

CSC 561: Neural Networks and Deep Learning

Course Logistics

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~~Neural Networks are taking over!~~



Image credit: Dall-E 2

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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

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Artificial Intelligence

Machine Learning

Deep Learning

Generative AI

ChatGPT Midjourney

Stable Diffusion

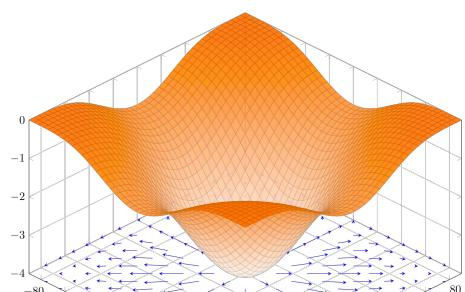
<https://www.kaggle.com/code/yashsarwaiya/generative-ai>

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The engine of NNs

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

Gradient Descent
and
Backpropagation



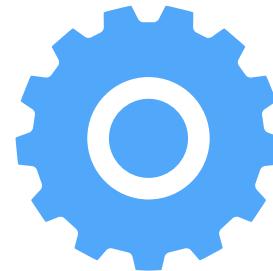
<https://en.wikipedia.org/wiki/Gradient>

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Progress driven by advances in CS and Engineering



Better algorithms



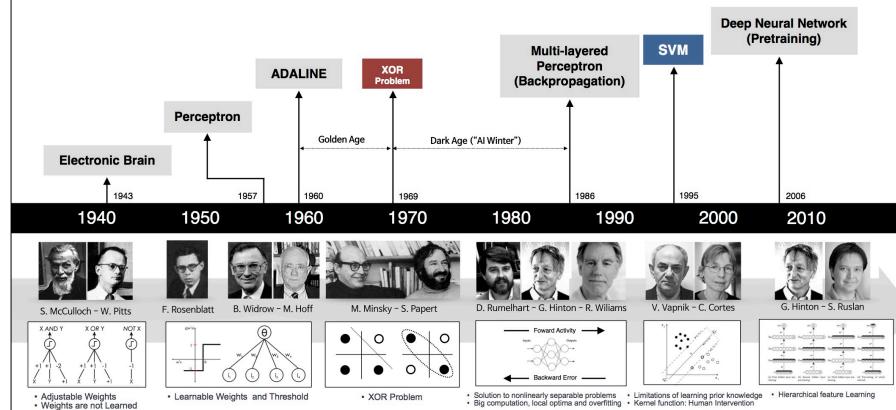
Faster hardware



More data

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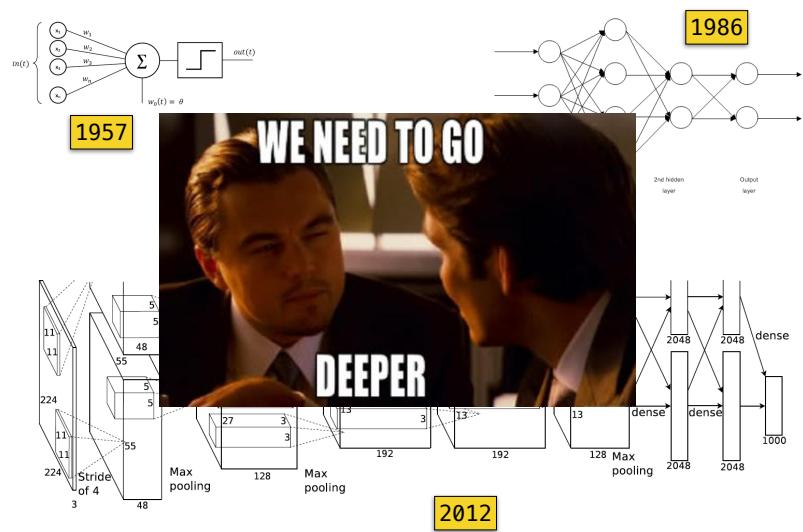
Early milestones in NNs



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

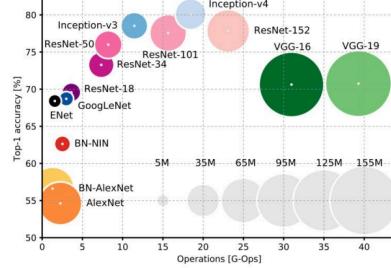
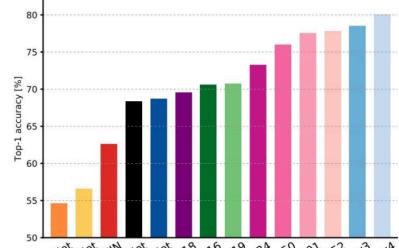
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How did we get here?



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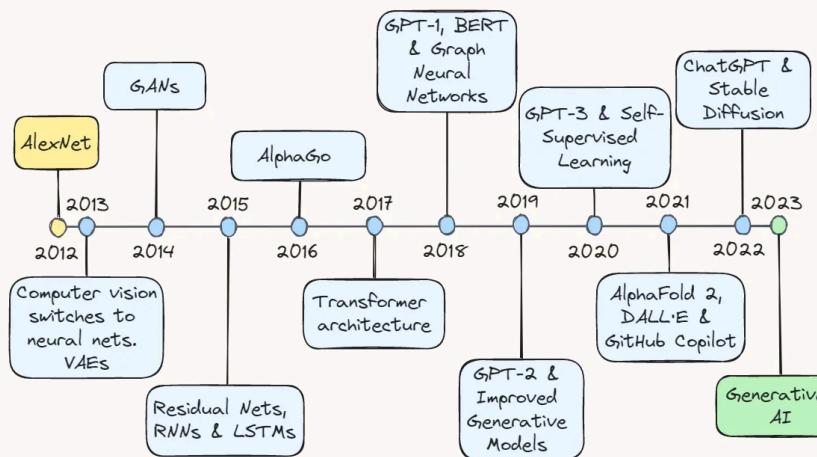
Back in 2017 ...



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

http://cs231n.stanford.edu/slides/2019/cs231n_2019_lecture09.pdf

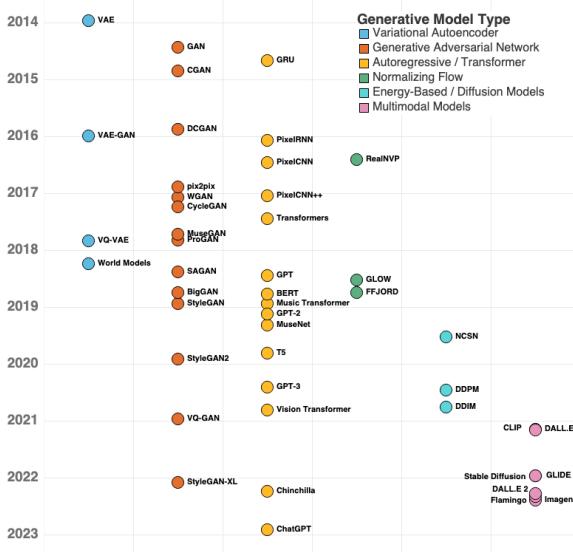
It only took 10 years ...



<https://towardsdatascience.com/ten-years-of-ai-in-review-85decd2ba540>

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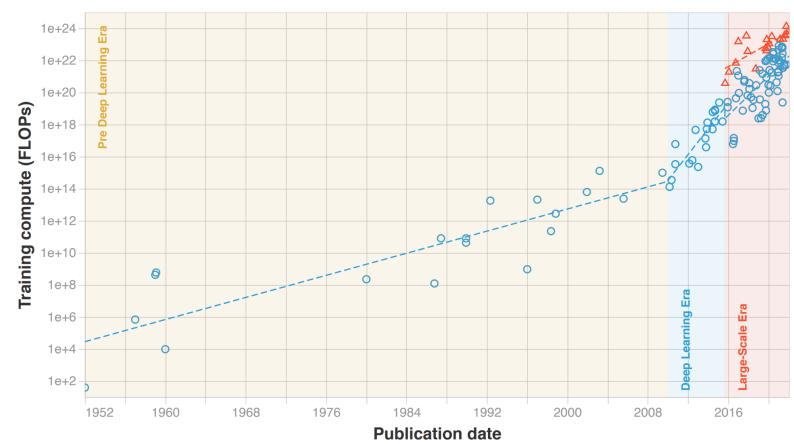
Generative AI Timeline



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

Need for compute

Training compute (FLOPs) of milestone Machine Learning systems over time

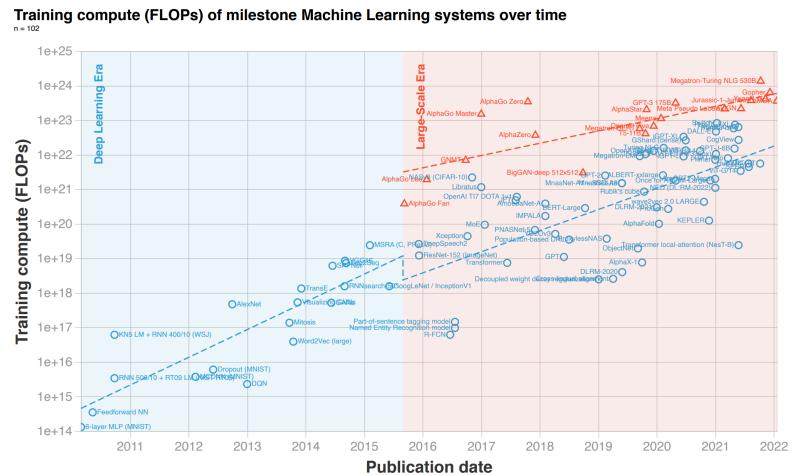


Compute Trends Across Three Eras of Machine Learning, Sevilla et al, ArXiv, 2022

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Need for compute



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

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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>

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Syllabus

Course info

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

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Pre-requisites

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

Check the **Resources** tab on the course website

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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)

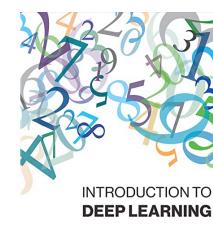
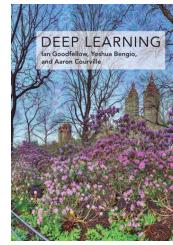
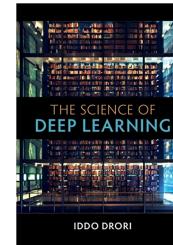
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Tentative plan

- Foundations
 - ✓ basics of neural networks, deep learning
 - ✓ loss functions, backpropagation, gradient descent
 - ✓ optimization and regularization
- Architectures
 - ✓ CNNs, RNNs, graph neural networks, transformers, etc
- Generative models
 - ✓ GANs, variational autoencoders, diffusion models
- Reinforcement learning
- Applications
 - ✓ computer vision, natural language processing, speech

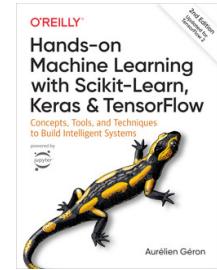
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Recommended textbook(s)



INTRODUCTION TO
DEEP LEARNING

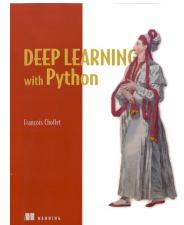
EUGENE CHARNIAC



Neural Networks and Deep Learning

Neural Networks and Deep Learning is a free online book. The book will teach you about:

- Neural networks, a beautiful biologically-inspired programming paradigm which enables a computer to learn from observational data
- Deep learning, a powerful set of techniques for learning in neural networks



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Grading (subject to change)

- Assignments (20%) — about 5-6
 - ✓ programming, problem sets
- Midterm Exam (25%)
- Technical Presentation (20%)
 - ✓ specific paper selected by instructor (April)
- Final Project (35%) — teams of 2
 - ✓ progress report (by end of March)
 - ✓ final report (by end of semester)
 - ✓ poster (workshop)



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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



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Assignments

- Discussions and collaboration are allowed, however students **must** submit their own work
- All assignments must be submitted on **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

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Ed Discussion

The screenshot shows a discussion thread titled "Quadratic equation" in the "Playground - Discussion" section. The thread has one answer from Scott Maxwell, which includes a formula for solving quadratic equations and a graph of a parabola. The interface includes course navigation (CS 101, ECON 102, MATH 201, ENGG 202), a sidebar with categories like General, Lectures, Tutorials, Problem Sets, Assignments, Midterm, and Exam, and a sidebar showing 42 others online.

Scott Maxwell 2 hours ago in [Lectures - W1](#)

Hi all,

How do we solve $ax^2 + bx + c = 0$?

Good question! You can use the quadratic formula:

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Also note the graph of a quadratic function is called a parabola and has this general shape:

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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**
 - ✓ 8+ hours (assignments, your final project, learning new technologies and theories, etc.)
 - ✓ 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

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Questions?