An incremental approach to gapping constructions

Petter Haugereid

Norwegian Section, Faculty of Education,
Western Norway University of Applied Sciences

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Gapping and Conjunction Reduction (Sag *et al.*, 1985)

Gapping:

(1) Kim likes Sandy, and Lee Leslie.

(2) Pat wanted to try to go to Berne, and Chris $\left\{\begin{array}{l}\text{to try to go to Rome.}\\ \text{to go to Rome.}\\ \text{to Rome.}\end{array}\right\}$

Conjunction reduction:

(3) Kim gave a dollar to Bobbie and a dime to Jean.

Particle verbs

(4) Jeg **tar** **med** mat, og du (*med) drikke.
I bring with food and you with drink
I will bring food, and you drinks.

Reflexive verbs

(5) Jeg **ønsker meg** fisk, og du (*deg) steik.
I wish REFL fish and you REFL roast
I want fish, and you roast.

Idiomatic expressions

(6) Jeg **brakte på bane** isen, og du (*på) (*bane) teen.
I brought on track ice-DEF and you on track tea-DEF
I brought up the ice cream, and you the tea.

Verbs with selected prepositions

(7) ??Jeg **hører på** Jon, og du Marit.
I listen to Jon and you Marit
I listen to Jon, and you Marit.

(8) Jeg **hører** på Jon, og du på Marit.
I listen to Jon and you to Marit
I listen to Jon, and you (listen) to Marit.

Ditransitive verbs

(9) Per **serverte** meg fisk, og Kari deg steik.
Per served me fish and Kari you roast
Per served me fish, and Kari you roast.

Passivized verbs

(10) Jeg **ble servert** fisk, og du steik.
I was served fish and you roast
I was served fish, and you roast.

Conjunction Reduction

It is possible to have gapping in cases where the topic is shared.

(11) Per **serverte** meg fisk og deg steik.
Per served me fish and you roast
Per served me fish, and you roast.

(12) I dag **ble** jeg **servert** fisk og du steik.
Today was I served fish and you roast
Today I was served fish, and you roast.

Conjunction Reduction in CCG

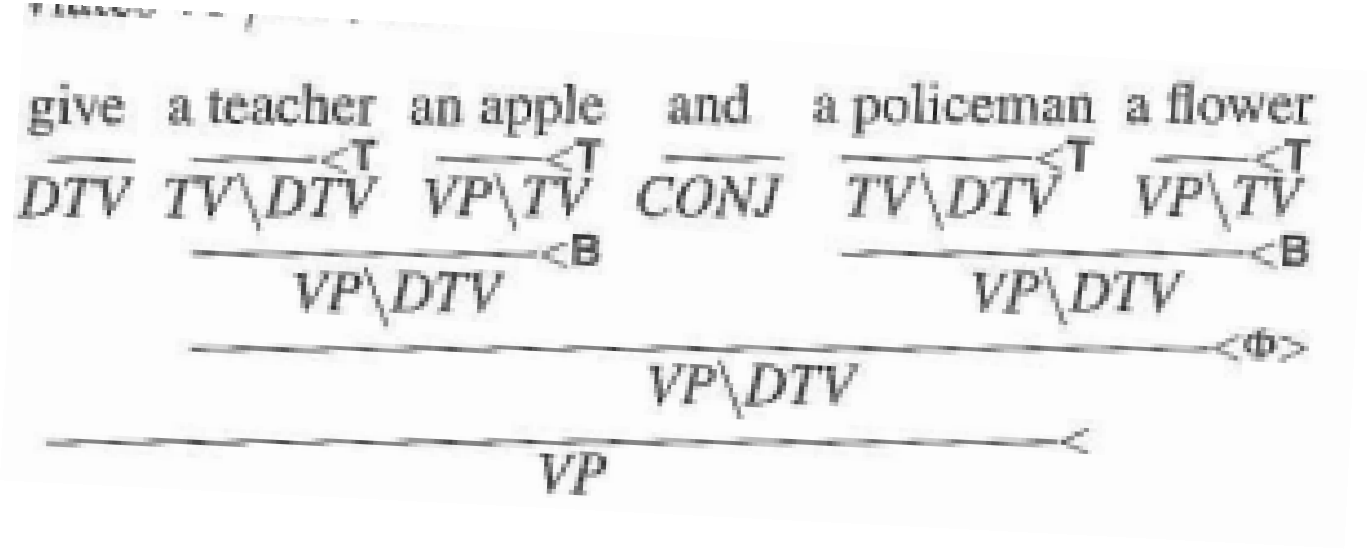


Figure 1: Conjunction Reduction in CCG (Steedman, 2000, 46)

Gapping in CCG

$$\dfrac{\dfrac{\dfrac{\text{Dexter eats bread,}}{\begin{array}{c}S\\ :\ eats'\,bread'\,dexter'\end{array}} \quad \dfrac{\text{and}}{CONJ} \quad \dfrac{\text{Warren, potatoes}}{\begin{array}{c}S\backslash((S/NP)/NP)\\ :\ \lambda f\,f\ potatoes'\,warren'\end{array}}}{\dfrac{\begin{array}{c}((S/NP)/NP)\\ \theta''(eats'\,bread'\,dexter')\end{array} \quad \begin{array}{c}S\backslash((S/NP)/NP)\\ :\ \lambda y.eats'\,bread'\,dexter'\end{array}}{\begin{array}{c}S\backslash((S/NP)/NP)\\ :\ \lambda f.and'(f\ potatoes'\,warren')(eats'\,bread'\,dexter')\end{array}}\,<\Phi>}}{\begin{array}{c}S:and'(\theta''(eats'\,bread'\,dexter')potatoes'\,warren')(eats'\,bread'\,dexter')\\ =S:and'(eats'\,potatoes'\,warren')(eats'\,bread'\,dexter')\end{array}}\,<$$

Figure 2: Gapping in CCG (Steedman, 2000, 190)

Gapping in HPSG – Linearization

- Linearization grammars
  - Constituent structure separated from phonological structure
  - DOM(ain) list: phonological items in surface order
  - Constraints define relationship between DOM list and constituent structure
- Accounts for
  - discontinuous constituents
  - non-constituent coordination (NCC)
- Assumed by most HPSG approaches to NCC (Kathol, 1995; Beavers and Sag, 2004; Chaves, 2005; Crysmann, 2008)
- Powerful and inefficient

Gapping in HPSG – Phrase structure rules

- DELPH-IN grammars
  - ERG (Flickinger, 2000)
  - JACY (Siegel *et al.*, 2016)
- Regular phrase structure rules
  - → Phonology is simply concatenated
  - → Constituents are reflected in the derivation tree
- Efficient
- Non-constituent coordination are challenging

Incremental parsing

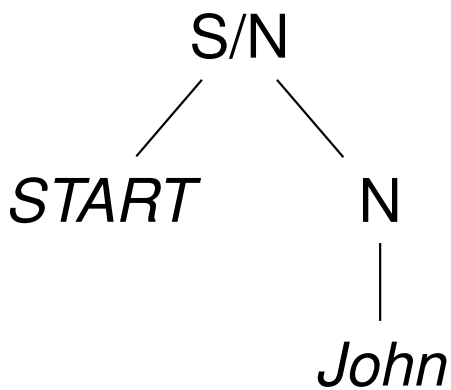
- An alternative, incremental approach to gapping is assumed (Haugereid and Morey, 2012)
  - regular phrase structure rules
  - derivation tree is separated from the constituent structure

Incremental parsing

START

Figure 3: Simplified derivation tree of the transitive sentence *John eats fish*

Incremental parsing



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Incremental parsing

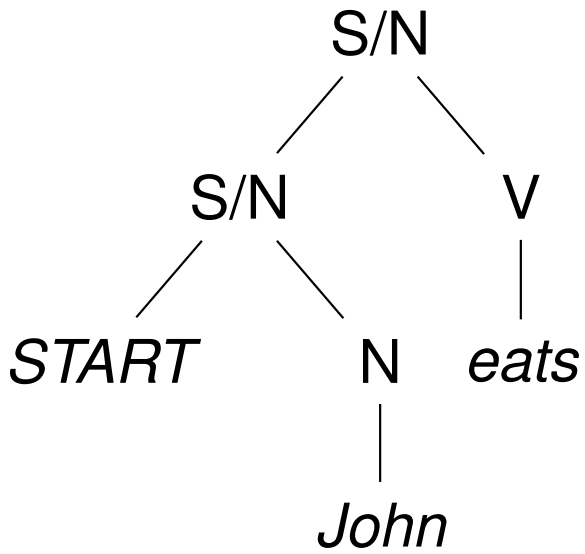


Figure 3: Simplified derivation tree of the transitive sentence *John eats fish*

Incremental parsing

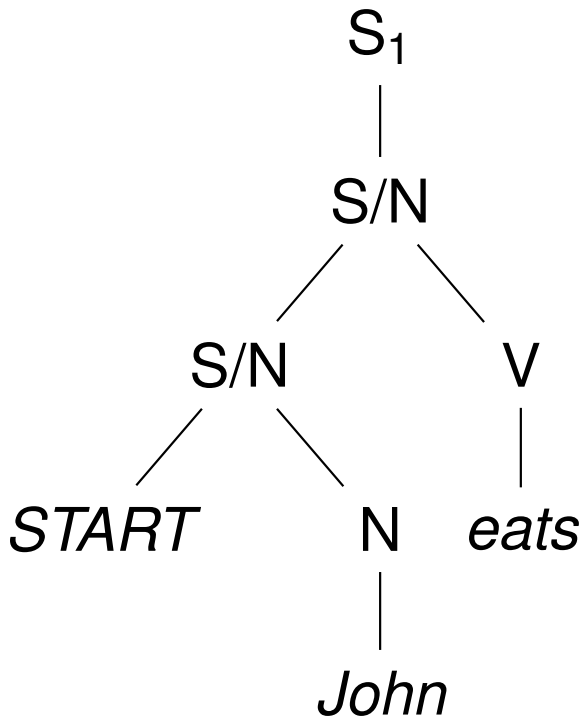


Figure 3: Simplified derivation tree of the transitive sentence *John eats fish*

Incremental parsing

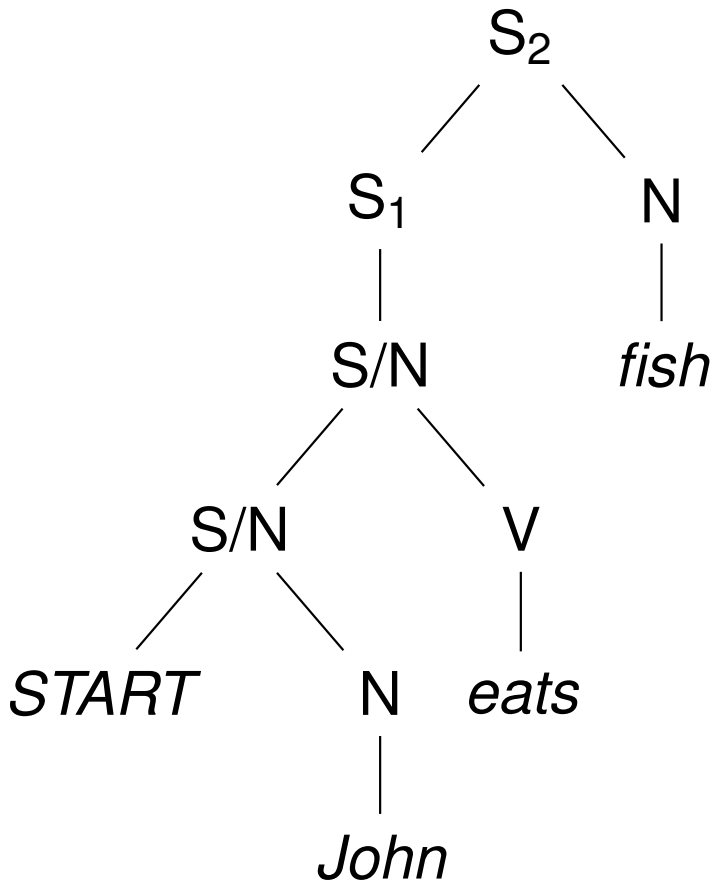


Figure 3: Simplified derivation tree of the transitive sentence *John eats fish*

Link hierarchy

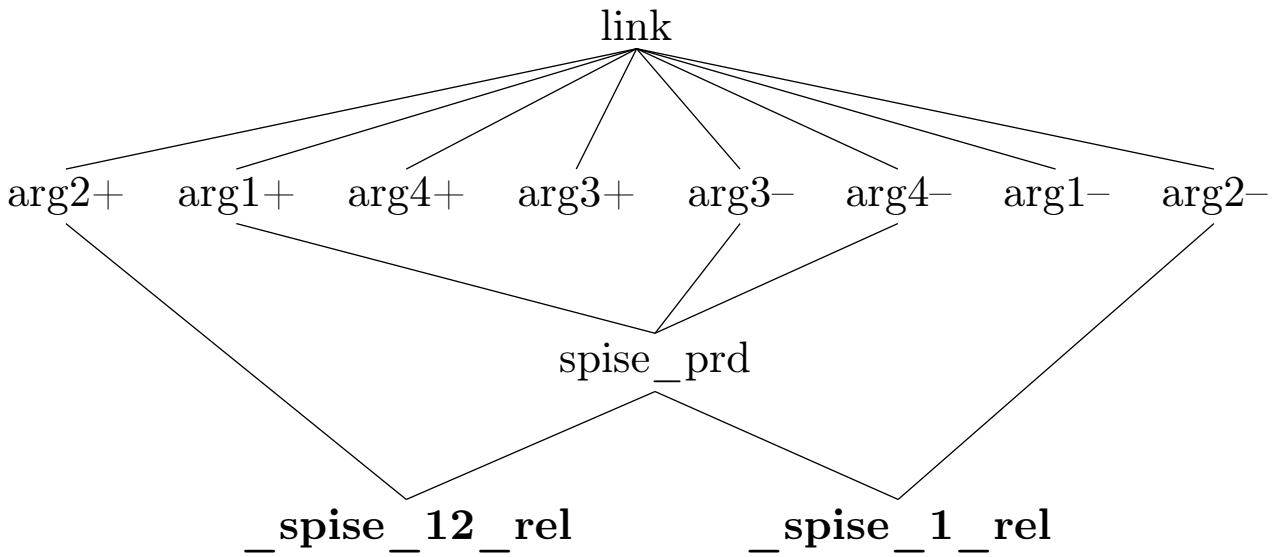


Figure 4: Type hierarchy of valence types

Link hierarchy

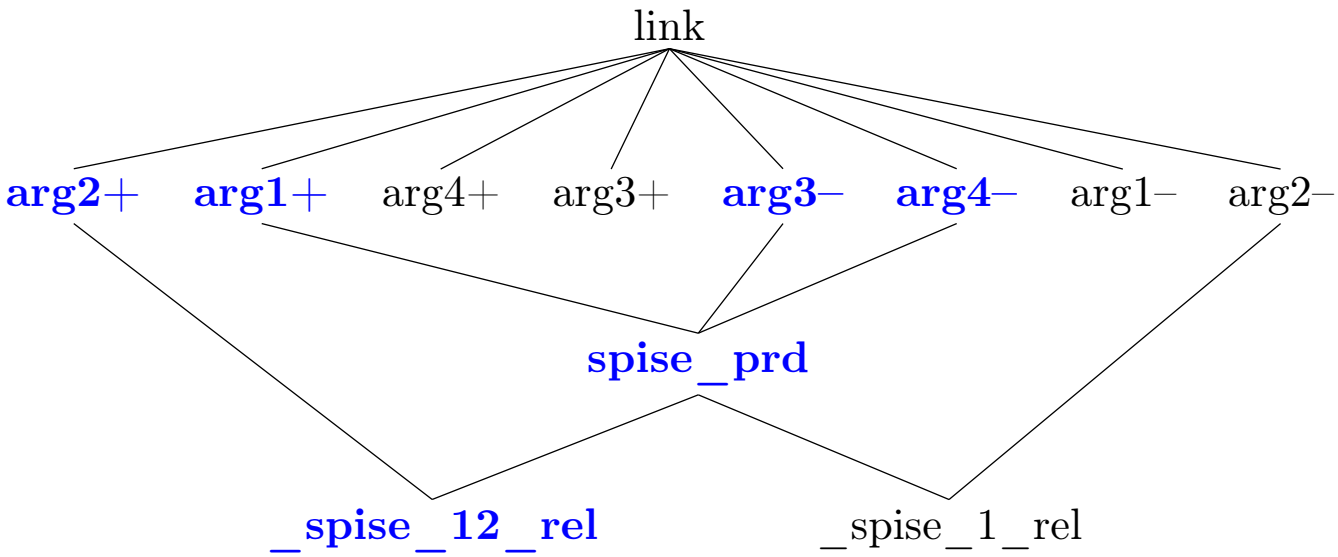


Figure 5: Type hierarchy of valence types

Valence features

(13)
$$\begin{bmatrix} \text{VAL} & \begin{bmatrix} \text{CMP1}|\text{LINK} & \textit{arg1}\text{–} \\ \text{CMP2}|\text{LINK} & \textit{arg2}\text{–} \\ \text{CMP3}|\text{LINK} & \textit{arg3}\text{–} \\ \text{CMP4}|\text{LINK} & \textit{arg4}\text{–} \end{bmatrix} \end{bmatrix}$$

(14)
$$\begin{bmatrix} \textit{START} & \\ \text{VAL} & \begin{bmatrix} \text{CMP1}|\text{LINK} & \boxed{0} \\ \text{CMP2}|\text{LINK} & \boxed{0} \\ \text{CMP3}|\text{LINK} & \boxed{0} \\ \text{CMP4}|\text{LINK} & \boxed{0} \end{bmatrix} \\ \text{KEYREL}|\text{PRED} & \boxed{0} \\ \text{SLASH} & \langle\rangle \end{bmatrix}$$

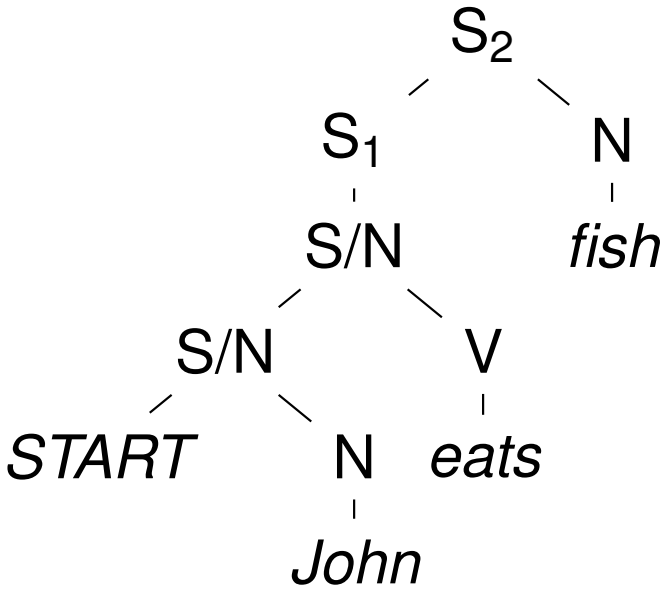
Incremental parsing and coordination

- In HPSG, coordination of full constituents is straightforward, at least as long as the constituents are of the same category:

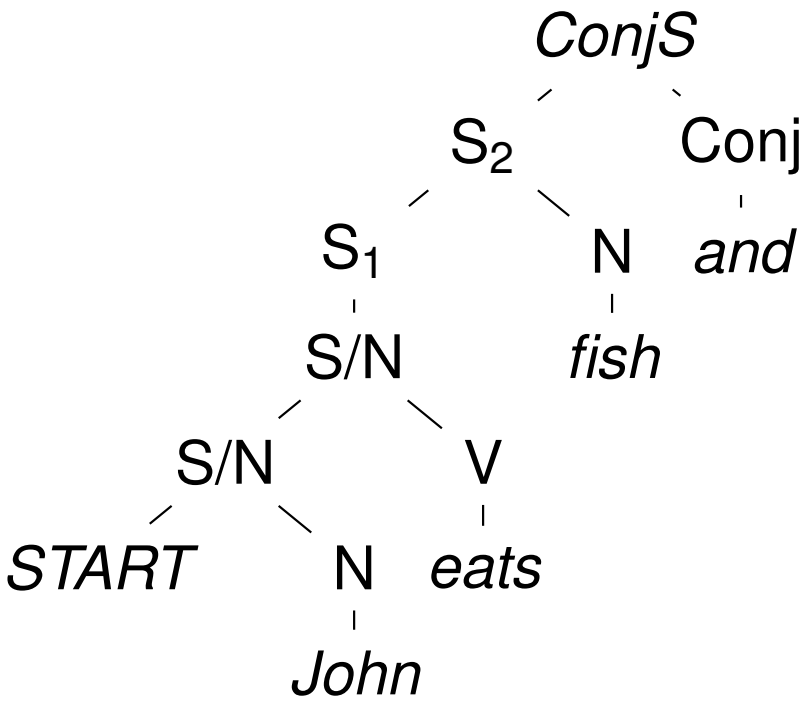
$$\text{XP} \Rightarrow \text{XP Conj XP}$$

- Coordination is obvious challenge for the incremental approach.

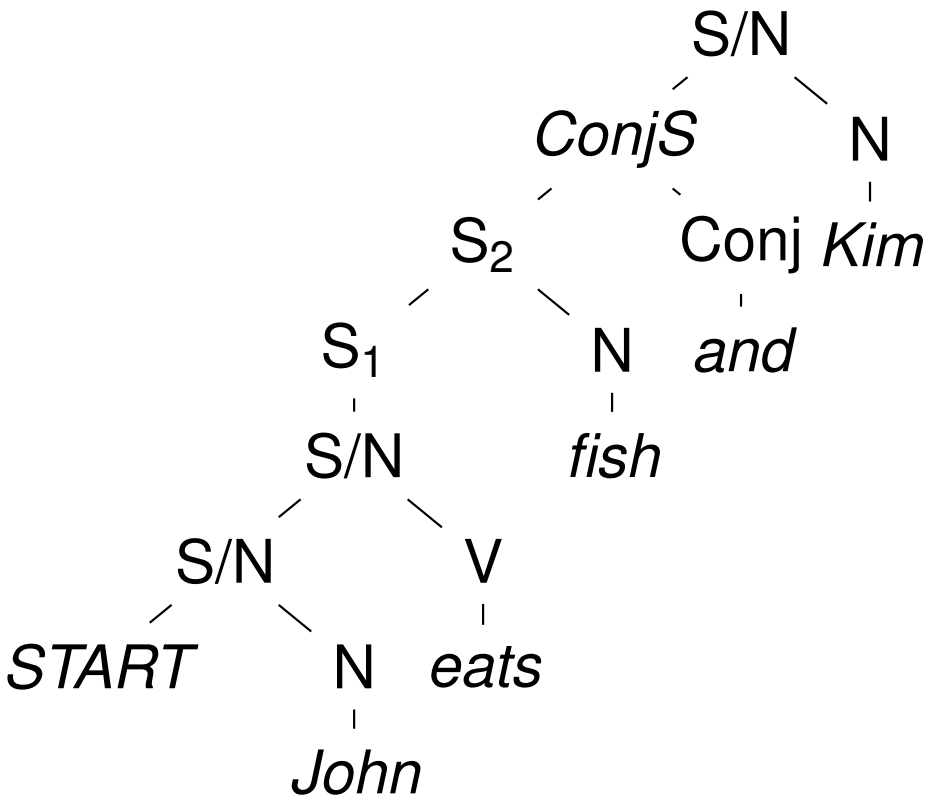
Incremental parsing and coordination



Incremental parsing and coordination



Incremental parsing and coordination



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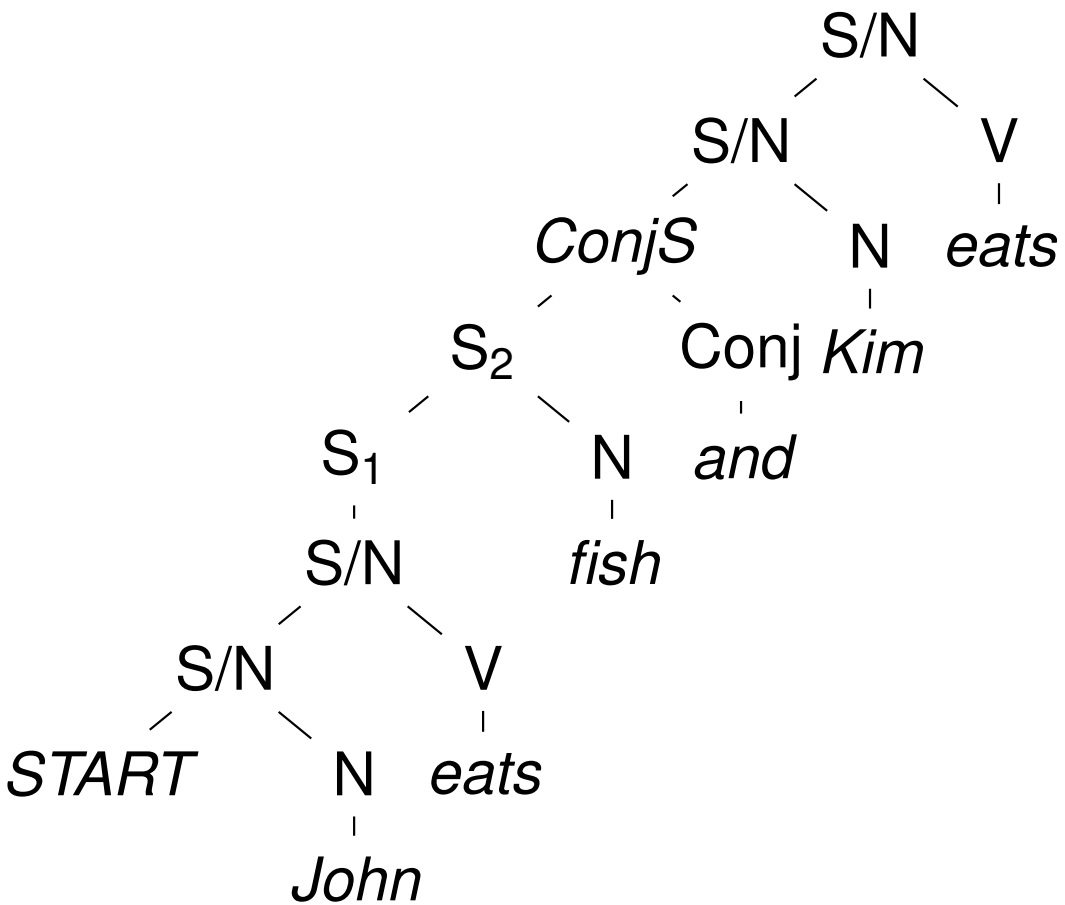

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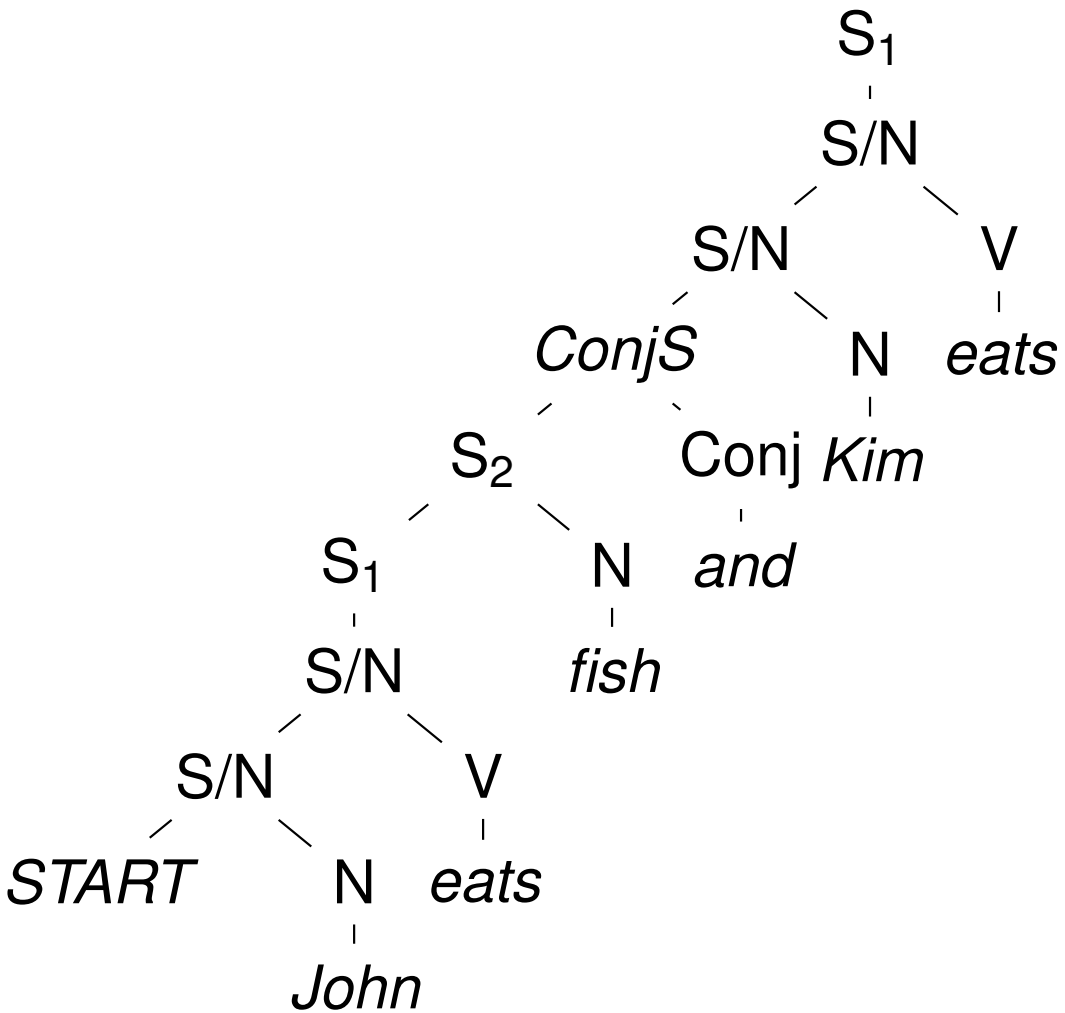

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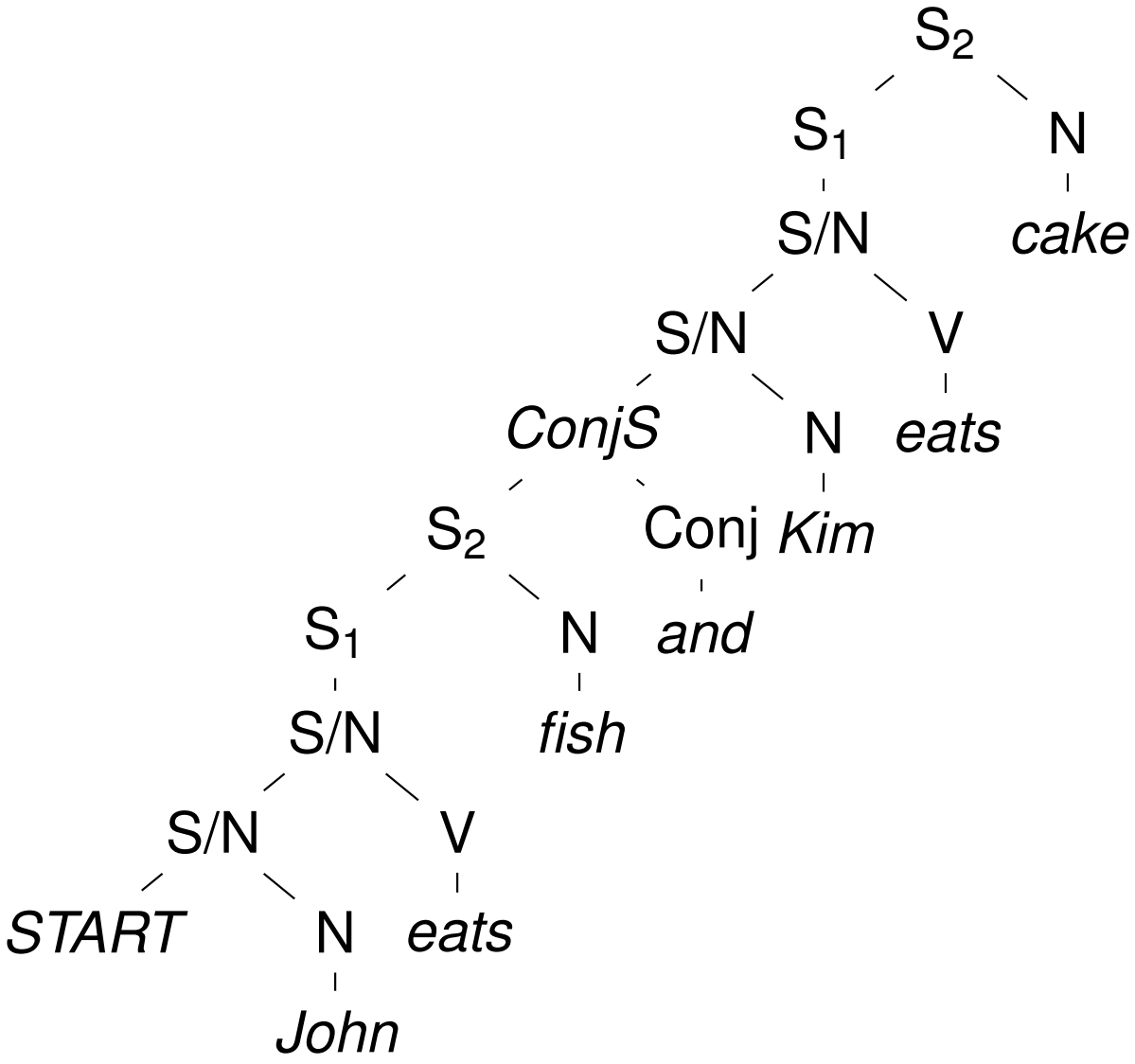


Coordination types

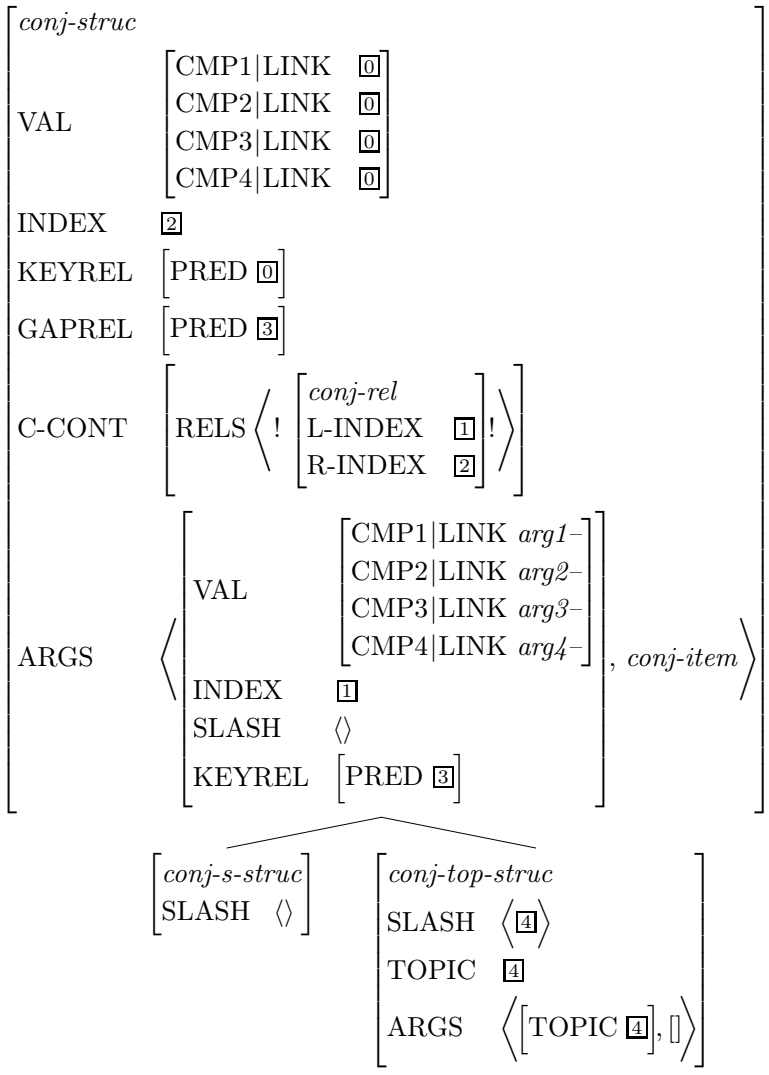


Figure 7: Hierarchy of coordination rules

Coordination types

$$\begin{bmatrix} \textit{conj-struc} & \\ \text{VAL} & \begin{bmatrix} \text{CMP1}|\text{LINK} & \boxed{0} \\ \text{CMP2}|\text{LINK} & \boxed{0} \\ \text{CMP3}|\text{LINK} & \boxed{0} \\ \text{CMP4}|\text{LINK} & \boxed{0} \end{bmatrix} \\ \text{INDEX} & \boxed{2} \\ \text{KEYREL} & \begin{bmatrix} \text{PRED} & \boxed{0} \end{bmatrix} \\ \text{GAPREL} & \begin{bmatrix} \text{PRED} & \boxed{3} \end{bmatrix} \\ \text{C-CONT} & \begin{bmatrix} \text{RELS} \left\langle ! \begin{bmatrix} \textit{conj-rel} & \\ \text{L-INDEX} & \boxed{1} \\ \text{R-INDEX} & \boxed{2} \end{bmatrix} ! \right\rangle \end{bmatrix} \\ \text{ARGS} & \left\langle \begin{bmatrix} \text{VAL} & \begin{bmatrix} \text{CMP1}|\text{LINK} & \textit{arg1}\text{–} \\ \text{CMP2}|\text{LINK} & \textit{arg2}\text{–} \\ \text{CMP3}|\text{LINK} & \textit{arg3}\text{–} \\ \text{CMP4}|\text{LINK} & \textit{arg4}\text{–} \end{bmatrix} \\ \text{INDEX} & \boxed{1} \\ \text{SLASH} & \langle\rangle \\ \text{KEYREL} & \begin{bmatrix} \text{PRED} & \boxed{3} \end{bmatrix} \end{bmatrix}, \textit{conj-item} \right\rangle \end{bmatrix}$$

Figure 8: General coordination type

Coordination types

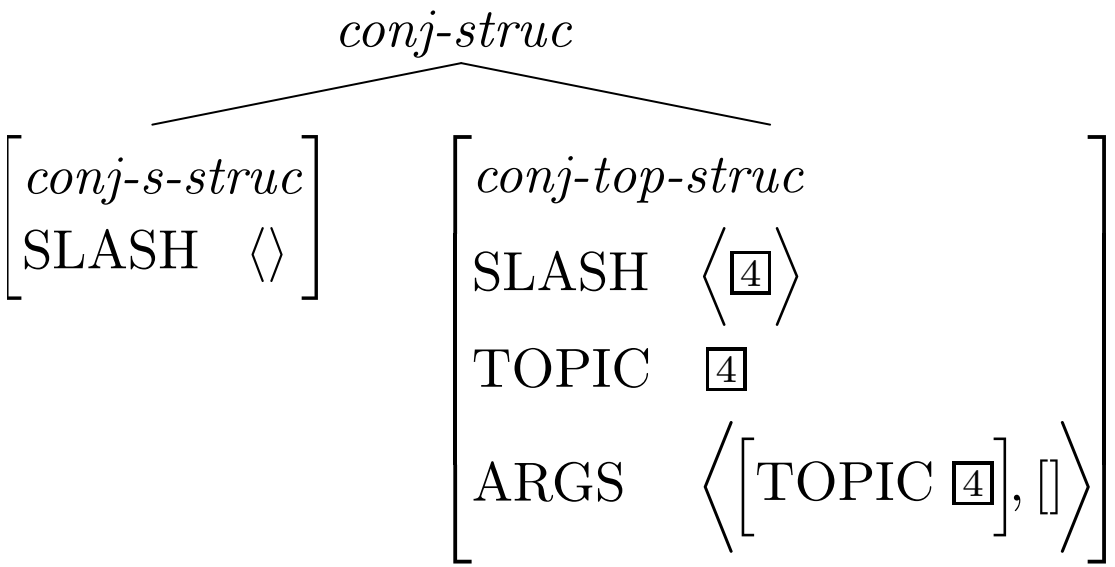


Figure 9: Coordination types

Incremental parsing and coordination

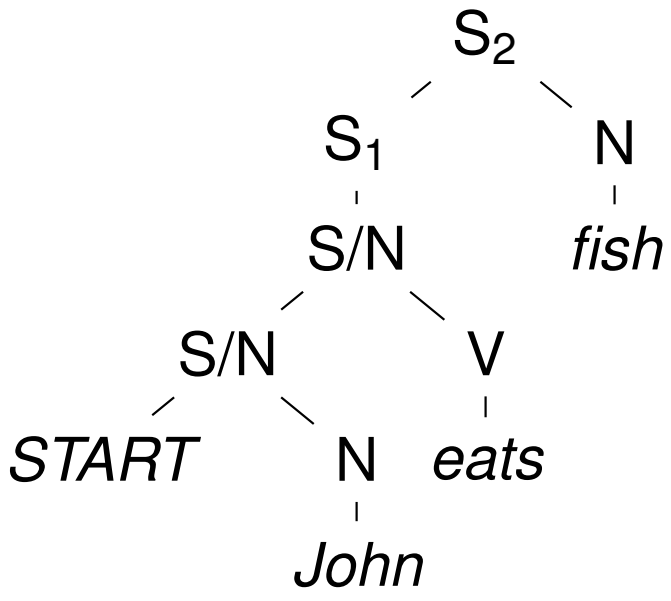
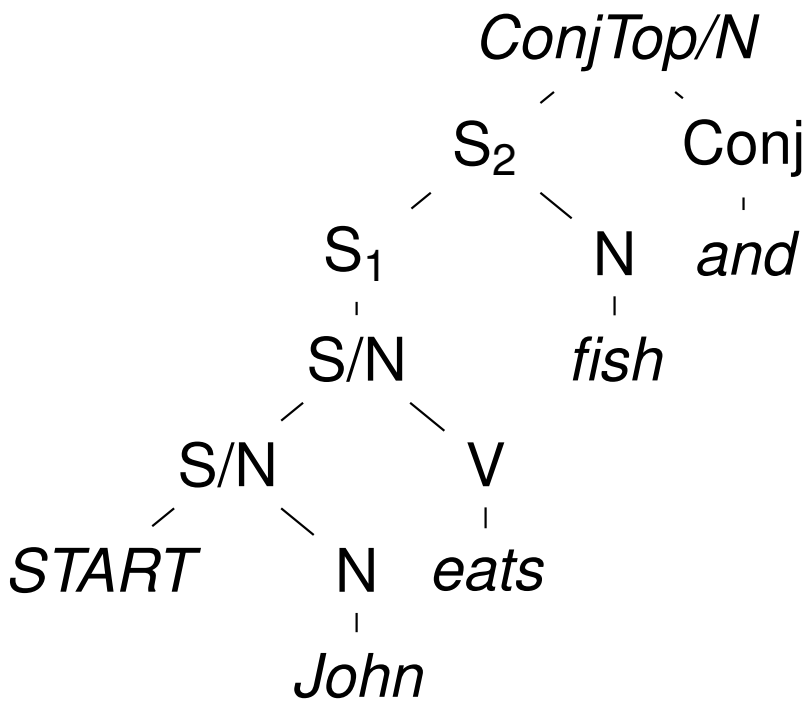


Figure 10: Derivation tree of two sentences with a shared topic

Incremental parsing and coordination



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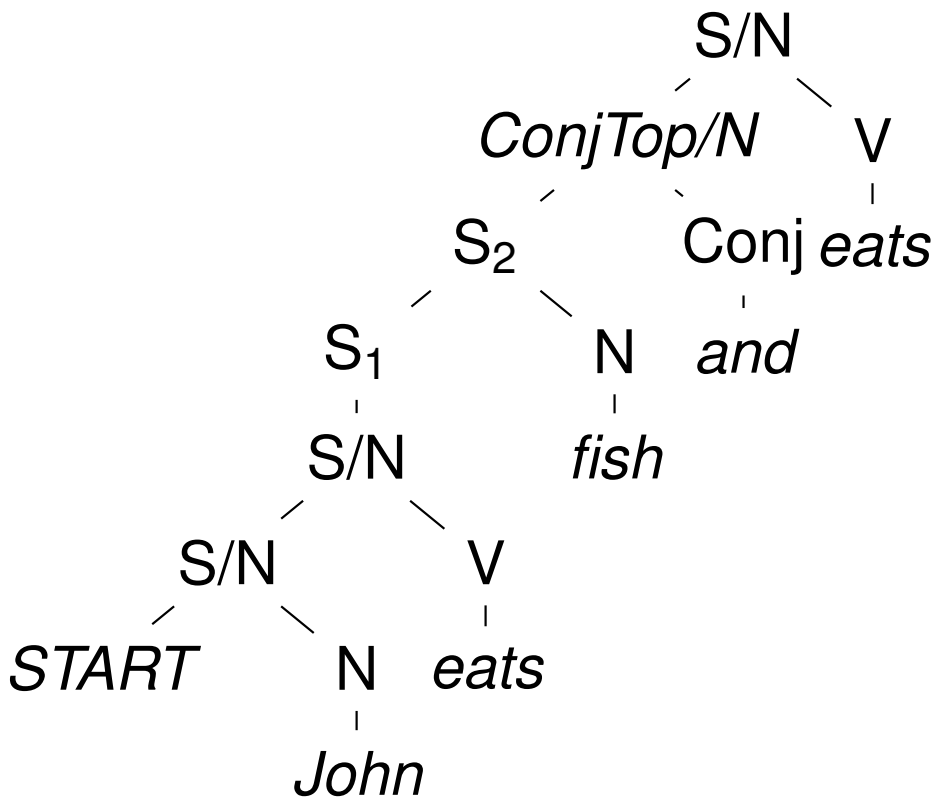

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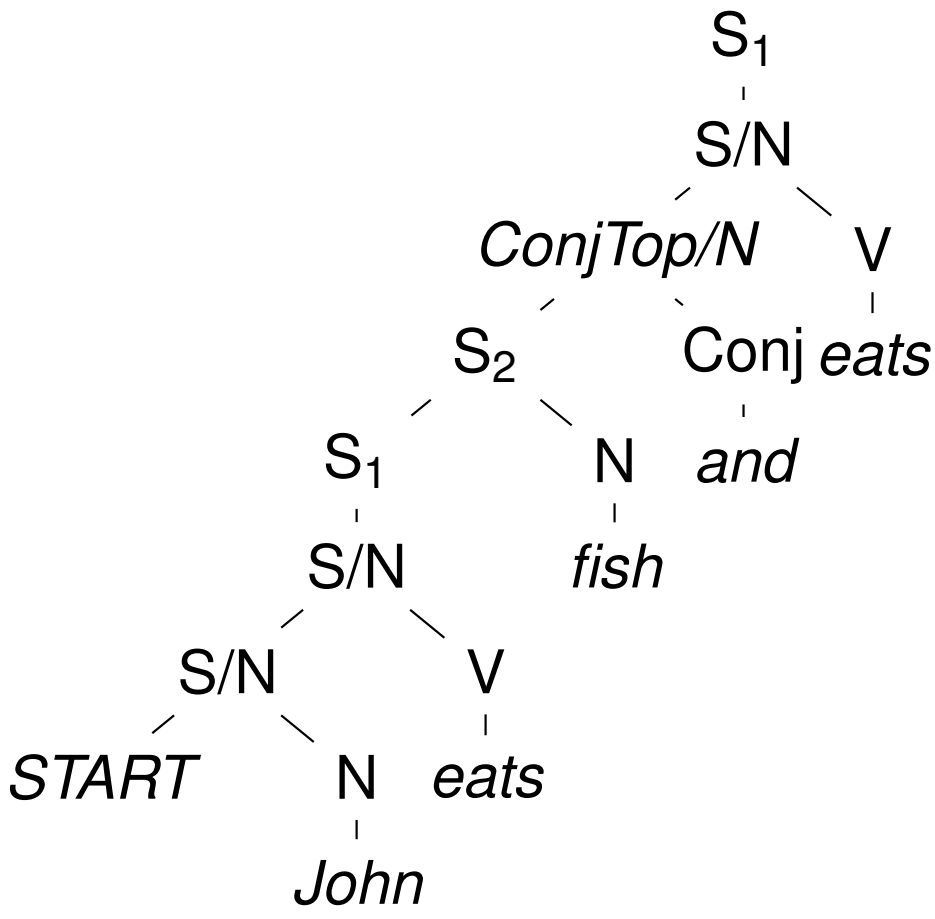

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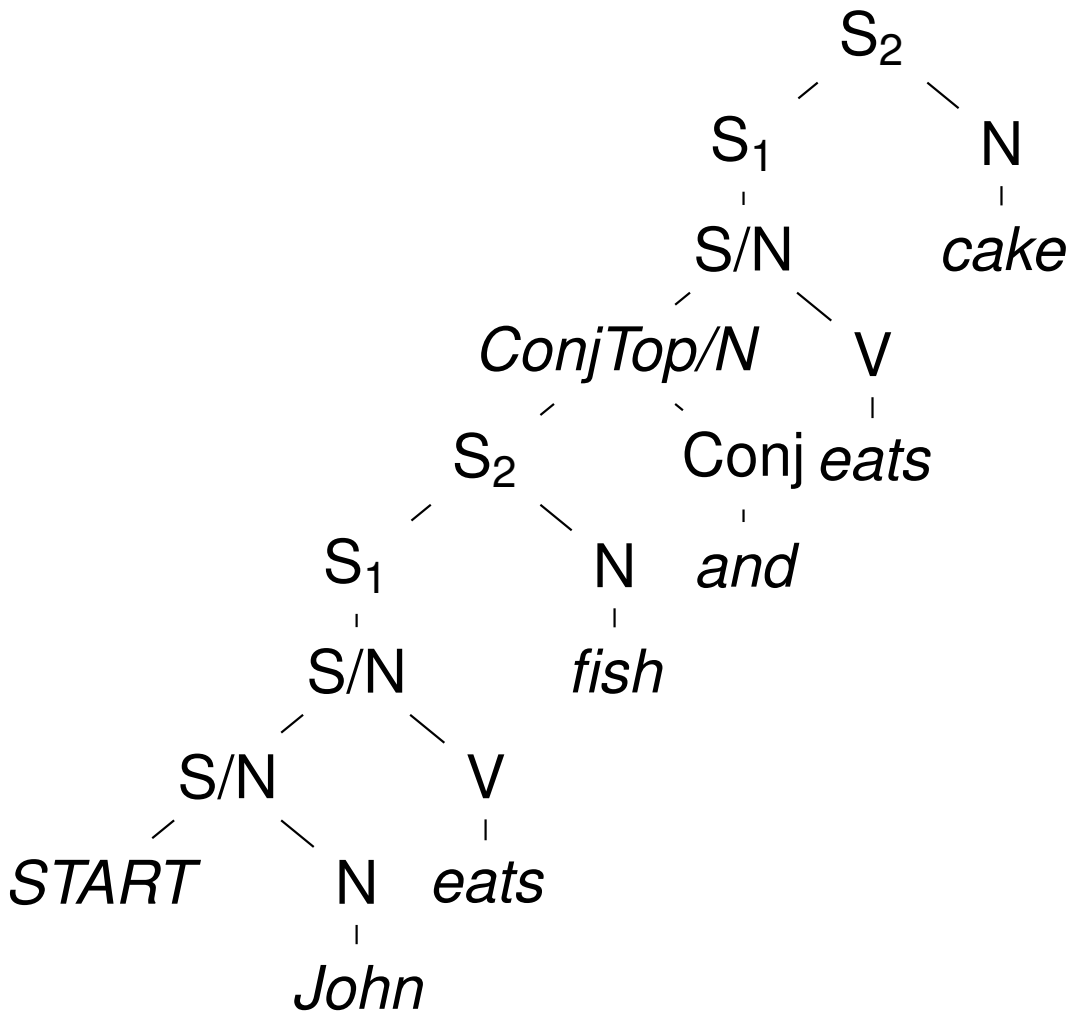


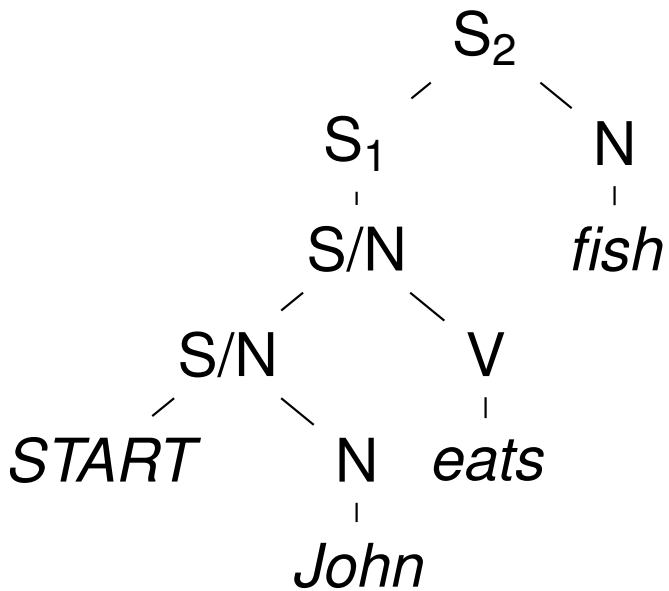
Figure 10: Derivation tree of two sentences with a shared topic

Analysis of gapping

$$\begin{bmatrix} \textit{verb-gapping-struc} & \\ \text{CAT} & \begin{bmatrix} \text{HEAD} & \boxed{1}\begin{bmatrix}\text{GAPPING} & +\end{bmatrix} \\ \text{VBL} & \textit{anti-synsem} \end{bmatrix} \\ \text{LKEYS} & \begin{bmatrix}\text{KEYREL} & \boxed{3}\end{bmatrix} \\ \text{C-CONT} & \begin{bmatrix}\text{RELS} & \langle\, !\ \boxed{3}\ !\,\rangle\end{bmatrix} \\ \text{ARGS} & \left\langle \begin{bmatrix} \text{CAT} & \begin{bmatrix}\text{HEAD} & \boxed{1} \\ \text{VBL} & \textit{synsem}\end{bmatrix} \\ \text{LKEYS} & \begin{bmatrix}\text{KEYREL} & \boxed{3} \\ \text{GAPREL} & \boxed{3}\end{bmatrix} \end{bmatrix} \right\rangle \end{bmatrix}$$

Figure 11: Unary rule for elided verbs

Analysis – Gapping



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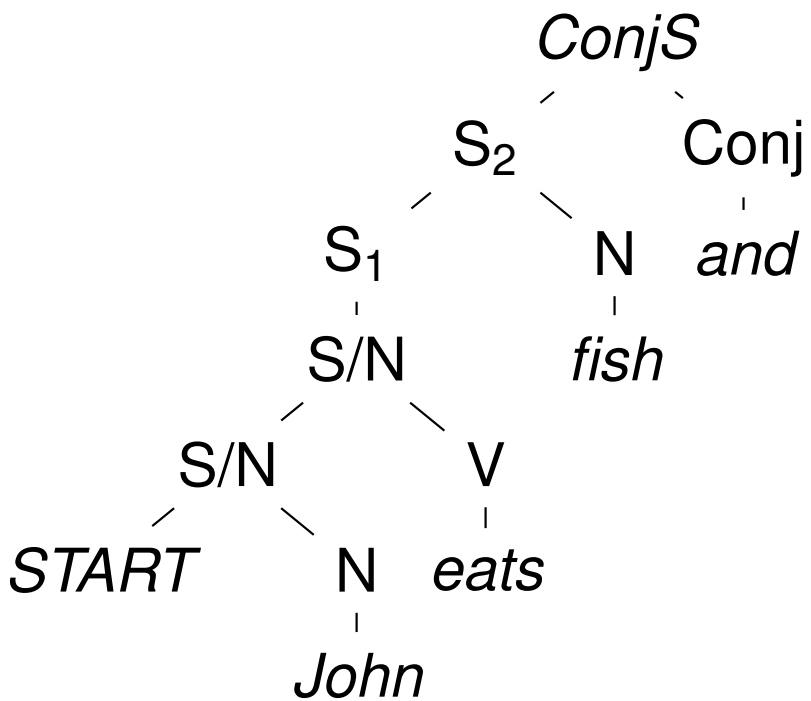

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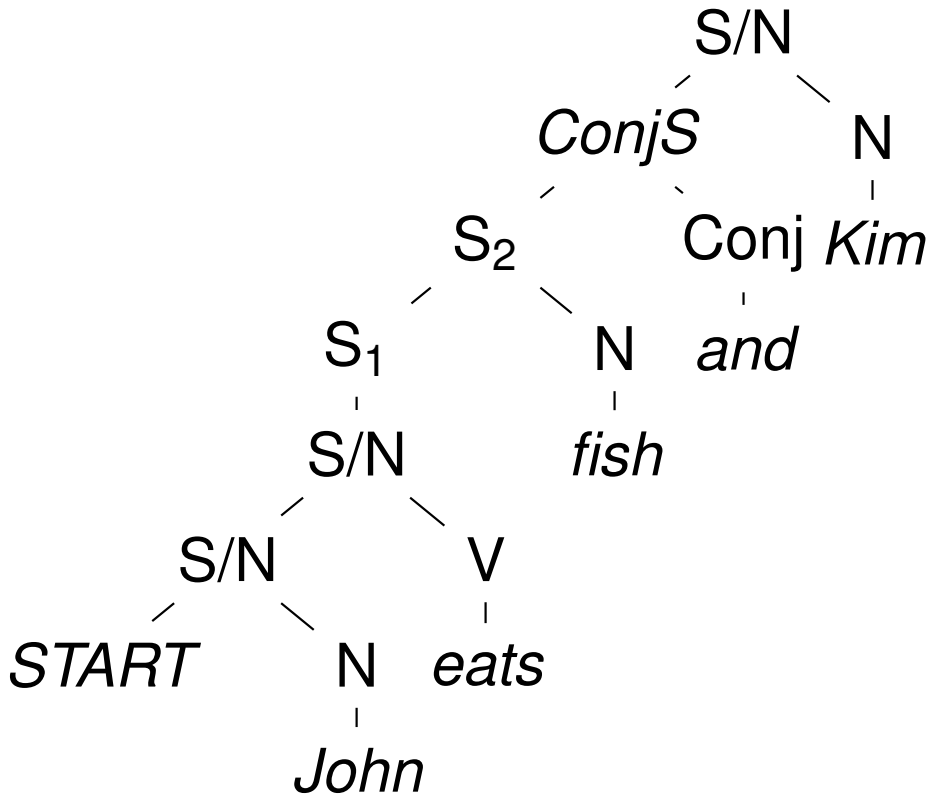

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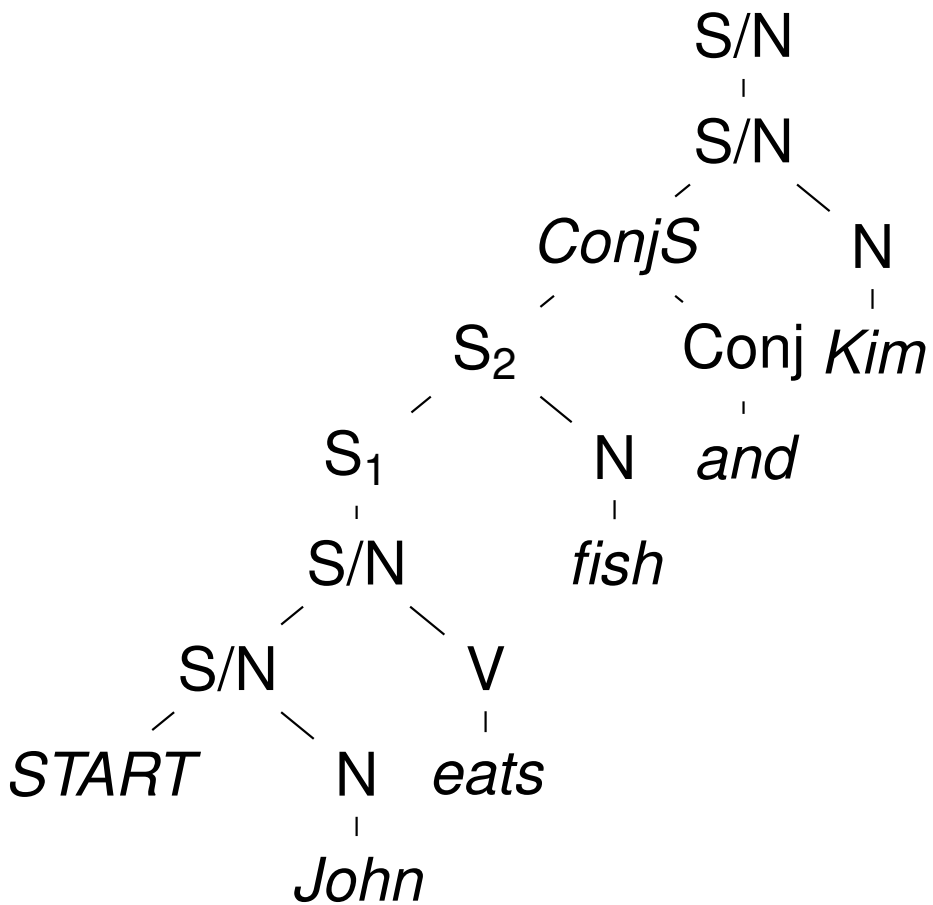

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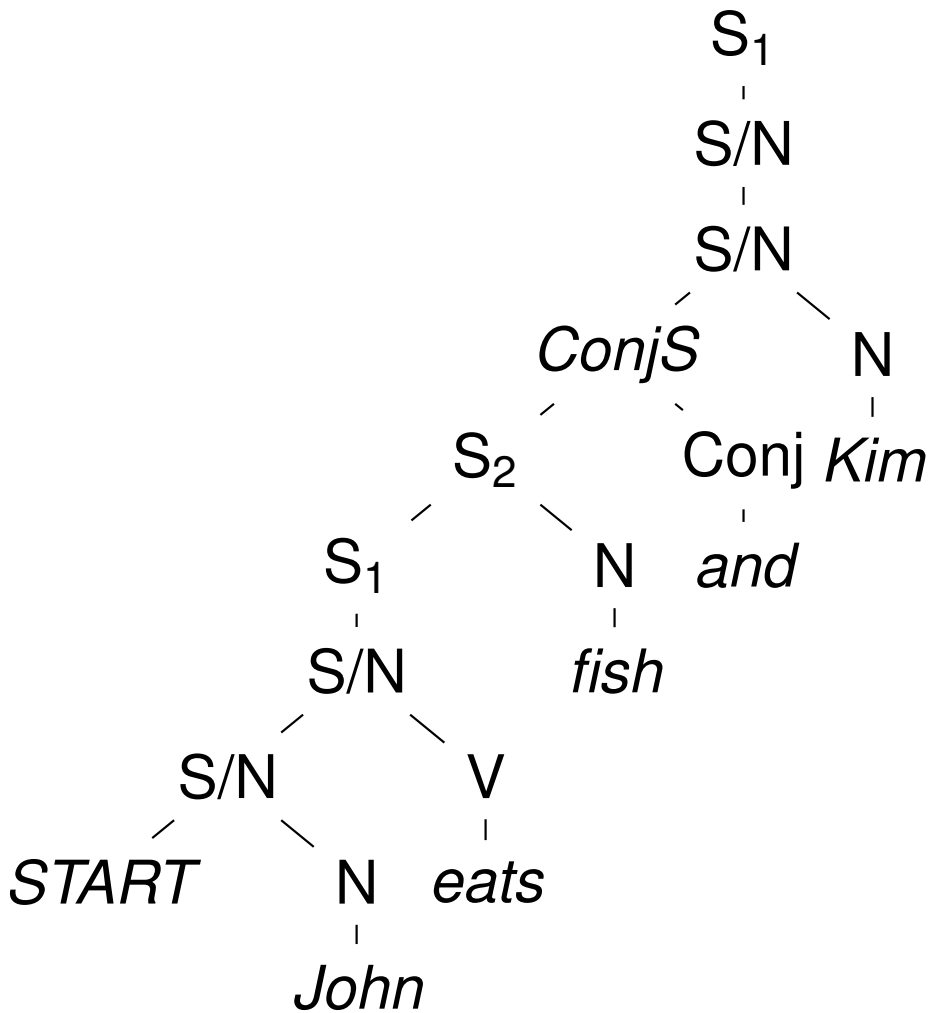

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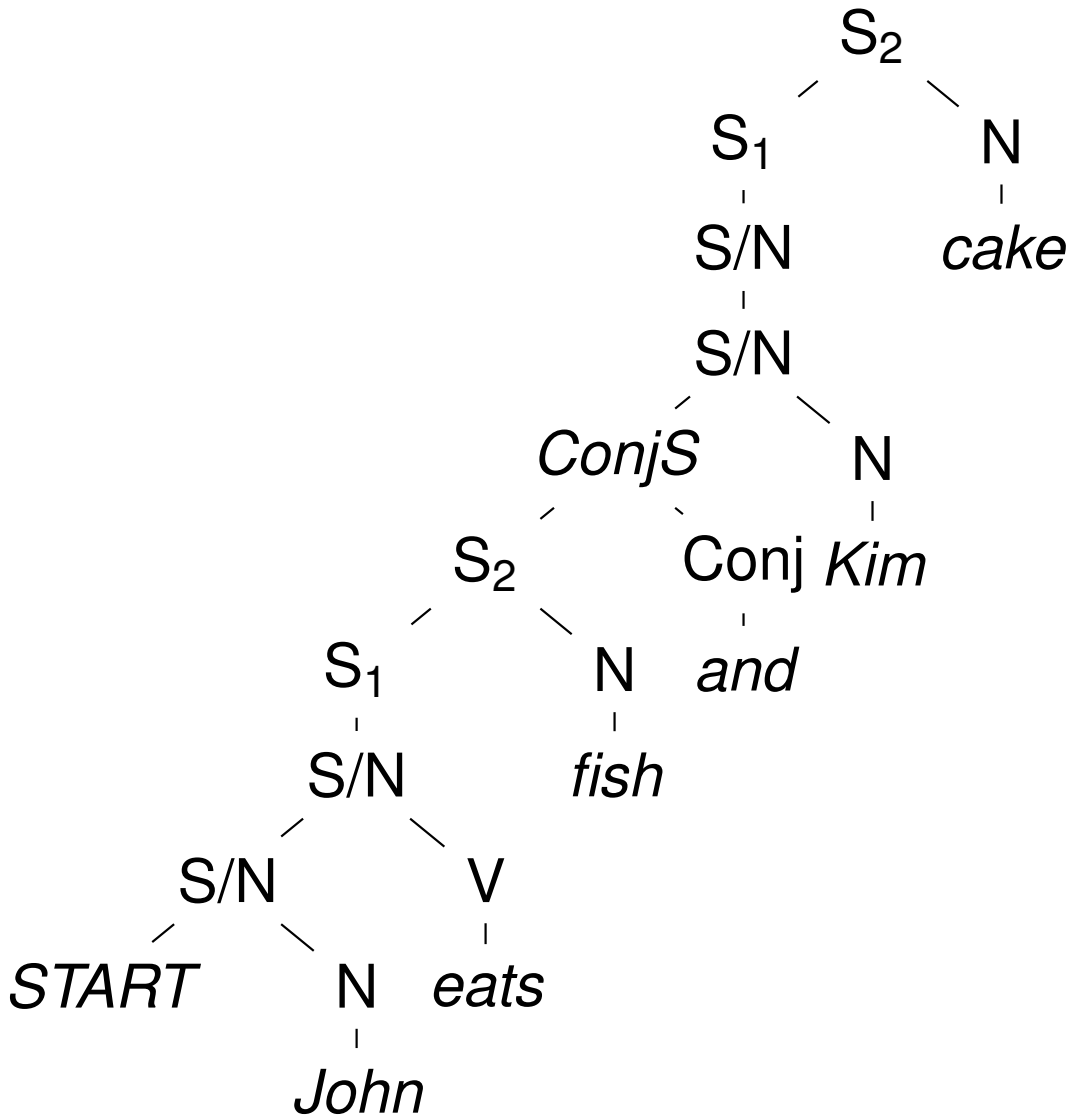
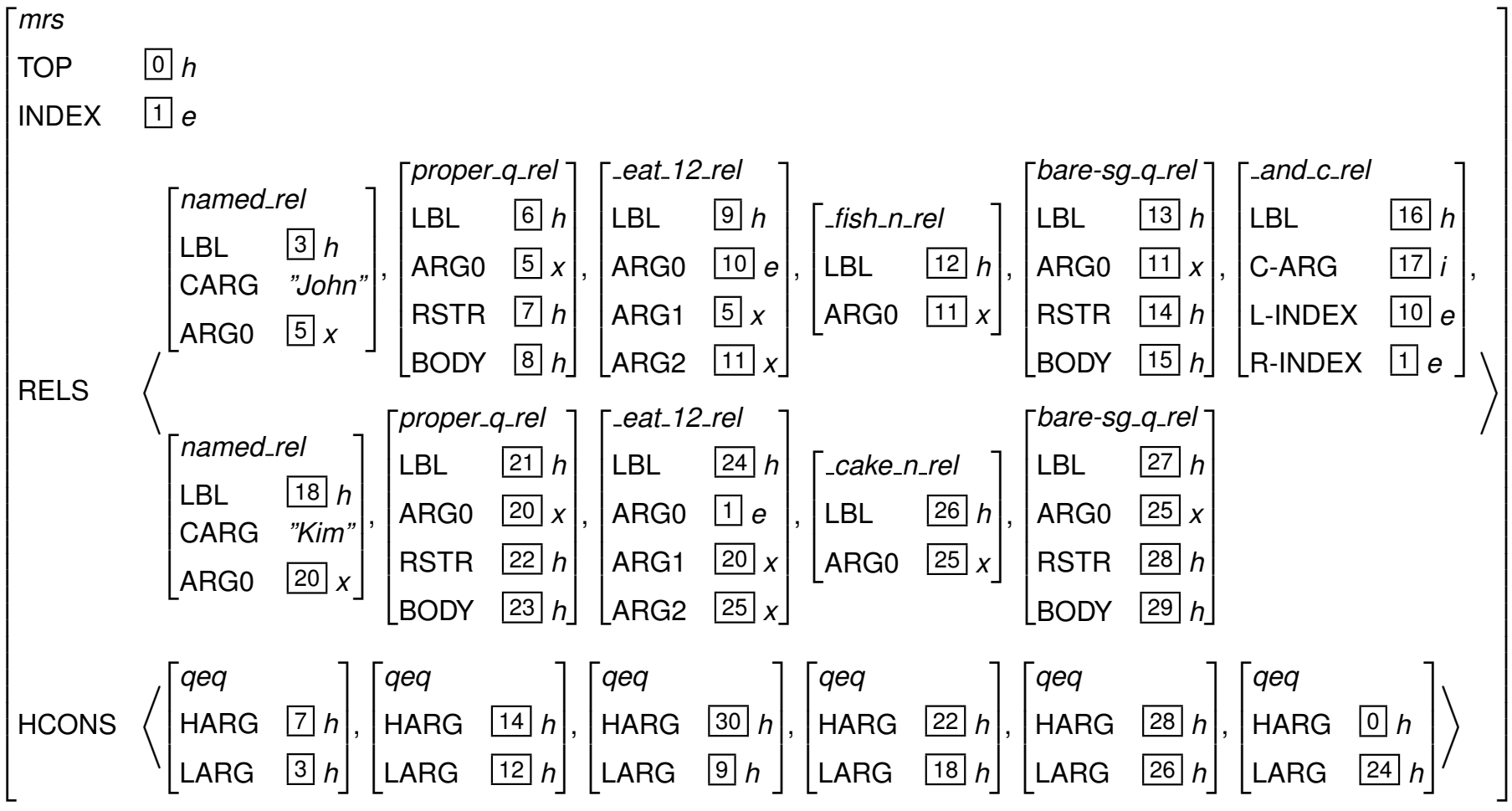
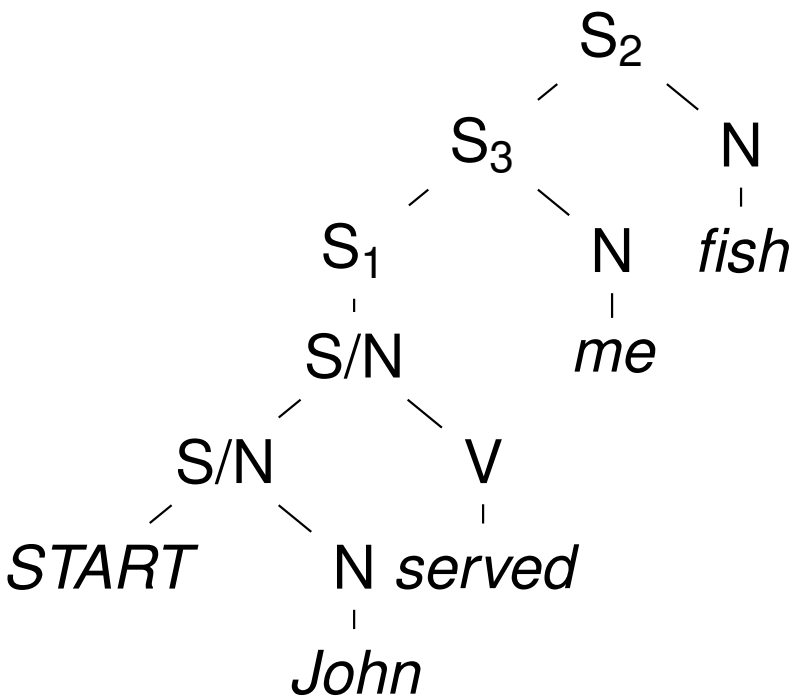


Semantic representation – Gapping



Analysis – Conjunction Reduction



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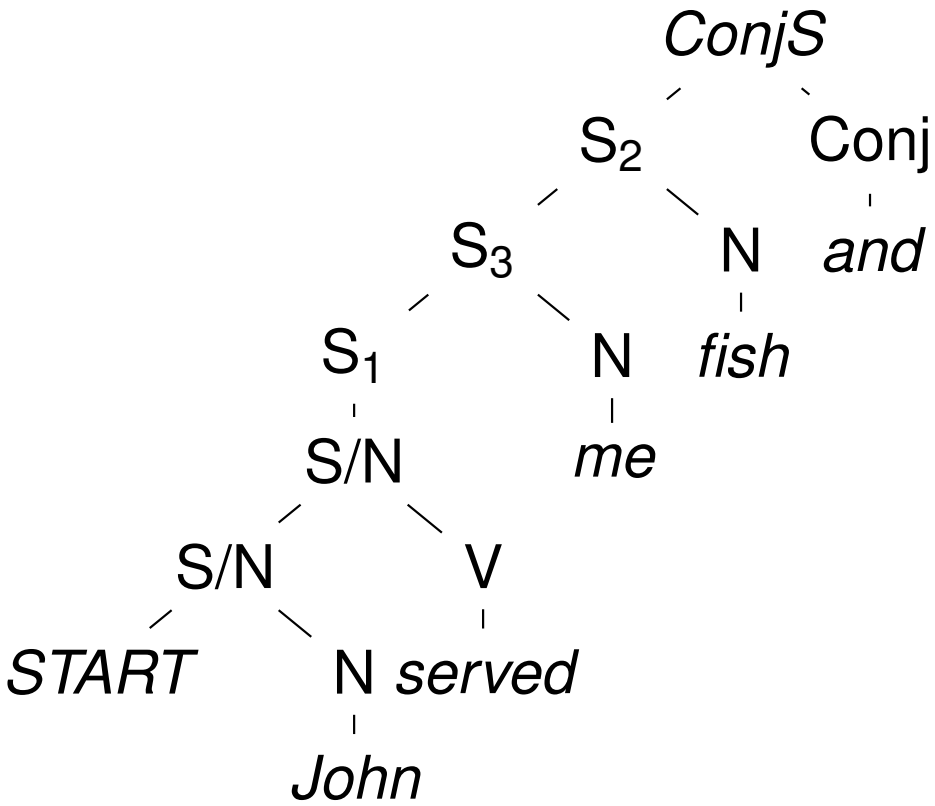
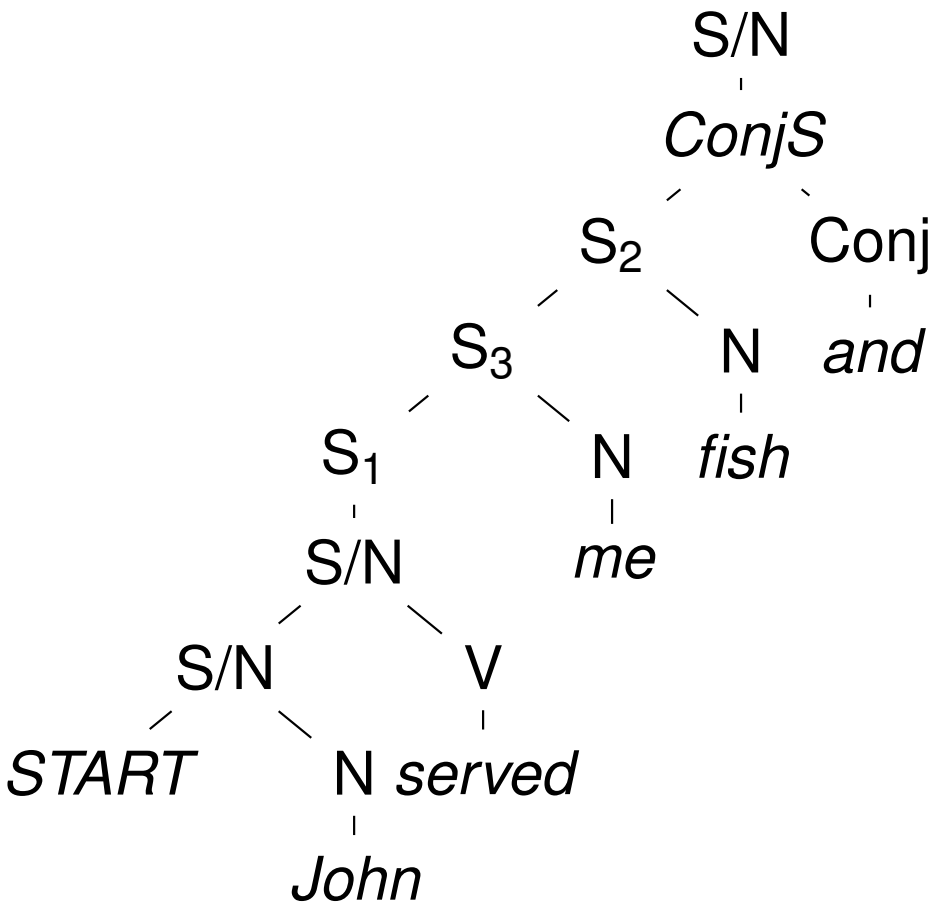
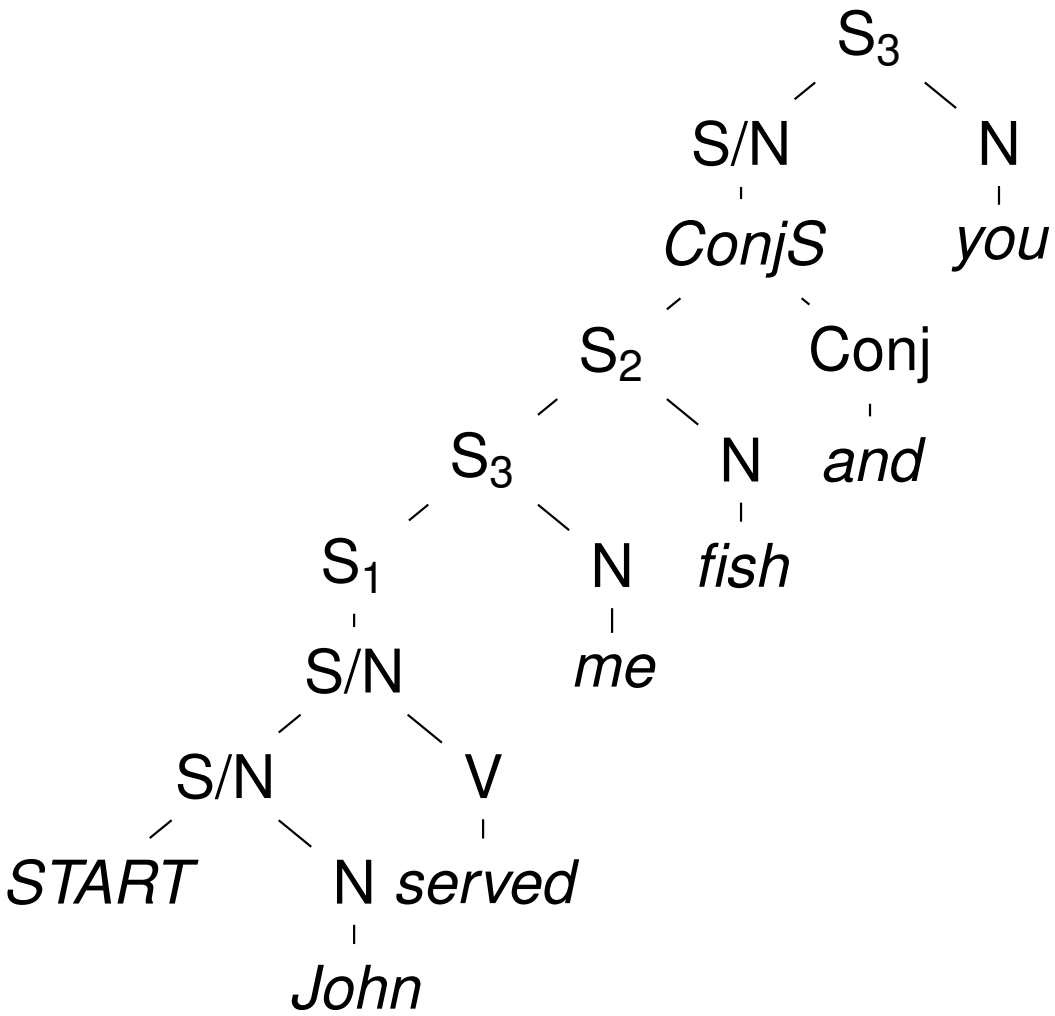


Analysis – Conjunction Reduction



Analysis – Conjunction Reduction



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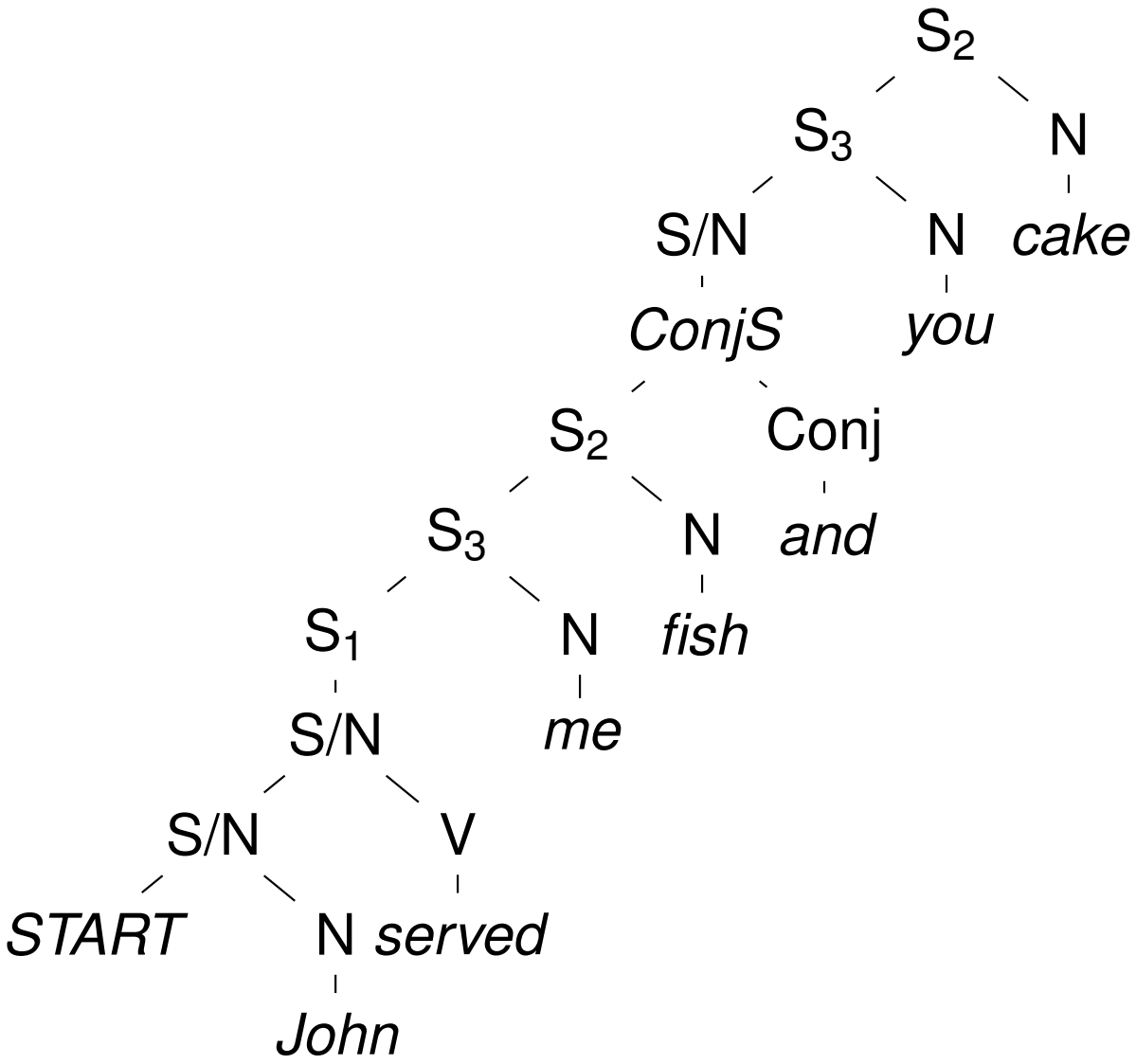

Results

- The analysis for gapping and conjunction reduction is implemented in the Norwegian HPSG grammar Norsyg
  - Transitive and ditransitive verbs
  - Particle verbs
  - Verbs with selected prepositions
  - Non-subject topics
  - Passive
  - Multiple conjuncts
- Ongoing experiments:
  - Reflexive verbs
  - VP idioms
- A test on 333 test sentences show an increase of processing effort of 46% (mainly due to one sentence).

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