ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

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ARTIFICIAL INTELLIGENCE

AI is a subfield of computer science that studies intelligent systems

Subfields/topics in AI studied in CS (adapted from IJCAI):

• Planning and Scheduling
• Agent-based and Multi-agent systems
• Combinatorial & Heuristic Search
• Constraints & Satisfiability
• Knowledge Representation, Reasoning and Logic
• Machine Learning
• Uncertainty in AI
• Natural Language Processing
• Robotics and Vision
• AI interfaces (conversational, human-computer interaction)

Methods and algorithms vs applications
AI BOOM: THE ACADEMIC PERSPECTIVE

Participants in the leading ML/AI conference (NIPS)
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arXiv submissions doubling every year, 1800 AI-papers submitted in March 2017!
AI: MACHINE LEARNING

Most of the boom because of machine learning

Arthur Samuel (1957): “Field of study that gives computers the ability to learn without being explicitly programmed.”

Tom Mitchell: “A computer program is said to learn from experience E with respect to some class of tasks T and performance measure P if its performance at tasks in T, as measured by P, improves with experience E.”

• Learns from data or experience, by a quantifiable amount
• Solves particular task – or typically family of tasks
AI: MACHINE LEARNING

Deep learning

Yann LeCun, Yoshua Bengio & Geoffrey Hinton

Affiliations | Corresponding author

Received 25 February 2015 | Accepted 01 May 2015 | Published online 27 May 2015

Probabilistic machine learning and artificial intelligence

Zoubin Ghahramani

Received 12 February 2015 | Accepted 21 April 2015 | Published online 27 May 2015

Reinforcement learning improves behaviour from evaluative feedback

Michael L. Littman

Received 11 January 2015 | Accepted 28 April 2015 | Published online 27 May 2015
AI: MACHINE LEARNING

Deep learning:

“Deep learning allows computational models that are composed of multiple processing layers to learn representations of data with multiple levels of abstraction.”

Bayesian machine learning:

“How can a machine learn from experience? Probabilistic modelling provides a framework for understanding what learning is and [...] for designing machines that learn from data acquired through experience.”

Reinforcement learning:

“Reinforcement learning is a branch of machine learning concerned with using experience gained through interacting with the world and evaluative feedback to improve a system's ability to make behavioural decisions.”
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All three streams studied primarily from the perspective of statistical modeling.
**AI: EXACT REASONING**

Constrained reasoning: Decisions, search and optimization over computationally hard (NP–complete and beyond) problems

- Combinatorial optimization, satisfiability, …
- Research in solving more complex problems efficiently

*Note: rough estimates, for propositional reasoning*

Picture from Kumar, DARPA
AI: APPLICATIONS

Progress highlighted by human interest applications, but the actual research is in the core algorithms

- CS can solve some applications internally – most progress in these
- For others, we need collaboration
SUPPORTING TECHNOLOGIES

CS research also in useful tools that are not about AI as such

- Scalable computation, distributed computing, computation platforms
- Software systems, data science, IoT
- Theoretical computer science
- Security

How to recognize whether research is about AI?

- AI is goal-driven – does the proposal solve a problem or provide tools for solving certain types of problems?
- Often involves learning from data, but not always