Philosophical Implications of Generative AI for Computing and Engineering Education

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Plan

- Reactions to AI
- Why is the word *"Philosophical"* in the title?
- Decision-Making
- The Role of Explanations in Learning
  - What is an Explanation?
- What changes with Generative AI?
- Implications for Pedagogy in Engineering and Computing

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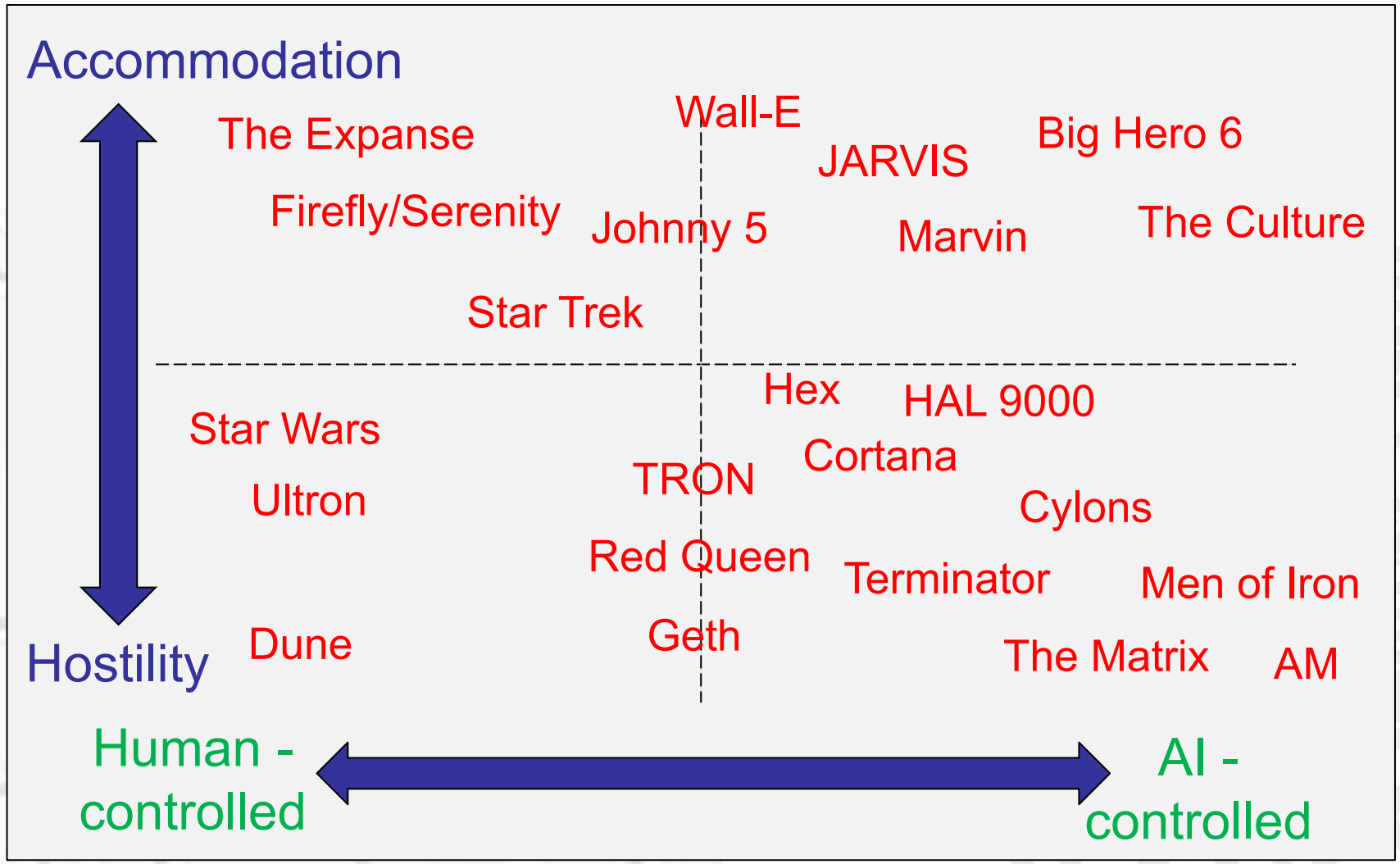
Reactions to AI



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What is "*Philosophical*" about AI and Education?

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What is "*Philosophical*" about AI and Education?

We use the word *"philosophical"* to indicate that the issue falls under the traditional areas of philosophical enquiry:

- What is the nature of reality:
  - metaphysics, ontology, philosophy of mind, ...
- What we can know:
  - epistemology, methodology, logic, ...
- What we value:
  - axiology – ethics, aesthetics, (political theory), ...

and that the question can only be *fully* addressed by conceptual analysis as opposed to empirical, scientific enquiry.

Fair Decision-Making

What principles should guide fair decision-making?

In order to have democratic legitimacy, public decision-making should conform to the **Principle of Publicity:**

1. **Reason giving**. This connects a decision with some features of the world (e.g., laws, relevant facts) and the specifics of the case.
2. **Accessibility.** The reasons are available to the directly affected party and to other relevant stakeholders.

Beckman et al., 2022, "Artificial intelligence and democratic legitimacy: The problem of publicity in public authority"

Decision-Making and Explanation

- The European Union's General Data Protection Regulation (GDPR) stipulates a right to obtain *"meaningful information about the logic involved"*—commonly interpreted as a *"right to an explanation"*— for consumers affected by an automatic decision (Parliament and Council of the European Union, 2016)

- Swedish Law on Public Administration: *"A decision that can be expected to affect a person in non-marginal ways should include a clear justification, unless clearly unnecessary"* (§ 32 Förvaltningslag 2017:900).

Learning and Explanations

From a pedagogical perspective, learning is deeply connected to the capacity to explain:

- As a pedagogical strategy
- To determine whether learning has taken place,
  - By demonstrating conceptual understanding and addressing misconceptions
  - By clarifying information and building knowledge
  - By promoting problem solving strategies and critical thinking
  - Connecting ideas and facilitating communication
  - Fostering engagement and customizing learning

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Models of Explainability

Theory	Explanations	Explainable Information
Causal Realism	Descriptions of causality, expressed as chains of causes and effects.	What can fully describe causality.
Constructive Empiricism	Contrastive information that answers why questions	What provides answers to contrastive why-questions.
Ordinary Language Philosophy	Answers to questions (not just why ones) given with the explicit intent of producing understanding in someone	What can be used to pertinently answer questions about relevant aspects with illocutionary force.
Cognitive Science	Mental representations resulting from a cognitive activity. Aims to fix failures in someone's mental model	What can have a perlocutionary effect, fixing failures in someone's mental model.
Naturalism and Scientific Realism	Information which increases the coherence of someone's belief system.	What can have a perlocutionary effect, increasing coherence of someone's belief system.

after: (F. Sovrano and F. Vitali, 2023 ; Table 1)

Characteristics of Explanation

Explanations are counterfactual.

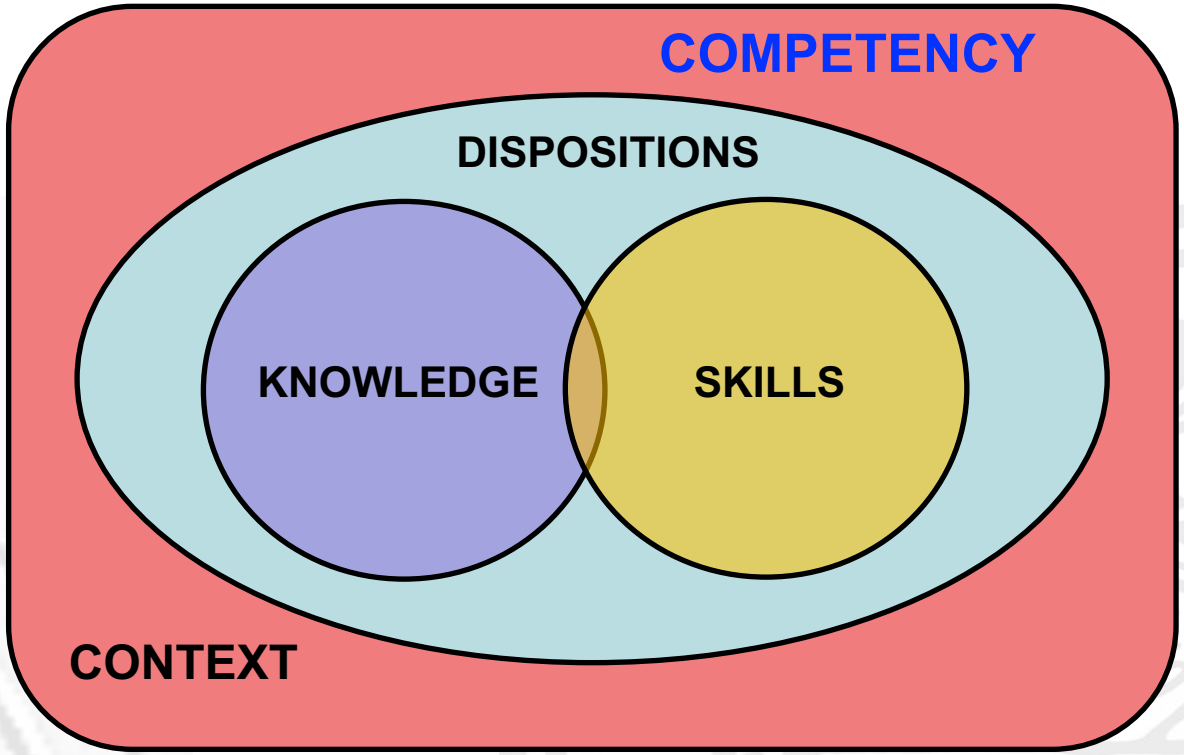
We do not ask "Why P?" but rather:

- Contrastive: Why P rather than Q?
- Bi-factual: Why P when sometimes Q?

(Miller, 2021)

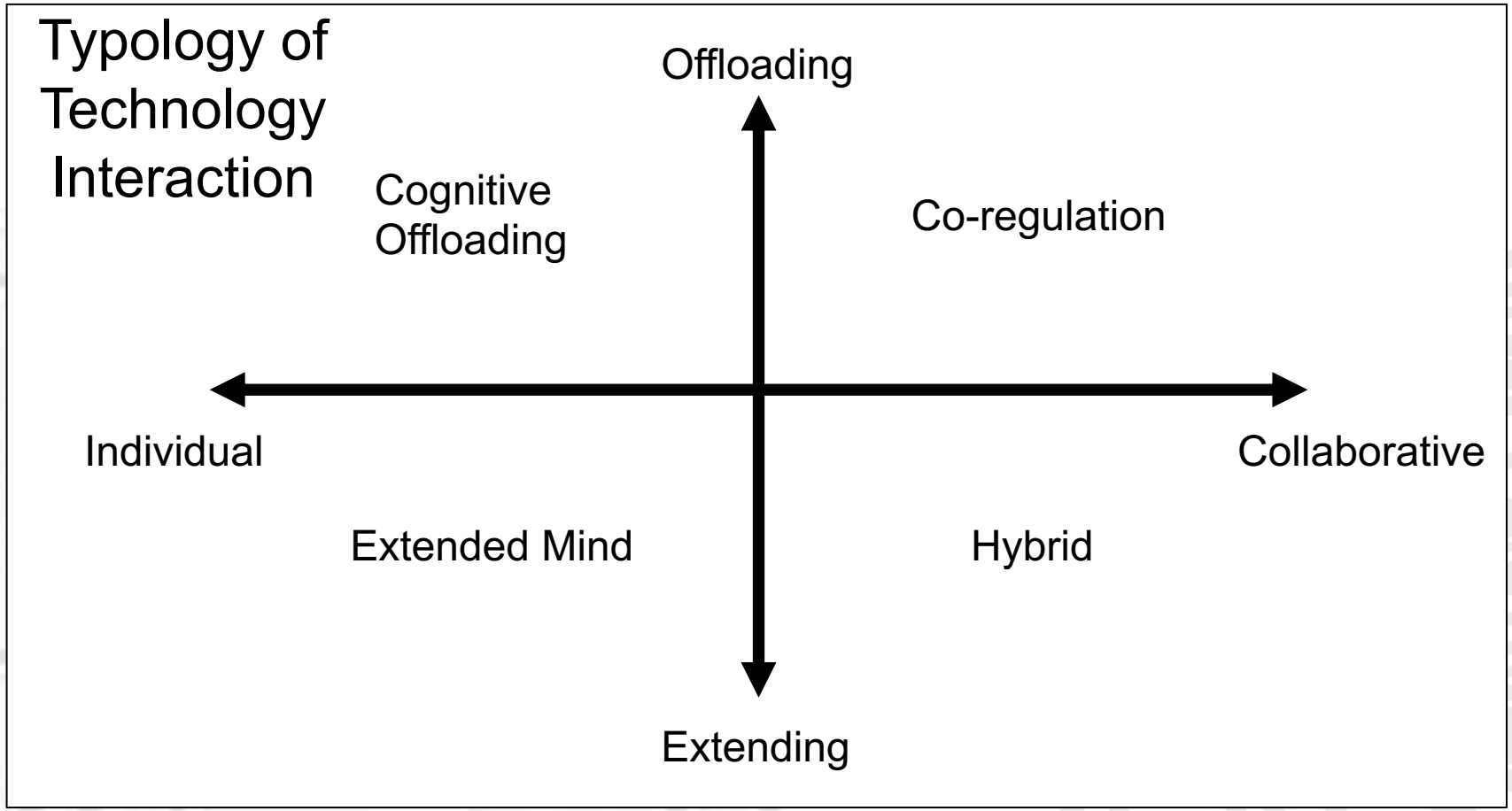
Explanations and Demonstrability

Competency Models of Learning Development presuppose an assessment model based on explainability (for knowledge) and demonstrability (for skills and dispositions)



Frezza, S. et al. "Modelling competencies for computing beyond 2020: a research based approach to defining competencies in the computing disciplines"

Does AI really change things?



Lodge et al, 2023, "It's not like a calculator so what is the relationship between learners and generative artificial intelligence"

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Explanation in AI Models

Concept	Definition
Explainability	How well humans can understand AI-system decisions
Interpretability	To explain or present in understandable terms to humans. How well humans can understand AI-system decisions.
Transparency	Representing system states in a way that is open to scrutiny, analysis, interpretation, and understanding by humans. Characteristic of model to be understandable for humans. Capacity of method to explain how a system works, even when behaving unexpectedly.
Understandability	To make a human understand how a model works, without any need for explaining its internal structure. Measuring how well humans understand model decisions. Capacity of a method of explainability to make a model understandable by end users.

Some Implications for Education

- Explainability will be an increasing problem in an educational setting.
- We need to move away from understanding competence as being demonstrated solely in a procedural way.
- We need to embrace a holistic "systems development" approach to competence assessment whereby implementation is just one element in the development process.
- We need to encourage the development of declarative skills, e.g. specification, as well as deliberative and evaluative judgement.
- We need to pay attention to the democratic deficit when we start using the technology to assess students.

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And Finally... Back to Philosophy