Are formal restrictions on crossing dependencies epiphenomenal?

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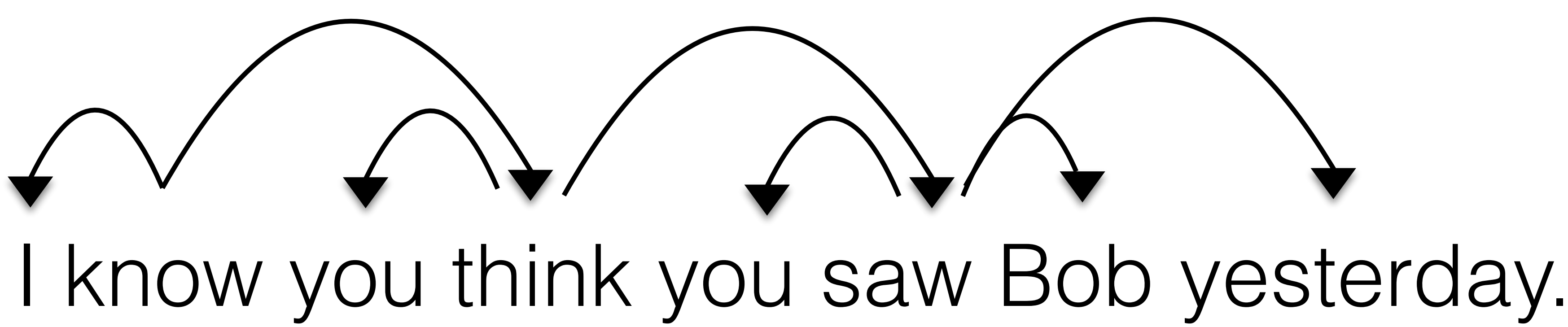

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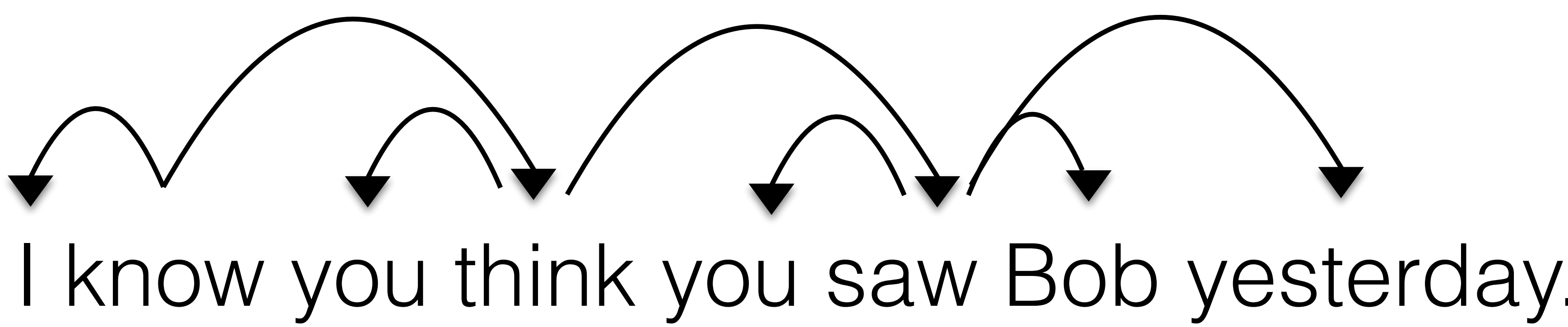
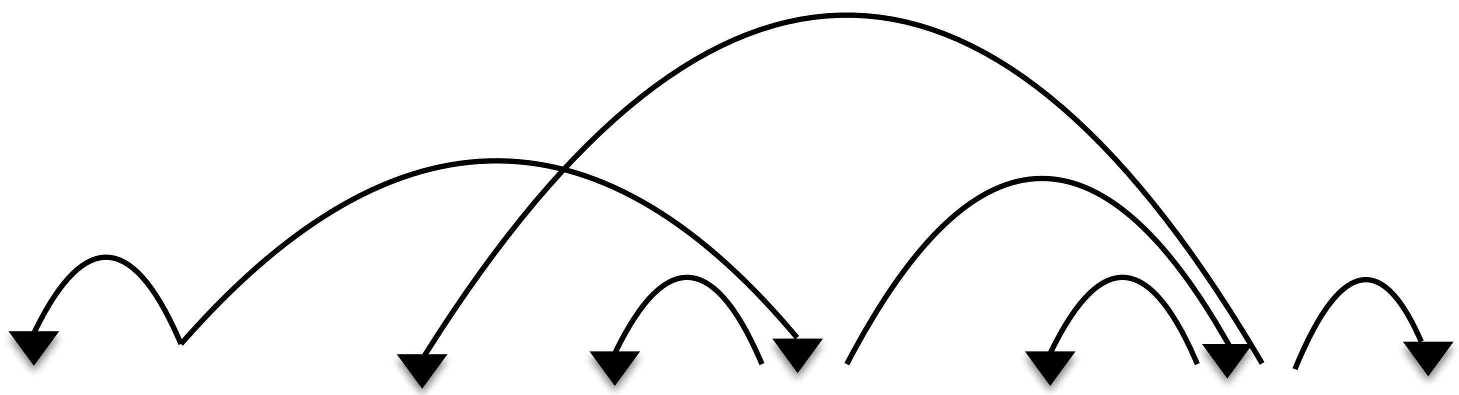


(that is, the lines don't cross)

But sometimes they’re not



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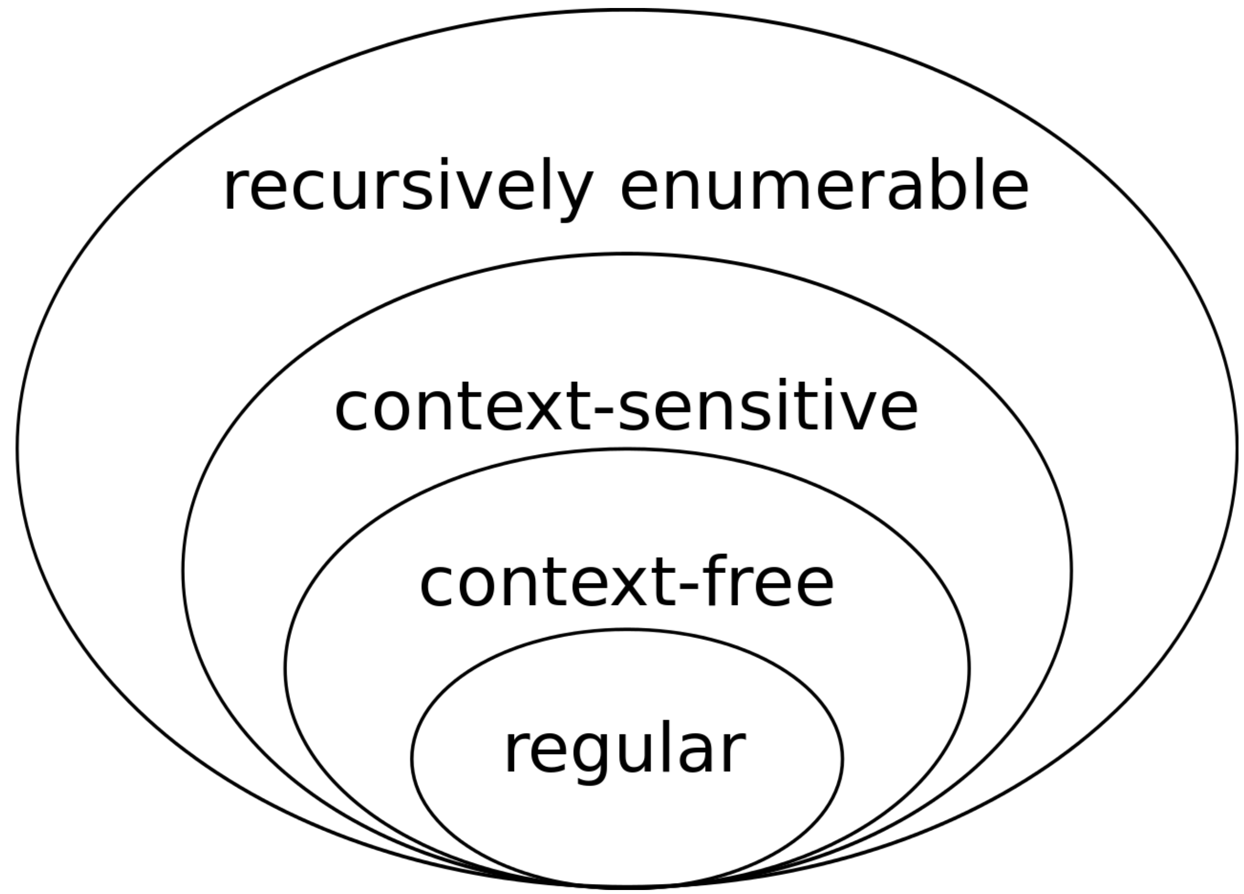

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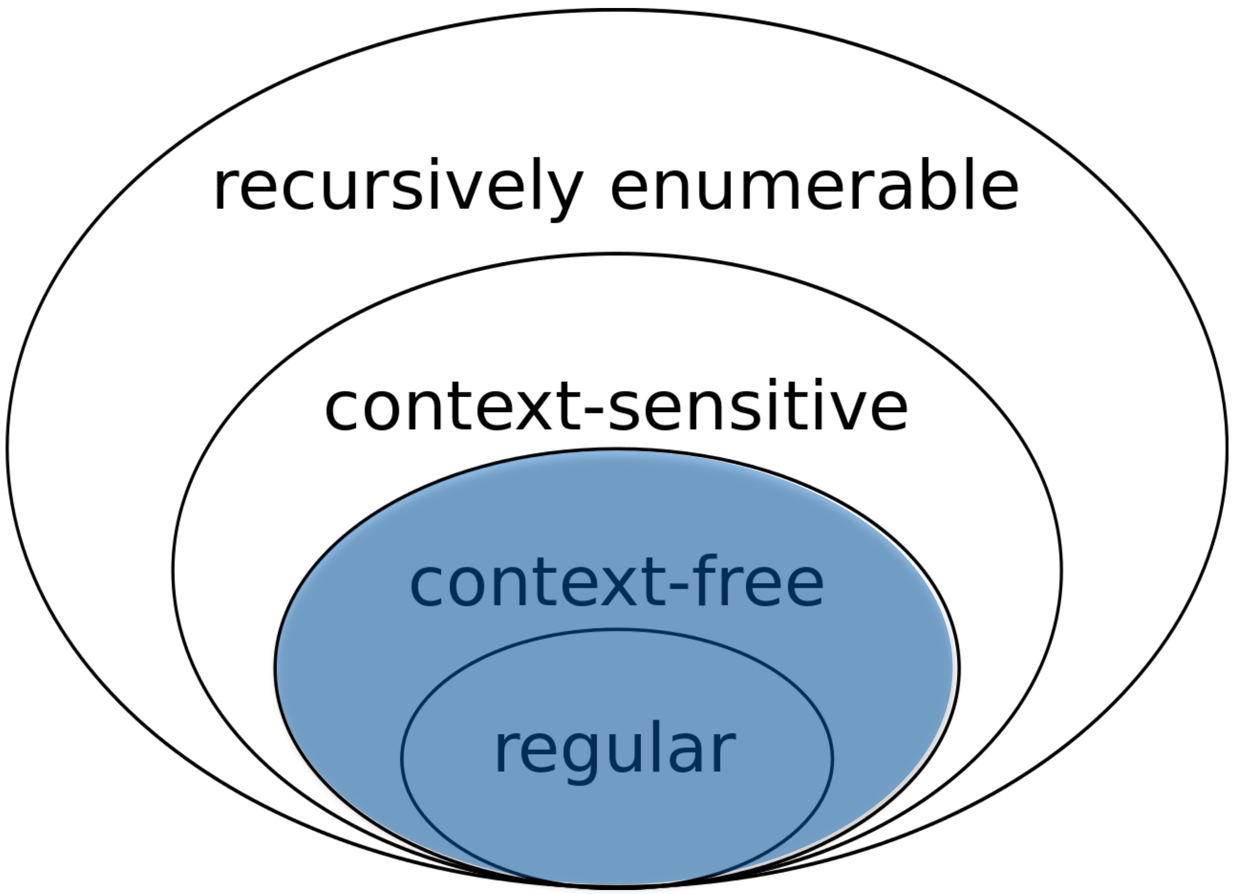

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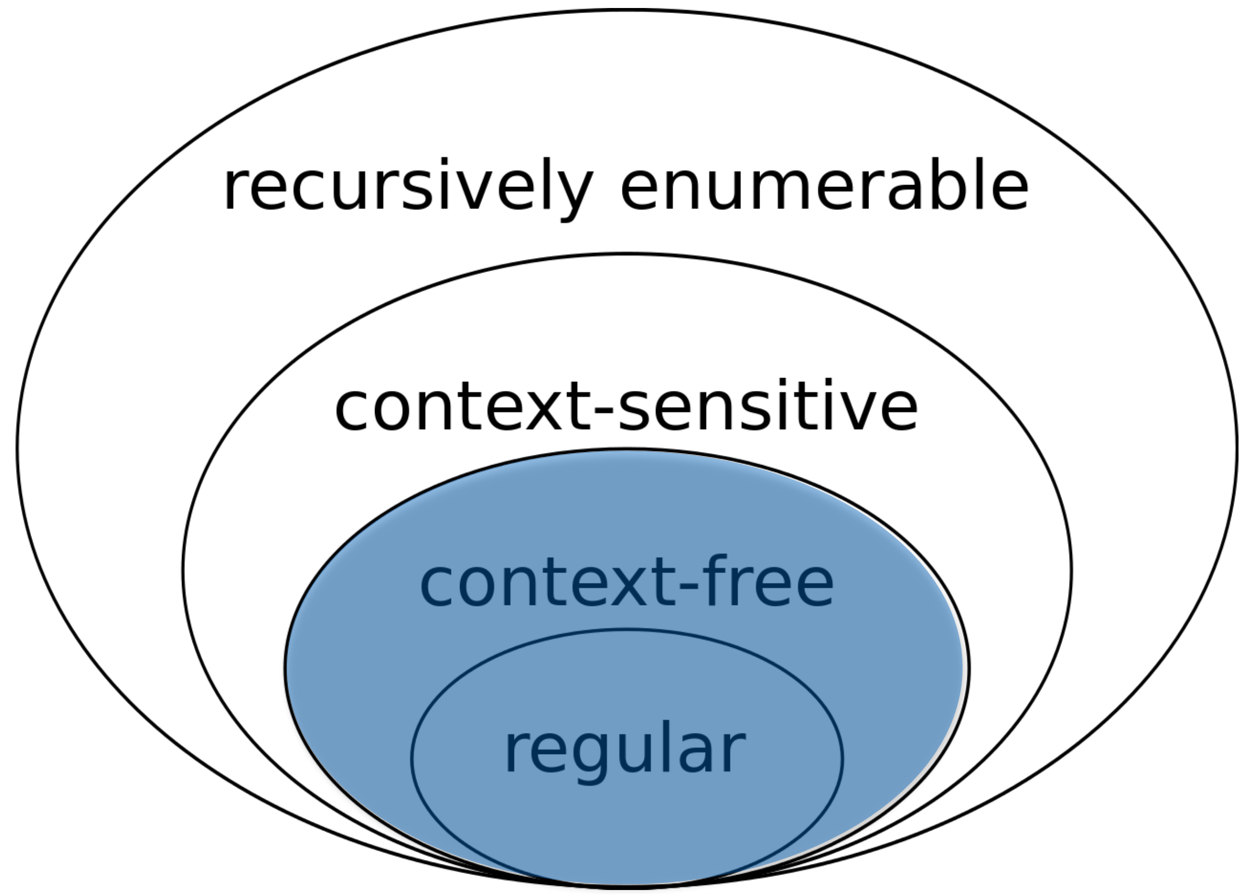

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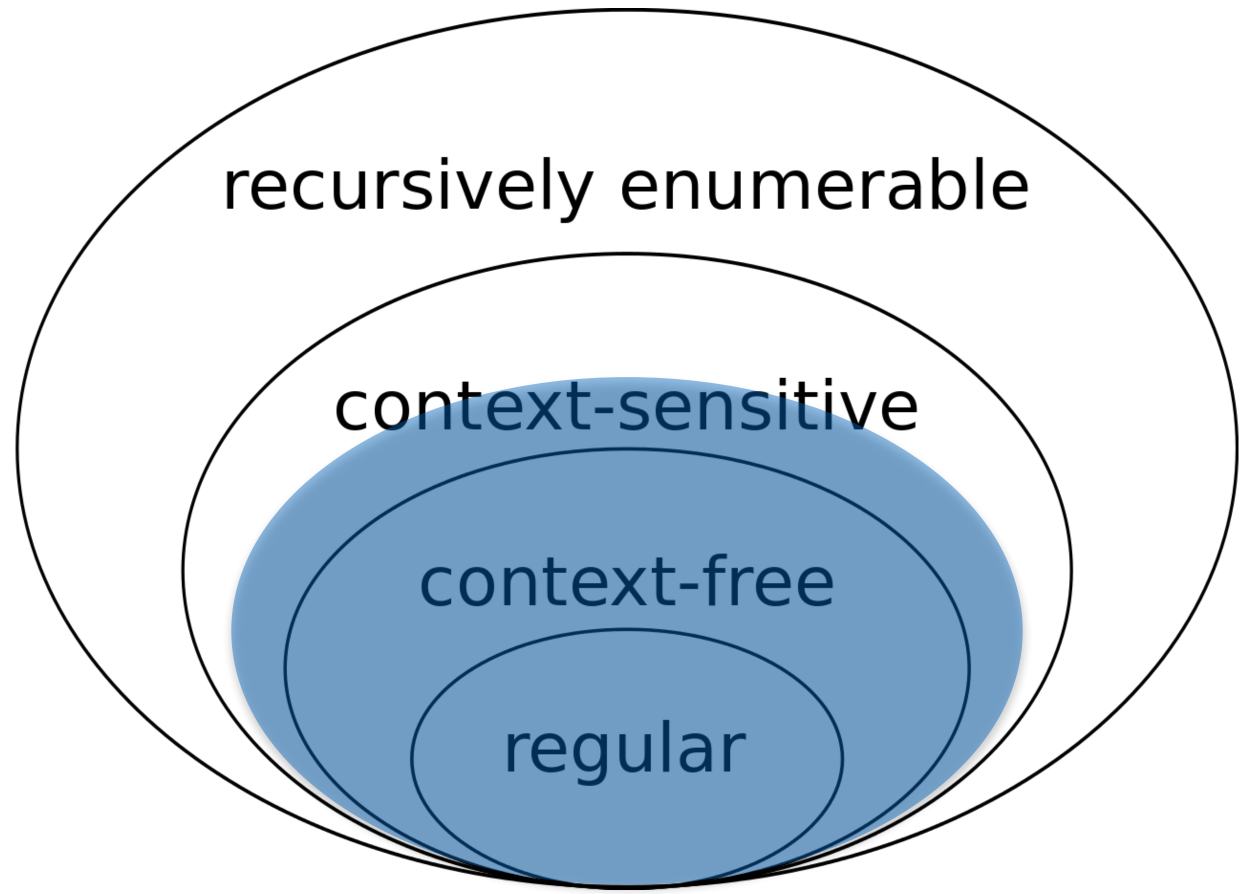

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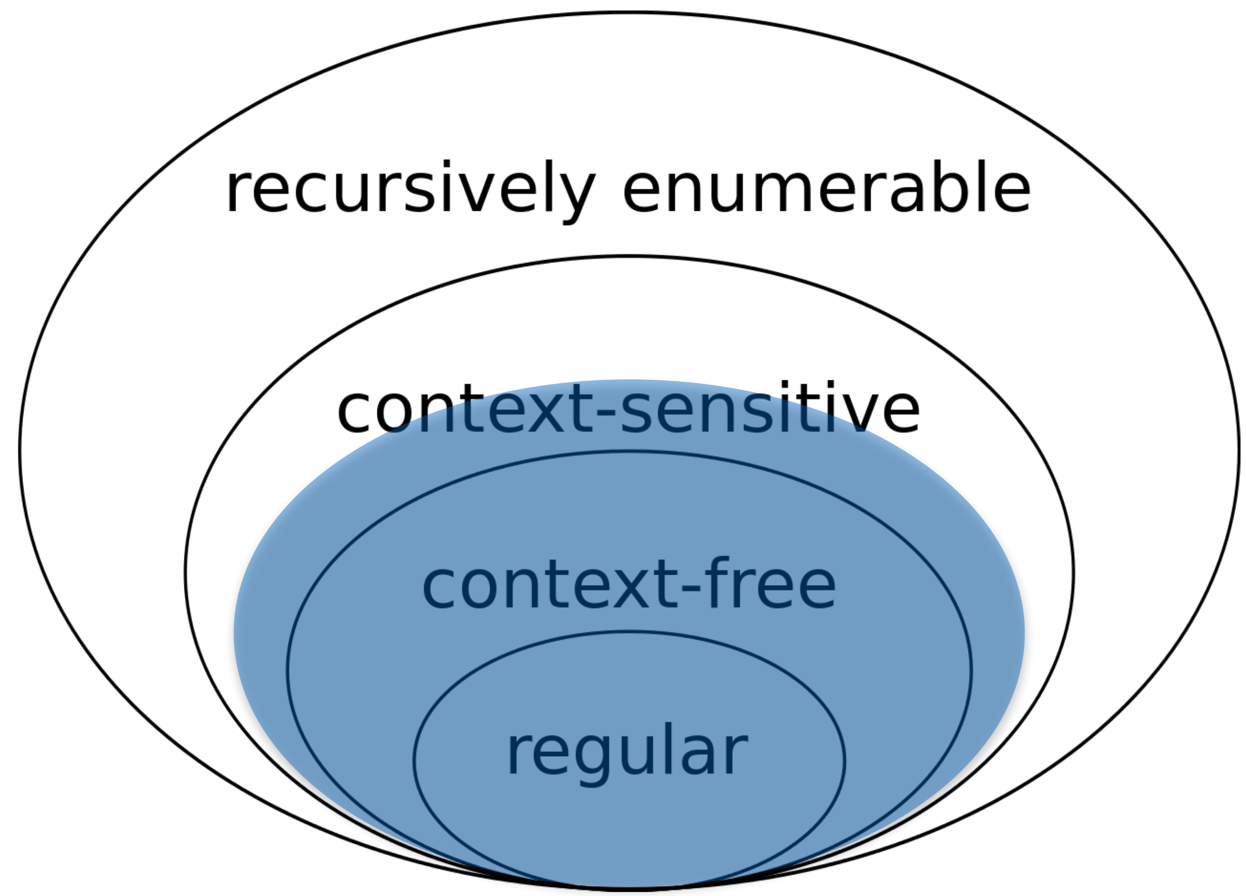

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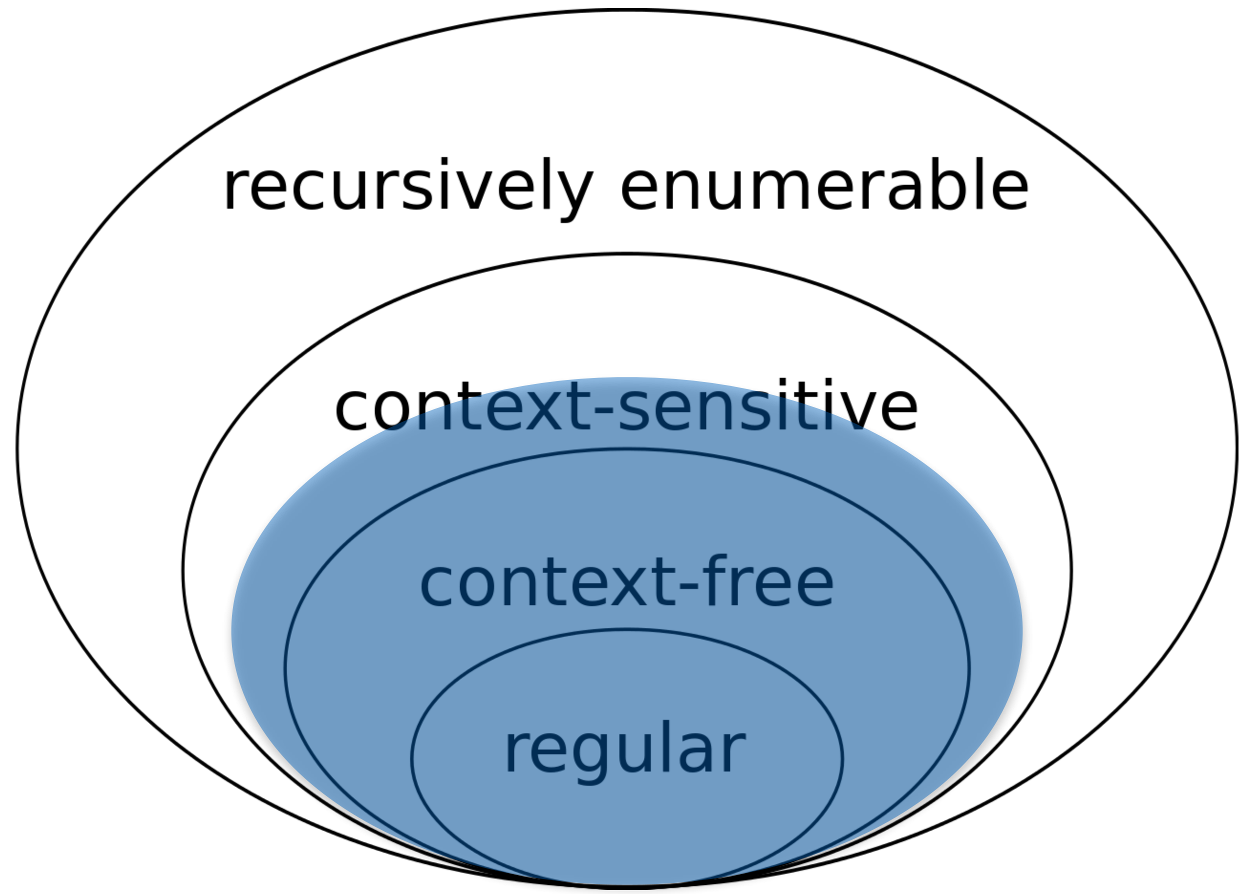
- The **mildly context-sensitive languages** are defined by **bounds on gap degree**.



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Observed distribution of gap degree in a treebank

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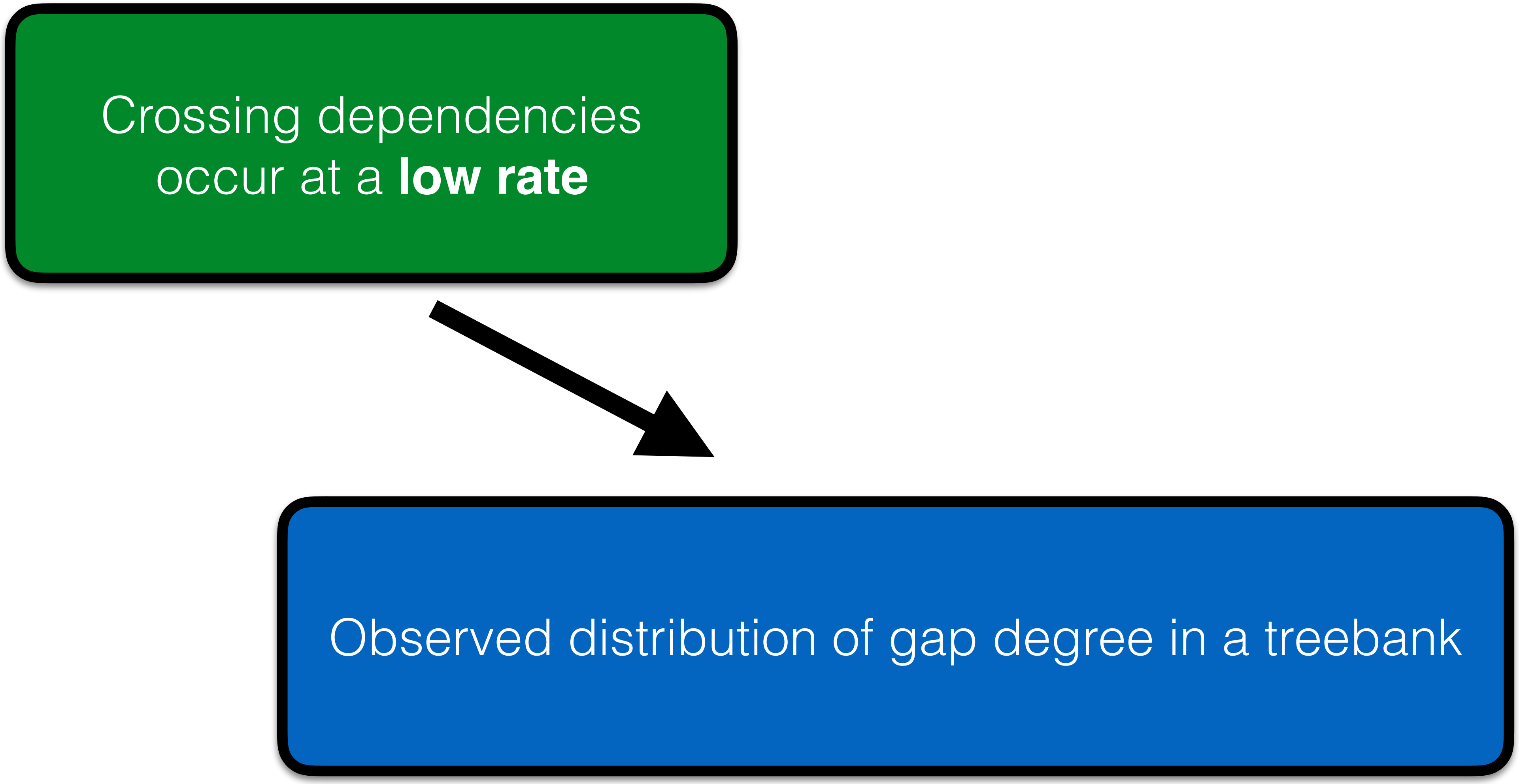

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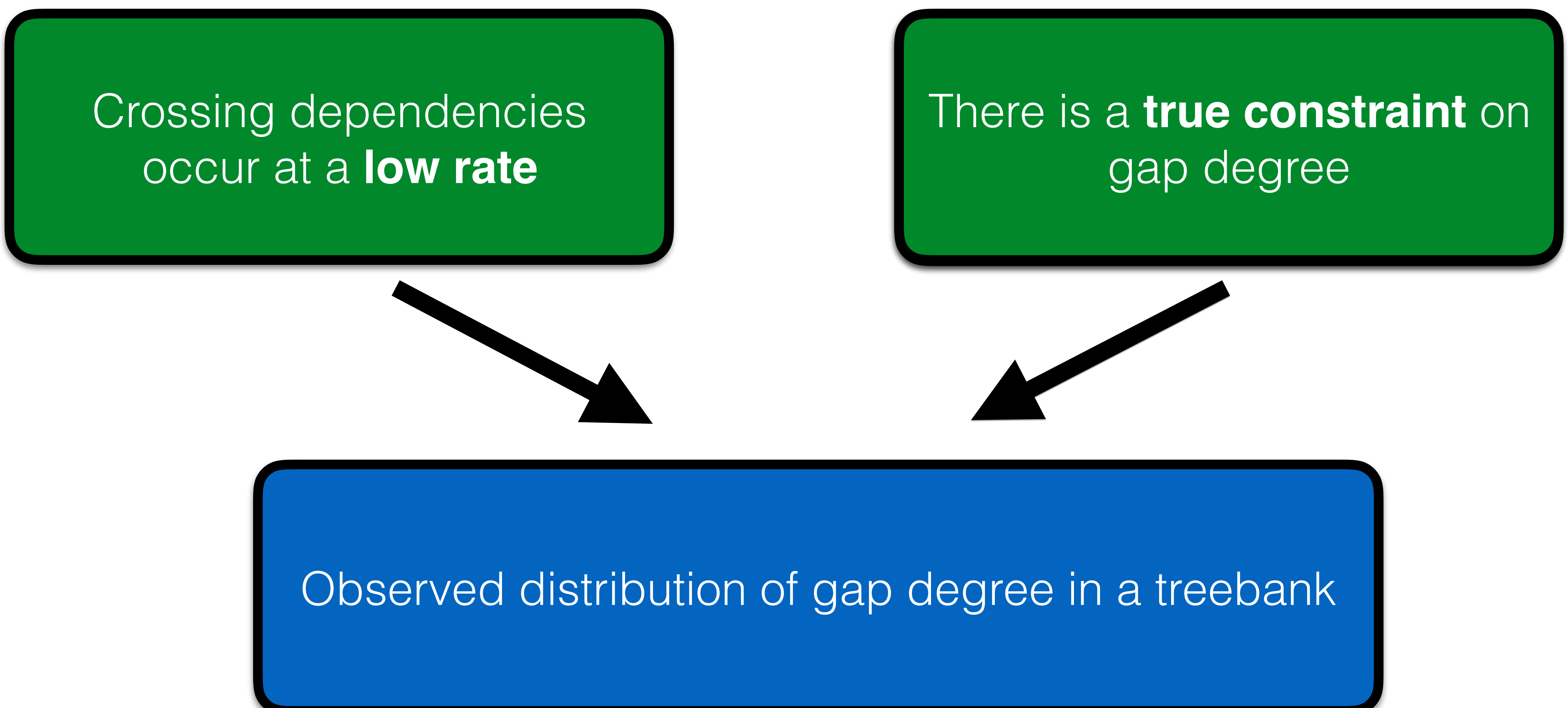

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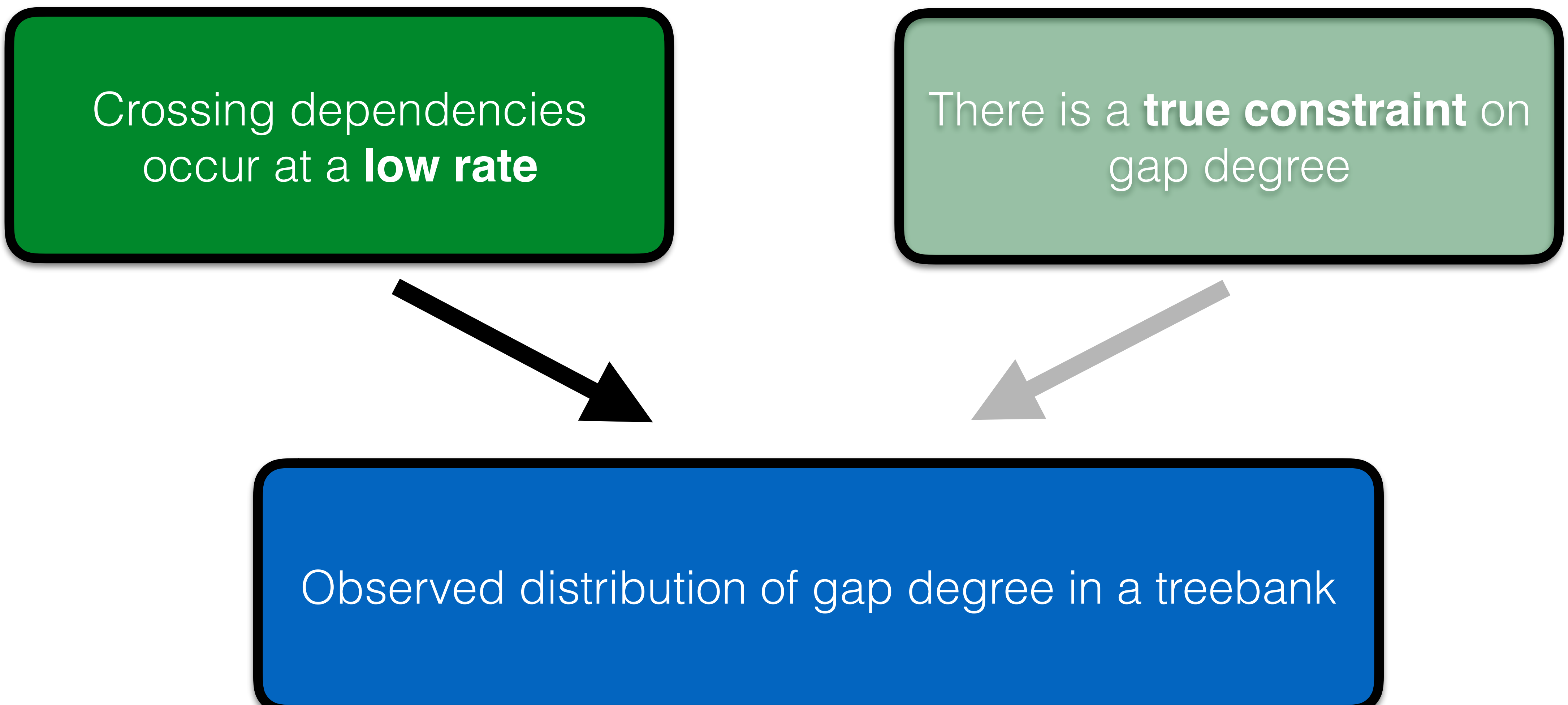

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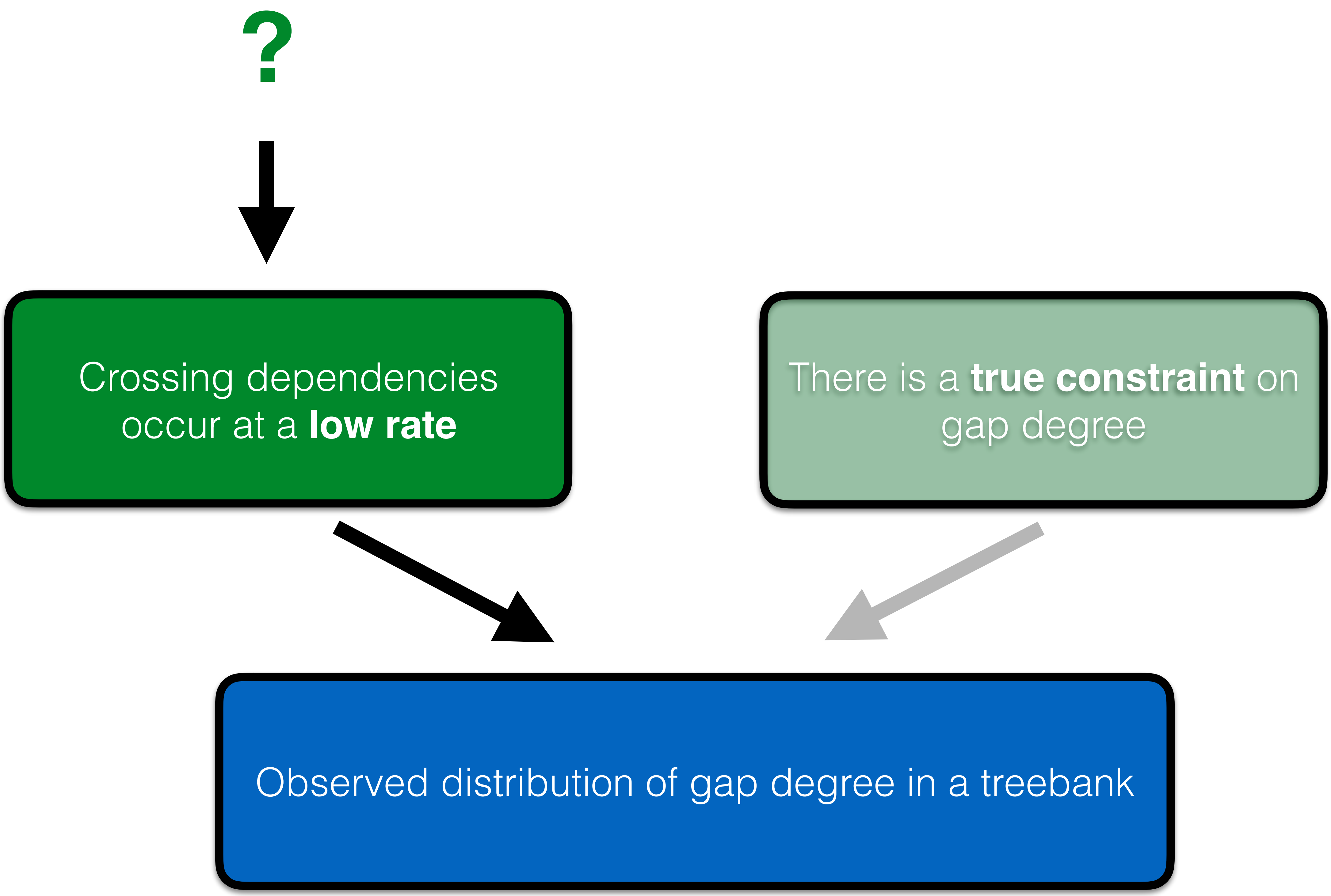

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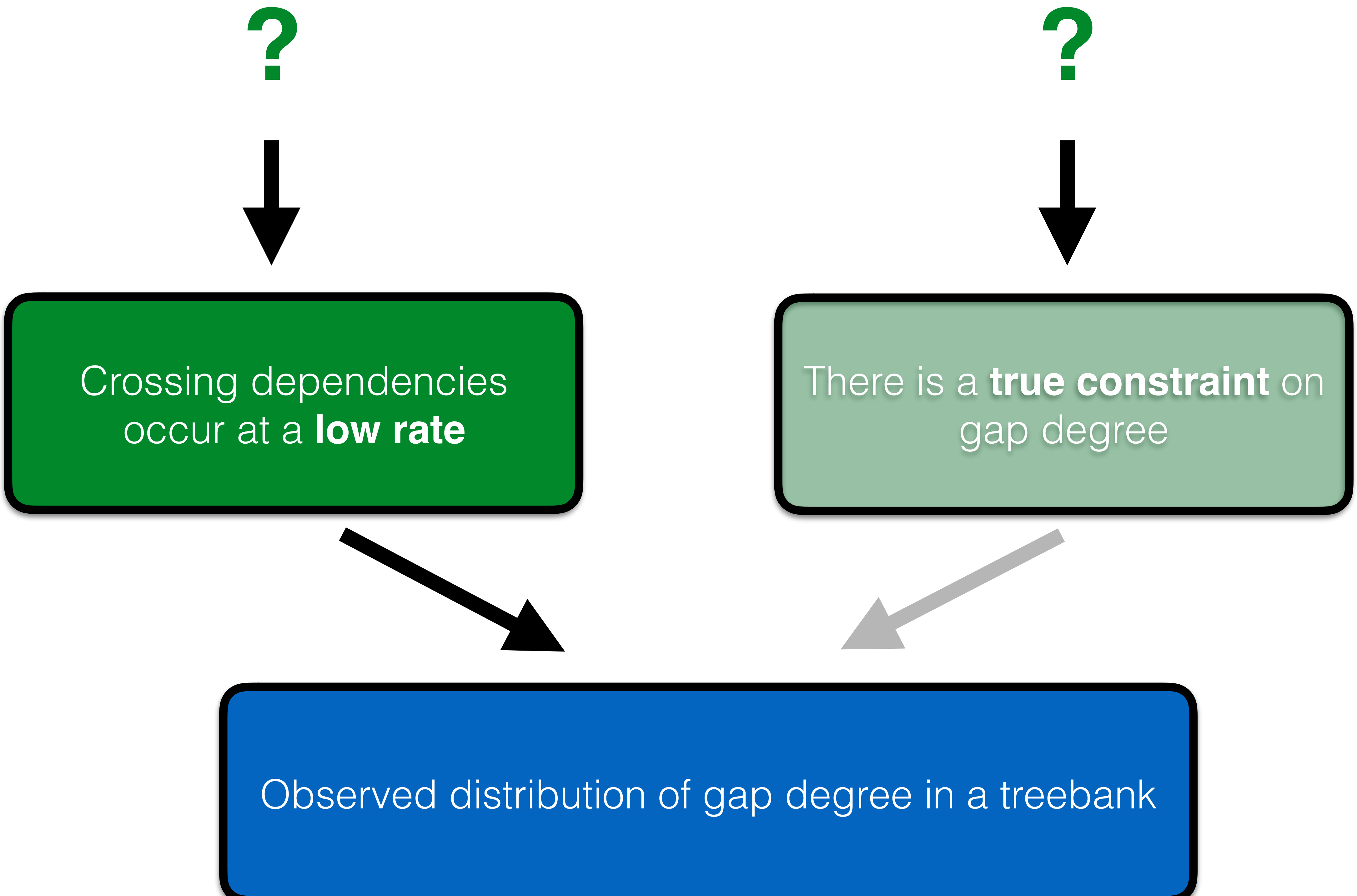

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- Introduction
- Methodology & Baselines
- Results
- Conclusion

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- **Random trees**: Uniform random trees generated using Prüfer codes, with the same distribution over sentence lengths as real trees.

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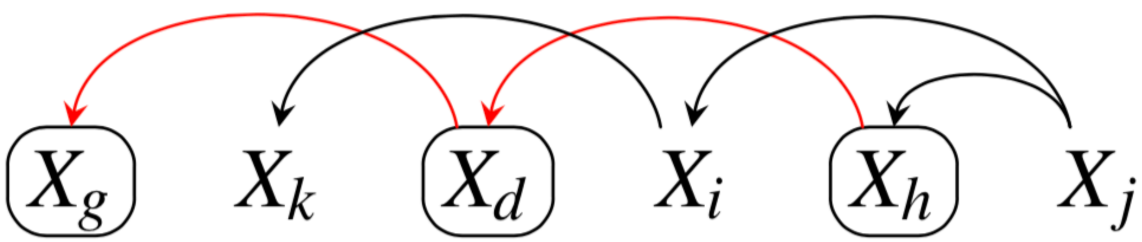

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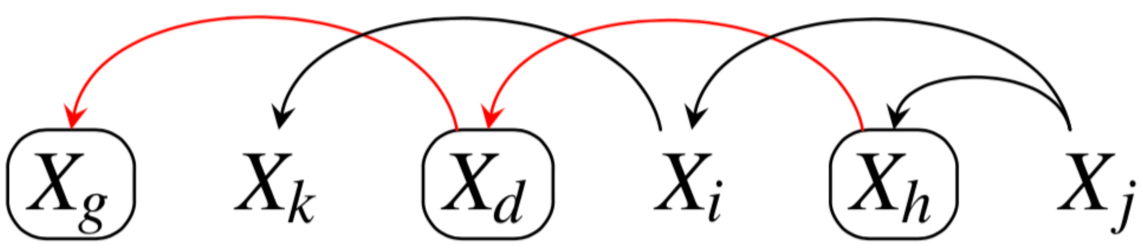

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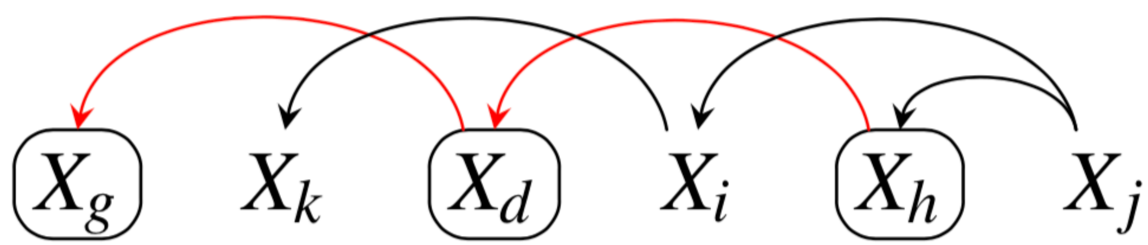

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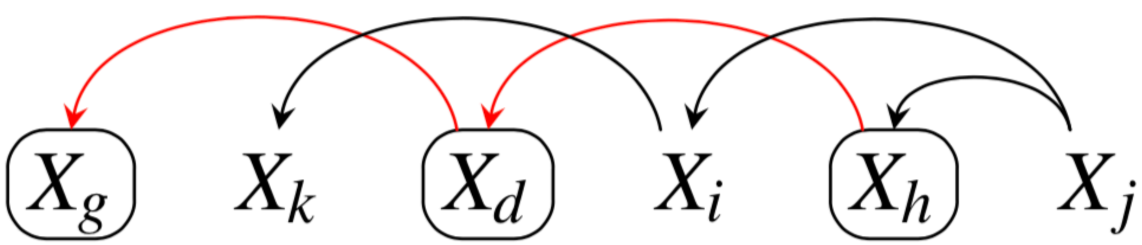

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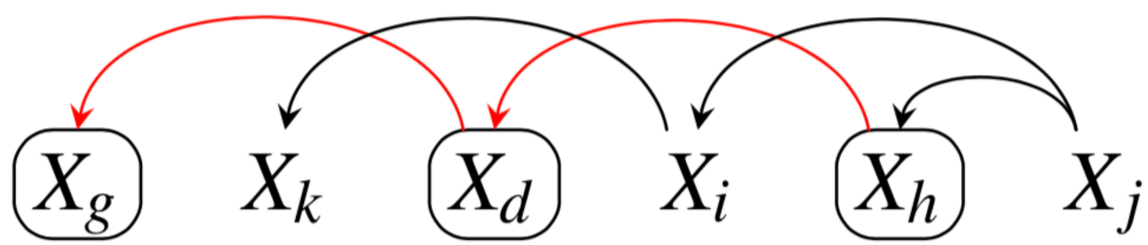

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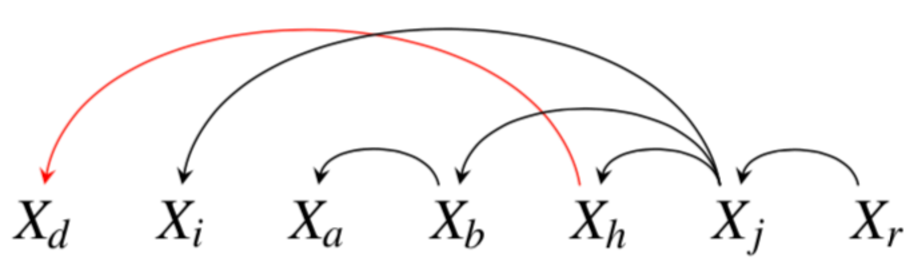

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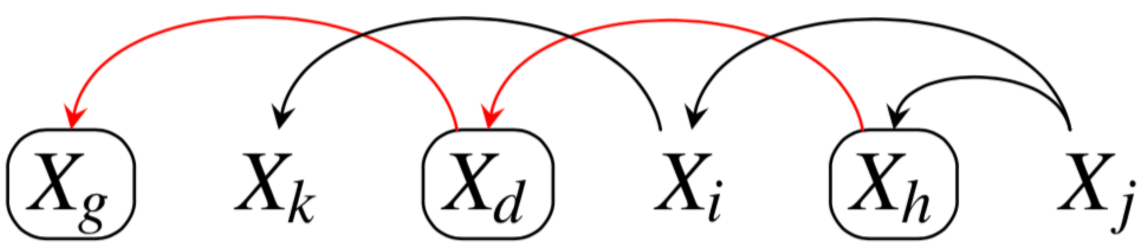

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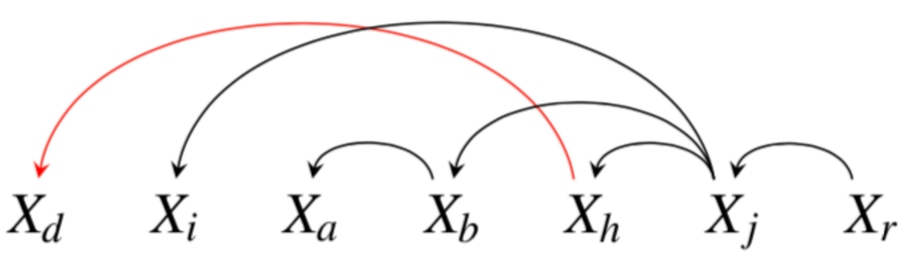

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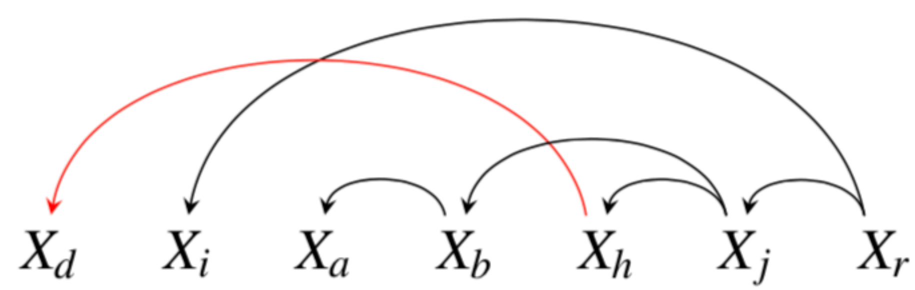

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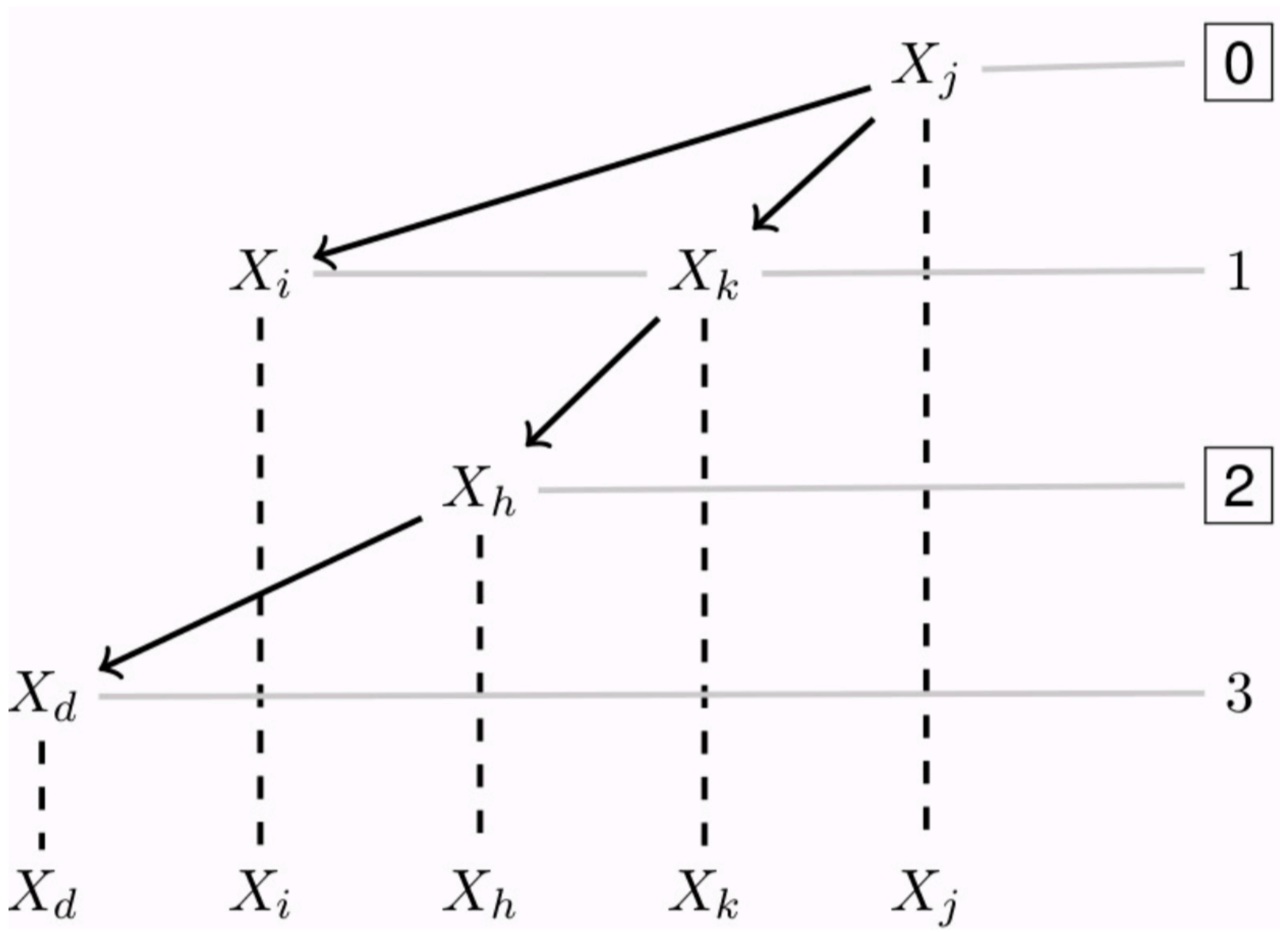

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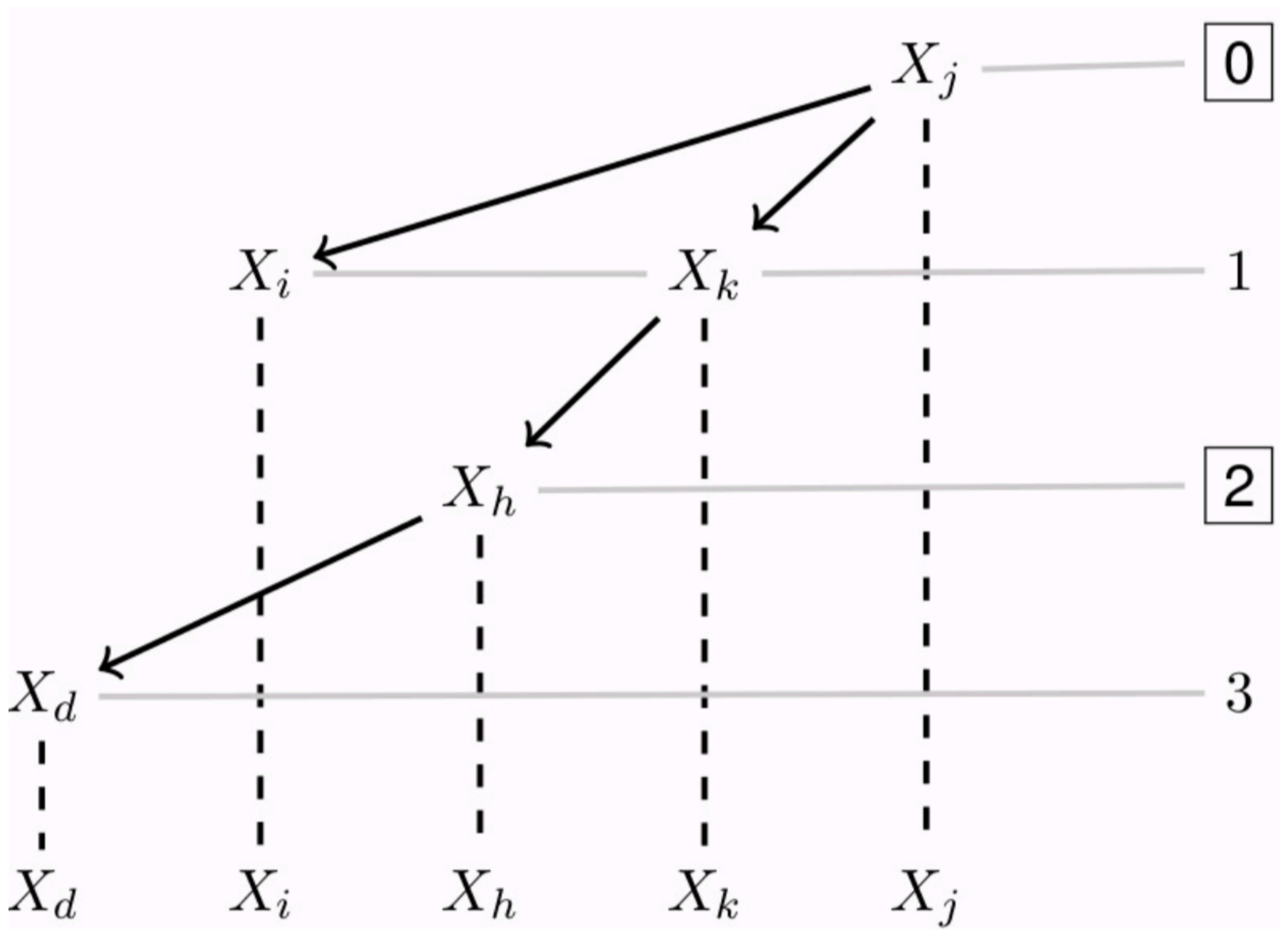

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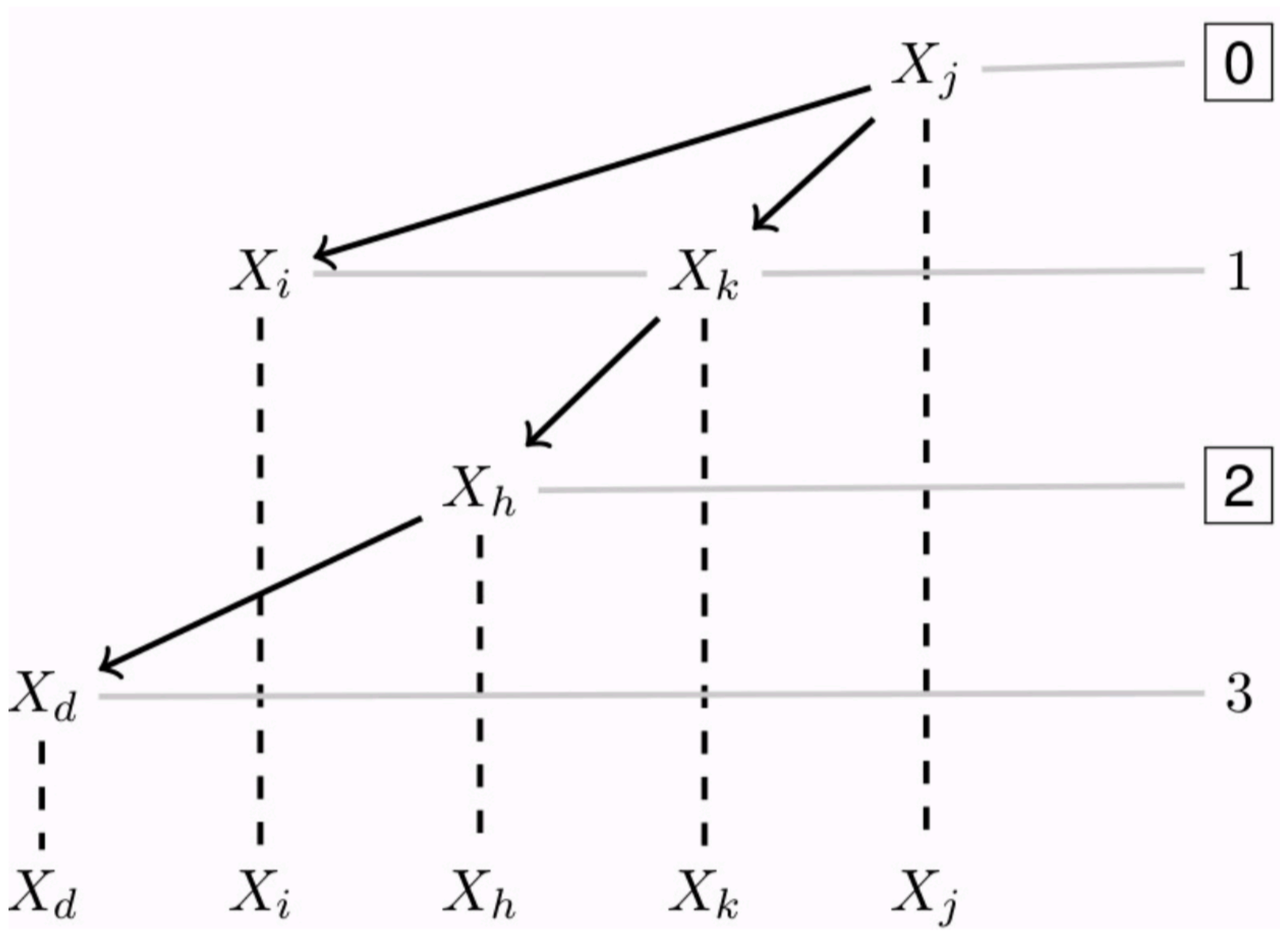

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- The important coefficient is β_{lr}, the **interaction coefficient**:
  - If it is negative, that means **gap degree grows slower with sentence length in real vs. random trees.**

Data

- We test on UD v2.3 treebanks of 14 languages:
  - German, English, Hindi, French, Arabic, Russian, Czech, Italian, Spanish, Afrikaans, Japanese, Korean, Bulgarian, Slovak
- We exclude all root and punctuation dependencies.
- We combine trees from all treebanks (but control for language in our regression models).

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Gap Degree

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- As a function of **sentence length:**

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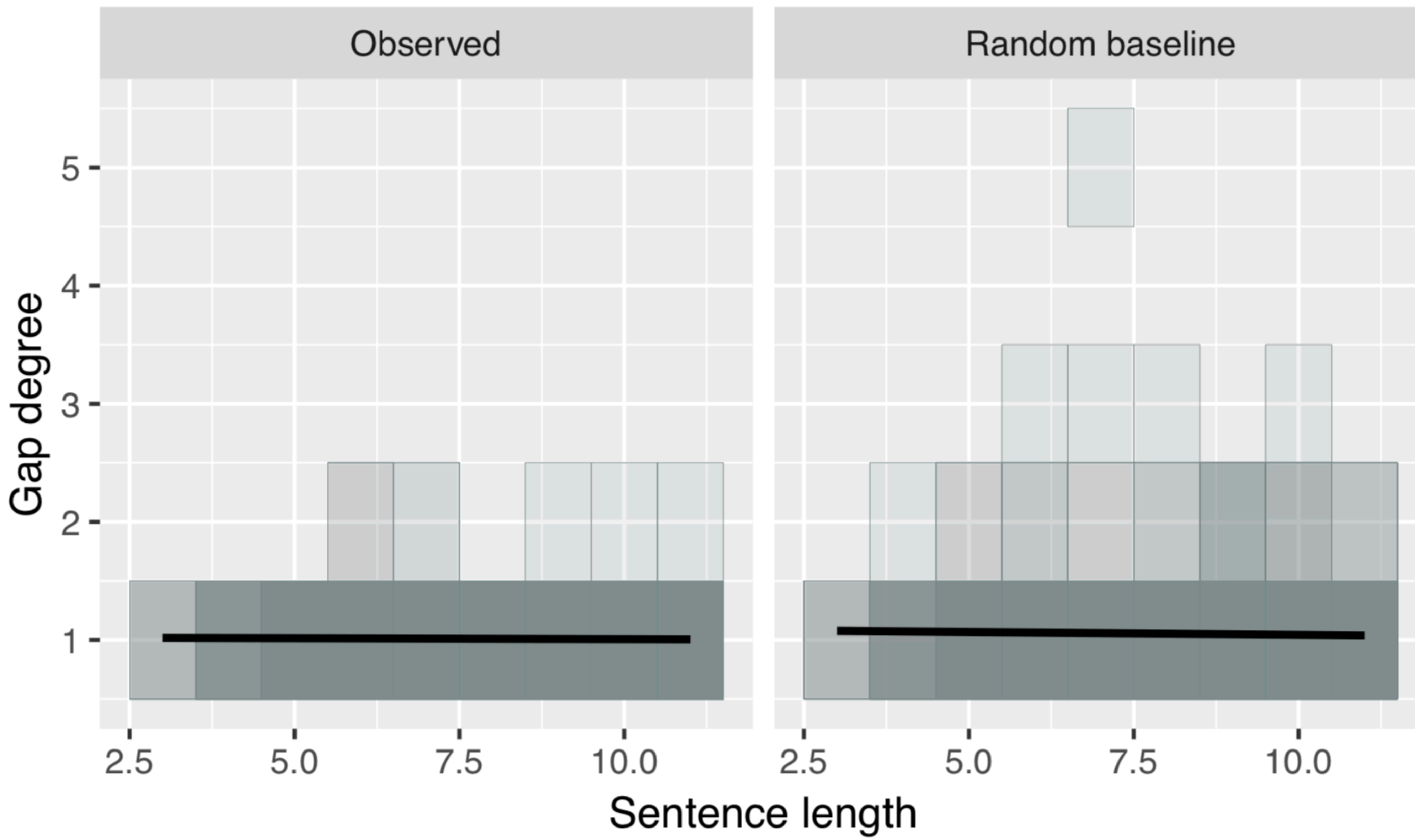

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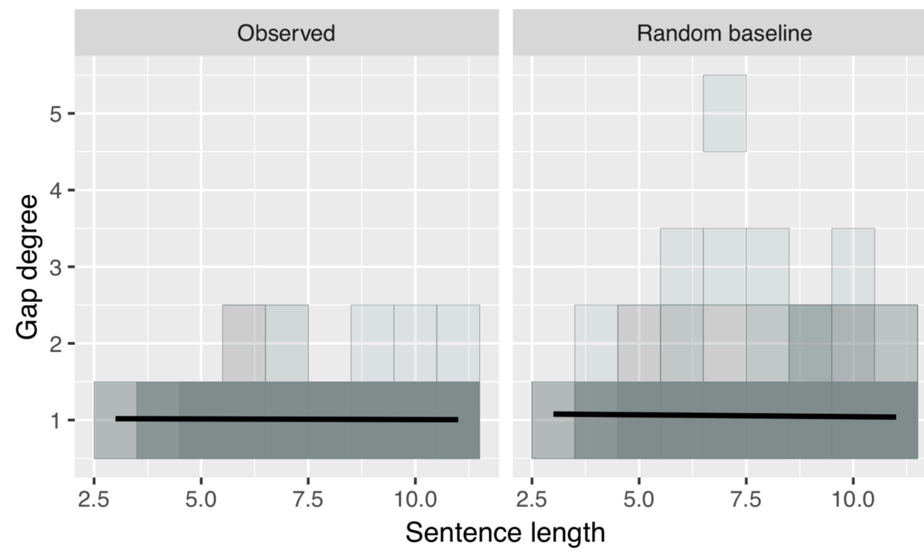

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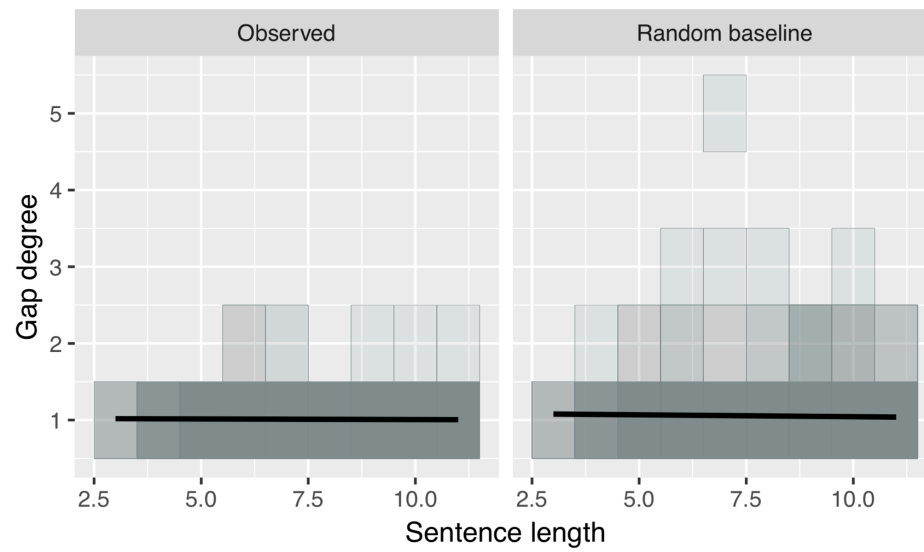

n.s.

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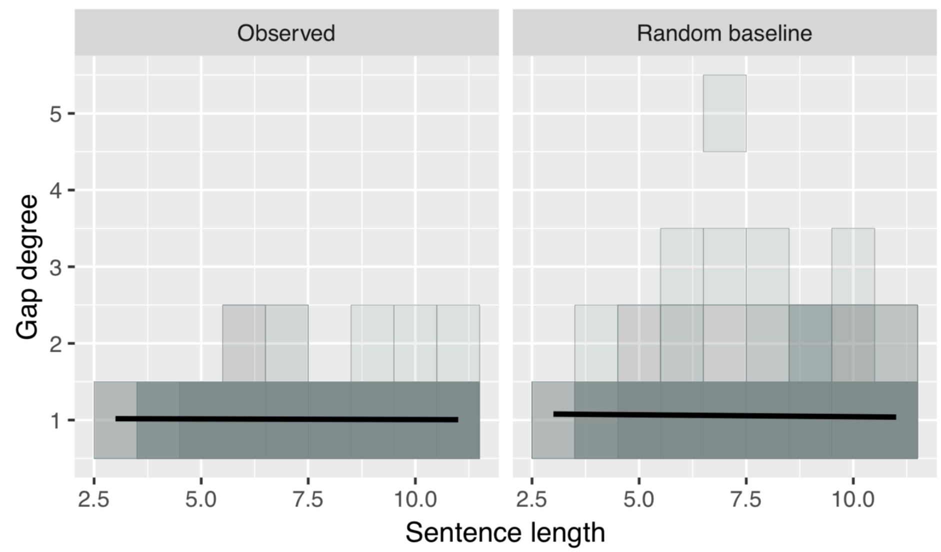

n.s.

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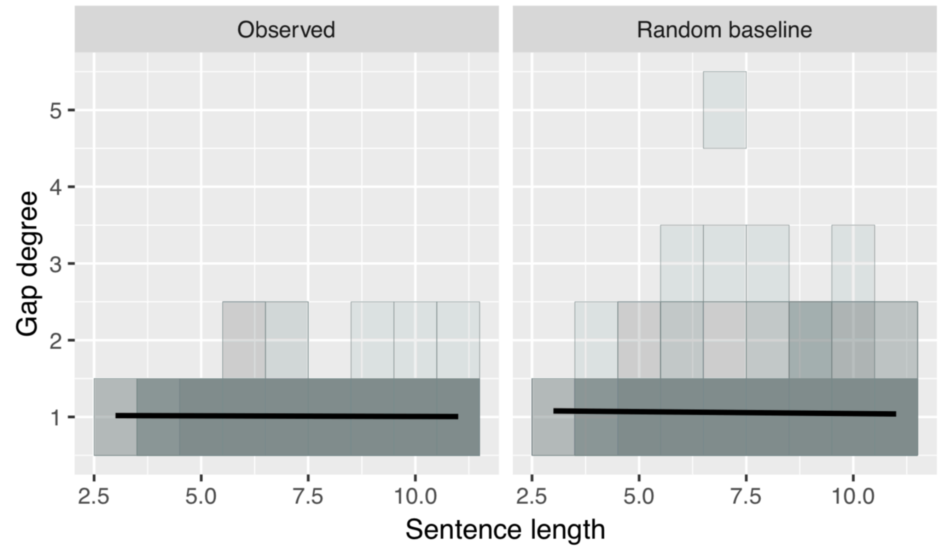

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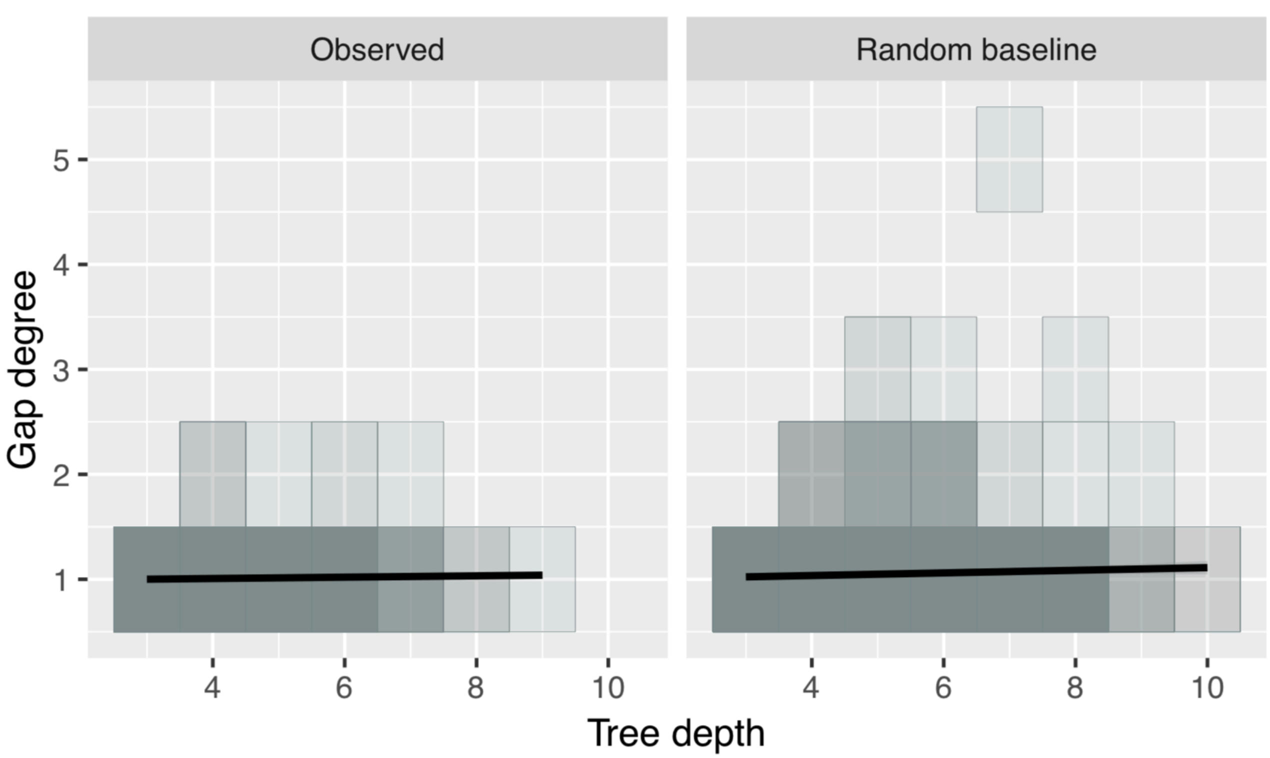

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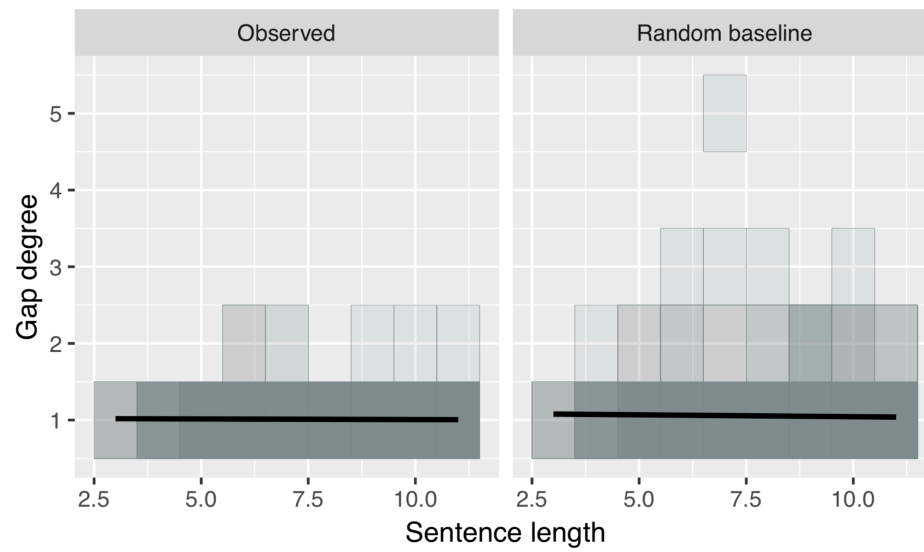

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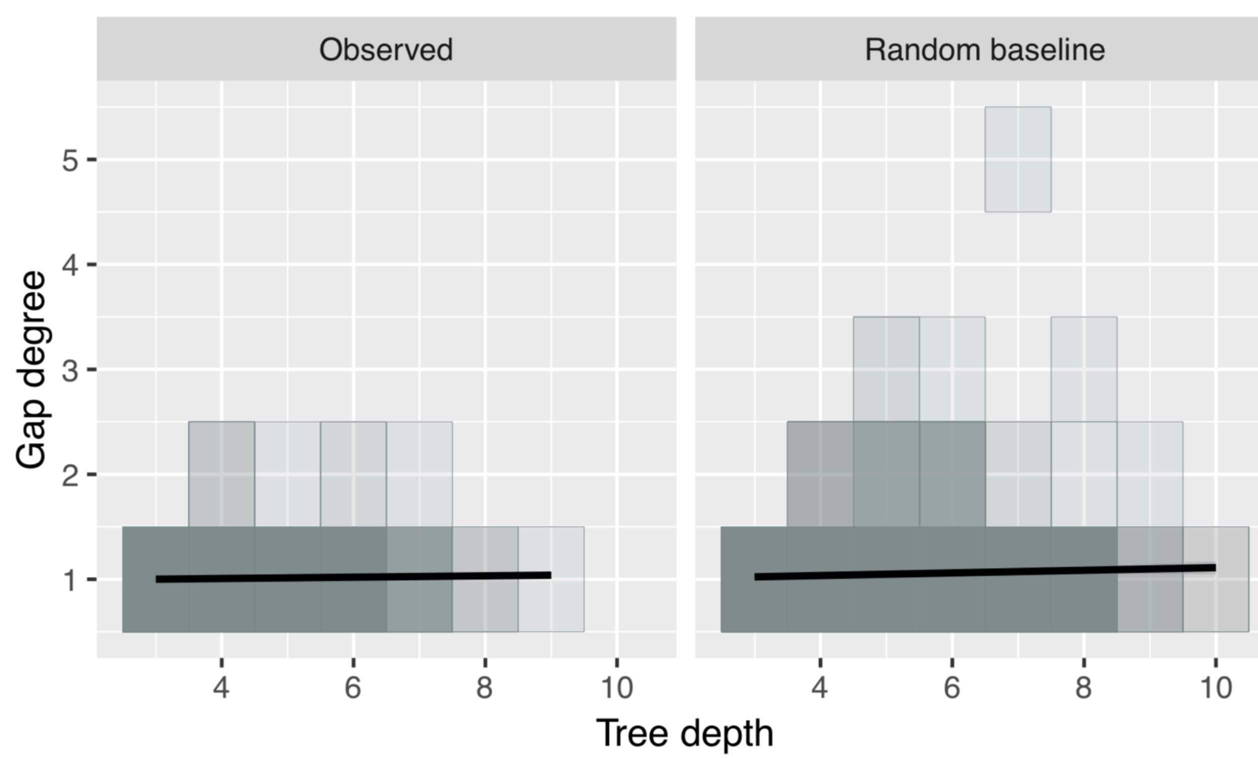

$p < .001$

End-point Crossings

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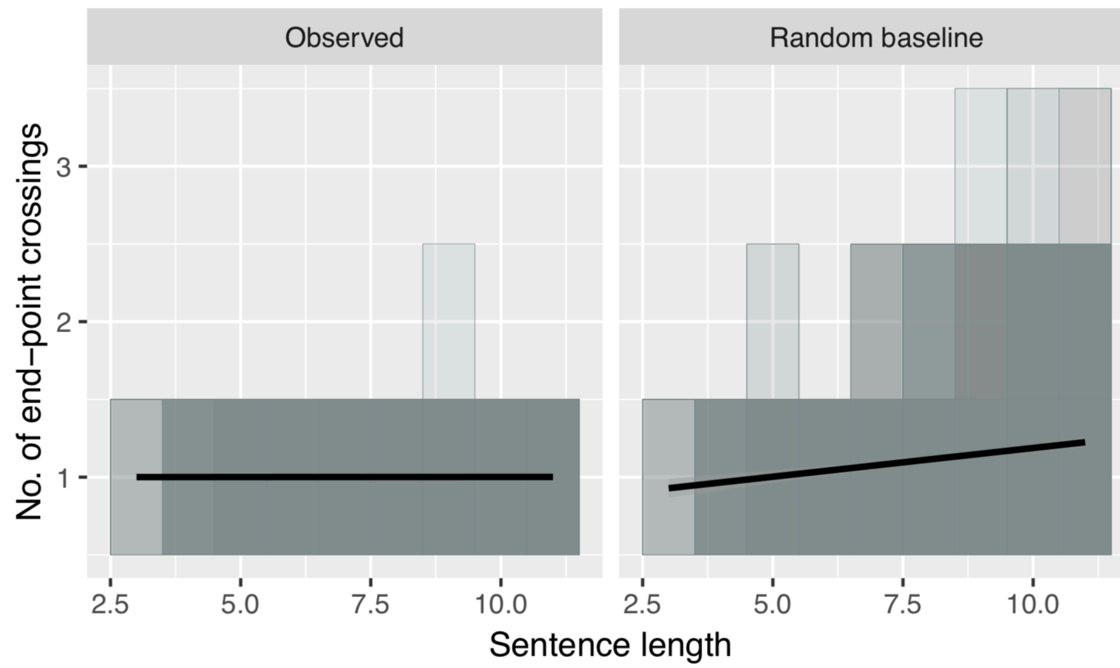

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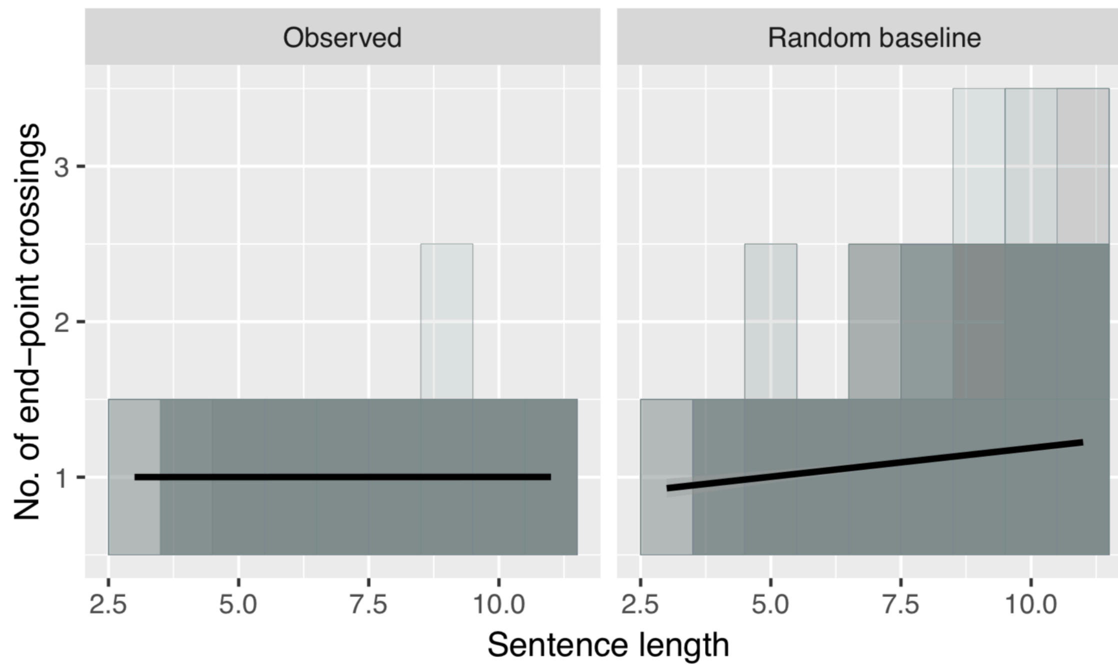

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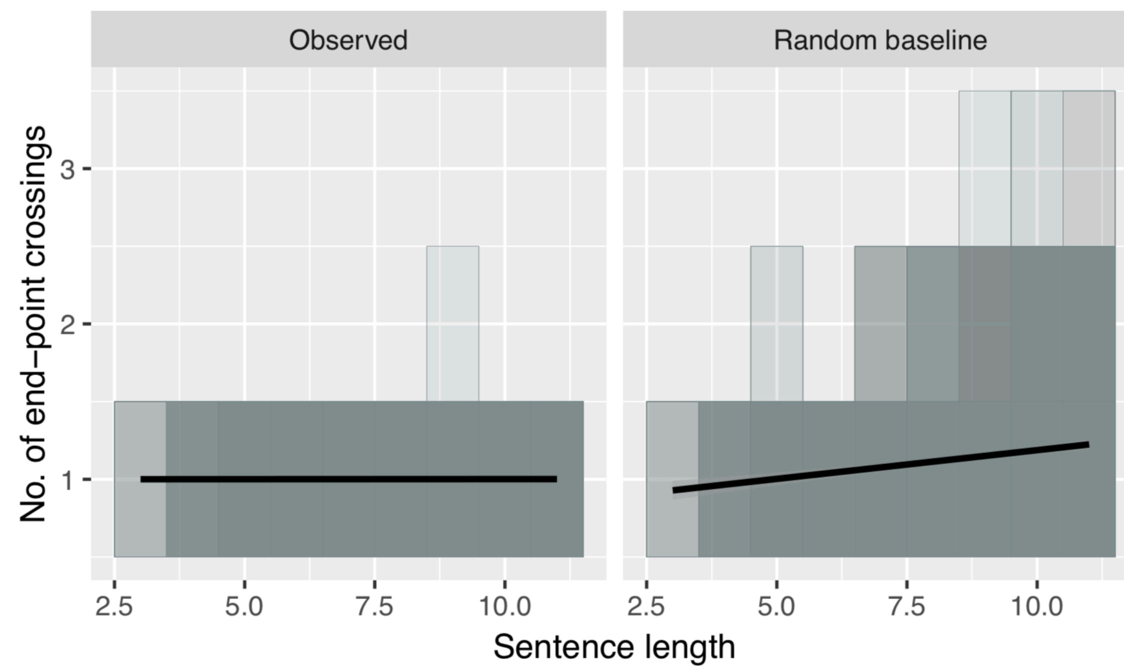

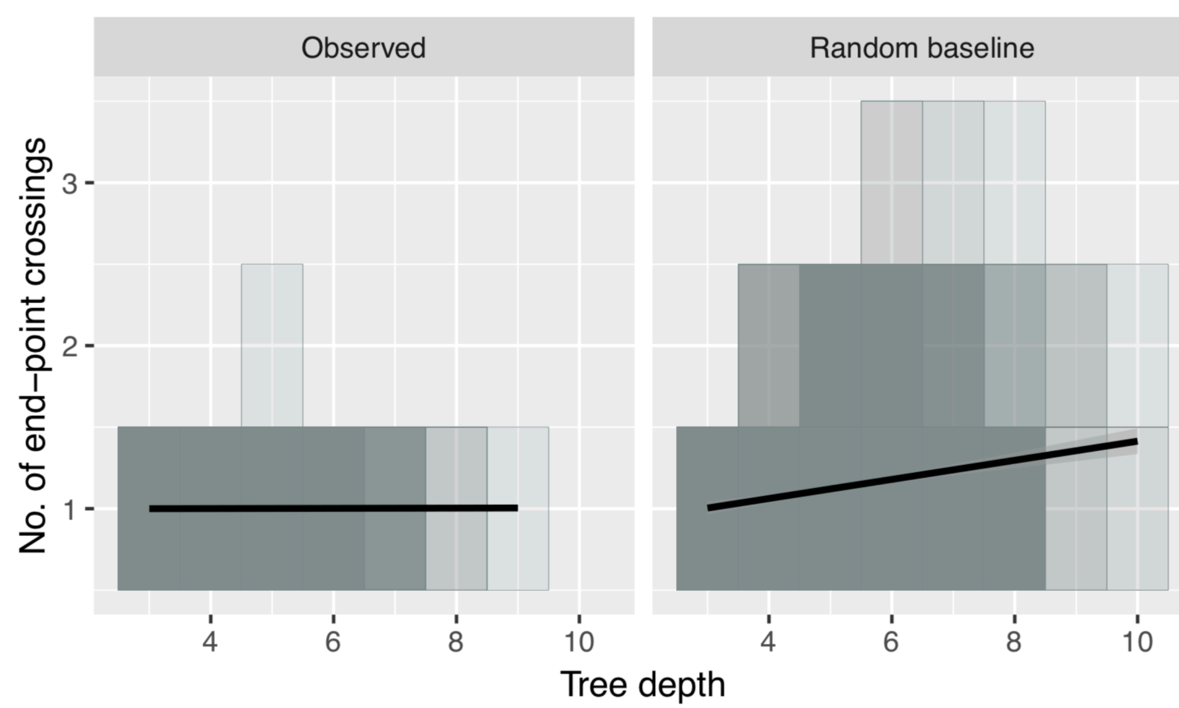

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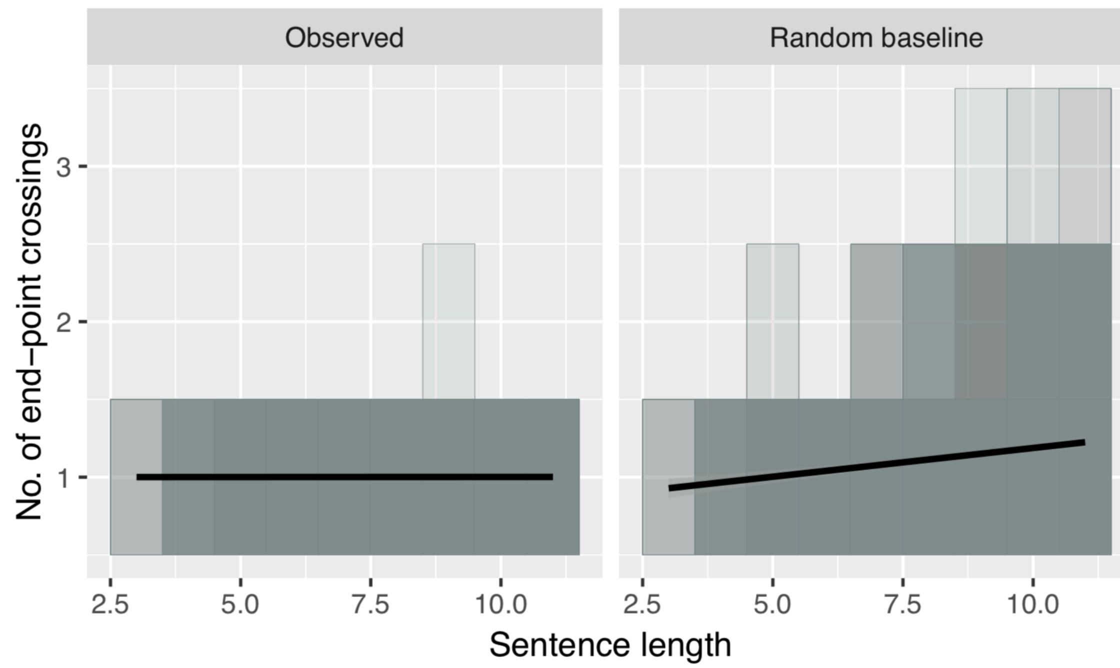

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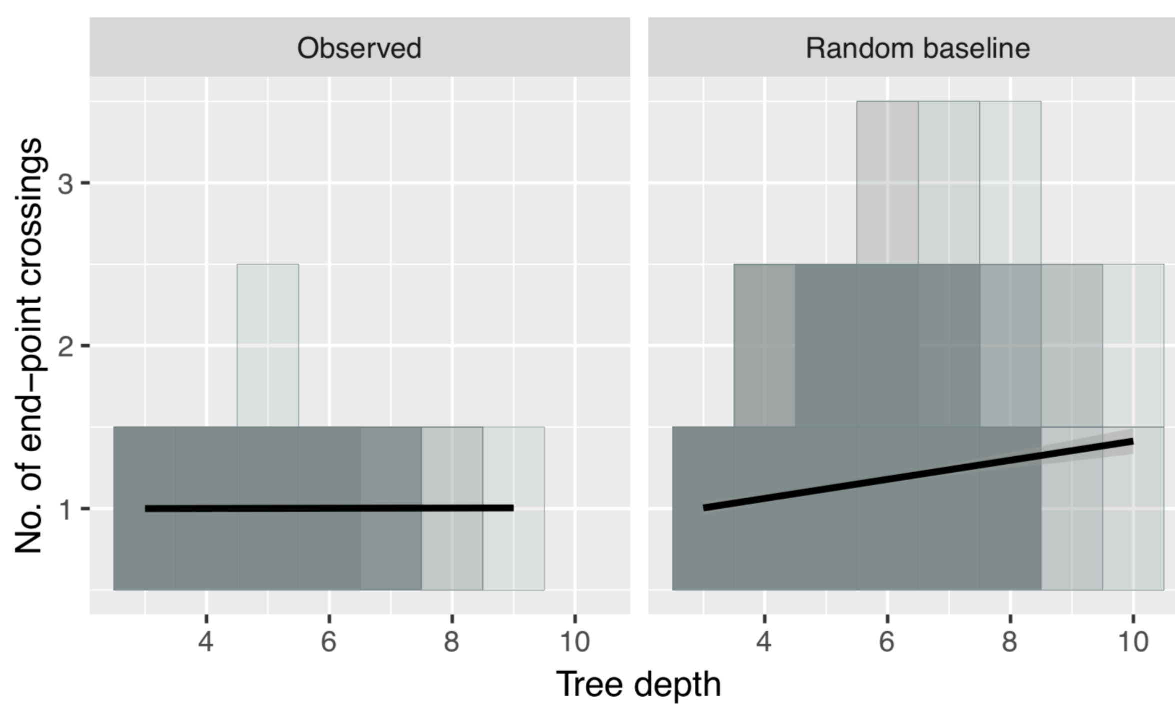

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Evidence for the True Constraint Hypothesis?

as a function of…	Gap degree	Edge Degree	End-point Crossings	Heads’ Depth Difference
~ length	✗	✓	✓	✗
~ arity	✗	✓	✓	✓
~ depth	✓	✓	✓	✓

✓ = significant interaction coefficient
✗ = nonsignificant interaction coefficient

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    - Future work: Control for tree depth, arity, etc. in the random trees.

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  - Tree depth and arity
  - Dependency length
  - Could controlling crossing constraints explain the rarity of crossings?

Thanks all!

- All code is available online at https://github.com/yadavhimanshu059/measures_of_nonProjectivity
- Thanks to **Roger Levy** and **Tim O'Donnell** for discussion, and to our **SyntaxFest reviewers** for helpful suggestions.
- Thanks to the **TLT organizers**!