Session 4
Introduction to Neural Networks

AI and Machine Learning

Hult International Business School

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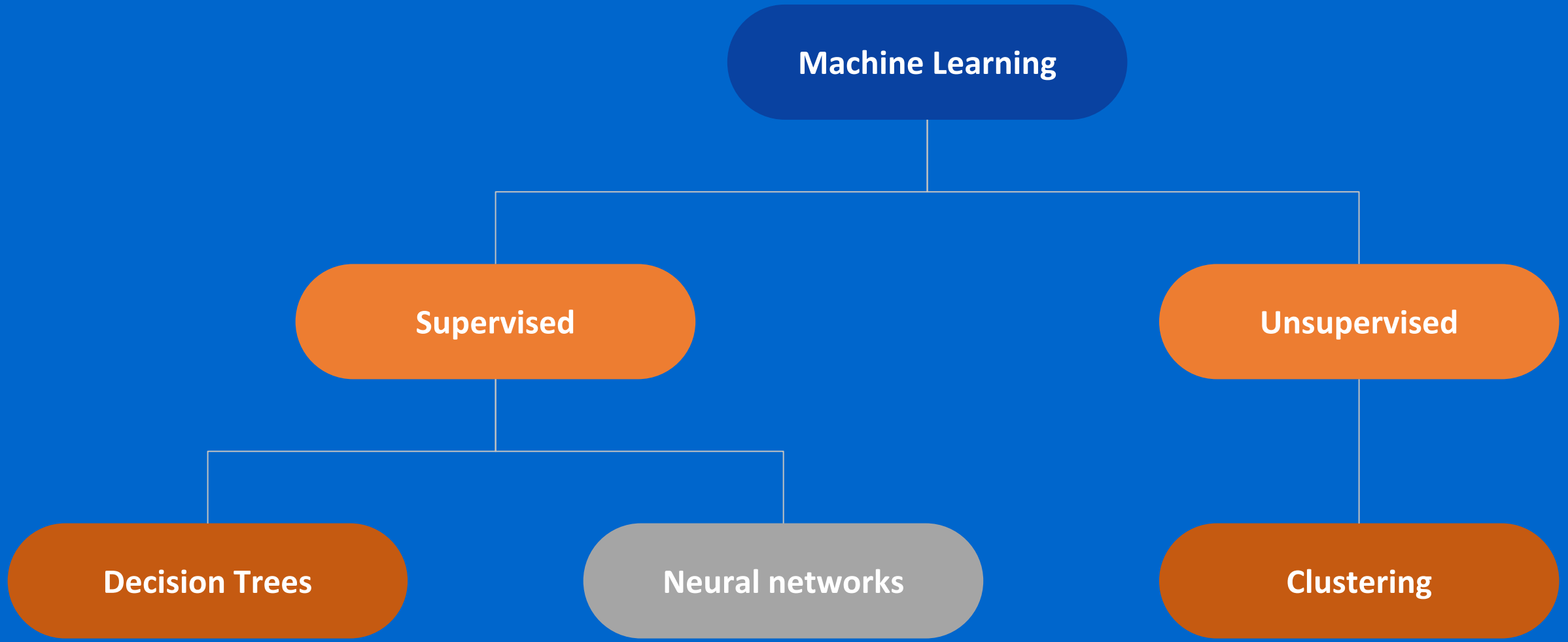
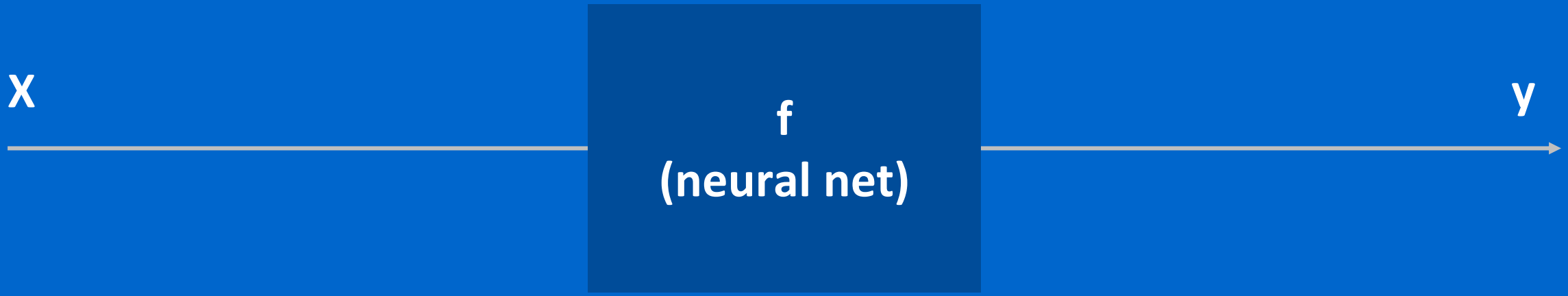
Version 1.1

Where are we now?



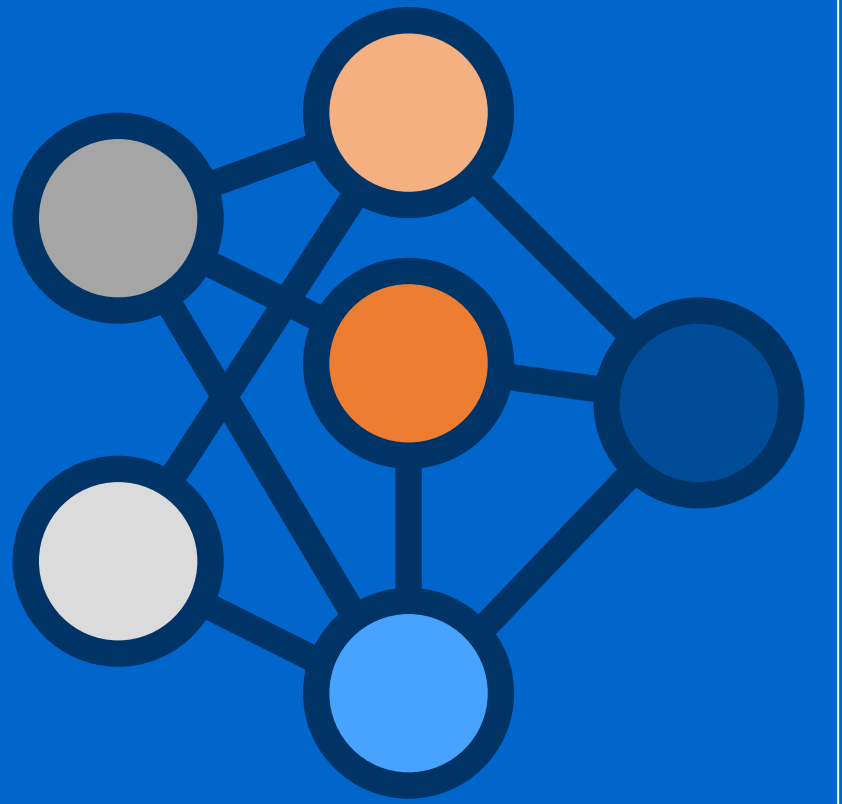
Supervised learning: Key idea

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

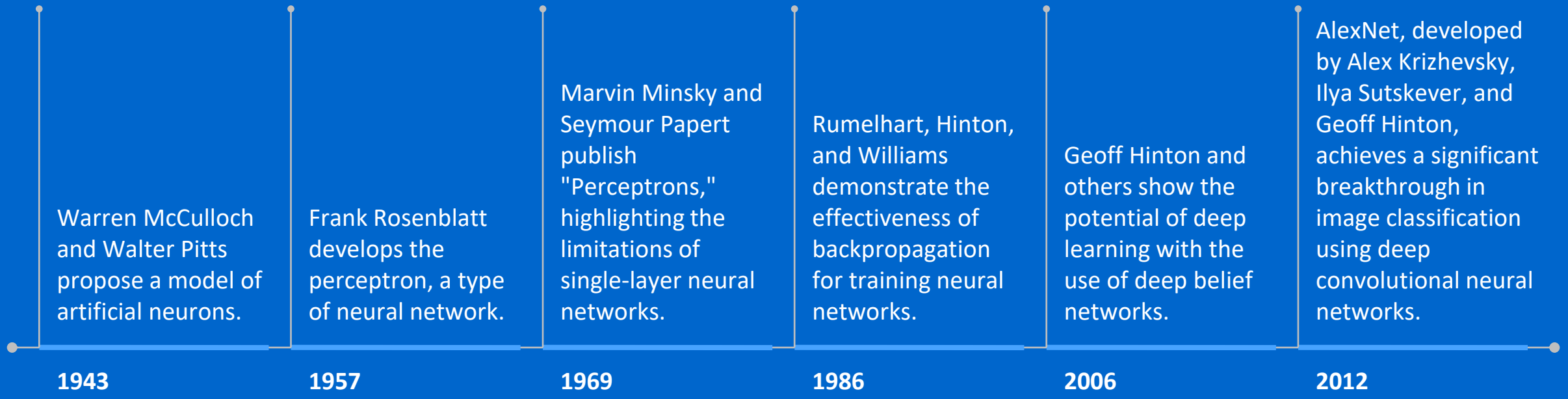


What are neural networks?

- 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



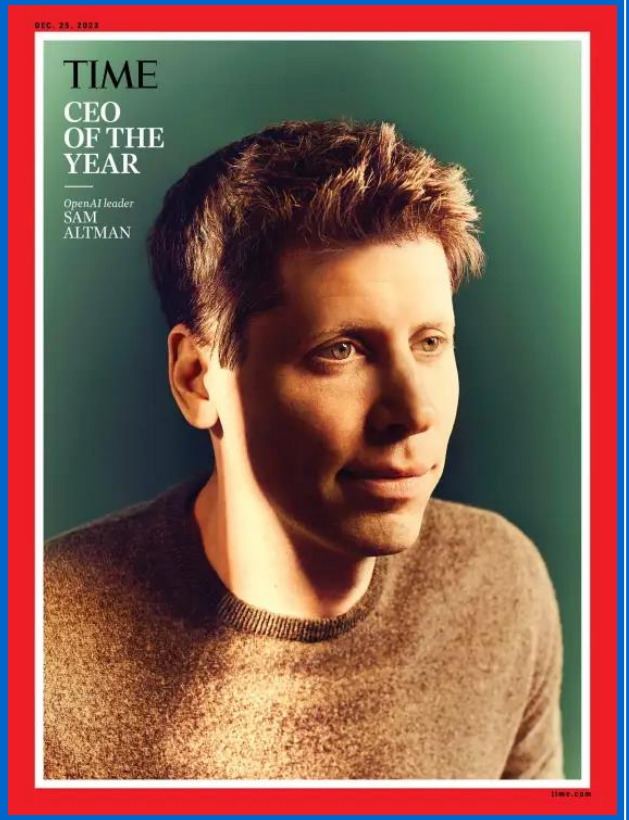
Neural networks have gone in and out of vogue multiple times. Right now they are ‘in vogue’ and (I predict) will continue to play a key role in the development of machine learning.

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

ChatGPT / OpenAI drive the current excitement

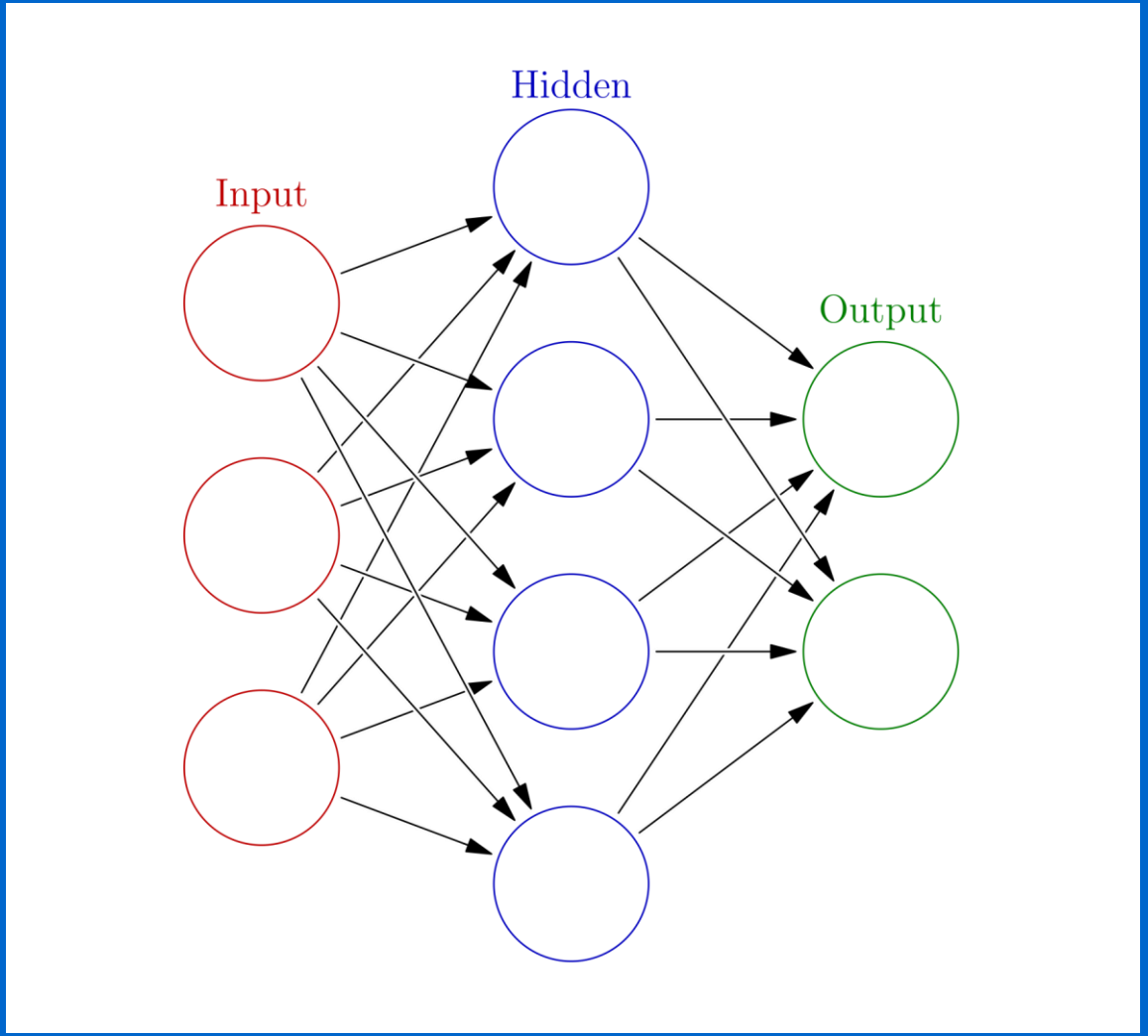
- 2015: OpenAI founded by Sam Altman, Greg Brockman, Elon Musk, and others
- November 30, 2022: OpenAI releases ChatGPT. Goes viral.

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



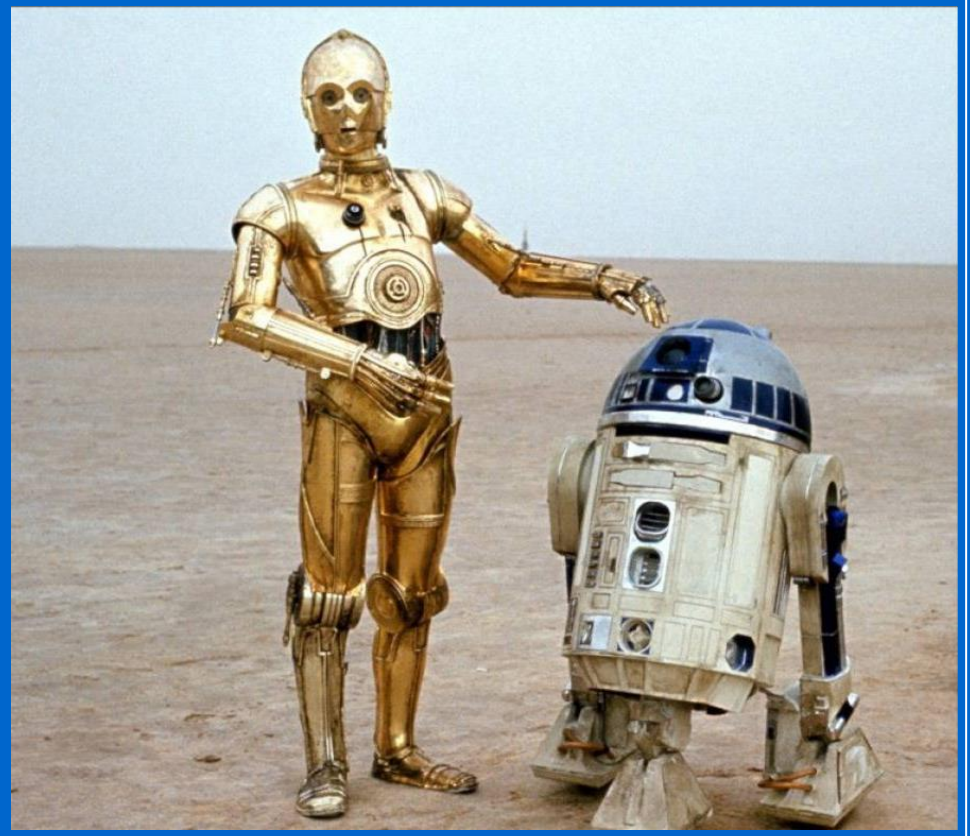
What does a neural network look like?

Geoff Hinton, Godfather of neural networks
https://www.youtube.com/watch?v=l9RWTMNnvi4



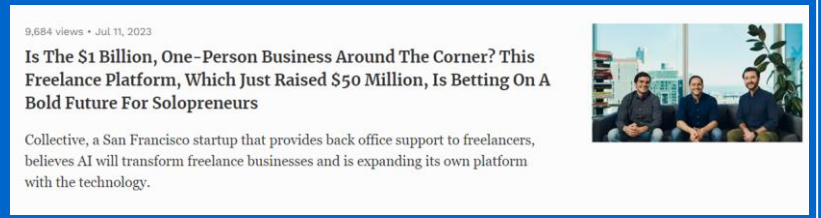
What will happen next? 2024 – 2026 will be crazy

- Self-driving cars: $10 trillion opportunity
- Biology: AlphaFold
- Medicine: Diagnosis
- Robotics: C3PO
- Energy: Nuclear power, solar
- Productivity tools
- AI assistants
- Rise of billion dollar, single person companies



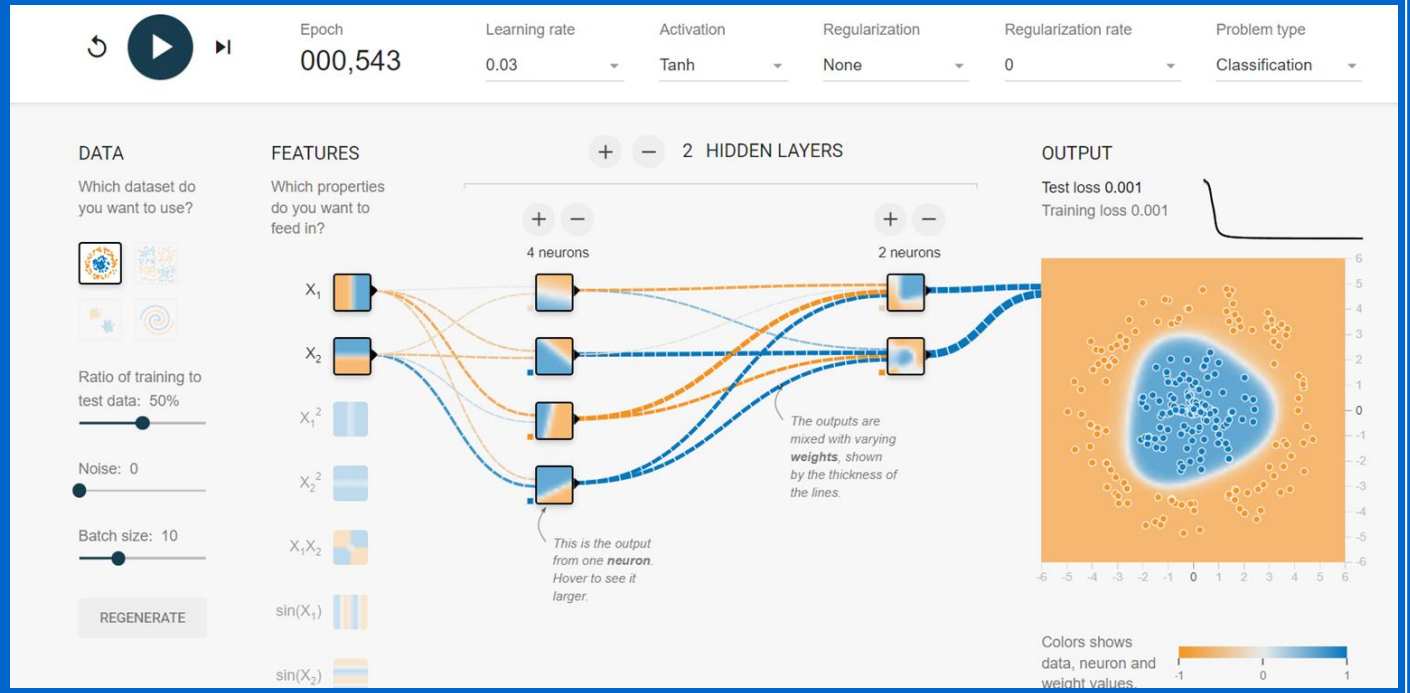
Extreme returns to talent: Billion dollar, one person businesses

- 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
    - AI writes the code
    - AI helps with marketing and sales
    - AI helps with customer support
  - Example: Skincare product
    - Creator develops product with help from AI
    - Creator tests product
    - AI helps with marketing and sales



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?

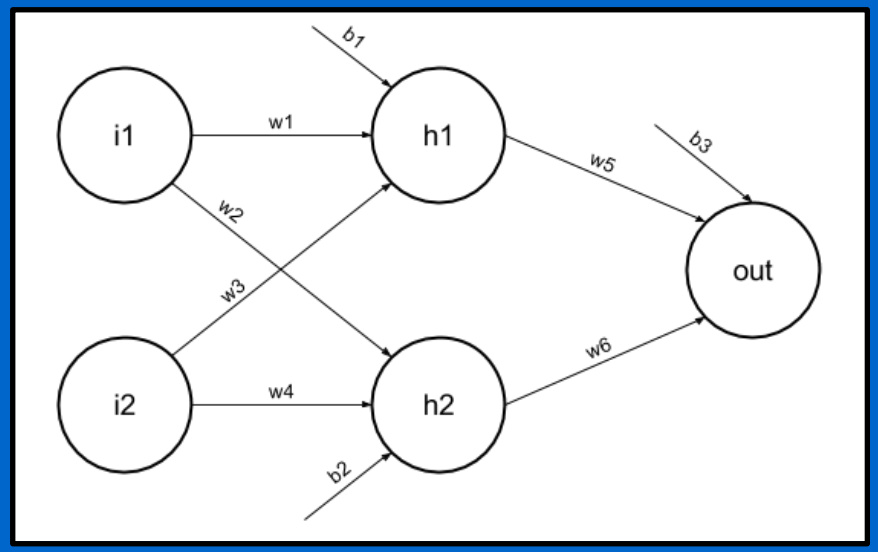
Question: Given a neural network with 2 input nodes, 2 hidden layers each with 3 neurons, and 1 output node, how many total weights are there, assuming full connectivity between layers?

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)

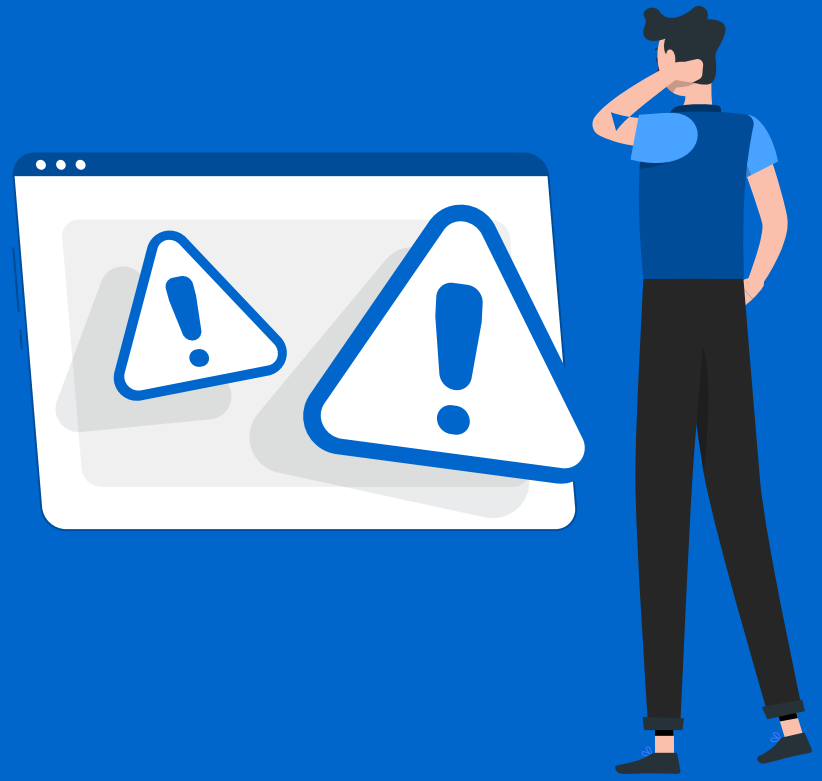
Summary: Updating parameters (weights, biases)

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