

Part 1 Lecture 1 Introduction to AI in Medicine







Pascal Tyrrell, PhDAssociate ProfessorDepartment of Medical Imaging, Faculty of MedicineInstitute of Medical Science, Faculty of MedicineDepartment of Statistical Sciences, Faculty of Arts and Science





How I got started in 1980....

The Commodore Vic 20

... with 5 kb RAM!







In 1997 Deep Blue (IBM) defeats Garry Kasparov



11.38 or 142 GFLOPS?









There are three great events in history. One, the creation of the universe. Two, the appearance of life. The third one, which I think is equal in importance, is the appearance of artificial intelligence. ??

-- Edward Fredkin former manager of MIT AI Laboratory



"We need to take the artificial away from our embrace of the technology. The term 'AI' should stand for 'augmented intelligence.'"

-Rasu Shrestha, MD, MBA





"I don't see AI as competitive but rather as an augmentation and expansion of the radiologist's capabilities."

-Lawrence Tanenbaum, MD, FACR





Why are we so smart?



Survived billions of years of evolution... and evolved into the species "dominating" the world

We learn from our mistakes

And we adapt ourselves to perform better





Artificial intelligence?



Definition of intelligence:

"The ability to acquire and apply knowledge and skills"

□ AI pioneer McCarthy in 1956:

"[AI is] the science and engineering of making intelligent machines"

Store, Compute, and Learn











10x improvement in less than 10 years (Blockbuster, Kodak)



4th Industrial Revolution







The Data Revolution

HBR Article on how big data accumulated and how we are going to manage it

Big Data is different from analytics in three ways

- Volume Constantly increasing
- 2) Velocity Speed of Data collection
- 3) VarietyData takes many different forms







AI Definition

- General definition
 - AI: capability of a machine to imitate intelligent human behaviour

 AI uses computers to model intelligent behaviour with minimal human intervention





History of AI

- Coined by John Mccarthy in 1956 during a conference held on this subject
- Possibility of machines being able to simulate human behavior and actually think was raised earlier by Alan Turing
 - Developed the Turing test in order to differentiate humans from machines





Alan Turing (Wikipedia)





Artificial intelligence?



Artificial intelligence: Machines that are programmed to mimic the way that humans think, and produce actions/decisions that simulates that of a real person

If machines simulate what humans do, would they have our intelligence?



Modelling the Human Brain

Brains function as the result of an immense number of neurons firing signals.

Neurons connect through synapses which propagate electrical impulses by releasing neurotransmitters.







Modeling the Human Brain

Synapses' plasticity allow for learning:
 Long-term changes in connection strength can be made.

How does this neural structure lead to thought and perception?
 We don't know.





Neuroscience has made several pivotal contributions to AI development.

"The fundamental questions cognitive neuroscientists and computer scientists seek to answer are similar. They have a complex system made of components — for one, it's called neurons, and for the other, it's called units."

- Aude Oliva of MIT





Neuroscience studies how the brain works in order to create recognizable behaviors.

Neuroscience theory believes individual neurons are fairly simple, and the information required for processing complex concepts is distributed across multiple neurons.

ANNs loosely follow the second theory





An ANN mimics the biological brain in the sense that it acquires knowledge through learning

...and stores this knowledge by adjusting the weights within the network.





In 1943

Neurophysiologist Warren McCulloch and mathematician Walter Pitts described how neurons in the brain might work by modeling a primary neural network using electrical circuits.



In 1949

Hebb describes if one neuron repeatedly stimulates a second one, then the connection between them will strengthen

 ...this is the notion of synaptic strength that is represented by weights in an ANN.





In 2012...

First year that neural nets grew to prominence as Alex Krizhevsky, Ilya Sutskever, and Geoffrey Hinton used them to win that year's ImageNet competition (basically, the annual Olympics of computer vision)

...dropping the classification error record from 26% to 15%, an astounding improvement at the time.





In November 2022...

OpenAl released a large language model called Generative Pre-Trained Transformer

□Largest neural network ever created to date □175 Billion Parameters







Neural Networks

Neural networks (NN) try to mimic how the brain works.

They simplify neurons to units (nodes) linked in layers







Nodes are comparable to old men with hearing difficulties standing at a distance from each other.





Neural Network Units



Each link has a weight and activation level.

Each unit has an input function, activation function, and output.



Why Machine Learning?

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□ Many problems are difficult to program rules for: E.g. computer vision, speech recognition, medical image analysis, etc.

□ Some systems need to adapt to changing tasks/environments: □ E.g. spam detection, robot movement, etc.

□ ML can find patterns in large amounts of data











Machine learning: what is it?

□ A set of algorithms

□ AKA "Models" in the world of statistics

□ Find patterns in existing data

Modifying parameters of algorithms to best describe the data pattern

□ Performance improves as the amount of training data increases

□ Make predictions/decisions

On new data taken from the same population as the training data
 Using the algorithm (pattern) found in previous training





Machine learning: how? How do the magical algorithms allow machines to "learn" like humans?



- One way: Cost function
 - Penalizes mistakes that machines make
 - □ The larger the "cost" is, the more the machine must adjust its parameters in the algorithm
 - Learning = minimizing cost function





Perceptron Learning Rule

To train a neural network, a batch of training data is used.

During each batch of processing the training data:
 If output is correct, don't change the weights
 If output is low, increment weights for all inputs which are 1
 If output is high, decrement weights for all inputs which are 1





Perceptron Learning Rule









Backpropagation

□ Similar to the Perceptron Learning Algorithm

Iterate through training data
 If output network is correct, do not change anything

□ If there is **error**, propagate back to previous layer and modify weights

Weight modification is performed through different optimization algorithms.





Optimization Algorithms

- Finding the best solution from a set of possible solutions
 - □Gradient Descent: Adjusts parameters in the direction that minimizes the cost function.
 - Genetic Algorithms: Mimics natural selection to find optimal solutions.
 Simulated Annealing: Randomly explores the solution space but gradually narrows down.
 - □Particle Swarm Optimization: Uses a swarm of agents to explore and find the best solution.







How do you choose a model?









act, and adapt

MACHINE LEARNING

Algorithms whose performance improve as they are exposed to more data over time

DEEP Learning

Subset of machine learning in which multilayered neural networks learn from vast amounts of data



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Next up Lecture 2: Different types of ML



