SAUSSURIAN ANALOGY: A THEORETICAL ACCOUNT AND ITS APPLICATION

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Analogy: the phenomenon

Latin: *ōrātōrem* : *ōrātor* = *honōrem* : x

x = *honor* instead of *honos*

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Analogy on words (Morphology)

- Prefixing: *desirable* : *undesirable* = *determined* : x

  x = *undetermined*

- Suffixing: *user* : *usable* = *doer* : x

  x = *doable*

- Infixing: *fable* : *fabulous* = *miracle* : x

  x = *miraculous*

Explains declension, conjugation, derivation.

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Analogy on sentences (Syntax?)

e.g.: *The signal is off* : *The green signal is on* = *The lamp turns on* : x

x = *The green lamp turns off*

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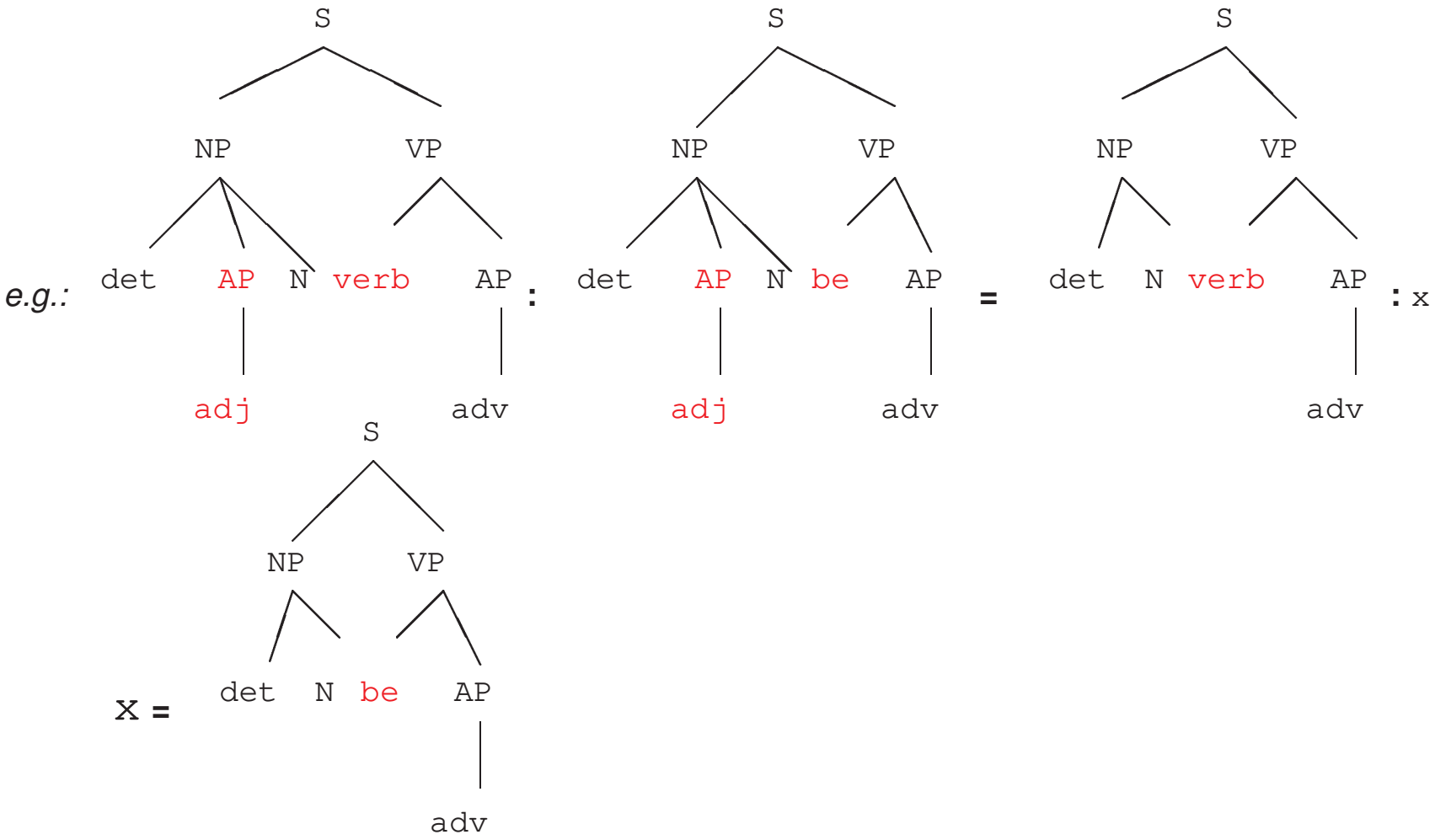
Analogy on linguistic representations



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Computational explanation

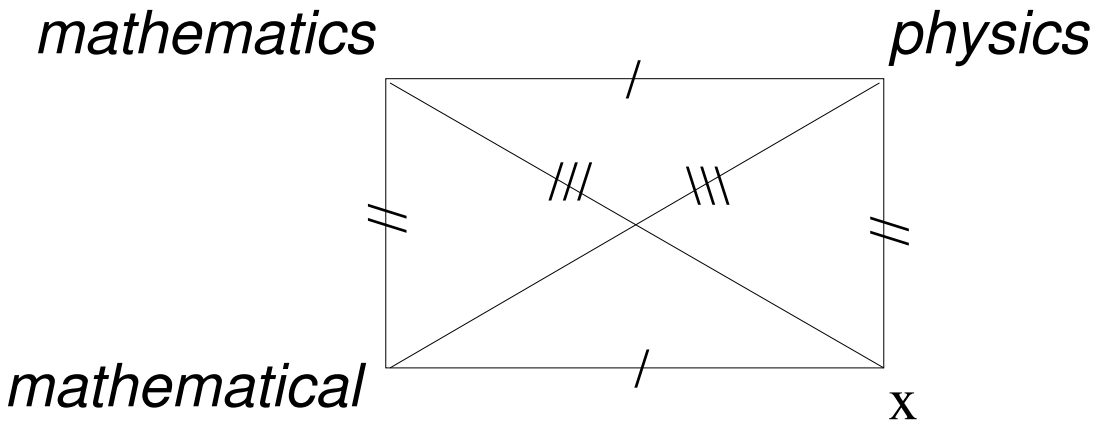
Arithmetical view: *mathematics* : *mathematical* = *physics* : x

x = *physical*

similar to: *2* : *4* = *3* : x

x = *6*

Geometrical view:



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Edit distances

Edit operations:

- Deletion (*e.g.* pretty → pet)
- Insertion (*e.g.* make → mistake)
- Substitution (*e.g.* big → bag)

dis = *min* nbr of edit op.

General definition on forests applies to

- Strings of chars (words)
- Strings of words (sentences)
- Trees (linguistic structures)

Explanation

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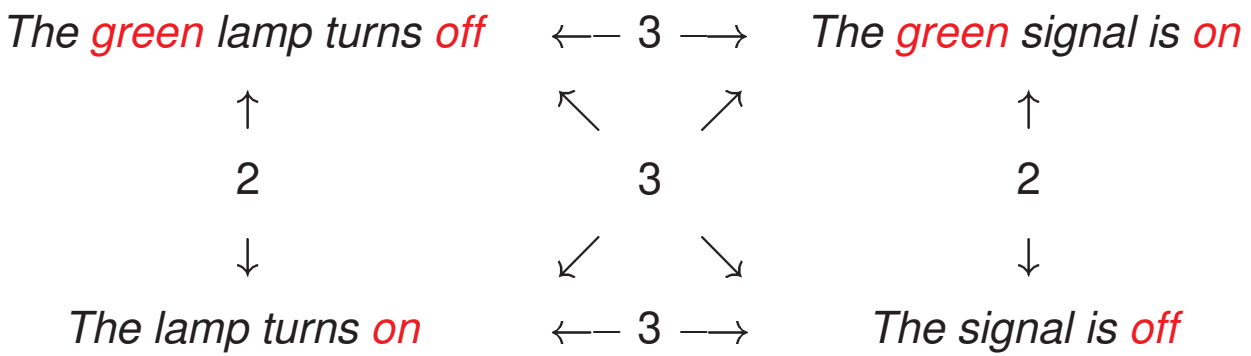
Analogy on sentences (explained)



Explanation

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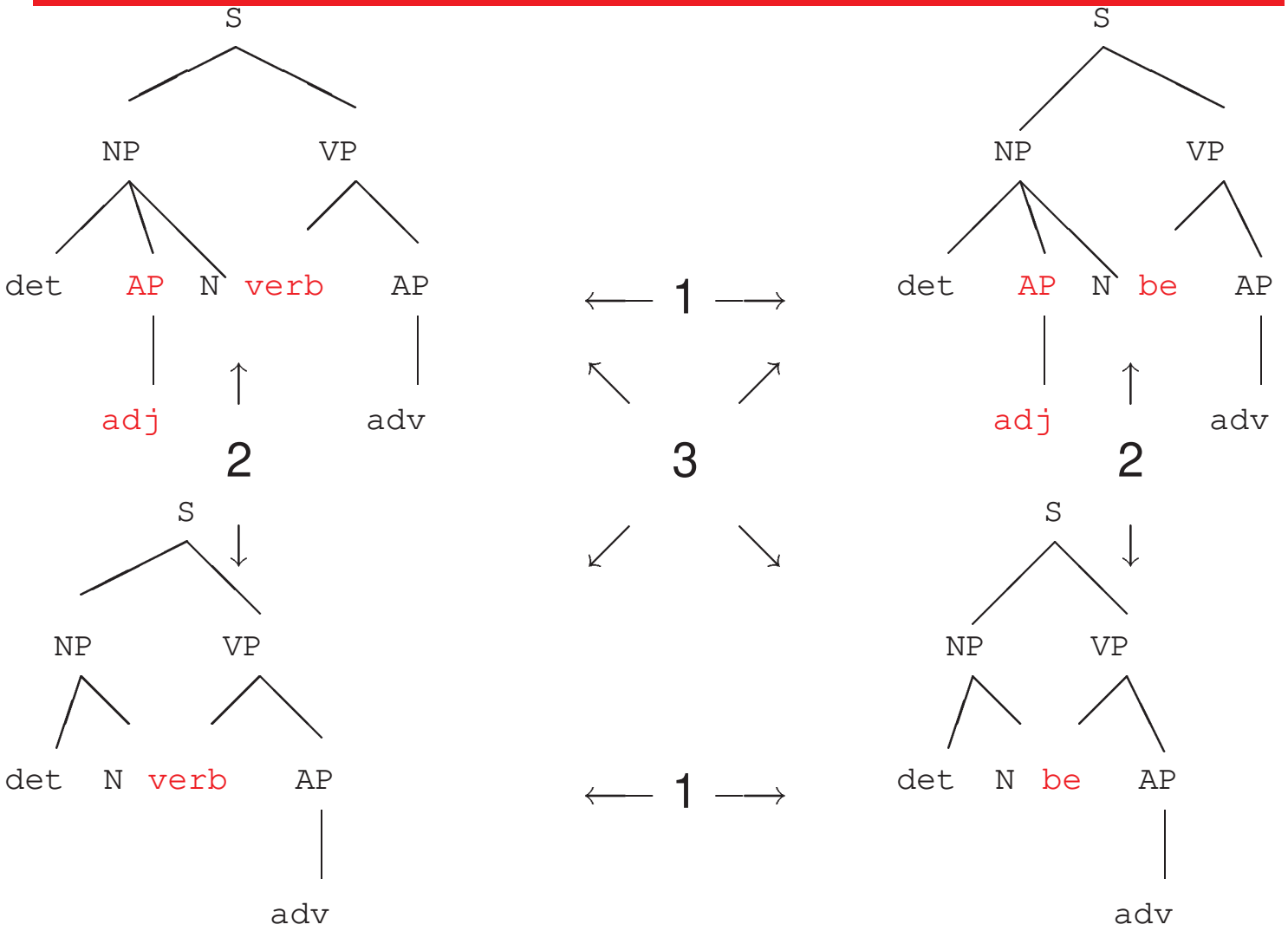
Analogy on ling. representations (explained)



Explanation

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Example-based stream

If sentences (a) and (b) are close (??), if analysis of (a) is known, perform slight modifications (??) $\Rightarrow$ analysis of (b).

Imitation

$\neq$

Analogy

If sentences (a), (b), (c) and (d) verify analogy, if analysis of (a), (b) and (c) are known, solve analogy $\Rightarrow$ analysis of (d).

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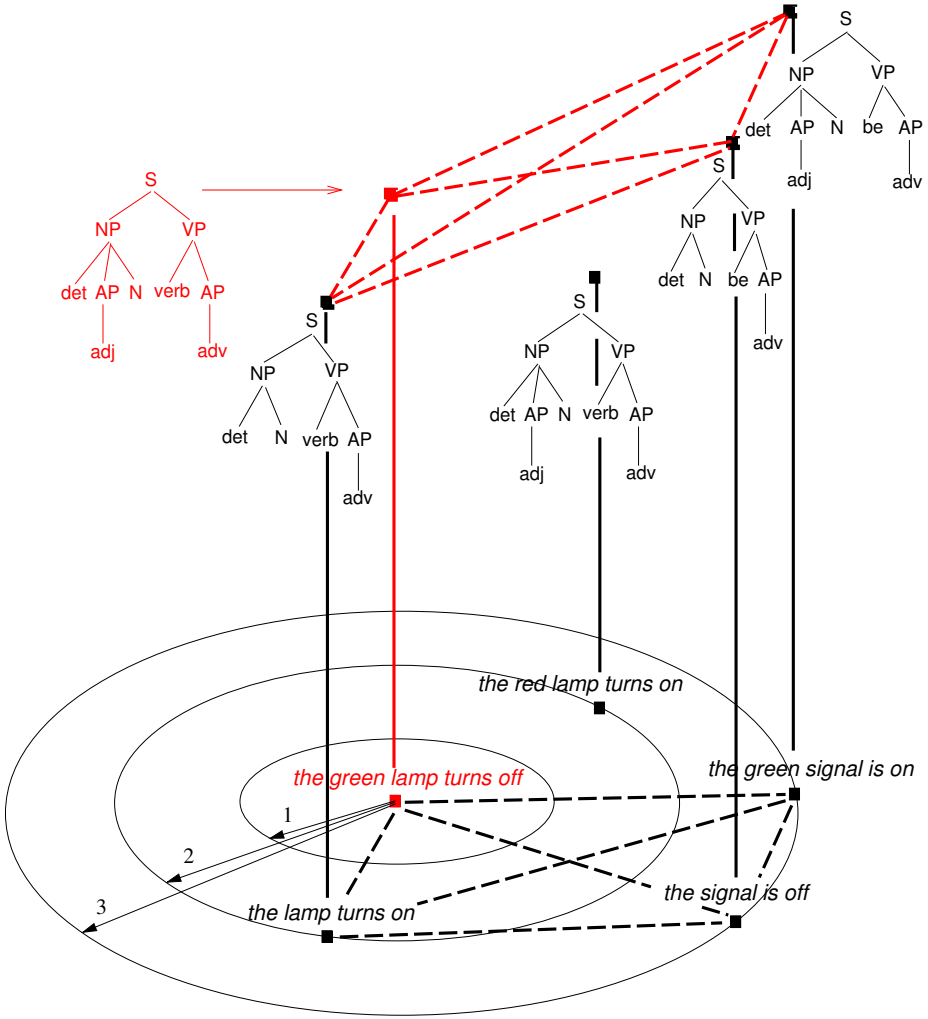
Analysis by analogy (Principle)



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Experiment data

Tree-bank: excerpt of UPenn (787 sentences and trees)

	$\neq$ words/nodes	size	
		mean	std. dev.
sentences	778	12.3	6.33
ling. structures	28	9.95	5.40

- Not true analysis: search for ling. structure in the tree-bank
- Distances in rectangle $\leq$ max size $\times$ 1/5, 1/4, 1/3, . . . , 1

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Results (for dist $\leq$ max size $\times$ 2/5)

Recall = prop. of relevant objects that are retrieved = **46%**

$$\frac{|\triangle\text{analogy} = \triangle\text{correct}|}{|\left(\overset{\triangle}{\leftrightarrow}, \overset{\triangle}{\leftrightarrow}\right) / \triangle = \triangle|}$$

Precision = prop. of retrieved objects that are relevant = **48%**

$$\frac{|\triangle\text{analogy} = \triangle\text{correct}|}{|\triangle\text{analogy}|}$$

Non-determinism = **90**

$$\left(\overset{\triangle}{\leftrightarrow}, \overset{\triangle}{\leftrightarrow}, \overset{\triangle}{\leftrightarrow}\right) \rightarrow \text{same solution}$$

Accuracy = **0.8** $\pm$ **1.2** (in nodes)

$$\text{dist}(\triangle\text{analogy}, \triangle\text{correct})$$

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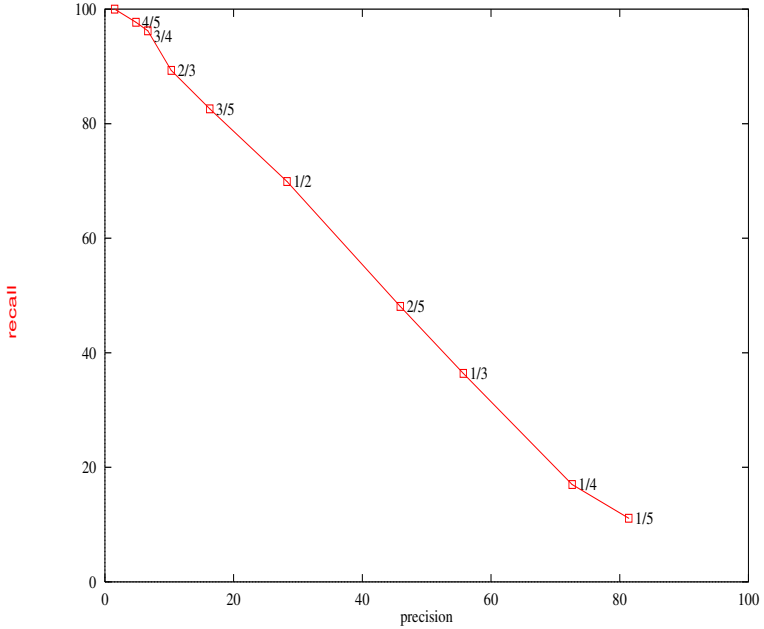
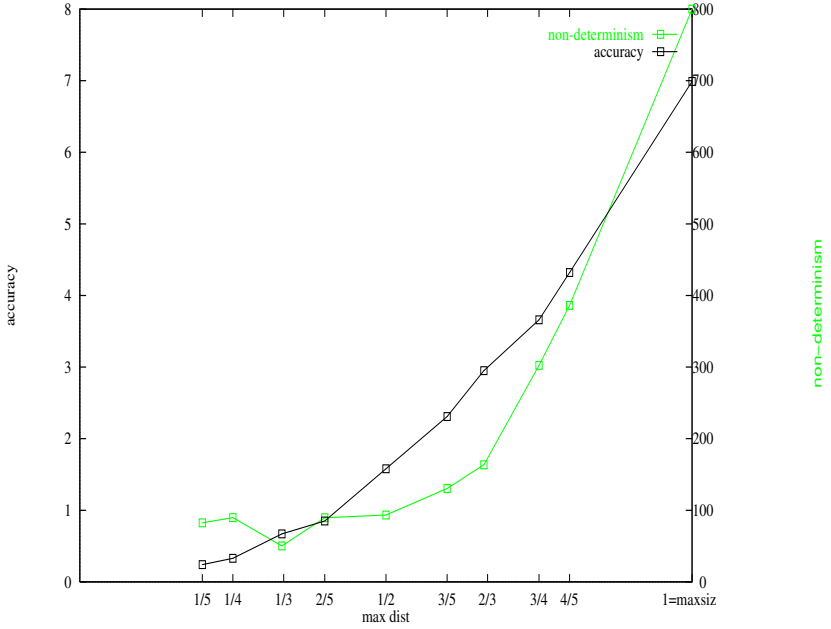
Recall/precision – non-det./accuracy





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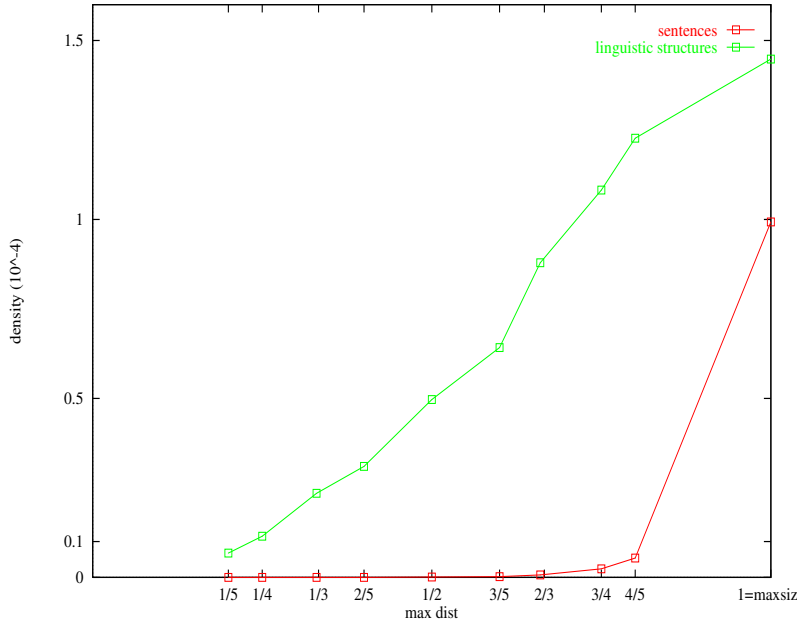
Density



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Conclusion

Analogy

- is transversal (structuralist) $\neq$ axiomatic (generativist)
- captures regularity

Explanation using edit distances: words, sentences, trees

Application to NLP

- analysis by analogy
- generation/transfer by analogy (?)

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