Syntactic discontinuities in treebanks and linguistic theories

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  - No other use for treebanks

Greek and Latin word order: state of the art

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- The agreement stops there. . .

Word order in Luke/Acts

	Luke + Acts		Luke only	
	Rife(1933)	Davison(1989)	Rife(1933)	Kirk(2012)
VSO	15	20	9	14
SVO	50	56	19	13
SOV	9	8	8	5
VOS	3	4	2	3
OVS	6	6	1	1
OSV	1	1	0	1

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- All the authors claim to report the same basic fact: word order in declarative main clauses where there is an NP subject and object
- How can we agree on higher level analyses if the facts are so unclear?

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  - How are terms defined?
- Davison (1989): "clauses . . . which contained at least one nominative noun, one accusative noun and one indicative verb . . . Verbs normally followed by a genitive or a dative were traced using a concordance"
  - Same problem, although the text is at least available electronically

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- Admirably explicit, but what are the chances of getting things right at first try?
- Even if everything that should be included is included, things may have been excluded that should not have been

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The cure

- We need treebanks and linguistic theory
  - Treebanks for replicability and iterated search
  - Linguistic theory for annotation schemes, and to know what we are looking for
- "annotations are no substitute for the understanding of a phenomenon. They are an encoding of that understanding." Zaenen (2006)
- There is a danger of encoding precisely what we want to test

Creating a treebank

- There are obvious upsides for a linguist in working within an established linguistic theory
  - Build on earlier work

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- So we need "theory-neutral" treebanks
- But the danger with that is that we may contribute to the (already too wide) gulf between theoretical work and corpus linguistics

Principles of annotation

Two conflicting constraints on annotation

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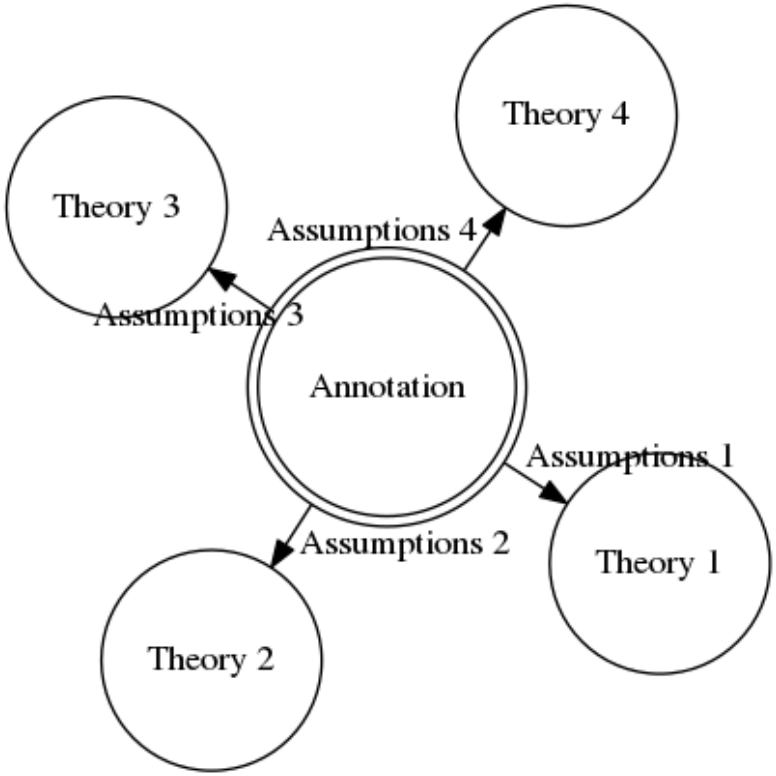
- To find "what is common to all frameworks" it may be necessary to choose concepts that are primary in one theory but derived in others (e.g. grammatical relations in LFG or DG vs. LTAG or CCG)

The ideal situation



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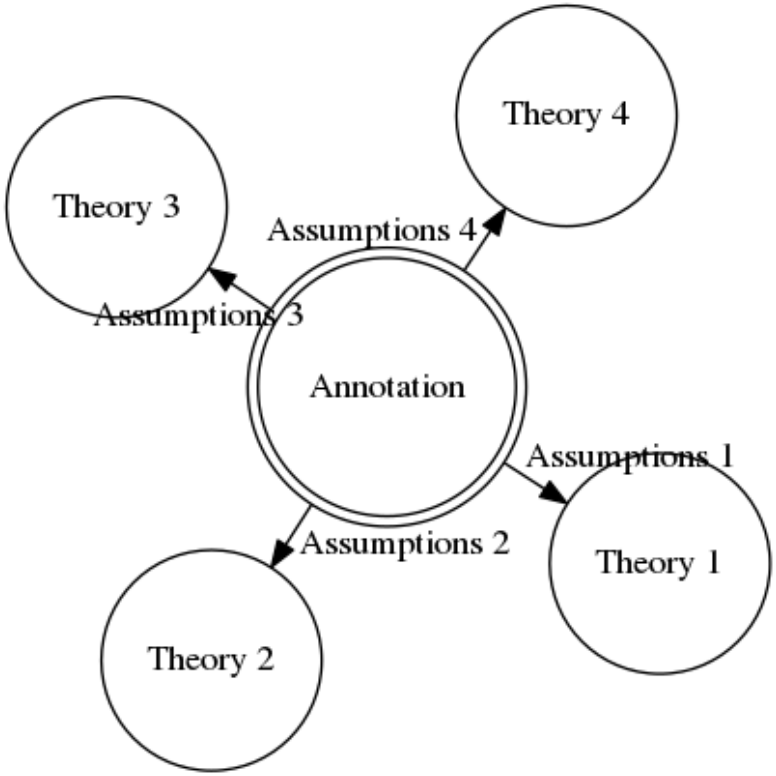

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- Conversion to a theoretically motivated structure can now be seen as testing of the underlying assumptions

A naturally ocurring parallel corpus

- The New Testament in its Greek original and Latin, Gothic, Classical Armenian and OCS translations

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- So these are important texts, and they are parallel texts

Later extensions

- Classical Greek and Latin:
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  - Gallic War, Letters to Atticus, De officiis
- Post-classical Greek and Latin
  - Sphrantzes' Chronicles
  - Peregrinatio Aetheriae
  - Palladius' De Agricultura

Other corpora in the same syntactic annotation scheme

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- For standardization a UD version is available

Two questions

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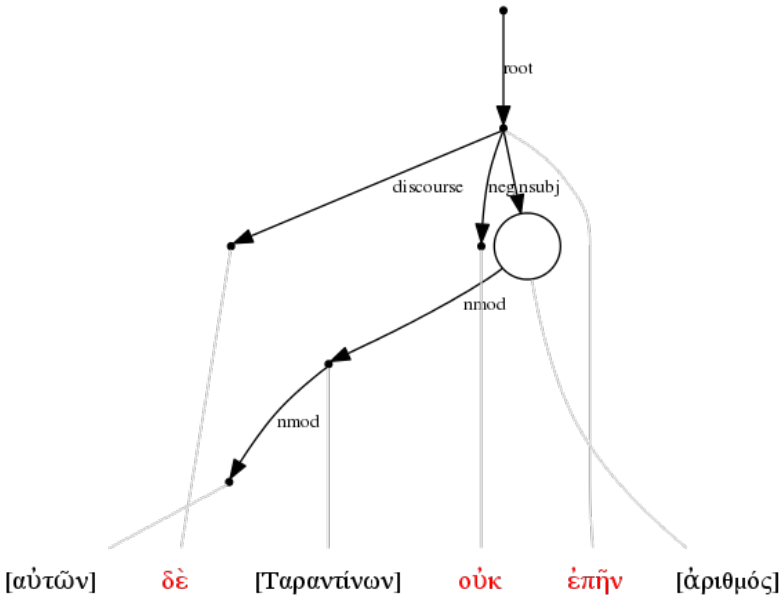
2. Do treebanks give us what we need to construct theoretically motivated representations of syntactic discontinuities?

Gap degree: the concept



Gap degree (trees) across treebanks in the UD corpora

	0	1	2	3		0	1	2	3
Ancient_Greek	0.368	0.548	0.079	0.005	Hungarian	0.748	0.232	0.016	0.003
Ancient_Greek-PROIEL	0.605	0.351	0.038	0.004	Indonesian	0.981	0.019	0.000	0.000
Arabic	0.918	0.081	0.001	0.000	Irish	0.872	0.126	0.002	0.000
Basque	0.663	0.287	0.045	0.005	Italian	0.961	0.036	0.003	0.000
Bulgarian	0.972	0.028	0.000	0.000	Japanese-KTC	1.000	0.000	0.000	0.000
Croatian	0.925	0.073	0.002	0.000	Latin	0.538	0.416	0.044	0.002
Czech	0.874	0.122	0.004	0.000	Latin-ITT	0.628	0.353	0.018	0.001
Danish	0.772	0.224	0.004	0.000	Latin-PROIEL	0.699	0.274	0.024	0.002
Dutch	0.691	0.286	0.022	0.000	Norwegian	0.923	0.076	0.001	0.000
English	0.950	0.046	0.003	0.000	Old_Church_Slavonic	0.784	0.203	0.012	0.000
Estonian	0.994	0.006	0.000	0.000	Persian	0.949	0.051	0.000	0.000
Finnish	0.923	0.075	0.002	0.000	Polish	0.997	0.003	0.000	0.000
Finnish-FTB	0.932	0.066	0.002	0.000	Portuguese	0.816	0.140	0.038	0.005
French	0.876	0.111	0.011	0.002	Romanian	0.886	0.106	0.006	0.002
German	0.879	0.112	0.007	0.001	Slovenian	0.864	0.128	0.008	0.000
Gothic	0.761	0.224	0.012	0.002	Spanish	0.939	0.060	0.000	0.000
Greek	0.721	0.252	0.026	0.001	Swedish	0.972	0.028	0.000	0.000
Hebrew	1.000	0.000	0.000	0.000	Tamil	0.978	0.022	0.000	0.000
Hindi	0.864	0.133	0.003	0.000					

Gap degree (trees) without punctuation

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Ancient_Greek	0.372	0.547	0.076	0.004	Hungarian	0.815	0.172	0.010	0.002
Ancient_Greek-PROIEL	0.605	0.351	0.038	0.004	Indonesian	0.994	0.006	0.000	0.000
Arabic	0.945	0.055	0.000	0.000	Irish	0.883	0.117	0.000	0.000
Basque	0.771	0.215	0.013	0.000	Italian	0.988	0.011	0.000	0.000
Bulgarian	0.972	0.028	0.000	0.000	Japanese-KTC	1.000	0.000	0.000	0.000
Croatian	0.936	0.063	0.001	0.000	Latin	0.551	0.409	0.038	0.002
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Estonian	0.992	0.008	0.000	0.000	Persian	0.955	0.045	0.000	0.000
Finnish	0.924	0.074	0.001	0.000	Polish	0.997	0.003	0.000	0.000
Finnish-FTB	0.933	0.065	0.002	0.000	Portuguese	0.838	0.149	0.013	0.000
French	0.960	0.039	0.001	0.000	Romanian	0.892	0.100	0.006	0.002
German	0.926	0.074	0.001	0.000	Slovenian	0.869	0.122	0.008	0.001
Gothic	0.761	0.224	0.012	0.002	Spanish	0.964	0.036	0.000	0.000
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- Ancient Greek (Gothic, OCS), Basque, Dutch, Greek, Hungarian, Latin, Portuguese, Romanian and Slovenian: more than 0.5% loss

Immediate lesssons

- Careful with your commas!
- Results in line with reports on Arabic (Kuhlmann, 2010), Czech (Kuhlmann & Nivre, 2006), Danish (Kuhlmann & Nivre, 2006), Slovene (Kuhlmann, 2010), Swedish (Gómez-rodríguez et al., 2009): gap degree 1 gives very little loss (<0.5%)
- The same holds for Croatian, English, Estonian, Finnish, French, German, Hindi, Indonesian, Irish, Italian, Japanese, Norwegian, Persian, Polish, Spanish and Tamil
- Ancient Greek (Gothic, OCS), Basque, Dutch, Greek, Hungarian, Latin, Portuguese, Romanian and Slovenian: more than 0.5% loss
- Ancient Greek stands out (Mambrini & Passarotti, 2013)

Theoretical implications

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- So it is reasonable to "step up" to unification-based formalisms
- Lexical-functional grammar (LFG) is particularly well-developed when it comes to studies of discontinuous syntax

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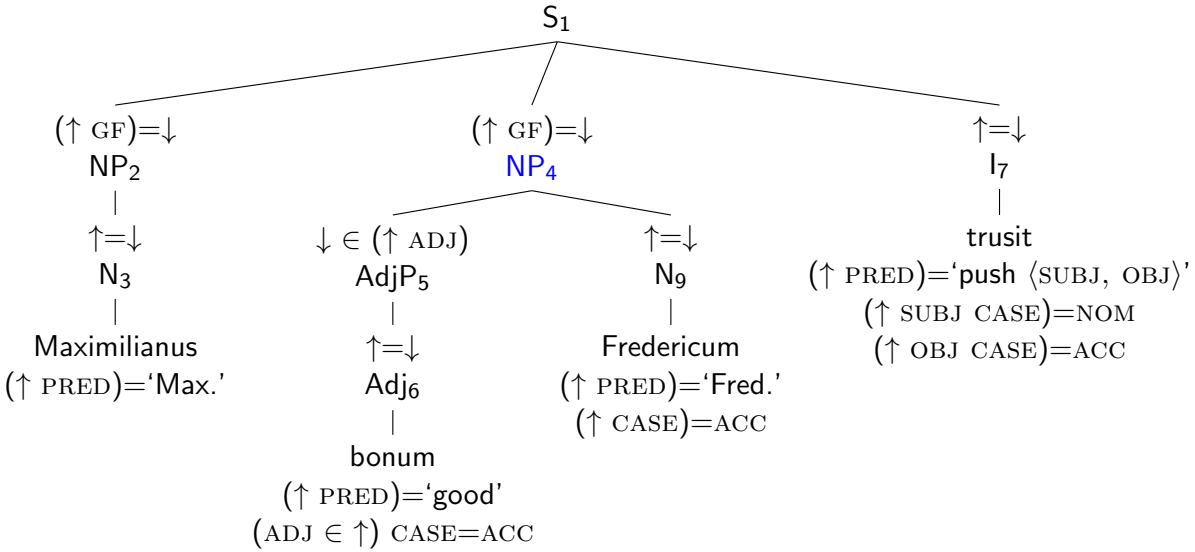
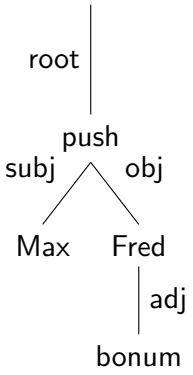
An LFG analysis





$$\begin{bmatrix} \text{PRED} & \text{'PUSH } \langle \text{SUBJ, OBJ} \rangle \text{'} \\ \text{SUBJ} & \begin{bmatrix} \text{PRED} & \text{'MAX.'} \end{bmatrix} \\ \text{OBJ} & \begin{bmatrix} \text{PRED} & \text{'FRED.'} \\ \text{ADJ} & \left\{ \begin{bmatrix} \text{PRED} & \text{'GOOD'} \end{bmatrix} \right\} \end{bmatrix} \end{bmatrix}$$

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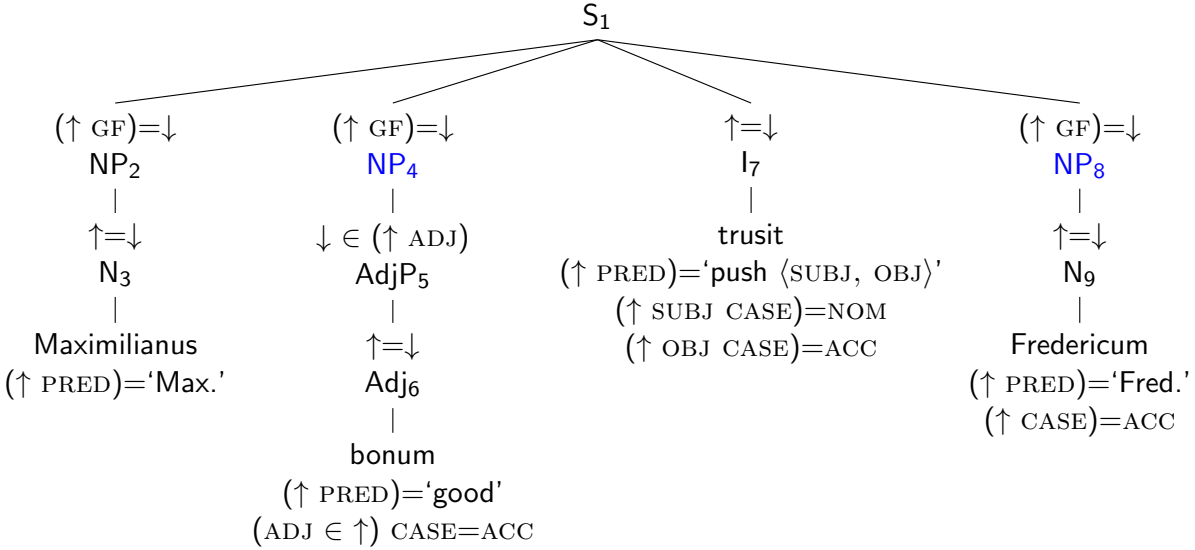

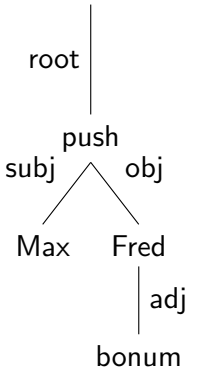

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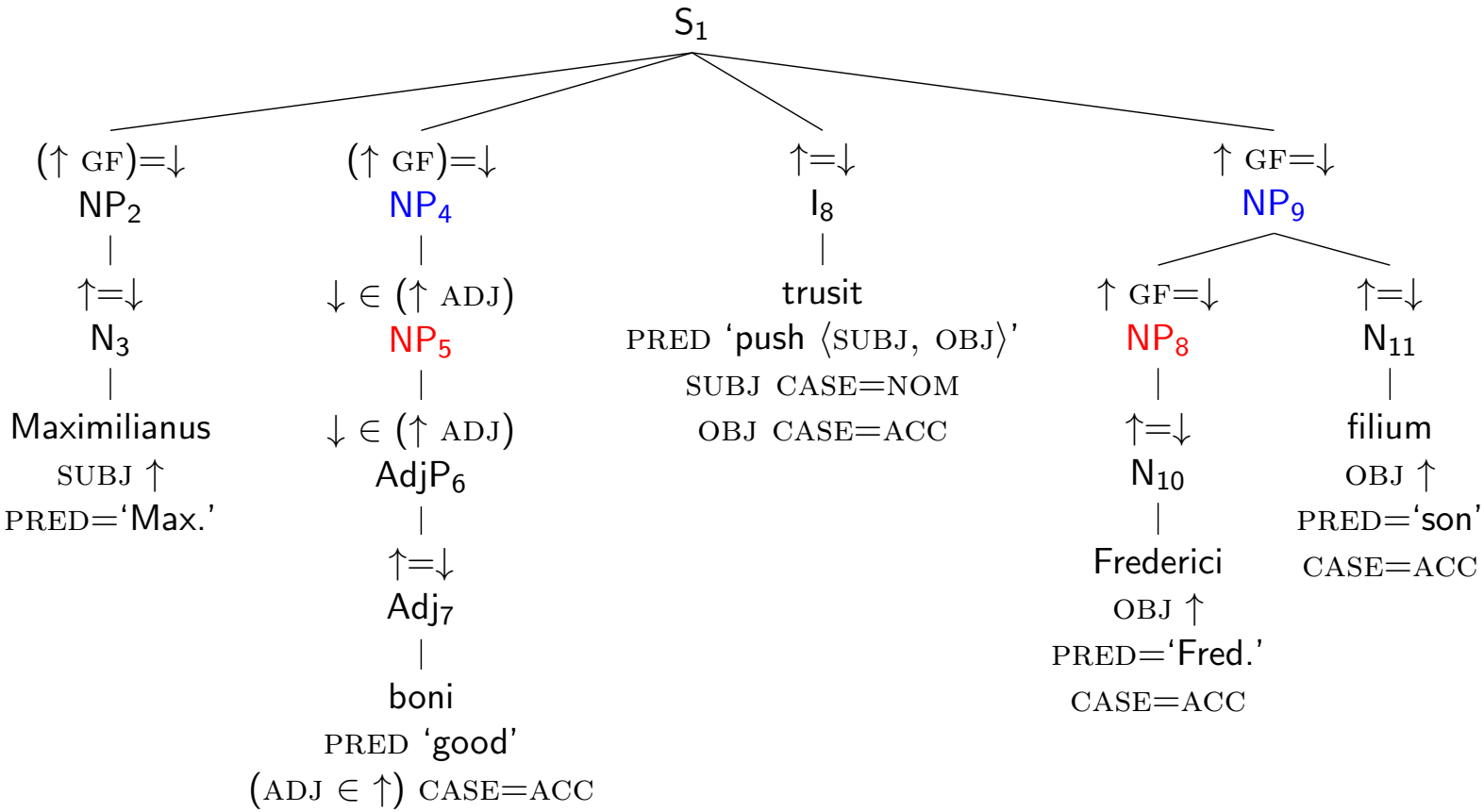
- Dependency graph ≈ f-structure
- Discontinuities correspond to reentrancies (one f-structure corresponding to multiple phrase structure nodes)

LFG analysis: gap depth



- Deeper gaps require more rentrancies

Depth vs. degree (edges)

		Depth						
Universal dependencies	Degree	0	1	2	3	4	5	6+
	0	1416015	0	0	0	0	0	0
	1	0	58667	4833	592	128	30	43
	2	0	3475	294	49	8	2	0
	3	0	266	15	2	0	0	0
	4	0	40	3	0	0	0	0
	5	0	18	3	1	0	0	0
	6	0	4	1	0	0	0	0
	7	0	2	0	0	0	0	0

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UD-Ancient Greek		0	1	2	3	4	5	6
	0	65707	0	0	0	0	0	0
	1	0	16182	1548	187	21	3	1
	2	0	1259	116	16	3	0	0
	3	0	73	2	0	0	0	0
	4	0	2	0	0	0	0	0

UD-Ancient Greek-PROIEL		0	1	2	3	4	5	6+
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	1	0	8900	596	65	13	2	8
	2	0	742	57	5	2	0	0
	3	0	88	5	0	0	0	0
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- To connect we need to derive c-structures from the dependencies (Haug, 2012)

Order domains (Adapted from Bröker 1998)

Definition

The order domain $\mathcal{D}_w$ of a word w is the largest subset of $\mathcal{W}$ such that

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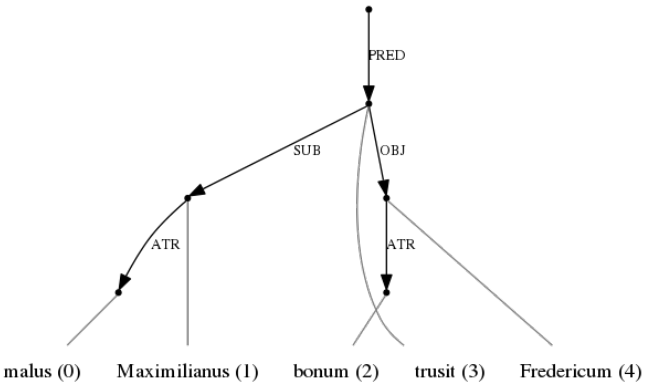
- Intuitively, the order domain corresponds to all of the node's dependents that are not 'displaced'

Example



- malus → {malus}
- Maximilianus → {malus,Max.}
- bonum → {bonum}
- trusit → {malus,Max.,bonum,trusit,Fred.}
- Fredericum → {Fred.}

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- A useful intermediate structure between PS and DS

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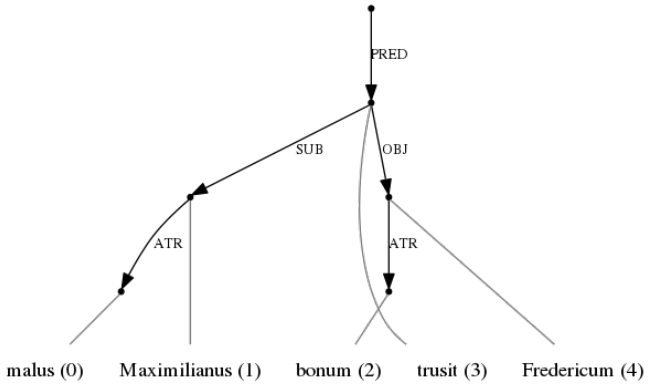

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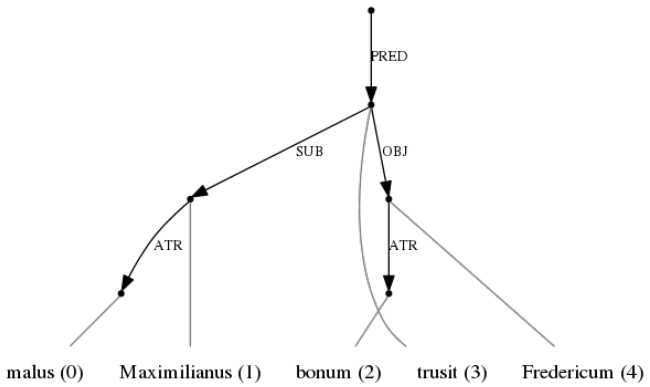

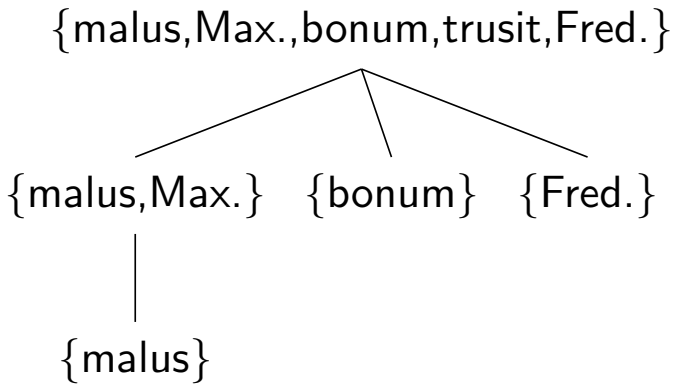

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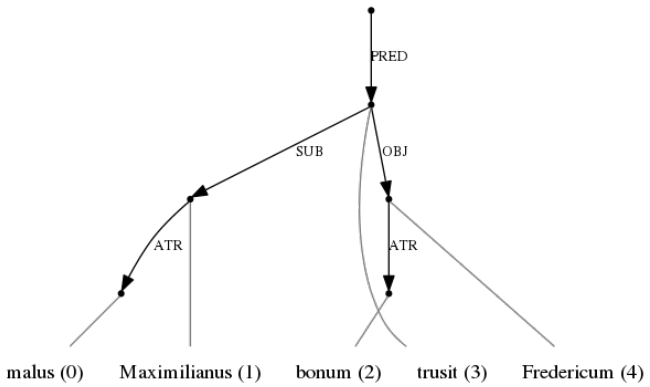

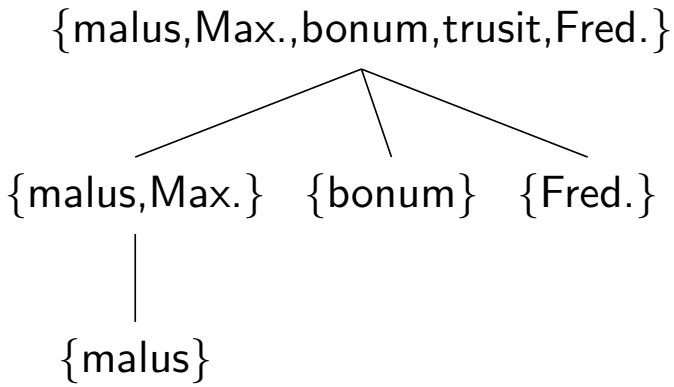

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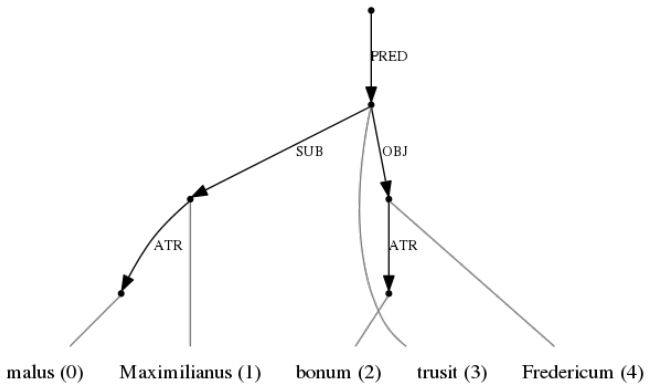

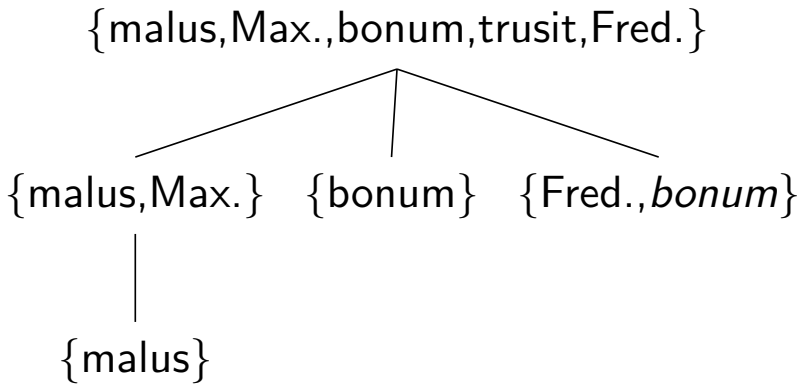

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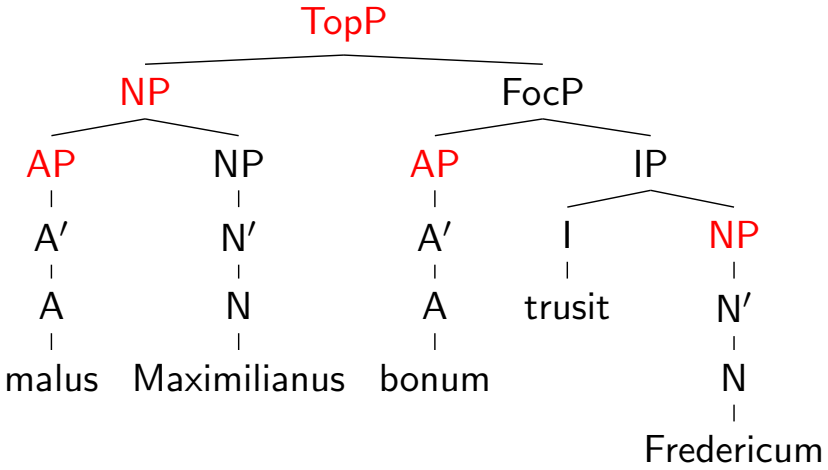
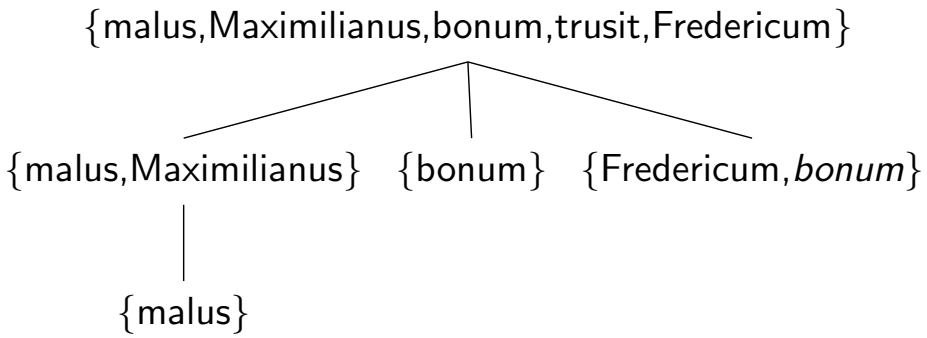
Some alternatives





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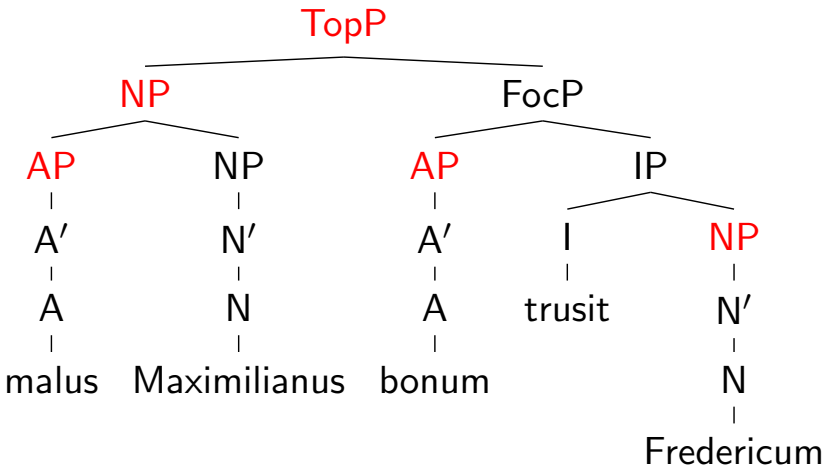

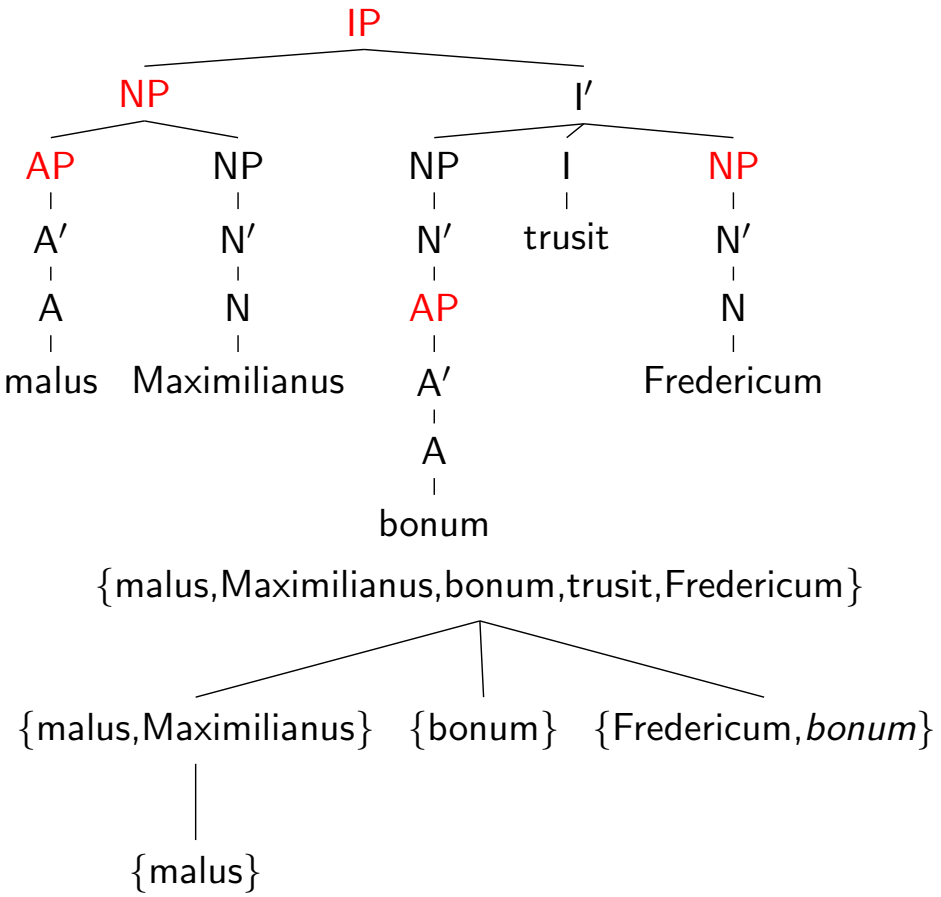

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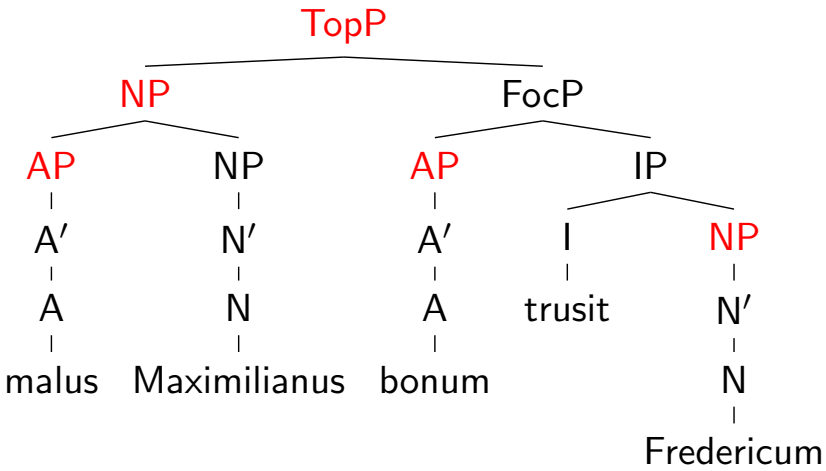

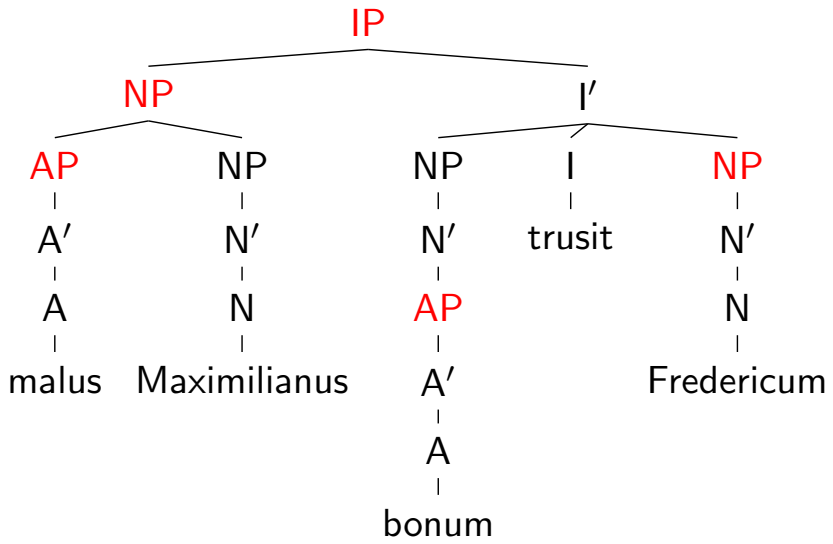

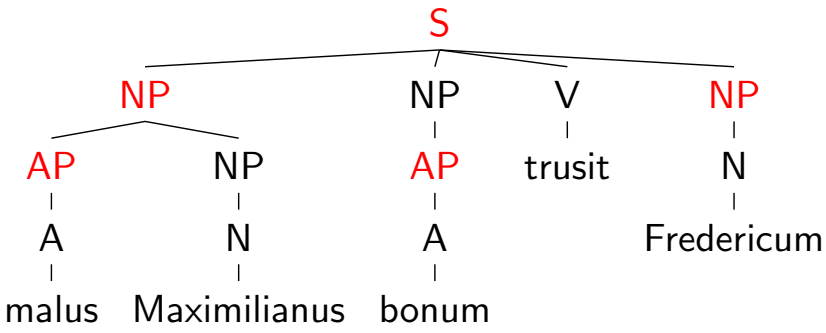

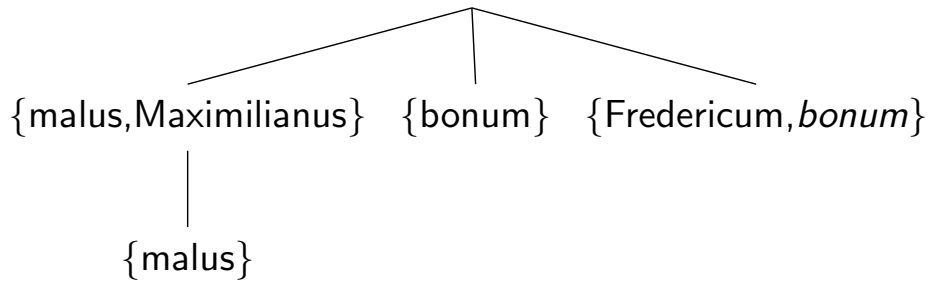

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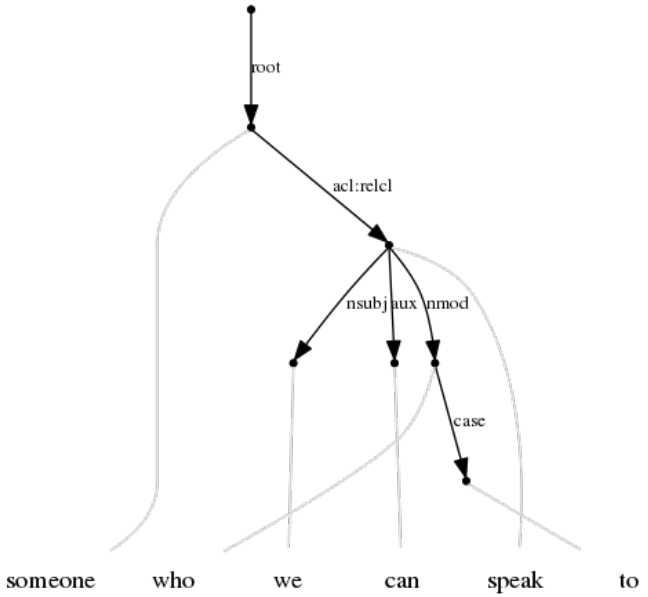
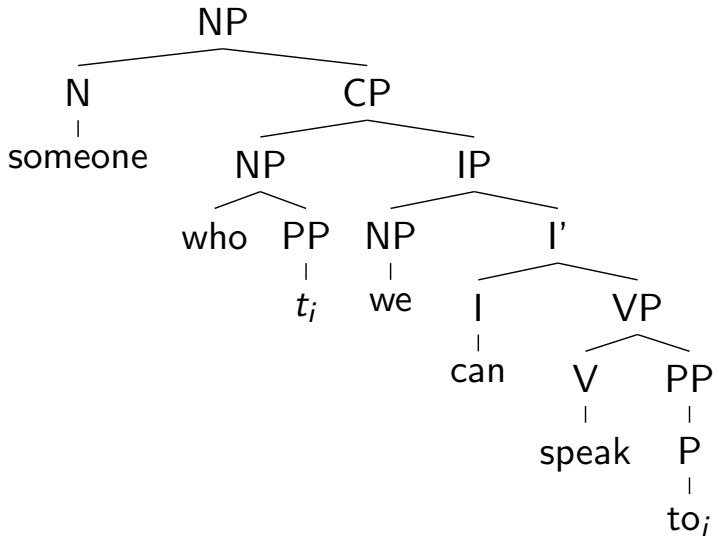
- DG here achieves the ideal situation: the treebank encodes our linguistic understanding, but does not make presuppositions about uncertain things
- Function words are typically challenging, as they are often c-structure heads, but typically taken as dependents in DG analyses

Constituency/function mismatch





- UD makes adpositions dependents, giving us a final displaced dependent

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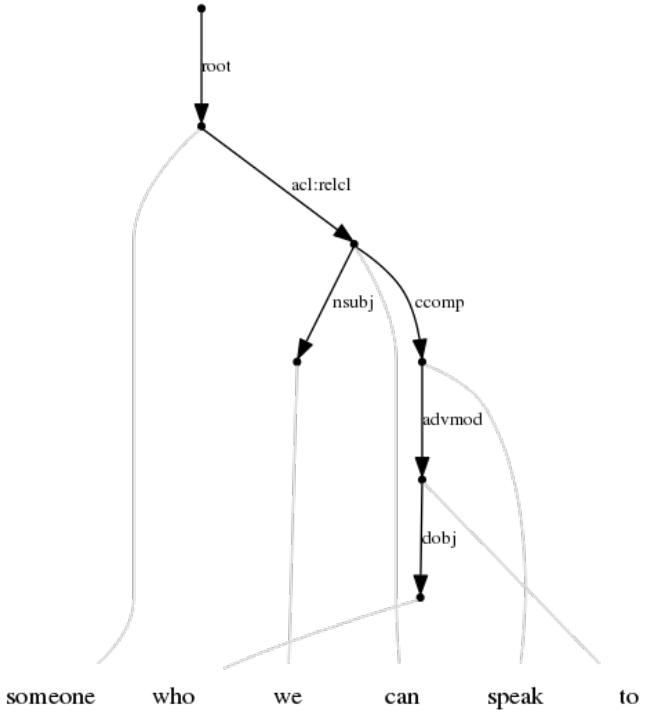

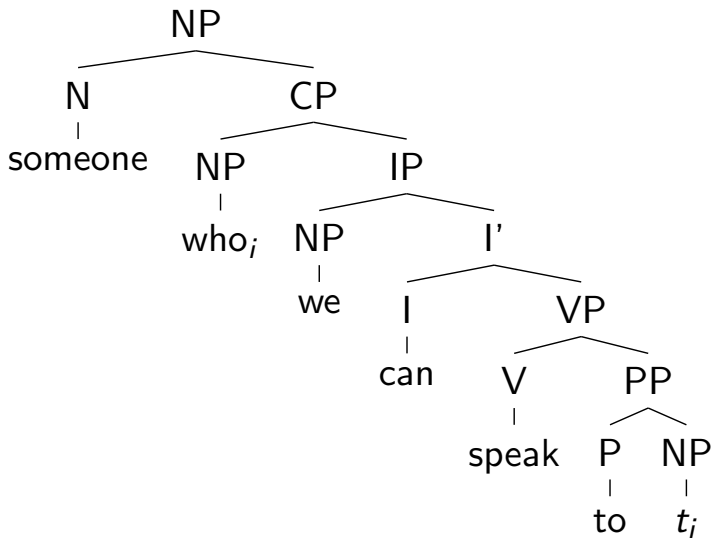

- The constituency evidence rather points to the clause-initial element begin displaced

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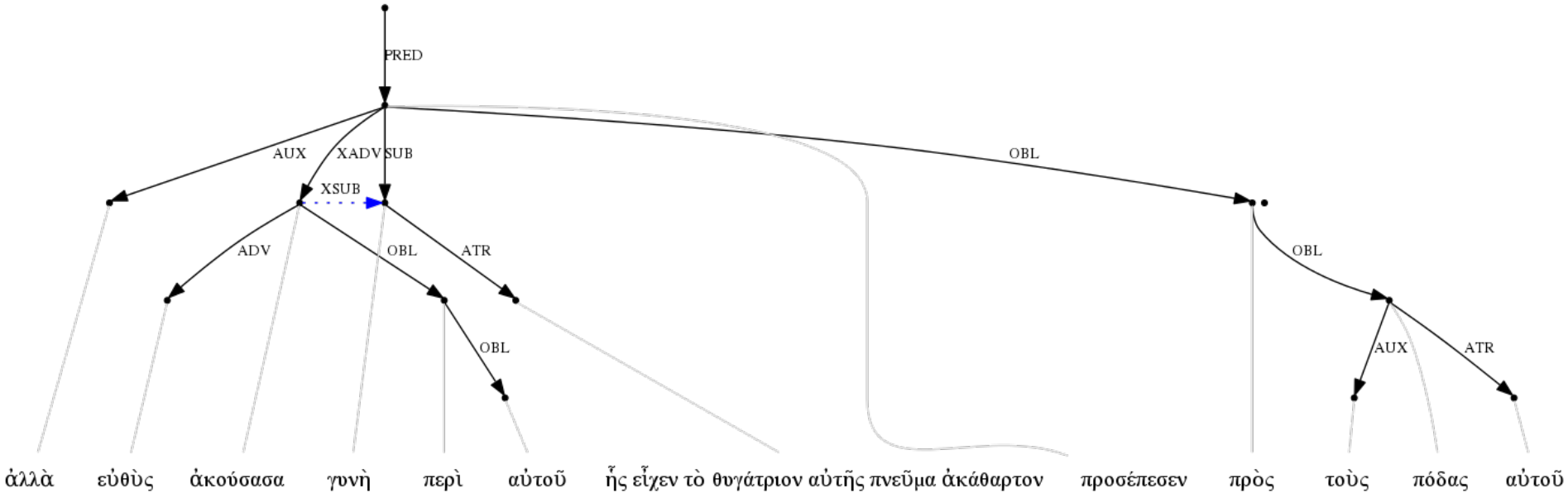
(1) akousasa gunê peri autou
hearing woman about him
hês eikhen to thugatrion autês pneuma akatharton
whose daughter had an evil spirit
prosepesen pros tous podas autou
fell down before his feet (Mark 7.25)

The analysis



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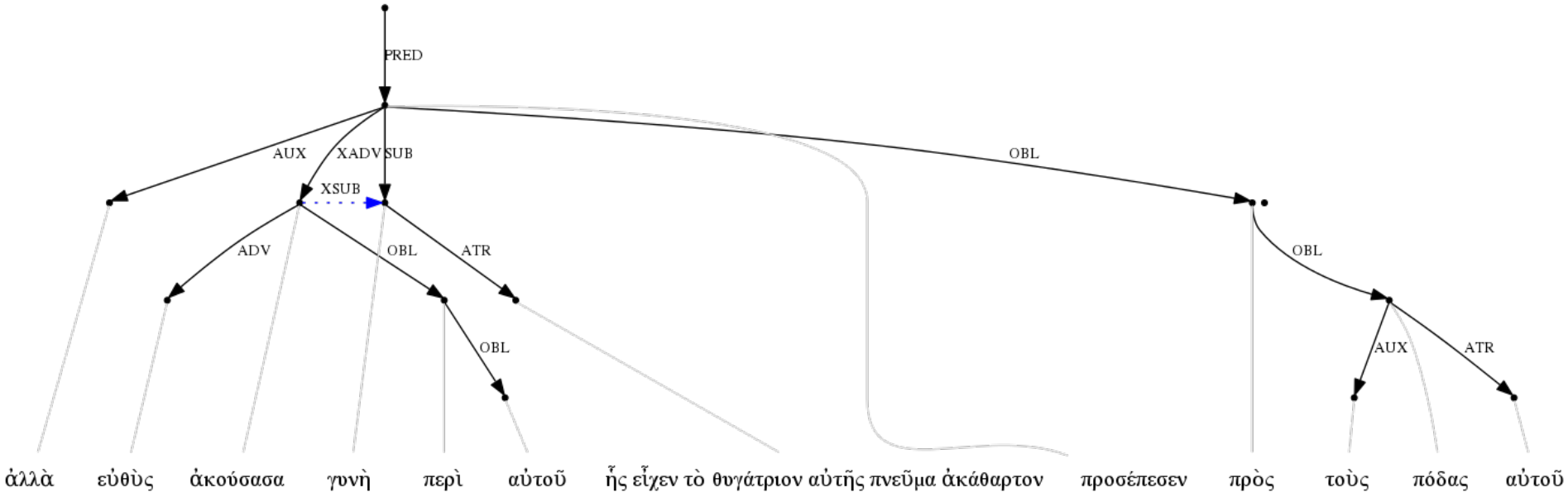

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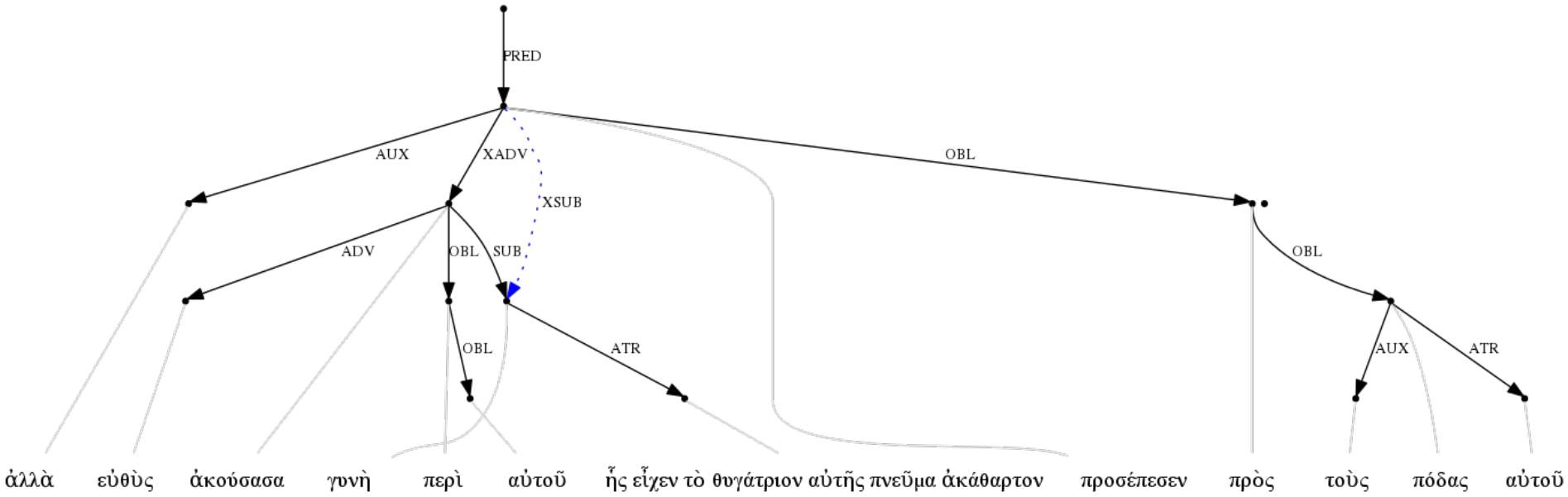
- But we get two discontinuities which moreover are illnested

The alternative



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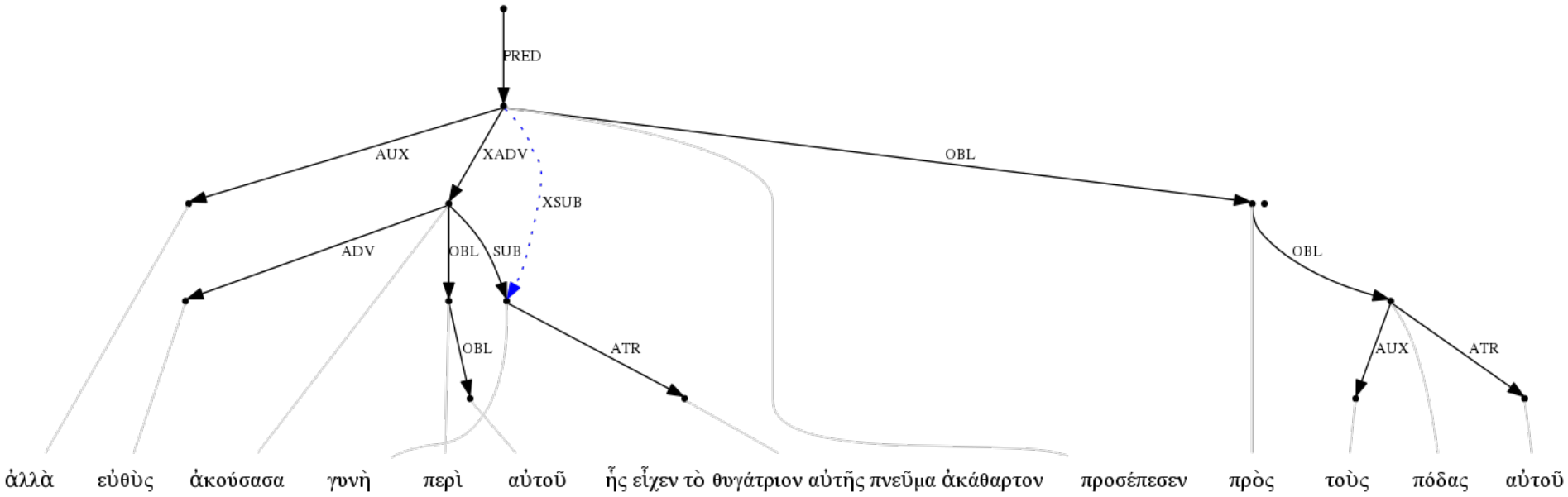

- We get one discontinuity (the relative clause) and no illnesting
- On this analysis it is not legitimate to count the matrix clause as S - V - OBL because there is no overt S

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- We can connect with known typologies of discontinuities
  - unbounded dependencies
  - extraposition
  - scrambling

How to choose?

- The question is better framed in terms of constituents than dependencies, i.e. as questions about properties of the participle's projection
- We can connect with known typologies of discontinuities
  - unbounded dependencies
  - extraposition
  - scrambling
- The presence/absence of a subject can be related to the type of the participle's projection (clausal or verb phrase)

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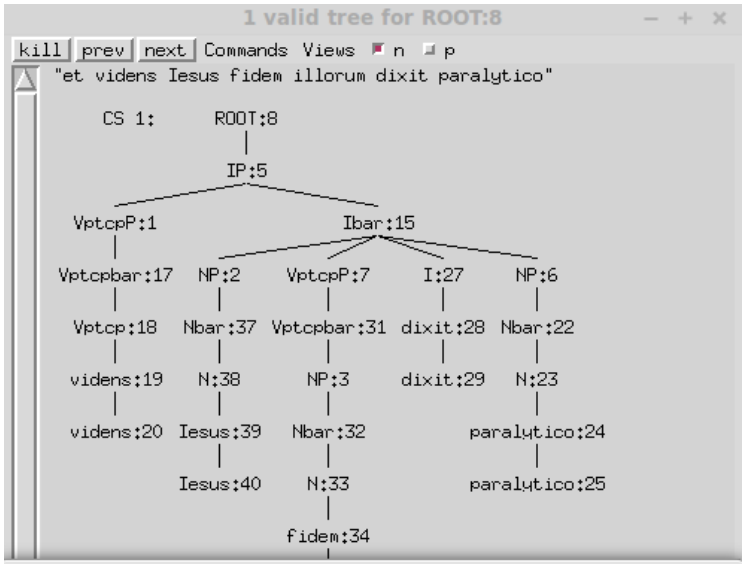
  - The discontinuous clause hypothesis predicts other things to intervene as well
- We generate c-structures based on both the SUB and XSUB relation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"et videns Iesus fidem illorum dixit paralytico"
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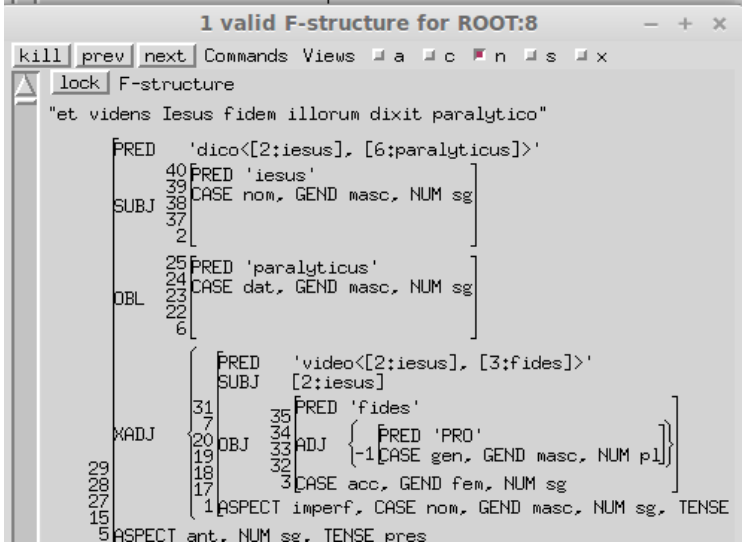
Ibar:15
Vptcpbar:17
NP:2
VptcpP:7
I:27
NP:6
Vptcp:18
Nbar:37
Vptcpbar:31
dixit:28
Nbar:22
videns:19
N:38
NP:3
dixit:29
N:23
videns:20
Iesus:39
Nbar:32
paralytico:24
Iesus:40
N:33
paralytico:25
fidem:34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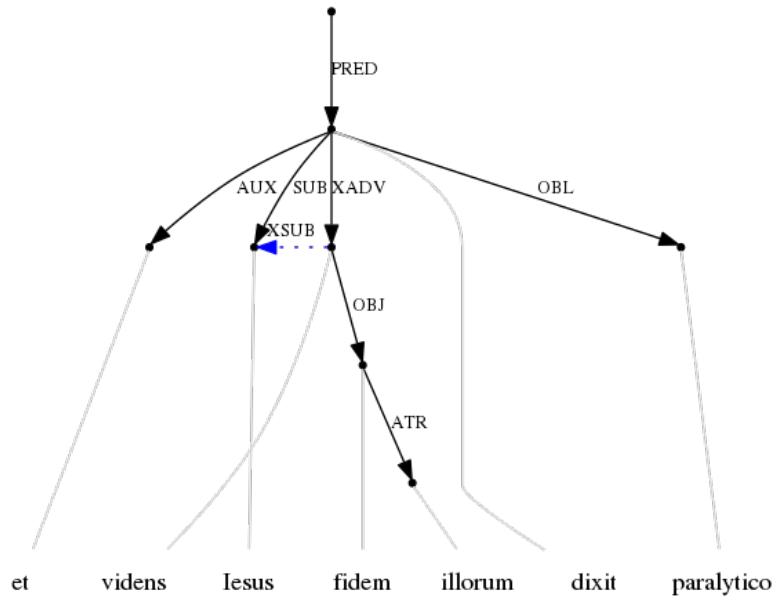
lock F-structure
"et videns Iesus fidem illorum dixit paralytico"
PRED 'dico<[2:iesus], [6:paralyticus]>'
SUBJ
PRED 'iesus'
CASE nom, GEND masc, NUM sg
OBL
PRED 'paralyticus'
CASE dat, GEND masc, NUM sg
XADJ
PRED 'video<[2:iesus], [3:fides]>'
SUBJ [2:iesus]
OBJ
PRED 'fides'
ADJ
PRED 'PRO'
CASE gen, GEND masc, NUM pl
CASE acc, GEND fem, NUM sg
ASPECT imperf, CASE nom, GEND masc, NUM sg, TENSE
ASPECT ant, NUM sg, TENSE pres


PRED
AUX
SUB
XADV
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ATR
et
videns
Iesus
fidem
illorum
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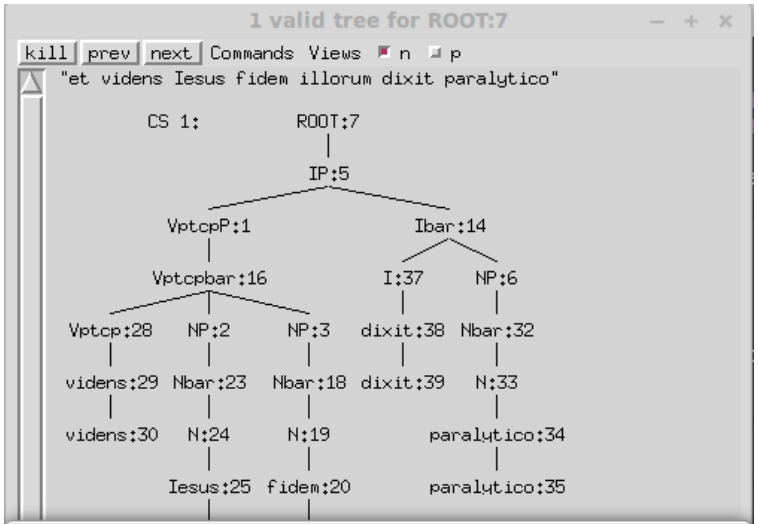
paralytico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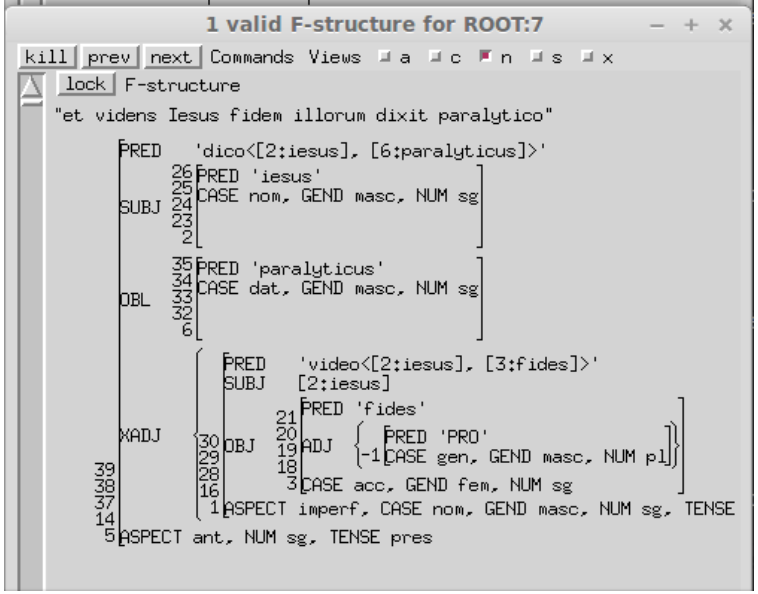
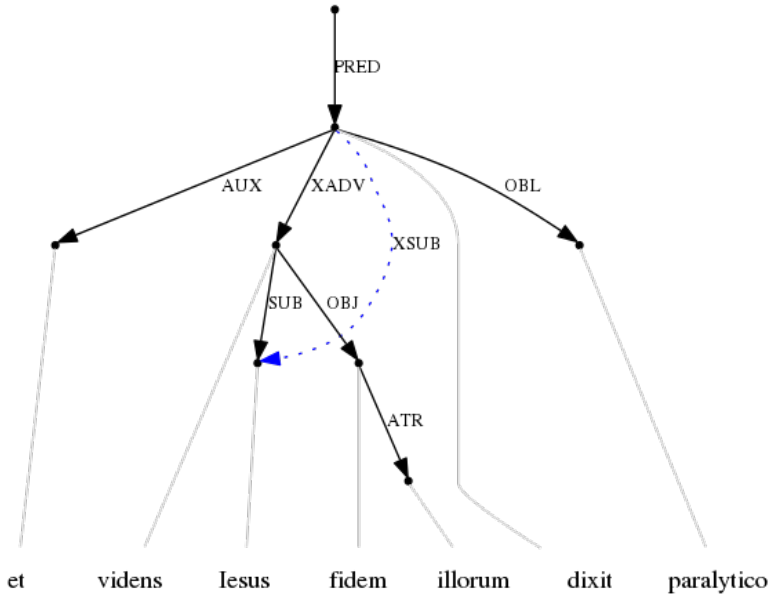
kill prev next Commands Views n p
"et videns Iesus fidem illorum dixit paralytico"
CS 1: ROOT:7
IP:5
VptcpP:1
Ibar:14
Vptcpbar:16
I:37
NP:6
Vptcp:28
NP:2
NP:3
dixit:38
Nbar:32
videns:29
Nbar:23
Nbar:18
dixit:39
N:33
videns:30
N:24
N:19
paralytico:34
Iesus:25
fidem:20
paralytico:35


1 valid F-structure for ROOT:7
kill prev next Commands Views a c n s x
lock F-structure
"et videns Iesus fidem illorum dixit paralytico"
PRED 'dico<[2:iesus], [6:paralyticus]>'
SUBJ
PRED 'iesus'
CASE nom, GEND masc, NUM sg
OBL
PRED 'paralyticus'
CASE dat, GEND masc, NUM sg
XADJ
PRED 'video<[2:iesus], [3:fides]>'
SUBJ [2:iesus]
OBJ
PRED 'fides'
ADJ
PRED 'PRO'
CASE gen, GEND masc, NUM pl
CASE acc, GEND fem, NUM sg
ASPECT imperf, CASE nom, GEND masc, NUM sg, TENSE
ASPECT ant, NUM sg, TENSE pres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The data

	Caesar			Gospels			Herodotus		
	op	no-op	cont	op	no-op	cont	op	no-op	cont
CP	3	0	707	7	0	1381	1	0	209

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- The data makes it very likely that the subject should be counted as internal to the participle phrase, so Kirk was right to exclude them from the main clause

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- With further statistical analysis the second outcome may stand in for negative evidence for historical language states
- But why should scrambling across participle clauses be disallowed?

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- So one could imagine that scrambling out of a participle clause is disallowed for complexity reasons

The obvious problem: infinitives

- It is well-known that German has long-distance scrambling across (coherent) infinitive constructions

(2) dass [die Witwen]$_j$ [der Opfer]$_i$ [dem Pfarrer]$_k$ der Rat
that the widows the victims the priest the council
gedenken zu lassen versprochen hat.
to commemorate let promised have
'. . . that the council has promised the priest to let the widows commemorate the victims' (Becker et al., 1991)'

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- Alternatively, Joshi et al. (2002) suggest that bounds on scrambling depth could be determined by the grammar

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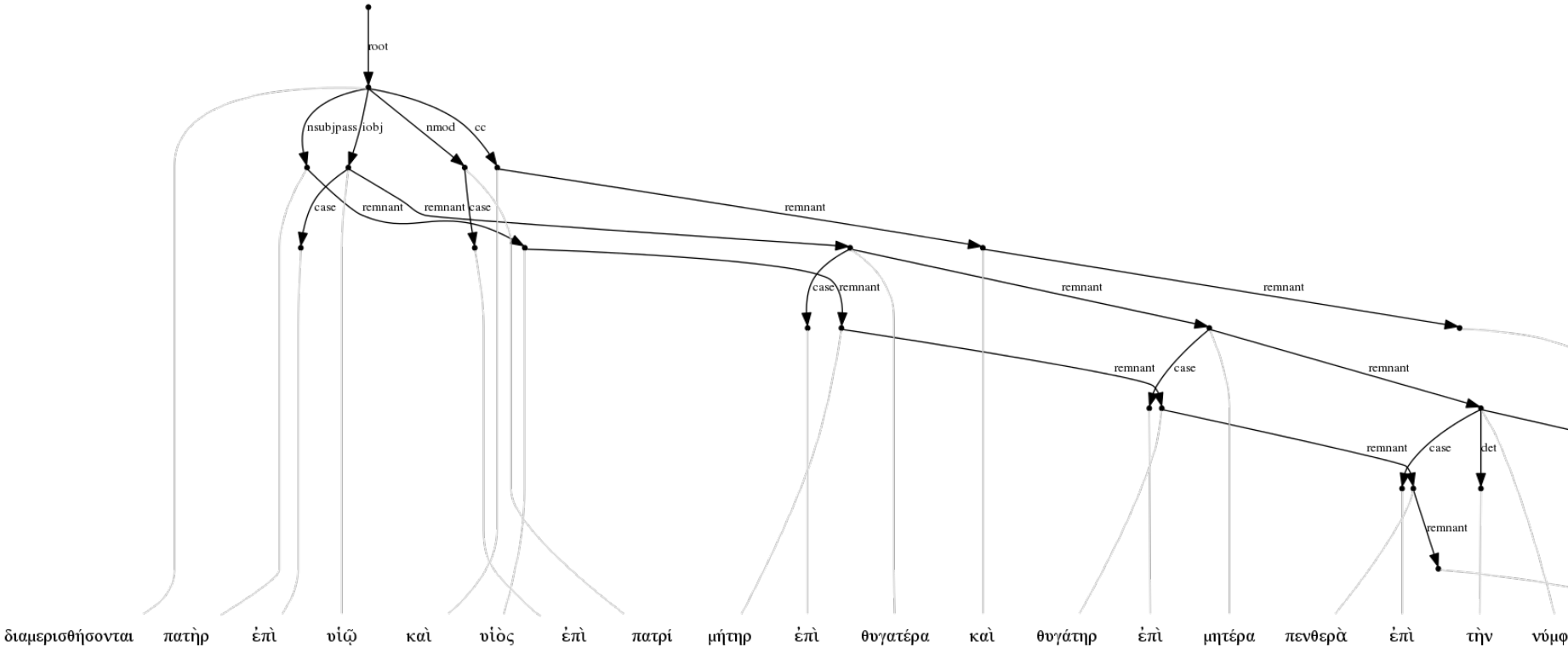
- As we saw, the correct analysis of participle clauses in Ancient Greek (and Latin) removes one source of illnestedness in the language
- In fact, there are strikingly few illnested constructions in AG and Latin, given the overall nonprojectivity in the languages
- They also share some characteristics among themselves and with corresponding examples in German, where Mambrini & Passarotti (2013) report illnestedness at 1.06%

Illnestedness in UD

	illnested	wellnested
Ancient_Greek	0.019	0.981
Ancient_Greek-PROIEL	0.023	0.977
Arabic	0.001	0.999
Basque	0.016	0.984
Bulgarian	0.000	1.000
Croatian	0.007	0.993
Czech	0.001	0.999
Danish	0.009	0.991
Dutch	0.001	0.999
English	0.002	0.998
Estonian	0.000	1.000
Finnish	0.006	0.994
Finnish-FTB	0.006	0.994
French	0.001	0.999
German	0.001	0.999
Gothic	0.019	0.981
Greek	0.005	0.995
Hebrew	0.000	1.000
Hindi	0.002	0.998

	illnested	wellnested
Hungarian	0.022	0.978
Indonesian	0.001	0.999
Irish	0.000	1.000
Italian	0.004	0.996
Japanese-KTC	0.000	1.000
Latin	0.042	0.958
Latin-ITT	0.003	0.997
Latin-PROIEL	0.015	0.985
Norwegian	0.001	0.999
Old_Church_Slavonic	0.018	0.982
Persian	0.000	1.000
Polish	0.000	1.000
Portuguese	0.001	0.999
Romanian	0.019	0.981
Slovenian	0.003	0.997
Spanish	0.000	1.000
Swedish	0.000	1.000
Tamil	0.000	1.000

Deep illnestedness in Greek



"Real" illnesting (without remnants and punctuation)

	illnested	wellnested
Ancient_Greek	0.014	0.986
Ancient_Greek-PROIEL	0.003	0.997
Arabic	0.000	1.000
Basque	0.001	0.999
Bulgarian	0.000	1.000
Croatian	0.000	1.000
Czech	0.001	0.999
Danish	0.001	0.999
Dutch	0.001	0.999
English	0.000	1.000
Estonian	0.000	1.000
Finnish	0.000	1.000
Finnish-FTB	0.000	1.000
French	0.000	1.000
German	0.000	1.000
Gothic	0.002	0.998
Greek	0.000	1.000
Hebrew	0.000	1.000
Hindi	0.001	0.999

	illnested	wellnested
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Indonesian	0.000	1.000
Irish	0.000	1.000
Italian	0.000	1.000
Japanese-KTC	0.000	1.000
Latin	0.037	0.963
Latin-ITT	0.002	0.998
Latin-PROIEL	0.002	0.998
Norwegian	0.001	0.999
Old_Church_Slavonic	0.002	0.998
Persian	0.000	1.000
Polish	0.000	1.000
Portuguese	0.000	1.000
Romanian	0.000	1.000
Slovenian	0.000	1.000
Spanish	0.000	1.000
Swedish	0.000	1.000
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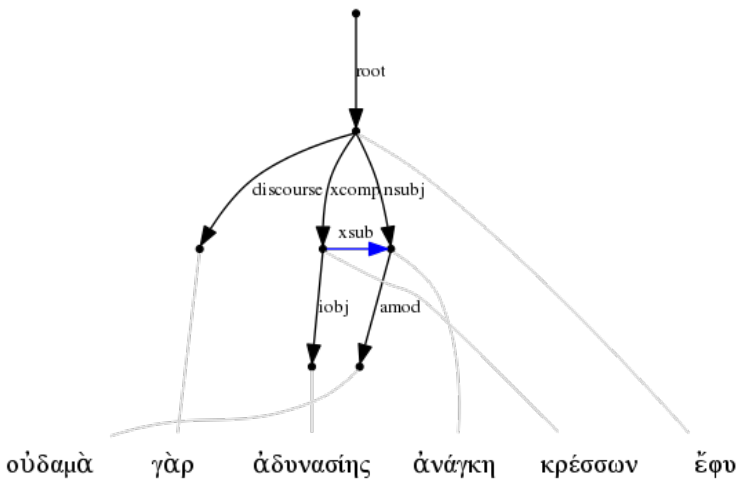
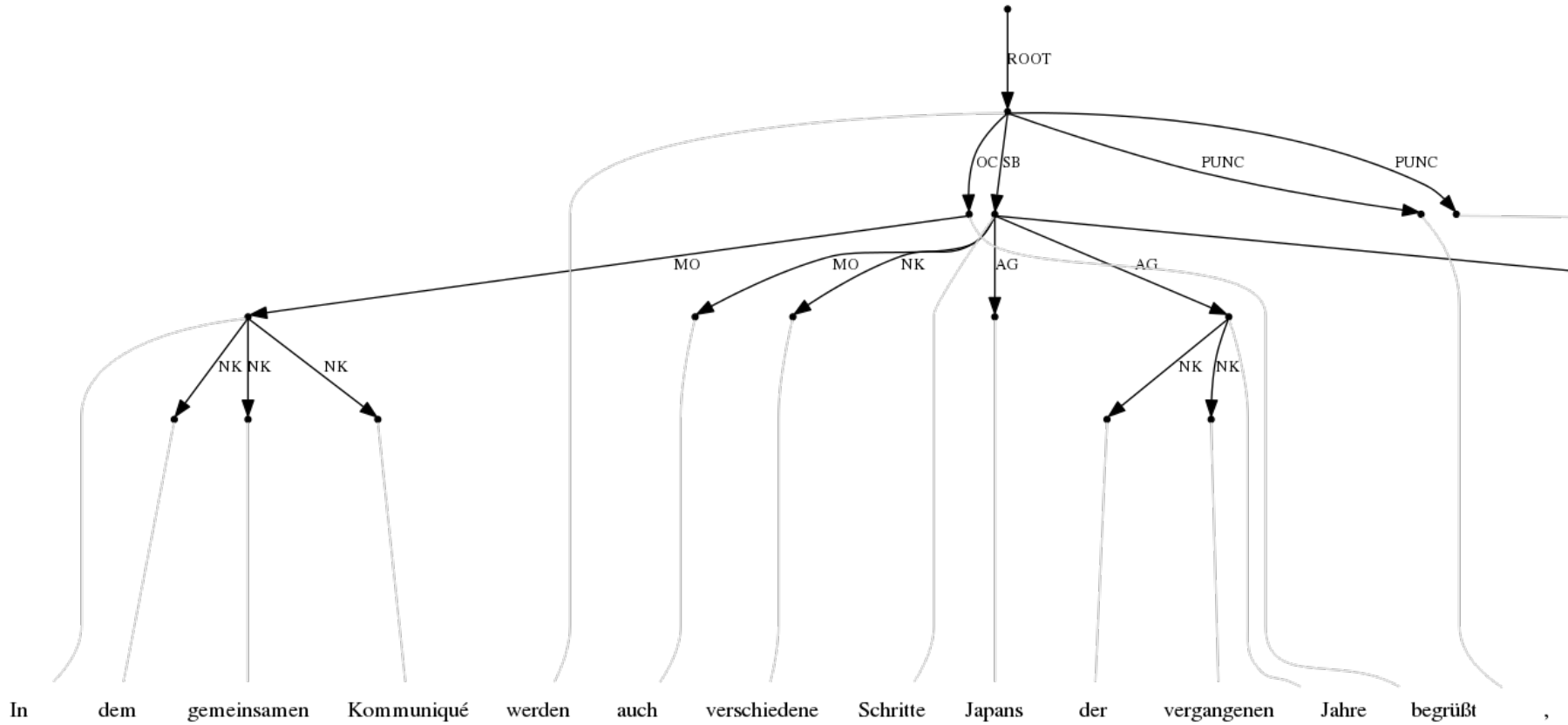
Greek illnestedness



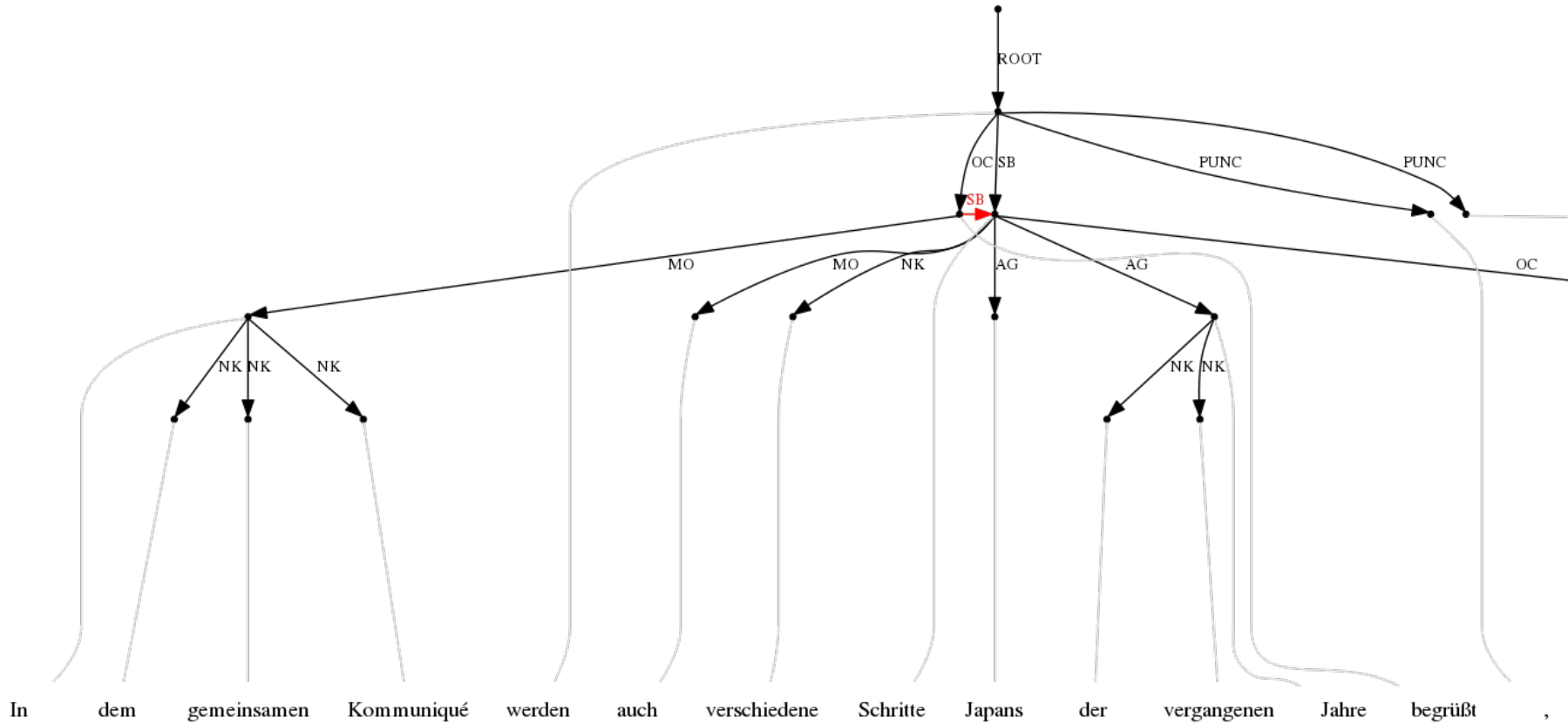
- The subject and the predicative are illnested

(3) oudama gar adunasiēs anagkē kressōn
no.NOM for lack of ability.GEN necessity.NOM stronger.NOM
efu
grow
'For no necessity can grow stronger than lack of ability.'

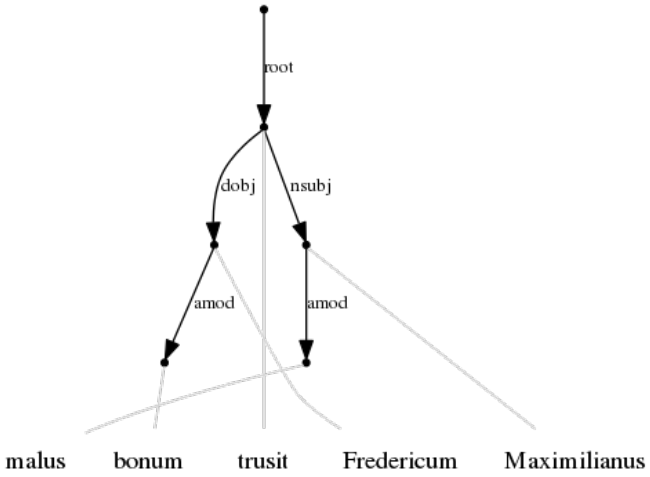
Illnestedness in Tiger

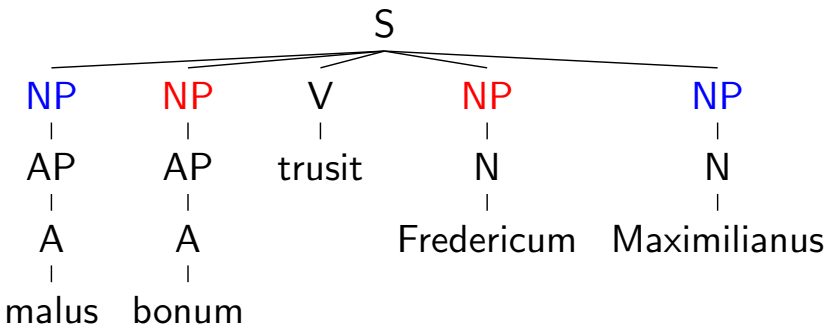


Illnestedness in Tiger

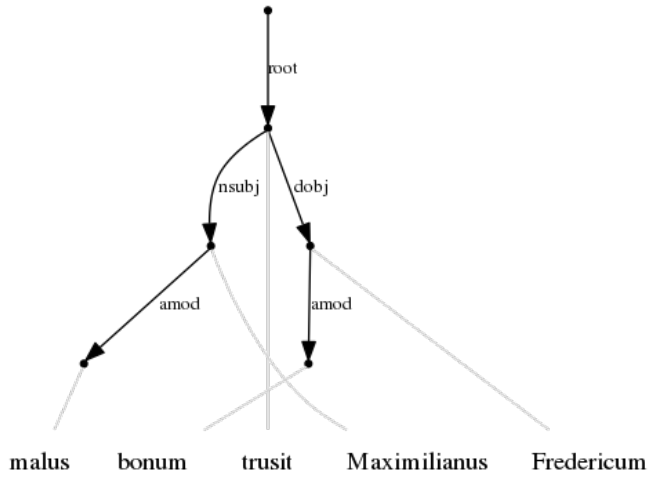


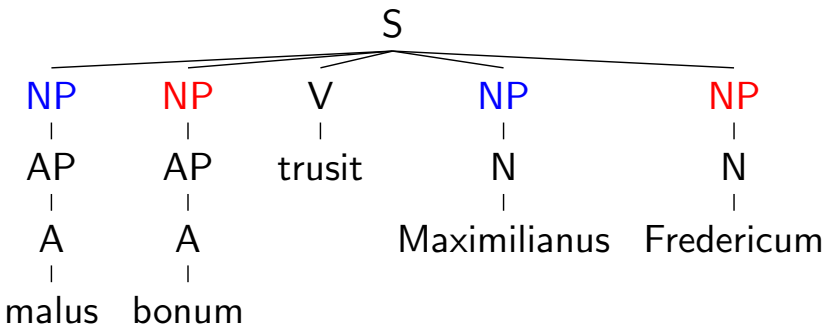
Illnestedness





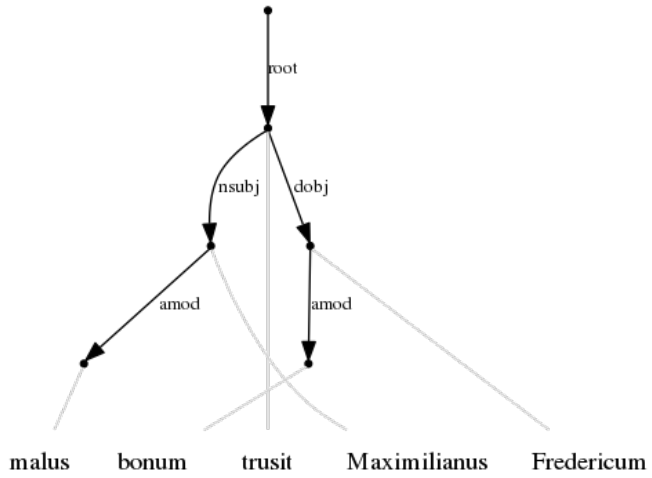
Illnestedness

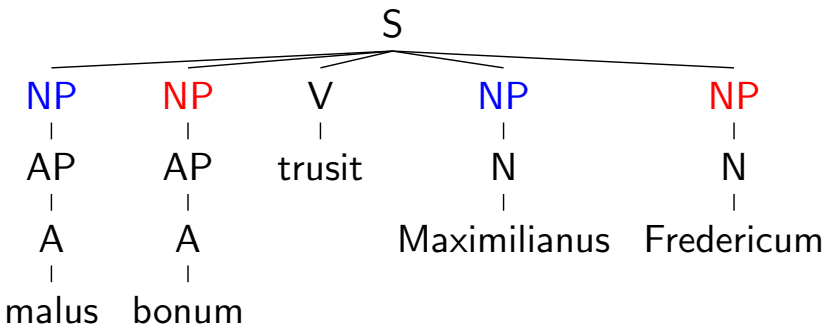




- The illnested structure does not require more reentrancies than the wellnested one

Illnestedness





- The illnested structure does not require more reentrancies than the wellnested one
- And yet illnested structures are practically nonextant in the UD treebanks

Conclusions

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- Motivated structures can provide evidence for non-standard analyses which avoid exponential blowup (e.g. reentrancies between recursive categories)
- But sometimes there is no connection between treebank data and theoretical structures, so there is more to do

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