



EECS 230 Deep Learning

Lecture 1: Introduction

Machine learning

❑ What is machine learning?

❑ The capability of a machine to learn from data to imitate intelligent human behavior.

❑ Many Applications

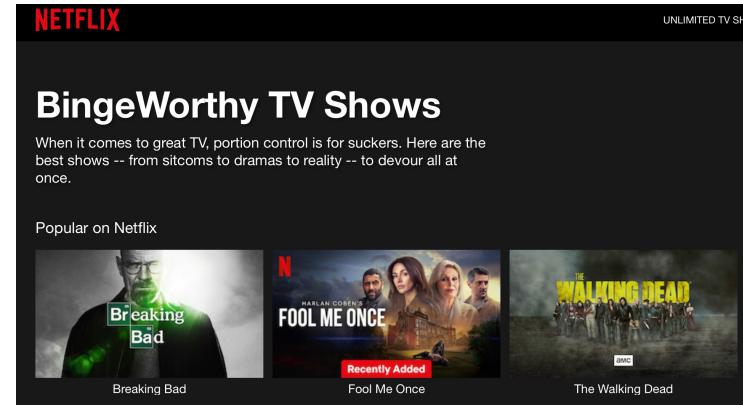


Autonomous driving



Hey Siri

Speech recognition



Recommendation system

Machine learning ≠ Artificial Intelligence

- ❑ Machine learning is a specific approach within the broader field of artificial intelligence.
- ❑ Machine learning specifically involves the use of algorithms and statistical models for learning from data.
- ❑ AI encompasses a wider range of techniques, including
 - ❑ rule-based systems
 - ❑ expert systems
 - ❑ machine learning
 - ❑ and more

Machine learning ≠ Artificial Intelligence

- ❑ IBM DeepBlue (1997)
 - ❑ Chess game
 - ❑ sophisticated algorithm, expert-system, and brute-force computation
 - ❑ Not machine learning
- ❑ Deepmind AlphaGo (2016)
 - ❑ Go game (more complex)
 - ❑ Use deep neural networks
 - ❑ Trained on datasets of expert go game



Major Types of machine learning

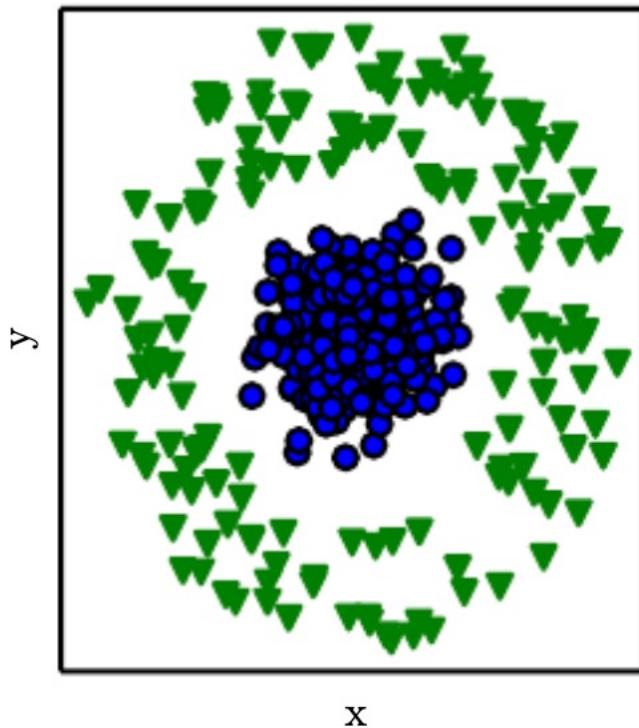
- ❑ Supervised learning: Given pairs of input-output, learn to map the input to output
 - ❑ Image classification
 - ❑ Speech recognition
 - ❑ Regression (continuous output)
- ❑ Unsupervised learning: Given unlabeled data, uncover the underlying structure or distribution of the data
 - ❑ Clustering
 - ❑ Dimensionality reduction
- ❑ Reinforcement learning: training an agent to make decisions within an environment to maximize a cumulative reward
 - ❑ Game playing (e.g., AlphaGo)
 - ❑ Robot control

Other Types of machine learning

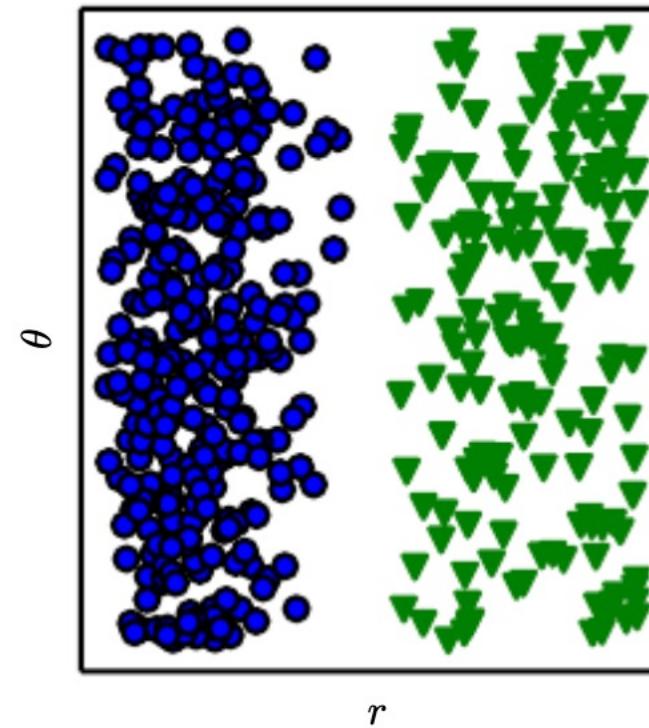
- ❑ Semi-supervised learning: Learning from a combination of labeled data and unlabeled data
- ❑ Transfer learning: applying knowledge learned from one task to another related task

Examples of representations

Cartesian coordinates

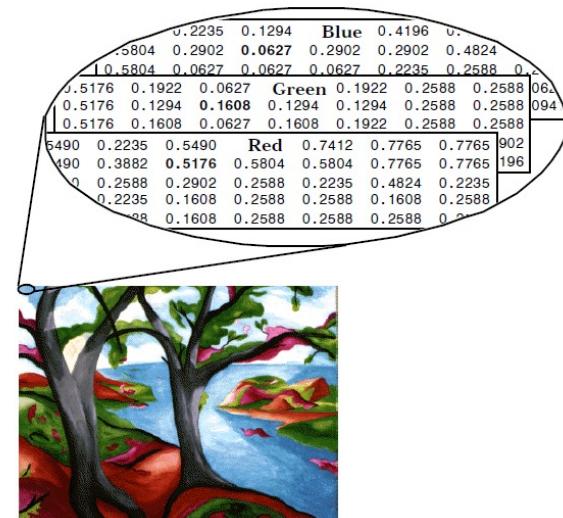
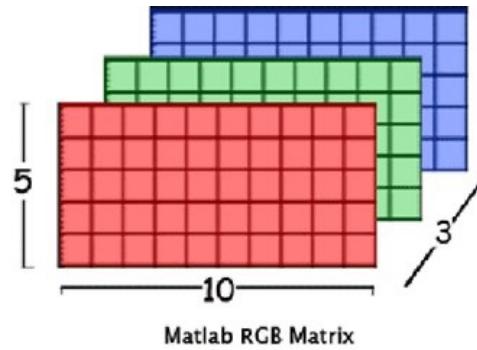
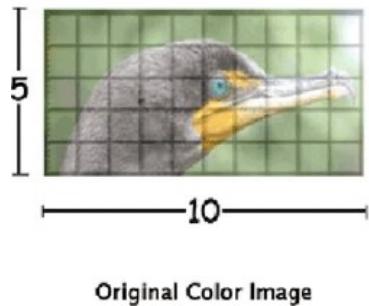


Polar coordinates



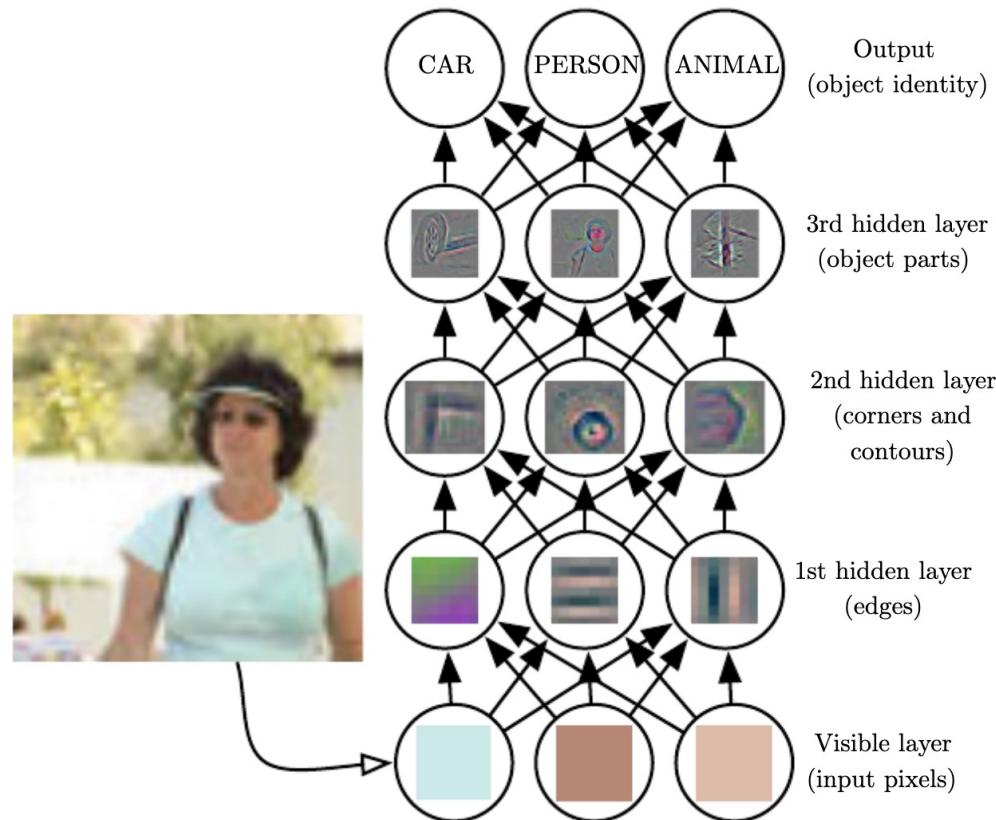
How to represent raw sensory data?

- ❑ Cannot hand-craft representation
- ❑ Representation learning

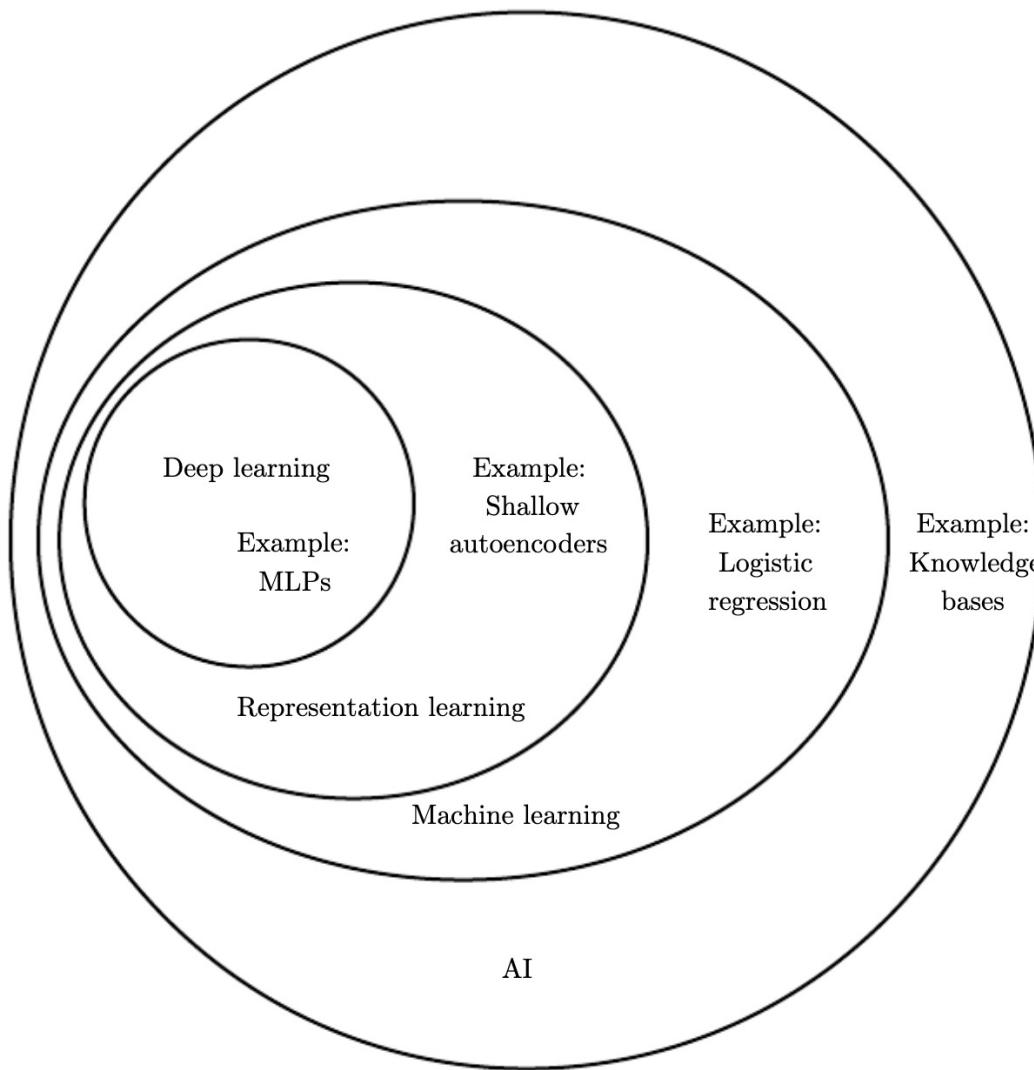


A deep learning model

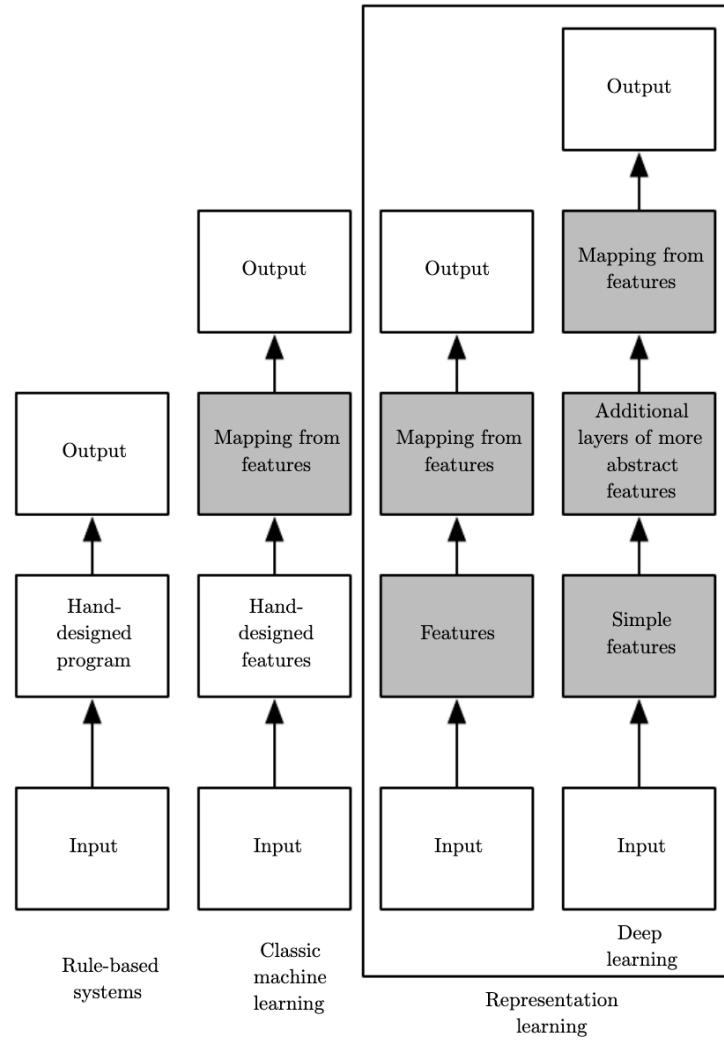
- Deep neural networks learn hierarchical representation



Deep Learning



Different AI systems



Deep Learning is not new

- ❑ Deep learning dates back to 1940s!
 - ❑ McCulloch, W. S. and Pitts, W., A logical calculus of ideas immanent in nervous activity. Bulletin of Mathematical Biophysics, 1943
- ❑ Rebranded multiple times, three waves of development
 - ❑ Known as “cybernetics” in the 1940s-1960s
 - ❑ “Connectionism” in the 1980s-1990s
 - ❑ Also known as “Artificial Neural Network” (ANN)
 - ❑ Out of fashion since the mid 1990s until 2006. In the meantime, kernel methods and graphical model has advanced much more
 - ❑ Breakthrough in 2006: greedy layer-wise pretraining

Deep Learning Era since 2012

ImageNet Classification with Deep Convolutional Neural Networks

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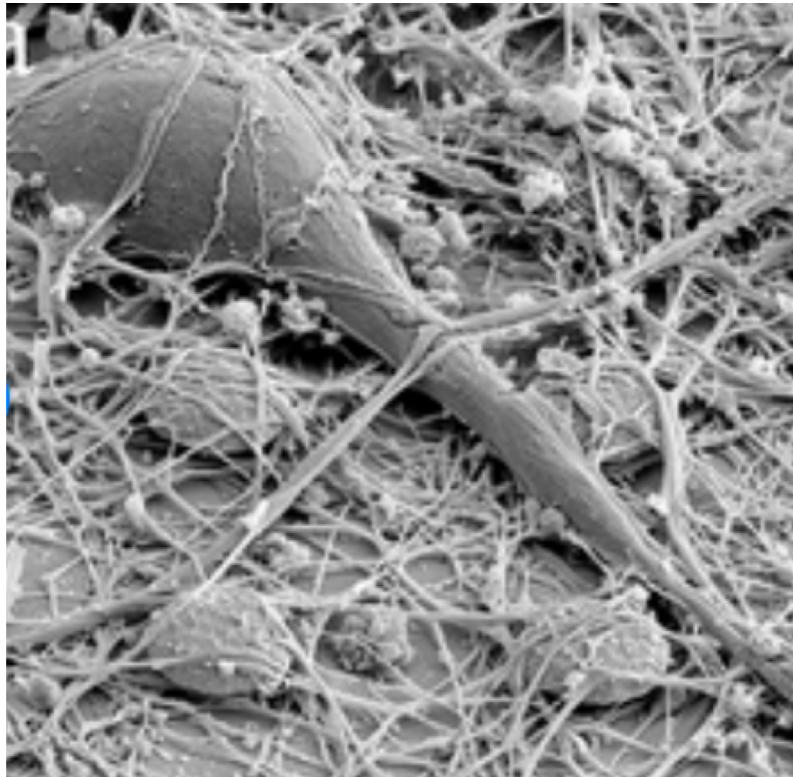
Geoffrey E. Hinton
University of Toronto
hinton@cs.utoronto.ca

Landmarks in deep learning

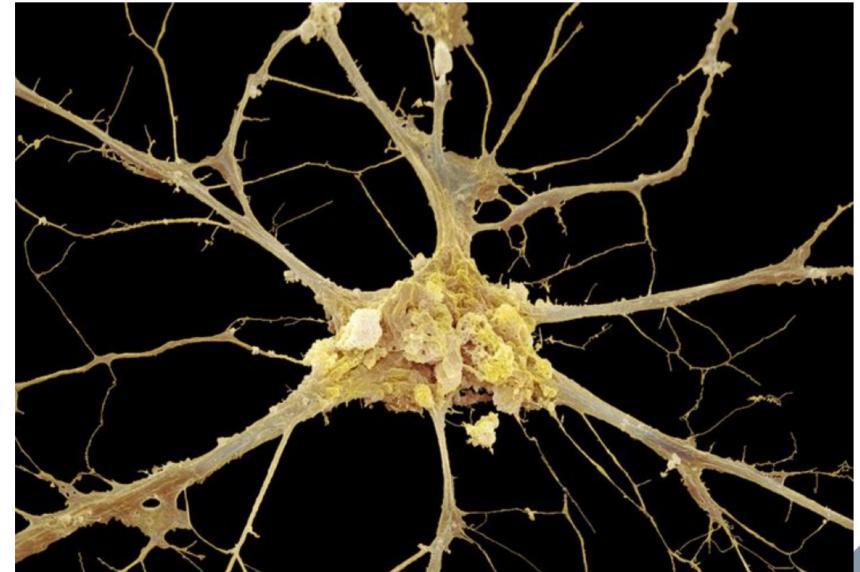
- 1958 Perceptron (Simple ‘neural’ model)
- 1986 Backpropagation (Practical Deep Neural networks)
- 1989 Convolutional networks (Supervised learning)
- 2012 AlexNet Image classification (Supervised learning)
- 2014 Generative adversarial networks (Unsupervised learning)
- 2014 Deep Q-Learning -- Atari games (Reinforcement learning)
- 2016 AlphaGo (Reinforcement learning)
- 2017 Machine translation (Supervised learning)
- 2019 Language models ((Un)supervised learning)
- 2022 Dall-E2 Image synthesis from text prompts ((Un)supervised learning)
- 2022 ChatGPT ((Un)supervised learning)
- 2023 GPT4 Multimodal model ((Un)supervised learning)

Biological Motivation for Neural Network

SEM of brain tissue



A colored scanning electron micrograph (SEM) of a neuron (nerve cell).



Biological Motivation for Neural Network

- ❑ Human Brain
 - ❑ Densely interconnected network of 10^{11} (100 billion) neurons
 - ❑ Each connected to 10^4 (10,000) others
 - ❑ Fastest neuron switching time is 10^{-3} seconds
- ❑ Activity excited or inhibited through connections to other neurons
- ❑ Slow compared to computer switching speed: 10^{-10} secs



Human Information Processing Speed

- ❑ Humans can make certain decisions (visually recognize your mother) in 10^{-1} secs
- ❑ Implies that in 10^{-1} sec interval cannot possibly have more than a few hundred steps, given switch speed
- ❑ Therefore, information processing abilities of biological systems follow from highly parallel processing operations distributed over many neurons



Applications of Deep Learning

Computer Vision

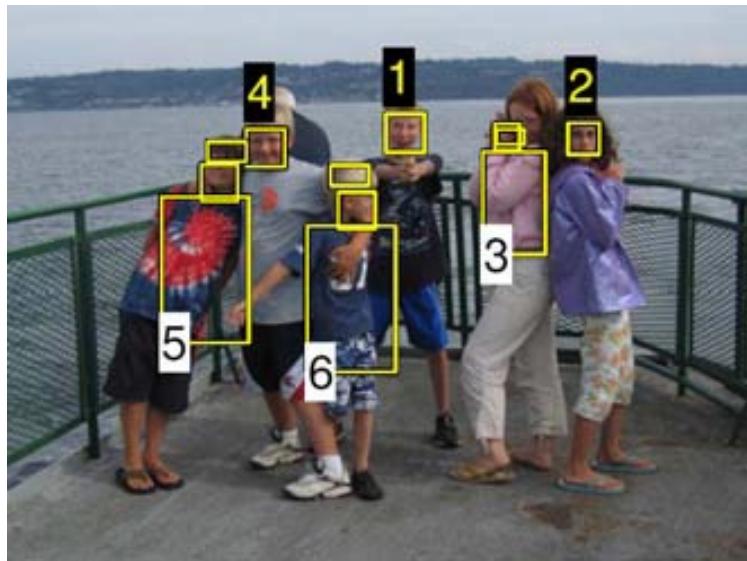
❑ Object detection and segmentation



[Detectron2](#)

Computer Vision

❑ Face Detection



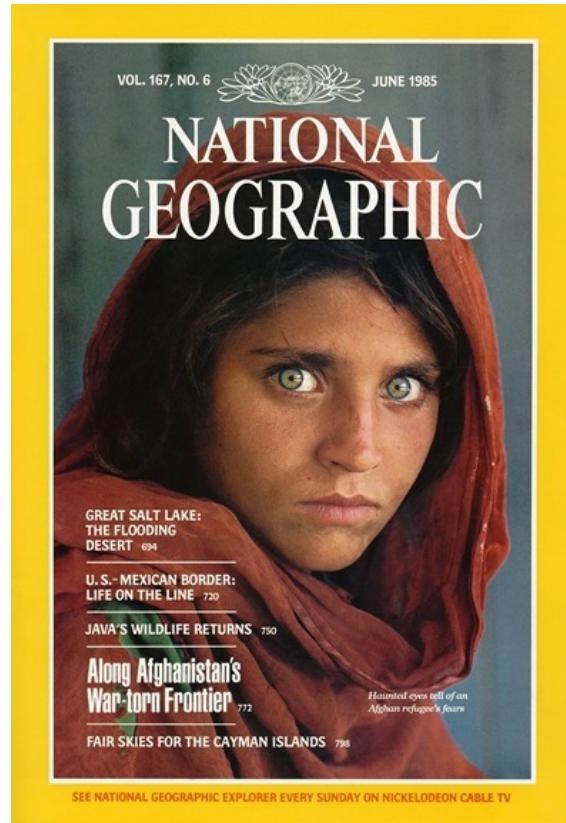
face detection around 00's



and now

Computer Vision

❑ Face recognition



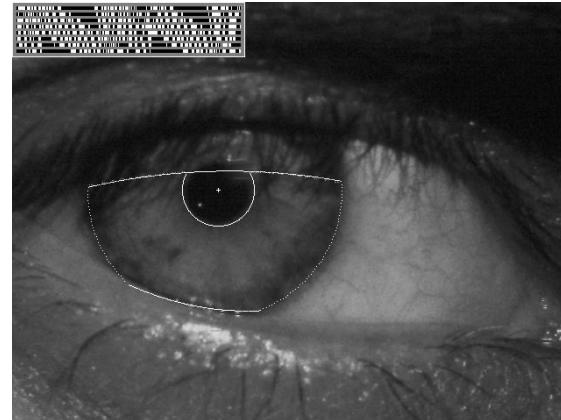
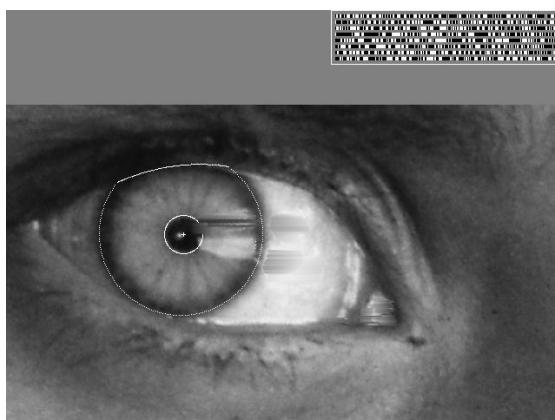
Who is she?

Computer Vision

❑ Face recognition

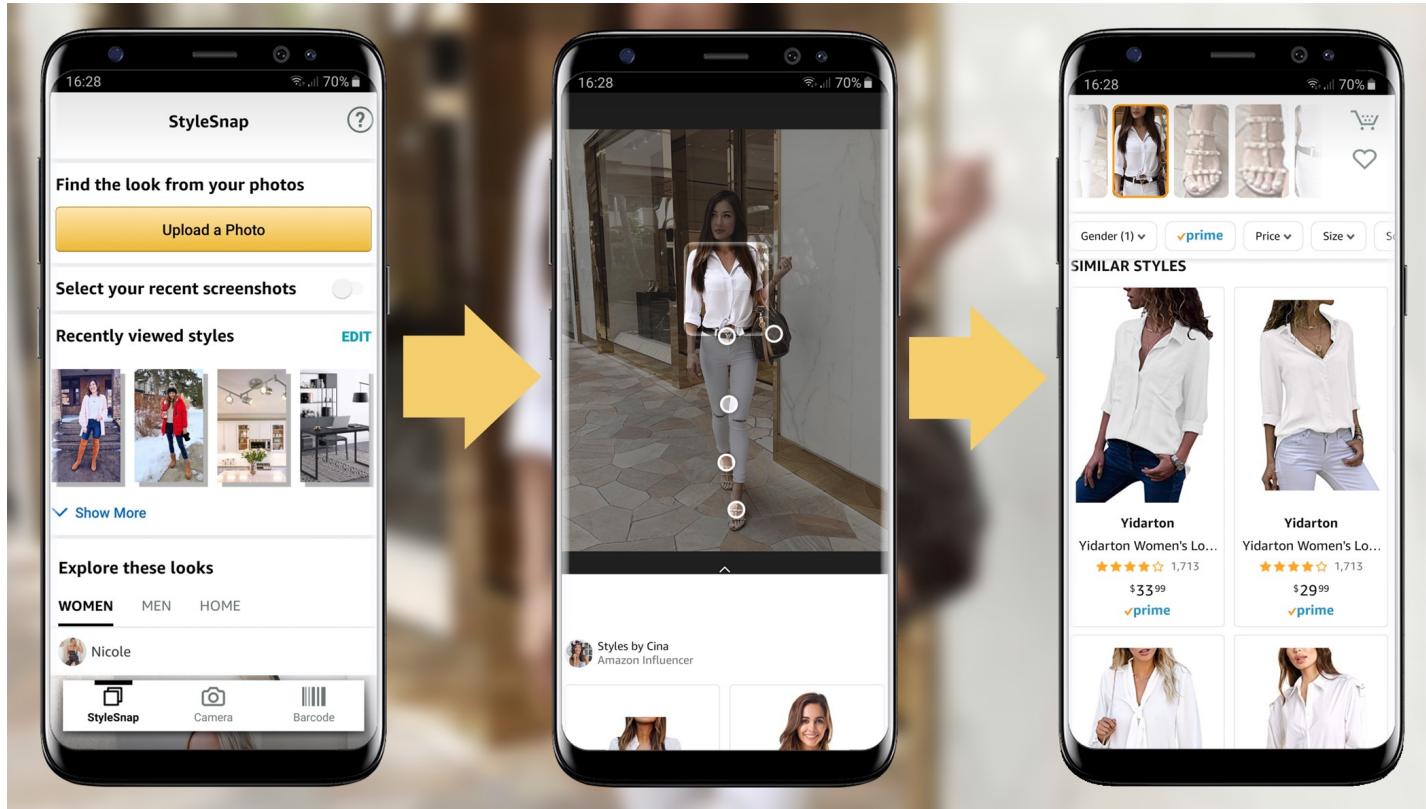


"How the Afghan Girl was Identified by Her Iris Patterns" Read the [story](#)



Computer Vision

❑ Visual Search



[Amazon Shop the Look: A Visual Search System for Fashion and Home](#)

Computer Graphics

❑ Avatar



Meta Reality Labs Research - Codec Avatar

Image Synthesis

❑ Generative Adversarial Network (GAN)



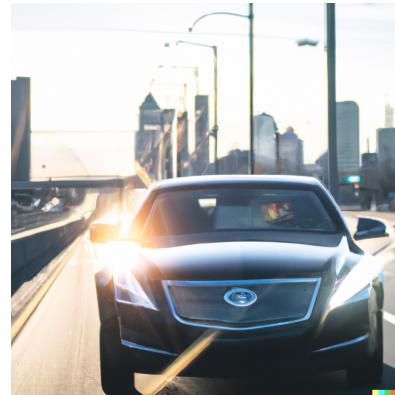
Image Synthesis from Text

❑ DALLE-2

❑ IMAGEN



"A photo of an astronaut riding a horse."



"A modern, sleek Cadillac drives along the Gardiner expressway with downtown Toronto in the background, with a lens flare, 50mm photography."



"A man walking through the bustling streets of Kowloon at night, lit by many bright neon shop signs, 50mm lens."

ChatGPT- <https://chat.openai.com/>

HU You

How to obtain A+ grade in a graduate level course on deep learning?

ChatGPT

Achieving an A+ grade in a graduate-level course on deep learning requires a combination of dedication, effective study strategies, and practical application of knowledge. Here are some tips to help you excel in your deep learning course:

1. Understand the Basics:

- Ensure you have a solid understanding of the foundational concepts in machine learning and neural networks before delving into deep learning.

2. Master the Fundamentals:

- Thoroughly understand key deep learning concepts, such as activation functions, loss functions, optimization algorithms, and backpropagation.

3. Stay Current:

- Deep learning is a rapidly evolving field. Stay updated on the latest research papers, advancements, and trends by following relevant conferences, journals, and online platforms.

4. Hands-On Practice:

- Apply theoretical concepts through hands-on projects. Use deep learning frameworks like TensorFlow or PyTorch to implement algorithms and models.

ChatGPT- <https://chat.openai.com/>

5. Work on Real-World Projects:

- Apply deep learning to real-world problems. This not only solidifies your understanding but also provides you with practical experience.

6. Participate in Competitions:

- Join online platforms like Kaggle to participate in deep learning competitions. This will give you exposure to diverse problems and help you improve your problem-solving skills.

7. Effective Time Management:

- Allocate dedicated time for studying and completing assignments. Avoid procrastination, and break down larger tasks into smaller, manageable chunks.

8. Engage with Class Material:

- Attend lectures regularly, actively participate in discussions, and ask questions. Engaging with the material will deepen your understanding.

9. Collaborate with Peers:

- Work on group projects or collaborate with classmates. Discussing concepts with others can provide different perspectives and enhance your learning.

10. Seek Feedback:

- Actively seek feedback from professors, TAs, or peers on your assignments and projects. Use constructive criticism to improve your work.

11. Review Regularly:

- Periodically review previous material to reinforce your understanding. Deep learning builds on foundational concepts, so a strong grasp of the basics is crucial.

ChatGPT- <https://chat.openai.com/>

12. Utilize Resources:

- Take advantage of online resources, tutorials, and books to supplement your learning. Recommended textbooks, online courses, and research papers can provide additional insights.

13. Stay Organized:

- Keep your study materials, notes, and assignments well-organized. This makes it easier to review and revise when necessary.

14. Balance Theory and Practice:

- Find the right balance between theoretical understanding and practical application. Both are essential for success in deep learning.

15. Take Care of Yourself:

- Ensure a healthy work-life balance. Take breaks, get enough sleep, and maintain your overall well-being to stay focused and productive.

Remember, achieving an A+ grade is not just about memorizing information but demonstrating a deep understanding and application of concepts. Consistent effort, active engagement, and a genuine interest in the subject will contribute to your success.

Topics

- ❑ Brief review of machine learning (10%, 1 lec.)
- ❑ Basics of neural networks (20%, 3 lec.)
 - ❑ Multi-layer perceptron
 - ❑ Feed-forward network and Recurrent neural network
 - ❑ Optimization and regularization
- ❑ Modern neural network architectures (40%, 5 lec)
 - ❑ Convolutional neural network
 - ❑ Neural network for graph and set
 - ❑ Transformer
- ❑ Advanced topics and applications (30%, 4 lec)
 - ❑ Deep structured model
 - ❑ Deep generative model (VAE, GAN, diffusion model)
 - ❑ Multimodal deep learning
- ❑ Guest lecture (1 lec.)

Prerequisites

- ❑ Linear algebra
- ❑ Probability and Statistics
- ❑ Basics of machine learning (To be reviewed)
- ❑ Data structure and algorithms
- ❑ Python programming
 - ❑ Will use Pytorch or Tensorflow framework

Grading

Exams (20%)

Midterm: 20%

Project (50%)

Midterm report 10%

Final presentation 10%

Final report 30%

Assignment (30%)

3 assignments

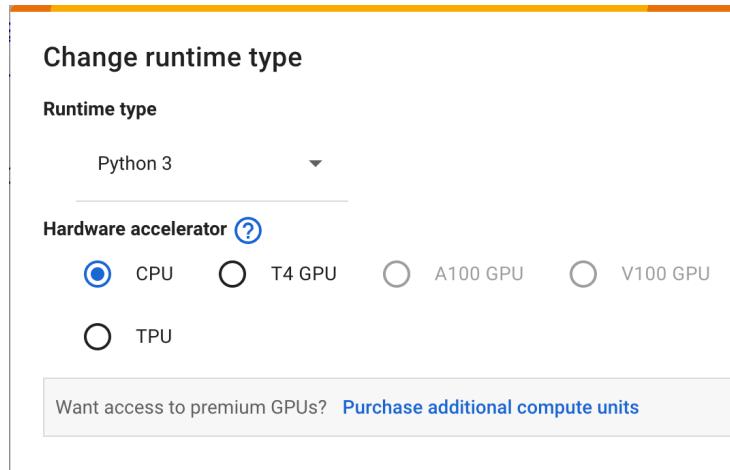
5%, 10%, 15%

Project

- ❑ At most two students for each project
 - ❑ If two, expect more complex/larger scale project, include a statement of each student's contribution.
- ❑ Midterm report (Up to 2 pages excluding reference)
 - ❑ Project proposal
 - ❑ Preliminary results
- ❑ Final project presentation (10 minutes + 2 minutes Q/A)
- ❑ Final project report (Up to 8 pages excluding reference)
- ❑ Can choose your own research project
- ❑ Alternatively, a list of projects provided

GPU

- ❑ Use Python notebook via Google Colab for assignment



- ❑ For project
 - ❑ Your own GPU
 - ❑ Google cloud credit (spot VM)

Course Materials

❑ Course webpage

- ❑ <https://ucmercedeecs230.github.io/>
- ❑ Syllabus
- ❑ Lecture notes
- ❑ Assignments

❑ Textbook

- ❑ Understanding Deep Learning by Simon J.D. Prince Published by MIT Press 2023.
<https://udlbook.github.io/udlbook/>

❑ Reference for background study:

- ❑ Deep Learning by Ian Goodfellow and Yoshua Bengio and Aaron Courville
<https://www.deeplearningbook.org/>
- ❑ UvA Deep Learning Tutorials <https://uvadlc-notebooks.readthedocs.io/en/latest/>