CSC 561: Neural Networks and Deep Learning

Course Logistics

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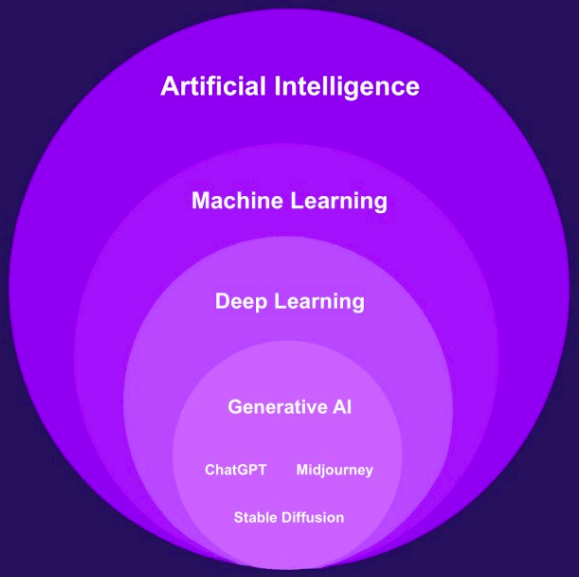
THINK BIG WE DO℠

~~Neural Networks are taking over !~~

Image credit: Dall-E 2

The AI landscape

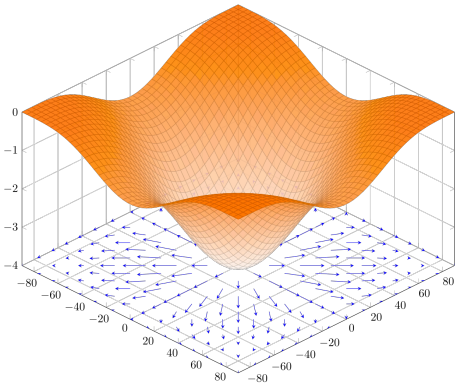
- Artificial Intelligence (AI)
  - broad field focused on simulating human intelligence
  - AI goals (problem solving, decision making, planning, etc) achieved through various methods
- Machine Learning (ML)
  - subfield of AI where algorithms learn from data without explicit programming
  - provides foundations for learning
- Neural Networks (NNs)
  - building blocks of DL, mimicking the interconnected neurons in the brain
- Deep Learning (DL)
  - subset of ML inspired by the structure and function of the brain
  - powerful for complex tasks



https://www.kaggle.com/code/yashsarwaiya/generative-ai

The engine of NNs

$$\nabla f(\mathbf{w}) = \left[\frac{\partial f}{\partial w_1}, \ldots, \frac{\partial f}{\partial w_n}\right]$$

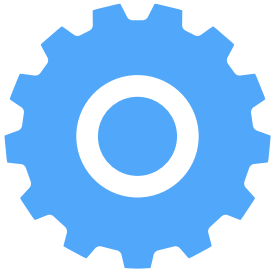


Gradient Descent and Backpropagation

https://en.wikipedia.org/wiki/Gradient

Progress driven by advances in CS and Engineering

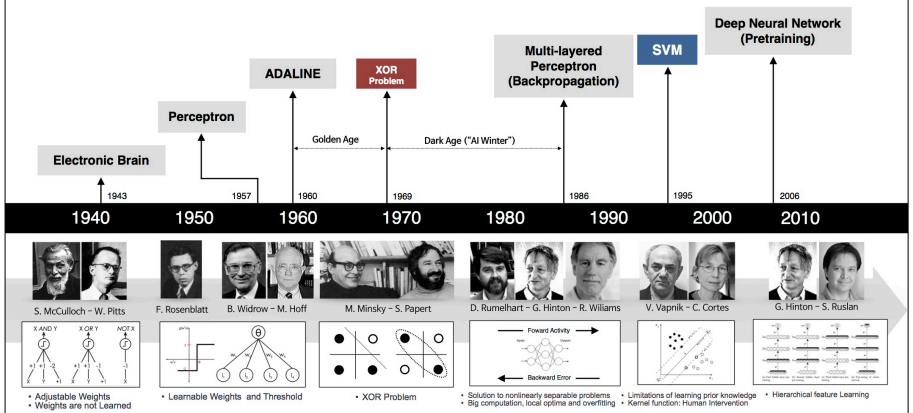
Better algorithms



Faster hardware

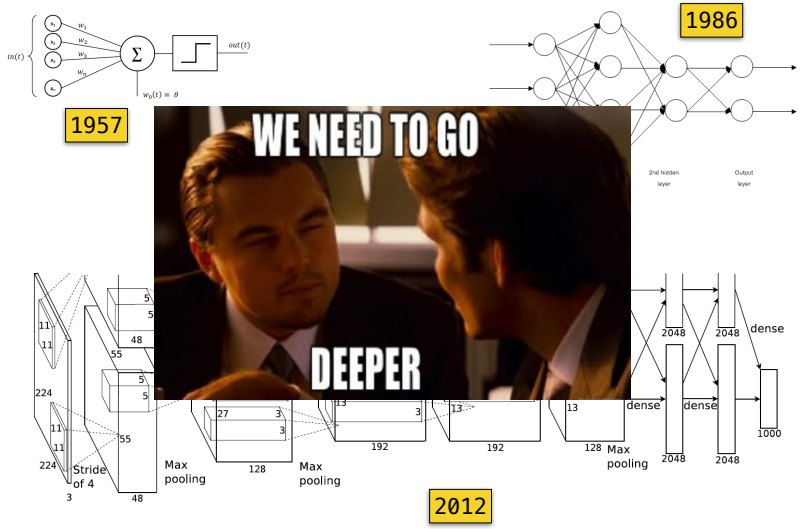
More data

Early milestones in NNs

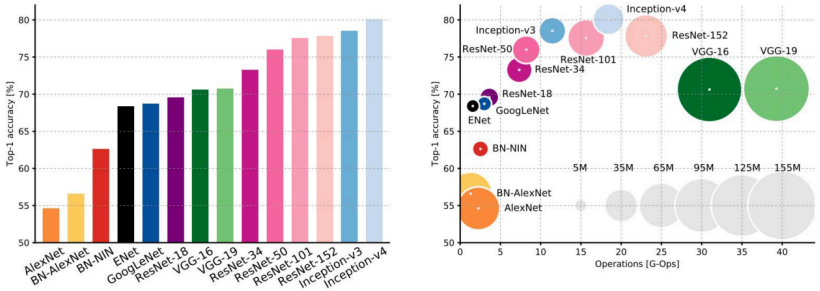


http://beamandrew.github.io/deeplearning/2017/02/23/deep_learning_101_part1.html

How did we get here?

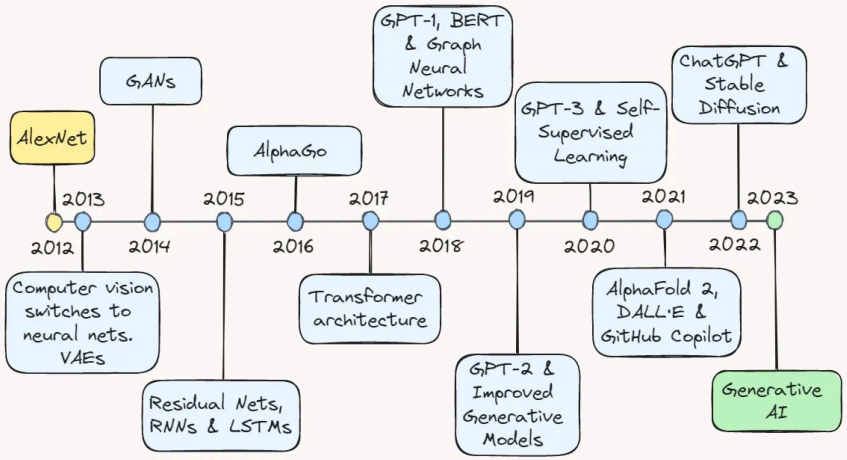


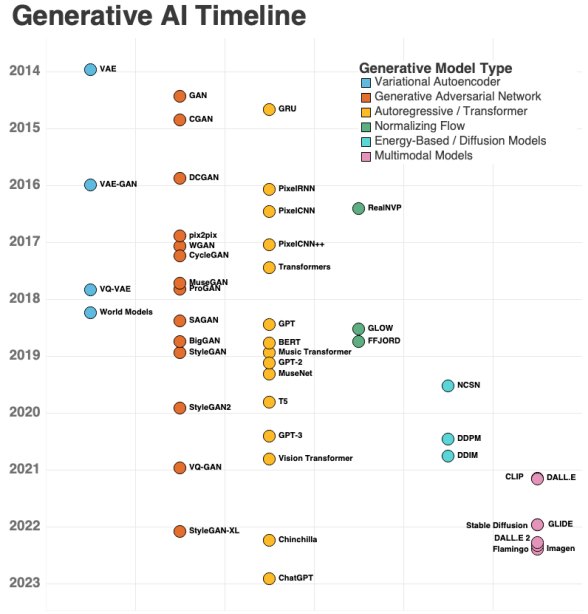
Back in 2017 …



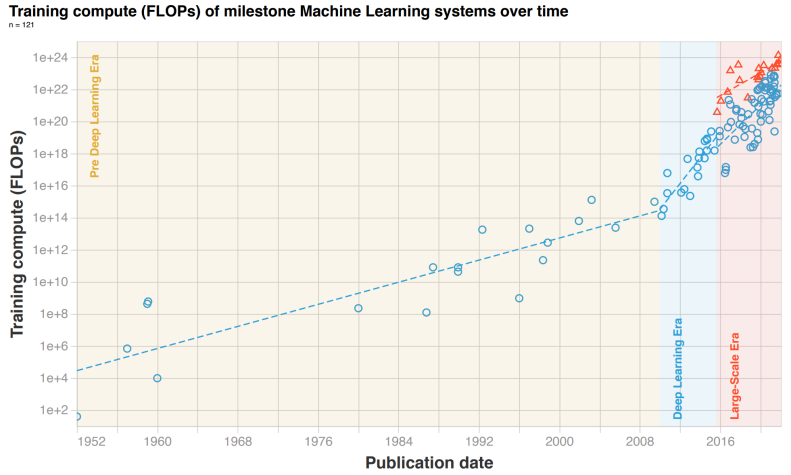
An Analysis of Deep Neural Network Models for Practical Applications, 2017.

It only took 10 years …

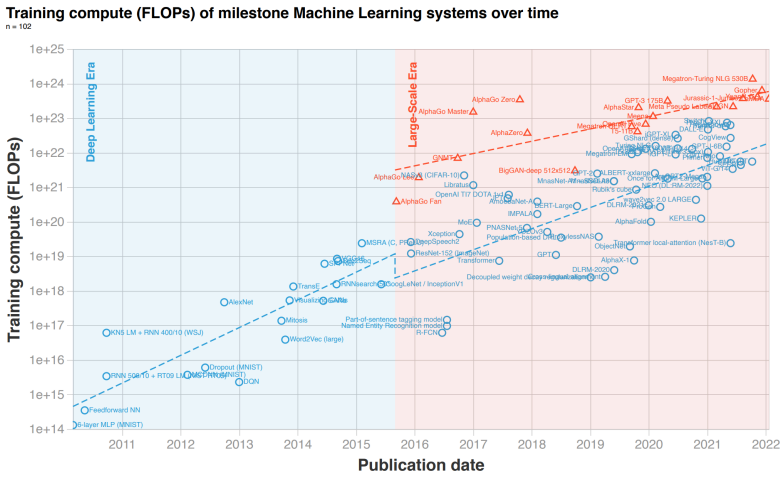




Need for compute



Need for compute



Compute Trends Across Three Eras of Machine Learning, Sevilla et al, ArXiv, 2022

The future …

This guy didn't know about neural networks (a.k.a deep learning)

This guy learned about neural networks (a.k.a deep learning)

http://deeplearning.cs.cmu.edu/S21/document/slides/lec0.logistics.pdf

Syllabus

Course info

- Instructor
  - Marco Alvarez
- Lectures
  - TTh 2-3:15p @ CBLS 152
- Office hours
  - T 3:30-4:30p @ Tyler 255
- Course website
  - https://homepage.cs.uri.edu/~malvarez/teaching/csc-561/

Pre-requisites

- Linear Algebra, Probability and Statistics, Multivariate Calculus
- Proficiency in Python
- Machine Learning Theory/Practice

`Check the Resources tab on the course website`

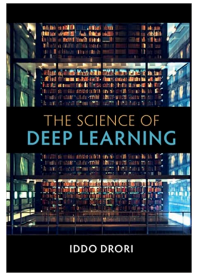
Objectives (high level)

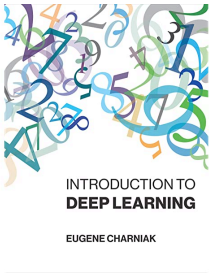
- Understanding the theoretical aspects of neural networks
- Understanding specific approaches and architectures
- Learning how to design, build, and train a variety of neural networks
- Getting ready for further work (your research or job market preparation)

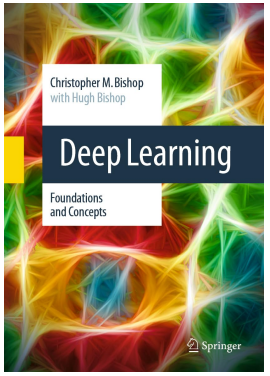
Tentative plan

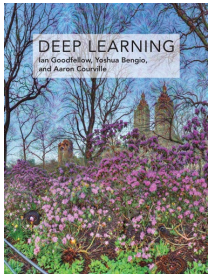
- Foundations
  - neural networks basics, deep learning
  - activations, loss functions, backpropagation
  - advanced optimization (gradient descent variants) and regularization techniques
  - mixed precision training
- Modern architectures
  - CNNs, RNNs, attention mechanisms, transformers, graph neural networks, etc
- Generative models
  - GANs, variational autoencoders, diffusion models
- Reinforcement learning
- Applications
  - computer vision, natural language processing, speech

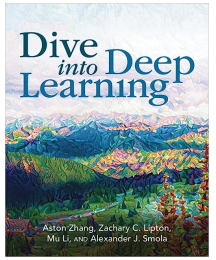
Recommended textbook(s)











Grading (subject to change)

- Homework Assignments (30%) — about 6
  - programming, problem sets
- Quizzes (40%) — about 5-6
  - short multiple choice tests
  - questions extracted from papers/readings assigned by the instructor
- Final Project (30%) — teams of 2
  - progress report (by mid-March)
  - final report (by end of semester)
  - poster (workshop)

Assignments

- Discussions and collaboration are allowed, however students **must** submit their own work
- All assignments must be submitted via **Gradescope** by the specified deadlines
  - late submissions are **NOT** accepted

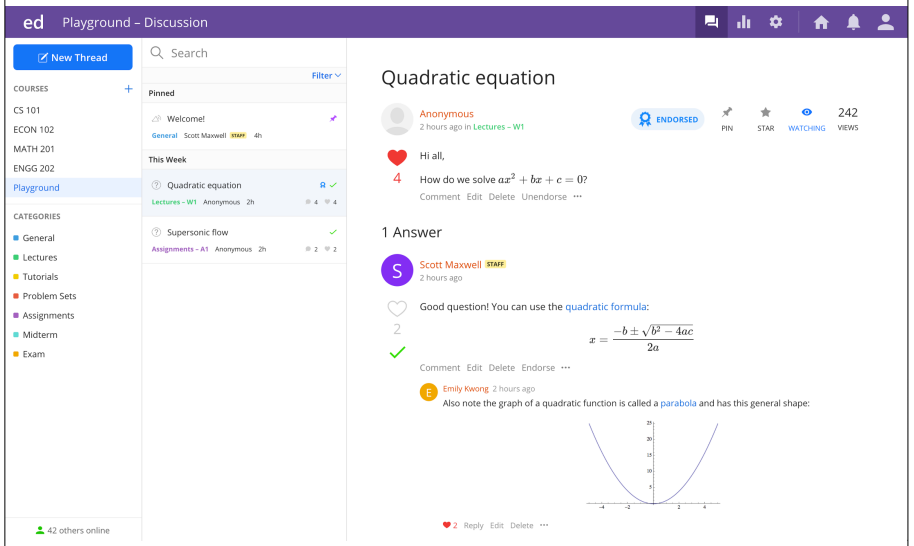
Plagiarism?

- just **don't do it**
- if you get caught your name(s) will be immediately reported

Need help?

- Come to office hours
  - or lets go for a coffee
- **Ed Discussion**
  - openly post your questions, big or small, your peers might have the answer, and others can learn alongside you
  - share your knowledge, offer insights or clarify a concept, don't hesitate to respond to questions and contribute to the collective understanding
- Avoid emails
  - use **Ed Discussion** for all class related communication
  - emails are welcome for personal/private issues

Ed Discussion



Participation

- This course isn't about passively absorbing information
  - students are encouraged to **dive deep and connect** to others
  - lectures, office hours, EdStem, etc.
- Set some time aside to work weekly
  - ambitious schedule
  - small and consistent efforts lead to significant progress
- Chances are this topic resonates with your research interests
  - be proactive in learning as much as you can
  - Although attendance is not taken, you don't want to skip lectures

Questions?