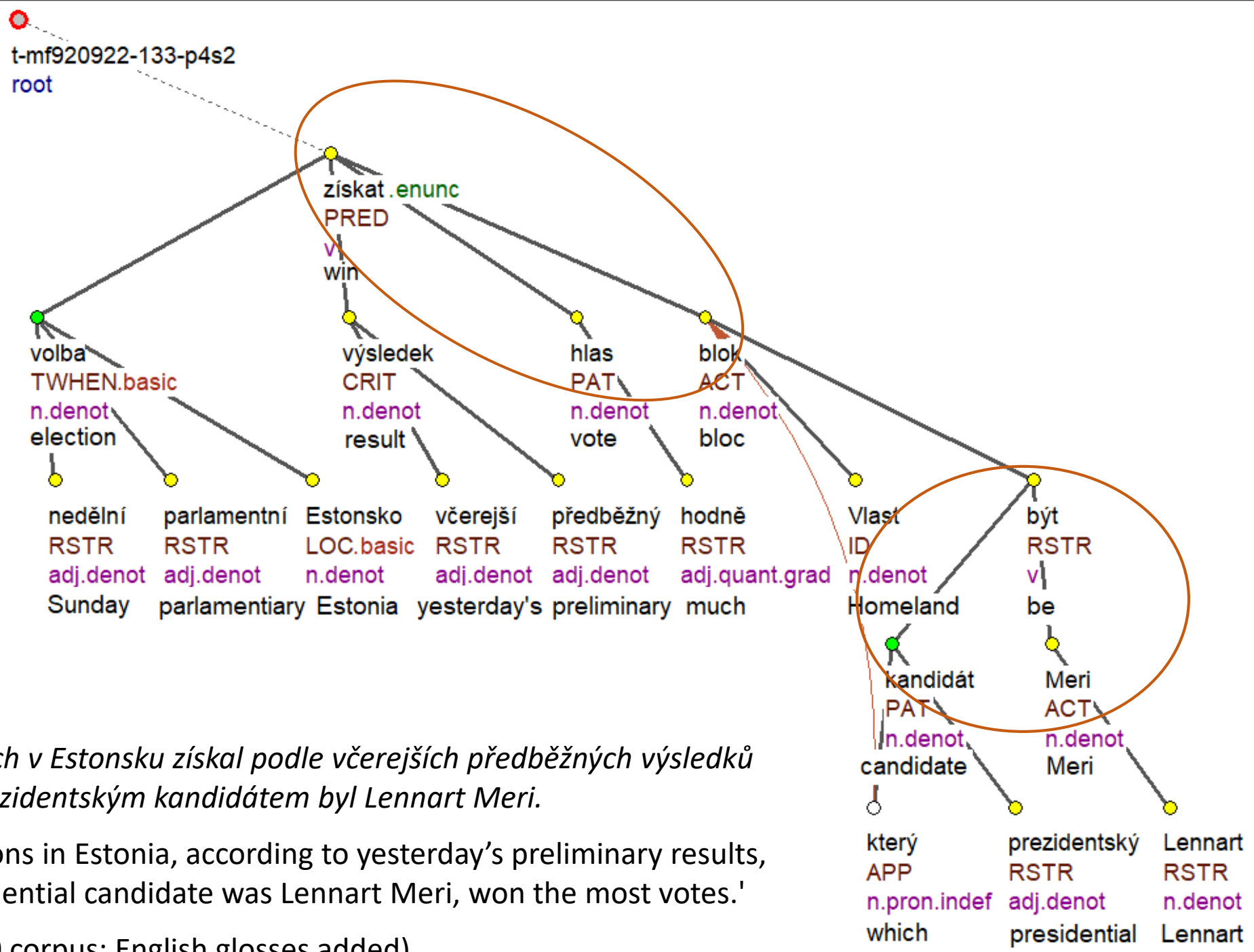

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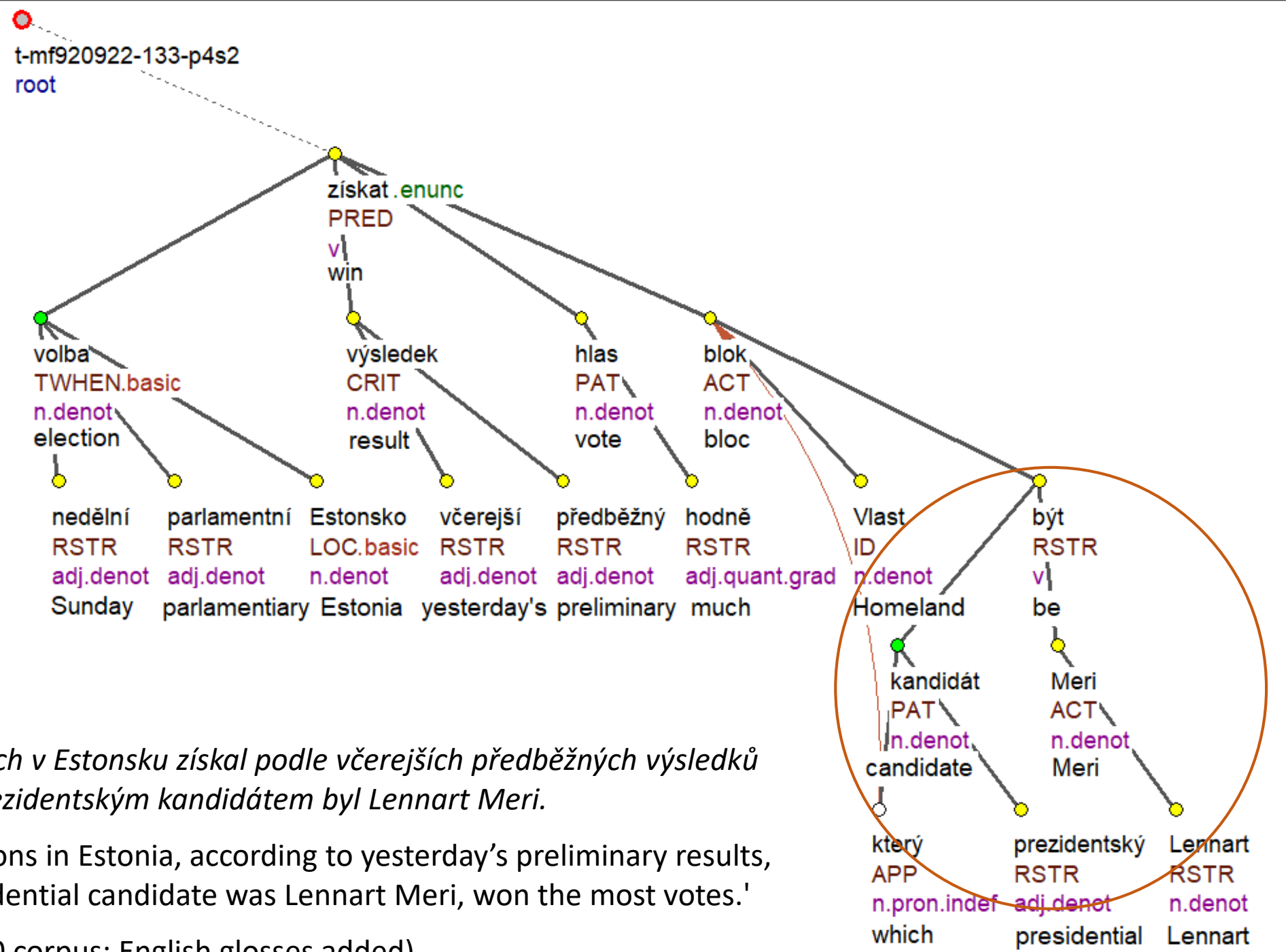

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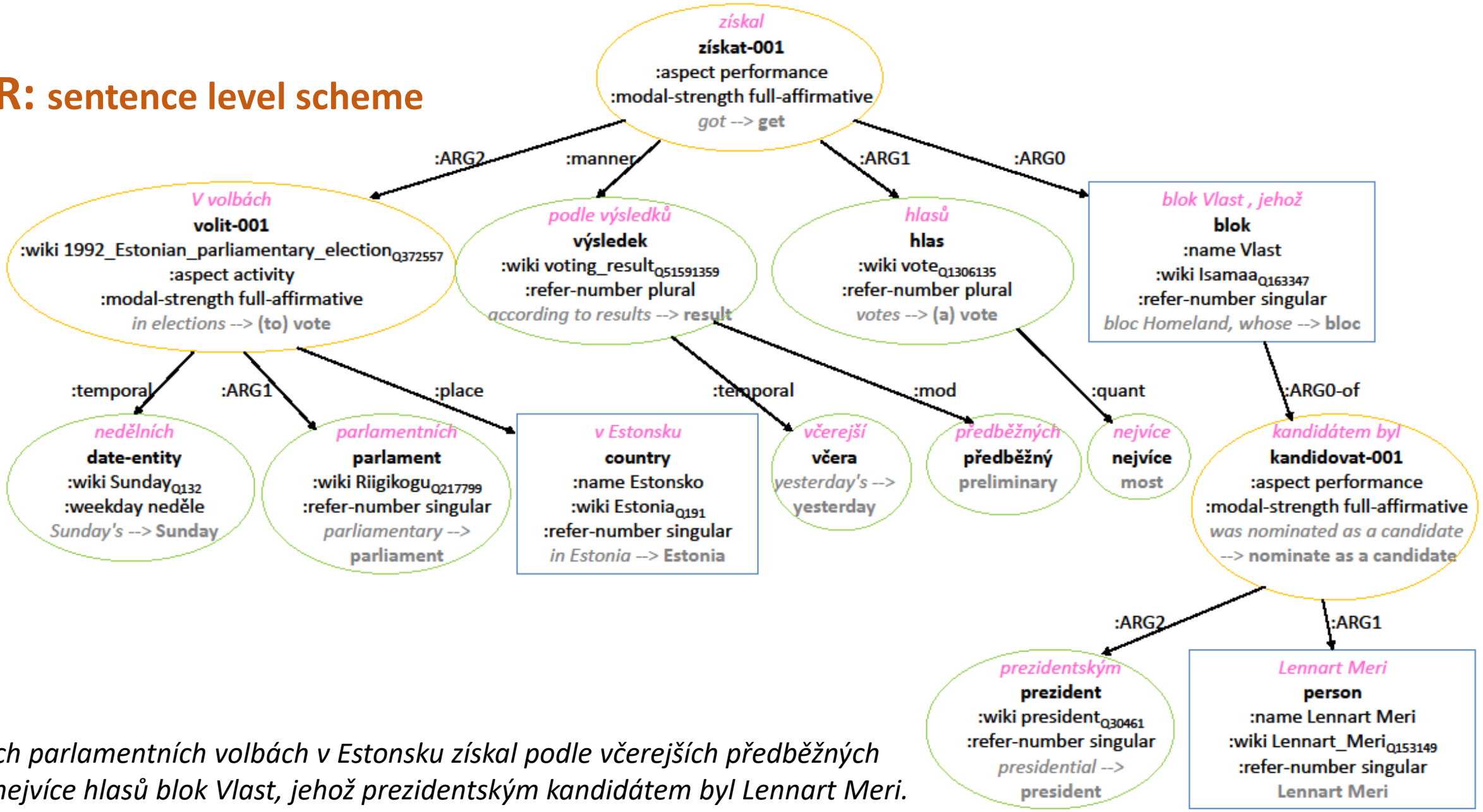
UMR: sentence level scheme



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UMR: document level scheme

```
(s5s0 / sentence
    :temporal((document-creation-time :before s5v3)
              (s5v3 :before s5d)
              (s5d :before s5k)
              (s5d :contained s5z)
              (s5d :contained s5v)
              (s5v :after s5z))
    :modal ((root :modal author)
            (author :full-affirmative s5v)
            (author :full-affirmative s5k)
            (author :full-affirmative s5z))
    :coref ((s3c :same-entity s5c)
            (s3p3 :same-entity s5p)
            (s3v :same-event s5v)))
```

včera 'yesterday'

neděle 'Sunday' (date-entity)

kandidovat-001 'nominate as a candidate'

získat-001 'get'

volit-001 'vote'

V nedělních parlamentních volbách v Estonsku získal podle včerejších předběžných výsledků nejvíce hlasů blok Vlast, jehož prezidentským kandidátem byl Lennart Meri.

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Towards PDT-MR to UMR Conversion

Selected deep syntactic phenomena

I. change of the graph structure
   - coreference relation: re-entrancies, inverse roles, listing
   - coordination (and re-entrancies)

II. events vs. entities

III. graph labeling:
   - valency frames → argument structure
     - verb specific mapping of arguments
     - default mapping of arguments
   - default mappings of adjuncts

I. Change of the Graph Structure: Coreference

coreference ≈ relation between two or more expressions that refer to the same concept

"words"

"mental concept" of a real-world entity/event

- such expressions typically form **coreferential chains** → text coherence

Mary lives in Prague. She likes ice-cream. The girl decided Ø to go for a trip.

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antecedent **anaphor**

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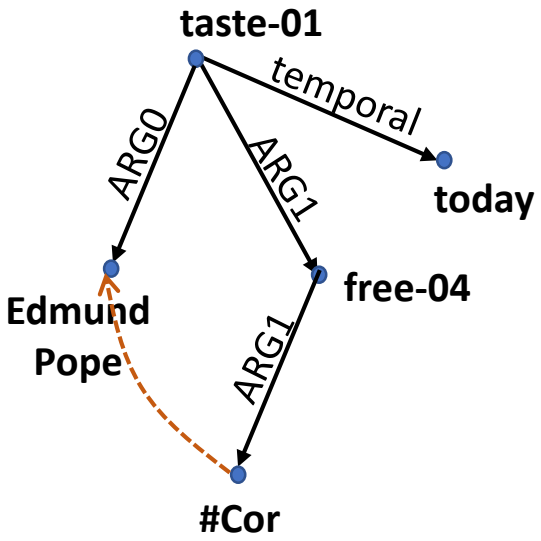
antecedent **anaphor**

- **PDT-MR**: all types the same representation
  - (the node for) the anaphor bears attributes for ID of its antecedent(s), type of relation
- **UMR** different treatment

Ia. PDT-MR Coreference → UMR "Re-entrancy"

Coreference of 2 nodes in PDT-MR



Edmund Pope tasted freedom today.

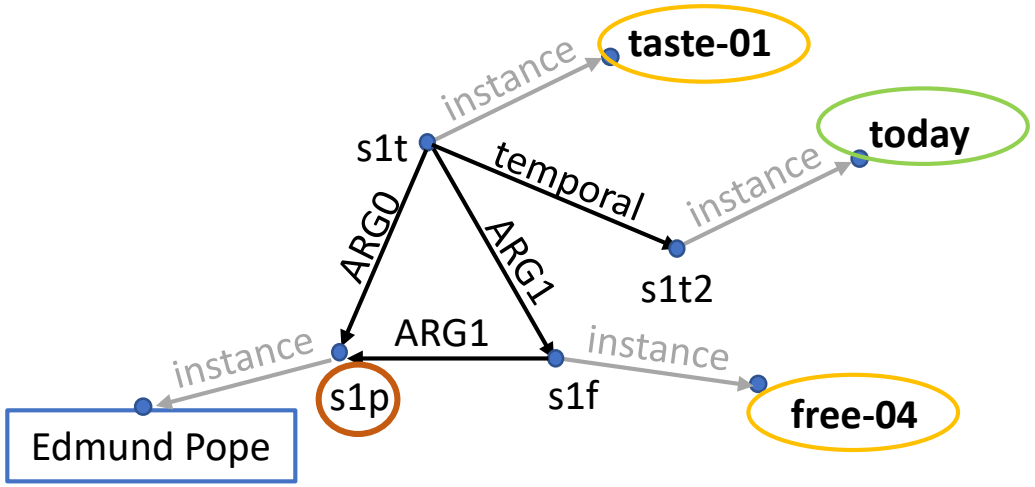
(taken from the released UMR data, simplified;
also used as an example sentence in the UMR 0.9 Specification)

Ia. PDT-MR Coreference → UMR "Re-entrancy"

```
(s1t / taste-01
     :ARG0 (s1p / person :wiki "Edmund_Pope"
                :name (s1n / name
                           :op1 "Edmund"
                           :op2 "Pope"))
     :ARG1 (s1f / free-04
                :ARG1 s1p)
     :temporal (s1t2 / today))
```

⟺

Concept of re-entrancy in UMR



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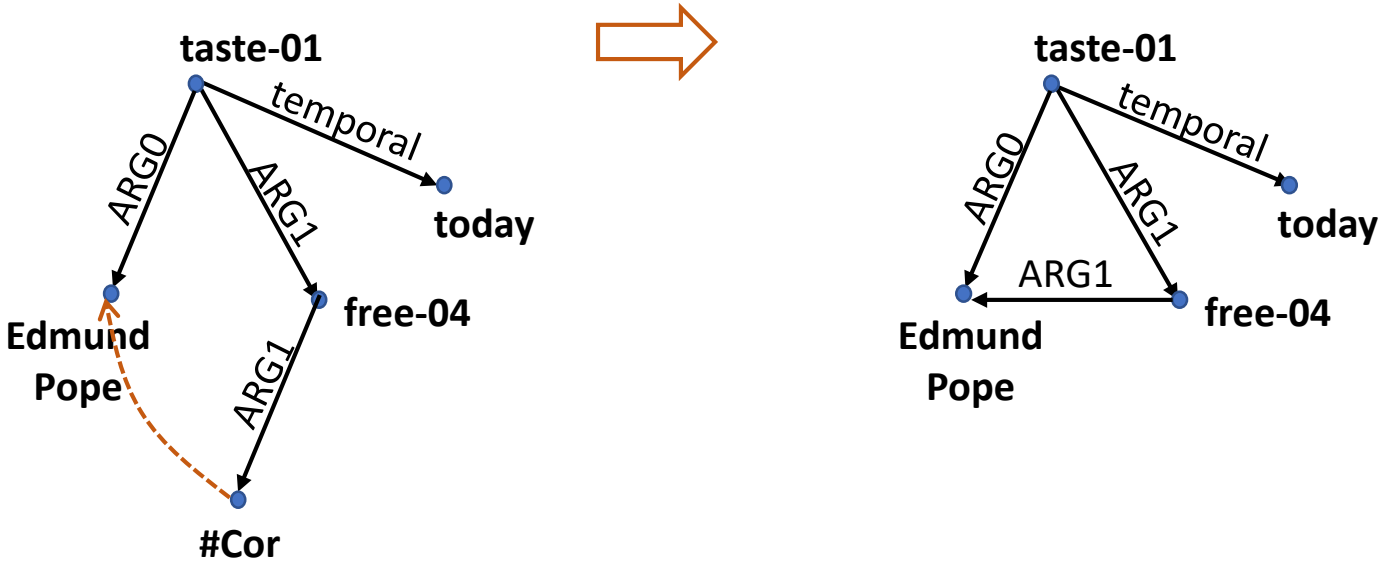

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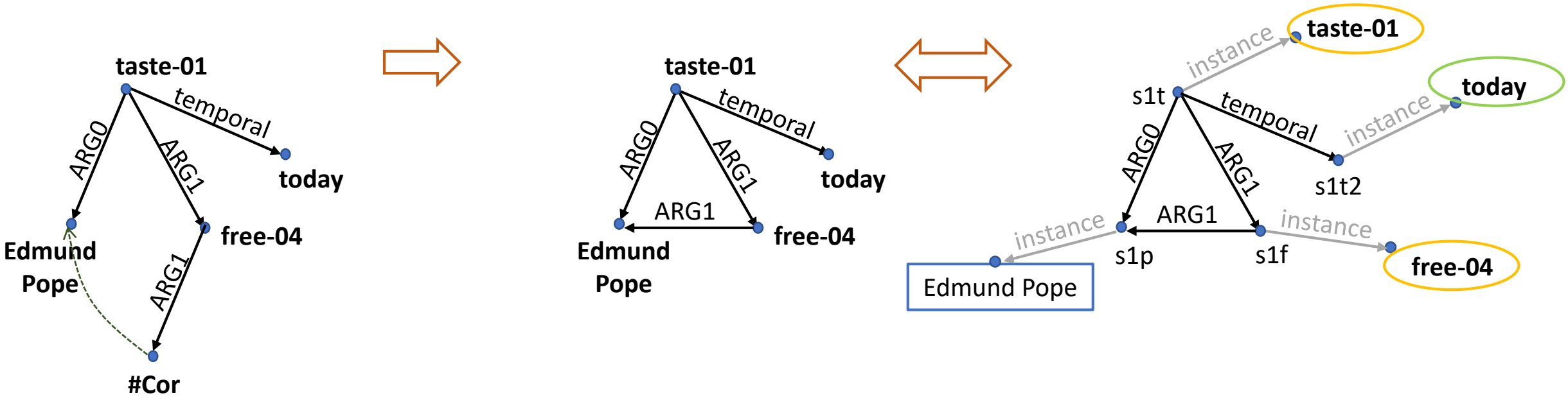

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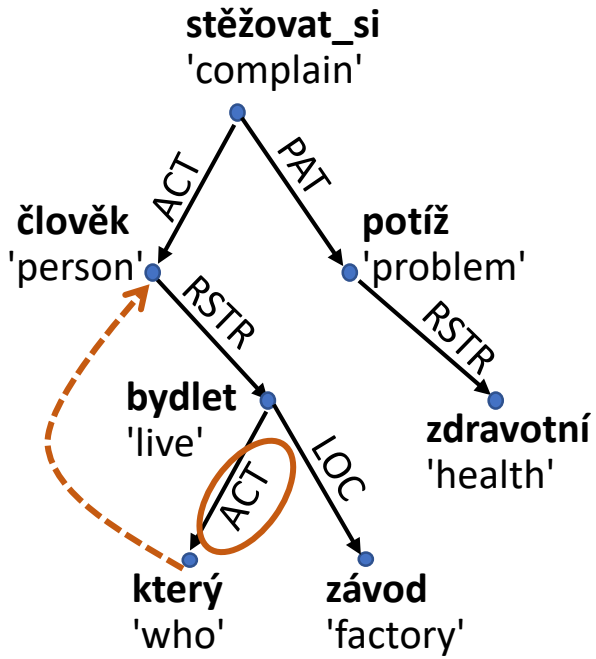
Ib. PDT-MR Coreference → UMR Inverse Role

Coreference of 2 nodes in PDT-MR



Lidé, kteří bydlí v blízkosti závodu, si stěžují na zdravotní potíže.
'People who live near the factory have been complaining of health problems'.

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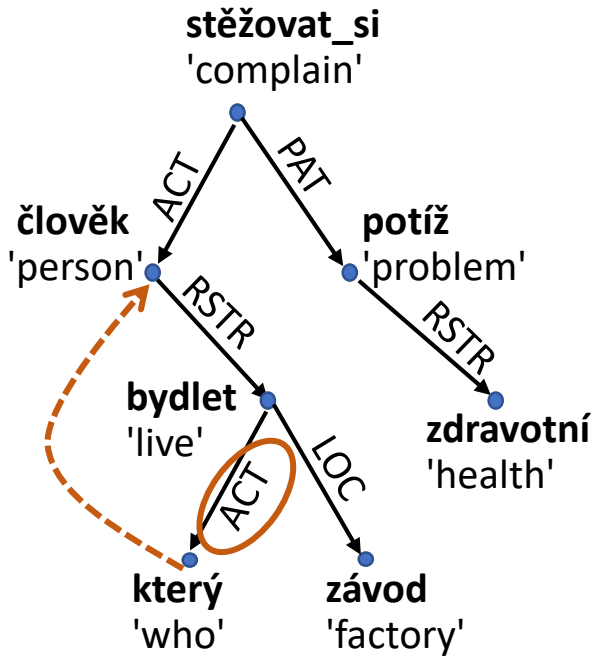
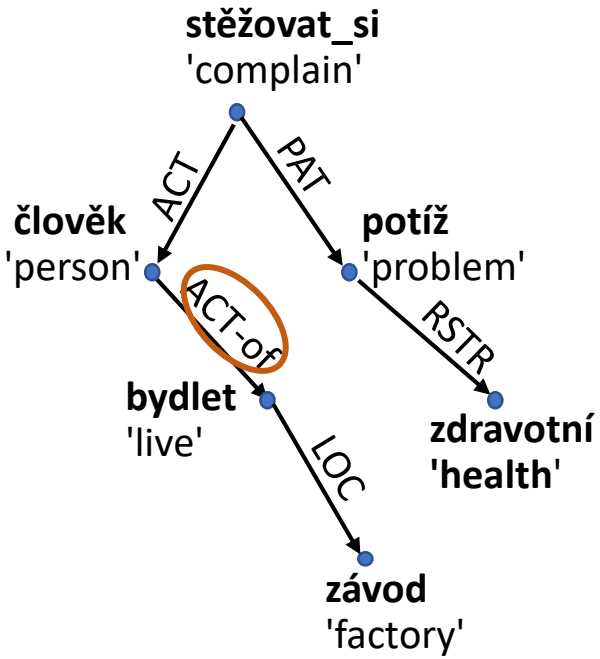


Merging 2 nodes in PDT
Inverse role (= inverse relation) in UMR



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Ic. PDT-MR Coreference → UMR Pairing

Inter-sentence coreference relation

PDT-MR

- the node for the anaphor bears attributes for
  - ID of its antecedent(s)
  - type of relation
  - type of reference (specific vs. generic)

UMR

- lists pairs of coreferring concepts
  - ID of both concepts
    - event or entity … entities
    - identity or subset … identity

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(s5s0 / sentence
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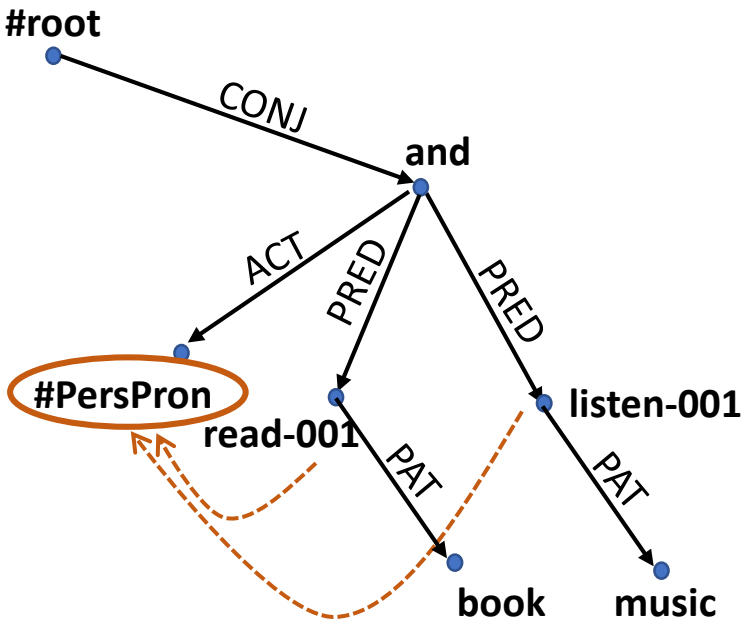
Id. Coordination

PDT-MR

- special node for coordinating expression
- coordinated expressions as children
- allows for common arguments/adjuncts



I read a book and listened to music. /
I read a book while listening to music. /
I read a book while I listened to music.

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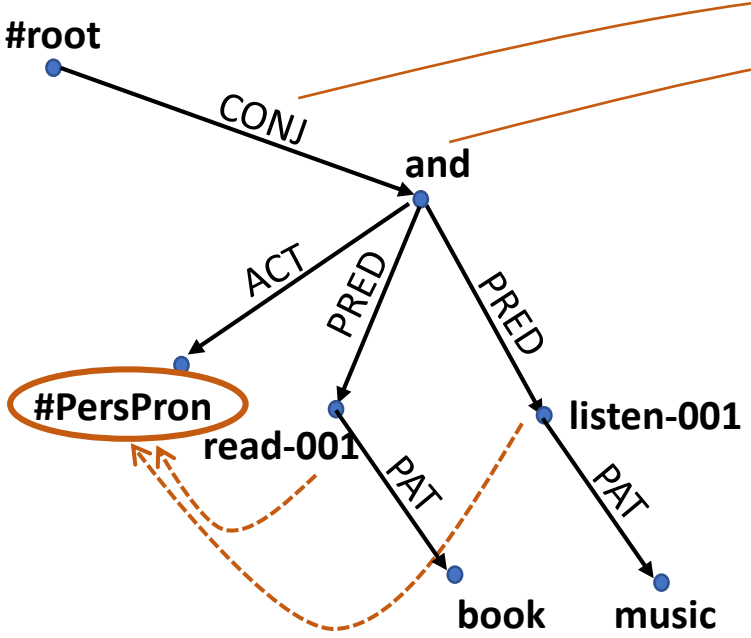

UMR

- special keyword for "discourse" relation
- coordinated expressions as children
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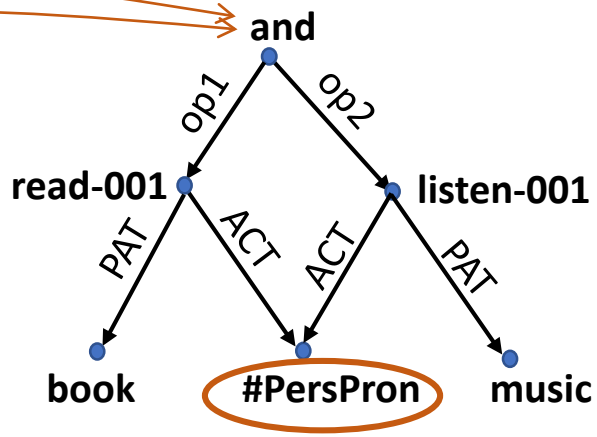

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II. Events vs. Entities

UMR

- conceptual distinction:
  - entities (objects) *man, cat*
  - states (properties) *tall, (to) love*
  - events (processes) *cry, storm, elections*
- no clear definition, no testable criteria
- skewed towards English (e.g., statives)
- big impact on annotation
  - modal, temporal, aspectual for events

- fuzzy boundary btw. entities and events
- big space for different interpretations
- intuitive decisions

II. Events vs. Entities

PDT-MR

- only small degree of abstraction

  e.g., *matčin* 'mother's' → *matka* 'mother' + possesive
  "normalization", e.g., *jehož* → *který* 'who'

- lack of information

  even for most systematic changes
  e.g., *bojování* 'fighting' → *bojovat* '(to) fight'
  (*příjezd*) *přijíždění* 'coming' → *přijet* '(to) come'

conversion:
first steps using additional resources

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III. Graph labeling

PDT-MR

arguments:

- PDT-Vallex valency lexicon (Hajič et al., 2003)
  - verbs, nouns (adjectives)
  - elaborated valency theory
  - 5 "arguments": ACT, PAT, ADDR, ORIG, EFF

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partial verb-specific mapping

~ 43% of PDT-Vallex labels (out of 42,116) (Hajič et al, 2024)

default mapping for the rest verb senses

most frequent argument mappings from the previous

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default mapping for the rest verb senses
most frequent argument mappings from the previous

adjuncts:

default mapping based on their semantics
further refined where necessary

What We Have Learned

PDT-MR

- **theory**:
  meaning **<u>as structured by the particular language</u>**
  → How different for various language?
  → consequence: too close to the text

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- **theory:**
  meaning representation **<u>as a basis for logical inference</u>**
  (BUT not much investigated so far)
  → Should be language independent (theory)!
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  refined criteria how to annotate
  many "running text" examples
  stress on consistency of annotation
  (→ consequences for ML)

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- **data annotation:**
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  stress on consistency of annotation
  (→ consequences for ML)
- **"technology":**
  massive consistency checking
  well-defined data format
  formal validation
  many tools (editing, visualization)

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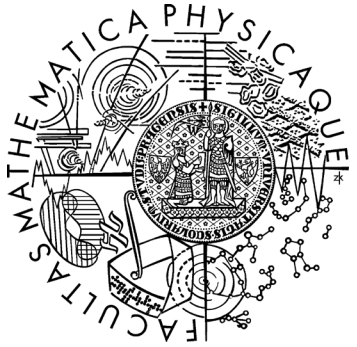
  (→ consequences for logical inference ?)
- **"technology":**
  NO consistency checking
  NO formal specification
  NO data validation
  NO usable tools

Future Work

- Refining the conversion of illustrated phenomena
  - focus on abstract predicates and rolesets (language-independent predicates)
  - nouns/adjectives to predicative verbs
- PDT-MR grammatemes to UMR attributes
  - tense, modality, gender, animateness, negation, degree, aspect (not in UMR for the time being), …
- Named Entities, their anchoring in Wikidata
- Structured data – addresses, sport scores, weather forecast, tables, ….
  (whatever appears in texts)
- Czech/Latin evaluation data !!!



Thank you for your attention!

Questions?

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ÚFAL

LINDAT CLARIAH-CZ