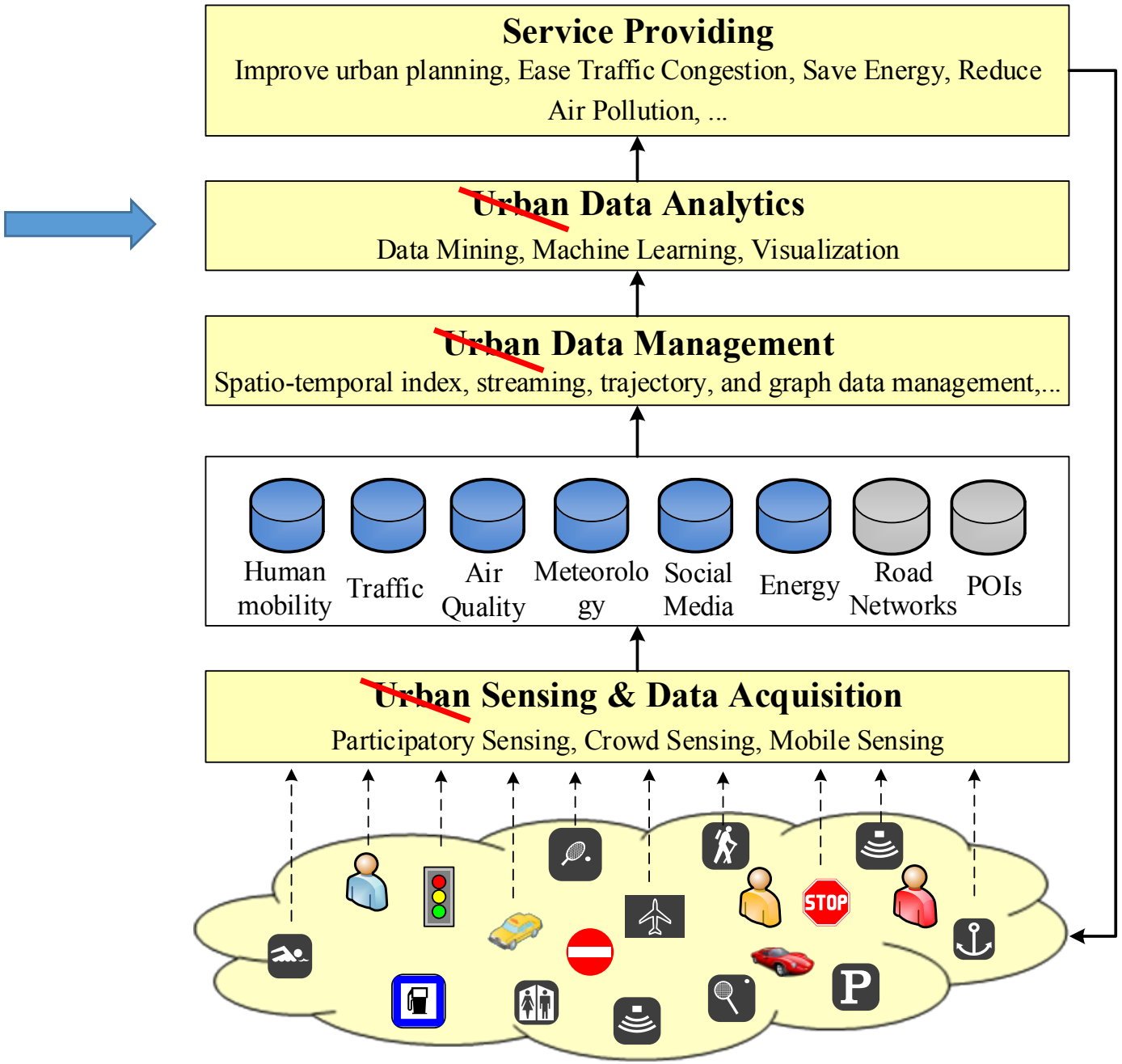
Welcome to

DS3010:
DS-III: Computational Data Intelligence
Machine Learning Introduction

Prof. Yanhua Li

Time: 11:00am – 12:50pm M & R
Location: HL 114
D-term 2022

Data pipeline

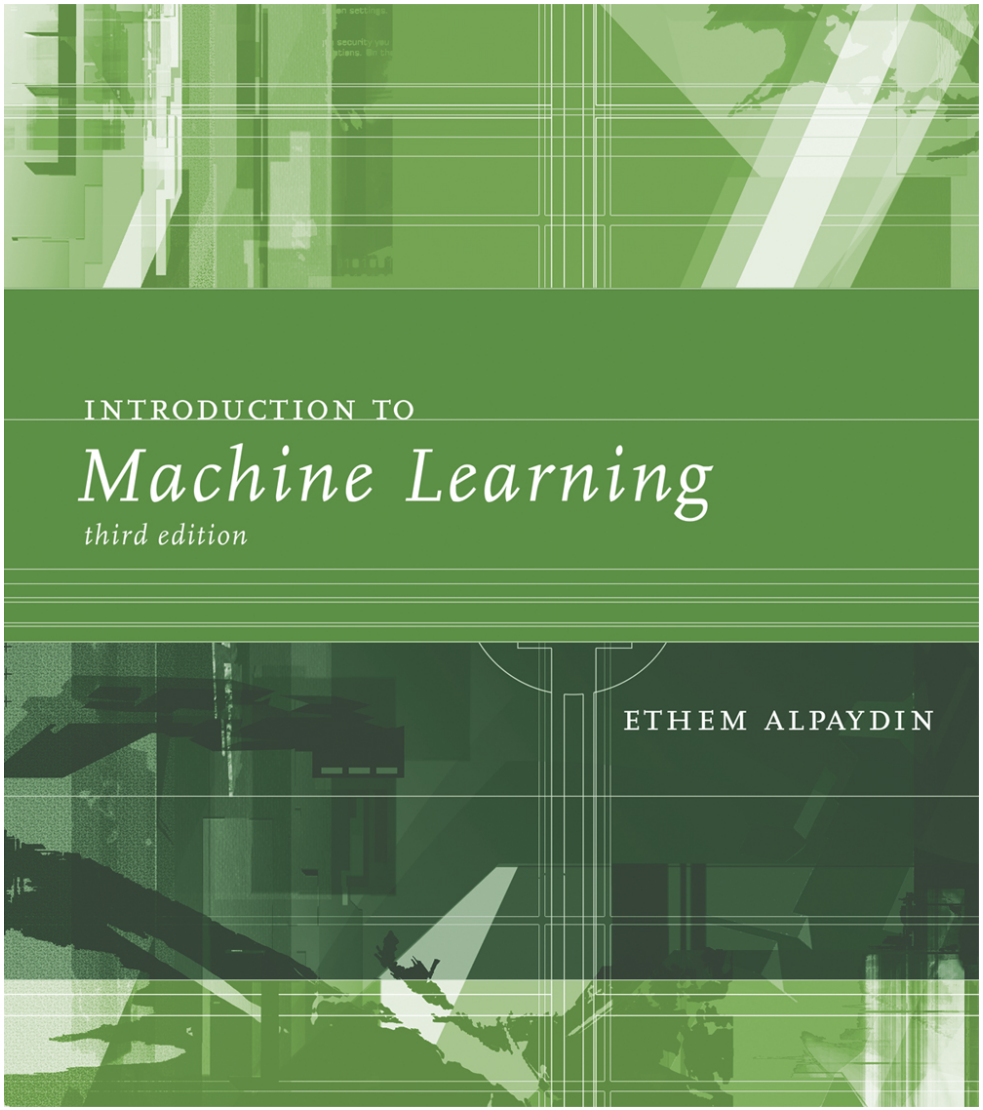


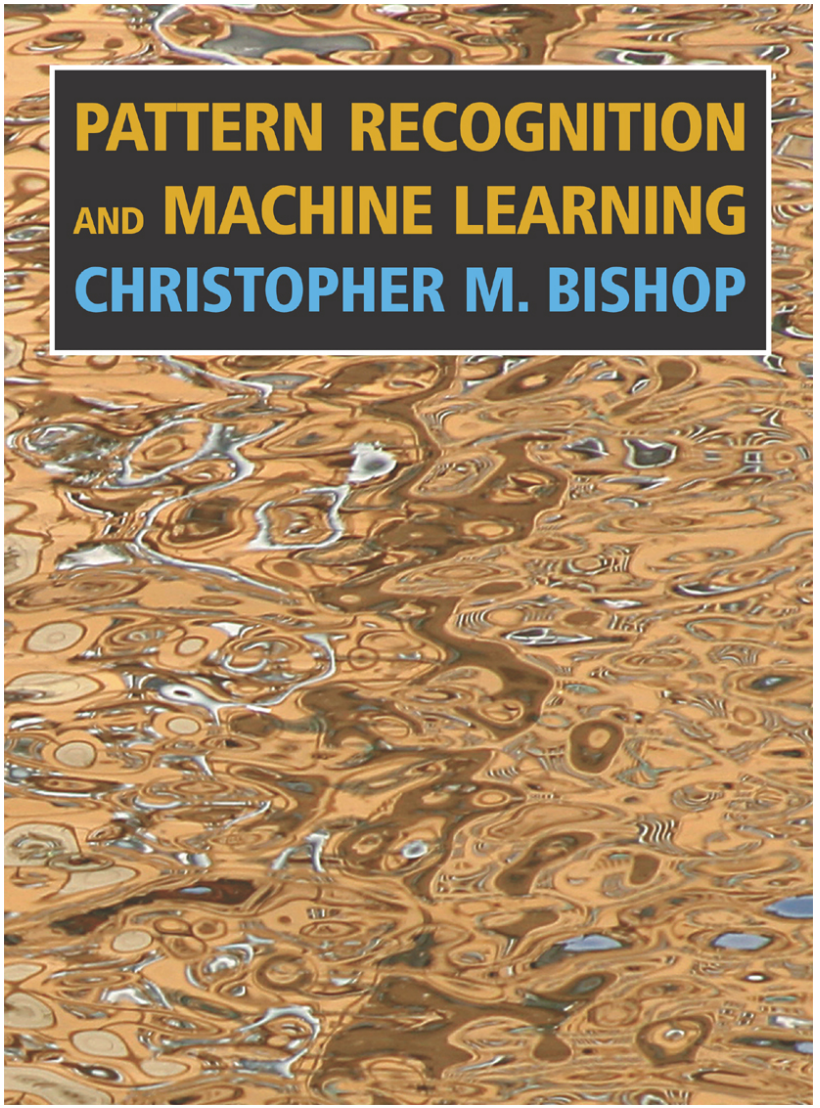
Urban Computing: concepts, methodologies, and applications.
Zheng, Y., et al. *ACM transactions on Intelligent Systems and Technology*.

Data analytics

Data mining, machine learning, etc.

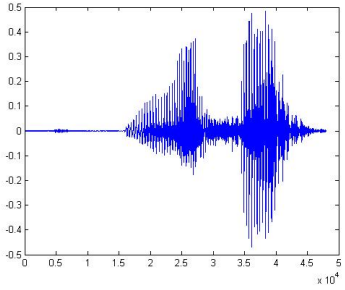
References


INTRODUCTION TO
Machine Learning
third edition
ETHEM ALPAYDIN


PATTERN RECOGNITION
AND MACHINE LEARNING
CHRISTOPHER M. BISHOP

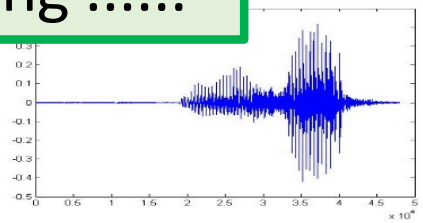
What is Machine Learning?

What is Machine Learning?

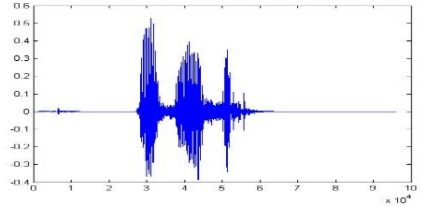


You said “Hello”

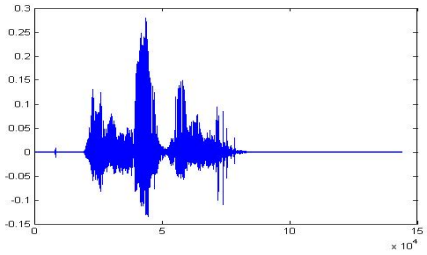
Learning ……



“Hi”



“How are you”



“Good bye”

A large amount of audio data

You write the program for learning.

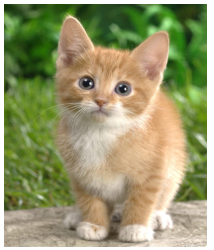
What is Machine Learning?

Learning .....

This is “cat”

You write the program for learning.

“monkey”



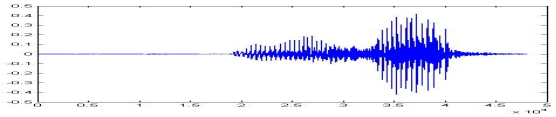
“cat”

“dog”

A large amount of images

Machine Learning ≈ Looking for a Function

- Speech Recognition

$f($  $)=$ “How are you”

- Image Recognition

$f($  $)=$ “Cat”

- Playing Go

$f($  $)=$ “5-5” (next move)

- Dialogue System

$f($ “Hi” $)=$ “Hello”

(what the user said) (system response)

Framework

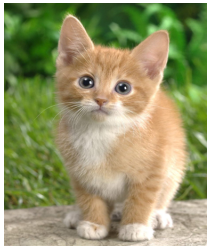
Image Recognition:

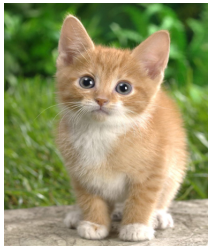
$f($  $)=$ “cat”

A set of function

Model

$f_1, f_2 \cdots$

$f_1($  $)=$ “cat”

$f_2($  $)=$ “money”

$f_1($  $)=$ “dog”

$f_2($  $)=$ “snake”

Framework

Image Recognition:

$f($  $) =$ "cat"

A set of function

Model

$f_1, f_2 \cdots$

Goodness of function f

Training Data

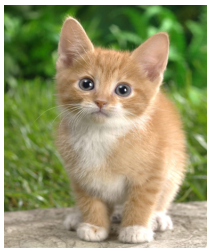
$f_1($  $) =$ "cat"

$f_2($  $) =$ "money"

Better!

$f_1($  $) =$ "dog"

$f_2($  $) =$ "snake"

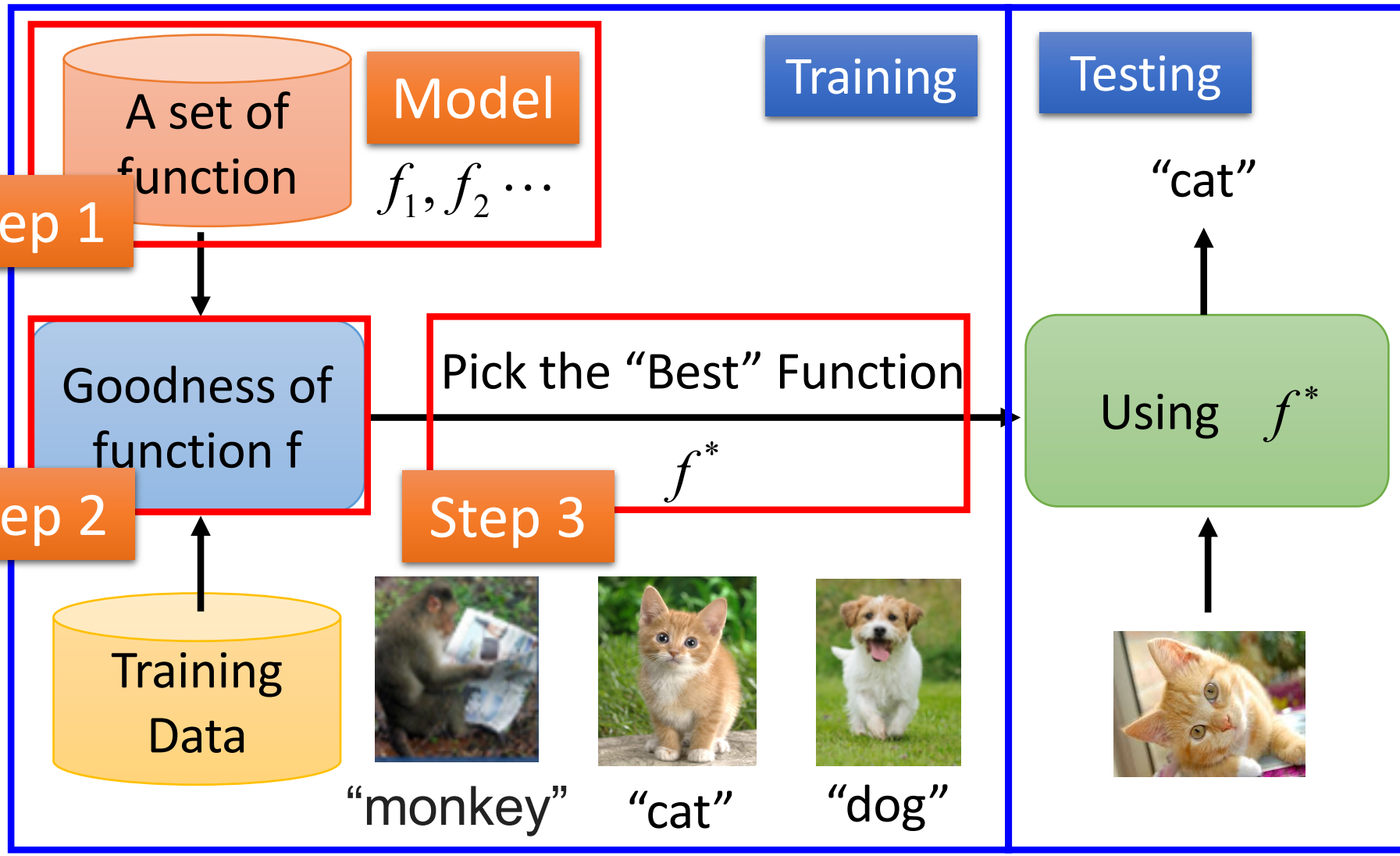
function input:   

function output: "monkey" "cat" "dog"

Framework

Image Recognition:

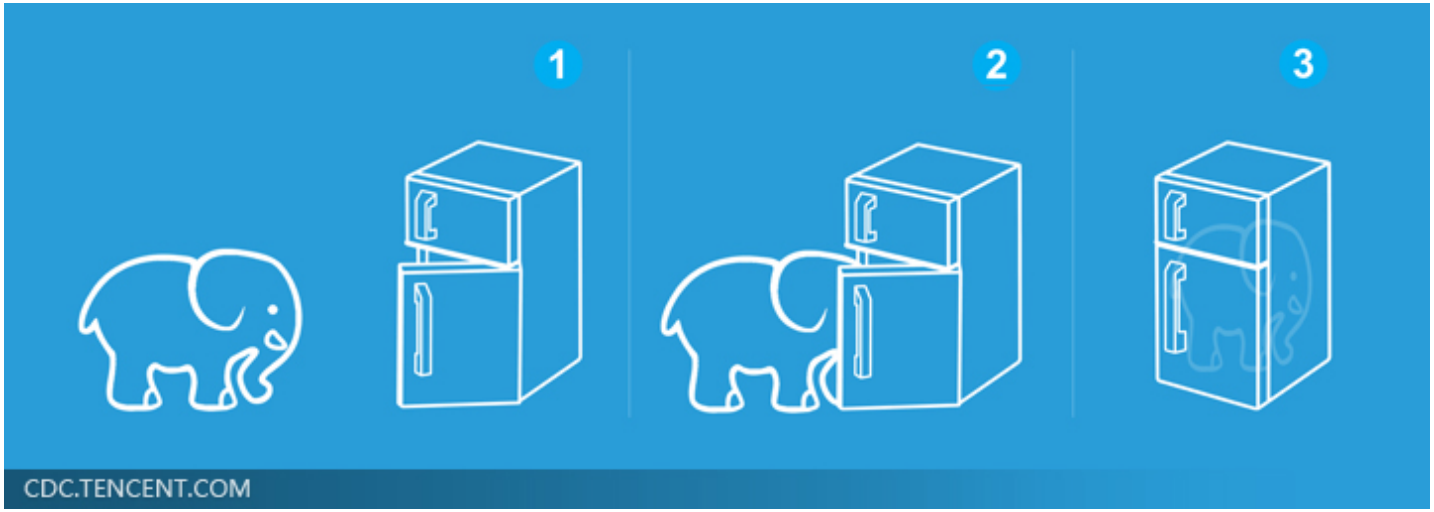
$f($  $)=$ "cat"



Machine Learning is so simple ……

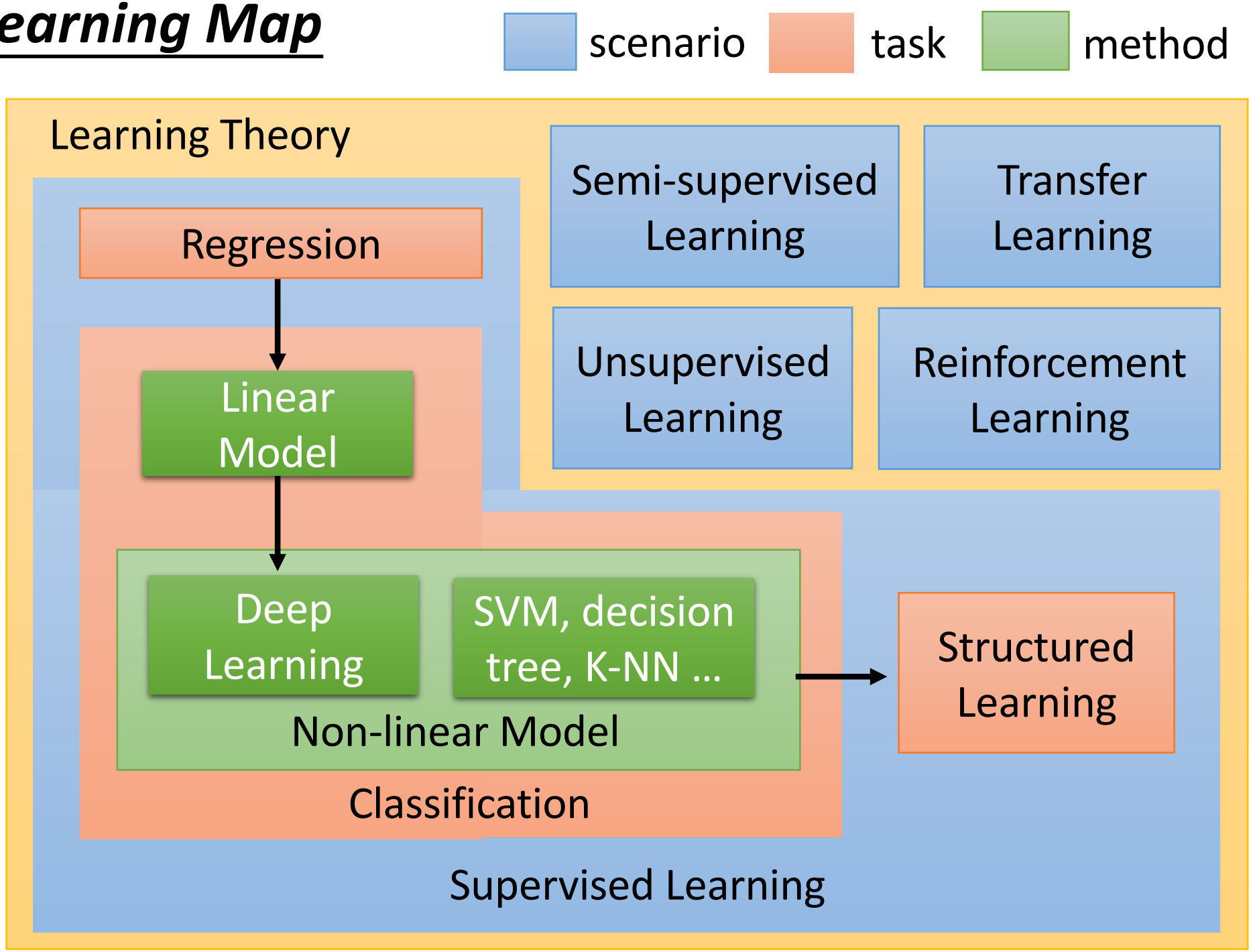
Step 1: define a set of function → Step 2: goodness of function → Step 3: pick the best function

It is as simple as putting an elephant into a refrigerator…



Machine learning paradigms

Learning Map

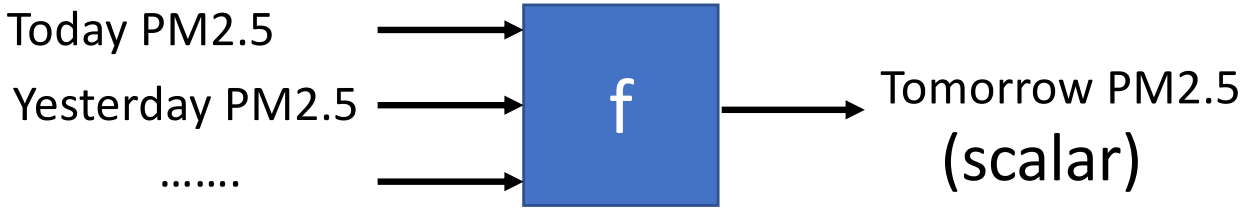


Learning Map

Regression

The output of the target function f is "scalar".

Predict PM2.5



Training Data:

Input:

9/01 PM2.5 = 63 9/02 PM2.5 = 65

Output:

9/03 PM2.5 = 100

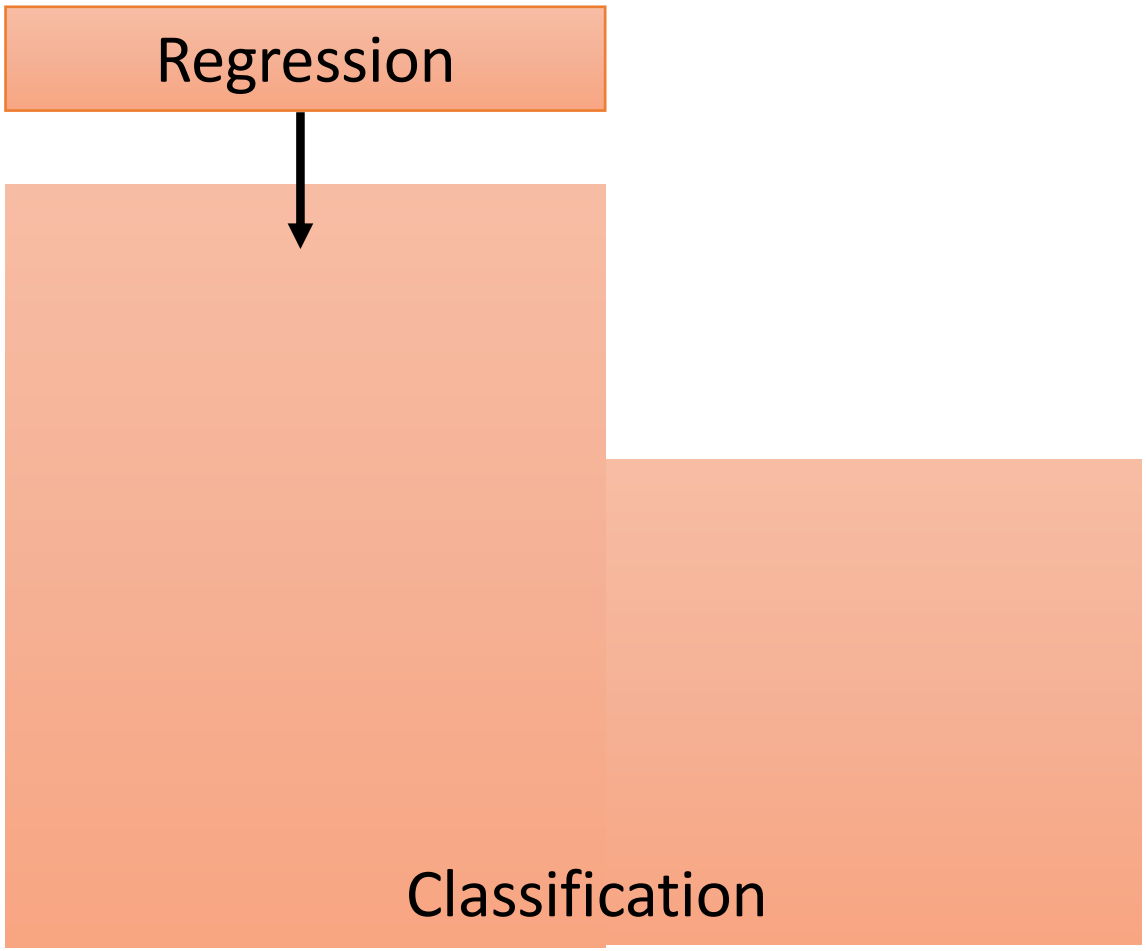
Input:

9/12 PM2.5 = 30 9/13 PM2.5 = 25

Output:

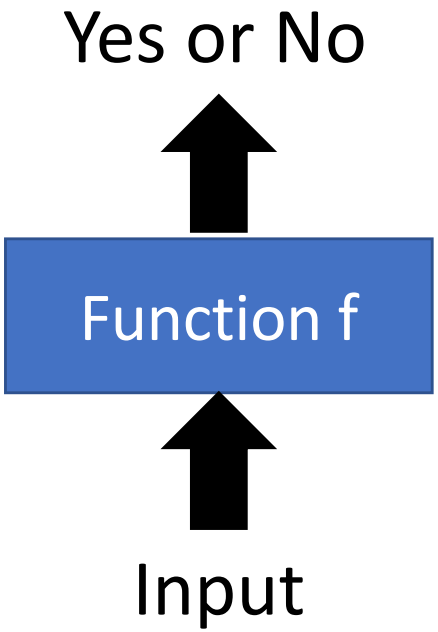
9/14 PM2.5 = 20

Learning Map

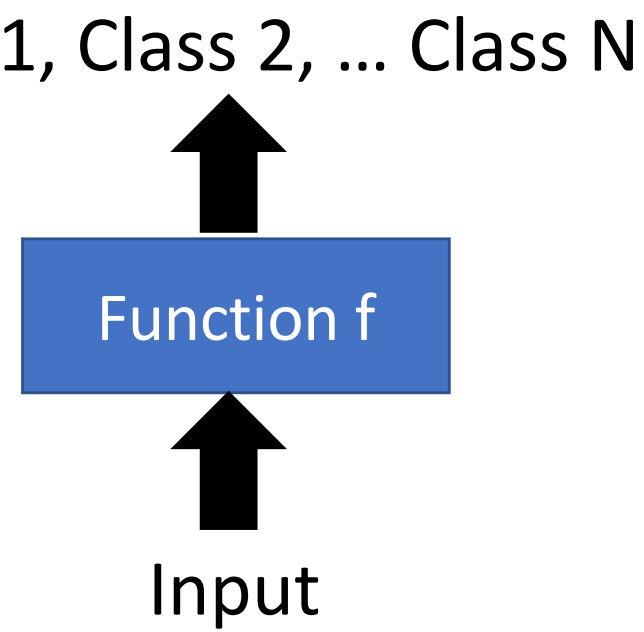


Classification

- Binary Classification

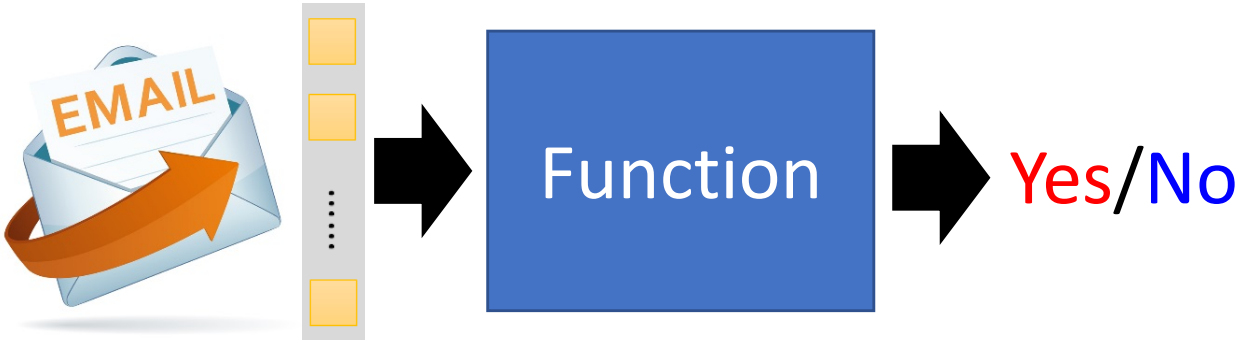


- Multi-class Classification



Binary Classification

Spam filtering

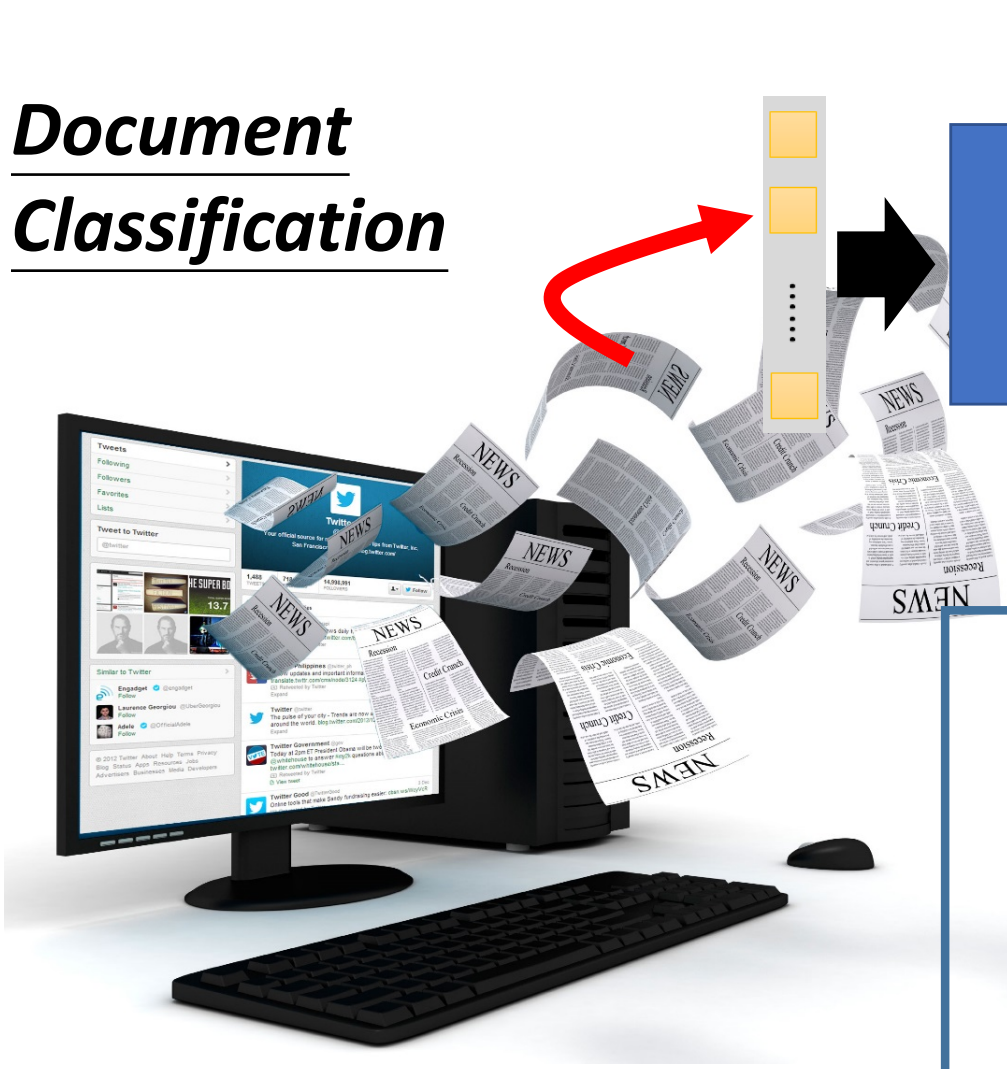


Training Data

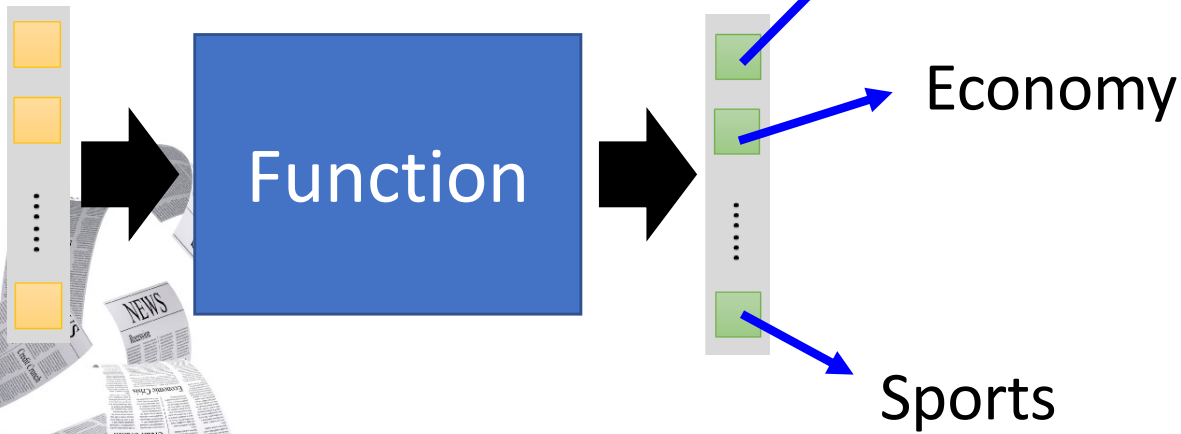
(http://spam-filter-review.toptenreviews.com/)

Multi-class Classification

Document Classification

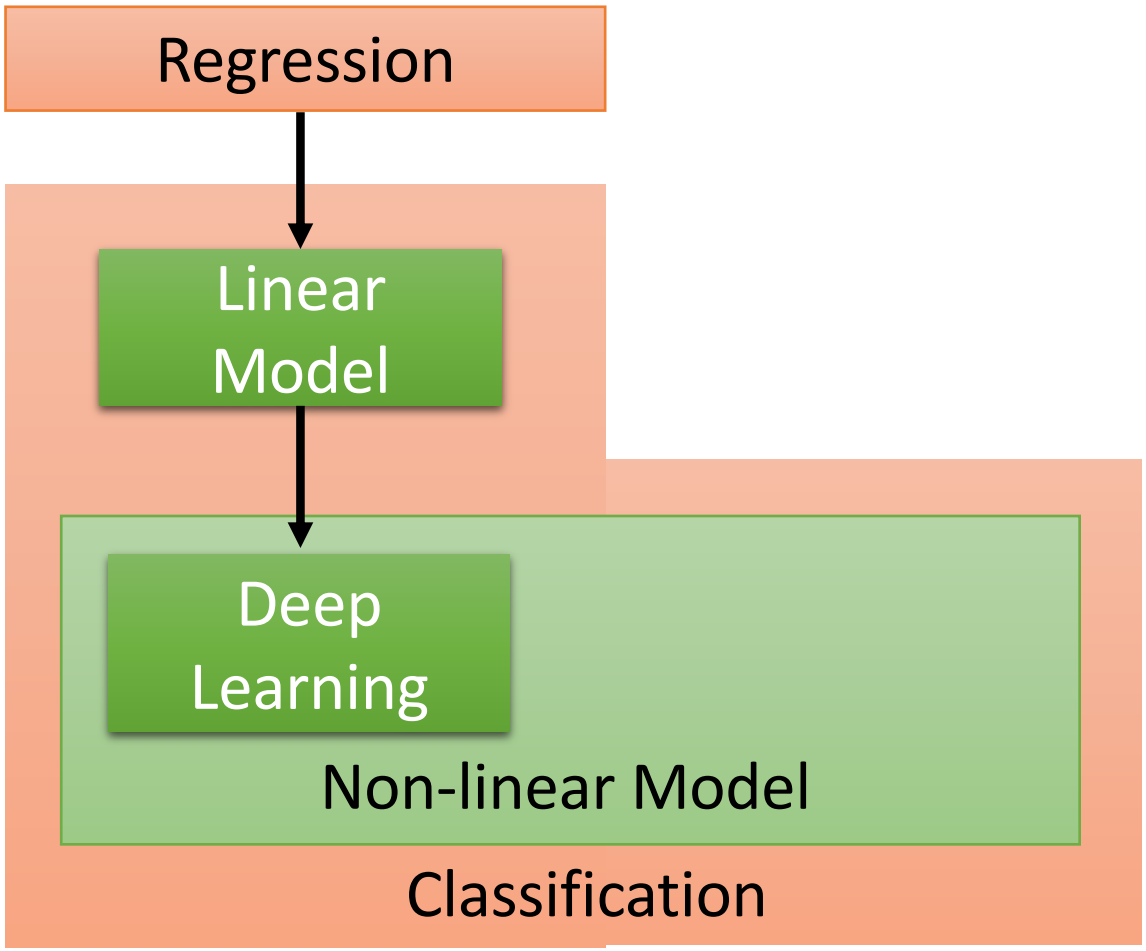


http://top-breaking-news.com/



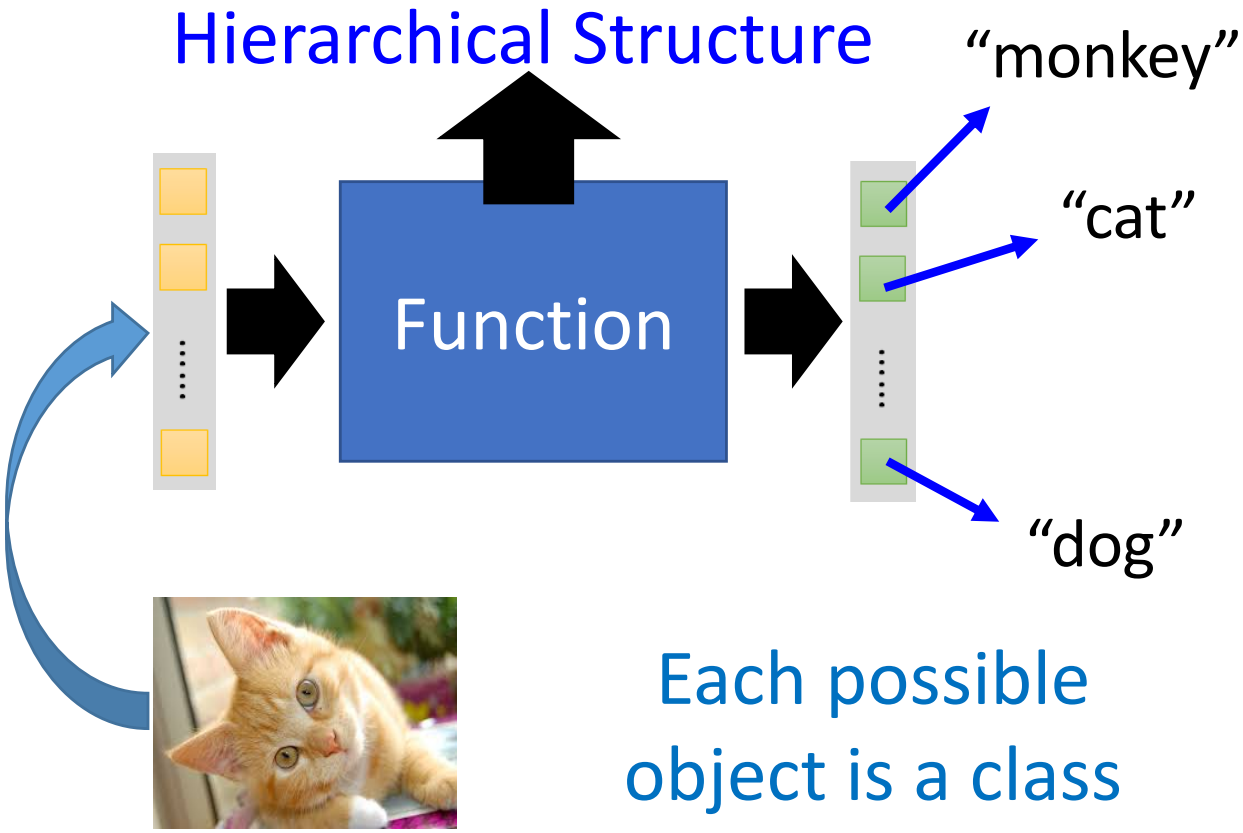
Training Data

Learning Map



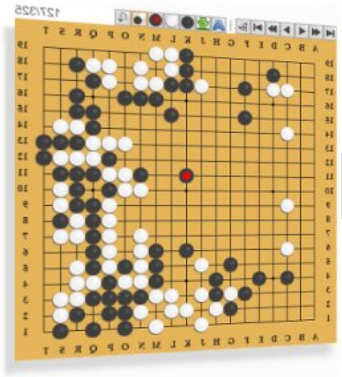
Classification - Deep Learning

- Image Recognition



Classification - Deep Learning

- Playing GO



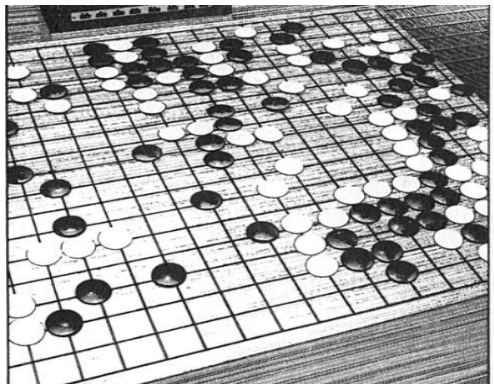
Function

Next move

Each position is a class

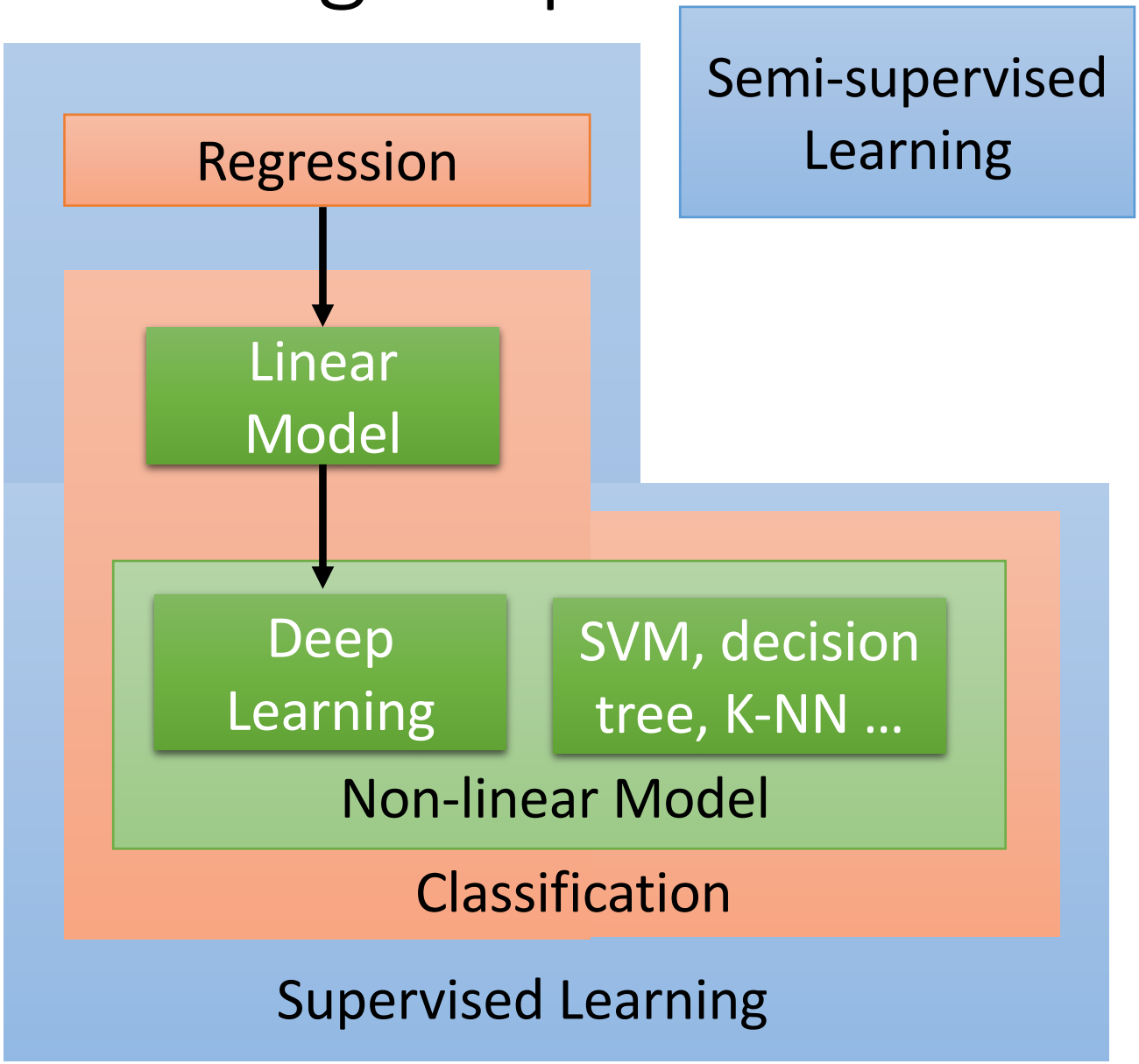
(19 x 19 classes)

Training Data



Learning Map

Hard to collect a large amount of labelled data



Training Data:

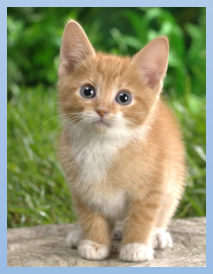
Input/output pair of target function

Function output = label

Semi-supervised Learning

For example, recognizing cats and dogs

Labelled data



cat

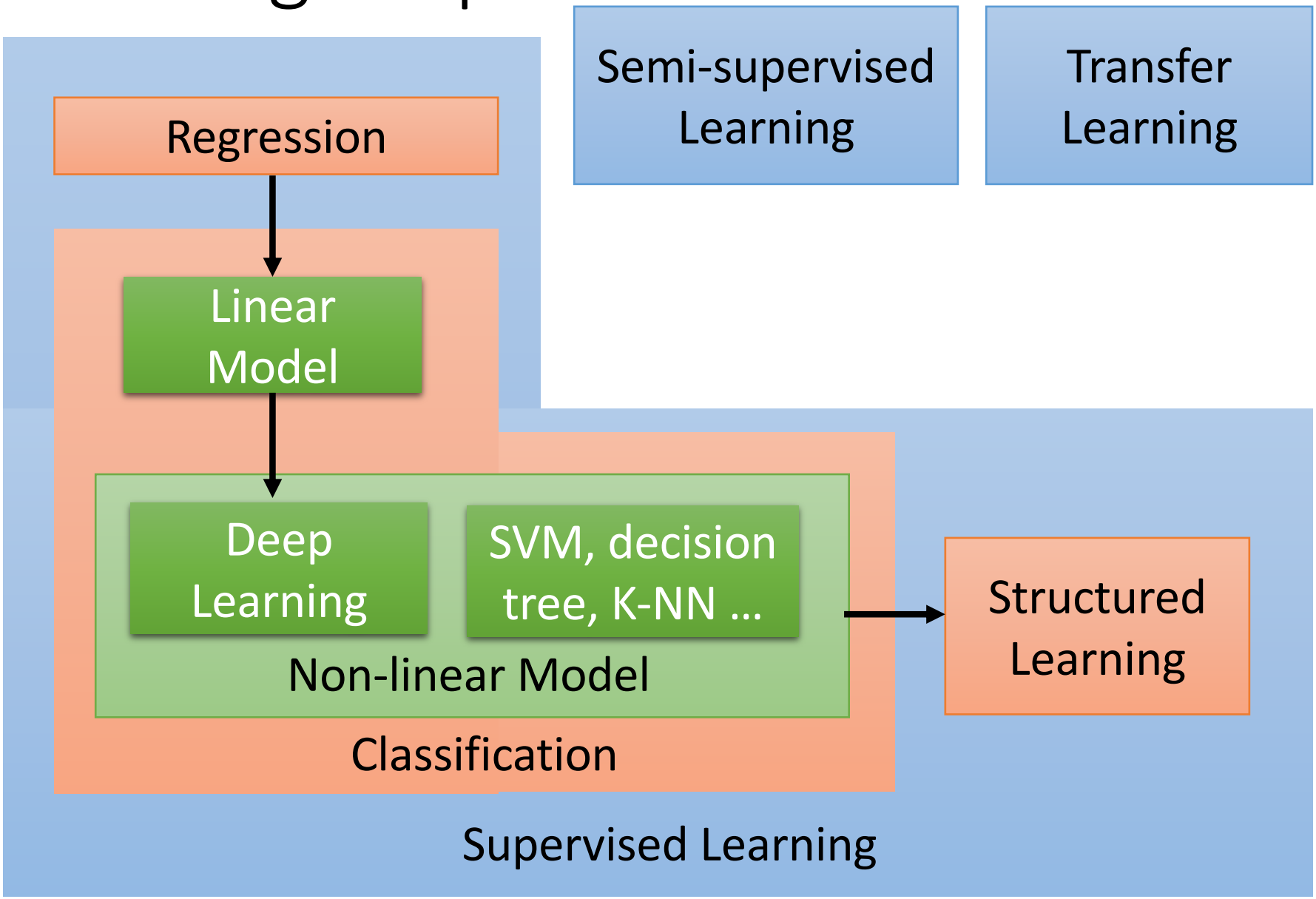
dog

Unlabeled data




(Images of cats and dogs)

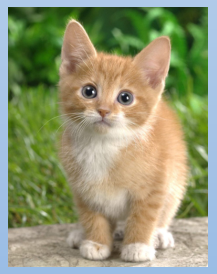
Learning Map



Transfer Learning

For example, recognizing cats and dogs

Labelled data

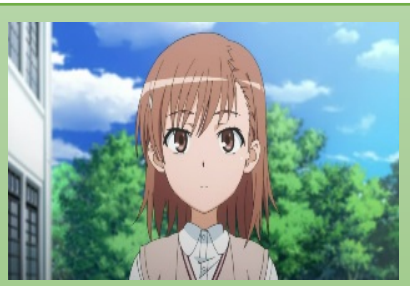


cat

dog

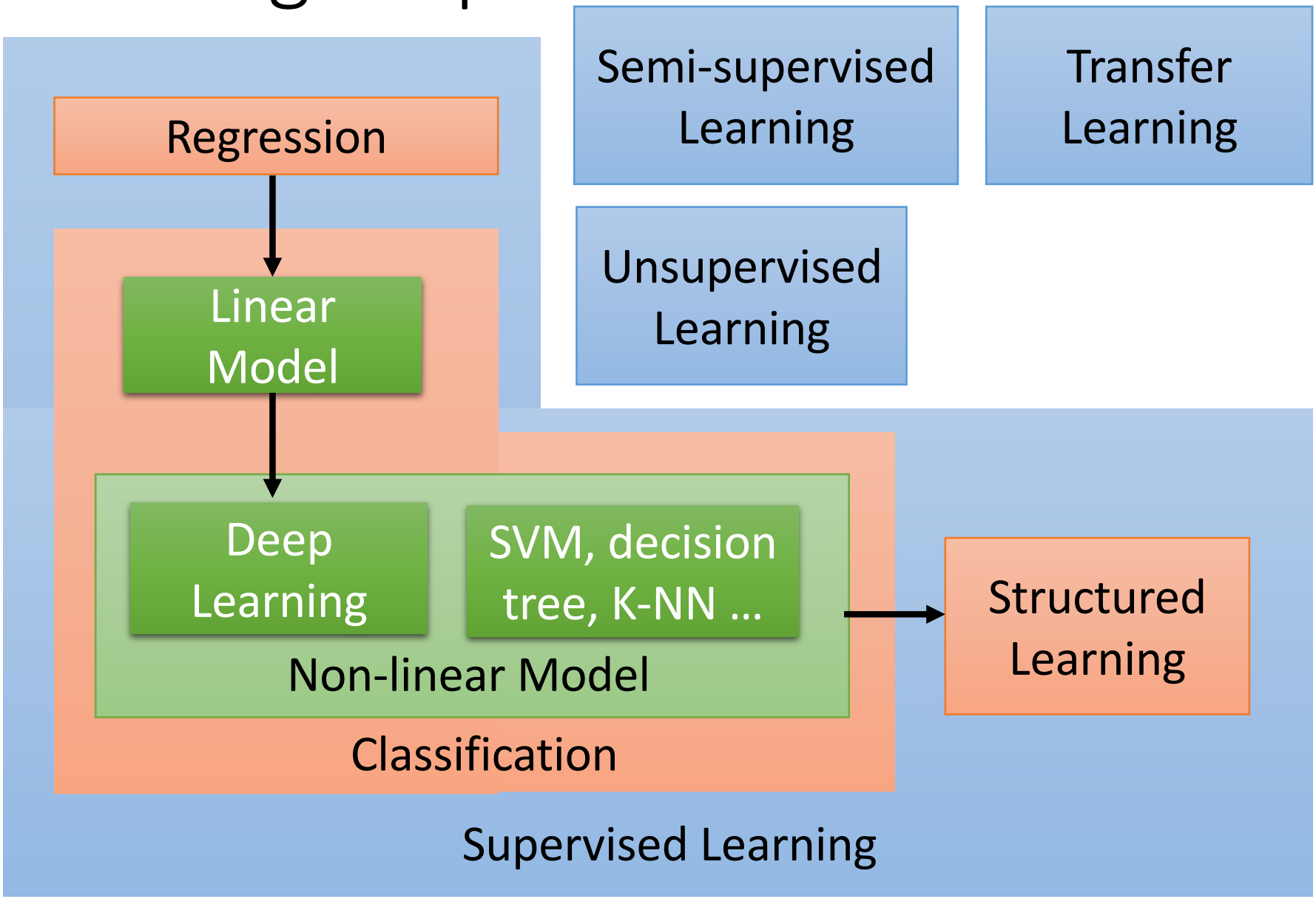
elephant

Haruhi



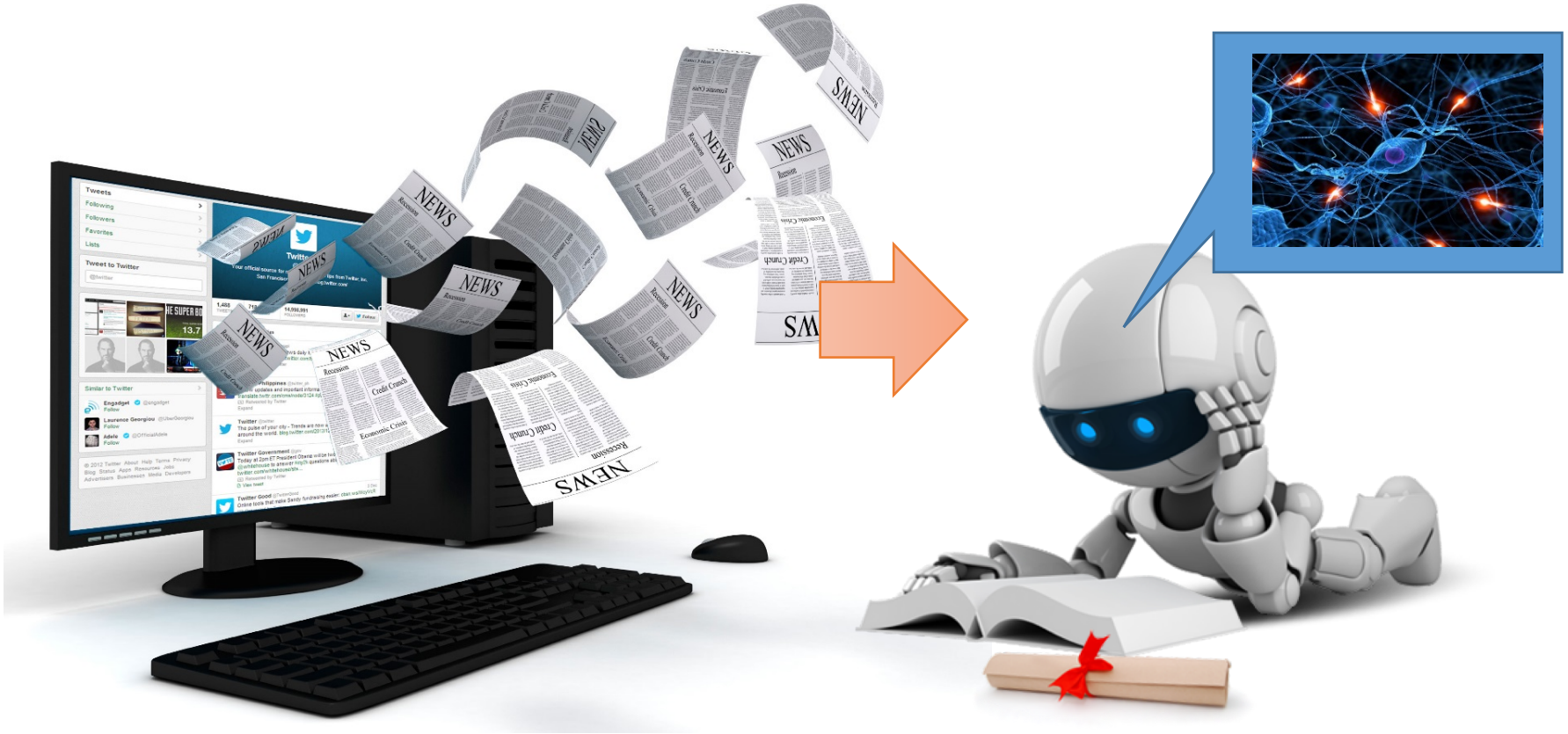
Data not related to the task considered
(can be either labeled or unlabeled)

Learning Map



Unsupervised Learning

- Machine Reading: Machine learns the meaning of words from reading a lot of documents



http://top-breaking-news.com/

Unsupervised Learning

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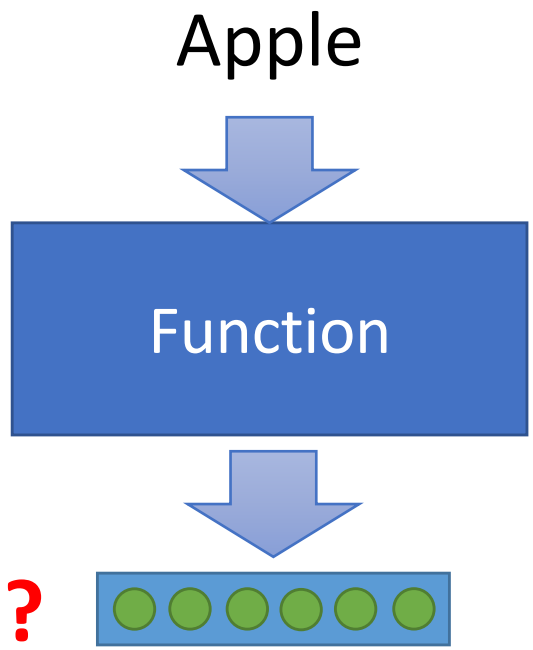
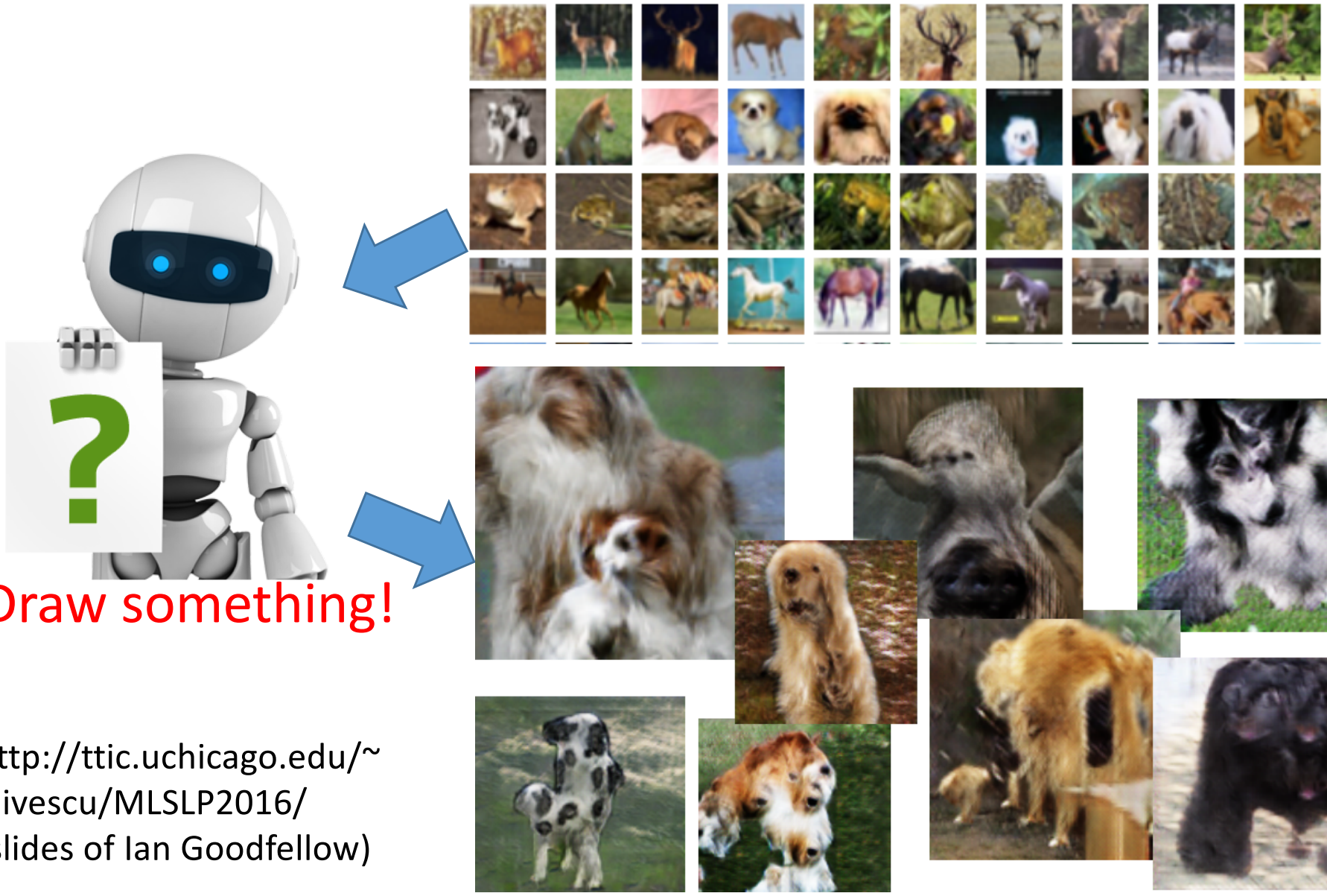


Training data is a lot of text

https://garavato.files.wordpress.com/2011/11/stacksdocuments.jpg?w=490

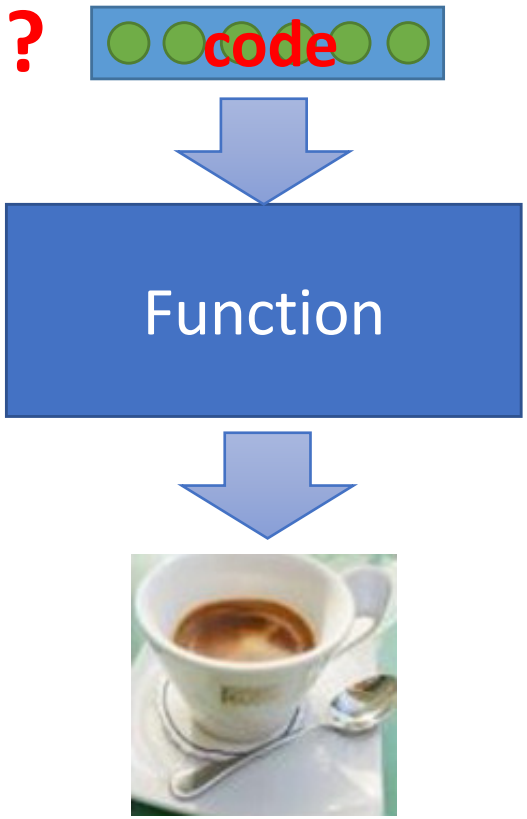
Unsupervised Learning



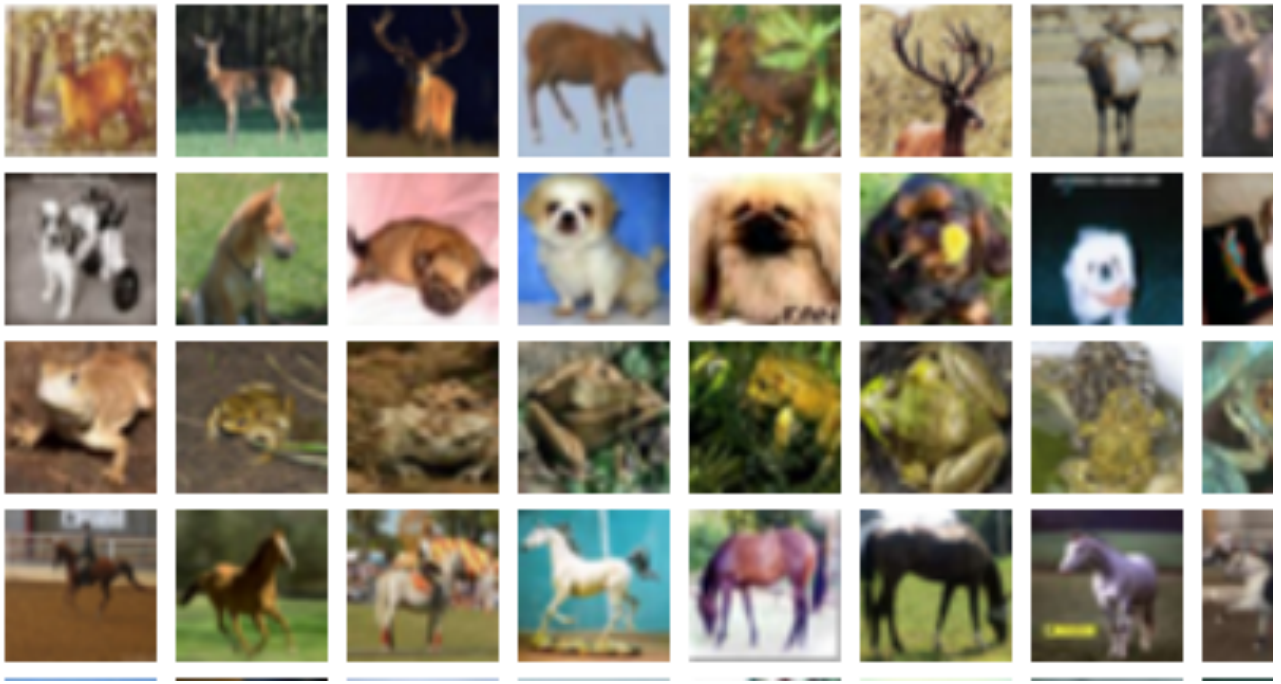
http://ttic.uchicago.edu/~klivescu/MLSLP2016/
(slides of Ian Goodfellow)

Unsupervised Learning

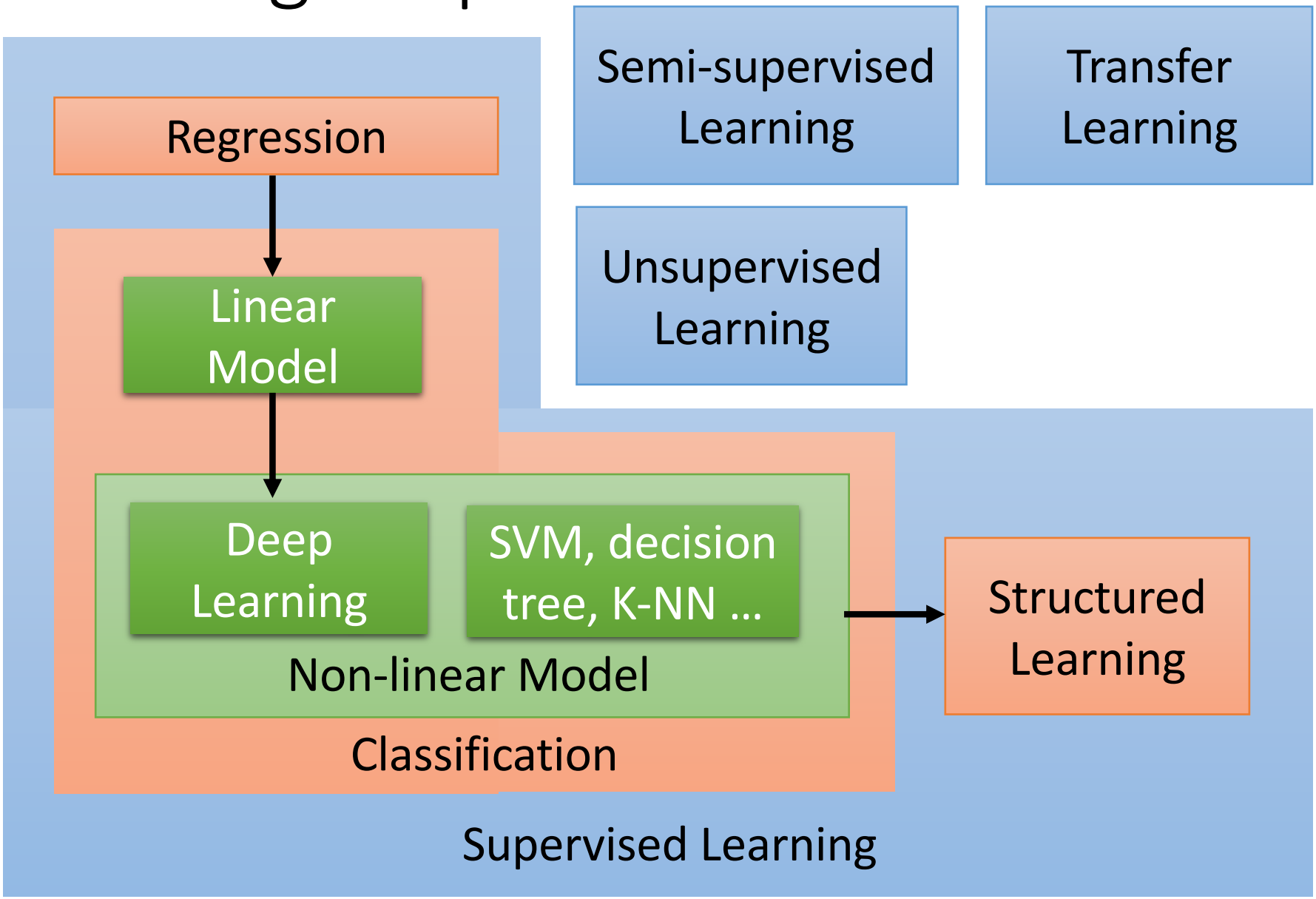
- Machine Drawing



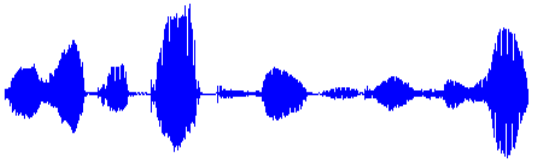
Training data is a lot of images



Learning Map



Structured Learning
- Beyond Classification



“Hello. Welcome to DS3010.”

Speech Recognition

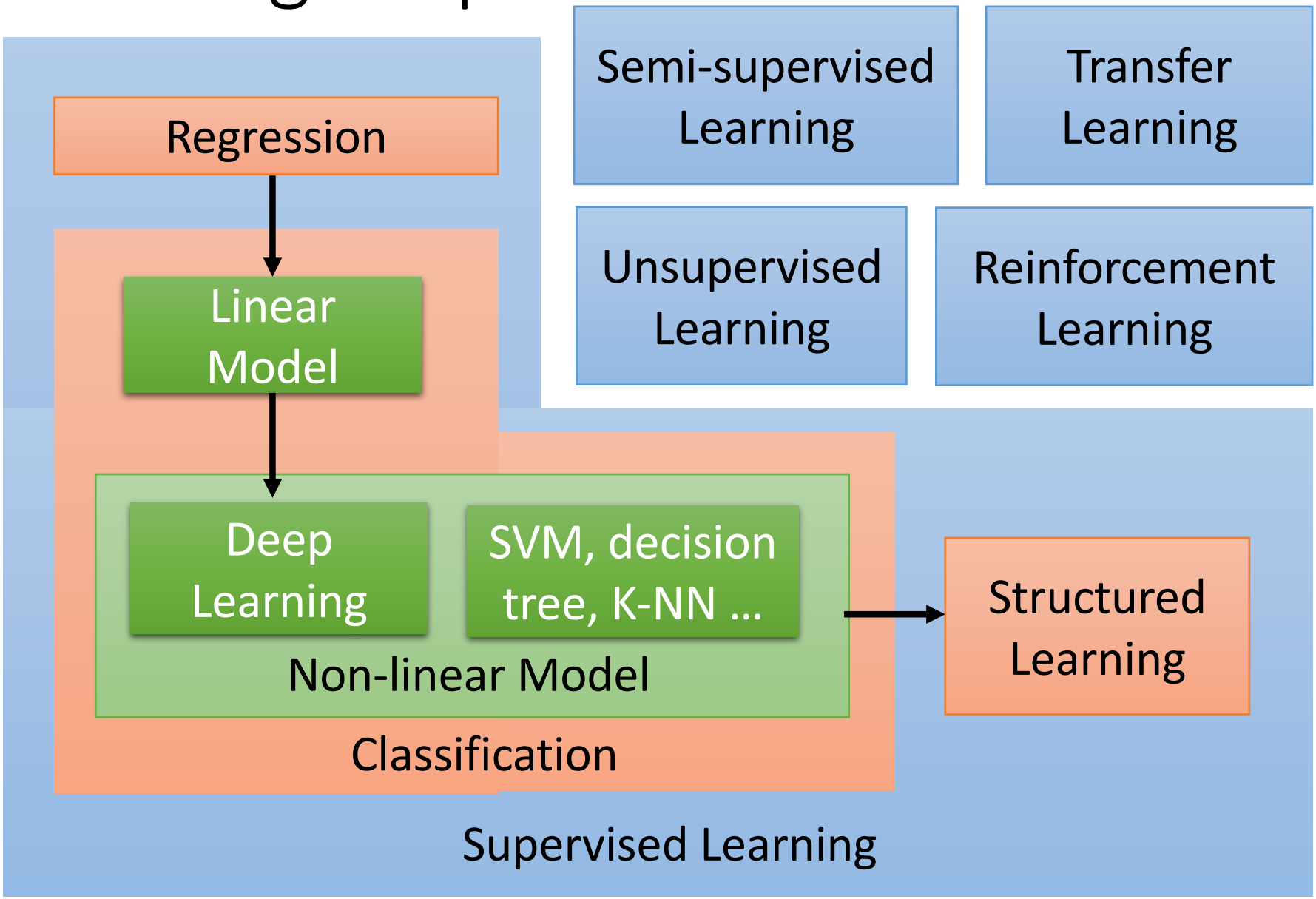
“机器学习”

“Machine Learning”

Machine Translation

Face recognition

Learning Map

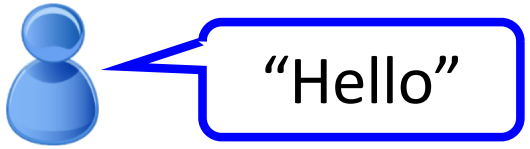


Reinforcement Learning

Supervised v.s. Reinforcement

- Supervised

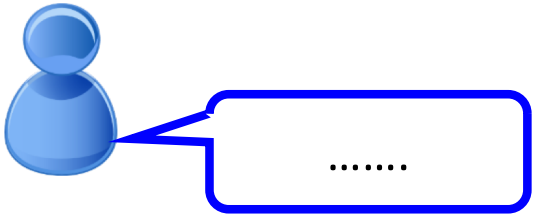
Learning from teacher

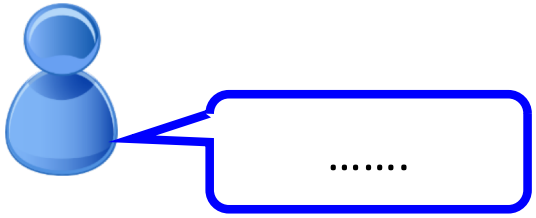


Say "Hi"

Say "Good bye"

- Reinforcement



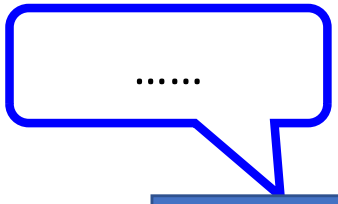


.....

Bad

Learning from critics

Agent



Agent

Supervised v.s. Reinforcement

- Supervised:

Next move:
"5-5"

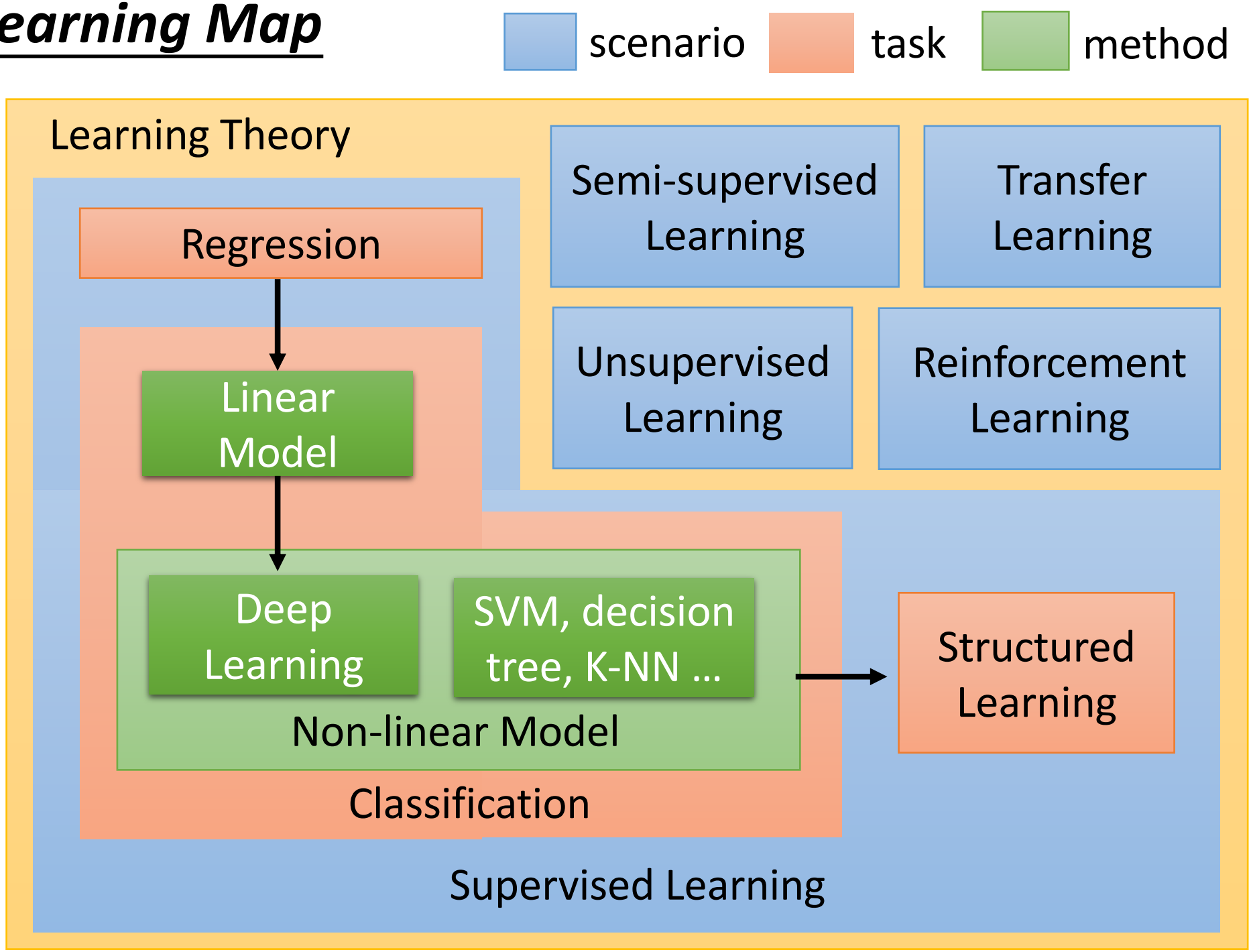
Next move:
"3-3"

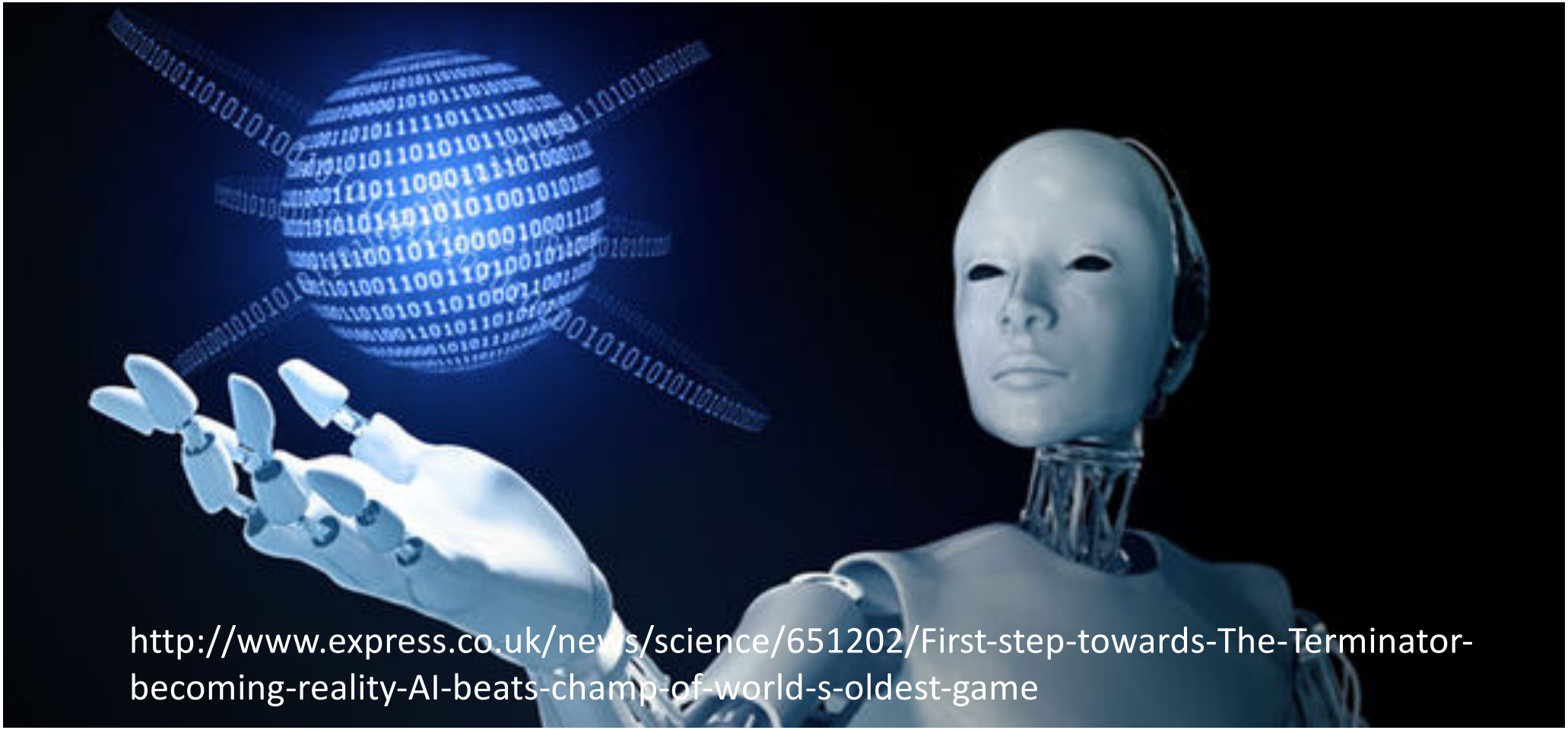
- Reinforcement Learning

First move → …… many moves …… → Win!

Alpha Go is supervised learning + reinforcement learning.

Learning Map

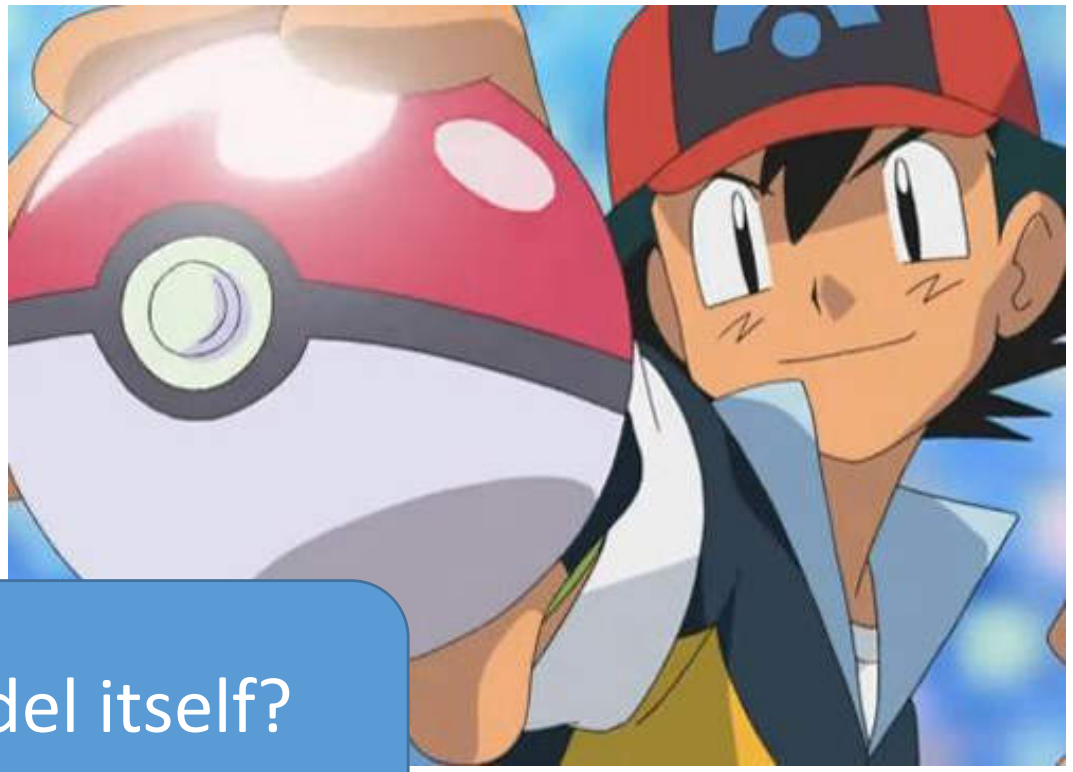




Why we need to learn Machine Learning?

AI will replace some jobs! New job：AI engineer

AI Engineer



AI can learn the model itself?
Why do we still need AI engineer?

Pokemon's can fight,
Why do we still need Pokemon trainers?

AI Engineer

Pokemon trainer

- Trainers need to choose high quality Pokemons to train with good attributes
  - Pokemons have different attributes

AI engineer

- AI engineers need to choose the right model, loss function
  - Different models, loss functions fit different problems

AI Engineer

Pokemon trainer

- Trainers need to choose high quality Pokemons to train with good attributes
  - Pokemons have different attributes
- Pokemons need to evolve to be stronger, but may not lead to the strongest ones.
  - Needs experienced Pokemon trainer

AI engineer

- AI engineers need to choose the right model, loss function
  - Different models, loss functions fit different problems
- May not find the best function
  - E.g. Deep Learning
  - Need experience from AI engineer

Questions?