Compounds in Universal Dependencies: A Survey in Five European Languages

Emil Svoboda, Magda Ševčíková
Charles University, Faculty of Mathematics and Physics
Institute of Formal and Applied Linguistics
{svoboda,sevcikova}@ufal.mff.cuni.cz

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Introduction

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Introduction

- Compounds are words formed by a combination of two or more {words, bases, roots, stems}.
  - *waterfall*, *černobřichý*, *Jahreabschlussprüfung*, *городской-государство*, *blauäugig*, etc.
  - Compoundhood is difficult to rigidly define, as it borders with
    - Syntax (compounds vs. syntactic phrase)
    - Word formation (compounds vs. neoclassical formations vs. derivatives)
  - It is ***not*** defined by spelling:
    - *flowerpot* (closed compound), *flower-pot* (hyphenated compound), *flower pot* (open compound)
- We survey how compounds are treated in Universal Dependencies.
  - Orthographic conventions dictate tokenization
  - Tokenization dictates dependency building
  - Inter- and intralinguistic comparison is therefore difficult
  - A compound annotation scheme based on existing relations in UD is proposed
    - It explicitly shows the analogy between compounds and phrases
  - {English, German, Czech, Russian, Latin}

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Theoretical background

- Debate around compounding centered around:
  - Compounding vs. derivation — *biology*? *biodegradable*? *understand*?
  - POS of the components — *mother tongue* → [N + N]; *Umfrageteilnehmer* → [V/N? + N]
  - Headedness — *mother tongue* → [N + **(N)**]; *lady-in-waiting* → [**(N)** + N]
  - Endo- vs exo- centricity — *toothbrush* (type of brush); *bluestocking* (unrelated to legwear)
  - Internal structure — *Straßenbahnlinie* → [[[Straße] Bahn] Linie]
  - Component relation — coordinative vs. subordinate/determinative etc.
- Bisetto and Scalise (2006) propose a two-level multilingual classification scheme:
  - Component relation is level 1
    - subordinate: *sunglasses*;
    - attributive: *blue cheese*;
    - coordinative: *actor-director*
  - Centricity is level 2
    - endocentric: *apple cake*; *backyard*; *God Emperor*
    - exocentric: *killjoy*; *white-collar*; *mind-brain*
  - The classification is used in the construction of a database of compounds

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Compounds in language data resources 1/2

- MorboComp (20 languages; 2006):
  - All languages in scope except Czech covered
  - Based on Bisetto and Scalise's classification

Compound	POS	Struc	Class	End	Head-C	Head-S	1st-C	2nd-C	Gloss
madrelingua	N	[N+N]	SUB	Tru	right	right	madre	lingua	mother+tongue
mano lesta	N	[N+A]	ATT	Fal	none	none	mano	lesta	quick+hand=thief
dormiveglia	N	[V+V]	CRD	Fal	none	none	dormi	veglia	sleep+be awake=dozing

- CELEX2 (English, German, Dutch; 2014):
  - General lexical database
  - English: 6,267 compounds; German: 19,304
  - Morphs replaced by a representative form

Umgangssprache	...	Umgang+s+Sprache	NxN	...	((((um)[V|.V],(geh)[V])[V])[N],\\(s)[N|N.N],((sprech)[V])[N])[N]	...
Grossmachtpolitik	...	Grossmacht+Politik	NN	...	(((gross)[A],(Macht)[N])[N],\\((polit)[R],(ik)[N|R.])[N])[N]	...
womenfolk	...	women+folk	NN	...	((women)[N],(folk)[N])[N]	...

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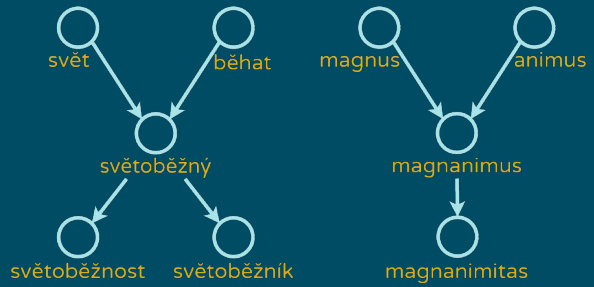
Compounds in language data resources 2/2

- GermaNet (German; 2014):
  - 120,000 compounds in its 2023 edition
  - Two closest existing ancestor words listed
- DeriNet 2.1 (Czech; 2006):
  - Lexical database of 432,000 attested lemmas
  - 45,473 compounds
  - Words linked to ancestors → tree-like structure
- Word Formation Latin (Latin; 2006):
  - Lexical database (36,258 entries; 3,198 compounds)
  - Similar structure to DeriNet 2.1
- Golden Compound Analyses (Russian; 2006):
  - 1,699 compounds linked to ancestors + POS
  - Compiled for the training of a compound splitter

Umgangssprache	Umgang	Sprache
Abbiegeassistent	abbiegen	Assistent
Umfrageteilnehmer	Umfrage|umfragen	Teilnehmer



полувсерьёз	adv	половина	noun	всерьёз	adv

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Current treatment of compounds in UD

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Annotation guidelines 1/2

- Guidelines follow tokenization
  - Closed compounds treated as atomic (discrete, internally unstructured)
    - not distinguished from other words at all → amount in UD difficult to establish
    - usage of data sources allow us to present a **lower bound estimate**

Language	Closed compounds	Total words	Sentences with closed compounds	Total sentences
English	5,934 (0.82%)	726K	5,286 (11.57%)	46K
German	156,629 (4.11%)	3,810K	87,104 (50.14%)	208K
Czech	47,103 (2.11%)	2,222K	34,775 (27.27%)	128K
Latin	26,271 (2.62%)	983K	18,353 (31.27%)	59K
Russian	4,803 (0.27%)	1,830K	4,460 (4.00%)	111K

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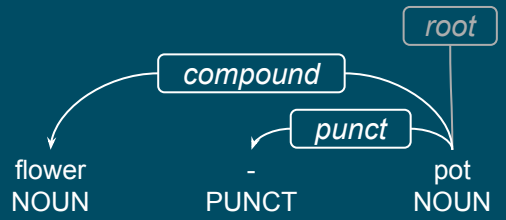
Annotation guidelines 2/2

- Guidelines follow tokenization
  - Open and hyphenated compounds treated as subtrees
    - head component as root node
    - the rest as dependent node(s)



Language	*compound* relations	Sentences with *compound*	*compound:prt* relations	Sentences with *compound:prt*	Total words	Total sentences
English	22,017 (3.03%)	13,459 (29.27%)	2,485 (0.34%)	2,313 (5.0%)	726K	46K
German	1,787 (0.05%)	1,418 (0.68%)	22,349 (0.59%)	21,897 (10.5%)	3,810K	208K
Czech	2,690 (0.12%)	1,356 (1.06%)	0 (0.00%)	0 (0.0%)	2,222K	128K
Latin	85 (0.01%)	82 (0.1%)	0 (0.00%)	0 (0.0%)	983K	59K
Russian	1,973 (0.11%)	1,812 (1.6%)	0 (0.00%)	0 (0,0%)	1,830K	111K

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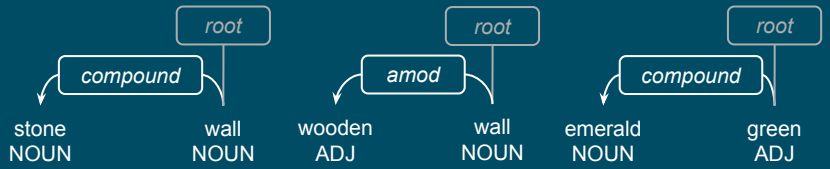
Compounds in UD treebanks - a closer look

English



German

Czech

Latin

Russian

Summary

- The *compound* relation is used inconsistently
- It is underspecified
- Interesting typological phenomena are lost

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Syntax-based annotation proposal

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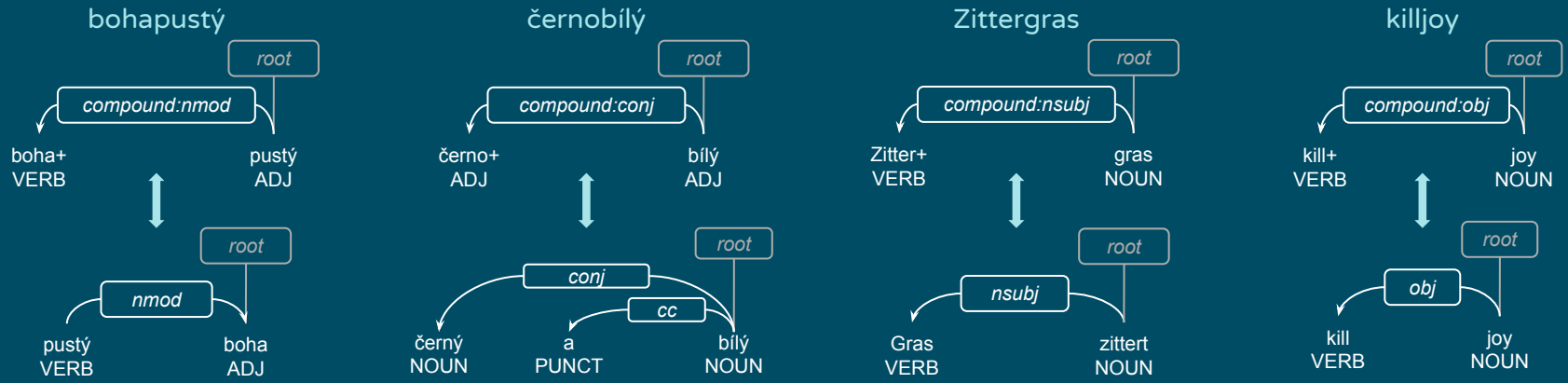
Proposal description (1/2)

- We want to unify the treatment of compounds regardless of spelling:
  a. Closed compounds should be split
  b. Compound constituents should be assigned a lemma
  c. Compounds should be a subtree with a *compound: <relation>* tag



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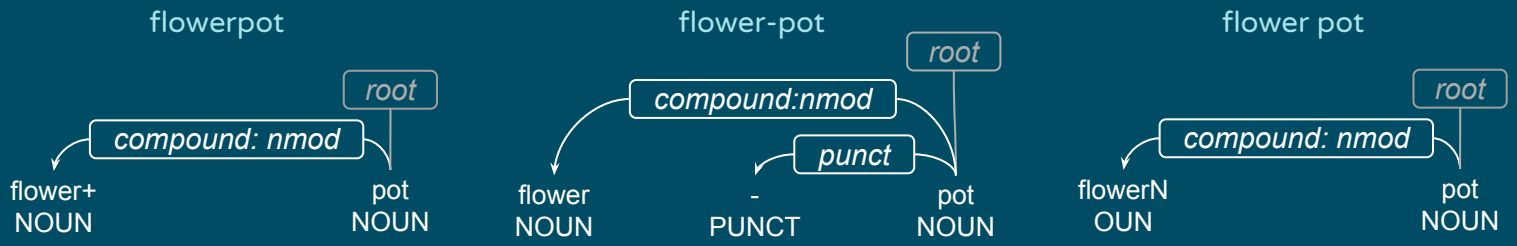
Proposal description (2/2)

- We want to unify the treatment of compounds regardless of spelling:
  a. Closed compounds should be split
  b. Compound constituents should be assigned a lemma
  c. Compounds should be a subtree with a *compound: <relation>* tag



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Steps toward implementation

- Identification of closed compounds
  - No. of closed compounds varies – 50% of sentences in German vs. 4% in Russian
  - Higher-coverage resources or more sophisticated tools may reveal higher numbers
- Splitting of closed compounds and component lemmatization
  - Previously mentioned data sources provide a starting point
  - *PaReNT* provides splitting + component lemmatization for Czech
- Assigning syntactic relation labels
  - Limited data available (CELEX)
  - Pilot procedure based around finding phrases encoded by each example and feeding them into UDPipe
  - Possible pipeline:
    - *PaReNT*: *černobílý* → *černo+bílý* → *černý, bílý*
    - *ChatGPT/LLM*: černý, bílý → *černý a bílý*
    - *UDPipe: černý a bílý* → *cconj*

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Conclusion

- We explored the current treatment of compounds in UD.
  - We used English, German, Czech, German, Russian, and Latin
  - The handling of compound varies widely
- We propose that compound should be treated analogously to syntactic phrases.
  - Compounds should be treated consistently regardless of spelling
  - Existing relations should be used to create *compound: <relation>* tags
- We are currently implementing the proposed scheme.
  - A pipeline based on existing tools is being developed

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