

A Gentle Introduction to Machine Learning

Dr. Rodrigue Rizk

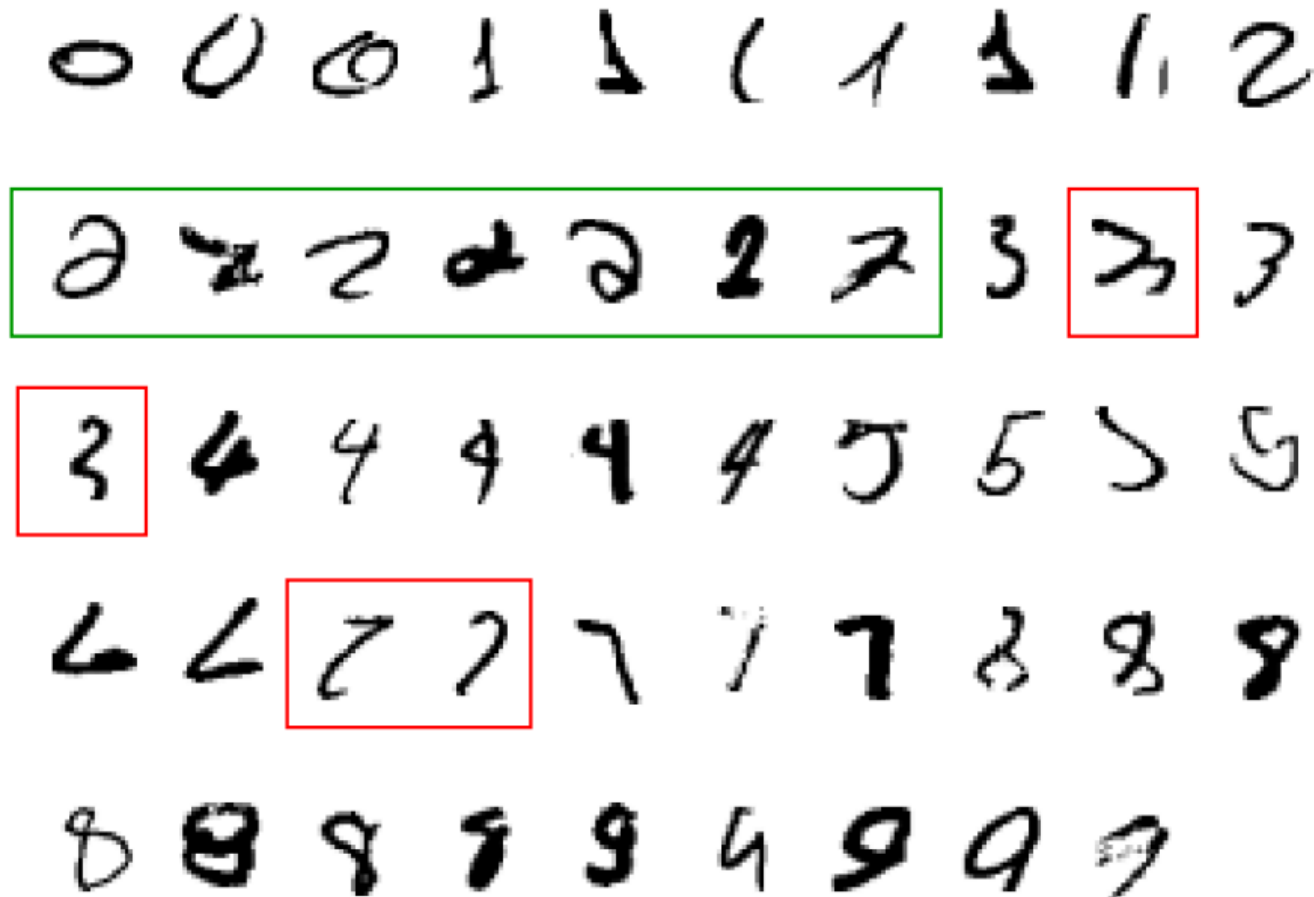
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Learning Objectives

- ❑ Understand what is machine learning and its applications
- ❑ Understand the key concepts of machine learning
- ❑ Learn how solving problems with machine learning is different from traditional approaches
- ❑ Understand the different types of learning and the most used machine learning algorithms

When Do We Use Machine Learning?

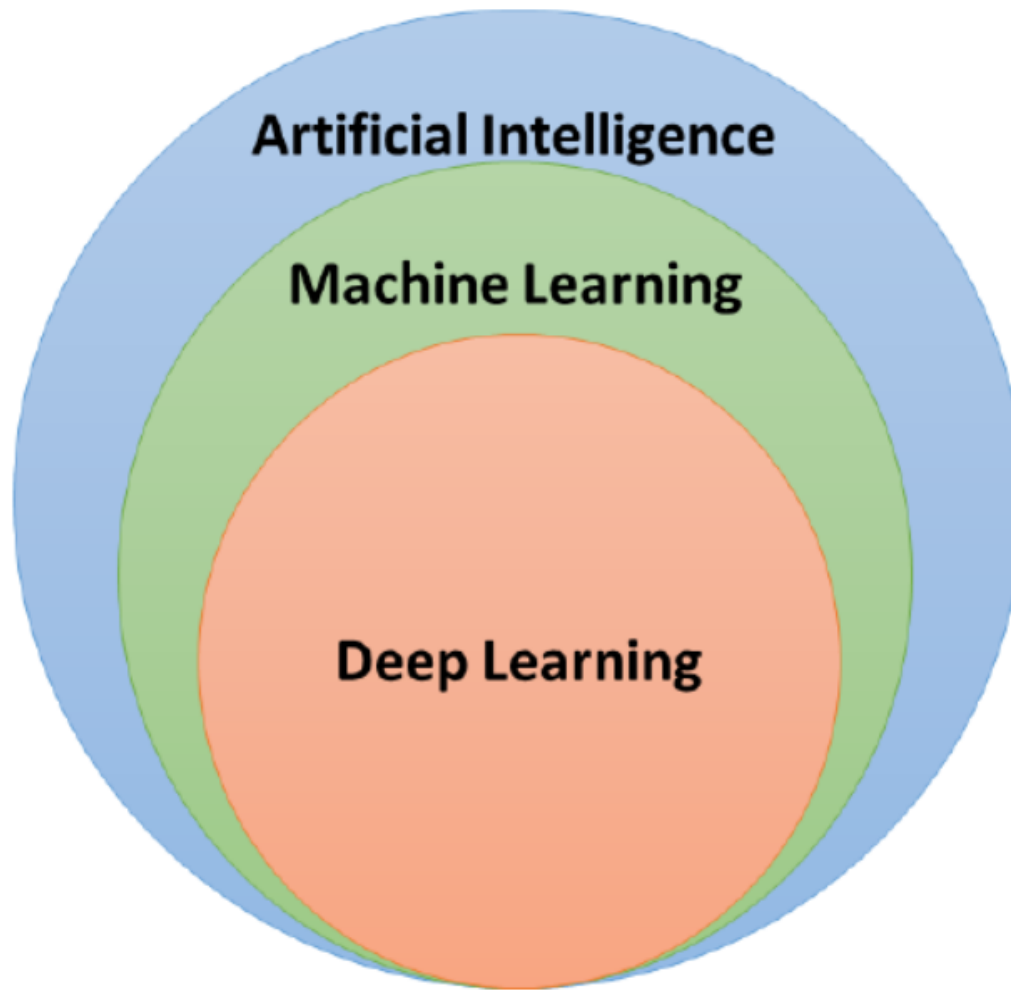
- A classic example of a task that requires machine learning: *It is very hard to say what makes a 2*



When Do We Use Machine Learning?

- ❑ Some more examples of tasks that are best solved by using a learning algorithm:
- ❑ *Recognizing patterns:*
 - ❑ *Facial identities or facial expressions*
 - ❑ *Handwritten or spoken words*
 - ❑ *Medical images*
- ❑ *Generating patterns:*
 - ❑ *Generating images or motion sequences*
- ❑ *Recognizing anomalies:*
 - ❑ *Unusual credit card transactions*
 - ❑ *Unusual patterns of sensor readings in a nuclear power plant*
- ❑ *Prediction:*
 - ❑ *Future stock prices or currency exchange rates*

What is Machine Learning?

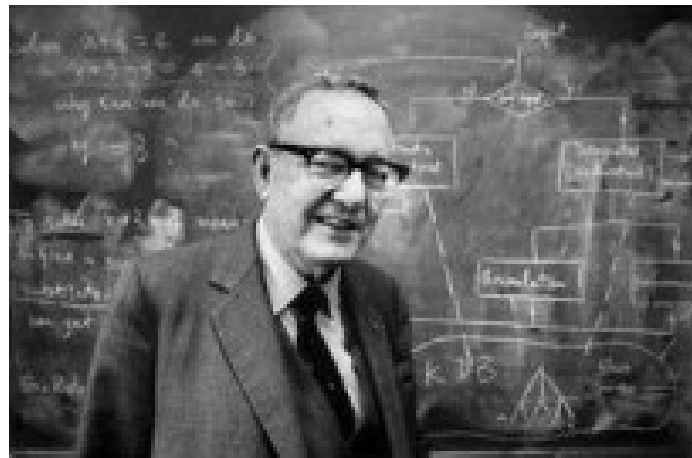


Artificial Intelligence, Machine Learning, and Deep Learning

What is Machine Learning?

“**Learning** is any process by which a system improves performance from **experience**.”

“**Machine Learning** is concerned with computer programs that automatically improve their performance through **experience**.”



Herbert Simon
Turing Award 1975
Nobel Prize 1978

What is Machine Learning?

“Machine Learning: Field of study that gives computers the ability to **learn** without being explicitly programmed.”



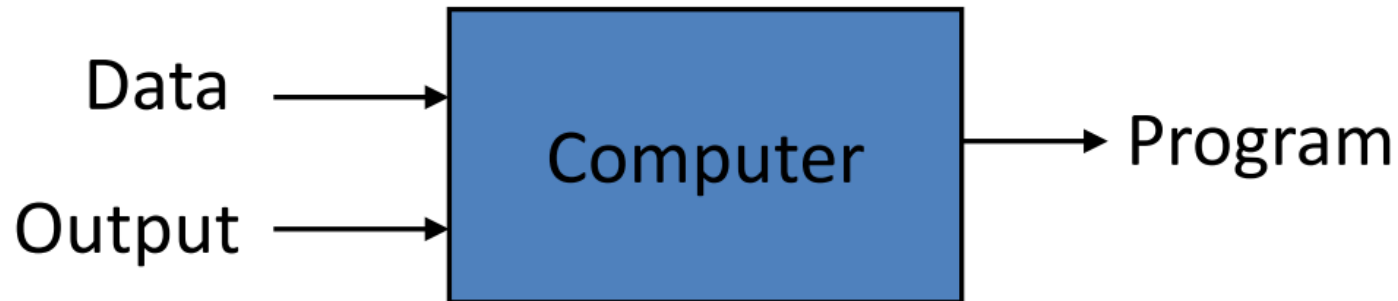
Arthur Lee Samuel (1959)

What is Machine Learning?

Traditional Programming

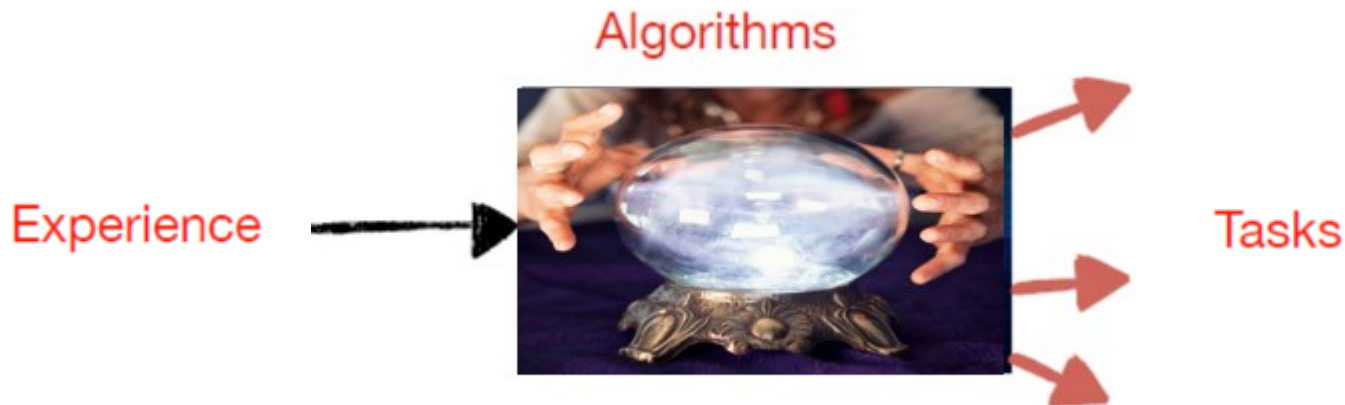


Machine Learning

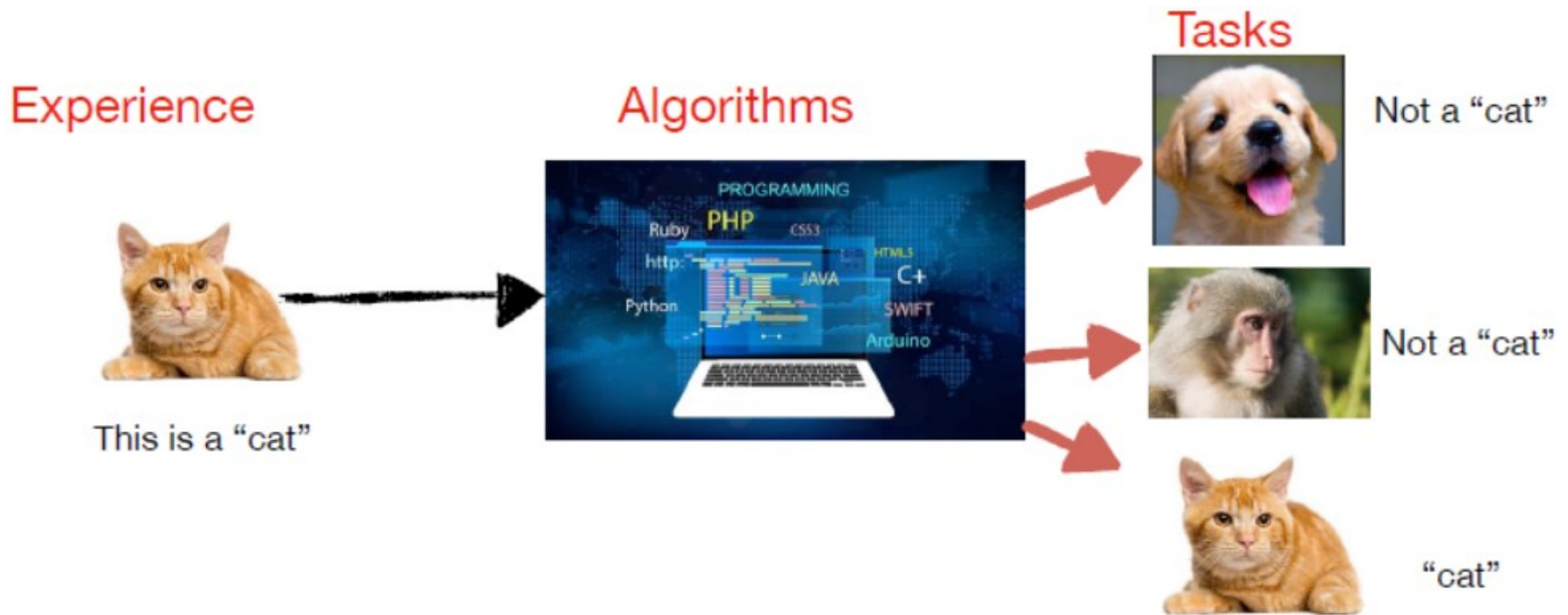


What is Machine Learning?

- ❑ Study of *Algorithms* that *improve* their *performance* at some *task* with *experience*.



Cat Classification Example



Weather Prediction Example

- Suppose a Mesonet station monitors the weather conditions for the past several years, then based on this **information**, a computer program can **learn** and **predict** the weather conditions in the next several days.



Past several years'
observation



Weather Prediction Example

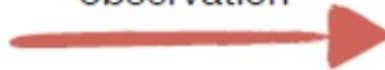
- Suppose a Mesonet station monitors the weather conditions for the past several years, then based on this **information**, a computer program can **learn** and **predict** the weather conditions in the next several days.



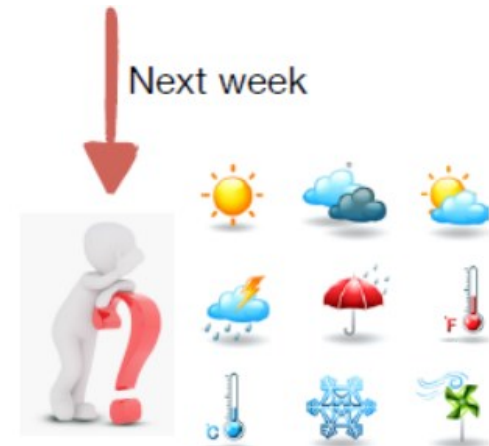
Past several years'
observation



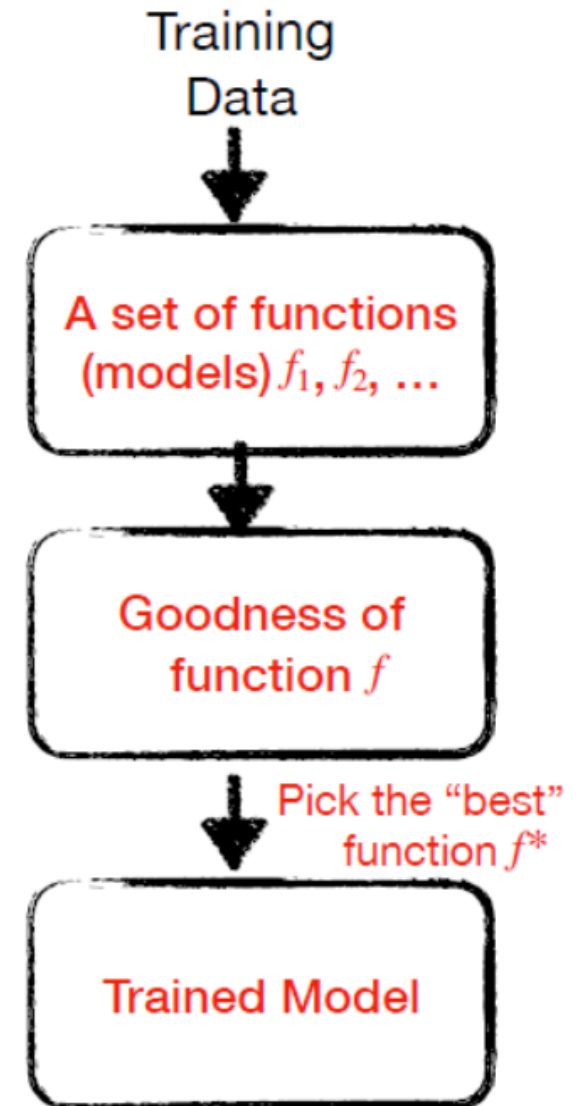
Last one month's
observation



Next week



Machine Learning ~ Training Framework



Machine Learning ~ Testing Framework



?

?

?



"Cat" (95%)

"Cat" (95%)

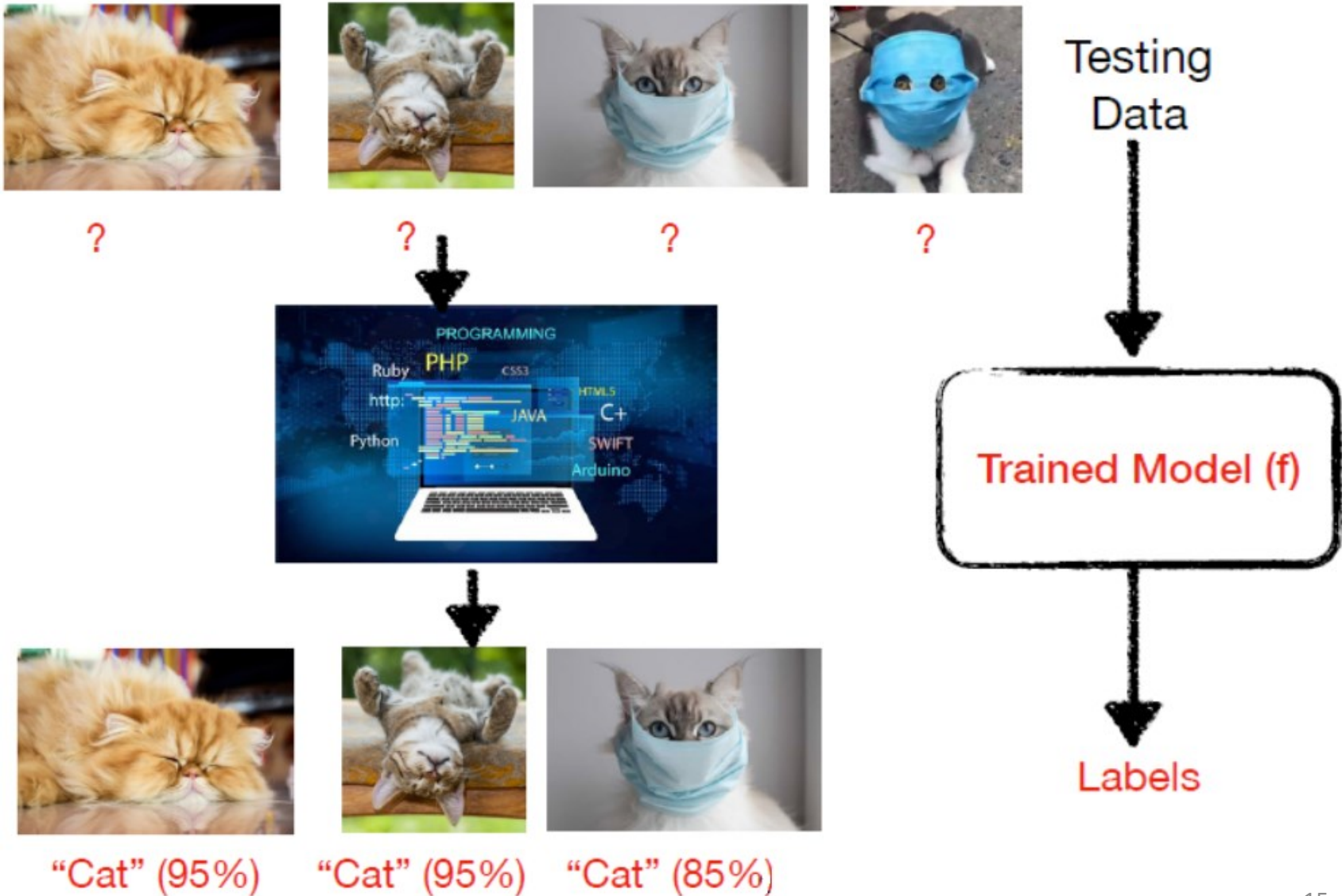
"Cat" (85%)

Testing
Data

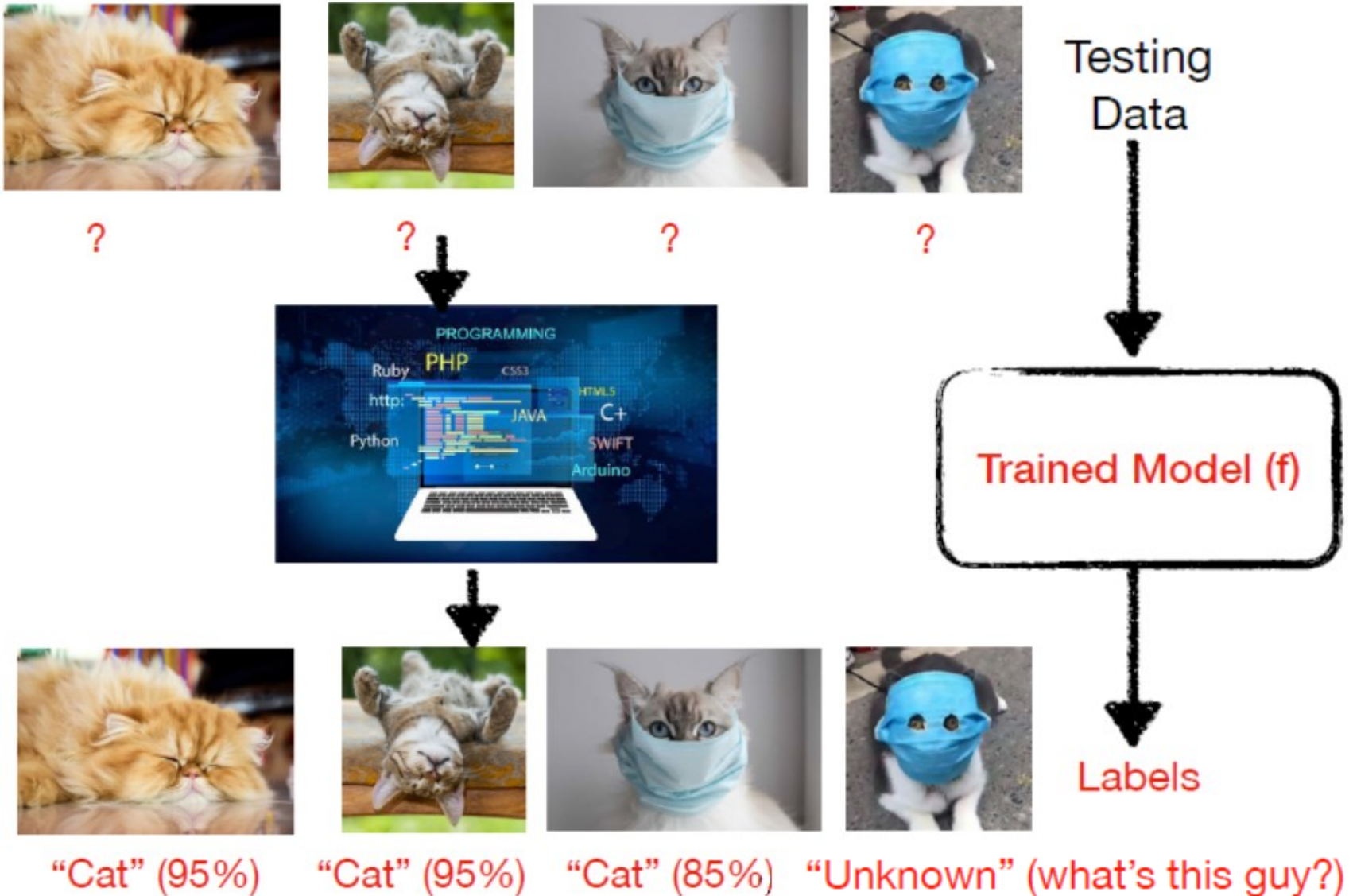
Trained Model (f)

Labels

Machine Learning ~ Testing Framework



Machine Learning ~ Testing Framework

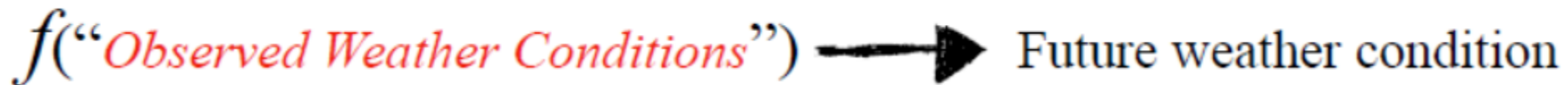


Machine Learning ~ Looking for a Function

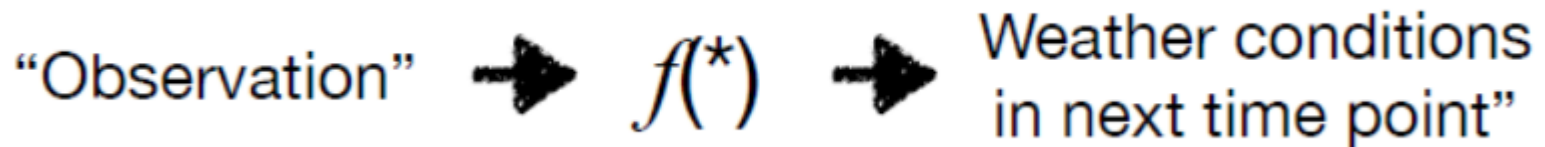
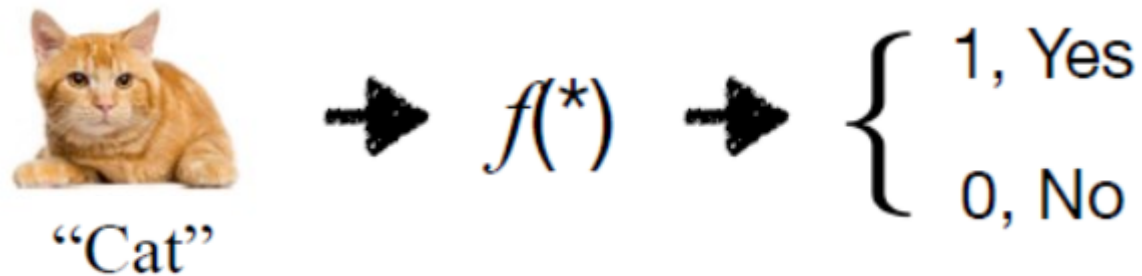
- So far, you can see finding a suitable function is the core of machine learning
 - Cat Classification (Image recognition)




- Weather Prediction



Machine Learning ~ Looking for a Function



Types of Learning



Supervised
Learning

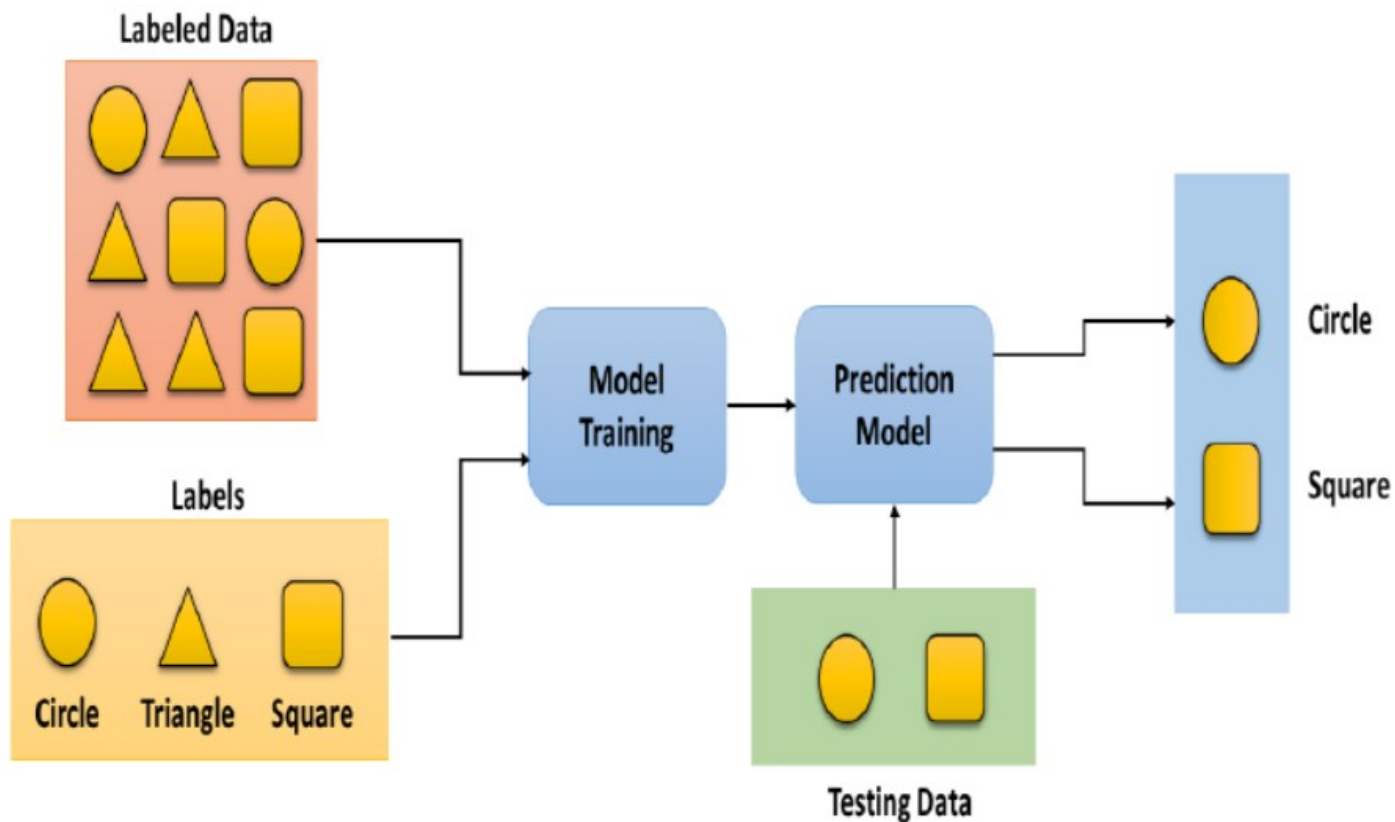
Unsupervised
Learning

Reinforcement
Learning

Supervised Learning

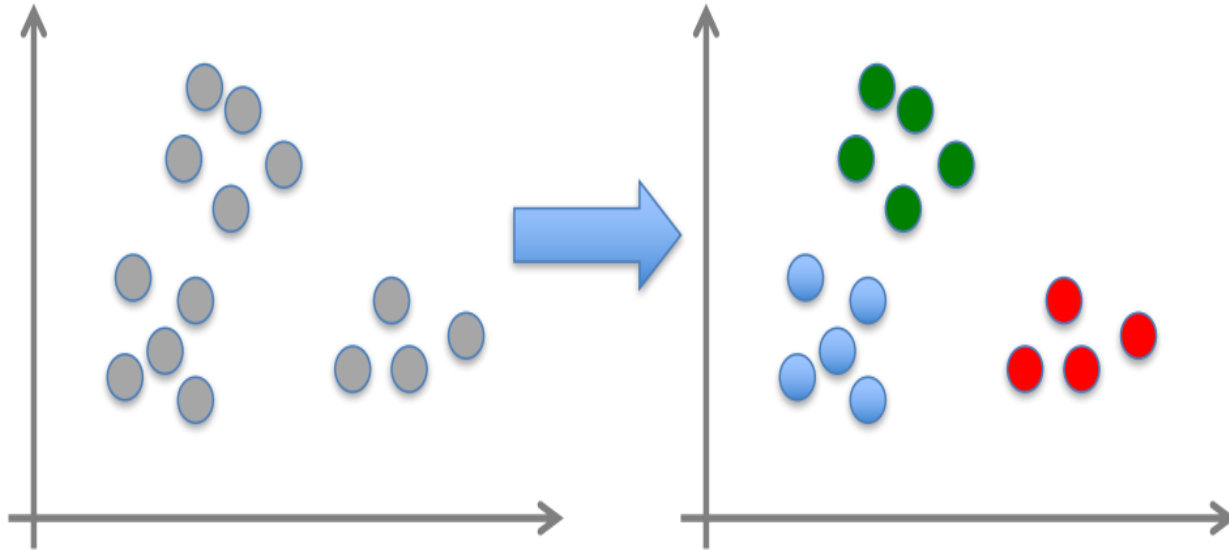
□ Supervised learning

- Given: training data + desired outputs (labels)



Unsupervised Learning

- Unsupervised learning
 - Given: training data (without desired outputs)



Reinforcement Learning

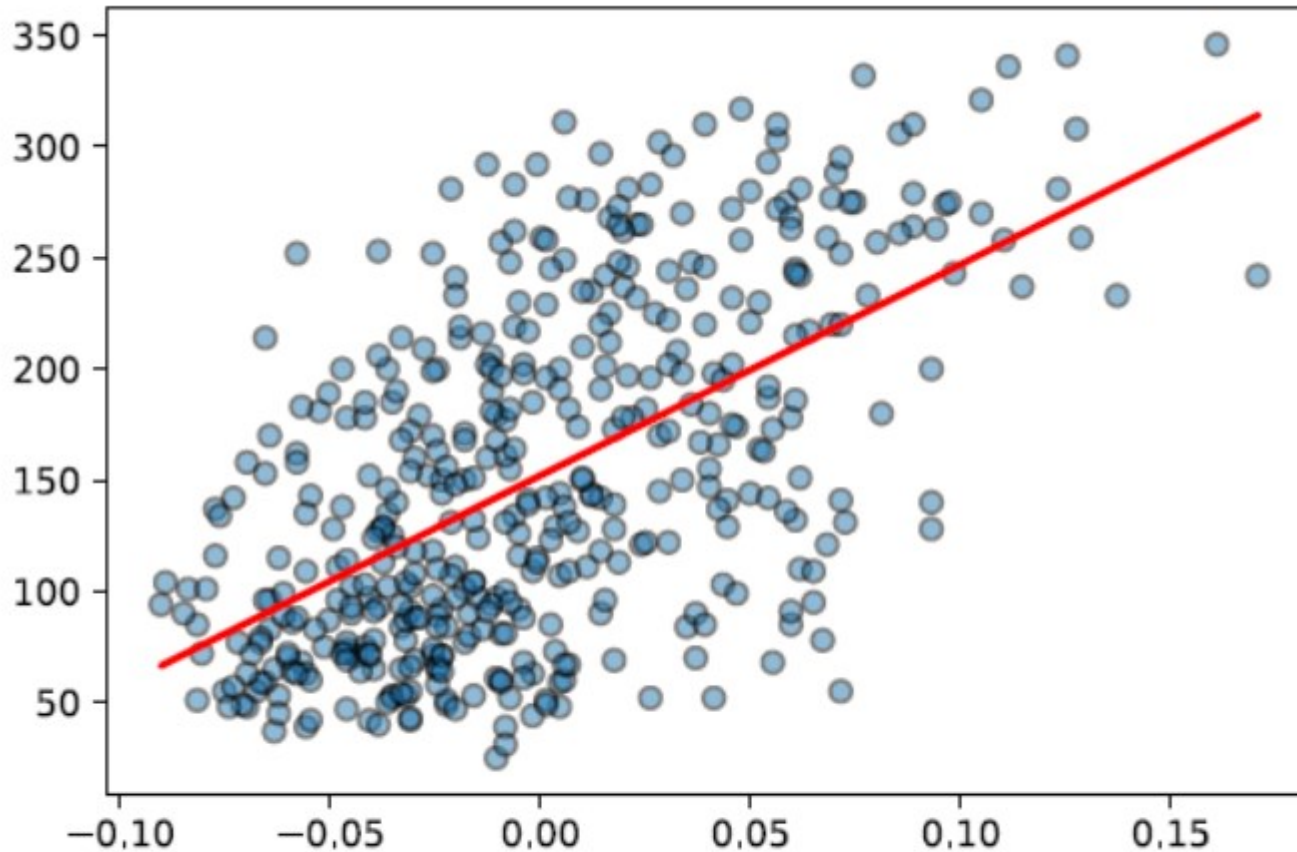
- ❑ Reinforcement learning
 - ❑ Rewards from sequence of actions



Examples of Machine Learning Algorithms

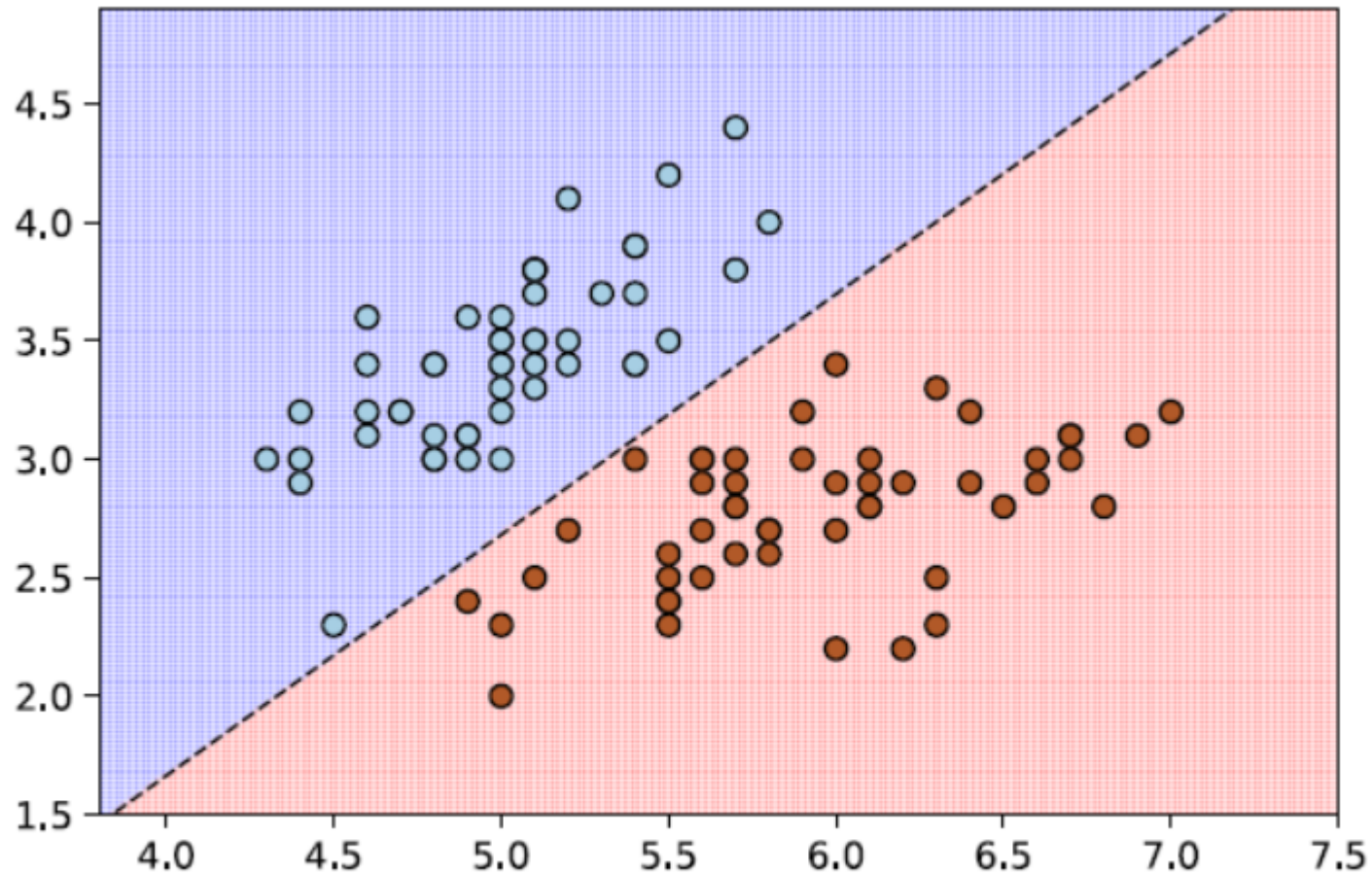


Linear Regression



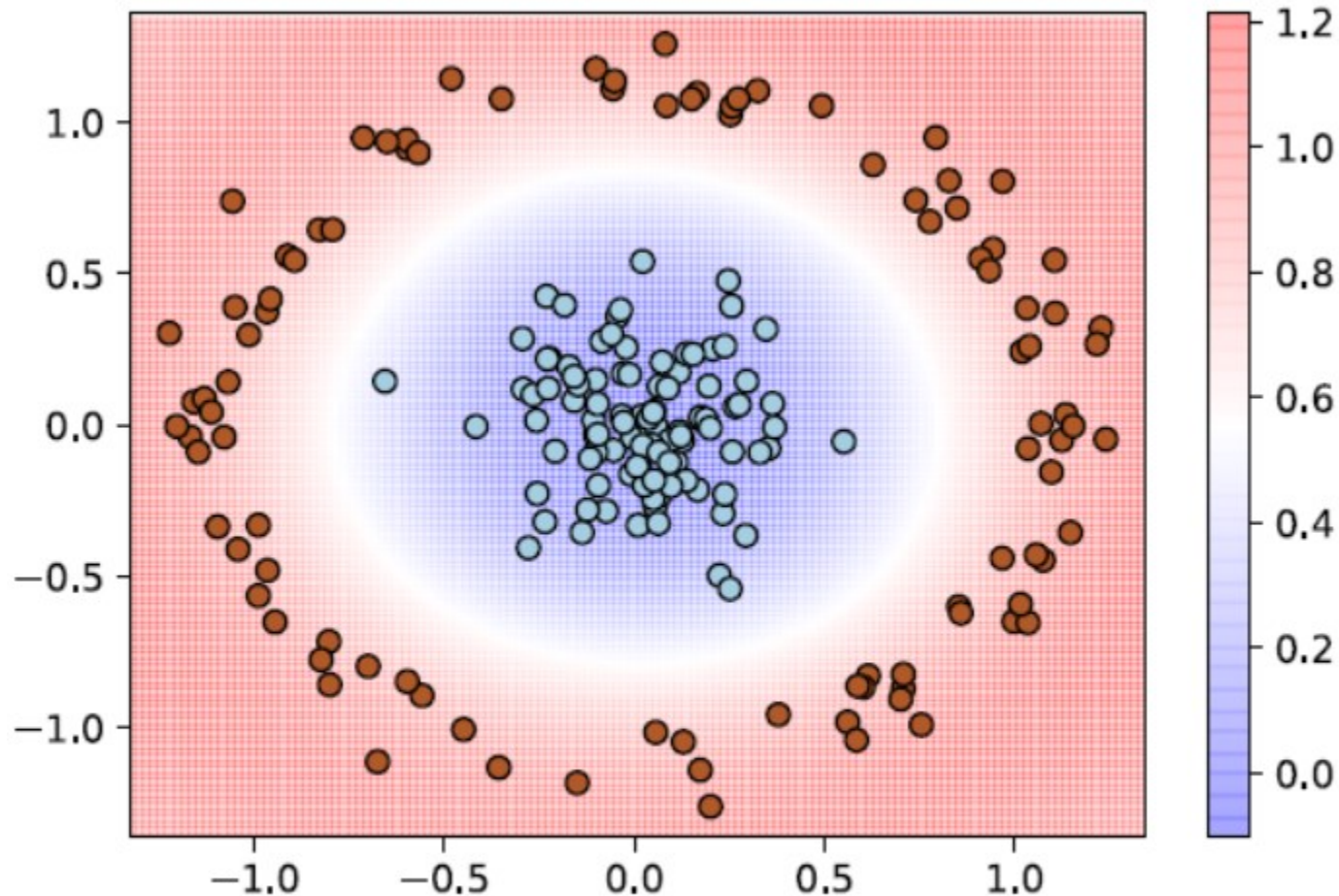
Finding a equation that best fit the curve

Logistic Regression



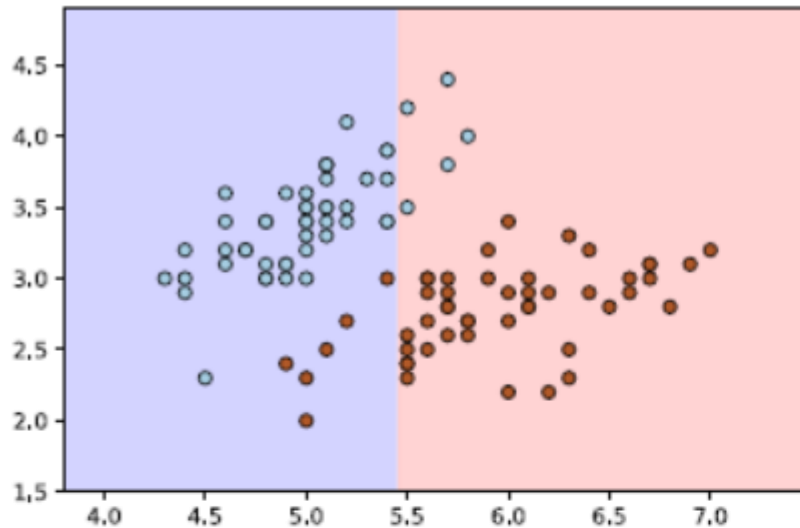
Equation is used to define the boundary line

Supported Vector Machine (SVM)

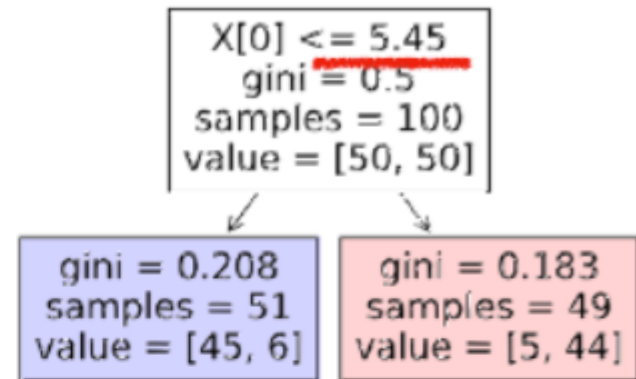


The boundary curves are non-linear.

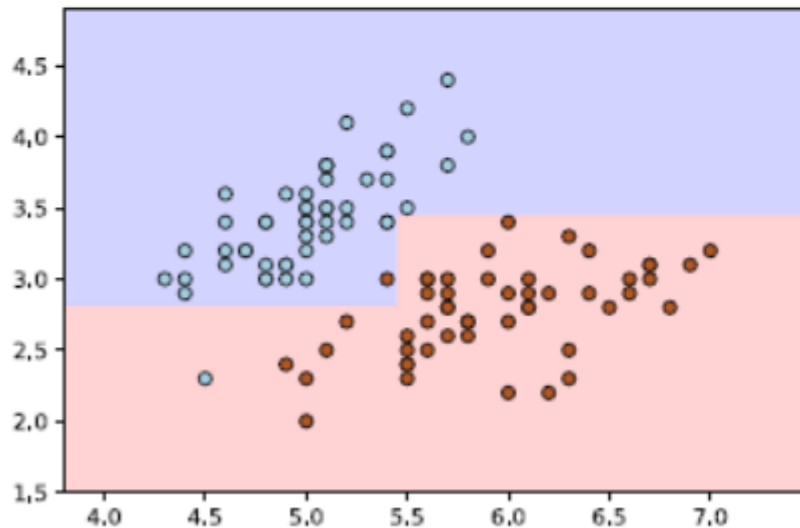
Decision Tree



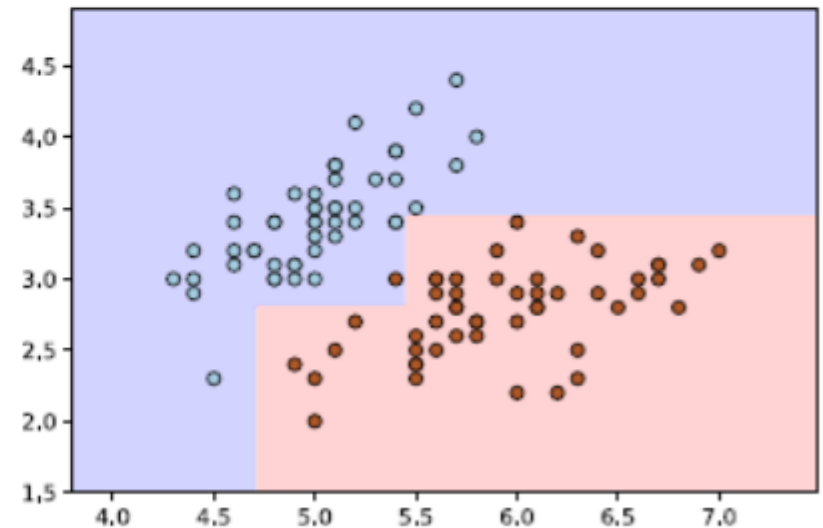
tree height = 1



Decision tree with height = 1

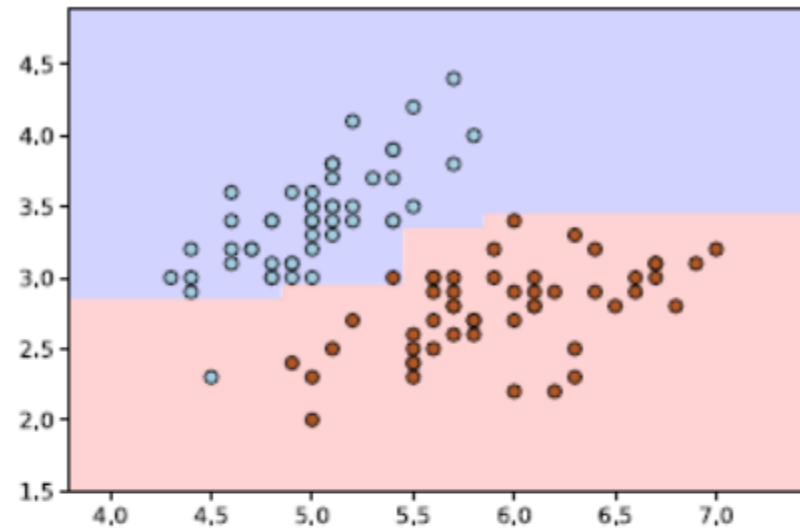


tree height = 2

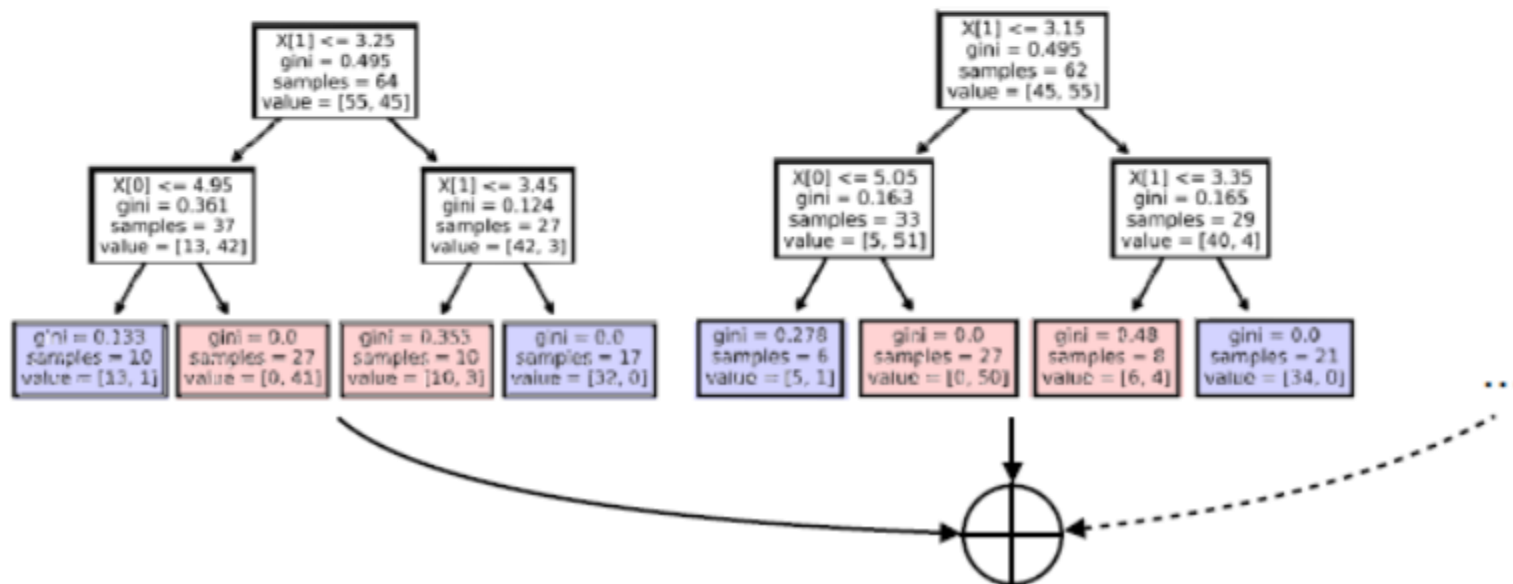


tree height = 3

Random Forest



number of trees = 10, tree height = 2



Hands-On Example

- ❑ In order to design a Machine Learning algorithm, we need:
 - ❑ Input, also known as features: **X**
 - ❑ Output, also known as labels: **y**
 - ❑ Target Function: **f: X → y** (unknown to us)
- ❑ Example:

x		y
0	1	a
1	2	a
2	1	b
2	3	b
1	3	a
2	2	b

Hands-On Example

- ❑ Python provides a set of libraries including different ML packets
- ❑ Standard libraries provide the ready-to-use implementation of algorithm
- ❑ The **scikit-learn** is the one we will use in this lecture



Hands-On Example

```
from sklearn import svm

X = [[0, 1], [1, 2], [2, 1], [2, 3], [1, 3], [2, 2]]
y = ['a', 'a', 'b', 'b', 'a', 'b']

clf = svm.SVC()

clf.fit(X, y)

result1 = clf.predict([[3, 1]])
print(result1)

result2 = clf.predict([[0, 2]])
print(result2)

['b']
['a']
```




The only stupid question is the one you were afraid to ask but never did.

-Rich Sutton