NLP and the Web – WS 2024/2025

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Lecture 1
Introduction

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Hovhannes Tamoyan
Kexin Wang

Ubiquitous Knowledge Processing Lab
Technische Universität Darmstadt

Introduction: Teaching Staff

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Dr. Thomas Arnold
Lectures

Hovhannes Tamoyan
Practice Class

Kexin Wang
Practice Class

Outline

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UKP Lab: profile and projects

Administrative course issues

NLP 4 Web Introduction

NLP Basics / Linguistic Analysis

Who Are We?

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- 1 Professor, ~5 Postdocs, ~35 Doctoral Researchers
- We mainly work in natural language processing (NLP)
- Research areas (growing every day!)

Deep Learning for NLP

Knowledge Graphs

Argument Mining

Interactive AI and NLP

Content Analytics for the Social Good

Writing Assistance and Language Learning

Teaching Concept – UKP (Lectures)

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	Winter Term	Summer Term
Introductory		Information Management
Application Oriented	NLP and the Web	Ethics in NLP
Advanced		Deep Learning for NLP

Teaching Concept – UKP (Seminars & Projects)

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Software Project

(irregular schedule)

Data Analysis Software Project for Natural Language

Winter 2023/24: Various Projects
Winter 2024/25: Various Projects

Regular Seminar

Text Analytics / Large Language Models

Winter 2023/24: Generative AI
Summer 2024: LLMs for Mental Health
Winter 2024/25: Understanding LLMs

Complementary Lectures and Seminars

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- **Machine Learning**
  - Einführung in die künstliche Intelligenz (Kersting)
  - Data Mining und maschinelles Lernen (Kersting)
  - Deep Learning (Kersting)

- **Computer Vision**
  - Computer Vision 1 and 2 (Roth)

- **Natural Language Processing**
  - Deep Learning for NLP
  - Ethics in NLP

Teaching Concept – UKP (PhD)

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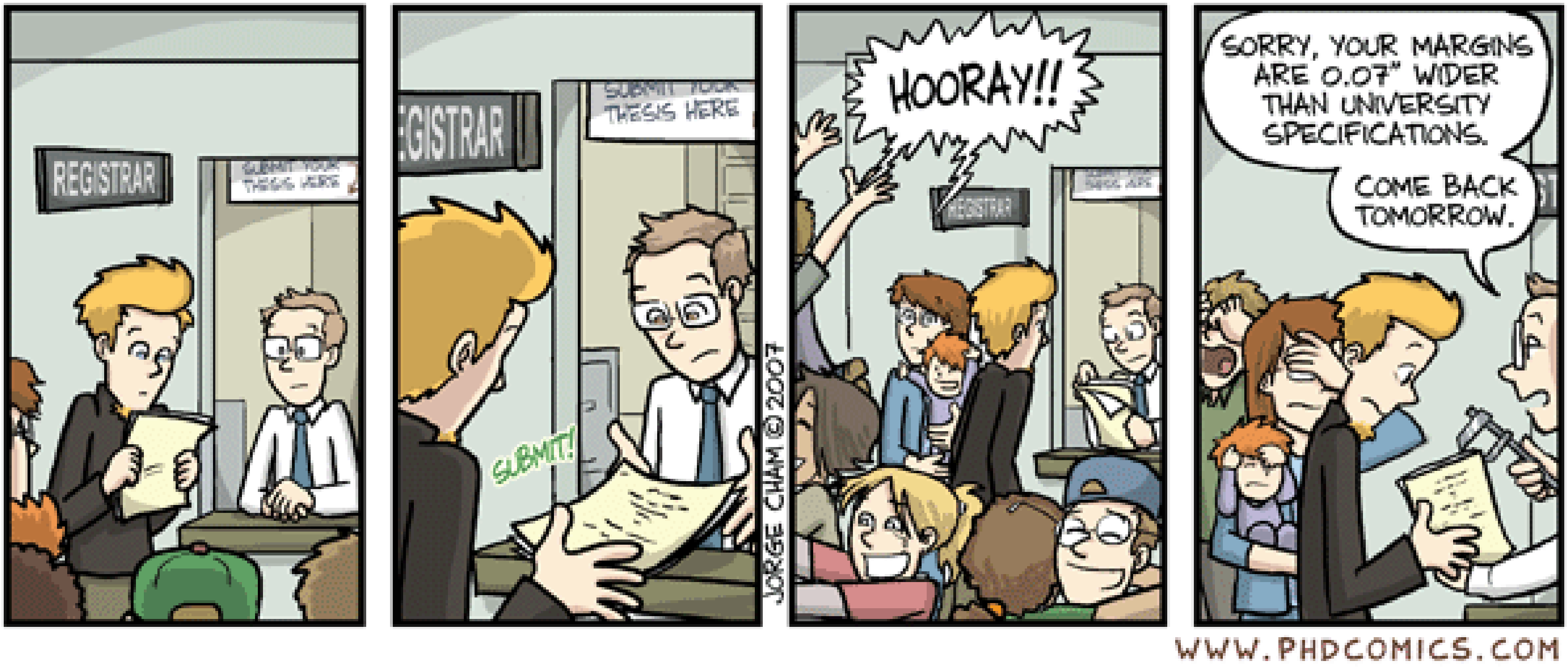
- Get involved early (HiWi, B.Sc. thesis, M.Sc. thesis)



More information

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UBIQUITOUS
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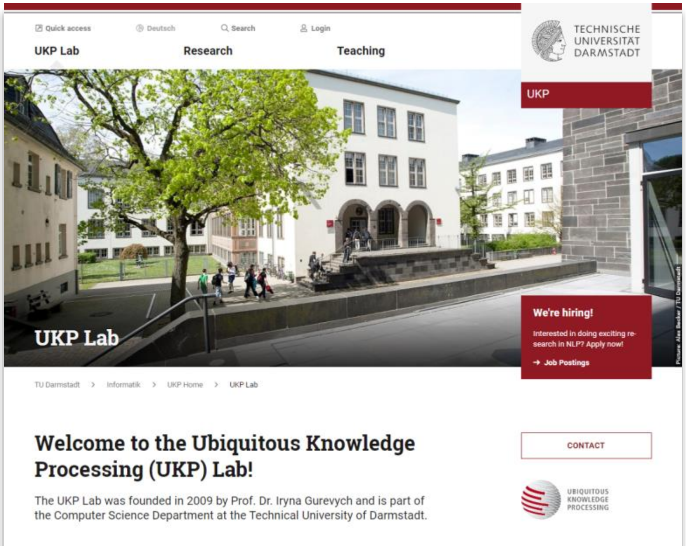
PROCESSING

- Website:
  www.ukp.tu-darmstadt.de
- GitHub:
  www.github.com/UKPLab
- Social Media:

@UKPLab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UKP Lab
Job Postings
Picture: Alex Becker / TU Darmstadt
TU Darmstadt > Informatik > UKP Home > UKP Lab
CONTACT
UBIQUITOUS KNOWLEDGE PROCESSING

We're hiring!

Interested in doing exciting research in NLP? Apply now!

Welcome to the Ubiquitous Knowledge Processing (UKP) Lab!

The UKP Lab was founded in 2009 by Prof. Dr. Iryna Gurevych and is part of the Computer Science Department at the Technical University of Darmstadt.

Outline

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UKP Lab: profile and projects

Administrative course issues

NLP 4 Web Introduction

NLP Basics / Linguistic Analysis

Course Goals

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- Learn the basic principles underlying **NLP systems**
- Two big NLP topics:
    - Information Retrieval (IR)
    - Large Language Model (LLM) Applications
- Gain insight into **open research problems** in natural language processing

Why Care?

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Information Overload

Business Intelligence

Need for Robust, Intelligent Systems

Textbook

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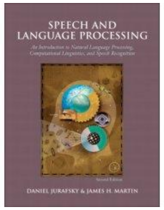
Constantly updated:



- Speech and Language Processing. An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition. Daniel Jurafsky and James H. Martin. 3nd edition, 2023 (draft).
  - https://web.stanford.edu/~jurafsky/slp3/

General Information

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- All lectures and practice classes will be in person
  Lectures: Tuesdays 13:30 – 15:10, S306 / 051
  Practice Class: Thursdays 16:15 – 17:55, S103 / 221

- All slides, handouts, readings etc. can be found on the Moodle e-Learning platform

- We also use Moodle as a central point for announcements and questions

- **Please use the Moodle forum!**

General Information – Practice Class

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- In the **practice classes**, you will work on programming exercises
  - Programming language is Python
  - First practice session will include a brief introduction to Python
  - This will give you some practical experience in NLP
  - Practice class topics are **relevant for the exam**! (including Python)

- In addition, there are **homework assignments** for an exam bonus:
  - Assignments will be bi-weekly – 6 exercises in total
  - Each assignment is worth a maximum of 20 points
  - If you get >= 75% of the points (>= 90 points), you get a bonus
    - You can improve your grade by 0.3/0.4 IFF you pass the exam without bonus

General Information – Practice Class

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- First class: **October 24th (no practice class this week)**

- Details will be announced in moodle
- If you need additional help regarding the practice class, use the Moodle forum

The assignments will require a significant amount of time, so start earlier than the day before submission.

Final exam

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Tuesday, 25.02.2025, 15:00
More info be announced in Moodle

- **Allowed:** Non-programmable calculator, no other material
- **Content:** lecture, readings, practice class

Syllabus (tentative)

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Nr.	Lecture
01	**Introduction / NLP basics**
02	Foundations of Text Classification
03	IR – Introduction, Evaluation
04	IR – Word Representation, Data Collection
05	IR – Re-Ranking Methods
06	IR – Language Domain Shifts, Dense / Sparse Retrieval
07	LLM – Language Modeling Foundations
08	LLM – Neural LLM, Tokenization
09	LLM – Transformers, Self-Attention
10	LLM – Adaption, LoRa, Prompting
11	LLM – Alignment, Instruction Tuning
12	LLM – Long Contexts, RAG
13	LLM – Scaling, Computation Cost
14	Review & Preparation for the Exam

Warm up

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Now it is your turn:

Which degree programme are you studying?

- Computer Science?
- Bachelor?
- Master?
- Other disciplines?

Warm up

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Now it is your turn:

Which other UKP courses did you already attend?

- FoLT
- Ethics in Natural Language Processing
- Deep Learning for NLP
- Data Analysis Software Project
- Text Analytics / LLM Seminar

Outline

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NLP in the Web – Search Engines

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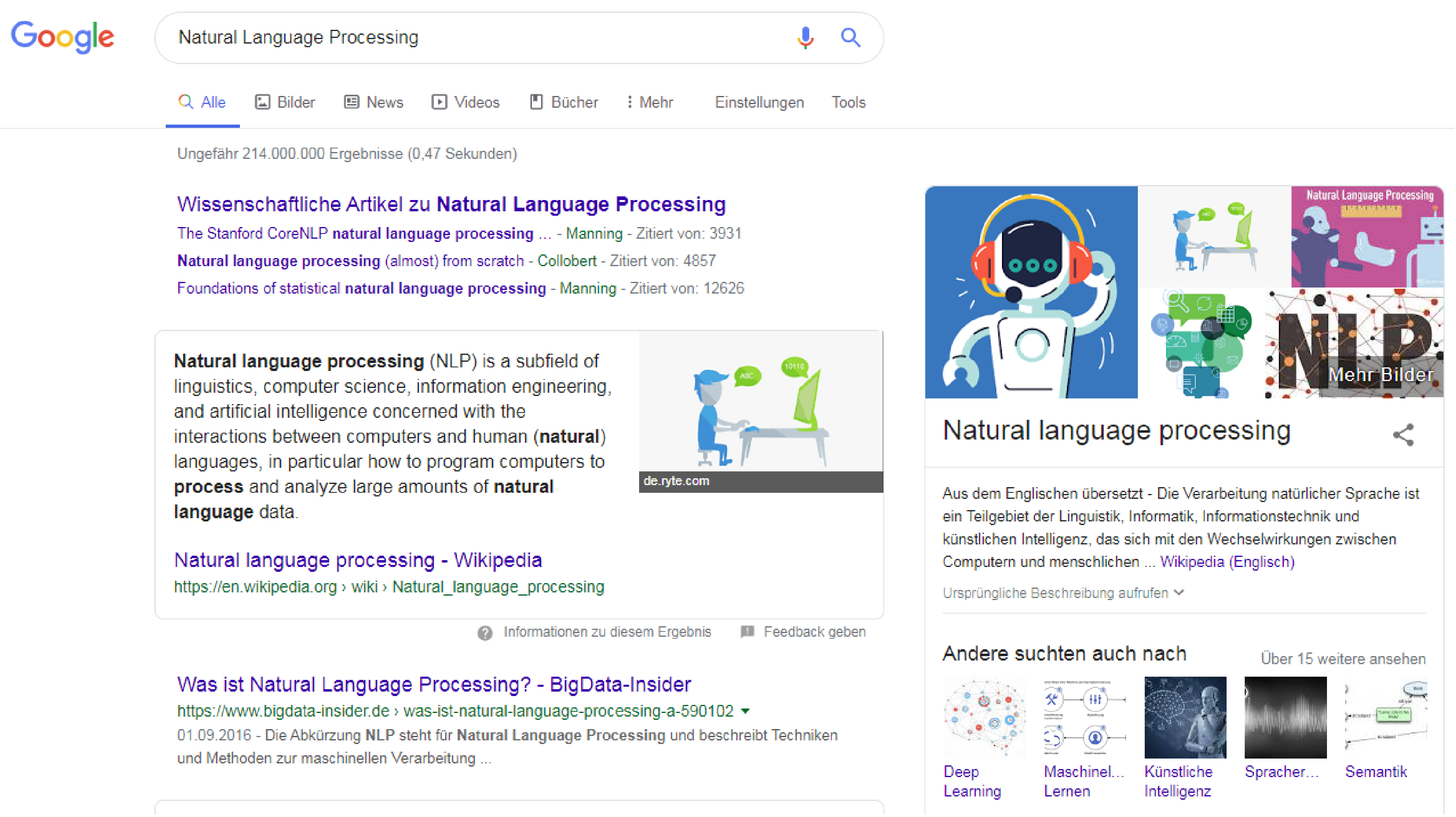

Ungefähr 214.000.000 Ergebnisse (0,47 Sekunden)

Wissenschaftliche Artikel zu **Natural Language Processing**

The Stanford CoreNLP **natural language processing** ... - Manning - Zitiert von: 3931

Natural language processing (almost) from scratch - Collobert - Zitiert von: 4857

Foundations of statistical **natural language processing** - Manning - Zitiert von: 12626

Natural language processing (NLP) is a subfield of linguistics, computer science, information engineering, and artificial intelligence concerned with the interactions between computers and human (**natural**) languages, in particular how to program computers to **process** and analyze large amounts of **natural language** data.

Natural language processing - Wikipedia

https://en.wikipedia.org › wiki › Natural_language_processing

Informationen zu diesem Ergebnis   Feedback geben

Was ist Natural Language Processing? - BigData-Insider

https://www.bigdata-insider.de › was-ist-natural-language-processing-a-590102 ▾

01.09.2016 - Die Abkürzung **NLP** steht für **Natural Language Processing** und beschreibt Techniken und Methoden zur maschinellen Verarbeitung ...

Natural language processing

Aus dem Englischen übersetzt - Die Verarbeitung natürlicher Sprache ist ein Teilgebiet der Linguistik, Informatik, Informationstechnik und künstlichen Intelligenz, das sich mit den Wechselwirkungen zwischen Computern und menschlichen ... Wikipedia (Englisch)

Ursprüngliche Beschreibung aufrufen ⌄

Andere suchten auch nach   Über 15 weitere ansehen

Deep Learning
Maschinel... Lernen
Künstliche Intelligenz
Spracher...
Semantik

NLP in the Web – Spelling Correction

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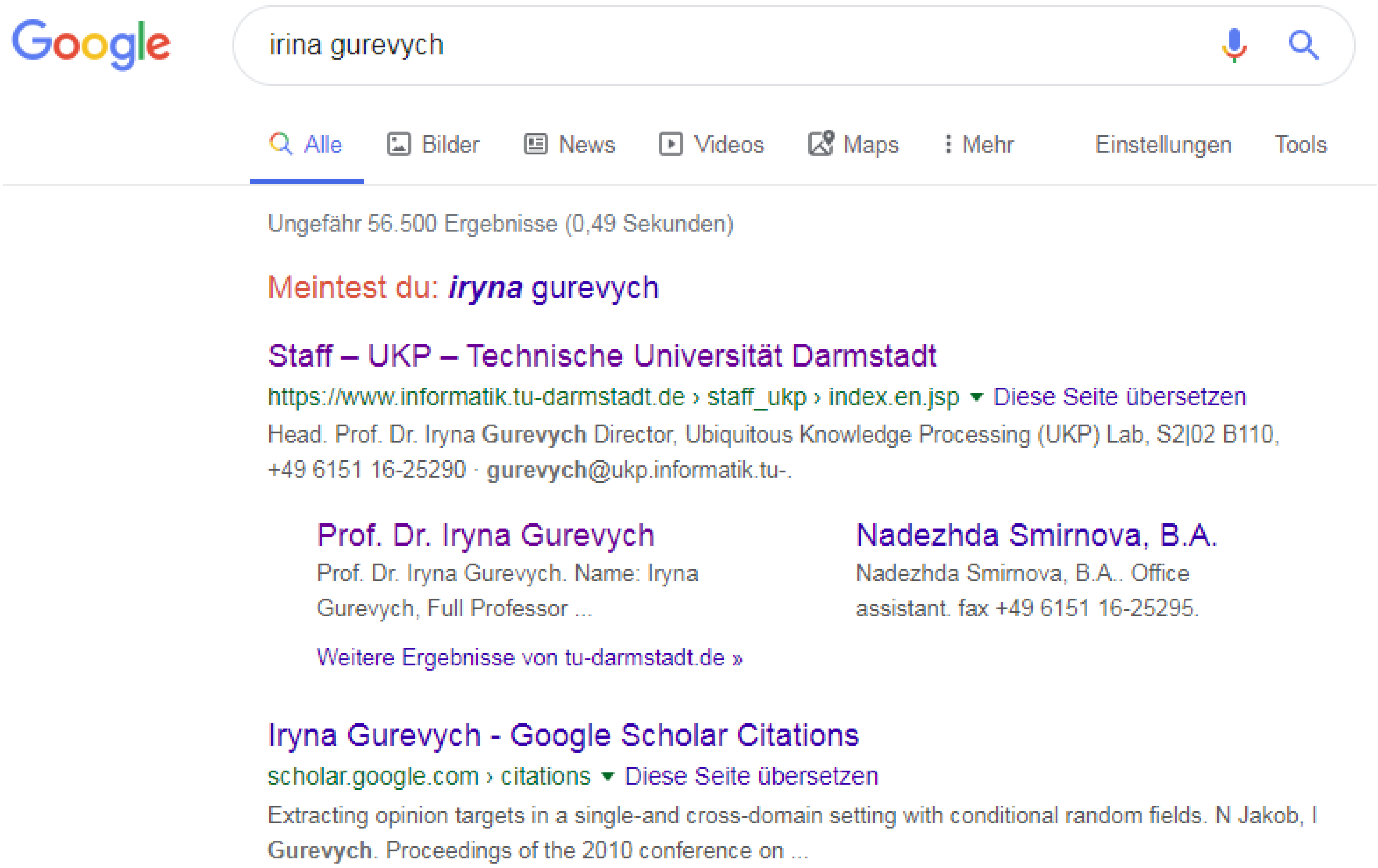

irina gurevych

Ungefähr 56.500 Ergebnisse (0,49 Sekunden)

Meintest du: ***iryna*** gurevych

Staff – UKP – Technische Universität Darmstadt
https://www.informatik.tu-darmstadt.de › staff_ukp › index.en.jsp ▾ Diese Seite übersetzen
Head. Prof. Dr. Iryna **Gurevych** Director, Ubiquitous Knowledge Processing (UKP) Lab, S2|02 B110, +49 6151 16-25290 · **gurevych**@ukp.informatik.tu-.

Prof. Dr. Iryna Gurevych
Prof. Dr. Iryna Gurevych. Name: Iryna Gurevych, Full Professor ...

Nadezhda Smirnova, B.A.
Nadezhda Smirnova, B.A.. Office assistant. fax +49 6151 16-25295.

Weitere Ergebnisse von tu-darmstadt.de »

Iryna Gurevych - Google Scholar Citations
scholar.google.com › citations ▾ Diese Seite übersetzen
Extracting opinion targets in a single-and cross-domain setting with conditional random fields. N Jakob, I **Gurevych**. Proceedings of the 2010 conference on ...

Question Answering

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NLP in the Web – Machine Translation

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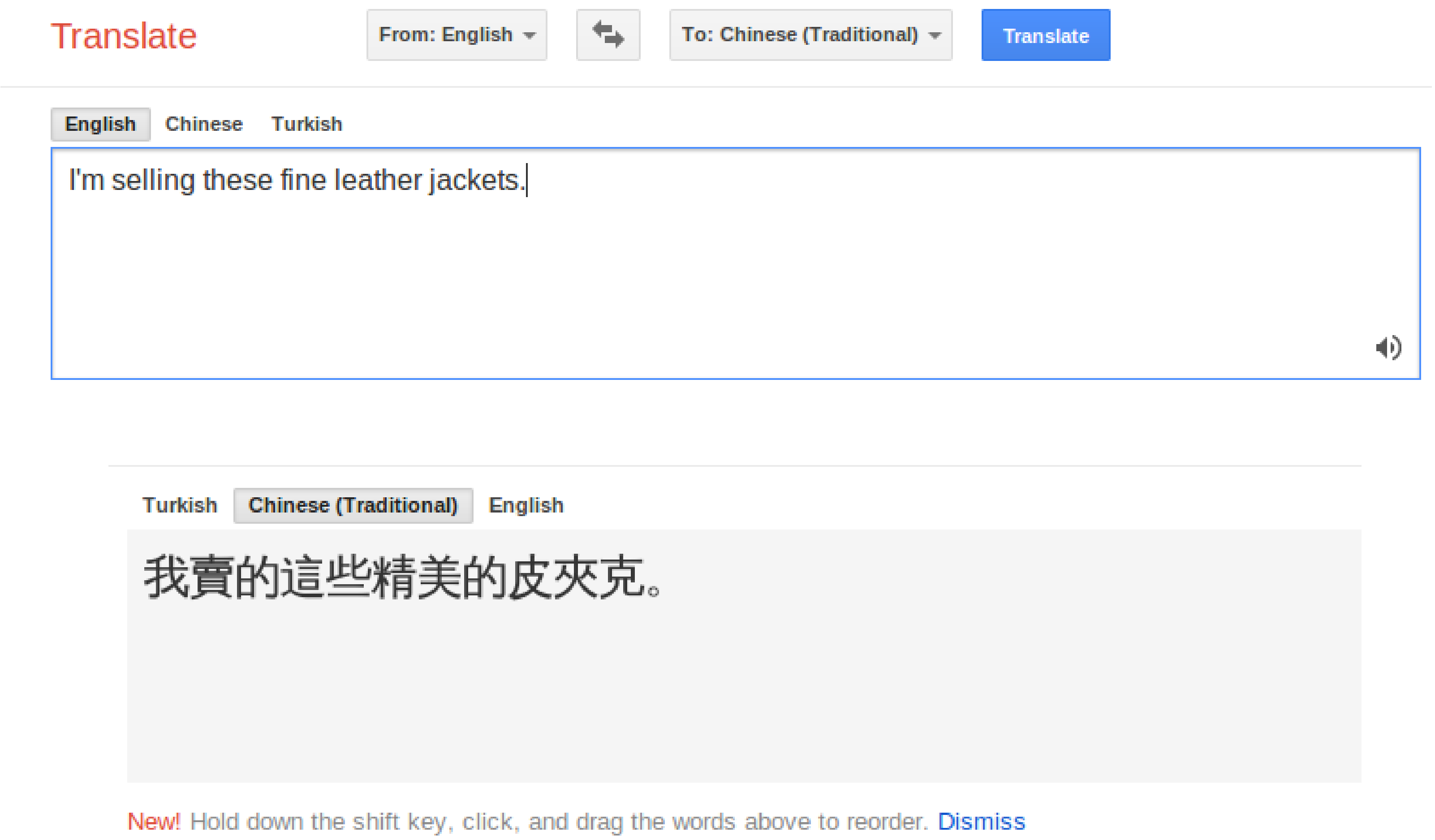

I'm selling these fine leather jackets.

我賣的這些精美的皮夾克。

New! Hold down the shift key, click, and drag the words above to reorder. Dismiss

NLP in the Web – Speech Recognition

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« Please, Siri, open my contacts »
I'm afraid I can't do that, Dave.

NLP in the Web – Plagiarism Detection

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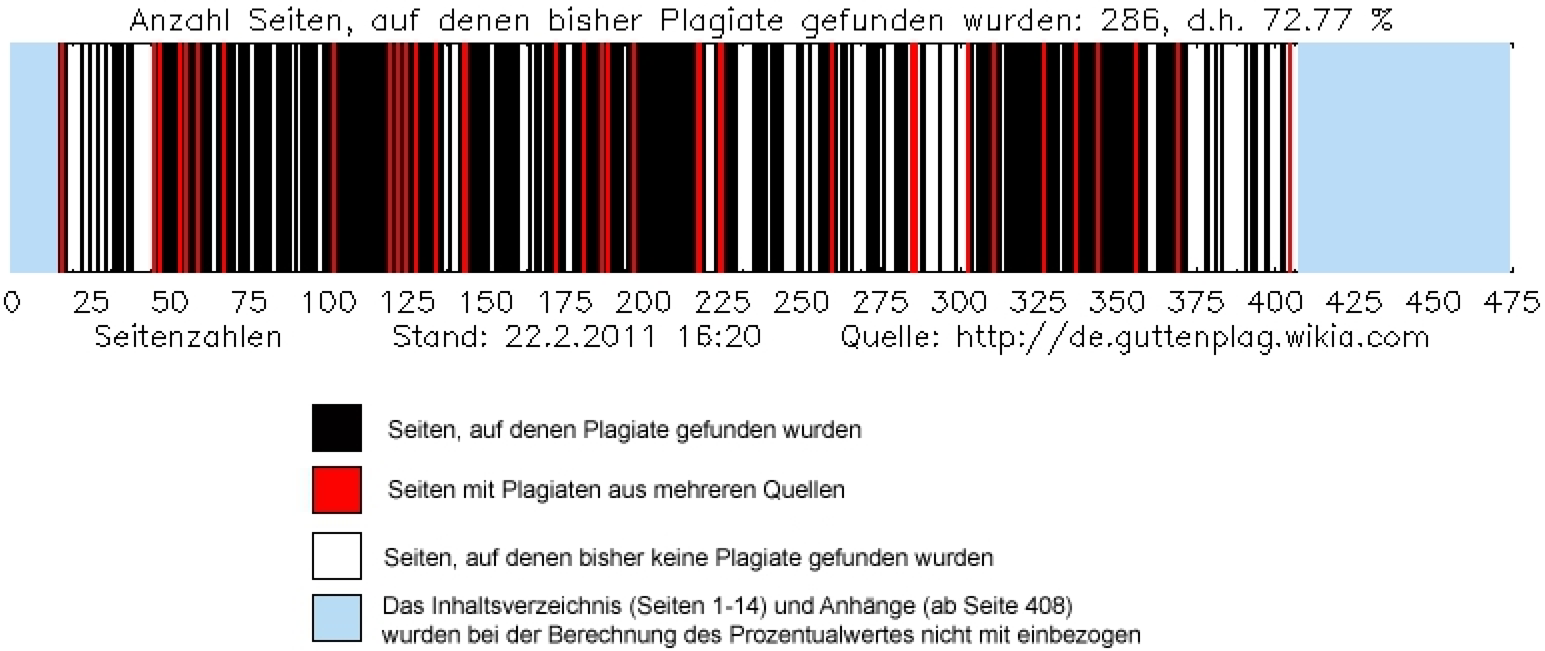
http://de.guttenplag.wikia.com/



NLP in the Web – Summarization

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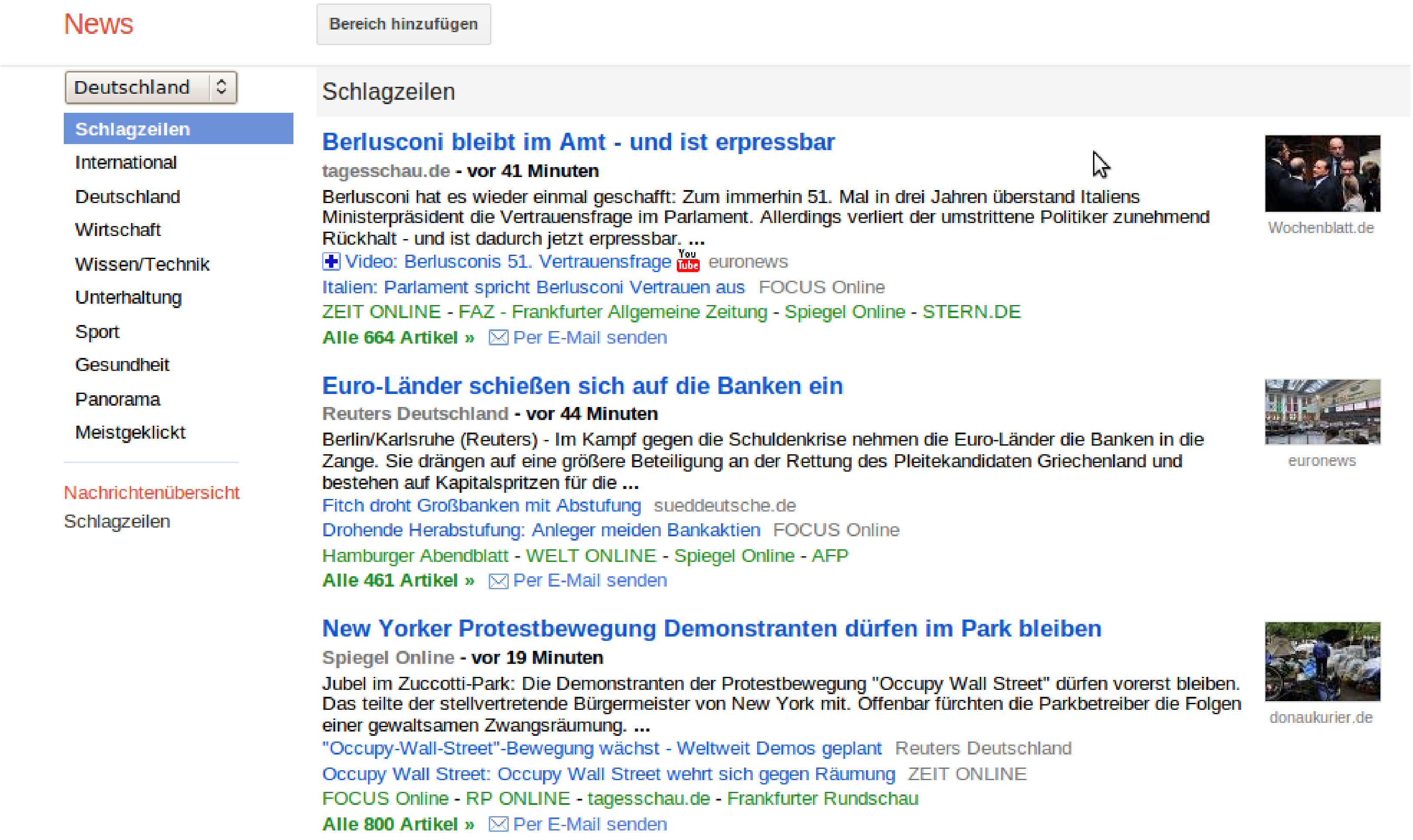

Berlusconi bleibt im Amt - und ist erpressbar
tagesschau.de - **vor 41 Minuten**
Berlusconi hat es wieder einmal geschafft: Zum immerhin 51. Mal in drei Jahren überstand Italiens Ministerpräsident die Vertrauensfrage im Parlament. Allerdings verliert der umstrittene Politiker zunehmend Rückhalt - und ist dadurch jetzt erpressbar. **...**
Video: Berlusconis 51. Vertrauensfrage euronews
Italien: Parlament spricht Berlusconi Vertrauen aus FOCUS Online
ZEIT ONLINE - FAZ - Frankfurter Allgemeine Zeitung - Spiegel Online - STERN.DE
Alle 664 Artikel » ✉ Per E-Mail senden

Euro-Länder schießen sich auf die Banken ein
Reuters Deutschland - **vor 44 Minuten**
Berlin/Karlsruhe (Reuters) - Im Kampf gegen die Schuldenkrise nehmen die Euro-Länder die Banken in die Zange. Sie drängen auf eine größere Beteiligung an der Rettung des Pleitekandidaten Griechenland und bestehen auf Kapitalspritzen für die **...**
Fitch droht Großbanken mit Abstufung sueddeutsche.de
Drohende Herabstufung: Anleger meiden Bankaktien FOCUS Online
Hamburger Abendblatt - WELT ONLINE - Spiegel Online - AFP
Alle 461 Artikel » ✉ Per E-Mail senden

New Yorker Protestbewegung Demonstranten dürfen im Park bleiben
Spiegel Online - **vor 19 Minuten**
Jubel im Zuccotti-Park: Die Demonstranten der Protestbewegung "Occupy Wall Street" dürfen vorerst bleiben. Das teilte der stellvertretende Bürgermeister von New York mit. Offenbar fürchten die Parkbetreiber die Folgen einer gewaltsamen Zwangsräumung. **...**
"Occupy-Wall-Street"-Bewegung wächst - Weltweit Demos geplant Reuters Deutschland
Occupy Wall Street: Occupy Wall Street wehrt sich gegen Räumung ZEIT ONLINE
FOCUS Online - RP ONLINE - tagesschau.de - Frankfurter Rundschau
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NLP in the Web – Diachronic Analysis

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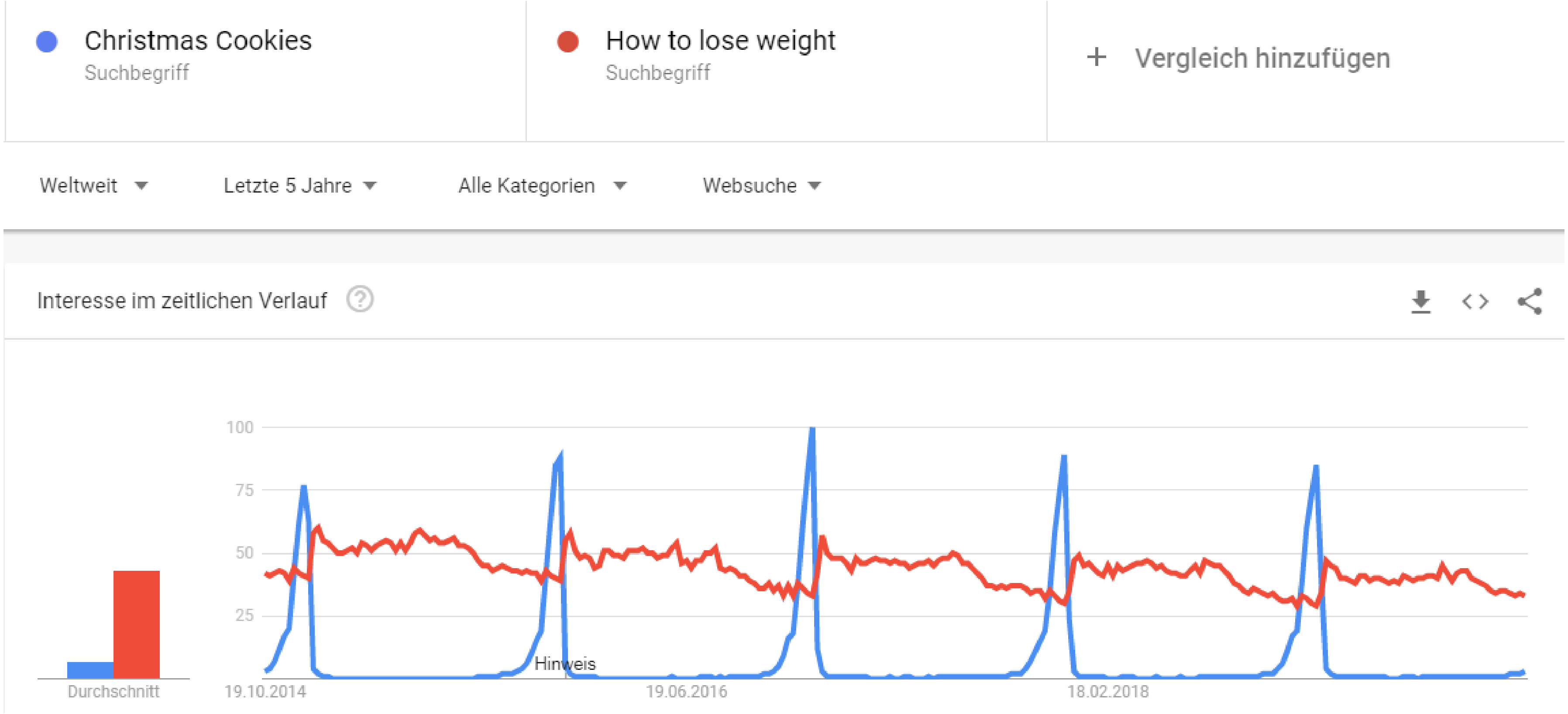

● Christmas Cookies
Suchbegriff

● How to lose weight
Suchbegriff

+ Vergleich hinzufügen

Weltweit ▾ Letzte 5 Jahre ▾ Alle Kategorien ▾ Websuche ▾

Interesse im zeitlichen Verlauf

NLP in the Web – Text Generators

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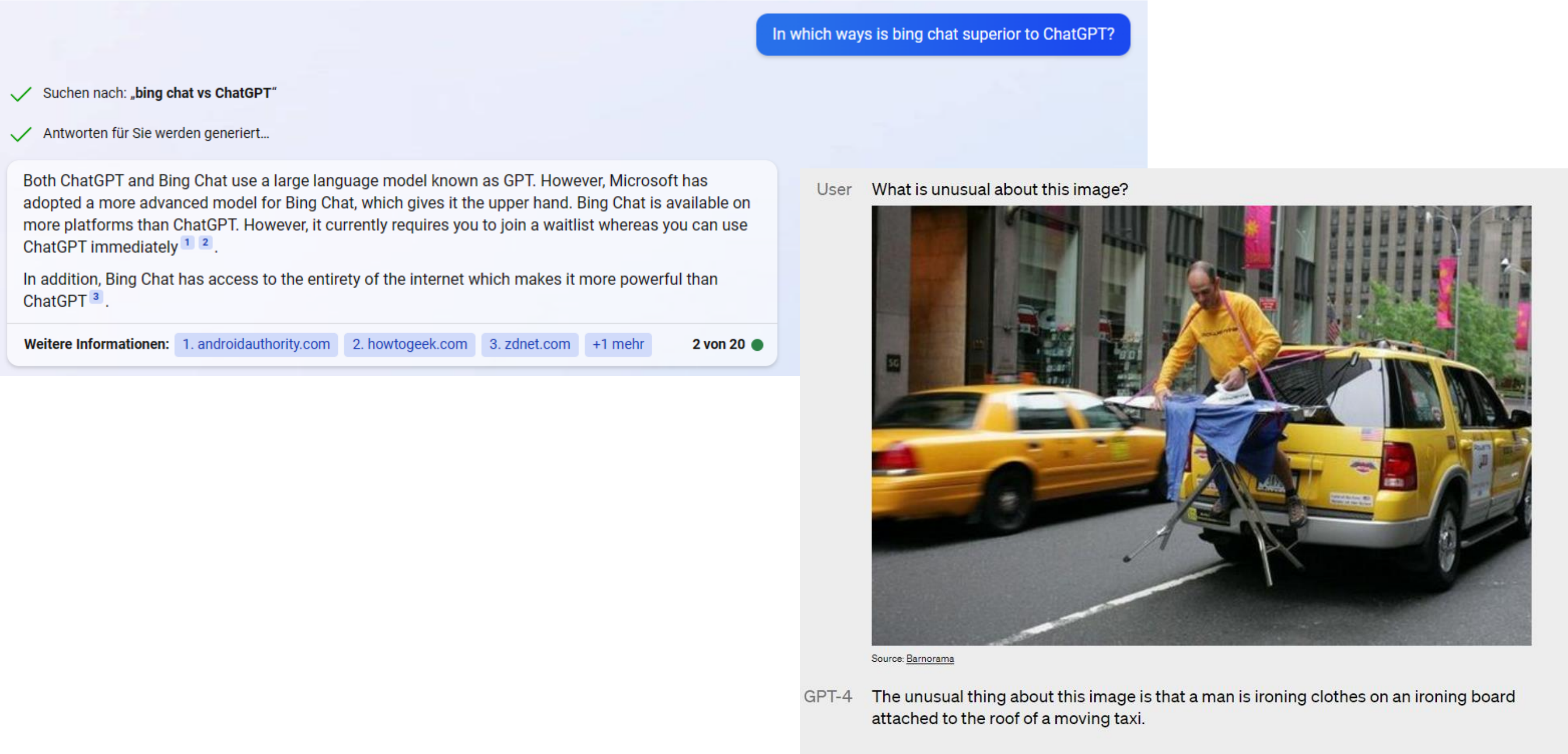

In which ways is bing chat superior to ChatGPT?

✓ Suchen nach: „**bing chat vs ChatGPT**"

✓ Antworten für Sie werden generiert…

Both ChatGPT and Bing Chat use a large language model known as GPT. However, Microsoft has adopted a more advanced model for Bing Chat, which gives it the upper hand. Bing Chat is available on more platforms than ChatGPT. However, it currently requires you to join a waitlist whereas you can use ChatGPT immediately [1] [2].

In addition, Bing Chat has access to the entirety of the internet which makes it more powerful than ChatGPT [3].

Weitere Informationen: 1. androidauthority.com 2. howtogeek.com 3. zdnet.com +1 mehr **2 von 20** ●

User What is unusual about this image?

Source: Barnorama

GPT-4 The unusual thing about this image is that a man is ironing clothes on an ironing board attached to the roof of a moving taxi.

Natural Language Processing and the Web

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- The web is an **application area** for NLP, e.g.:
  - Information retrieval:
    - Search engines
    - Question answering
    - News aggregation
  - Recommender Systems
  - Chatbots…
- Web is a **resource** to improve the quality of NLP, e.g.:
  - Web as a corpus
  - Analyzing web-based knowledge repositories
    - Wikipedia
    - Wiktionary
  - Recognizing synonyms, paraphrases and the like

Challenges for NLP

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- How to remove noise, e.g. duplicates?
- How to assess the quality of content?
- How to integrate the content of heterogeneous and scattered nature?
- How to deal with errors, e.g. spelling or grammar errors?
- How to „clean“ the data?

Data Cleansing is Necessary

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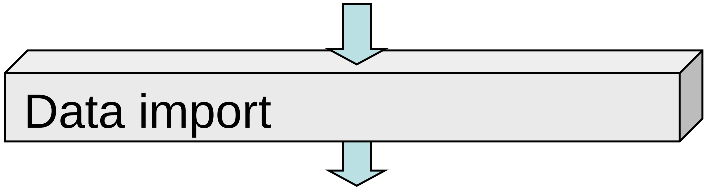
- User-generated content contains errors, smileys, abbreviations, etc.

```
Hi
        Micheal,
                           have u seen my
posting,last week u said that u
will look in to my problem thsi week.can i ask u
now?
```



Data import

Data cleansing

Outline

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NLP 4 Web Introduction

NLP Basics / Linguistic Analysis

Analysis Levels in Language Understanding

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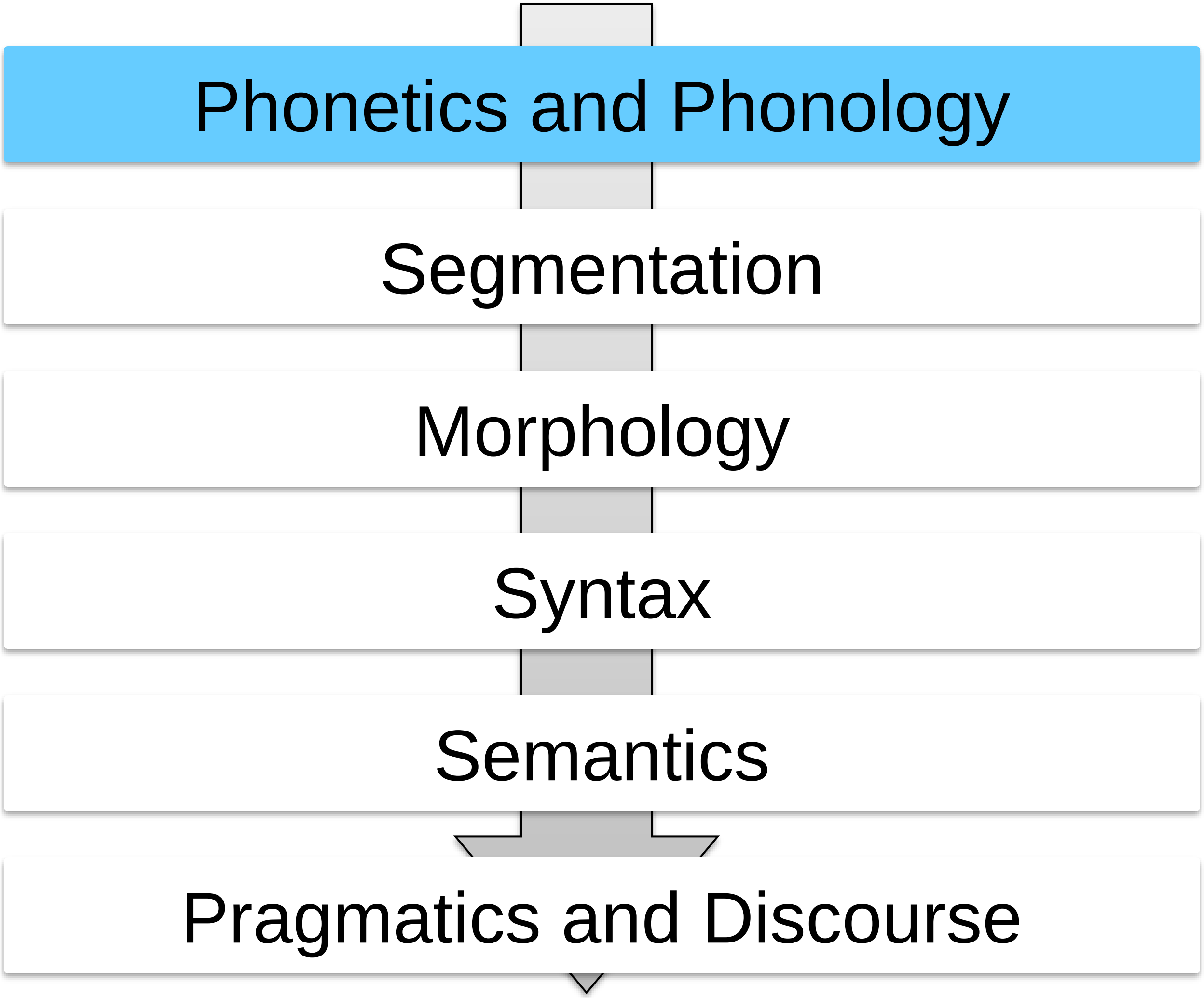

Phonetics and Phonology

Segmentation

Morphology

Syntax

Semantics

Pragmatics and Discourse

Phonetics and Phonology

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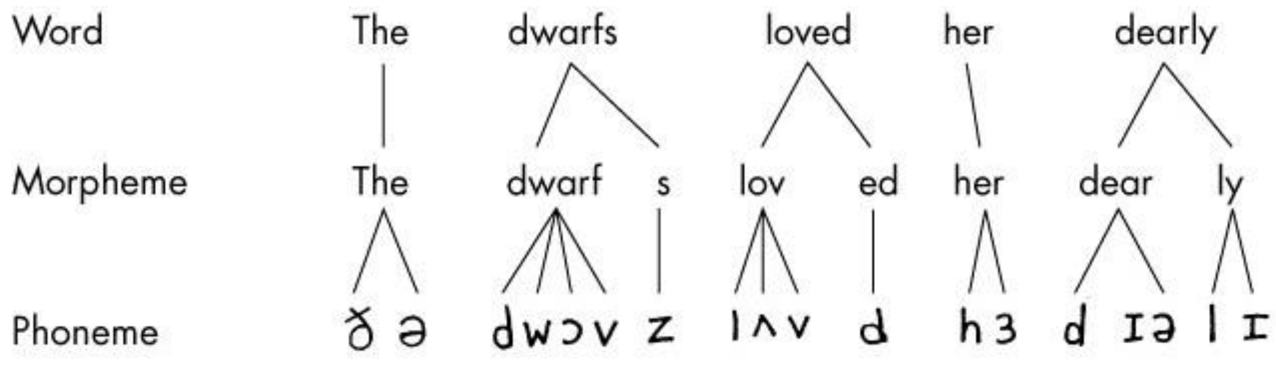

(c) David Groome, 2006

Homophones

/naɪt/

night

knight

Analysis Levels in Language Understanding

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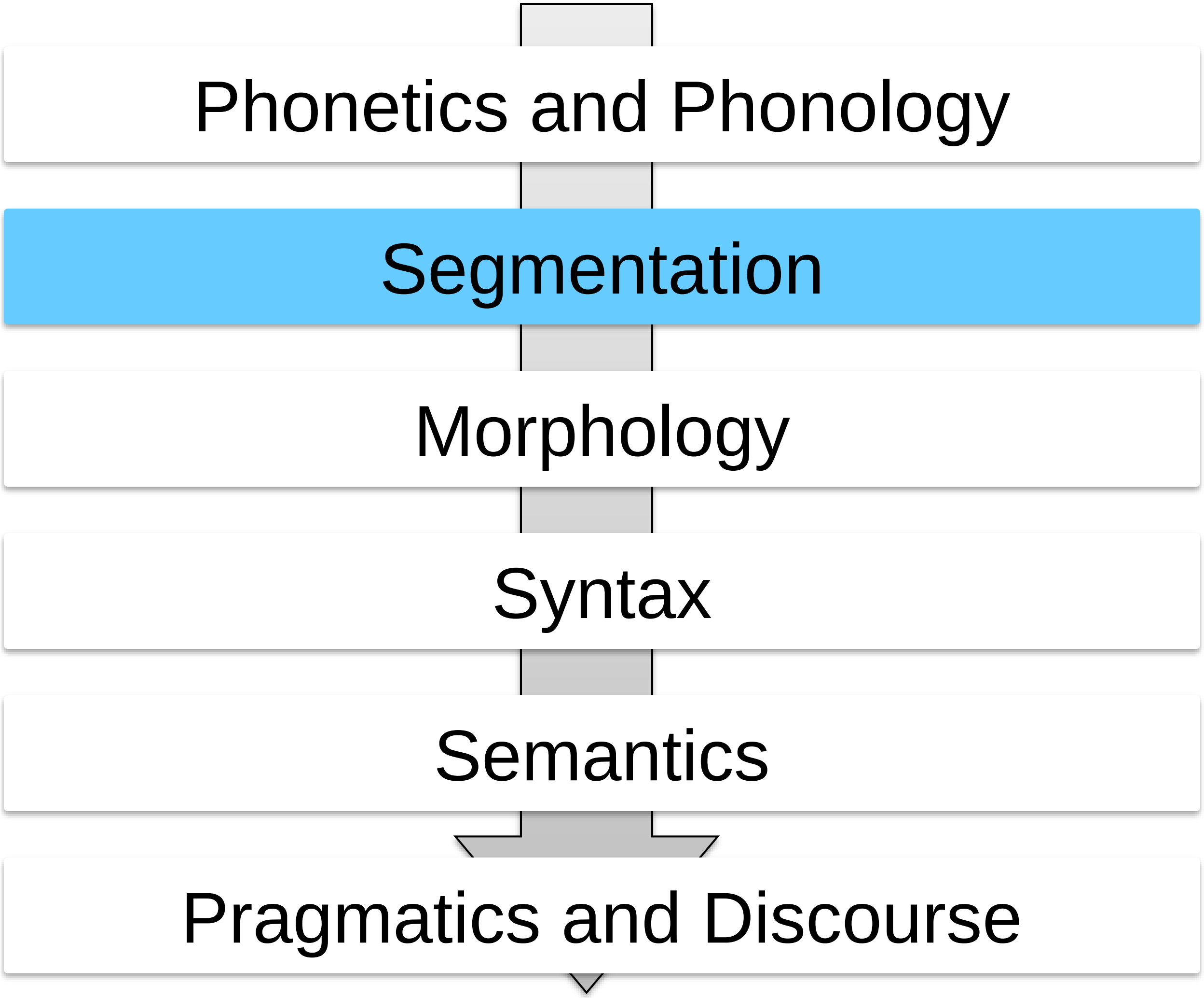

Phonetics and Phonology

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Segmentation

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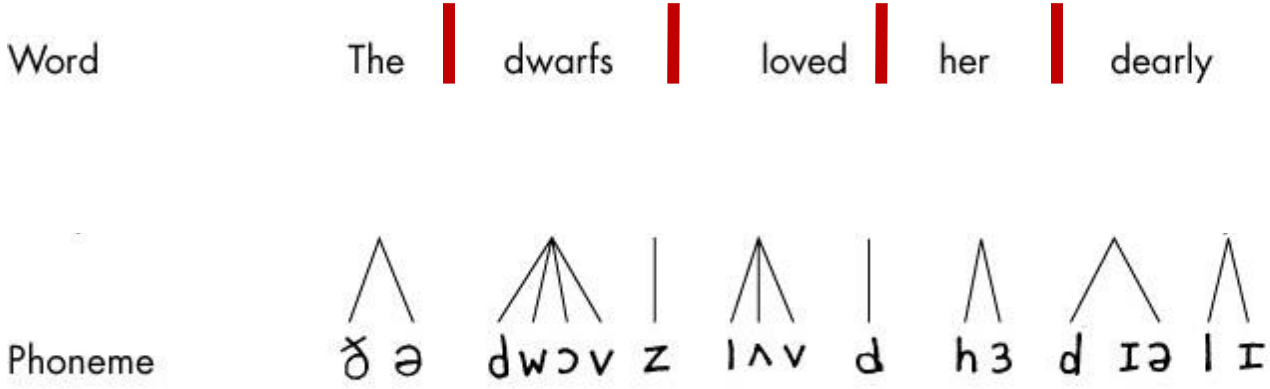

(c) David Groome, 2006

Tokenization

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- Segmenting an input stream into an ordered sequence of units is called **tokenization**.
- A token can correspond to an inflected word form or sub-word units, and may be subject to a subsequent morphological analysis.
- Tokens include punctuation!

- A system which splits texts into tokens is called a **tokenizer**

A very simple example:

- Input text:
  John likes Mary and Mary likes John.
- Tokens:
  {"John", "likes", "Mary", "and", "Mary", "likes", "John", "."}

Tokenization

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English Example

- Mr. Sherwood said, reaction to Sea Containers‘ proposal has been „very positive.“ In New York Stock Exchange composite trading yesterday, Sea Containers closed at $62.625, up 62.5 cents.

Where could be problems for a tokenizer?

Tokenization

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English Example

- Mr. Sherwood said, reaction to Sea Containers‘ proposal has been „very positive.“ In New York Stock Exchange composite trading yesterday, Sea Containers closed at $62.625, up 62.5 cents.

- Split at whitespace characters?
  `cents.` `said,` `positive.”` `$62.625,`

Tokenization Ambiguities

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Period

- In most of the cases: Final sentence punctuation symbol
- Part of an abbreviation, e.g. F.D.P.
- Numbers, ordinal numbers, e.g.: 21., numbers with fractions, e.g. 1.543
- References to resources locators, e.g.: www.apple.com
- To complicate things, if a sentence ends with an abbreviation which ends with a period, only one period is written. “I go to Apple, Inc.”
- …

Whitespace character

- Part of numbers, e.g. “1 543”
- No segmentation character in multi-word expressions
  - “New York”

Ambiguities

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Comma

- Part of numbers, e.g. 1,543

Single quote

- Within tokens to mark contractions and elisions, e.g. English: *don’t, won’t, you’ve, James’ new hat*; German: *Ich hab’s!*
- Part of a token in French, e.g. *aujourd´hui*
- But in **most cases:** Enclosing quoted groups of words

Dash

- A delimiter, if it connects strings of digits, e.g. "see pages 100-101”
- In French: Signal a close connection between two tokens, e.g. verb and personal pronoun: *donne-le*
- In **most cases**, however, it is part of the token, e.g. *multi-word*

Tokenization in Other Languages

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Chinese

爱国人

- No spaces
- Two possible segmentations, both of them are syntactically and semantically correct
- Disambiguation can only be done with contextual information

爱国/人

country-loving person

爱/国人

love country-person

Bird et al., NLP with Python, p.113

German Compounds

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German

STAUBECKEN

- No spaces within noun compounds
- Two possible segmentations, both of them are syntactically and semantically correct
- Disambiguation can only be done with contextual information

STAU BECKEN

water reservoir

STAUB ECKEN

dusty corners

Analysis Levels in Language Understanding

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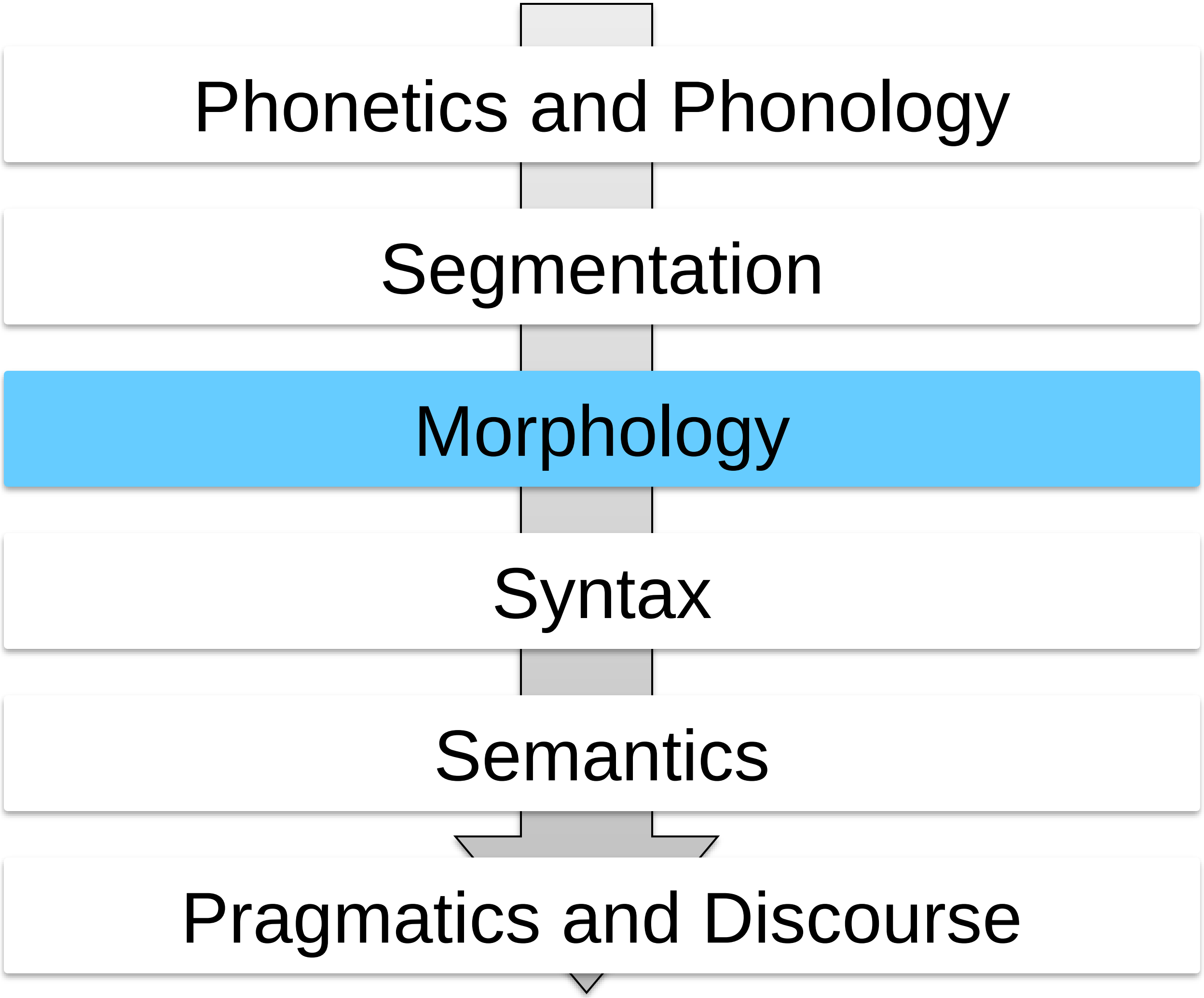

Phonetics and Phonology

Segmentation

Morphology

Syntax

Semantics

Pragmatics and Discourse

Morphology

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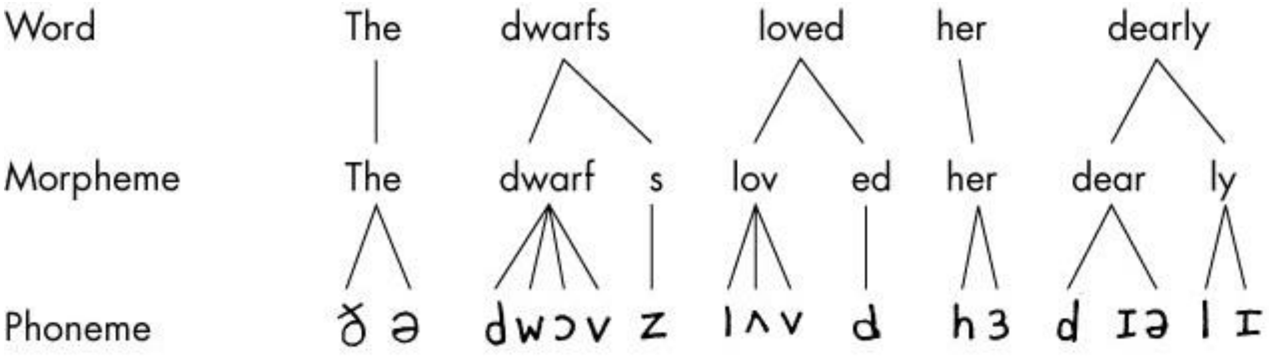
- Morphology is the branch of linguistics that studies word forms and word formation
- Words are composed of **morphemes**
- Morphemes are the **smallest meaning-bearing units**



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Morphology

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Words can be further decomposed into smaller units:

“pneumonoultramicroscopicsilicovolcanoconiosis”

lung disease caused by the inhalation of very fine silica dust found in volcanoes

Bases and Affixes

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- Remember: Morphemes are the smallest meaning-bearing units
- Examples:
  - cats → cat (noun) + s (plural)
  - unknowingly → un + know + ing + ly
  - bedenken → be + denk + en
- Both *cat* and *cats* can be uttered in isolation but *s* cannot:
  -*s* is a **bound** morpheme

- Minimal **free** morphemes = **stems**
  - *cat* is a free morpheme
- Stems carry the main meaning of the word
- Affixes are bound morphemes

Types of Affixes

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Suffixes: appear after the base

- cat + s, nice + ly

Prefixes: appear before the base

- un + true

Infixes: appear inside the base

- fan + bloody + tastic

Circumfixes: appear on both sides of the base

- ge + sag + t

Morphological Normalization

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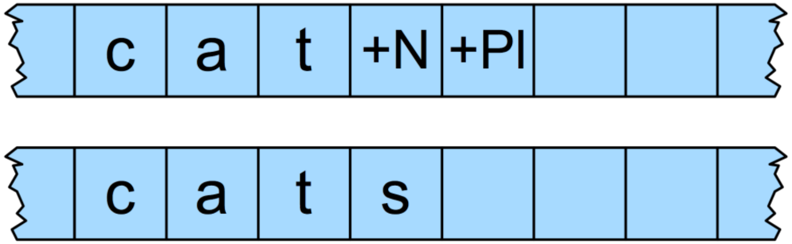

- **Morphological normalization** consists in identifying a single canonical representative for morphologically related word-forms

Methods

- Stemming
- Lemmatization

Stemming

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Stemming is an algorithmic approach to strip off the endings of words

sitting → sitt

anarchism, anarchy, anarchistic → anarchi

Objective: group words belonging to the same morphological family by transforming them into the same stemmed representation

- stemming does not distinguish between inflection and derivation
- the stems obtained do not necessarily correspond to a real word form

Well-known stemming algorithms for English have been developed by Lovins and Porter

Algorithmic Stemming Method

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Stemming is rule-based. Example rules from Porter:

```
*ATIONAL -> *ATE (relational -> relate)

*[> 0 vowels] + ING -> * (monitoring -> monitor)

*SSES -> *SS (grasses -> grass)
```

Rule-based stemming methods are hard to create, often yield arbitrary distinctions, but can be executed very quickly at runtime.

Porter's Stemmer

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Original Word	Stemmed Word
vision	vision
visible	visibl
visibility	visibl
visionary	visionari
visioner	vision
visual	visual

Stemming Errors

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Under-stemming: remove too little

- adhere → adher
- adhesion → adhes

Over-stemming: remove too much

- appendicitis → append
- append → append

Problem with Stemming: Syntactic Ambiguity

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Homographs: words which have the same spelling but different meanings

I **saw** the **saw**

Past form
of the verb
SEE

≠

Singular form
of the noun
SAW

Such cases **cannot** be properly dealt with by stemming only, the word's grammatical category also has to be identified

Lemmatization

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- “undo” the inflectional changes of a base form
- Usually needs lexical resources and **part-of-speech tagging**
  - cats (NOUN) → cat
  - left (VERB) → leave
  - left (ADJ) → left

- Has to deal with **Irregularities**
  - sing, sang, sung → sing
  - indices → index
  - Bäume → Baum

Stemming vs. Lemmatization

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Original	Stemmed	Lemmatized
visibilities	visibl	visibility
adhere	adher	adhere
adhesion	adhes	adhesion
appendicitis	append	appendicitis
oxen	oxen	ox
indices	indic	index
swum	swum	swim

Analysis Levels in Language Understanding

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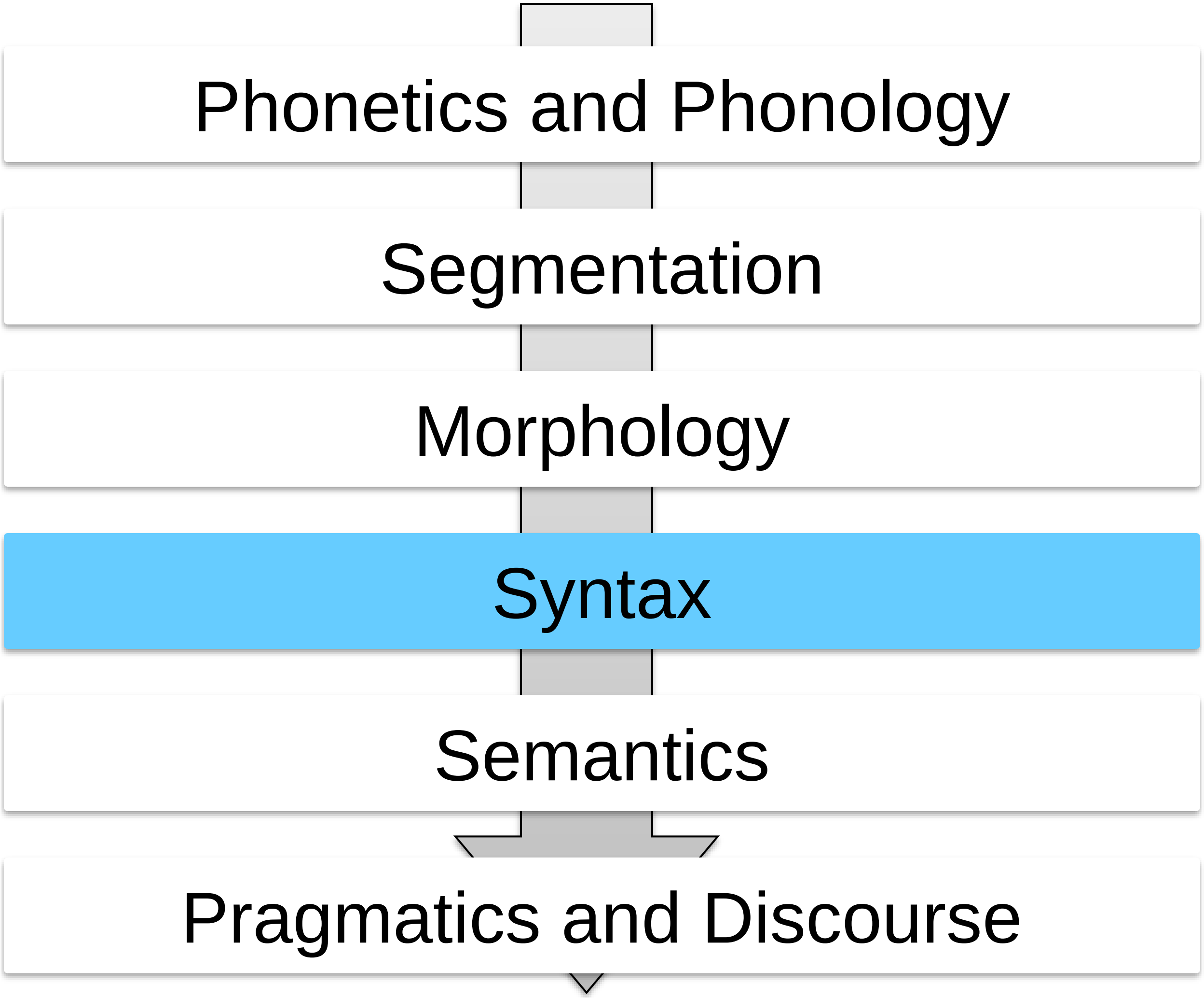

Phonetics and Phonology

Segmentation

Morphology

Syntax

Semantics

Pragmatics and Discourse

Syntax

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- **Syntax** refers to the way words are arranged together
- "Syntax is the study of the regularities and constraints of word order and phrase structure"
  (Manning & Schütze, 2003, p. 93)
- There is an infinite number of ways in which words can be arranged together to form sentences
- Yet, we can understand sentences we have never heard or read before

POS Tagging

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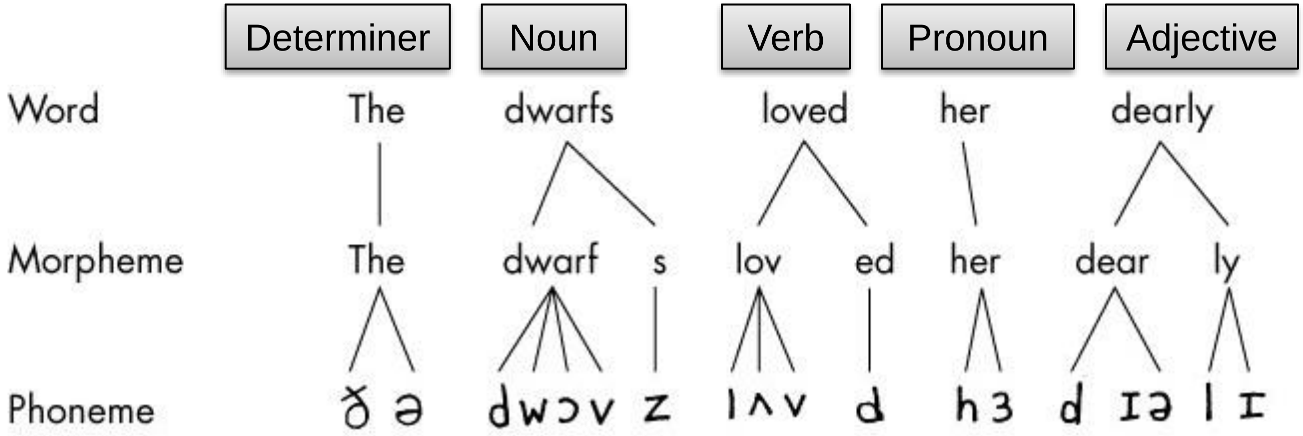
- The process of assigning **a part of speech** or **lexical class marker** to each word in a corpus
- The input to a tagging algorithm is a sequence of words and a tagset, and the output is a sequence of tags, a single best tag for each word



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Parts of Speech

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- In English we traditionally have 8 parts of speech

N	Noun	*chair, bandwidth, pacing*
V	Verb	*study, debate, munch*
ADJ	Adjective	*purple, tall, ridiculous*
ADV	Adverb	*unfortunately, slowly*
P	Preposition	*of, by, to*
PRO	Pronoun	*I, me, mine*
DET	Determiner	*the, a, that, those*
INTJ	Interjection	*oh!, m-hm, huh?*

Penn Treebank Tagset

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1. CC Coord. conjunc.
2. CD Cardinal number
3. DT Determiner
4. EX Existential there
5. FW Foreign word
6. IN Prep./subord. conj.
7. JJ Adject.
8. JJR Adject., comp.
9. JJS Adject., superl.
10. LS List item marker
11. MD Modal
12. NN Noun, sing. or mass
13. NNS Noun, plural
14. NNP Proper noun, sing.
15. NNPS Proper noun, plural
16. PDT Predeterminer
17. POS Possessive ending
18. PRP Personal pronoun
19. PP$ Poss. pronoun
20. RB Adverb
21. RBR Adverb, comp.
22. RBS Adverb, superl.
23. RP Particle
24. SYM Symbol
25. TO to
26. UH Interjection
27. VB V, base form
28. VBD V, past tense
29. VBG V, gerund/pres. part.
30. VBN V, past part.
31. VBP V, non-3rd ps. sing. pres.
32. VBZ V, 3rd ps. sing. pres.
33. WDT wh-det.
34. WP wh-pronoun
35. WP$ Poss. wh-pronoun
36. WRB wh-adverb
37. # Pound sign
38. $ Dollar sign
39. . Sent.-final punct.
40. , Comma
41. : Colon, semi-colon
42. (L. bracket char.
43.) R. bracket char.
44. “ Straight dbl. quote
45. ‘ L. open sngl. quote
46. “ L. open dbl. quote
47. ’ R. close sngl. quote
48. ” R. close dbl. quote

Language	**Tagset Size**
English	139
Czech	970
Estonian	476
Hungarian	401
Romanian	486
Slovene	1033

(Hajič, 2000)

An Example

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WORD	LEMMA	TAG
the	the	+DET
host	host	+NOUN
kissed	kiss	+VPAST
the	the	+DET
friend	friend	+NOUN
on	on	+PREP
the	the	+DET
cheek	cheek	+NOUN

Ambiguities

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- POS Tagging is a disambiguation task
  - Words are ambiguous—have more than one possible part-of-speech
  - The word “book”:
    - book that flight: verb
    - hand me that book: noun
  - The word “that”:
    - Does that flight serve dinner? : determiner
    - I thought that your flight was earlier: complementizer

- **POS Tagging**: resolves ambiguities, choosing the proper tag for the context
  - Baseline: Most Frequent Class (accuracy 92.34% [Jurafsky & Martin])
  - Outdated: Rule-based tagging, probabilistic tagging
  - State of the art: Neural approaches, accuracy ~ 98%

Parsing

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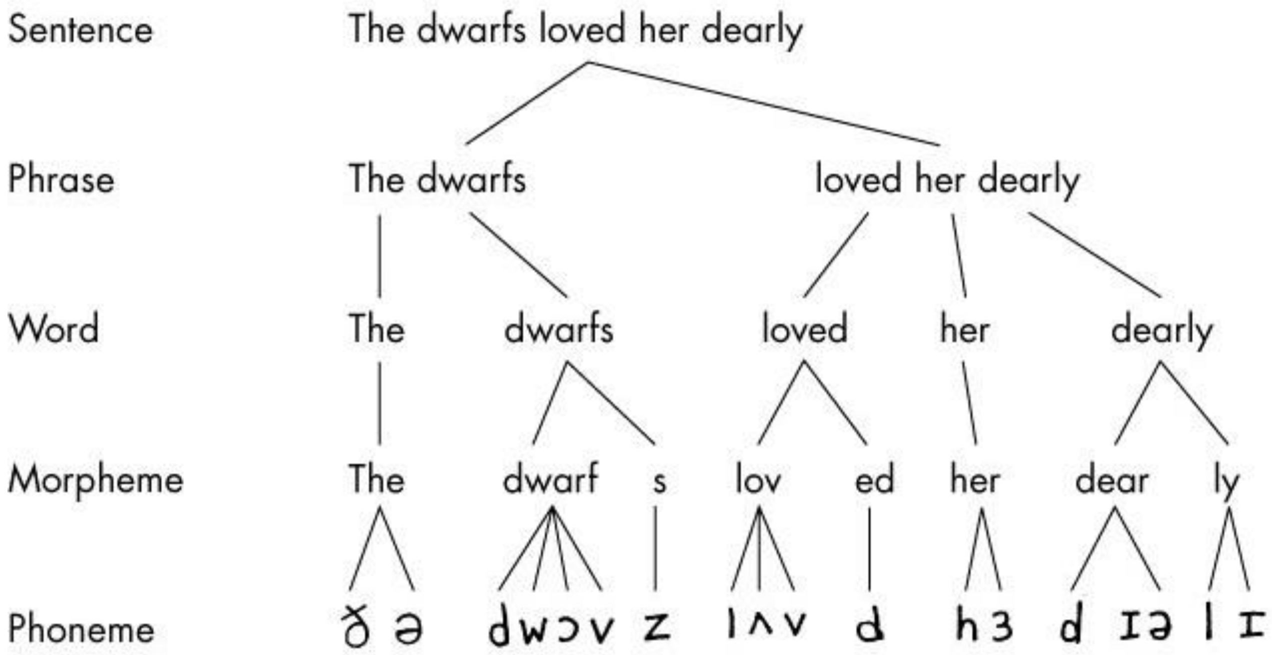
- The process of determining the grammatical structure with respect to a given grammar.



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Alternative representations

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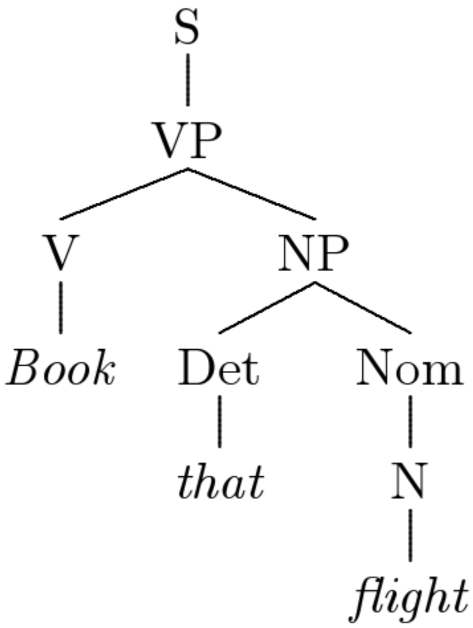
- Bracketed notation:
  [$_S$ [$_{NP}$ [$_{Det}$ the] [$_N$ dog]] [$_{VP}$ [$_V$ ate] [$_{NP}$ [$_{Det}$ a] [$_N$ cookie]]]]
- Parenthesized notation:
  (S
  (NP
  (Det the)
  (N dog))
  (VP
  (V ate)
  (NP
  (Det a)
  (N cookie))))

Parse Tree:



Syntactic Ambiguity

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- If you love money problems show up
  - If you love, money problems show up.
  - If you love money, problems show up.
  - If you love money problems, show up.
- “I made her duck.”
- “We're eating grandpa!” vs. "We're eating, grandpa!"
- “Weil er drei Monate verfallene Medikamente nahm, ...”

- Different interpretations are mainly caused by syntactic ambiguity.

Syntactic Ambiguities:
Two Possible Parsing Possibilities

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“I saw the man with a telescope.”

Syntactic Ambiguities:
Two Possible Parsing Possibilities

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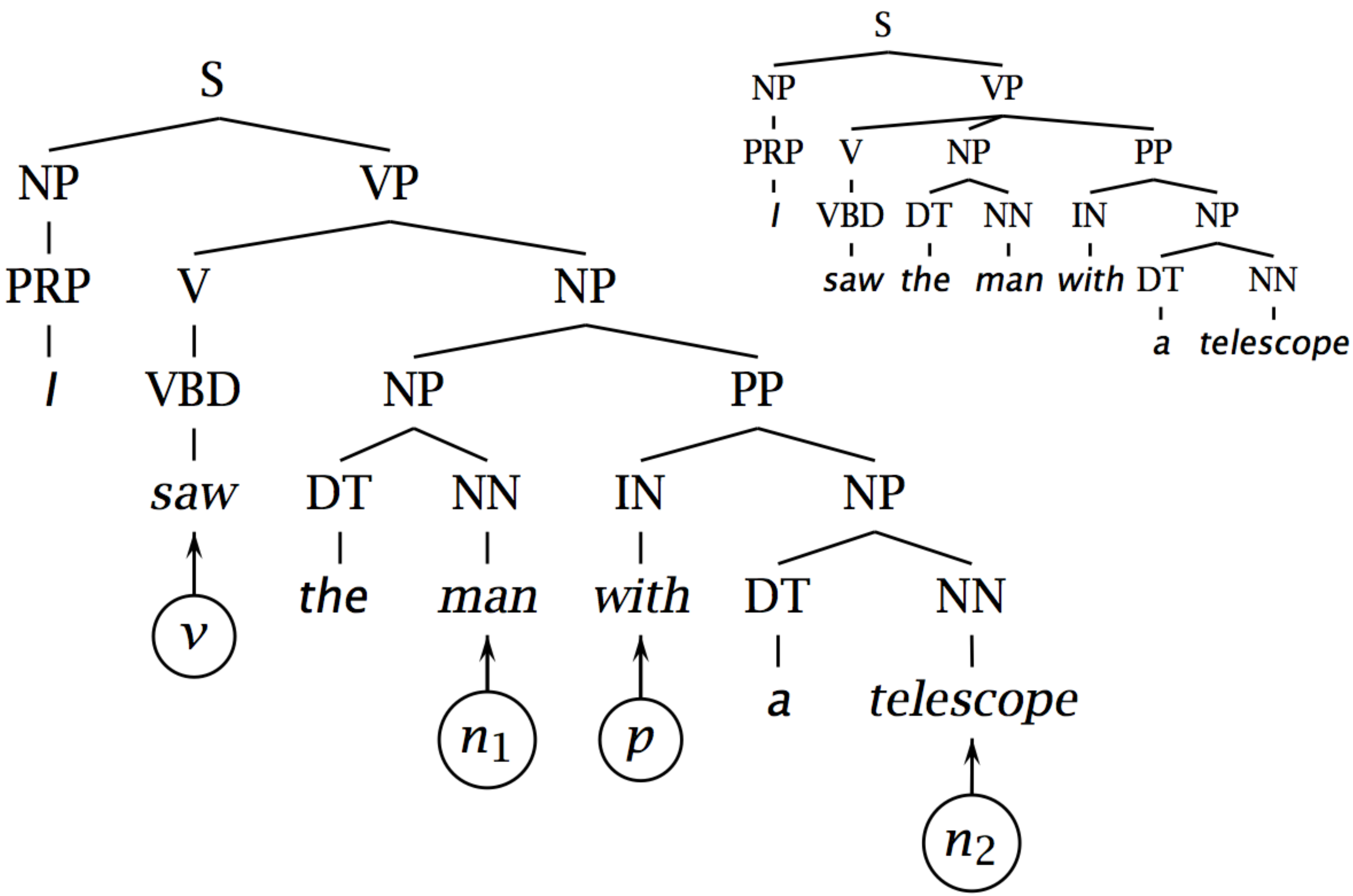

Analysis Levels in Language Understanding

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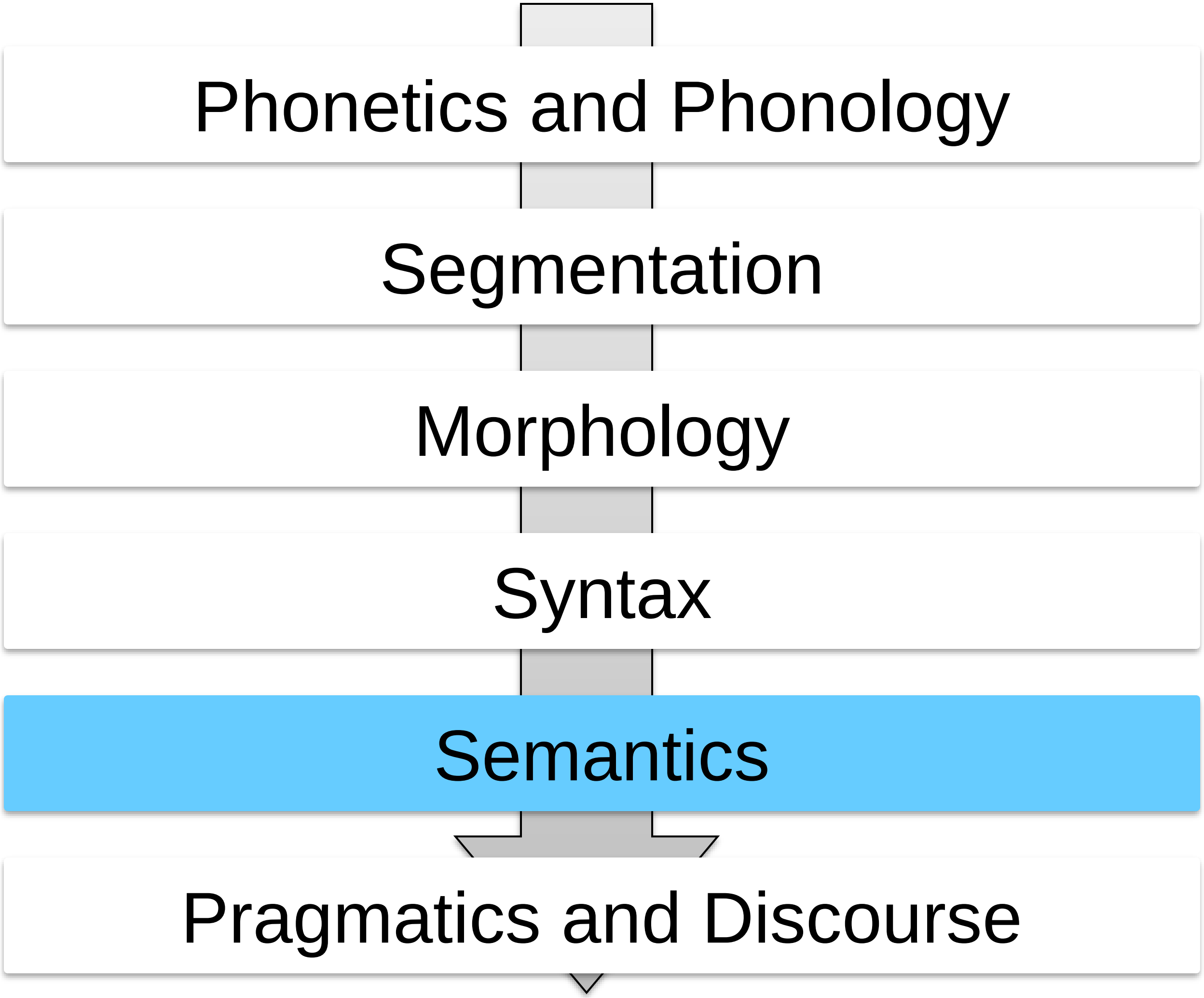

Phonetics and Phonology

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Semantics

Pragmatics and Discourse

Definition

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Semantics:

- Study of the meaning of **words, phrases, sentences, or documents**

Lexical Semantics

- Study of the meaning of lexical units, i.e. **words**.

Lexical Ambiguity

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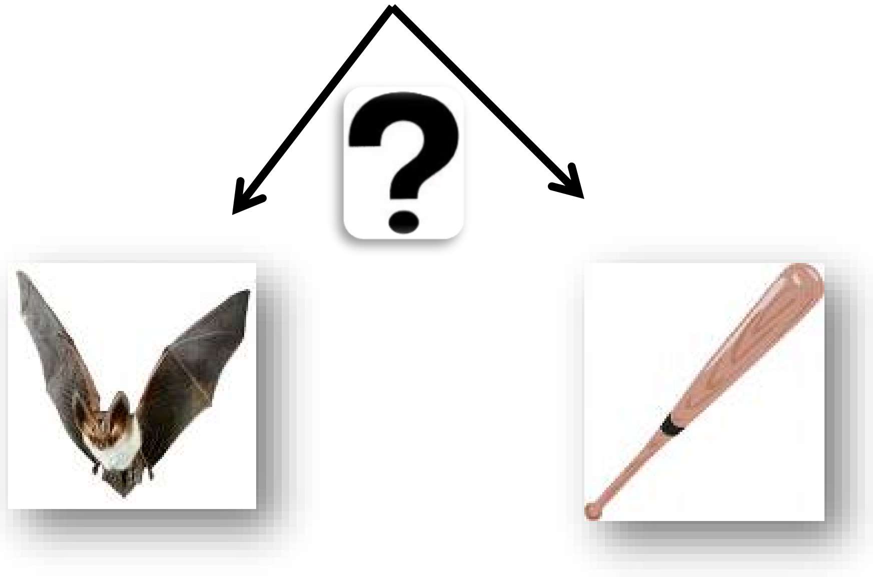
He hit the ball with the bat.

Chuck Norris can hit a bat with a ball.



- Different interpretations are caused by lexical ambiguity.

Analysis Levels in Language Understanding

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- Phonetics and Phonology
- Segmentation
- Morphology
- Syntax
- Semantics
- **Pragmatics and Discourse**

Pragmatics

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What is the purpose of an utterance?

“I **never** said she stole my money"	I simply didn't ever say it.
▪ “**I** never said she stole my money”	Someone else said it, but I didn't.
▪ “I never **said** she stole my money”	I might have implied it in some way, but I never explicitly said it.
▪ “I never said **she** stole my money”	I said someone took it; I didn't say it was she.
▪ “I never said she **stole** my money”	I just said she probably borrowed it.
▪ “I never said she stole **my** money”	I said she stole someone else's money.
▪ “I never said she stole my **money**”	I said she stole something of mine, but not my money.

Example from Wikipedia

Pragmatics

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What is the purpose of an utterance?

Utterance: “Is it cold in here or is it just me?

Intended meaning: “Please close the window!”

Utterance: “Oh, great! Another meeting.”

Intended meaning: The speaker likely means the opposite of what they are literally saying—meetings might be something they dislike, despite the positive tone.

Summary – Linguistic Analysis Levels

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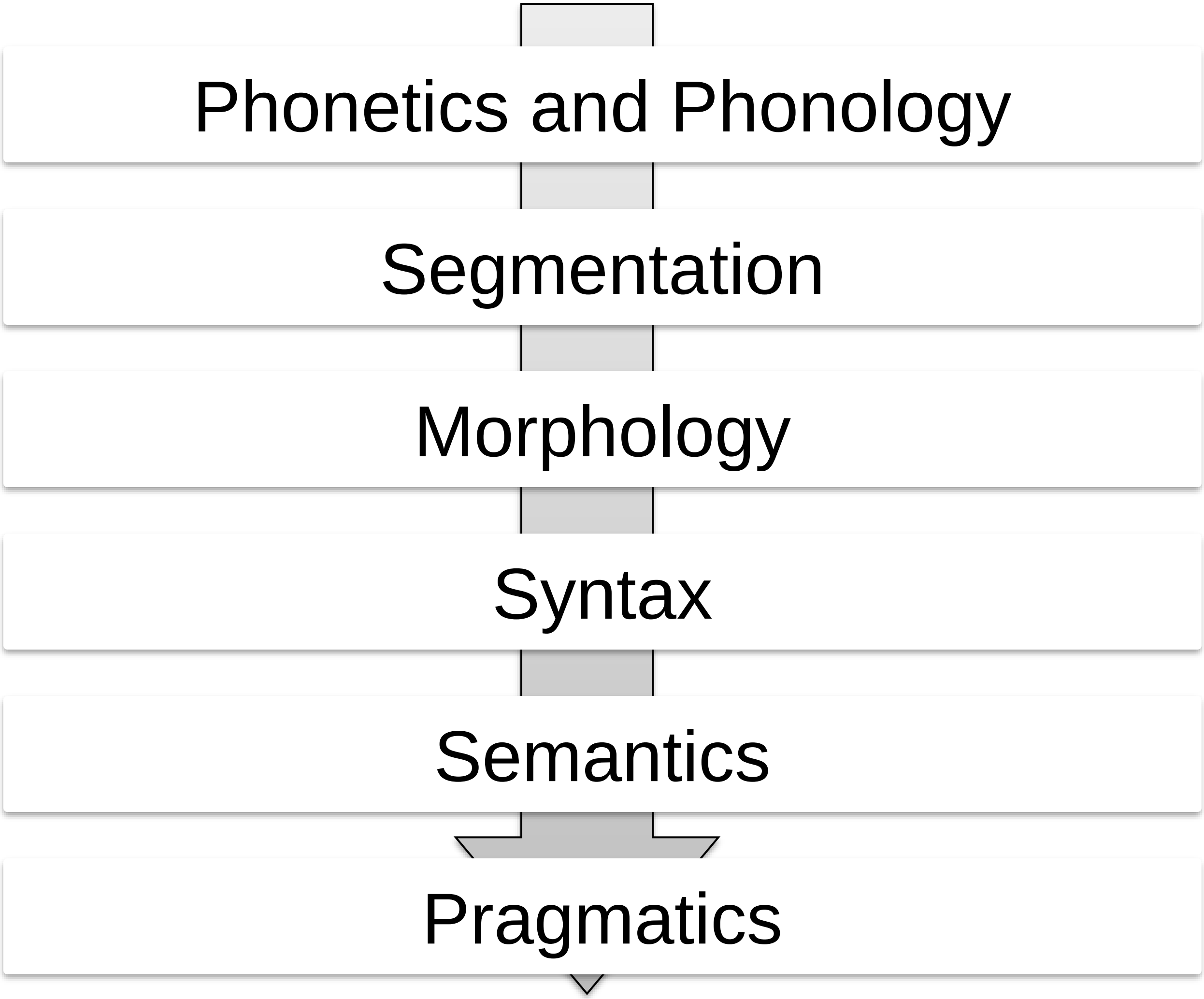

Phonetics and Phonology

Segmentation

Morphology

Syntax

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Pragmatics

Summary – Linguistic Analysis Levels

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Elementary, my dear Watson

Summary – Linguistic Analysis Levels

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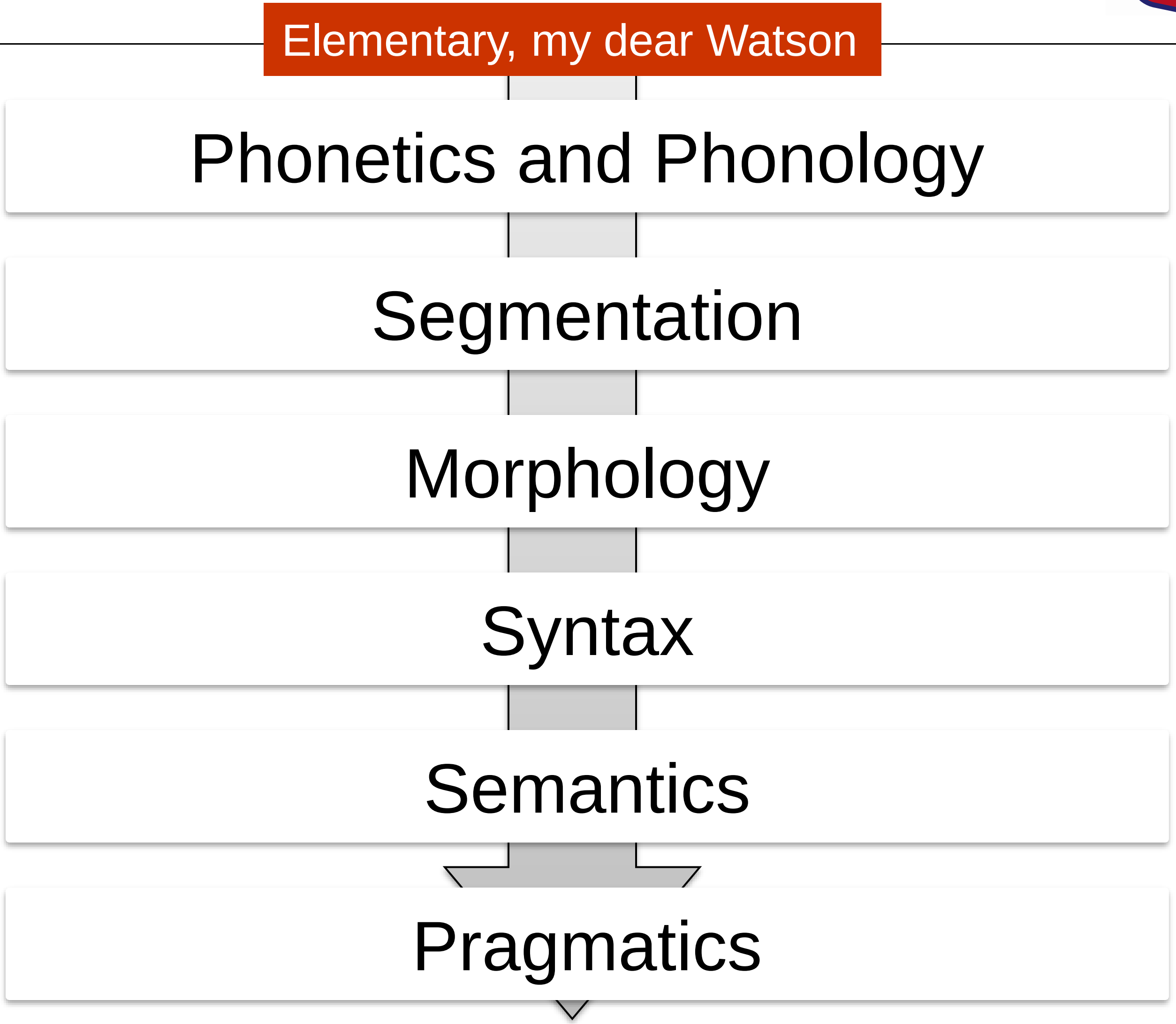
Elementary, my dear Watson



- Phonetics and Phonology
- Segmentation
- Morphology
- Syntax
- Semantics
- Pragmatics

Summary – Linguistic Analysis Levels

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Elementary, my dear Watson

[ɛlɪˈmɛntəri, maɪ dɪə ˈwɒtsən]

Segmentation

Morphology

Syntax

Semantics

Pragmatics

Summary – Linguistic Analysis Levels

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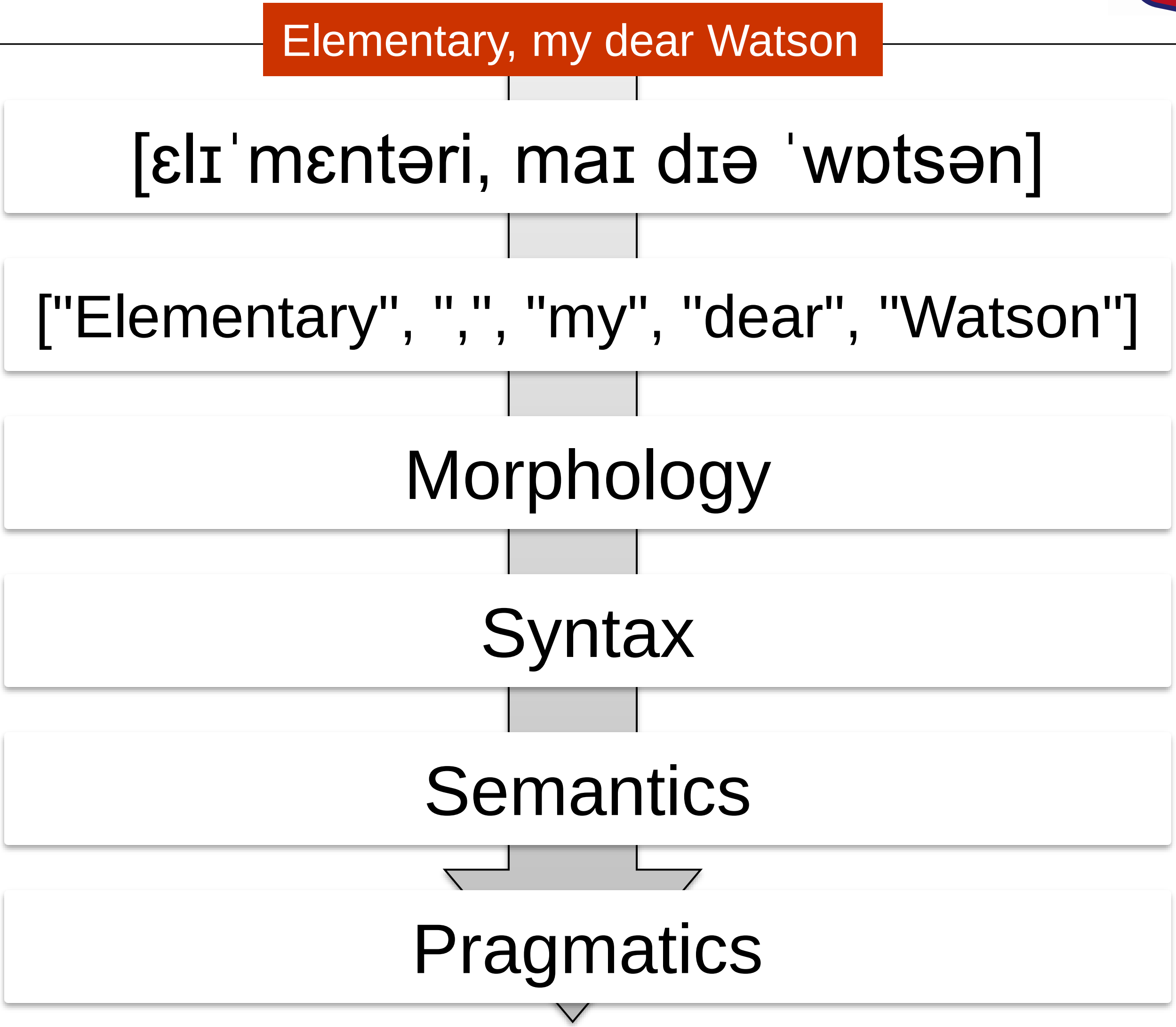

Elementary, my dear Watson

[ɛlɪˈmɛntəri, maɪ dɪə ˈwɒtsən]

["Elementary", ",", "my", "dear", "Watson"]

Morphology

Syntax

Semantics

Pragmatics

Summary – Linguistic Analysis Levels

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Elementary, my dear Watson

[ɛlɪˈmɛntəri, maɪ dɪə ˈwɒtsən]

["Elementary", ",", "my", "dear", "Watson"]

Base: Element, Suffix: -ary

Syntax

Semantics

Pragmatics

Summary – Linguistic Analysis Levels

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["Elementary", ",", "my", "dear", "Watson"]

Base: Element, Suffix: -ary

ADJ, PRP$ ADJ NNP

Semantics

Pragmatics

Summary – Linguistic Analysis Levels

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ADJ, PRP$ ADJ NNP

Watson: Dr. John H. Watson (not IBM)

Pragmatics

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["Elementary", ",", "my", "dear", "Watson"]

Base: Element, Suffix: -ary

ADJ, PRP$ ADJ NNP

Watson: Dr. John H. Watson (not IBM)

"You are so stupid…"

Take-Home-Messages

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- Natural language processing is an interesting topic ☺
- There are a lot of challenges ☹

- Typical preprocessing steps:
  - Tokenization for splitting texts into tokens
  - Stemming / Lemmatization to normalize tokens
  - PoS-Tagging and parsing analyze syntactic features
    - PoS-tags roughly represent word classes
    - Phrases group words to function as a single unit

- Ambiguity in language makes analysis a hard problem

Next Lecture

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Text Classification