Introduction, administrivia

Parsing
ISCL-BA-06

Çağrı Çöltekin
/tʃaːˈɾɯ tʃœltecˈın/
ccoltekin@sfs.uni-tuebingen.de

University of Tübingen
Seminar für Sprachwissenschaft

Winter Semester 2020/21

version: e1b8f57 @2020-11-16

What is parsing?

- *Parsing* is the task of analyzing a string of symbols to discover its (inherent) structure
- Typically, the structure (and the valid strings in the language) is defined by a *grammar*
- The output of a parser is a structured representation of the input string, often a tree
- *Recognition* is an intimately related task which determines whether a given string is in a language

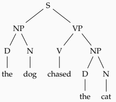
Ingredients of a parser

(for natural language parsing)

- A formal grammar defining a language of interest
- An algorithm that (efficiently) verifies whether a given string is in the language (recognizer) and enumerate the grammar rules used for verification (parser)
- A system for ambiguity resolution (very limited coverage in this course)

Grammars

- A grammar is a finite specification of a possibly infinite language
- The most commonly studied type of grammars are *phrase structure grammars*
- Analysis using a (type of) phrase structure grammars result in *constituency* or *phrase structure* trees



S → NP VP NP → D N VP → V NP
V → chased D → the N → cat N → dog

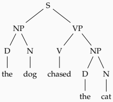
Formal languages and natural languages

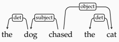
> *There is in my opinion no important theoretical difference between natural languages and the artificial languages of logicians.*
> — *Richard Montague, in "Universal Grammar"* (1970)

- Formal grammars are equally important for linguistics as they are important for computer science
- Historically, there has been very strong connections between linguistics and computer science
- The formal languages (that originate in linguistics) has important theoretical consequences for computer science as well

Why study parsing?

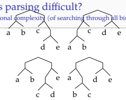
- In general, it is a intermediate step for interpreting sentences
- Applications include:
  - Compiler construction
  - Grammar checking
  - Sentiment analysis
  - Information (e.g., relation) extraction
  - Argument mining
  - ...





Why is parsing difficult?

computational complexity (of searching through all binary trees)



... Not enough space for trees.

- In short: combinatorial expansion.
- Most of what we study in this course is ways to limit this search space based on the grammar at hand

words	search space
1	1
2	1
3	2
4	5
5	14
10	4862
15	2 674 440
20	1 767 263 190
25	1 289 904 147 324

Fun exercise: try to systematically produce all binary bracketings of a given number of words.

Why is parsing difficult?

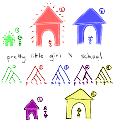
ambiguity (for natural languages) – examples from newspaper headlines

FARMER BILL DIES IN HOUSE
TEACHER STRIKES IDLE KIDS
SQUAD HELPS DOG BITE VICTIM
BAN ON NUDE DANCING ON GOVERNOR'S DESK
PROSTITUTES APPEAL TO POPE
KIDS MAKE NUTRITIOUS SNACKS
DRUNK GETS NINE MONTHS IN VIOLIN CASE
MINERS REFUSE TO WORK AFTER DEATH

Most of the above are lexical ambiguities, but structural ambiguity is also common in natural languages.

Why is parsing difficult?

more on ambiguities



What is in this course?

A bird's eye view

- Grammars, languages, automata, computation
- Parsing as search: bottom-up, top-down
- Chart parsing: CKY, Earley
- Table driven/deterministic parsing: LL/LR/SLR/GLR parsers
- Probabilistic (context-free) parsing
- Dependency grammars
- Dependency parsing: MST, transition-based parsing

Literature

- *Parsing Techniques: A Practical Guide.* Grune and Jacobs (2007)
- *Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition.* Jurafsky and Martin (2009)
- *Dependency Parsing.* Kübler, McDonald, and Nivre (2009)

Practical information

- Lectures Mon/Thu 8:30, online, synchronous via Zoom
- Course web page at `https://iscl-parsing2020.github.io/`
- The class sessions include lectures and exercises, but exact division is unclear
- Most assignments are mostly pencil-and-paper exercises, there will also be practical assignments, but no programming exercises in this course
- Please obtain a GitHub account if you do not have one. We will use GitHub for some of the exercises (more on this later)
- Please register to the Moodle page of the course, and pay attention to the announcements posted there

Prerequisites

You should have already taken

- Linguistic fundamentals
- Data Structures and Algorithms for CL I
- Data Structures and Algorithms for CL II

effectively, you need to know some linguistics and formal thinking

programming skills/knowledge is useful, it is not required for this course

Evaluation

- Final exam at the end of the semester
- Assignments (not graded, but required)
  - (Almost) weekly pencil-and-paper exercises
  - Three bigger, group assignments:
    - Writing a grammar for a subset of English
    - Writing a small constituency treebank
    - Creating a small dependency treebank

Your first assignment

- Your first assignment is available at `https://iscl-parsing2020.github.io/a0/`
- Please complete as soon as you can (it is easy)
- In summary: introduce yourself, and provide 5 grammatical and 5 ungrammatical sentences
- We will use the data gathered for future practical assignments

Acknowledgments, references, additional reading material

- This set of slides are based on earlier slides by Kurt Eberle, which in turn was based on slides by Helmut Schmid
- Some of the (later) examples are inspired by, or sometimes verbatim borrowings from, the material listed below
- The artwork ("pretty little girl's school") is from Speculative Grammarian (`http://specgram.com/CLIII.4/school.gif`).

Grune, D. and C.J.H. Jacobs (2007). *Parsing Techniques: A Practical Guide*. second. Monographs in Computer Science. The first edition is available at `http://dickgrune.com/Books/PTAPG_1st_Edition/BookBody.pdf`. Springer New York. ISBN: 9780387689548.

Jurafsky, Daniel and James H. Martin (2009). *Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition*. second. Pearson Prentice Hall. ISBN: 978-0-13-504196-3. URL: `http://web.stanford.edu/~jurafsky/slp3/`.

Kübler, Sandra, Ryan McDonald, and Joakim Nivre (2009). *Dependency Parsing*. Synthesis lectures on human language technologies. Morgan & Claypool. ISBN: 9781598295962.