

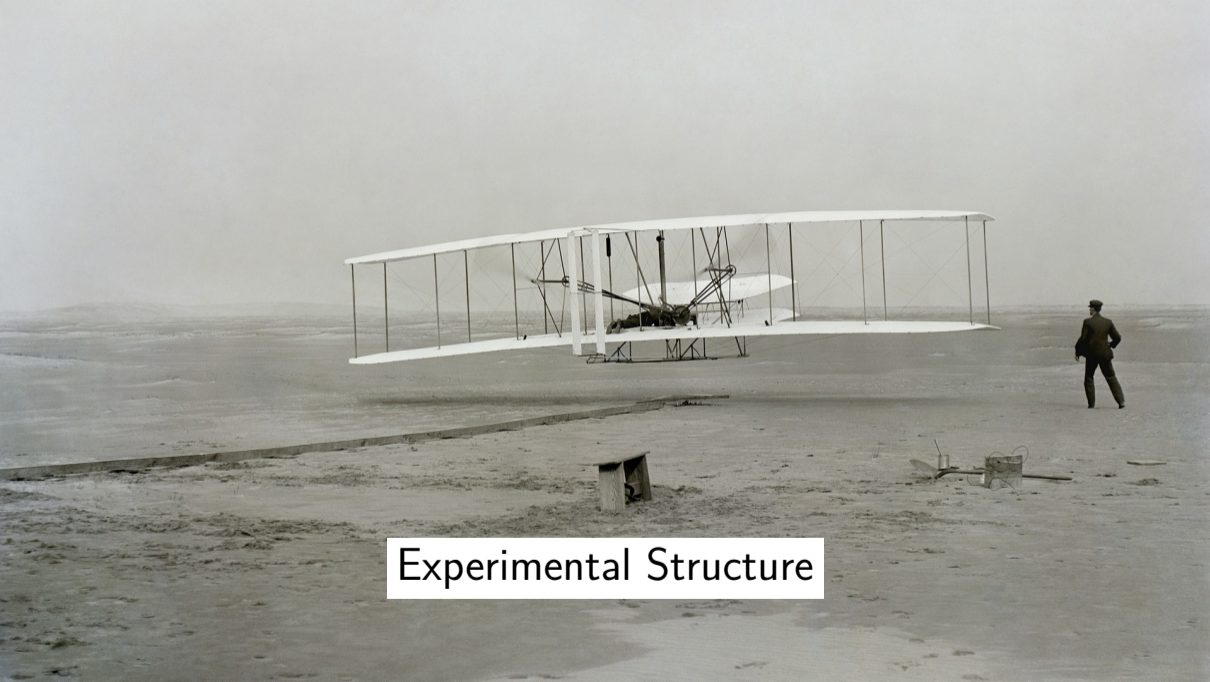
Natural Language Processing 1: Big Picture

HS Sprachtechnologie für eine bessere Welt (Winter term 2022/23)

Nils Reiter,

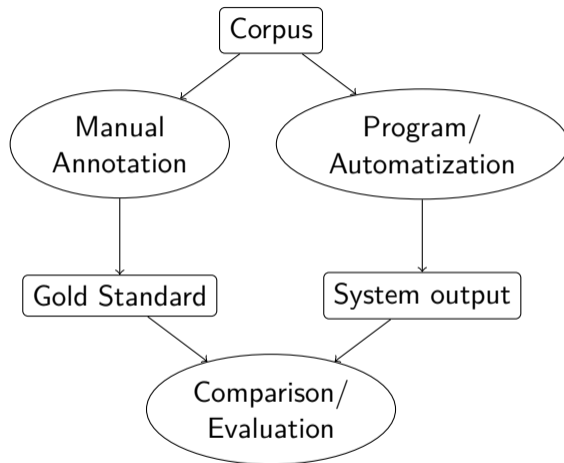
`nils.reiter@uni-koeln.de`

October 25, 2022

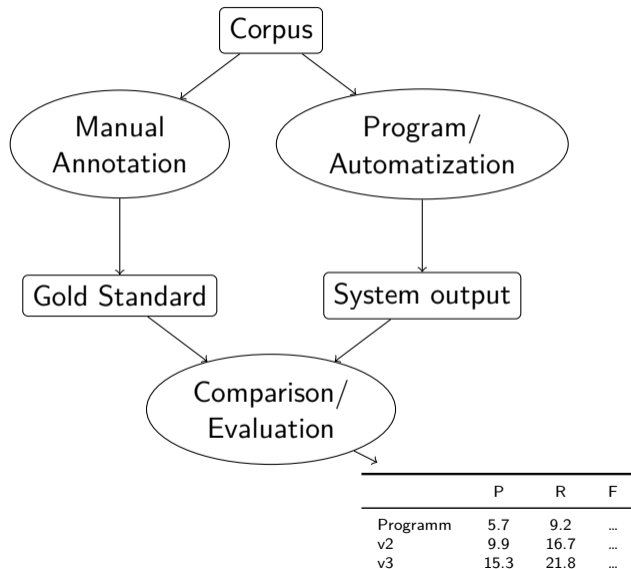


Experimental Structure

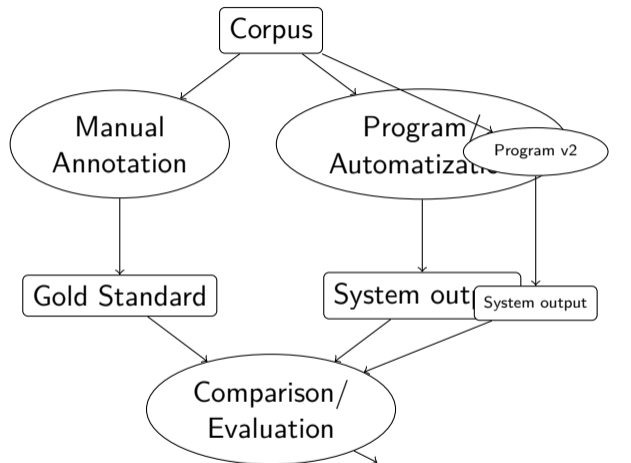
Experiments



Experiments

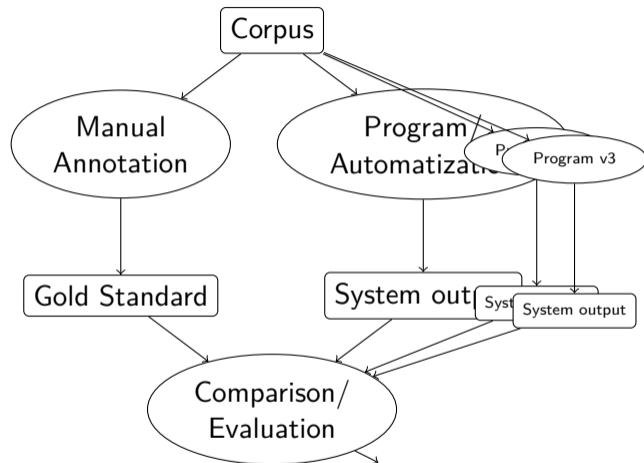


Experiments



	P	R	F
Programm	5.7	9.2	...
v2	9.9	16.7	...
v3	15.3	21.8	...

Experiments



	P	R	F
Programm	5.7	9.2	...
v2	9.9	16.7	...
v3	15.3	21.8	...

Experiments

- ▶ Reproducibility
- ▶ Hypotheses about the operationalisation of language/text phenomena

Example

- ▶ Position within a sentence is indicative for the part of speech
- ▶ Meaning of a word depends on its context
- ▶ The protagonist of a play is the character who talks the most

Manual Annotation

12 I have told you earthly things, and ye believe not, how shall ye believe, if I tell you of heavenly things?
13 And no man hath ascended up to heaven, but he that came down from heaven, even the Son of man which is in heaven.
14 And as Mo-ses lifted up the serpent in the wilderness, even so must the Son of man be lifted up:
15 That whosoever believeth in him should not perish, but have eternal life.
16 For God so loved the world, that he gave his only begotten Son, that whosoever believeth in him should not perish, but have everlasting life.
17 For God sent not his Son into the world to condemn the world; but that the world through him might be saved.
18 He that believeth on him is not condemned, but he that believeth not, is condemned already, because he hath not believed in the name of the only begotten Son of God.
19 And this is the condemnation, that light is come into the world, and men love darkness rather than light, because their deeds are evil.
20 For every one that doeth these things, hateth the light, and cometh not to the light, lest his deeds should be reproved.
21 But he that doeth the truth, cometh to the light, that his deeds may be made manifest, which are done in truth.

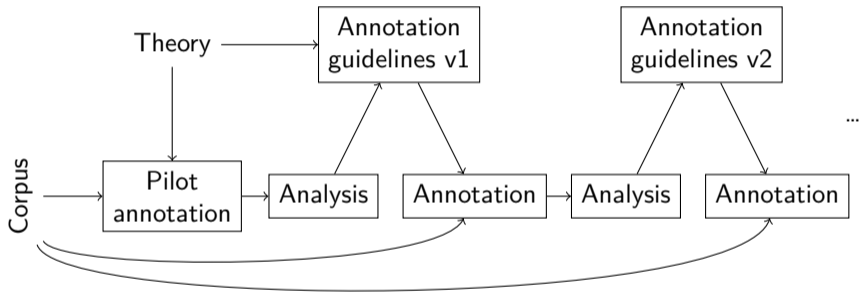
And what he hath seen and heard, that he telleth, and no man receiveth his testimony. For he seal that God is true.
35 The Father loveth the Son, and hath given all things into his hand.
36 He that believeth on the Son, and hath given life: and he that believeth not the Son, shall see life, but the wrath of God abideth on him.
The Woman at Jacob's Well
4 When therefore the Lord knew how the Phar-i-sees had heard that Je'-sus made and baptized more disciples than John,
2 (Though Je'-sus himself baptized not, but his disciples.)
3 He left Ju-dae'-a, and departed again into Gal-i-lee.
4 And he must needs go through sea-side.
5 And when he had so passed by, he came into a city which is called Sychar, where Jacob's well was. About the sixth hour he sat on the well.
6 And when the woman of Sychar came, she said unto him, Sir, thou art less than this well, which our fathers and we draw water out of, dost thou sayest to us, Draw water?

7 He answered and said unto her, My lady, draw water, and thou shalt see that I say to thee less than this well.
8 She saith unto him, Sir, thou art a Samaritan, and thou sayest to me, Draw water? For the Samaritans say, We have no communication with thee.
9 He answered and said unto her, My lady, believe me, the hour cometh, when ye shall worship neither in this well, nor yet at Je'-ru'-sa-lem.
10 Ye worship ye know not what: we worship, for salvation is of the spirit, and in truth: for the Father seeketh such to worship him.
11 God is a Spirit: and they that worship him, must worship him in spirit, and in truth.
12 The woman saith unto him, I know that Mess-i-as cometh, which is called Christ.
13 Je'-sus saith unto her, I that speak to thee am he.
14 And upon this came his disciples, and said unto him, What speakest thou with her? For she said nothing to us.
15 He answered and said unto them, My meat is to do the will of him that sent me, and to finish his work.
16 They say unto him, What work dost thou do? He answered and said unto them, My work is that I should bring forth many more fruit to the Father, than I do now: because I say to the Samaritans, Draw water, and they say, Draw: whereas I say unto them, Draw not, but believe on me, that ye may receive water of life.
17 He answered and said unto her, My lady, believe me, the hour cometh, when ye shall neither drink of water, nor thirst ye, for ever.
18 Whosoever drinketh of the water that I shall give him, shall never thirst, but the water that I shall give him, shall be in him, and shall be to him a well of water, springing up to eternal life.
19 She saith unto him, Sir, give me of this water.
20 He answered and said unto her, My lady, I have no water to give thee.
21 She saith unto him, Sir, thou sayest to me, I have no water: yet thou sayest to me, Draw not? For thou art greater than Jacob, which gave the well to us, dost thou sayest to me, Draw not?
22 He answered and said unto her, My lady, my hour is now at hand. I say to thee, Draw water, and thou shalt never thirst, neither shalt thou walk to draw water: for thou shalt drink of the living water.
23 She saith unto him, Sir, thou hast no bucket, how canst thou draw water? For I see no bucket here.
24 He answered and said unto her, My lady, I am he that speak to thee. He that believeth on me, though he have never drunk of the water, shall thirst no more, but shall drink of the living water, which I shall give him.
25 She saith unto him, Sir, thou sayest to me, I am he: yet thou sayest to me, Draw water, and I have no bucket?
26 He answered and said unto her, My lady, my hour is now at hand. I say to thee, Draw water, and thou shalt never thirst, neither shalt thou walk to draw water: for thou shalt drink of the living water, which I shall give him.
27 She saith unto him, Sir, thou sayest to me, I am he: yet thou sayest to me, Draw water, and I have no bucket?
28 He answered and said unto her, My lady, my hour is now at hand. I say to thee, Draw water, and thou shalt never thirst, neither shalt thou walk to draw water: for thou shalt drink of the living water, which I shall give him.
29 She saith unto him, Sir, thou sayest to me, I am he: yet thou sayest to me, Draw water, and I have no bucket?
30 He answered and said unto her, My lady, my hour is now at hand. I say to thee, Draw water, and thou shalt never thirst, neither shalt thou walk to draw water: for thou shalt drink of the living water, which I shall give him.
31 She saith unto him, Sir, thou sayest to me, I am he: yet thou sayest to me, Draw water, and I have no bucket?
32 He answered and said unto her, My lady, my hour is now at hand. I say to thee, Draw water, and thou shalt never thirst, neither shalt thou walk to draw water: for thou shalt drink of the living water, which I shall give him.
33 She saith unto him, Sir, thou sayest to me, I am he: yet thou sayest to me, Draw water, and I have no bucket?
34 He answered and said unto her, My lady, my hour is now at hand. I say to thee, Draw water, and thou shalt never thirst, neither shalt thou walk to draw water: for thou shalt drink of the living water, which I shall give him.
35 She saith unto him, Sir, thou sayest to me, I am he: yet thou sayest to me, Draw water, and I have no bucket?
36 He answered and said unto her, My lady, my hour is now at hand. I say to thee, Draw water, and thou shalt never thirst, neither shalt thou walk to draw water: for thou shalt drink of the living water, which I shall give him.
37 She saith unto him, Sir, thou sayest to me, I am he: yet thou sayest to me, Draw water, and I have no bucket?
38 He answered and said unto her, My lady, my hour is now at hand. I say to thee, Draw water, and thou shalt never thirst, neither shalt thou walk to draw water: for thou shalt drink of the living water, which I shall give him.
39 She saith unto him, Sir, thou sayest to me, I am he: yet thou sayest to me, Draw water, and I have no bucket?
40 He answered and said unto her, My lady, my hour is now at hand. I say to thee, Draw water, and thou shalt never thirst, neither shalt thou walk to draw water: for thou shalt drink of the living water, which I shall give him.
41 She saith unto him, Sir, thou sayest to me, I am he: yet thou sayest to me, Draw water, and I have no bucket?
42 He answered and said unto her, My lady, my hour is now at hand. I say to thee, Draw water, and thou shalt never thirst, neither shalt thou walk to draw water: for thou shalt drink of the living water, which I shall give him.
43 She saith unto him, Sir, thou sayest to me, I am he: yet thou sayest to me, Draw water, and I have no bucket?
44 He answered and said unto her, My lady, my hour is now at hand. I say to thee, Draw water, and thou shalt never thirst, neither shalt thou walk to draw water: for thou shalt drink of the living water, which I shall give him.
45 She saith unto him, Sir, thou sayest to me, I am he: yet thou sayest to me, Draw water, and I have no bucket?
46 He answered and said unto her, My lady, my hour is now at hand. I say to thee, Draw water, and thou shalt never thirst, neither shalt thou walk to draw water: for thou shalt drink of the living water, which I shall give him.
47 She saith unto him, Sir, thou sayest to me, I am he: yet thou sayest to me, Draw water, and I have no bucket?
48 He answered and said unto her, My lady, my hour is now at hand. I say to thee, Draw water, and thou shalt never thirst, neither shalt thou walk to draw water: for thou shalt drink of the living water, which I shall give him.
49 She saith unto him, Sir, thou sayest to me, I am he: yet thou sayest to me, Draw water, and I have no bucket?
50 He answered and said unto her, My lady, my hour is now at hand. I say to thee, Draw water, and thou shalt never thirst, neither shalt thou walk to draw water: for thou shalt drink of the living water, which I shall give him.
51 She saith unto him, Sir, thou sayest to me, I am he: yet thou sayest to me, Draw water, and I have no bucket?
52 He answered and said unto her, My lady, my hour is now at hand. I say to thee, Draw water, and thou shalt never thirst, neither shalt thou walk to draw water: for thou shalt drink of the living water, which I shall give him.
53 She saith unto him, Sir, thou sayest to me, I am he: yet thou sayest to me, Draw water, and I have no bucket?
54 He answered and said unto her, My lady, my hour is now at hand. I say to thee, Draw water, and thou shalt never thirst, neither shalt thou walk to draw water: for thou shalt drink of the living water, which I shall give him.
55 She saith unto him, Sir, thou sayest to me, I am he: yet thou sayest to me, Draw water, and I have no bucket?
56 He answered and said unto her, My lady, my hour is now at hand. I say to thee, Draw water, and thou shalt never thirst, neither shalt thou walk to draw water: for thou shalt drink of the living water, which I shall give him.
57 She saith unto him, Sir, thou sayest to me, I am he: yet thou sayest to me, Draw water, and I have no bucket?
58 He answered and said unto her, My lady, my hour is now at hand. I say to thee, Draw water, and thou shalt never thirst, neither shalt thou walk to draw water: for thou shalt drink of the living water, which I shall give him.
59 She saith unto him, Sir, thou sayest to me, I am he: yet thou sayest to me, Draw water, and I have no bucket?
60 He answered and said unto her, My lady, my hour is now at hand. I say to thee, Draw water, and thou shalt never thirst, neither shalt thou walk to draw water: for thou shalt drink of the living water, which I shall give him.
61 She saith unto him, Sir, thou sayest to me, I am he: yet thou sayest to me, Draw water, and I have no bucket?
62 He answered and said unto her, My lady, my hour is now at hand. I say to thee, Draw water, and thou shalt never thirst, neither shalt thou walk to draw water: for thou shalt drink of the living water, which I shall give him.
63 She saith unto him, Sir, thou sayest to me, I am he: yet thou sayest to me, Draw water, and I have no bucket?
64 He answered and said unto her, My lady, my hour is now at hand. I say to thee, Draw water, and thou shalt never thirst, neither shalt thou walk to draw water: for thou shalt drink of the living water, which I shall give him.
65 She saith unto him, Sir, thou sayest to me, I am he: yet thou sayest to me, Draw water, and I have no bucket?
66 He answered and said unto her, My lady, my hour is now at hand. I say to thee, Draw water, and thou shalt never thirst, neither shalt thou walk to draw water: for thou shalt drink of the living water, which I shall give him.
67 She saith unto him, Sir, thou sayest to me, I am he: yet thou sayest to me, Draw water, and I have no bucket?
68 He answered and said unto her, My lady, my hour is now at hand. I say to thee, Draw water, and thou shalt never thirst, neither shalt thou walk to draw water: for thou shalt drink of the living water, which I shall give him.
69 She saith unto him, Sir, thou sayest to me, I am he: yet thou sayest to me, Draw water, and I have no bucket?
70 He answered and said unto her, My lady, my hour is now at hand. I say to thee, Draw water, and thou shalt never thirst, neither shalt thou walk to draw water: for thou shalt drink of the living water, which I shall give him.
71 She saith unto him, Sir, thou sayest to me, I am he: yet thou sayest to me, Draw water, and I have no bucket?
72 He answered and said unto her, My lady, my hour is now at hand. I say to thee, Draw water, and thou shalt never thirst, neither shalt thou walk to draw water: for thou shalt drink of the living water, which I shall give him.
73 She saith unto him, Sir, thou sayest to me, I am he: yet thou sayest to me, Draw water, and I have no bucket?
74 He answered and said unto her, My lady, my hour is now at hand. I say to thee, Draw water, and thou shalt never thirst, neither shalt thou walk to draw water: for thou shalt drink of the living water, which I shall give him.
75 She saith unto him, Sir, thou sayest to me, I am he: yet thou sayest to me, Draw water, and I have no bucket?
76 He answered and said unto her, My lady, my hour is now at hand. I say to thee, Draw water, and thou shalt never thirst, neither shalt thou walk to draw water: for thou shalt drink of the living water, which I shall give him.
77 She saith unto him, Sir, thou sayest to me, I am he: yet thou sayest to me, Draw water, and I have no bucket?
78 He answered and said unto her, My lady, my hour is now at hand. I say to thee, Draw water, and thou shalt never thirst, neither shalt thou walk to draw water: for thou shalt drink of the living water, which I shall give him.
79 She saith unto him, Sir, thou sayest to me, I am he: yet thou sayest to me, Draw water, and I have no bucket?
80 He answered and said unto her, My lady, my hour is now at hand. I say to thee, Draw water, and thou shalt never thirst, neither shalt thou walk to draw water: for thou shalt drink of the living water, which I shall give him.
81 She saith unto him, Sir, thou sayest to me, I am he: yet thou sayest to me, Draw water, and I have no bucket?
82 He answered and said unto her, My lady, my hour is now at hand. I say to thee, Draw water, and thou shalt never thirst, neither shalt thou walk to draw water: for thou shalt drink of the living water, which I shall give him.
83 She saith unto him, Sir, thou sayest to me, I am he: yet thou sayest to me, Draw water, and I have no bucket?
84 He answered and said unto her, My lady, my hour is now at hand. I say to thee, Draw water, and thou shalt never thirst, neither shalt thou walk to draw water: for thou shalt drink of the living water, which I shall give him.
85 She saith unto him, Sir, thou sayest to me, I am he: yet thou sayest to me, Draw water, and I have no bucket?
86 He answered and said unto her, My lady, my hour is now at hand. I say to thee, Draw water, and thou shalt never thirst, neither shalt thou walk to draw water: for thou shalt drink of the living water, which I shall give him.
87 She saith unto him, Sir, thou sayest to me, I am he: yet thou sayest to me, Draw water, and I have no bucket?
88 He answered and said unto her, My lady, my hour is now at hand. I say to thee, Draw water, and thou shalt never thirst, neither shalt thou walk to draw water: for thou shalt drink of the living water, which I shall give him.
89 She saith unto him, Sir, thou sayest to me, I am he: yet thou sayest to me, Draw water, and I have no bucket?
90 He answered and said unto her, My lady, my hour is now at hand. I say to thee, Draw water, and thou shalt never thirst, neither shalt thou walk to draw water: for thou shalt drink of the living water, which I shall give him.
91 She saith unto him, Sir, thou sayest to me, I am he: yet thou sayest to me, Draw water, and I have no bucket?
92 He answered and said unto her, My lady, my hour is now at hand. I say to thee, Draw water, and thou shalt never thirst, neither shalt thou walk to draw water: for thou shalt drink of the living water, which I shall give him.
93 She saith unto him, Sir, thou sayest to me, I am he: yet thou sayest to me, Draw water, and I have no bucket?
94 He answered and said unto her, My lady, my hour is now at hand. I say to thee, Draw water, and thou shalt never thirst, neither shalt thou walk to draw water: for thou shalt drink of the living water, which I shall give him.
95 She saith unto him, Sir, thou sayest to me, I am he: yet thou sayest to me, Draw water, and I have no bucket?
96 He answered and said unto her, My lady, my hour is now at hand. I say to thee, Draw water, and thou shalt never thirst, neither shalt thou walk to draw water: for thou shalt drink of the living water, which I shall give him.
97 She saith unto him, Sir, thou sayest to me, I am he: yet thou sayest to me, Draw water, and I have no bucket?
98 He answered and said unto her, My lady, my hour is now at hand. I say to thee, Draw water, and thou shalt never thirst, neither shalt thou walk to draw water: for thou shalt drink of the living water, which I shall give him.
99 She saith unto him, Sir, thou sayest to me, I am he: yet thou sayest to me, Draw water, and I have no bucket?
100 He answered and said unto her, My lady, my hour is now at hand. I say to thee, Draw water, and thou shalt never thirst, neither shalt thou walk to draw water: for thou shalt drink of the living water, which I shall give him.

Annotation

- ▶ Interdisciplinary 'false friend'
- ▶ Different meanings in different disciplines
 - ▶ Adding TEI/XML markup: DH community
 - ▶ Adding comments to page margins: Hermeneutic traditions
 - ▶ Literary studies, bible studies
 - ▶ Assigning categories to textual material: (computational) linguistics

Annotation Workflow



Hovy/Lavid (2010); Pagel et al. (2018)

Annotation guidelines

- ▶ Describe the way to create the machine-readable truth
- ▶ What is to be annotated (which words)
- ▶ Working definitions or tests for categories
- ▶ Living documents: Need to be iteratively improved
- ▶ Community-wide accepted standards are needed

Annotation Analysis

- ▶ Multiple annotators annotate the same text(s)
- ▶ Annotations are compared
- ▶ Disagreements can be quantified ('Inter-Annotator-Agreement', IAA)

Cohen, 1960; Fleiss, 1971; Fournier, 2013; Mathet et al., 2015

- ▶ Inter- und Intra-AA
- ▶ ... it's also a good idea to talk to the annotators

Indirect Annotations

- ▶ Annotations as a by-product of games

- ▶ <https://www.artigo.org>

- ▶ <https://anawiki.essex.ac.uk/phrasedetectives/>

Kohle (2010)

Chamberlain et al. (2008)

Indirect Annotations

- ▶ Annotations as a by-product of games
 - ▶ <https://www.artigo.org>
 - ▶ <https://anawiki.essex.ac.uk/phrasedetectives/>
- ▶ Captchas for OCR correction



Kohle (2010)

Chamberlain et al. (2008)

Indirect Annotations

- ▶ Annotations as a by-product of games
 - ▶ <https://www.artigo.org>
 - ▶ <https://anawiki.essex.ac.uk/phrasedetectives>
- ▶ Captchas for OCR correction



Select all images with **bridges**


2010)
108)

VERIFY

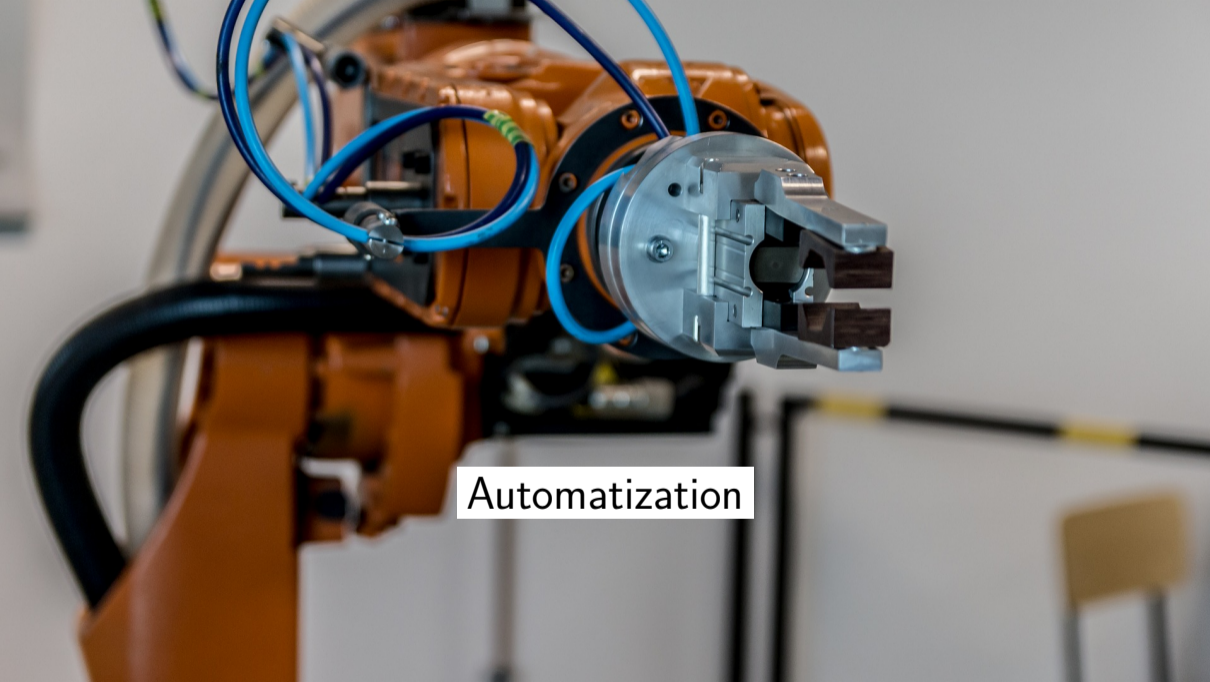
Learning from Raw Data

- ▶ Train on things that are already there
- ▶ word2vec: Is 'dog' a context word of 'lazy'? Mikolov et al. (2013)
- ▶ BERT Devlin et al. (2019)
 - ▶ Can you fill in this blanked word? ("masked language modeling", MLM)
 - ▶ Are these two sentences natural neighbours? ("next sentence prediction", NSP)

Learning from Raw Data

- ▶ Train on things that are already there
- ▶ word2vec: Is 'dog' a context word of 'lazy'? Mikolov et al. (2013)
- ▶ BERT Devlin et al. (2019)
 - ▶ Can you fill in this blanked word? ("masked language modeling", MLM)
 - ▶ Are these two sentences natural neighbours? ("next sentence prediction", NSP)
- ▶ Training data available in abundance
 - ▶ As long as there is digital data for a language
 - ▶  Difficult to control what exactly is in there
 - ▶ More obvious for text-image data sets Birhane et al. (2021)

haveibeentrained.com



Automation

Welche Methoden kennen Sie?

Systems

- ▶ Predict annotations
- ▶ Ideally: The same annotations as a human (the correct ones)
- ▶ Parameters
 - ▶ On what exactly does the program make predictions?
 - ▶ What information, criteria and features does it need?

Systems

- ▶ Predict annotations
- ▶ Ideally: The same annotations as a human (the correct ones)
- ▶ Parameters
 - ▶ On what exactly does the program make predictions?
 - ▶ What information, criteria and features does it need?

System types

- ▶ Rule-based (not so popular anymore)
- ▶ Supervised machine learning
 - ▶ Deep learning

Supervised Systems

- ▶ Classification: Assign items into previously known categories
 - ▶ Sequence labeling: Special case. Class for item n depends on item $n - 1$
- ▶ Learn patterns from annotated data
- ▶ Relations between input (X) and output (Y)
 - ▶ Can be an n -to- m relation, but mostly n -to-1 (i.e., we predict a single target category)

Features

- ▶ The properties of a item that is to be classified
- ▶ Classical machine learning
 - ▶ Manual coding of explicit, scientifically validated features: Feature extraction
 - ▶ “Translation” of the corpus into feature vectors
 - ▶ Feature engineering
 - ▶ Design and implementation of feature extractors
 - ▶ Linguistic features need to be determined somehow
 - Dependencies, modularization

Features

- ▶ The properties of a item that is to be classified
- ▶ Classical machine learning
 - ▶ Manual coding of explicit, scientifically validated features: Feature extraction
 - ▶ “Translation” of the corpus into feature vectors
 - ▶ Feature engineering
 - ▶ Design and implementation of feature extractors
 - ▶ Linguistic features need to be determined somehow
 - Dependencies, modularization
- ▶ Deep learning
 - ▶ Embeddings used as features
 - ▶ A word is mapped onto an n -dimensional vector, which is then put into the ML system
 - ▶ Vector dimensions = features
 - ▶ But not interpretable anymore

Parameters and Hyper Parameters

Parameters

- ▶ What is learned by the algorithm during training
 - ▶ E.g., probability/frequency of feature F and class C (= weights)
- ▶ Parameters are stored in the model

Parameters and Hyper Parameters

Parameters

- ▶ What is learned by the algorithm during training
 - ▶ E.g., probability/frequency of feature F and class C (= weights)
- ▶ Parameters are stored in the model

Hyper Parameters

- ▶ Set during the training process by us
 - ▶ E.g., number of training epochs in a neural network, data set size, ...
- ▶ Not automatically optimised, but important for performance

Parameters and Hyper Parameters

Parameters

- ▶ What is learned by the algorithm during training
 - ▶ E.g., probability/frequency of feature F and class C (= weights)
- ▶ Parameters are stored in the model

Hyper Parameters

- ▶ Set during the training process by us
 - ▶ E.g., number of training epochs in a neural network, data set size, ...
- ▶ Not automatically optimised, but important for performance
- ▶ Development set: Find optimal hyper parameters

Example: Parts of Speech

Feature	Data type
Case	Binary
Length	> 0
Sentence initial	Binary

Table: Features

Token	Case	L.	S. initial
Der	u	3	Y
Hund	u	4	N
bellt	l	5	N
.	?	1	N
Die	u	3	Y
Katze	u	5	N
schnurrt	l	8	N
.	?	1	N

Table: Feature extraction



Comparison/Evaluation

Evaluation

Intrinsic

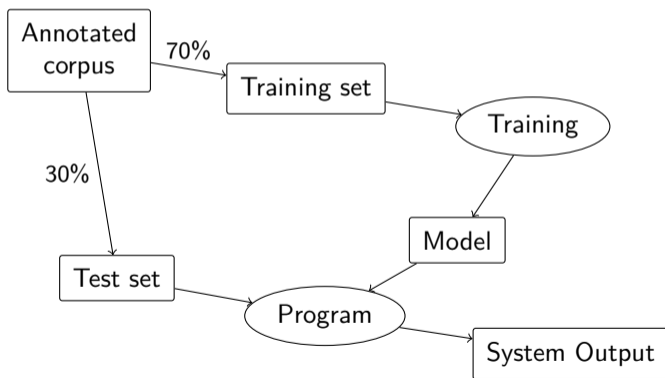
- ▶ Compare the automatically produced annotations with the gold standard
- ▶ Can be quantified (similar to IAA)
 - ▶ *precision, recall, f-score*
- ▶ System treated as a black box

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



Classification Evaluation Metrics

(MS99, 267 ff.)

- ▶ Accuracy: How many items were correctly classified over all classes?
(one value for everything)
- ▶ Precision: How many of the items classified as category C actually belong to category C ?
(one value per category)
- ▶ Recall: How many of the items in category C have been classified as C ?
(one value per category)
- ▶ F-Score: Harmonic mean between precision and recall

Baseline

- ▶ What does an evaluation score tell us?
 - ▶ Nothing, if not compared to anything

Baseline

- ▶ What does an evaluation score tell us?
 - ▶ Nothing, if not compared to anything
- ▶ Artificial baselines
 - ▶ Majority baseline: Classify everything into the most frequent class
 - ▶ Random baseline: Classify everything at random

Baseline

- ▶ What does an evaluation score tell us?
 - ▶ Nothing, if not compared to anything
- ▶ Artificial baselines
 - ▶ Majority baseline: Classify everything into the most frequent class
 - ▶ Random baseline: Classify everything at random
- ▶ Self baselines
 - ▶ Take a single feature (classical machine learning)
 - ▶ Pre-trained embeddings
 - ▶ BERT without fine-tuning

Baseline

- ▶ What does an evaluation score tell us?
 - ▶ Nothing, if not compared to anything
- ▶ Artificial baselines
 - ▶ Majority baseline: Classify everything into the most frequent class
 - ▶ Random baseline: Classify everything at random
- ▶ Self baselines
 - ▶ Take a single feature (classical machine learning)
 - ▶ Pre-trained embeddings
 - ▶ BERT without fine-tuning
- ▶ Foreign baselines
 - ▶ Last year's system
 - ▶ Competition system
 - ▶ Shared task winner

If baseline has hyper parameters,
they need to be optimized as well
(for a fair comparison)

Results

	P	R	F
Baseline 1
Baseline 2
Variant 1
Variant 2
Variant 3

Table: A typical results table

Error Analysis

- ▶ Systems do not deliver perfect results (i.e., scores are below 100%)
- ▶ What can we say about the remaining errors?

Error Analysis

- ▶ Systems do not deliver perfect results (i.e., scores are below 100%)
- ▶ What can we say about the remaining errors?
- ▶ Workflow
 - ▶ Extract n errors, inspect them manually
 - ▶ Can we detect regularities/patterns in them? E.g., why they were misclassified?
 - ▶ Ideally, error analysis makes quantitative statements about error sources

Error Analysis

- ▶ Systems do not deliver perfect results (i.e., scores are below 100%)
- ▶ What can we say about the remaining errors?
- ▶ Workflow
 - ▶ Extract n errors, inspect them manually
 - ▶ Can we detect regularities/patterns in them? E.g., why they were misclassified?
 - ▶ Ideally, error analysis makes quantitative statements about error sources
- ▶ Directions for further improvements of the system

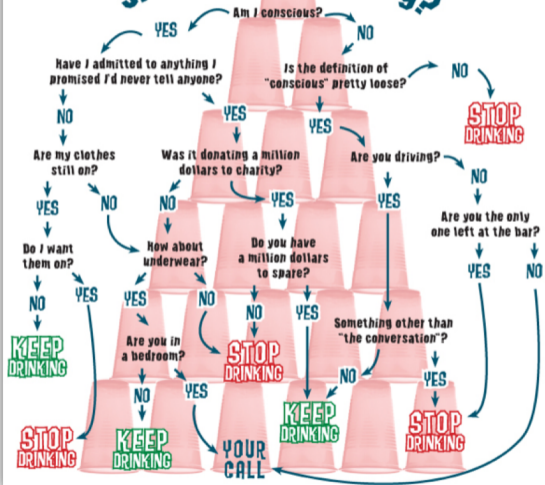
Analysis \neq Generation

- ▶ Analysis: Text as input, annotations as output
- ▶ Generation: Some data as input, text as output
 - ▶ Machine translation, digital assistants, summarization, ...
- ▶ Different kinds of systems (not classification)
- ▶ Different evaluation metrics
 - ▶ Machine translation: BiLingual Evaluation Understudy (BLEU) Papineni et al. (2001)
 - ▶ Weighted overlap between reference and system



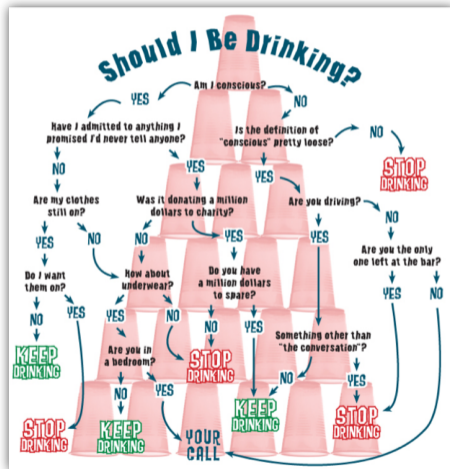
Decision Trees

Should I Be Drinking?



Decision Trees

Prediction Model – Toy Example



- ▶ What are the instances?
 - ▶ Situations we are in (this is not really automatisable)
- ▶ What are the features?
 - ▶ Consciousness
 - ▶ Clothing situation
 - ▶ Promises made
 - ▶ Whether we are driving
 - ▶ ...

Decision Trees

Prediction Model

- ▶ Each non-leaf node in the tree represents one feature
- ▶ Each leaf node represents a class label
- ▶ Each branch at this node represents one possible feature value
 - ▶ Number of branches = $|v(f_i)|$ (number of possible values)



Decision Trees

Prediction Model

- ▶ Each non-leaf node in the tree represents one feature
- ▶ Each leaf node represents a class label
- ▶ Each branch at this node represents one possible feature value
 - ▶ Number of branches = $|v(f_i)|$ (number of possible values)
- ▶ Make a prediction for x :
 1. Start at root node
 2. If it's a leaf node
 - ▶ assign the class label
 3. Else
 - ▶ Check node which feature is to be tested (f_i)
 - ▶ Extract $f_i(x)$
 - ▶ Follow corresponding branch
 - ▶ Go to 2



Decision Trees

Learning Algorithm

- ▶ Core idea: The tree represents splits of the training data
 1. Start with the full data set D_{train} as D
 2. If D only contains members of a single class:
 - ▶ Done.
 3. Else:
 - ▶ Select a feature f_i
 - ▶ Extract feature values of all instances in D
 - ▶ Split the data set according to f_i : $D = D_v \cup D_w \cup D_u \dots$
 - ▶ Go back to 2

- ▶ Remaining question: How to select features?




And now:



The cliffhanger

to be continued on Nov. 8th

References I

-  Birhane, Abeba/Vinay Uday Prabhu/Emmanuel Kahembwe (2021). “Multimodal datasets: misogyny, pornography, and malignant stereotypes”. In: *CoRR* abs/2110.01963. arXiv: 2110.01963. URL: <https://arxiv.org/abs/2110.01963>.
-  Chamberlain, Jon/Massimo Poesio/Udo Kruschwitz (2008). “Phrase detectives: a web-based collaborative annotation game”. In: *I-SEMANTICS '08: International Conference on Semantic Systems*. Graz, Austria: Verlag der Technischen Universität Graz, pp. 42–49.
-  Cohen, Jacob (1960). “A Coefficient of Agreement for Nominal Scales”. In: *Educational and Psychological Measurement* 20.1, pp. 37–46.




References II

-  Devlin, Jacob/Ming-Wei Chang/Kenton Lee/Kristina Toutanova (2019). “BERT: Pre-training of Deep Bidirectional Transformers for Language Understanding”. In: *Proceedings of the 2019 Conference of the North American Chapter of the Association for Computational Linguistics: Human Language Technologies, Volume 1 (Long and Short Papers)*. Minneapolis, Minnesota: Association for Computational Linguistics, pp. 4171–4186. DOI: 10.18653/v1/N19-1423. URL: <https://aclanthology.org/N19-1423>.
-  Fleiss, Joseph L. (1971). “Measuring nominal scale agreement among many raters”. In: *Psychological Bulletin* 76.5, pp. 420–428.
-  Fournier, Chris (2013). “Evaluating Text Segmentation using Boundary Edit Distance”. In: *Proceedings of the 51st Annual Meeting of the Association for Computational Linguistics (Volume 1: Long Papers)*. Sofia, Bulgaria: Association for Computational Linguistics, pp. 1702–1712. URL: <http://aclweb.org/anthology/P13-1167>.

References III

-  Hovy, Eduard/Julia Lavid (2010). “Towards a ‘Science’ of Corpus Annotation: A New Methodological Challenge for Corpus Linguistics”. In: *International Journal of Translation Studies* 22.1.
-  Kohle, Hubertus (2010). “Artigo. Social image tagging pour les oeuvres d’art”. In: *L’art et la mesure. Histoire de l’art et méthodes quantitatives*. Ed. by Béatrice Joyeux-Prunel. Paris: Ed. Rue d’Ulm, pp. 153–164.
-  Manning, Christopher D./Hinrich Schütze (1999). *Foundations of Statistical Natural Language Processing*. Cambridge, Massachusetts and London, England: MIT Press.
-  Mathet, Yann/Antoine Widlöcher/Jean-Philippe Métivier (2015). “The Unified and Holistic Method Gamma () for Inter-Annotator Agreement Measure and Alignment”. In: *Computational Linguistics* 41.3, pp. 437–479.
-  Mikolov, Tomáš/Kai Chen/Greg Corrado/Jeffrey Dean (2013). “Efficient Estimation of Word Representations in Vector Space”. In: *arXiv cs.CL*. URL: <https://arxiv.org/pdf/1301.3781.pdf>.

References IV

-  Pagel, Janis/Nils Reiter/Ina Rösiger/Sarah Schulz (2018). “A Unified Text Annotation Workflow for Diverse Goals”. In: *Proceedings of the Workshop on Annotation in Digital Humanities, co-located with ESSLLI 2018*. Ed. by Sandra Kübler/Heike Zinsmeister. Sofia, Bulgaria.
-  Papineni, Kishore/Salim Roukos/Todd Ward/Wei-Jing Zhu (2001). *Bleu: a method for automatic evaluation of machine translation*. IBM Research Division.
-  Shannon, Claude E. (1948). “A mathematical theory of communication”. In: *The Bell System Technical Journal* 27.3, pp. 379–423.