Annotation

VL Sprachliche Informationsverarbeitung

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INSTITUT FÜR
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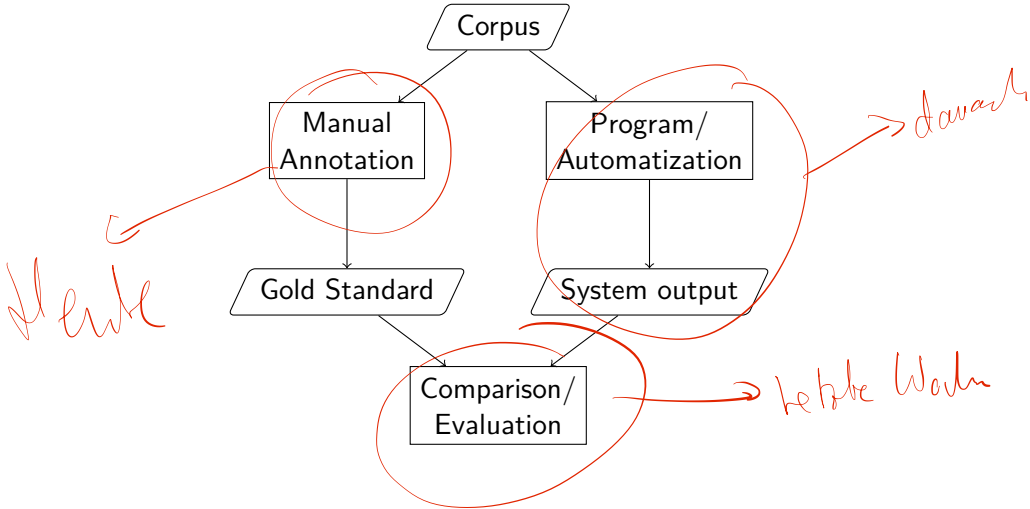
Corpus
Manual Annotation
Program/ Automatization
Gold Standard
System output
Comparison/ Evaluation

Section 1

Annotation

Was sind Annotationen?

Annotation bedeutet "Anmerkung", "Beifügung", "Hinzufügung". In diesem Sinn haben Annotationen bei Stichworten, Begriffsklärungen oder ausführlichen Texten den Charakter der Erklärung beziehungsweise Ergänzung.

WP: Annotation, Version 134526826

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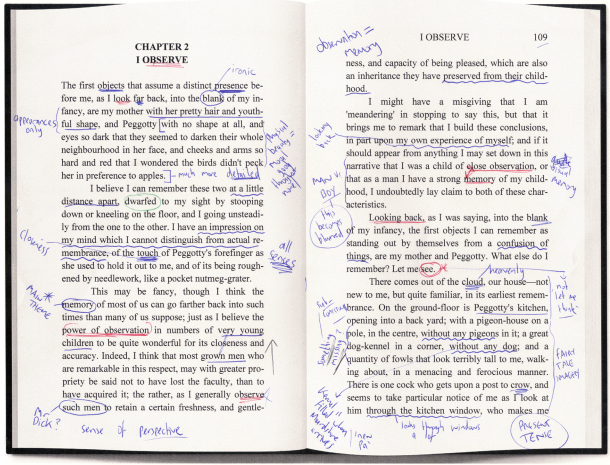

CHAPTER 2
I OBSERVE

The first objects that assume a distinct presence before me, as I look far back, into the blank of my infancy, are my mother with her pretty hair and youthful shape, and Peggotty with no shape at all, and eyes so dark that they seemed to darken their whole neighbourhood in her face, and cheeks and arms so hard and red that I wondered the birds didn't peck her in preference to apples.

I believe I can remember these two at a little distance apart, dwarfed to my sight by stooping down or kneeling on the floor, and I going unsteadily from the one to the other. I have an impression on my mind which I cannot distinguish from actual remembrance, of the touch of Peggotty's forefinger as she used to hold it out to me, and of its being roughened by needlework, like a pocket nutmeg-grater.

This may be fancy, though I think the memory of most of us can go farther back into such times than many of us suppose; just as I believe the power of observation in numbers of very young children to be quite wonderful for its closeness and accuracy. Indeed, I think that most grown men who are remarkable in this respect, may with greater propriety be said not to have lost the faculty, than to have acquired it; the rather, as I generally observe such men to retain a certain freshness, and gentle-

ness, and capacity of being pleased, which are also an inheritance they have preserved from their childhood.

I might have a misgiving that I am 'meandering' in stopping to say this, but that it brings me to remark that I build these conclusions, in part upon my own experience of myself; and if it should appear from anything I may set down in this narrative that I was a child of close observation, or that as a man I have a strong memory of my childhood, I undoubtedly lay claim to both of these characteristics.

Looking back, as I was saying, into the blank of my infancy, the first objects I can remember as standing out by themselves from a confusion of things, are my mother and Peggotty. What else do I remember? Let me see.

There comes out of the cloud, our house—not new to me, but quite familiar, in its earliest remembrance. On the ground-floor is Peggotty's kitchen, opening into a back yard; with a pigeon-house on a pole, in the centre, without any pigeons in it; a great dog-kennel in a corner, without any dog; and a quantity of fowls that look terribly tall to me, walking about, in a menacing and ferocious manner. There is one cock who gets upon a post to crow, and seems to take particular notice of me as I look at him through the kitchen window, who makes me

Figure: Handschriftliche Annotationen auf Papier

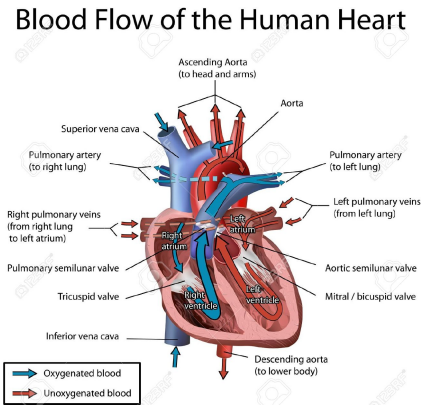

Figure: Bild-Annotationen

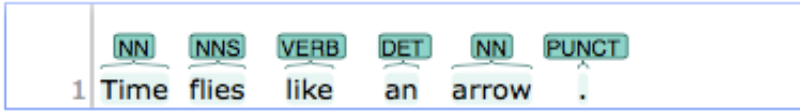

Figure: Digitale Annotationen von Parts of Speech

Background Reading

Eduard Hovy/Julia Lavid (2010). "Towards a 'Science' of Corpus Annotation: A New Methodological Challenge for Corpus Linguistics". In: *International Journal of Translation Studies* 22.1

Nils Reiter (2020). "Anleitung zur Erstellung von Annotationsrichtlinien". In: *Reflektierte Algorithmische Textanalyse. Interdisziplinäre(s) Arbeiten in der CRETA-Werkstatt*. Ed. by Nils Reiter/Axel Pichler/Jonas Kuhn. Berlin: De Gruyter, pp. 193–202. DOI: 10.1515/9783110693973-009

Empirische Validierung und Ergänzung von Theorien

Empirische Validierung und Ergänzung von Theorien

- Theorien machen Aussagen über bestimmte Kategorien
  - "In narrativen Texten variiert die Erzählgeschwindigkeit"
  - "Artikel und Nomen bilden zusammen eine Nominalphrase"
- Annotation: Anwendung der Theorie auf einen Text

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- Annotation: Anwendung der Theorie auf einen Text
- Validierung
  - Annotatorinnen können auf Kategorien hinweisen, die nicht von der Theorie abgedeckt sind
    - "Wörter können nicht annotiert werden"
  - Systematisch verwechselte Kategorien sind mglw. unklar definiert
    - The Duke was pretty last night.
    - The Duchess was entertaining last night.
    - Adjektiv oder Verb (gerund)?

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    - The Duke was pretty last night.
    - The Duchess was entertaining last night.
    - Adjektiv oder Verb (gerund)?
- Annotationen erlauben quantitative Aussagen über Kategorien
  - $x\%$ der Wörter sind Verben

Empirische Validierung und Ergänzung von Theorien

- Annotationen als Mittel zum Zweck
  - Theorien müssen adaptiert werden, um quantitativ mit ihnen zu arbeiten
  - Adaptation: Formalisierung, Einschränkung oder Generalisierung
  - Annotation kann ein Werkzeug dazu sein
    - Zwingt zur Genauigkeit
    - Erlaubt den Vergleich von verschiedenen Lesarten der Theorie
- Wortarten: Weitgehend gelöst (STTS, Penn Treebank)

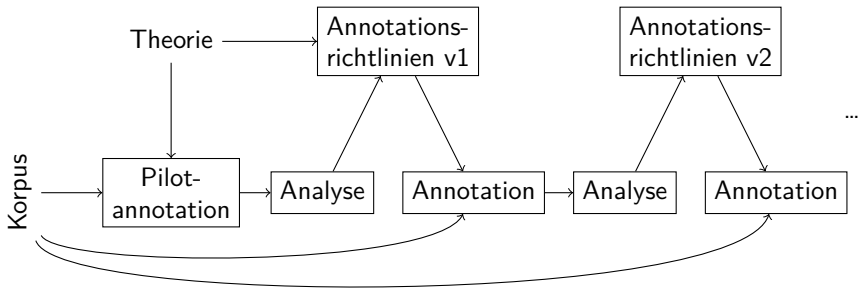
Datenerzeugung für automatische Verarbeitung

- Testdaten für automatische Verfahren
- Trainingsdaten für maschinelle Lernverfahren
  - $\rightarrow$ einsetzbar auf neuen, noch nicht annotierten Daten

Subsection 2

How to annotate

Workflow zu Annotationen



Parallele Annotationen

- Annotation der gleichen Text(stellen) durch verschiedene, unabhängige Annotatoren
- Erlaubt Gegenprobe
- Erhöht insgesamt Zuverlässigkeit der Annotationen
- Deckt Probleme mit Kategorien/Richtlinien/Definitonen auf

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Wer annotiert?

Idealerweise: Unabhängige Personen

- Hiwis
- Crowd Sourcing
- Studierende

demo

Annotationsrichtlinien

- Instanziierung der Theorie
- Objektivierung
- Annotatorinnen sollen (ausschließlich) auf Basis der Richtlinien annotieren

Stuttgart-Tübingen Tagset (STTS)

- Annotationsrichtlinien für Wortarten, die in großen Projekten verwendet wurden
- 11 Oberkategorien (Haupt-tags):
  Nomen, Verben, Artikel, Adjektive, Pronomina, Kardinalzahlen, Adverbien, Konjunktionen, Adpositionen, Interjektionen, Partikeln

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

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- Goal: High agreement
  - Based on the same guideline, different annotators should annotate the same categories
  - IAA: Metric for the quality of the annotation guidelines
    - Not: ...of the annotators

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- Manual inspection helpful, but not reliable
  - Researchers are *biased*: They have interests in a high agreement

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- Manual inspection helpful, but not reliable
  - Researchers are *biased*: They have interests in a high agreement
- Quantitative metrics: Free from personal influence

Inter-Annotator Agreement

First attempt

- Metric: Percentage agreement
- Portion of items for which annotators agree

Inter-Annotator Agreement

First attempt

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- Portion of items for which annotators agree

Example

	A1	A2
1	A	A
2	B	C
3	C	C
4	A	C
5	C	B

Inter-Annotator Agreement

First attempt

- Metric: Percentage agreement
- Portion of items for which annotators agree

Example

	A1	A2
1	A	A
2	B	C
3	C	C
4	A	C
5	C	B

- 5 instances, 2 annotators (A1, A2), 3 categories (A, B, C)
- Percentage agreement: $\frac{2}{5} = 0.2 = 20\%$

Inter-Annotator Agreement

First attempt

	A1	A2
1	A	A
2	B	C
3	C	C
4	A	C
5	C	B

- 5 instances,
  2 annotators (A1, A2),
  3 categories (A, B, C)
- Percentage agreement:
  $\frac{2}{5} = 0.2 = 20\%$

	A1	A2	A3
1	A	A	A
2	B	C	A
3	C	C	C
4	A	C	C
5	C	B	B

- 5 instances
  3 annotators (A1, A2, A3),
  3 categories (A, B, C)
- Percentage agreement:
  $\frac{2}{5} = 0.2 = 20\%$

Are they equally good?

Inter-Annotator Agreement

Data Structures

Word	A1	A2	A3
Zwei	Artikel (ART)	Artikel (ART)	Kardinalzahl (CARD)
Hunde	Nomen (NN)	Nomen (plural, NNS)	Nomen (plural, NNS)
bellen	Finites Vollverb (VVFIN)	Infinites Verb (VVINF)	Imperatives Verb (VVIMP)
.	$.	$.	$.

Inter-Annotator Agreement

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.	$.	$.	$.

⇓ conversion ⇓

Word	ART	CARD	NN	NNS	VVFIN	VVINF	VVIMP	$.
Zwei	2	1						
Hunde			1	2				
bellen					1	1	1	
.								3

Inter-Annotator Agreement

Pairs

Word	ART	CARD	NN	NNS	VVFIN	VVINF	VVIMP	$.
Zwei	2	1						
Hunde			1	2				
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- How many pairwise agreements are there?

Inter-Annotator Agreement

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- How many pairwise agreements are there?
  - $1 + 1 + 0 + 3 = 5$

Inter-Annotator Agreement

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- How many pairwise agreements are there?
  - $1 + 1 + 0 + 3 = 5$
- Why 3? binomial coefficient!

Binomial Coefficient / ‘n choose k’ / ‘n über k’

Number of sub sets with k elements from a set of n elements

$$\binom{n}{k} = \frac{n!}{k!(n-k)!}$$

Binomial Coefficient / 'n choose k' / 'n über k'

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Factorial:

$$n! = n(n-1)(n-2)(n-3)\cdots 1$$

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for $k = 2$:

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Factorial:

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for $k = 2$:

$$\binom{n}{2} = \frac{n!}{(n-2)!2!} = \frac{1}{2}\frac{n!}{(n-2)!}$$

Binomial Coefficient / 'n choose k' / 'n über k'

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$$\binom{n}{k} = \frac{n!}{k!(n-k)!}$$

Factorial:

$$n! = n(n-1)(n-2)(n-3)\cdots 1$$

for $k = 2$:

$$\begin{aligned}\binom{n}{2} &= \frac{n!}{(n-2)!2!} = \frac{1}{2}\frac{n!}{(n-2)!} \\ &= \frac{1}{2}\frac{n(n-1)(n-2)(n-3)\cdots 1}{(n-2)(n-3)\cdots 1}\end{aligned}$$

Binomial Coefficient / 'n choose k' / 'n über k'

Number of sub sets with k elements from a set of n elements

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Factorial:

$$n! = n(n-1)(n-2)(n-3)\cdots 1$$

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$$\begin{aligned}\binom{n}{2} &= \frac{n!}{(n-2)!2!} = \frac{1}{2}\frac{n!}{(n-2)!} \\ &= \frac{1}{2}\frac{n(n-1)(n-2)(n-3)\cdots 1}{(n-2)(n-3)\cdots 1} \\ &= \frac{1}{2}n(n-1)\end{aligned}$$

Inter-Annotator Agreement

Problems

Situation 1:

Word	A	B	C	D
1	2	1		
2			1	2
3	1	1		1
4	3			

- 3 annotators (=n)
- 5 pairwise agreements

Inter-Annotator Agreement

Problems

Situation 1:

Word	A	B	C	D
1	2	1		
2			1	2
3	1	1		1
4	3			

- 3 annotators (=n)
- 5 pairwise agreements

Situation 2:

Word	A	B	C	D
1	2	1	1	
2		1	1	2
3	1	1	1	1
4	3	1		

- 4 annotators (=n)
- 5 pairwise agreements

Inter-Annotator Agreement

Problems

Situation 1:

Word	A	B	C	D
1	2	1		
2			1	2
3	1	1		1
4	3			

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Situation 2:

Word	A	B	C	D
1	2	1	1	
2		1	1	2
3	1	1	1	1
4	3	1		

- 4 annotators (=n)
- 5 pairwise agreements

How much worse is Situation 2 compared to 1?
$\rightarrow$ Scaling!

Inter-Annotator Agreement

Scaling

- Sometimes, values have different scales
  - i.e., different min and max values
- Scaling: Apply a function to values so that they are comparable
  - Simplest way: Divide by the (theoretical) maximum

Inter-Annotator Agreement

Scaling

- Sometimes, values have different scales
  - i.e., different min and max values
- Scaling: Apply a function to values so that they are comparable
  - Simplest way: Divide by the (theoretical) maximum
- What's the theoretical maximum here?
  - If all annotators agree: $\binom{n}{2} = \frac{1}{2}n(n-1)$ (on a single item)

Inter-Annotator Agreement

Situation 1:

Word	A	B	C	D
1	2	1		
2			1	2
3	1	1		1
4	3			

- 3 annotators (=n)
- 5 pairwise agreements
- Scaled: $\frac{5}{4\binom{3}{2}} = \frac{5}{4\times 3} = \frac{5}{12} = 0.416$

Situation 2:

Word	A	B	C	D
1	2	1	1	
2		1	1	2
3	1	1	1	1
4	3	1		

- 4 annotators (=n)
- 5 pairwise agreements
- Scaled: $\frac{5}{4\binom{4}{2}} = \frac{5}{4\times 6} = \frac{5}{24} = 0.208$

Inter-Annotator Agreement

Observed Agreement

Word	A	B	C	D
1	2	1		
2			1	2
3	1	1		1
4	3			

$N = 4, k = 4, n = 3$

Normalized observed agreement for item i

Problem: k categories, n annotators, N items

Inter-Annotator Agreement

Observed Agreement

Word	A	B	C	D
1	2	1		
2			1	2
3	1	1		1
4	3			

$N = 4, k = 4, n = 3$

Normalized observed agreement for item i

Problem: k categories, n annotators, N items

$$\underbrace{\sum_{j=1}^{k} n_{i,j}(n_{i,j} - 1)}_{\text{abs. pairwise agr. for item } i}$$

Inter-Annotator Agreement

Observed Agreement

Word	A	B	C	D
1	2	1		
2			1	2
3	1	1		1
4	3			

$N = 4, k = 4, n = 3$

Normalized observed agreement for item i

Problem: k categories, n annotators, N items

$$\underbrace{\frac{1}{n(n-1)}}_{\text{scaling for annotators}} \times \underbrace{\sum_{j=1}^{k} n_{i,j}(n_{i,j}-1)}_{\text{abs. pairwise agr. for item } i}$$

Inter-Annotator Agreement

Observed Agreement

Word	A	B	C	D
1	2	1		
2			1	2
3	1	1		1
4	3			

$N = 4, k = 4, n = 3$

Normalized observed agreement for item i

Problem: k categories, n annotators, N items

$$O_i = \underbrace{\frac{1}{n(n-1)}}_{\text{scaling for annotators}} \times \underbrace{\sum_{j=1}^{k} n_{i,j}(n_{i,j}-1)}_{\text{abs. pairwise agr. for item } i}$$

Inter-Annotator Agreement

Observed Agreement

Word	A	B	C	D
1	2	1		
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3	1	1		1
4	3			

$N = 4, k = 4, n = 3$

Normalized observed agreement for item i

Problem: k categories, n annotators, N items

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Normalized observed agreement for all items

$$O = \frac{1}{N}\sum_{i=1}^{N} \hat{P}_i \qquad \text{(arithmetic mean / average)}$$

Inter-Annotator Agreement

Expected Agreement

Situation 1:

Word	A	B	C	D
1	2	1		
2			1	2
3	1	1		1
4	3			

- $n = 3$ annotators
- $k = 4$ categories
- 5 pairwise agreements

Situation 2:

Word	A	B	C
1	2	1	
2	2		1
3	1	1	1
4	3		

- $n = 3$ annotators
- $k = 3$ categories
- 5 pairwise agreements

What situation had the better agreement? How much better?

Inter-Annotator Agreement

Expected Agreement

Situation 1:

Word	A	B	C	D
1	2	1		
2			1	2
3	1	1		1
4	3			

Situation 2:

Word	A	B	C
1	2	1	
2	2		1
3	1	1	1
4	3		

- $p(\text{"selecting category A"}) = \frac{\text{Number of positive events}}{\text{Number of possible events}} = \frac{\text{How often was category A selected?}}{\text{How many decisions were made / How often could it have been selected?}}$

Inter-Annotator Agreement

Expected Agreement

Situation 1:

Word	A	B	C	D
1	2	1		
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Situation 2:

Word	A	B	C
1	2	1	
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- $p(\text{"selecting category A"}) = \frac{\text{Number of positive events}}{\text{Number of possible events}} = \frac{\text{How often was category A selected?}}{\text{How many decisions were made / How often could it have been selected?}}$
- $p(\text{"selecting category A"}) =$
  - Situation 1: $\frac{6}{12}$
  - Situation 2: $\frac{8}{12}$

Inter-Annotator Agreement

Expected Agreement

- Probability that category j gets selected (by one annotator)

$$\underbrace{\sum_{i=1}^{N} n_{i,j}}_{\text{positive events (= annotations with cat. } j\text{)}}$$

Inter-Annotator Agreement

Expected Agreement

- Probability that category j gets selected (by one annotator)

$$\underbrace{\frac{1}{nN}}_{\text{Possible events (all annotations)}} \times \underbrace{\sum_{i=1}^{N} n_{i,j}}_{\text{positive events } (= \text{ annotations with cat. } j)}$$

Inter-Annotator Agreement

Expected Agreement

- Probability that category j gets selected (by one annotator)

$$p_j = \underbrace{\frac{1}{nN}}_{\text{Possible events (all annotations)}} \times \underbrace{\sum_{i=1}^{N} n_{i,j}}_{\text{positive events (= annotations with cat. } j\text{)}}$$

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- Probability that two annotators select category j

$$p_j \times p_j = p_j^2$$

Inter-Annotator Agreement

Expected Agreement

- Probability that category j gets selected (by one annotator)

$$p_j = \underbrace{\frac{1}{nN}}_{\text{Possible events (all annotations)}} \times \underbrace{\sum_{i=1}^{N} n_{i,j}}_{\text{positive events (= annotations with cat. } j\text{)}}$$

- Probability that two annotators select category j

$$p_j \times p_j = p_j^2$$

- Probability that two annotators are in agreement (over all categories):

$$E = \sum_{j=1}^{k} p_j^2$$

Inter-Annotator Agreement

Expected and Observed Agreement

- Expected agreement
  - What level of agreement do we get by chance?
  - Statements about categories – calculated over columns
- Observed agreement
  - What level of agreement did we actually get?
  - Statements about items – calculated over rows

Inter-Annotator Agreement

Expected and Observed Agreement

- Expected agreement
  - What level of agreement do we get by chance?
  - Statements about categories – calculated over columns
- Observed agreement
  - What level of agreement did we actually get?
  - Statements about items – calculated over rows
- We are interested in the agreement *above chance*

Fleiss' Kappa (Fleiss, 1971)

p_j	Probability for j
O_i	Observed agreement for i

Fleiss' Kappa (Fleiss, 1971)

p_j Probability for j

O_i Observed agreement for i

$$O = \frac{1}{N}\sum_{i=1}^{N} O_i$$

Fleiss' Kappa (Fleiss, 1971)

p_j Probability for j

O_i Observed agreement for i

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- $O - E$: Tatsächlich erreichtes, nicht-zufälliges Agreement
- $1 - E$: Maximal erreichbares, nicht-zufälliges Agreement

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- $1 - E$: Maximal erreichbares, nicht-zufälliges Agreement
- $-\infty < \kappa < 1$: Je höher desto besser
  - Extremfälle?

Section 2

Annotation in Practice

Practical Annotation Work

- Crowd sourcing via Amazon mechanical turk, crowdflower, prolific, ...
  - Pay random people on the internet

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- Inception
  - Most feature-rich web-based annotation tool
  - Developed at TU Darmstadt
  - Useable for all kinds of annotation projects (span, link, entity repository, ...)