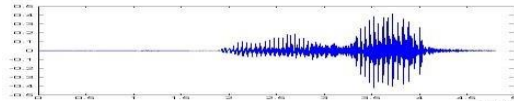


Concepts in Artificial Intelligence & Machine Learning Technologies

Machine Learning Overview
Dr. Wei Zhang

Machine Learning --- Finding Functions


- Speech Recognition

$$f(\text{  }) = \text{"How are you"}$$

- Image Recognition

$$f(\text{  }) = \text{"Cat"}$$

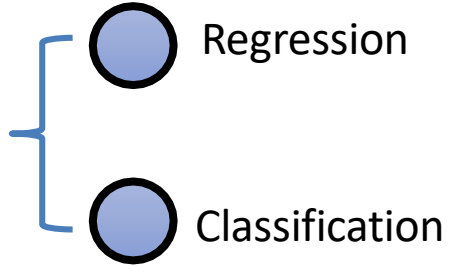
- Playing Go

$$f(\text{  }) = \text{"5-5"} \text{ (next move)}$$

- Dialogue System

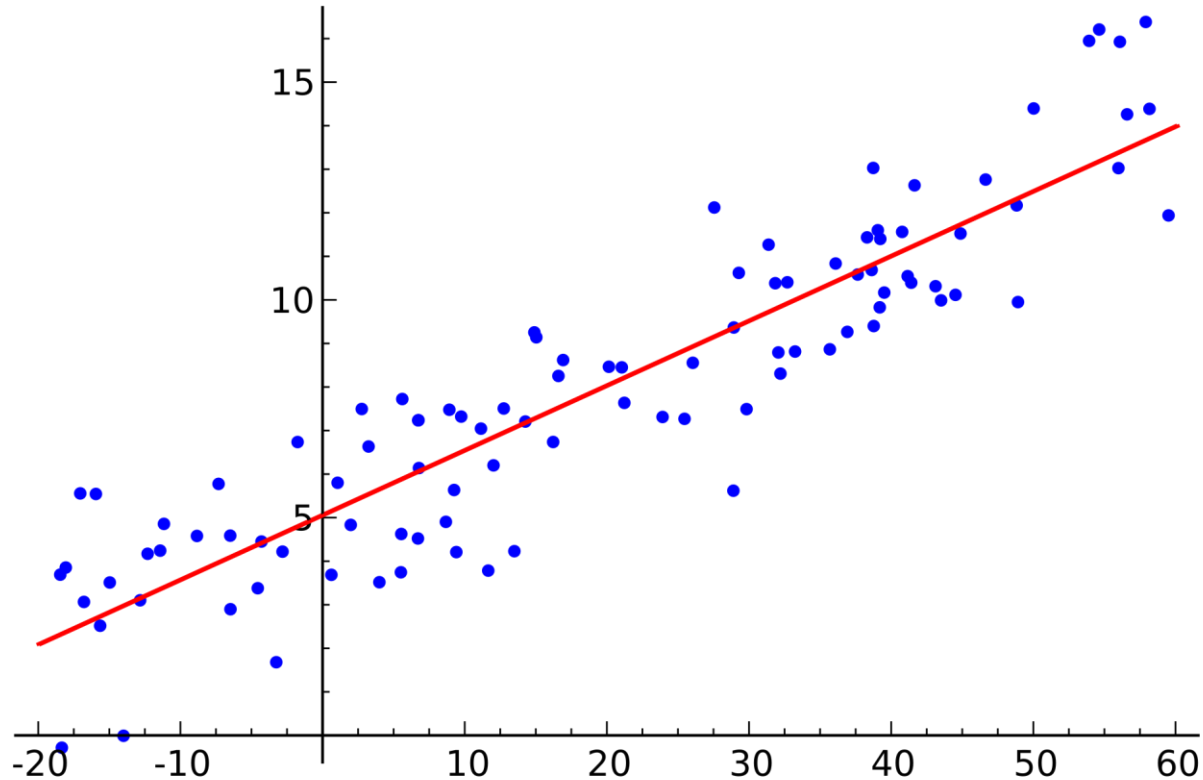
$$f(\text{ "How are you?" } \text{ (what the user said) }) = \text{ "I am fine." } \text{ (system response)}$$

Machine Learning Roadmap

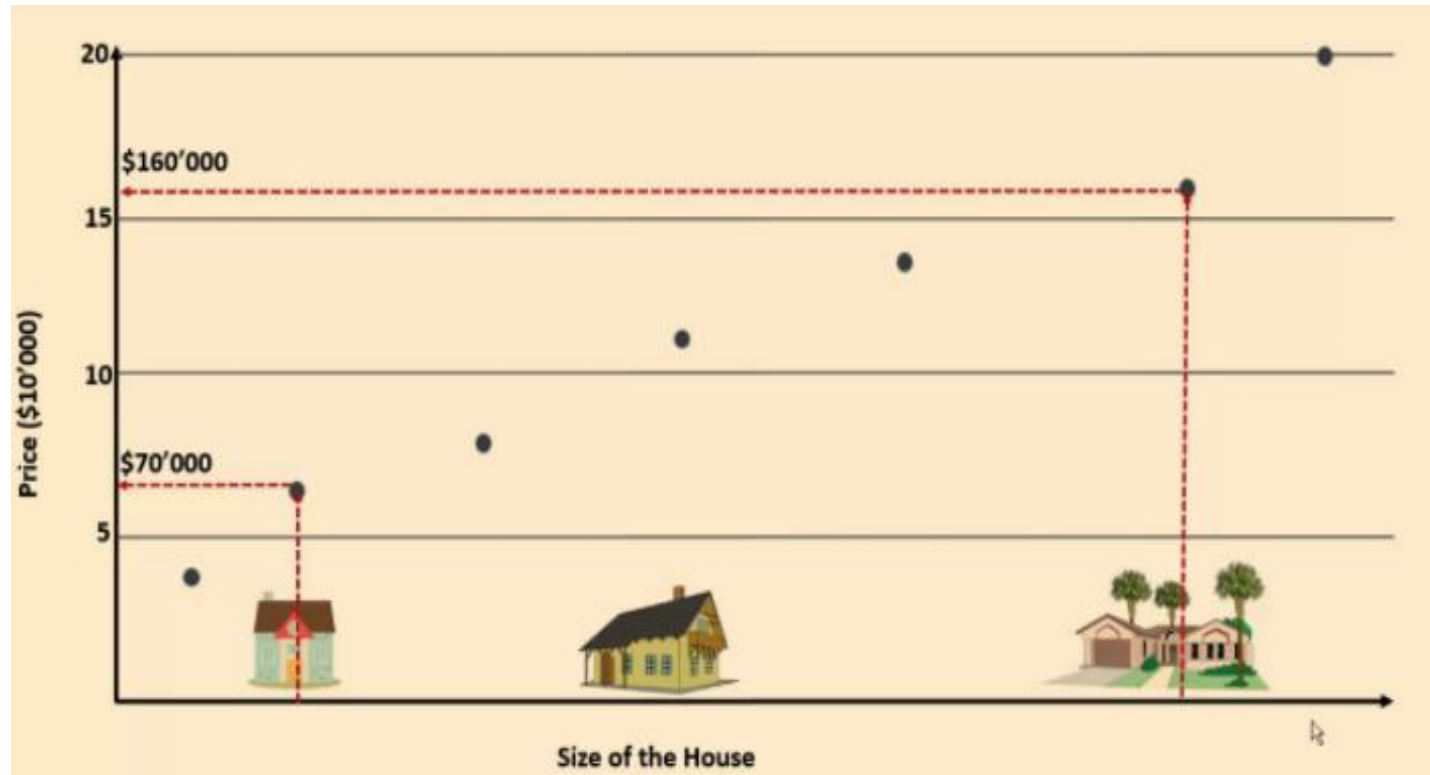


Regression

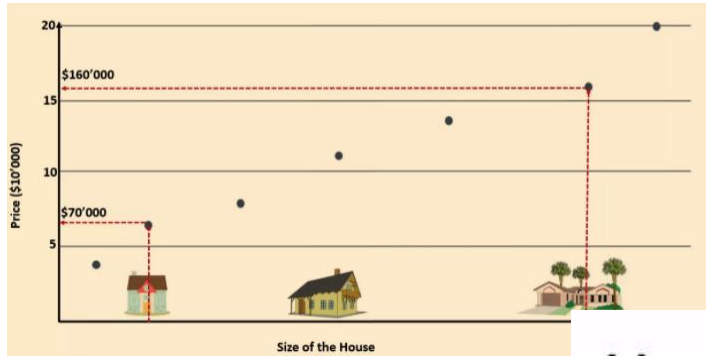
- **Regression --- Intuition**



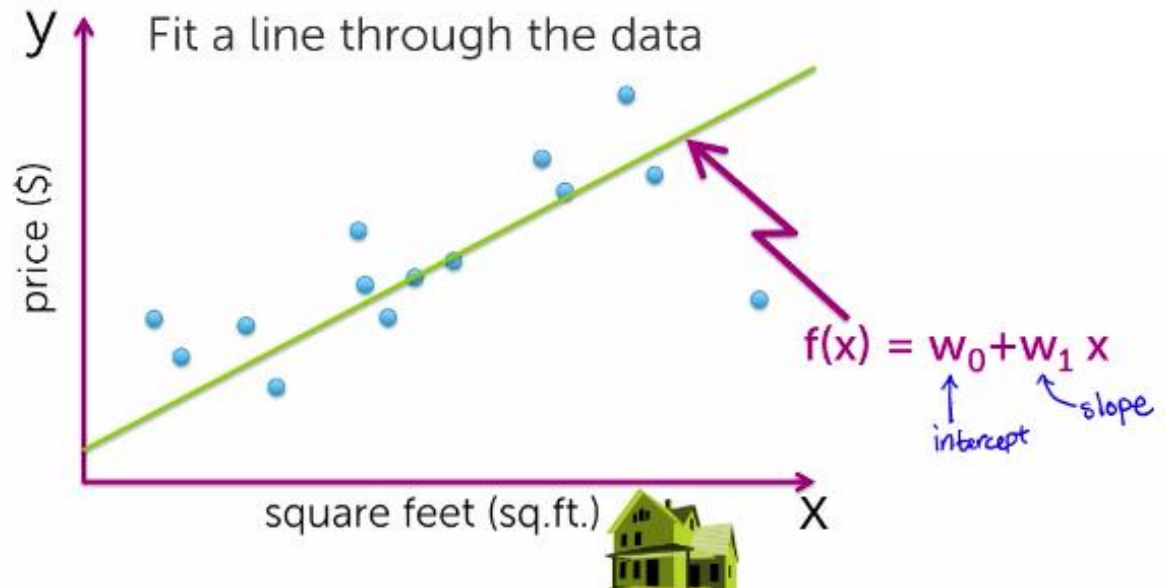
- Regression --- An example



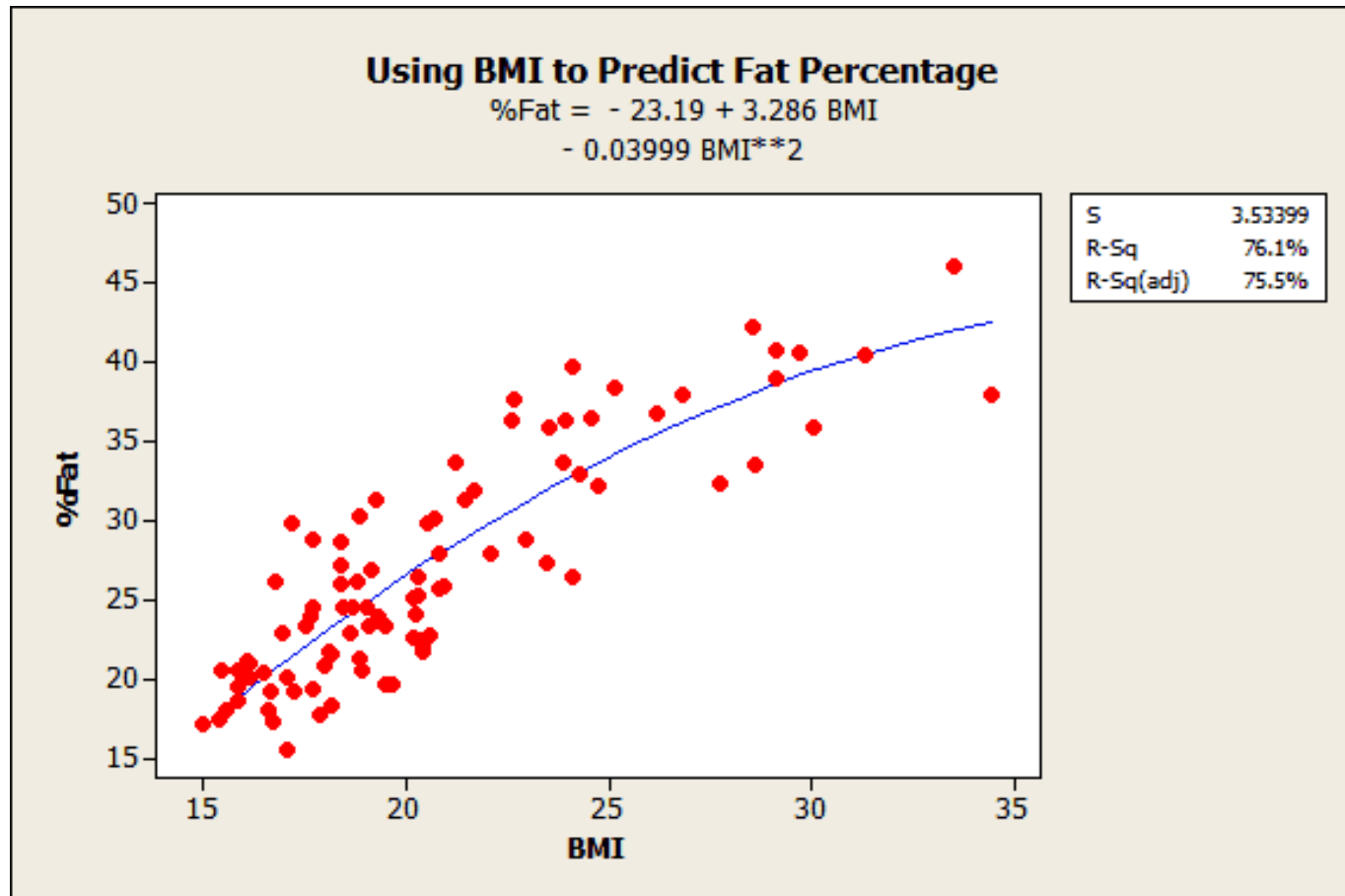
- Regression --- Linear Regression



Use a **linear** regression model

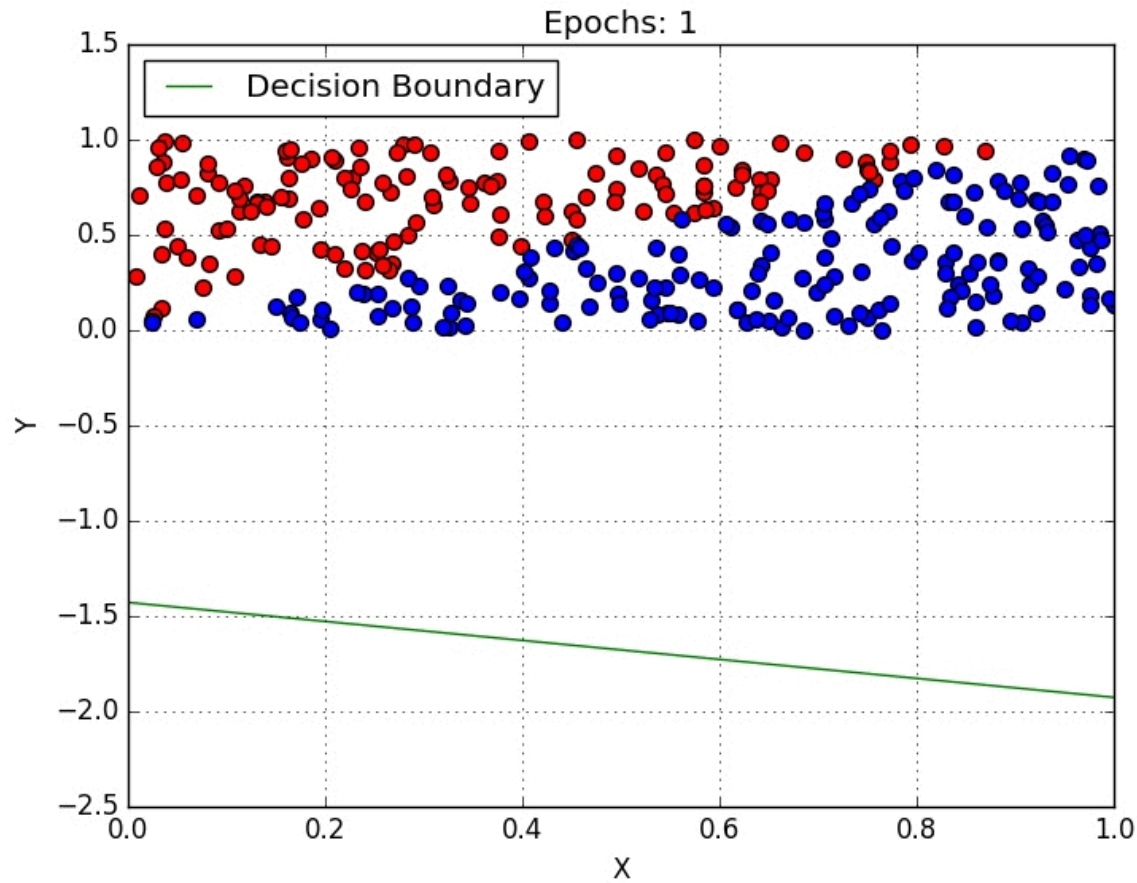


- Regression --- Non-linear regression

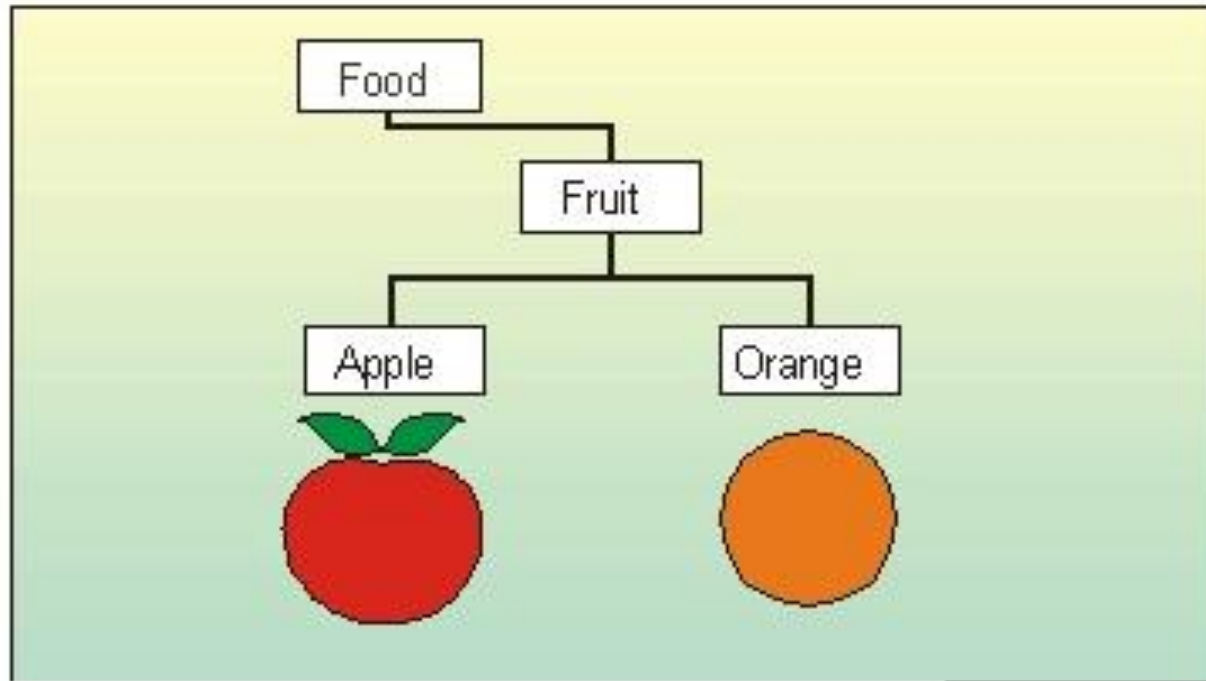


Classification

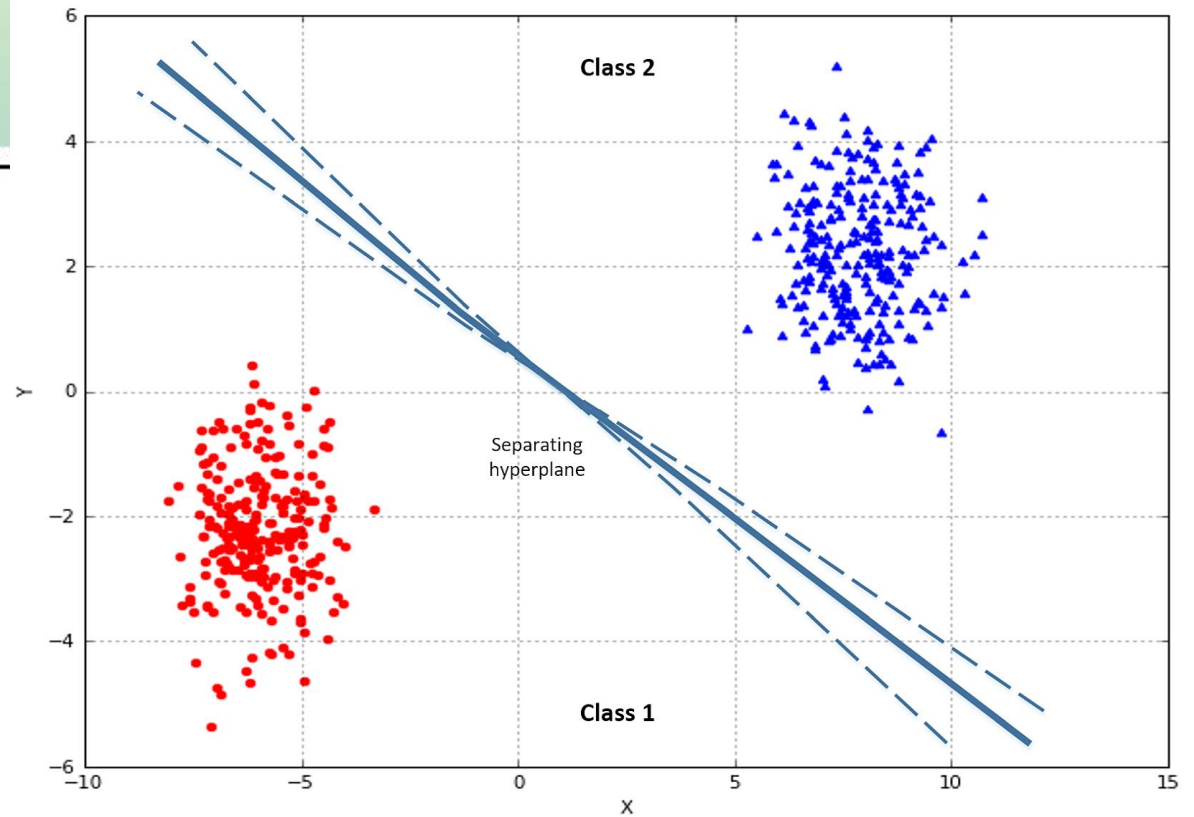
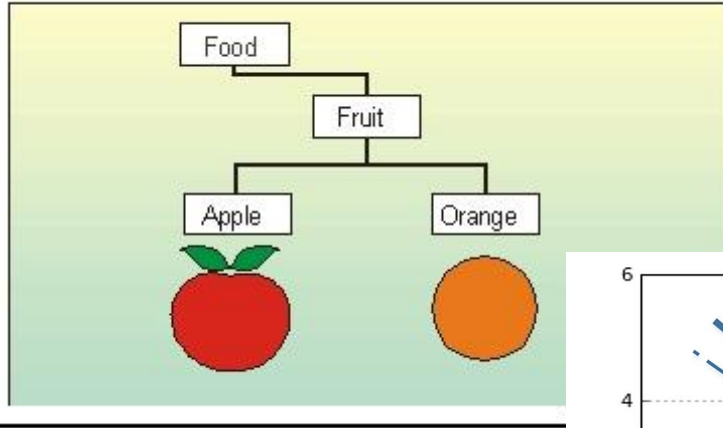
- **Classification --- Intuition**



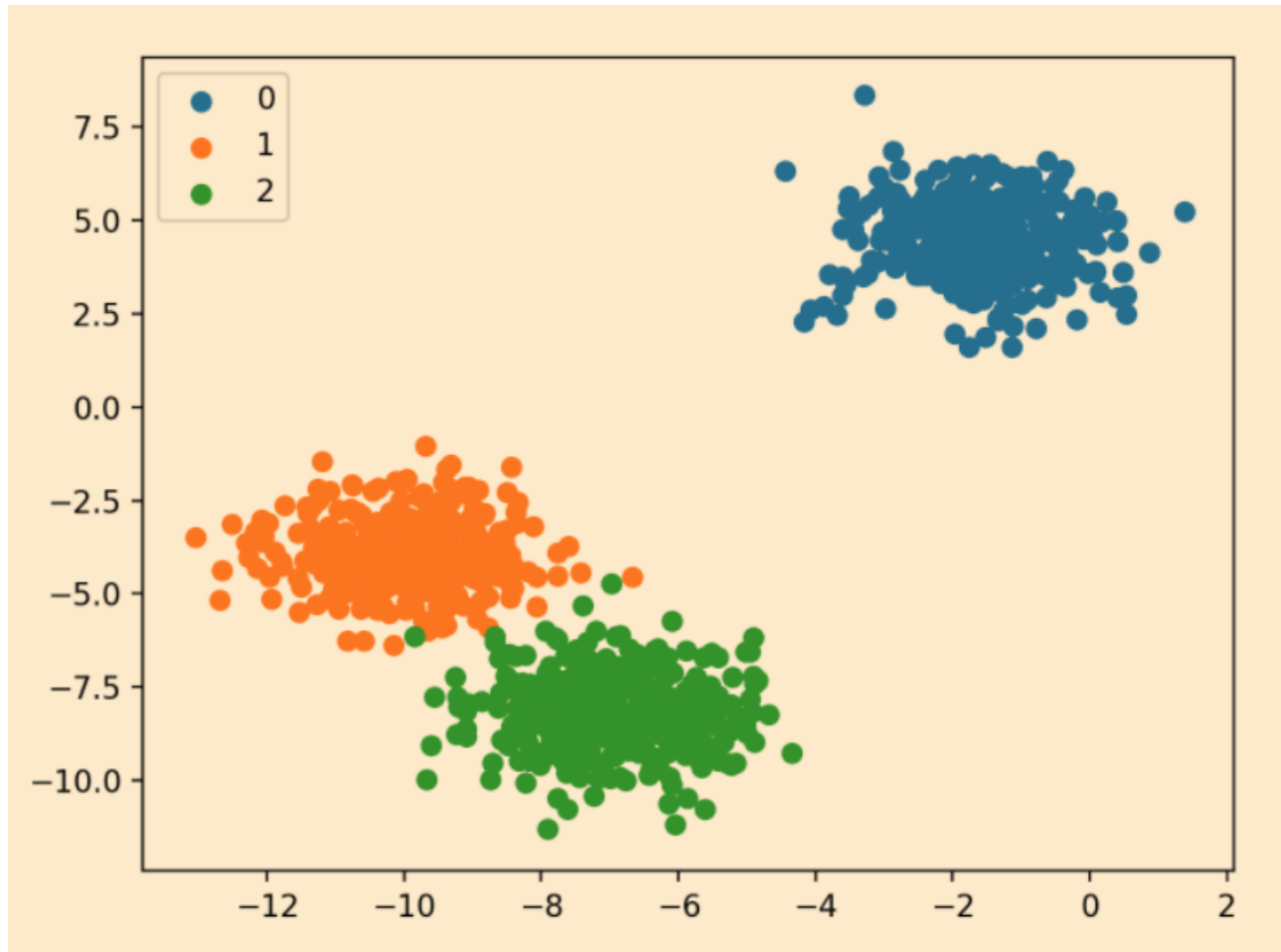
- **Classification --- An example**



- **Classification --- An example**



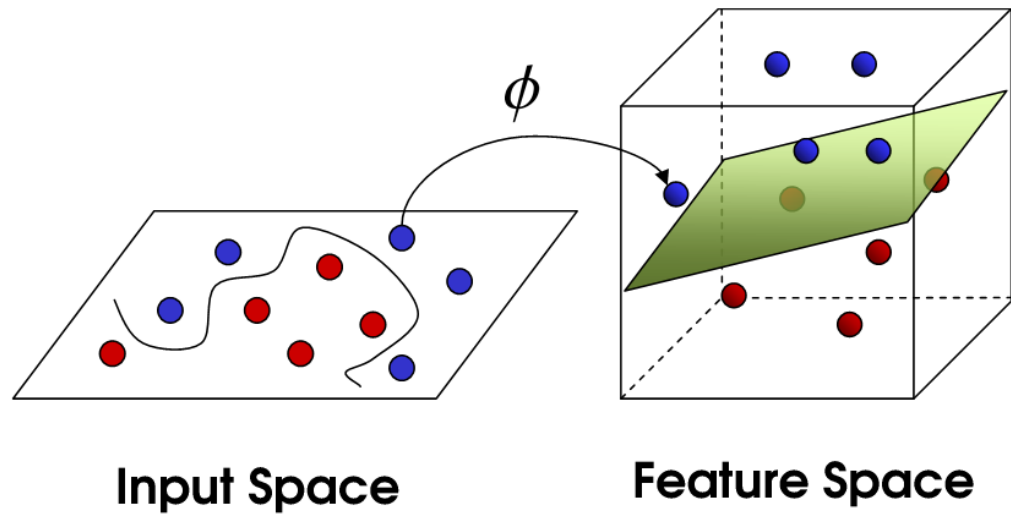
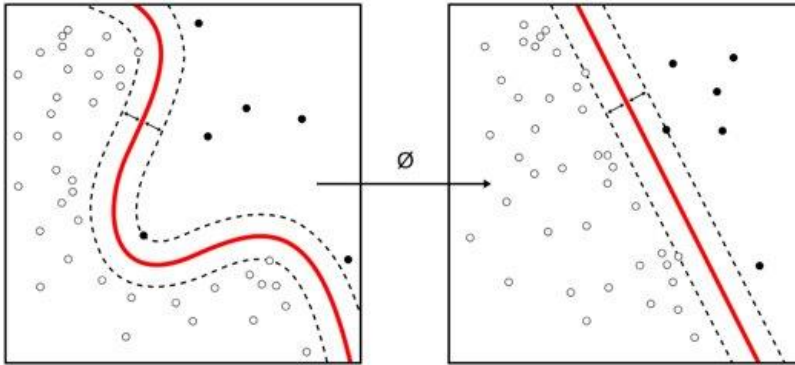
- **Classification --- Multi-class**



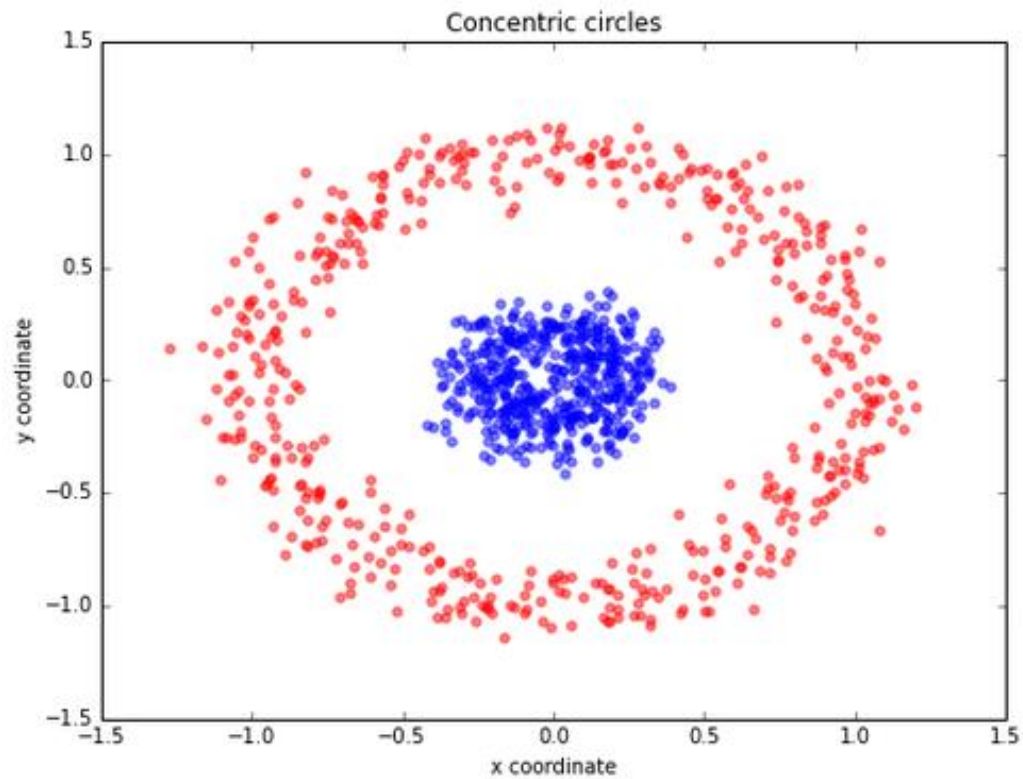
Demo

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

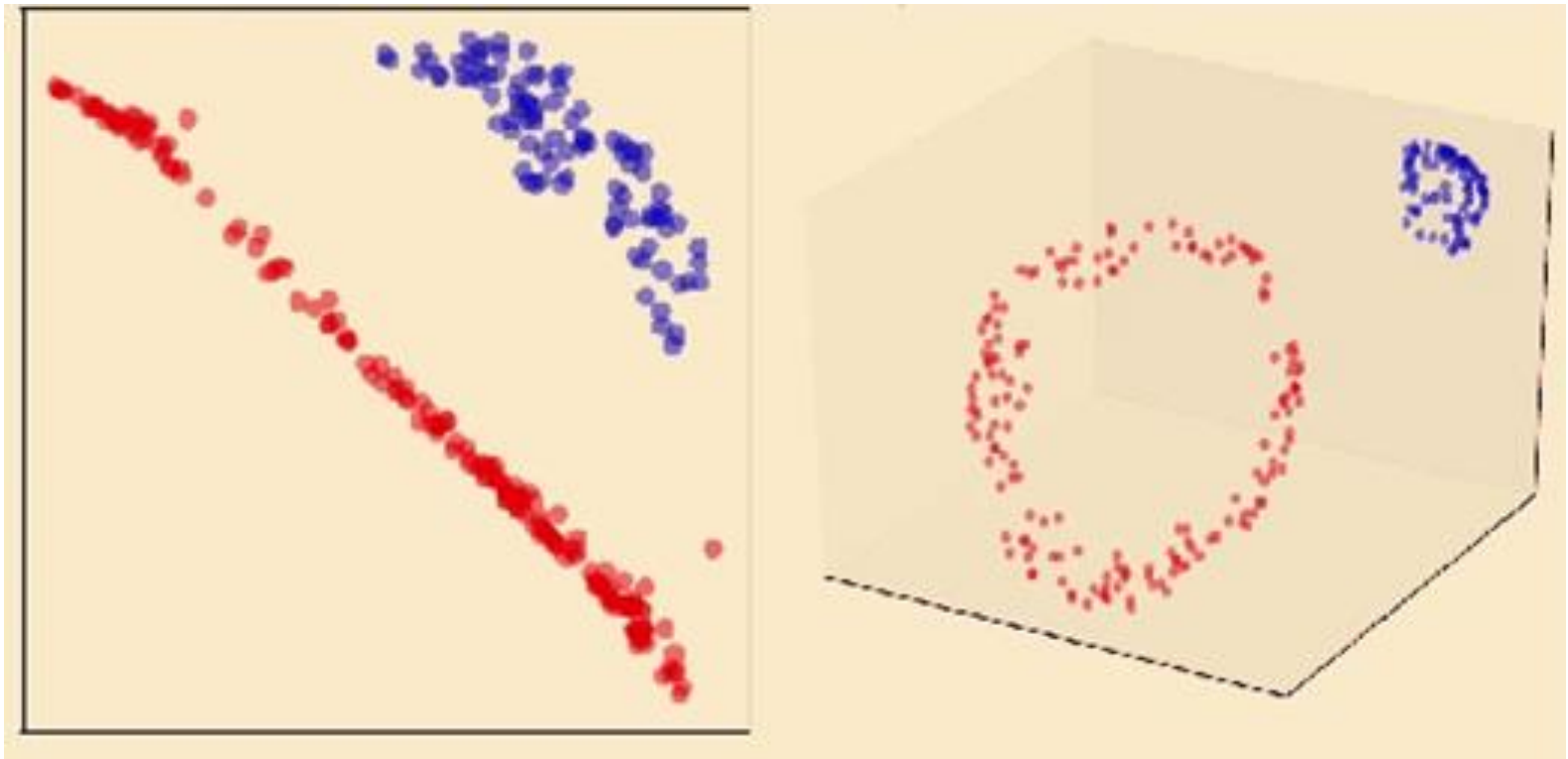
- **Classification --- Non-linear**



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

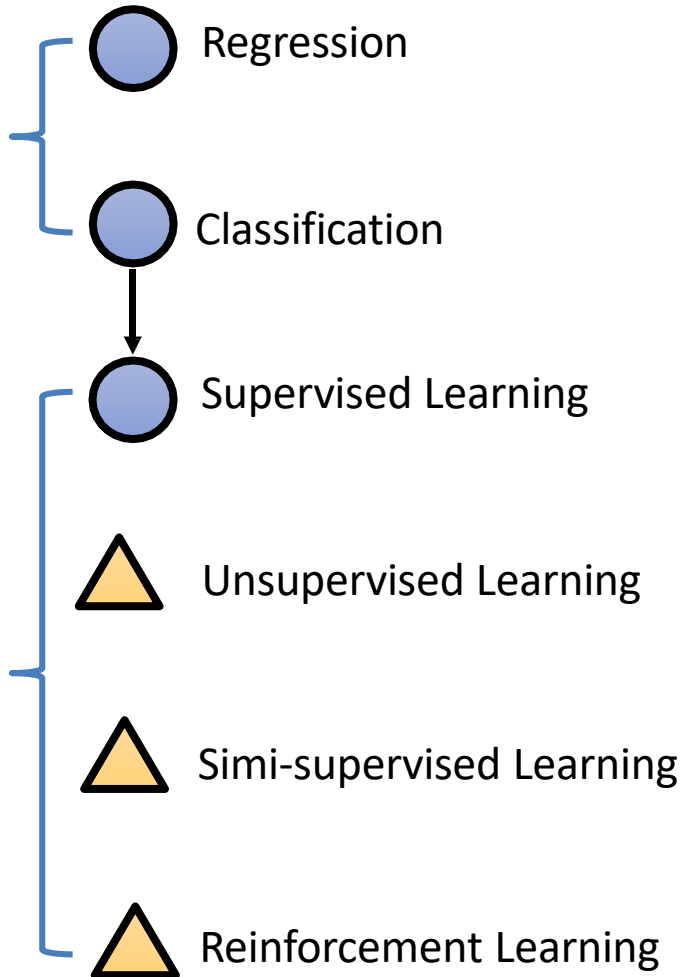


- **Classification --- Non-linear**



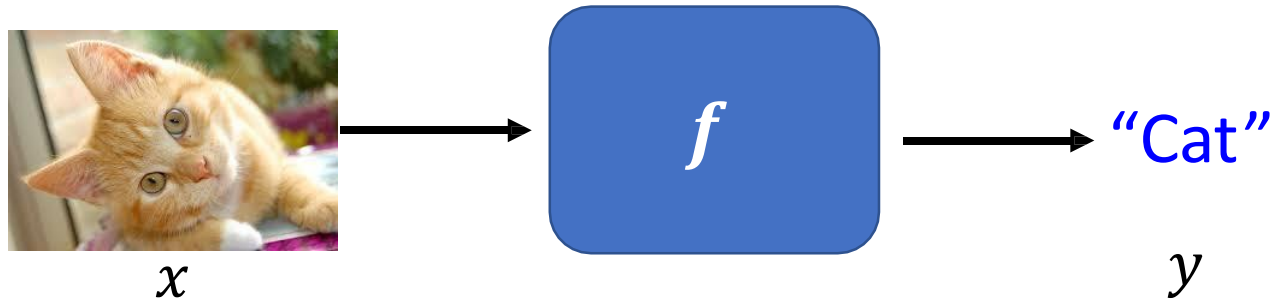
Machine Learning Roadmap

● Easy ▲ Normal ★ Challenging



Supervised Learning

Supervised Learning



x_1 :



y_1 : "Cat"

x_2 :



y_2 : "Cat"

x_3 :



y_3 : "Dog"

x_4 :

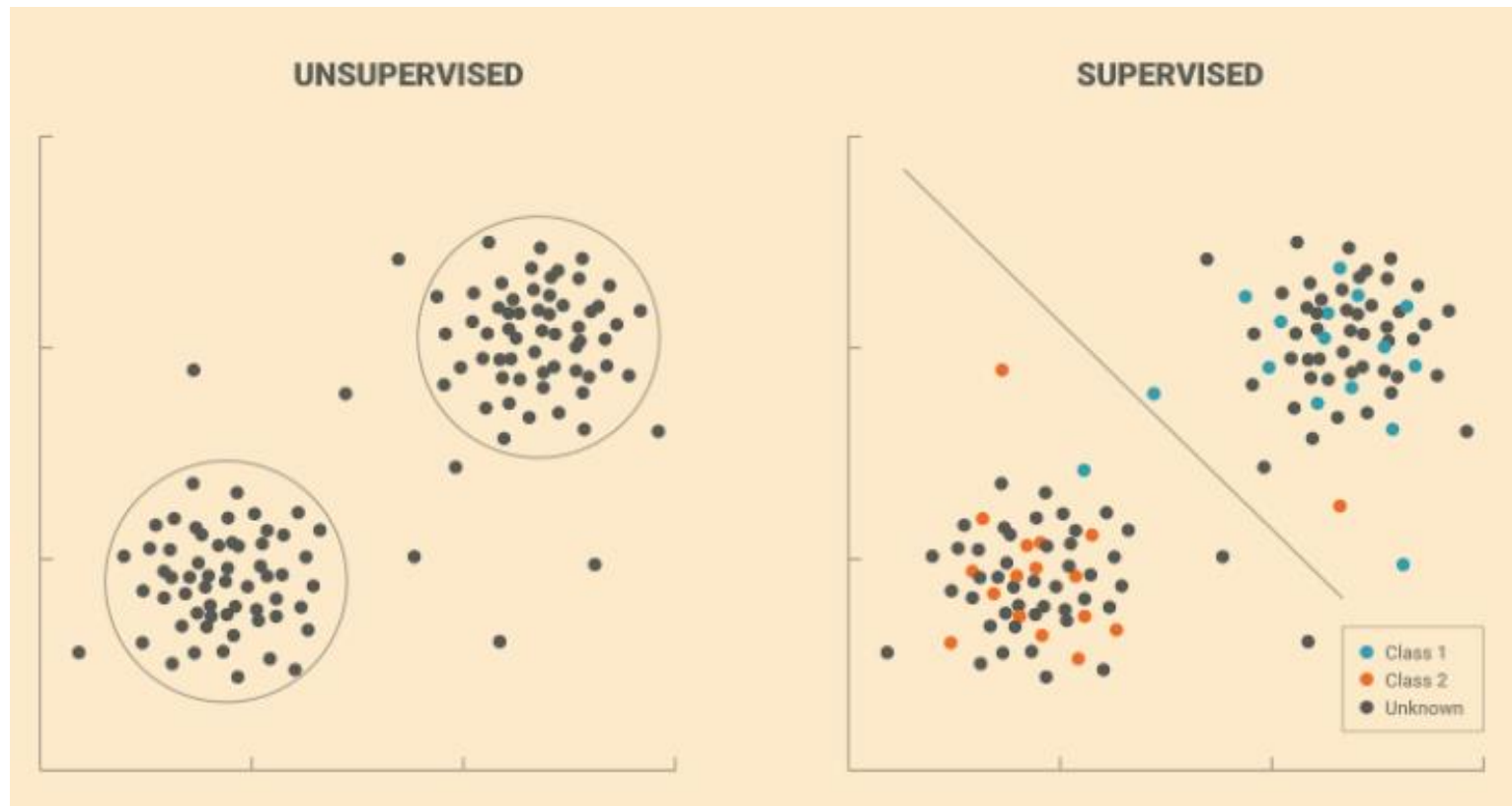


y_4 : "Dog"

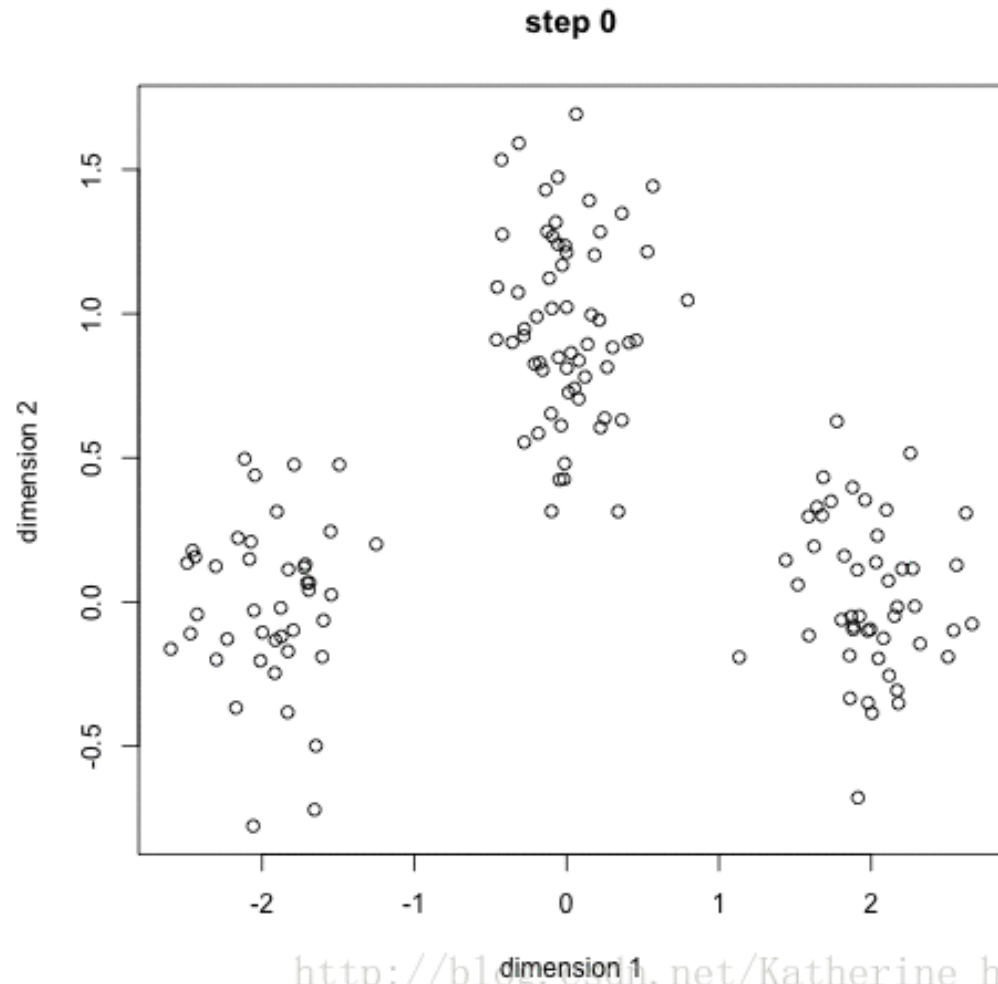
Labelled Data

Unsupervised Learning

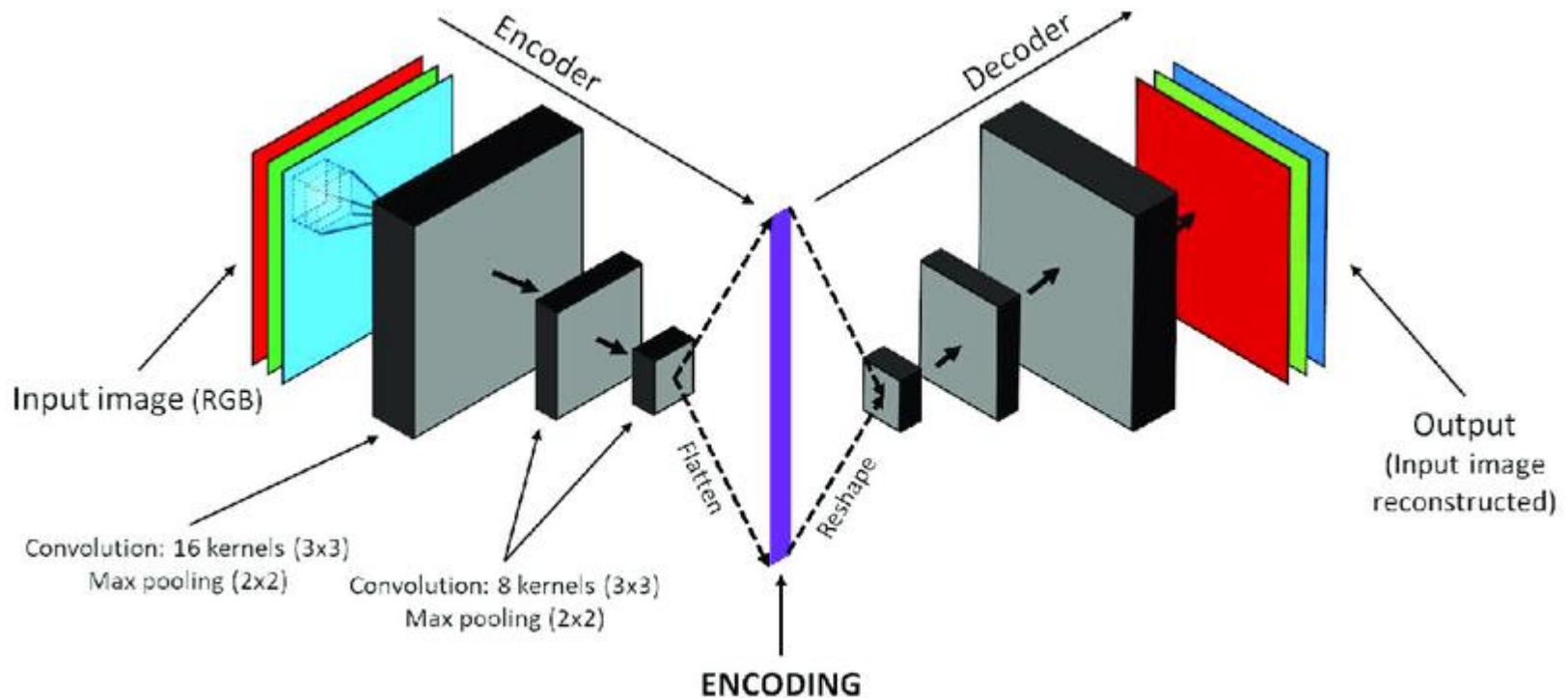
Unsupervised Learning



Unsupervised Learning --- clustering

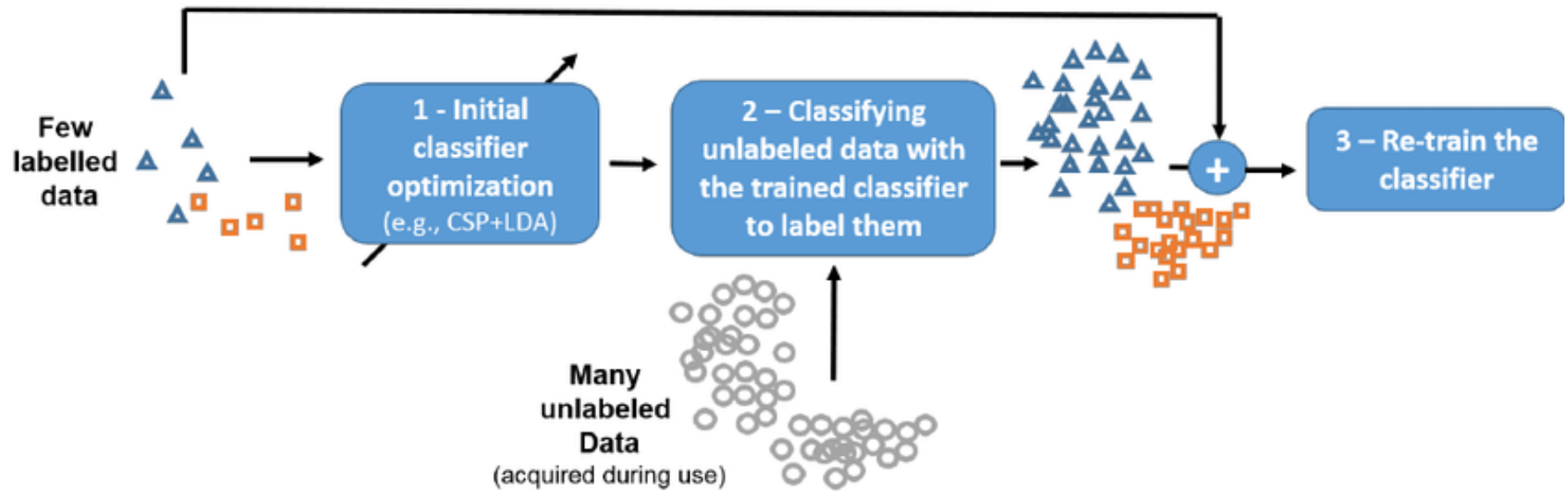


Unsupervised Representation Learning

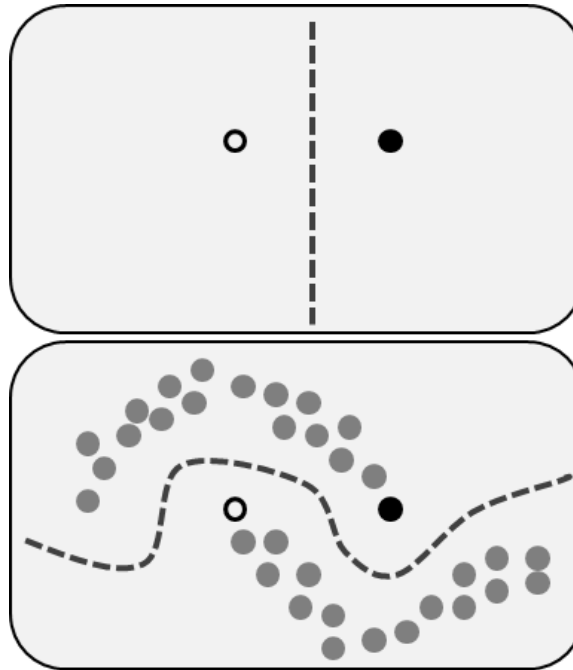


Semi-supervised Learning

Semi-supervised Learning



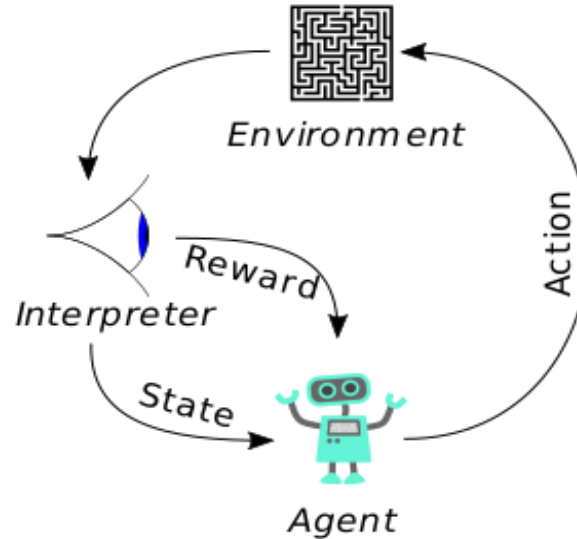
Semi-supervised Learning



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.

Reinforcement Learning

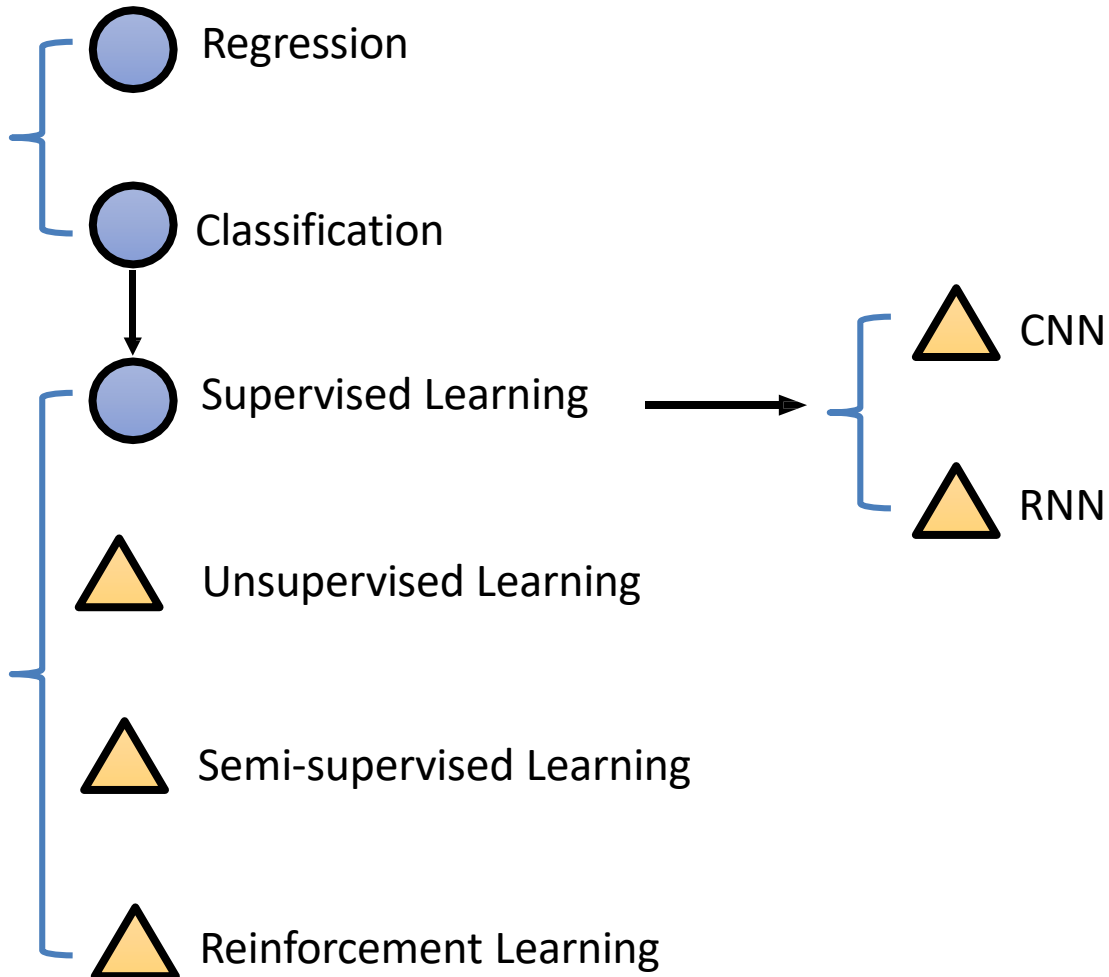
Reinforcement Learning



- 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

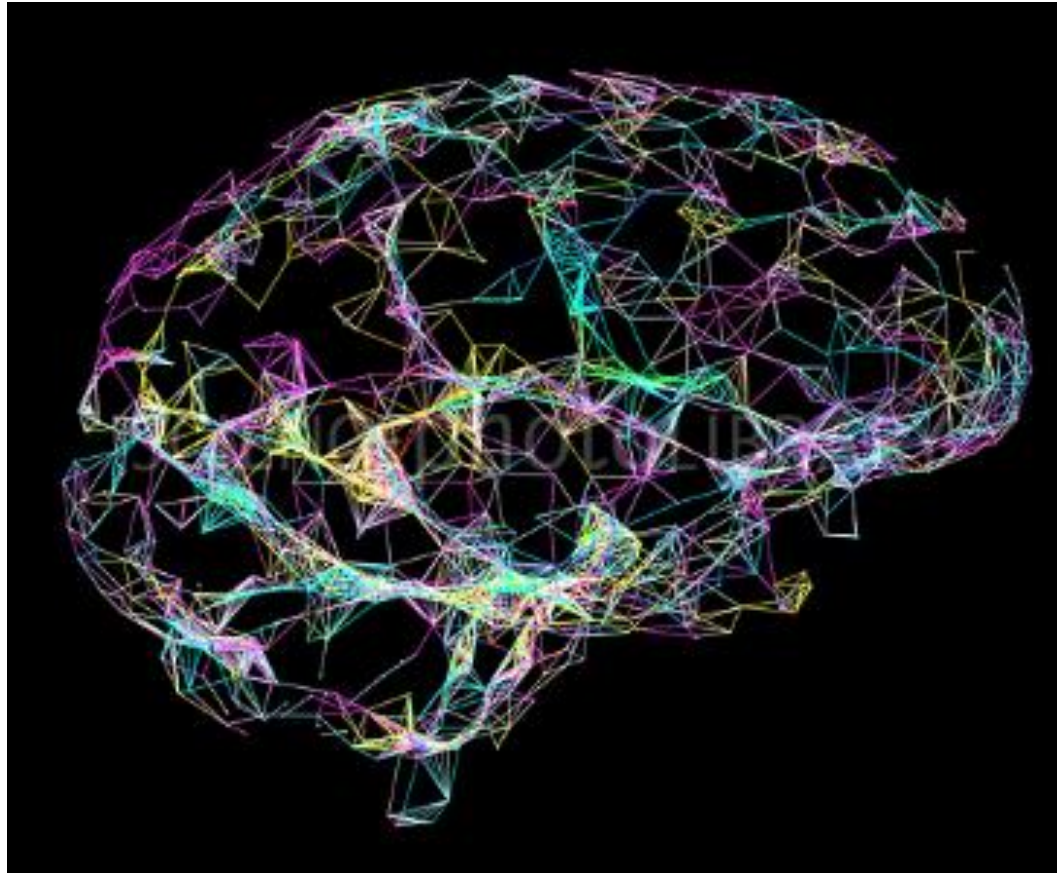
Machine Learning Roadmap

● Easy ▲ Normal ★ Challenging

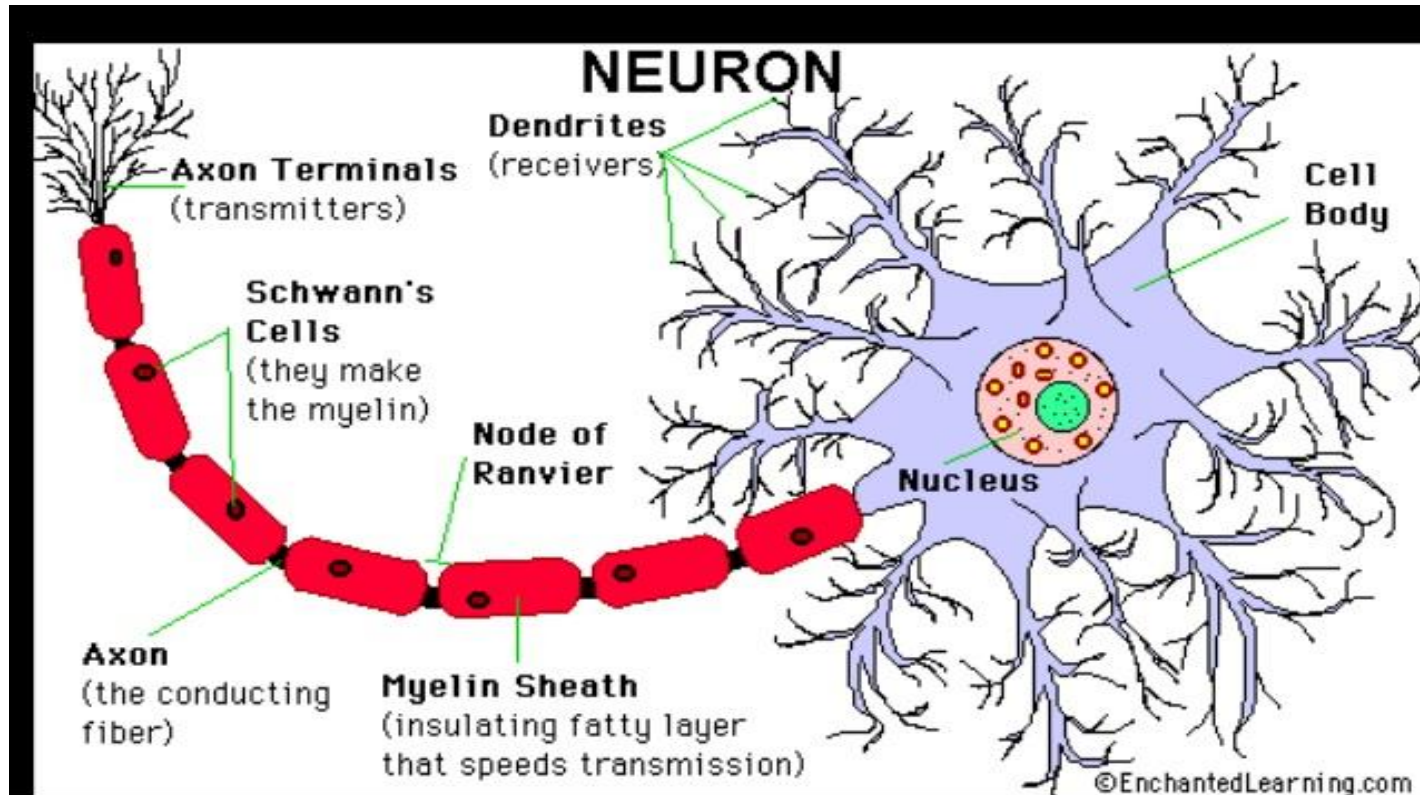


Neural networks

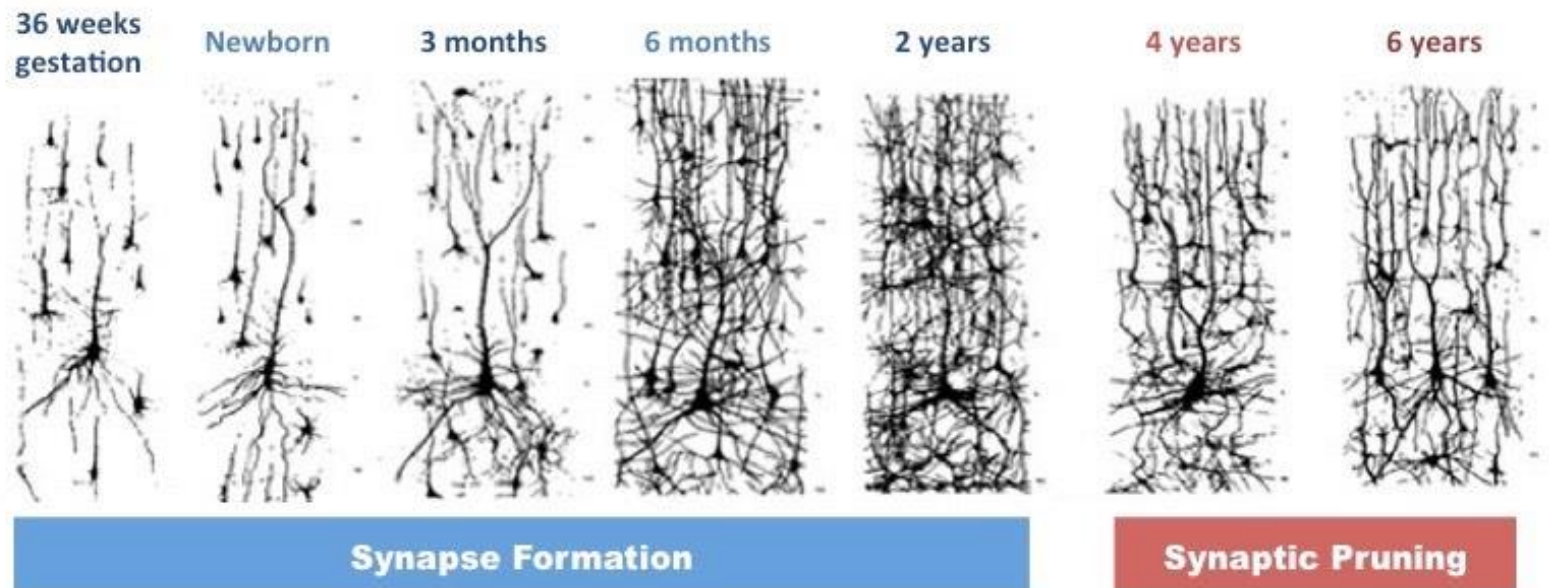
Neural networks



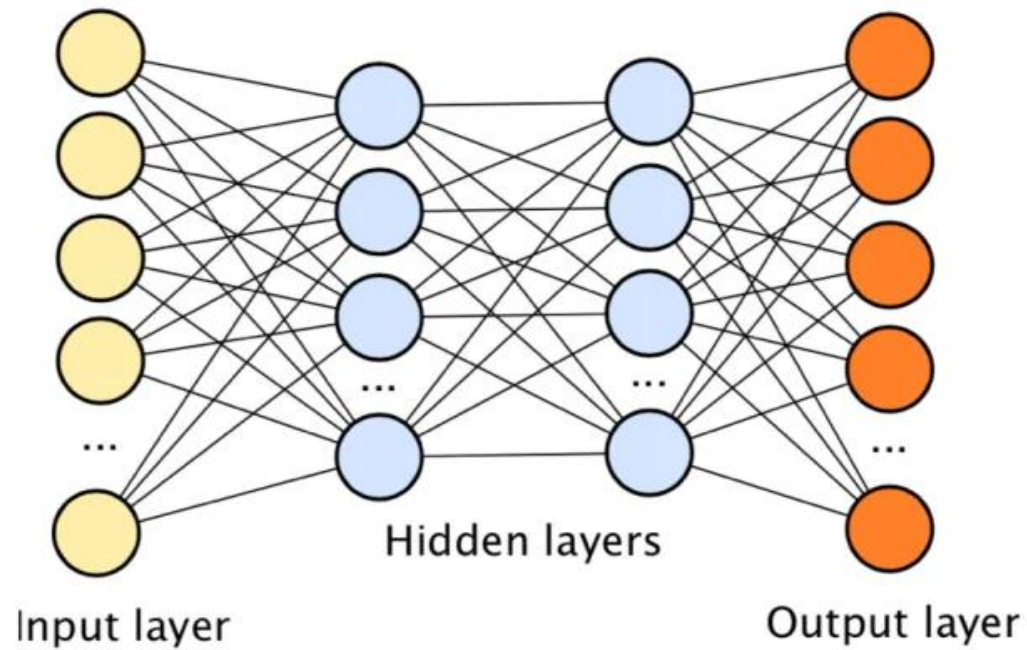
- Perceptron --- prototype



- Perceptron --- prototype



Neural networks



- Convolutional neural network
--- digital images

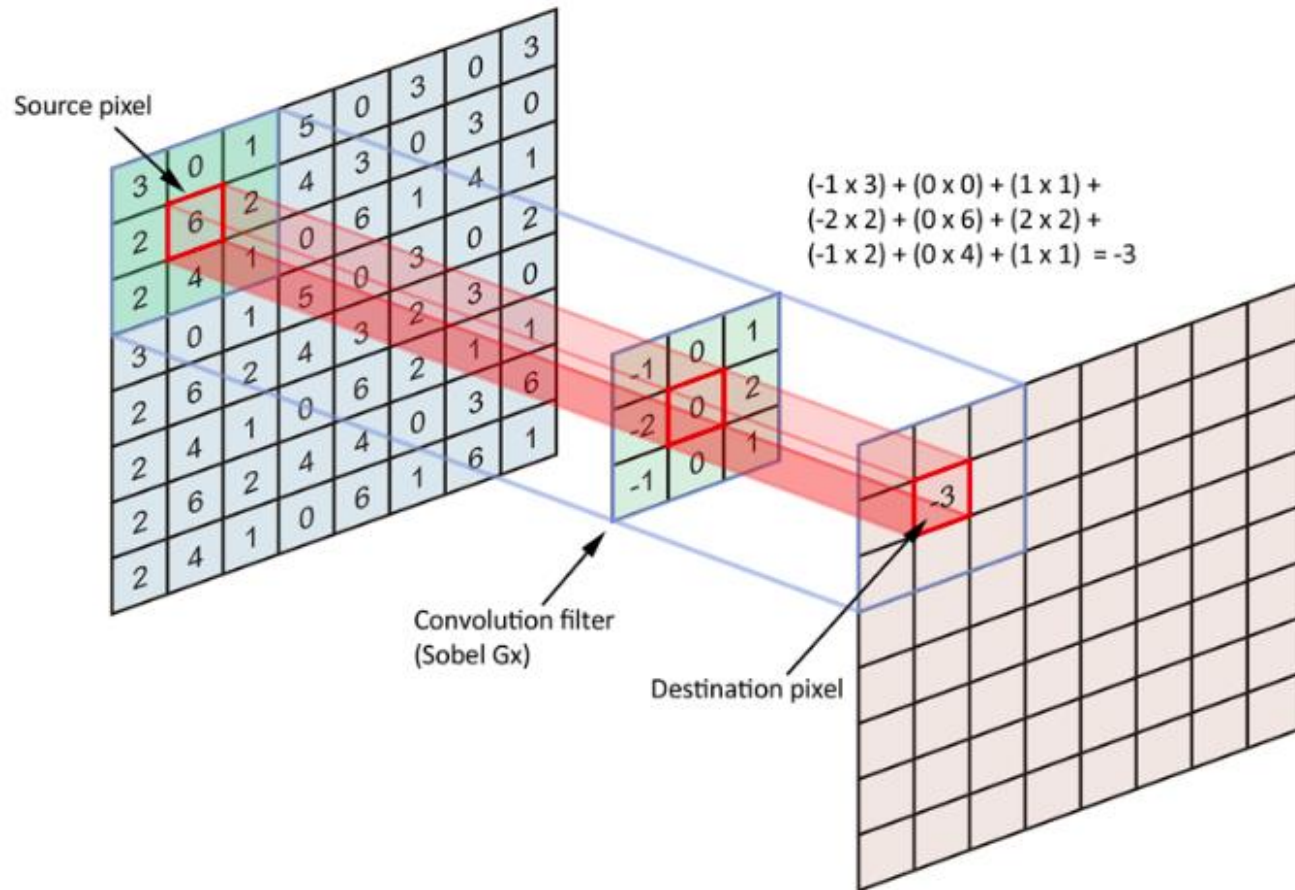


08	02	22	97	38	15	00	40	00	75	04	05	07	78	52	12	50	77	91	28
49	49	99	40	17	81	18	57	60	87	17	40	98	43	69	45	06	56	62	00
81	49	31	73	55	79	14	29	93	71	40	67	58	88	30	03	49	13	36	65
52	70	95	23	04	60	11	42	69	21	63	56	01	32	56	71	37	02	36	91
22	31	16	71	51	63	83	89	41	92	36	54	22	40	40	28	66	33	13	80
24	47	33	60	99	03	45	02	44	75	33	53	78	36	84	20	35	17	12	50
32	98	81	28	64	23	67	10	26	38	40	67	59	54	70	66	18	38	64	70
67	26	20	68	02	62	12	20	95	63	94	39	63	08	40	91	66	49	94	21
24	55	58	05	66	73	99	26	97	17	78	78	96	83	14	88	34	89	63	72
21	36	23	09	75	00	76	44	20	45	35	14	00	61	33	97	34	31	33	95
78	17	53	28	22	75	31	67	15	94	03	80	04	62	16	14	09	53	56	92
16	39	05	42	96	35	31	47	55	58	88	24	00	17	54	24	36	29	85	57
86	56	00	48	35	71	89	07	05	44	44	37	44	60	21	58	51	54	17	58
19	80	81	68	05	94	47	69	28	73	92	13	86	52	17	77	04	89	55	40
04	52	08	83	97	35	99	16	07	97	57	32	16	26	26	79	33	27	98	66
85	36	68	87	57	62	20	72	03	46	33	67	46	55	12	32	63	93	53	69
04	42	16	73	38	85	39	11	24	94	72	18	08	46	29	32	40	62	76	36
20	69	36	41	72	30	23	88	34	82	99	69	82	67	59	85	74	04	36	16
20	73	35	29	78	31	90	01	74	31	49	71	48	55	81	16	23	57	05	54
01	70	84	71	83	51	54	69	16	92	33	48	61	43	52	01	89	29	67	48

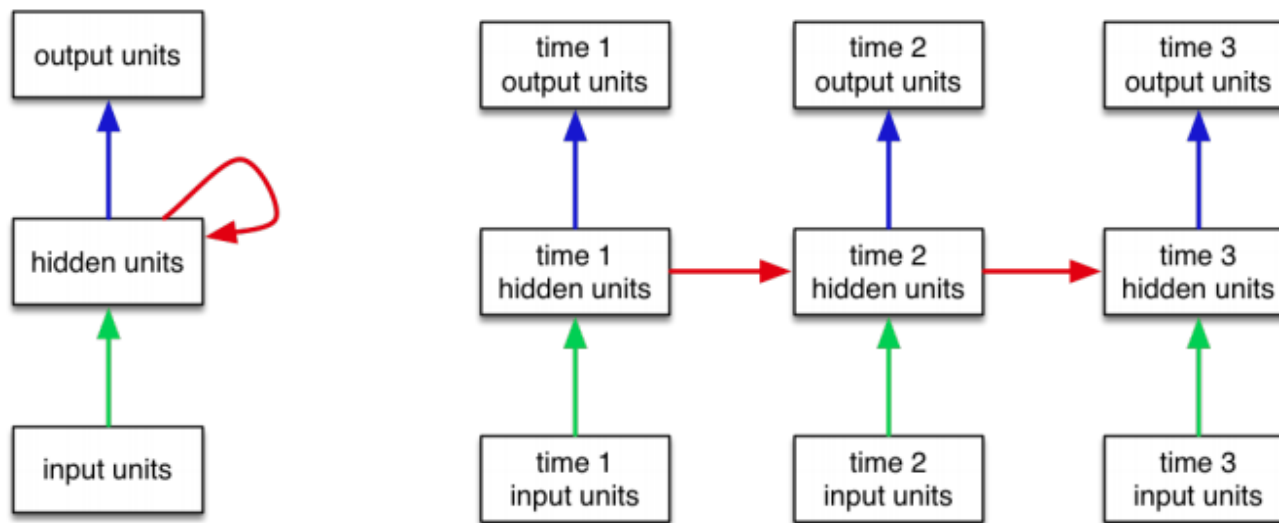
What the computer sees

image classification → 82% cat
15% dog
2% hat
1% mug

- CNN

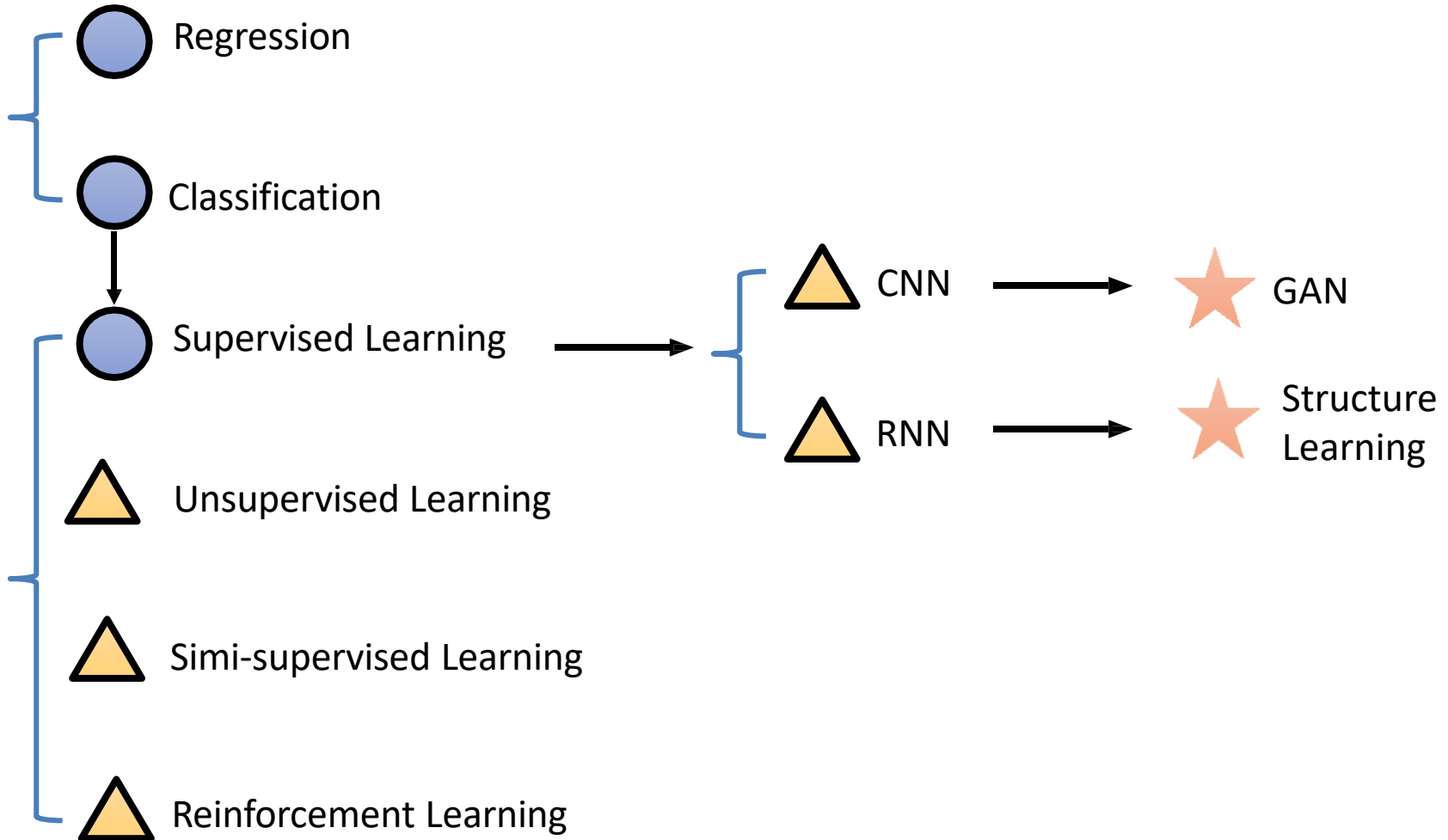


Recurrent neural network



Machine Learning Roadmap

● Easy ▲ Normal ★ Challenging



- Generative adversarial network

Generator



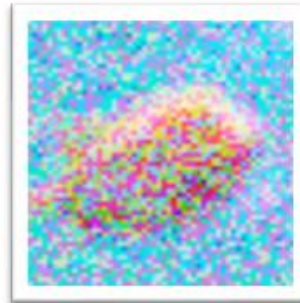
Look at the
fish I drew!



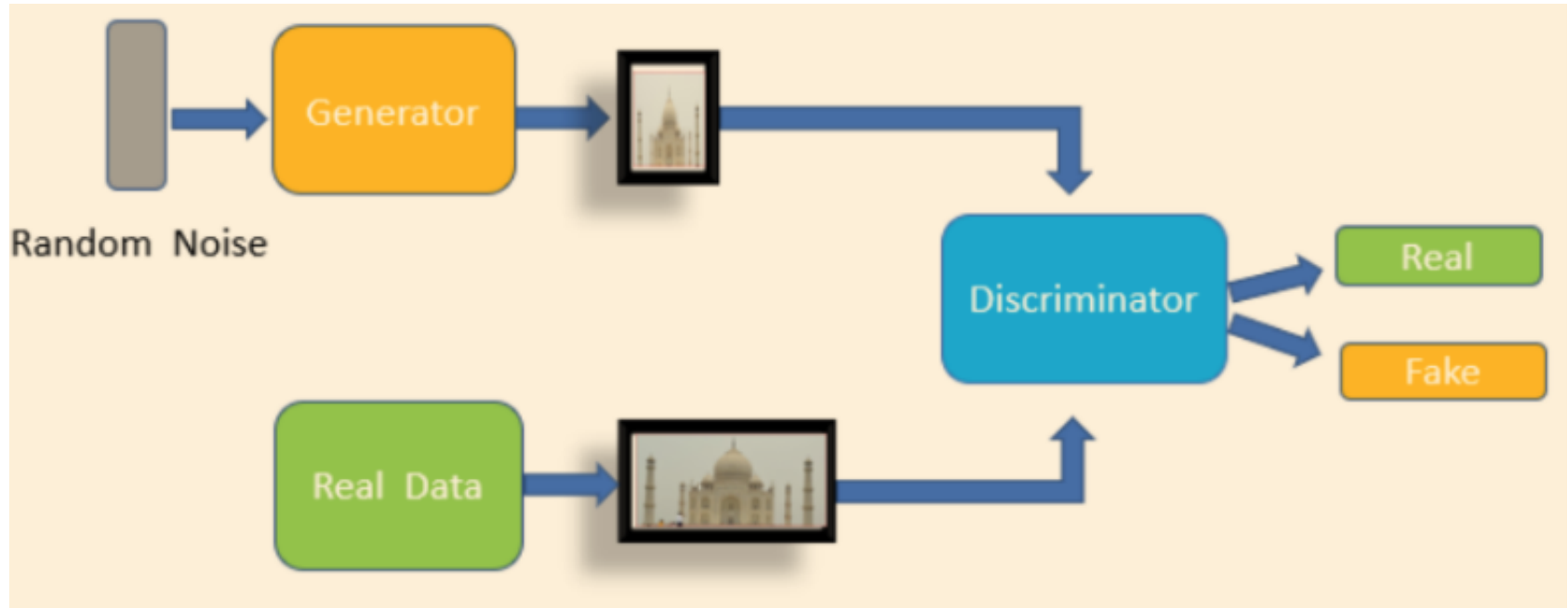
Discriminator



Arg... That looks so fake, G.
Try like this...



- Generative adversarial network



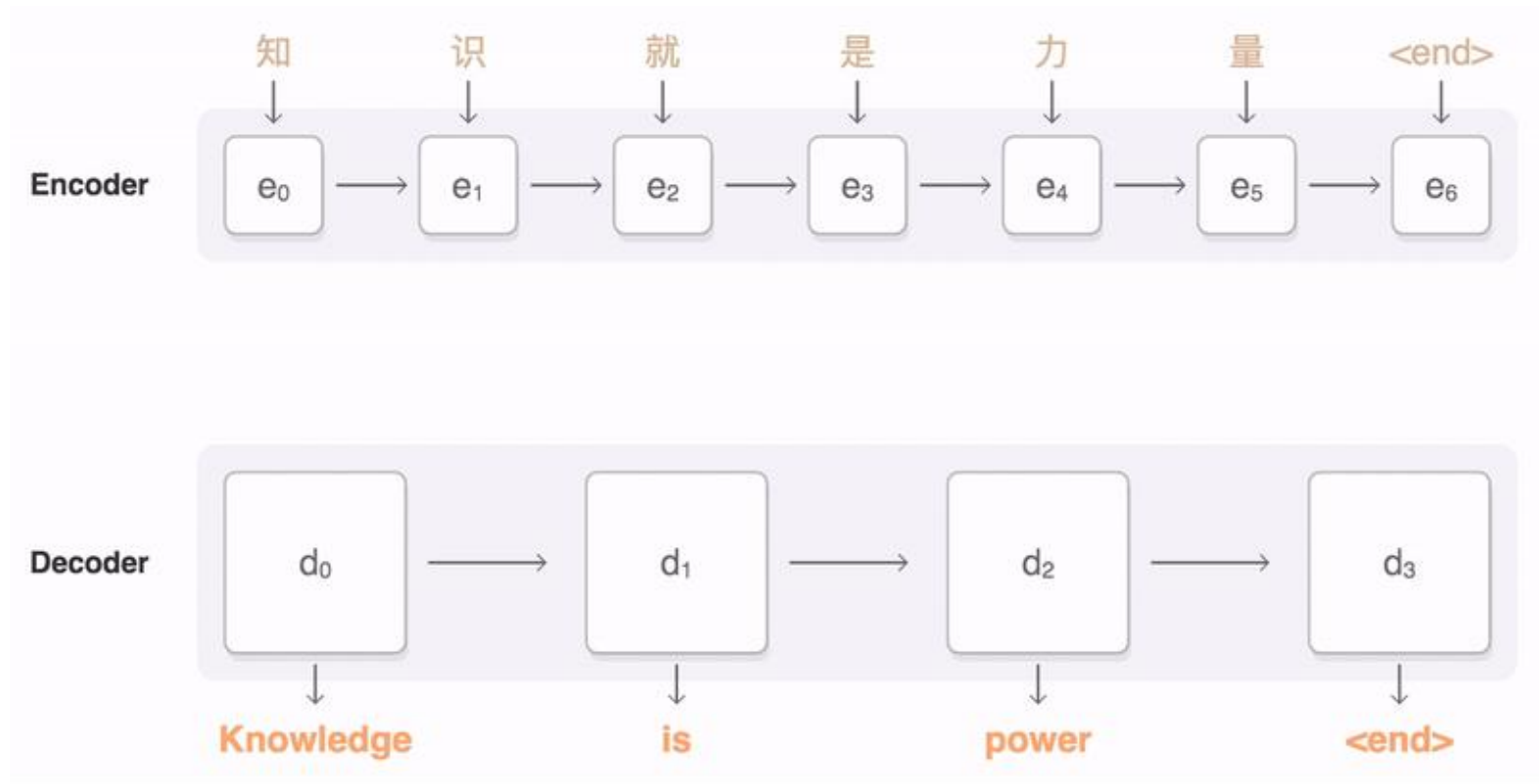
- Generative adversarial network



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

Structure Learning

- Seq to seq learning



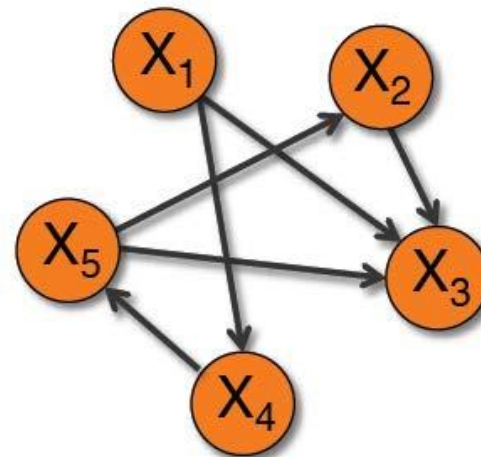
- Structure Learning

Input: Data, D

X_1	X_2	X_3	X_4	X_5
0	2	1	0	2
1	1	0	0	0
		\vdots	\vdots	
1	0	1	1	2

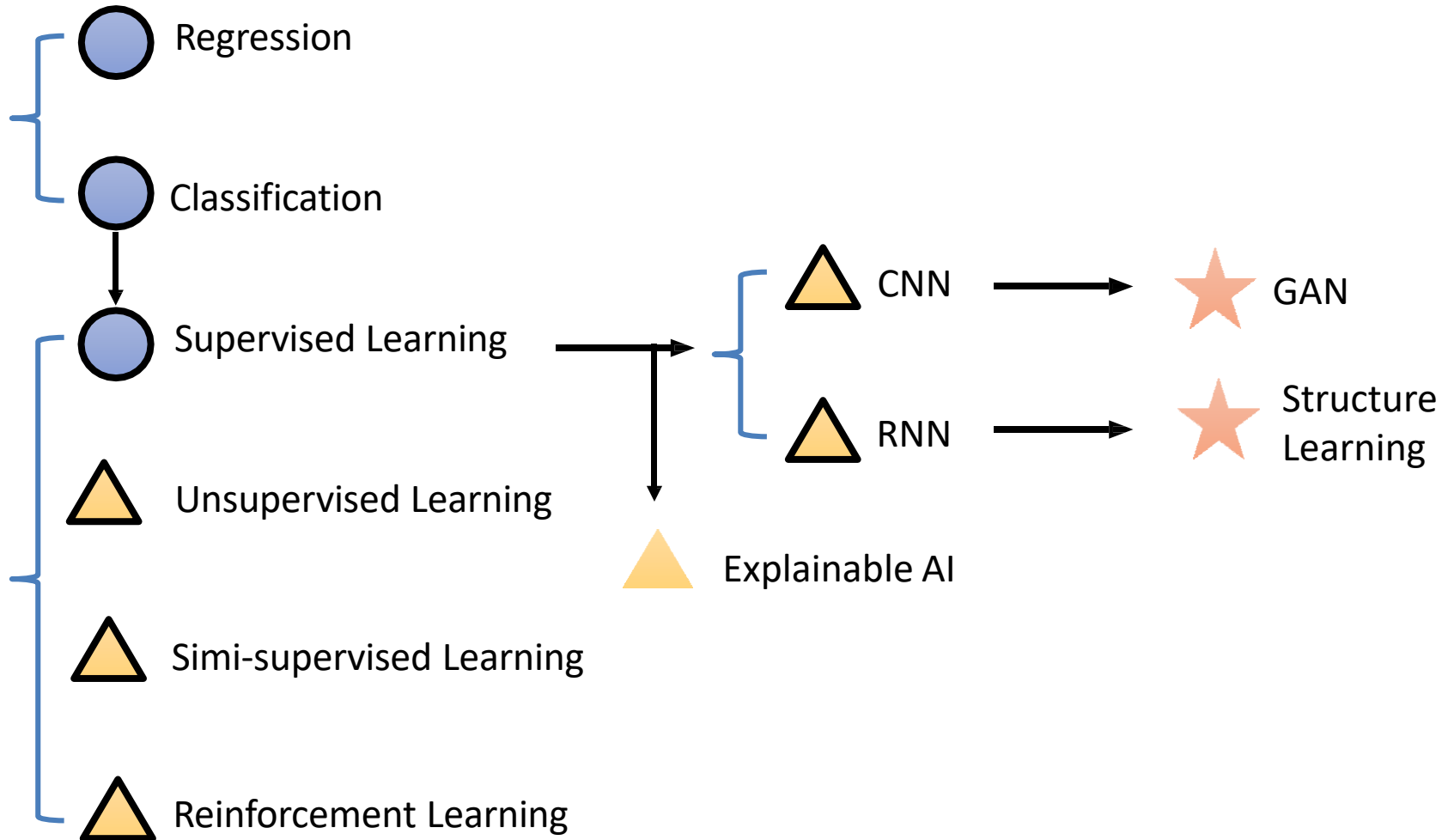


Output: Graph, G



Machine Learning Roadmap

● Easy ▲ Normal ★ Challenging

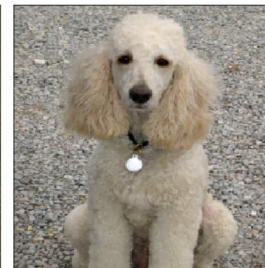
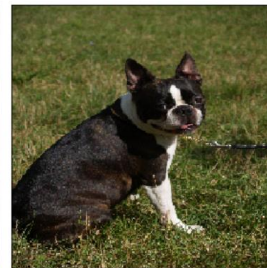
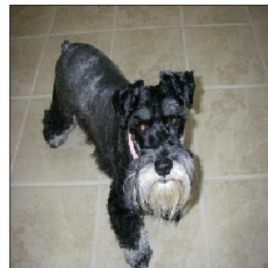
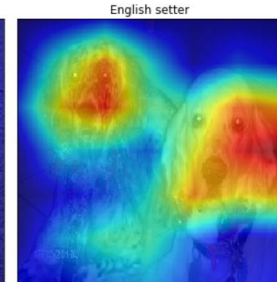
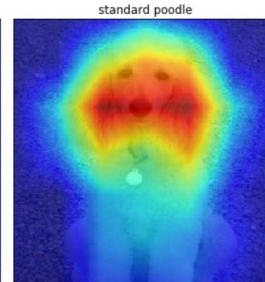
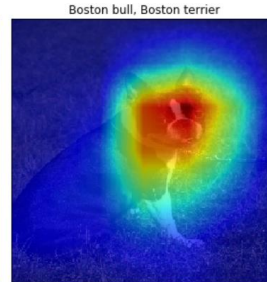
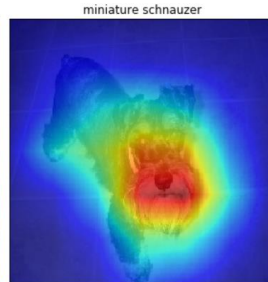
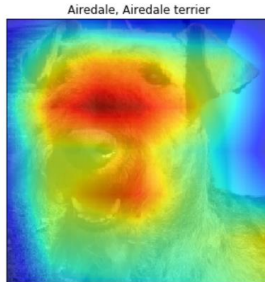


Machine Explainable AI



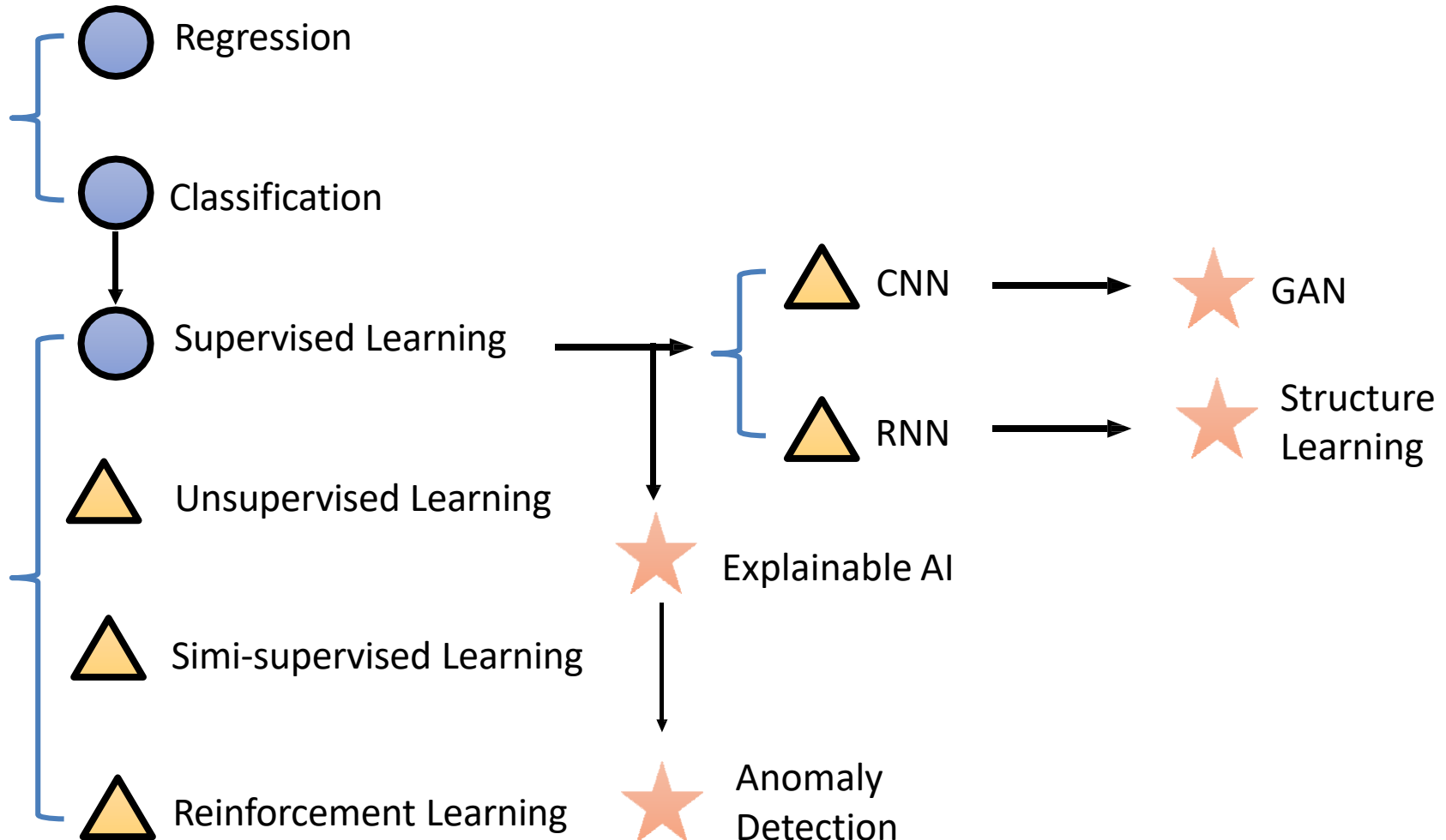
This is a "dog"

Because ...



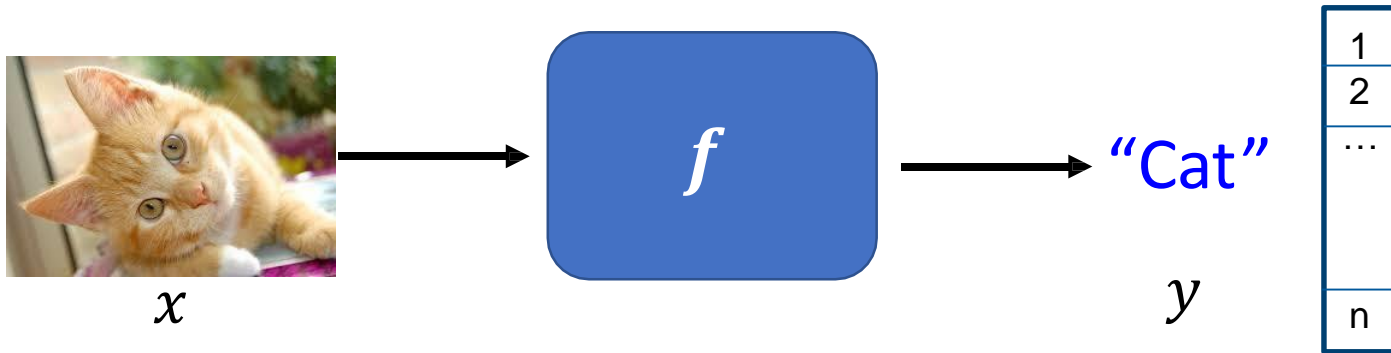
Machine Learning Roadmap

● Easy ▲ Normal ★ Challenging

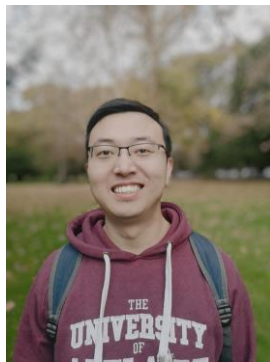


Anomaly Detection

- Anomaly Detection



- Anomaly Detection



x



???

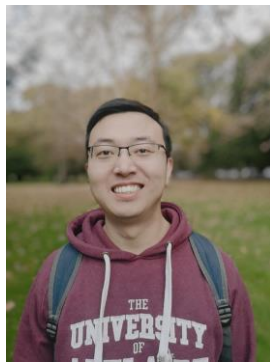


“Cat”

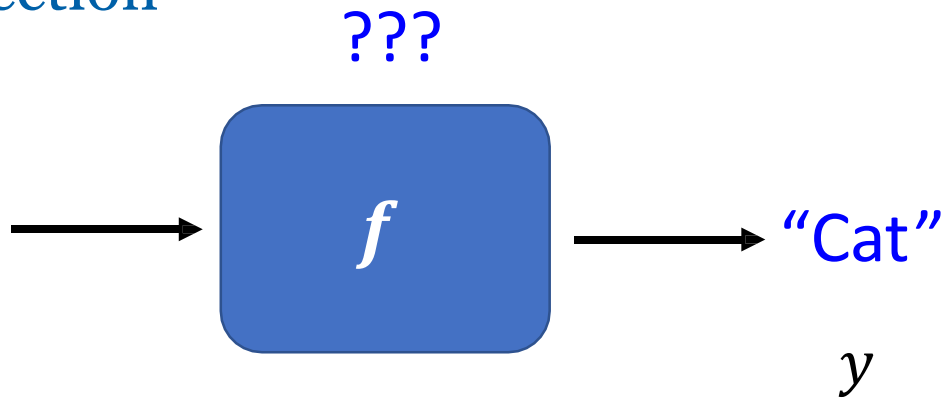
y

1
2
...
n

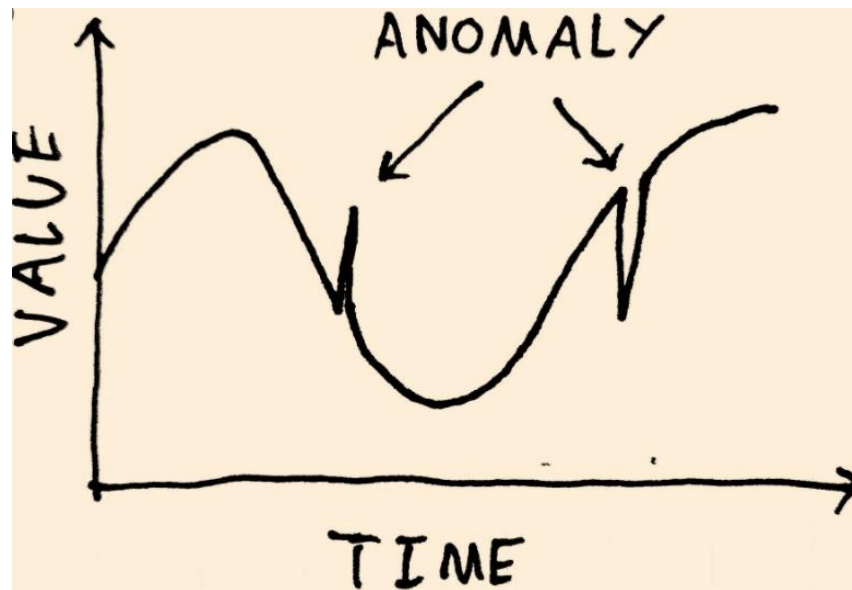
- Anomaly Detection



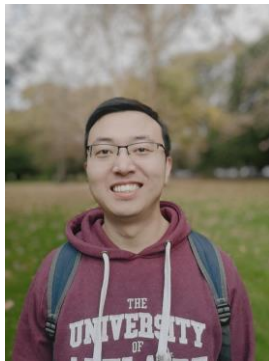
x



1
2
...
n



- Anomaly Detection



x

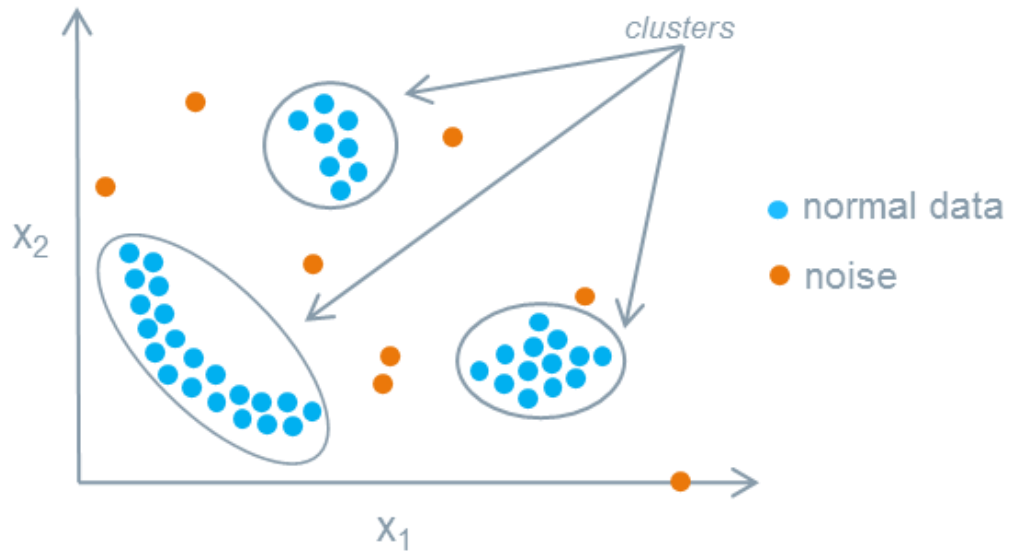
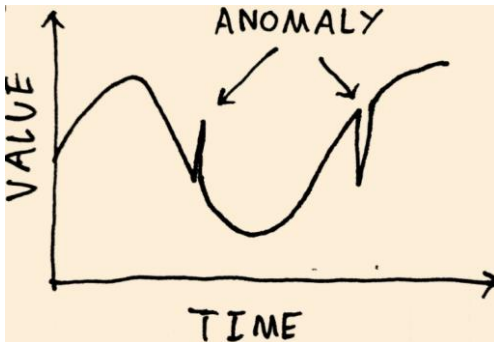
???



“Cat”

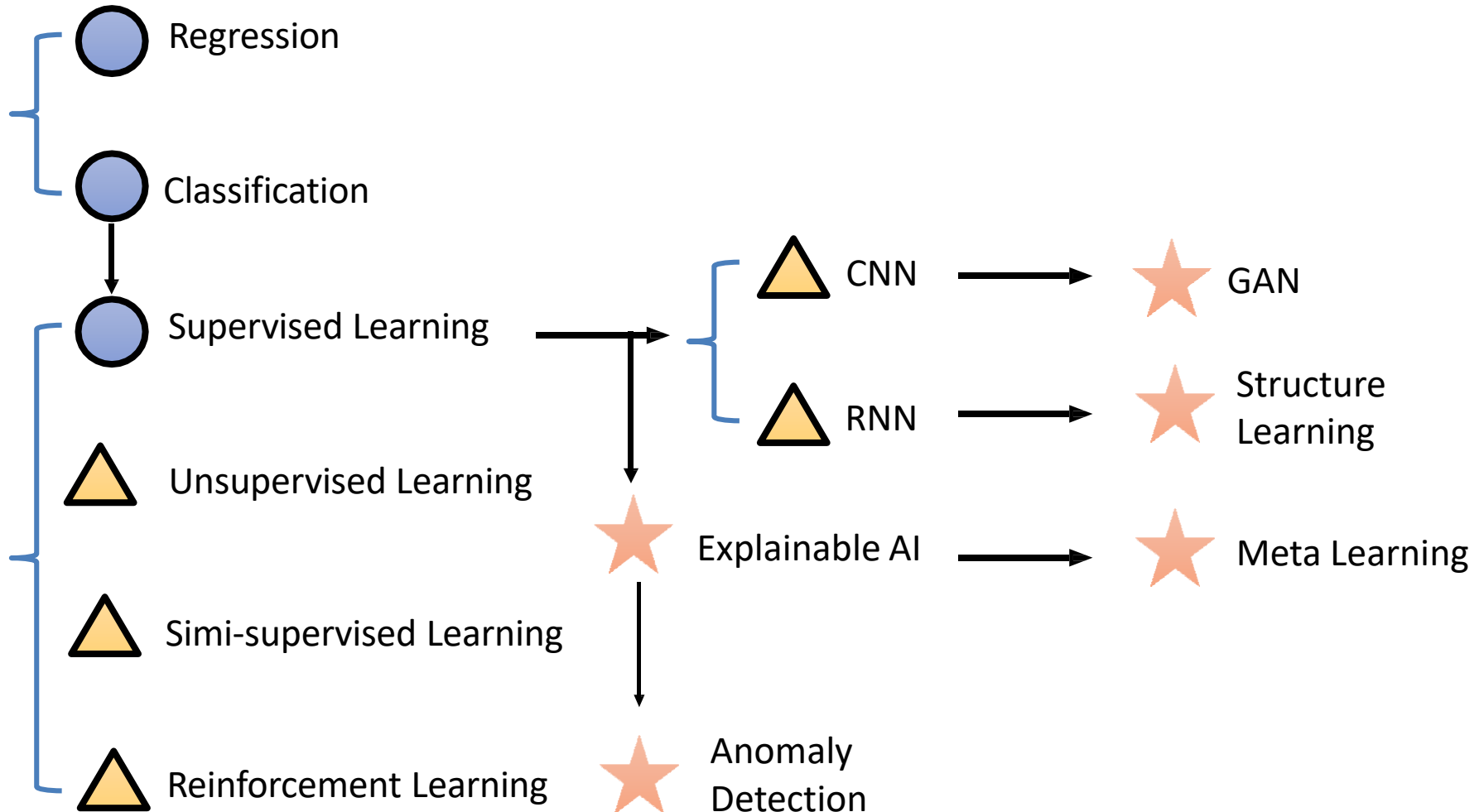
y

1
2
...
n



Machine Learning Roadmap

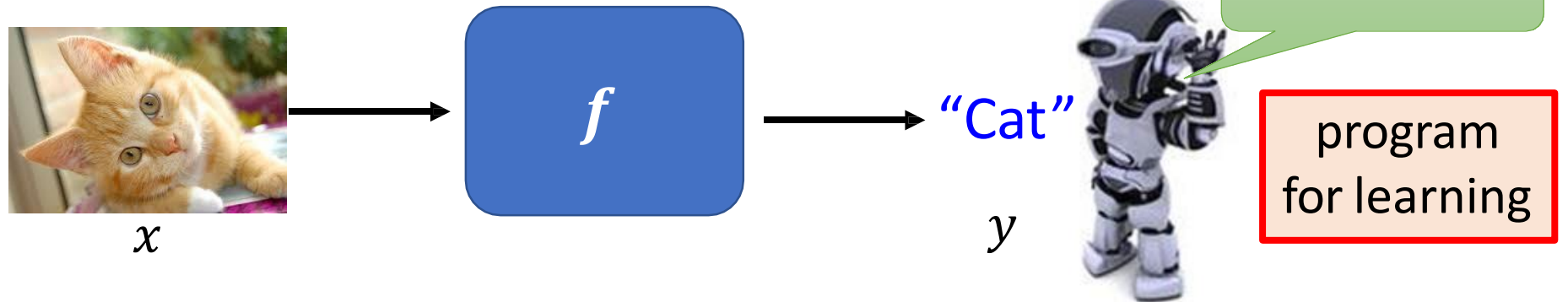
● Easy ▲ Normal ★ Challenging



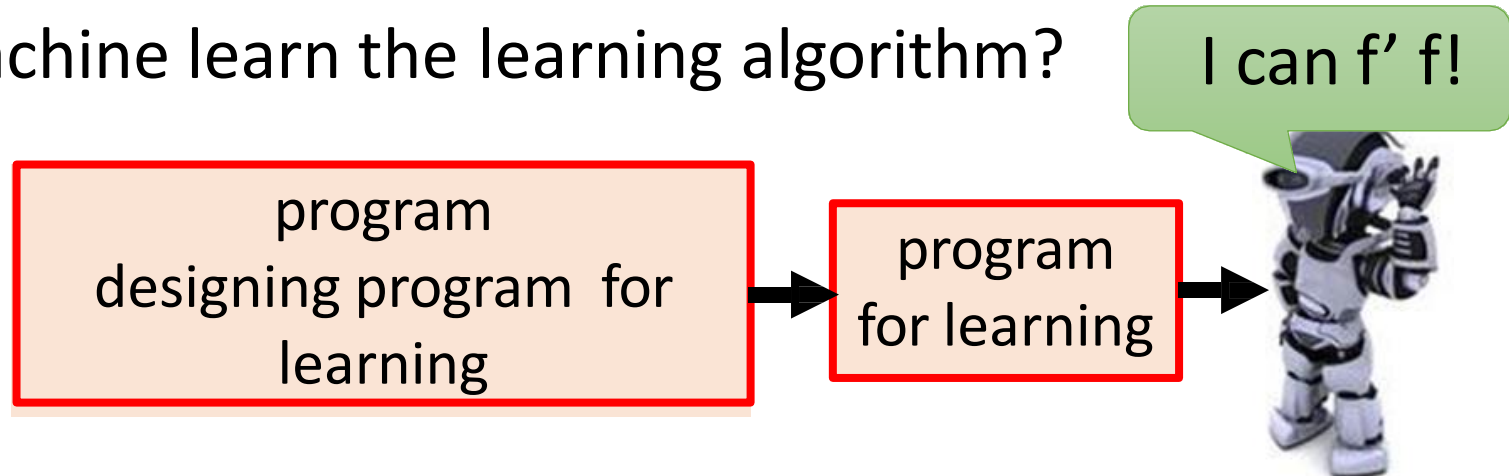
Meta Learning

Meta Learning = Learn to learn

- Now we design the learning algorithm

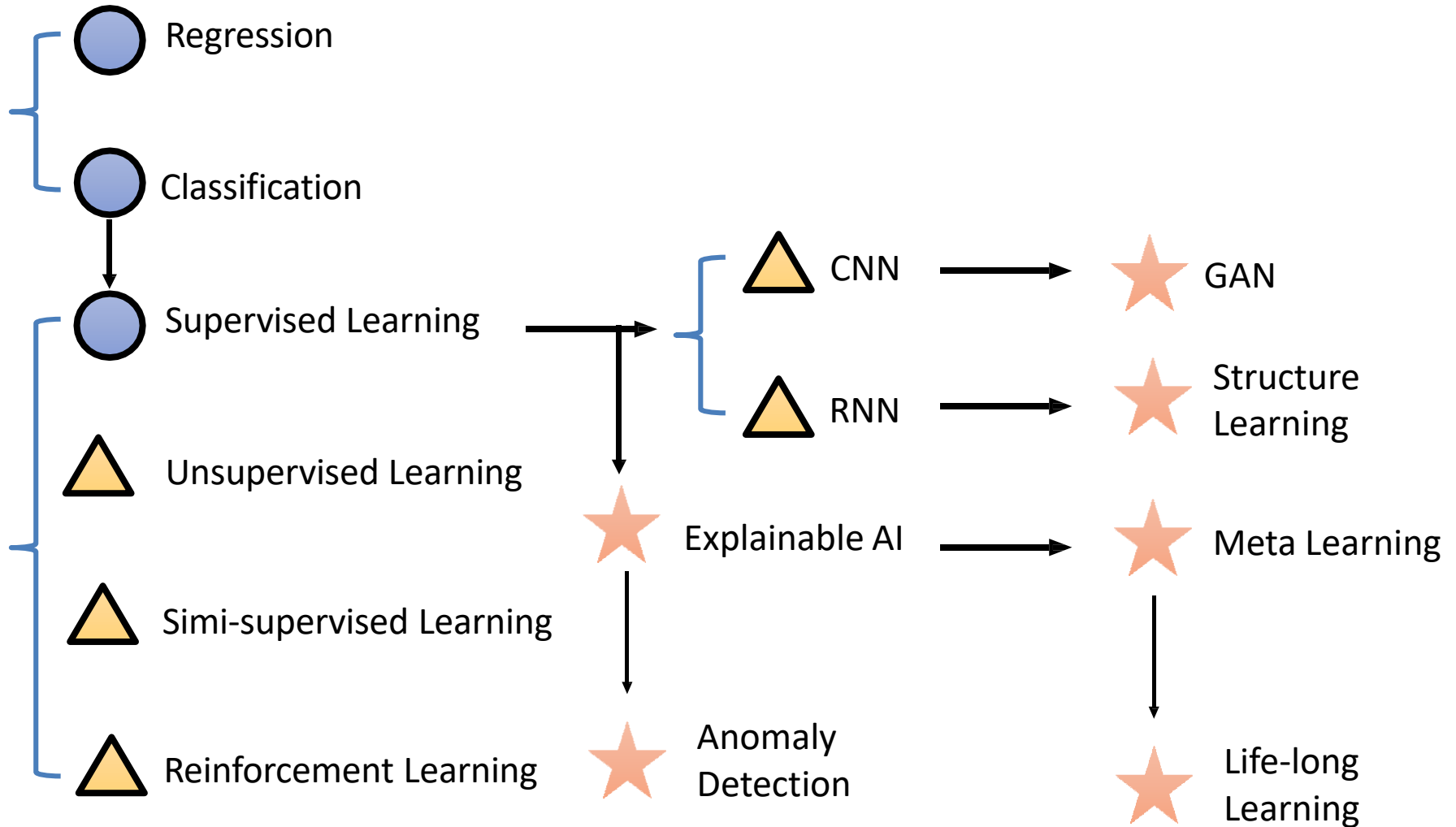


- Can machine learn the learning algorithm?



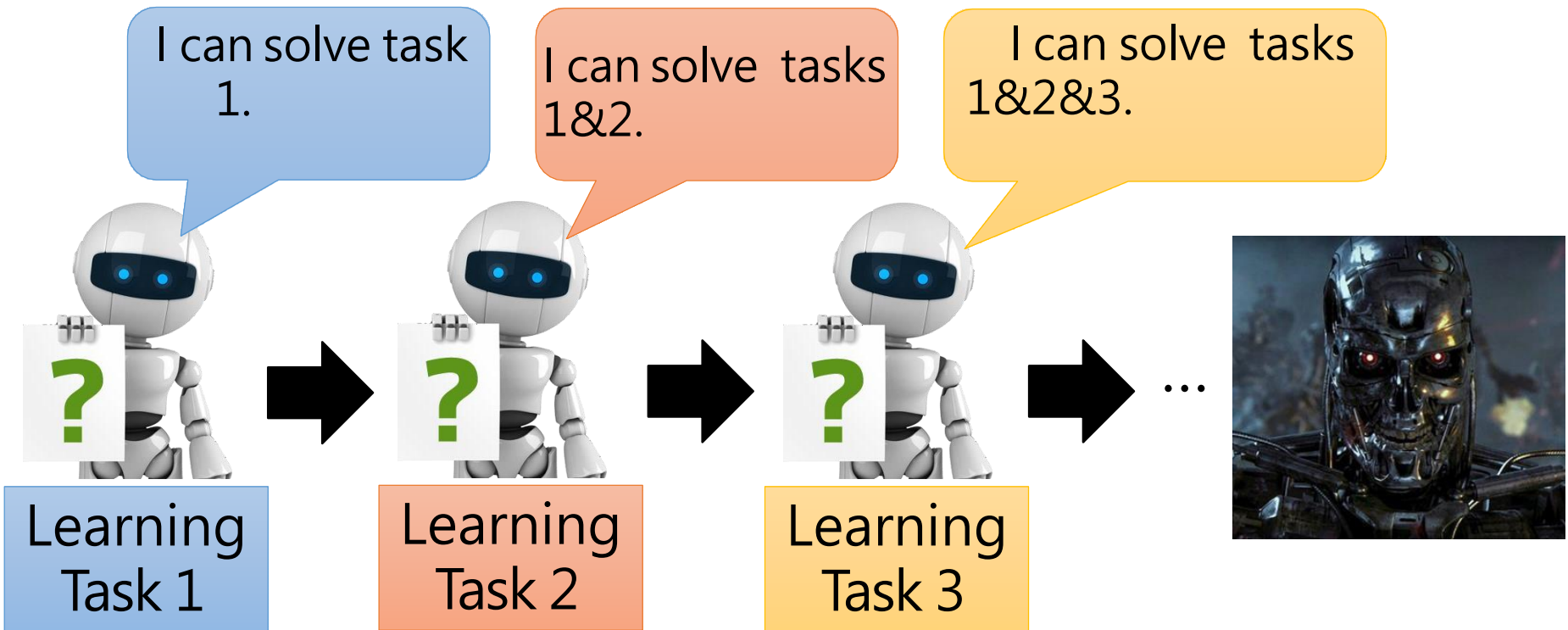
Machine Learning Roadmap

● Easy ▲ Normal ★ Challenging



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