# To tree or not to tree

Zdeněk Žabokrtský

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Charles University
Faculty of Mathematics and Physics
Institute of Formal and Applied Linguistics

# Troubles with choosing an annotation scheme: a case study on problematic corpus/treebank design decisions

# Corpus annotation criticism

- some critics: an annotated corpus is worse than a raw corpus because of forced interpretations
  - one has to struggle with different linguistic traditions of different national schools
  - example: part of speech categories
- relying on annotation might be misleading if the quality is low (errors or inconsistencies)

# Variability of PoS tag sets

## Penn Treebank POS tagset (for English)

**CC** coordinating conjunction (*and*)
**CD** cardinal number (*1, third*)
**DT** determiner (*the*)
**EX** existential there (*there is*)
**FW** foreign word (*d'hoevre*)
**IN** preposition/subordinating conjunction (*in, of, like*)
**JJ** adjective (*green*)
**JJR** adjective, comparative (*greener*)
**JJS** adjective, superlative (*greenest*)
**LS** list marker (*1)*)
**MD** modal (*could, will*)
**NN** noun, singular or mass (*table*)
**NNS** noun plural (*tables*)
**NNP** proper noun, singular (*John*)
**NNPS** proper noun, plural (*Vikings*)
**PDT** predeterminer (*¡iż both¡/iż the boys*)
**POS** possessive ending (*friend's*)
**PRP** personal pronoun (*I, he, it*)
**PRP$** possessive pronoun (*my, his*)
**RB** adverb (*however, usually, naturally, here, good*)
**RBR** adverb, comparative (*better*)
**RBS** adverb, superlative (*best*)
**RP** particle (*give up*)
**TO** to (*to go, to him*)
**UH** interjection (*uhhuhhuhh*)
**VB** verb, base form (*take*)
**VBD** verb, past tense (*took*)
**VBG** verb, gerund/present participle (*taking*)
**VBN** verb, past participle (*taken*)
**VBP** verb, sing. present, non-3d (*take*)
**VBZ** verb, 3rd person sing. present (*takes*)
**WDT** wh-determiner (*which*)
**WP** wh-pronoun (*who, what*)
**WP$** possessive wh-pronoun (*whose*)
**WRB** wh-abverb (*where, when*)

# Variability of PoS tag sets, cont.

## Negra Corpus POS tagset (for German)

**ADJA** Attributives Adjektiv
**ADJD** Adverbiales oder prädikatives Adjektiv
**ADV** Adverb
**APPR** Preposition; Zirkumposition links
**APPRART** Preposition mit Artikel
**APPO** Postposition
**APZR** Zirkumposition rechts
**ART** Bestimmter oder unbestimmter Artikel
**CARD** Kardinalzahl
**FM** Fremdsprachliches Material
**ITJ** Interjektion
**KOUI** Unterordnende Konjunktion mit zu und Infinitiv
**KOUS** Unterordnende Konjunktion mit Satz
**KON** Nebenordnende Konjunktion
**KOKOM** Vergleichspartikel, ohne Satz
**NN** Normales Nomen
**NE** Eigennamen
**PDS** Substituierendes Demonstrativpronomen
**PDAT** Attribuierendes Demonstrativpronomen
**PIS** Substituierendes Indefinitpronomen
**PIAT** Attribuierendes Indefinitpronomen
**PIDAT** Attribuierendes Indefinitpronomen mit Determiner
**PPER** Irreflexives Personalpronomen
**PPOSS** Substituierendes Possessivpronomen
**PPOSAT** Attribuierendes Possessivpronomen
**PRELS** Substituierendes Relativpronomen
**PRELAT** Attribuierendes Relativpronomen
**PRF** Reflexives Personalpronomen
**PWS** Substituierendes Interrogativpronomen
**PWAT** Attribuierendes Interrogativpronomen
**PWAV** Adverbiales Interrogativ- oder Relativpronomen
**PROAV** Pronominaladverb
**PTKZU** zu vor Infinitiv
**PTKNEG** Negationspartikel
**PTKVZ** Abgetrennter Verbzusatz
**PTKANT** Antwortpartikel
**PTKA** Partikel bei Adjektiv oder Adverb
**TRUNC** Kompositions-Erstglied
**VVFIN** Finites Verb, voll
**VVIMP** Imperativ, voll
**VVINF** Infinitiv, voll
**VVIZU** Infinitiv mit zu, voll
**VVPP** Partizip Perfekt, voll
**VAFIN** Finites Verb, aux
**VAIMP** Imperativ, aux
**VAINF** Infinitiv, aux
**VAPP** Partizip Perfekt, aux
**VMFIN** Finites Verb, modal
**VMINF** Infinitiv, modal
**VMPP** Partizip Perfekt, modal
**XY** Nichtwort, Sonderzeichen
$, Komma
$. Satzbeendende Interpunktion
$( Sonstige Satzzeichen; satzintern
**NNE** Verbindung aus Eigennamen und normalen Nomen

# Variability of PoS tag sets, cont.

Prague Dependency Treebank morphologitagset (for Czech), several thousand combinations using 15-character long positional tags

| Form | Lemma | Morphological tag |
|---|---|---|
| *Některé* | *některý* | PZFP1---------- |
| *kontury* | *kontura* | NNFP1-----A---- |
| *problému* | *problém* | NNIS2-----A---- |
| *se* | *se_^*(zvr._zájmeno/částice) | P7-X4---------- |
| *však* | *však* | J^---------- |
| *po* | *po-1* | RR--6---------- |
| *oživení* | *oživení_^*(*3it) | NNNS6-----A---- |
| *Havlovým* | *Havlův_;S_^*(*3el) | AUIS7M--------- |
| *projevem* | *projev* | NNIS7-----A---- |
| *zdají* | *zdát* | VB-P---3P-AA--- |
| *být* | *být* | Vf--------A---- |
| *jasnější* | *jasný* | AAFP1----2A---- |
| . | . | Z:---------- |

# Treebanks

- a treebank is a corpus in which sentences' syntax and/or semantics is analyzed using tree-shaped data structures
- a tree in the sense of graph theory (a connected acyclic graph)
- sentence syntactic analysis ... it sounds familiar to most of you, doesn't it?

Credit: http://konecekh.blog.cz

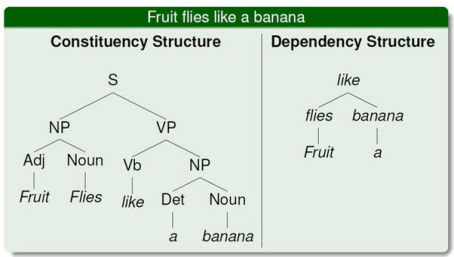
# Why trees: Initial thoughts

1. Honestly: trees are irresistibly attractive data structures.
2. We believe sentences can be reasonably represented by discrete units and relations among them.
3. Some relations among sentence components (such as some word groupings) make more sense than others.
4. In other words, we believe there is an latent but identifiable discrete structure hidden in each sentence.
5. The structure must allow for various kinds of nestedness (*...a já mu řek, že nejsem Řek, abych mu řek, kolik je v Řecku řeckých řek ...*).
6. This resembles recursivity. Recursivity reminds us of trees.
7. Let's try to find such trees that make sense linguistically and can be supported by empirical evidence.
8. Let's hope they'll be useful in developing NLP applications such as Machine Translation.

# So what kind of trees?

There are two types of trees broadly used:

- constituency (phrase-structure) trees
- dependency trees




Credit: https://www.quora.com/What-is-the-difference-between-dependency-parsing-and-semantic-role-labeling

Constituency trees simply don't fit to languages with freer word order, such as Czech. Let's use dependency trees.

# BTW how do we know there is a dependency between two words?

- There are various clues manifested, such as
  - word order (juxtapositon): "*...přijdu zítra ...*"
  - agreement: "*...novými*$_{.pl.instr}$ *knihami*$_{.pl.instr}$*...*"
  - government: "*...slíbil Petrovi*$_{.dative}$*...*"

- Different languages use different mixtures of morphological strategies to express relations among sentence units.

# Basic assumptions about building units

If a sentence is to be represented by a dependency tree, then we need to be able to:

- identify **sentence boundaries**.
- identify **word boundaries** within a sentence.

# Basic assumptions about dependencies

If a sentence is to be represented by a dependency tree, then:

- there must be a **unique parent word** for each word in each sentence, except for the root word
- there are **no loops** allowed.

# Even the most basic assumptions are violated

- Sometimes **sentence boundaries are unclear** – generally in speech, but e.g. in written Arabic too, and in some situations even in written Czech (e.g. direct speech)
- Sometimes **word boundaries are unclear**, (Chinese, "ins" in German, "abych" in Czech).
- Sometimes its **unclear which words should become parents** (A preposition or a noun? An auxiliary verb or a meaningful verb? ...).
- Sometimes there are too many relations ("Zahlédla ho bosého."), which implies **loops**.

Life's hard. Let's ignore it and insist on trees.

# Counter-examples revisited

If we cannot find linguistically justified decisions, then make them at least consistent.

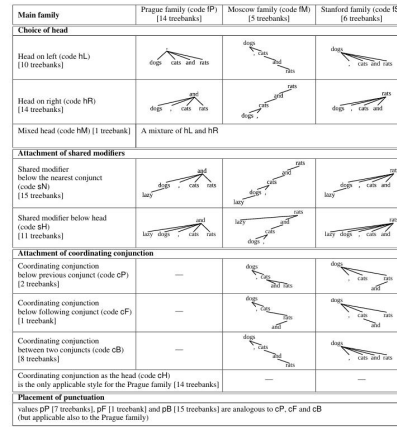
- Sometimes sentence boundaries are unclear (generally in speech, but e.g. in written Arabic too…)
  - **OK, so let's introduce annotation rules for sentence segmentation.**
- Sometimes word boundaries are unclear, (Chinese, "ins" in German, "abych" in Czech).
  - **OK, so let's introduce annotation rules for tokenization.**
- Sometimes it's not clear which word should become parent (e.g. a preposition or a noun?).
  - **OK, so let's introduce annotation rules for choosing parent.**
- Sometimes there are too many relations ("Zahlédla ho bosého."), which implies loops.
  - **OK, so let's introduce annotation rules for choosing tree-shaped skeleton.**

# Treebanking

- Is our dependency approach viable? Can we check it?
- Let's start by building the trees manually.
- a treebank - a collection of sentences and associated (typically manually annotated) dependency trees
- for English: Penn Treebank [Marcus et al., 1993]
- for Czech: Prague Dependency Treebank [Hajič et al., 2001]
  - layered annotation scheme: morhology, surface syntax, deep syntax
  - dependency trees for about 100,000 sentences
- high degree of design freedom and local linguistic tradition bias
- different treebanks $\Longrightarrow$ different annotation styles

# An example of a treebank variability cause: the case of coordination

- coordination structures such as "*lazy dogs, cats and rats*" consists of
  - conjuncts
  - conjunctions
  - shared modifiers
  - punctuation tokens
- 16 different annotation styles identified in 26 treebanks (and many more possible)
- different expressivity, limited convertibility, limited comparability of experiments...
- **harmonization of annotation styles badly needed!**



# Btw how many treebanks are there out there?

- growing interest in dependency treebanks in the last decade or two
- existing treebanks for about 100 languages now (but roughly 7,000 languages in the world)
- UFAL participated in several treebank unification efforts:
  - 13 languages in CoNLL in 2006
  - 29 languages in HamleDT in 2011
  - 37 languages in Universal Dependencies in 2015:
  - 70 languages in UD in 2019
  - 138 languages in UD in 2022

# Conclusion

- one should keep in mind that there's no straightforward "God's truth" when it comes to language data resources
- all resources are heavily influenced by numerous design choices, for which no perfect answers exists
- examples of trade-offs:
  - the bigger data the better, but you can't remove all noise from really big data
  - parallel annotation reduces the amount of annotation errors, but increases costs
  - linguistically-based annotation brings interpretability, but at the same time we risk being trapped in some suboptimal traditions that are possibly not useful beyond a given language family
  - a better quality/coverage is sometimes achievable by integrating more resources focused on a same task, but their licenses might be incompatible