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)
For both it holds that:

- there is a strong **form-function** asymmetry, 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` - `sněhu` (inflection: snow gen.sg.), `sníh` - `sněžný` (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 gradually 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 nejnepodlejč
podle-1^(*3ý-1) Dg-------3N----- nejnepodleji
podle-1^(*3ý-1) Dg-------3A-----6 nejpodlejč
podle-1^(*3ý-1) Dg-------3A----- nejpodleji
podle-1^(*3ý-1) Dg-------1N----- nepodle
podle-1^(*3ý-1) Dg-------2N-----6 nepodlejč
podle-1^(*3ý-1) Dg-------2N----- nepodleji
podle-1^(*3ý-1) Dg-------1A----- podle
podle-1^(*3ý-1) Dg-------2A-----6 podlejč
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

- NOUNS: 421,213
- VERBS: 52,422
- ADVERBS: 155,096
- ADJECTIVES: 340,295
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- ADVERBS: 155,096
- NOUNS: 421,213
- VERBS: 52,422
- ADVERBS: 155,096
- ADJECTIVE
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 distinguishing 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 equipped with several user interfaces
- is available to you under CC-BY-NC-SA, see
  http://ufal.mff.cuni.cz/derinet or
  http://ufal.mff.cuni.cz/morphodita
Thank you!