CHALMERS UNIVERSITY OF TECHNOLOGY | UNIVERSITY OF GOTHENBURG

Requirements Engineering

for **Artificial Intelligence**-based Systems

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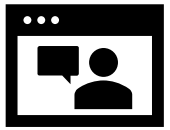
https://julianfrattini.github.io/

JulianFrattini/**seminar-refun** Public

Goal



Requirements engineering emerged based on **traditional software**.

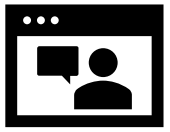
Systems including artificial intelligence (AI) **are not traditional software**.

Companies struggle to engineer AI-enabled systems.

AI Systems

As an AI system, I will refer to any **data-driven software** (component) throughout this unit

> A **data-driven software component** is a piece of software that solves a given task (e.g., image segmentation, sentiment analysis, classification, etc.), using methods from data science, such as machine learning (ML), data mining, natural language processing, signal processing, statistics, etc. The functionality of data-driven software components (or at least part of it) is not entirely defined by the programmer in the classical way (by programming it directly), *but is derived (i.e., learned) from data*.
>
> Siebert, J., Joeckel, L., Heidrich, J., Trendowicz, A., Nakamichi, K., Ohashi, K., ... & Aoyama, M. (2022). Construction of a quality model for machine learning systems. *Software Quality Journal*, *30*(2), 307-335.



Traditional Software

requires formal problem

generally transparent

decomposable

AI System

requires no formalization

generally obscure

generally atomic

Requirements Engineering for AI systems (RE4AI) and Machine Learning (RE4ML)

Due to these properties of AI systems, companies struggle to engineer modern systems with traditional SE/RE techniques. Research aims to support companies by working on

Prioritization of Software Qualities

Development of Quality Meta-Models

Proposal of Data Quality Attributes

RE4AI Research: Prioritization of Software Qualities

AI systems may experience different requirements on their quality. In comparison to traditional software, the following qualities are considered

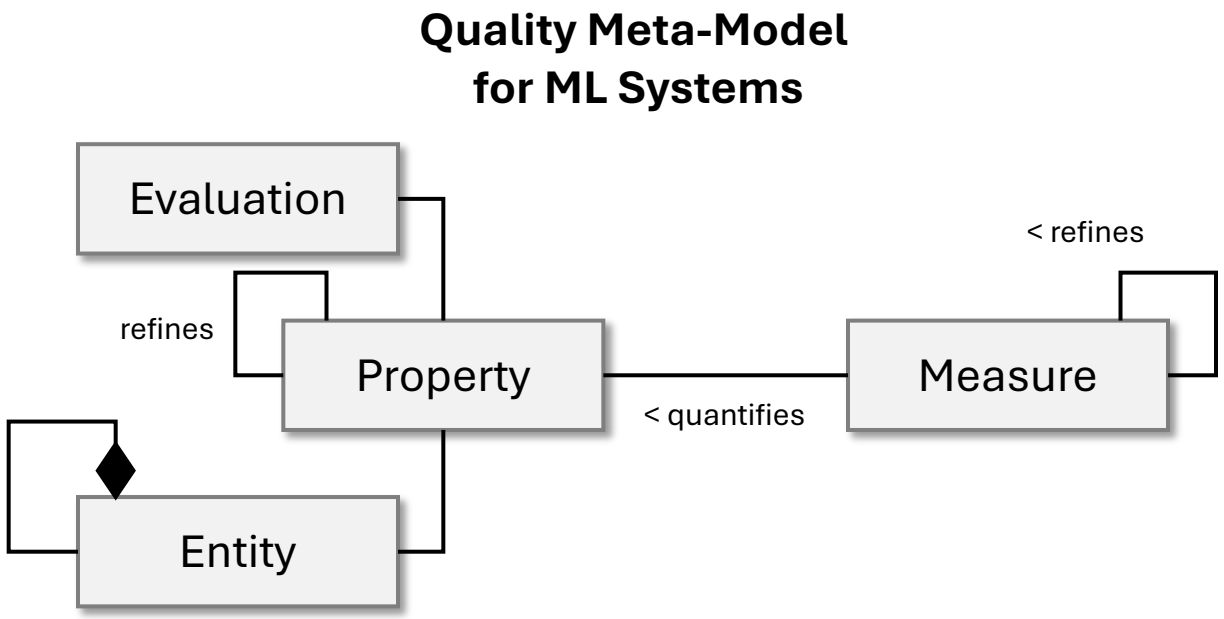
less important	equally important	more important
Usability	Privacy	Accuracy
Flexibility	Reliability	Fairness
Revisability		Maintainability

Other qualities seem entirely new, like Re-trainability

Habibullah, K. M., Gay, G., & Horkoff, J. (2023). Non-functional requirements for machine learning: Understanding current use and challenges among practitioners. *Requirements Engineering*, *28*(2), 283-316.

RE4AI Research: Quality Meta-Model

System qualities apply to different entities of an AI system but capturing them is still difficult.



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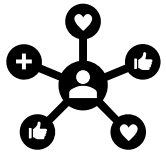
RE4AI Research: Data Quality

One critical entity of an AI system is the data used to train its AI component(s), which itself becomes subject to quality concerns.

How the training data was sampled affects the robustness of models on unseen data.



Causal modelling techniques can be used to ensure the representativeness of data.

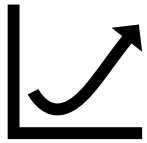
Heyn, H. M., Mao, Y., Weiss, R., & Knauss, E. (2025). Causal Models in Requirement Specifications for Machine Learning: A vision. *arXiv preprint arXiv:2502.11629*.

Misconceptions of RE4AI

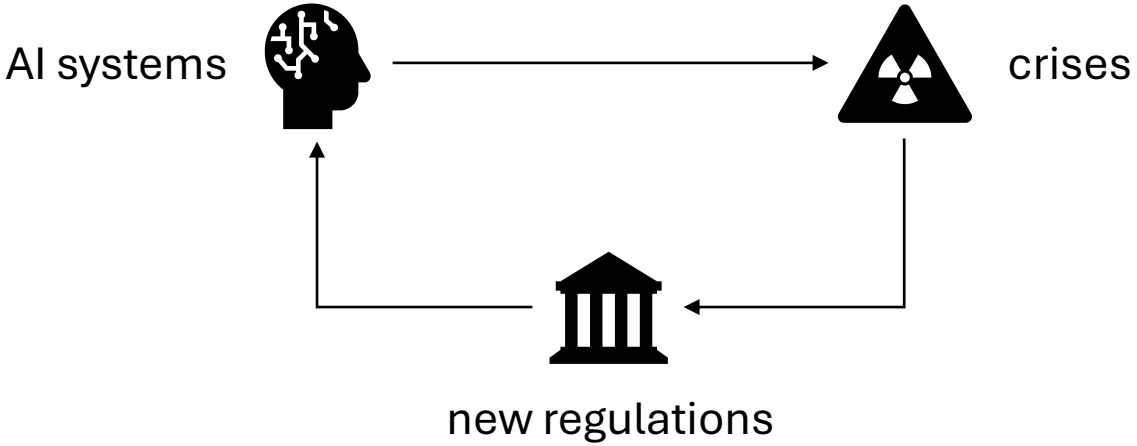
AI is a **solution**, so it has – per se – no direct effect on requirements.

The only two exceptions:

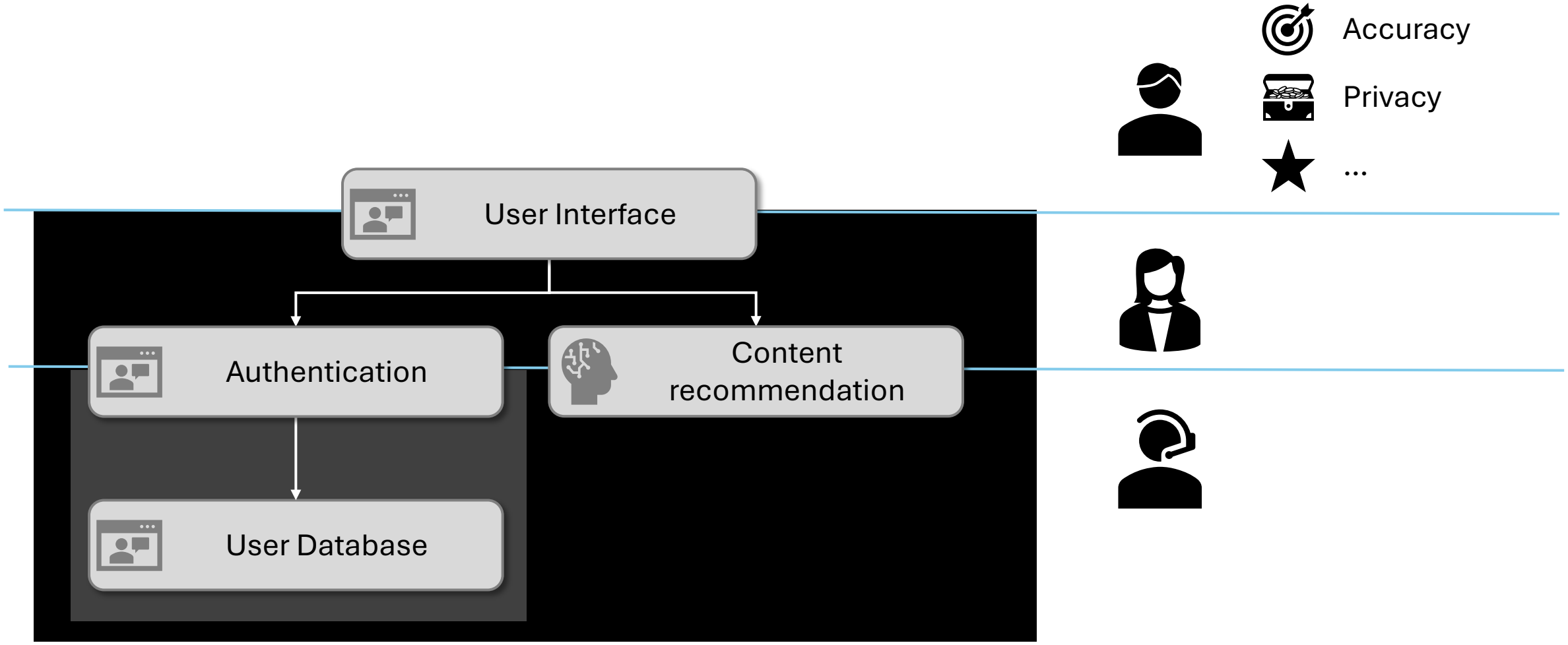
Increased expectations



Transitive Impacts



RE4AI on Levels of Abstraction



Lesson Learned

Systems including artificial intelligence (AI) **are not traditional software** and traditional requirements engineering techniques may not apply to them.

AI is a solution, so **it does not affect RE directly**. However, when integrating AI into a system, this component will imply specific **requirements on its respective level of abstraction**.

System qualities may be both **defined and tested differently** for AI systems.