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

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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

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

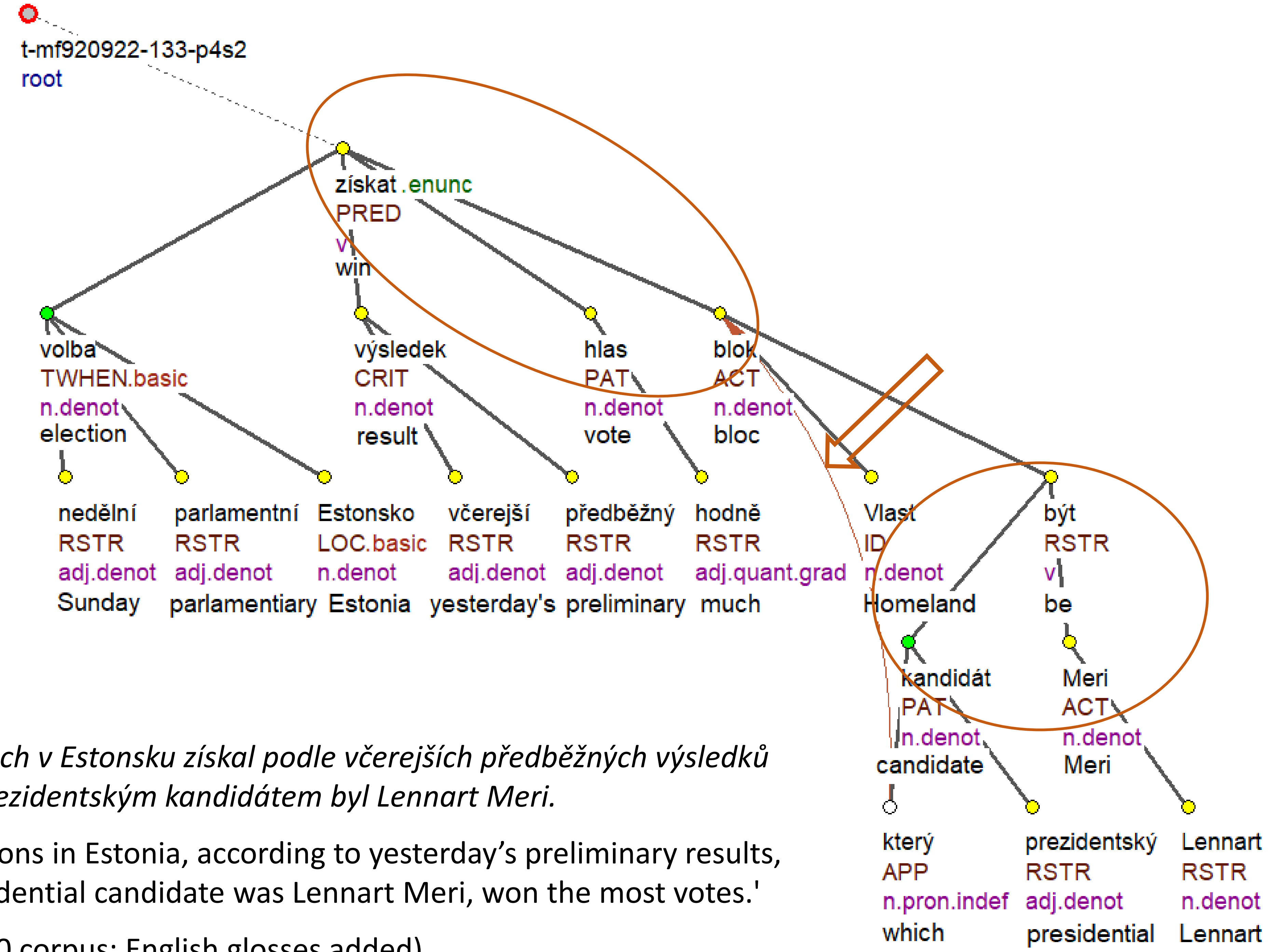
⇨ focus on **meaning as structured by the given language**
more-or-less **directly reflects the text**

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

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

PDT-MR

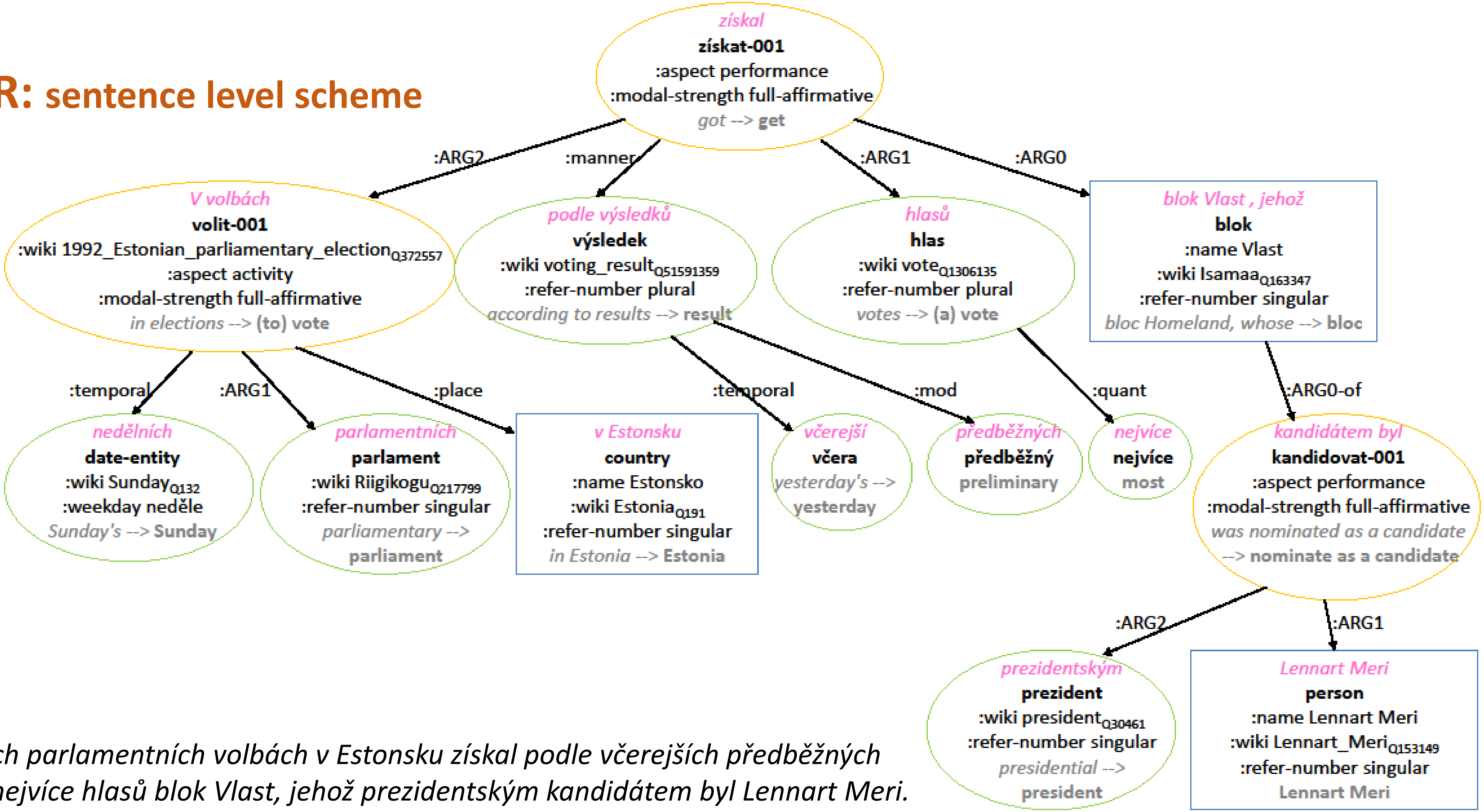


V nedělních parlamentních volbách v Estonsku získal podle včerejších předběžných výsledků nejvíce hlasů blok Vlast, jehož prezidentským kandidátem byl Lennart Meri.

'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).

UMR: sentence level scheme



získal
získat-001
:aspect performance
:modal-strength full-affirmative
got --> **get**

:ARG2

V volbách
volit-001
:wiki 1992_Estonian_parliamentary_election$_{Q372557}$
:aspect activity
:modal-strength full-affirmative
in elections --> **(to) vote**

:manner

podle výsledků
výsledek
:wiki voting_result$_{Q51591359}$
:refer-number plural
according to results --> **result**

:ARG1

hlasů
hlas
:wiki vote$_{Q1306135}$
:refer-number plural
votes --> **(a) vote**

:ARG0

blok Vlast , jehož
blok
:name Vlast
:wiki Isamaa$_{Q163347}$
:refer-number singular
bloc Homeland, whose --> **bloc**

:temporal

nedělních
date-entity
:wiki Sunday$_{Q132}$
:weekday neděle
Sunday's --> **Sunday**

:ARG1

parlamentních
parlament
:wiki Riigikogu$_{Q217799}$
:refer-number singular
parliamentary -->
parliament

:place

v Estonsku
country
:name Estonsko
:wiki Estonia$_{Q191}$
:refer-number singular
in Estonia --> **Estonia**

:temporal

včerejší
včera
yesterday's -->
yesterday

:mod

předběžných
předběžný
preliminary

:quant

nejvíce
nejvíce
most

:ARG0-of

kandidátem byl
kandidovat-001
:aspect performance
:modal-strength full-affirmative
was nominated as a candidate
--> nominate as a candidate

:ARG2

prezidentským
prezident
:wiki president$_{Q30461}$
:refer-number singular
presidential -->
president

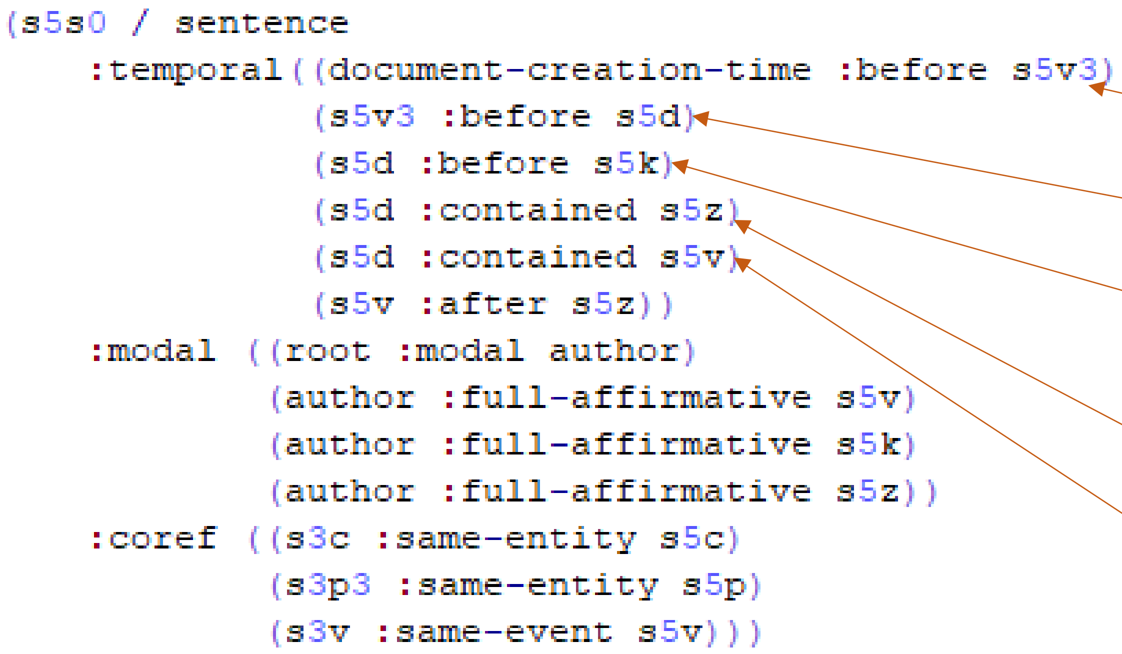
:ARG1

Lennart Meri
person
:name Lennart Meri
:wiki Lennart_Meri$_{Q153149}$
:refer-number singular
Lennart Meri

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.'

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.

'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.'

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

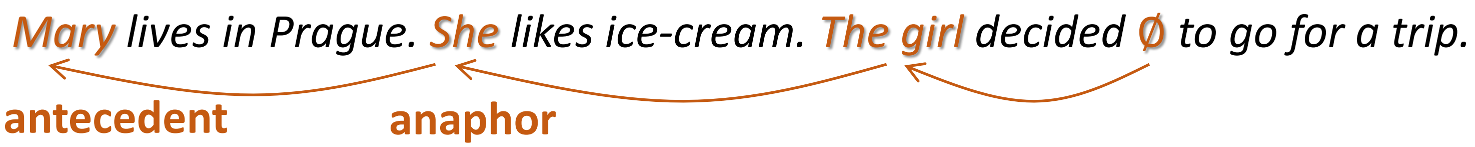
I. Coreference

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

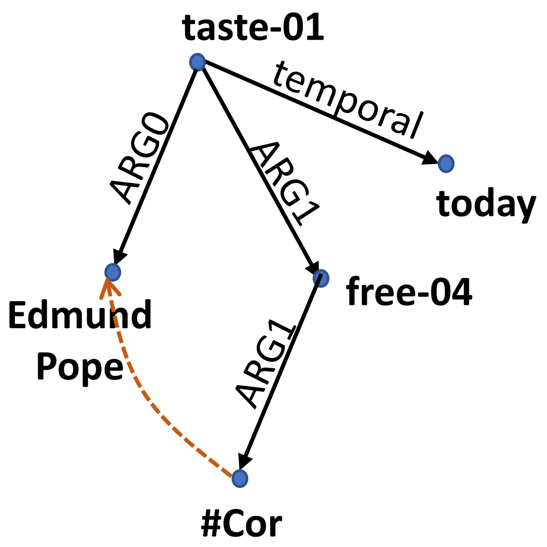


Mary lives in Prague. She likes ice-cream. The girl decided Ø to go for a trip.

- **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

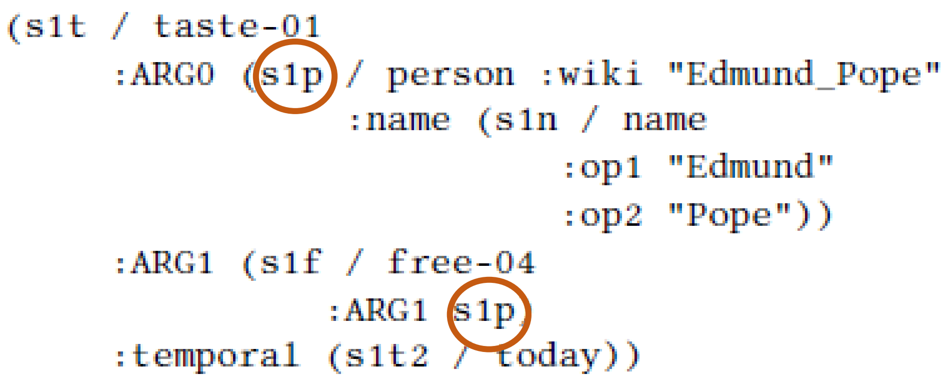


Edmund Pope tasted freedom today.

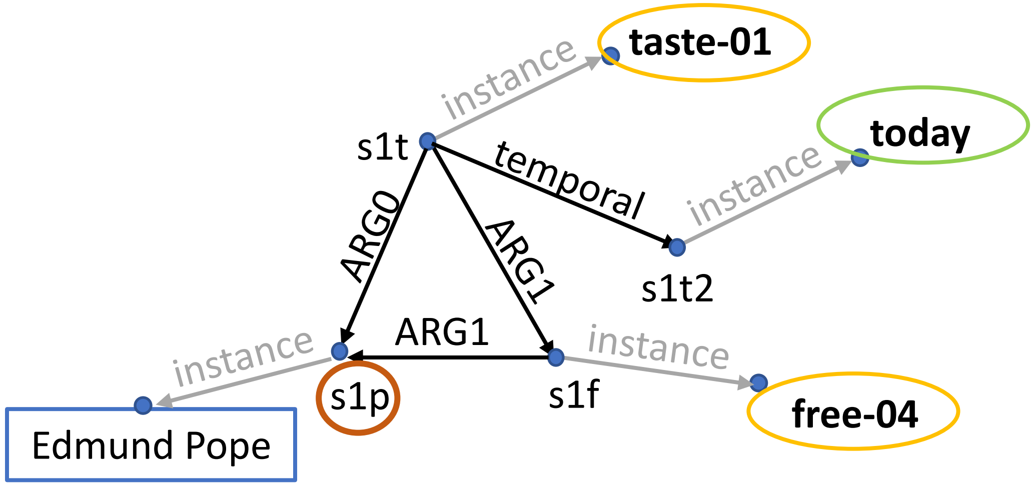
(taken from the released UMR data, simplified;
also used as an example sentence in the UMR 0.9 Specification)

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

Concept of re-entrancy in UMR



```
(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))
```



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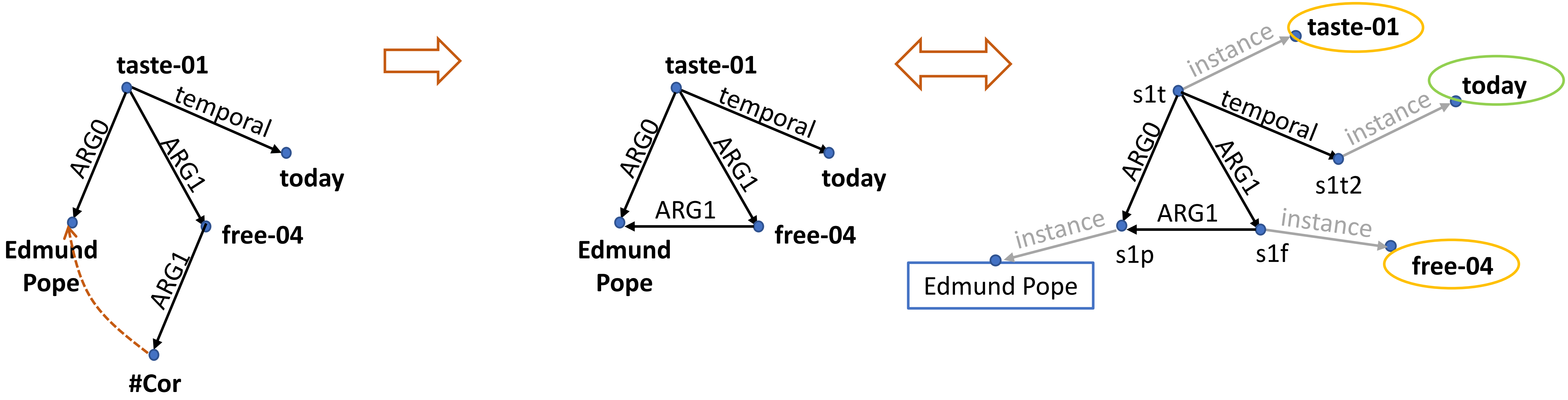
Ia. PDT-MR Coreference → UMR "Re-entrancy"

Conversion: Merging 2 nodes in PDT



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(taken from the released UMR data, simplified;
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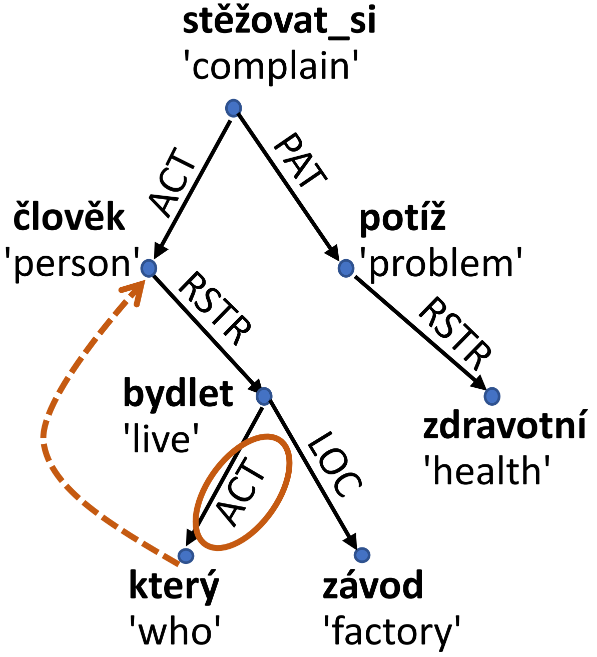
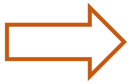
Ib. PDT-MR Coreference → UMR Inverse Role

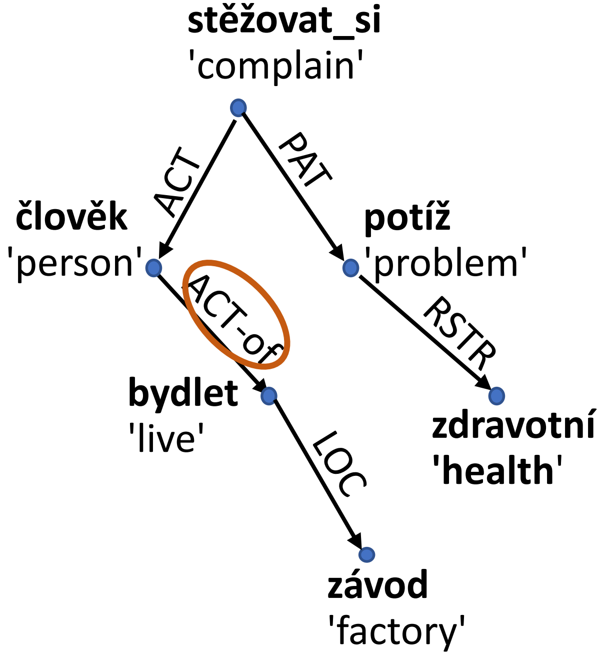
Coreference of 2 nodes in PDT-MR





Merging 2 nodes in PDT

Inverse role (= inverse relation) in UMR



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

Ic. PDT-MR Coreference → UMR Pairing

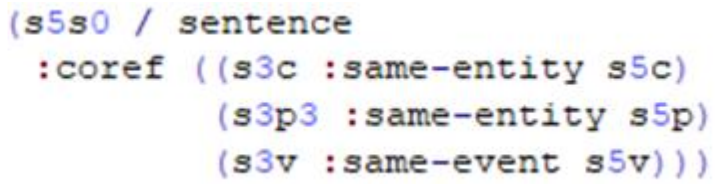
Inter-sentence coreference relation

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 ✓



```
(s5s0 / sentence
 :coref ((s3c :same-entity s5c)
         (s3p3 :same-entity s5p)
         (s3v :same-event s5v)))
```

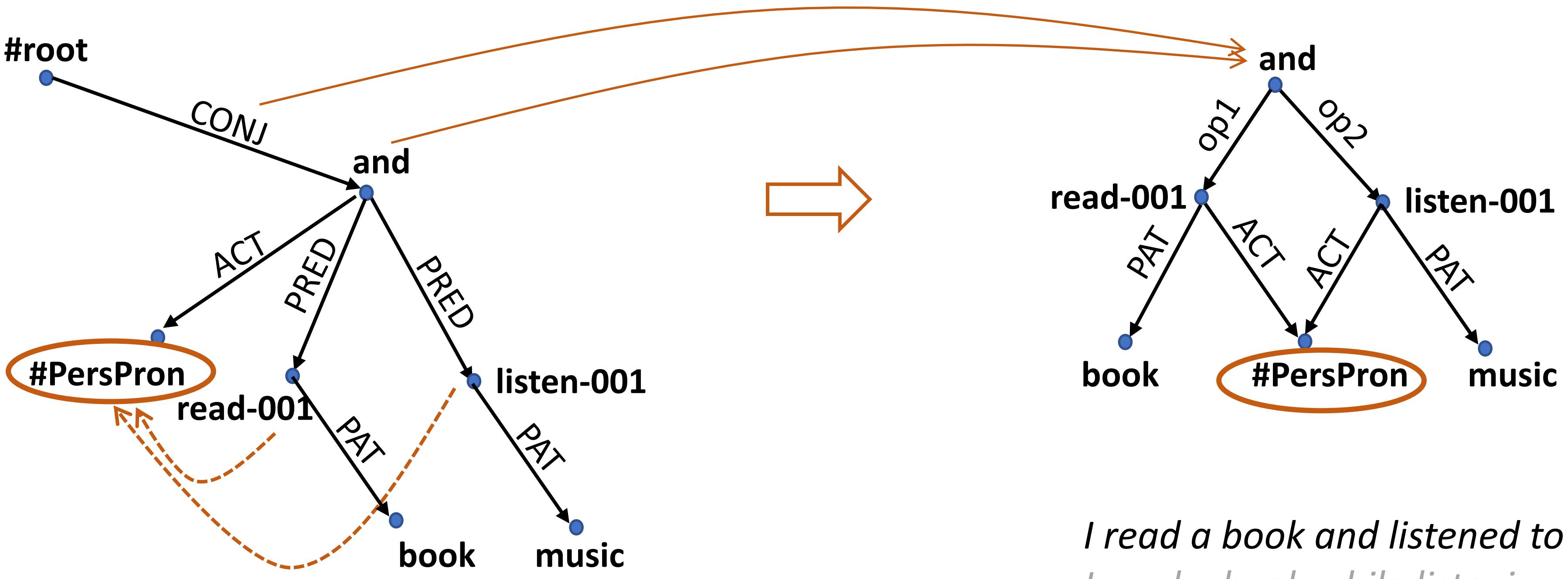
Id. Coordination

PDT-MR

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

UMR

- special keyword for "discourse" relation
- 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.

II. Events vs. Entities

PDT-MR

- verbs ≈ events and states → event annotation
- other nodes → entities or keywords

  with some degree of abstraction

  e.g., *matčin* 'mother's' → *matka* 'mother' + possesive

  "normalization", e.g., *jehož* → *který* 'who'
- refinement: lack of information

  even for most systematic changes

  e.g., *bojování* 'fighting' → *bojovat* '(to) fight'

  (*příjezd*) *přijíždění* 'coming' → *přijíždět* '(to) come'

conversion:
first steps using additional resources

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 ☹

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

UMR

arguments:

- PropBank lexicon (Palmer at al 2005, Pradhan et al., 2022)
  - verbs, nouns (adjectives)
  - coarse-grained semantic roles
  - ARG0, ARG1, ... ARG5, ARGM

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

adjuncts:

default mapping based on their semantics

further refined where necessary

What We Have Learned

PDT-MR

- **theory**:

  meaning **as structured** by **the particular language**

  THUS: too close to the text?

  → How different for various language?

- **data annotation:**

  refined criteria how to annotate

  many "running text" examples

  stress on consistency of annotation

  (→ consequences for ML)

- **"LR technology":**

  massive consistency checking

  well-defined data format

  formal validation

  many tools (editing, visualization)

UMR

- **theory:**

  meaning representation **as language independent**

  THUS: broad interpretation

  → should serve **as a basis for logical inference**

  BUT not much investigated so far

- **data annotation:**

  vague description

  small number of examples (to illustrate the theory)

  interest in the annotator's understanding

  (→ consequences for logical inference ?)

- **"LR 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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