Coordination in *Universal Dependencies*

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ZIL IPI PAN
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Universal Dependencies

Universal Dependencies

Universal Dependencies (UD; Nivre *et al.* 2016; version 2.4 announcement):

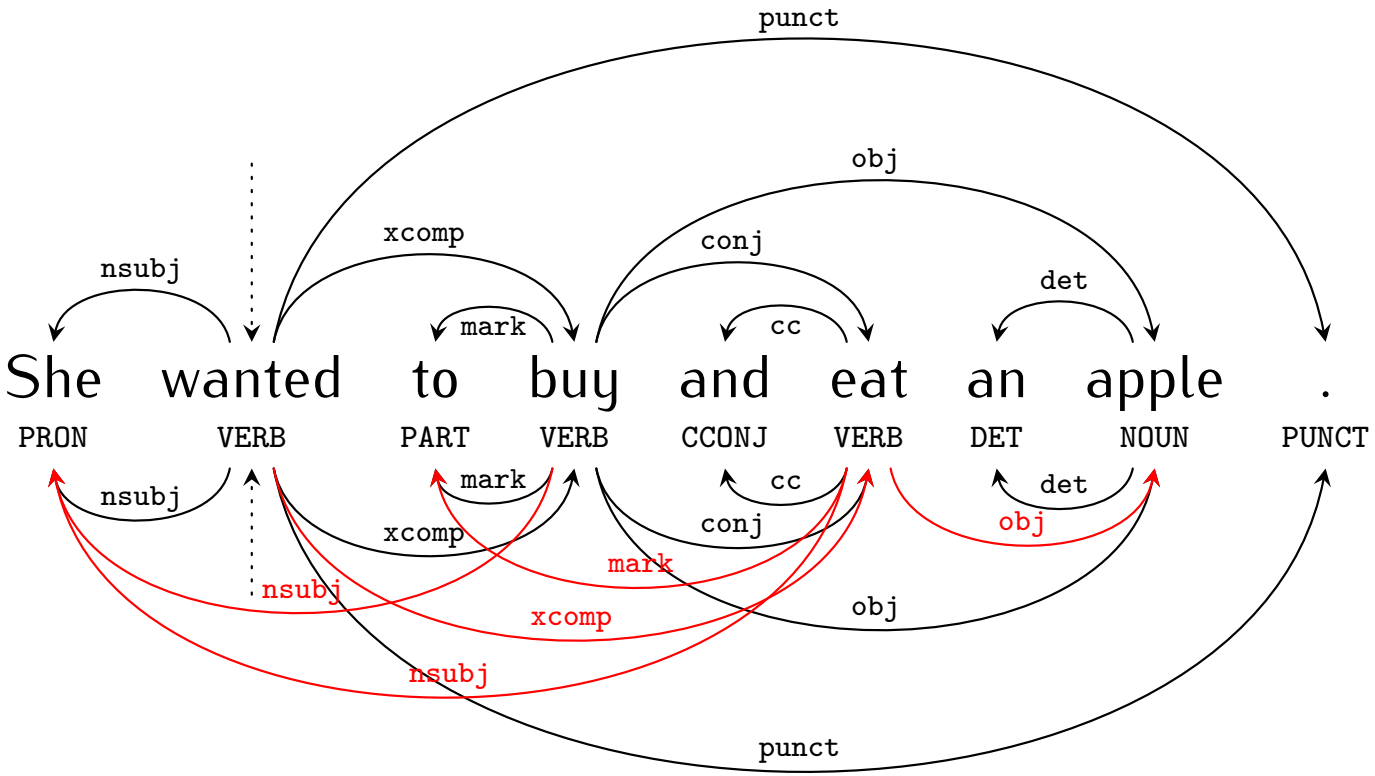
> *a project that seeks to develop **cross-linguistically consistent treebank annotation for many languages**...*

Version 2.4 (May 2019) – **146 treebanks** of **83 languages**:

Afrikaans, Akkadian, Amharic, Ancient Greek, Arabic, Armenian, Assyrian, Bambara, Basque, Belarusian, Breton, Bulgarian, Buryat, Cantonese, Catalan, Chinese, Classical Chinese, Coptic, Croatian, Czech, Danish, Dutch, English, Erzya, Estonian, Faroese, Finnish, French, Galician, German, Gothic, Greek, Hebrew, Hindi, Hindi English, Hungarian, Indonesian, Irish, Italian, Japanese, Karelian, Kazakh, Komi Zyrian, Korean, Kurmanji, Latin, Latvian, Lithuanian, Maltese, Marathi, Mbya Guarani, Naija, North Sami, Norwegian, Old Church Slavonic, Old French, Old Russian, Persian, **Polish**, Portuguese, Romanian, Russian, Sanskrit, Serbian, Slovak, Slovenian, Spanish, Swedish, Swedish Sign Language, Tagalog, Tamil, Telugu, Thai, Turkish, Ukrainian, Upper Sorbian, Urdu, Uyghur, Vietnamese, Warlpiri, Welsh, Wolof, Yoruba.

She wanted to buy and eat an apple. (UD)

(basic tree)



(enhanced structure)

Nested Coordination

Adam Przepiórkowski and Agnieszka Patejuk. *Nested coordination in Universal Dependencies*. In Alexandre Rademaker and Francis Tyers, editors, *Proceedings of the Third Workshop on Universal Dependencies (UDW, SyntaxFest 2019)*, pages 58–69. Association for Computational Linguistics, 2019.

Problem – UD

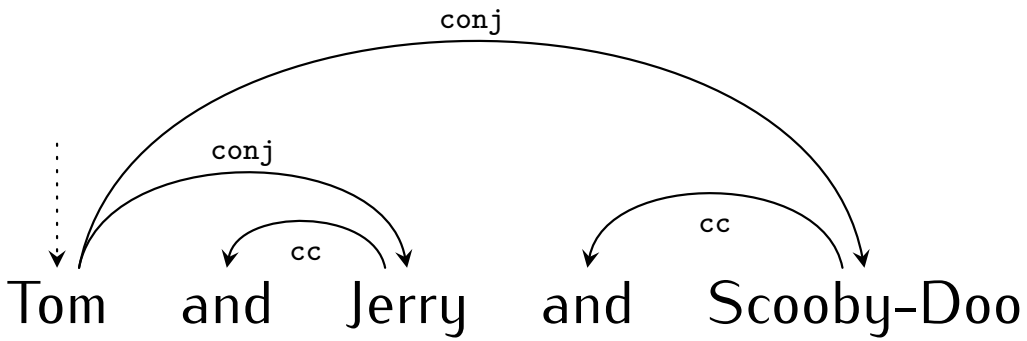
1 Tom and Jerry and Scooby-Doo (ternary)

2 [Tom and Jerry] and Scooby-Doo (binary)

3 Tom and [Jerry and Scooby-Doo] (binary)

Universal Dependencies (UD):

1, 2



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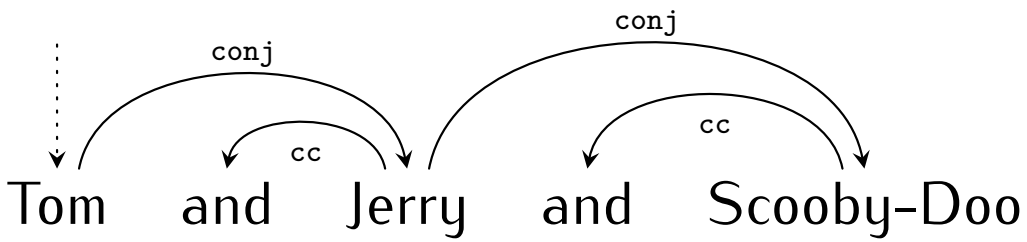
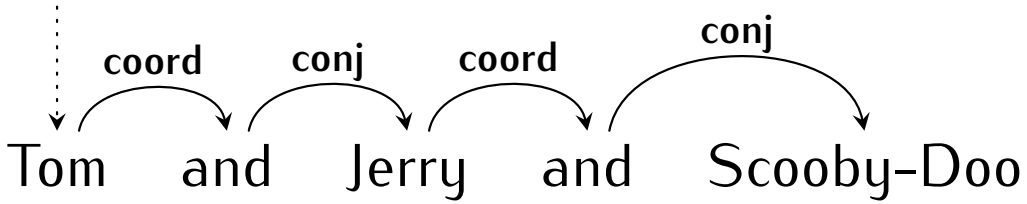


Problem – MTT

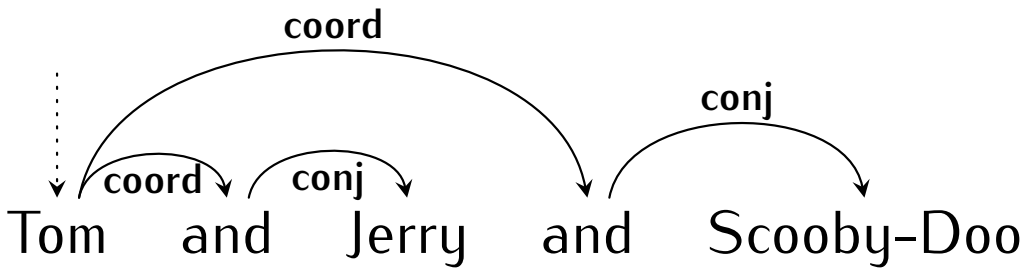
1. Tom and Jerry and Scooby-Doo
2. [Tom and Jerry] and Scooby-Doo
3. Tom and [Jerry and Scooby-Doo]

Igor Mel'čuk's Meaning–Text Theory (MTT):

1, 3



2

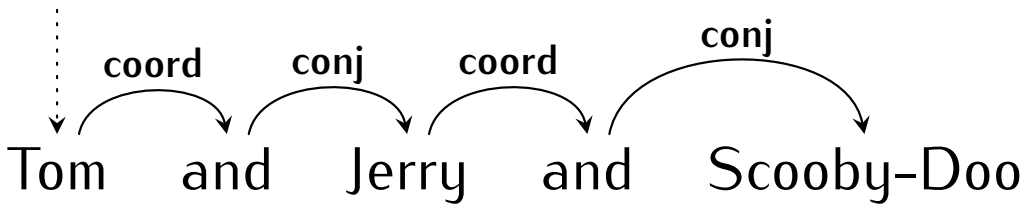


Solution – MTT

1. Tom and Jerry and Scooby-Doo
2. [Tom and Jerry] and Scooby-Doo
3. Tom and [Jerry and Scooby-Doo]

Groupings in MTT:

1



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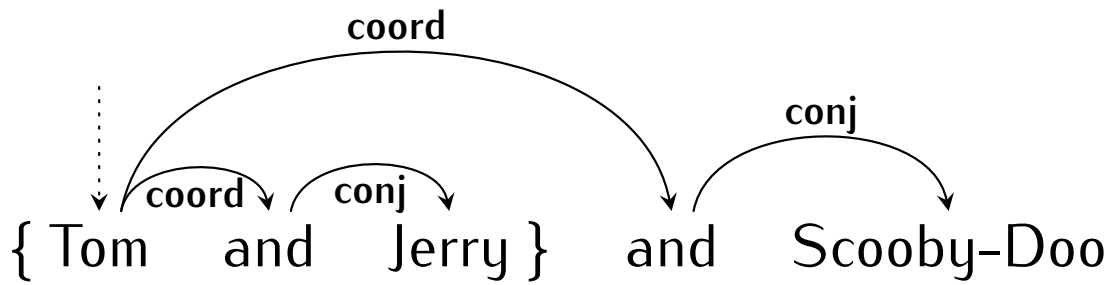

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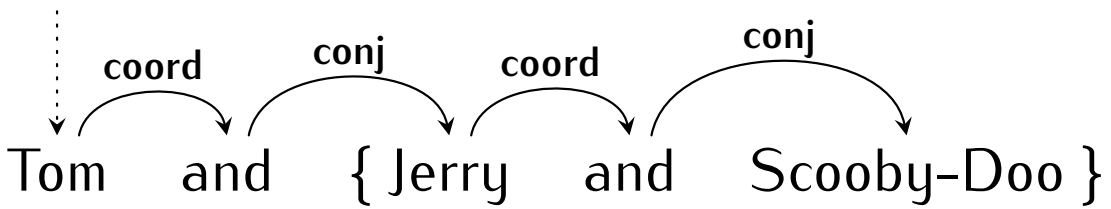
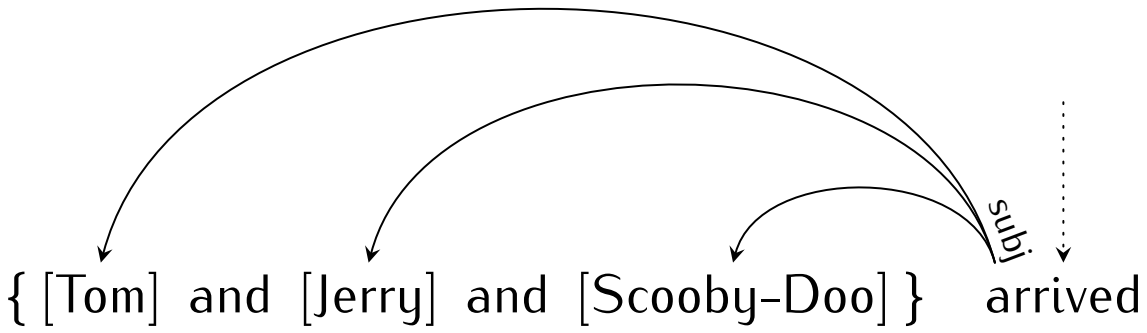


Solution – WG

Constituents in Dick Hudson's Word Grammar:

1



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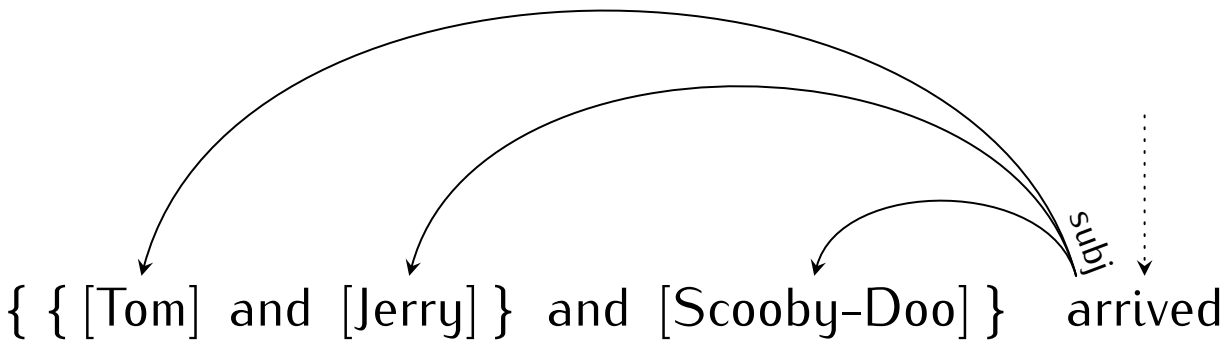

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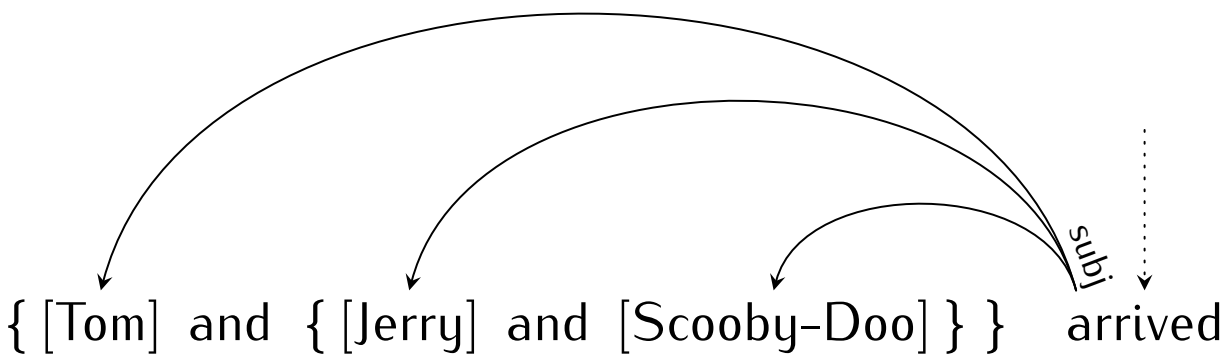
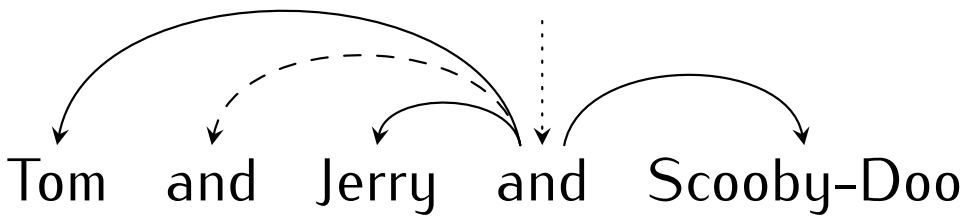


No problem for Prague

1. Tom and Jerry and Scooby-Doo
2. [Tom and Jerry] and Scooby-Doo
3. Tom and [Jerry and Scooby-Doo]

Prague-style:

1



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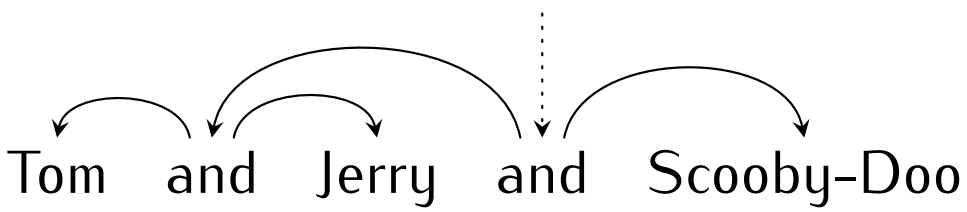

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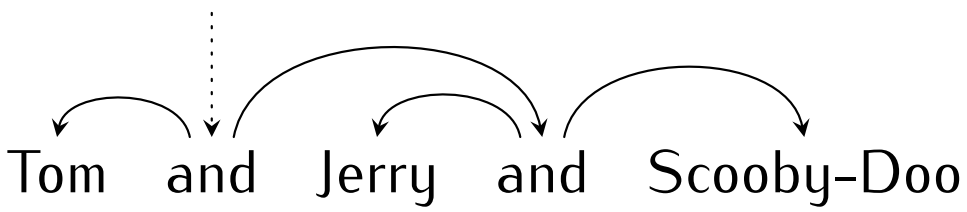


Problem – UD (summary)

But Prague-style analysis is **theoretically problematic** and rejected by many linguists of different theoretical persuasions (Mel'čuk and Pertsov 1987: 65, Hudson 1988: 314–315, Gerdes and Kahane 2015: 102–105; also Borsley 2005).

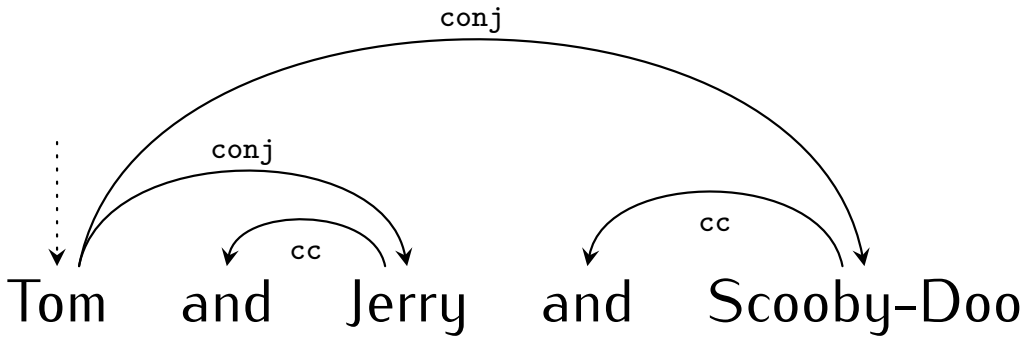
Summary of the problem:

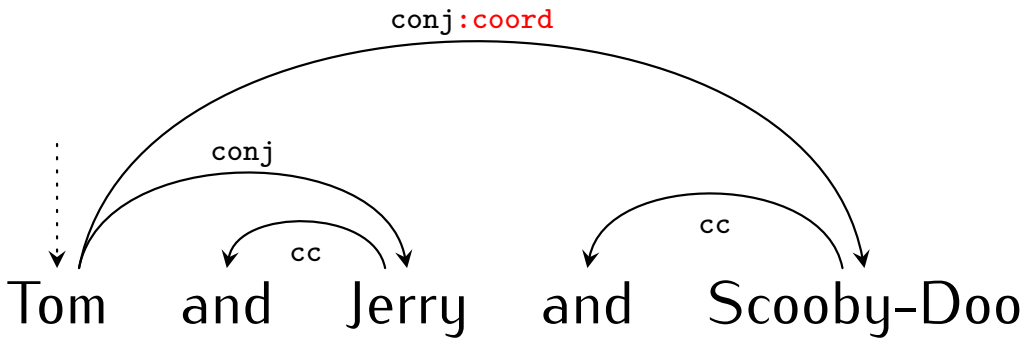
- **UD does not distinguish between certain nestings of coordination**,
- **MTT and WG use mechanisms unavailable in UD** (groupings, constituents),
- **not a technical problem for Prague**-style analysis of coordination,
- but such an analysis is rejected by many theoretical linguists.

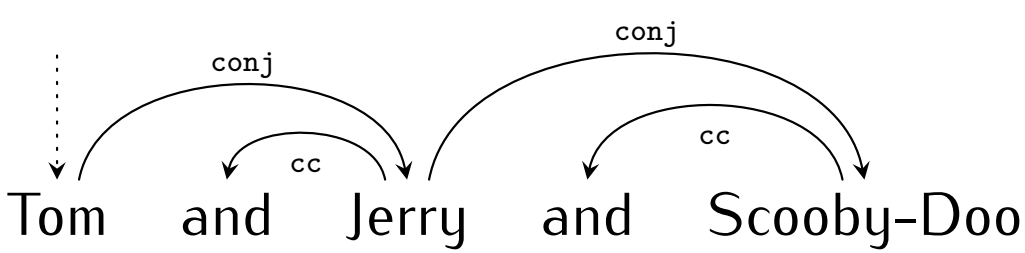
This talk: **conservative solutions within standard UD**.

Enriching labels 1

Enriching dependency labels via **subtyping**:

- 

- 

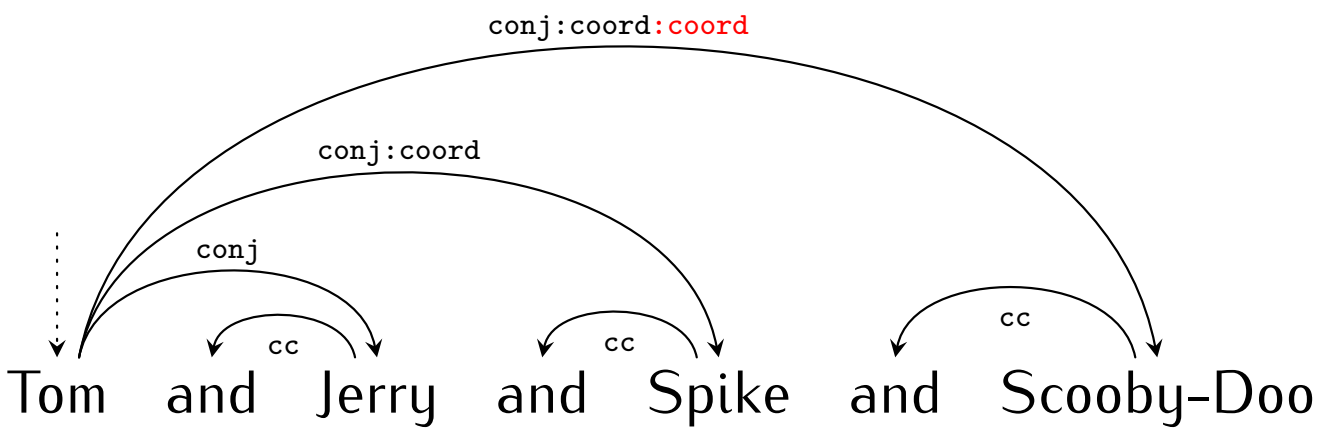
- 

Enriching labels 2

Similar solution considered in Mel'čuk 1988: 30 and Mel'čuk 2009: 93–94 and earlier. **Rejected** as 'highly unnatural' and leading to the doubling of dependency labels.

A problem for UD – **no theoretical limit** to the number of subtypes (Schuster *et al.* 2017: 130–131):

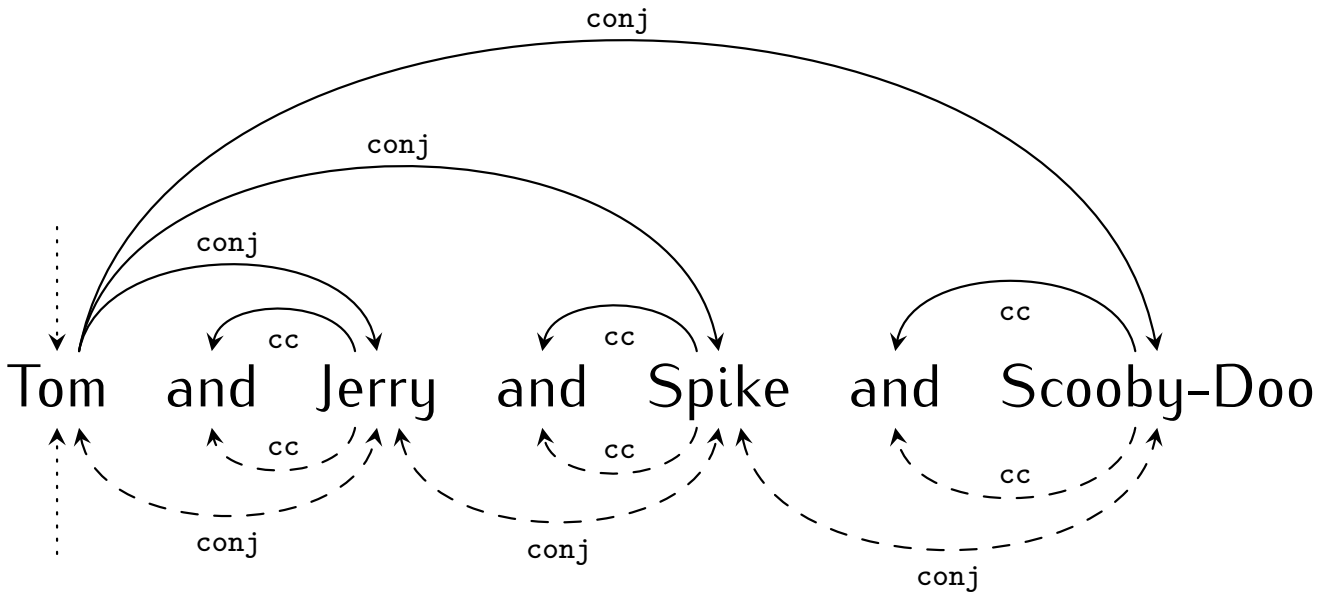
- [[Tom and Jerry] and Spike] and Scooby-Doo



Conjuncts as co-heads in enhanced representations 1

Retain basic tree representation, add **different enhanced representation**:

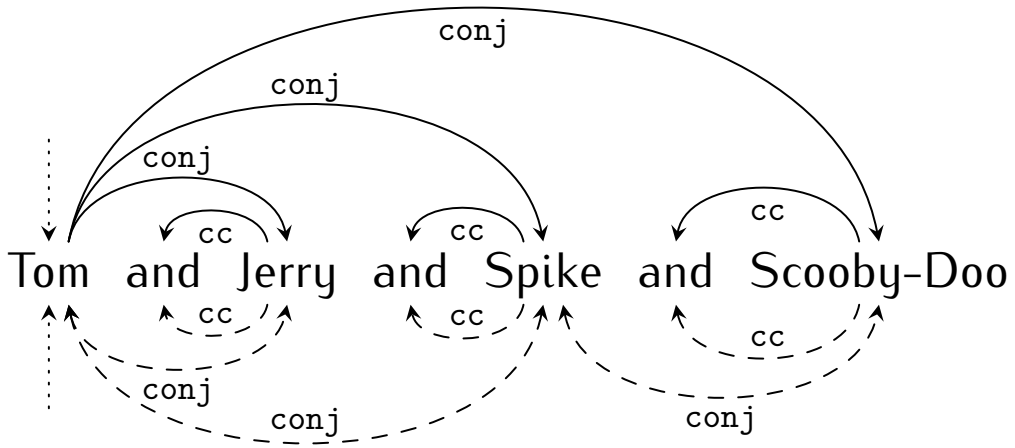
- Tom and Jerry and Spike and Scooby-Doo: (no nesting)



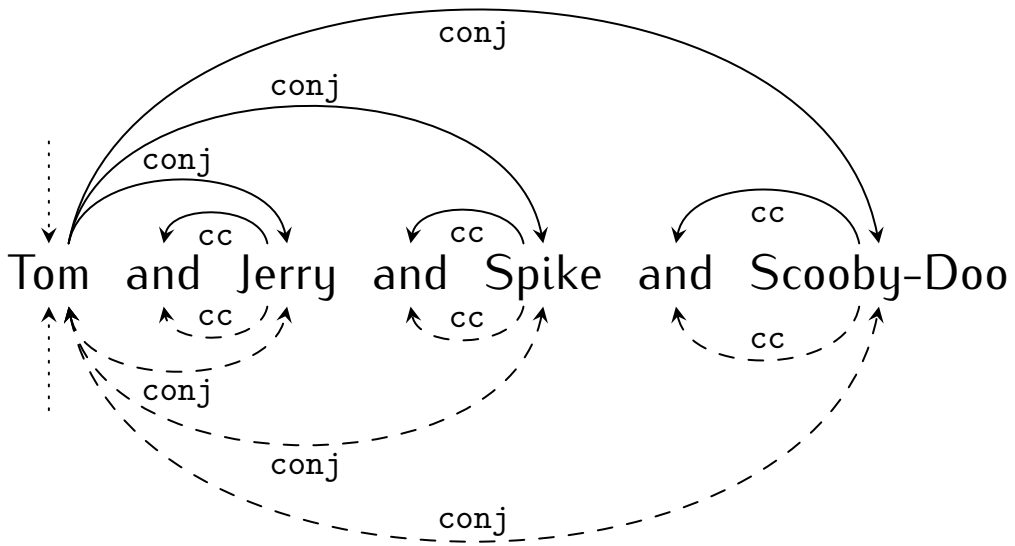
Idea: pairs of dependencies (in both directions) between neighbouring conjuncts.

Conjuncts as co-heads in enhanced representations 2

- [Tom and Jerry] and Spike and Scooby-Doo:



- [[Tom and Jerry] and Spike] and Scooby-Doo:



Conjuncts as co-heads in enhanced representations 2

Pros:

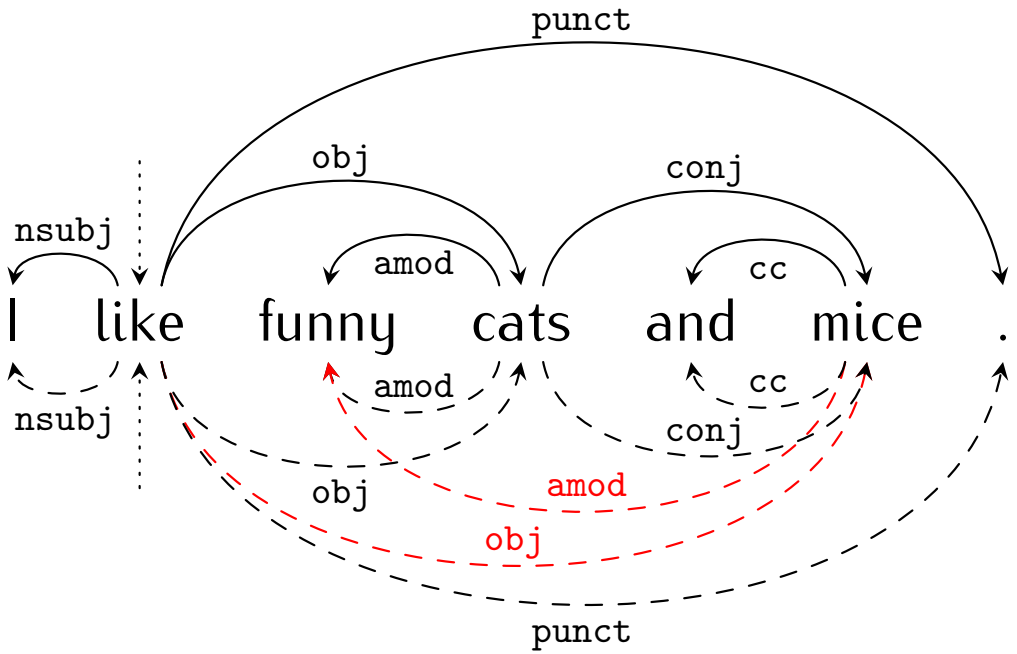
- it can be shown that **representations of different nestings differ**
- enhanced graph implements the common idea that **conjuncts are co-heads**
  - in dependency approaches: Tesnière 1959 (similar sentiments expressed by Hudson)
  - in constituency approaches: Gazdar *et al.* 1985 (similar sentiments in some HPSG work)
  - in combined approaches: Kahane 1997, Kahane and Mazziotta 2015

Cons:

- **basic trees and enhanced graphs must be inspected together** to reveal full structure
- although this may be rectified by copying basic tree to enhanced graphs (and modifying labels accordingly)

Distribution in enhanced representations 1

Recall **standard UD treatment of coordination**:

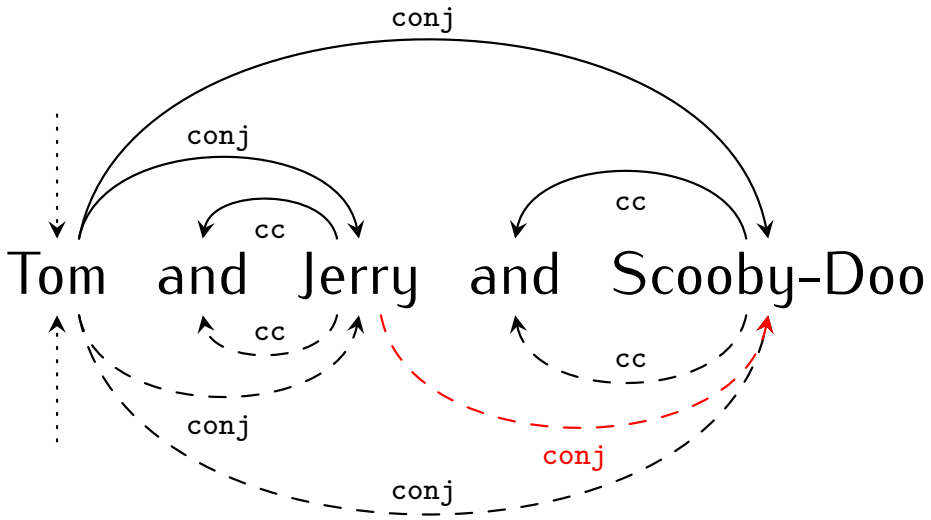
- I like funny cats and mice.
- 

In **enhanced representation**:

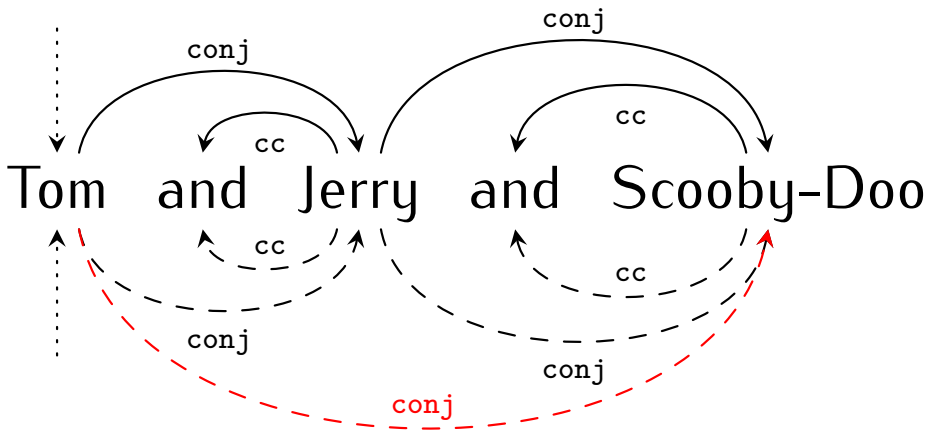
- distribute dependencies **to** coordinate structure (cf. obj above),
- distribute dependencies **from** coordinate structure (cf. amod above).

Distribution in enhanced representations 2

- [Tom and Jerry] and Scooby-Doo:



- Tom and [Jerry and Scooby-Doo]:



Pros:

- **maximally conservative** solution

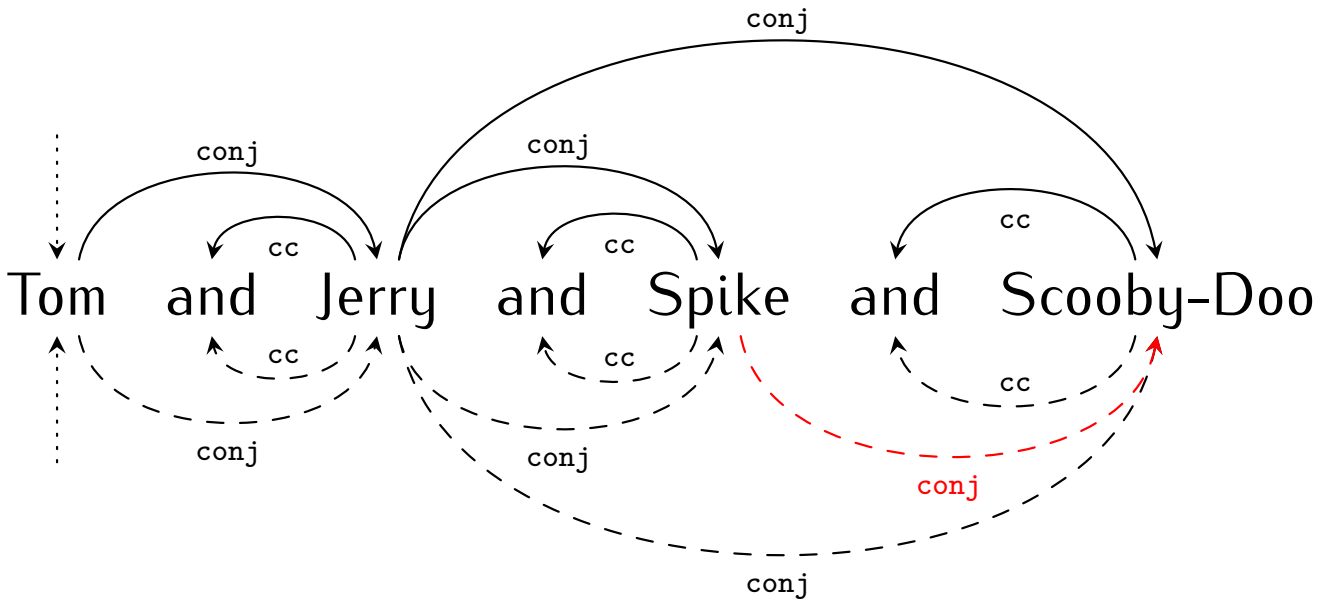
Cons:

- **requires inspecting both levels** (basic trees and enhanced graphs)
- this time, this can't be rectified so easily
- (**does not encode the co-heads idea**)

Distribution in enhanced representations 3

Better solution: only distribute dependencies **from** coordinate structures:

- Tom and [[Jerry and Spike] and Scooby-Doo]:



Pros:

- **different nestings distinguished in enhanced representations** (alone)
- another argument for getting rid of the problematic aspect of UD approach to distribution in coordinate structures (two outgoing `obl` dependencies – two dependents or one?)

Solutions – summary

Solution	Pros	Cons
subtypes	• works at the level of basic trees	• indefinite number of labels • 'highly unnatural' (Mel'čuk)
co-heads	• conjuncts as co-heads • may be made to work at the enhanced level	• basic version requires inspecting both levels
distribution	• works at the level of enhanced graphs • relatively conservative • argument for getting rid of distribution **to** coordination	• (does not encode co-heads)

Fun fact

Fun fact: how many nestings for *n* conjuncts?

conjuncts	2	3	4	5	…	10	…
nestings	1	3	11	45	…	103,049	…

- **little Schröder numbers** (Schröder–Hipparchus numbers, super-Catalan numbers)
- sequence A001003 in the On-line Encyclopedia of Integer Sequences
- the value for 10 calculated already by Hipparchus of Nicaea, c. 190 – c. 120 BC
- see Stanley 1997 for the history of these numbers, and their other interpretations

Coordination of Unlike Grammatical Functions

Agnieszka Patejuk and Adam Przepiórkowski. *Coordination of unlike grammatical functions*. In Kim Gerdes and Sylvain Kahane, editors, *Proceedings of the Fifth International Conference on Dependency Linguistics (DepLing, SyntaxFest 2019)*, pages 26–37. Association for Computational Linguistics, 2019.

Coordination

(Hudson 1984: 225):
"[W]e need to make sure that, in some sense, all the conjuncts in a coordinate structure have the same external relations... If we mix up conflicting external relations, the result is zeugma (e.g. *He came in {(a hurry) and (a taxi)}*, where the conjuncts require conflicting meanings of *in*), **or sheer incoherence** (e.g. *I ate potatoes and in the kitchen*)."

Coordinating different grammatical functions seems bad:

- *[[I] and [an apple]] have already eaten.
  (intended: I have already eaten an apple.)
- *I have already eaten [[an apple] and [today]].
  (intended: I have already eaten an apple today.)

Sheer incoherence?

There are attested good examples:

- [[**What**] and [**when**]] to eat to reduce insulin
- some were mentioned in dependency literature (Mel'čuk)
- but there is no in-depth discussion
- and no worked out dependency analysis

In this talk we will:

- present cases of coordination of different grammatical functions
- show it is true coordination, without ellipsis
- discuss challenges to dependency grammars
- propose a UD analysis

Where does it occur?

- robust, widely attested:
  - Slavic:
    - Russian – first mentioned (Sannikov 1979, 1980)
    - **Polish**
    - Bulgarian
    - Croatian
  - Romanian
  - Hungarian
  - West Armenian
- restricted (only some GFs, only interrogative):
  - English
  - French
  - German
  - Dutch
  - Italian
  - Spanish
  - ...

Is it only about wh-words?

No, in Polish (and selected other languages):

- wh-words (~ *who*, *when*)
- free choice (~ *whoever*, *whenever*)
- universal quantifiers (~ *everybody*, *always*)
- n-words (~ *nobody*, *never*)
- and more:
  - demonstratives
  - indefinites (existential quantifiers)
  - free relatives
  - comparatives

Wh-words

[[**Co,**] [**komu**] i [**z** **czym**]] się kojarzy, to jego
what.NOM who.DAT and with what.INST REFL associate is POSS.GEN
prywatna sprawa.
own business
'Who associates what with what is their own business.' (NKJP)

- subject
- indirect object
- oblique

N-words

[[**Nic**] i [**nikogo**]] nie może tłumaczyć.
nothing.NOM and nobody.GEN NEG can excuse.INF
'Nothing may excuse anybody.' (NKJP)

- subject (of *może*)
- direct object (of *tłumaczyć*)

Is this coordination?

- the joining element is a conjunction:
  - various conjunctions can be used:
    - AND/OR-type
    - preconjunctions (BOTH... AND...)
    - imposing special constraints
  - and only conjunctions
- more than two items can be joined

Is this ellipsis?

No, not ellipsis:

- [[**Ile**] i [**kto**]] rozwiązał zadań?
  how many.ACC and who.NOM solved tasks.GEN
  'How many tasks did who solve?'
- Ile rozwiązał zadań?
- *Kto rozwiązał zadań?
- Ile kto rozwiązał zadań?

Exception – *czy* 'if/whether':

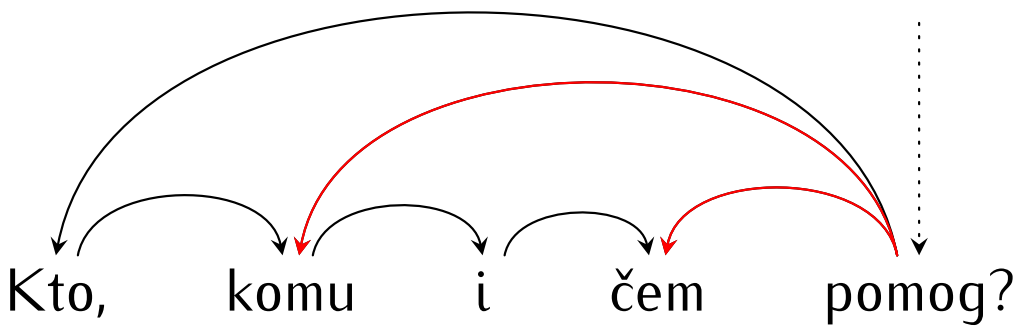
- [[**Czy**] i [**kto**]] przyszedł?
  whether and who.NOM came
  'Has anyone come and who has come?'
- Czy przyszedł?
- Kto przyszedł?
- *Czy kto przyszedł?

Previous dependency approaches 1

Hardly any discussion of such constructions in dependency literature (exceptions: Sannikov 1979, 1980 in Russian, Kallas 1993 in Polish).

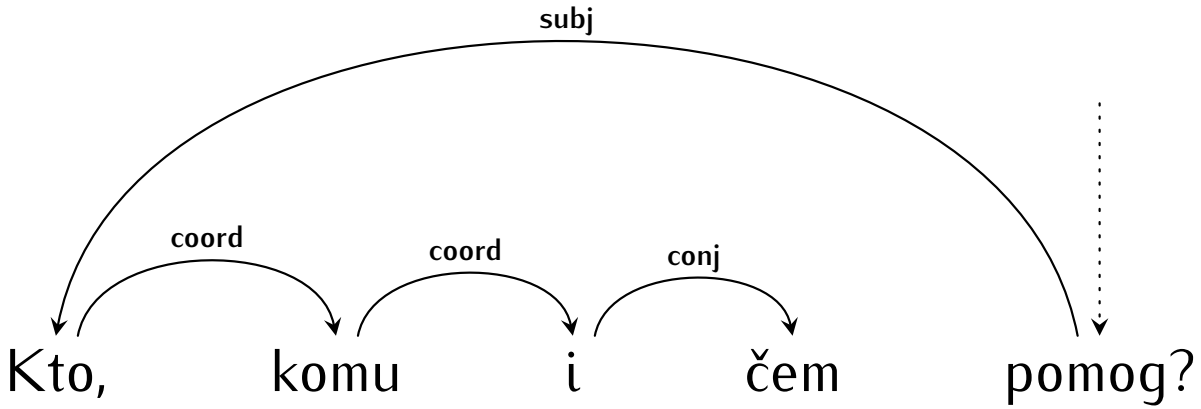
- Kto, komu i čem pomog? (Russian)
  who.NOM who.DAT and what.INS helped
  'Who helped whom with what?'

Mel'čuk (1988) criticises Sannikov's attempt saying that non-initial conjuncts do not depend on the verb syntactically:

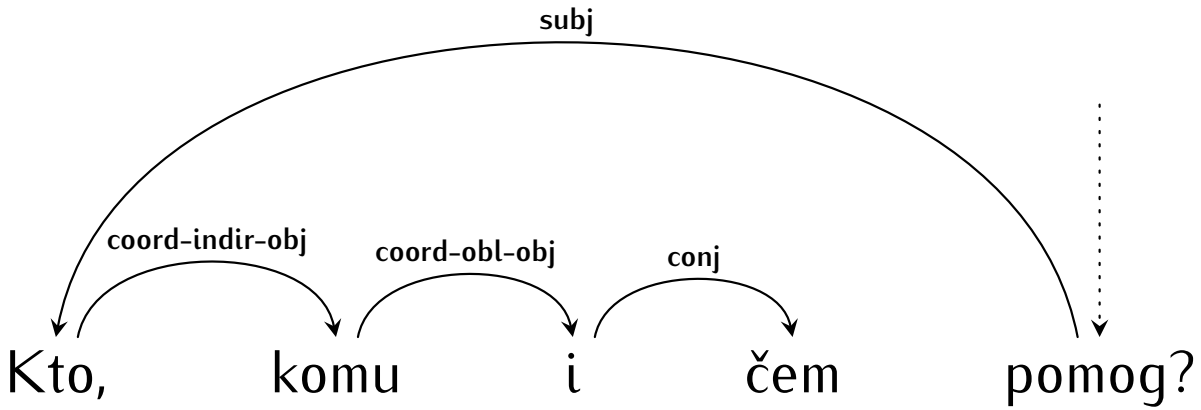


Previous dependency approaches 2

Mel'čuk 2009:

- 

misleading!

- 

adopted

Previous dependency approaches 3

Problems with the proposal of Mel'čuk 2009:

- instead of one **coord** relation, as many **coord–...** relations as grammatical functions,
- coordinated items may have **different heads**, so relations should also encode paths to heads – in(de)finitely many needed.

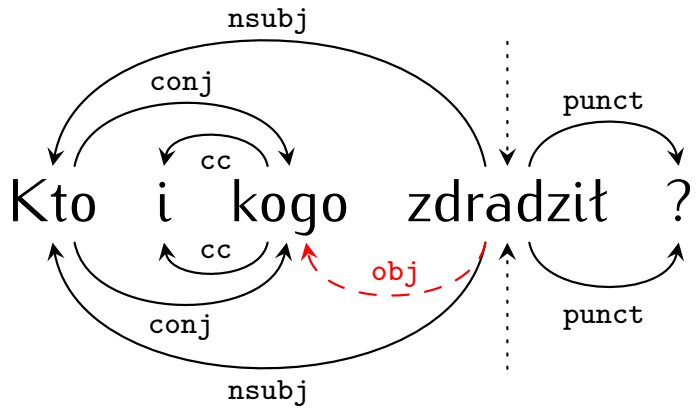
Consider:

- Nic i nikogo nie może tłumaczyć.
  nothing.NOM and nobody.GEN NEG may excuse.INF
  'Nothing may excuse anybody.'
- Jakie i kto może ponieść konsekwencje?
  what.ADJ.ACC and who.NOM may bear.INF consequences.ACC
  'Who may suffer what consequences?'
- Czego i ile trzeba dostarczyć organizmowi?
  what.GEN and how much.ACC should provide.INF organism.DAT
  'How much of what should one provide one's organism with?'

UD representations 1

- [[**Kto**] i [**kogo**]] *zdradził*?
  who.NOM and who.ACC betrayed
  'Who betrayed whom?'

Extrapolating **UD guidelines**:

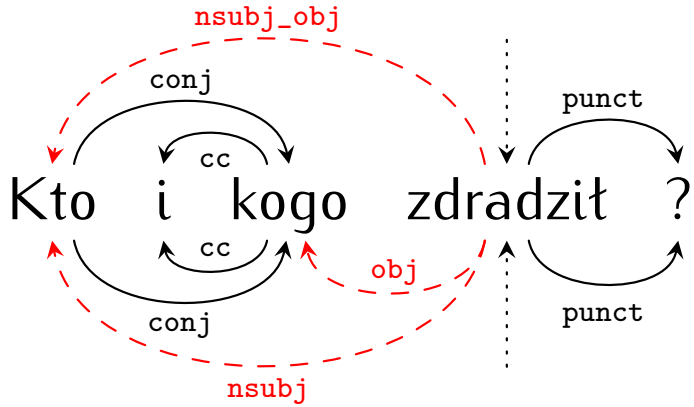


First problem:

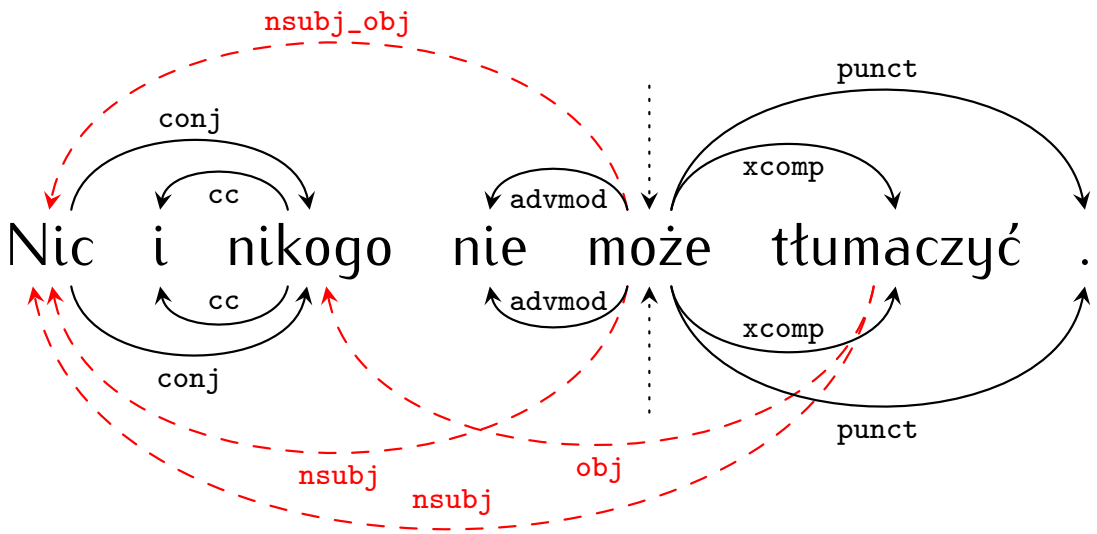
- the **basic tree** is not 'underspecified' – it is **highly misleading** (otherwise *John and Mary ate already* may be taken to possibly mean *John already ate Mary*),
- current **UD parsers** only look at basic trees,
- **downstream applications misinformed** about who did what to whom.

UD representations 2

Another attempt:



Recall the problem with conjuncts with **different heads**, e.g.:

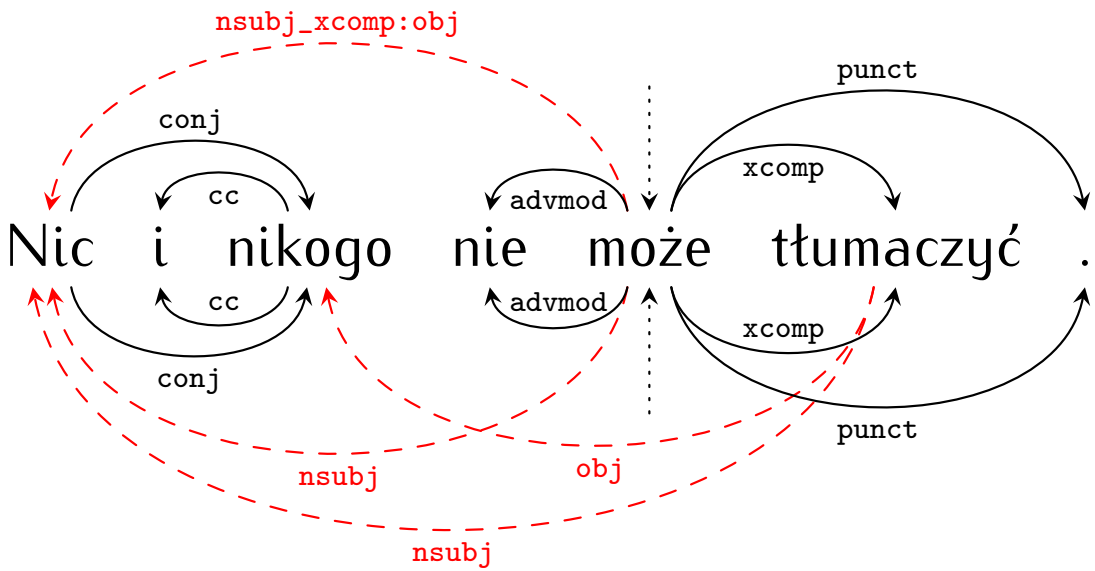
- [[**Nic**] i [**nikogo**]] nie *może tłumaczyć*.
  nothing.NOM and nobody.GEN NEG may excuse.INF
  'Nothing may excuse anybody.'
- 

UD representations 3

Example repeated:

- [[**Nic**] i [**nikogo**]] nie *może tłumaczyć*.
  nothing.NOM and nobody.GEN NEG may excuse.INF
  'Nothing may excuse anybody.'

Full paths to heads need to be encoded in labels:

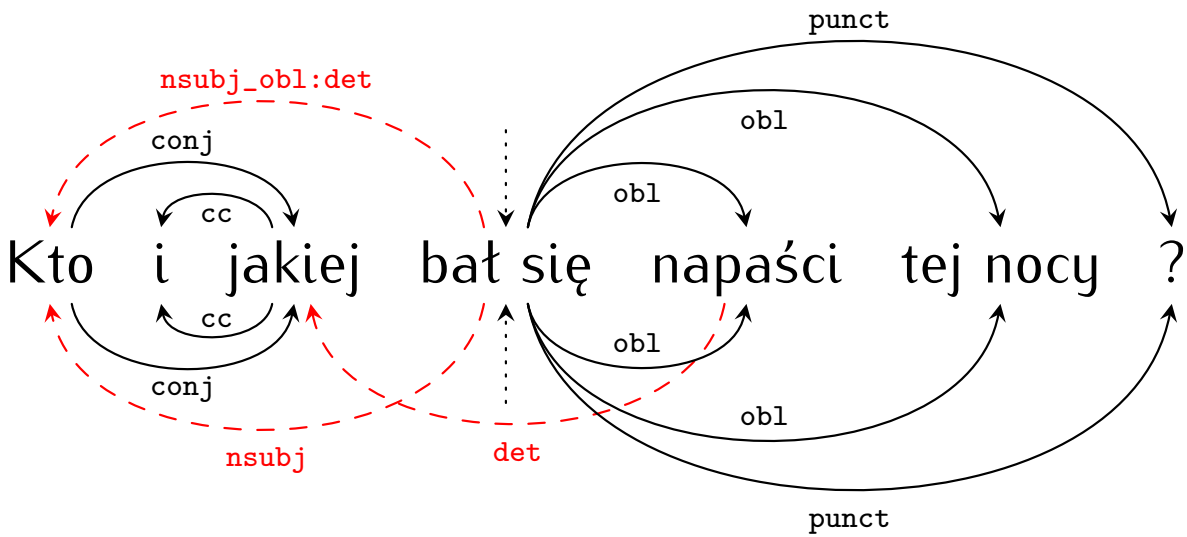


Second problem: potentially in(de)finite number of labels.

UD representations 4

This is still **not sufficient**; consider:

- [[**Kto**] i [**jakiej**]] *bał* *się* *napaści*
  who.NOM.M and what.ADJ.GEN.F feared.3.SG.M RM assault.GEN.F
  tej nocy?
  that.GEN.F night.GEN.F
  'Who feared what assault on that night?'

- 

- **which** `obl` is meant in `obl:det`?
- labels need to be **complicated further (by adding indices)**

Proposed UD representations 1

General **UD methodology**:

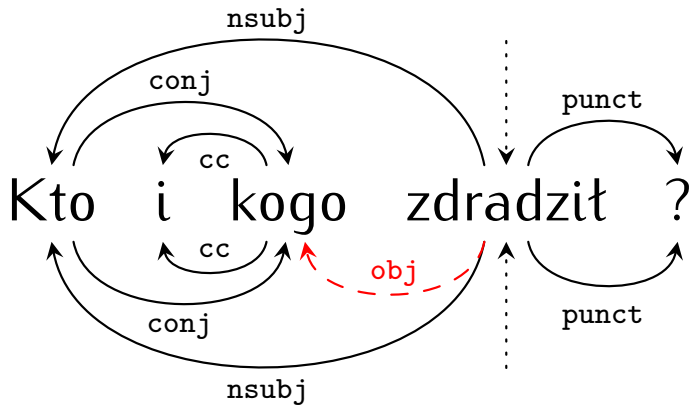
- **basic tree underspecifies** full (enhanced) representation,
- contains **most important information** (useful for downstream applications).

What is more important in the following?

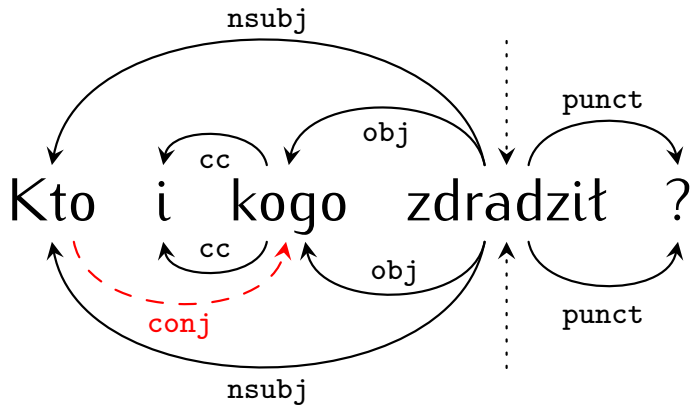
- [[**Kto**]$_{\texttt{nsubj}}$ i [**kogo**]$_{\texttt{obj}}$] *zdradził*?
  who.NOM and who.ACC betrayed
  'Who betrayed whom?'

Coordination (C) or **grammatical functions** (GFs)?

C:

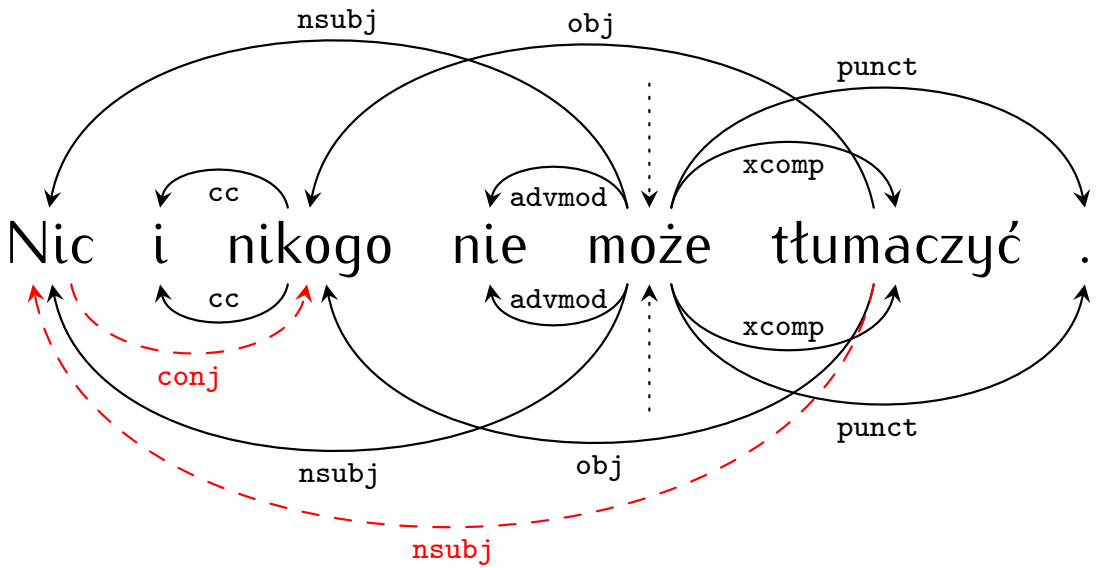


GFs:



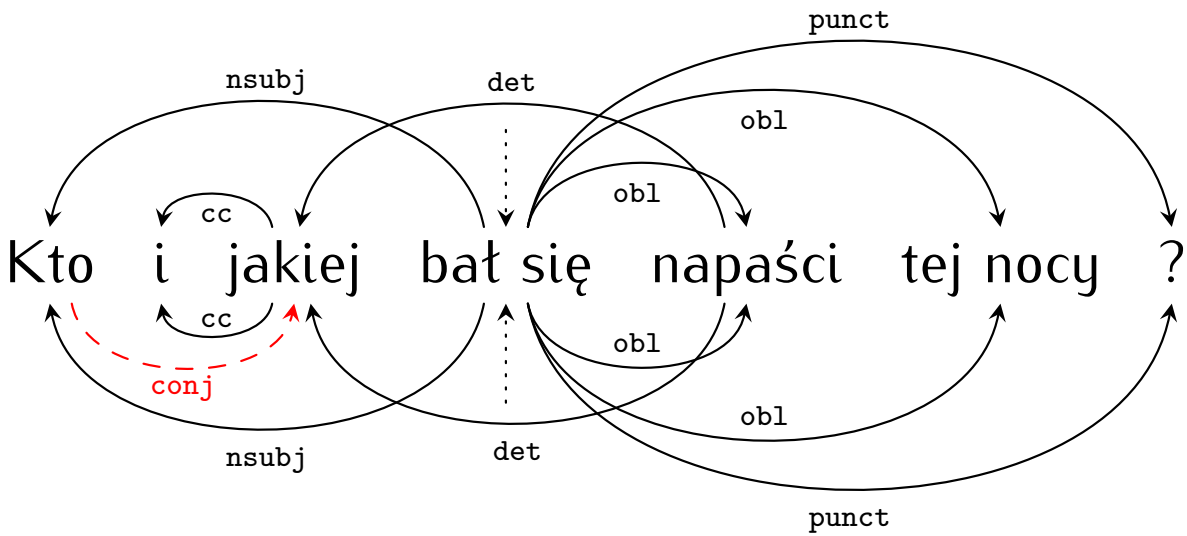
Proposed UD representations 2

- [[**Nic**]$_{\text{nsubj}}$ i [**nikogo**]$_{\text{obj}}$] nie *może tłumaczyć*.
  nothing.NOM and nobody.GEN NEG may excuse.INF
  'Nothing may excuse anybody.'

- 

Proposed UD representations 3

- [[**Kto**]$_{\text{nsubj}}$ i [**jakiej**]$_{\text{det}}$] *bał* *się* *napaści*
  who.NOM.M and what.ADJ.GEN.F feared.3.SG.M RM assault.GEN.F
  tej nocy?
  that.GEN.F night.GEN.F
  'Who feared what assault on that night?'

- 

Conclusion

- coordination of unlike GFs is attested, natural and robust
- possible approaches:
  - MTT: complicated labels
  - Prague: ellipsis (not discussed here)
  - UD default (basic trees):
    - representing coordination
    - at the cost of losing GFs of non-initial conjuncts
    - alternative: complicated labels (like MTT, same issues)
    - cannot represent numeral phrases (not discussed above)
  - UD proposed (basic trees):
    - representing GFs
    - at the cost of representing coordination
    - simple labels, direct relations
    - can represent numeral phrases (not discussed above)

Thank you for your attention!

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