COMP/EECE 4720/6720
Intro to Artificial Intelligence

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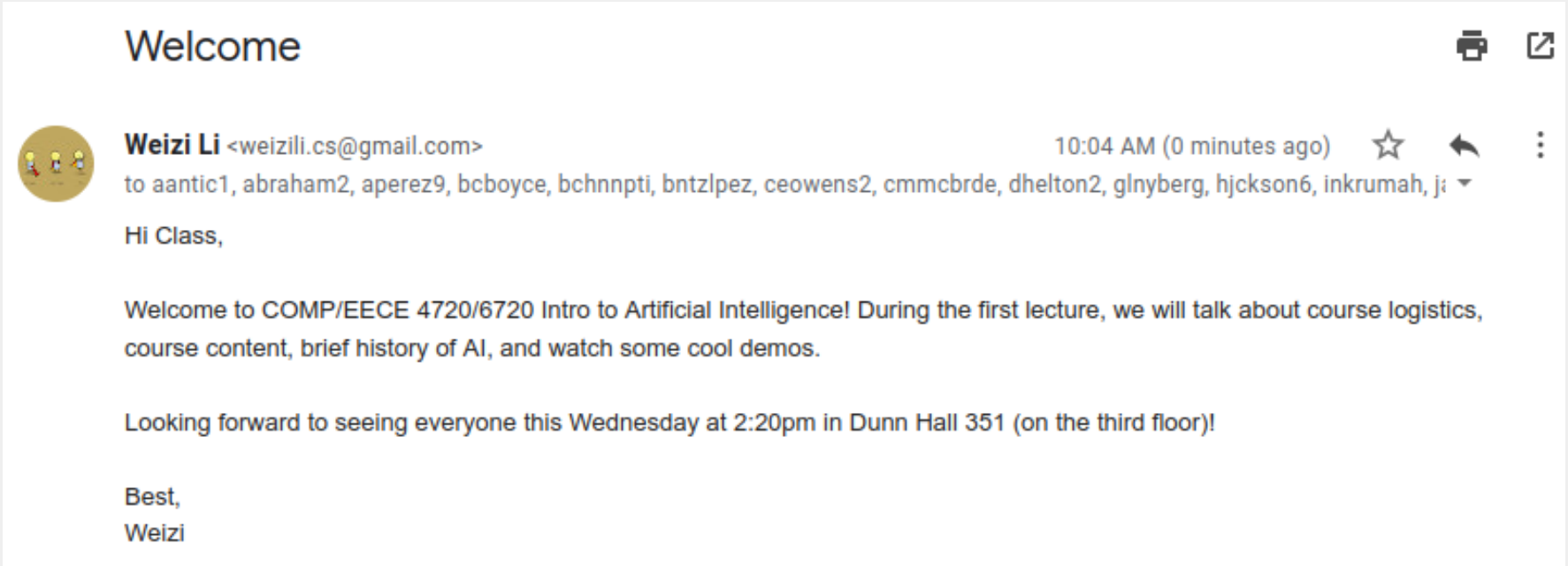
Outline

- Logistics
- Course Content
- What is AI
- Brief History of AI
- Personal Experience with AI
- Demos

Logistics

- Course website (link)
- Email for updates and notifications
- Let me know if you didn't receive my email or prefer a different email for notifications.



Welcome

Weizi Li <weizili.cs@gmail.com> 10:04 AM (0 minutes ago)

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Hi Class,

Welcome to COMP/EECE 4720/6720 Intro to Artificial Intelligence! During the first lecture, we will talk about course logistics, course content, brief history of AI, and watch some cool demos.

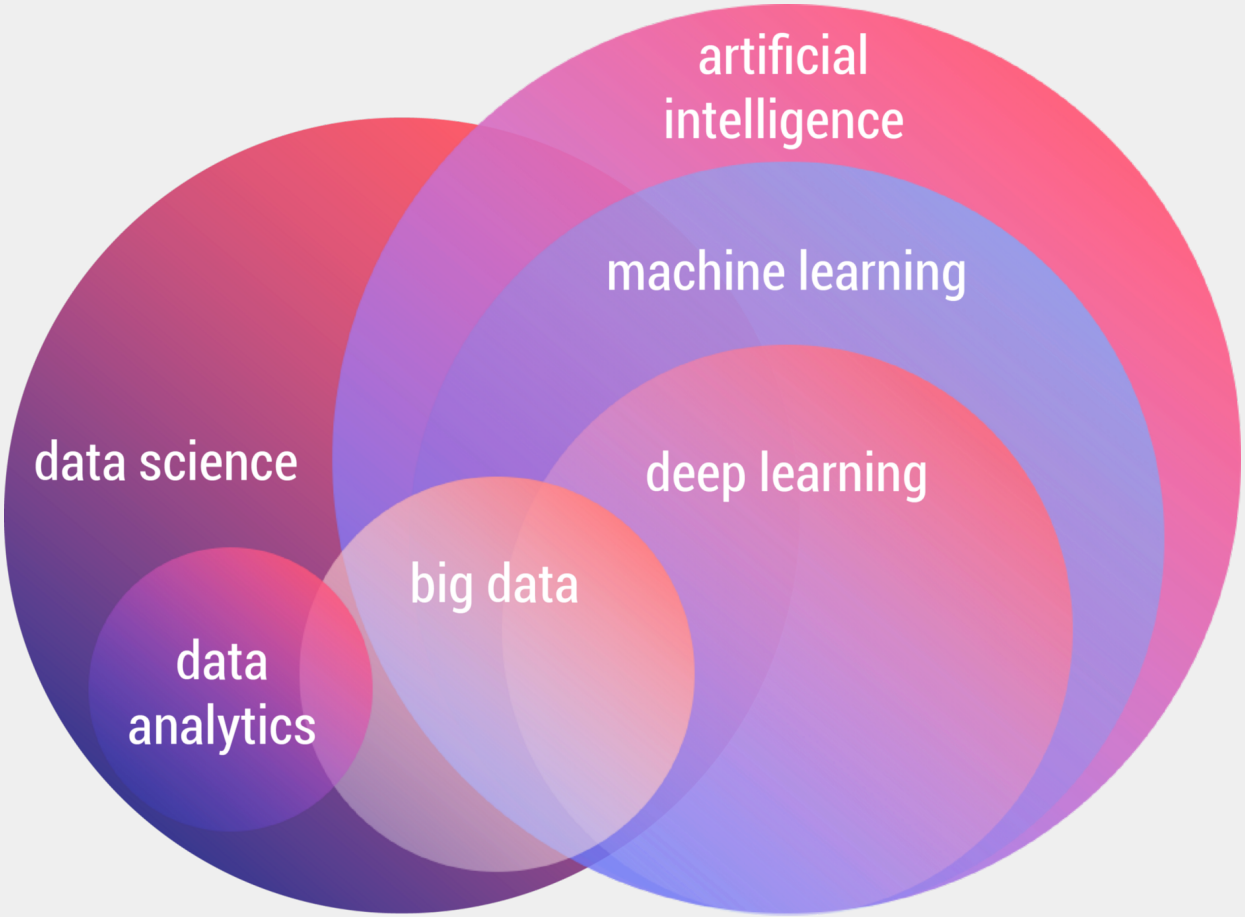
Looking forward to seeing everyone this Wednesday at 2:20pm in Dunn Hall 351 (on the third floor)!

Best,
Weizi

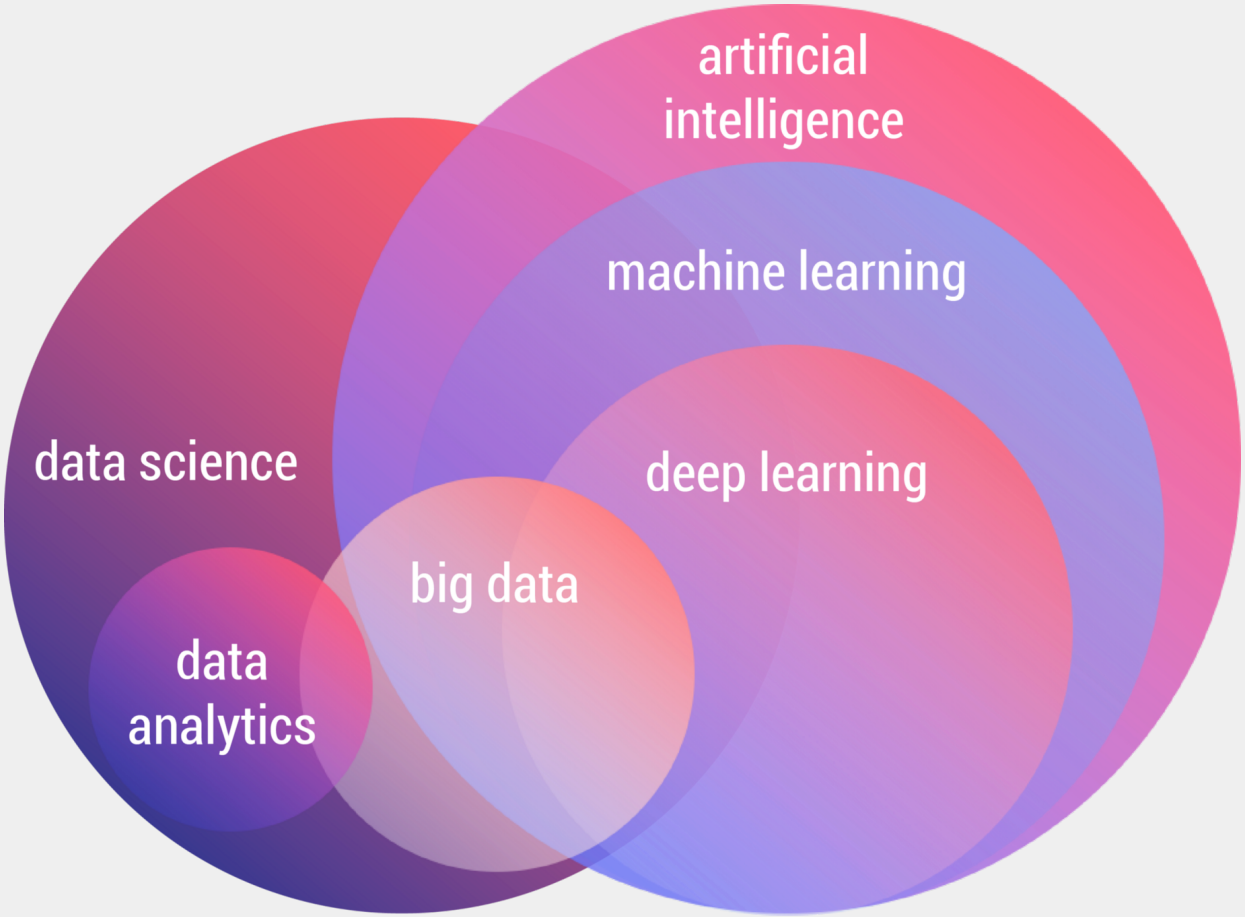
- Prerequisites
  - Math: basic Linear Algebra, Calculus, and Probability Theory
  - Programming: proficient with Python
- Course material
  - No required textbook
  - Slides ($\sim 80\%$)
  - Writing on the whiteboard ($\sim 20\%$)

Course Content

- Modern AI and deep learning, not the topics found in Undergraduate Syllabi on the department website!



- COMP 4151 Intro to Data Science
- COMP 4745 Intro to Machine Learning



- Unit 1: Foundations
  - Machine Learning Basics
  - Linear Models
  - Non-linear Models
- Unit 2: Supervised Learning (w/ Neural Networks)
  - Neural Networks Basics
  - Convolutional Neural Networks
  - Recurrent Neural Networks
  - Optimization and Stochastic Gradient Descent
- Unit 3: Unsupervised Learning (w/ Neural Networks)
  - Clustering
  - Autoencoders
  - Information Theory Basics
  - Variational Inference and Variational Autoencoders
  - Generative Adversarial Networks

- Unit 4: Reinforcement Learning (w/ Neural Networks)
  - Reinforcement Learning Basics
  - Bandits
  - Markov Decision Process
  - Dynamic Programming
  - Model-free Prediction
  - Model-free Control
  - Value Function Approximation
- Unit 5: Additional Topics
  - Philosophy, Ethics, and Safety of AI
  - Research Talks

What is AI

- Intelligence is essential to us. We call ourselves *Homo sapiens*—man the wise.
- Our brain can perceive, understand, predict, and manipulate a world, which is one of the greatest scientific mysteries.

- Artificial Intelligence: understand and build intelligent agent.
- One of the most interesting and fastest-growing fields (especially the last decade).
- Over a trillion dollars a year in revenue (=Netherlands's GDP, 17th in the world)
- AI expert Kai-Fu Lee predicts AI's impact will be "more than anything in the history of mankind."
- Not like other fields such as physics, AI research is still wide open.

Brief History of AI

- Turning (1950): "Computing Machinery and Intelligence" introduced Turning test, machine learning, genetic algorithms, and reinforcement learning
- Minsky (1969) and McCarthy (1971): defining the foundations based on representation and reasoning
- Newell and Simon (1975): symbolic models of problem solving and human cognition
- Feigenbaum and Reddy (1994): expert systems that encode human knowledge to solve real-world problems
- Pearl (2011): probabilistic reasoning
- Bengio, Hinton, LeCun (2019): deep learning

- General Problem Solver (Newell and Simon), RL checkers player (Samuel), Lisp programming language (McCarthy), Microworlds (Minsky), Perceptrons (Rosenblatt), ...

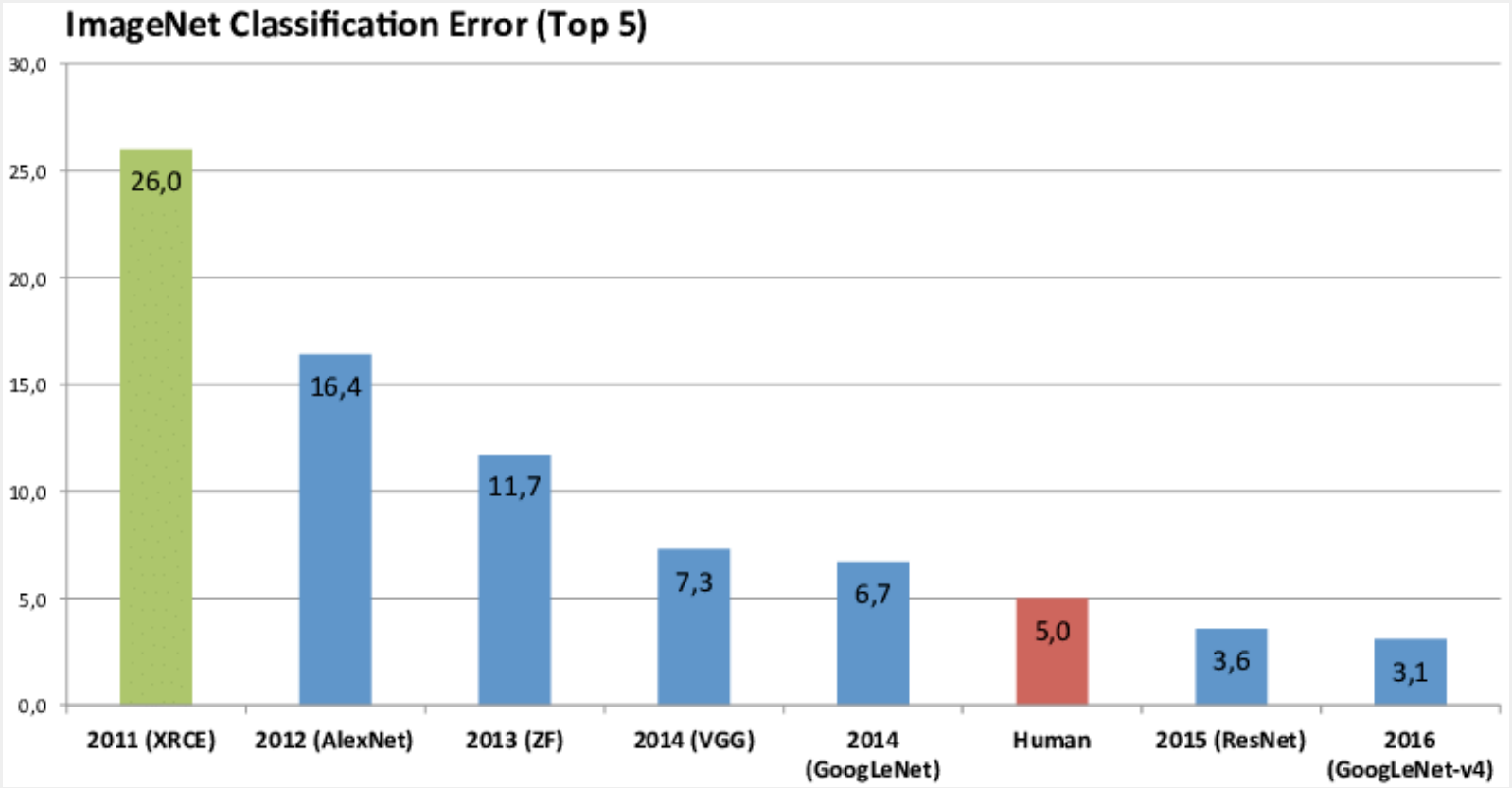
- Early systems found fail more difficult problems due to 1) the lack of analysis of specific tasks and 2) intractability of the tasks
- Minsky and Papert (1969) showed limitations of neural networks causing the first winter for these architectures

- The rising of expert systems: domain knowledge + reasoning
- The AI industry went from a few million dollars in 1980 to billions of dollars in 1988
- However, expert systems are difficult to built for complex domains due to the reasoning methods broke down in the face of uncertainty and the systems could not learn from experience
- Many companies failed to deliver their promises, causing the second AI winter until 1997

- Backpropagation (first developed in the early 1960s) is reinvented.
- Hinton: skeptical about symbolic AI research
- Probabilistic reasoning: hidden markov models, Bayesian networks, ...
- Reinforcement learning: TD-GAMMON, temporal-difference learning

- Big data: internet (text, images, videos), ubiquitous sensors, ...

- Deep learning: the breakthroughs of convolutional neural networks on ImageNet competition started everything



- By 2019, AI has reported to exceed human-level performance on various domains.
- Computer vision: ImageNet object detection
- Language processing: speech recognition in a limited domain, Chinese-to-English translation in a restricted domain
- Games (classic and video): chess, Go, poker, Pac-Man, Jeopardy!, Quake III, Dota 2, StarCraft II, various Atari games
- Biology: skin cancer detection, prostate cancer detection, protein folding, and diabetic retinopathy diagnosis

- Major improvements have been achieved on many other domains: autonomous vehicles (ground and air), autonomous planning and scheduling, recommendations, medicine discovery, climate change, ...

- These successes have stimulated huge interest in AI in both academia and industry.
- AI papers increased 20-fold between 2010 and 2019 to 20,000 a year. The most popular category is machine learning.
- Course enrollment increased 5-fold in the U.S. and 16-fold internationally from a 2010 baseline. AI is the most popular specialization in CS.
- AI startups increased 20-fold in the U.S. to over 800.
  - OpenAI and DeepMind are leading companies on deep learning.

Personal Experience with AI

- 2009: study AI in graduate school: Lisp programming, expert systems, linear temporal logic, etc.
- 2010: study ML in graduate school: Bayesian inference, graphical models, HMMs, CRFs, topic modeling, nonparametric approaches, etc.
- Until 2015: "data-driven" is a hot keyword to put into paper titles for computer graphics research
- 2015: during internship at Disney research, support vector machines are still widely used (even deep learning revolution has started).
- 2016: start to use deep neural networks
- 2018: start to use deep reinforcement learning

- 2013–2016: besides AI and ML, other branches of CS are slowly picking up deep learning.
- 2016–Present: all CS branches (except for a few such as theoretical CS and systems) have adopted deep learning.
- 2018–Present: other fields are adopting deep learning at an increased speed depending on the technical barriers such as programming.

Demos

- Atari games (link)
- AlphaZero (link), AlphaGo documentary (link)
- AlphaStar (link)
- AlphaFold (link)
- OpenAI Five (link)
- Hide and Seek (link)
- Rubik's Cube (link)