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Introduction

Syntactic analysis (5LN455)

2012-11-13

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Mostly based on slides from Marco Kuhlmann

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Today

- Introduction to syntactic analysis
- Course information

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What is syntax?

- Syntax addresses the question how sentences are constructed in particular languages.
- The English word *syntax* comes from the Ancient Greek word *sýntaxis* ‘arrangement’.

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What is syntax not?

Syntax does not answer questions about …

… how speech is articulated and perceived (phonetics, phonology)

… how words are formed (morphology)

… how utterances are interpreted in context (semantics, pragmatics)

simplified

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Why should you care about syntax?

- Syntax describes the distinction between well-formed and ill-formed sentences.
- Syntactic structure can serve as the basis for semantic interpretation and can be used for
  - Machine translation
  - Information extraction and retrieval
  - Question answering
  - ...

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Parsing

The automatic analysis of a sentence
with respect to its syntactic structure.

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Theoretical frameworks

- Generative syntax
  Noam Chomsky (1928–)
- Categorial syntax
  Kazimierz Ajdukiewicz (1890–1963)
- Dependency syntax
  Lucien Tesnière (1893–1954)

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Theoretical frameworks

Chomsky

Ajdukiewicz

Tesnière

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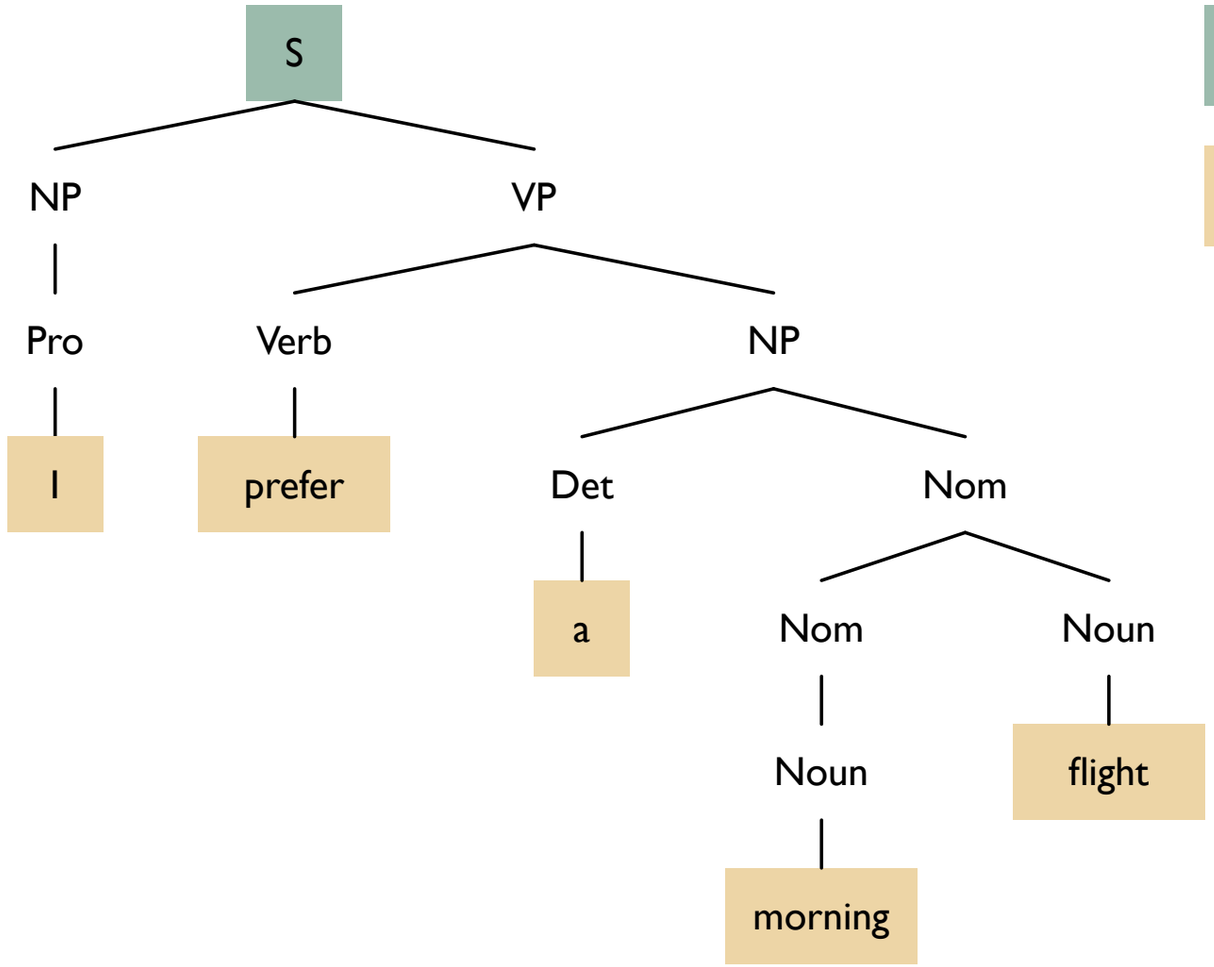
Phrase structure trees



root (top)

leaves (bottom)

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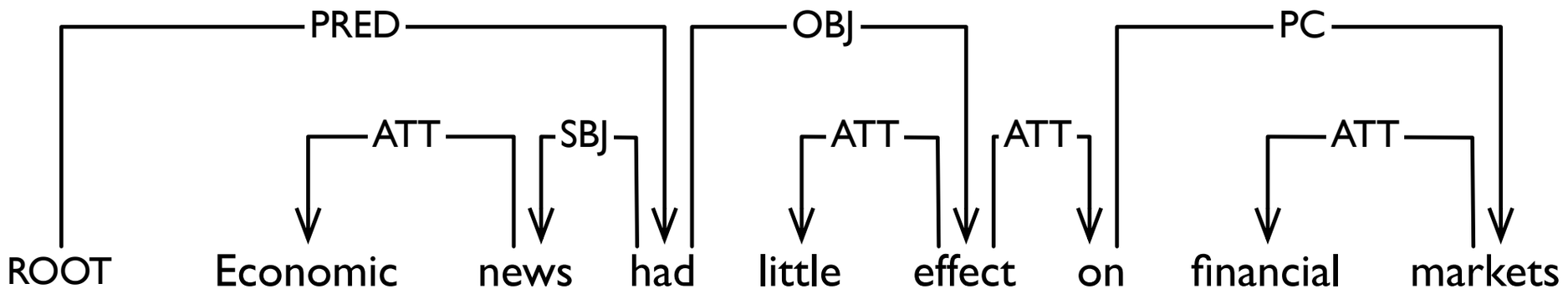
Dependency trees



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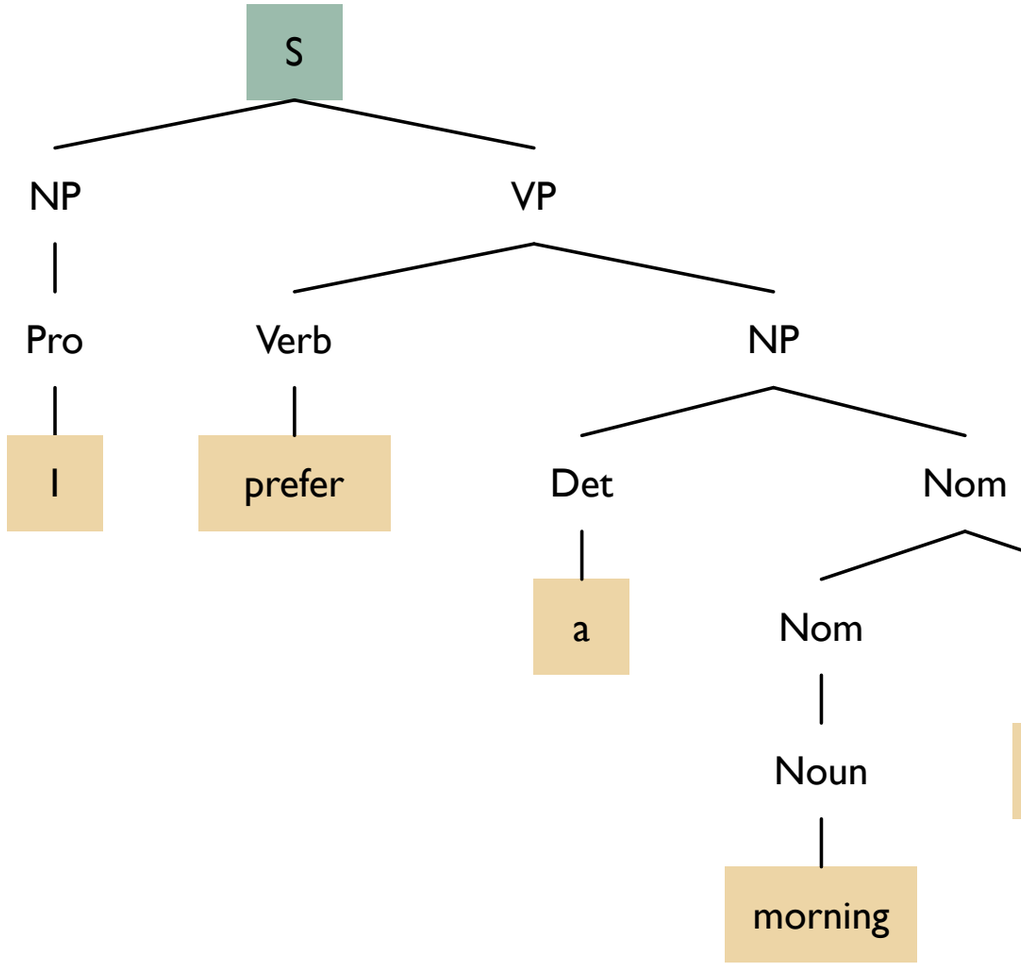
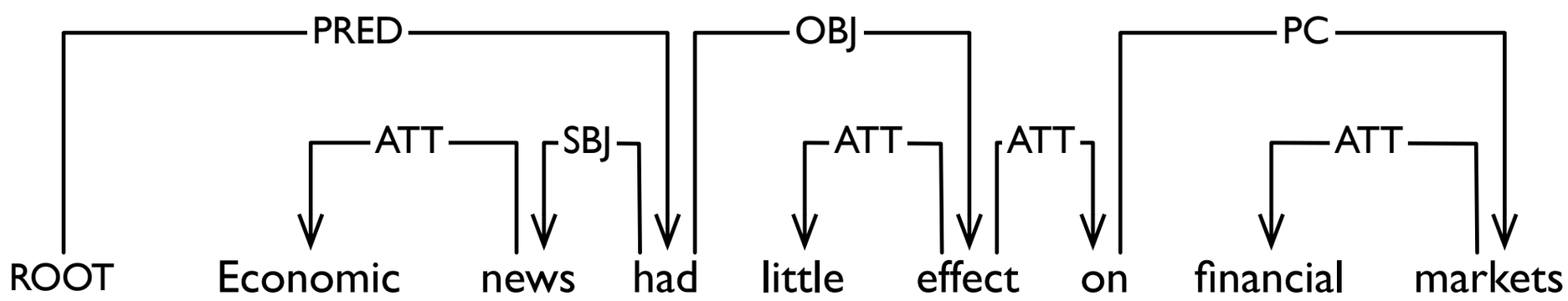
Phrase structure vs dependency trees





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Ambiguity

I booked a flight from LA.

- This sentence is ambiguous. In what way?
- What should happen if we parse the sentence?

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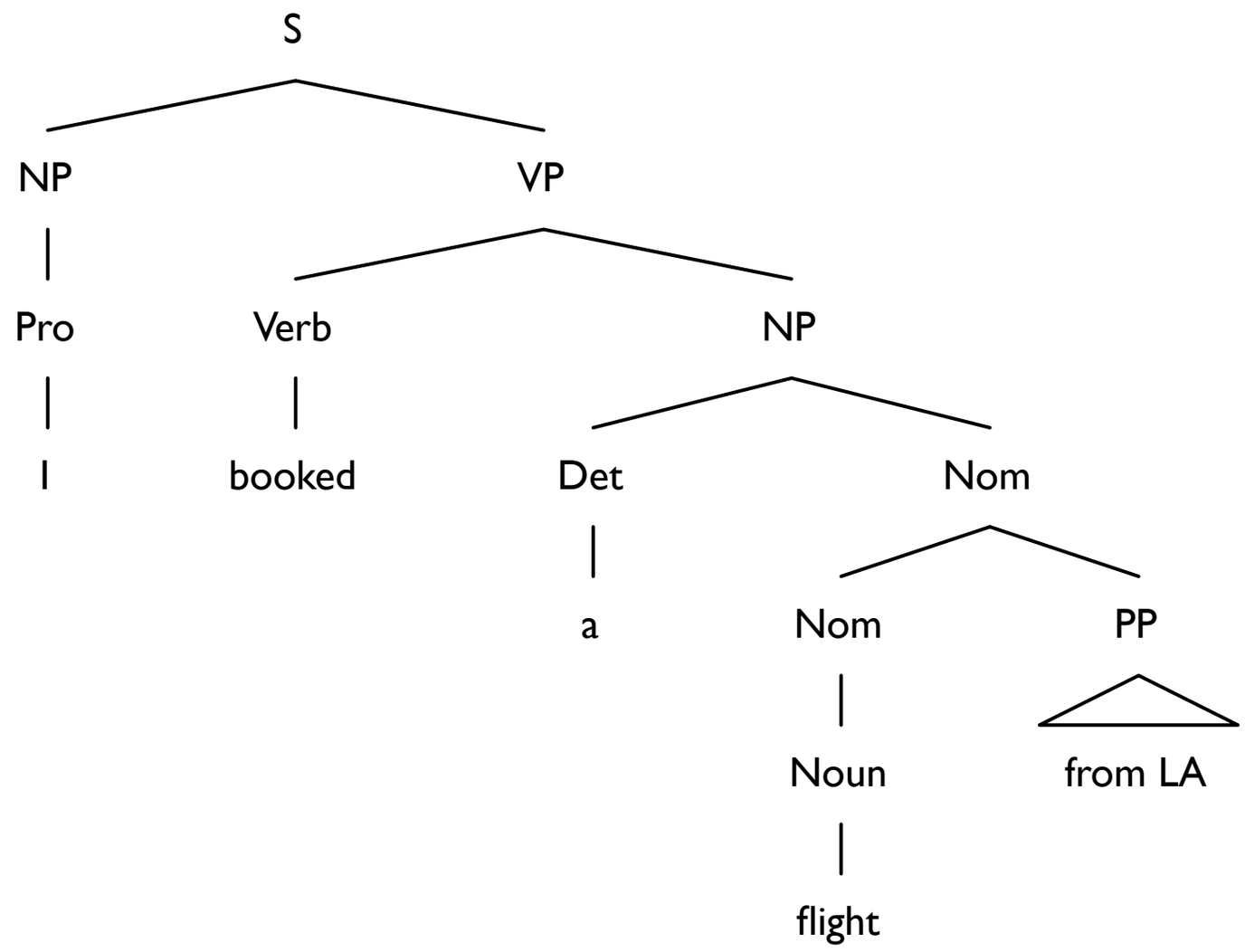
Ambiguity



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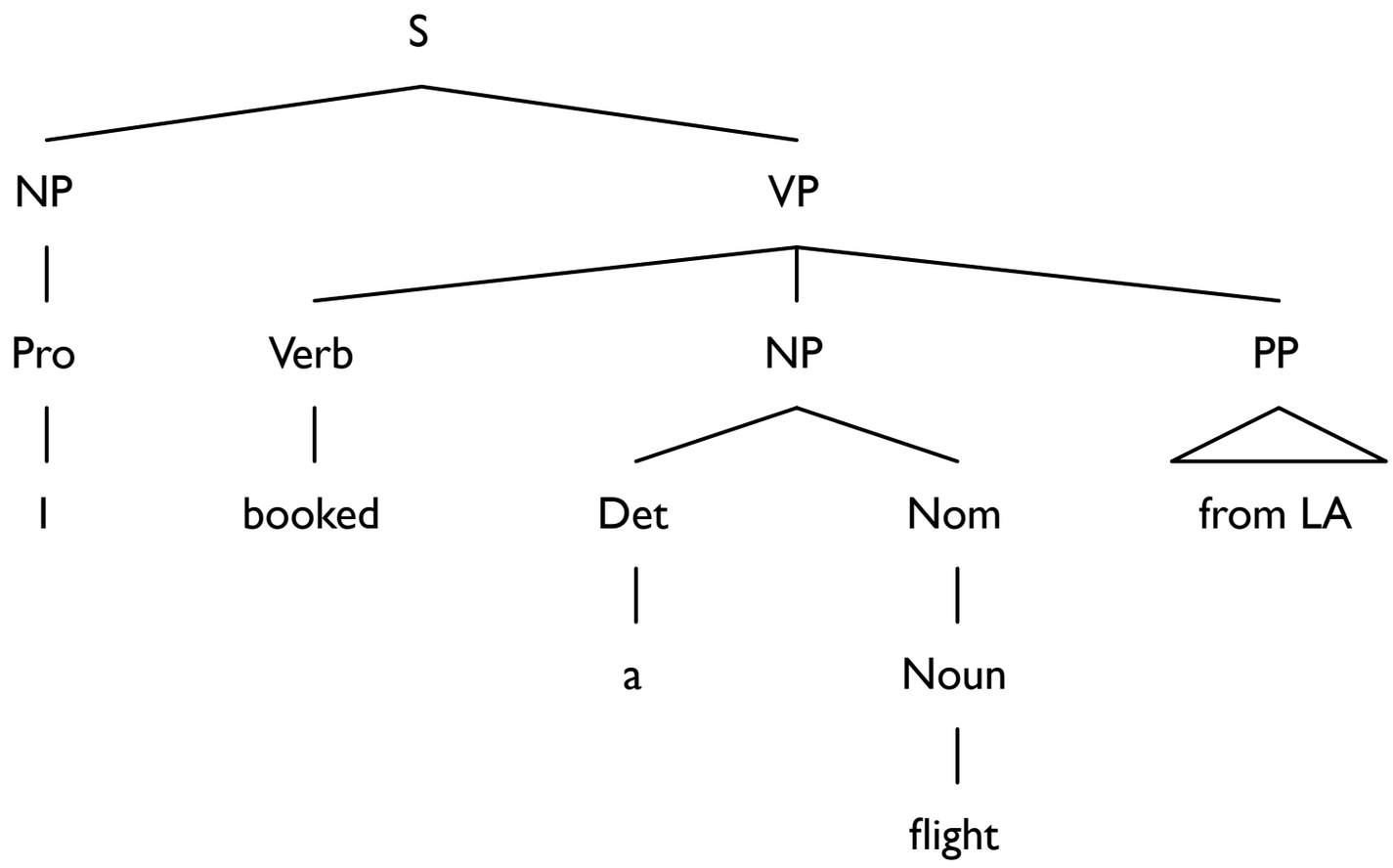
Ambiguity



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Interesting questions

- Is there any parse tree at all?
- What is the best parse tree?

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Parsing as search

- Parsing as search:
  Search through all possible parse trees for a given sentence.
- In order to search through all parse trees we have to ‘build’ them.

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Top–down and bottom–up

top–down

only build trees that are rooted at *S*

may produce trees that do not match the input

bottom–up

only build trees that match the input

may produce trees that are not rooted at *S*

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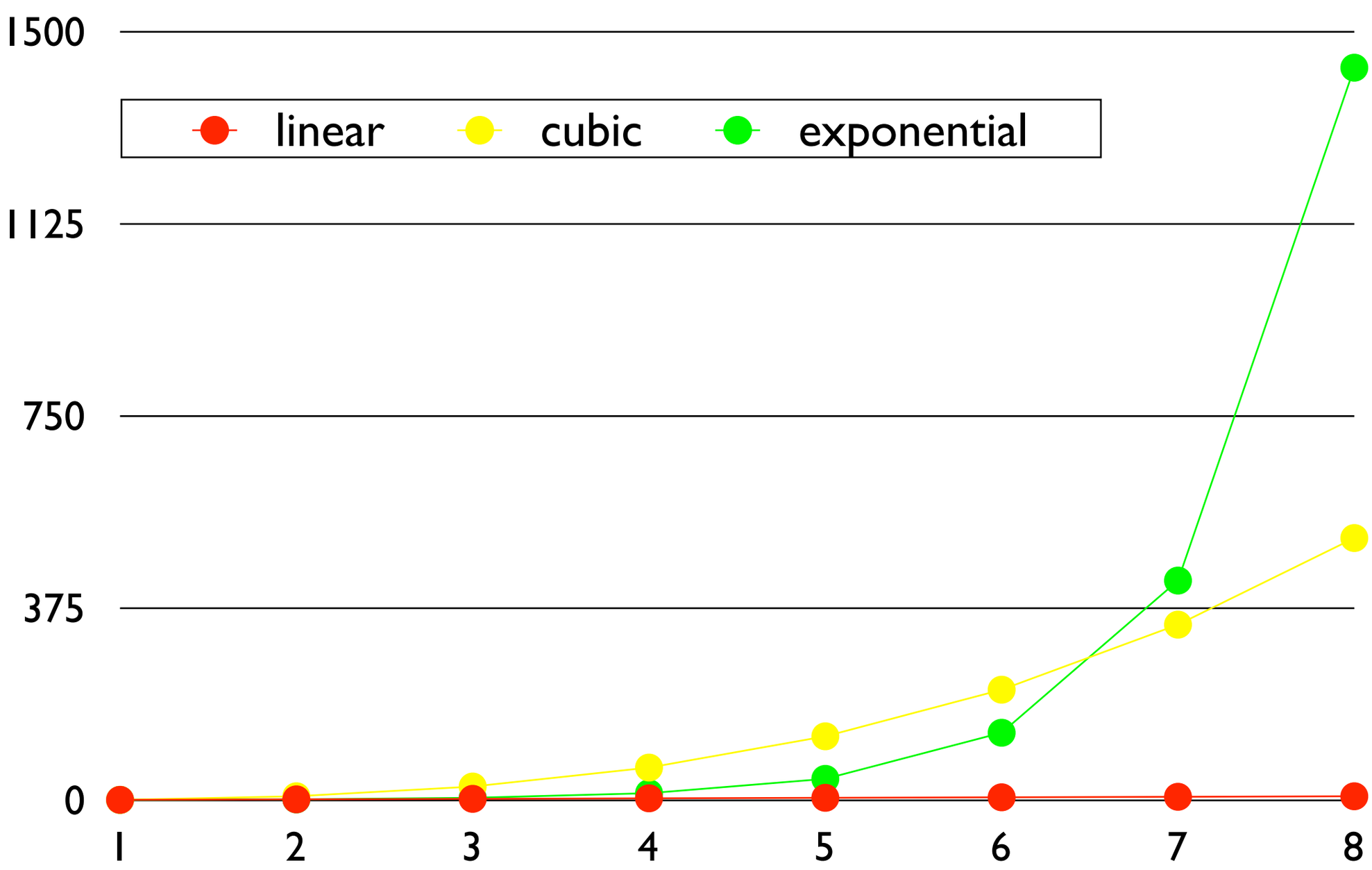
How many trees are there?



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Dynamic programming (DP)

- Divide and conquer:
  In order to solve a problem, split it into subproblems, solve each subproblem, and combine the solutions.

- Dynamic programming:
  Solve each subproblem only once and save the solution in order to use it as a partial solution in a larger subproblem.

- Memoisation:
  Solve only the necessary subproblems and store their solutions for resue in solving other subproblems.

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Complexity

- Using DP we can (sometimes) search through all parsetrees in polynomial time.
- That is much better than to spend exponential time!
- But it may still be too expensive!
  In these cases one can use an approximative method such as greedy search or beam search.

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Course information

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Intended learning outcomes

At the end of the course, you should be able to

- account for the parsing problem of phrase structure grammar and dependency grammar;
- explain at least two different methods for automatic syntactic analysis: one for phrase structure parsing, one for dependency parsing;
- account for statistical methods for syntactic disambiguation;

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Intended learning outcomes

- apply existing systems that use these methods to realistic data and evaluate them with respect to their accuracy and efficiency;
- implement a central component of at least one approach to syntactic analysis in a suitable programming language.

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Examination

- Examination is continuous and distributed over four graded assignments and one seminar.
- Two assignments are one-page papers.
  Time to invest: about 8 hours per assignment.
- The other two assignments are small projects where you need to implement/test parsers.
  Time to invest: about 40 hours per assignment.
- In the final seminar you will discuss some of your assignment results orally, and discuss issues of the other course participants

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Assignments

1. Written assignment on phrase structure parsing
2. Programming assignment: implement CKY parsing
3. Written assignment on dependency parsing
4. Use and evaluate an exisiting system for dependency parsing

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Learning outcomes and examination

- account for the parsing problem of phrase structure grammar and dependency grammar; paper assignments
- explain at least two different methods for automatic syntactic analysis: one for phrase structure parsing, one for dependency parsing; paper assignments
- account for statistical methods for syntactic disambiguation; paper assignments

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Learning outcomes and examination

- apply existing systems that use these methods to realistic data and evaluate them with respect to their accuracy and efficiency; project assignment 1
- implement a central component of at least one approach to syntactic analysis in a suitable programming language. project assignment 2

- All learning outcomes: final seminar

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Grading

- The assignments are graded with G and VG
- G on the seminar if present and active. The seminar is obligatory!

- To achieve G on the course:
  - G on all assignments and final seminar
- To achieve VG on the course:
  - Same as for G **and** VG on at least two assignments

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Teachers

- Sara Stymne
  - Course coordinator, most lectures, assignments
- Joakim Nivre
  - Examiner, two lectures

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Course workload

- 7.5 hp means about 200 hours work
- 16 h lectures
- 2 h seminar
- 182 h work on your own
  - ~ 96 h assignment work
  - ~ 86 h reading
- No scheduled assignment supervision. Contact Sara when you need help!

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Schedule

week 46	(2 hrs taught, 14 hrs reading, 4 hrs assignments)	
13/11	13–15	Lecture: Introduction
week 47	**(4 hrs taught, 8 hrs reading, 8 hrs assignments)**	
18/11	10–12	Lecture: Phrase structure parsing 1
20/11	10–12	Lecture: Phrase structure parsing 2
week 48	**(2 hrs taught, 4 hrs reading, 14 hrs assignments)**	
27/11	13–15	Lecture: Phrase structure parsing 3
week 49	**(2 h taught, 4 hrs reading, 14 hrs assignments)**	
04/12	10–12	Lecture: Phrase structure parsing 4

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Schedule

week 50 (2 hrs taught, 8 hrs reading, 10 hrs assignments)		
11/12		Deadline: Assignments 1 and 2
11/12	13–15	Lecture: Dependency parsing 1 (JN)
week 51 (4 hrs taught, 12 hrs reading, 4 hrs assignments)		
16/12	10–12	Lecture: Dependency parsing 2 (JN)
18/12	10–12	Lecture: Dependency parsing 3
week 52-02 (0 hrs taught, 32 hrs reading, 28 hrs assignments)		
week 03 (2 hrs taught, 4 hrs reading, 14 hrs assignments)		
15/01	13–15	Final seminar
15/01		Deadline: Assignments 3 and 4

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Reading

- Daniel Jurafsky and James H. Martin.
  Speech and Language Processing. 2nd edition.
  Pearson Education, 2009.
  Chapters 12-14.
- Sandra Kübler, Ryan McDonald,
  and Joakim Nivre. Dependency Parsing.
  Morgan and Claypool, 2009.
  Chapter 3-4.

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Evaluation from last year

- Overall score: 4.25
  - Overall students found the course interesting, and the assignments good
- This year
  - New teachers
  - Seminar at the end of the course
  - Otherwise not much change, since the course was working well