Optimizing for parsing: modeling word-order preferences

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Leipzig University

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The presentation in bullet points:

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- A left-corner Minimalist Grammar parsing model captures mixed word-order preferences.

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- A left-corner Minimalist Grammar parsing model captures mixed word-order preferences.
- Syntactic operations allow optimization for parsing?

Outline

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1. Introduction

2. Modeling mix word-order preferences
   - English heavy NP shift
   - Japanese transitive

3. Next steps and open questions

Introduction

Previously in my parsing corner...

- Complexity metric: tenure

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In this episode...

left-corner MG parsing model and word-order preferences.

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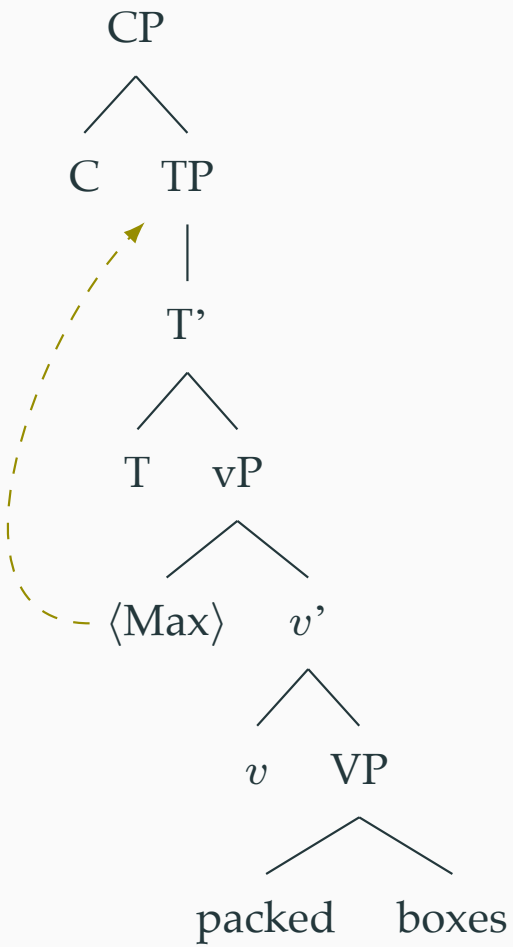

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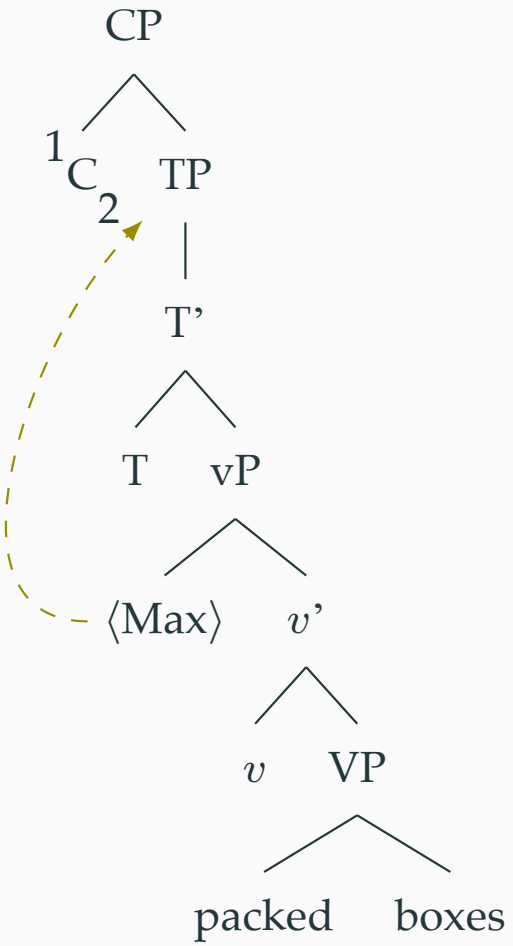

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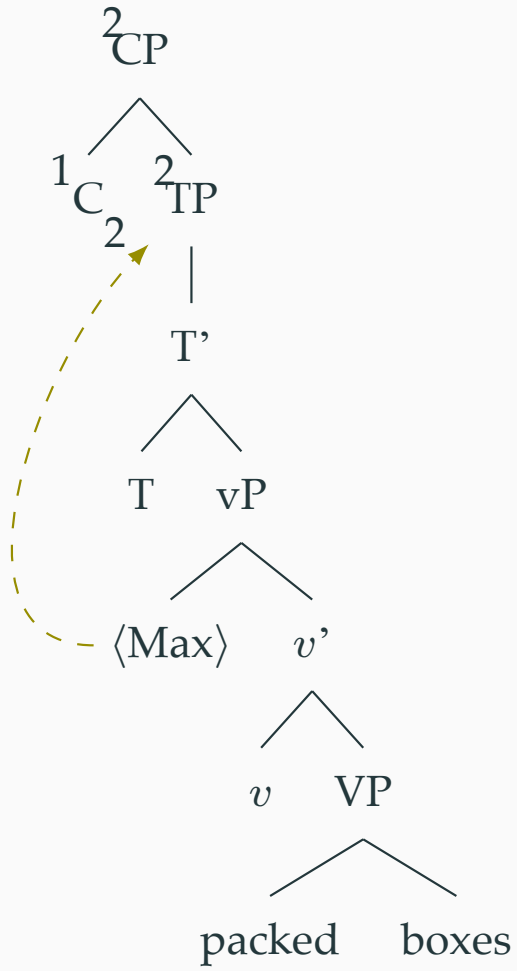

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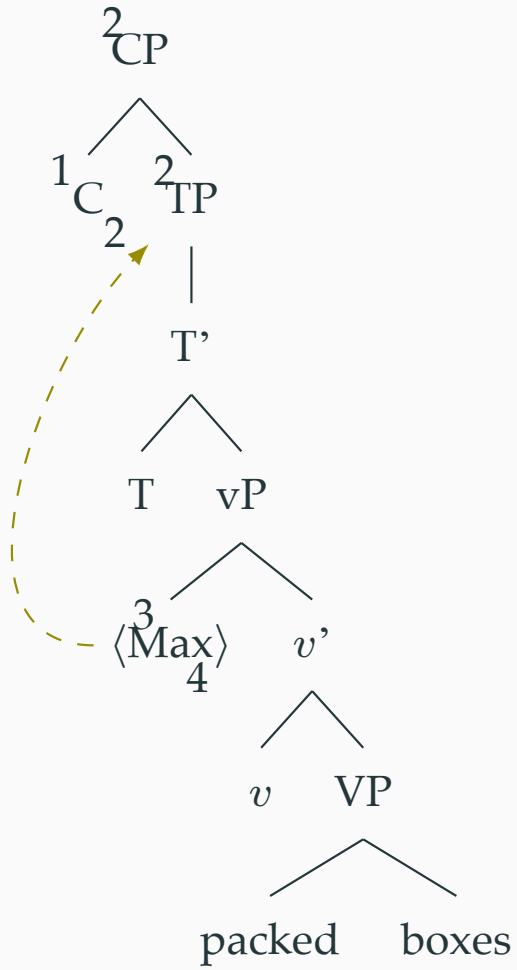

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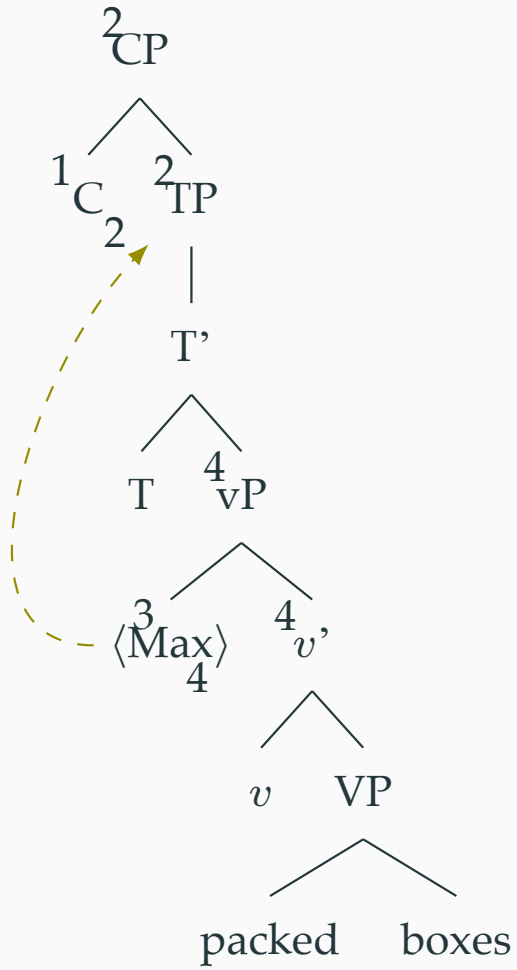

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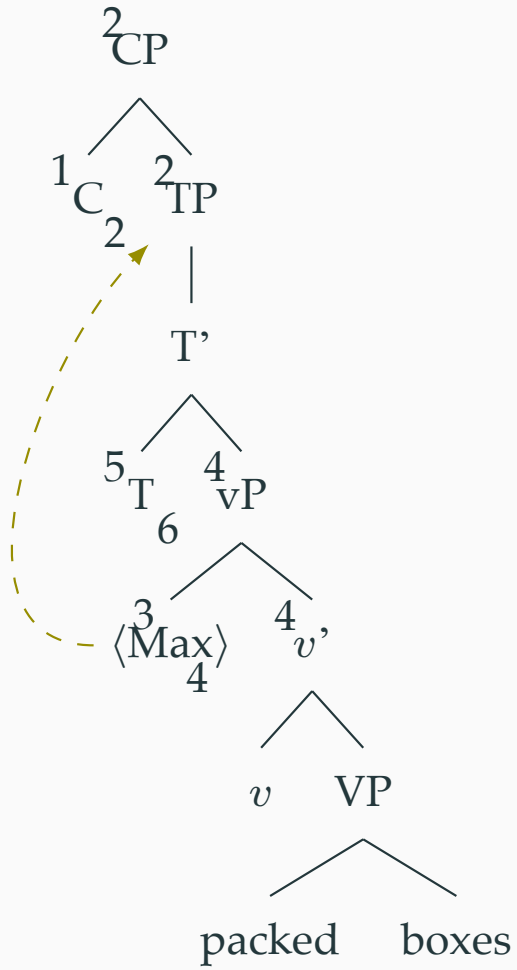

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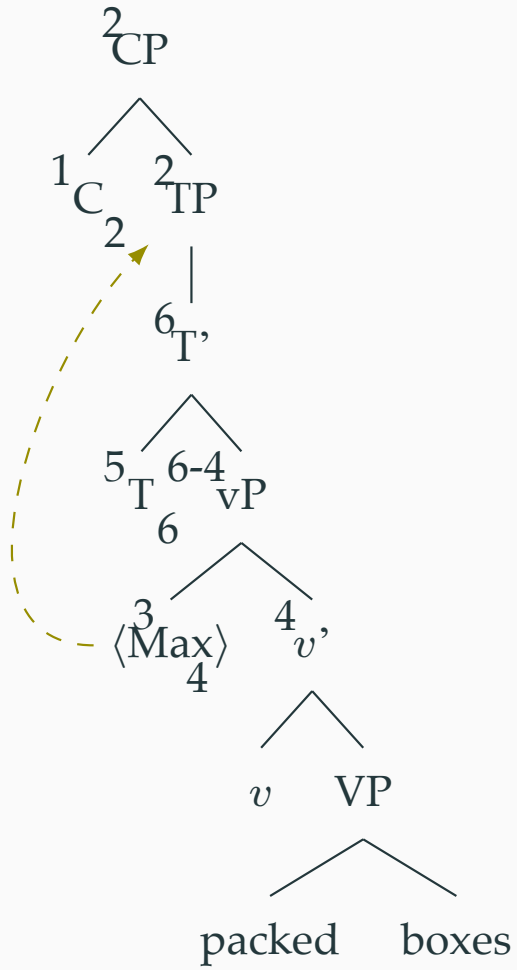

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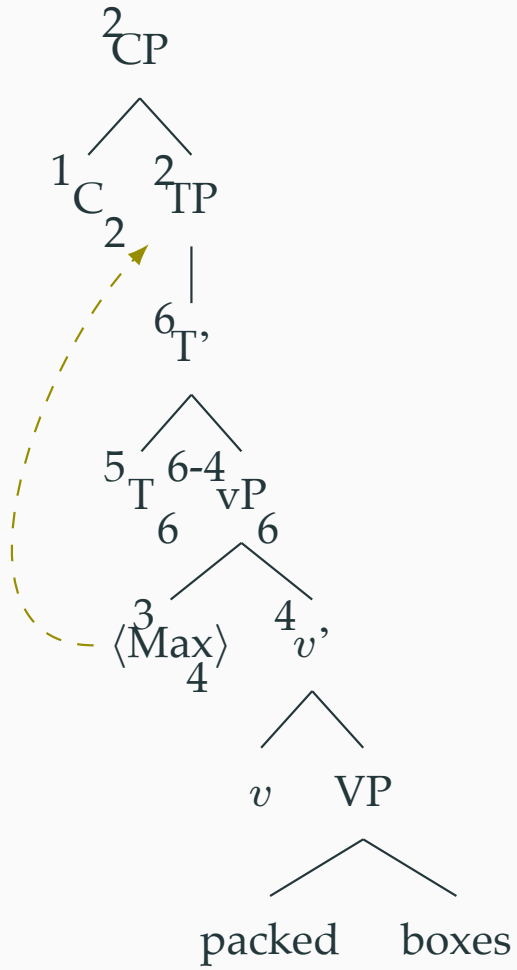

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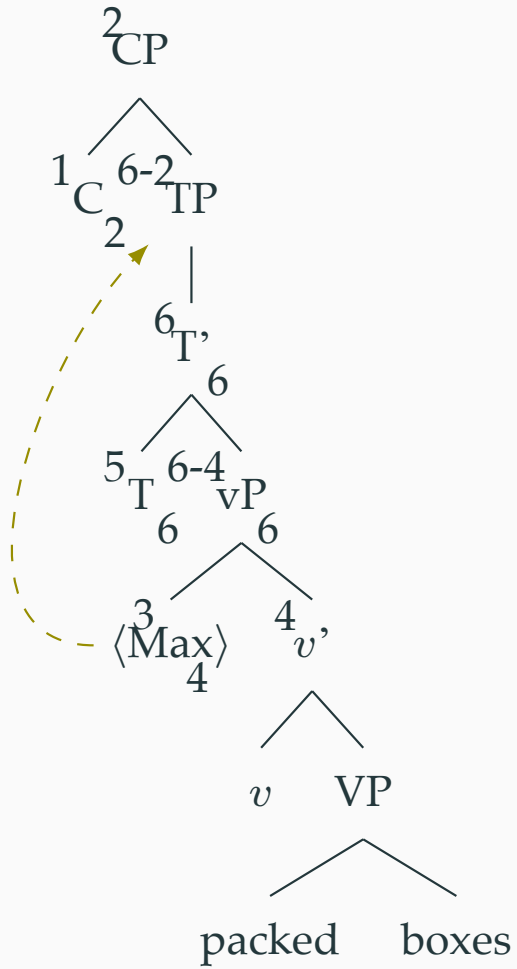

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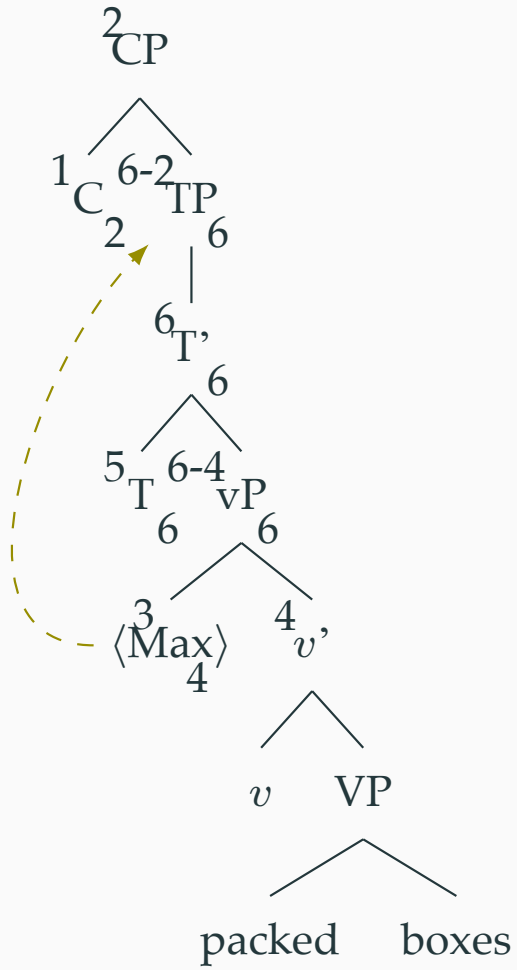

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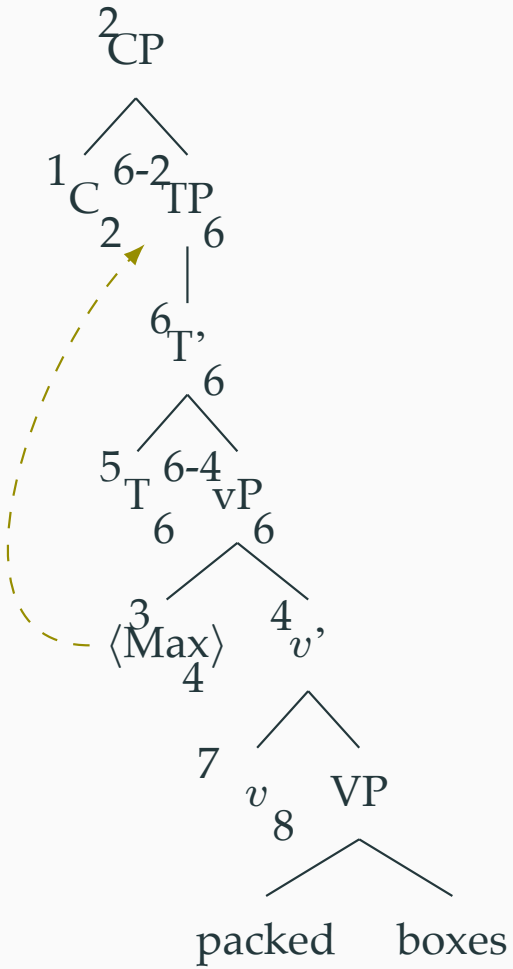

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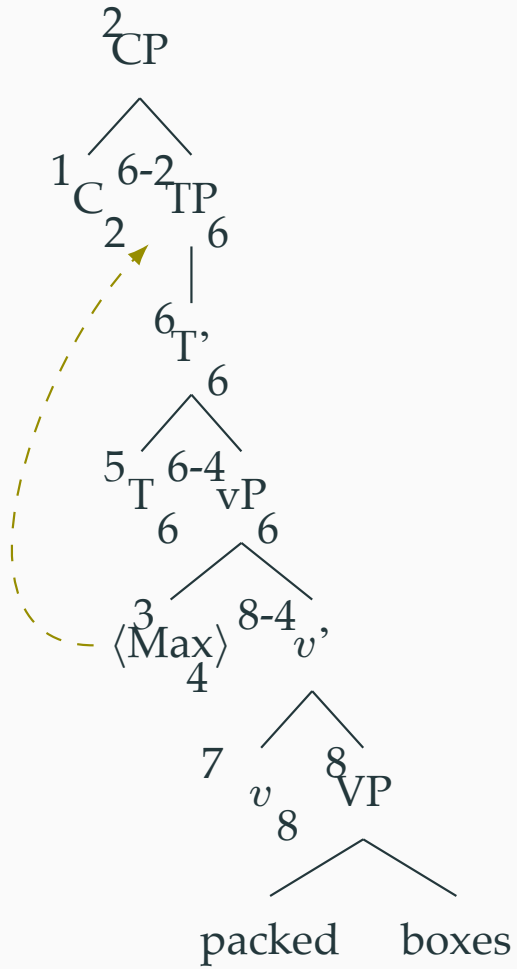

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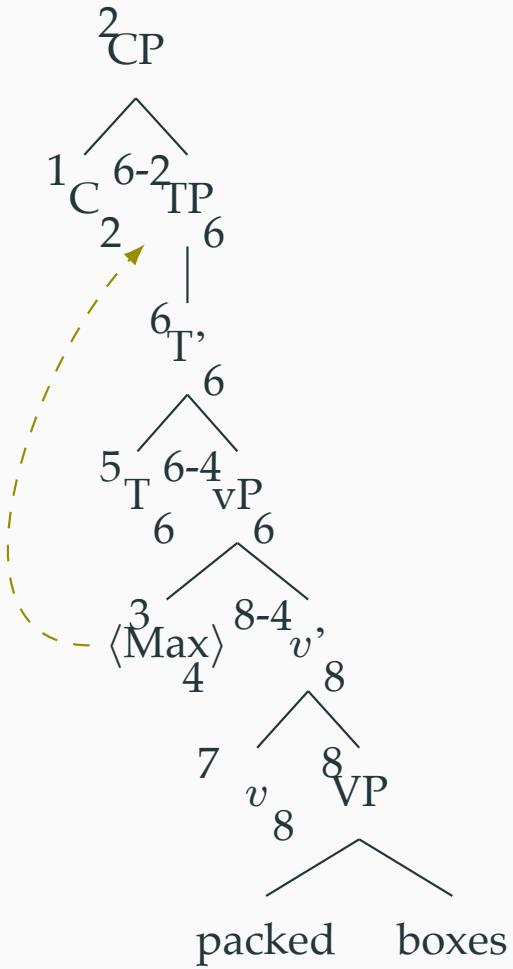

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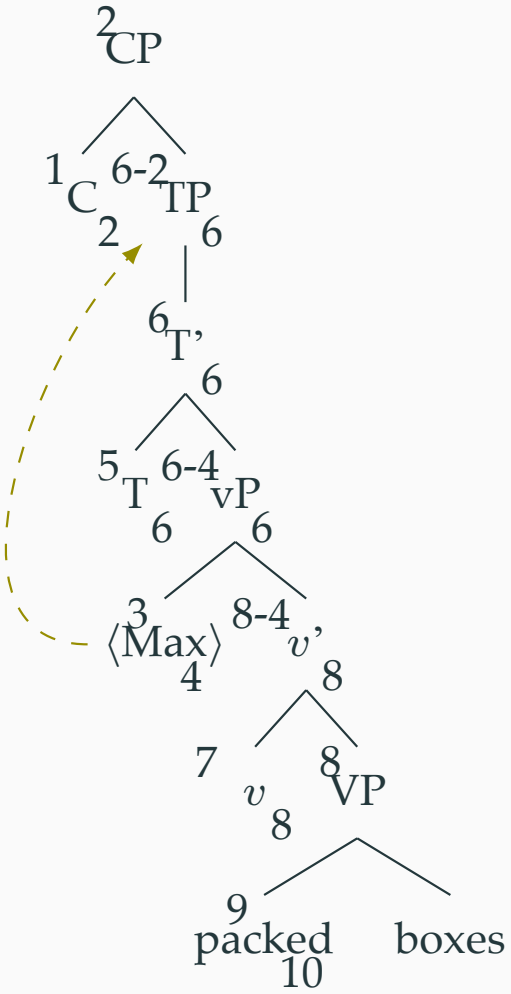

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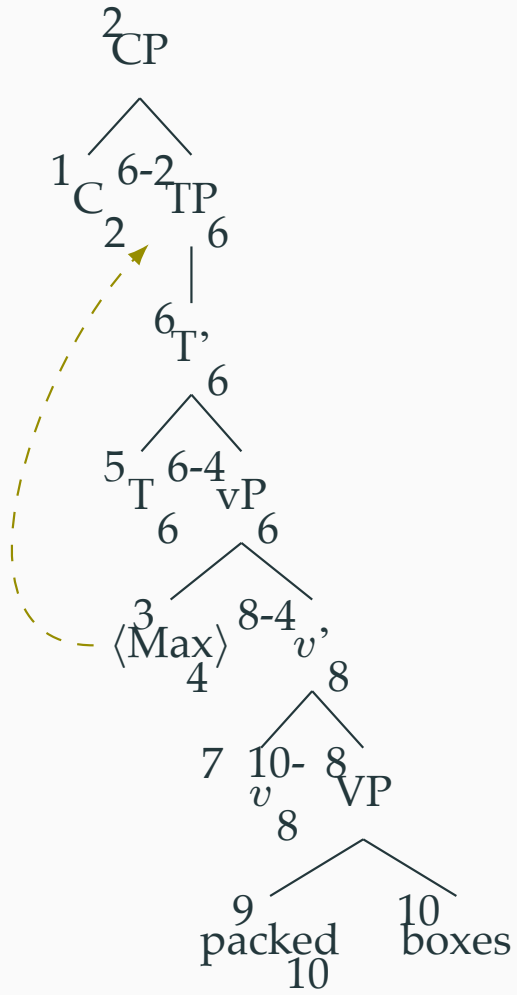

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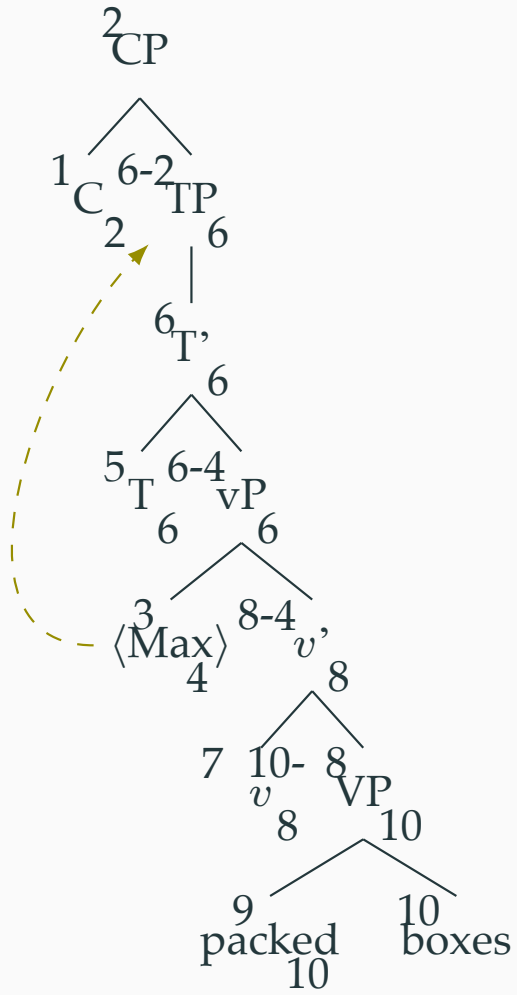

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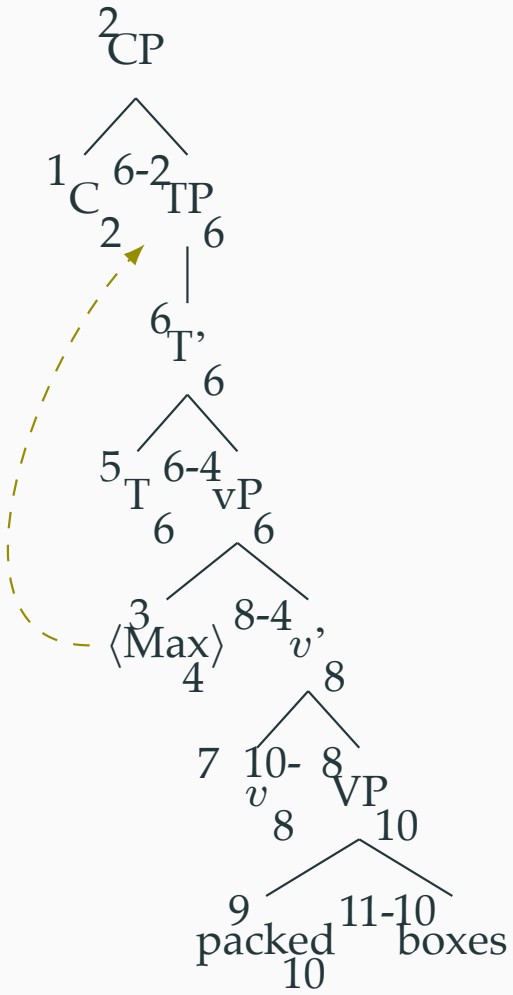

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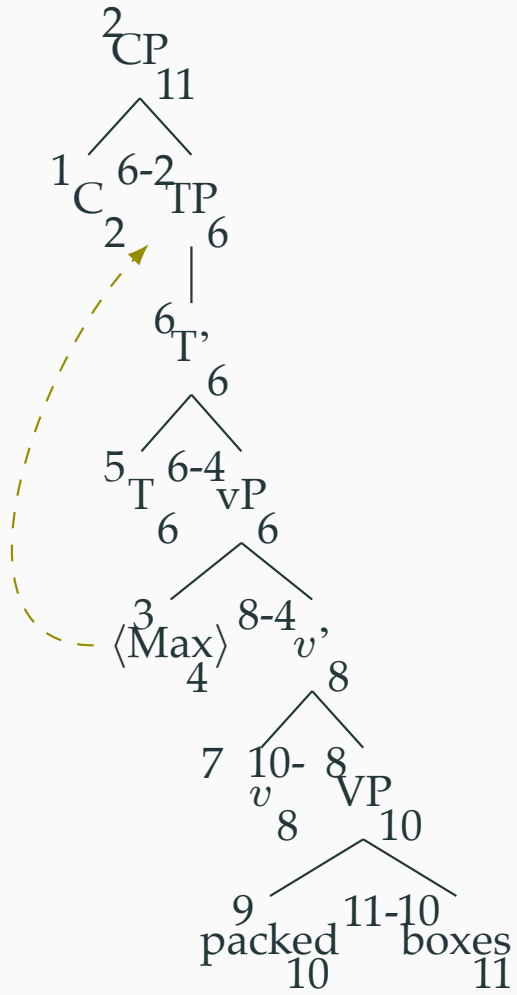

Modeling mix word-order preferences

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LC MG parsing captures all of the above!

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Overview: mixed word-order preferences

- Short-before-long preference
  - English heavy NP shift (HNPS)
    - how does the model work
- Long-before-short preference
  - Japanese transitive
    - syntactic analyses
- No preference
  - Mandarin preverbal PPs
    - Other metrics?

English HNPS: Data

(1) Max put [$_{PP}$ in his car] [$_{DP}$ all the boxes of home furnishings].

(2) ?Max put [$_{DP}$ all the boxes of home furnishings] [$_{PP}$ in his car].

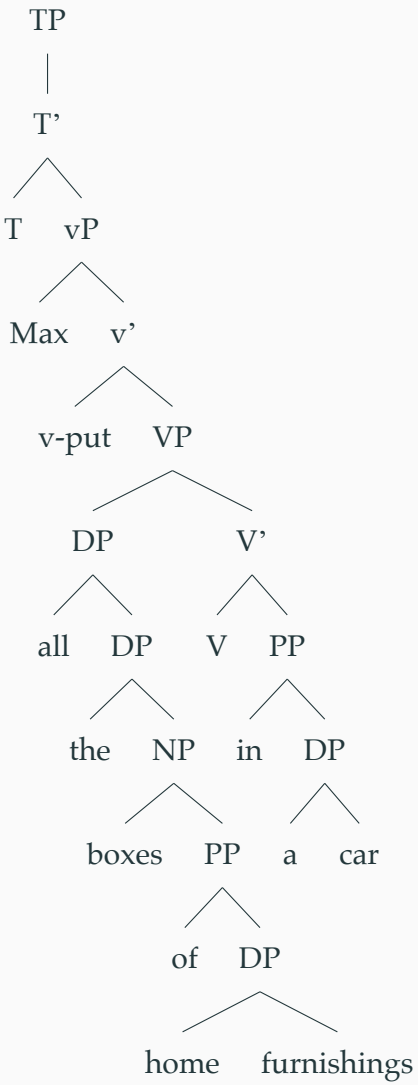
English HNPS: Data

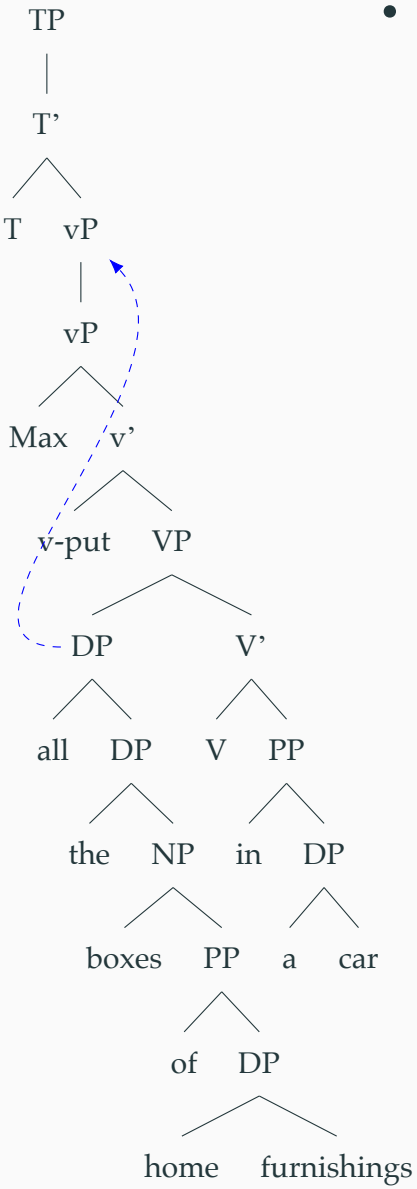
(1) Max put [$_{PP}$ in his car] [$_{DP}$ all the boxes of home furnishings].

(2) ?Max put [$_{DP}$ all the boxes of home furnishings] [$_{PP}$ in his car].

A shifted order (PP-DP) is preferred when the DP is heavy (e.g. Brown corpus Wasow 1997).

English HNPS: Syntax and modeling





- Shifted order: rightward movement (Ross 1986)

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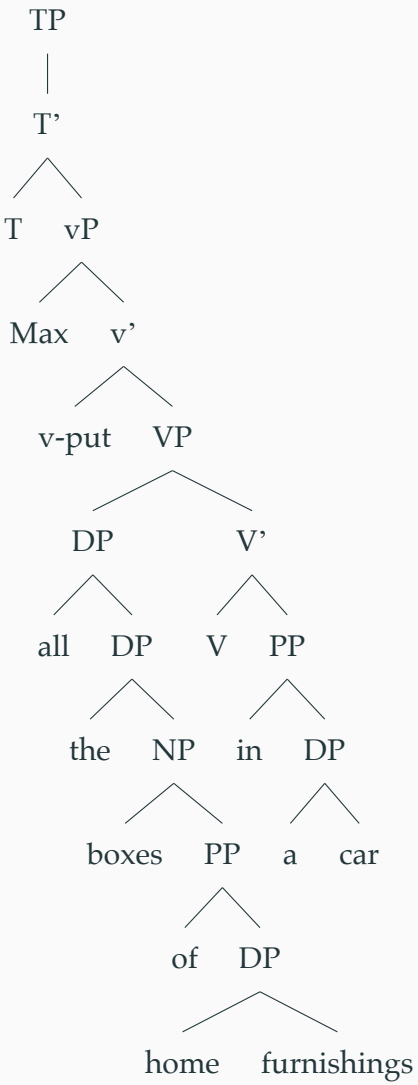

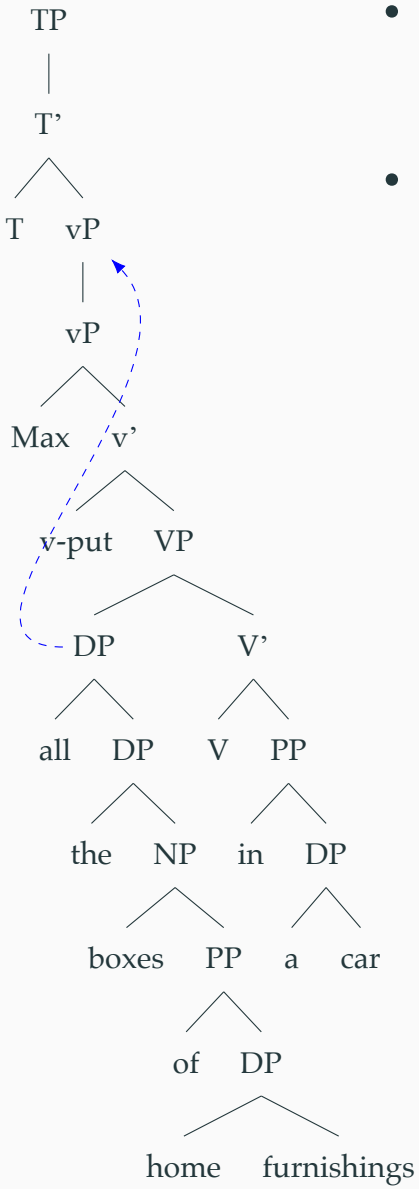

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- Ignored: V-to-v movement, ArgO-movement

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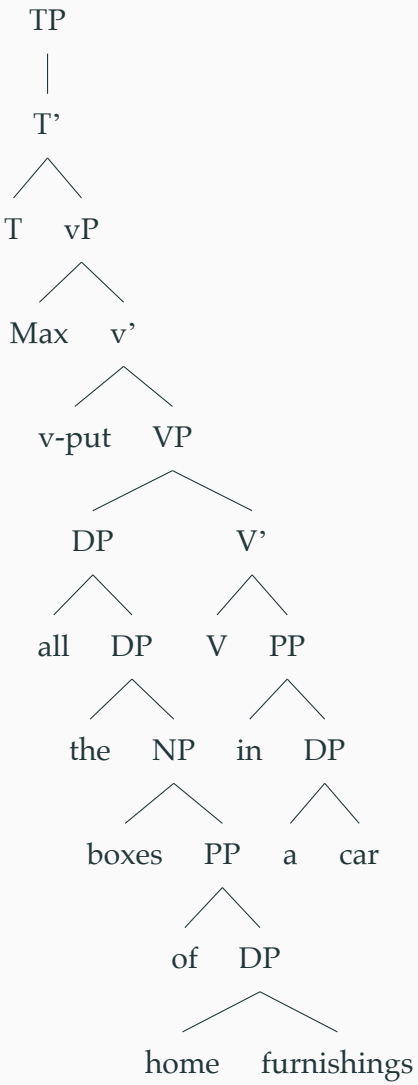

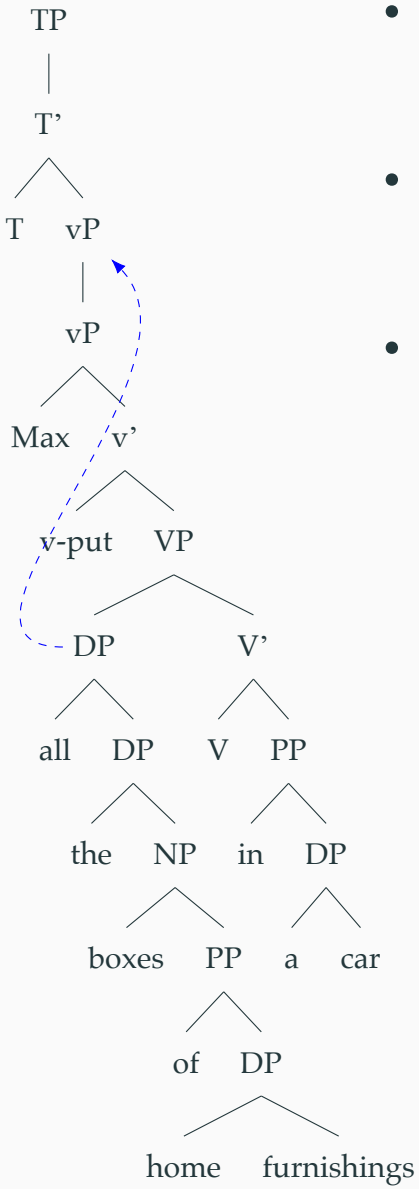

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- Results:

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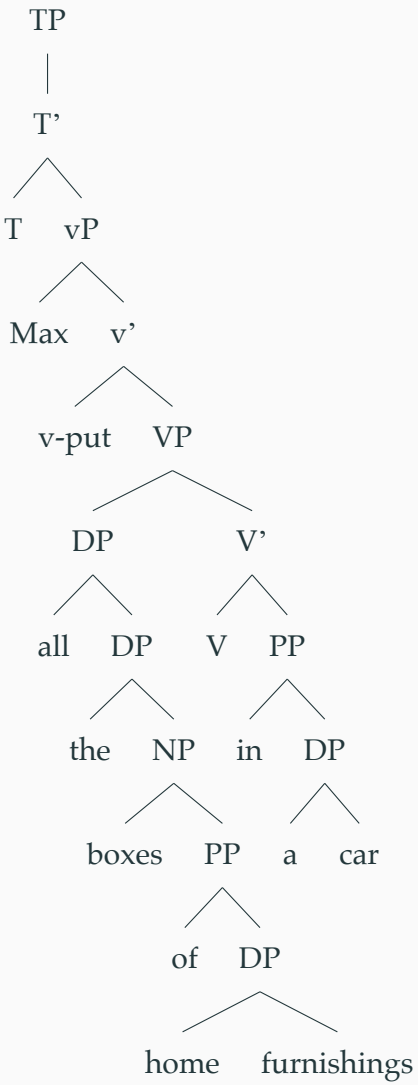

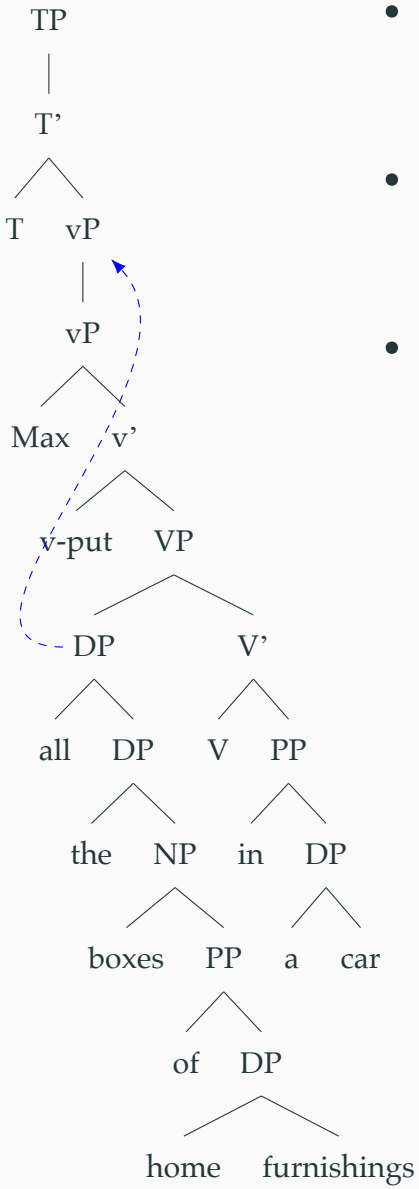

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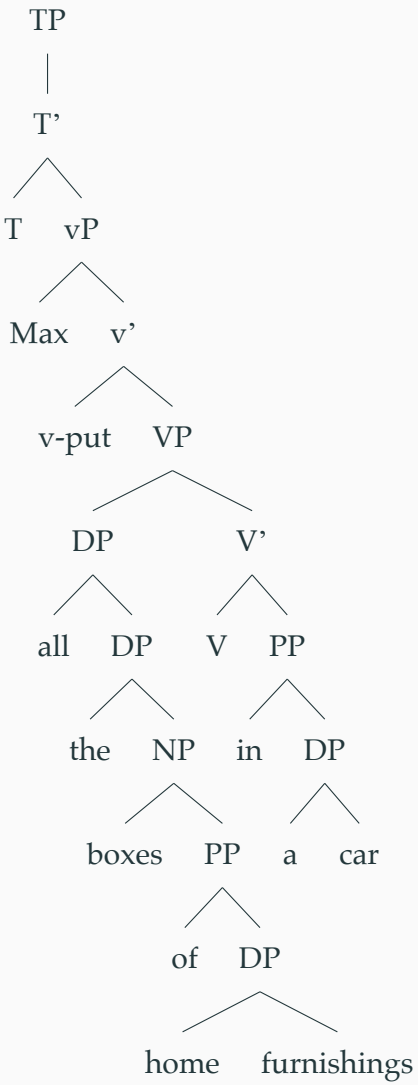
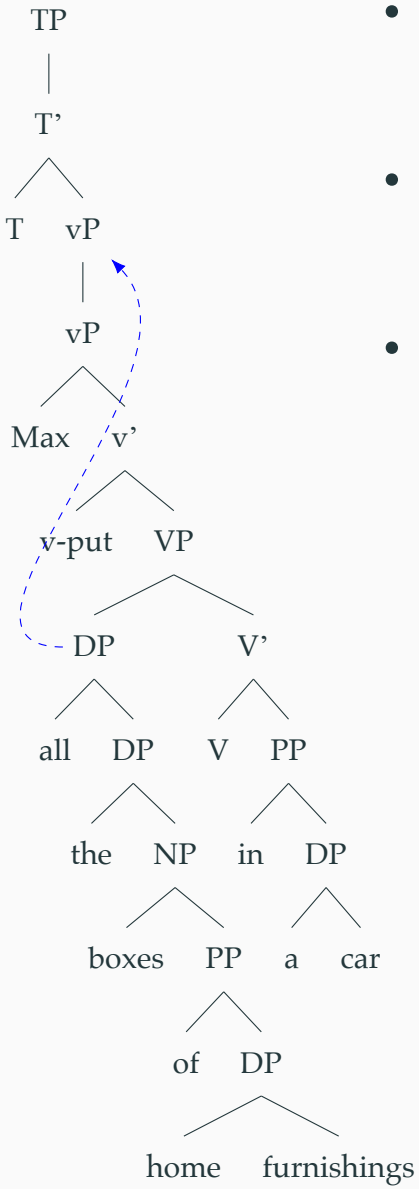
- Ignored: V-to-v movement, ArgO-movement
- Results:
  - canonical order: MaxTitem = 8

English HNPS: Syntax and modeling





- Shifted order: rightward movement (Ross 1986)
- Ignored: V-to-v movement, ArgO-movement
- Results:
  - canonical order: MaxTitem = 8
  - Shifted order: MaxTitem = 12

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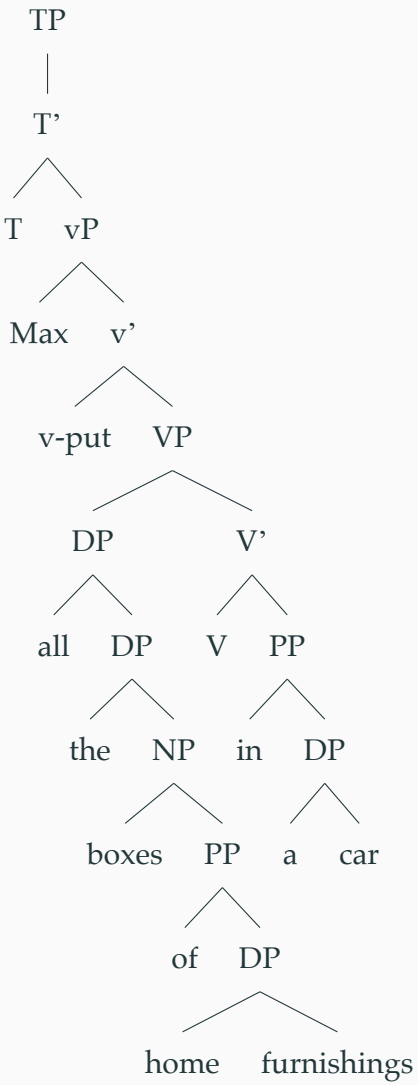

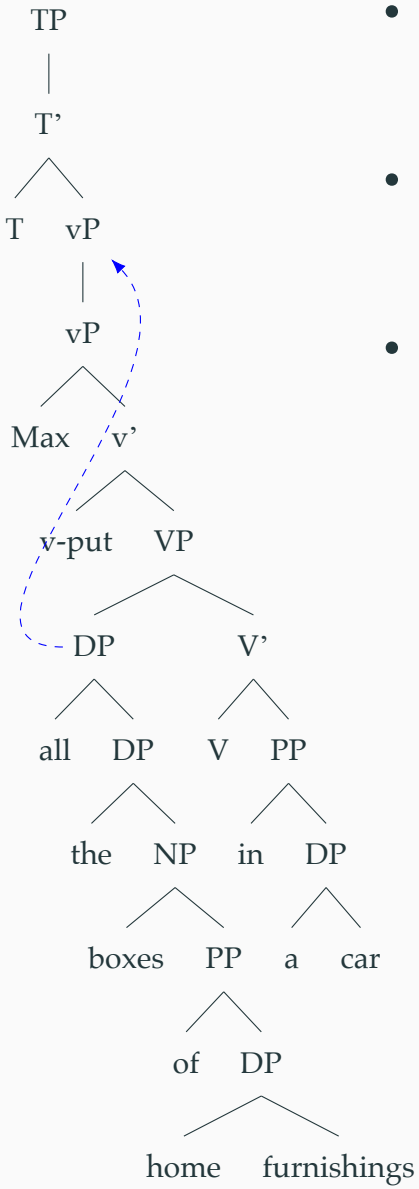

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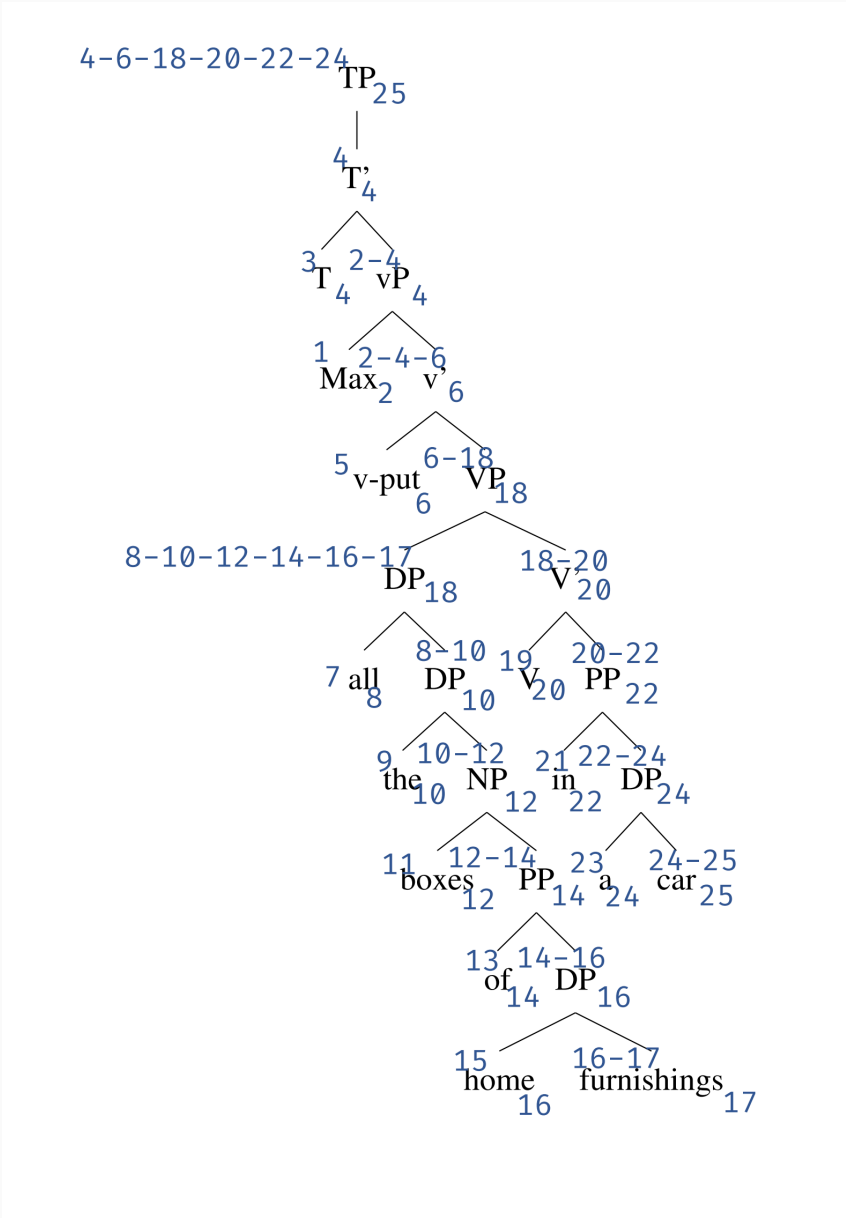
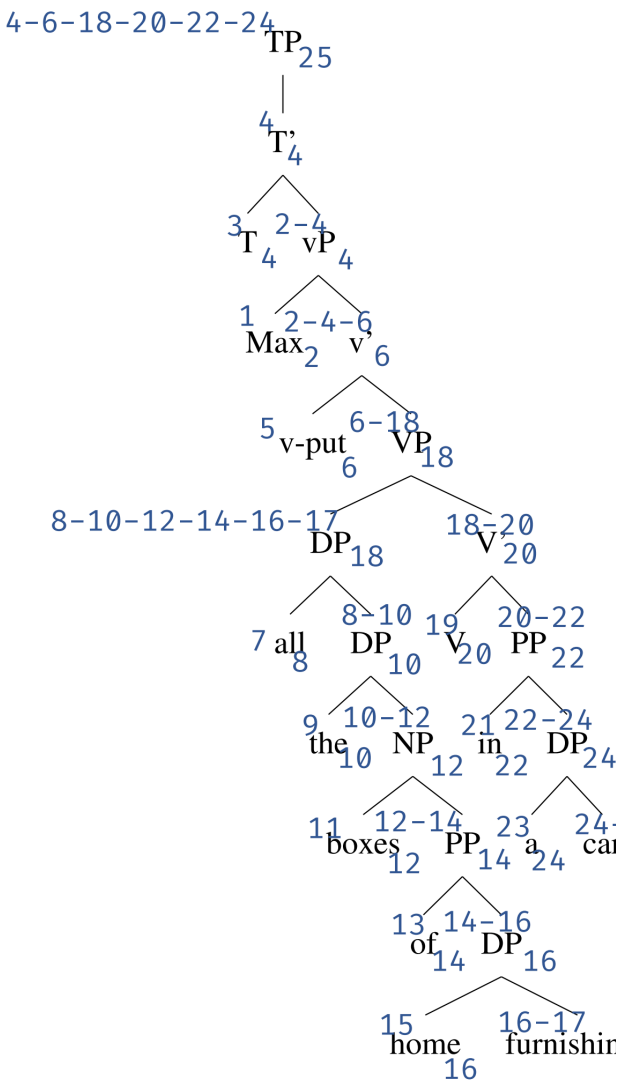
  - Shifted order: MaxTitem = 12

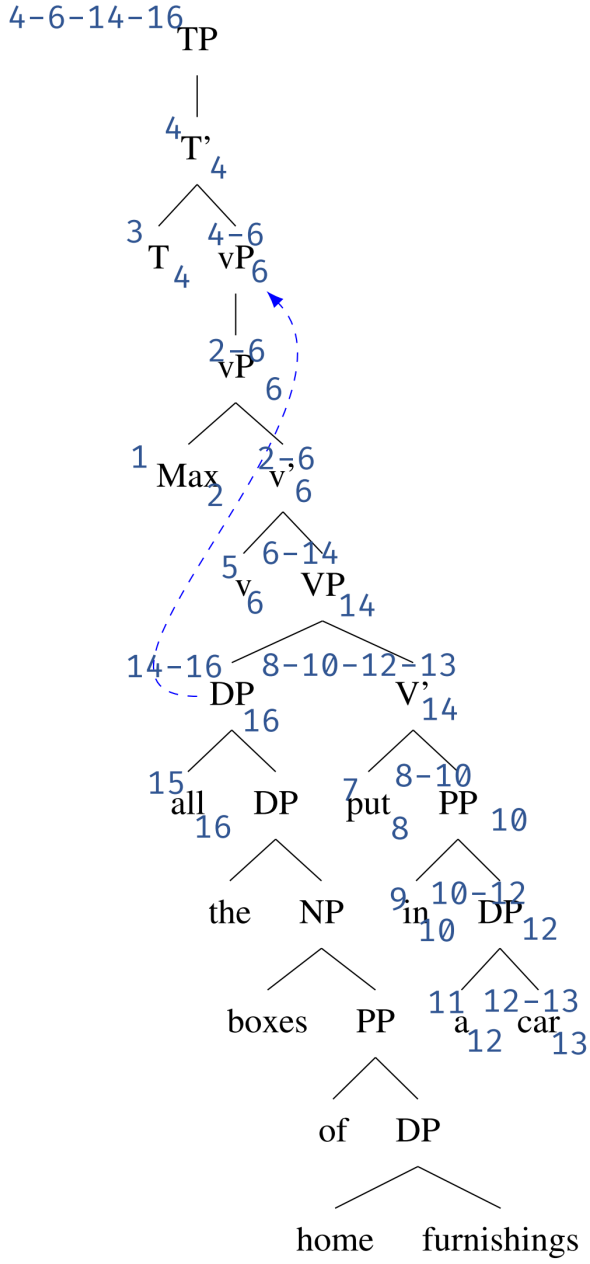
  => Shifted order is easier to process

English HNPS: Modeling results



English HNPS: Modeling results





English HNPS and similar cases

- Similar short-before-long preferences predicted in
  - English heavy NP shift (HNPS)
  - English post-verbal PP adjuncts
  - Mandarin *ba*-construction and its alternative

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- Next steps
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Japanese transitive: Data

(3) SOV

[keezi-ga] [Se-ga takakute gassiri sita hanni-o] oikaketa
detective-nom height-nom tall-and big-boned suspect-acc chased

'The detective chased the suspect who is tall and big-boned.'

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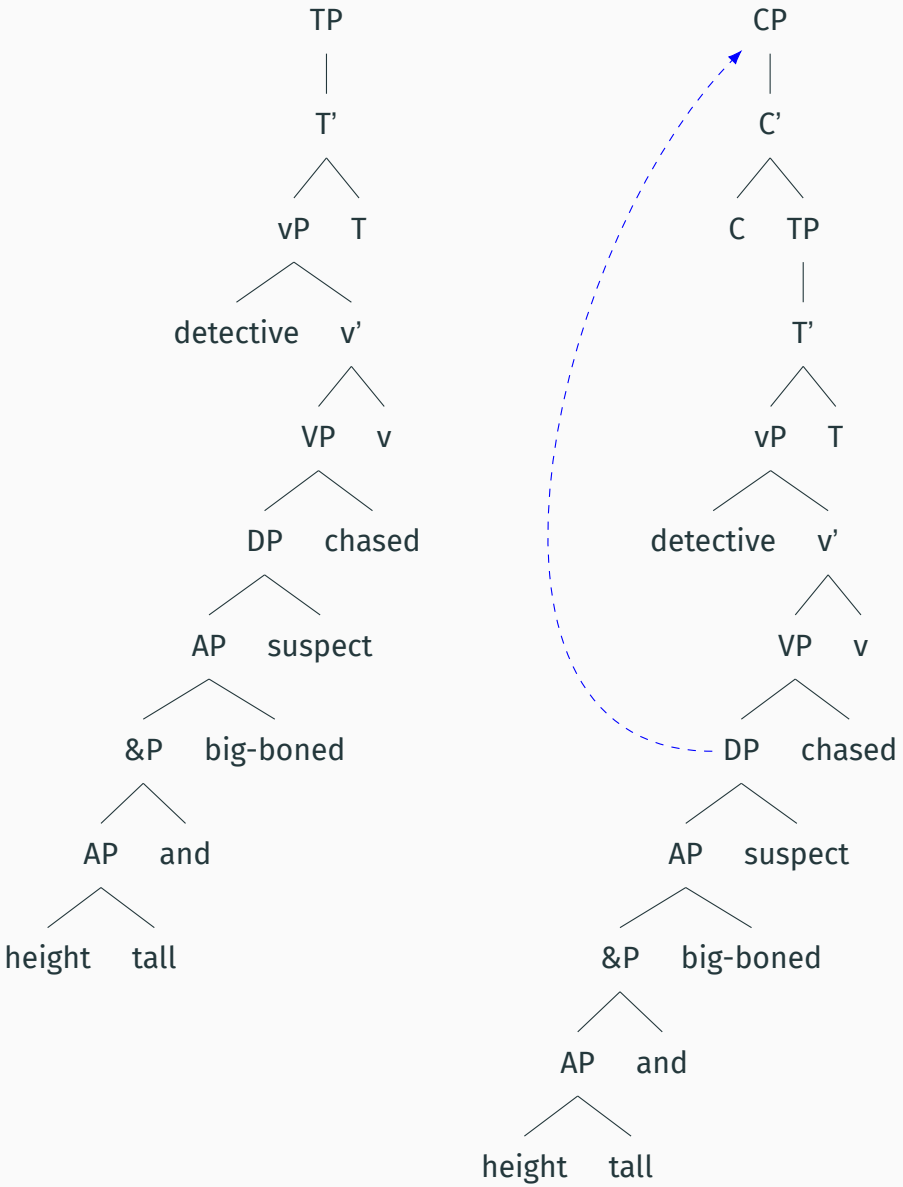
"Japanese speakers tend to shift long arguments ahead of short ones in an on-line task." (Yamashita and Chang 2001)

Japanese transitive: Syntax and modeling



- Shifted order: scrambling to CP (Saito 1992)

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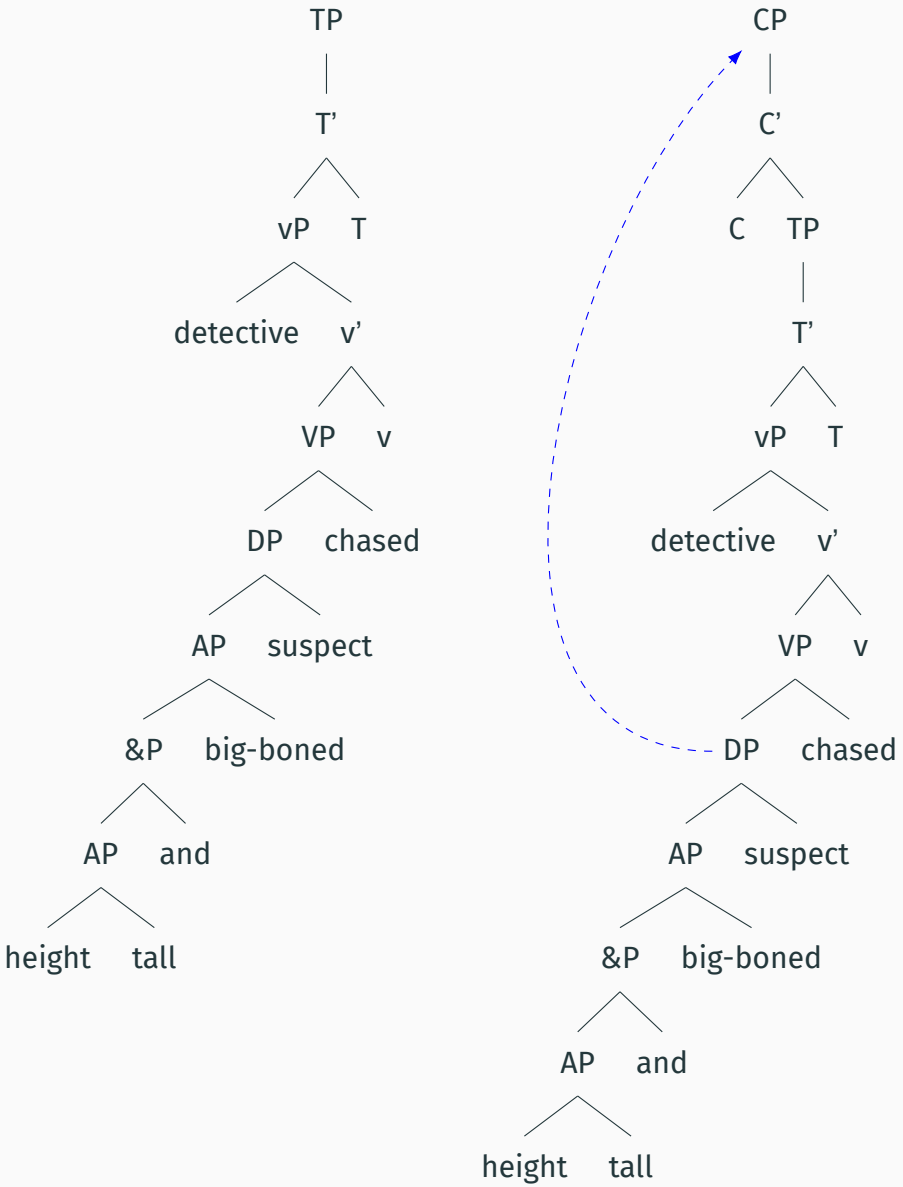

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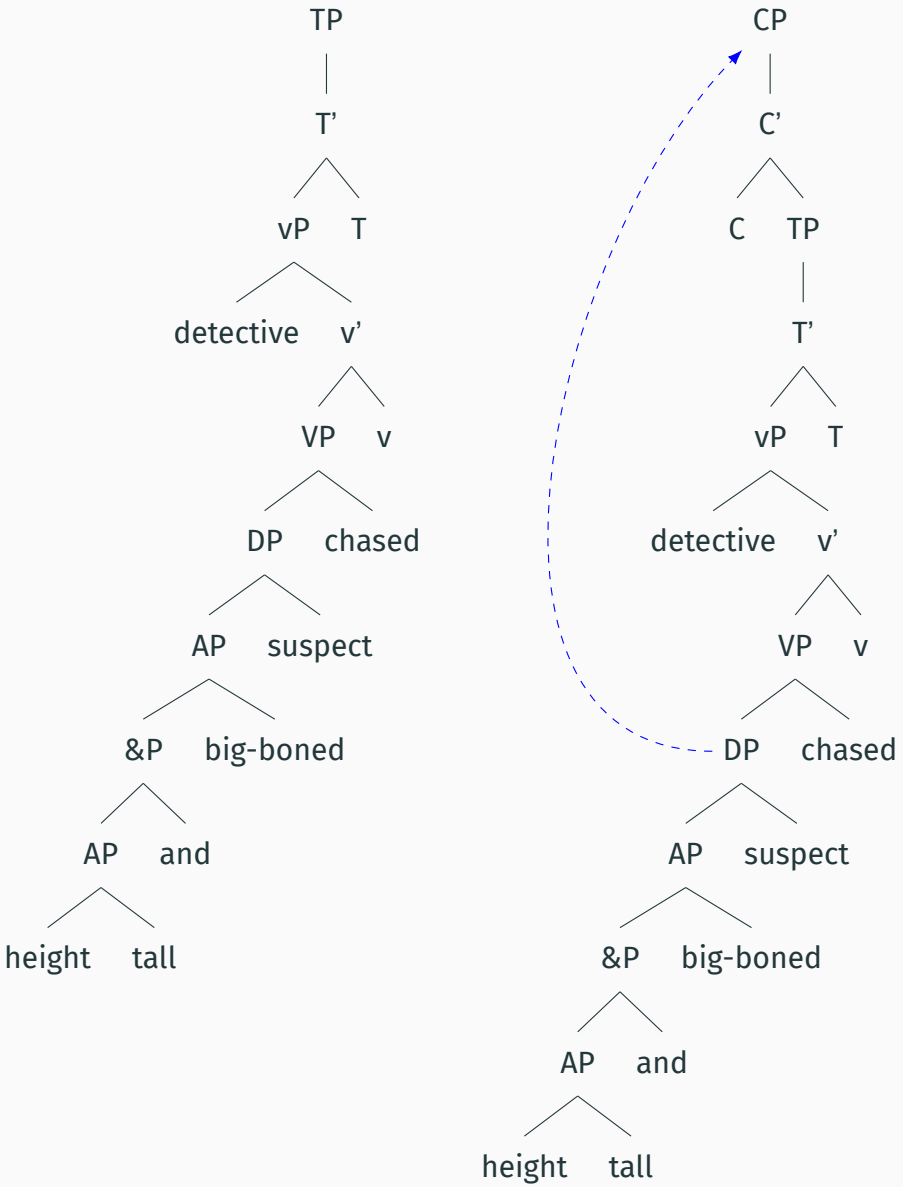

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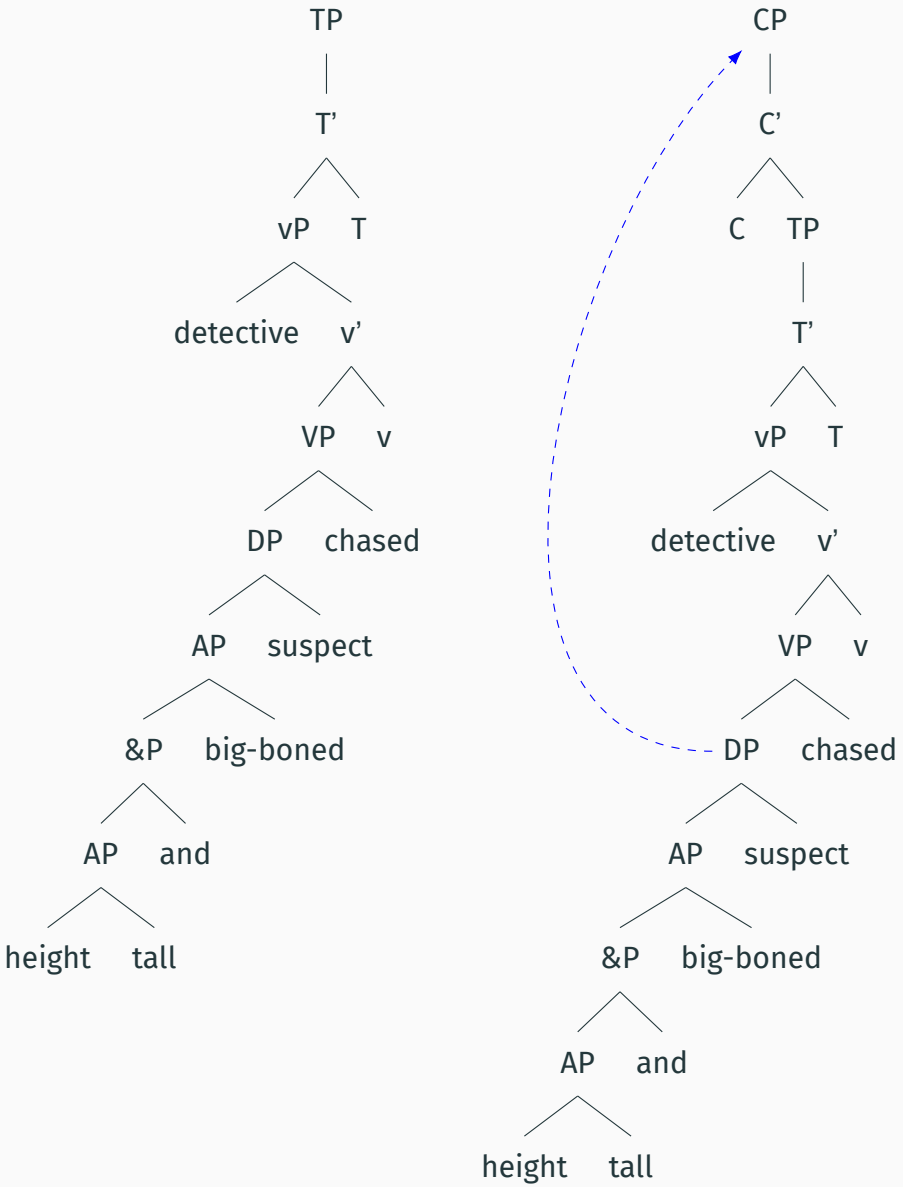

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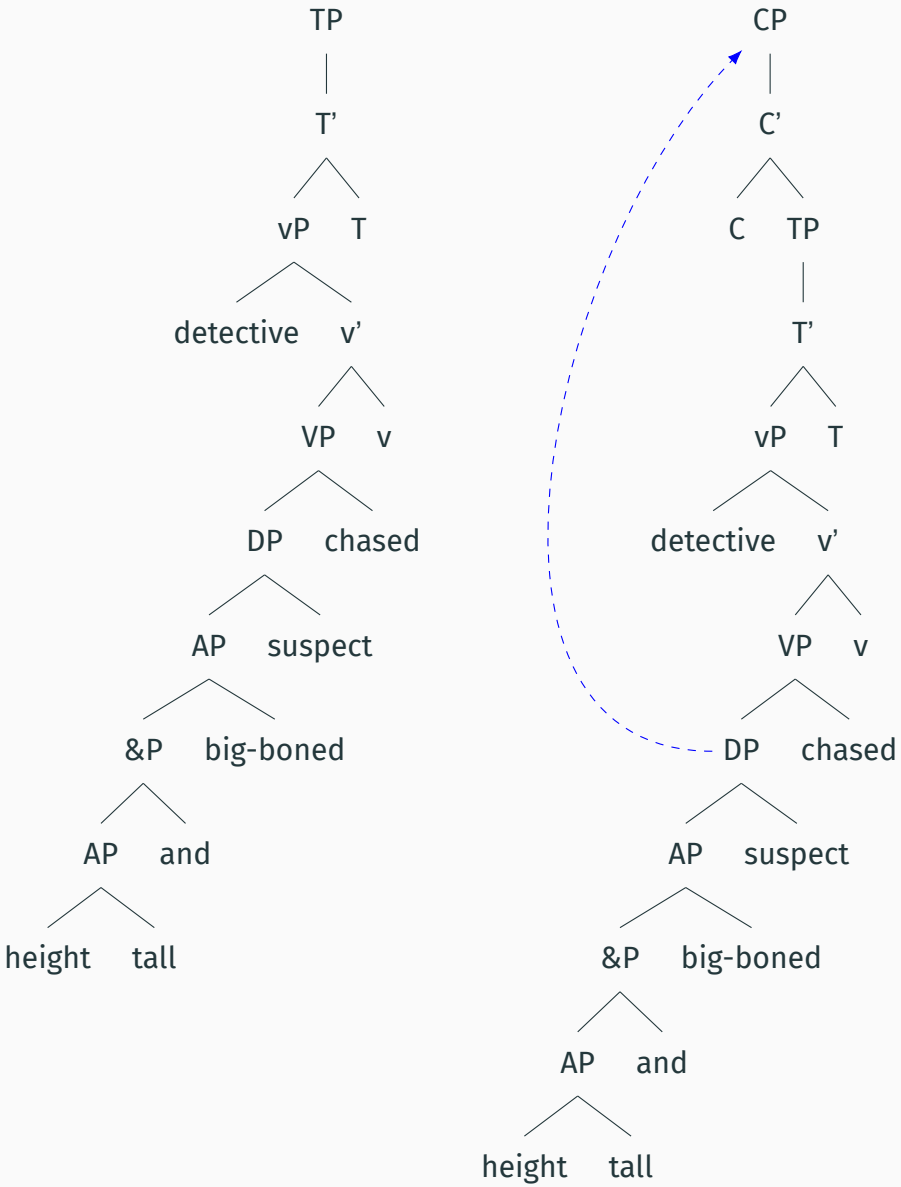
  - canonical order: MaxTitem = 12

Japanese transitive: Syntax and modeling



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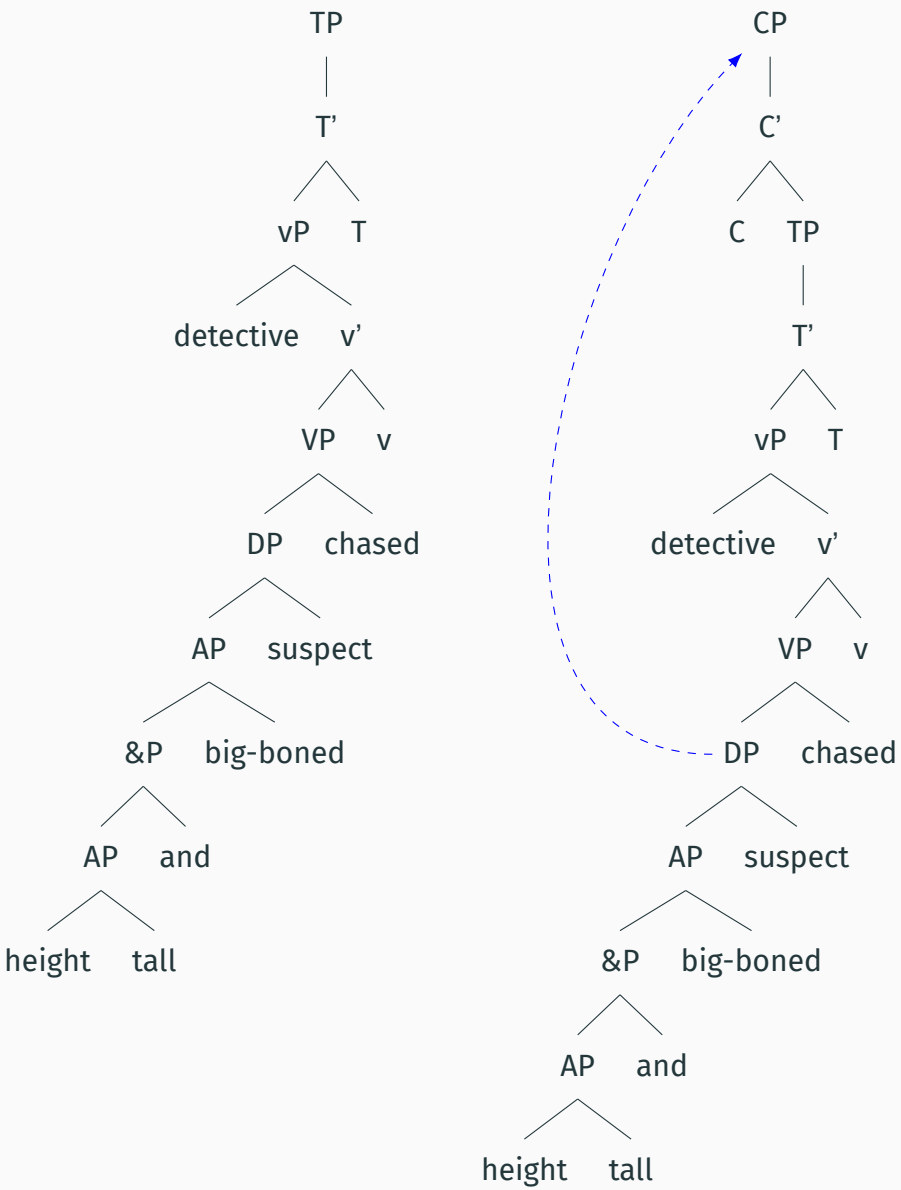
- Ignored: V-to-v movement, ArgO-movement
- Results:
  - canonical order: MaxTitem = 12
  - Shifted order: MaxTitem = 7

Japanese transitive: Syntax and modeling



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- Results:
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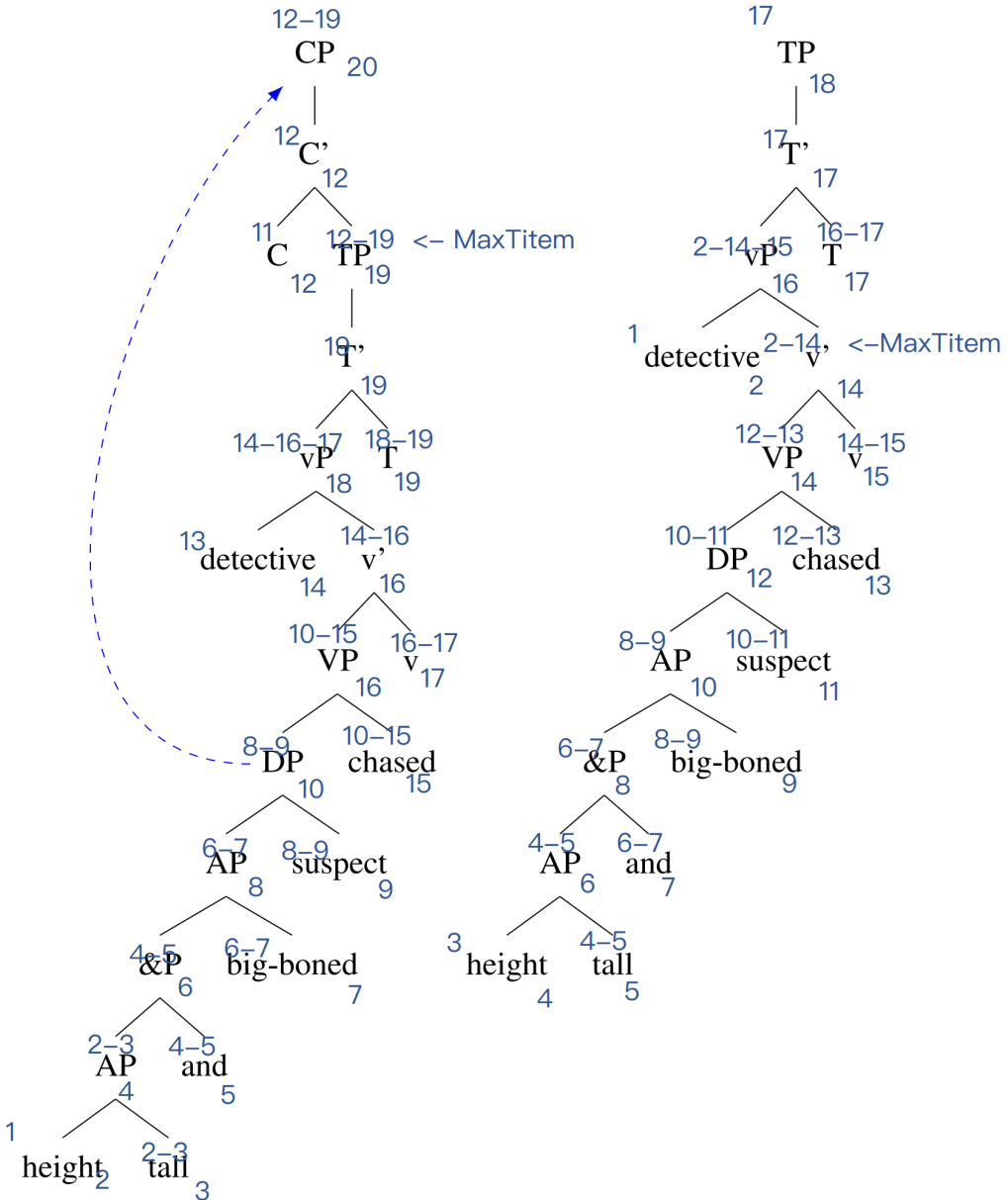
=> Shifted order is easier to process

Japanese transitive: Modeling results



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- Also
  - Heavy $\Rightarrow$ shift
  - Other syntactic proposals?

Next steps and open questions

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- Alternative complexity metrics

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- Alternative complexity metrics
- Alternative syntactic analyses

Next steps and open questions

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- Shift iff heavy vs. Heavy => shift

Next steps and open questions

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(5) Niuean transitive wh-questions (Tollan et al. 2019)

a. Ko e pusi fē ne tutuli tūmau e lapiti?
PRED cat which past chase always ABS rabbit
'Which cat always chased the rabbit?'

b. Ko e pusi fē ne tutuli tūmau he kulī?
PRED cat which past chase always ERG dog
'Which cat did the dog always chased?'

References

Choi, H.-W. (2007). Length and order: A corpus study of korean dative-accusative construction. 담화와인지, 14(3):207–227.

Liu, L. (2022). *Phrasal Weight Effect on Word Order*. PhD thesis, State University of New York at Stony Brook.

Liu, Z. (2020). Mixed evidence for crosslinguistic dependency length minimization. *STUF-Language Typology and Universals*, 73(4):605–633.

Ross, J. R. (1986). *Infinite syntax*. Ablex Publishing Corporation.

Saito, M. (1992). Long distance scrambling in japanese. *Journal of East Asian Linguistics*, 1(1):69–118.

Tollan, R., Massam, D., and Heller, D. (2019). Effects of case and transitivity on processing dependencies: Evidence from niuean. *Cognitive science*, 43(6):e12736.

Wasow, T. (1997). Remarks on grammatical weight. *Language variation and change*, 9(1):81–105.

Yamashita, H. and Chang, F. (2001). "long before short" preference in the production of a head-final language. *Cognition*, 81(2):B45–B55.