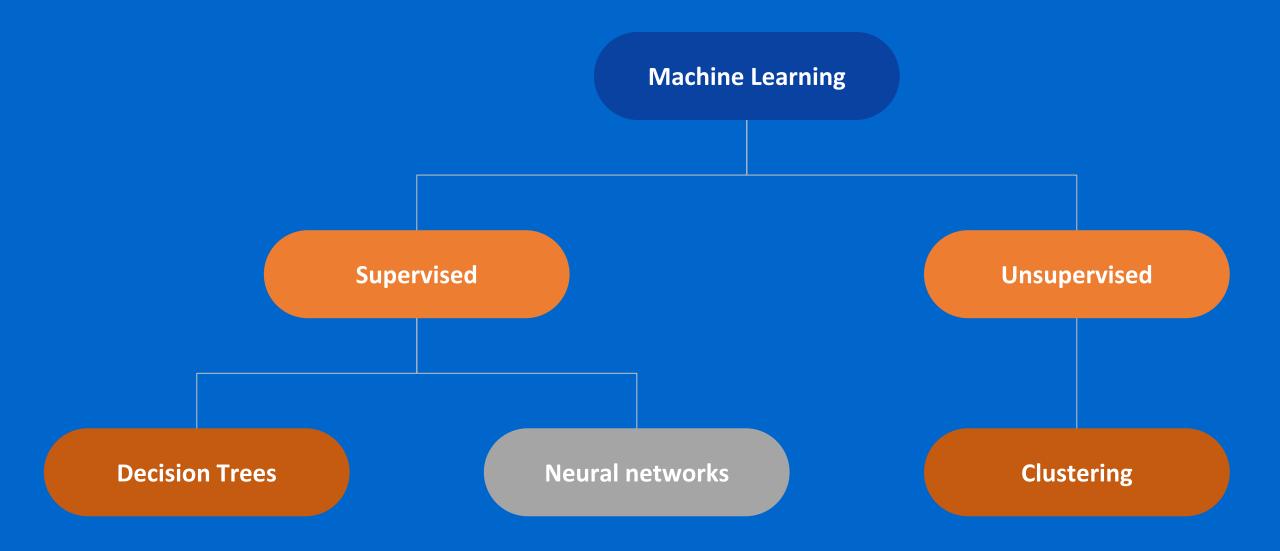
Session 4 Introduction to Neural Networks

Al and Machine Learning
Hult International Business School
Michael de la Maza
Version 1.1



Where are we now?



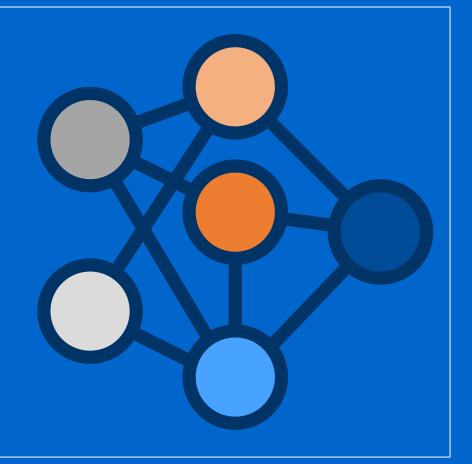
Supervised learning: Key idea

Given training data X and target y, learn function f: f(x) = y.



What are neural networks?

- Neural networks are a machine learning algorithm inspired by the human brain.
- They consist of a large number of interconnected elements (neurons) which learn by repeatedly examining data.
- Neural networks are universal function approximators.



History of neural networks

Warren McCulloch and Walter Pitts propose a model of artificial neurons.	Frank Rosenblatt develops the perceptron, a type of neural network.	Marvin Minsky and Seymour Papert publish "Perceptrons," highlighting the limitations of single-layer neural networks.	Rumelhart, Hinton, and Williams demonstrate the effectiveness of backpropagation for training neural networks.	Geoff Hinton and others show the potential of deep learning with the use of deep belief networks.	AlexNet, developed by Alex Krizhevsky, Ilya Sutskever, and Geoff Hinton, achieves a significant breakthrough in image classification using deep convolutional neural networks.
1943	1957	1969	1986	2006	2012

Neural networks have gone in and out of vogue multiple times. Right now they are 'in vogue' and (I predict) will continue to play a key role in the development of machine learning.

Video - Rosenblatt and Minsky: https://www.youtube.com/watch?v=Suevq-kZdlw

ChatGPT / OpenAl drive the current excitement

- 2015: OpenAI founded by Sam Altman, Greg Brockman, Elon Musk, and others
- November 30, 2022: OpenAI releases ChatGPT. Goes viral.

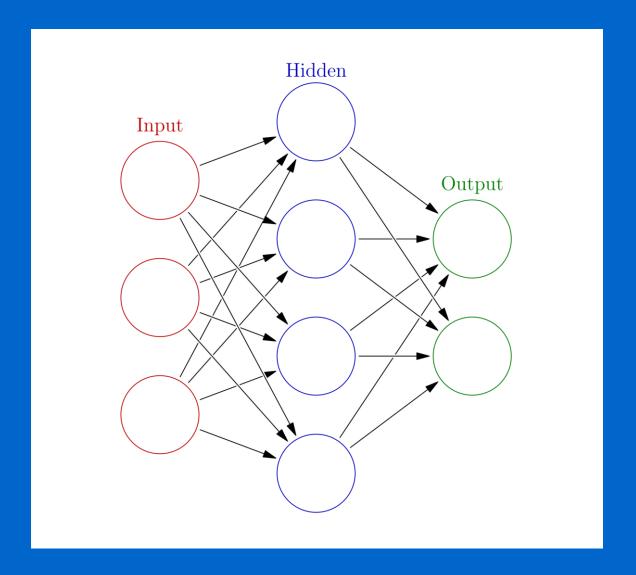
Sam Altman Time Video: https://www.youtube.com/watch?v=naq4FUWAZ1Y



What does a neural network look like?

Geoff Hinton, Godfather of neural networks

https://www.youtube.com/watch?v=I9R WTMNnvi4



What will happen next? 2024 – 2026 will be crazy

Self-driving cars: \$10 trillion opportunity

Biology: AlphaFold

Medicine: Diagnosis

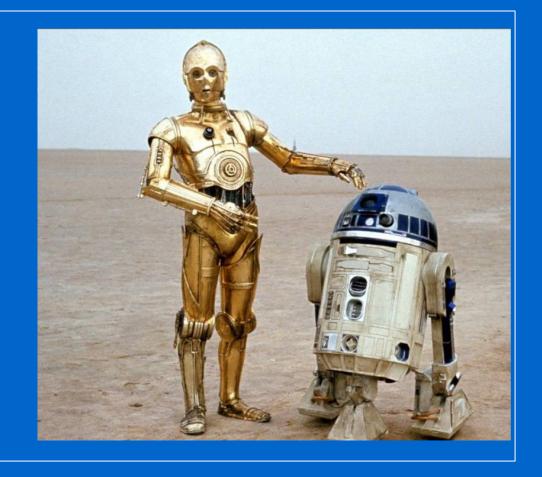
• Robotics: C3PO

Energy: Nuclear power, solar

Productivity tools

Al assistants

Rise of billion dollar, single person companies



Extreme returns to talent: Billion dollar, one person businesses

- Think of generative AI tools today as being extremely capable assistants. Generative AI does an excellent job of creating a first draft.
- Now a single creator can develop and market a product.
 - Example: SaaS
 - Creator develops idea in conjunction with AI
 - Al writes the code
 - Al helps with marketing and sales
 - Al helps with customer support
 - Example: Skincare product
 - Creator develops product with help from AI
 - Creator tests product
 - Al helps with marketing and sales



9.684 views • Jul 11, 2023

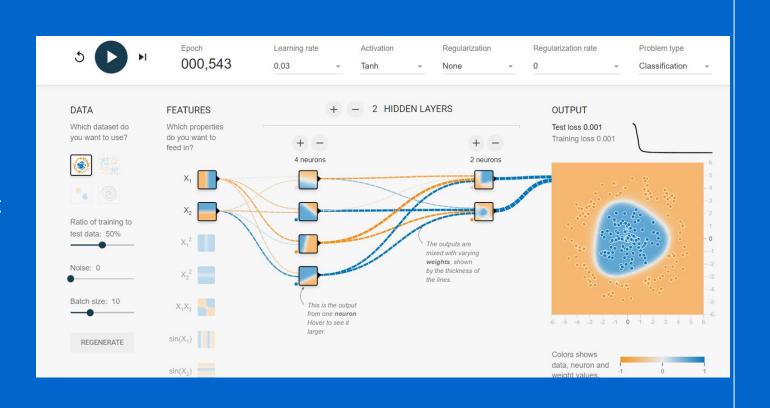
Is The \$1 Billion, One-Person Business Around The Corner? This Freelance Platform, Which Just Raised \$50 Million, Is Betting On A Bold Future For Solopreneurs



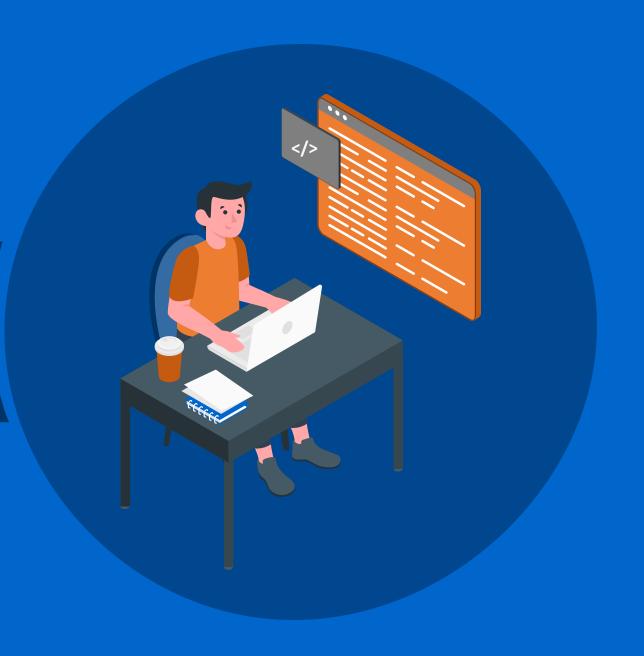
Collective, a San Francisco startup that provides back office support to freelancers, believes AI will transform freelance businesses and is expanding its own platform with the technology.

Let's build intuition!

- Epoch: a pass through training set
- Batch: number of instances processed before parameters are updated
- Activation function: Function applied at neurons (RELU, Sigmoid)
- Input layer, hidden layers, output layer
- https://playground.tensorflow.org/

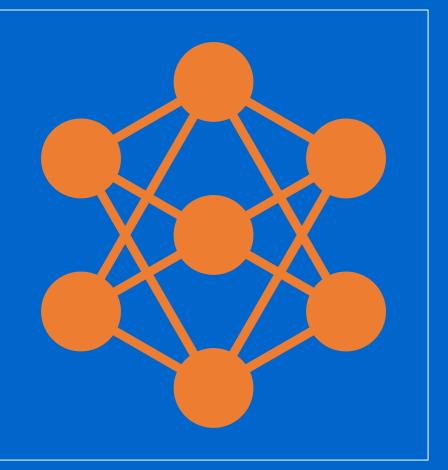


Let's write some code!



Summary: Neural network structure

- Layers
 - Input layer (data)
 - Hidden layers
 - Output layer
- Neurons in each layer
- Connectivity: dense, convolutional, recurrent
- Weights, biases
- Activation function: sigmoid / logistic, rectified linear unit (RELU), softmax



How many weights does a neural network have?

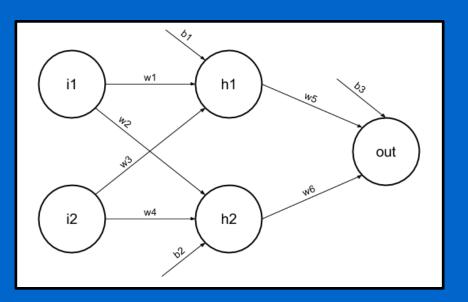
Question: Given a neural network with 2 input nodes, 2 hidden layers each with 3 neurons, and 1 output node, how many total weights are there, assuming full connectivity between layers?

Answer:

Weights: (2 inputs * 3 neurons) + (3 neurons * 3 neurons) + (3 neurons * 1 output) = 6 + 9 + 3 = 18 weights.

Biases: Hidden layer and output layer neurons have biases: 3 + 3 + 1 = 7.

25 parameters total



Summary: Preprocessing data

- Convert categorical to numerical (one hot encoding; pd.get_dummies)
- Scale variables (0-1 or z-score; sklearn.preprocessing.MinMaxScaler, StandardScaler)



Summary: Updating parameters (weights, biases)

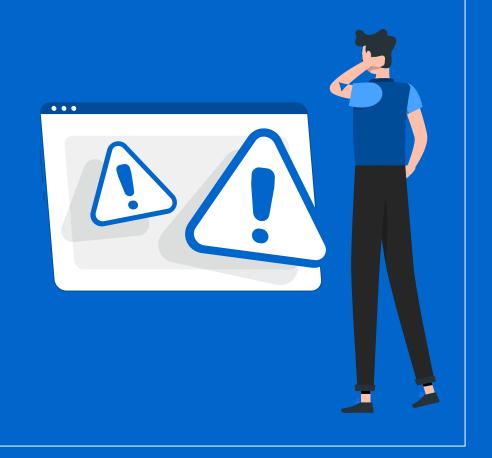
Backpropagation algorithm

- Calculate output on training instances (batch)
- Compare to correct output
- Calculate error and 'propagate back' to update parameters
- Learning rate reflects weight given to error term in update



Summary: Ways to avoid overfitting

- Reduce 'size' of neural network: reduce neurons or number of hidden layers
- Limit epochs
- Use third data set (validation set) to stop training



Summary: Advantages and disadvantages of neural nets

Advantages

- Widely applicable; good performance on a wide variety of problems (classification, natural language, image processing)
- Key to AI Renaissance (ChatGPT, self driving cars)
- Universal function approximators

Disadvantages

- Uninterpretable black box!
- Computation heavy (need cloud and lots of funding for large models)
 https://www.youtube.com/watch?v=9iqn1HhFJ6c

