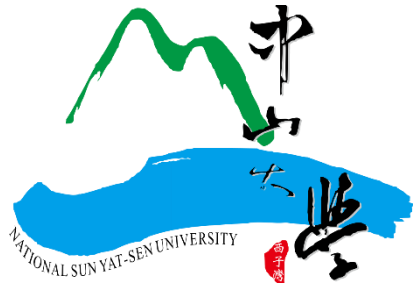
進階機器學習

國立中山大學
資訊工程系
張雲南



Course introduction

Course info

- Instructor:
  - 張雲南 Yun-Nan Chang
    - Room EC5006, TEL: (07) 525-2000-ext 4332
    - Email: ynchang@cse.nsysu.edu.tw
- TA:
  - 游辰生 m103040086@student.nsysu.edu.tw @ 電資EC5009B
  - 陳啟嘉 m103040071@student.nsysu.edu.tw @ 電資EC5009B
- Office Hour @ 電資EC5006
  - Tue 10:00~12:00
  - Thu 10:00~11:00

Course info

- Pre-requisites:
  - Python programming
  - Basic machine learning concept

- Grading Policy:

Homework	35~40%
Final Project	15~25%
Term Exam	30%
Others	5~10%

- Course Homepage:
  - 中山網路大學 http://cu.nsysu.edu.tw

- Notes:
  - At most 2人/group

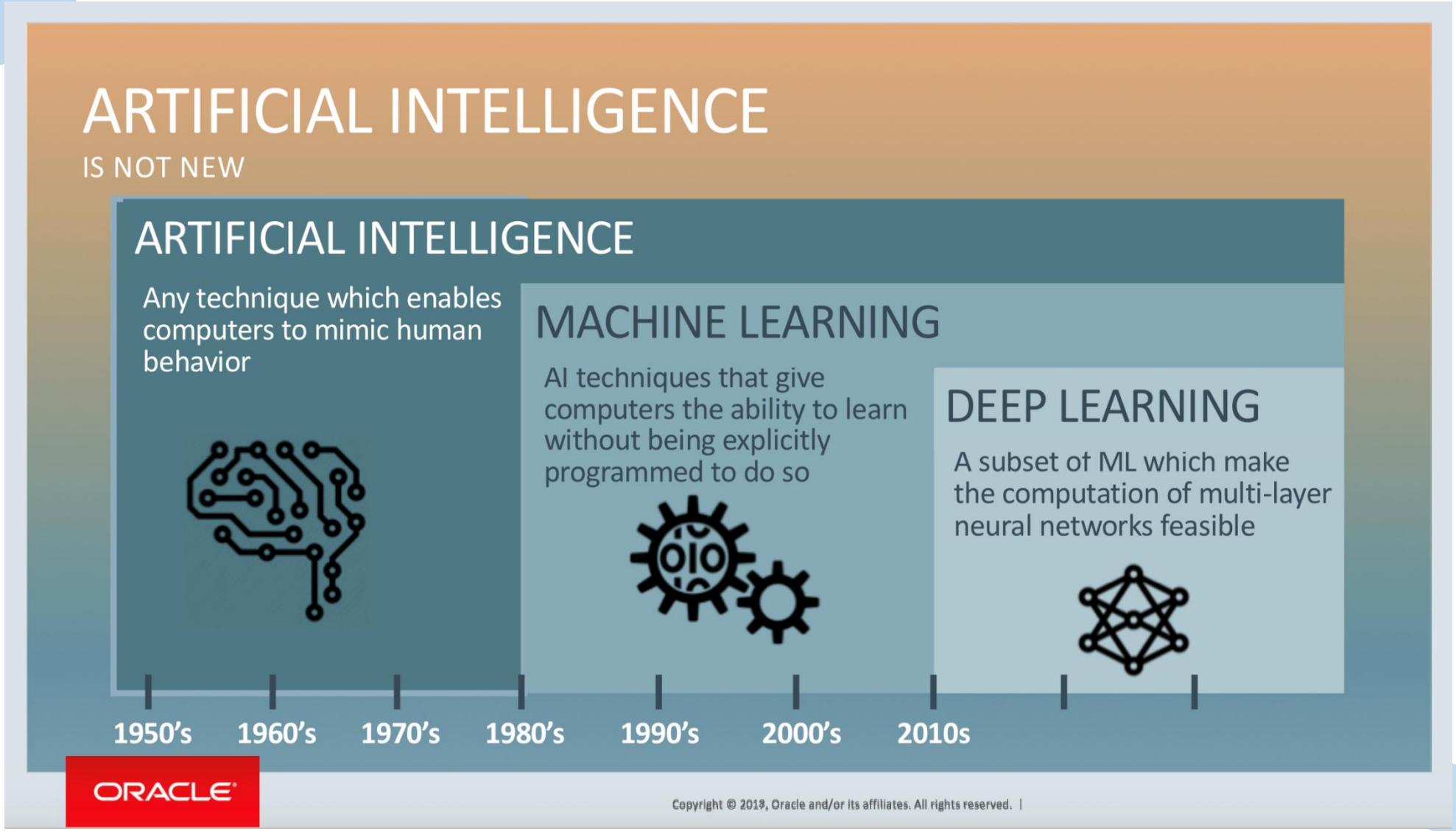
Teaching materials

- Reference:
  - Ian Goodfellow and Yoshua Bengio, 2016, Deep Learning, The MIT Press, Cambridge, Massachusetts, London, England
  - **Online videos**
    - 台大NTU 李宏毅
    - 台大NTU 林軒田
- Handout Materials (Slides)
- Python package - *http://scikit-learn.org/*
  - On-line e-book
- Data set - *http://www.kaggle.com*

Course content

- Neural network & Backpropagation
- Tensorflow/Pytorch
- Convolutional Neural Network（CNN）
- Object and Pose Detection
- GAN
- Recurrent Neural Network（RNN）
- Anomaly Detection
- Semi-supervised Learning

AI vs ML vs DL



圖源: https://blogs.oracle.com/bigdata/difference-ai-machine-learning-deep-learning

Machine Learning

- ***Train*** a ***model*** by ***data*** to learn the mapping of ***features (X)*** to the ***results (Y)***.

$$f: X \rightarrow Y$$

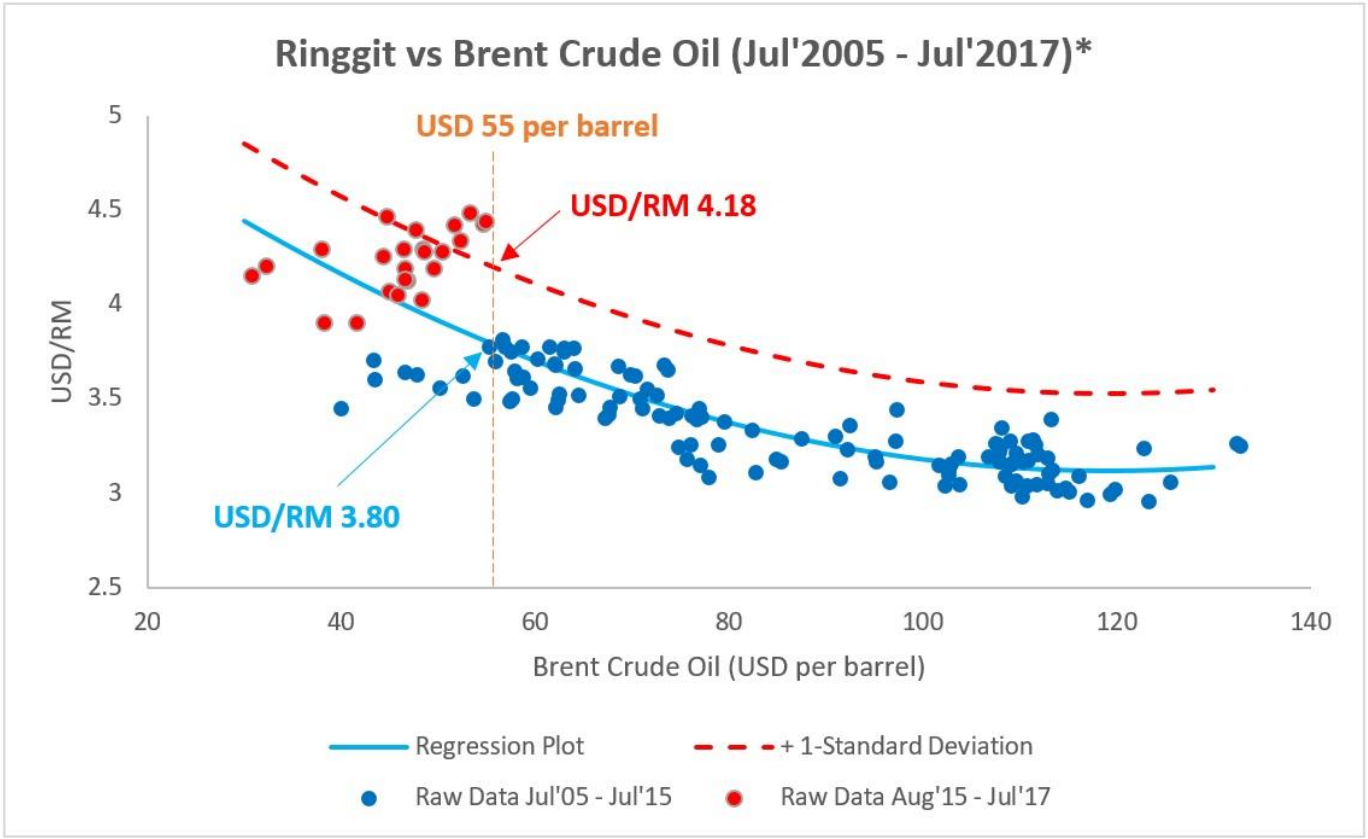
  - The ***model*** is used to realize the mapping function, and will be implemented by the software.
  - Depending on the relationship between ***X*** and ***Y***, different types of ***models*** may be chosen.
    - f: 身高 → 體重 *=> can choose linear regression model*
    - f: 客戶資料 → 信用核可 *=> decision tree model may be better*
  - The dimension of ***X*** and ***Y*** may be low or high, but they all have to be encoded by numbers.

ML Applications

Regression

- $y = f(x_1, x_2, \ldots, x_n)$
- Target y is a float.
- For example:
  - Oil price forecast
  - House price estimation

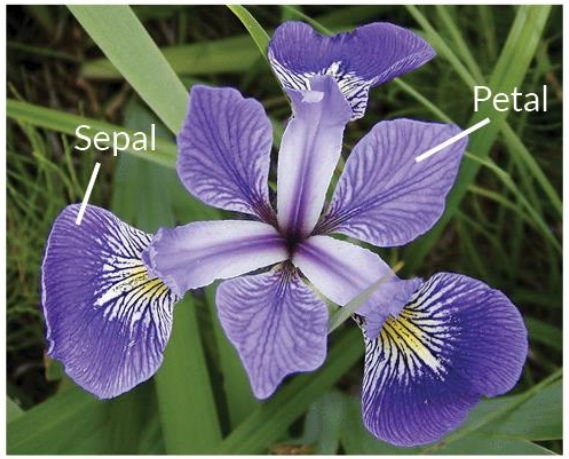
- **Use *data* to learn *hypothesis functions* based on different machine-learning *models*.**



** The data range was chosen from July 2005 onwards because the Ringgit was unpegged after July 2005.*

Classification

- $y = f(x_1, x_2, \ldots, x_n)$
- Target y is a binary vector or discrete number, which corresponds to some categories.
- For example:
  - Iris flowers classification
  - Yes/NO, Live/Dead, Positive/negative,…..



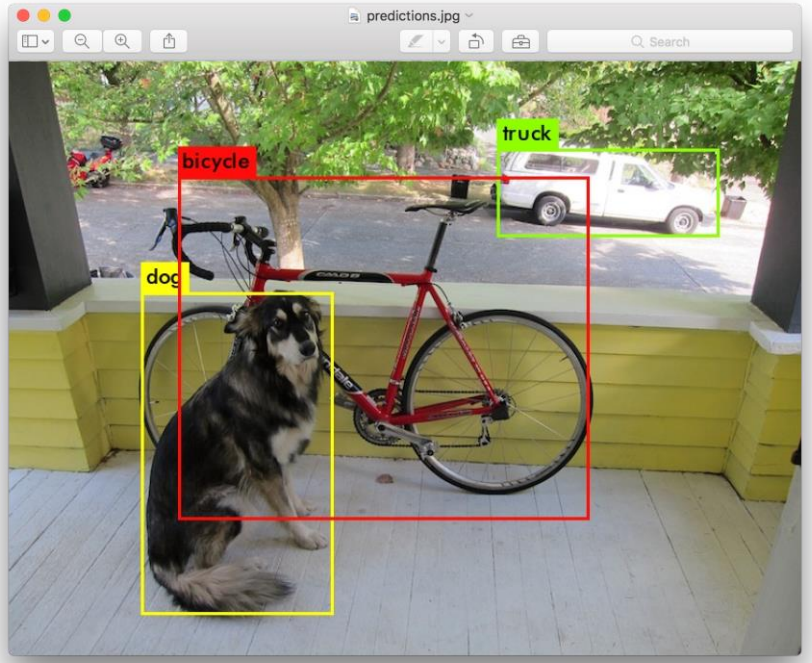
Iris Versicolor

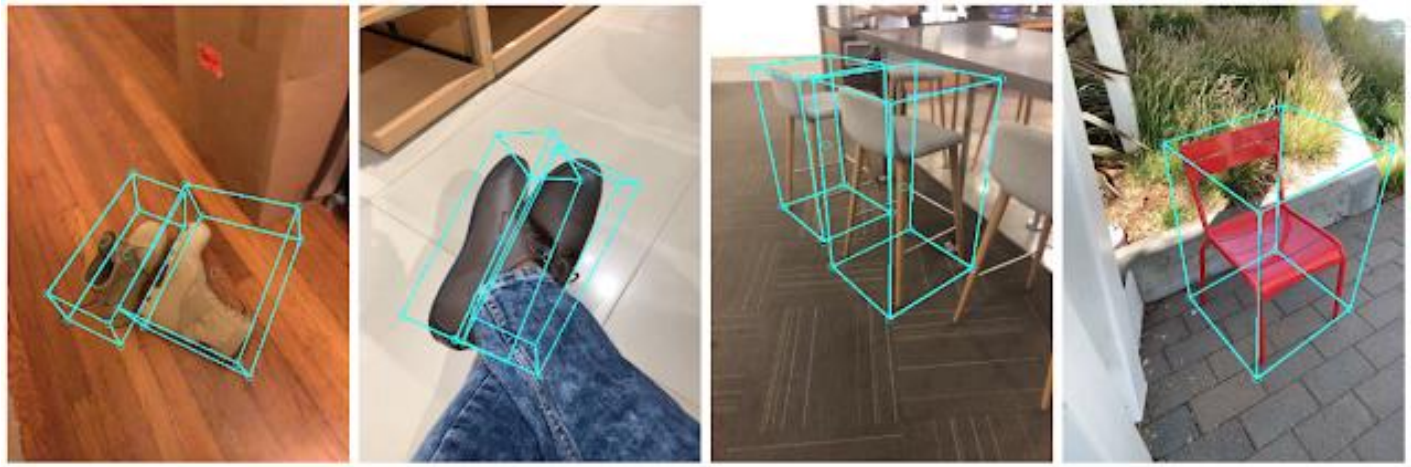
Iris Setosa

Iris Virginica

Pattern recognition

- $y = f(x_1, x_2, \ldots, x_n)$
- Target y is a list of triplets ***(class, w, h)***
- For example:
  - Object Detection





Data generation

- $y = f(x_1, x_2, \ldots, x_n)$
  - Target y is a vector.

(1.2,0.8) → G → 

Hello → G → I'm fine

 → G → 

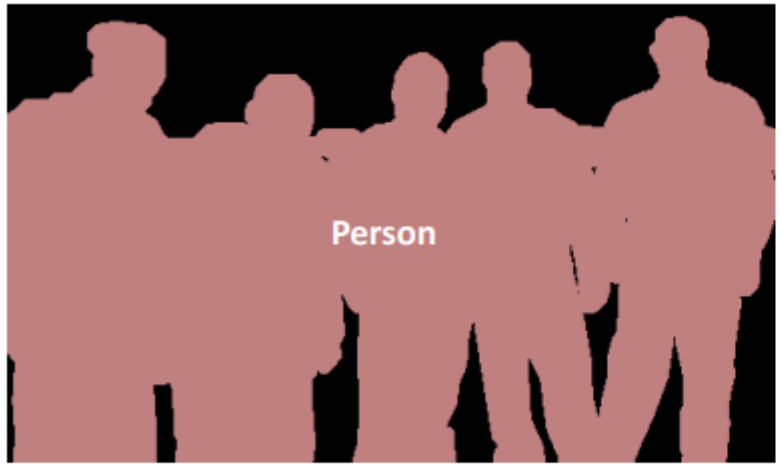
→ G → 

this bird is red with white and has a very short beak → G → 

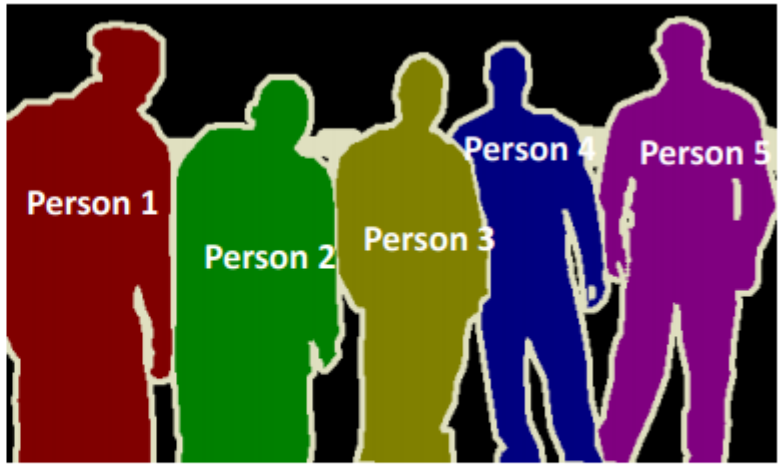
 → G → 

Segmentation

- $y = f(x_1, x_2, \ldots, x_n)$
- Target y is a high-dimensional vector consisting of discrete numbers.



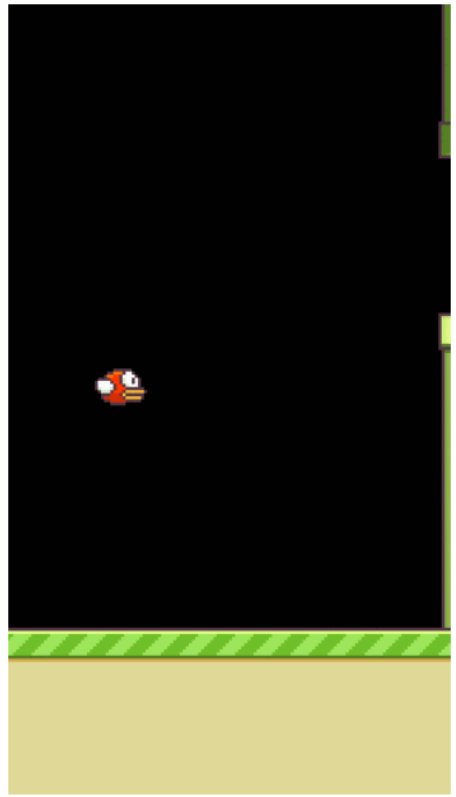
Semantic Segmentation



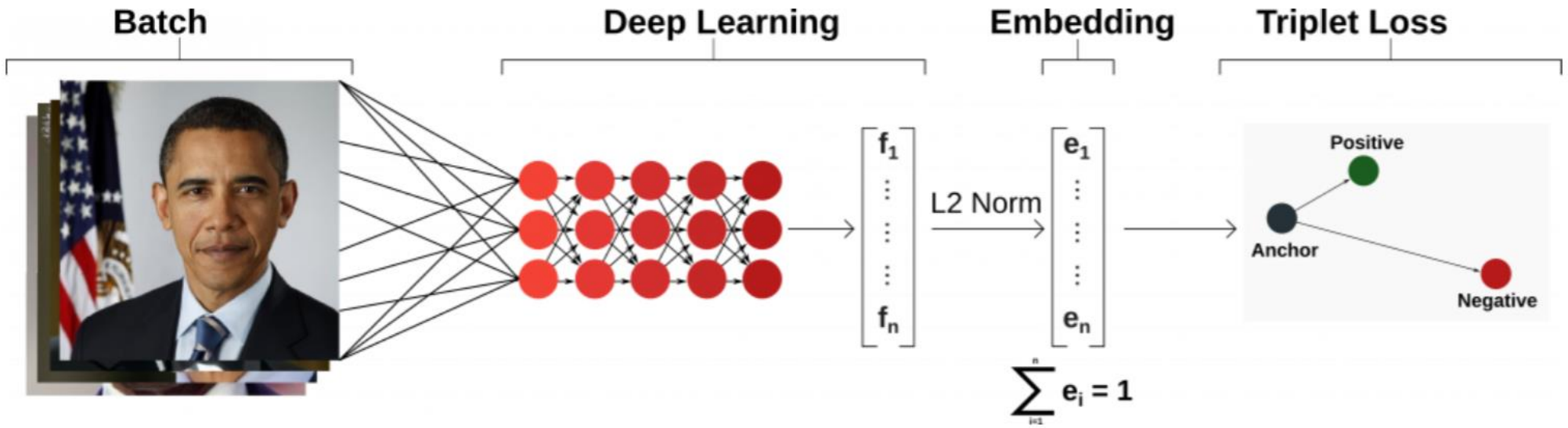
Instance Segmentation

Action choice

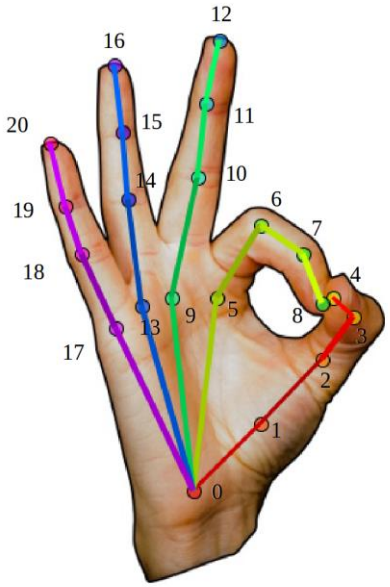
- $y = f(x_1, x_2, \ldots, x_n)$
- Target y corresponds to the actions to be taken.
- For example:
  - AlphaGo
  - Play video game

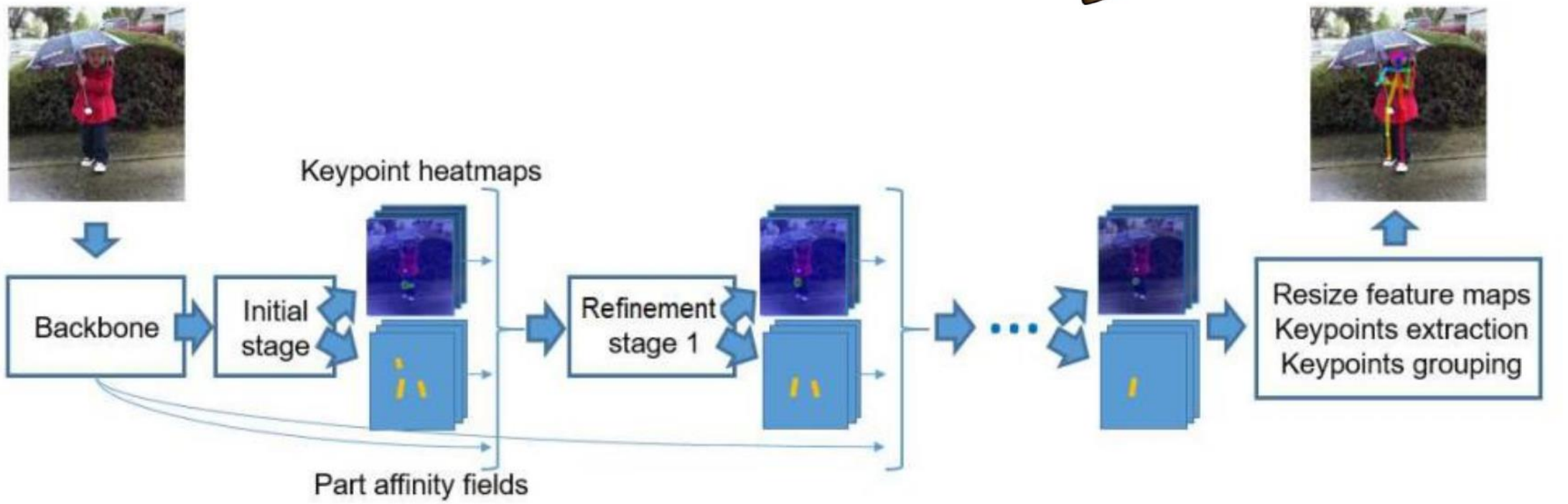


Face/Voice Identification

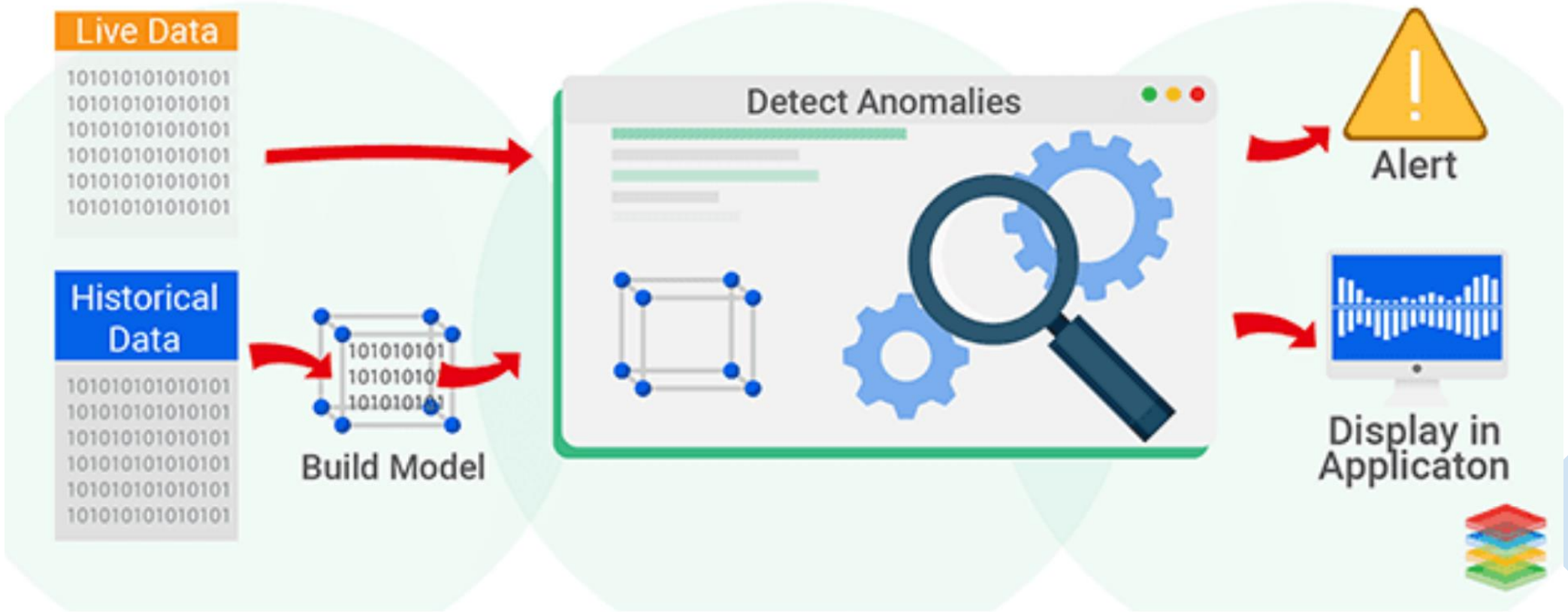


Keypoint Detection





Anomaly detection



Combinational Optimization

ML methods

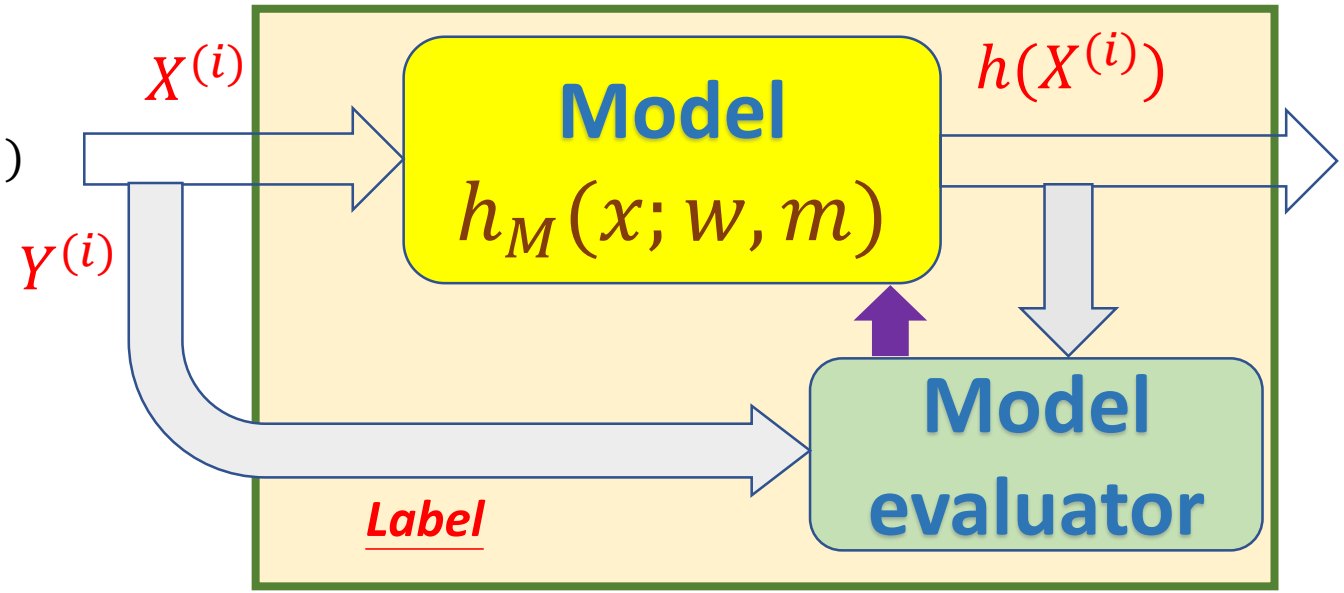
Supervised learning

Training stage

dataset

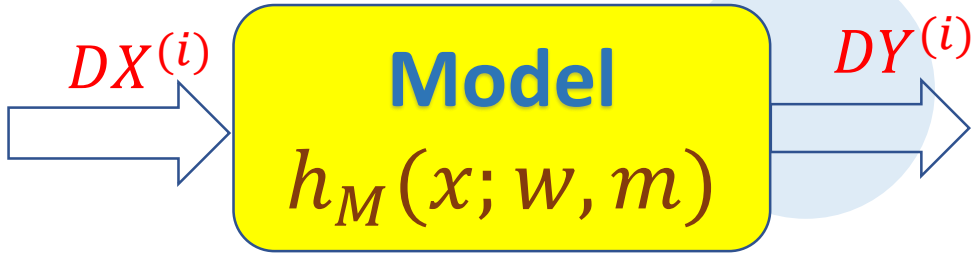
$$f: X \rightarrow Y$$

$$(X^{(N)}, Y^{(N)}) \cdots\cdots (X^{(2)}, Y^{(2)}) \ (X^{(1)}, Y^{(1)})$$



** Depend on whether the object function includes "label".*

Inference stage



Supervised learning

Training stage

X_2

Y_2 : Monkey

X_1

Y_1 : Monkey

X_0

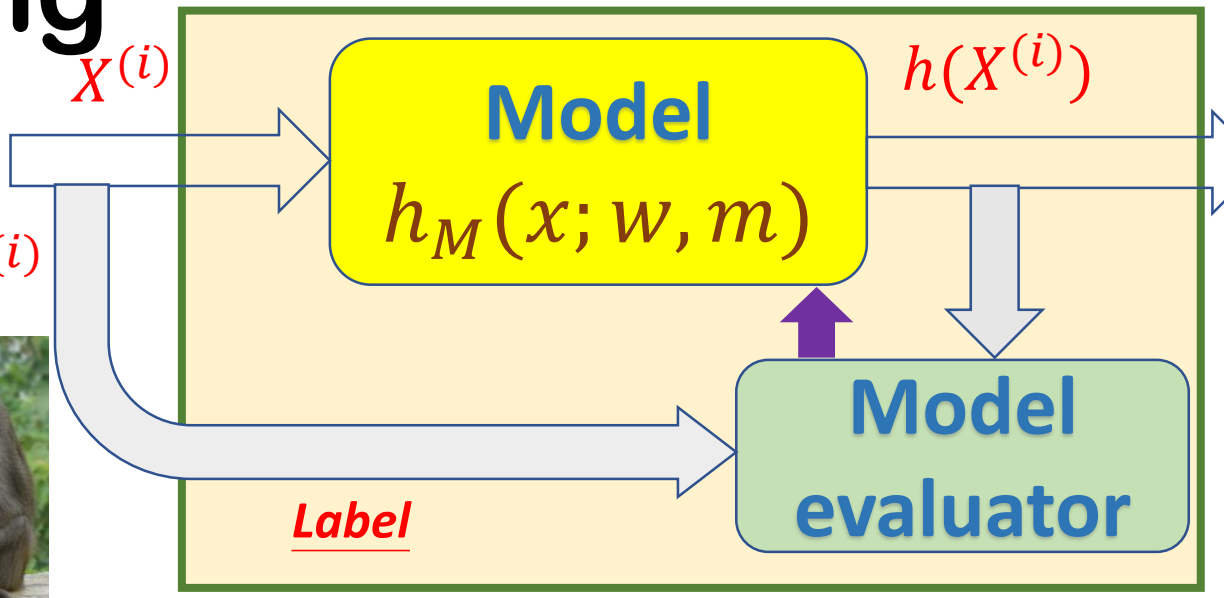
Y_0 : Monkey

X_4

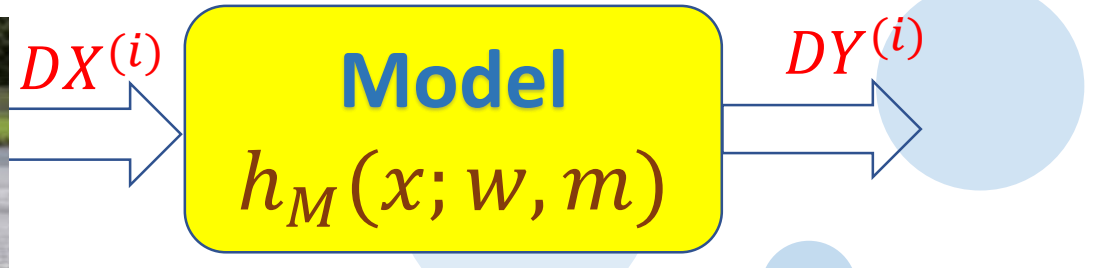
Y_4 : Dog

X_3

Y_3 : Dog

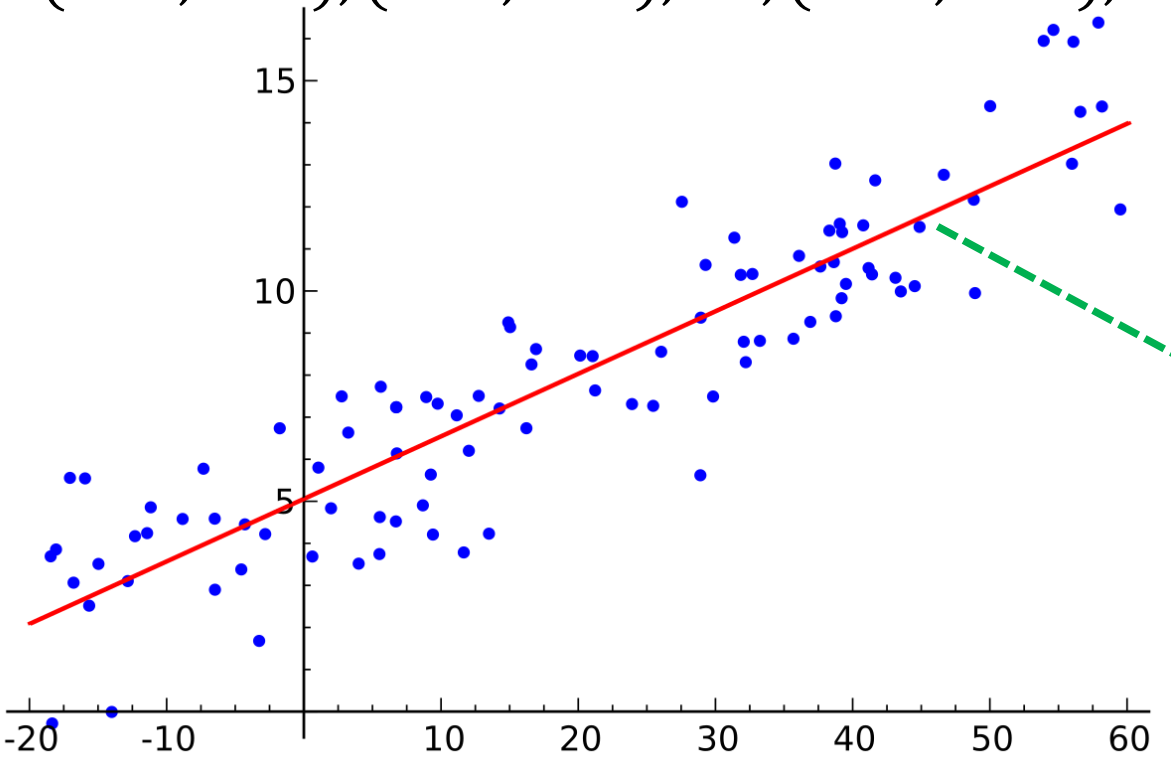


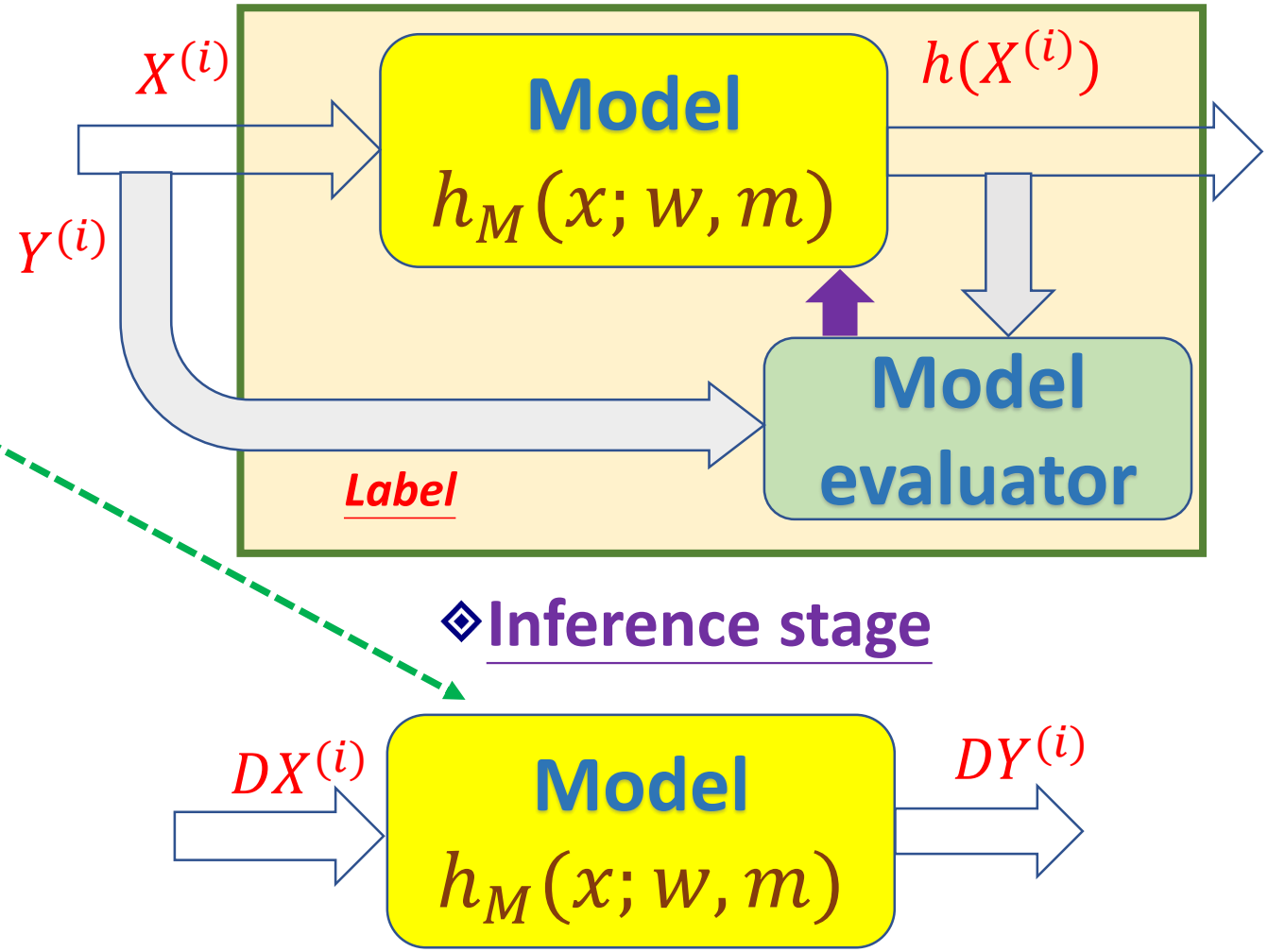
Inference stage



Supervised learning for regression

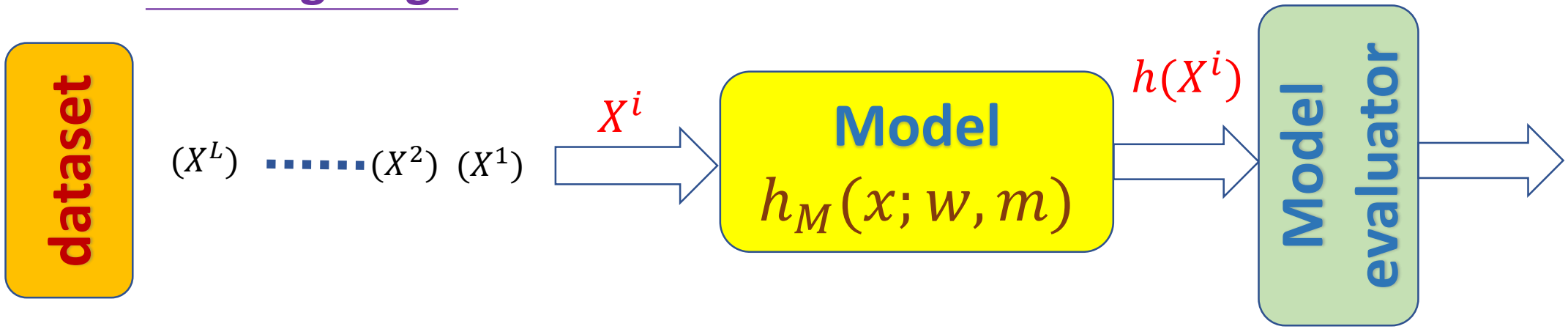
$(X^{(0)}, Y^{(0)}), (X^{(1)}, Y^{(1)}), \ldots, (X^{(N)}, Y^{(N)}),$



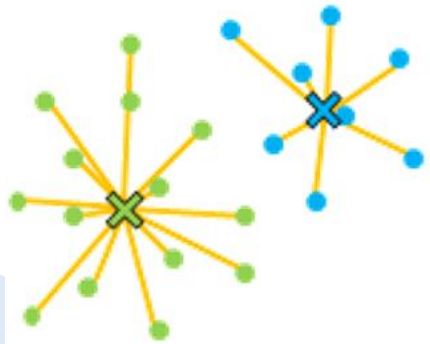


Unsupervised learning

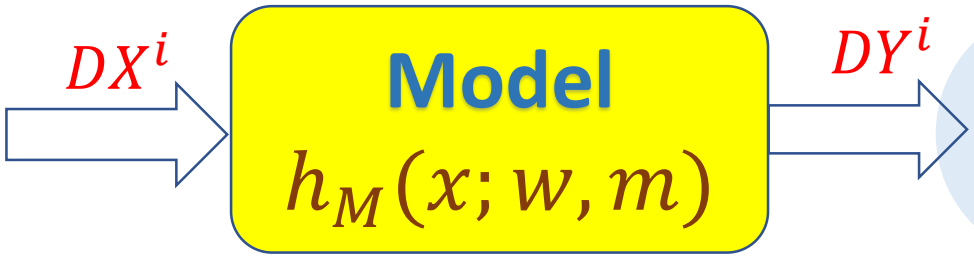
Training stage



** Clustering's object function is to minimize the maximum cluster distance.*

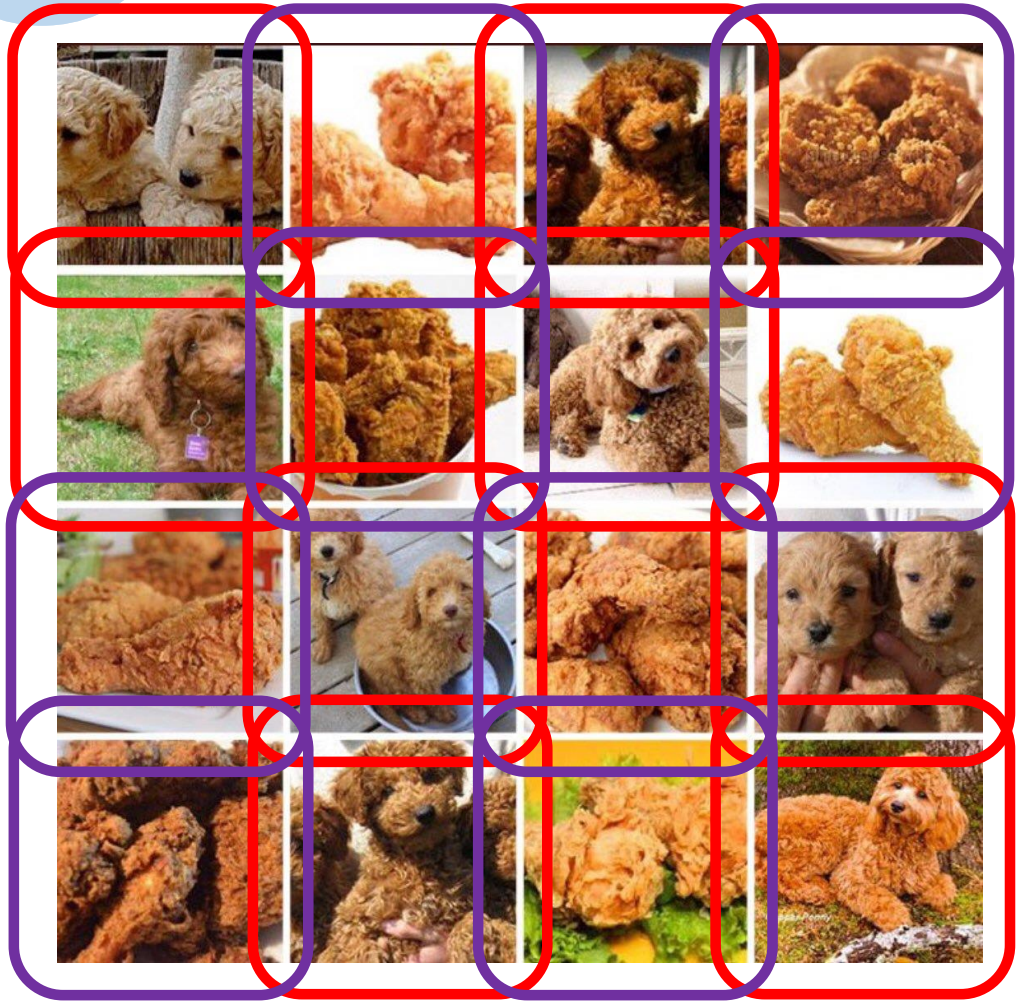


Inference stage



Unsupervised learning

Clustering

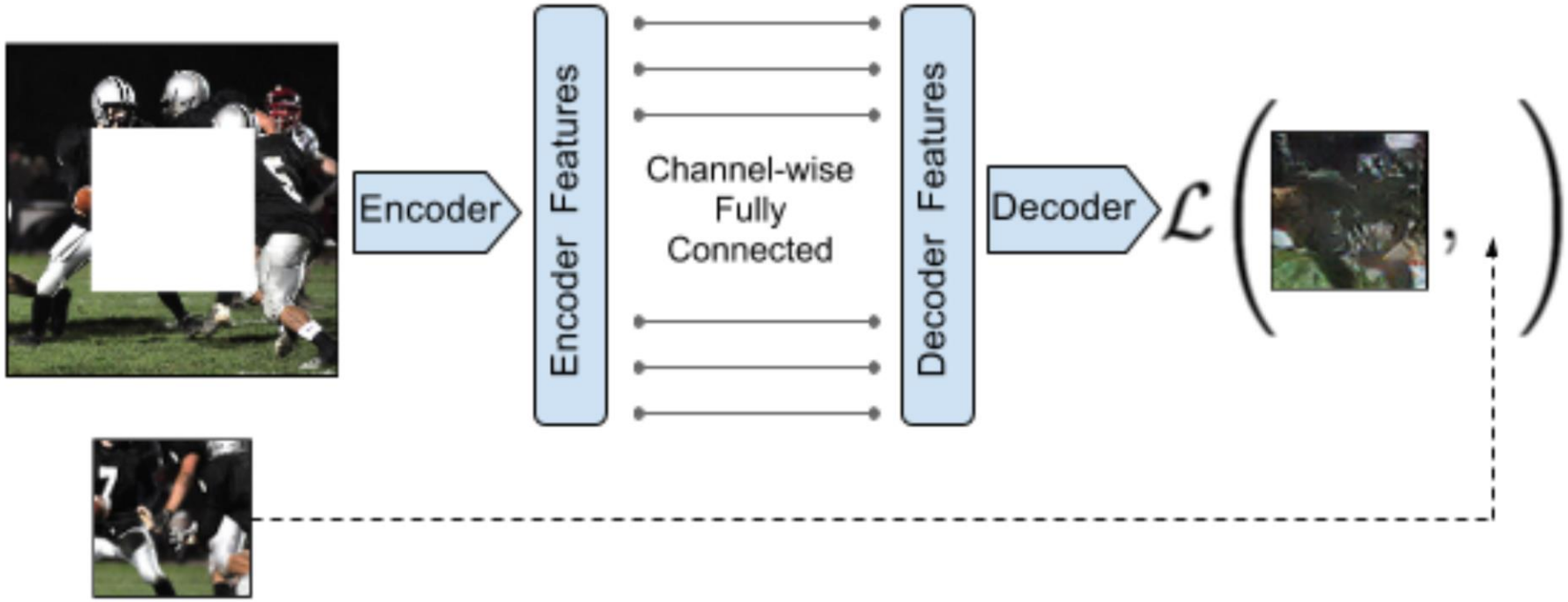


Dog

Fried Chicken

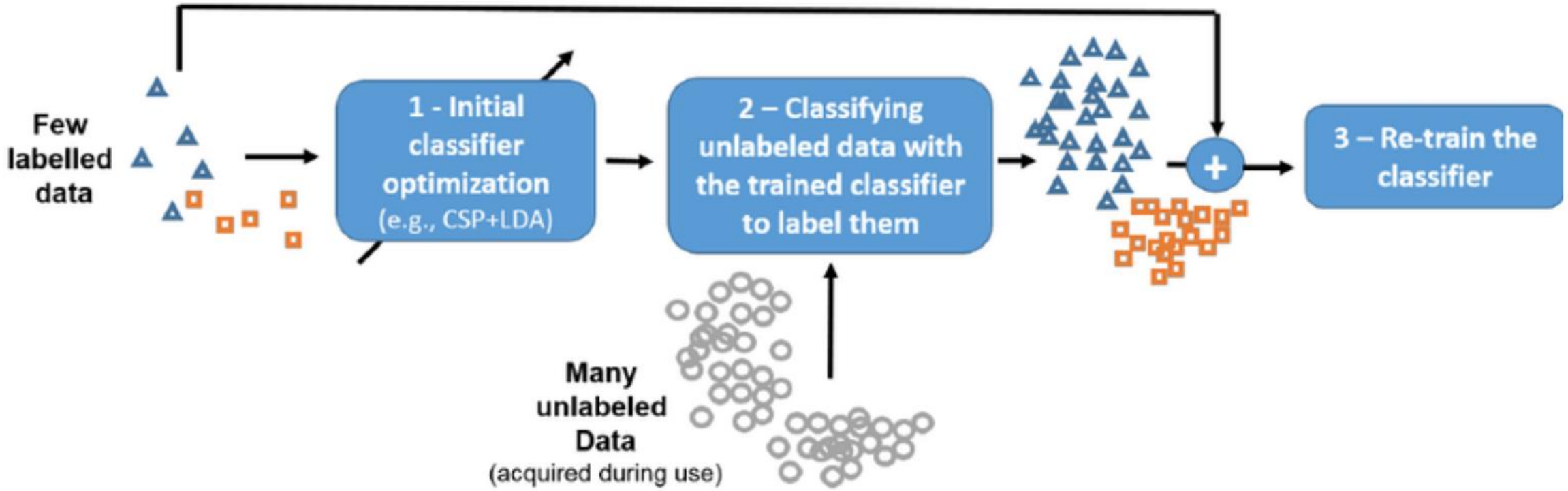
Self-supervised Learning

- The labels are created automatically from the original data.
- Mostly used as a ***pretext*** task, which will be followed by ***downstream*** tasks.



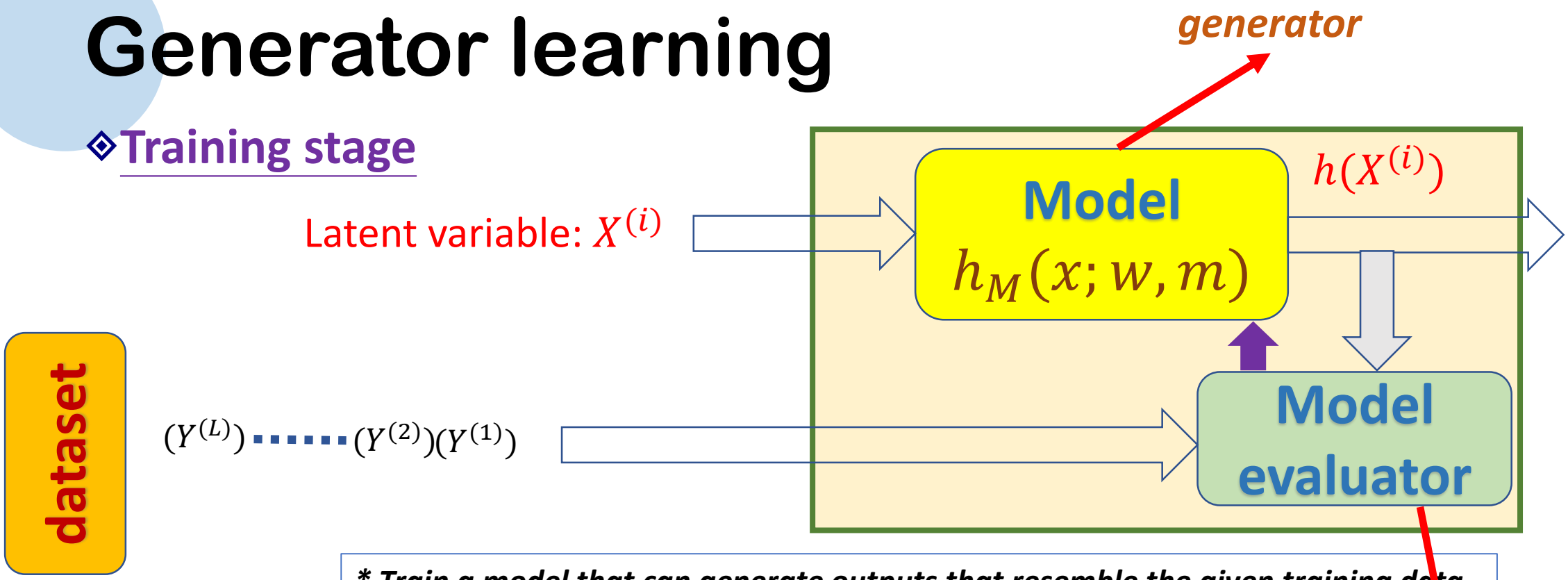
Semi-supervised Learning

- Only label small part of the big dataset.



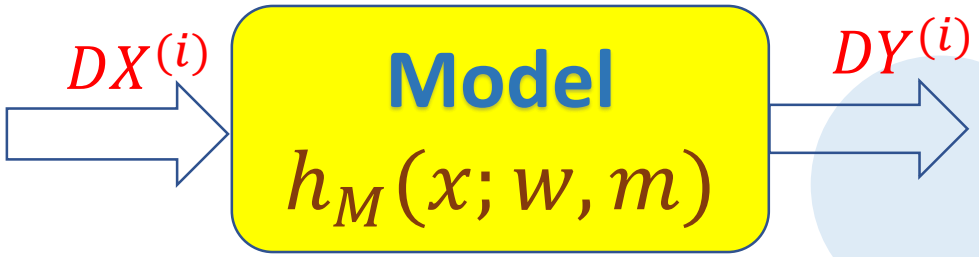
Generator learning

Training stage



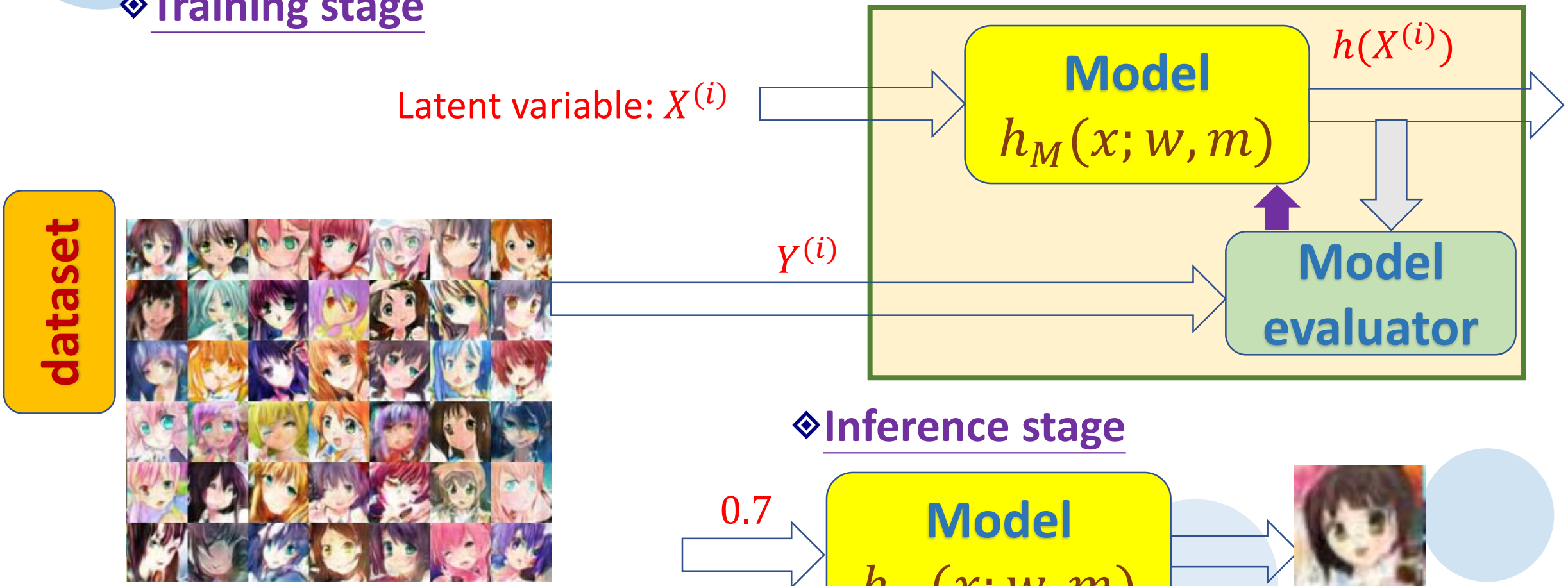
** Train a model that can generate outputs that resemble the given training data.*

Inference stage



Generator learning

◈Training stage



◈Inference stage

Reinforcement

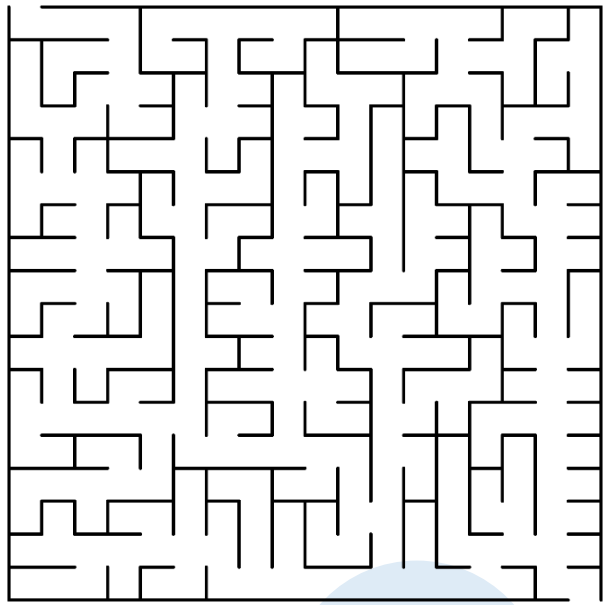
- Train ***an agent function*** to decide ***actions*** which can lead to maximum ***rewards***.

Agent

Action a_t

Reward r_t

State s_t



Environment

Reinforcement Learning

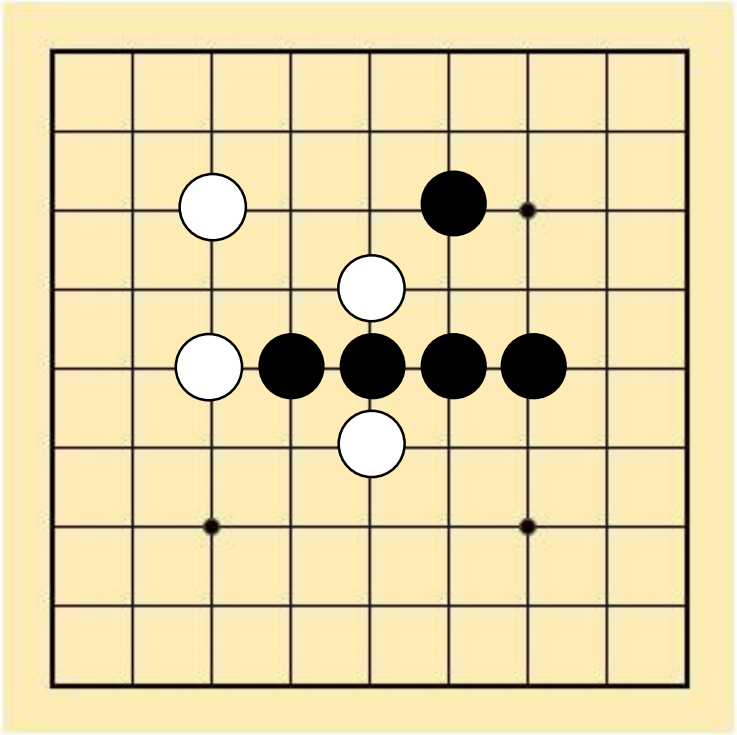
- In Gomoku, one who can form an unbroken chain of five is the winner

State s_t

Board

Environment

Opponent



Action a_t

Where to place the stone

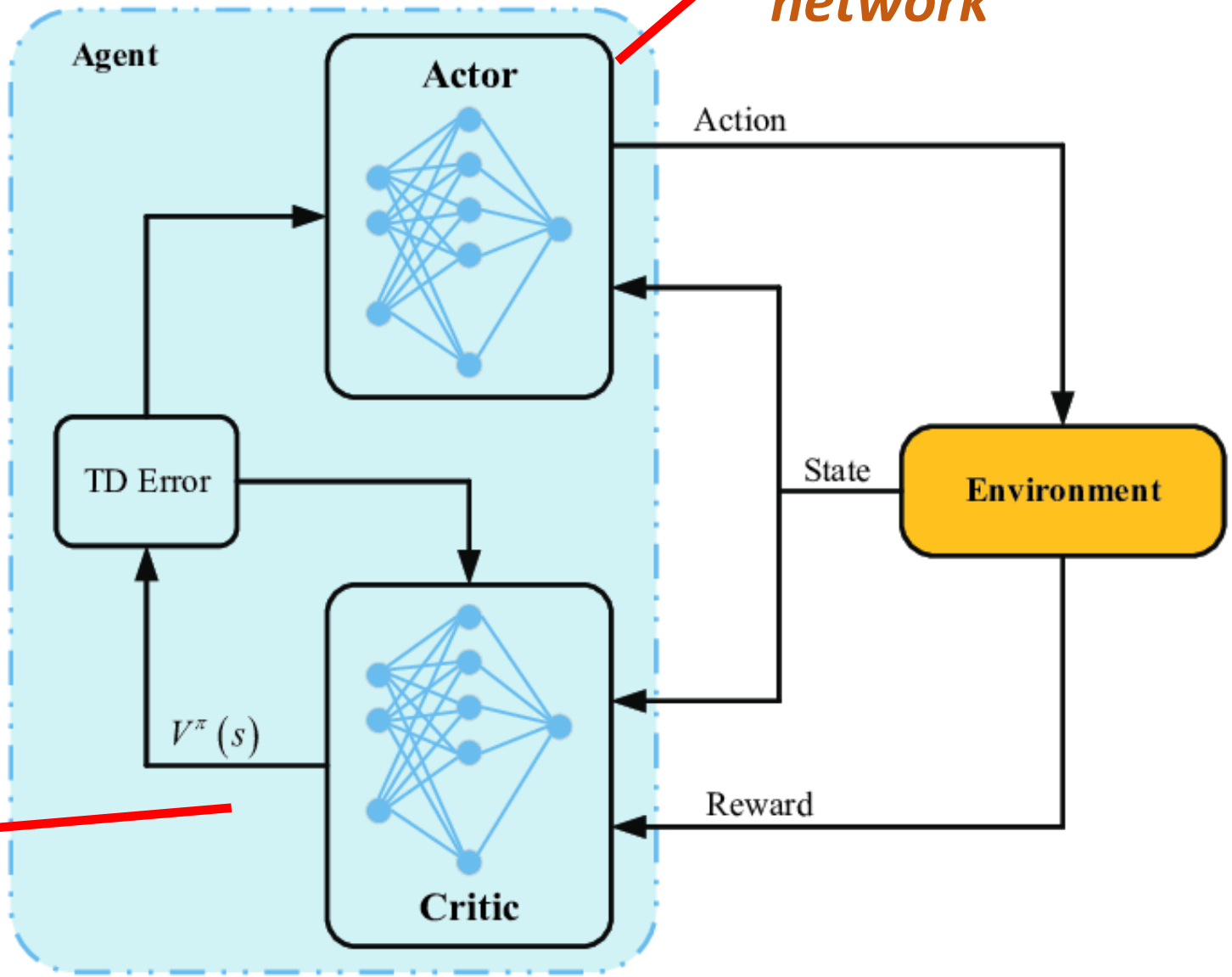
Reward r_t

Win : get 1 point

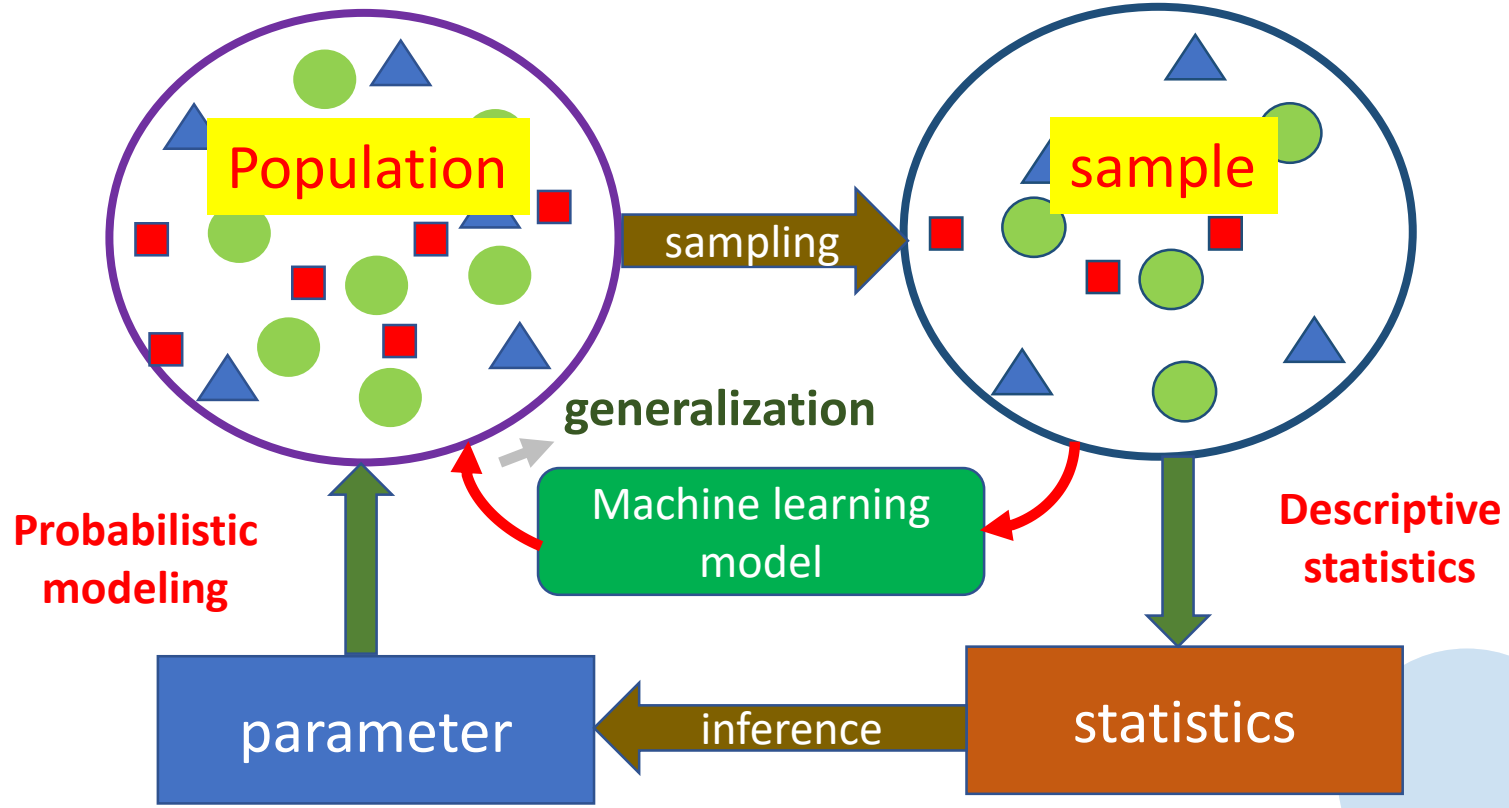
Not-Win : get 0

Loss: get -1 point

Deep RL

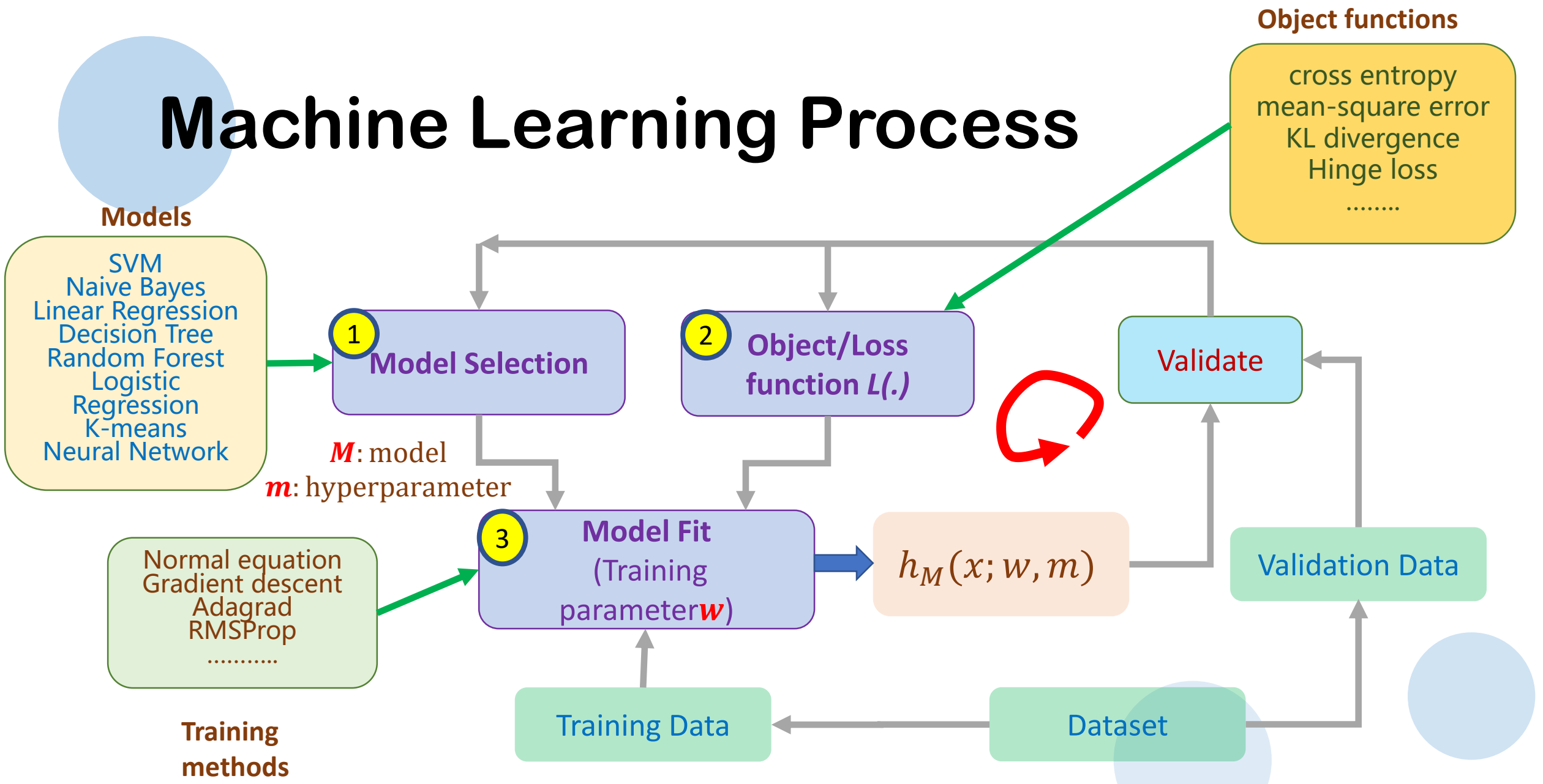

regression or classification network
Agent
Actor
Action
TD Error
State
Environment
$V^{\pi}(s)$
Reward
Critic
regression network

Sampling & Learning

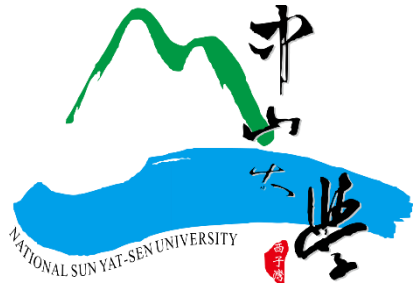


Overfitting vs Underfitting

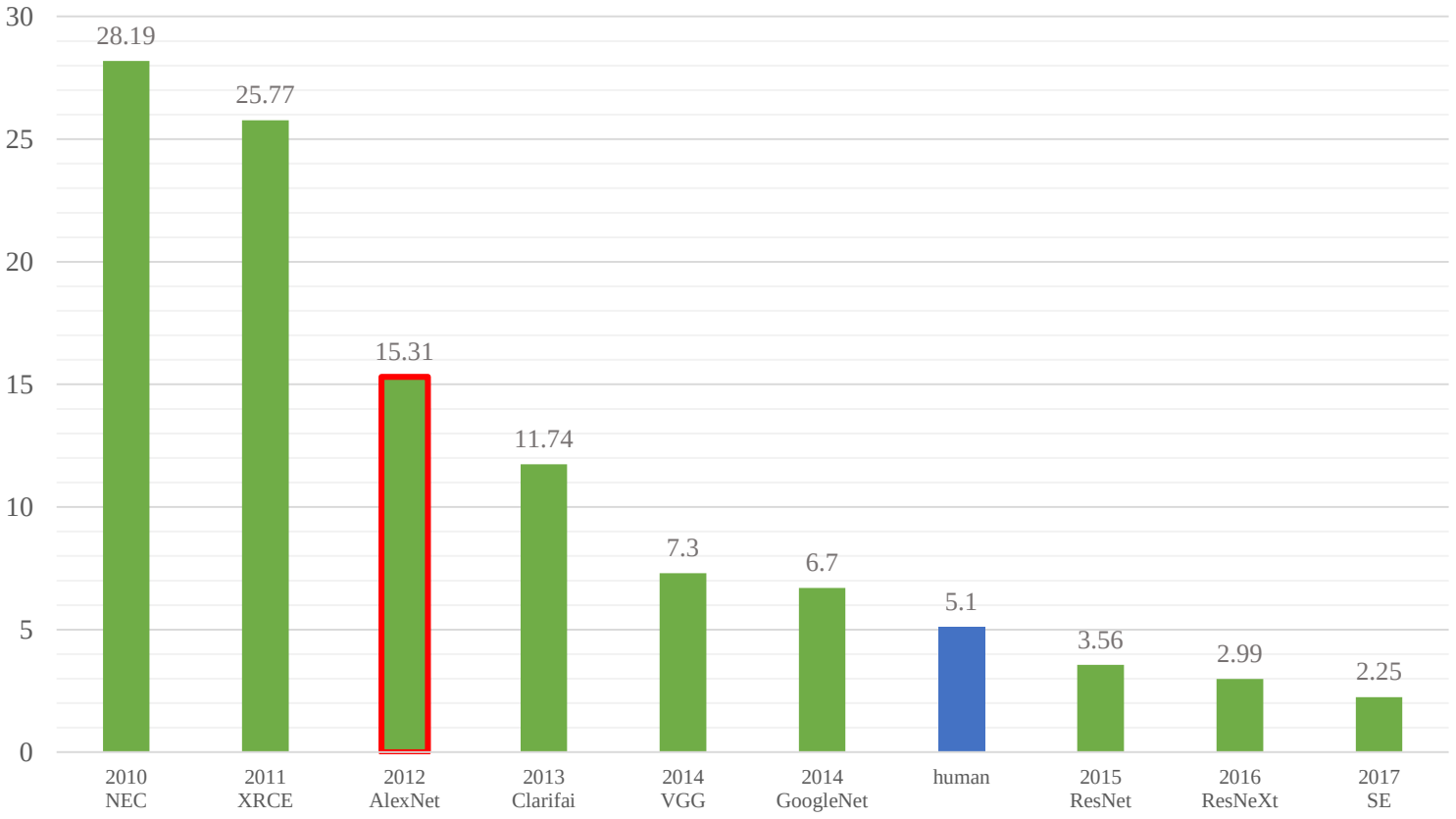
Machine Learning Process



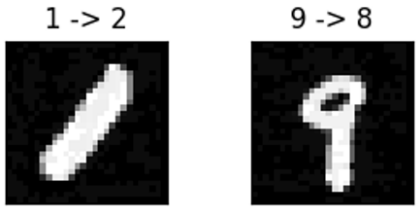
The END



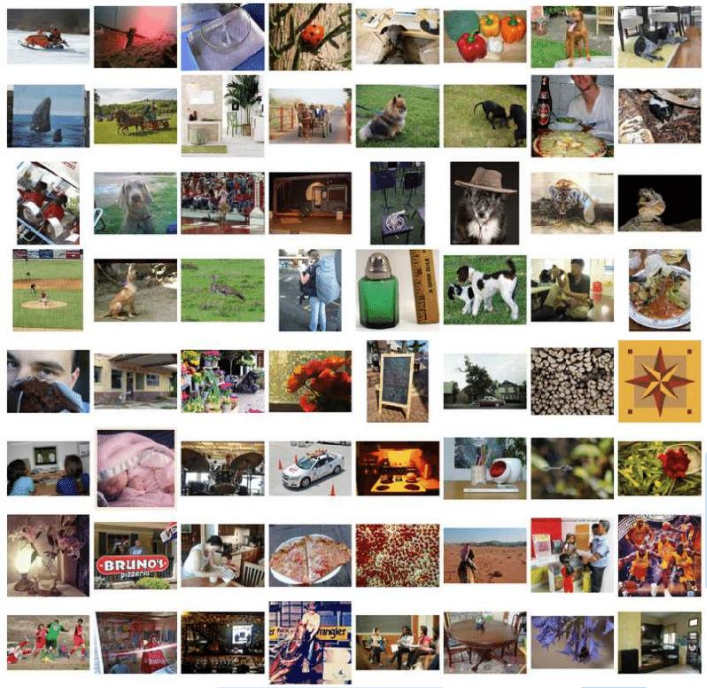
Right perception of current AI tech



ImageNet Large Scale Visual Recognition Competition



14 million images, 20000 categories



Three driving forces for AI

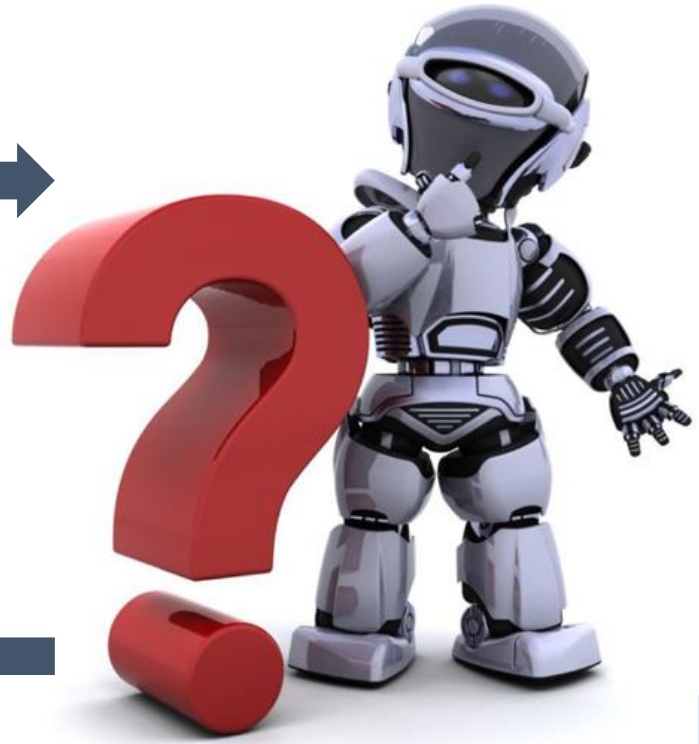
- 數據 Data
- 演算法 Algorithm ★
  - Machine learning model (Neural Network architecture)
  - Training schemes and methods
- 計算能力 Computing Power
  - Tesla M40 GPU: 14 days, nVidia DGX (8 x P100 GPU): 21hr
    - Training Data : ImageNet 1K, ~1M image, 1000 class
    - ResNet-50, 90 epochs, Top-1 Accuracy : 72%

What is machine learning

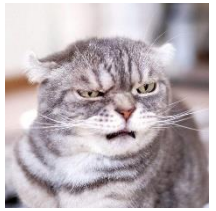
test

這是“貓”

Learning……



寫一個程式賦予他學習的能力



“貓”

“狗”

“羊駝”

圖源:https://makerpro.cc/2017/08/what-is-a-robot/

Ex & Hyper (meta) -parameters

Setting of sklearn decision-tree module

sklearn.tree.DecisionTreeClassifier

class sklearn.tree. **DecisionTreeClassifier** (*criterion='gini', splitter='best', max_depth=None, min_samples_split=2, min_samples_leaf=1, min_weight_fraction_leaf=0.0, max_features=None, random_state=None, max_leaf_nodes=None, min_impurity_decrease=0.0, min_impurity_split=None, class_weight=None, presort=False*)

[source]

Setting of sklearn SVM module

sklearn.svm.SVC

class sklearn.svm. **SVC** (*C=1.0, kernel='rbf', degree=3, gamma='auto_deprecated', coef0=0.0, shrinking=True, probability=False, tol=0.001, cache_size=200, class_weight=None, verbose=False, max_iter=-1, decision_function_shape='ovr', random_state=None*)

[source]

Import package

Load dataset

Choose model
Set hyper para

Set label

Fit model

inference

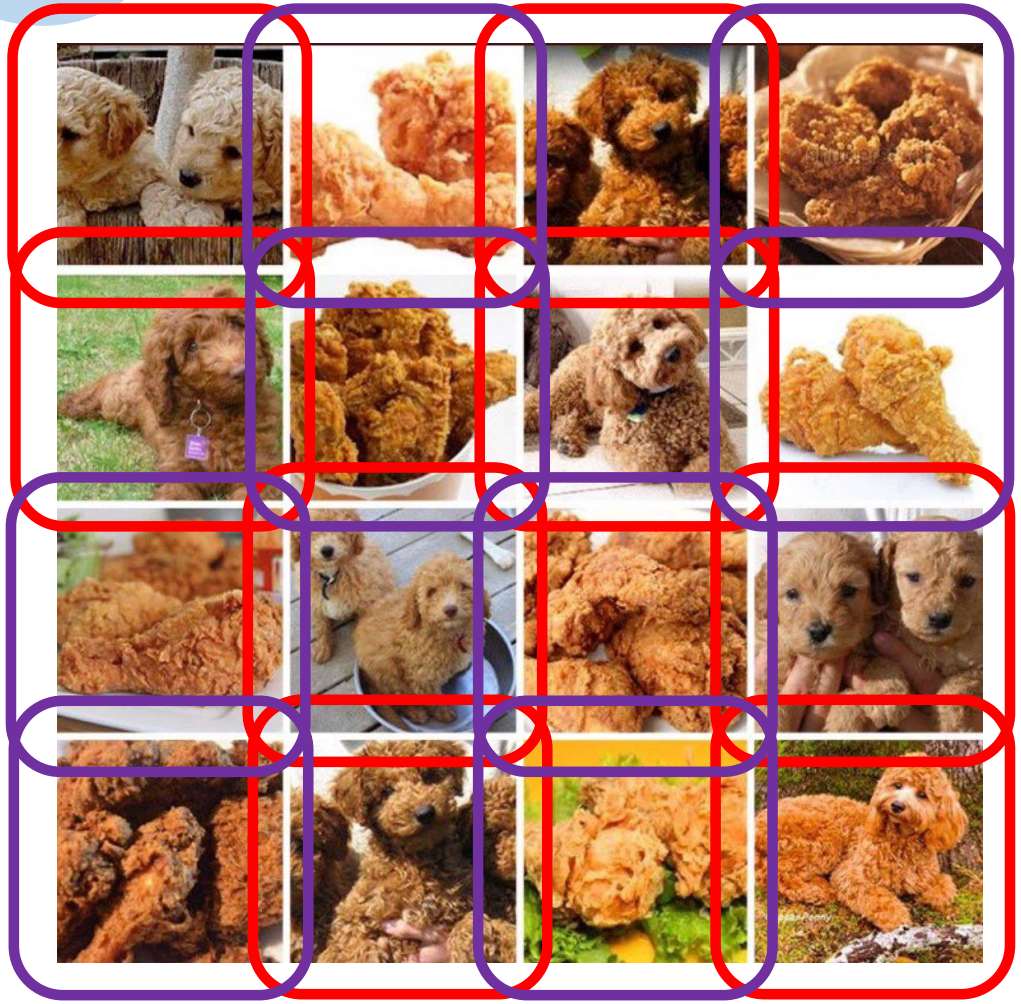
Display result

```
from sklearn import svm
from sklearn import datasets

#digit dataset from sklearn
digits = datasets.load_digits()

#creat the LinearRegression  model
clf = svm.SVC(C=1.0, kernel='linear')

#set training set
x, y = digits.data[:-1], digits.target[:-1]

#train model

clf.fit(x,y)

#predit
y_pred = clf.predict([digits.data[-1]])
y_true = digits. target[-1]

print(y_pred)
print(y_true)
```

```
[8]
8
```

Unsupervised learning

Clustering

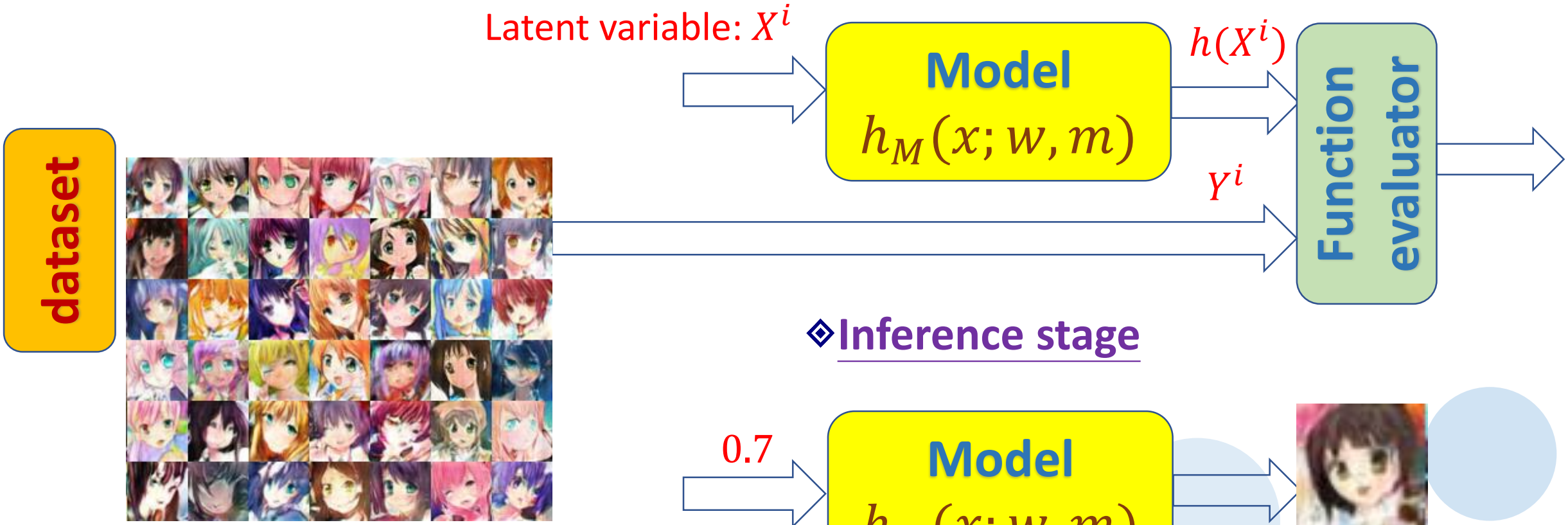


Dog

Fried Chicken

Generator learning

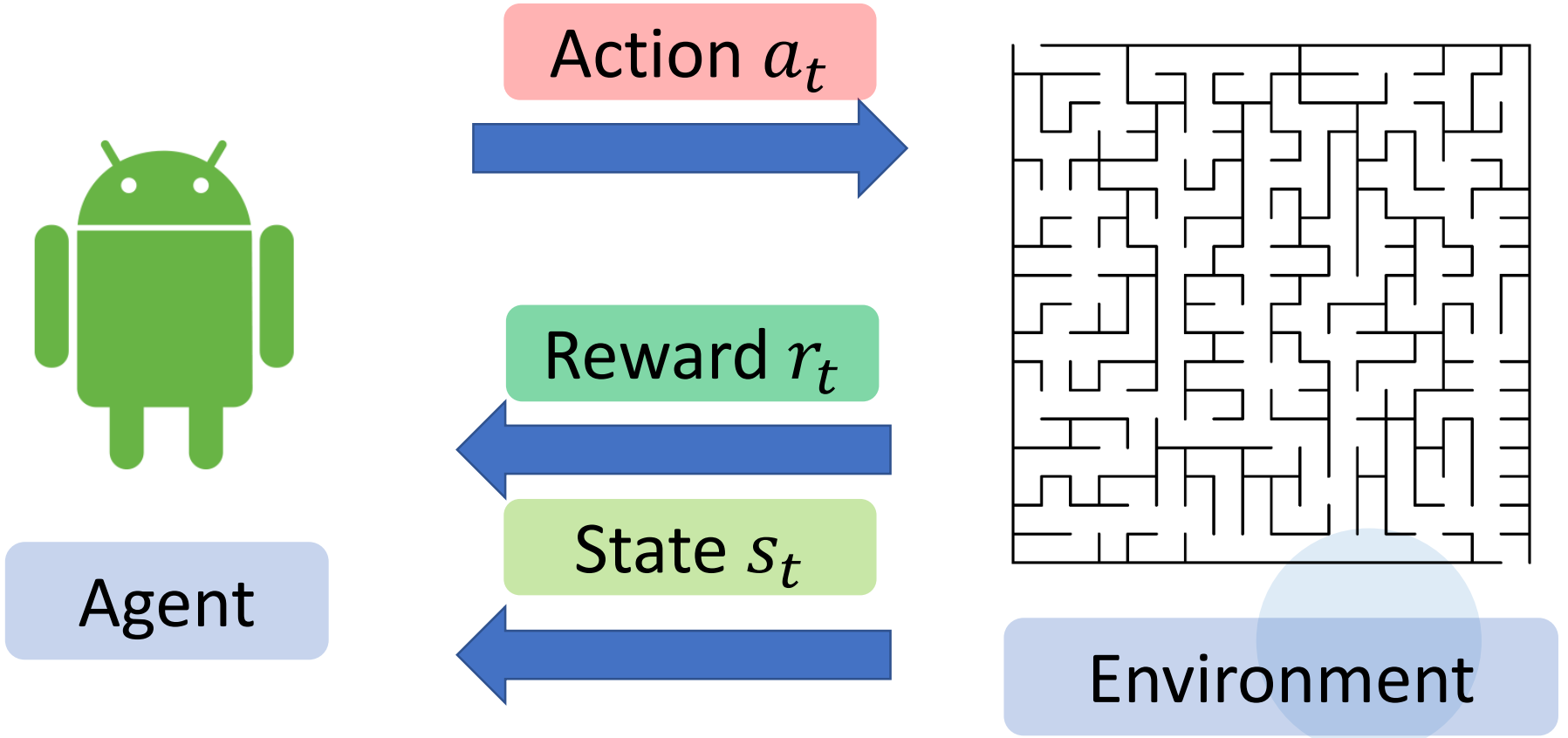
Training stage



Inference stage

Reinforcement

- Train a agent function to decide action



Reinforcement Learning

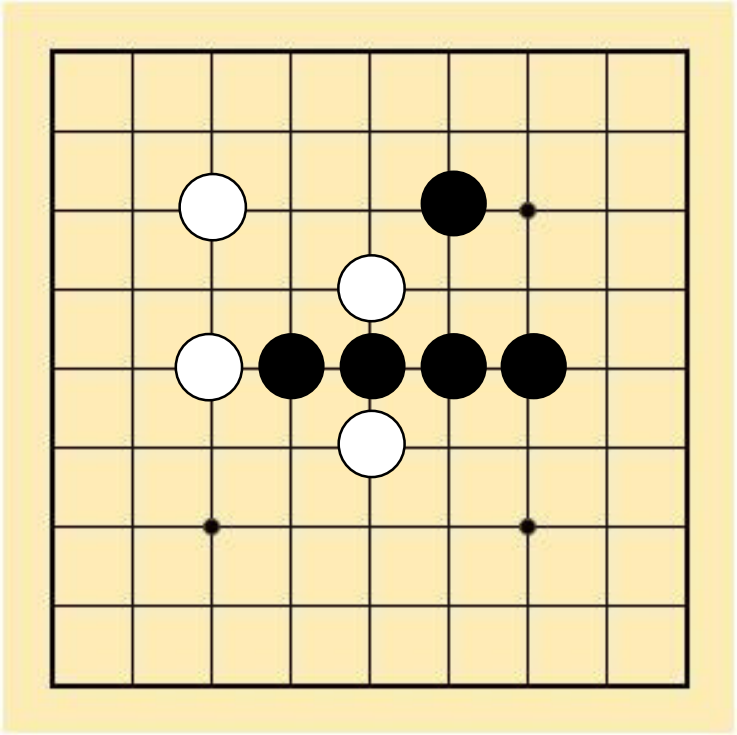
- In Gomoku, one who can form an unbroken chain of five is the winner

State s_t

Board

Environment

Opponent



Action a_t

Where to place the stone

Reward r_t

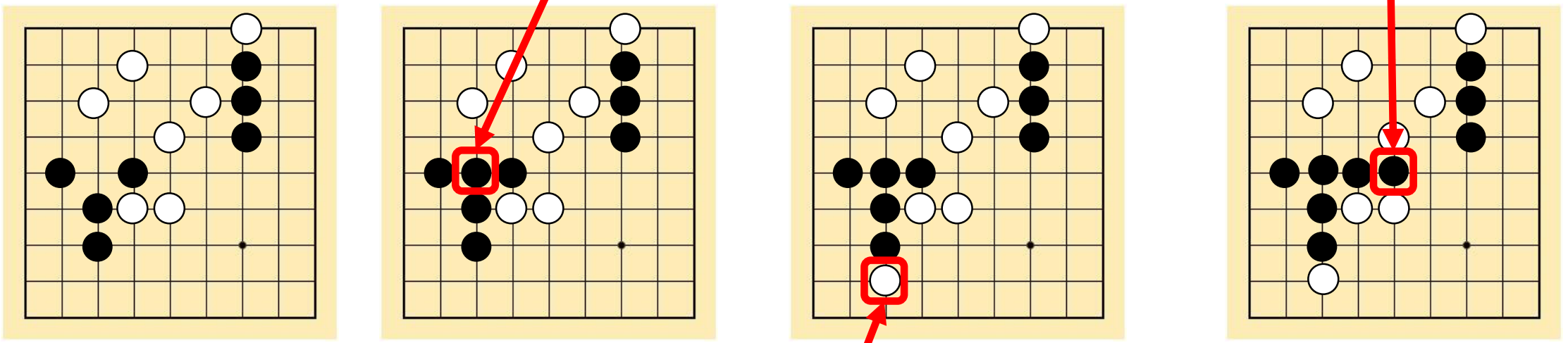
Win : get 1 point

Not-Win : get 0

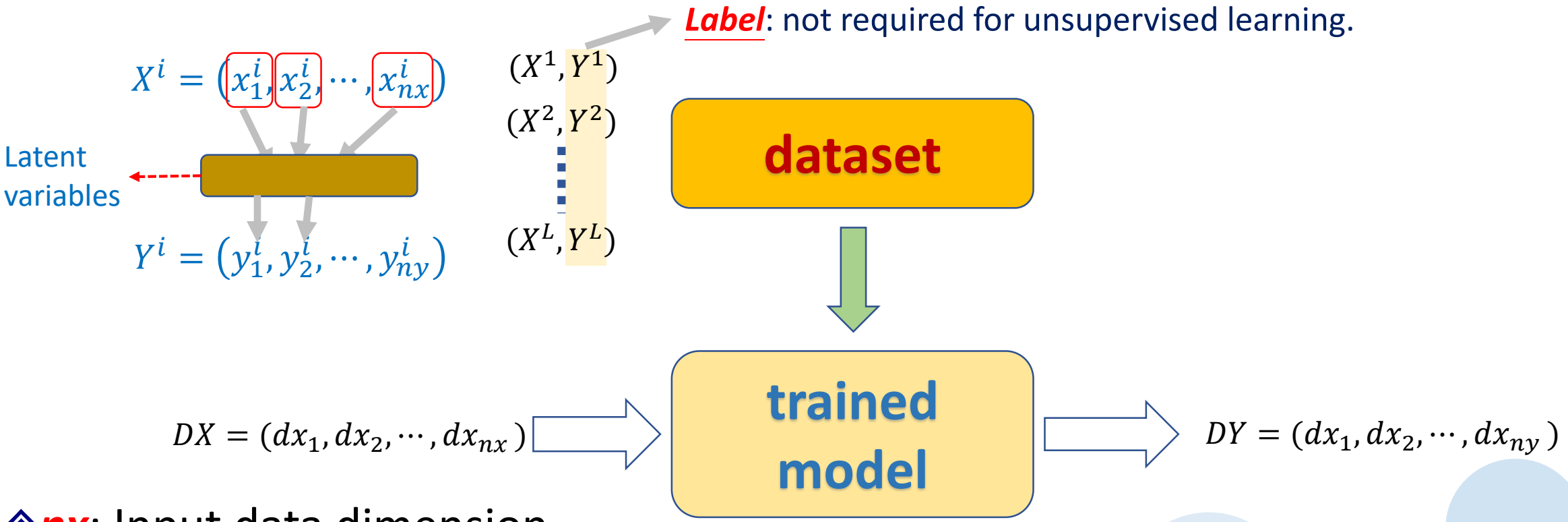
Loss: get -1 point

Reward

Agent



How Machine Learning Works



- ***nx***: Input data dimension
- ***ny***: output data dimension.
  - ***ny=1*** for binary classification, regression.

競賽參與

- 請參與公開之AI或機器學習競賽
  - 競賽成績必須能於學期結束前公佈

- 教育部全國大專校院人工智慧競賽 AI CUP 2021
  - https://moeaincu.wixsite.com/aicup/copy-of-ai-cup-2020
  - 水稻無人機全彩影像植株位置自動標註與應用

- 教育部全國大專校院人工智慧競賽 AI CUP 2020
  - 和弦辨識競賽：佳作
  - 愛文芒果五類不良品分類競賽：佳作

課程AI平台帳號申請

- 每組可以申請一個帳號
- 資源有限，請分散使用