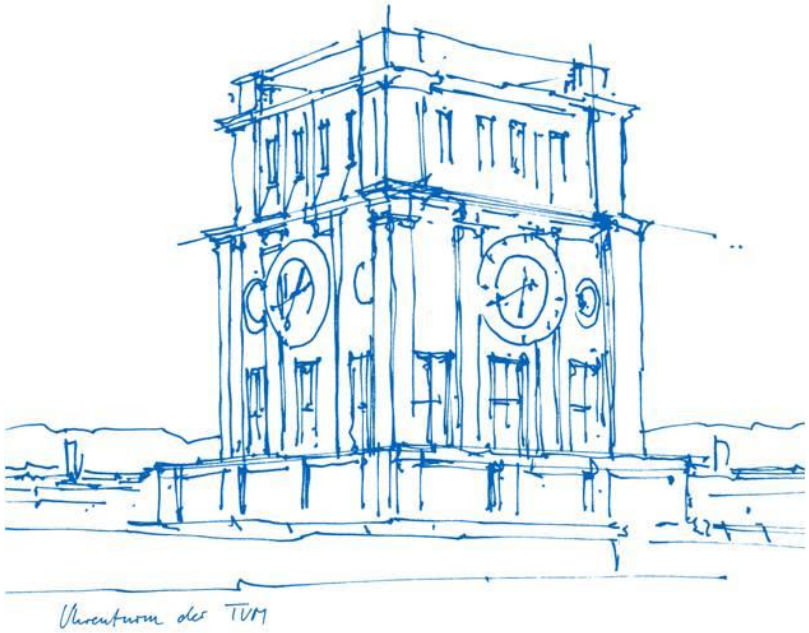
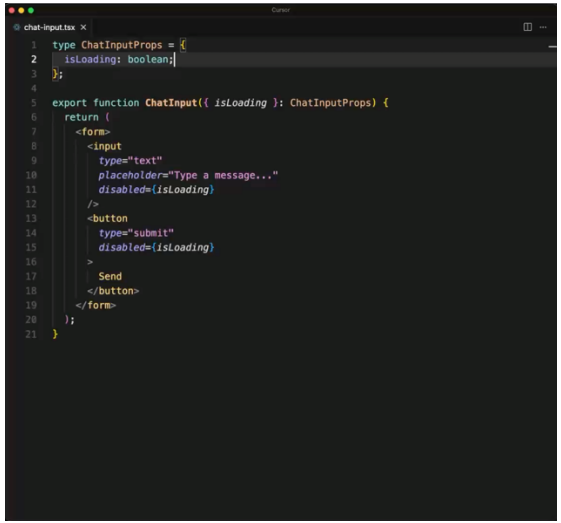
How do technical and scientific contributions of Foundation Models for robotics develop over time compared to those for language - a large-scale systematic analysis using LLMs



Tobias Geilen
Master Thesis
M. Sc. Information Systems
2025

Background

Over the last few years, Artificial Intelligence has increasingly shaped our daily lives in various tasks



Software Development

Content Creation

Autonomous Driving

Background

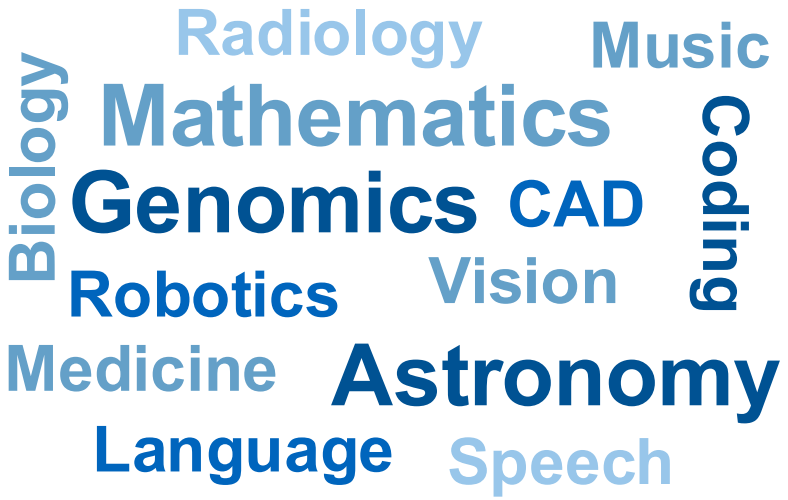
Foundation Models (FM) are a technological driver of that development, and have substantially enhanced AI's capabilities and broadened its range of application

Definition of Foundation Models

"Foundation Models are a type of AI technology that are trained on **vast amounts of data** that can be **adapted to a wide range of tasks** and operations"

On the Opportunities and Risks of Foundation Models (Bommasani et. al., 2022)

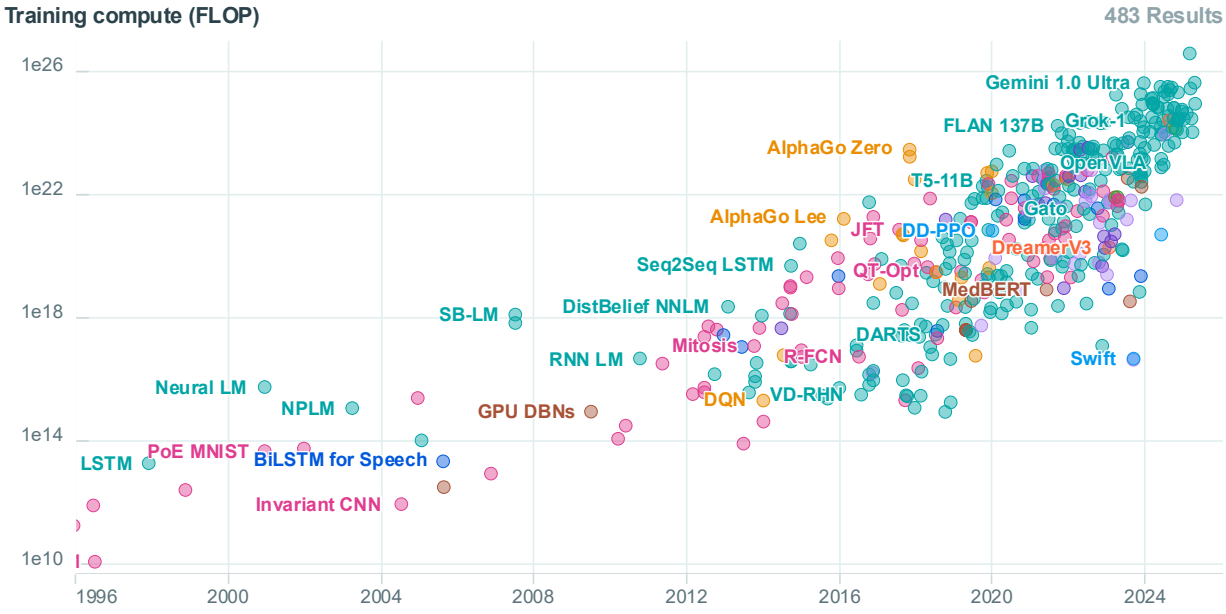
Selected application domains of FMs



Background

Epoch AI provides an overview of Foundation Model development trends including their different application domains

Notable AI Models Dataset



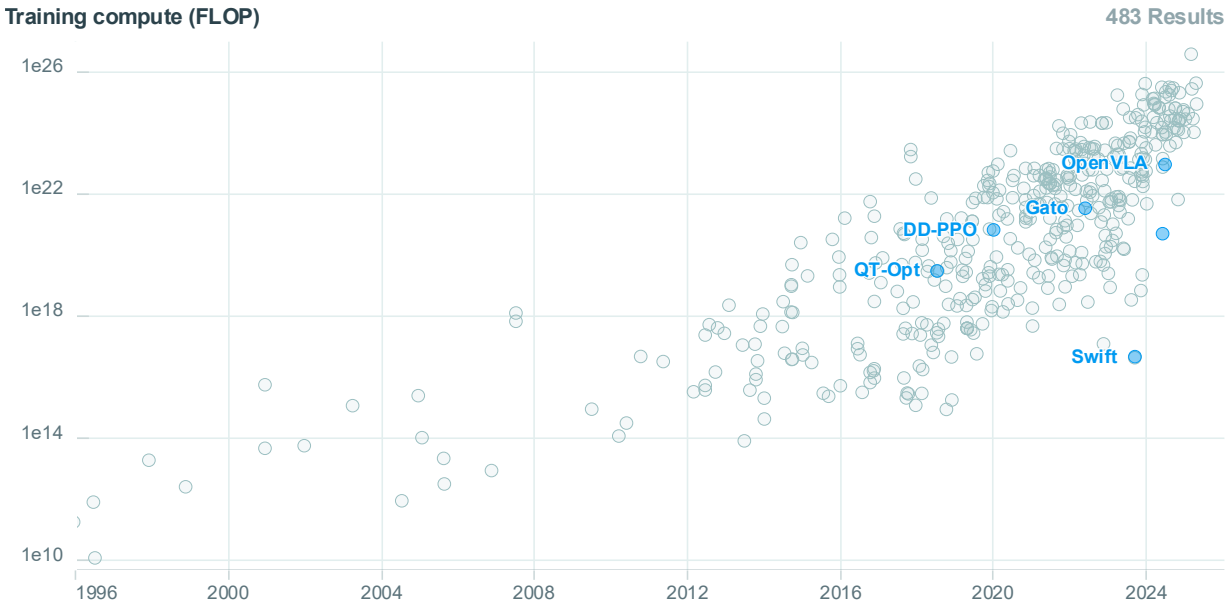
Epoch AI

- Epoch AI is a multidisciplinary research institute investigating the trajectory of AI
- Their flagship dataset on notable AI models contains information on over 900 models that were state of the art or highly cited
- It tracks key factors driving machine learning progress and is created through manual paper review by the Epoch AI researchers

Research Gap

The extensive Epoch AI dataset does only include very few Foundation Models for Robotics and hence does not provide a holistic overview across all domains

Notable AI Models Dataset



Epoch AI

- The Epoch AI dataset also includes information on the application domain of the respective models
- For the robotics domain the dataset only includes 26 models in total, although there are over 400 publications matching a search query on “Foundation Model” and “Robotics” on ArXiv

Research Question

How do technical and scientific contributions of Foundation Models for robotics develop over time compared to those for language?

Objective

- The objective is to **create a comprehensive overview of robotics models and their characteristics** - like the Epoch AI dataset - by **developing a software tool, which automates the manual paper review and utilizes LLMs** for the information retrieval process to extend the currently existing overviews

Research Questions

1. Are NLP tools able to **extract relevant objective parameters** from previously identified papers? What is the **quality of the results** from the automated solution compared to the Epoch AI dataset?
2. What is the **status quo in FM development** for the specific field **of Robotics** and how do the models compare in their characteristics to other fields?
3. Are there **statistically relevant differences** between the robotics domain and other domains (such as language)?

Methodology

To structurally compare the different models, a standardized approach will be used to extract the following information from all publications

Meta information

- Model name
- Authors
- Organization
- Organization type
- Organization country
- Citations
- Publication date

Model information

- Domain
- Parameters
- Input modality
- Output modality
- Architecture
- Base model
- Accessibility

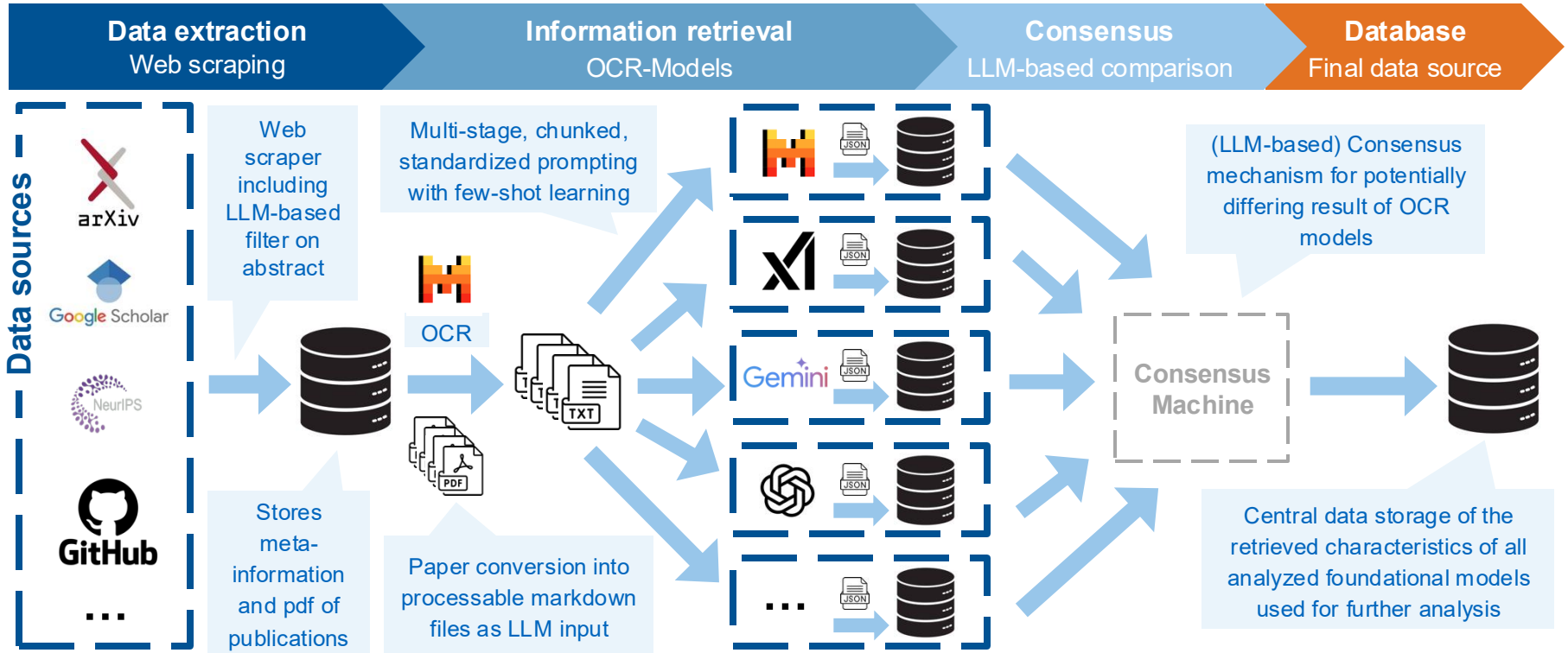
Training information

- Training dataset
- Training dataset size
- Epochs
- Batch size
- Training time
- Training hardware
- Hardware quantity

As some publications might not always include all information, fields with only few datapoints might be neglected later if the extracted data does not allow for a reliable comparison.

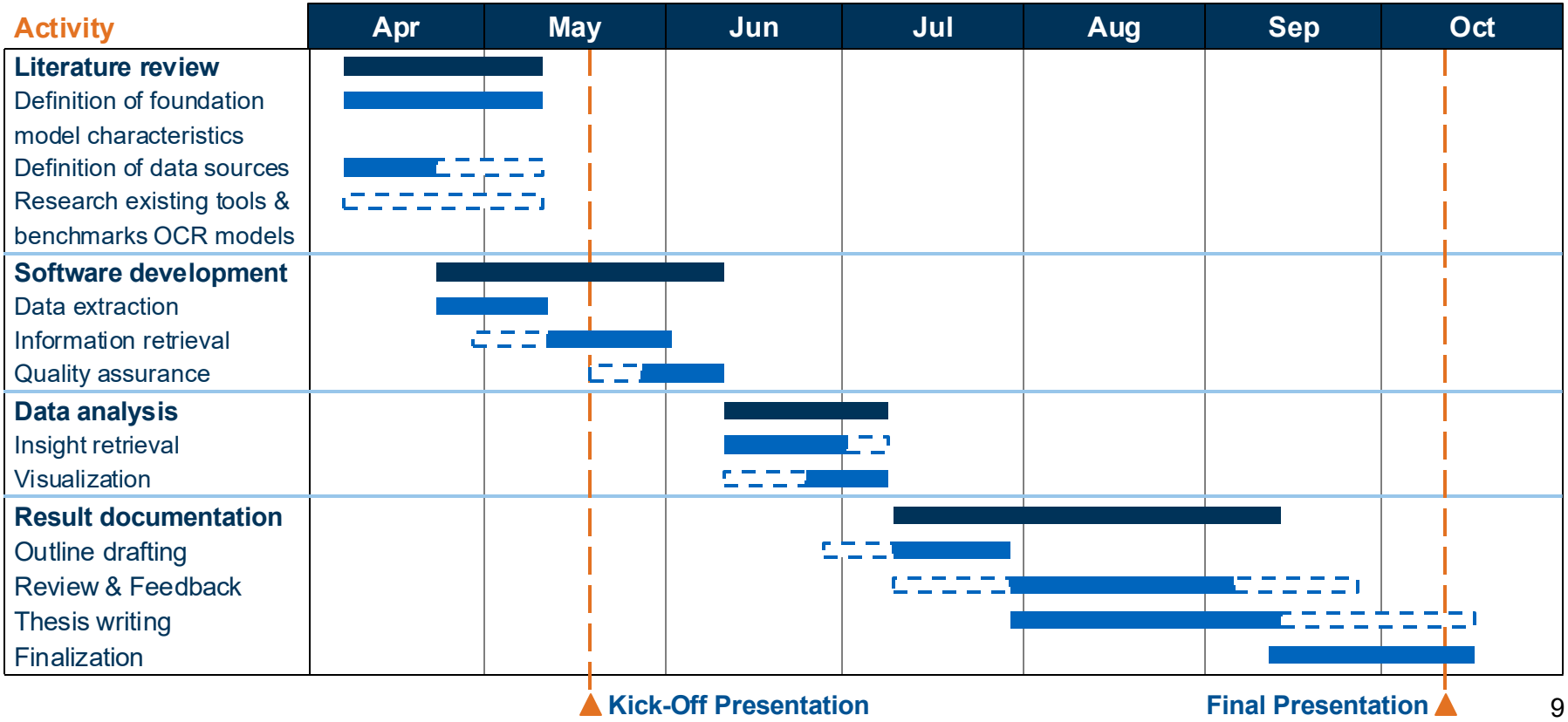
Methodology

A LLM-based multilayer software tool will be developed for validated information retrieval from the publications describing the respective models



Timeline

Expected timeline for the master thesis



Q & A