

# **CS 480**

## ***Introduction to Artificial Intelligence***

**April 19, 2022**

# Announcements / Reminders

- **Final Exam: April 28th!**
  - Ignore Registrar date for CS 480
  - **Online section: please contact Mr. Charles Scott (scott@iit.edu) to make arrangements if necessary**
- **End of semester course evaluation: open. Thank you!**
- **Programming Assignment #02: due TOMORROW (04/20)**
- **Written Assignment #03: due TONIGHT (04/19)**
- **Written Assignment #04: due on Wednesday (04/27)**
- **Grading TA assignment:**

[https://docs.google.com/spreadsheets/d/1Cav\\_GBTGC7fLGzxuBCAUmEuJYPeF-HMLCYvwPbq8Fus/edit?usp=sharing](https://docs.google.com/spreadsheets/d/1Cav_GBTGC7fLGzxuBCAUmEuJYPeF-HMLCYvwPbq8Fus/edit?usp=sharing)

# Plan for Today

- **Casual Introduction to Machine Learning**

# Main Machine Learning Categories

## Supervised learning

**Supervised learning** is one of the most common techniques in machine learning. It is based on **known relationship(s) and patterns within data** (for example: relationship between inputs and outputs).

Frequently used types: **r e g r e s s i o n**, and **classification**.

## Unsupervised learning

**Unsupervised learning** involves finding underlying patterns within data. Typically used in **clustering** data points (similar customers, etc.)

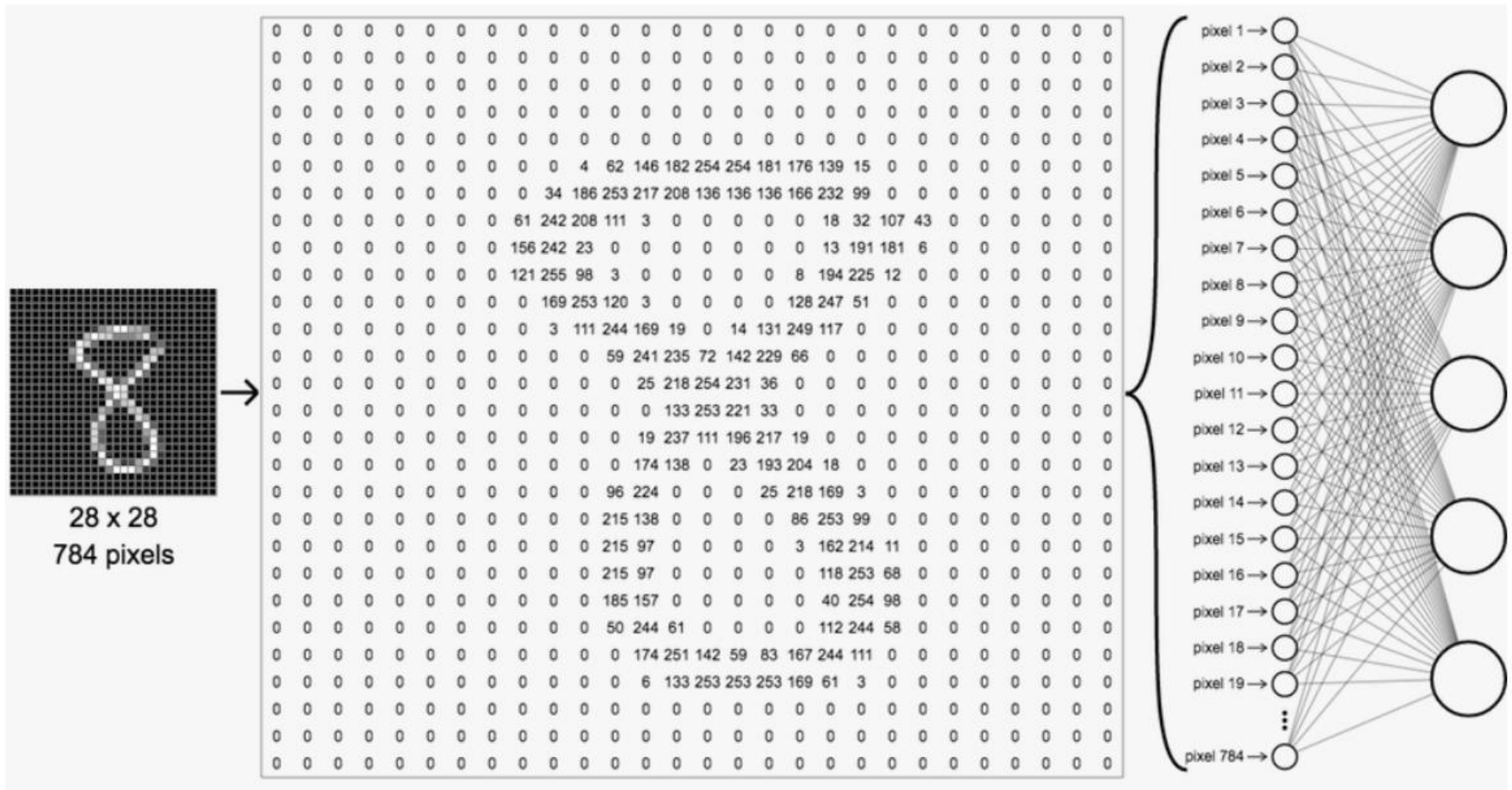
## Reinforcement learning

Reinforcement learning is inspired by behavioral psychology. It is **based on a rewarding / punishing an algorithm**.

Rewards and punishments are based on algorithm's action within its environment.

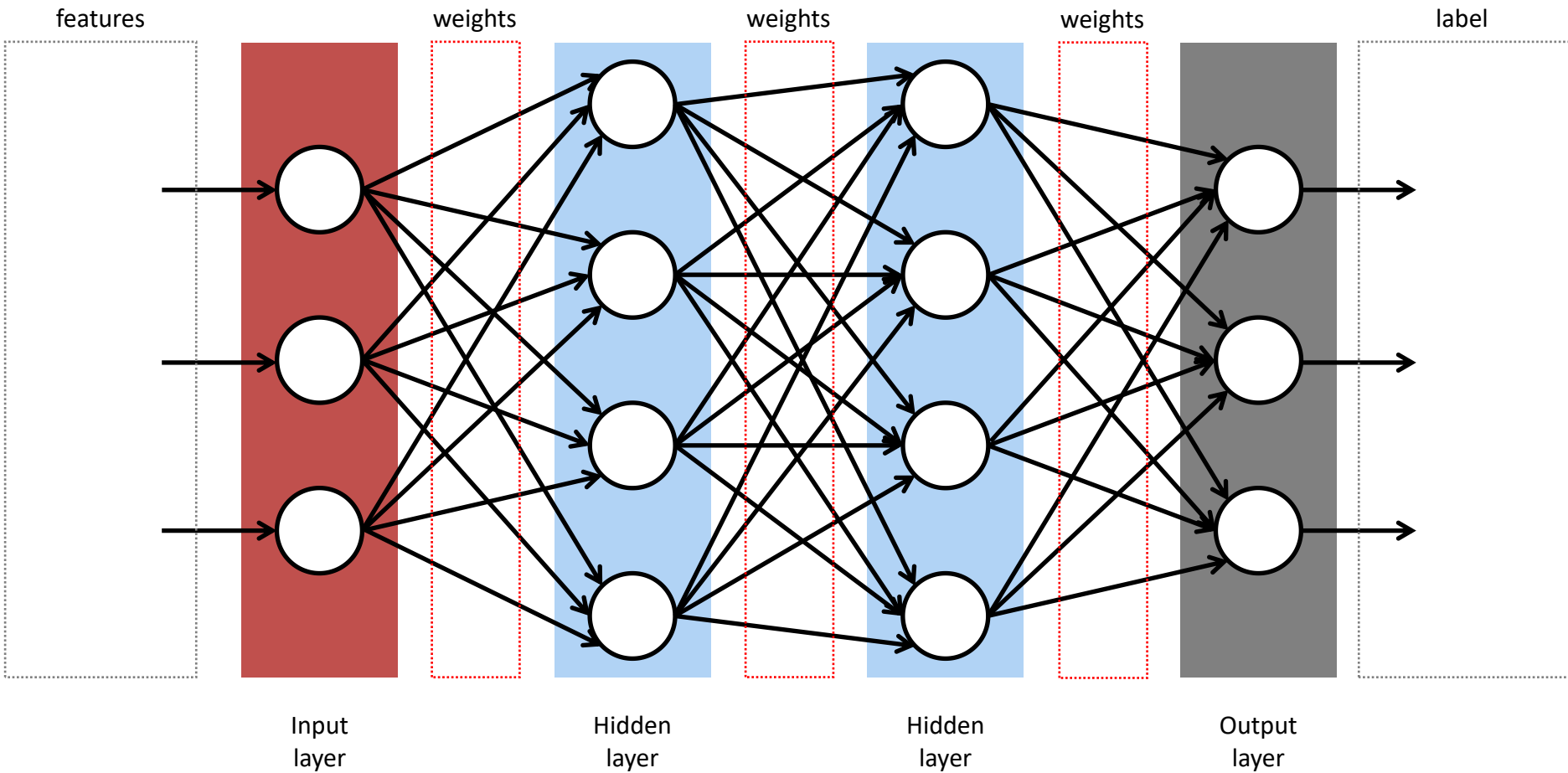
# Digit Image as ANN Feature Set

Individual features need to be “extracted” from an image. An image is numbers.

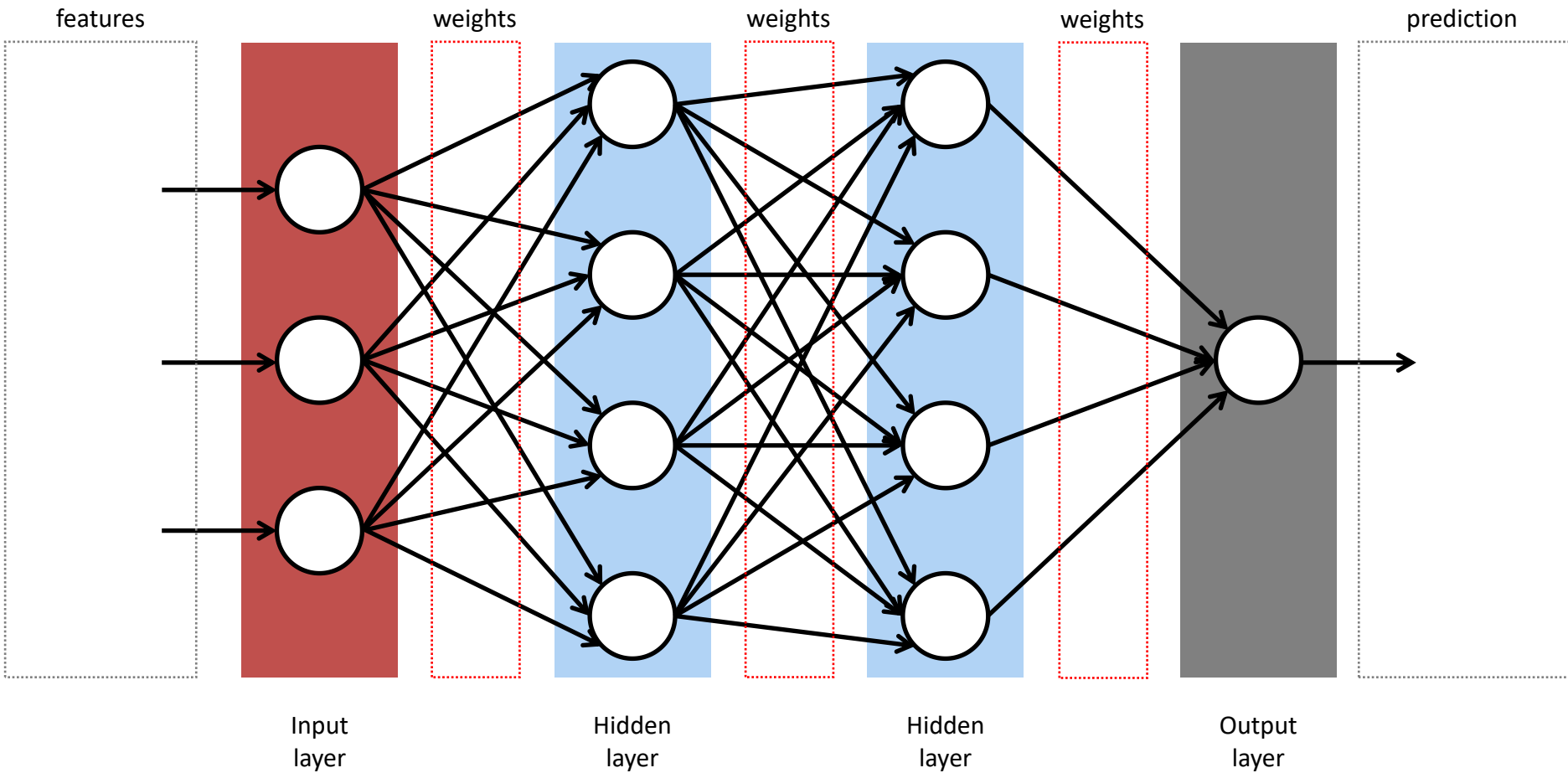


Source: <https://nikolanews.com/not-just-introduction-to-convolutional-neural-networks-part-1/>

# ANN for Classification



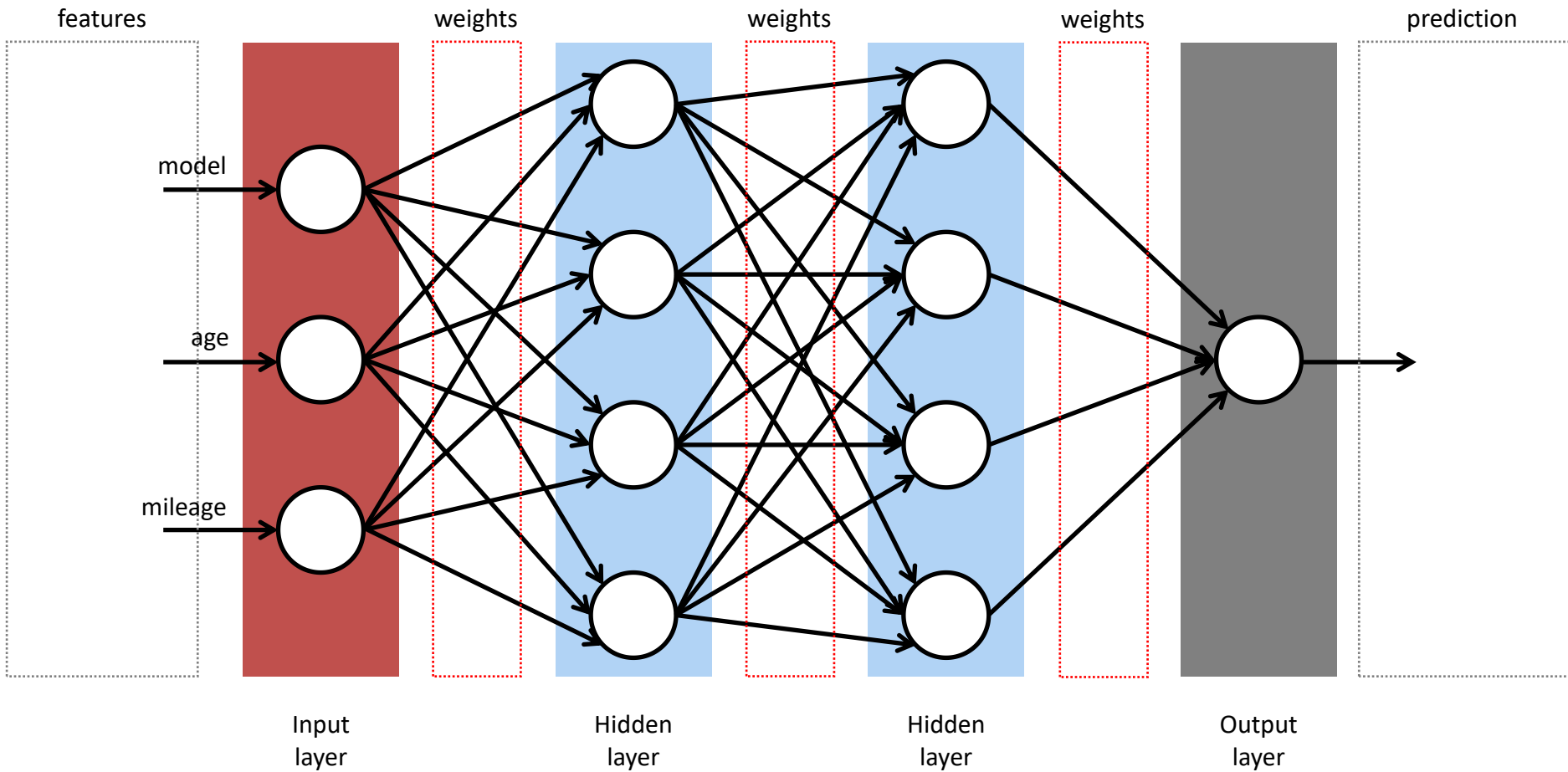
# ANN for Regression





# ANN for Regression: Used Car Price

Used car price predictor: train it first with used **car data - price** pairs.





# Unsupervised Learning

# What is Unsupervised Learning?

## Idea:

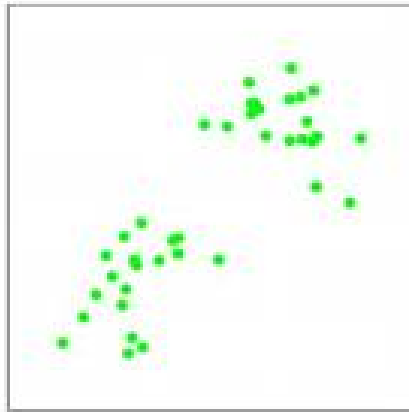
**Unsupervised learning** involves finding underlying patterns within data. Typically used in **clustering** data points (similar customers, etc.).

In other words:

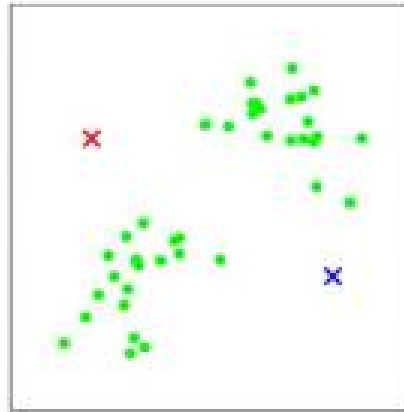
- there is some structure (groups / clusters) in data (for example: customer information)
- we don't know what it is (= **no labels!**)
- unsupervised learning tries to discover it

# Unsupervised Learning: K-Means Clustering

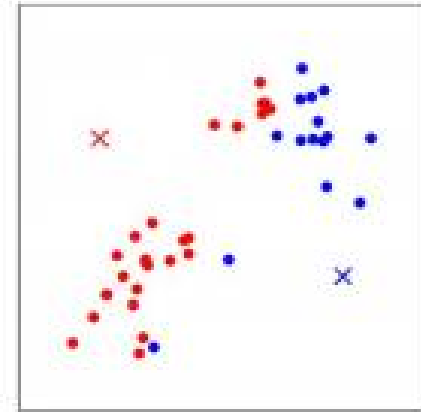
# K-Means Clustering: The Idea



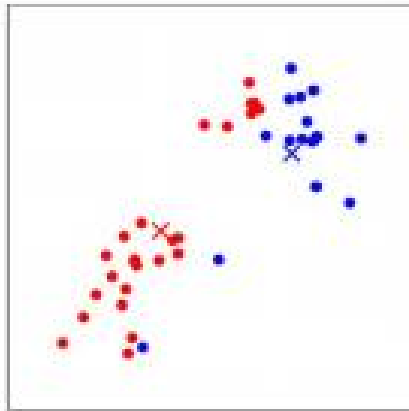
(a)



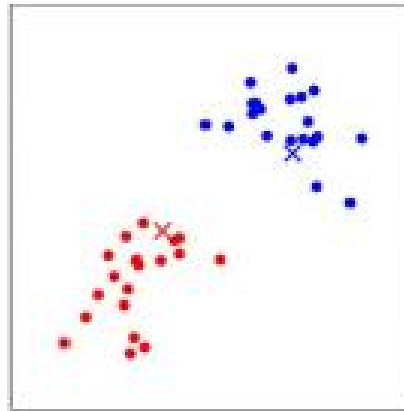
(b)



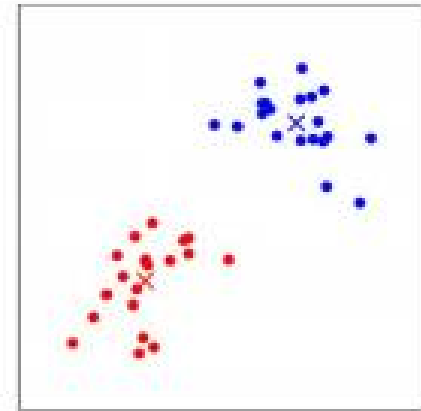
(c)



(d)



(e)



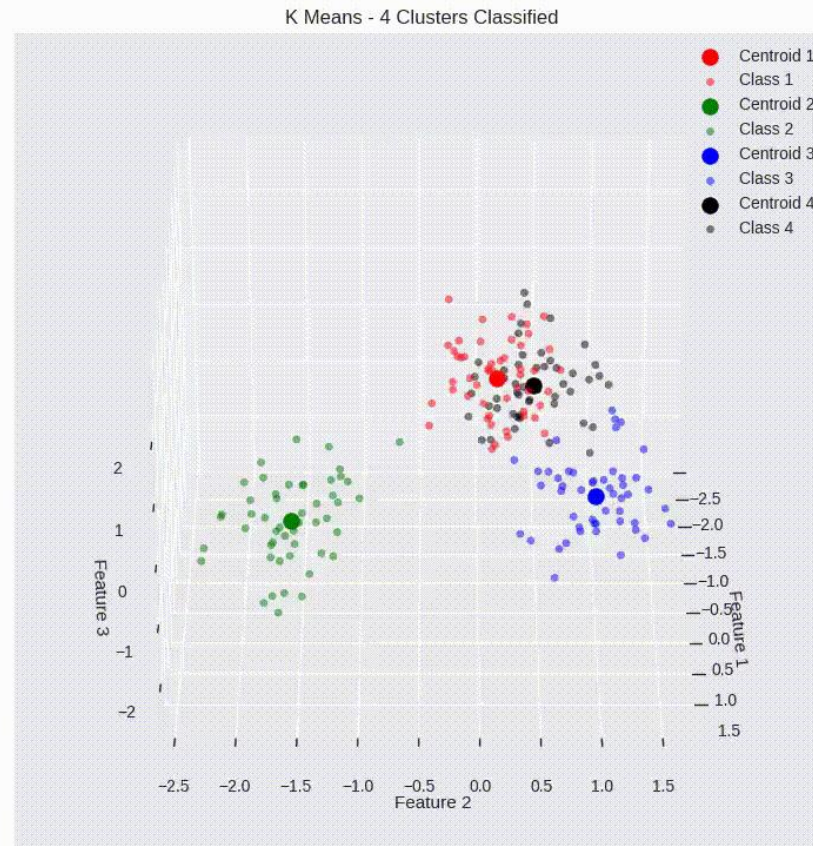
(f)

Source: <https://stanford.edu/~cpiech/cs221/handouts/kmeans.html>

# Exercise: K-Means Clustering

[https://lalejini.com/my\\_empirical\\_examples/KMeansClusteringExample/web/kmeans\\_clustering.html](https://lalejini.com/my_empirical_examples/KMeansClusteringExample/web/kmeans_clustering.html)

# 3D K-Means Clustering Visualized

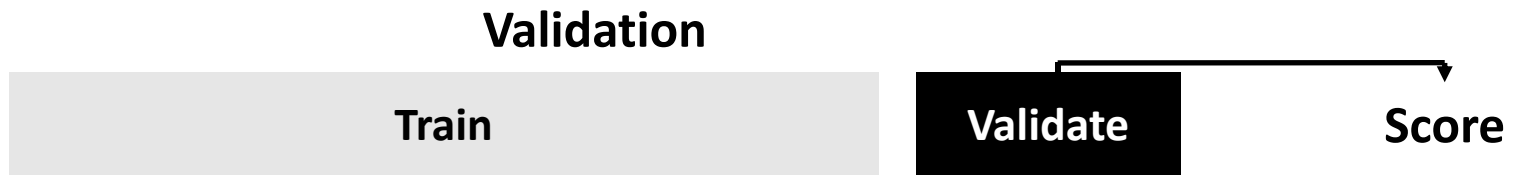


Source: <https://github.com/Gautam-J/Machine-Learning>

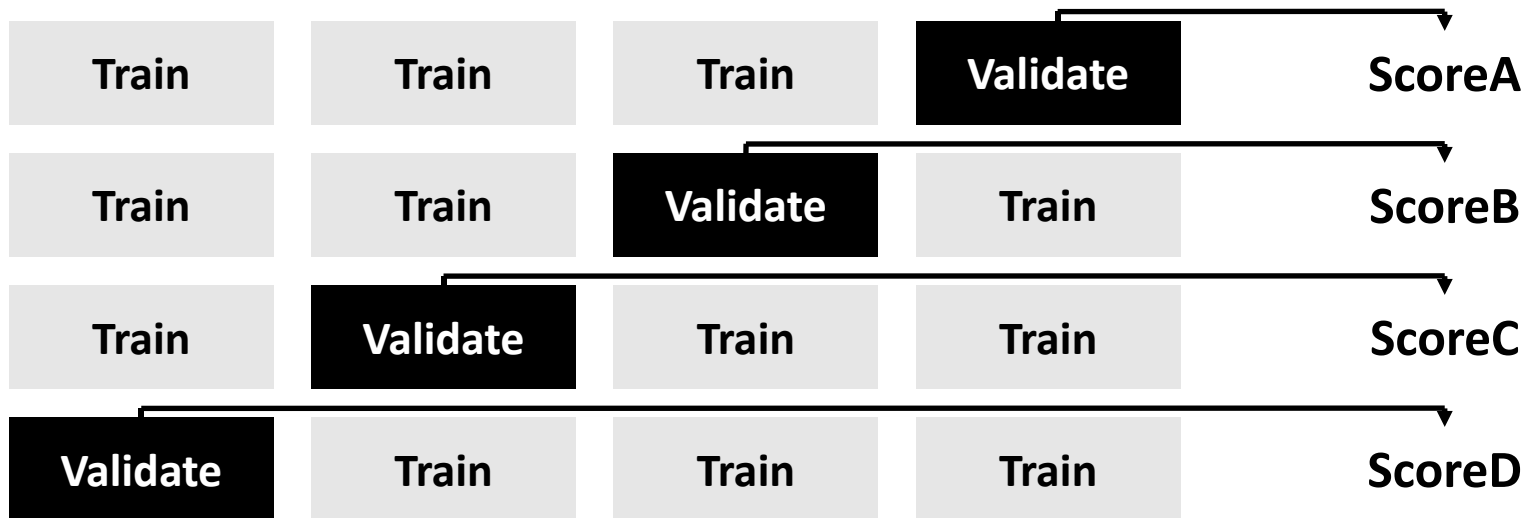
# Where Would You Use Clustering?



# K-Fold Cross-Validation



**4-fold** cross-validation



$$\text{Score} = \frac{\text{ScoreA} + \text{ScoreB} + \text{ScoreC} + \text{ScoreD}}{4}$$

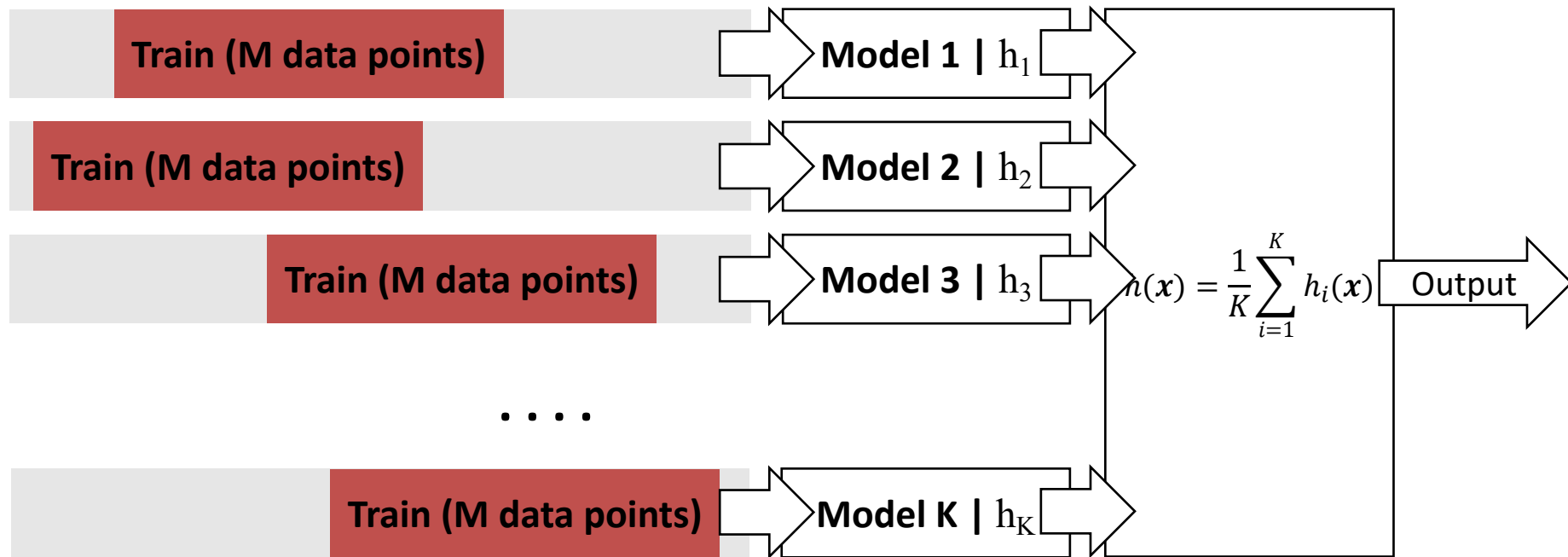
# Ensemble Learning

In ensemble learning we are creating a **collection** (an **ensemble**) of hypotheses (models)  $h_1, h_2, \dots, h_N$  and **combine their predictions by averaging, voting, or another level of machine learning**. Individual hypotheses (models) are **based models** and their combination is the **ensemble model**.

- Bagging
- Boosting
- Random Trees
- etc.

# Bagging: Regression

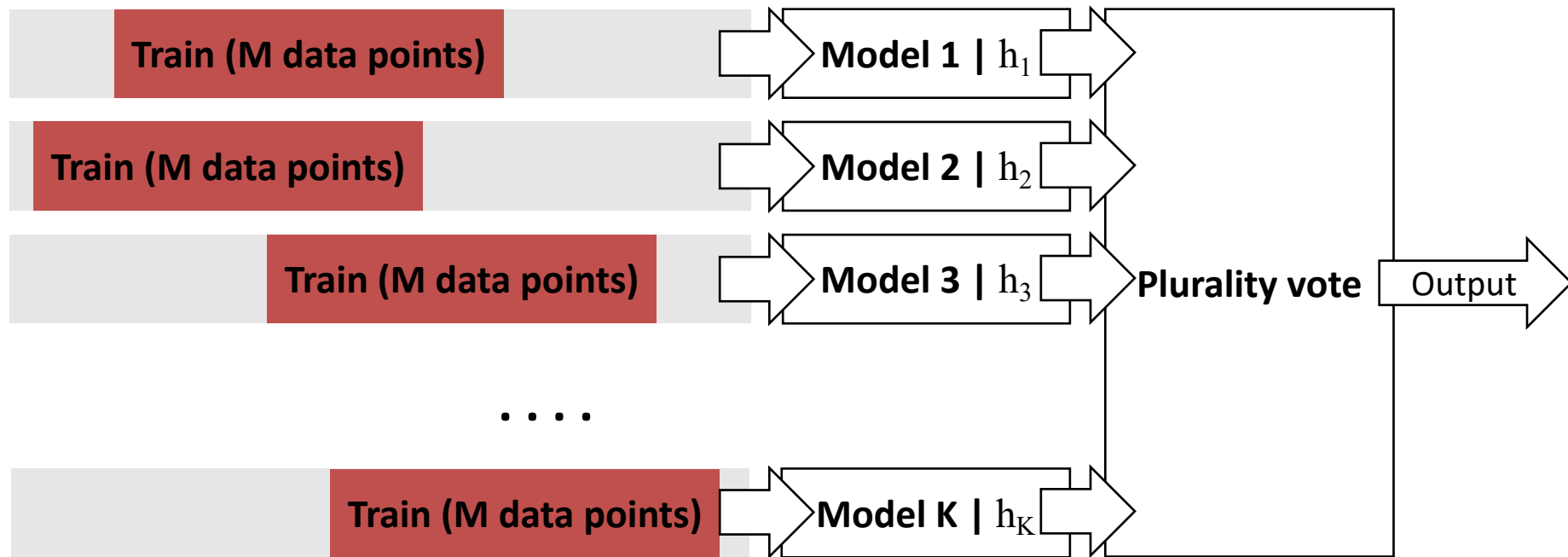
In bagging we generate  $K$  training sets by sampling with replacement from the original training set.



Bagging tends to reduce variance and helps with smaller data sets.

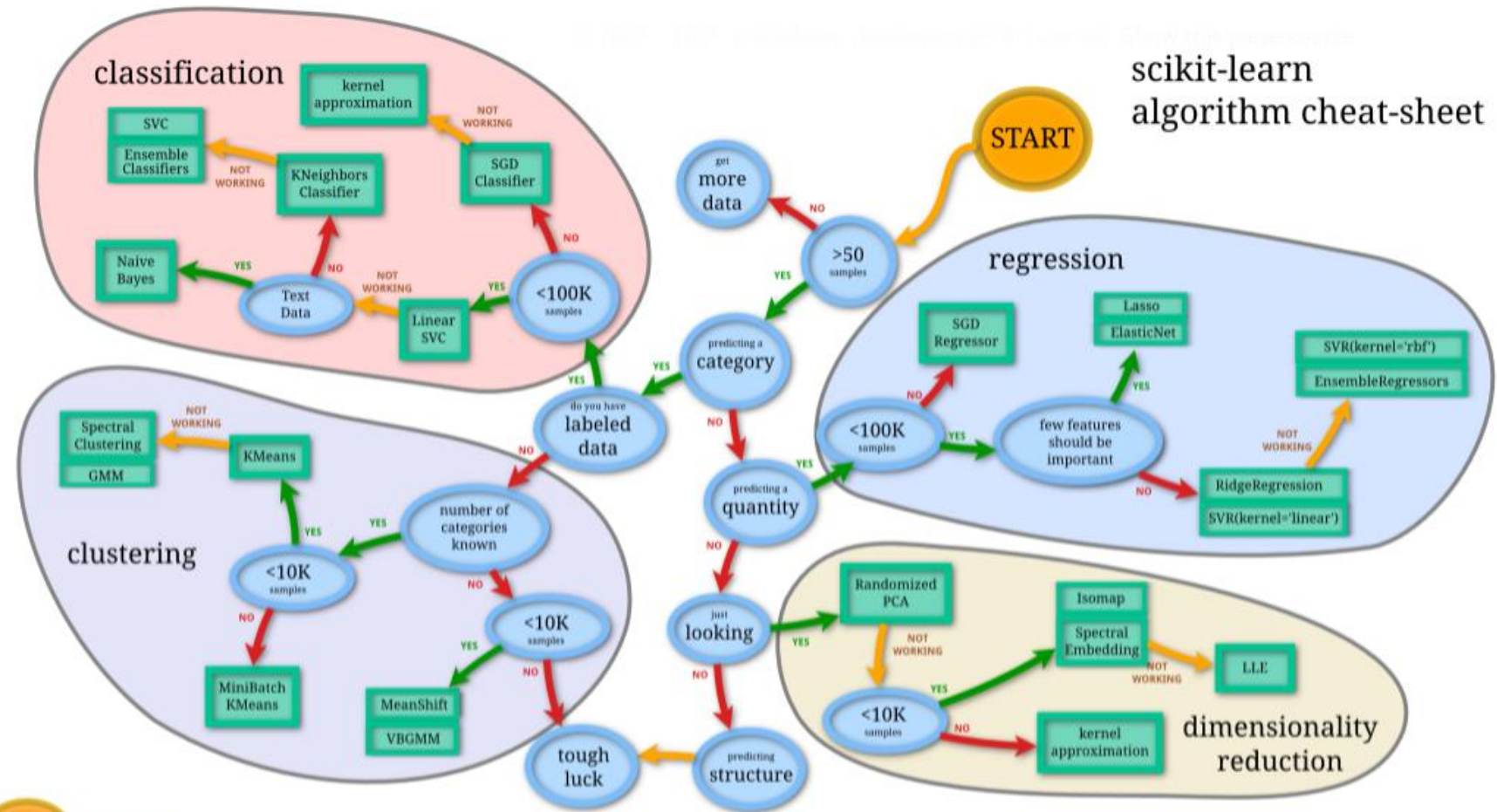
# Bagging: Classification

In bagging we generate  $K$  training sets by sampling with replacement from the original training set.



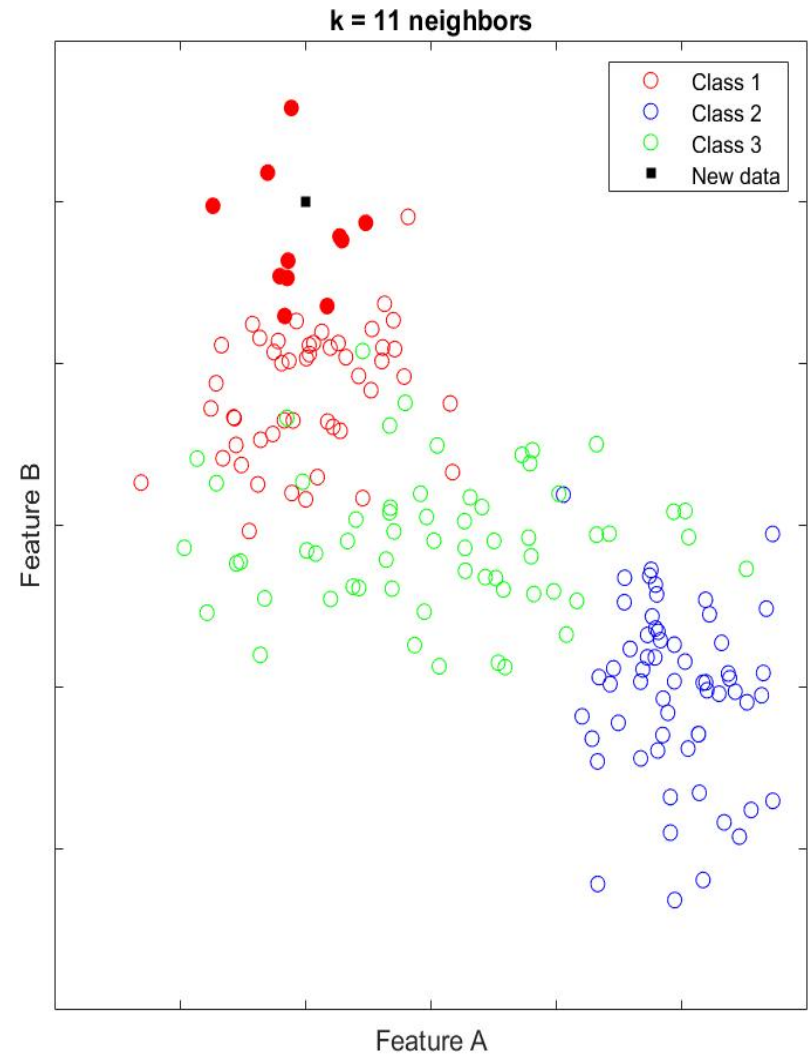
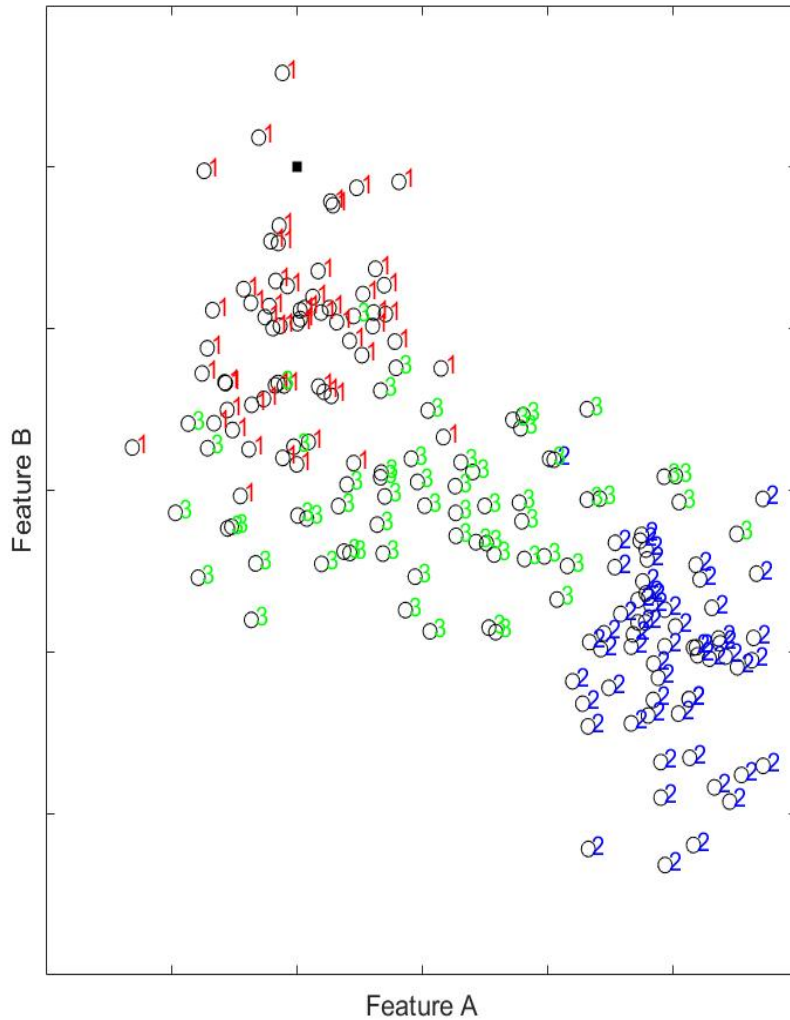
Bagging tends to reduce variance and helps with smaller data sets.

# scikit-learn Algorithm Cheat Sheet



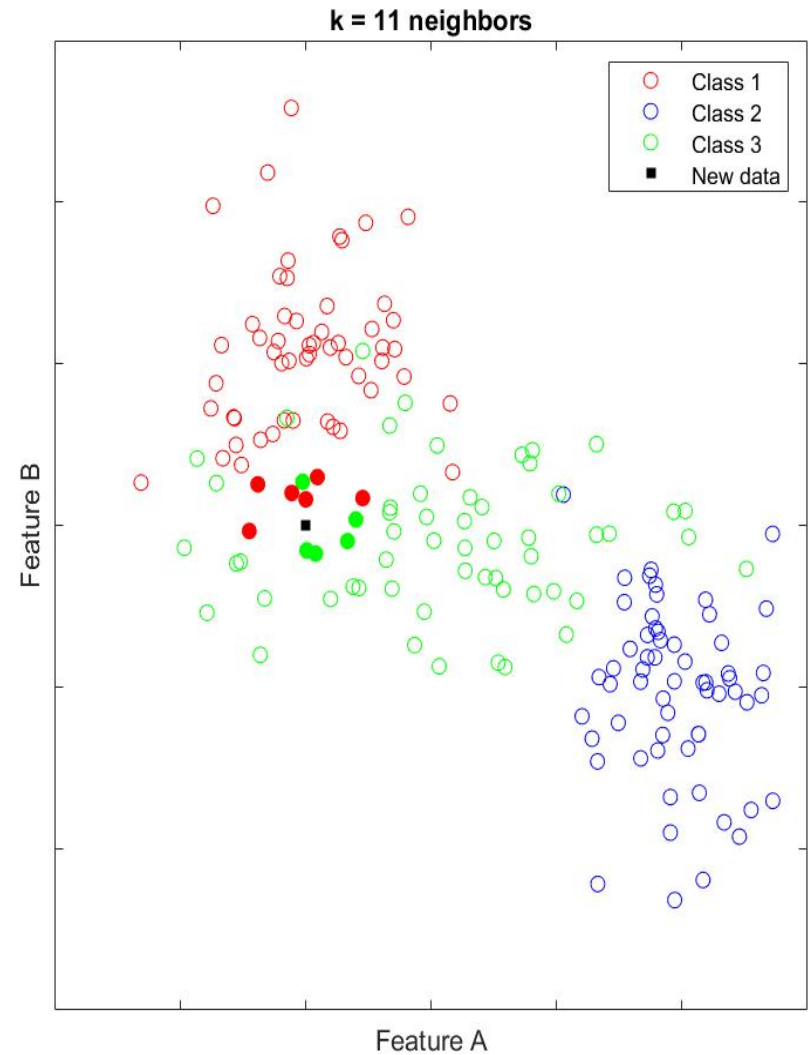
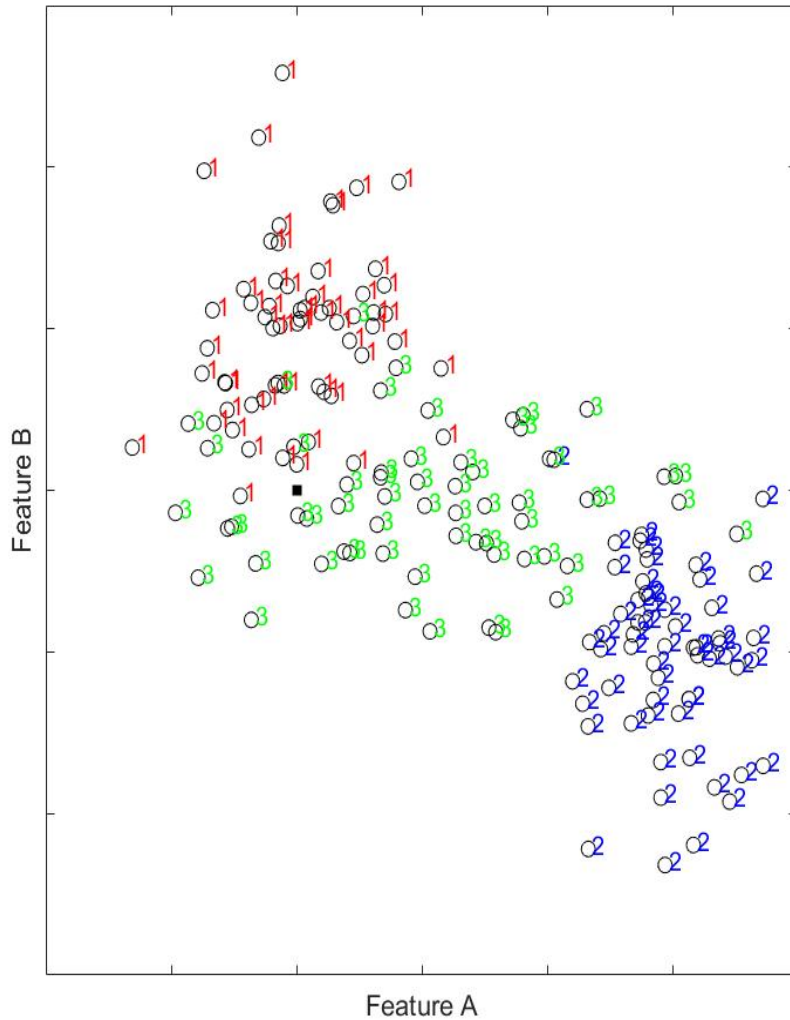
Source: [https://scikit-learn.org/stable/tutorial/machine\\_learning\\_map/index.html](https://scikit-learn.org/stable/tutorial/machine_learning_map/index.html)

# k = 11 Nearest Neighbors



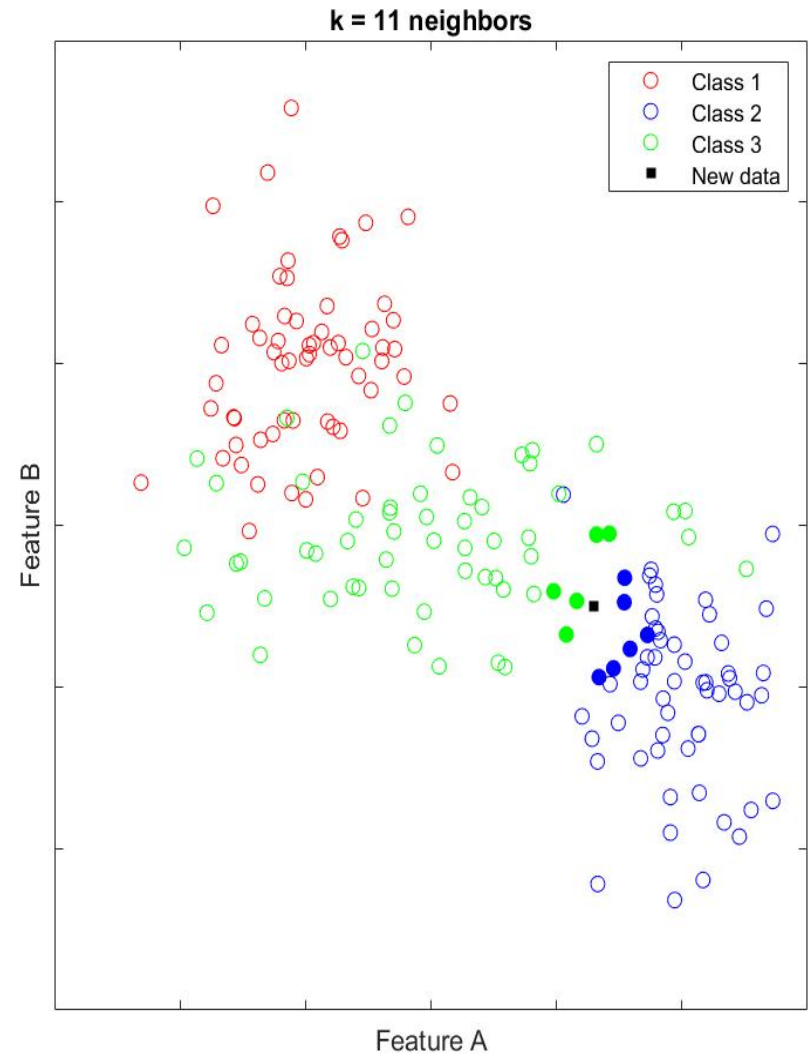
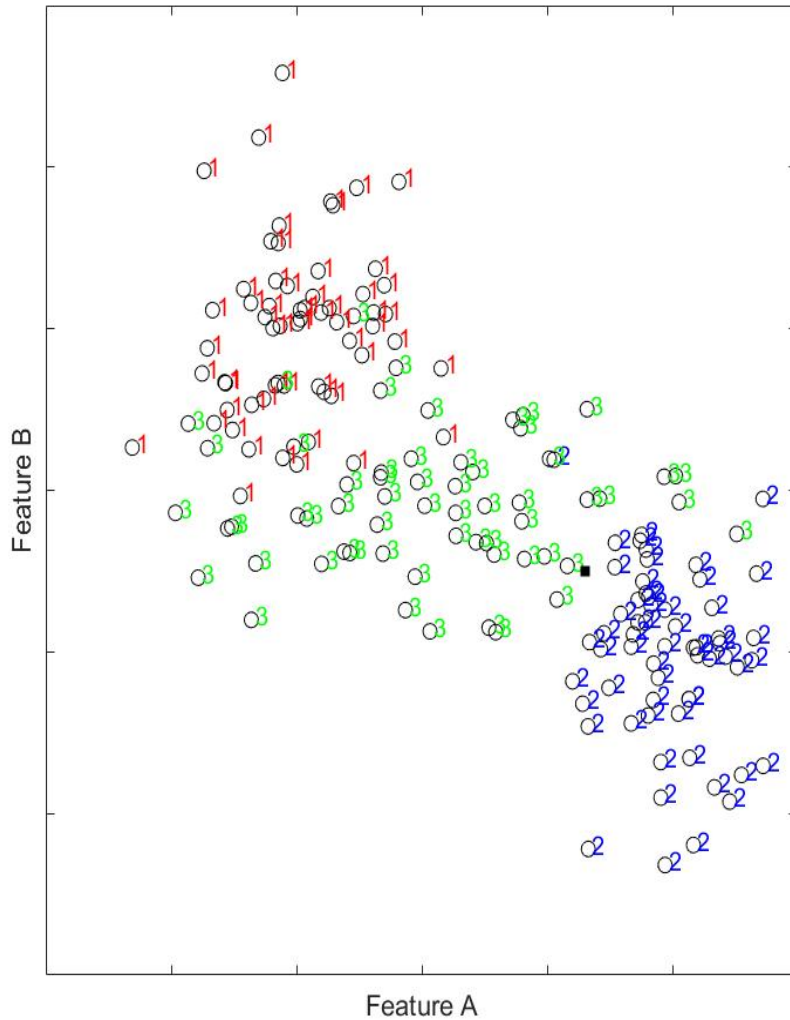


# k = 11 Nearest Neighbors

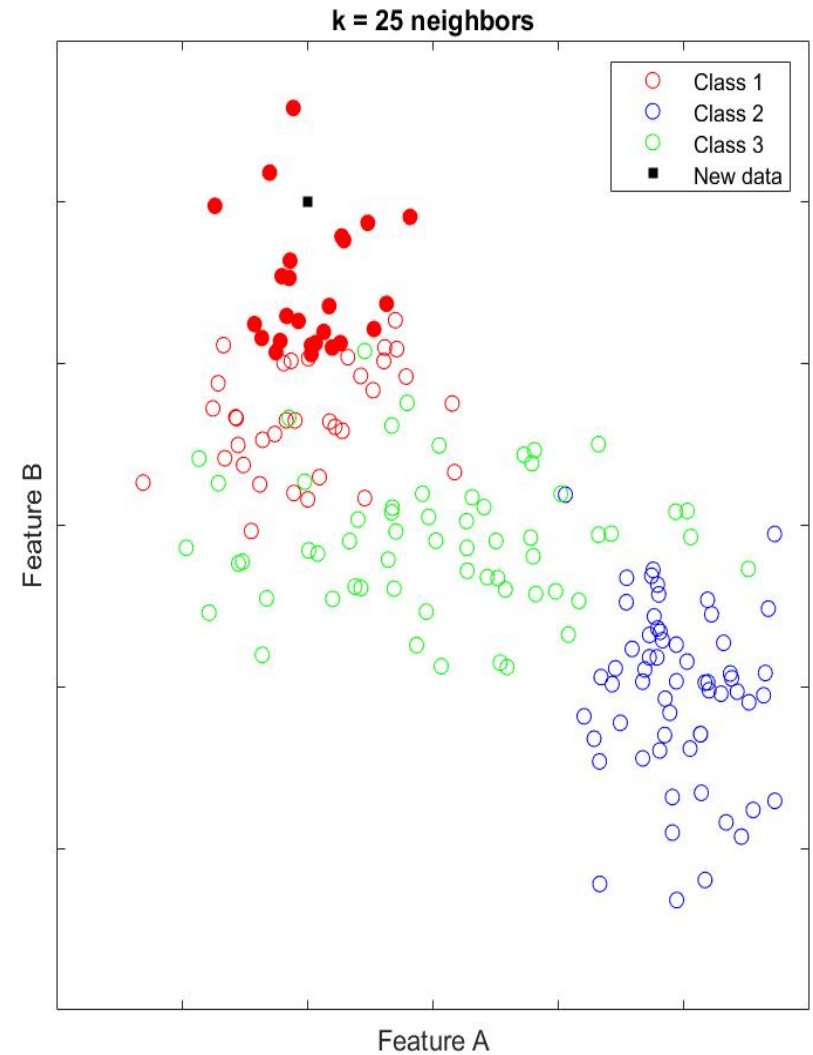
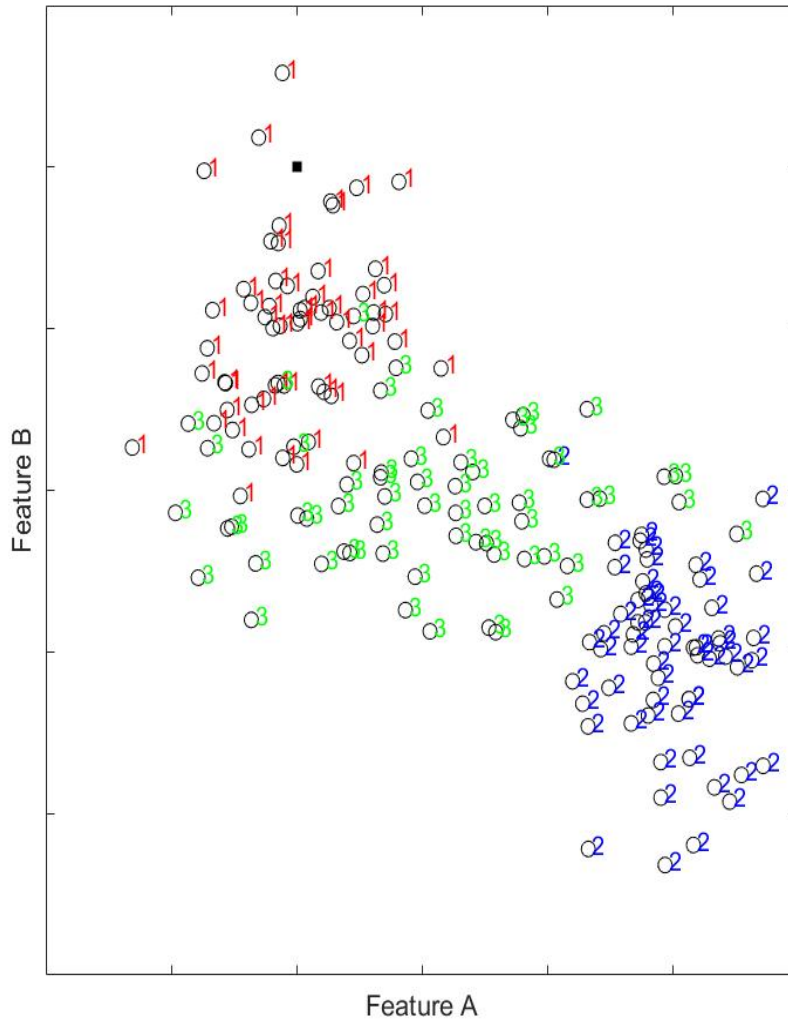




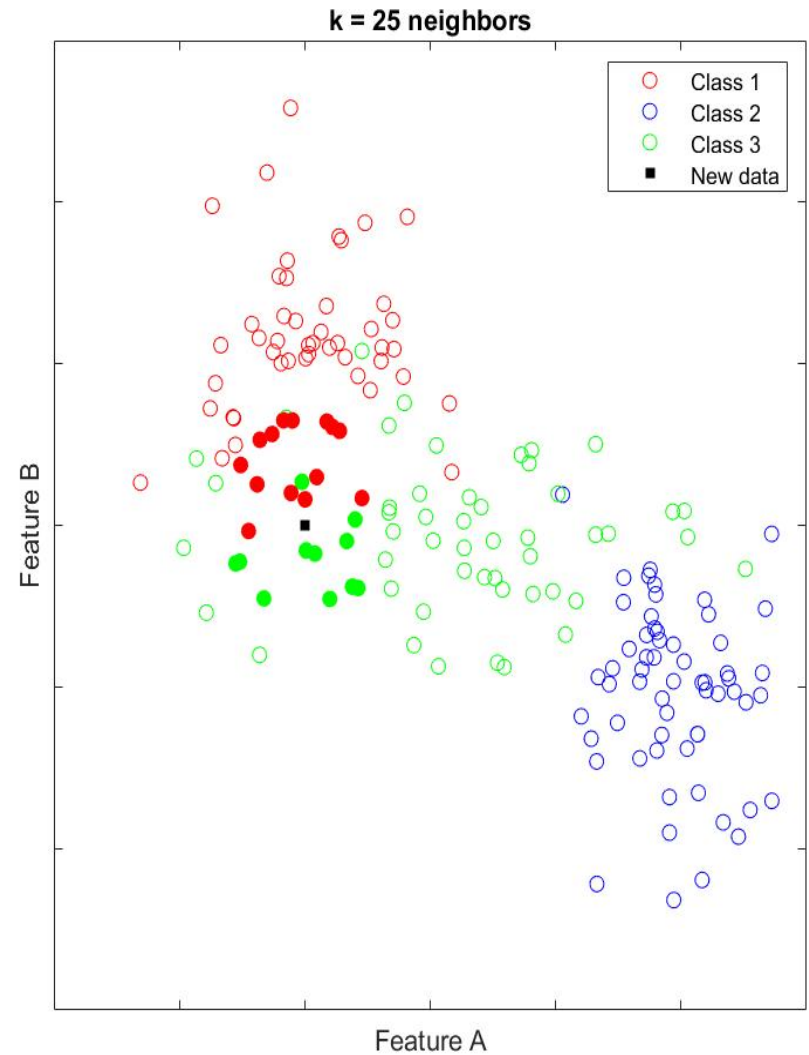
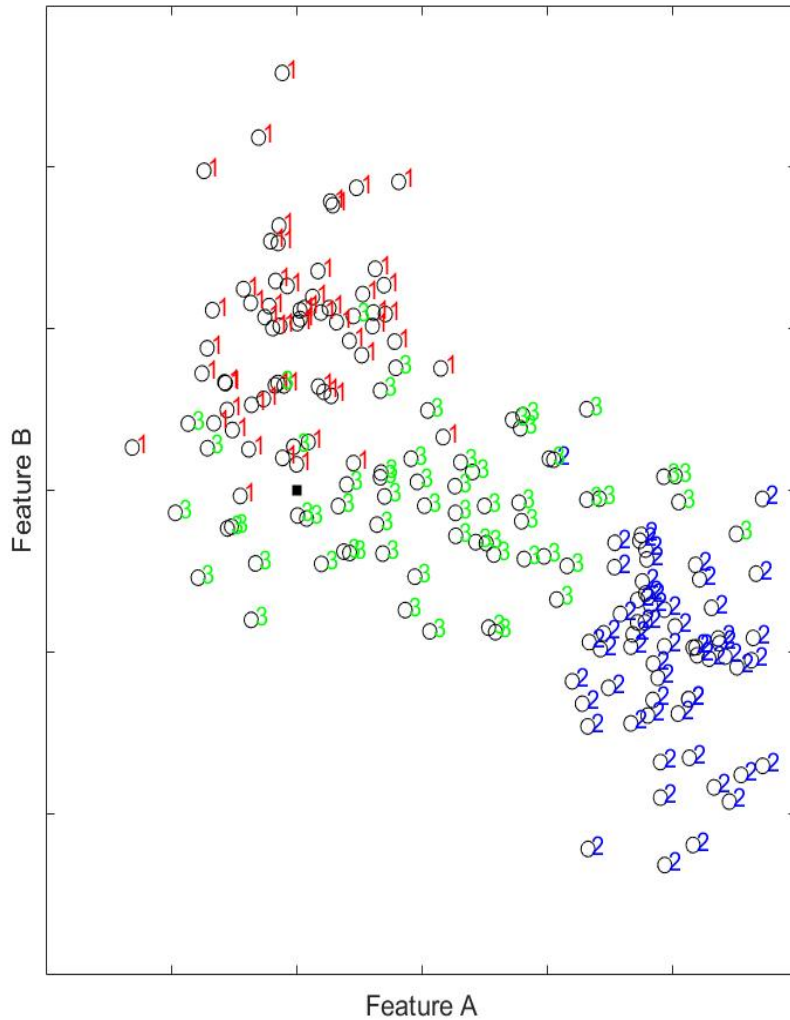
# k = 11 Nearest Neighbors



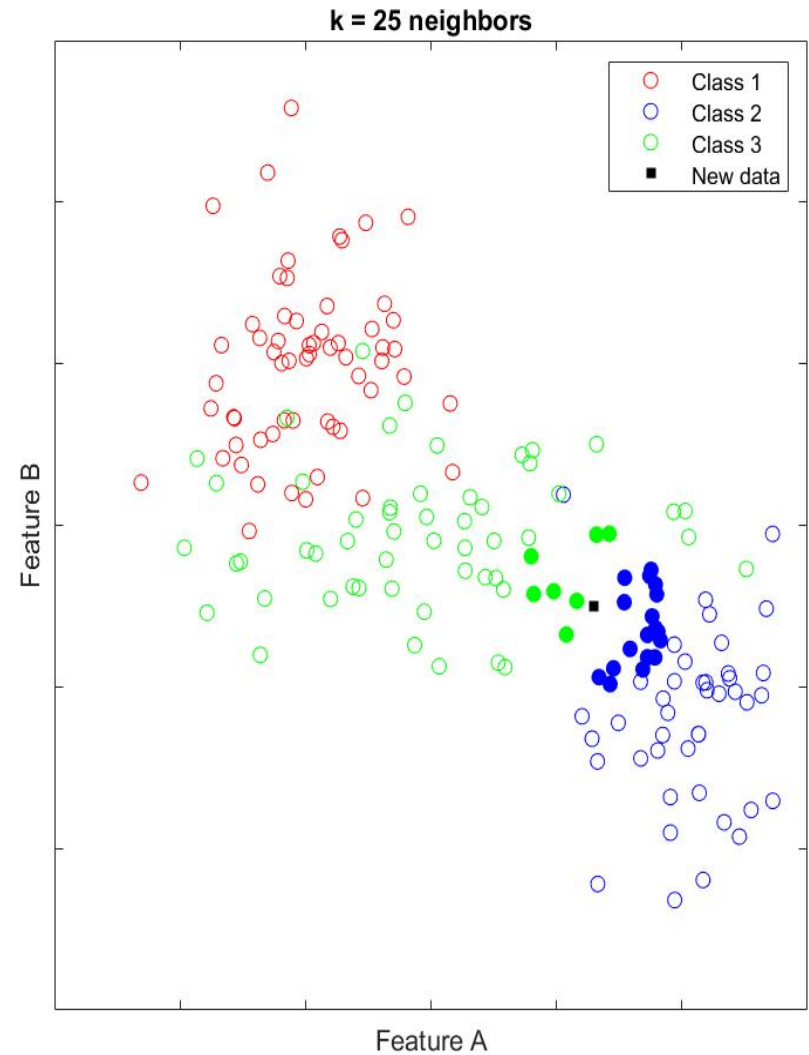
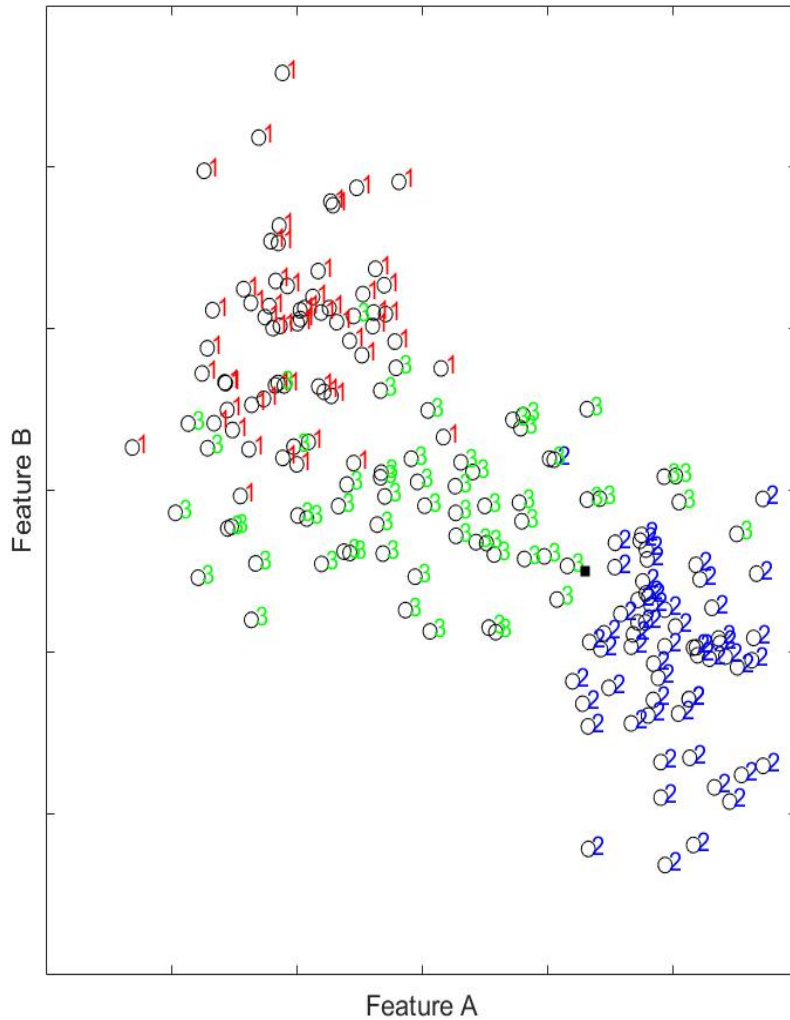
# k = 25 Nearest Neighbors



# k = 25 Nearest Neighbors



# k = 25 Nearest Neighbors

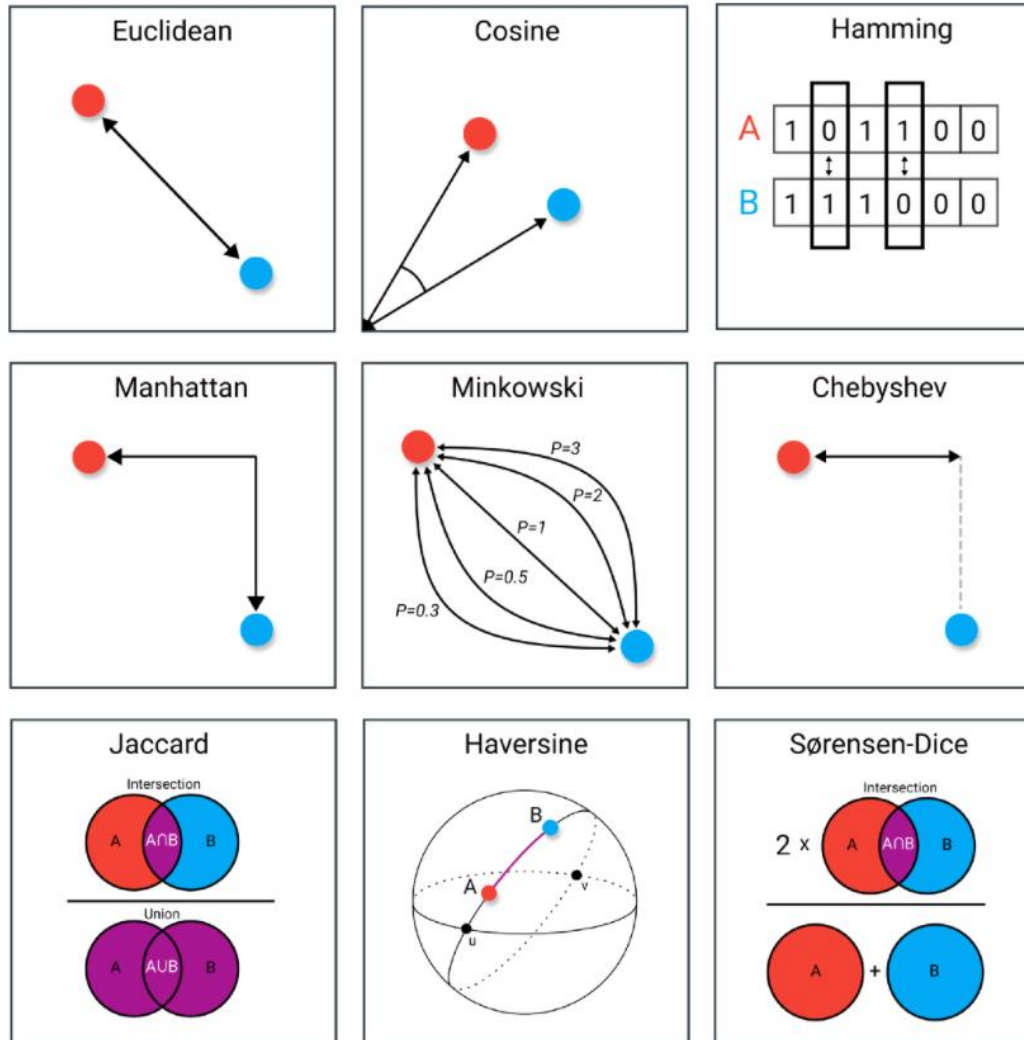


# How Would kNN Do Here?





# Distance Measures



Source: <https://towardsdatascience.com/9-distance-measures-in-data-science-918109d069fa>

# Practical ML: Feature Engineering

- **One-hot encoding**

red = [1, 0, 0]

yellow = [0, 1, 0]

green = [0, 0, 1]

- **Binning / Bucketing**

- **Normalization**

- **Dealing with missing data / features**



# Reinforcement Learning (RL)

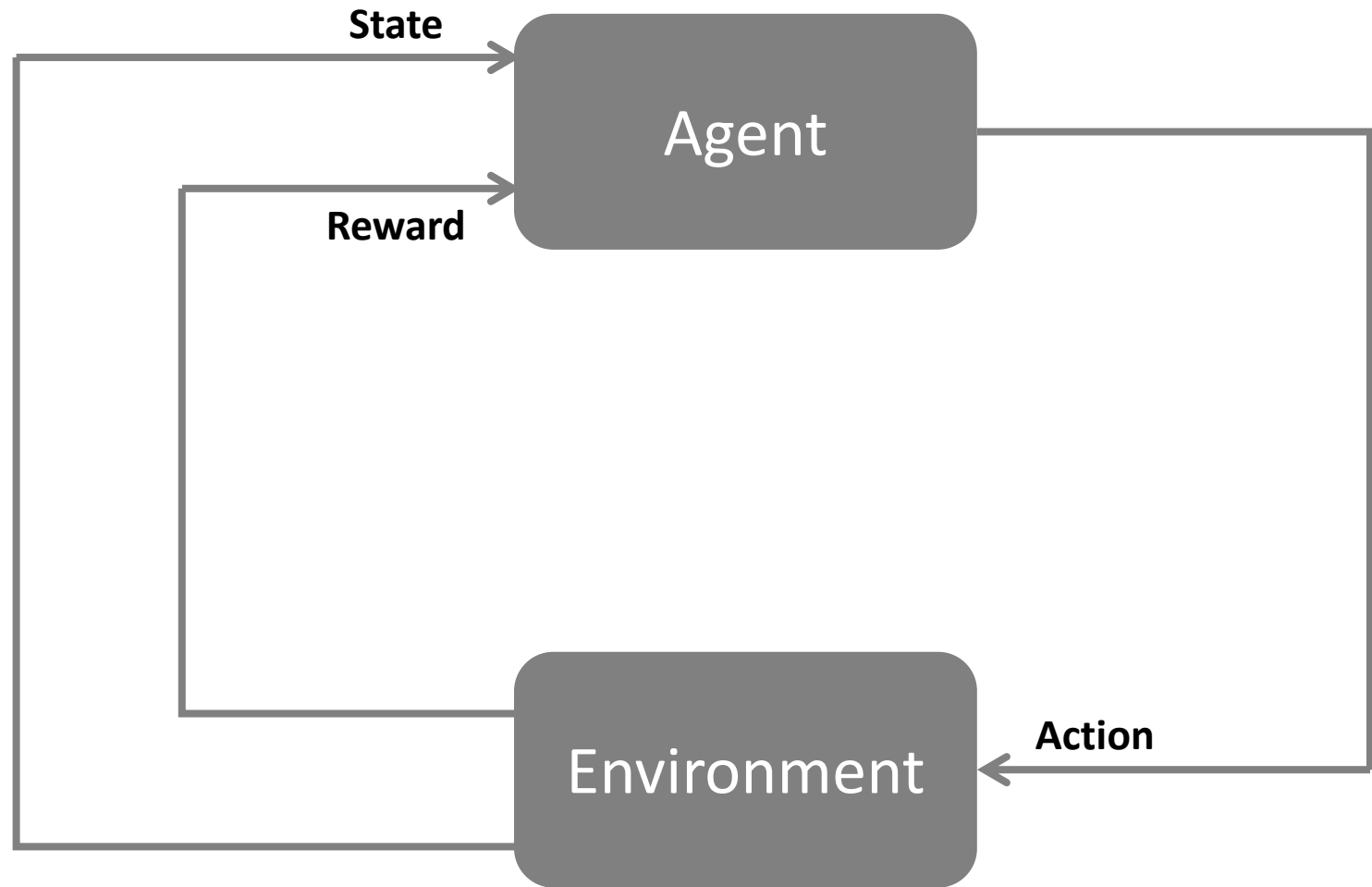
# What is Reinforcement Learning?

## Idea:

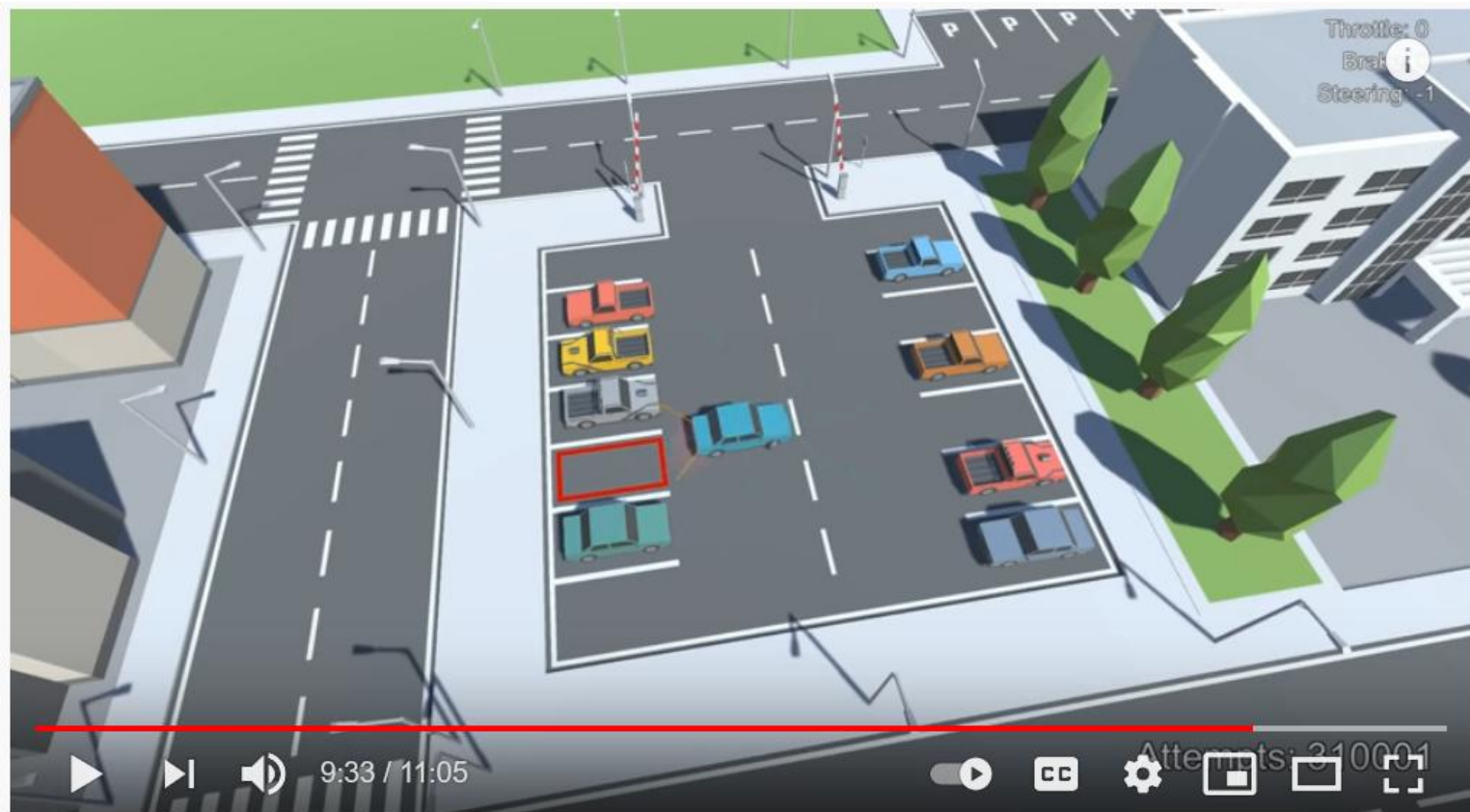
Reinforcement learning is inspired by behavioral psychology. It is **based on a rewarding / punishing an algorithm.**

Rewards and punishments are based on algorithm's action within its environment.

# RL: Agents and Environments



# Reinforcement Learning in Action



#ArtificialIntelligence #MachineLearning #ReinforcementLearning

AI Learns to Park - Deep Reinforcement Learning

1,744,342 views • Aug 23, 2019



28K



1.1K



SHARE

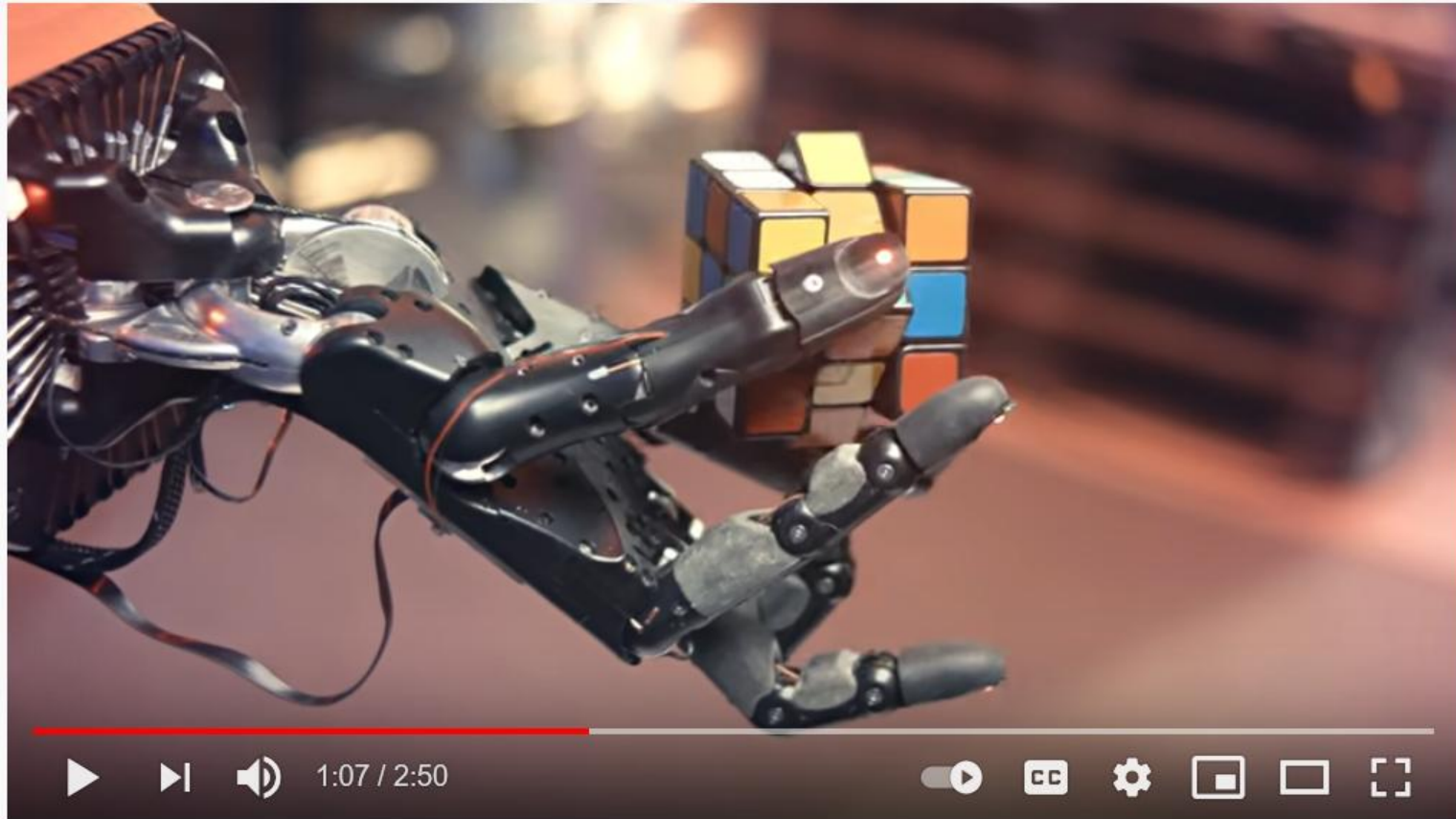


SAVE



Source: [https://www.youtube.com/watch?v=VMp6pq6\\_QjI](https://www.youtube.com/watch?v=VMp6pq6_QjI)

# Reinforcement Learning in Action



Solving Rubik's Cube with a Robot Hand

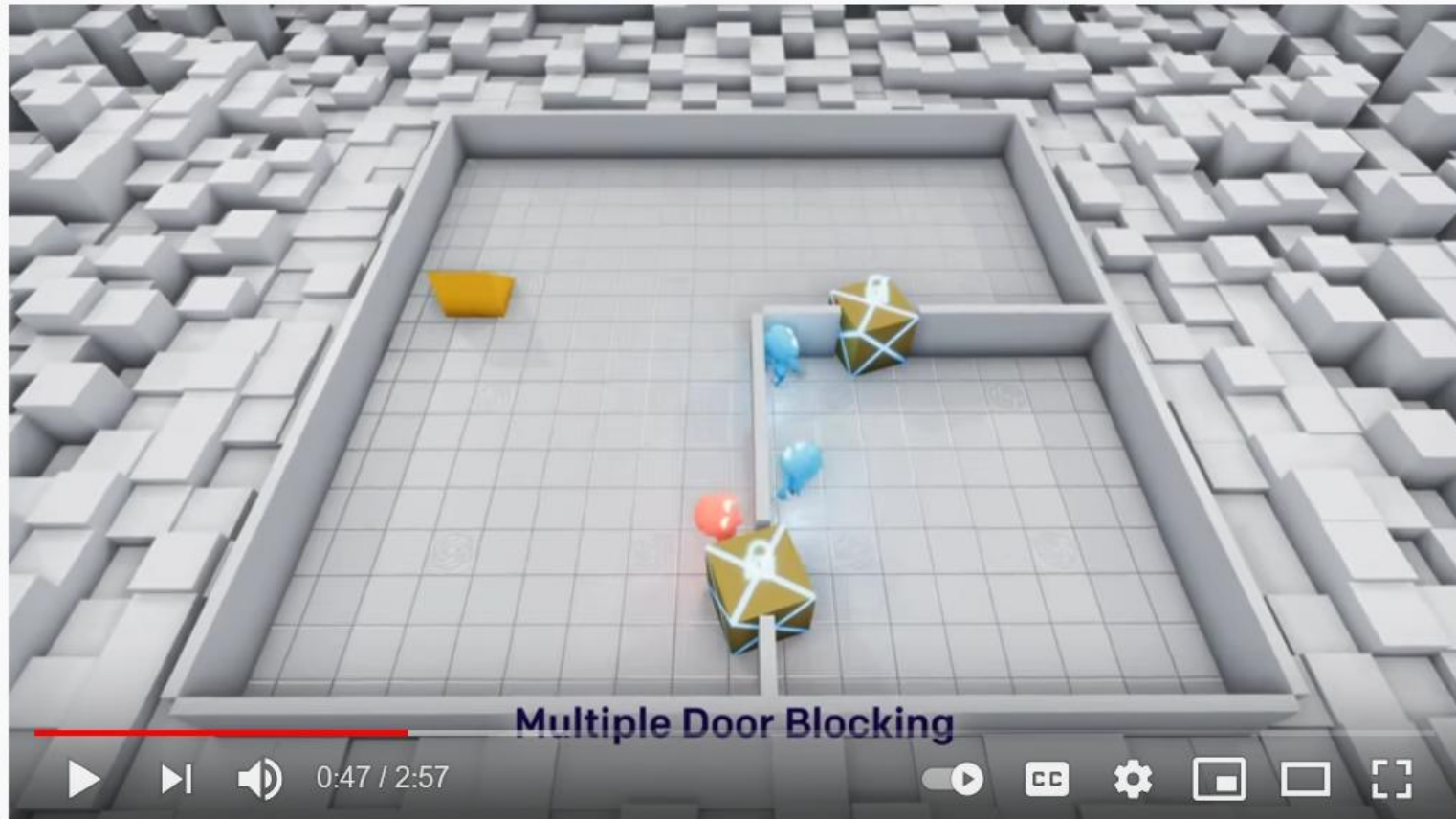
409,438 views • Oct 15, 2019

👍 9.7K    💬 127    ➦ SHARE    ≡+ SAVE    ...

Source: <https://www.youtube.com/watch?v=x4O8pojMF0w>



# Reinforcement Learning in Action



## Multi-Agent Hide and Seek

4,588,797 views • Sep 17, 2019

 120K

1.7K

 SHARE SAVE

...

Source: <https://www.youtube.com/watch?v=kopoLzvh5jY>

# Reinforcement Learning in Action

Tryhard: 100% 00' 28'' 05

Input Neural Network Output

MarlQ -- Q-Learning Neural Network for Mario Kart -- 2M Sub Special

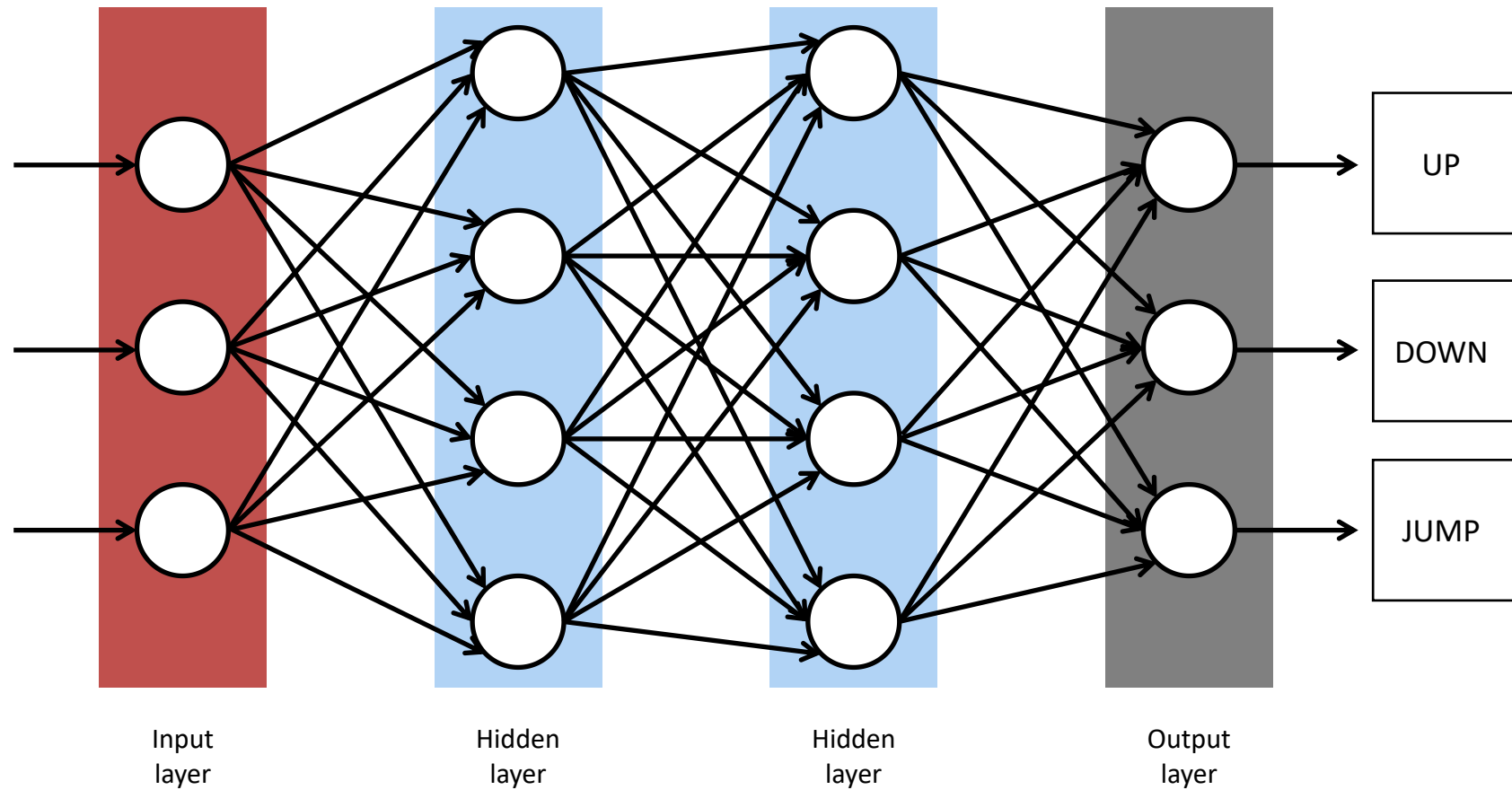
330,560 views • Jun 29, 2019

18K 163 SHARE SAVE ...

Source: [https://www.youtube.com/watch?v=Tnu4O\\_xEmVk](https://www.youtube.com/watch?v=Tnu4O_xEmVk)

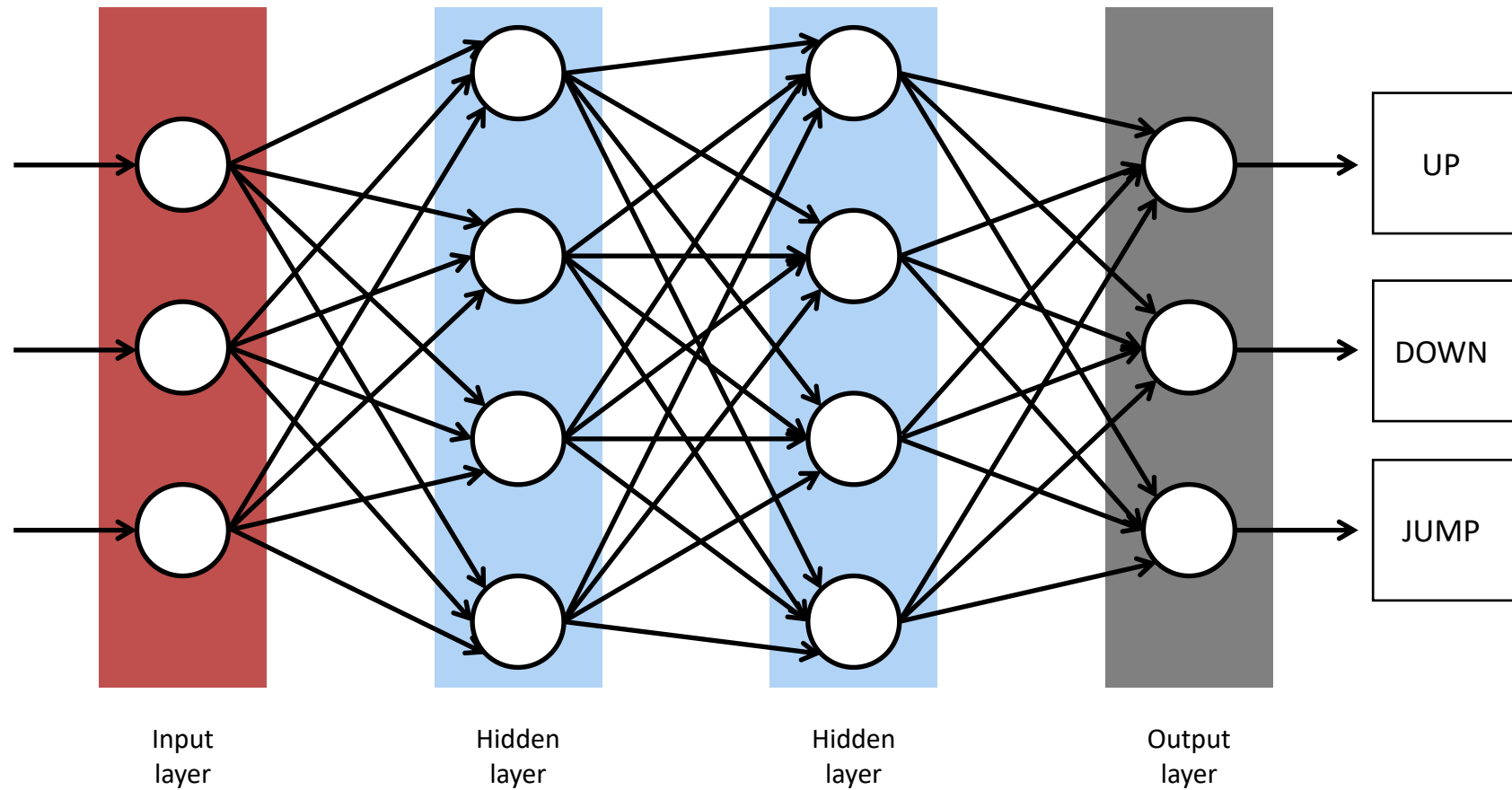


# ANN for Simple Game Playing



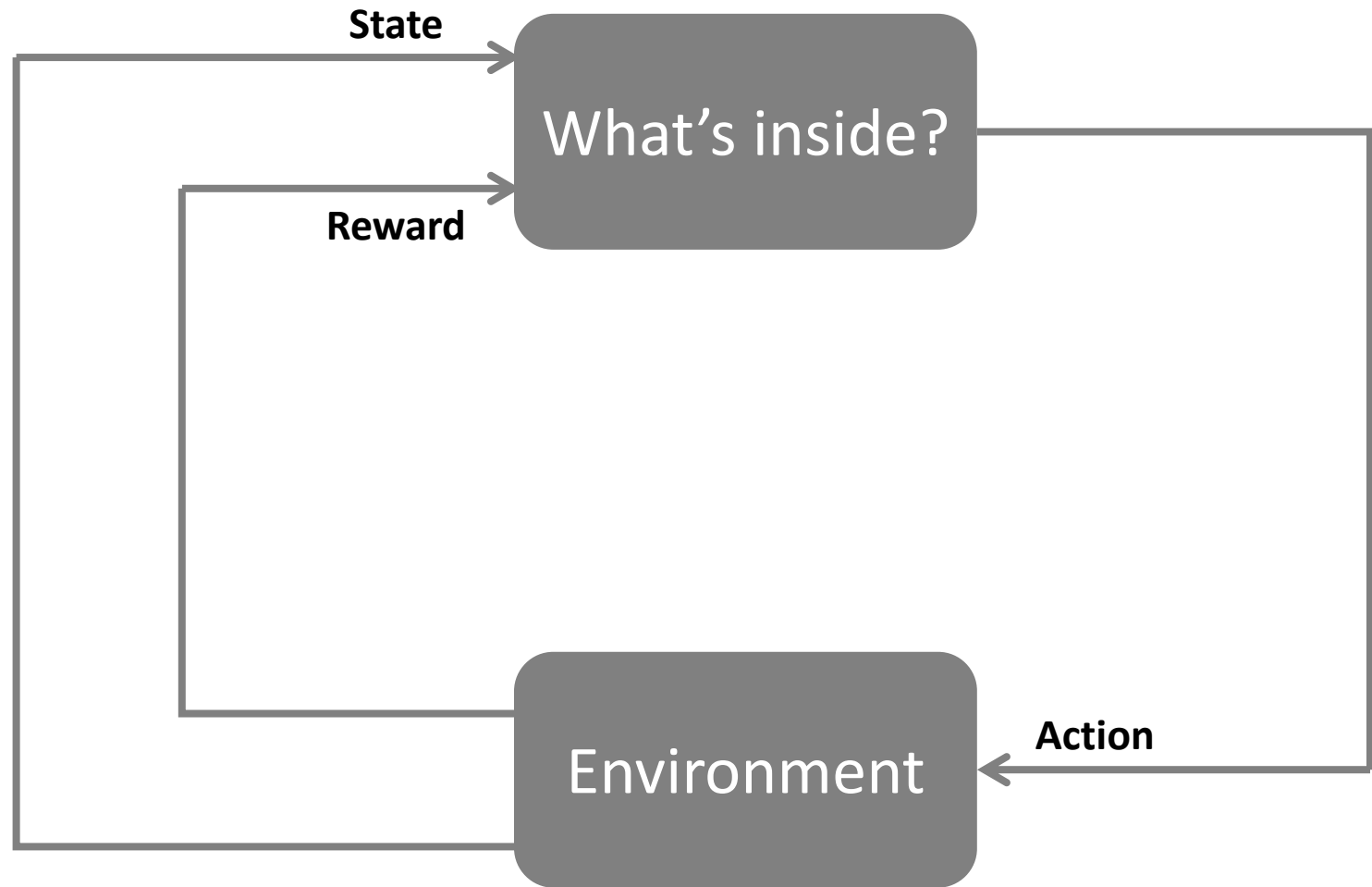
# ANN for Simple Game Playing

Current game is an input. Decisions (UP/DOWN/JUMP) are rewarded/punished.

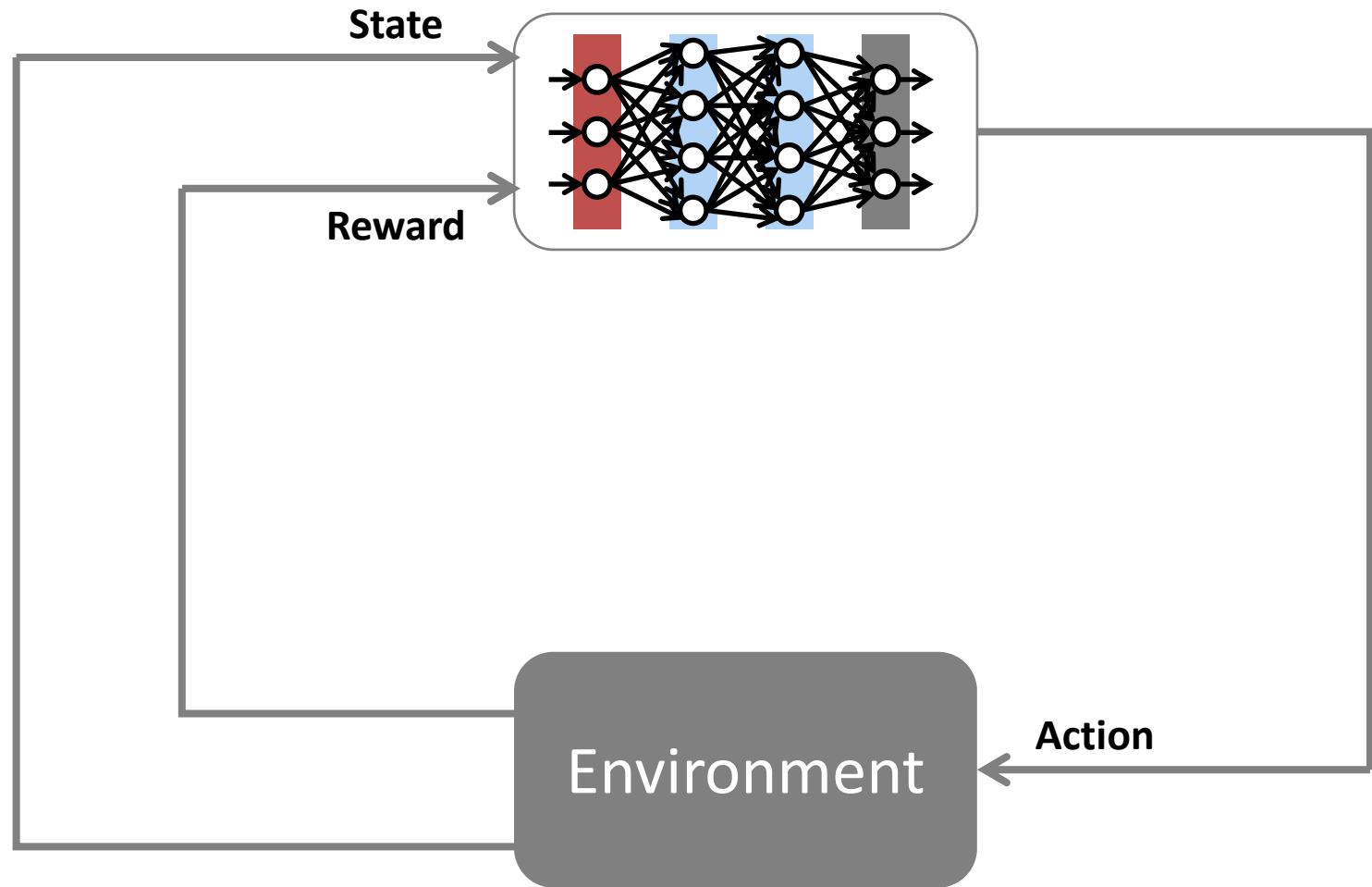


**Correct all the weights** using Reinforcement Learning.

# RL: Agents and Environments



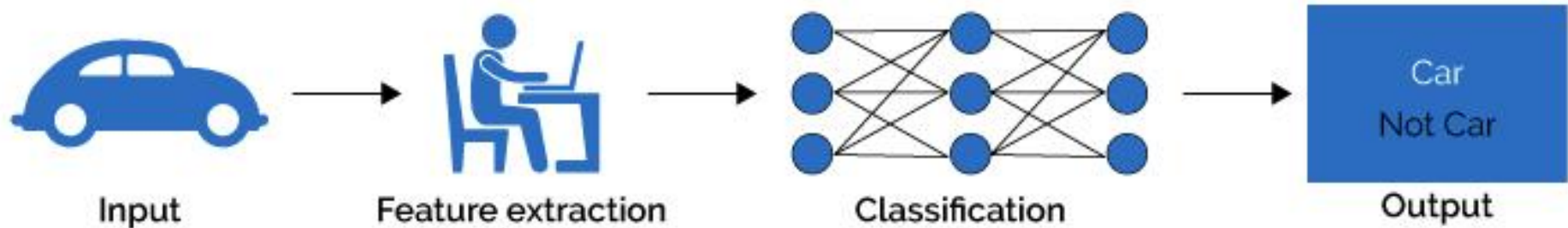
# RL: Agents and Environments



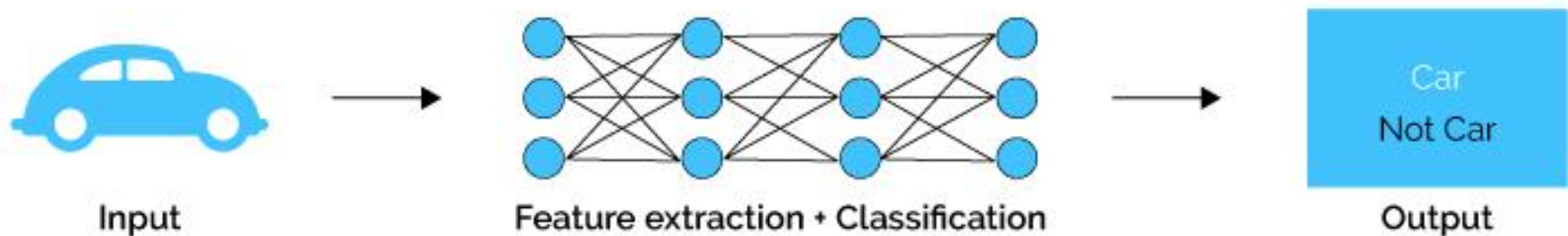
# Deep Learning

# Machine Learning vs. Deep Learning

## Machine Learning



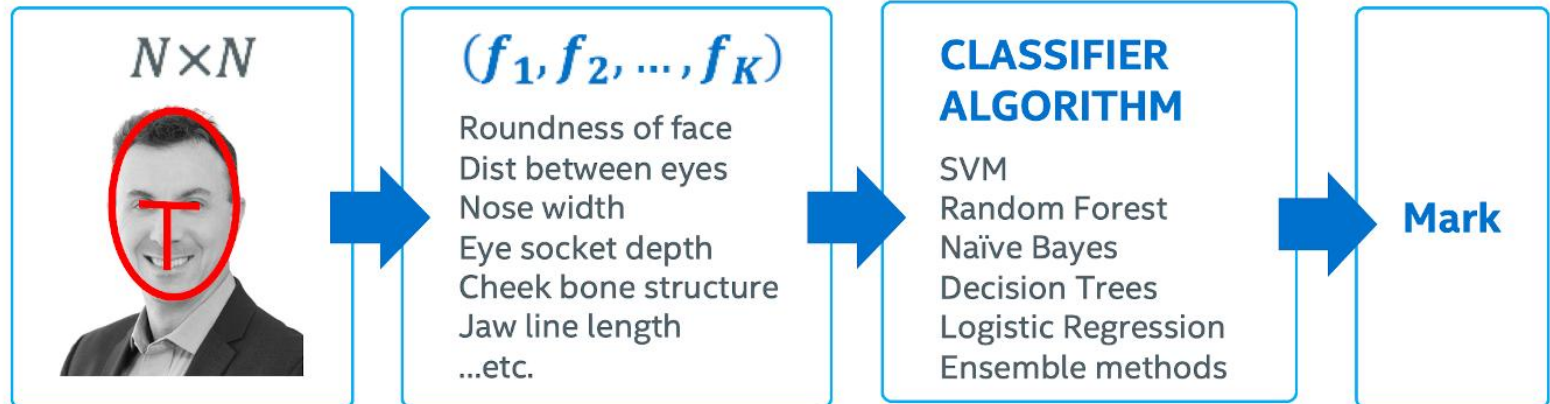
## Deep Learning



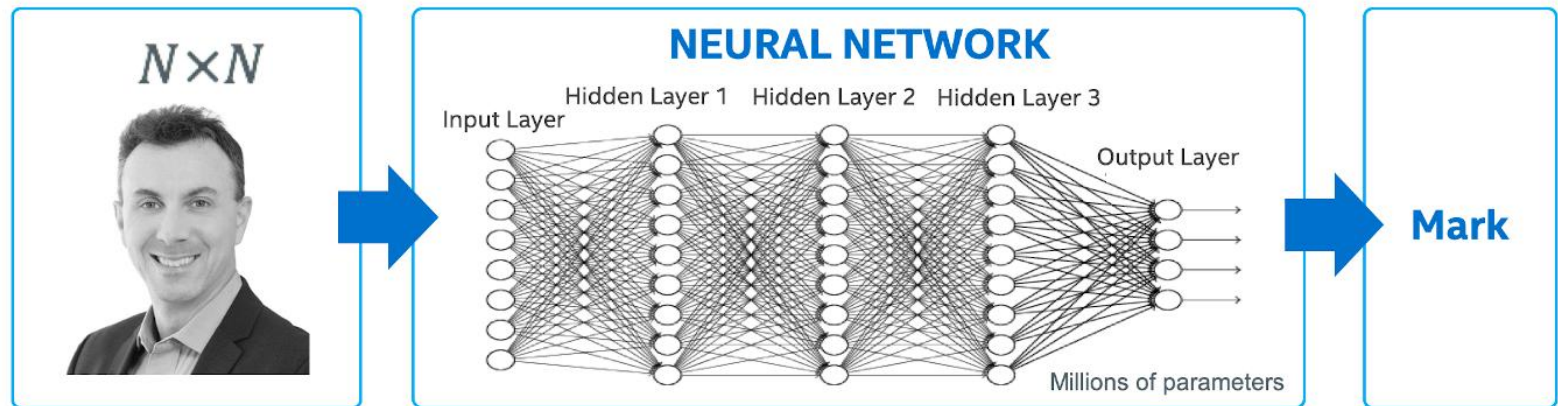
Source: <https://www.quora.com/What-is-the-difference-between-deep-learning-and-usual-machine-learning>

# Machine Learning vs. Deep Learning

## Classic Machine Learning



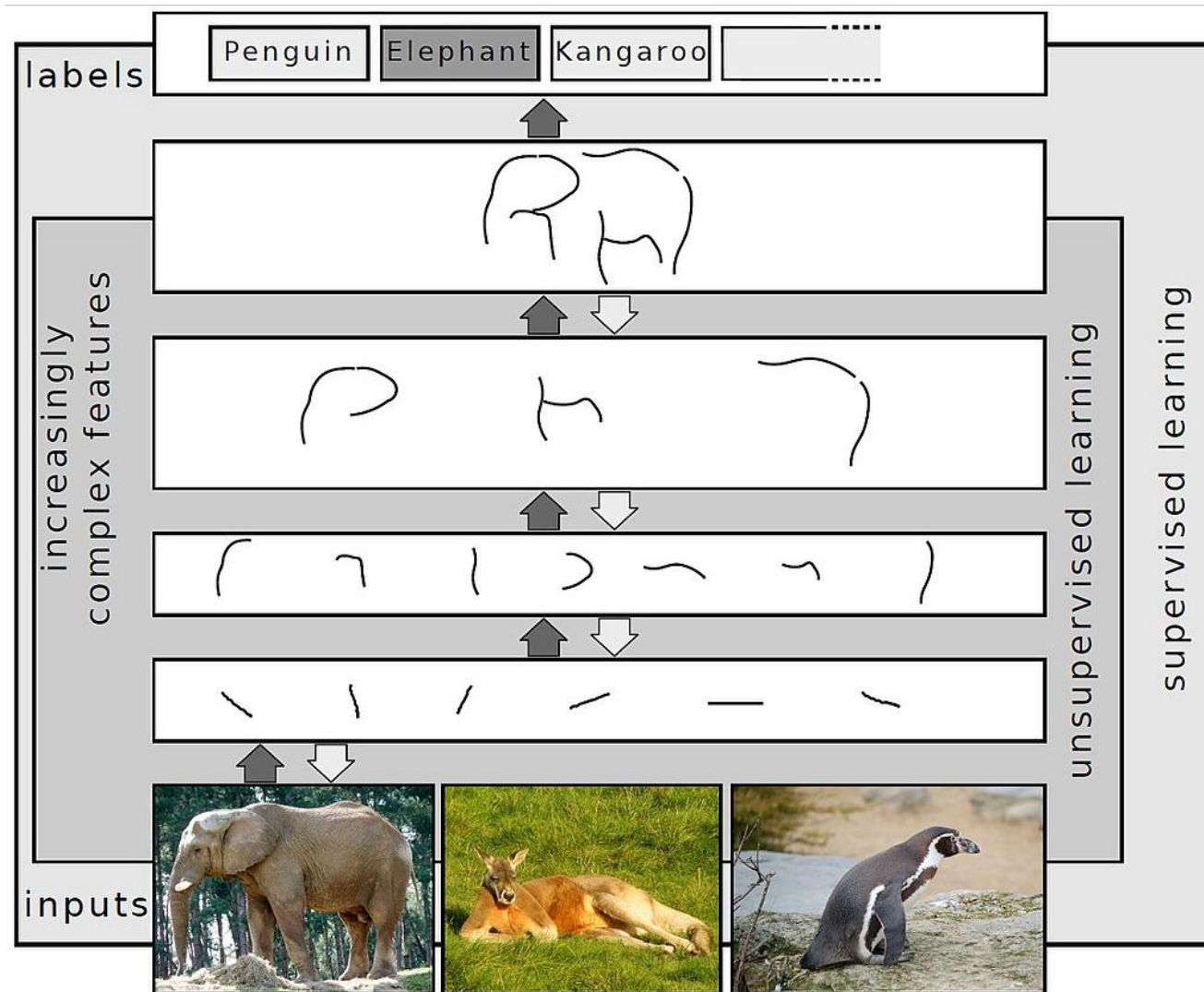
## Deep Learning



Source: <https://www.intel.com/content/www/us/en/artificial-intelligence/posts/difference-between-ai-machine-learning-deep-learning.html>



# Deep Learning: Feature Extraction



Source: [https://en.wikipedia.org/wiki/Deep\\_learning](https://en.wikipedia.org/wiki/Deep_learning)

# **Exercise: Object Recognition**

**<https://braneshop.com.au/object-detection-in-the-browser.html>**

**(you can try it on your smartphone)**

# **Exercise: Image Colorizer**

**<https://deepai.org/machine-learning-model/colorizer>**

# Exercise: Deep Learning

<https://www.handwriting-generator.com/>