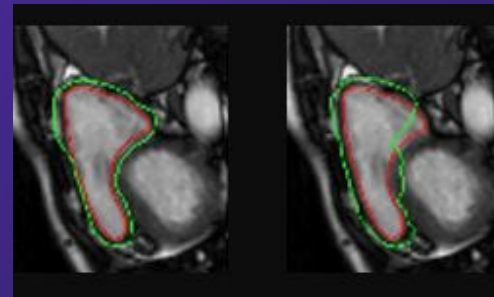
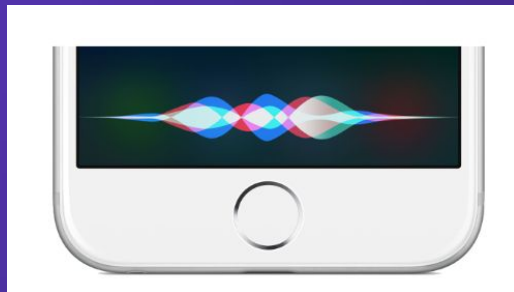
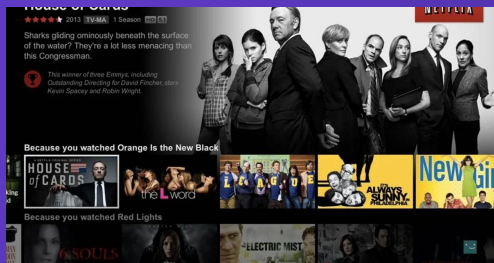
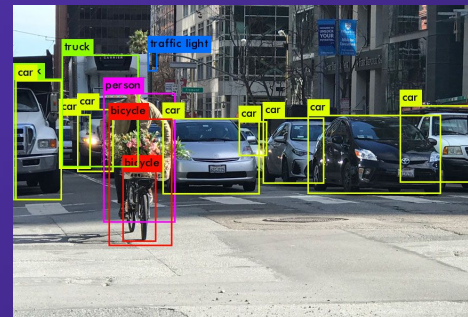
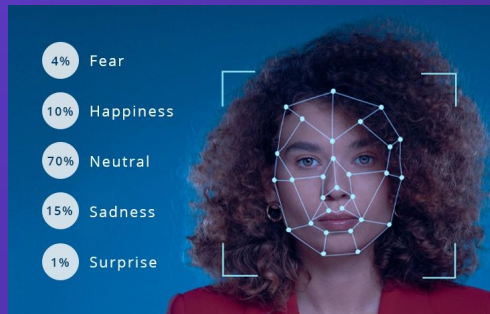


Python For Deep Learning



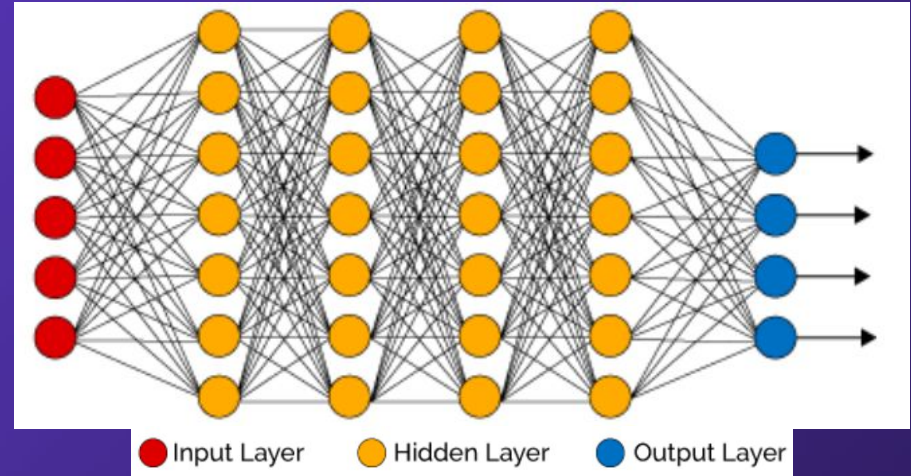
What comes to mind when you
hear the term
“Deep Learning”?

Applications of Deep Learning?



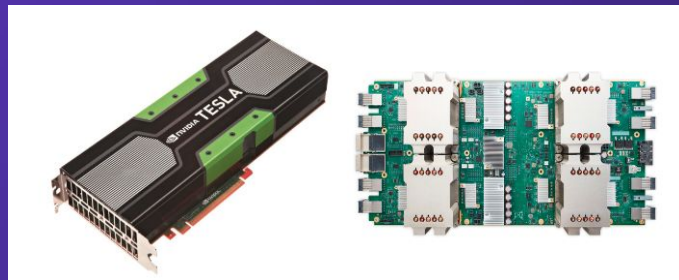
What is Deep Learning?

- A subset of machine learning
- Utilizes artificial neural networks with multiple layers
- Inspired by the structure and function of the brain



Why is Deep Learning Booming?

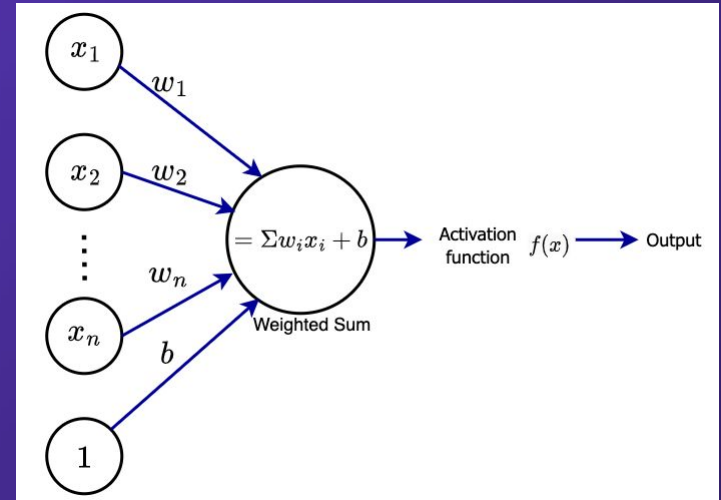
- Better algorithms & understanding
- Computing power (GPUs, TPUs, etc.)
- Data with labels
- Open source tools and models



Deconstructing Neural Networks

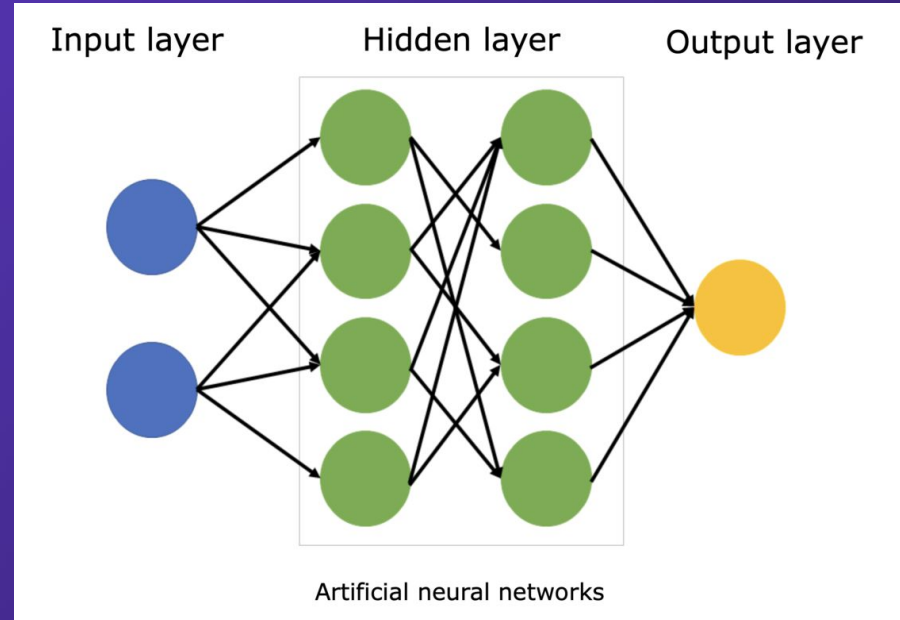
What is a Perceptron?

- A perceptron is the most basic unit of a neural network
- Its design takes cues from the structure of a biological neuron
- A perceptron receives multiple inputs, each associated with a weight representing its importance
- The weighted inputs are summed, and an activation function determines the output (often a binary 0 or 1)



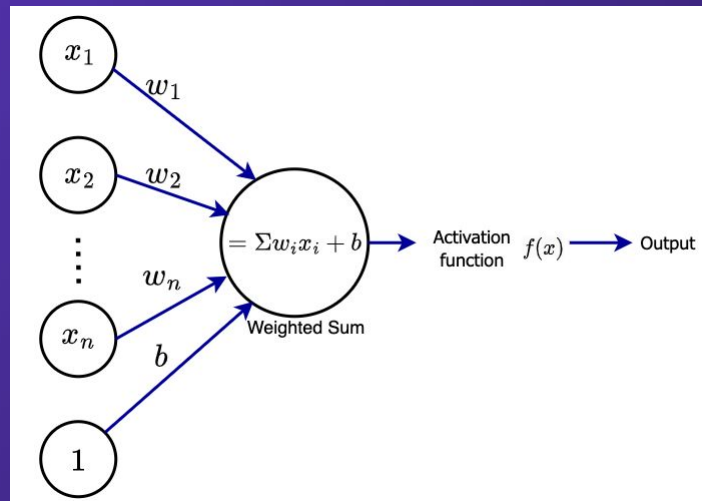
Multilayer Perceptrons (MLPs)

- MLPs introduce additional layers of perceptrons called 'hidden layers'
- The use of non-linear activation functions in hidden layers allows MLPs to learn complex patterns
- MLPs can approximate a wide range of functions, making them versatile problem-solvers

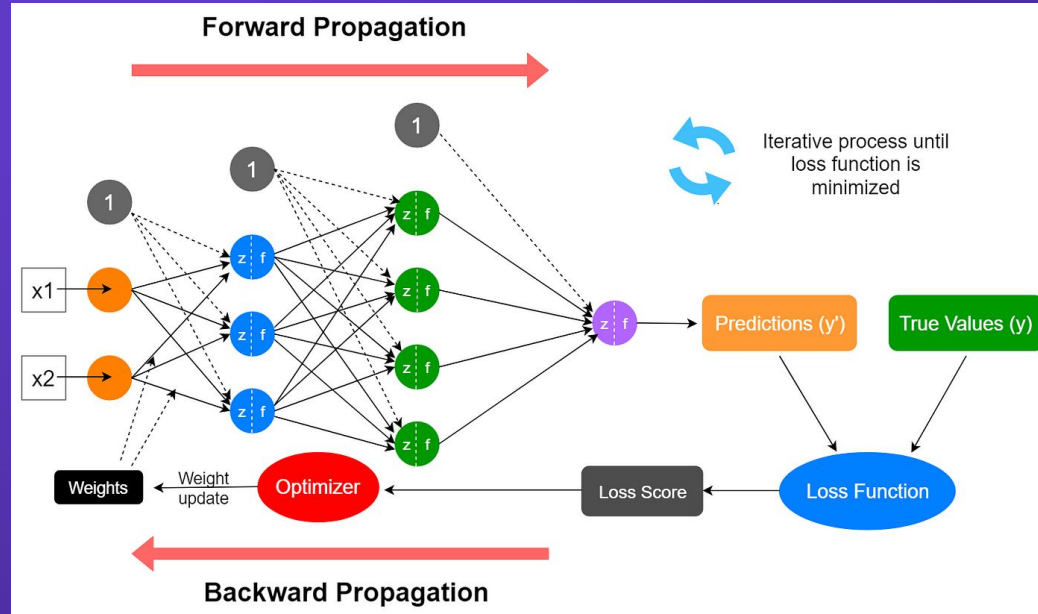


What are Activation Functions?

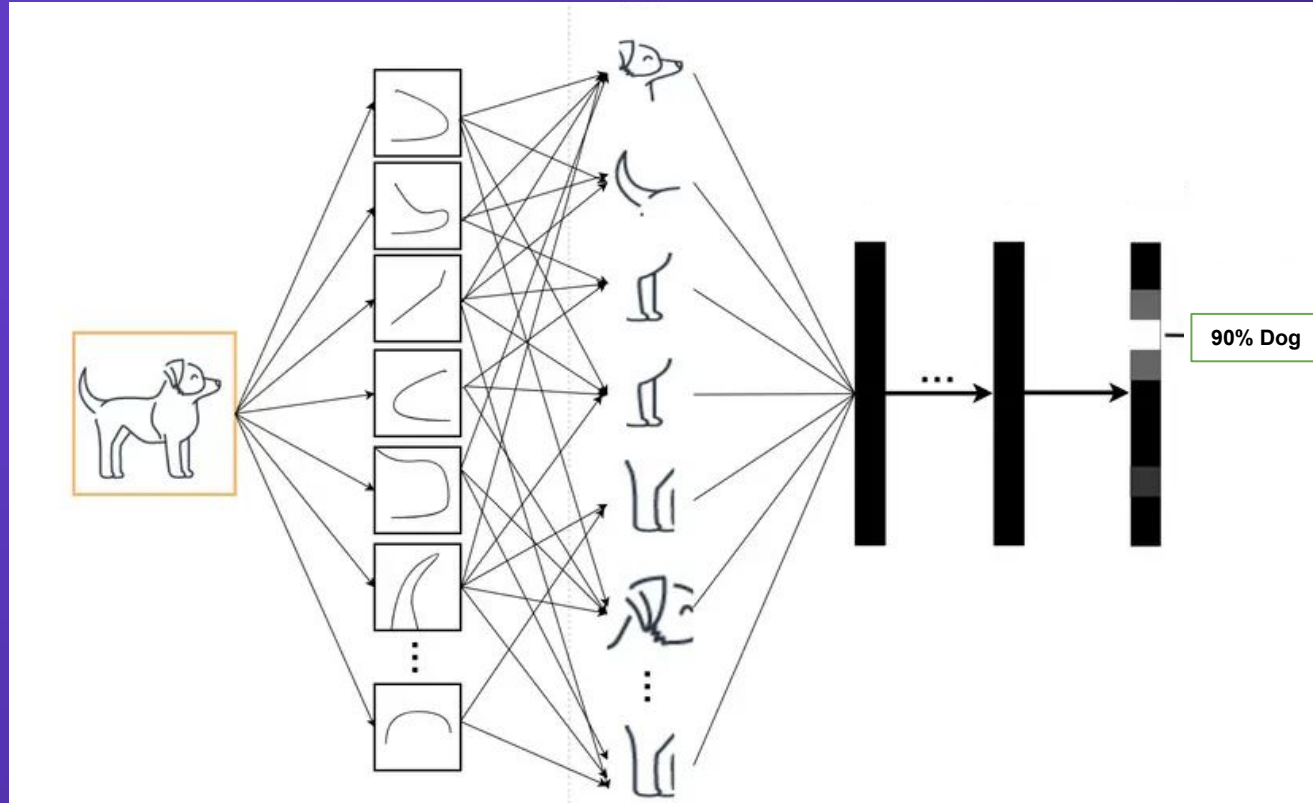
- Activation functions are mathematical functions applied to the output of a neuron (or node) in a neural network.
- They determine whether a neuron should 'fire' (activate), and to what degree, based on the weighted sum of its inputs.
- This non-linear behavior empowers neural networks to learn complex patterns that would be impossible with linear models.



How a Neural Network Learns



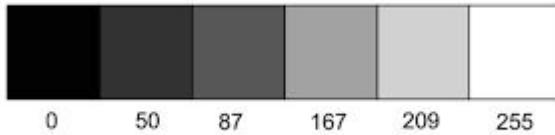
How Deep Learning Works



Training a model to recognize handwritten digits

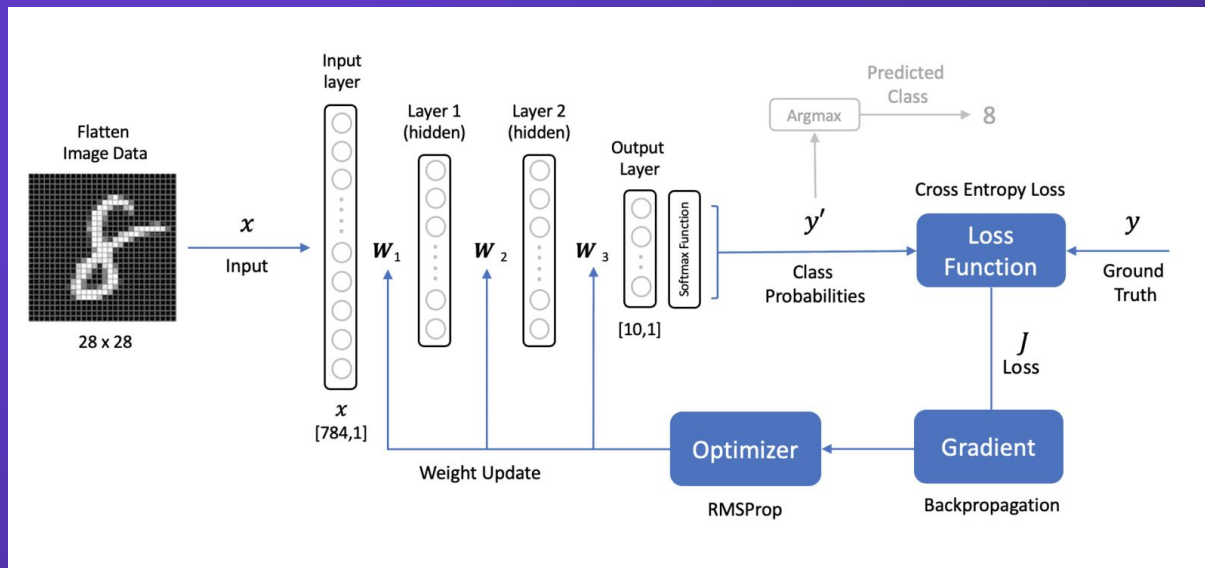
| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 8 | 2 | 7 | 6 | 4 | 6 | 9 | 7 | 2 | 1 | 5 | 1 | 4 | 6 |
| 0 | 1 | 2 | 3 | 4 | 4 | 6 | 2 | 9 | 3 | 0 | 1 | 2 | 3 | 4 |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 0 | 1 | 2 | 3 | 4 | 5 | 0 |
| 7 | 4 | 2 | 0 | 9 | 1 | 2 | 8 | 9 | 1 | 4 | 0 | 9 | 5 | 0 |
| 0 | 2 | 7 | 8 | 4 | 8 | 0 | 7 | 7 | 1 | 1 | 2 | 9 | 3 | 6 |
| 5 | 3 | 9 | 4 | 2 | 7 | 2 | 3 | 8 | 1 | 2 | 9 | 8 | 8 | 7 |
| 2 | 9 | 1 | 6 | 0 | 1 | 7 | 1 | 1 | 0 | 3 | 4 | 2 | 6 | 4 |
| 7 | 7 | 6 | 3 | 6 | 7 | 4 | 2 | 7 | 4 | 9 | 1 | 0 | 6 | 8 |
| 2 | 4 | 1 | 8 | 3 | 5 | 5 | 5 | 3 | 5 | 9 | 7 | 4 | 8 | 5 |

Introduction to Image Data



```
0 2 15 0 0 11 10 0 0 0 0 9 9 0 0 0
0 0 0 4 60 151 236 255 255 177 95 61 32 0 0 29
0 10 16 115 238 255 244 245 243 250 249 255 222 101 10 0
0 14 170 255 255 244 254 255 253 245 255 249 253 251 124 1
2 5 255 228 255 251 254 211 11 118 122 215 251 238 255 49
13 217 243 255 155 31 226 82 2 0 10 13 32 255 255 36
16 229 252 254 49 12 0 0 7 7 0 10 237 252 235 62
6 141 245 255 212 25 11 9 3 0 111 236 243 255 137 0
0 87 252 250 248 218 60 0 1 111 252 255 248 144 6 0
0 13 11 255 255 245 255 182 181 248 252 242 206 36 0 19
1 0 6 117 251 255 241 255 247 255 241 182 17 0 7 0
0 0 0 4 58 251 255 246 254 253 255 120 11 0 1 0
0 0 4 97 255 255 255 248 252 255 244 255 182 19 0 4
0 22 206 252 246 251 241 100 24 111 255 245 255 184 9 0
0 111 255 242 255 182 24 0 0 6 39 255 232 230 56 0
0 218 251 250 117 7 11 0 0 0 2 62 255 250 128 3
0 172 255 255 101 9 20 0 13 3 15 182 251 245 61 0
0 10 251 241 255 235 18 65 10 111 217 248 253 255 52 4
0 16 114 250 255 247 255 255 255 249 255 240 255 17 0 5
0 0 23 115 215 255 250 248 255 255 248 248 114 14 12 0
0 0 6 1 0 57 118 233 255 252 141 37 0 0 4 1
0 0 5 5 0 0 0 0 0 14 1 0 6 6 0 0
```


Training a model to recognize handwritten digits



Hands-on activity