

# Language Processing, part 2 & Linguistics Overview

Einführung in die Informationsverarbeitung

Nils Reiter

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Computational Linguistics  
Comparison/Evaluation

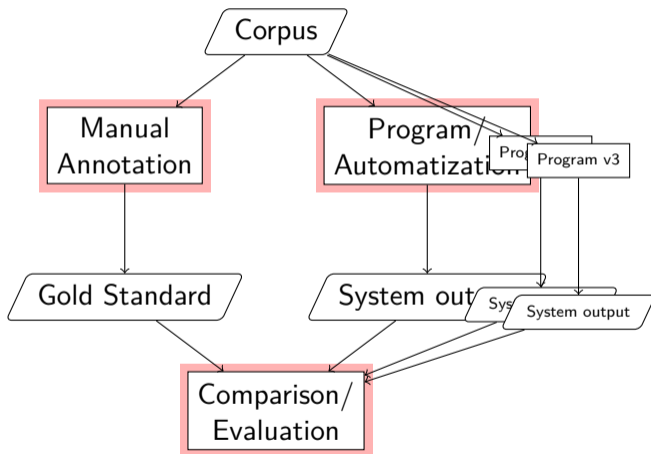
Language and Linguistics  
Phonology and Phonetics  
Morphology  
Syntax  
Semantics  
Pragmatics

Summary

## Section 1

# Computational Linguistics

## Recap: Experiments





Comparison/Evaluation

# Evaluation

## Intrinsic

- ▶ Compare the automatically produced annotations with the gold standard
- ▶ Can be quantified (similar to inter-annotator agreement)
- ▶ Accuracy:  
 $X\%$  of the items are classified as they are in the gold standard
- ▶ Other metrics: *precision*, *recall*, *f-score*

# Evaluation

## Intrinsic

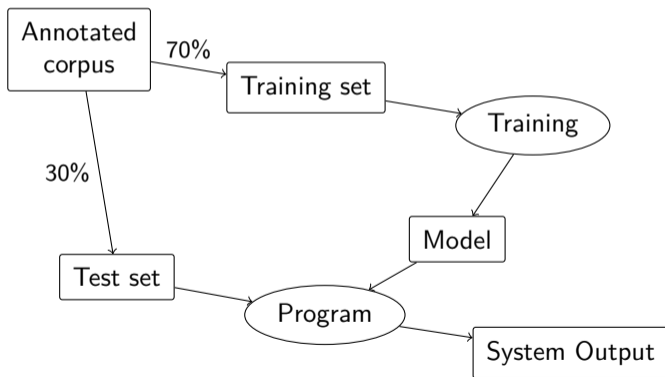
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## Extrinsic

- ▶ Use of the program in another program that can be evaluated
  - ▶ *downstream tasks*
  - ▶ e.g., use of a PoS tagger in a machine translation system

## Intrinsic Evaluation

- ▶ Goal: Predict the quality on new data
- ▶ The program cannot have seen the data, so that it's a realistic test





## Section 2

# Language and Linguistics

Computational Linguistics

Comparison/Evaluation

Language and Linguistics

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# What is Linguistics?

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- ▶ ›Scientific study‹
  - ▶ ›the‹ scientific method
  - ▶ Testable explanations
- ▶ Language
  - ▶ ?

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## Prescriptive vs. descriptive

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- ▶ Descriptive: Observing and analysing how people do use language

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- ▶ Descriptive: Observing and analysing how people do use language
- ▶ Academic linguistics: Nowadays mostly descriptive

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# What is Language?

- ▶ Communication system
- ▶ Conventionalised: We agree (mostly)
  - ▶ Only partially authoritative
- ▶ What do we agree on?
  - ▶ Relation between *signs* and its *meaning* (which is not the same!)
    - ▶ Saussure: Semiotics
  - ▶ E.g.: ›the students in this class‹ *means* all of you

# Linguistic sign

- ▶ Abstract notion
- ▶ Different levels
  - ▶ Texts
  - ▶ Sentences
  - ▶ Words
  - ▶ Syllables, morphemes
  - ▶ Spoken utterances

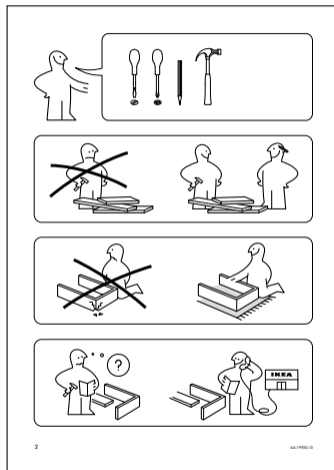


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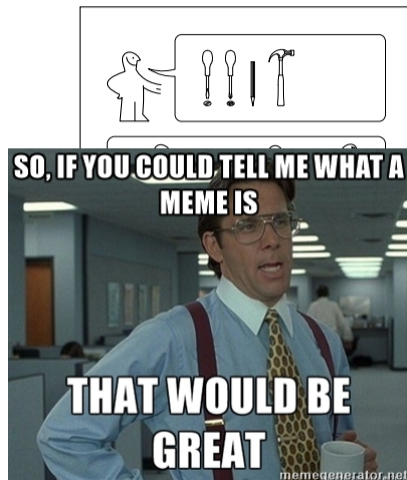
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    - ▶ Assembly instructions
    - ▶ Memes
    - ▶ ...



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- ▶ The sign could be different, e.g., ›cat‹
- ▶ No inherent meaning in signs
  - ▶ ...but strongly conventionalised
- ▶ Interpreting signs (and language) is something we learn
- ▶ Language is a social construct
  - ▶ Studying language is different from studying gravity



# Ambiguities

- ▶ Der Jäger traf den Mann mit dem Gewehr.
- ▶ Mädchenhandelsschule
- ▶ Maria hat Petra beim Einkaufen getroffen. Sie hat ihr Geld geliehen.
- ▶ maria hat dort liebe genossen.
- ▶ ...

Linguistics: Let's explain / represent / reproduce these ambiguities

## Computational Linguistics

Comparison/Evaluation

## Language and Linguistics

Phonology and Phonetics

Morphology

Syntax

Semantics

Pragmatics

## Summary



# Phonology and Phonetics

## Phonetics

- ▶ How are language sounds produced and understood/processed?
- ▶ Focus: Practical, verbal and gestural use of language
- ▶ Links to biology, acoustics

## Phonology

- ▶ Which function have certain phonemes within a language?
- ▶ Focus: Relation to other areas of linguistics and grammar
- ▶ Abstraction over concrete phonemes

# Understanding Spoken Language

## Relevant and irrelevant differences

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## International Phonetic Alphabet (IPA)

- ▶ <https://www.internationalphoneticassociation.org>
- ▶ Symbols defined via physiological properties of the pronunciation

# Pronunciation mishaps

Reisebüro-Panne

## Sächsische Kundin bucht Bordeaux statt Porto

Eine undeutliche Aussprache im Reisebüro kann teuer werden. Fast 300 Euro muss eine Kundin aus Sachsen für einen Flug zahlen, den sie nie angetreten hat - weil sie den gewünschten Zielort Porto dialektbedingt nicht klar artikuliert.



# Pronunciation mishaps

## Bordeaux vs. Porto

- ▶ Porto: ['pɔ:tə]
- ▶ Bordeaux: [bɔ:ʁ'dɔ:]

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## Bordeaux vs. Porto

- ▶ Porto: ['pɔʁto]
- ▶ Bordeaux: [bɔʁ'doː]
- ▶ Key difference: Voicing of the plosives p/b and t/d
  - ▶ /p/, /t/: voiceless (stimmlos)
  - ▶ /b/, /d/: voiced (stimmhaft)

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## Voice and Plosives

- ▶ Voice
  - ▶ Sounds with the use of the larynx (dt. Stimmlippen)
  - ▶ Example: Phase (voiceless: /f/) vs. Vase (voiced: /v/)
  - ▶ You can feel voice if you touch your throat



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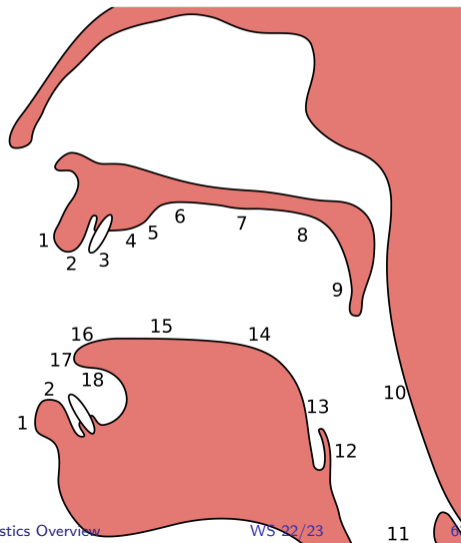
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  - ▶ You can feel voice if you touch your throat
- ▶ Plosive
  - ▶ Air stream is blocked, but suddenly re-opened
  - ▶ Example: /bʊs/ (plosive) vs. /mʊs/ (nasal)

# Producing Sounds

## Important Locations for German Sounds (Consonants)

2. labial (Lippen): [b], [p]
3. dental (Zähne): [v], [f]
4. alveolar (Zahnfach): [d], [t], ...
5. postalveolar: [ʃ]
7. palatal: [ç]
8. velar: [g], [k], ...
11. glottal: [ʔ]
  - ▶ ›ein Echo‹: [am ʔεçɔ]
  - ▶ ›Student:in‹: [ʃtu'dentʔm]



# Producing Sounds

## Consonants vs. Vowels

### ▶ Consonant

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### ▶ Vowel

- ▶ Produced without closure of the vocal tract
- ▶ Usually voiced
- ▶ Shaped by tongue position and lip rounding
  - ▶ (this is a simplification)

## Subsection 2

### Morphology

#### Computational Linguistics

Comparison/Evaluation

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Phonology and Phonetics

**Morphology**

Syntax

Semantics

Pragmatics

#### Summary

# Morphology

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- ▶ Ambiguity:
  - ▶ Order in which parts of words are assembled
- ▶ Morphological processes are language-dependent
  - ▶ German: Nominal composition
    - ▶ Rindfleischetikettierungsüberwachungsaufgabenübertragungsgesetz



## Subsection 3

### Syntax

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# Syntax

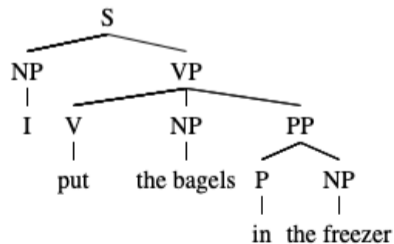
- ▶ Syntax: How are words used to form sentences?
  - ▶ Related to grammar
  - ▶ Two ways to look at syntax
    - ▶ Phrase structure
    - ▶ Dependency (not today)

## Phrase Structure

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- ▶ Parts of speech (Wortarten) are not enough to explain sentences

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- ▶ Words are not put in any arbitrary order
- ▶ Parts of speech (Wortarten) are not enough to explain sentences
- ▶ Constituents
  - ▶ Words that are grouped together as a unit
  - ▶ What can appear in diff. positions of a sentence is a constituent
    - (1) I put **the bagels** in the freezer.
    - (2) **The bagels**, I put in the freezer.
    - (3) I put in the fridge **the bagels** (that John had given me).



# Phrase Structure

## Heads

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## Examples

(1) Nominal phrase  
┌───────────┐  
Der flauschige Hund  
└───────────┘ bellt .  
Head  
┌───┐  
Hund  
└───┘

(2) Nominal phrase  
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- ▶ Free word order
  - ▶ ›Den Hund hat er gestreichelt.‹
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  - ▶ ›Er hat den Hund gestreichelt.‹
- ▶ Separable verbs
  - ▶ aufstehen: ›Sie steht jeden Tag früh auf.‹
    - ▶ \*›Sie aufsteht jeden Tag früh.‹
  - ▶ bestehen: ›Sie besteht die Prüfung.‹
    - ▶ \*›Sie steht die Prüfung be.‹
  - ▶ Mark Twain: 'The Germans have another kind of parenthesis, which they make by splitting a verb in two and putting half of it at the beginning of an exciting chapter and the other half at the end of it. Can any one conceive of anything more confusing than that?'

# German Syntax

## Nominal Phrases

NP  $\rightarrow$  Artikel? Adjektiv\* Nomen (PP|Relativsatz)\*

? 0 oder 1 mal  
\* 0 mal oder öfter  
(|) Alternative

## Subsection 4

### Semantics

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## Truth-conditional semantics

Davidson (1967)

- ▶ Meaning: Conditions that make a sentence true
  - ▶ (we're talking about full sentences now)
- ▶ Intuitively: If we know what makes a sentence true, we know something about its meaning

# What makes a sentence true?

Formal representation

## Examples

- ▶ Margaret Atwood is a writer.

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- ▶ Every hippo swims.
  - ▶  $\forall x : \text{hippo}(x) \Rightarrow \text{swim}(x)$
- ▶ A hippo swims.
  - ▶ Indefinite article
  - ▶  $\exists x : \text{hippo}(x) \wedge \text{swim}(x)$

# What makes a sentence true?

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Every woman loves a man.

# What makes a sentence true?

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## Examples

Every woman loves a man.

- ▶ Ambiguous: Is it the same man?
- ▶ Ambiguity can be represented by different scopes of the quantors
- ▶  $\forall w : \text{woman}(w) \Rightarrow \exists m : \text{man}(m) \wedge \text{love}(w,m)$
- ▶  $\exists m : \forall w : \text{woman}(w) \Rightarrow \text{man}(m) \wedge \text{love}(w,m)$



## Subsection 5

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# Pragmatics

- ▶ Pragmatics: Language and the rest of the world
  - ▶ ›pragmatic wastebasket‹
  - ▶ What semantics can't explain belongs to pragmatics 😊

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    - ▶ Grice: The co-operative principle Grice (1975)

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- ▶ E.g., the maxim of Quantity

(i) make your contribution as informative as is required for the current purposes of the exchange

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▶ Presupposition

▶ Speech acts

▶ ›I hereby christen this ship the H.M.S. Flounder.‹

Austin (1962)

▶ Change of the state of the world

▶ Conversational structure

# Presupposition

Implicit assumptions about the world

## Example

- (1) John managed to stop in time.
- (2) John stopped in time.
- (3) John tried to stop in time.

# Presupposition

Implicit assumptions about the world

## Example

- (1) John managed to stop in time.
- (2) John stopped in time.
- (3) John tried to stop in time.

From (1), we can infer (2) and (3).

## Example

- (4) John didn't manage to stop in time.

From (4), we cannot infer (2), but (3).



# Presupposition

- ▶ Entailments are cancelled under negation
- ▶ Presuppositions remain stable

## Presupposition

- ▶ Entailments are cancelled under negation
- ▶ Presuppositions remain stable
- ▶ Where does the presupposition come from?
  - ▶ The word 'manage' – let's replace it by 'try'

### Example

(5) John tried to stop in time.

(6) John didn't try to stop in time.

(5) is not presupposed by (6).

### Presupposition triggers

- ▶ Some words trigger presuppositions
- ▶ Trigger words have been collected and categorized

## Presupposition triggers

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  - there exists a man with two heads

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    - Strawson was born
- ▶ Comparisons and contrasts
  - ▶ Marianne called Adolph a male chauvinist, and then HE insulted HER
    - For Marianne to call Adolph a male chauvinist would be to insult him
- ▶ ...

# Presupposition properties

- ▶ So far: Presuppositions
  - ▶ are implicit assumptions about the world
  - ▶ survive under negation
- ▶ Now:
  - ▶ Defeasibility



# Presupposition

## Defeasibility

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  - ▶ At least John won't have to regret that he did a PhD.

# Presupposition

## Defeasibility

- ▶ Presuppositions can be cancelled/prevented/defeated
- ▶ By background knowledge (that John didn't do a PhD)
  - ▶ At least John won't have to regret that he did a PhD.
- ▶ By the meaning of the sentence
  - (1) Sue cried before she finished her thesis.
    - Sue finished her thesis
    - ▶ ›before‹ triggers a presupposition

# Presupposition

## Defeasibility

- ▶ Presuppositions can be cancelled/prevented/defeated
- ▶ By background knowledge (that John didn't do a PhD)
  - ▶ At least John won't have to regret that he did a PhD.
- ▶ By the meaning of the sentence
  - (1) Sue cried before she finished her thesis.
    - Sue finished her thesis
    - ▶ ›before‹ triggers a presupposition
  - (2) Sue died before she finished her thesis.
    - Sue finished her thesis

# Presupposition

## Defeasibility

- ▶ By more context
  - (1) He isn't aware that Serge is on the KGB payroll
    - Serge is on the KGB payroll

# Presupposition

## Defeasibility

- ▶ By more context
  - (1) He isn't aware that Serge is on the KGB payroll
    - Serge is on the KGB payroll
      - ▶ A: Well we've simply got to find out if Serge is a KGB infiltrator
      - B: Who if anyone would know?
      - C: The only person who would know for sure is Alexis; I've talked to him and he isn't aware that Serge is on the KGB payroll. So I think Serge can be trusted
- ▶ A specific discourse context can override a presuppositional inference



Summary

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- ▶ Computational Linguistics
  - ▶ Evaluation scores
  - ▶ Training and test split
- ▶ Linguistics
  - ▶ Phonetics/phonology: How are sounds made and described
  - ▶ Morphology: How are words made
  - ▶ Syntax: How are sentences made
  - ▶ Semantics: How is meaning made
  - ▶ Pragmatics: How do words impact the world
- ▶ Ambiguity on every language level
  - ▶ Ambiguities may occur combined, creating a large number of readings