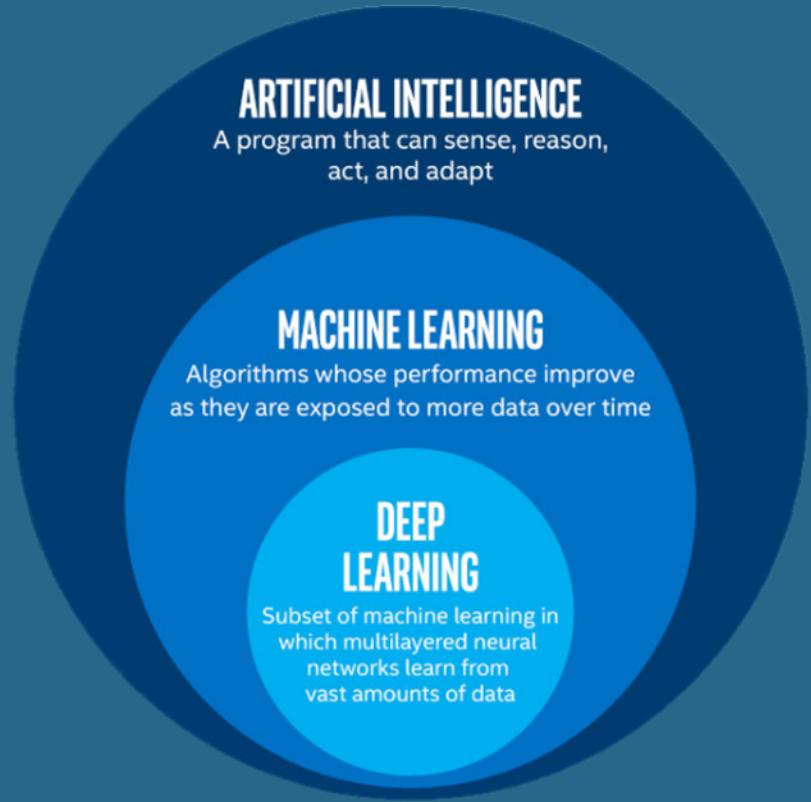


# Neural Networks

Raymond Doudlah  
Physiology Graduate Training Program  
LUCID Training Program

# Today's outline

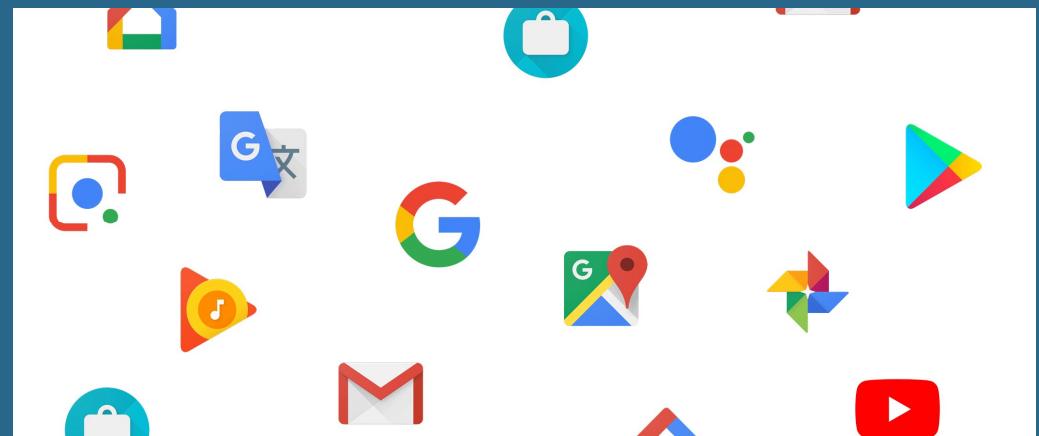
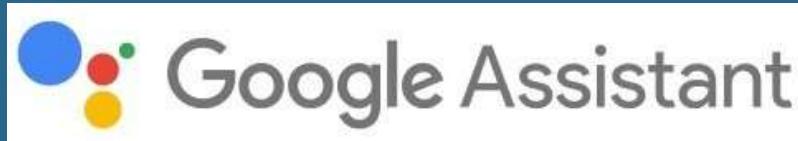
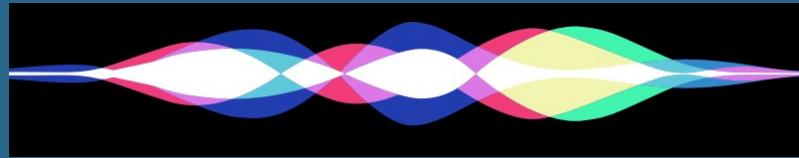
1. Introduction to machine learning and artificial intelligence
2. Perceptron
3. Neural networks
4. Breakout session #1
5. Deep learning
6. Breakout session #2
7. Future of machine learning in science



# What is Artificial Intelligence (AI)?

- Program or machine that can perform a task that would require a human to **apply intelligence** to accomplish the same task
  - 1950's – McCarthy and Minsky
- So... what is intelligence?
- Typical behaviors of modern AI
  - Learning
  - Reasoning
  - Perception
  - Planning
  - Knowledge representation
- Narrow vs general AI

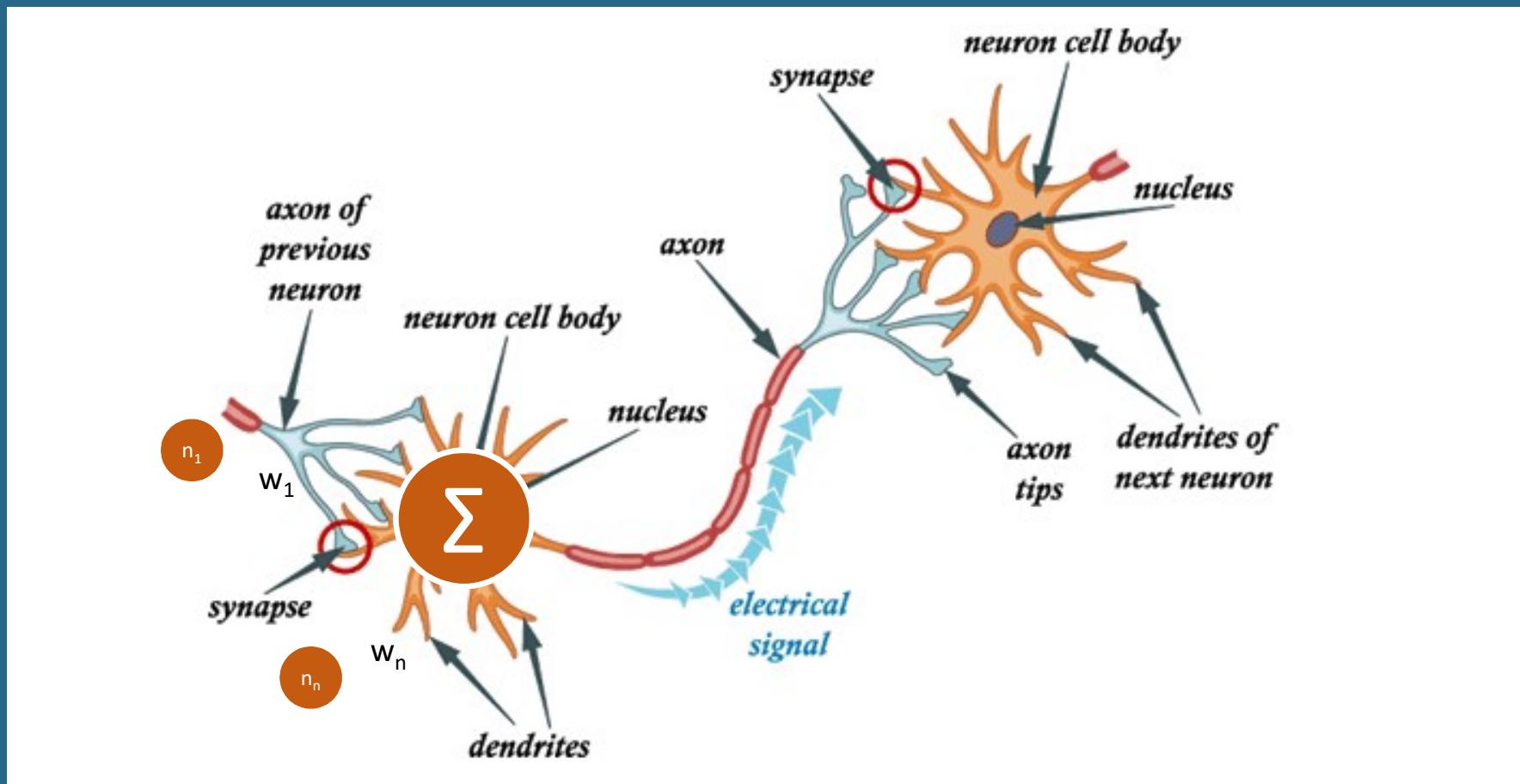
# Examples of AI in your everyday life



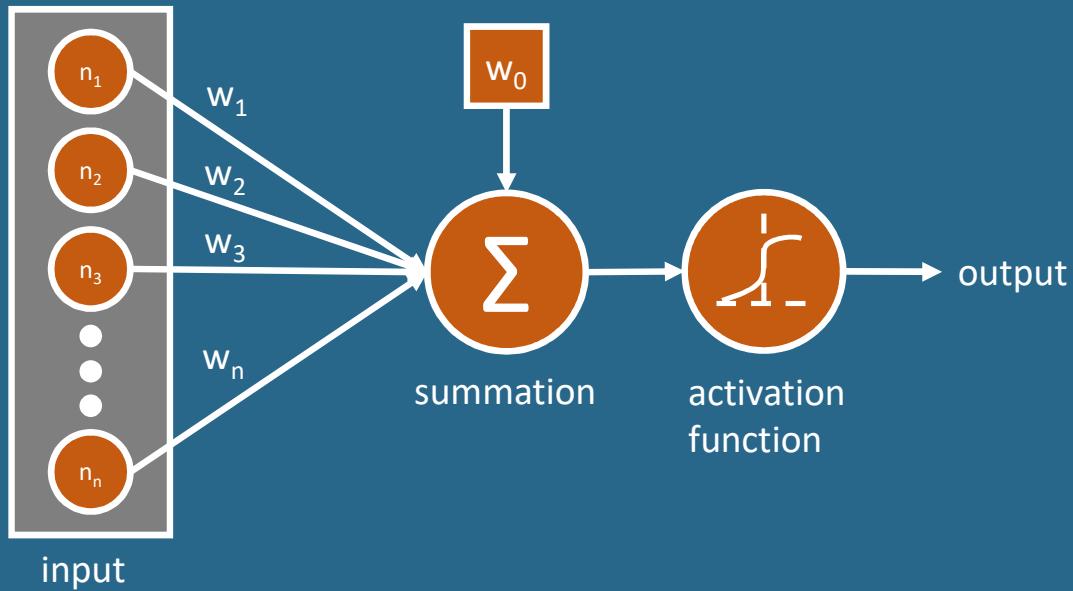
# A brief history lesson of AI

- 1940's
  - Alan Turing – Father of artificial intelligence
- 1956
  - Term "artificial intelligence" was adopted
- 1970 – 1990
  - AI winter
- 1997
  - IBM's *Deep Blue* defeats Garry Kasparov at Chess
- 2011
  - IBM's *Watson* wins *Jeopardy!*
- 2016
  - Google DeepMind's *AlphaGo* defeats Lee Sedol at Go
- January 2019
  - Google DeepMind's *AlphaStar* defeats professional *StarCraft II* players
- April 2019
  - OpenAI defeats professional *Dota 2* players

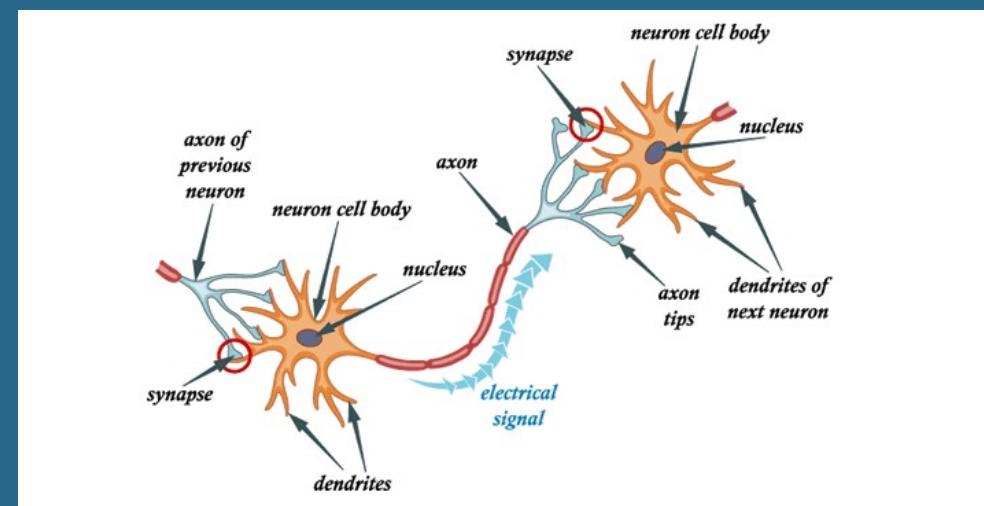
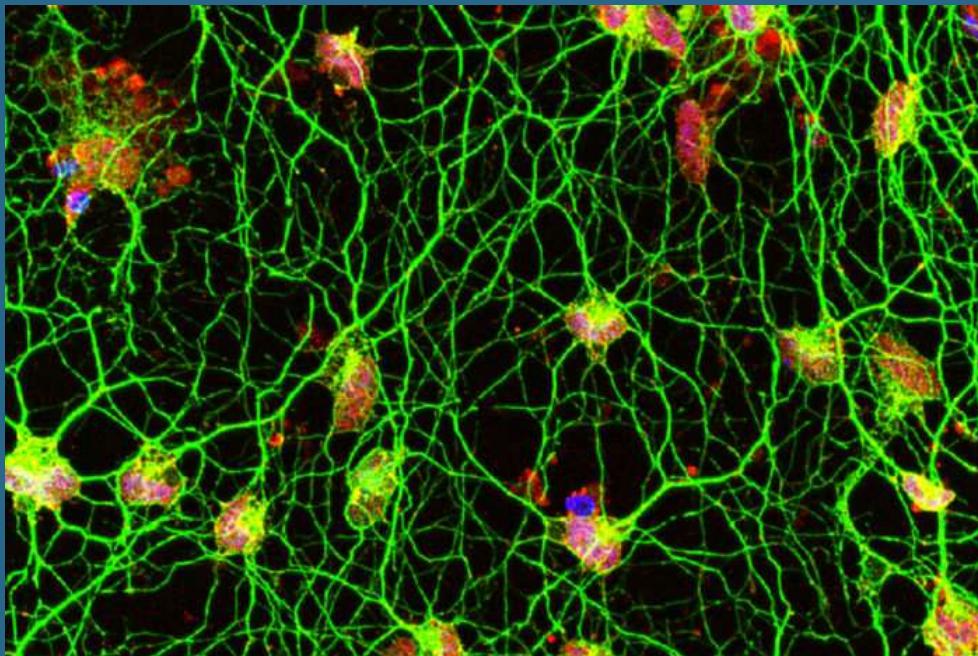
# Biological inspiration for the perceptron



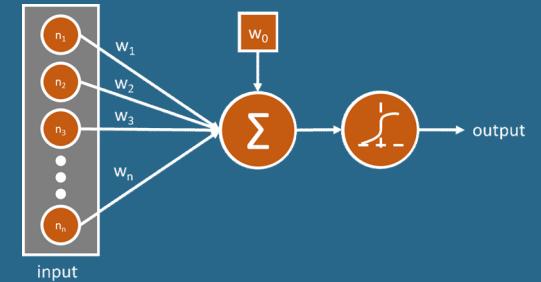
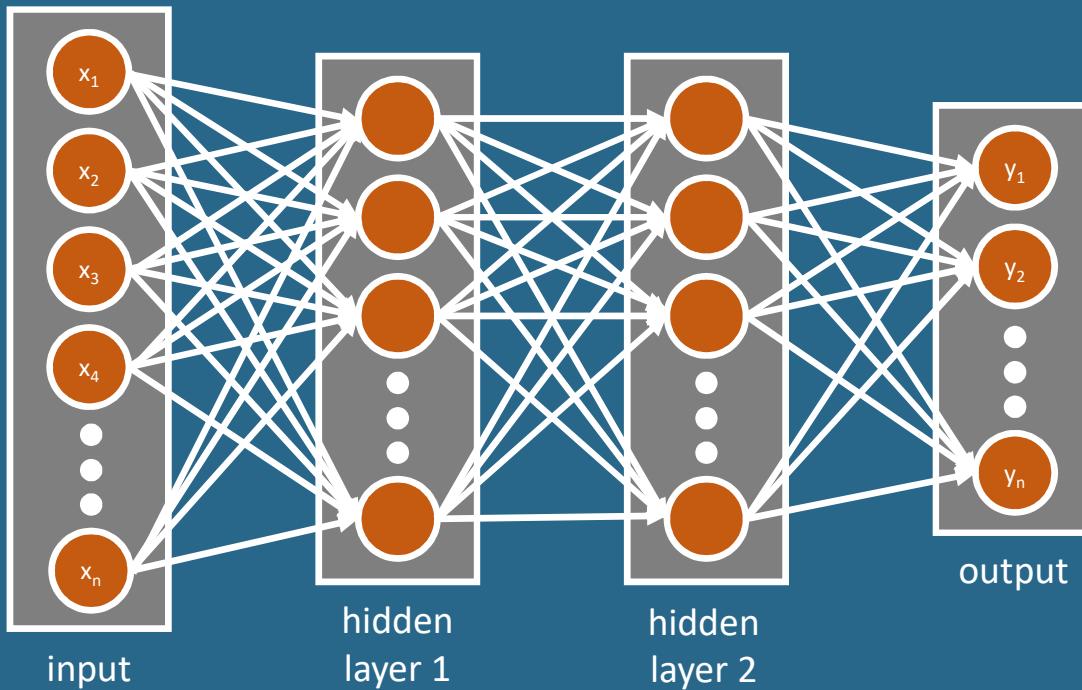
# Perceptron



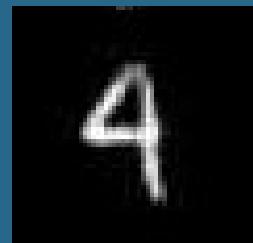
# Biological neural networks



# Neural network architecture



# Recognizing hand written digits



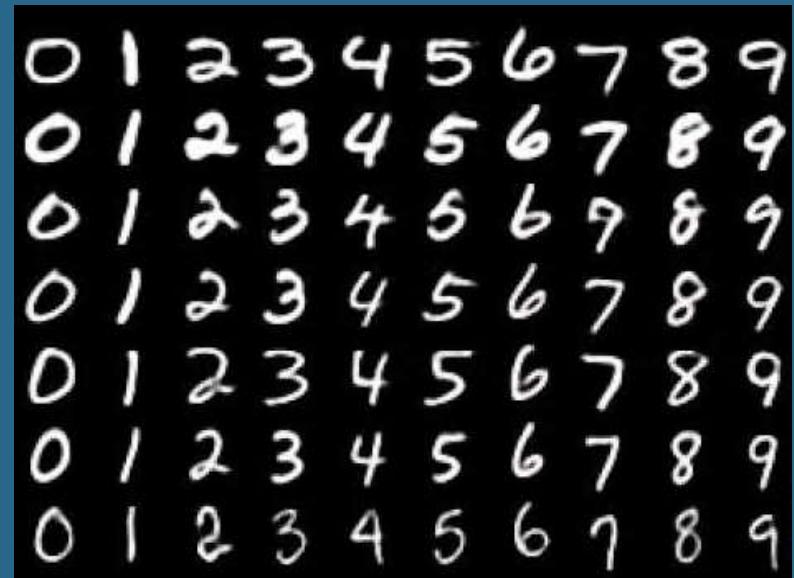
# How would you classify these images?

- How would you create a program to classify these hand written digits?



# MNIST dataset of hand written digits

- Hand written digits 0-9
- 70,000 labeled examples
- Image size: 28x28 pixels
- Created by:
  - Yann LeCun – NYU
  - Corinna Cortes – Google
  - Christopher Burges – Microsoft



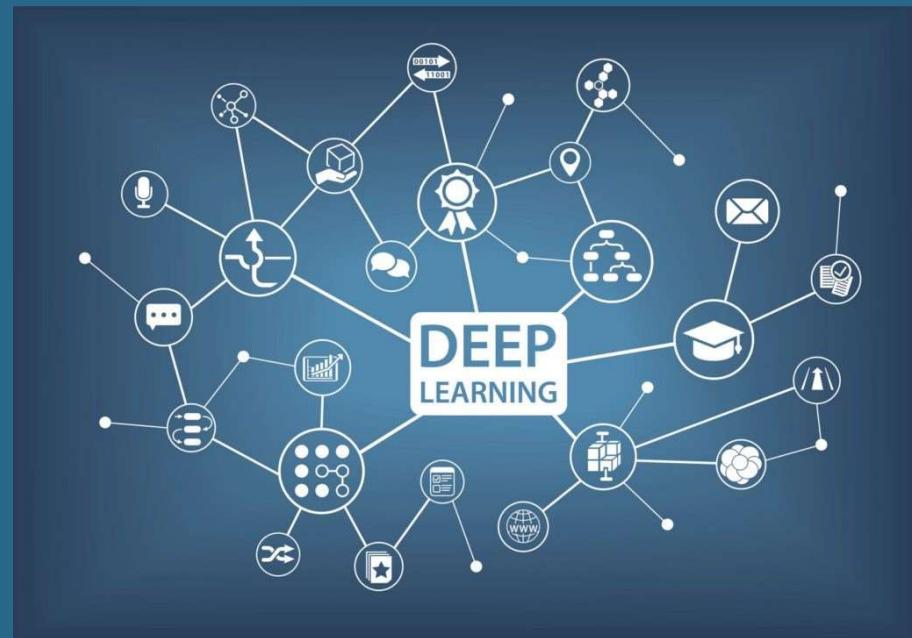
# Breakout session #1

- Use a neural network to classify hand written digits
- Play with the parameters to try and achieve a better accuracy
  - Example parameters:
    - Number of nodes in each layer
    - Number of fully connected layers
    - Different activation functions
    - Different cost functions

# Discussion – What did you lean?

# Deep learning

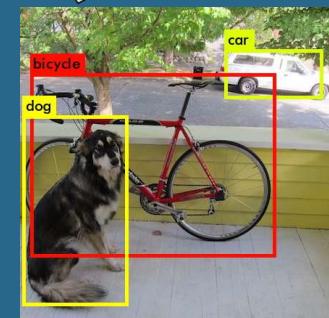
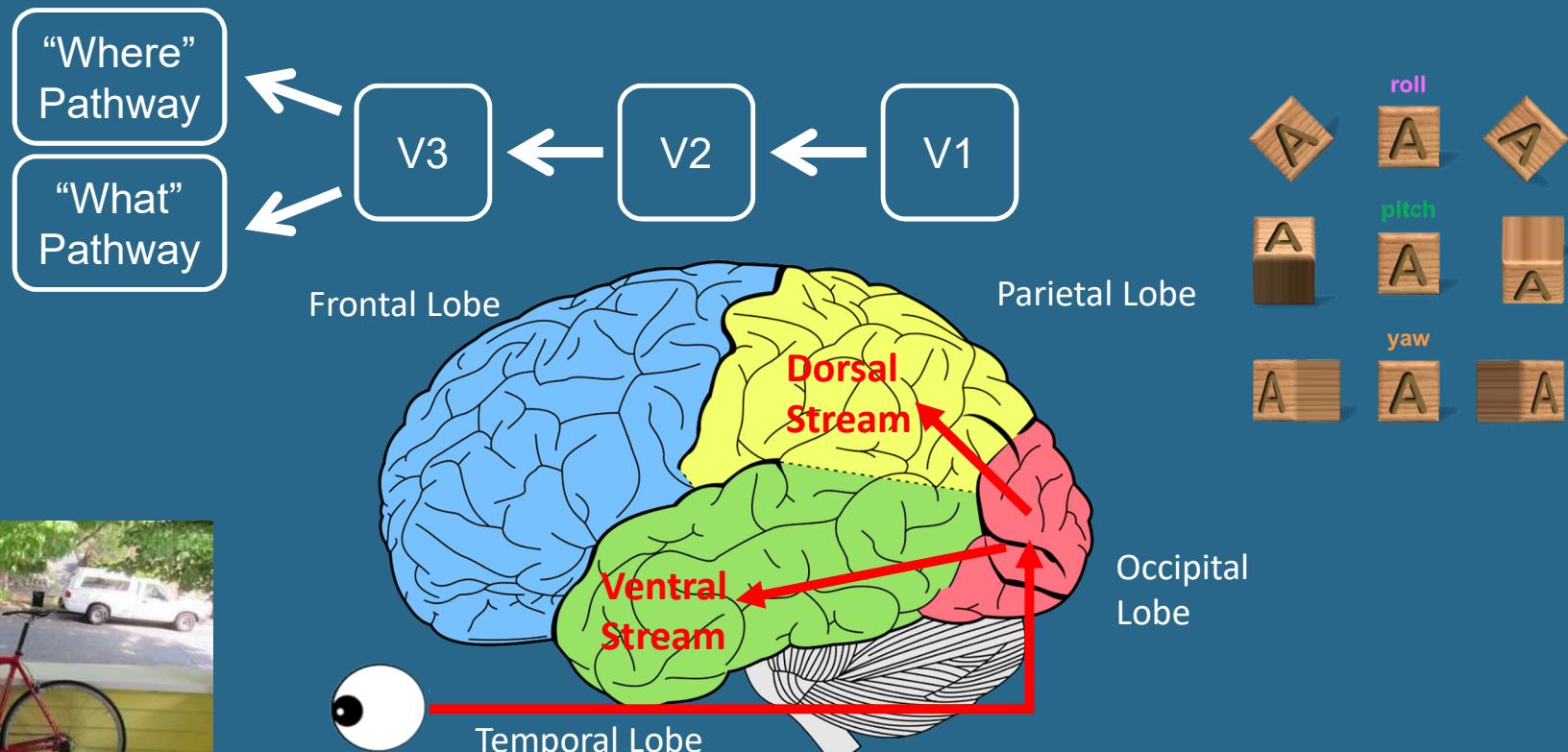
- Similar to neural network, but with many more layers
- End-to-end learning
- Learn features at each layer
  - Deeper layers usually have higher abstraction
- Example models
  - Convolutional neural network (CNN) – image recognition
  - Deep reinforcement learning (DRL) – playing games/autonomous robotics
  - Recurrent neural network (RNN) – natural language processing



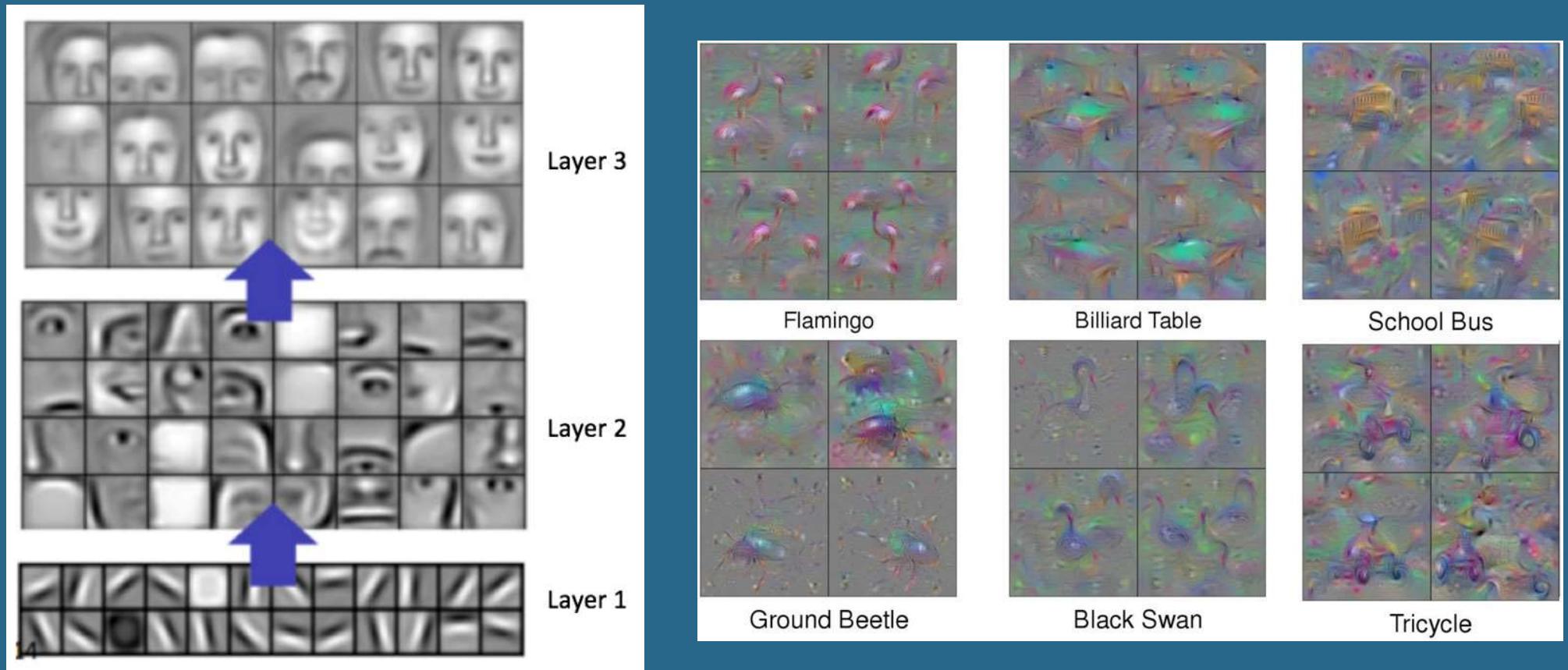
# Recent progress in deep learning

- Google DeepMind's *AlphaGo*
  - Go
- Google DeepMind's *AlphaStar*
  - *StarCraft II*
- *Tesla*
  - *Self driving cars*





# Convolution neural networks (CNN)



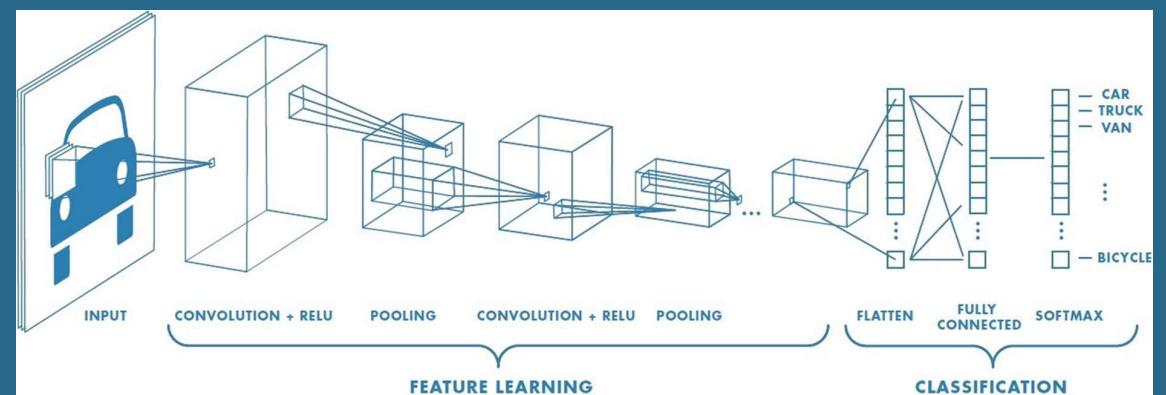
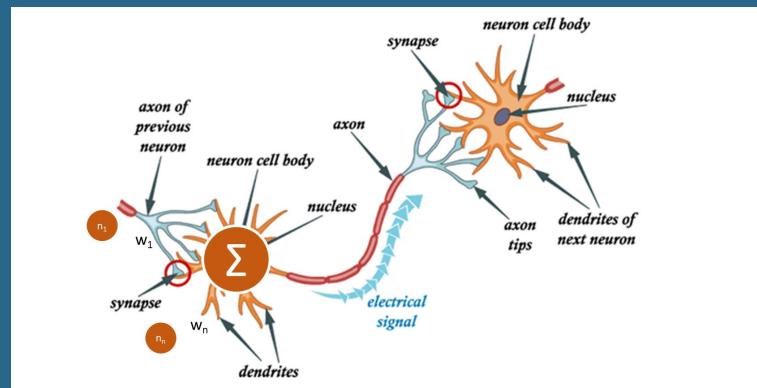
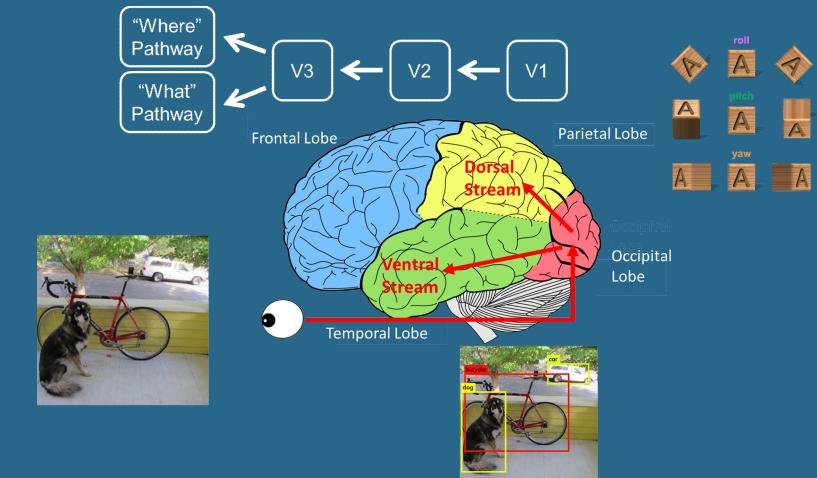
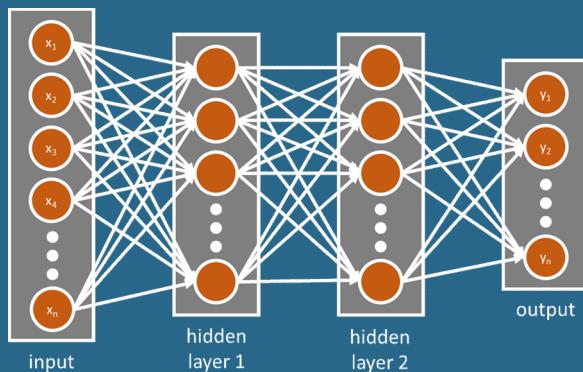
## Break out session #2

- Use a deep learning model to classify hand written digits
  - Convolutional neural network (CNN)
- Play with the parameters to try and achieve a better accuracy
  - Example parameters:
    - Learning rate
    - Number of nodes in each layer
    - Number of fully connected layers
    - Learning rate
    - Momentum

# Discussion – What did you lean?

# Summary

- Perceptron
- Neural networks
- Deep learning



# Future of machine learning in science

- Vision and other sensory processing
- Learning and decision making
- Better understanding of the human brain
- Continual shared learning between computer systems and biological systems
- Assistance with data collection and analysis?

# Thank you!

