

The background of the slide is a complex, abstract geometric pattern composed of numerous overlapping triangles. The color palette is primarily purple, ranging from light lavender to deep, dark indigo. There are also some greenish-yellow triangles scattered throughout, particularly in the upper left quadrant. The overall effect is a textured, low-poly aesthetic.

Data Science for Digital Humanities 2

1. Course Introduction

Prof. Dr. Goran Glavaš
Lennart Keller

April 25, 2024

Course Title

- Data Science?
- Digital Humanities?

Data Science: Definitions

Interdisciplinary field that uses scientific methods, processes, algorithms and systems to extract or extrapolate knowledge and insights from noisy, structured and unstructured data, and apply knowledge from data across a broad range of **application domains**.

Wikipedia

The use of scientific methods to obtain useful information from (large amounts of) computer data.

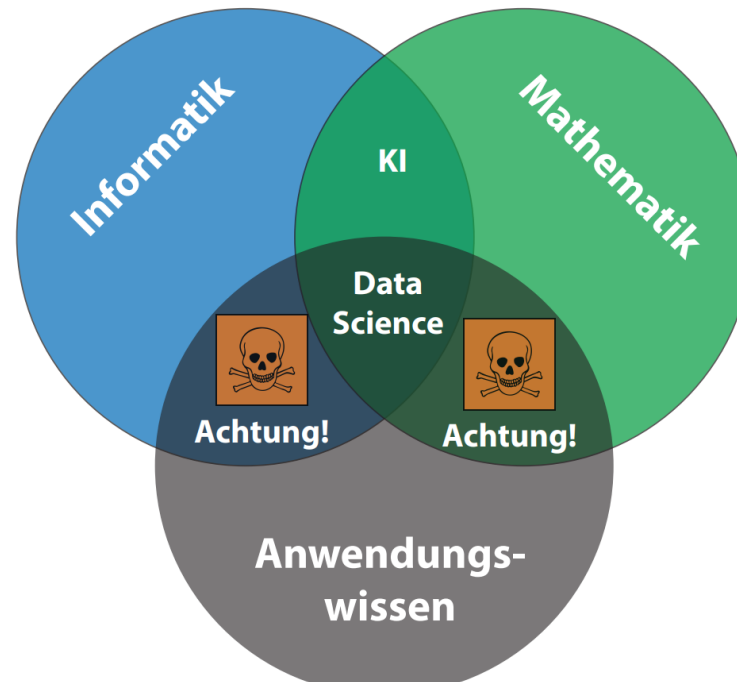
Cambridge dictionary

A field that deals with **advanced data analytics** and modeling, using mathematics, statistics, programming, and machine learning to **extract valuable, often predictive information** from large data sets.

Dictionary.com

Data Science

- **Data science = AI methods + data from an application area**
 - Yields **insights/knowledge/information** in the application area



Artificial Intelligence?

Theory and development of computer systems able to perform tasks normally requiring human intelligence, such as visual perception, speech recognition, decision-making, and translation between languages.

Oxford dictionary

Intelligence demonstrated by machines, as opposed to the natural intelligence displayed by animals and humans.

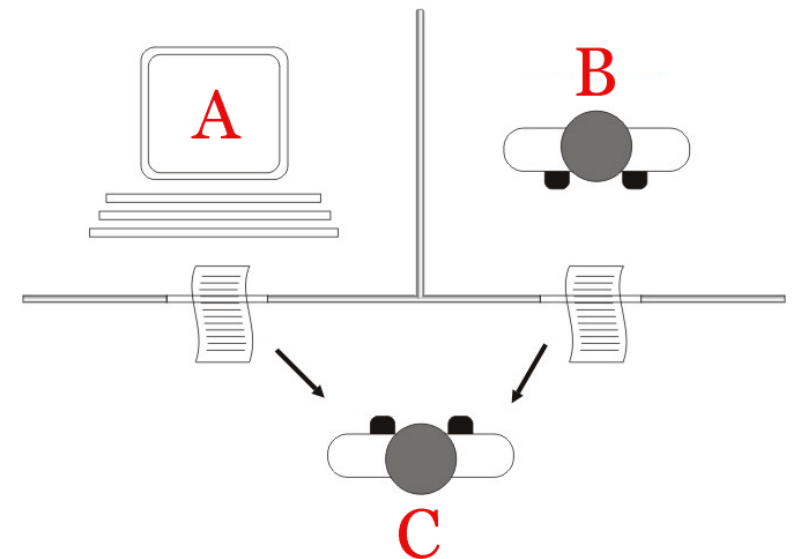
Wikipedia

The field of study of intelligent agents, which refers to any „rational agent” that perceives its environment and takes actions that maximize its chance of achieving its goals.

Russell & Norvig

The Turing Test

- Machine behaviour **indistinguishable** from human?
- **Turing test:** „the imitation game”
 - Natural language (text) communication
 - Can **C** successfully guess (better than chance) whether the answers come from **A** (machine) or **B** (human)?
- **Natural language communication and language understanding** one of the **main pillars of human intelligence**



The Turing Test: Google LaMDA

Google fires researcher who claimed LaMDA AI was sentient

Why LaMDA Is Nothing Like a Person

Is Google's LaMDA AI Truly Sentient?

Lemoine went p

emotions. It's not, be sentient.

Language models are no more sentient than your reflection in the mirror

In June 2022 the [Google LaMDA](#) (Language Model for Dialog Applications) chatbot received widespread coverage regarding claims about it having achieved sentience. Initially in an article in *The Economist* Google Research Fellow Blaise Agüera y Arcas said the chatbot had demonstrated a degree of understanding of social relationships.^[99] Several days later, Google engineer Blake Lemoine claimed in an interview with the *Washington Post* that LaMDA had achieved sentience. Lemoine had been placed on leave by Google for internal assertions to this effect. Agüera y Arcas (a Google Vice President) and Jen Gennai (head of Responsible Innovation) had investigated the claims but dismissed them.^[100] Lemoine's assertion was roundly rejected by other experts in the field, pointing out that a language model appearing to mimic human conversation does not indicate that any intelligence is present behind it,^[101] despite seeming to pass the Turing test. Widespread discussion from proponents for and against the claim that LaMDA has reached sentience has sparked discussion across social-media platforms, to include defining the meaning of sentience as well as what it means to be human.

Course Title

- Data Science?
- Digital Humanities?

~~Digital~~ Computational Humanities

Computational Social Science (Science, vol. 323, no. 6, February 2009)

"The capacity to **collect** and **analyze** massive amounts of data has transformed such fields as biology and physics. But the emergence of a **data-driven 'computational social science'** has been much slower. Leading journals in economics, sociology, and political science show little evidence of this field. But computational social science is occurring in Internet companies such as Google and Yahoo, and in government agencies such as the U.S. National Security Agency. Computational social science could become the exclusive domain of private companies and government agencies. Alternatively, there might emerge a privileged set of academic researchers presiding over private data from which they produce papers that cannot be critiqued or replicated. Neither scenario will serve the long-term public interest of accumulating, verifying, and disseminating knowledge."

- Replace „Social Science” with „**Humanities**”

~~Digital~~ Computational Humanities

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~~Digital~~ Computational Humanities

Digital Humanities

- Collecting, digitizing, and storing data from humanities disciplines
- Superficial analysis (size, frequency, ...)
- Search and navigate data collections

Computational humanities use digital tools and **computational techniques** to explore new modes of doing research in the humanities.

CH Uni Leipzig: <https://ch.uni-leipzig.de/>

- **Computational Humanities**
 - Derive **knowledge** from data

Computational Humanities Research

- <https://2024.computational-humanities-research.org/>
- The time of collecting data (digitizing, storing, sharing) is behind us
 - OCR-ing texts
 - Digitizing images
 - ...
- The time has come to **analyze large data** from humanities disciplines and **derive insights** (i.e., new **knowledge**)

CH Examples

The Riddle of Literary Quality (Huygens-ING, Fryske Akademy, Universiteit van Amsterdam)

Literary quality is one of the most fascinating issues in Literary Studies. Scholars have found that social and cultural factors play an important role in the acceptance of a work as literary or non-literary and as good or bad. In the project "The Riddle of Literary Quality" we assume, however, that formal characteristics of a text may also be of importance in calling a fictional text literary or non-literary, and good or bad – non-literary texts can also be good and literary text can also be bad. Many formal characteristics can be thought of as having a part in this, e.g. the use of difficult words, the number of adjectives and adverbs, or complex syntactic style. This project explores this assumption, integrating the analysis of low-level lexical-statistical features and high-level syntactic and narrative features. The main results that will come out of this project are:

- a list of formal characteristics and their distribution in a training corpus of differently valued Modern Dutch novels,
- an evaluation of other Modern Dutch novels based on the results of the training corpus,
- results of first experiments of the application of the same measurements on novels from another time period or language.

The first two will be described in publications, and the third will take the form of a project plan for a new research program to adapt the tools for diachronic and cross-language application, to make the method applicable to longitudinal research and to the comparison of formal characteristics of literary quality in different languages.



Application of **Natural Language Processing!**

CH Examples



Elite network shifts during regime change; a computational approach to network analysis using Indonesian language electronic newspaper archives. (KITLV, NIOD, University of Amsterdam, Bandung Institute of Technology, Erasmus University, and DANS)

Historians have composed a large body of literature on the major Indonesian regime transitions of 1945–50 and 1998 using conventional techniques. Elite circulation is a central theme in that literature. Today, new computational techniques offer the possibility of approaching the same problem in a novel way, complementing existing knowledge and acquiring new insights.

Elite Network Shifts will extract elite names and their relationships from substantial electronic archives of news media, concentrating on the transitional events of 1945 and 1998 for which data are already in our possession. For 1945, the sources consist of recently digitized national and subnational newspapers for the period 1942–1957. For 1998, they consist of newspaper articles published on the (then new) Internet between

1994 and 2010.

The project aims to analyze formation, circulation and relocation of new and old elites in times of significant political change in the Netherlands Indies and Indonesia, by means of computational exploration of a large corpus of digitized newspapers.

1. What new insight can computational analysis of contemporary newspaper accounts produce about elite network shifts?
2. What are the similarities and differences between the elite network shifts of 1945 (post-war decolonization and centralization) and 1998 (post-authoritarian decentralization)?




Application of **Natural Language Processing** and **Network Analysis!**


CH Examples

Fairness in NLP

- Measuring Biases and Debiasing NLP models

technology
science  NASA

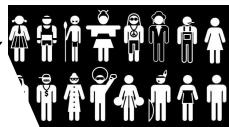
poetry  art
literature  dance

his father
man  brother
male him he

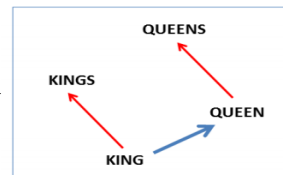
woman  mother
hers sister
female her she

$$\overline{\text{man}} - \overline{\text{woman}} \approx \overline{\text{computer programmer}} - \overline{\text{homemaker}}$$

[Bolukbasi et al., NeurIPS 16]







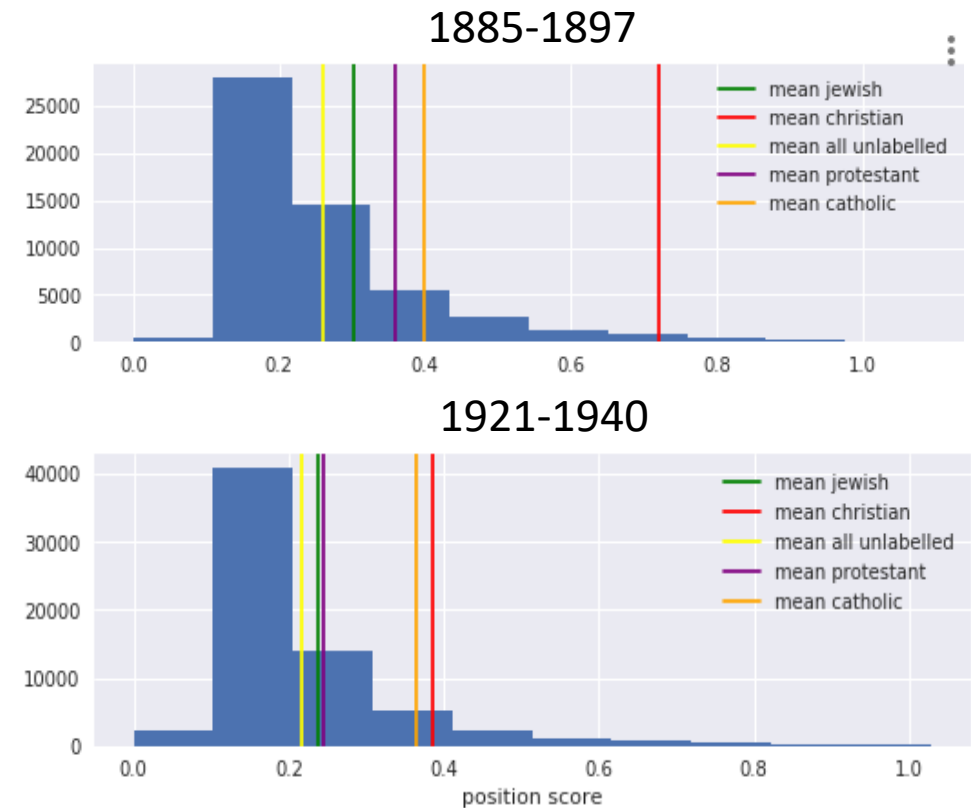
CH Examples

Application of bias measurement methodology to measure biases in **historical corpora**

Diachronic analysis of **anti-semitic** and **anti-leftist** biases in **German parliamentary speeches** (*Reichstagsprotokolle, Bundestagsprotokolle*)

(Implicit) bias specification

- Judentum terms („Rabbi“, „Jude“, ...} vs.
- Christentum terms {„Katholizismus“, „Kreuz“, ...}



Course Organization



Brought to you by: WüNLP

<https://www.informatik.uni-wuerzburg.de/nlp>

WÜNLP NEWS TEACHING RESEARCH TEAM

NATURAL LANGUAGE PROCESSING

We at the Chair for Natural Language Processing (Computer Science XII) try to make **machines understand human language!** In fact, we try to make them understand very many different human languages. We primarily focus on written text (after all, speech can always be transcribed to text). Methodologically, the work of the group focuses on **deep learning and representation learning methods for semantic modeling of natural language** (that is, precise modeling of meaning of natural language statements and text documents), with the special focus on multilingual representation learning and cross-language transfer of models for concrete NLP tasks.

Driven by deep learning advances, NLP has lately seen substantial progress, primarily due to the technical ability to (pre)train ever larger neural models on ever more text. Such progress can be exclusive as its benefits are beyond reach for most of the world's population (e.g., speakers of low-resource languages, anyone who lacks computational resources needed to train or use these models). Moreover, training ever larger language models based on complex neural architectures (for example, the popular Transformer) has a large carbon footprint and such models tend to encode a wide range of negative societal stereotypes and biases (e.g., sexism, racism). At WüNLP we specifically address these challenges and aim to **democratize state-of-the-art language technology**. To this end, we pursue three research threads that we hope will lead to **equitable, societally fair, and sustainable language technology**: (i) *sustainable, modular, and sample-efficient NLP models*, (ii) *fair and ethical (i.e., unbiased) NLP*, and (iii) *truly multilingual NLP, with special focus on low-resource languages*.

Text data is all around – besides the core methodological NLP work, we also work on **interdisciplinary projects** where we apply cutting-edge NLP methods to interesting problems from other disciplines, most prominently in the area of Computational Social Science (and so far most often in collaboration with political scientists).

Our Chair has [international prominence and visibility](#). We regularly publish our research results at the very competitive **top-tier NLP conferences** ([ACL](#), [EMNLP](#), [NAACL](#), [EACL](#)). Further, Prof. Glavaš served as an **Editor-in-Chief** for the [ACL Rolling Review](#), the centralized reviewing service of the [Association for Computational Linguistics](#). We have established numerous research collaborations, most prominently with the Language Technology Group of the University of Cambridge., CIS at LMU München, and UKP at TU Darmstadt.

News



› Three papers accepted at EMNLP 2022

WüNLP will have three papers in the Main Conference Program of Empirical Methods in Natural Language Processing, one of the most prestigious venues in



› Welcome Fabian David Schmidt!

Fabian David Schmidt will join WüNLP from July!
› Mehr



› Two papers accepted for NAACL 2022

WüNLP will have two papers in the Main Conference Program of the Conference of the North-American Chapter of the Association for Computational



What Was Covered in DS4DH1?

- L1: Introduction to DS4DH
 - Basics of Python
 - Basic data types and data structures, conditions, loops, ...
- L2: (Re-)introduction to Python
 - Functions, list expressions, Object-oriented programming
- L3: Data modeling
 - Working with vectors and matrices in Numpy

What Was Covered in DS4DH1?

- **L4: Data Acquisition and Preparation**
 - Data loading and manipulation with **Pandas**
 - Data cleaning and preprocessing
 - Web scraping
- **L5: Descriptive Data Analysis and Visualization**
 - Descriptive Statistics (Uni-, Bi-, and Multivariate data analysis)
 - Data visualization with **Seaborn**
- **L6: Clustering (and Distance functions)**
 - Vector Space Model representations (of text)
 - Distance and similarity measures (between vectors)
 - K-Means, DBScan, Hierarchical agglomerative clustering (with **Scikit-Learn**)

What Was Covered in DS4DH1?

- **L7: Predictive Analysis – Gentle Introduction to Machine Learning**
 - Supervised Machine Learning – Classification with **Scikit-Learn**
 - Text Preprocessing and classification with Logistic Regression
 - Image classification with SVM
- **L8: Basics of Computational Linguistics / NLP**
 - Distributional Semantics: Latent Semantic Analysis, Word Embeddings
 - Syntactic Analysis: Part-of-Speech Tagging and Parsing
 - Named Entity Recognition

DS4DH2

- Having taken DS4DH1 **helps**, but not necessary for DS4DH2
 - We aim to make lectures/sessions self-contained
 - Still, basics of Python (covered in **DS4DH1**) needed
(If needed, we can make a recap session for **Intro to Python**)
- Topics in **DS4DH2** are not more complex than those from **DS4DH1**
 - In that sense, DS4DH2 is not „advanced” compared to DS4DH1
 - DS4DH2 just covers complementary topics, not covered in DS4DH1

DS4DH2: Topics & Organization

- More **practical work** for the students compared to DS4DH1
- S1: Introduction and Recap of DS4DH1
- S2: Corpus Linguistics
 - Lexical association measures
 - Multi-word expressions, collocations, idioms
 - Lexico-semantic resources: WordNet, BabelNet, PanLex

DS4DH2: Topics & Organization

- S3: Topic Modeling
 - Latent Dirichlet Allocation w. **Gensim**
 - Interpreting topic mixtures
 - **Homework/Individual project #1**
- S4: Network Analysis
 - Introduction to networks and graph theory w. **NetworkX**
 - Node importance – degree, closeness, and betweenness centrality
 - Shortest paths, Partitioning, PageRank, ...
- S5: Student Project Presentations (**Topic Modeling**)

DS4DH2: Topics & Organization

- S6: Statistical Testing and Evaluation
 - Common evaluation measures for classification and regression
 - Data Annotation and inter-annotator agreement
 - Significance testing of results (parametric vs. non-parametric testing)
- S7: Deep Learning (w. **Keras**)
 - Convolutional and Recurrent Neural Networks
 - Attention Mechanism and Transformers/Large Language Models
 - **Homework/Individual project #2**

DS4DH2: Topics & Organization

- S8: Interpretability and Fairness
 - Explainability and Interpretability in AI
 - Fairness: Biases and Debiasing
- S9: Student Project Presentations (Deep Learning & Evaluation)
- S10: Wrap up

Content (planned!)



**Plans are useless, but
planning is essential.**

Dwight D. Eisenhower

Practical parts

- Tutoriums and homeworks
- In Jupyter/Python Notebooks
 - Interactive execution of Python code
- In principle no need to install anything on your computer!!!
 - **Google Collaboratory (Colab)**
(files on Google Drive)



Examination and Grading

- **Practical Examination – grading based on projects**
 - First homework/project (**Topic Modeling**): 25%
 - Second homework/project (**Deep Learning & Evaluation**): 25%
 - Final project: 50%
- **Final project**
 - Homework projects focus on one narrow topic
 - **Final project**: a task combining multiple topics
 - Detailed description in **last regular session**
 - No presentation – you need to submit **a report** (in the format of a research paper, 6-8 pages long without references)
 - Submission deadline: **as late as possible** (a week or two before the deadline for registering grades); in any case should not be earlier than late August

How hard is this going to be?

- DS4DH 2 is formally a DH “Seminar” type of course
 - But more practical (and perhaps **more practically useful!**) than some other
- **5 ECTS = 125 to 150 hours** of work
 - Ca. 25 hours go to joint sessions (lectures + tutoriums)
 - That still leaves **75-100 hours** of **self-study**

All It Takes is Dedication and Effort!



Questions?

