

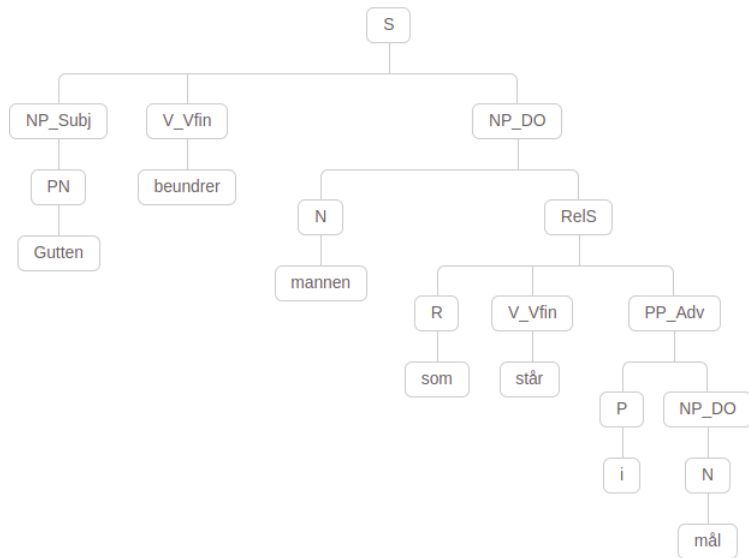
Possible Insights from a Hierarchy of Construction Types

Petter Haugereid

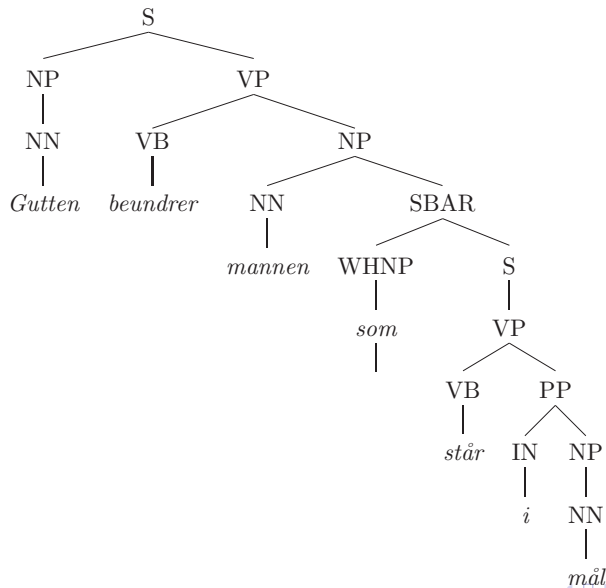
Department of Language, Literature, Mathematics and Interpreting
Western Norway University of Applied Sciences

Galicia, June 26, 2023

Constituent tree - from Norysg



Constituent tree - ChatGPT



Advantage of rule based systems

- ChatGPT already gives reasonable analyses of Norwegian sentences
- What is the biggest value of a rule based system?
 - It is transparent
 - We can fix mistakes
 - It can be analyzed

An investigation of the hierarchy of construction types

- Norsyg - a Norwegian HPSG-inspired grammar
 - Lexicon from
 - NorKompLeks (Norwegian Computational Lexicon) - based on dictionary definitions
 - NorGram (Norwegian LFG grammar) - argument frames added during tree banking
 - 6984 verbs
 - 15076 argument frames
 - On average 2.16 frame per verb
 - 3778 verbs have only one frame
 - The verb *ta* 'take' may enter 76 different frames

Bake 'bake' – three alternations

- (1) a. Jon baker.
Jon bakes
Jon bakes.
- b. Jon baker en kake.
Jon bakes a cake
Jon bakes a cake.
- c. Jon baker henne en kake.
Jon bakes her a cake
Jon bakes a cake for her.

Bringe 'bring' – six (of eight) alternations

- (2) a. Jon bringer en kake.
Jon brings a cake
Jon brings a cake.
- b. Jon bringer med seg en kake.
Jon brings with himself cake
Jon brings a cake.
- c. Jon bringer henne en kake.
Jon brings her a cake
Jon brings her a cake.
- d. Jon bringer barna til konserten.
Jon brings child-DEF to concert-DEF
Jon brings the children to the concert.
- e. Jon bringer inn nye ideer.
Jon brings in new ideas
Jon brings in new ideas.
- f. Jon bringer nye ideer på banen.
Jon brings new ideas on field-DEF
Jon comes up with new ideas.

Verb lexical entries

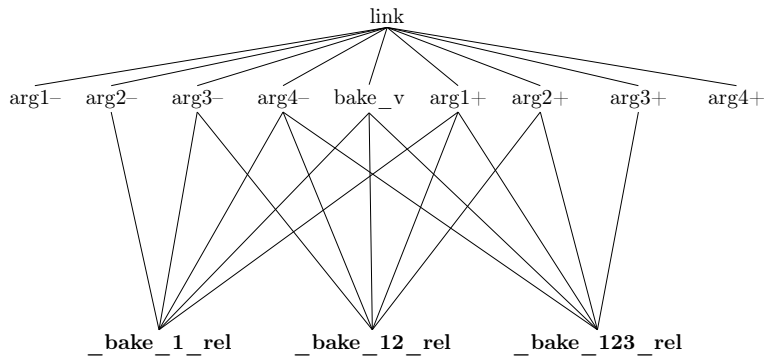
```
bake_v := main-verb-lxm &  
  [ STEM <"bake">,  
    INFLECTION v1,  
    SYNSEM.LKEYS.KEYREL.PRED bake_v ].
```

```
bringe_v := main-verb-lxm &  
  [ STEM <"bringe">,  
    INFLECTION v1,  
    SYNSEM.LKEYS.KEYREL.PRED bringe_v ].
```

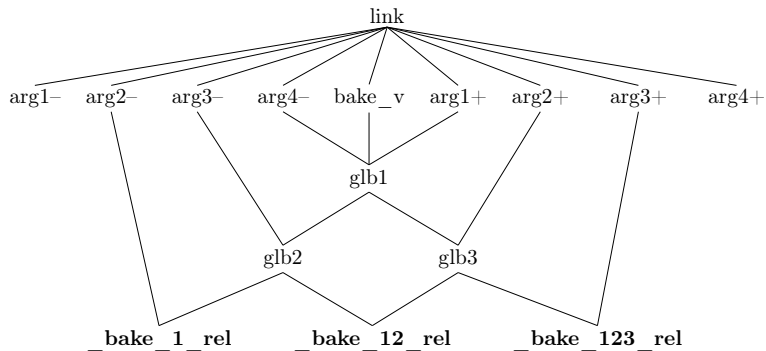

Construction types for *bake*

```
_bake_123_rel := bake_v & 1np & 2np & 3np & arg4- & prt-.  
_bake_12_rel  := bake_v & 1np & 2np & arg3- & arg4- & prt-.  
_bake_1_rel   := bake_v & 1np & arg2- & arg3- & arg4- & prt-.
```

Type hierarchy of construction types



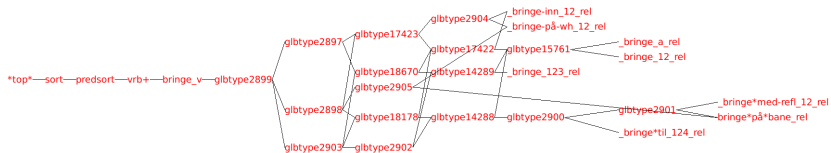
Type hierarchy with GLB types



Type hierarchy of *bake_v*



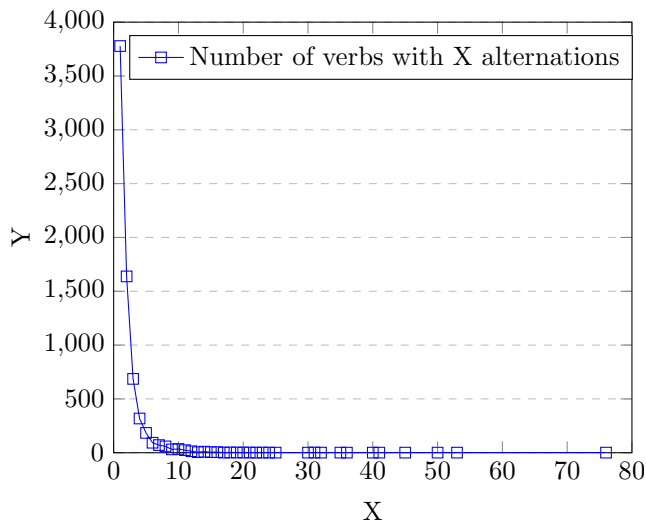
Type hierarchy of *bringe_v*



Some verbs can enter many frames

- 6984 verbs
- 15076 argument frames
- On average 2.16 frame per verb
- 3778 verbs have only one frame
- The verb *ta* 'take' may enter 76 different frames

Number of verbs with X number of alternations



Most common frame combinations

Frame 1	Frame 2	Number	Possible alternation
intransitive	transitive	797	Intransitive/Transitive
transitive	reflexive	524	Reflexive
transitive	transitive with CP	299	That-complement
transitive	unergative	230	Causative-Inchoative
intransitive	intransitive with <i>på</i> PP	203	Resultative
transitive	transitive with <i>opp</i> particle	202	Resultative
transitive	intransitive with <i>på</i> PP	198	Conative?
intransitive	intransitive with <i>med</i> PP	189	
transitive	transitive with <i>til</i> PP	177	Dative
transitive	transitive with <i>ut</i> particle	157	Resultative
unaccusative	unergative	131	Unergative-Unaccusative
intransitive	reflexive	129	Reflexive
intransitive	transitive with <i>opp</i> particle	123	Resultative
transitive	transitive with Wh object	121	Wh-complement
transitive	ditransitive	116	Benefactive
transitive	transitive with <i>for</i> PP	113	Dative?
intransitive	transitive with <i>ut</i> particle	99	Resultative
transitive	transitive with IP object	96	To-complement
transitive	transitive with <i>inn</i> particle	95	Resultative

Most common frame combinations of 3

Frame 1	Frame 2	Frame3	Number
intransitive	transitive	intransitive with <i>på</i> PP	123
intransitive	transitive	transitive with <i>opp</i> particle	106
intransitive	transitive	reflexive	105
transitive	transitive with CP	transitive with Wh object	92
intransitive	transitive	transitive with <i>ut</i> particle	82
transitive	unergative	unaccusative	71
transitive	transitive with <i>opp</i> particle	transitive with <i>ut</i> particle	58
intransitive	transitive	transitive with CP	57
intransitive	transitive	intransitive with <i>med</i> PP	57
transitive	reflexive	transitive with <i>opp</i> particle	51
transitive	transitive with direct speech	transitive with CP	51
transitive	reflexive	transitive with <i>ut</i> particle	51

Most common frame combinations of 4

Frame 1	Frame 2	Frame3	Frame4	Number
intransitive	transitive	reflexive	transitive/ <i>på</i> part	32
intransitive	transitive	transitive/ <i>opp</i> part	transitive/ <i>ut</i> part	32
intransitive	transitive	transitive/ <i>opp</i> part	transitive/ <i>på</i> PP	31
intransitive	transitive	reflexive	transitive/ <i>på</i> PP	30
intransitive	transitive	transitive/ <i>ut</i> part	transitive/ <i>på</i> PP	28
intransitive	transitive	reflexive	transitive/ <i>ut</i> part	28
transitive	reflexive	transitive/ <i>opp</i> part	transitive/ <i>ut</i> part	27

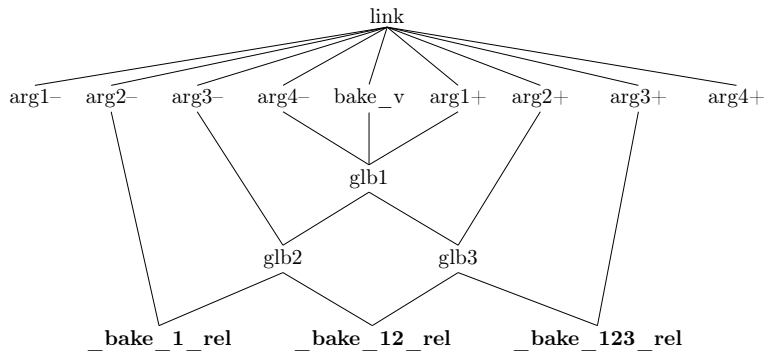
Verbs with frame combination of 6

- 6 most common frames
 - intransitive
 - transitive
 - reflexive
 - transitive/*ut* part
 - transitive/*opp* part
 - transitive/*på* PP
- 8 verbs with all these frames:
 - *ta* 'take'
 - *trekke* 'pull'
 - *kaste* 'throw'
 - *holde* 'hold'
 - *dele* 'share'
 - *skrive* 'write'
 - *løfte* 'lift'
 - *dra* 'pull'/'leave'

What can be learned?

- Many of the verbs have a common meaning:
 - Using hands to control the location of an object
- This is the most common grouping of argument frames
- Maybe a less frequent grouping is associated with verbs with more specific meanings
- Hypothesis 1: Supertypes of the construction types can be associated with abstract mental representations
- Hypothesis 2: Each subconstruction at the top of the hierarchy is also associated with abstract mental representations

Type hierarchy with GLB types



Verbs with frame combination of 4 – 1

- Frames
 - intransitive
 - reflexive
 - transitive/*ned* part
 - transitive/*på* PP
- Verbs with these frames:
 - *ta* 'take'
 - *kaste* 'throw'
 - *presse* 'press'
 - *skrive* 'write'
 - *dra* 'pull'/'leave'
- Physical actions that result in a change of state, movement, or manipulation of objects

Verbs with frame combination of 4 – 2

- Frames
 - ditransitive/CP
 - transitive/Wh
 - ditransitive
 - transitive
- Verbs with these frames:
 - *fortelle* 'tell'
 - *forklare* 'explain'
 - *si* 'say'
 - *vise* 'show'
 - *svare* 'answer'
- Communication and sharing information

Verbs with frame combination of 4 – 3

- Frames
 - transitive/*igjen* part
 - transitive/*opp* part
 - transitive/it ut part
 - intransitive
- Verbs with these frames:
 - *ta* 'take'
 - *slå* 'hit'
 - *gi* 'give'
 - *få* 'get'
 - *låse* 'lock'
- No clear common meaning

Verbs with frame combination of 4 – 4

- Frames
 - intransitive/*på* PP with CP
 - transitive with CP
 - transitive with IP
 - intransitive
- Verbs with these frames:
 - *tenke* 'think'
 - *huske* 'remember'
 - *vente* 'wait'
 - *håpe* 'hope'
 - *se* 'see'
- Mental processes, perception, or emotional states

Verbs with frame combination of 4 – 5

- Frames
 - intransitive/*på* PP with CP
 - transitive with CP
 - transitive with Wh
 - intransitive
- Verbs with these frames:
 - *gjette* 'guess'
 - *kjenne* 'feel'
 - *tro* 'believe'
 - *huske* 'remember'
 - *se* 'see'
- Processes of perceiving, understanding, or evaluating information (very similar to the previous set of frames)

Verbs with frame combination of 4 – 6

- Frames
 - transitive/*istykker* part
 - transitive/*opp* part
 - transitive/*sund* part
 - transitive
- Verbs with these frames:
 - *hakke* 'hack'
 - *flenge* 'fling'
 - *rive* 'tear'
 - *slå* 'hit'
 - *skjære* 'cut'
- Physical actions that involve force, movement, and manipulation of objects or substances

Verbs with frame combination of 4 – 7

- Frames
 - unaccusative
 - reflexive
 - transitive/*av* part
 - transitive
- Verbs with these frames:
 - *gnage* 'gnaw'
 - *ta* 'take'
 - *slå* 'hit'
 - *brenne* 'burn'
 - *brekke* 'break'
- Intentional physical action that brings about noticeable transformations or alterations

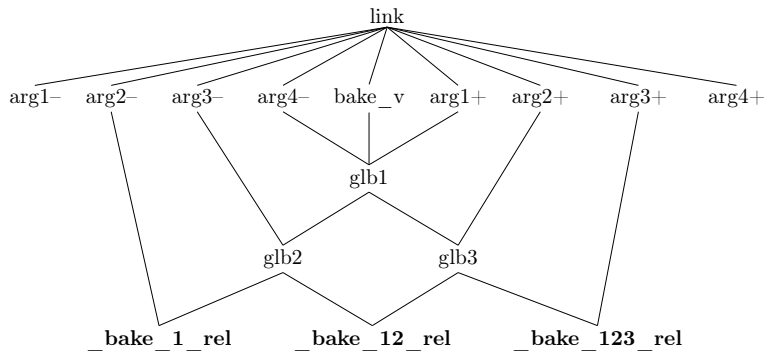
Verbs with frame combination of 4 – 8

- Frames
 - intransitive
 - transitive/*bort* part
 - transitive/*ut* part
 - transitive/*av* PP with reflexive
- Verbs with these frames:
 - *ta* 'take'
 - *rive* 'tear'
 - *vaske* 'wash'
 - *kaste* 'throw'
 - *få* 'get'
- No clear common meaning

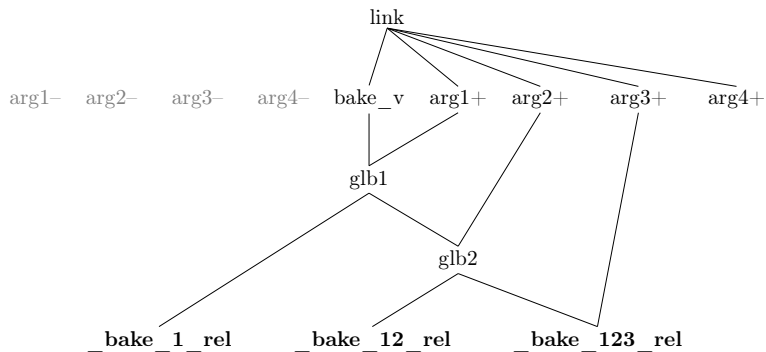
Verbs with frame combination of 4 – 9

- Frames
 - transitive
 - reflexive
 - transitive/*i* PP
 - transitive/*på* PP
- Verbs with these frames:
 - *røre* 'touch'
 - *endre* 'change'
 - *take* 'take'
 - *knipe* 'pinch'
 - *hold* 'hold'
- Physical engagement, manipulation, or contact with objects, surfaces, or people

Type hierarchy with GLB types



Type hierarchy without negative types



Type hierarchies and neural networks

- Type hierarchies are different from neural networks
 - No gravity in type hierarchies
 - No weights
- Still, I would like to argue that one can model neural networks with type hierarchies
 - Add gravity by means of negative types (engineering artifacts)
 - Using statistical models to choose between possible constructions