FROM DATA TO DECISION
– HARNESSING AI AND LANGUAGE MODELS FOR REAL-WORLD APPLICATIONS

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Center for Humanities Computing, Aarhus University

OUTLINE

1. **whoami**
2. **Langauge Models**
   - LLMs - a short history
3. **Applications**
   - Issues
   - Danish foundation models
4. **Summary**

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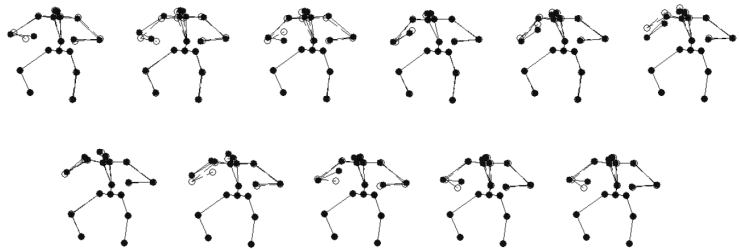
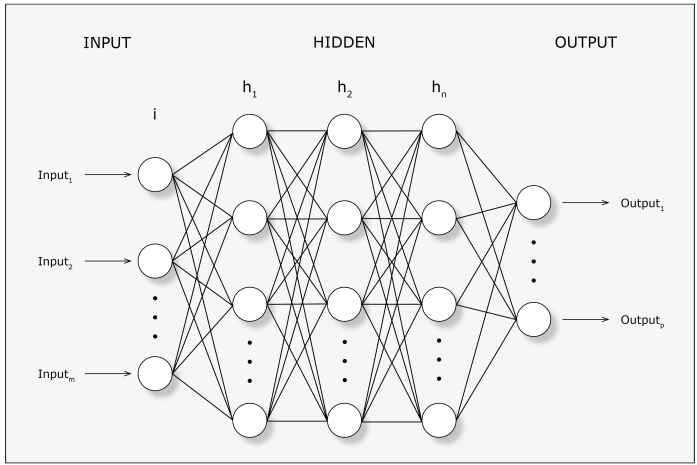


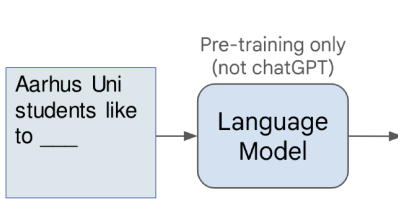
A person in a context that does? *type of action*



Artificial Neural Network

OUTLINE

Language Models and Large Language Models



(hypothetical)

Word	Probability
a	*0.00001*
aardvark	*0.000004*
...	
drink	*0.5*
...	
study	*0.23*
...	
zucchini	*0.000002*

Grammar	In my free time, I like to {**run**, banana}
Lexical semantics	I went to the zoo to see giraffes, lions, and {**zebras**, spoon}
World knowledge	The capital of Denmark is {**Copenhagen**, London}
Sentiment analysis	Movie review: I was engaged and on the edge of my seat the whole time. The movie was {**good**, bad}
Harder sentiment analysis	Movie review: Overall, the value I got from the two hours watching it was the sum total of the popcorn and the drink. The movie was {**bad**, good}
Translation	The word for "pretty" in Spanish is {**bonita**, hola}
Spatial reasoning	[...] Iroh went into the kitchen to make some tea. Standing next to Iroh, Zuko pondered his destiny. Zuko left the {**kitchen**, store}
Math question	First grade arithmetic exam: 3 + 8 + 4 = {**15**, 11}

Transformer-based language models

2013: Word2vec

2015: Attention

2017: Transformer

2018: BERT, GPT-1, GPT-2

2019: BART

2020: GPT-3, RAG

2022: Instruct GPT, RLHF, ChatGPT

2023: LLaMA, Gemini, GPT-4

2024: Multimodality, SLM, open source

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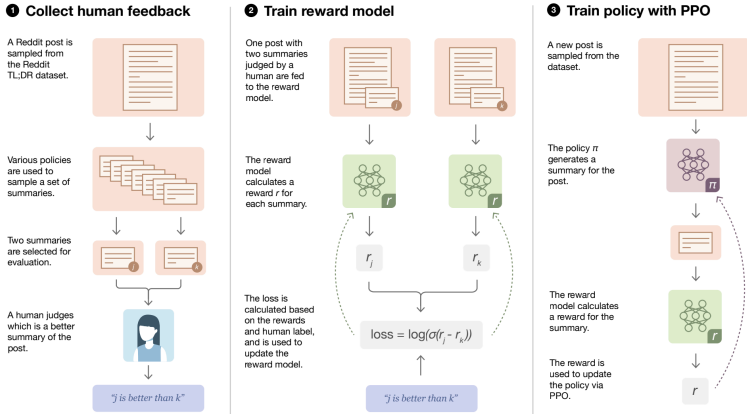
What happened in 2022?



Alignment with RLHF, Ouyang et al. [2022]

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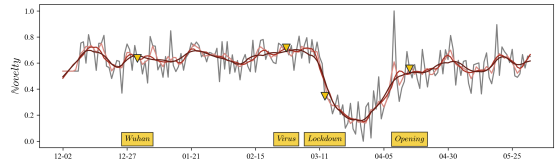
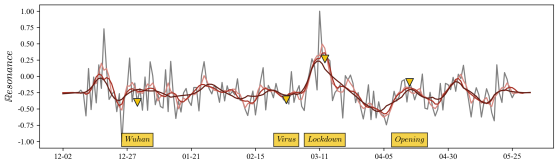
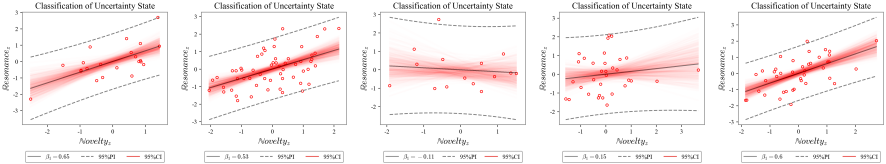




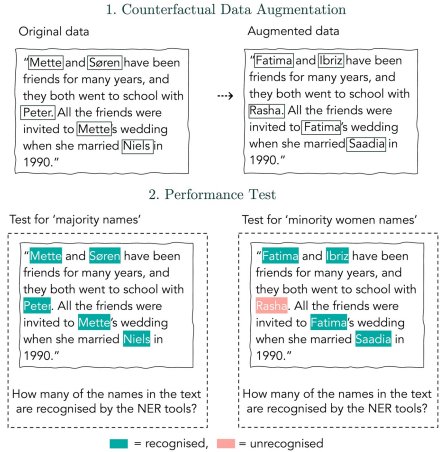


Change detection on novelty, $\mathcal{N}$, and chance description on the resonance on novelty slope, $\mathcal{N} \cdot \mathcal{R}$-slope, Nielbo et al. [2023].

	majority	*minority*
women	$\mathcal{A}$	$\mathcal{B}$
men	$\mathcal{C}$	$\mathcal{D}$

Intersectional biases in LLM applications

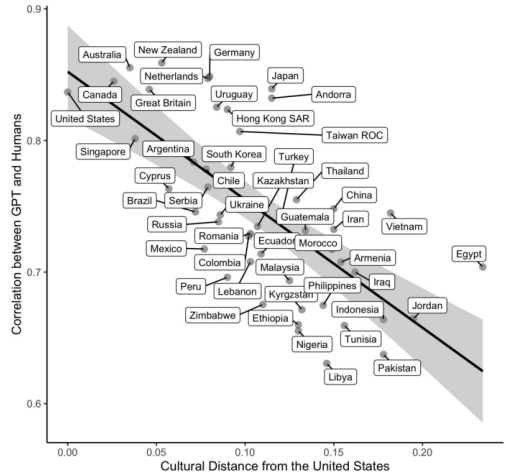
- originates in training objectives and data
- results in LLM misalignment with a range of ethical and security issues



Homogeneous monolingual setting

LLMs learn from data, if the data reflects historical biases, AI will too

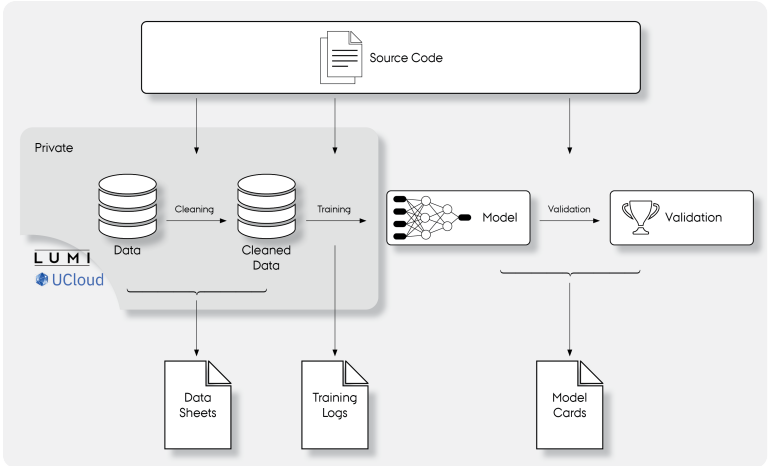
- **Data encoding biases** stem from non-representative training datasets or prejudiced annotators
- Preference training that **overfits on a Western value set**
- Eroding trust and can cause societal harm by reinforcing stereotypes



Cultural (mis-)alignment, Source: J. Henrich

Danish Foundation Models

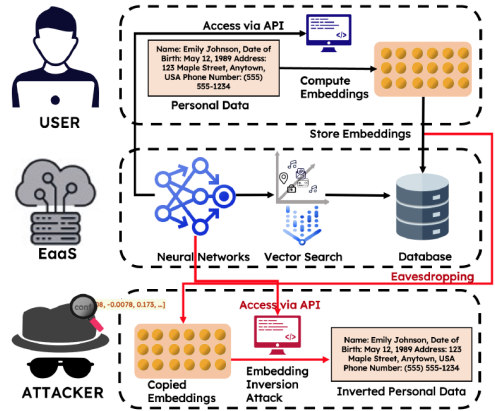
1. Develop and maintain **state-of-the-art** models for Danish,
2. which are **well-validated** across a wide range of tasks.
3. Furthermore, we wish to **ensure good documentation**, which allows users to assess the model for their use-case critically
4. **Open-source**, both model and source code
5. Models should comply with **regulatory frameworks** and use responsible AI governance
6. **Continuous monitoring** and adaptation in development and deployment



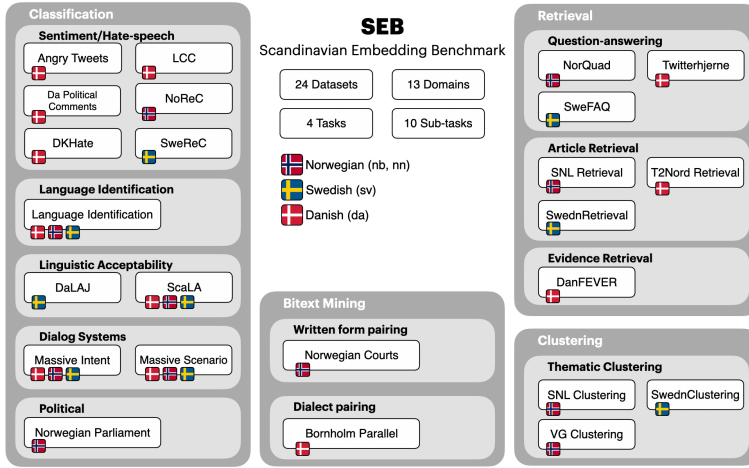
DFM environment for training Danish base models Enevoldsen et al. [2023] on ScandEval Nielsen [2023]

Exploiting embedding vulnerabilities

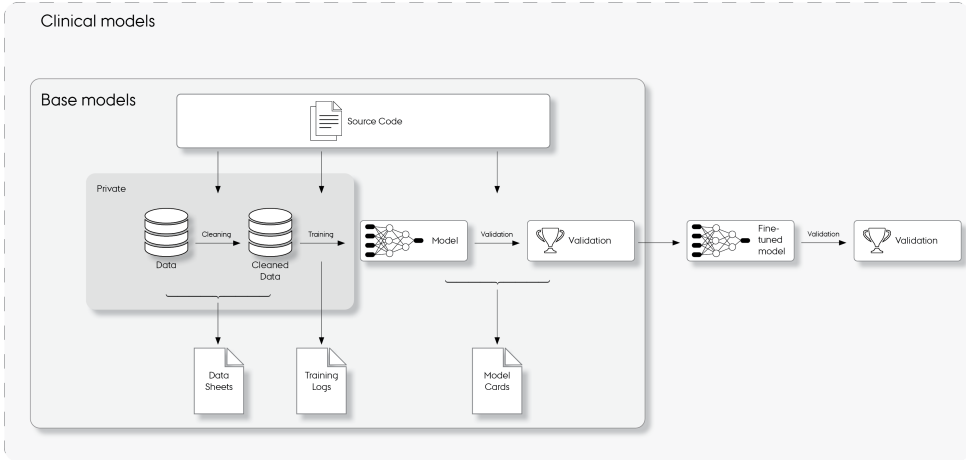
- Using **prompt injections** to manipulate the output of the model
- neural embeddings of sensitive data retain much of the original data – **embedding inversion attack**
- existing **defense mechanisms focus on English** – leaving other languages more susceptible to security threats
- linguistic bias becomes a cybersecurity threat



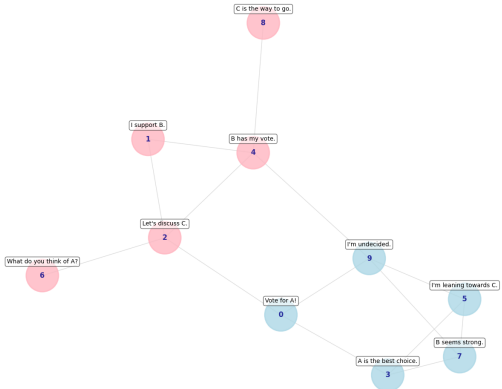
Source: Chen et al. [2024]



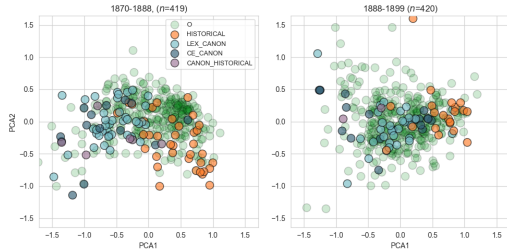
Intrinsic Model Evaluation with SEB, Enevoldsen et al. [2024]; Nielsen et al. [2024]



Extended DFM development environment for fine-tuning and aligning DFM models for clinical applications



European Citie^2 Simulating democratic processes (voting mechanisms) with Danish municipalities



Golden Arrays – Identifying drivers of historical change since the 16th century.

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In summary

- The field of AI-based language technology is diversifying
- Still suffers from a) *homogeneous monolingual setting* and b) preference training that overfit on common Western-centric data sets
- National models have value in a range of applications that have specific quality and security requirements
- clinical decision support, educational instructors, public sector agents …

THANK YOU

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SLIDES

knielbo.github.io/files/ai-is-ml.pdf

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