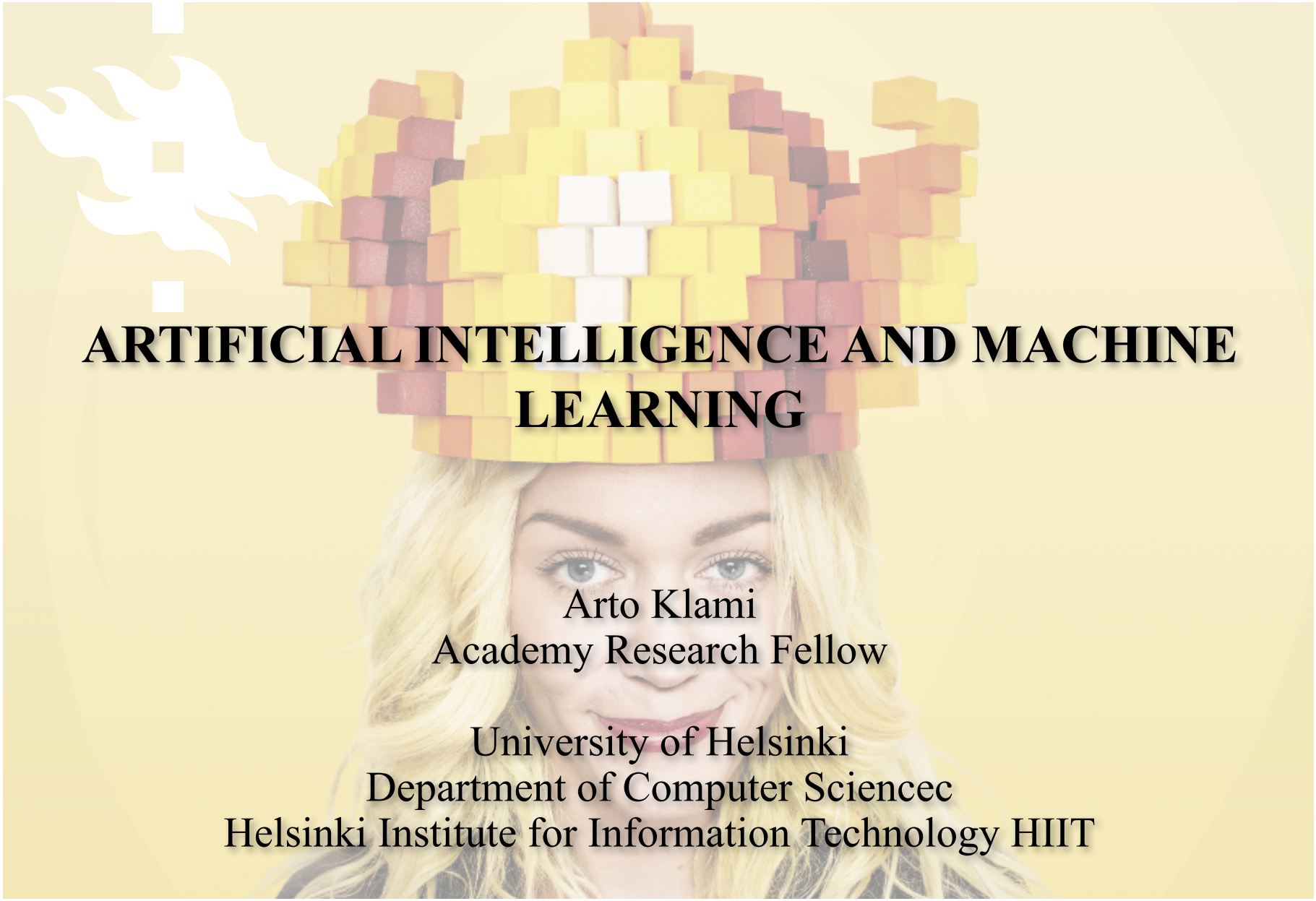

ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

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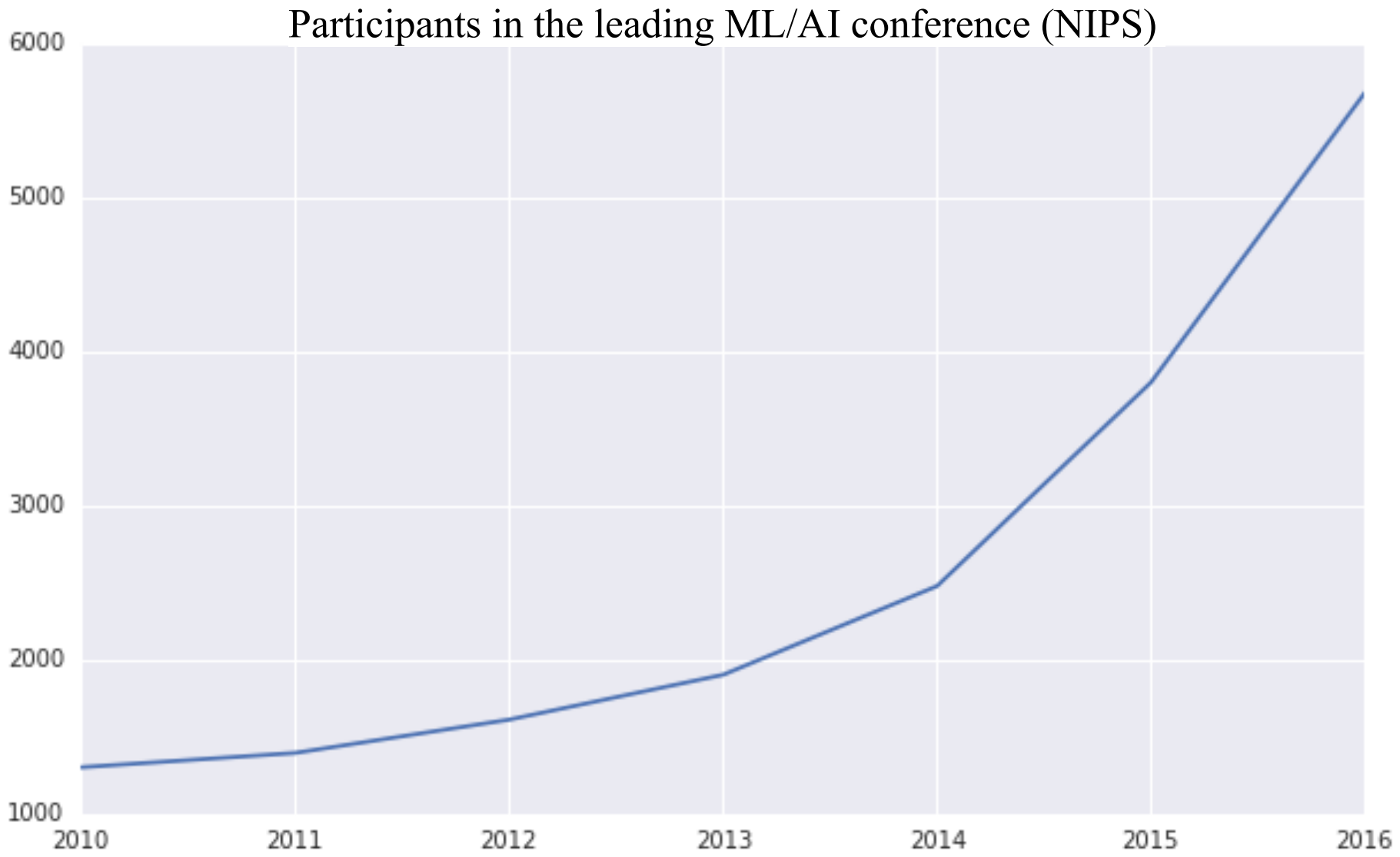
ARTIFICIAL INTELLIGENCE

AI is a subfield of computer science that studies intelligent systems

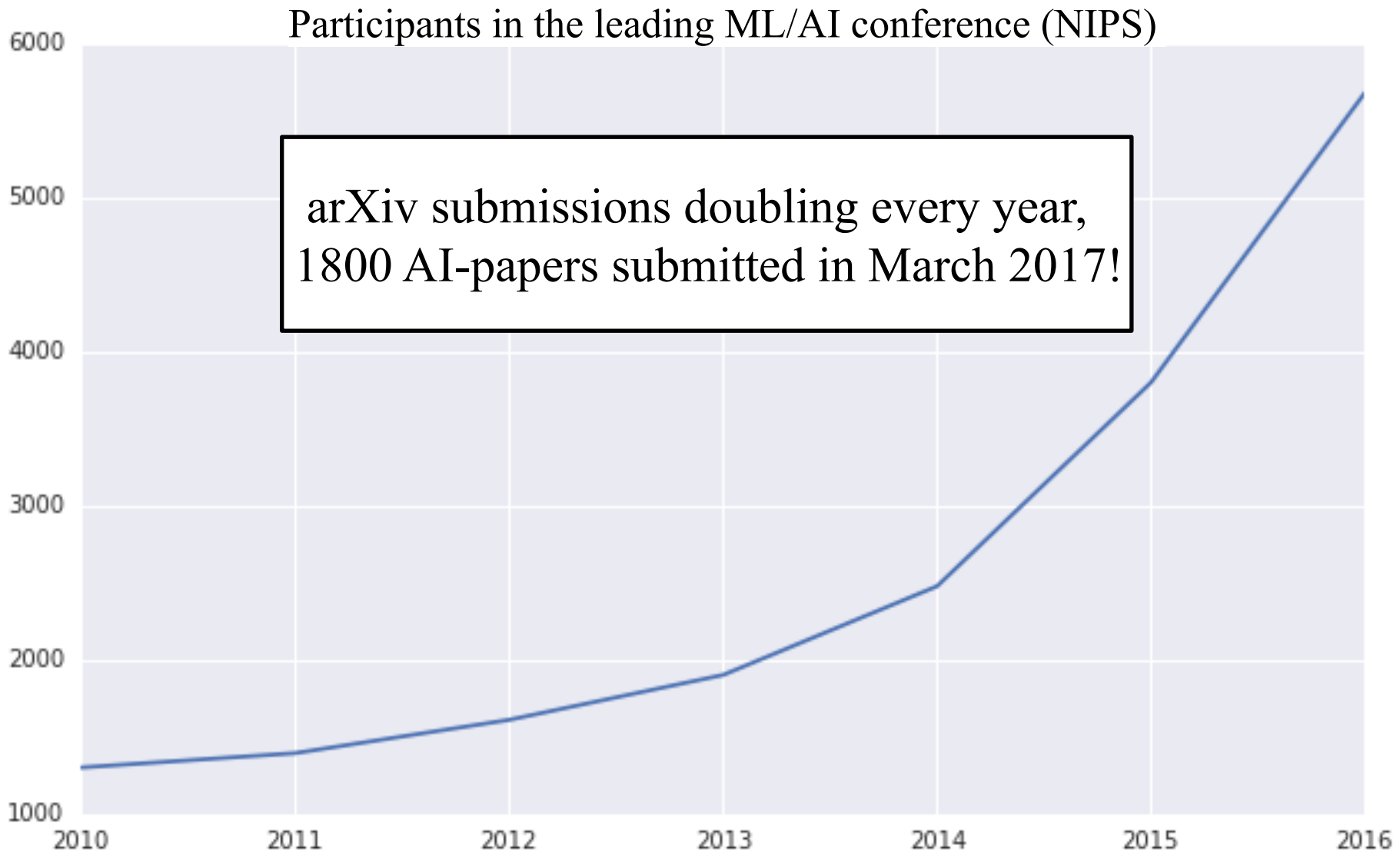
Subfields/topics in AI studied in CS (adapted from IJCAI):

- **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)*

AI BOOM: THE ACADEMIC PERSPECTIVE



AI BOOM: THE ACADEMIC PERSPECTIVE



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**

Nature **521**, 436–444 (28 May 2015) | doi:10.1038/nature14539
Received 25 February 2015 | Accepted 01 May 2015 | Published online 27 May 2015

Probabilistic machine learning and artificial intelligence

Zoubin Ghahramani

Nature **521**, 452–459 (28 May 2015) | doi:10.1038/nature14541
Received 12 February 2015 | Accepted 21 April 2015 | Published online 27 May 2015

Reinforcement learning improves behaviour from evaluative feedback

Michael L. Littman

Nature **521**, 445–451 (28 May 2015) | doi:10.1038/nature14540
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.*"

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

"*How can a* *delling provides a framewor* *designing machines th*

All three streams studied primarily from the perspective of statistical modeling

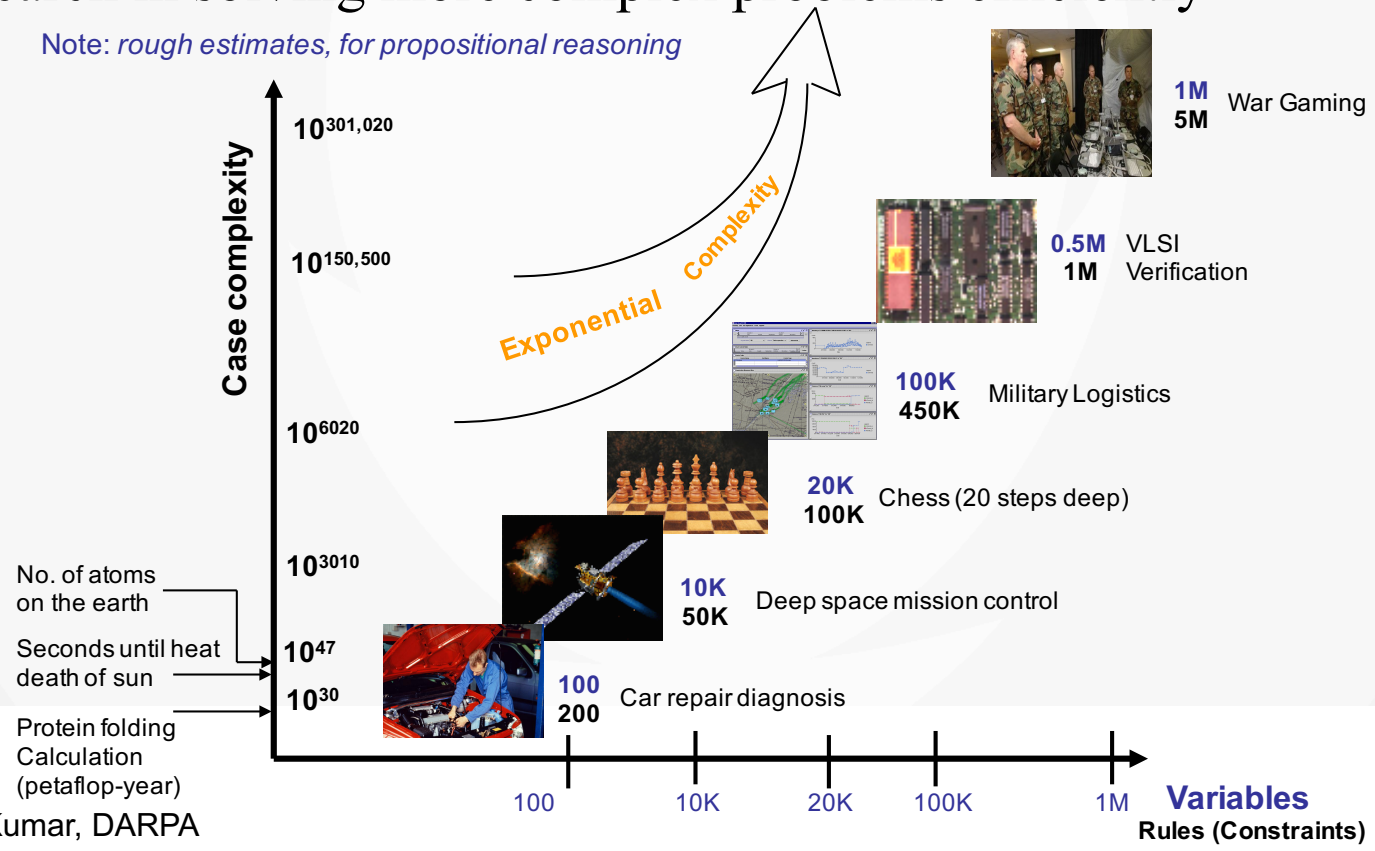
Reinforcement learning:

"*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.*"

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

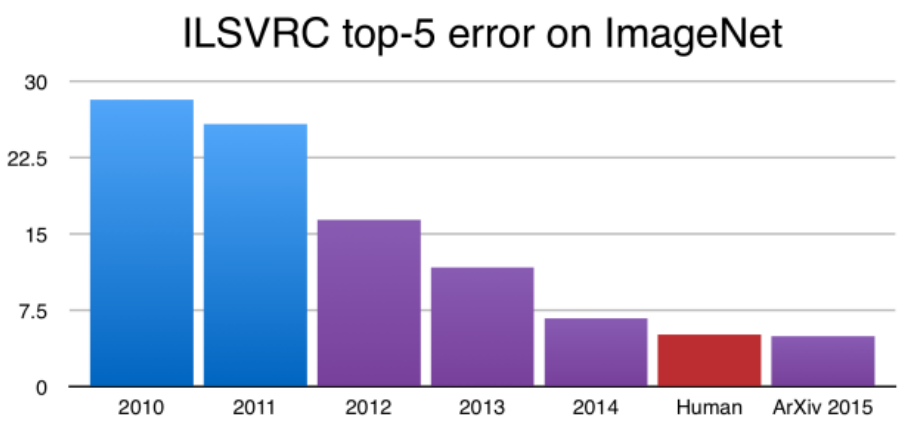


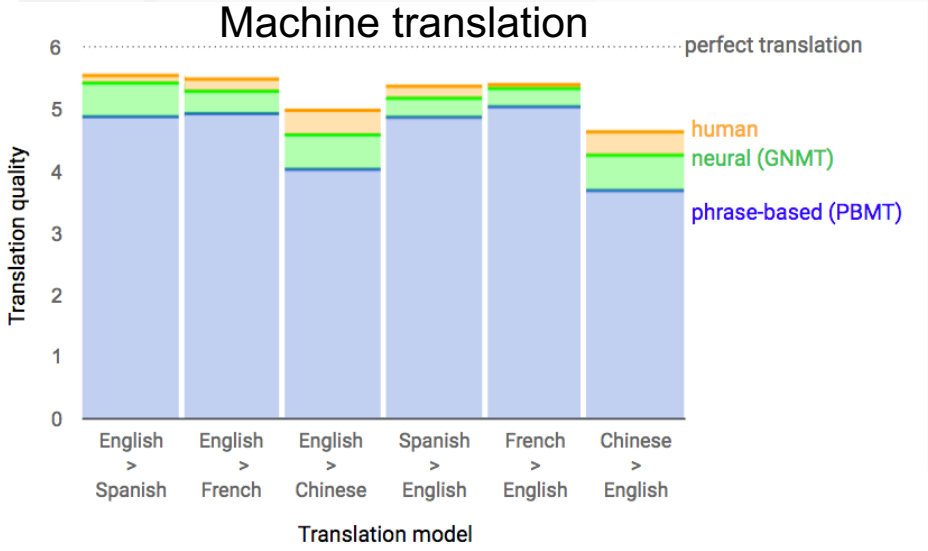
Picture from Kumar, DARPA

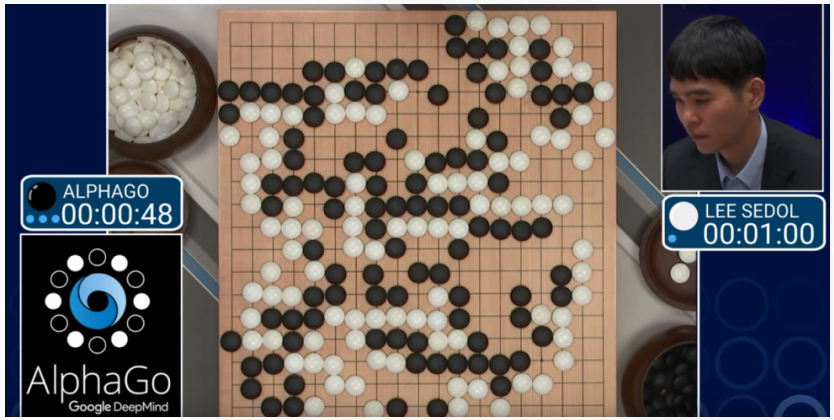
AI: APPLICATIONS

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