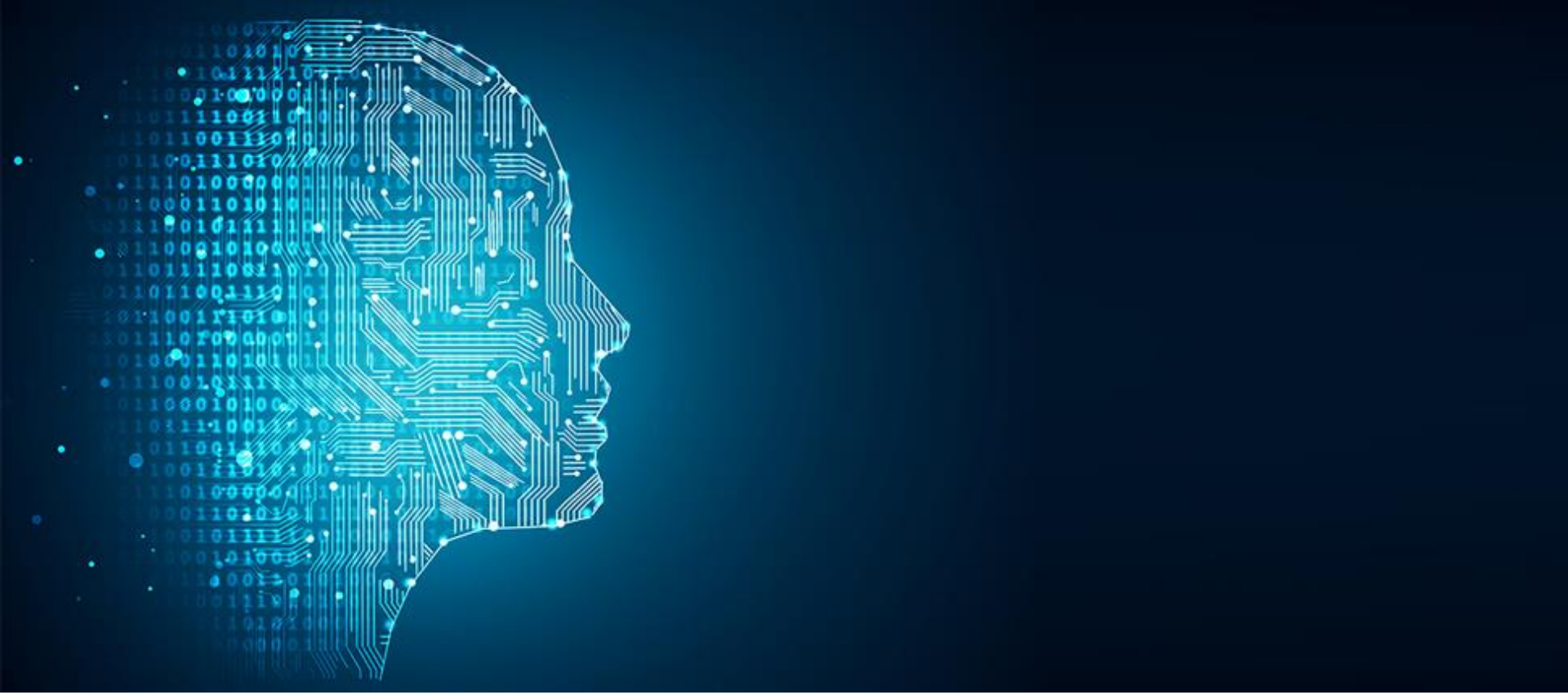


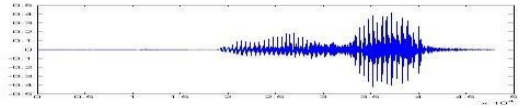
Concepts in Artificial Intelligence & Machine Learning Technologies

Machine Learning Overview

Dr. Wei Zhang

Machine Learning --- Finding Functions

- Speech Recognition

$f($  $)=$ “How are you”

- Image Recognition

$f($  $)=$ “Cat”

- Playing Go

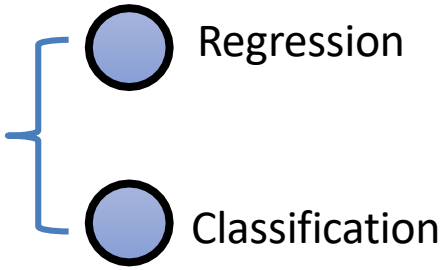
$f($  $)=$ “5-5” (next move)

- Dialogue System

$f($ “How are you?” $)=$ “I am fine.”

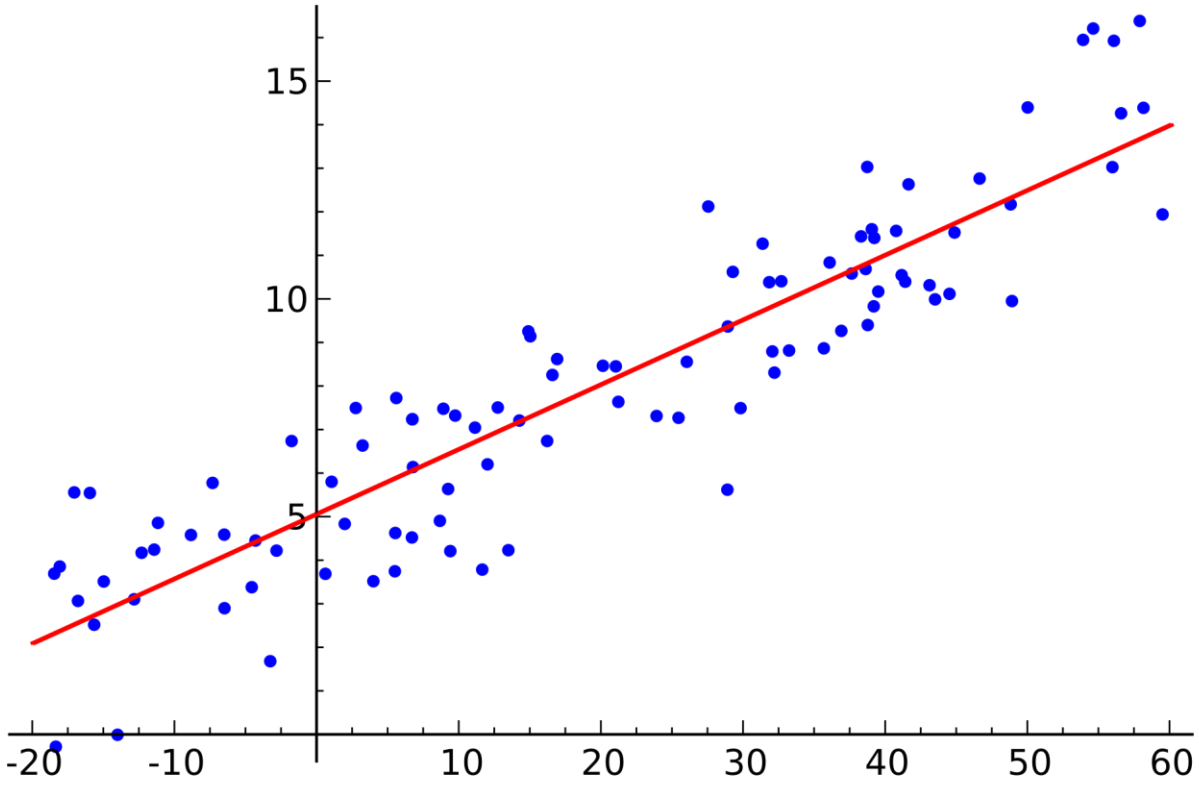
(what the user said) (system response)

Machine Learning Roadmap

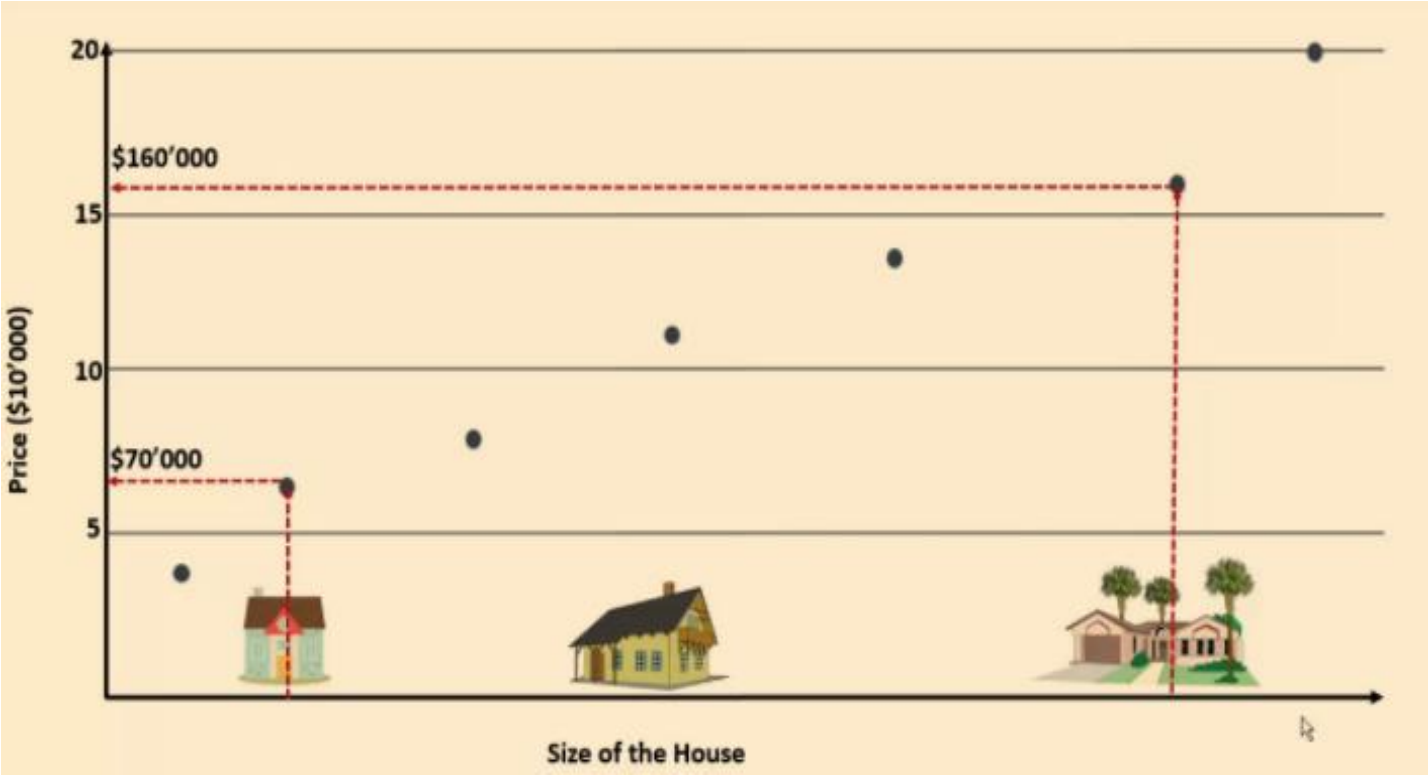


Regression

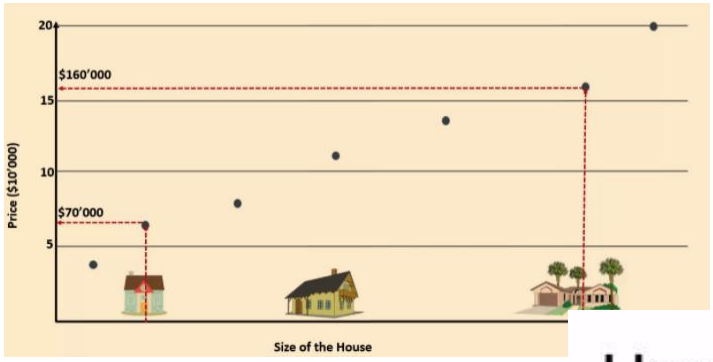
- # Regression --- Intuition

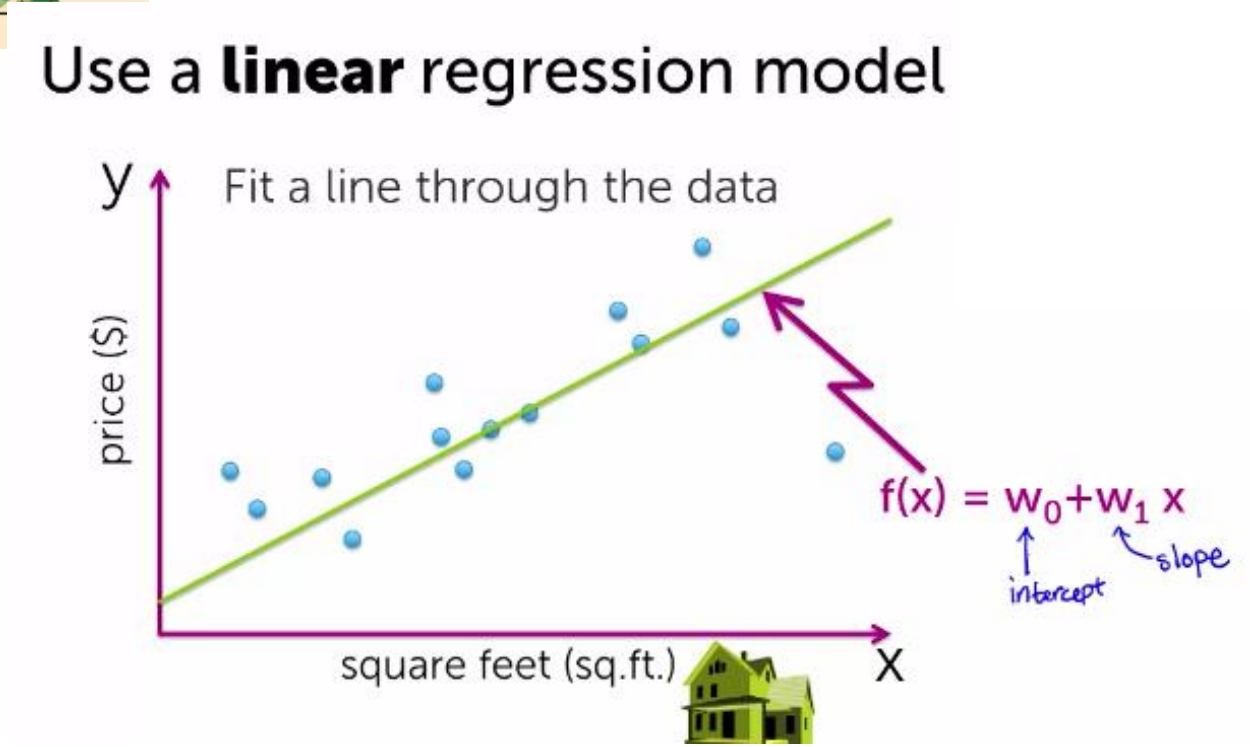


Regression --- An example

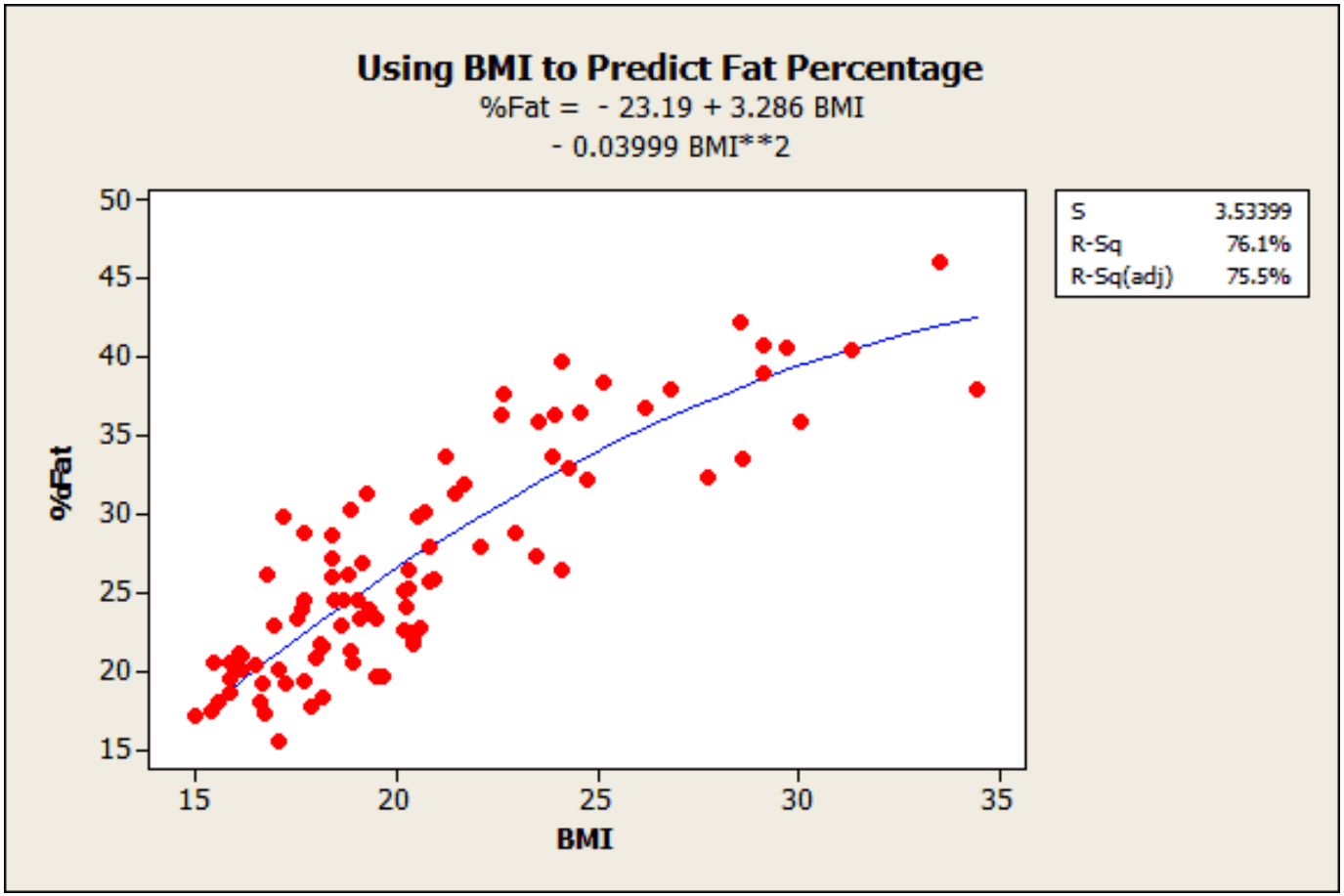


Regression --- Linear Regression



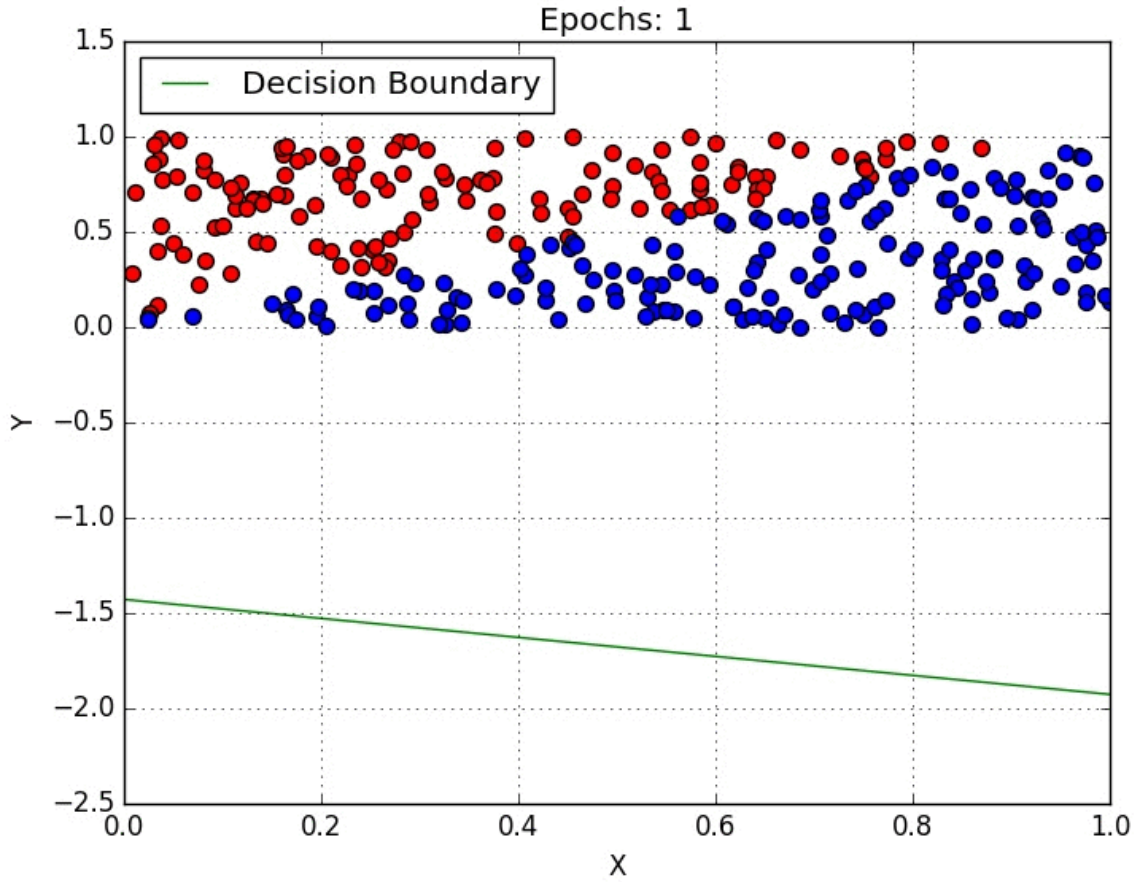


- # Regression --- Non-linear regression

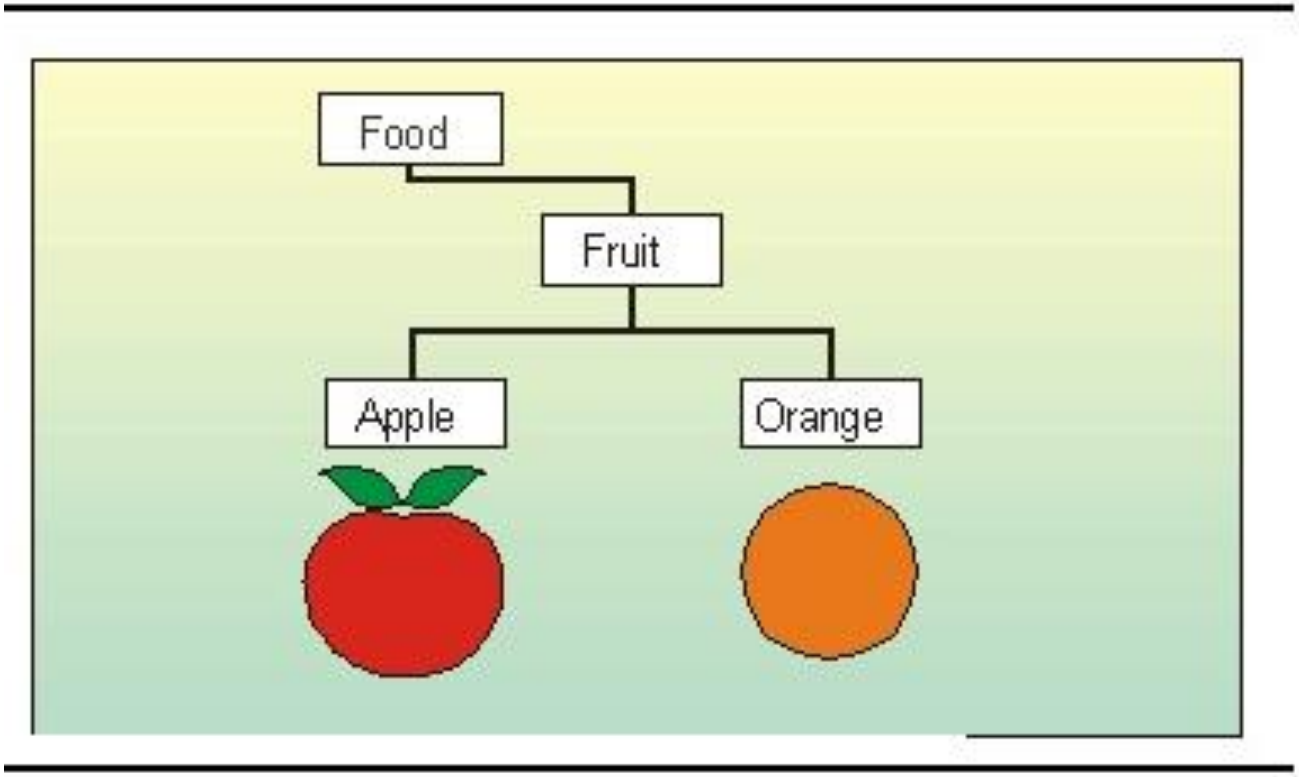


Classification

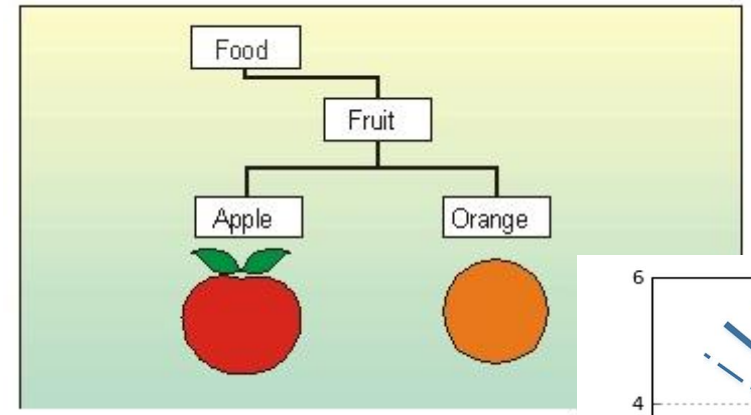
Classification --- Intuition

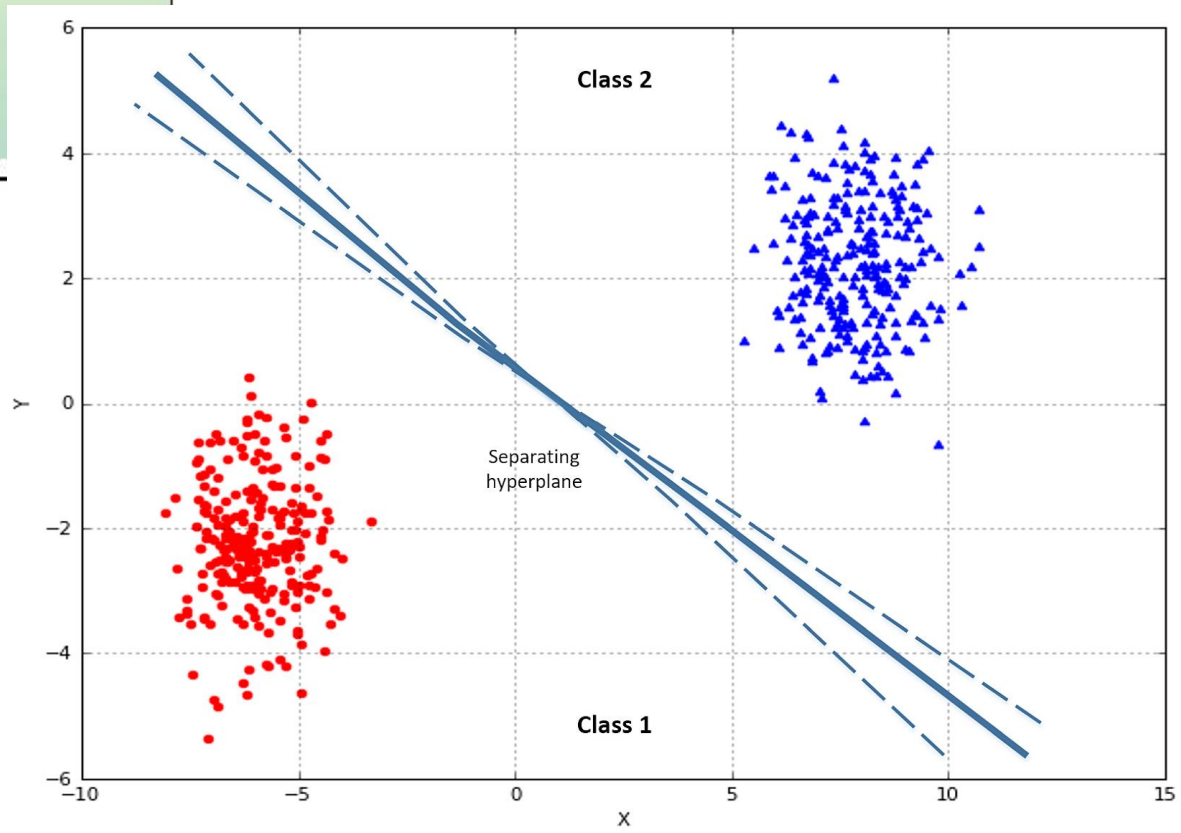


- **Classification --- An example**

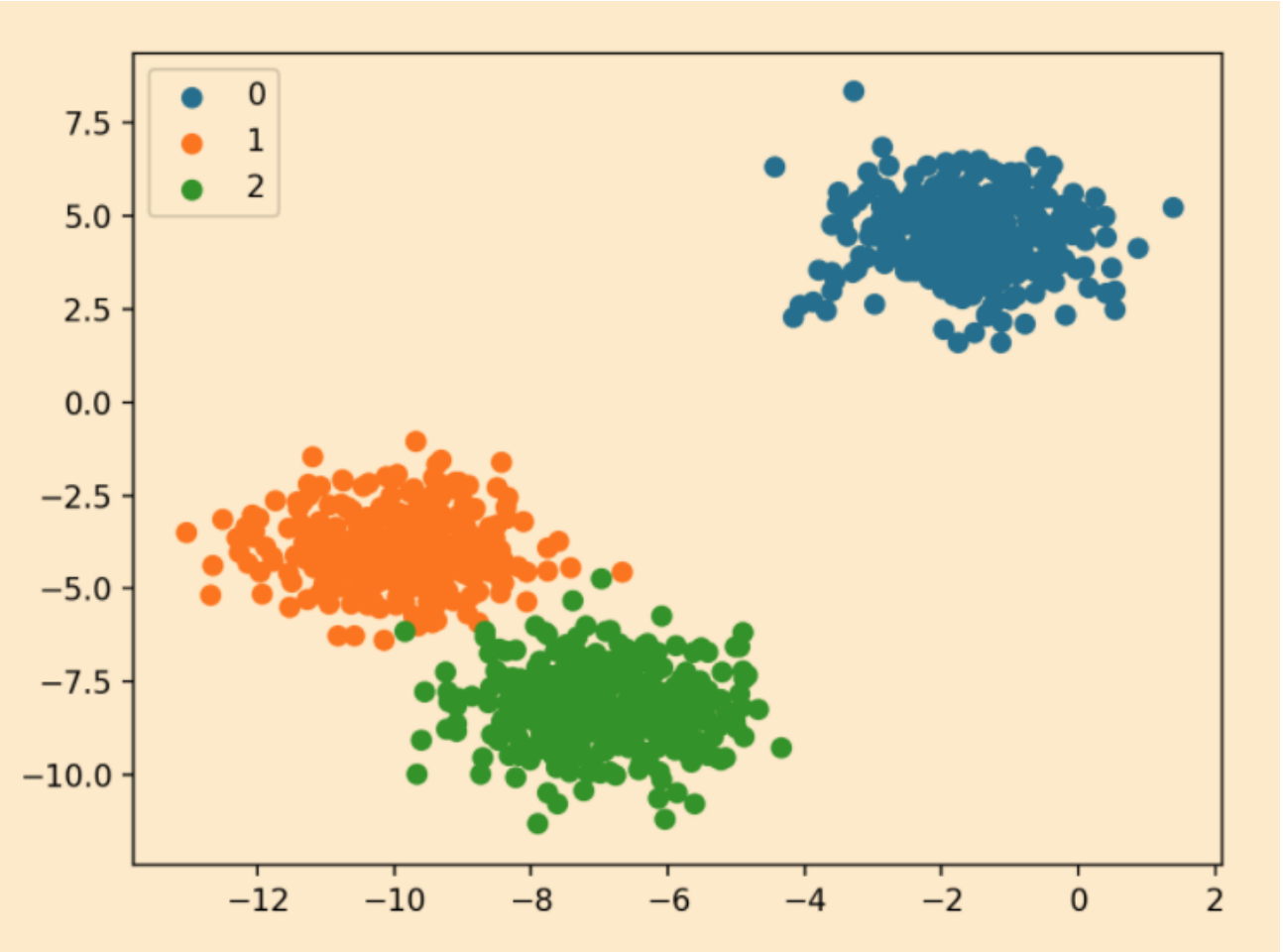


Classification --- An example





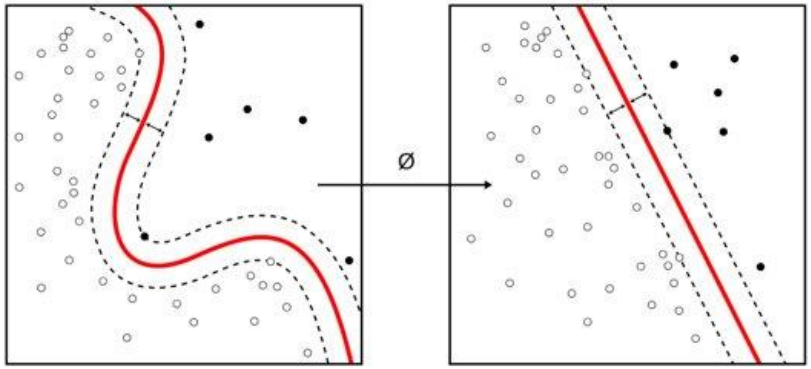
- **Classification --- Multi-class**

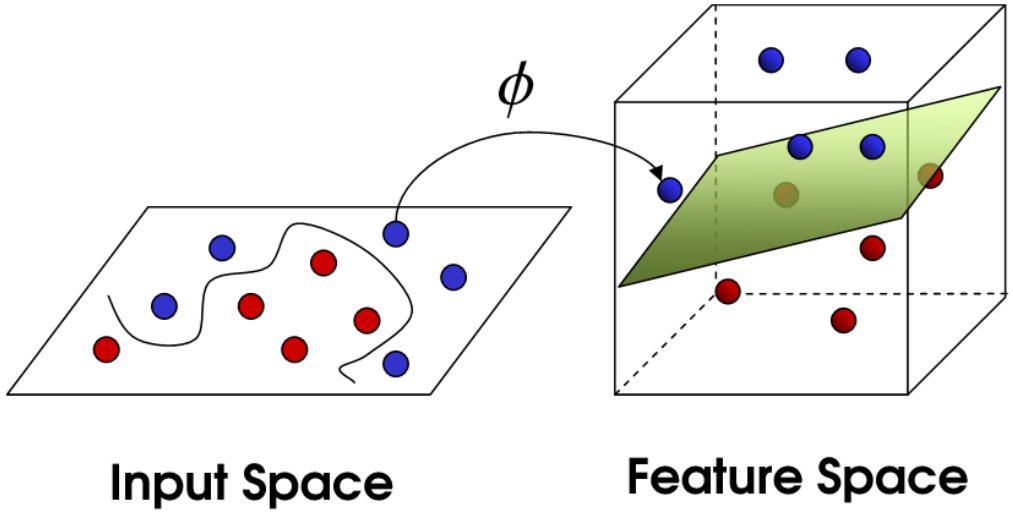


Demo

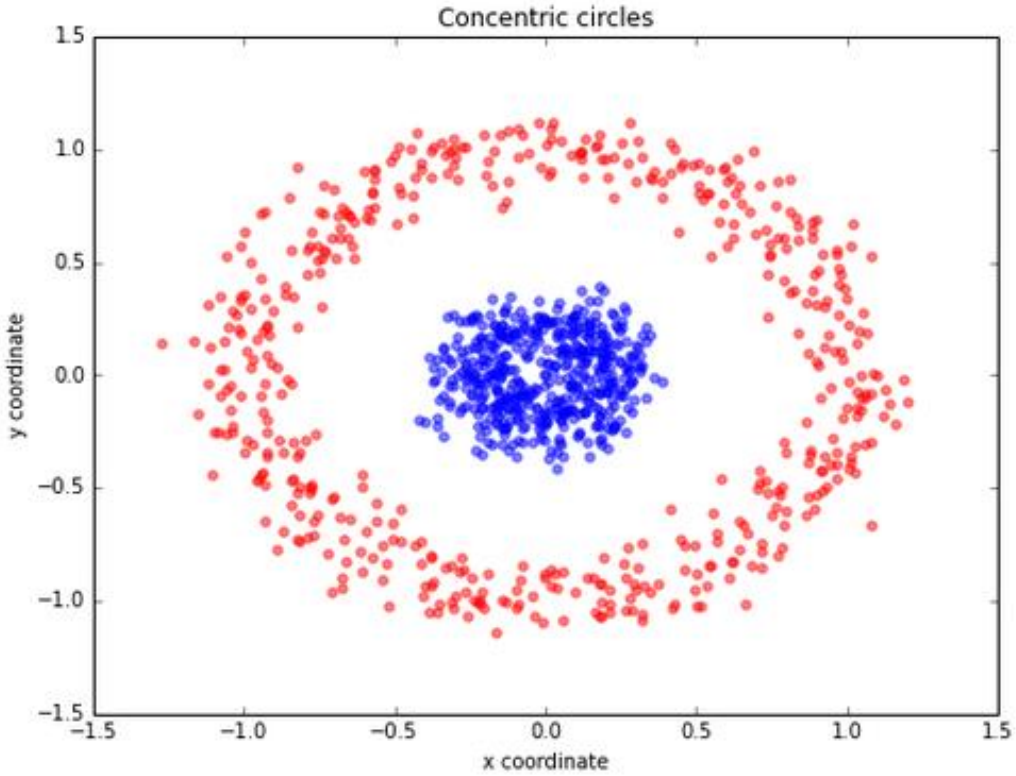
http://vision.stanford.edu/teaching/cs231n-demos/linear-classify/

Classification --- Non-linear

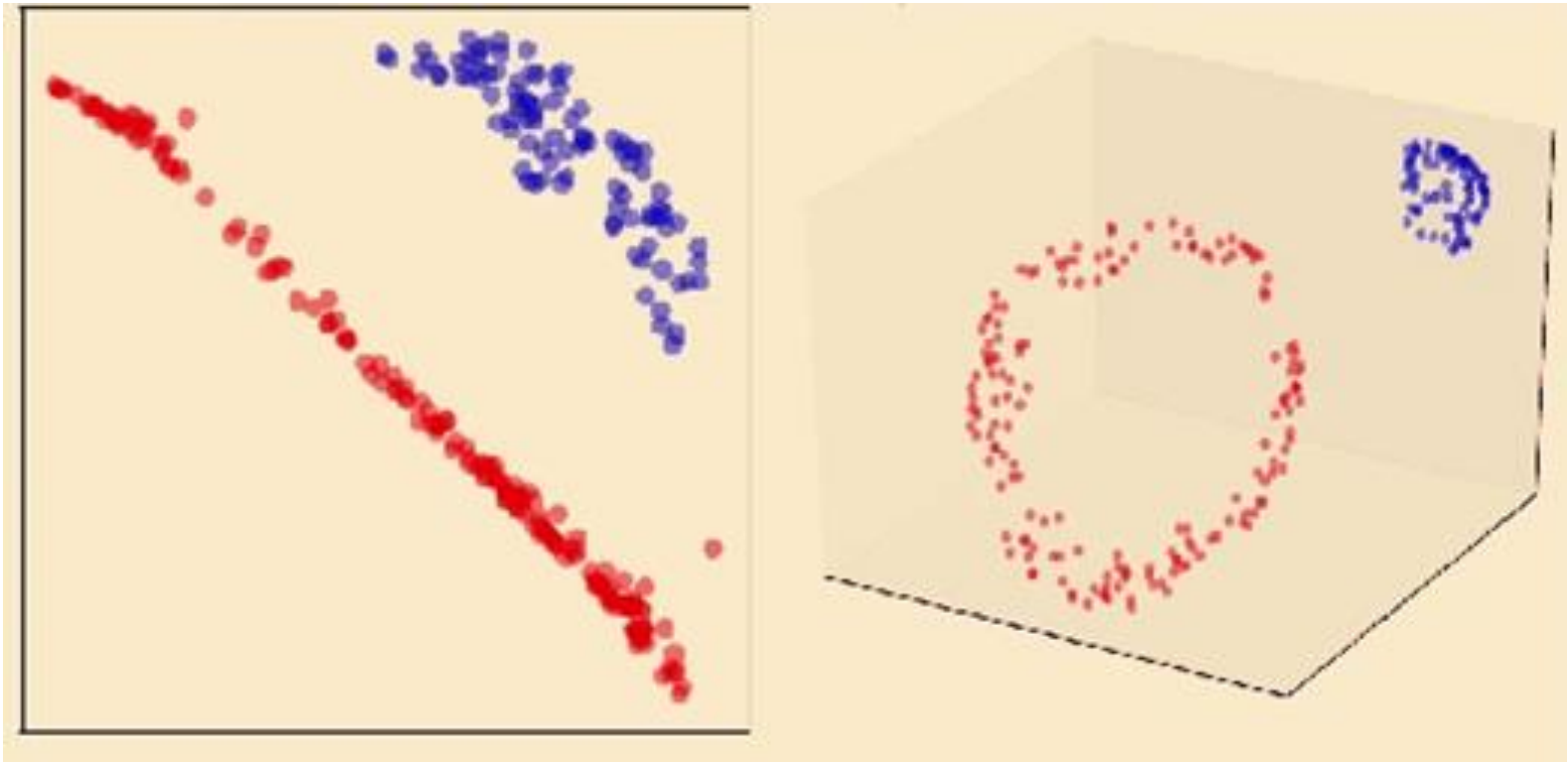




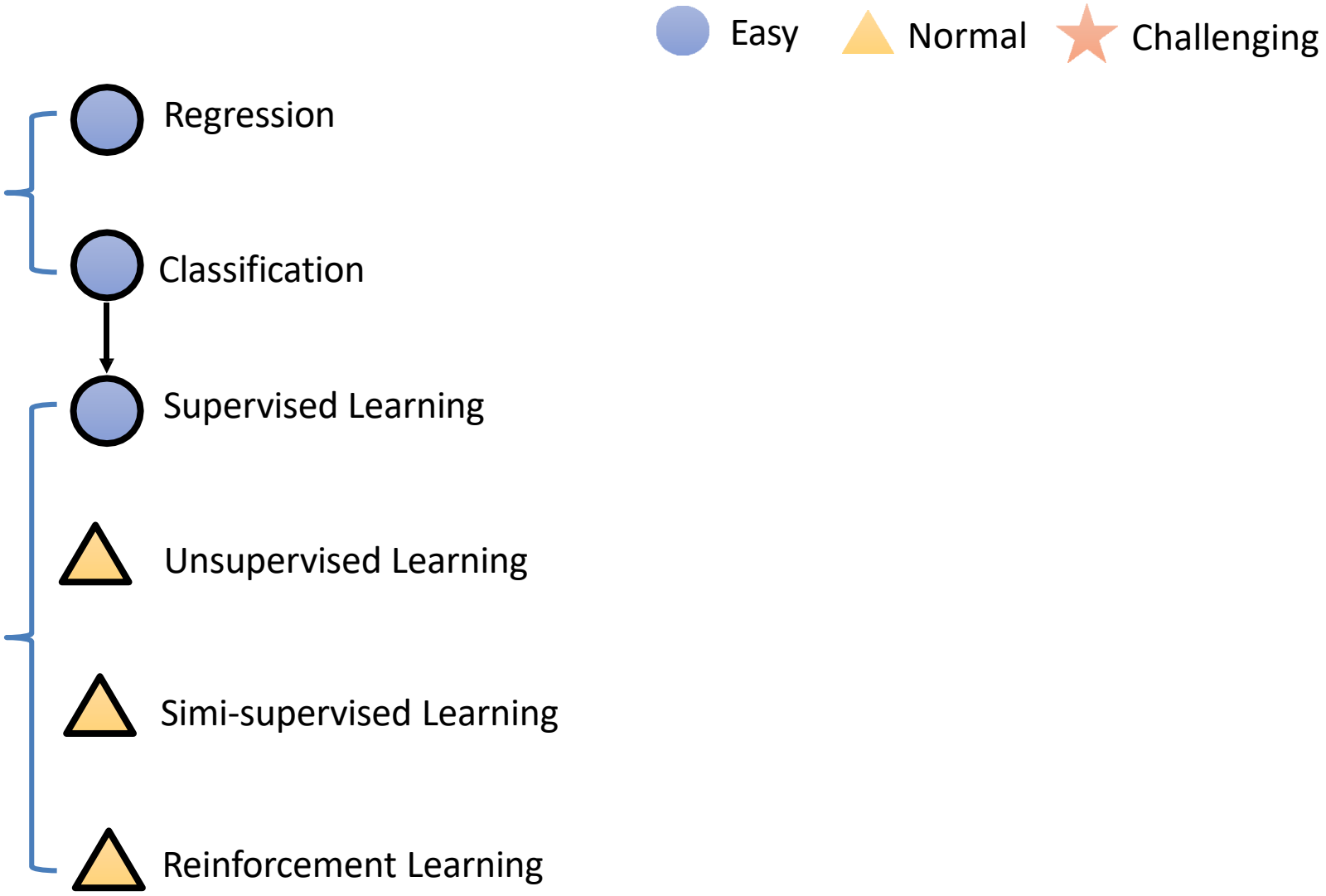
- # Classification --- Non-linear



- **Classification --- Non-linear**



Machine Learning Roadmap



Supervised Learning

Supervised Learning

x

f

"Cat"

y

x_1:  y_1:"Cat"

x_2:  y_2:"Cat"

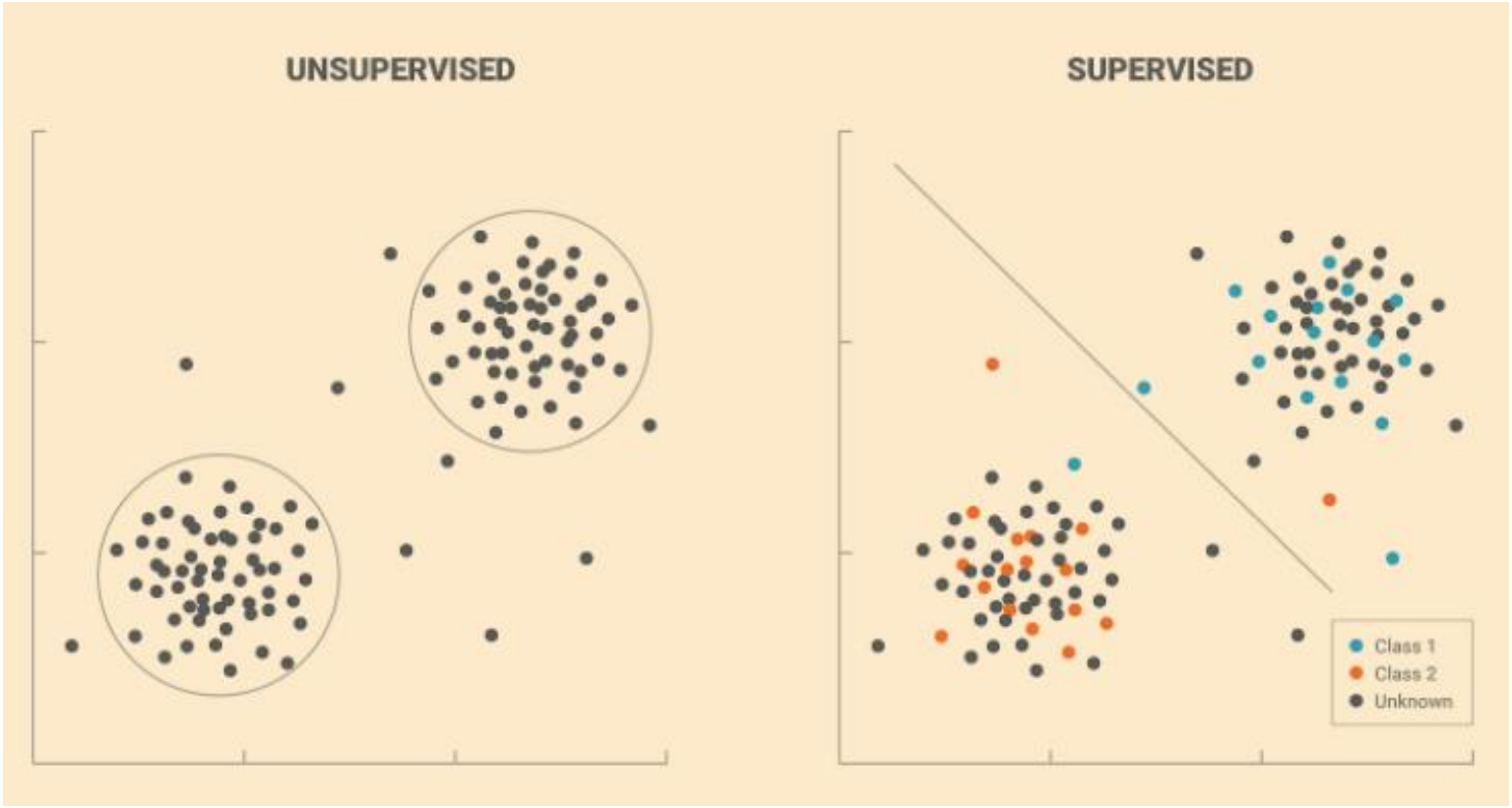
x_3:  y_3:"Dog"

x_4:  y_4:"Dog"

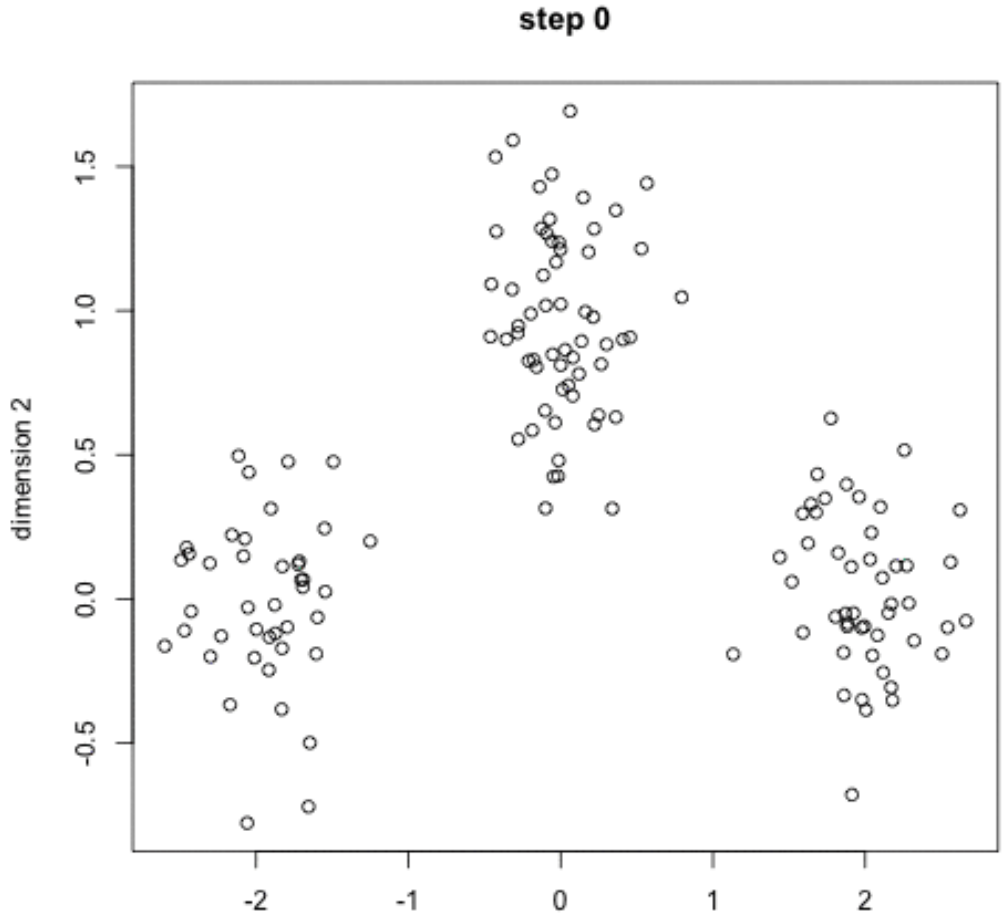
Labelled Data

Unsupervised Learning

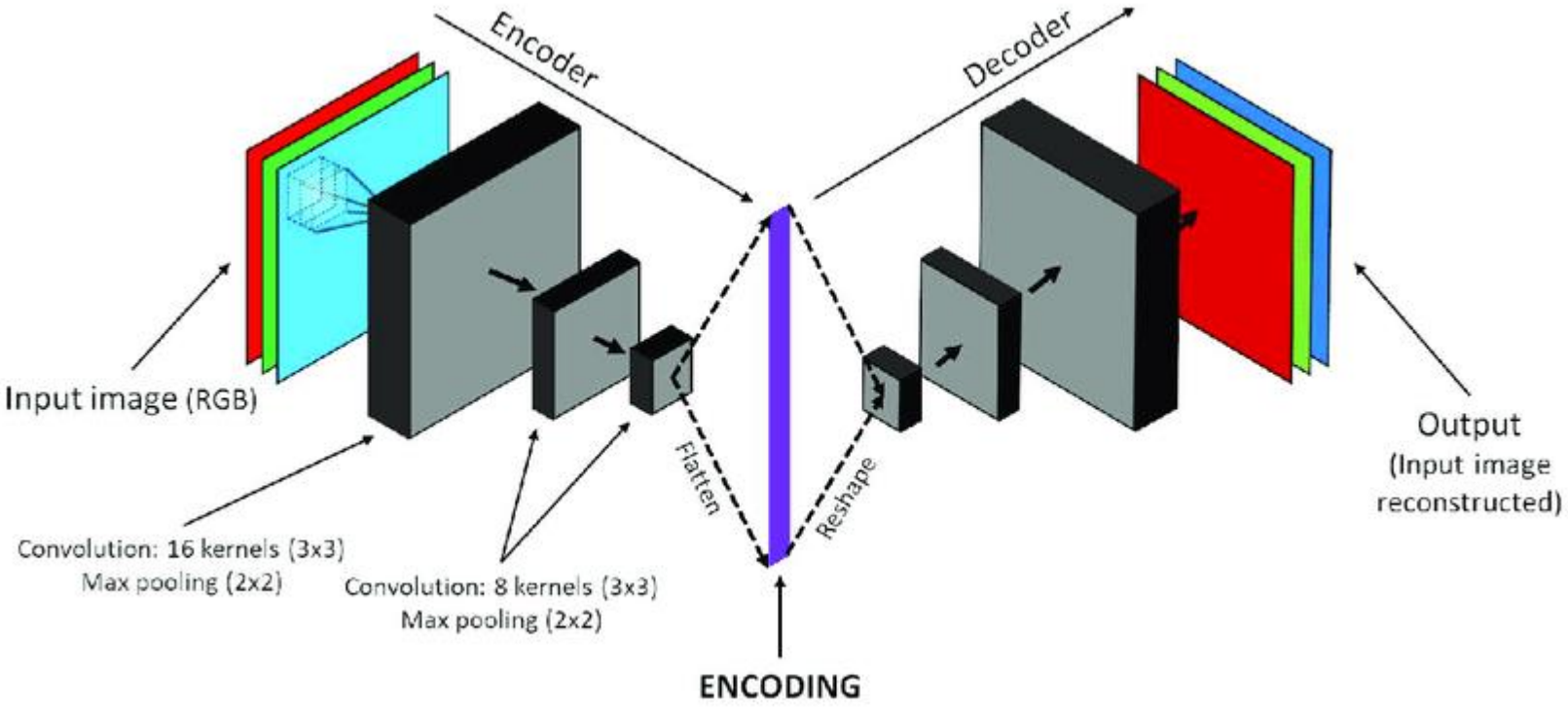
Unsupervised Learning



Unsupervised Learning --- clustering

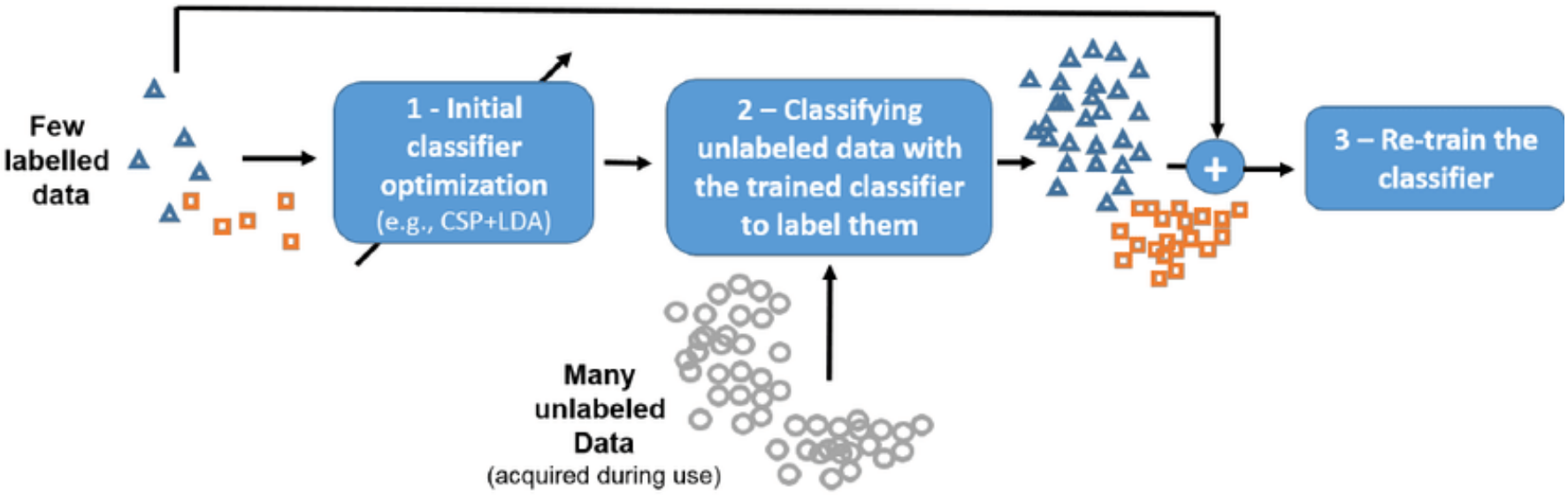


Unsupervised Representation Learning

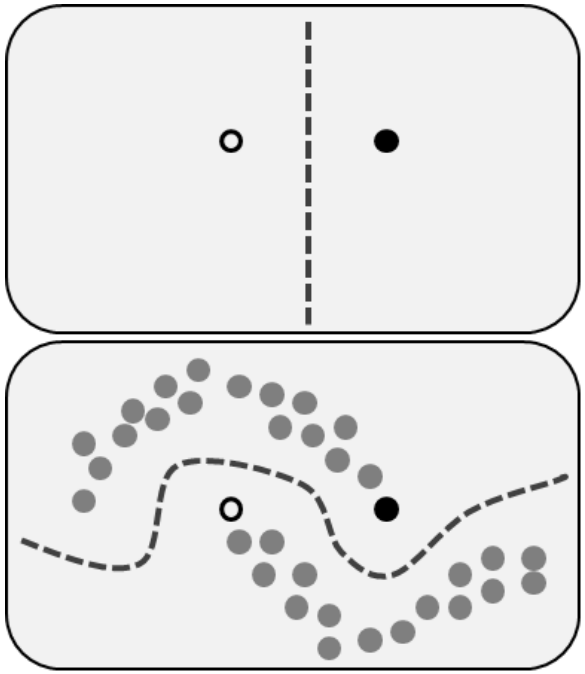


Semi-supervised Learning

Semi-supervised Learning



Semi-supervised Learning

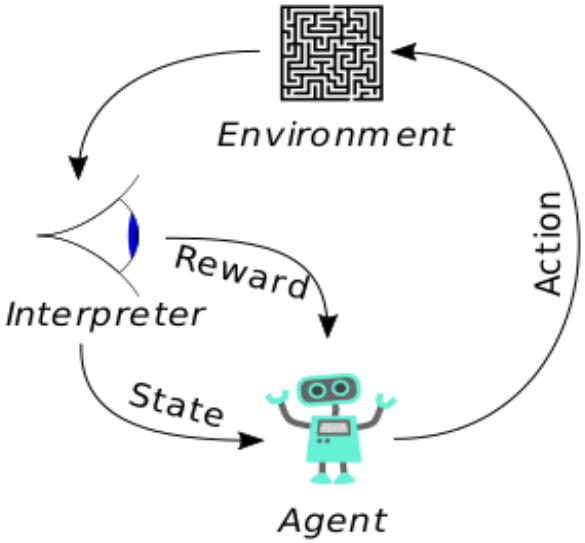


An example of the influence of unlabeled data in semi-supervised learning. The top panel shows a decision boundary we might adopt after seeing only one positive (white circle) and one negative (black circle) example. The bottom panel shows a decision boundary we might adopt if, in addition to the two labeled examples, we were given a collection of unlabeled data (gray circles). This could be viewed as performing clustering and then labeling the clusters with the labeled data, pushing the decision boundary away from high-density regions, or learning an underlying one-dimensional manifold where the data reside.

https://en.wikipedia.org/wiki/Semi-supervised_learning

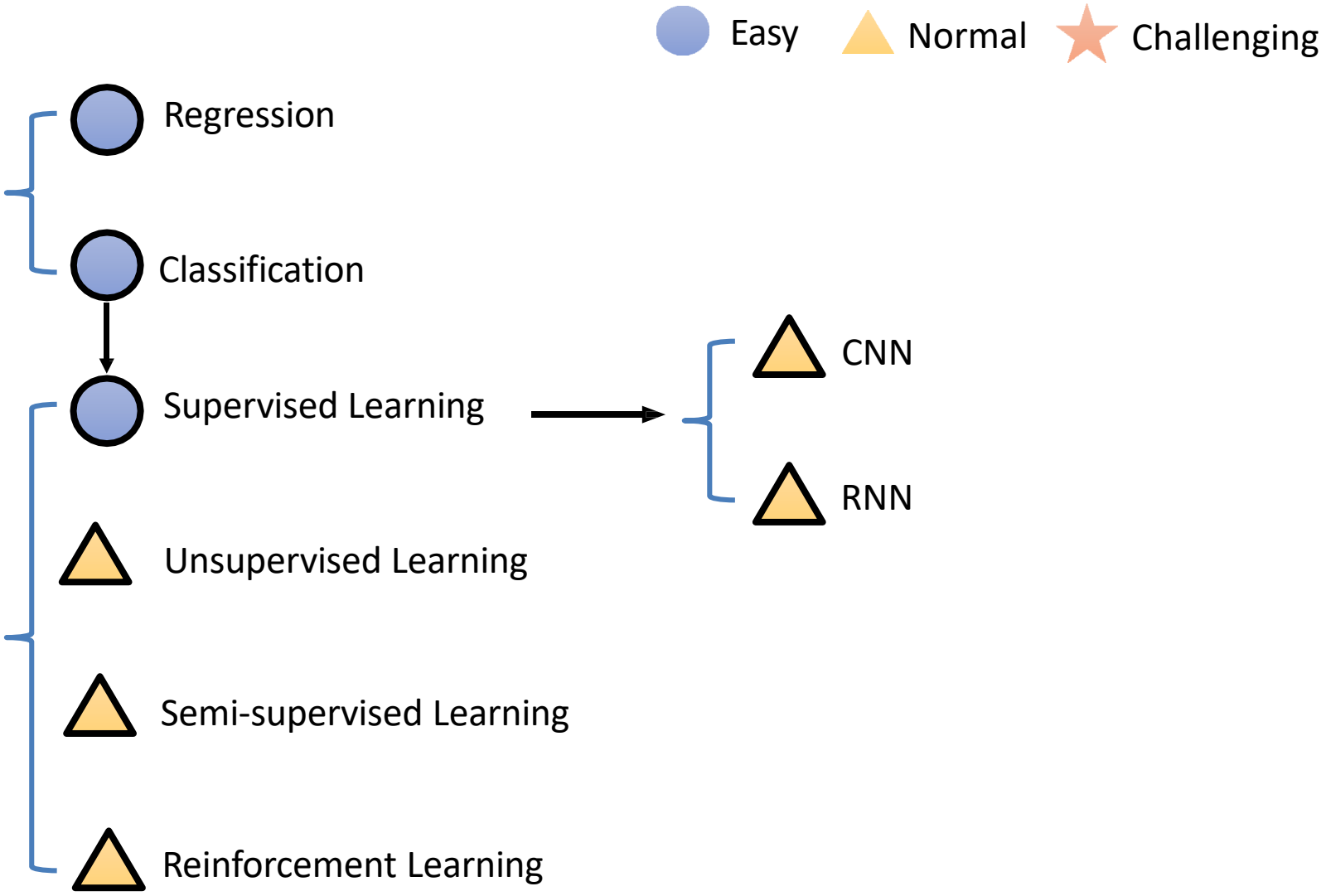
Reinforcement Learning

Reinforcement Learning



- State: Observation of current environment
- Action: Reaction of an agent
- Reward: return from environment as an indicator
- Objective: **maximize cumulative reward**
- Similar with human: observing by eyes ---> judging by brain ---> taking actions by hands

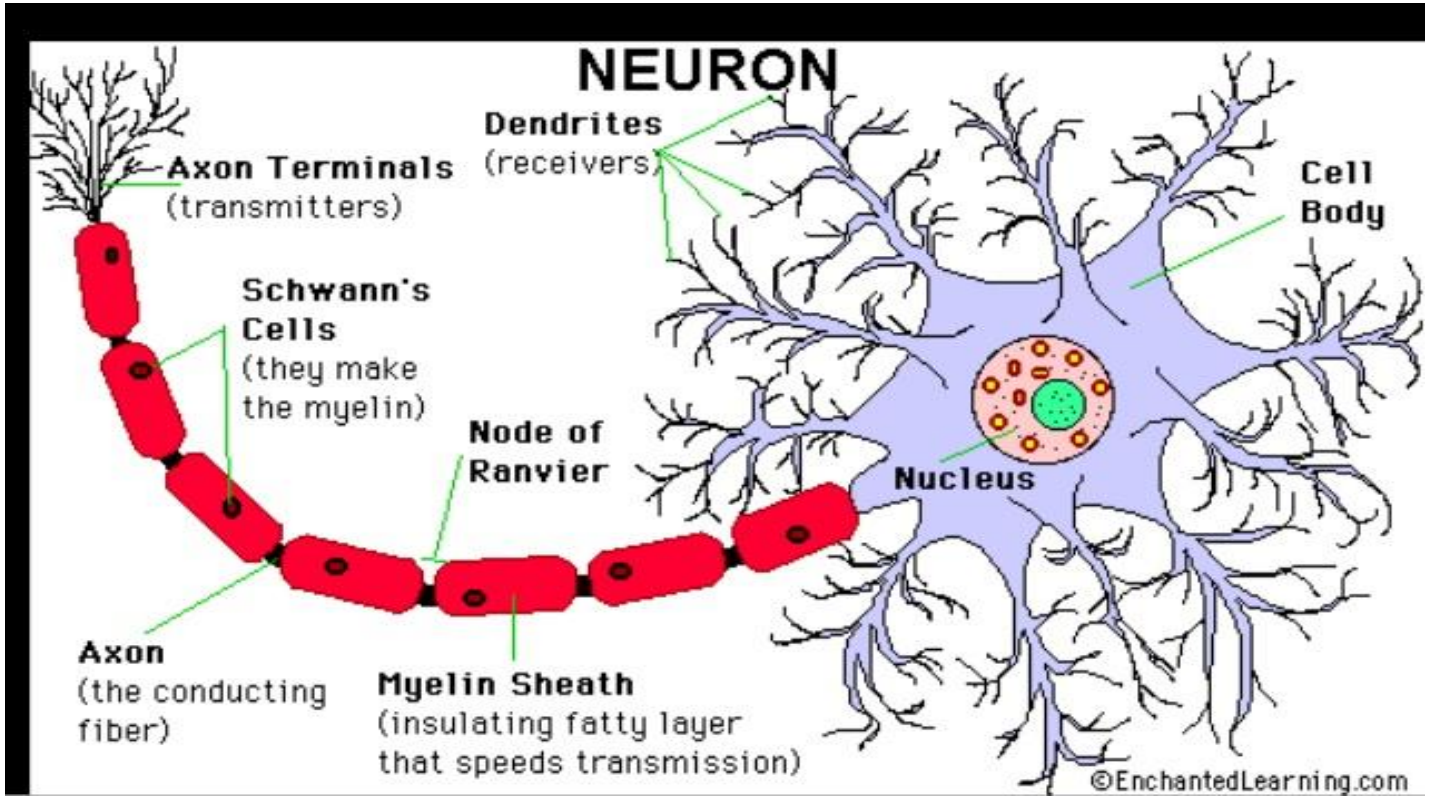
Machine Learning Roadmap



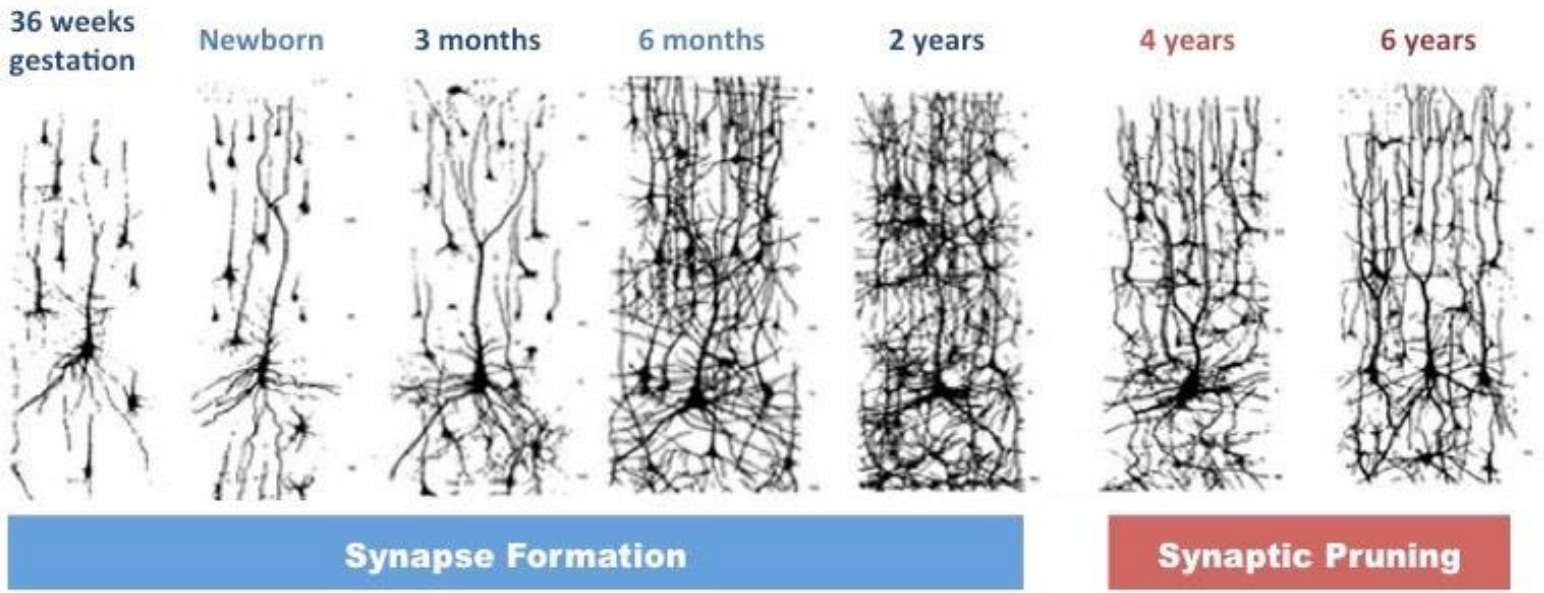
Neural networks

Neural networks

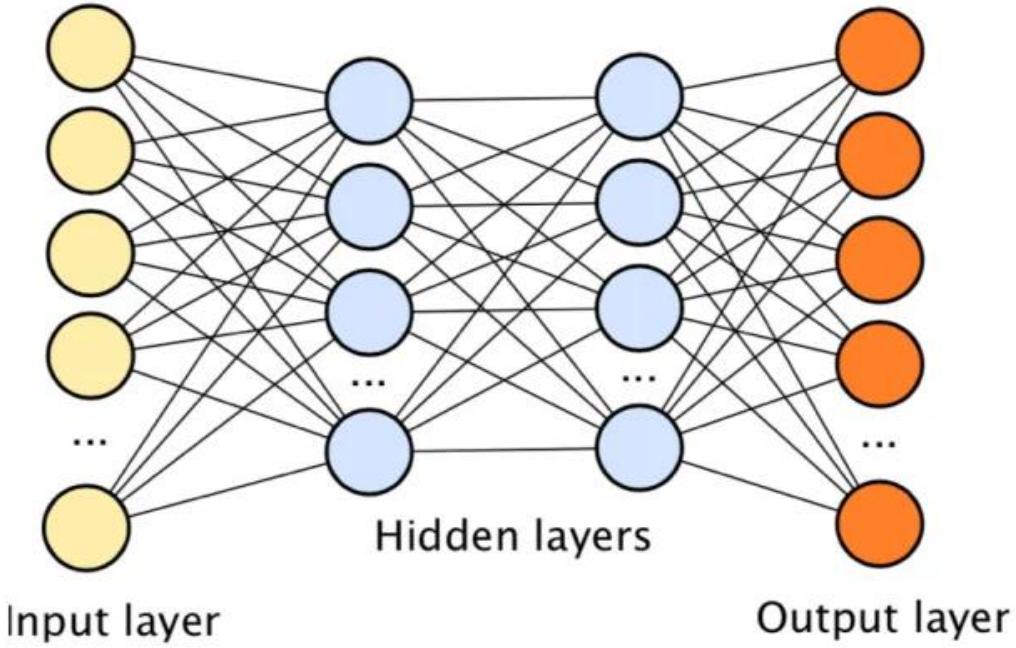
- Perceptron --- prototype



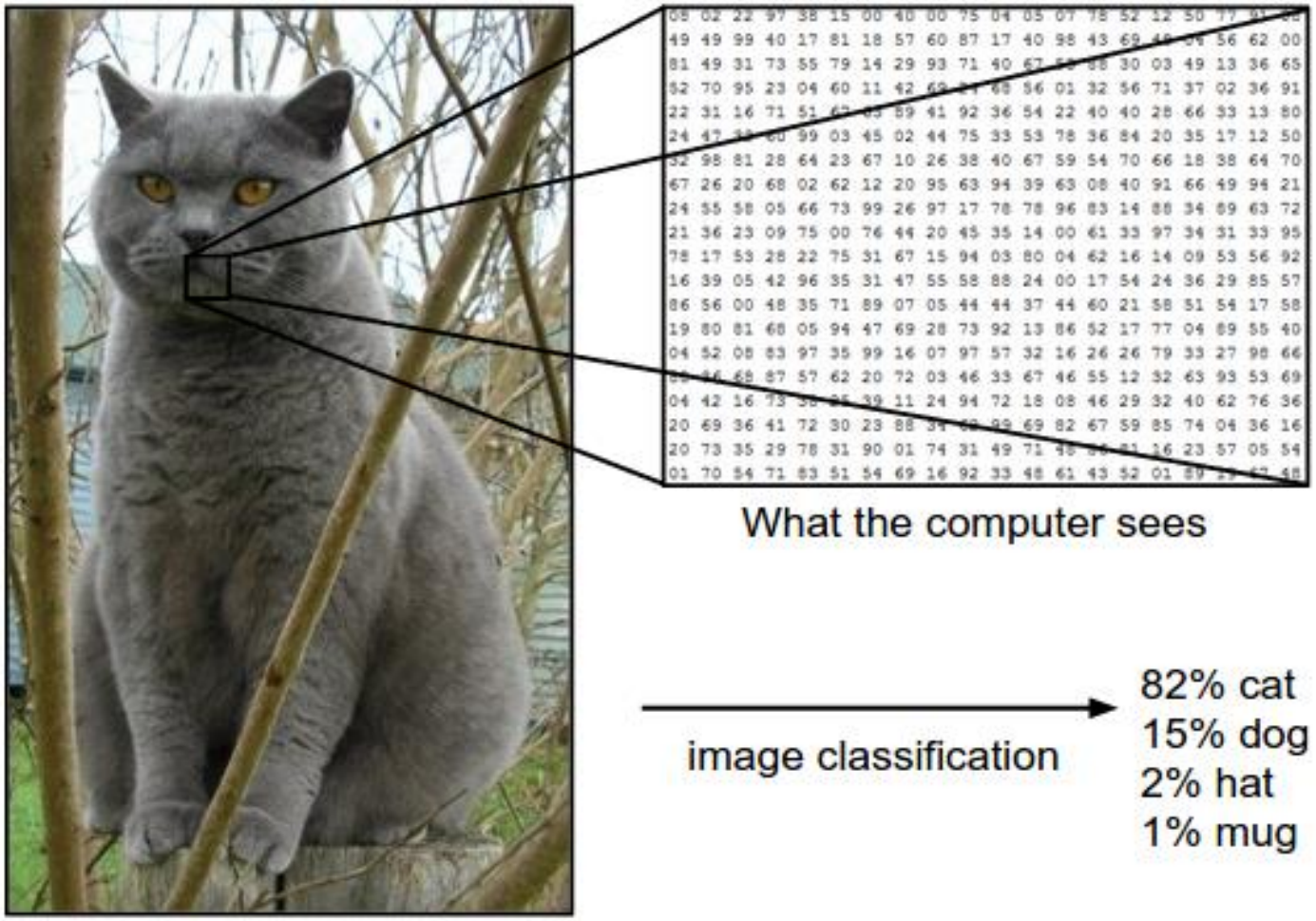
- Perceptron --- prototype



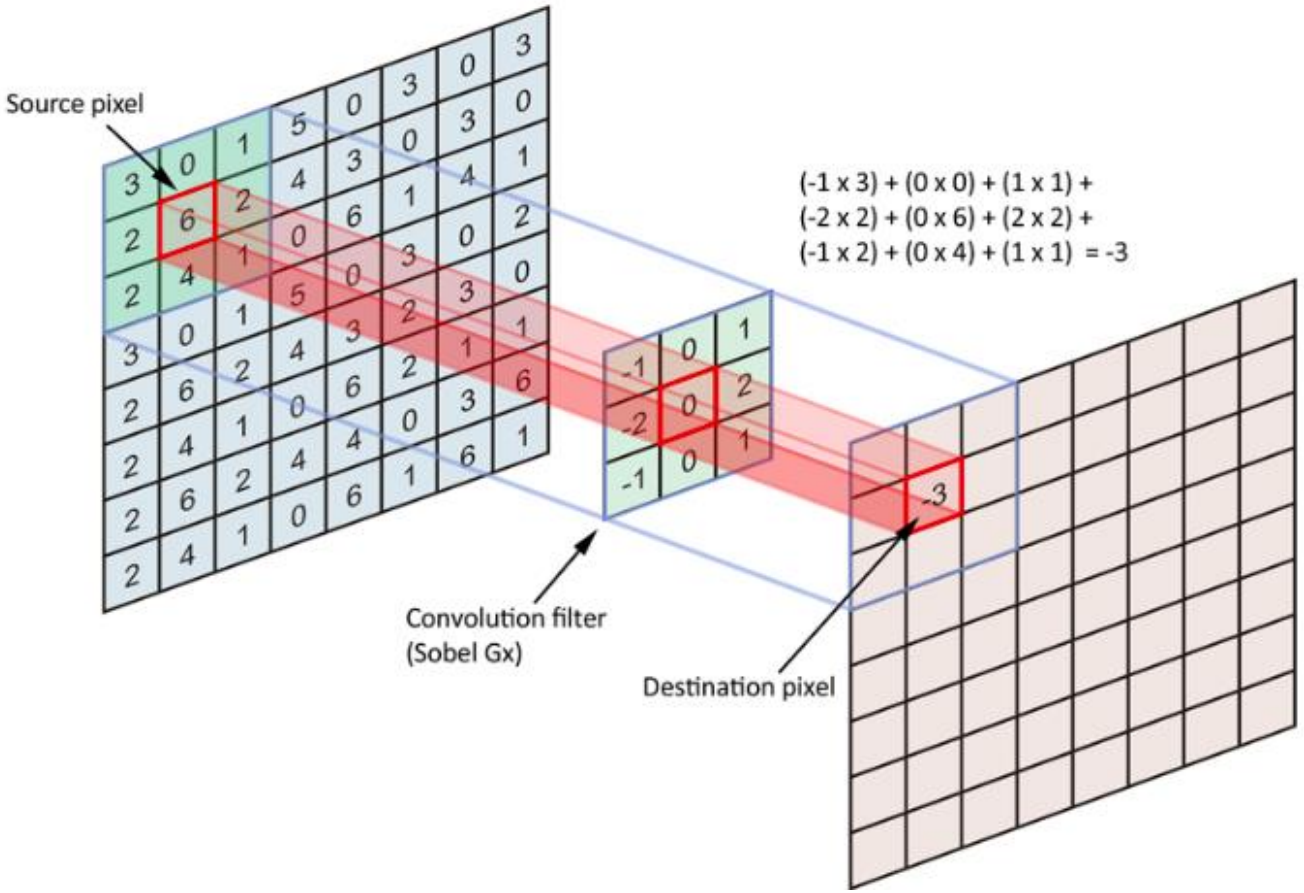
Neural networks



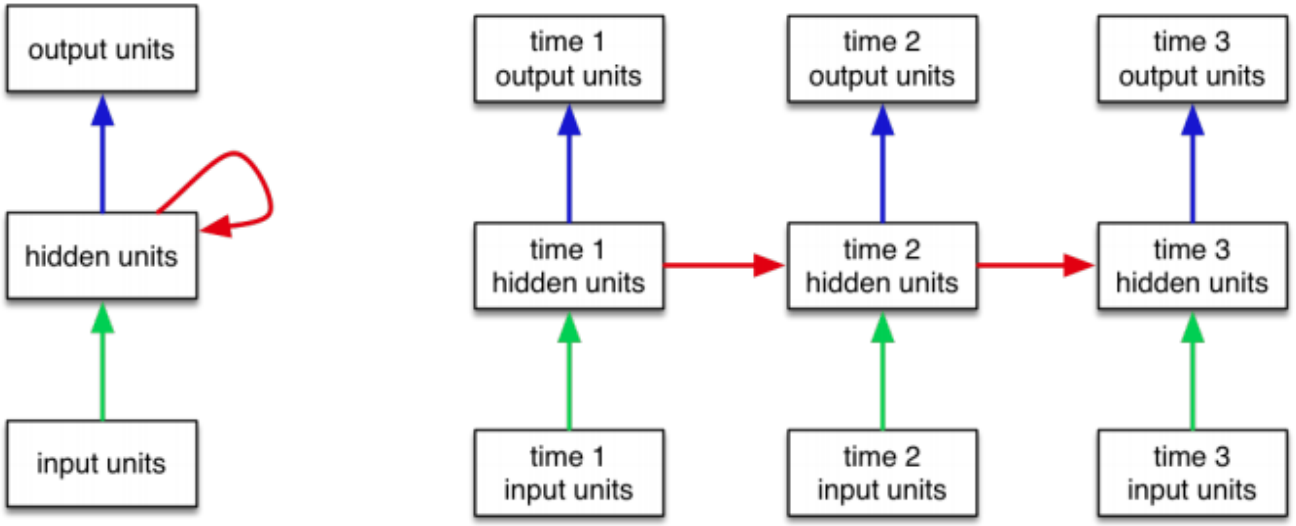
- Convolutional neural network
  --- digital images



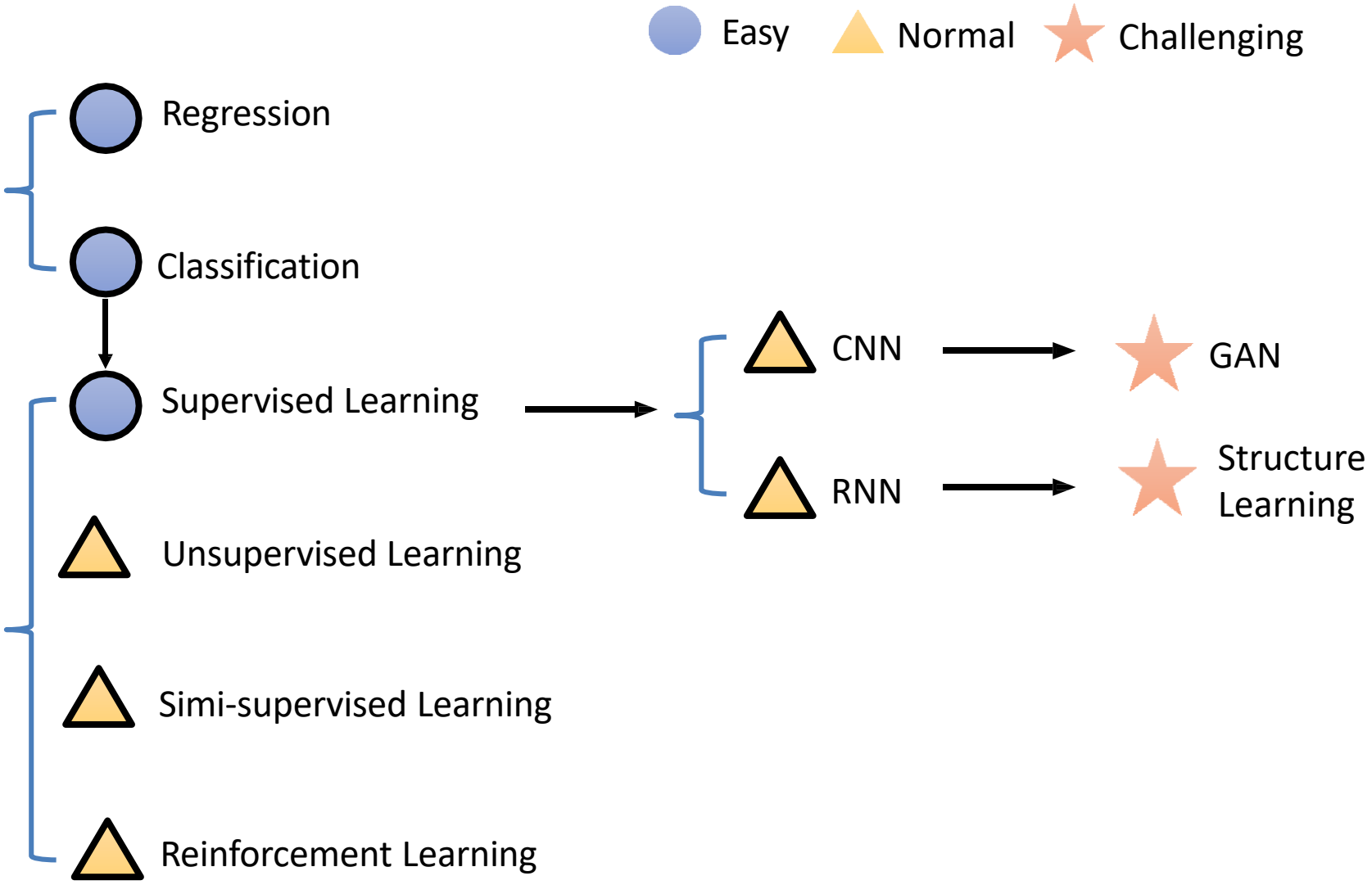
- **CNN**


Source pixel
(-1 x 3) + (0 x 0) + (1 x 1) +
(-2 x 2) + (0 x 6) + (2 x 2) +
(-1 x 2) + (0 x 4) + (1 x 1) = -3
Convolution filter
(Sobel Gx)
Destination pixel

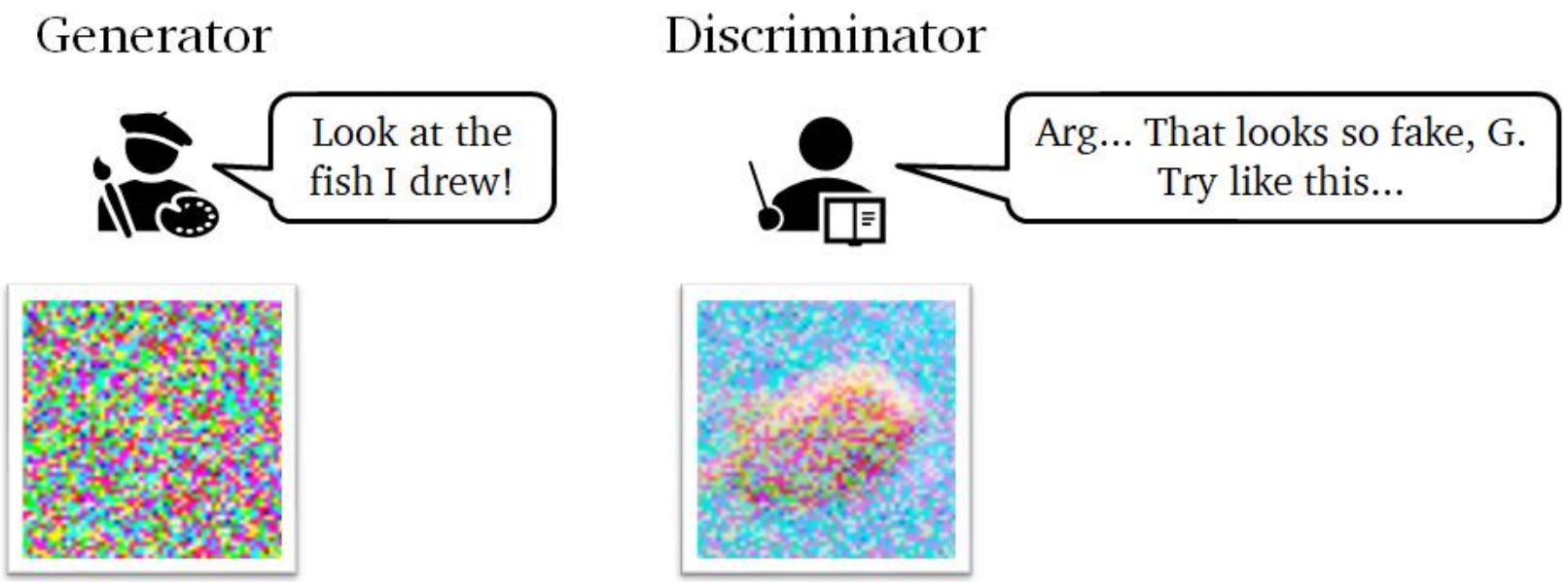
Recurrent neural network



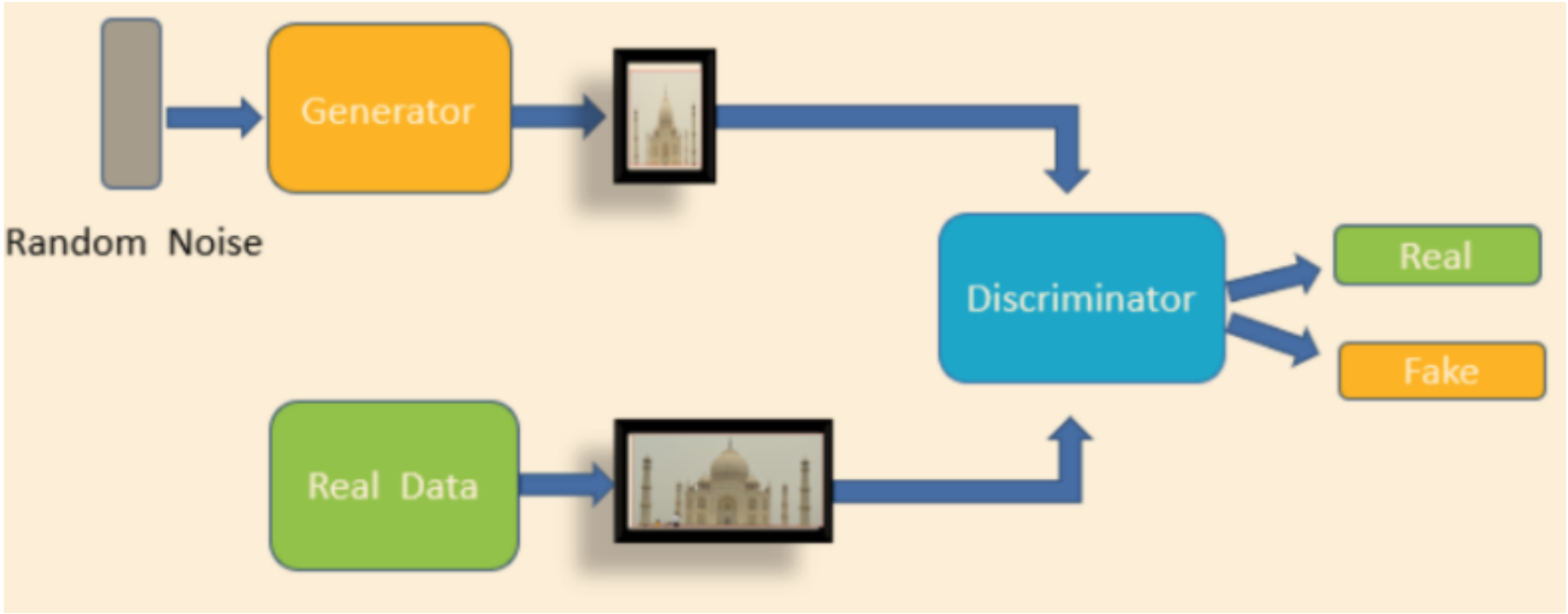
Machine Learning Roadmap



- Generative adversarial network



- Generative adversarial network

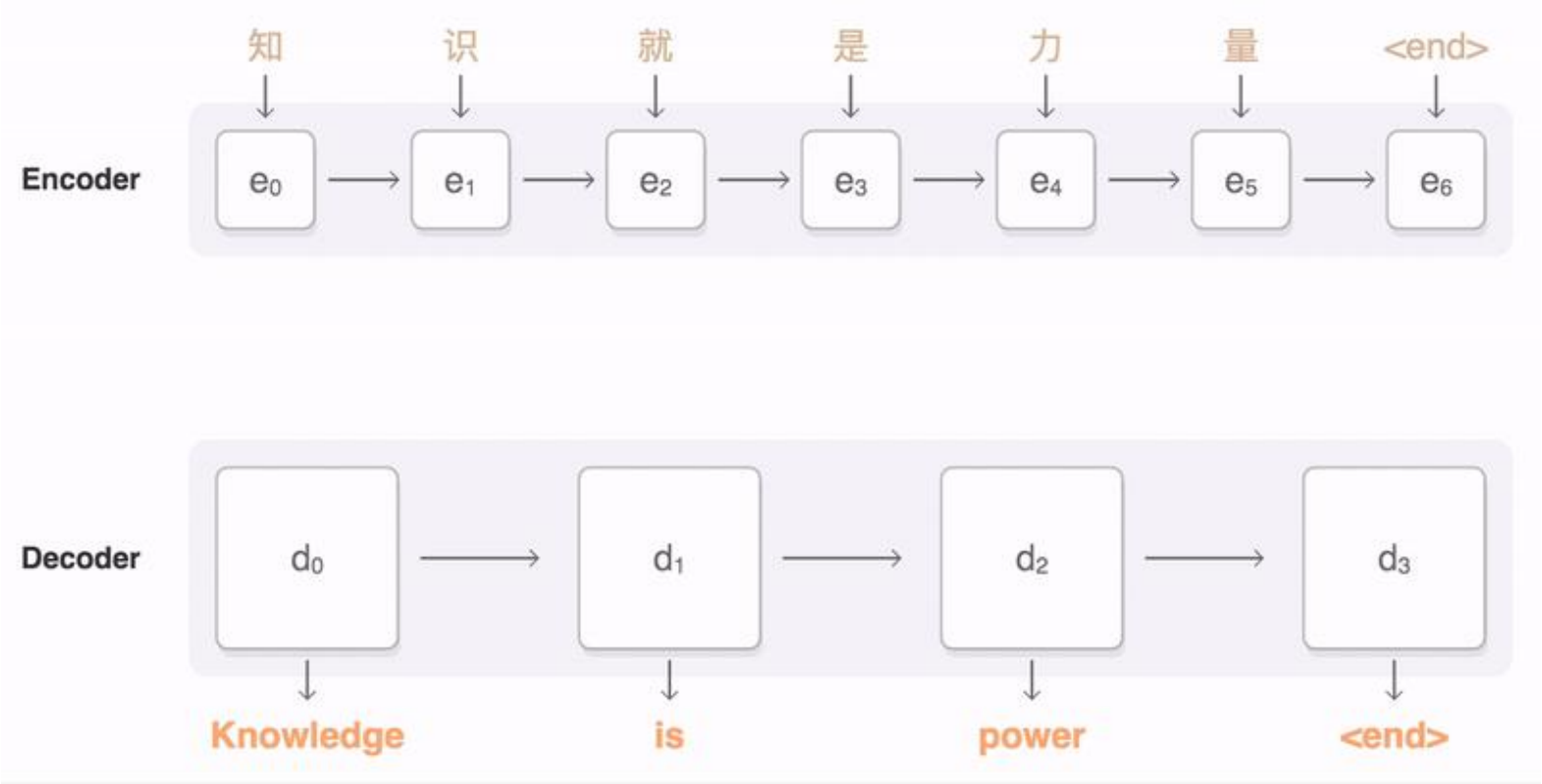


- Generative adversarial network

https://www.theverge.com/tldr/2019/2/15/18226005/ai-generated-fake-people-portraits-thispersondoesnotexist-stylegan

Structure Learning

- Seq to seq leaning



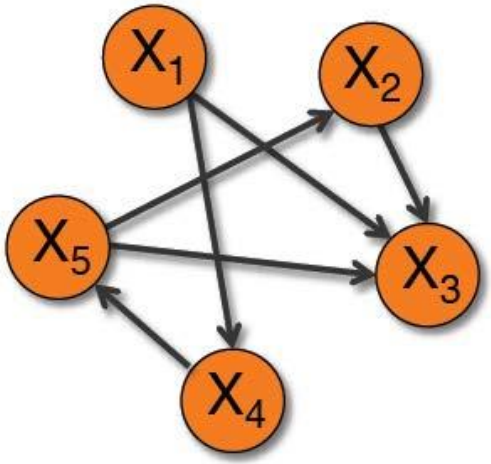
https://github.com/google/seq2seq

- Structure Learning

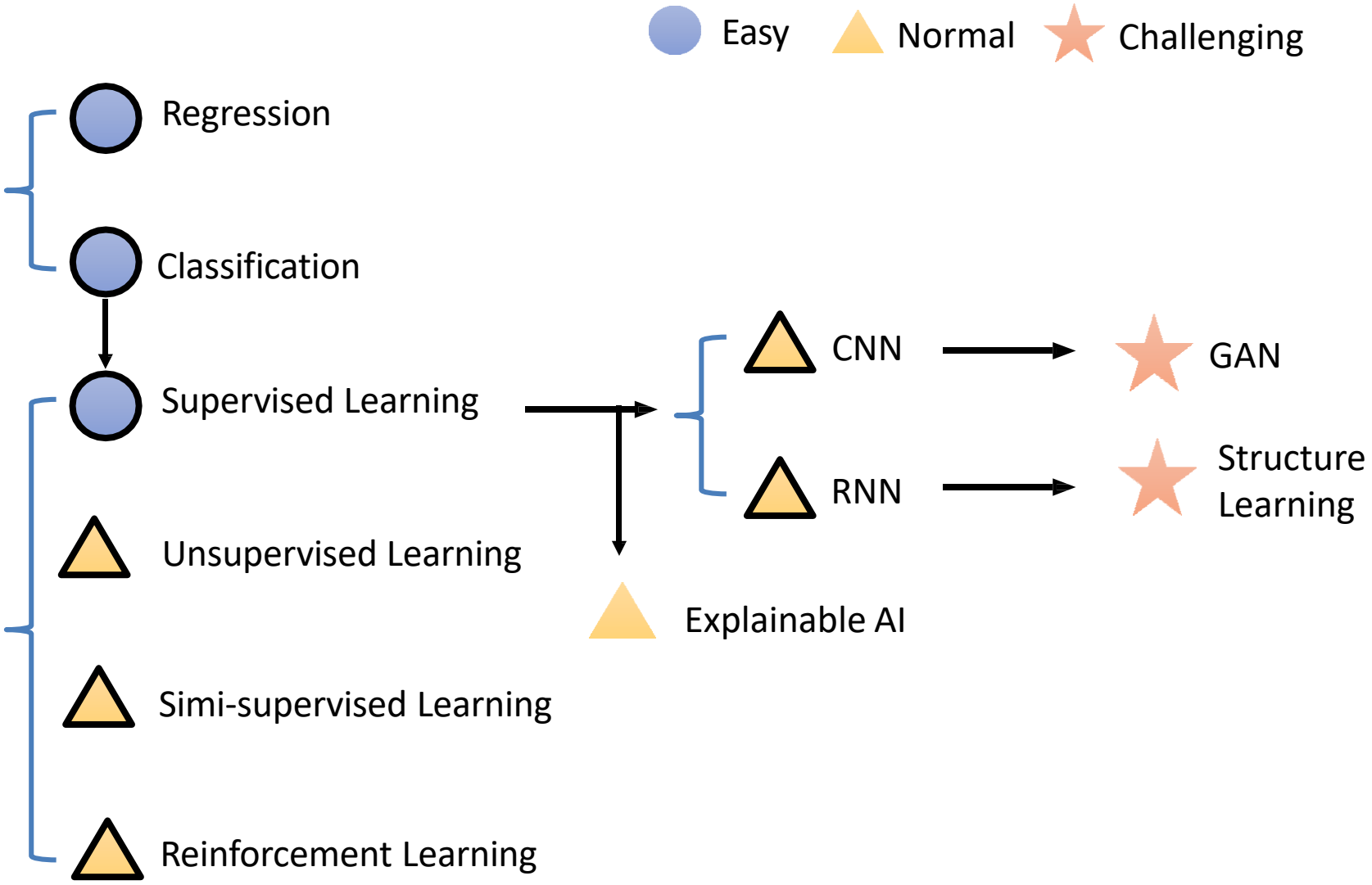
Input: Data, D

X_1	X_2	X_3	X_4	X_5
0	2	1	0	2
1	1	0	0	0
⋮		⋮		
1	0	1	1	2

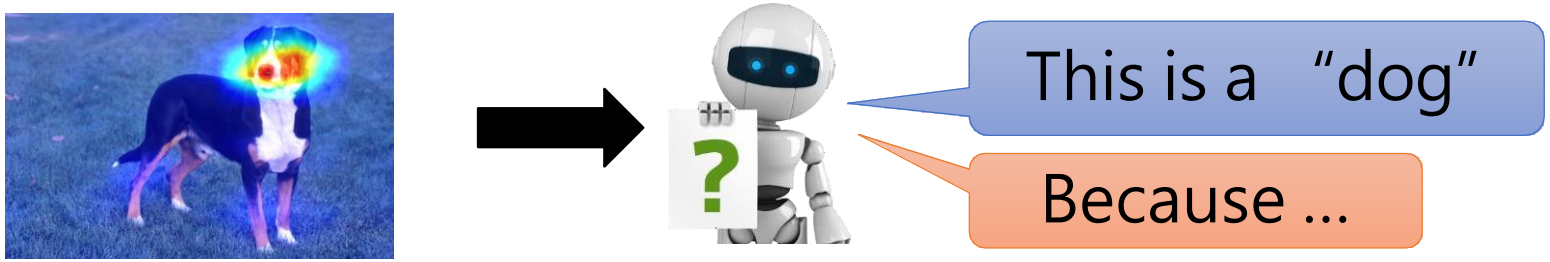
Output: Graph, G

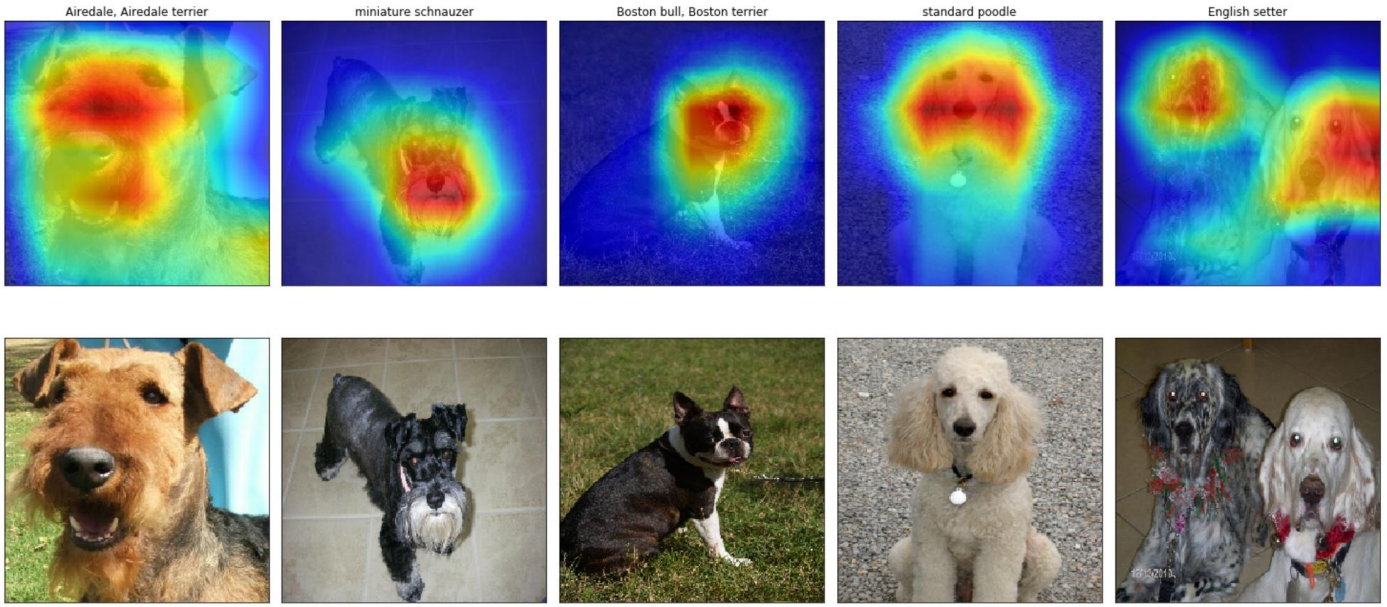


Machine Learning Roadmap

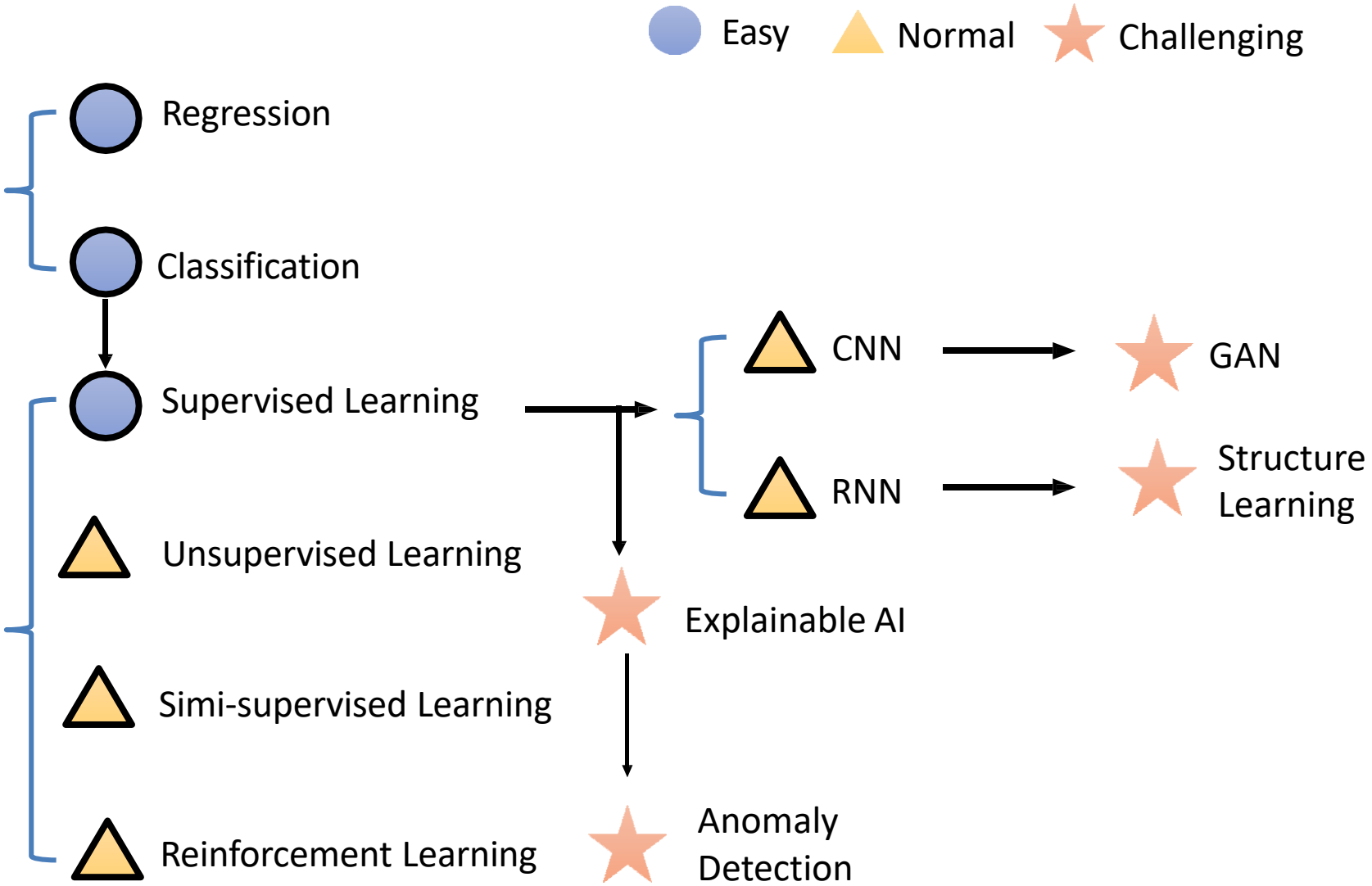


Machine Explainable AI





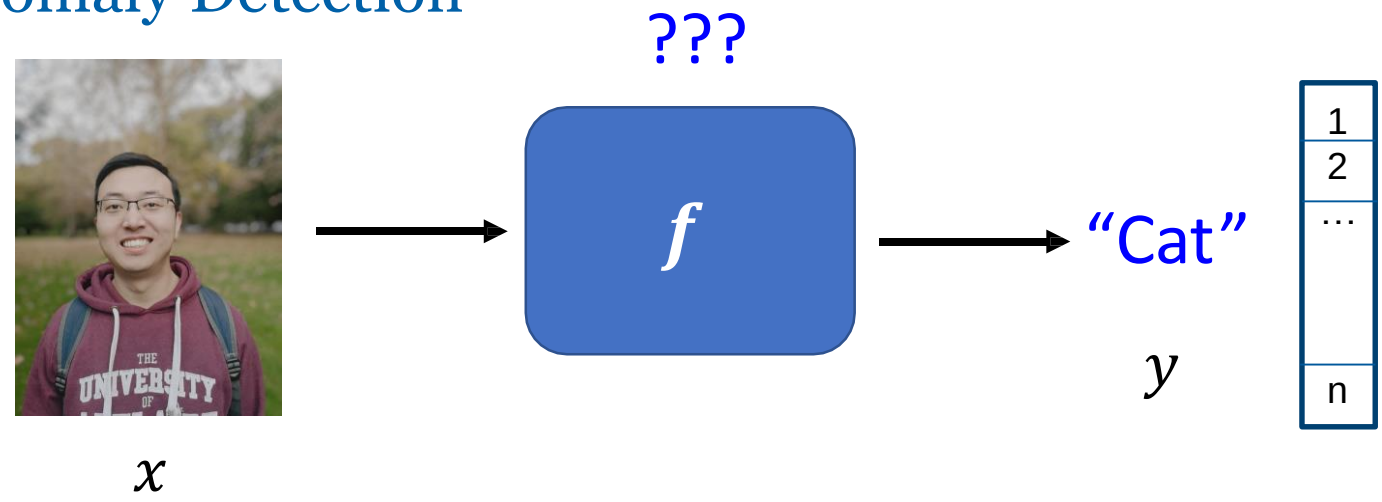
Machine Learning Roadmap



Anomaly Detection

- Anomaly Detection

- Anomaly Detection



- Anomaly Detection

x

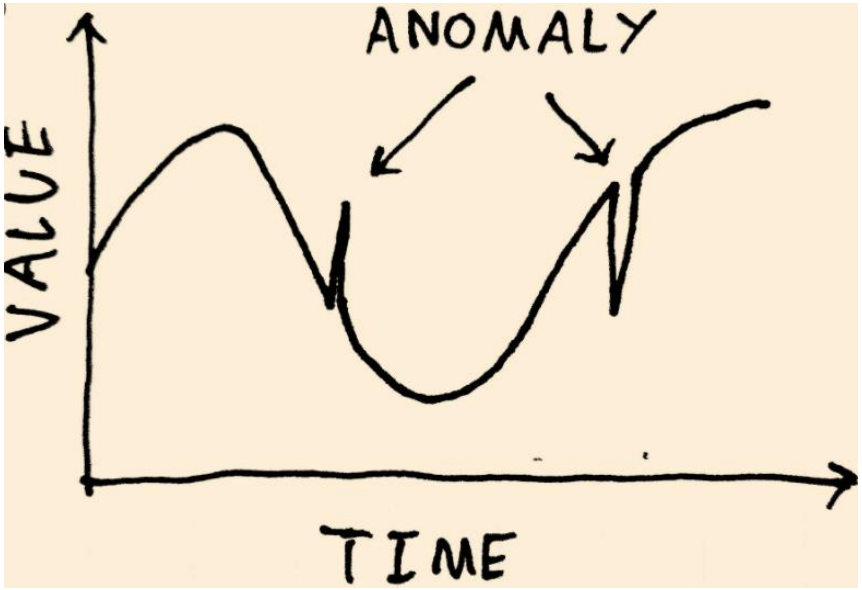
???

f

"Cat"

y

1
2
…
n



- Anomaly Detection

x

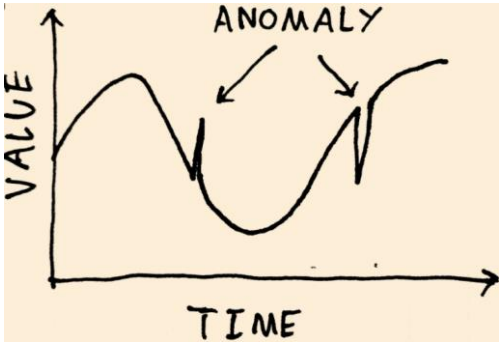
???

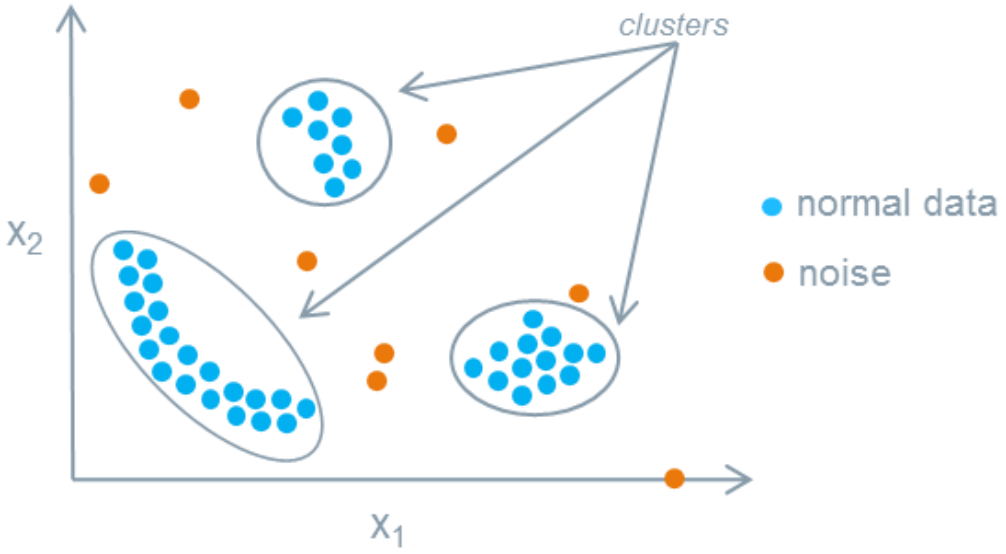
f

"Cat"

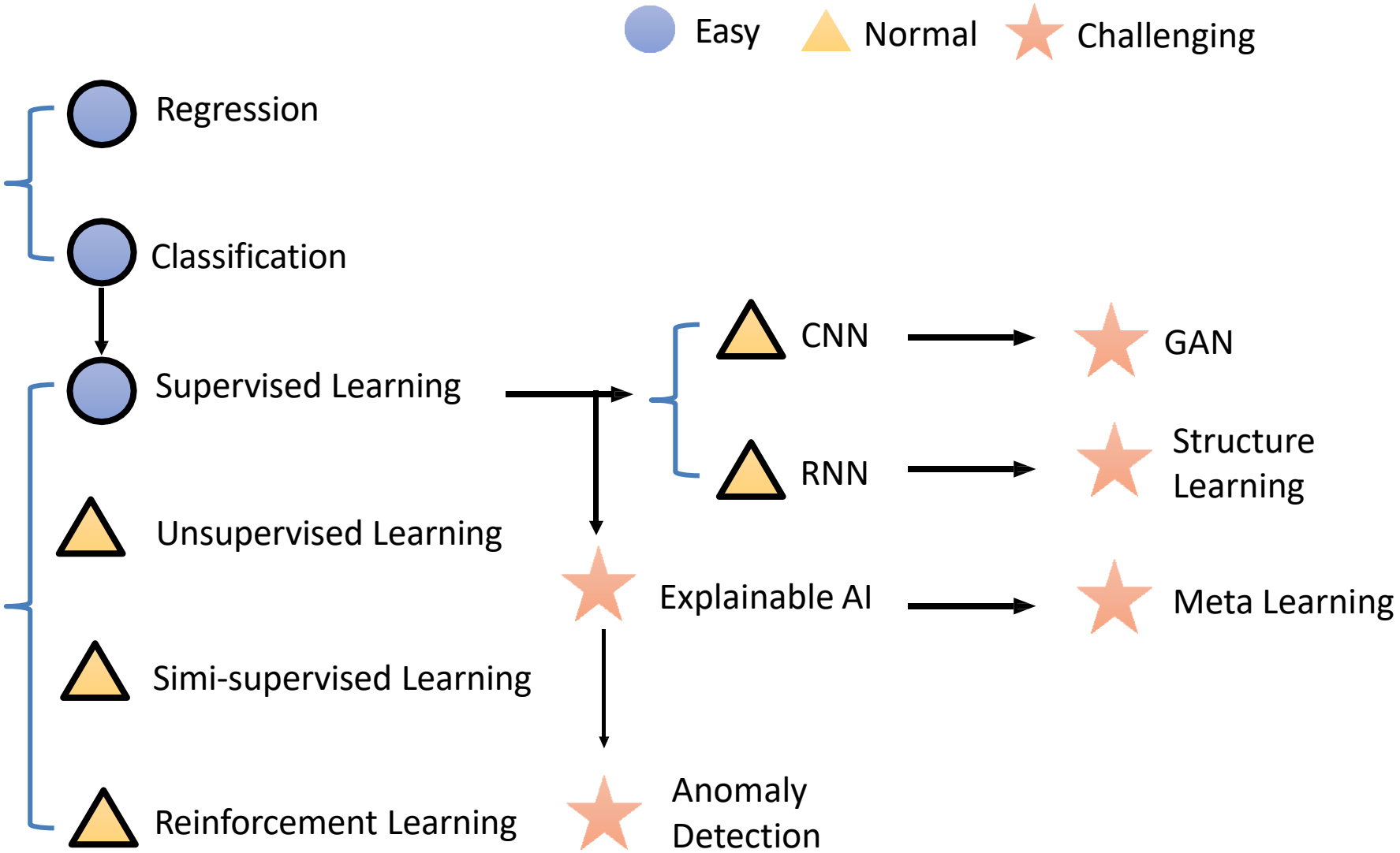
y

1
2
…
n





Machine Learning Roadmap



Meta Learning

Meta Learning = Learn to learn

- Now we design the learning algorithm

x

f

"Cat"

y

I can learn f!

program for learning

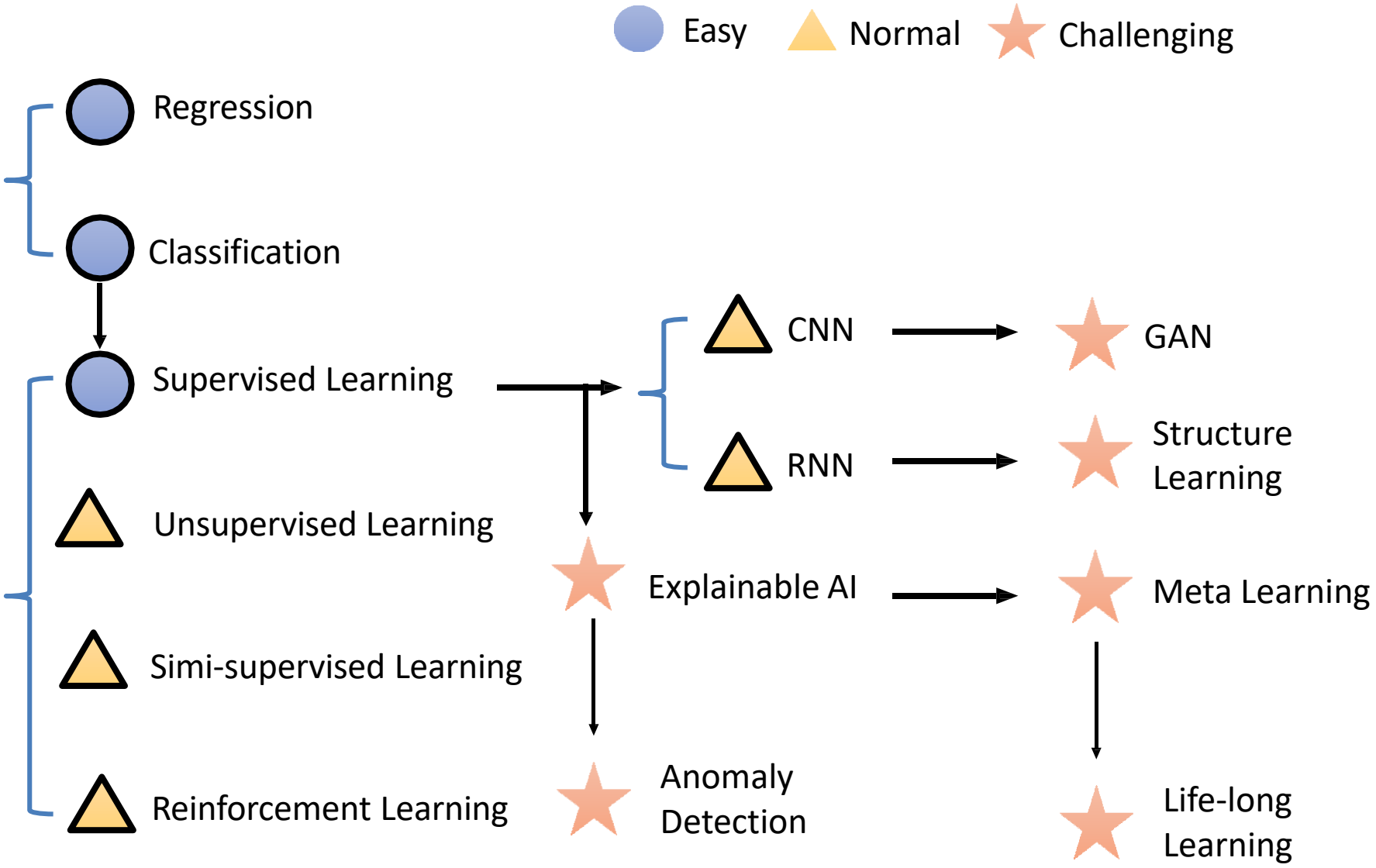
- Can machine learn the learning algorithm?

program designing program for learning

program for learning

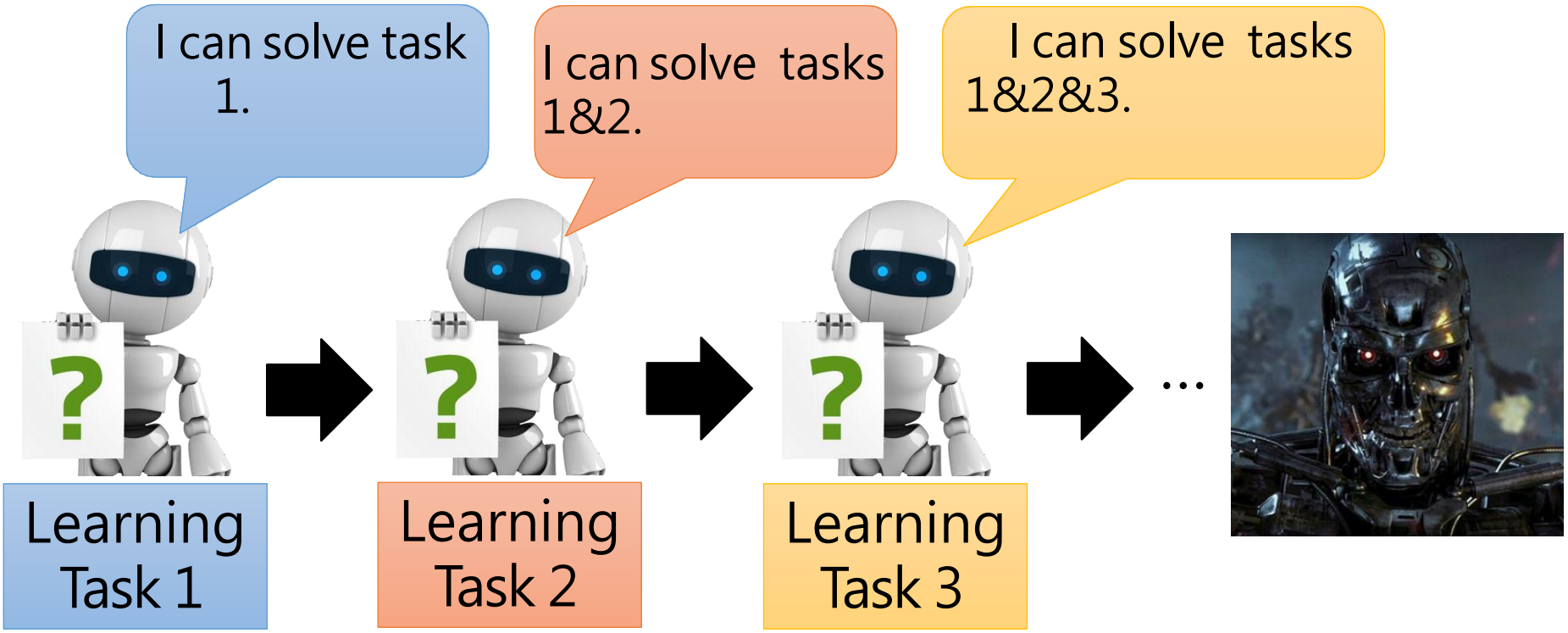
I can f' f!

Machine Learning Roadmap



Life-long Learning

Life-long Learning



Life-Long Learning, Continuous Learning, Never End Learning, Incremental Learning

Reference

- Cs231n Tutorial

  https://cs231n.github.io/linear-classify/

- Hungyi Lee Tutorial

  http://speech.ee.ntu.edu.tw/~tlkagk/courses_ML20.html

- Semi-supervised learning wiki

  https://en.wikipedia.org/wiki/Semi-supervised_learning