Merging Data Resources for Inflectional and Derivational Morphology in Czech

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Outline

- Motivation for processing inflection and derivation together
- Inflectional and derivation resources for Czech
- The resulting (merged) data resource
- User interfaces to the data
- Conclusions

Basic notions

- morphological inflection: *to derive* $\rightarrow$ *derives*, *derived*, *deriving*
- morphological derivation: *to derive* $\rightarrow$ *derivative*, *derivation*, *derivator*

Motivation

- an omnipresent problem of NLP: zillions of different words
- one of the reasons: morphological variation
- standards ways to reduce the lexical space:
  - lemmatization – replacing inflectionally related words by a selected representative
  - stemming – replacing related words by a common stem (usually approximated very roughly)

Motivation, cont.

- in morphologically complex languages:
  - possibly several tens (or more) inflected word forms per lemma
  - but possibly several tens (or more) derived lemmas too!
- a common-sense expectation: extending lemmatization (as *anti-inflection*) with nesting (as *anti-derivation*) might help NLP apps
- in Czech, derivation is the most productive word formation method (hundreds of suffixes)
- surprisingly few data resources for derivation (e.g., Derivancze for Czech, DerivBase for German, Démonette for French)

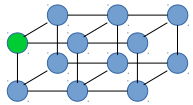
Derivation vs. inflection: similarities

For both it holds that

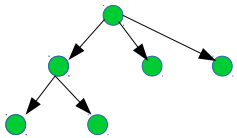
- there is a strong **form-function** asymetry, e.g.
  - there are several suffixes that express the same meaning (e.g. an actor)
  - one specific suffix can express several roles
- the way how forms are combined is **far from simple catenation**
  - consonant and vowel changes (not limited to morpheme boundaries, can appear inside roots too)
  - sometimes similar changes for inflection and derivation: *sníh* - *sn***ě***hu* (inflection: snow gen.sg.), *sníh* - *sn***ě***žný* (derivation: snowy adj.)
- **fuzzy boundaries** of parole
  - exhaustive enumeration of all potentially inflected/derived forms often reaches language periphery

Derivation vs. inflection: differences

- different data structure
  - a set of words connected by **inflection**:
    - ★ typically a full **Cartesian product** of morphological categories



  - a set of lemmas connected by **derivation**:
    - ★ rather an **oriented graph** (a nest), a rooted tree is often enough



- in inflection, the paradigm representative is chosen by a convention, while in derivation, the tree root seems more tangible
- semantic relatedness gradully weakens for more distant words in a derivation nest
- in NLP, lemmatization is widely used while nesting is not

MorfFlex CZ

- Czech morphological dictionary
- developed originally by Jan Hajič as a spelling checker and lemmatizer
- more than two decades of improvements
- 985 thousand unique lemmas with their inflectional paradigms
- associated with a positional tagset
- capable of analyzing/generating 120 million word forms (form-lemma-tag tripples)
- used *inter alia* in the Prague Dependency Treebank and Czech National Corpus

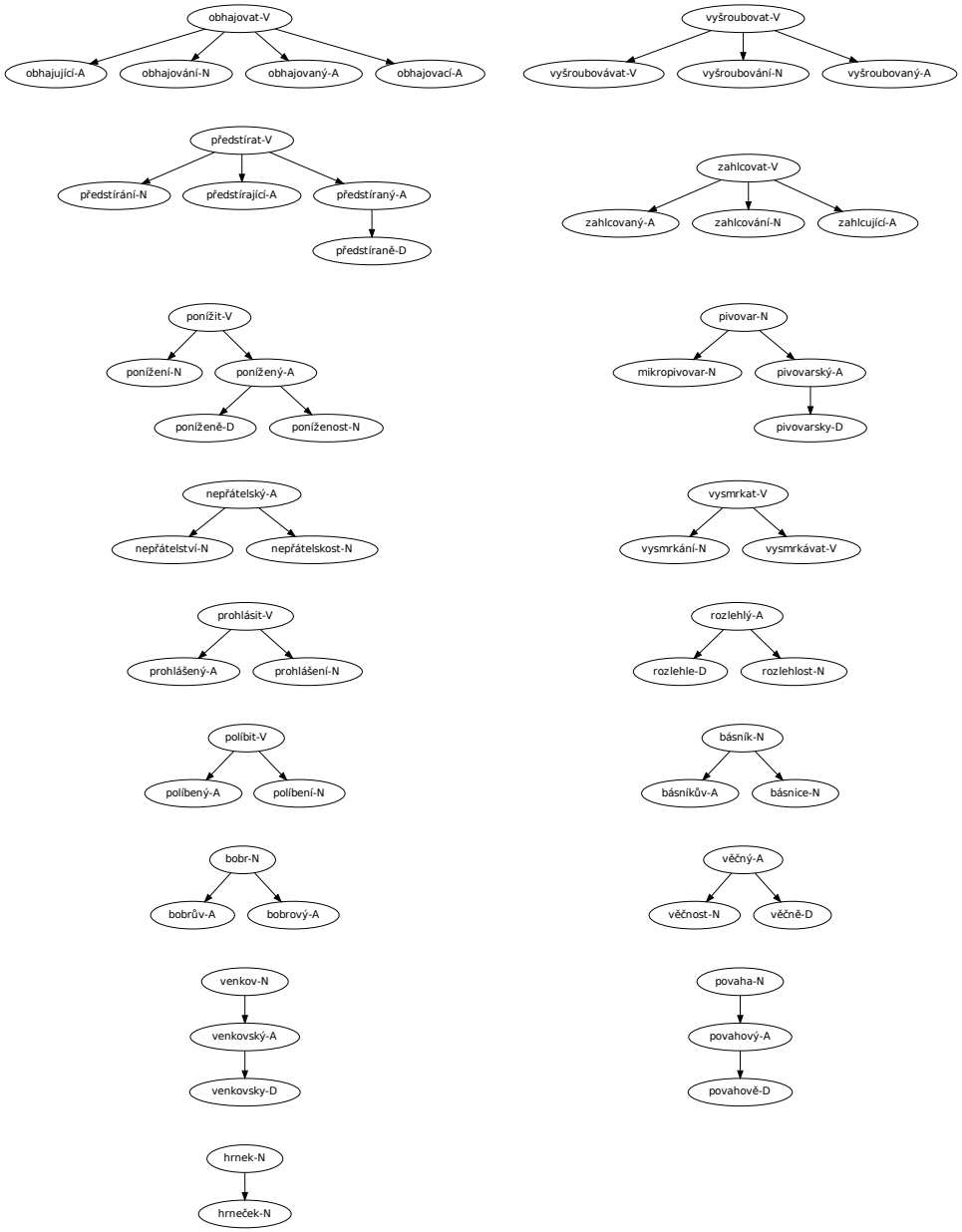
A glimpse at the MorfFlex CZ data

```
podle-1_^(*3ý-1)  Dg-------3N---6  nejnepodlejc
podle-1_^(*3ý-1)  Dg-------3N----  nejnepodleji
podle-1_^(*3ý-1)  Dg-------3A---6  nejpodlejc
podle-1_^(*3ý-1)  Dg-------3A----  nejpodleji
podle-1_^(*3ý-1)  Dg-------1N----  nepodle
podle-1_^(*3ý-1)  Dg-------2N---6  nepodlejc
podle-1_^(*3ý-1)  Dg-------2N----  nepodleji
podle-1_^(*3ý-1)  Dg-------1A----  podle
podle-1_^(*3ý-1)  Dg-------2A---6  podlejc
podle-1_^(*3ý-1)  Dg-------2A----  podleji
podle-2           RR--2----------  podle
```

DeriNet

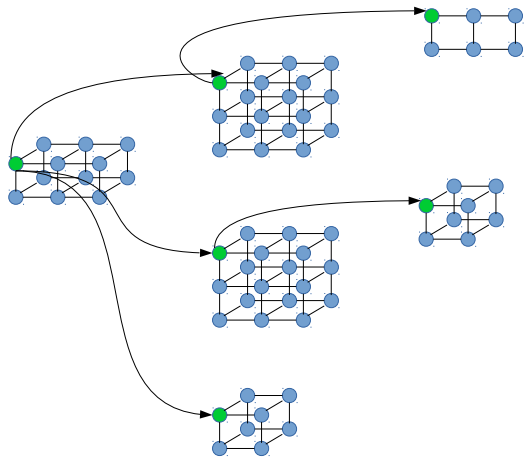
- a network capturing derivation in Czech, developed since 2013
- oriented graph (forest, each rooted tree = one derivational nest)
  - nodes = lemmas
  - edges = derivation relations (from base to derived lemmas)
- size before merging with MorfFlex CZ
  - 306 thousand nodes (chosen according to frequency in the Czech National Corpus)
  - 117 thousand edges
- compiled using semi-automatic procedure, based especially on
  - suffix substitution rules (extracted both from grammar books and from data)
  - manually assembled lists of exceptions
  - patterns for vowel and consonants changes

A glimpse at the DeriNet data



Merging process

- set of lemmas of the previous DeriNet version extended to that of MorfFlex CZ
- the pipeline for building DeriNet re-executed on the new lemma set
- only minor modifications of substitution rules and exception lists needed
- resulting data: 970 thousand lemmas connected with 715 thousand derivational relations

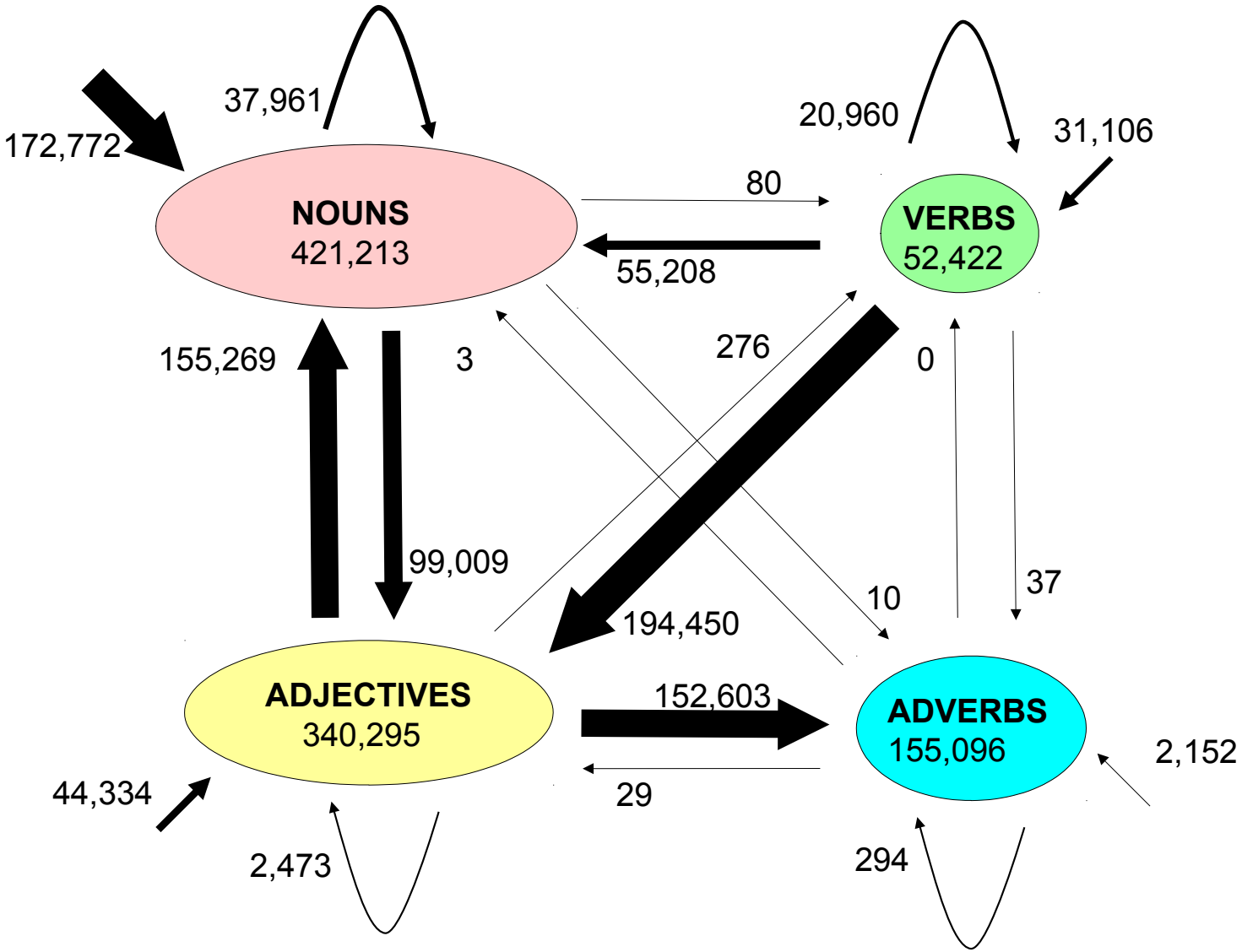


Extension of the derivation forest

after merging DeriNet with MorfFlex CZ

- in the derivational forest
  - #nodes increased 3.2 times
  - #edges increased 6.1 times
- evaluation (based on a manually annotated sample) shows that
  - precision of derivations stayed at 99 %
  - recall increased from 75 % to 85 %
- we attribute both observations to language economy:
  - lower-frequency words tend to be derived more frequently...
  - ...and they tend to be derived in a more regular way

POS and POS→POS counts in the merged data

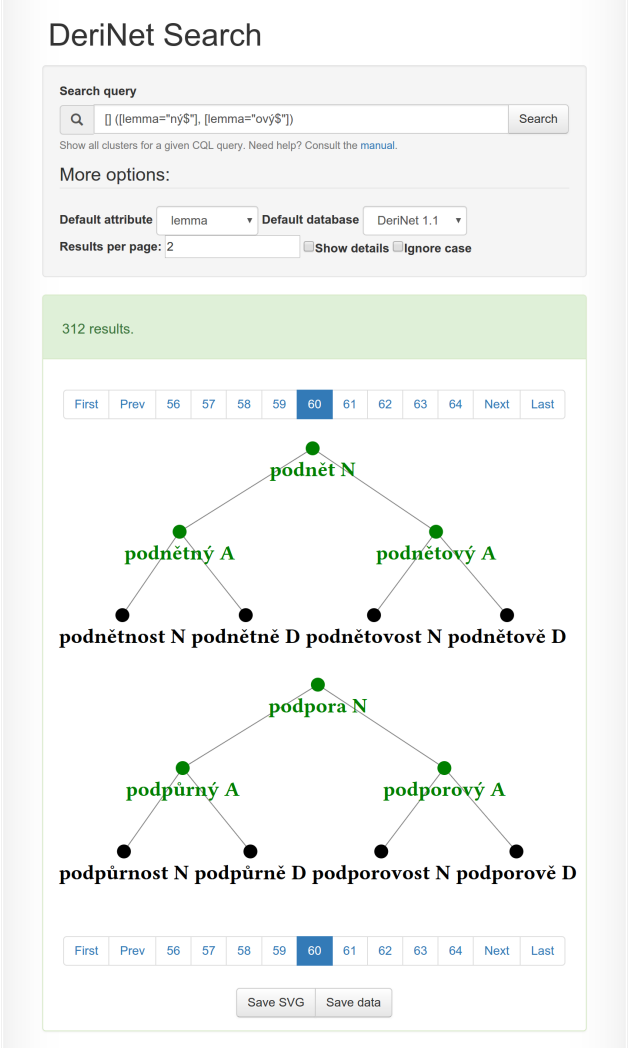


Access to the data

- Application Programming Interfaces
  - derivations integrated in the MorphoDiTa tool since version 2.0
  - REST API
- Graphical User Interfaces (in web browsers)
  - MorphoDiTa online demo - shows both derivations and inflections
  - DeriNet Viewer - for browsing derivation trees
  - DeriNet Search - query language allowing quite complex search queries

Query example

- The query `[] ([lemma="ný$"], [lemma="ový$"])` searches for adjectives which were derived by the two different suffixes.



Future work and open questions

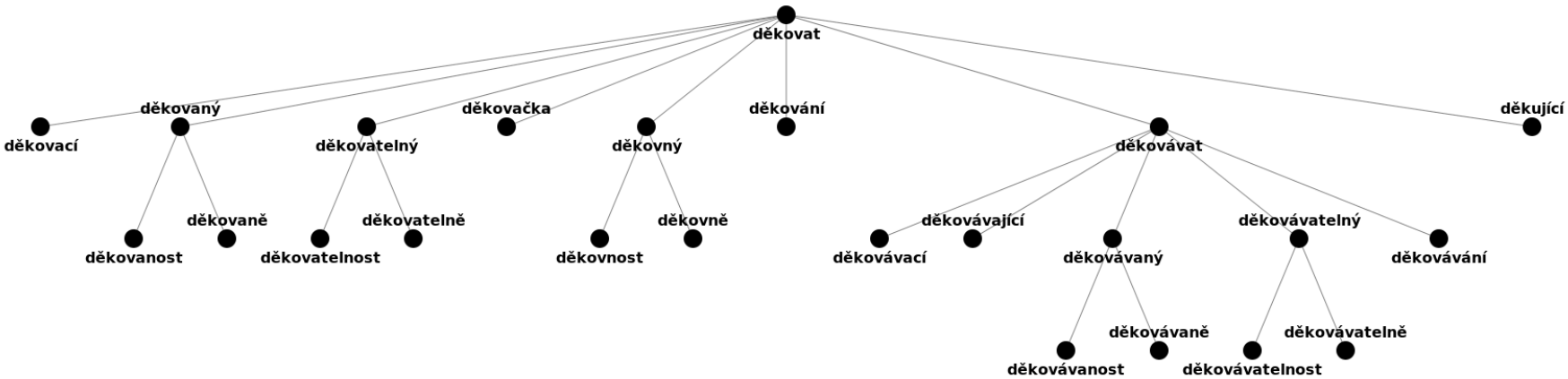
- add some **missing derivations** (e.g. verb prefixation, aspectual counterparts created by suffixation, etc.)
- **abandon the treeness** constraint to allow composition
- **semantic labelling** of derivation relations (diminutives, possessives. . .)
- resolve **homonymy** – inflection and derivation might pose different criteria on distingushing homonyms
- some problems **analogous to** that of **dependency trees**
  - clear presence of an edge, but unclear orientation
  - sometimes intermediate words are "predicted" that simply do not exist (phantom lexemes, similar to elipsis)
  - we know trees are actually not enough even for derivations, but are irresistibly attractive

Conclusions

There is a morphological resource for Czech that

- handles both morphological inflection and derivation
- covers roughly one million Czech lemmas
- is equiped with several user interfaces
- is available to your under CC-BY-NC-SA, see `http://ufal.mff.cuni.cz/derinet` or `http://ufal.mff.cuni.cz/morphodita`

Thank you!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