Connecting the Dots: NLP support for Analyzing Arguments, Evidence and Translations in the Humanities

Acknowledgements to Dr. Johannes Daxenberger and Chris Stahlhut, M.Sc. for the slides

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1. Knowledge-Based Search: Retrieving Translations

2. Information Retrieval and Classification: Arguments

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How to Computationally Approach Extinct Languages: A Case Study on Hittite

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- BMBF-funded "**Ce**ntre for the **Di**gital **Fo**undation of **R**esearch in the Humanities, Social, and Educational Sciences"
- Coordination: TU Darmstadt (Iryna Gurevych), partners: Goethe-Universität Frankfurt a.M. and Leibniz Institute DIPF Frankfurt a.M.
- CEDIFOR intends to contribute to bridging the gap between research in the humanities and computer based methods, and help researchers to master the characteristic problems in this process

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Parts of this work are accepted to be published at the DHd conference 2017:

Daxenberger, J., Görke, S., Siahdohoni, D., Gurevych, I., & Prechel, D. (2017). Semantische Suche in Ausgestorbenen Sprachen: Eine Fallstudie für das Hethitische. In Proceedings of the DHd 2017 (p. to appear).

CEDIFOR Pilot Project: Building a Framework for Semantic Search on Cuneiform Scripts

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- **Goal:** Make the translations of Hittite cuneiform documents more accessible by adding an additional layer of information
- **Methods:** Lexical-semantic methods based on Natural Language Processing technology for a deeper exploration of the documents

- *Cooperation with Prof. Doris Prechel and Susanne Görke, Altorientalische Philologie, Johannes Gutenberg-Universität Mainz*

JOHANNES GUTENBERG UNIVERSITÄT MAINZ JG|U

The Cuneiform Script

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- Cuneiform Script (4 cent. BC) is documented on clay tablets only
- Well-Documented Cuneiform Languages include
  - Akkadian (Semitic)
  - Sumerian (Isolated)
  - Hittite (Indo-European)

Digitizing Cuneiform Clay Tablets...

7	--	[... GÙ]B-laza [...]
7	A	Vs. II 6' [... GÙ]B-la-za (Rasur) Vs. II 7' [...]
8	--	[... Ḫ]I.A adanna [...]
8	A	Vs. II 7' [... Ḫ]I.A a-da-an-na Vs. II 8' [...]
9	--	[nu=tta DUGKA.G]AG gulšantan [...]
9	A	Vs. II 8' [... DUGKA.G]AG gul-ša-an-ta-an Vs. II 9' [...]
10	--	[... walh]it? [...]
10	A	Vs. II 9' [... wa-al-h]i?-it Vs. II 10' [...]

Digitizing Cuneiform Clay Tablets...

7	--	[... li]nks [...]
8	--	[...] zu Essen [...]
9	--	[... dir] den eingeritzten [Bech]er [...]
10	--	[...] mit [walḫ]i-Getränk$^{?}$ [...]
11	--	Ich ließ [...]
12	--	[Iss Erstklassiges]
13	--	[und] stille deinen Hunger!
14	--	[Trink Erstklassiges]
15	--	[und] stille deinen Durst!
16	--	[...]
17	--	[Der Bedrü]kte aber [...]
18		[...] komm [wieder] in Ordnung!

Motivation: Accessing the Content of Digitized Cuneiform Documents

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- Digitalization and Accessibility are highly desirable goals
- Currently no means to automatically process the transliterations
- But we can work with the translations (which are a bit special...)

- **Semantic Search**
  - Assume we have only a rough idea of what we want to search/find, e.g. a king, a god or a city
  - There are plenty of named entities in the document falling into these categories

- **Primary requirements for the search engine**
  - Return both exact matches as well as results motivated by semantic relatedness
  - Intuitive usage by non-experts

Current Data

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- Original documents: Hittite and Akkadian
  - about 700 documents and growing…
  - approx. 400.000 translated words
- Translations in German, Italian, French, and English
- Content: rituals, myths, state treaties, prayers
- Parallel Text: Transliterations and Translations
  - Mapping on the level of meaning units
- Title and introductory comments for each document

Particularities of the Data

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- Comments: in-line annotations and footnotes
- Mixed dialects/languages
- Normalized translations vs. text evidences
- Language experts/translators have diverging conventions (e.g. meaning of special characters)
- Damaged and thus fragmentary text (to the extent of illegibleness of entire documents)

Indexing: Technologies

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- DKPro Core/UIMA as convenient NLP processing framework
  - Reader recognizes document structure and parallel translation/transliterations (e.g. footnotes)
  - Tokenizer: OpenNLP and Language Tool
  - Fixing token boundaries due to fragmentary text
  - POS-tagging: OpenNLP
  - Lemmatizing: MateTool, LanguageTool
  - Word Sense Disambiguation: DKPro WSD/Lesk
  - Semantic Preprocessing: Uby
  - Writer: MySQL writer (12 tables)

https://dkpro.github.io/

Indexing: Semantic Preprocessing

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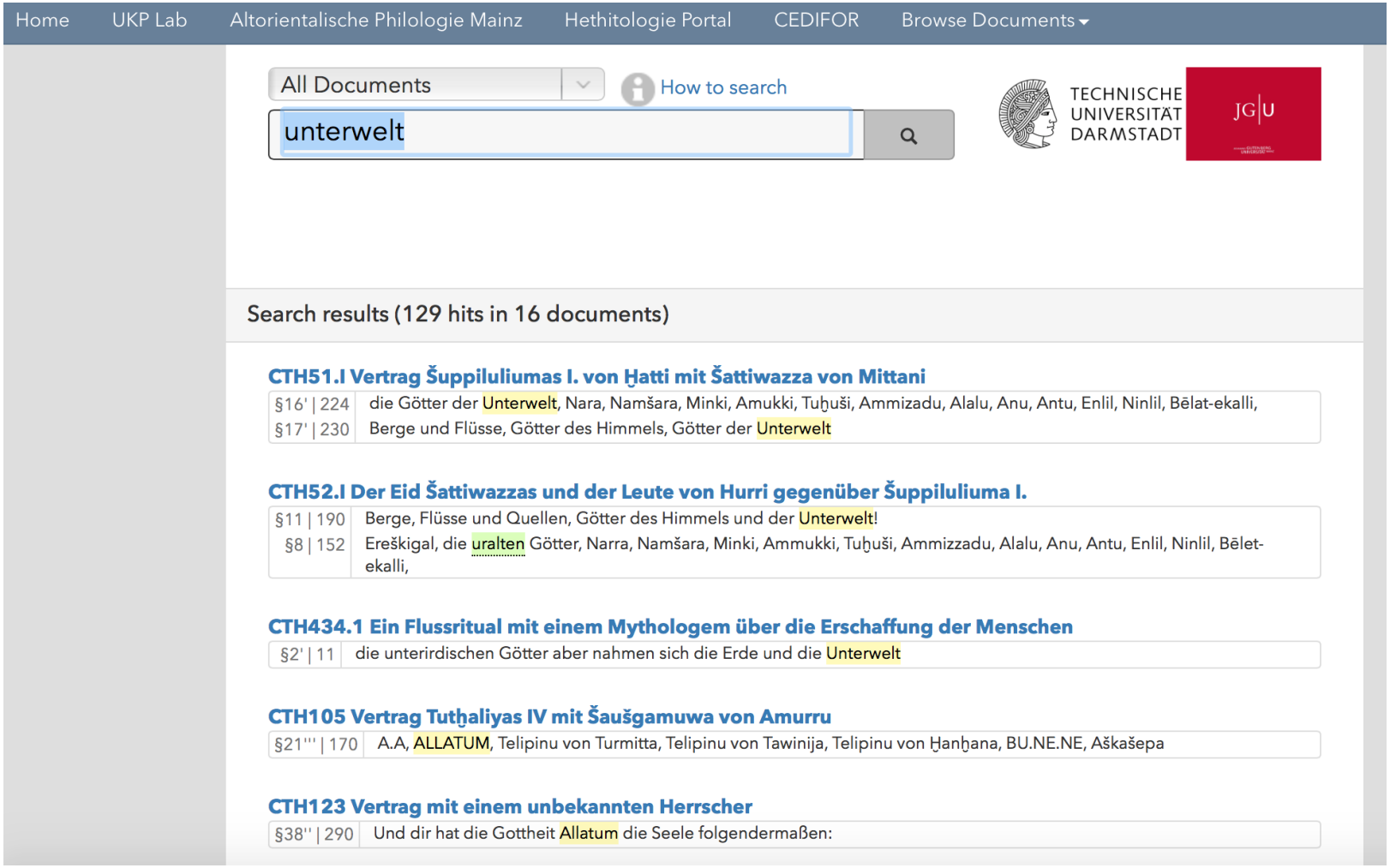
- Uby (combines sense information from WordNet, FrameNet, VerbNet, Wiktionary, Wikipedia and others)
  - **Semantic Labels**
    - Semantic Field (e.g. person)
    - Category (e.g. fruit)
    - Domain (e.g. sports)
  - **Synonyms**

- **Custom Dictionaries** (extensible)
  - Alternative Spellings
    - e.g. *Ḫattuša, Hattusa, Hattuscha, Hattuşaş, Hattusha, Hatusha, ...*
  - Hypernyms
    - e.g. *Herrscher, Großkönig, König : Pitḫana, Anitta, Labarna, Ḫattušili, ...*

https://dkpro.github.io/dkpro-uby/

Query Interface



Computationally Approaching Extinct Languages: Lessons Learned

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- Typical issues when computationally approaching extinct languages:
  - **Small data** (not just small training data)
  - **Non-standard vocabulary** (translations)
  - **Fragmentary** text

- Some solutions
  - Implement **language-independent**, broad approaches
  - any available **meta-information** (commentaries, footnotes, etc.) should be used
  - Use **NLP machinery off-the-shelf** a far as possible, add custom solutions where required

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Argument Retrieval and Classification

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Topic

Autonomous trucks

PRO: The use of such technology will reduce fatal truck and bus accidents by 20 per cent, resulting in 800 less deaths on European roads.
http://www.theautochannel.com

CON: These components are still expensive today; for example, the 600-rpm spinning light-imaging radar system that crowns most current autonomous vehicles costs upward of $70,000.
http://www.strategy-business.com

Search Engine: Retrieval and Classification

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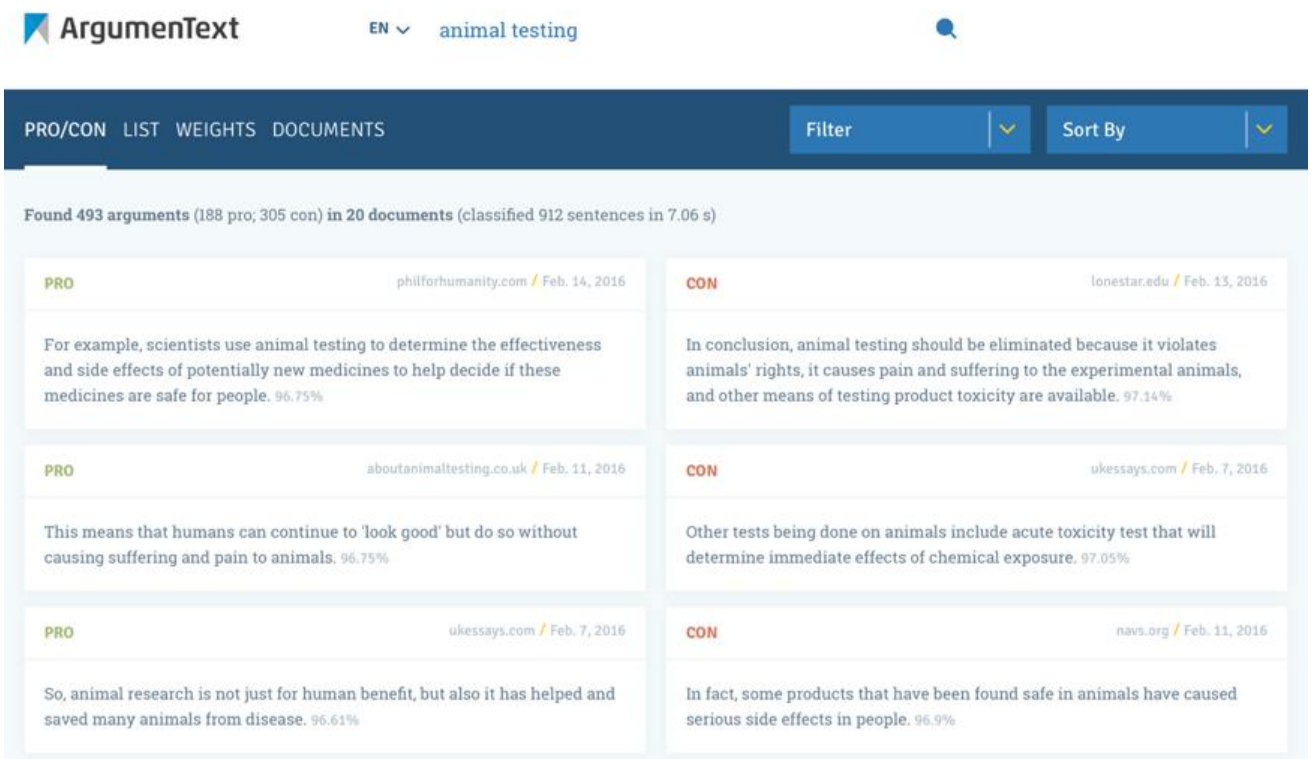

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Challenges in the Web Scenario

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Heterogeneity	Scalability	Robustness
Multiple text types	Small training resources	Specific domains
Different languages	Expert annotations	Various applications

Training Data Generation

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Data

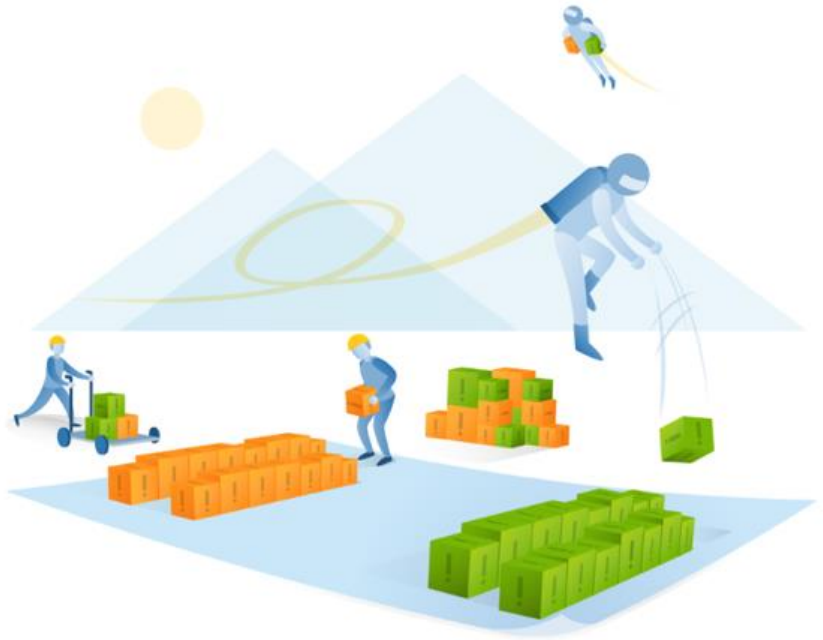
- Heterogeneous text types
- Collected from web searches
- 100+ topics

Task

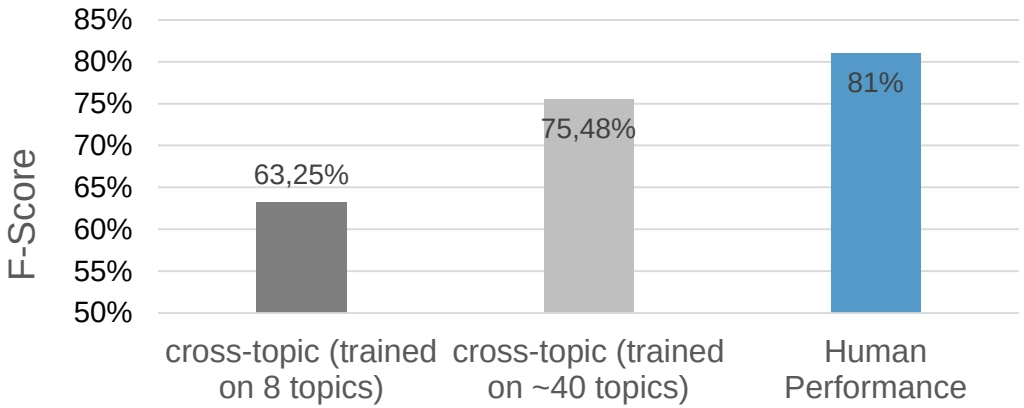
- Given a (controversial) topic
- Label text as pro or con argument

Crowdsourcing

- Amazon Mechanical Turk



Results (BERT): Stance + Argument Detection



Reimers, N., Schiller, B., Beck, T., Daxenberger, J., et al. (2019)

- 3-class problem: pro, con, non-argument
- Approx. 5pp improvement over BiLSTM

Visualizing Argument Clusters

Topic: Abortion

- cluster167: *Fetuses are incapable of feeling pain when most abortions are performed.*
- cluster63: *Abortion is the killing of a human being, which defies the word of God.*
- cluster91: *Allowing abortion conflicts with the unalienable right to life recognized by the Founding Fathers of the United States.*

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Interactive Evidence Detection for Historical Research

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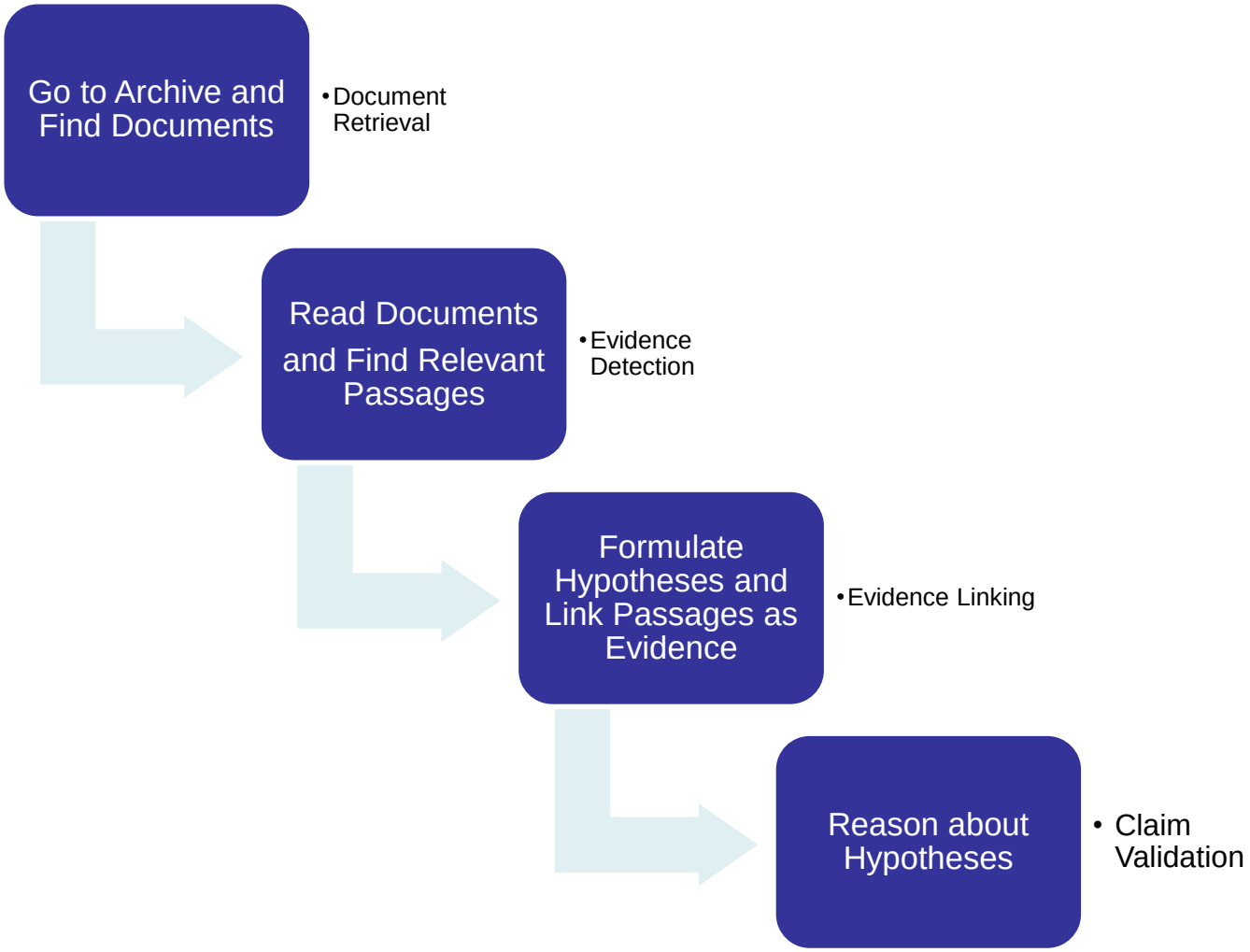
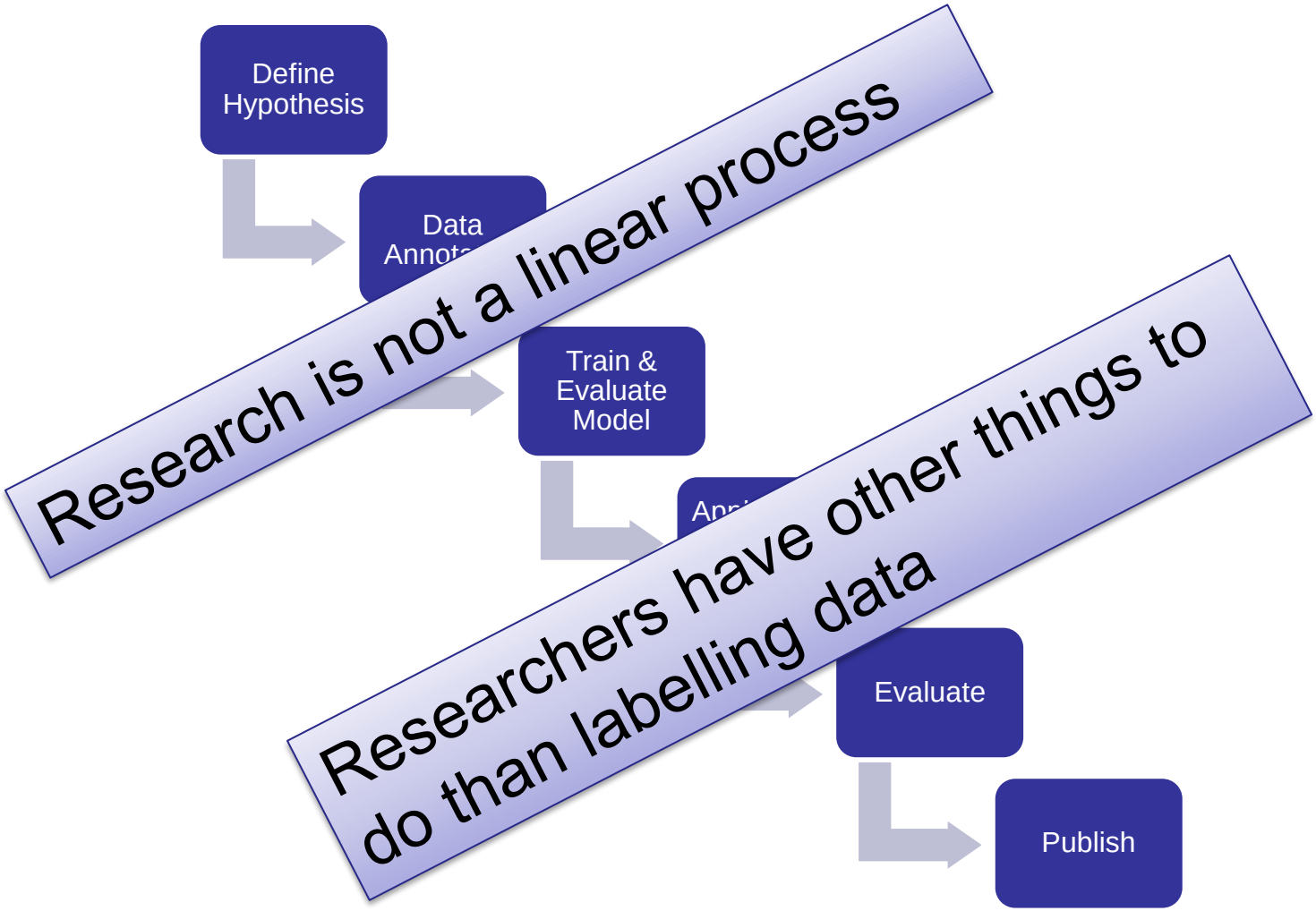
- Historians spend a vast amount of time reading to find the piece of evidence they can use to (in)validate a hypothesis

- **Our goal:** given a research hypothesis, automatically detect and link evidence

IR and Classification as a Viable Solution?



IR and Classification as a Viable Solution?



How do researchers in the humanities and social sciences actually work?

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- Conducted a user study in a student seminar on the topic of *Environmental catastrophes in the second half of the 20th century*
- 24 students participating
- Students were asked to *Compare the political discourse after the Chernobyl and Fukushima catastrophes*
- To formulate hypotheses and (in)validate them with evidence found in the provided text
- Text sources were 9 speeches from the German parliament
  - 4 from 1986
  - 3 them 2011

- We logged and analysed their behaviour

EDoHa: Evidence Detection fOr Hypothesis vAlidation

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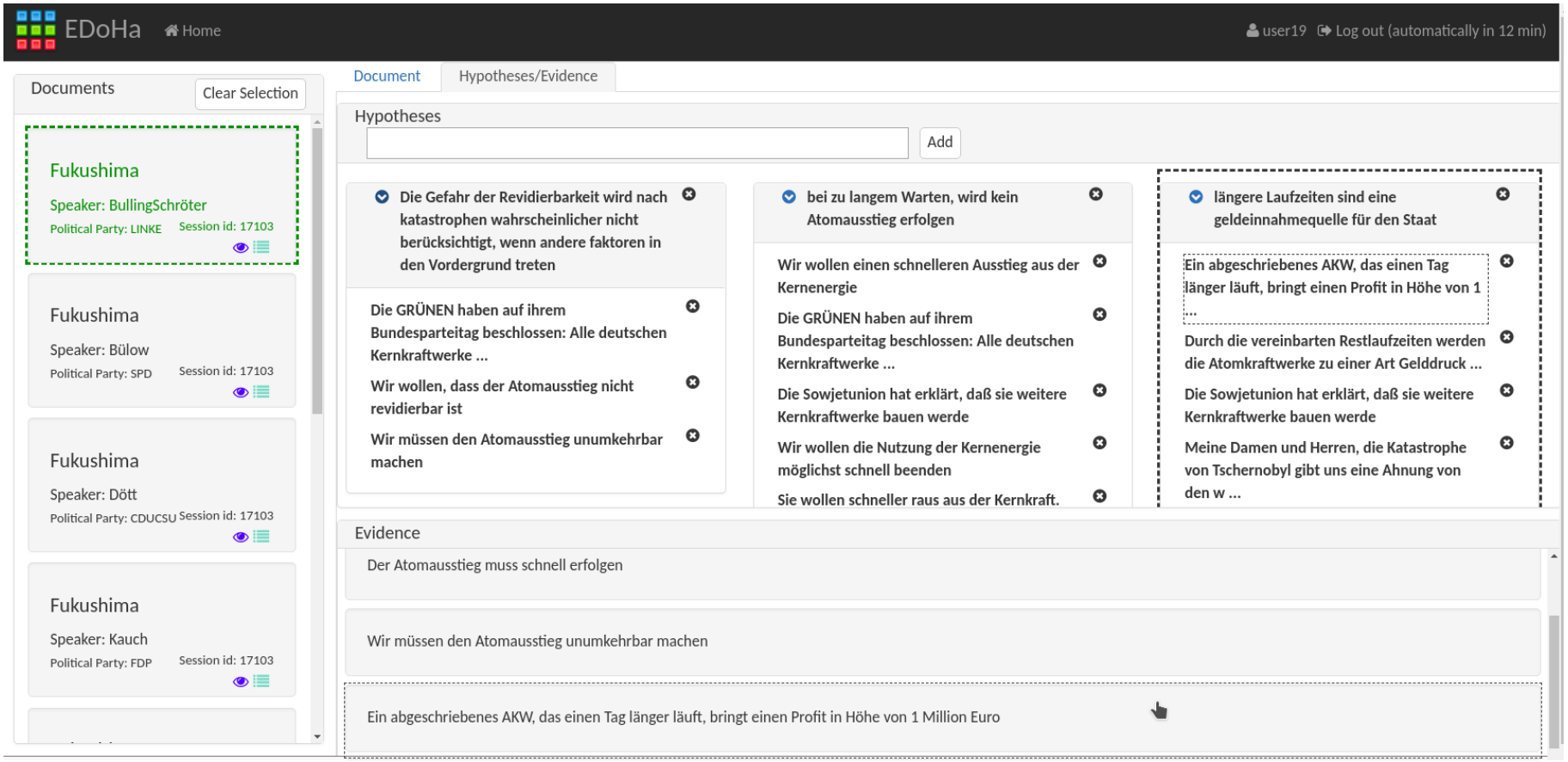

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Findings

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- No uniform approach to evidence detection and linking
  - Some users work in different phases of *evidence detection* and *hypothesis validation*, other do not
  - Some users validated multiple hypotheses at the same time, while others validated only one hypothesis at a time.
- No agreement on evidence for similar hypotheses
- Hypotheses with similar evidence show no similarity

  - **-> Solution:** Interactively trained machine learning models

The interactively trained models out-perform BERT in recall

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	Macro values across both classes			Evidence only		
	F1	Precision	Recall	F1	Precision	Recall
			ED-ACL-2014			
$\text{bilstm}_{\text{direct}}$	0.509 (0.033)	0.514 (0.028)	0.526 (0.039)	0.117 (0.058)	0.091 (0.055)	0.183 (0.053)
$\text{bilstm}_{\text{fine}}$	0.481 (0.043)	0.518 (0.018)	**0.553 (0.047)**	**0.139 (0.064)**	0.088 (0.045)	**0.373 (0.118)**
BERT	**0.540 (0.052)**	**0.590 (0.055)**	0.538 (0.048)	0.118 (0.098)	**0.238 (0.105)**	0.094 (0.096)
			ED-EMNLP-2015			
$\text{bilstm}_{\text{direct}}$	**0.572 (0.062)**	0.566 (0.050)	0.613 (0.075)	**0.225 (0.133)**	0.176 (0.114)	0.340 (0.160)
$\text{bilstm}_{\text{fine}}$	0.544 (0.063)	0.553 (0.046)	**0.631 (0.089)**	0.212 (0.132)	0.145 (0.101)	**0.453 (0.212)**
BERT	0.550 (0.060)	**0.596 (0.084)**	0.558 (0.081)	0.143 (0.118)	**0.251 (0.169)**	0.143 (0.171)

Especially when computational resources are scarce, it is better to use small amounts of in-domain data to train a model:

BERT requires a GPU <-> A bilstm can be trained on a laptop

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Thank you!

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