

CS 486/686

Introduction to Artificial Intelligence

Alice Gao
Lecture 1

Outline

Learning goals

Introductions

What is Artificial Intelligence?

Topics in CS 486/686

Course Outline

Revisiting the learning goals

Learning goals

By the end of the lecture, you should be able to

- ▶ Get to know a bit about Alice and one or more classmates.
- ▶ Name an application of AI. Name a topic in this course.

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Who am I?

My name is Alice Gao. Please call me Alice. I grew up in Beijing, China, and have lived in Vancouver, Toronto, Cambridge (MA), Cambridge (UK), New York City, and Waterloo.

My work/education history:

- ▶ Lecturer, Computer Science, University of Waterloo.
- ▶ Postdoc, Computer Science, UBC.
- ▶ Ph.D., Computer Science, Harvard University.
- ▶ Undergraduate, Computer Science and Mathematics, UBC.

My research: artificial intelligence, game theory, peer evaluation, education.

My teaching: CS 136, CS 245, and CS 486/686

Hobbies: board games, escape room games, hiking, swimming, and traveling.

Meet your peers

- ▶ In the next 2 minutes, introduce yourself to someone you don't know.
- ▶ Talk about courses, co-op, summer activities, dorms, extracurricular activities, graduation, jobs, etc.
- ▶ I encourage you to sit in a different section of the classroom every lecture and get to know the people around you.

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The State of Art of AI

What can AI do today?

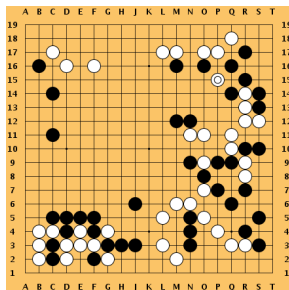
- ▶ Little success on the grand goal (building a general intelligence agent)
- ▶ Lots of success in restricted domains

Chess



- ▶ Search; evaluation function; Grandmaster game database.
- ▶ Campbell, M., Hoane Jr, A. J., & Hsu, F. H. (2002). **Deep blue**. *Artificial intelligence*, 134(1-2), 57-83.

Go or Weiqi



- ▶ Deep neural networks; supervised learning; reinforcement learning.
- ▶ AlphaGo: Silver et al. (2016). **Mastering the game of Go with deep neural networks and tree search.** Nature, 529(7587), 484-489.
- ▶ **AlphaGo Zero** and **Alpha Zero**

Poker



- ▶ Play with uncertainty. Must model opponent(s). Care about long-term payoff.
- ▶ Bowling, M., Burch, N., Johanson, M., & Tammelin, O. (2015). **Heads-up limit hold'em poker is solved**. Science, 347(6218), 145-149.
- ▶ Brown, N., & Sandholm, T. (2019). **Superhuman AI for multiplayer poker**. Science, 365(6456), 885-890.

Atari 2600 Games



Figure 1: Screen shots from five Atari 2600 Games: (Left-to-right) Pong, Breakout, Space Invaders, Seaquest, Beam Rider

- ▶ Outperforms previous approaches; Surpasses a human expert.
- ▶ Reinforcement learning; Convolutional neural network; High-dimensional sensory input.
- ▶ Mnih et al. (2013). **Playing atari with deep reinforcement learning**. arXiv preprint arXiv:1312.5602.
- ▶ Video: <https://youtube.com/watch?v=V1eYniJ0Rnk>

StarCraft II



Figure: https://sn1.no/StarCraft_II

- ▶ Multi-agent problem; Imperfect information; Large action and state space; Delayed credit assignment.
- ▶ Vinyals et al. (2019). [Grandmaster level in StarCraft II using multi-agent reinforcement learning](#). Nature, 575(7782), 350-354.
- ▶ Video: <https://www.youtube.com/watch?v=jt1rWb10yP4>

Jeopardy!

“AI for \$100, Alex.”

“This popular TV quiz show is the latest challenge for IBM.”

“What is Jeopardy?”

- ▶ In 2011, IBM's Watson beat the two highest ranked players in a two-game Jeopardy! match.
- ▶ Questions from a broad domain. Must answer questions with high precision and with accurate confidence. Fast answering.
- ▶ Ferrucci et al. (2010). **Building Watson: An Overview of the DeepQA Project**. *AI Magazine*, 31(3), 59-79.
- ▶ Ferrucci et al. (2013). **Watson: beyond jeopardy!**. *Artificial Intelligence*, 199, 93-105.

Self-Driving Cars

- ▶ DARPA Grand/Urban Challenges
- ▶ The perception system
 - ▶ Tasks: Locate car in the environment; map static obstacles; map moving obstacles; lane detection; traffic sign detection.
 - ▶ Algorithms: supervised learning, for example, SVM and convolutional neural networks
- ▶ The decision-making system
 - ▶ Tasks: route and path planning; choosing driving behaviour; avoiding obstacles.
 - ▶ Algorithms: search algorithms (Dijkstra, A*), finite state machines, Markov decision processes.
- ▶ Badue et al. (2021). [Self-driving cars: A survey](#). Expert Systems with Applications, 165, 113816.

Many other applications of AI

- ▶ Solving partial differential equations
- ▶ Antibiotic Discovery
- ▶ Hide and Seek Games
- ▶ How AI is Changing Science

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Topics in CS 486/686 (1/3)

Introduction to AI and CS486/686

1: Introduction to AI and CS 486/686, Definitions of AI

Search:

2: Uninformed Search

3: Heuristic Search

4: Constraint Satisfaction Problems

5: Local Search

Topics in CS 486/686 (2/3)

Supervised Learning:

6: Machine Learning, Decision Trees 1

7: Decision Trees 2

8: Neural Networks 1

9: Neural Networks 2

Reasoning Under Uncertainty:

10: Uncertainty and Probability

11: Semantics of Bayesian Networks

12: Testing Independence, Constructing Bayesian Networks

13: Variable Elimination Algorithm

14: Hidden Markov Models 1

15: Hidden Markov Models 2

Topics in CS 486/686 (3/3)

Decision Making Under Uncertainty:

16: Decision Theory and Decision Networks 1

17: Decision Networks 2

18: Markov Decision Process 1

19: Markov Decision Process 2

20: Reinforcement Learning 1

21: Reinforcement Learning 2

Multi-agent Systems:

22: Game Theory 1

23: Game Theory 2

24: Conclusion

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You can find the course outline at outline.uwaterloo.ca.

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