Introduction of this course

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Since an early flush of optimism in the 1950s, smaller subsets of artificial intelligence – first machine learning, then deep learning, a subset of machine learning – have created ever larger disruptions.

人類設定好的天生本能

• E.g. You want to build a Chat-bot ...
  • If there is “turn off” in the input, then “turn off the music” (hand-crafted rules)
    • You can say “Please turn off the music” or “Can you turn off the music?”. Smart?
    • What if someone says “Please don’t turn off the music” ......

• Weakness of hand-crafted rules
  • Hard to consider all possibilities
    • 永遠無法超越創造者
  • Lots of human efforts (not suitable for small industry)
人類設定好的天生本能

• AI?


Shared on Yann LeCun’s FB
What is Machine Learning?

You said “Hello”

You write the program for learning.

A large amount of audio data

“Hi”

“How are you”

“Good bye”

Learning ......
What is Machine Learning?

You write the program for learning.

This is "cat"

A large amount of images
Machine Learning ≈ Looking for a Function

- Speech Recognition
  \[ f( \text{(what the user said)} ) = \text{“How are you”} \]

- Image Recognition
  \[ f( \text{(system response)} ) = \text{“Cat”} \]

- Playing Go
  \[ f( \text{(next move)} ) = \text{“5-5”} \]

- Dialogue System
  \[ f( \text{“Hi” (system response)} ) = \text{“Hello” (what the user said)} \]
Image Recognition:

\[ f(\text{cat}) = \text{“cat”} \]

\[ f(\text{money}) = \text{“money”} \]

\[ f(\text{snake}) = \text{“snake”} \]
Framework

A set of function $f_1, f_2 \ldots$

Goodness of function $f$

Training Data

Model

Image Recognition:

$f(\text{cat}) = \text{“cat”}$

Better!

$f_1(\text{cat}) = \text{“cat”}$
$f_2(\text{money}) = \text{“money”}$

$f_1(\text{dog}) = \text{“dog”}$
$f_2(\text{snake}) = \text{“snake”}$

function input:

function output: “monkey” “cat” “dog”
Image Recognition:

\[ f(\text{cat}) = \text{“cat”} \]

**Framework**

1. **Training Data**
2. **Goodness of function f**
3. **Pick the “Best” Function**
4. **Using \( f^* \)**
Machine Learning is so simple ......

Step 1: define a set of function

Step 2: goodness of function

Step 3: pick the best function

就好像把大象放进冰箱 ......
Learning Map
Learning Map

Supervised Learning

Regression

Linear Model

Semi-supervised Learning

Transfer Learning

Unsupervised Learning

Reinforcement Learning

Structured Learning

Classification

Supervised Learning

Non-linear Model

Deep Learning

SVM, decision tree, K-NN ...

Learning Theory

Learning Map scenario task method
The output of the target function $f$ is “scalar”.

Training Data:

<table>
<thead>
<tr>
<th>Input</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>9/01 上午 PM2.5 = 63</td>
<td>9/03 上午 PM2.5 = 100</td>
</tr>
<tr>
<td>9/02 上午 PM2.5 = 65</td>
<td></td>
</tr>
<tr>
<td>9/12 上午 PM2.5 = 30</td>
<td>9/14 上午 PM2.5 = 20</td>
</tr>
<tr>
<td>9/13 上午 PM2.5 = 25</td>
<td></td>
</tr>
</tbody>
</table>
Learning Map

Regression

Classification
Classification

• Binary Classification

Yes or No

Function f

Input

• Multi-class Classification

Class 1, Class 2, ... Class N

Function f

Input
Binary Classification

**Spam filtering**

Yes / No

Function

Yes

No

Training Data

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

Document Classification

Function

Training Data

http://top-breaking-news.com/
Classification - Deep Learning

• Image Recognition

Hierarchical Structure

Function

Training Data

Each possible object is a class
Classification - Deep Learning

- Playing GO

Next move
Each position is a class
(19 x 19 classes)

Training Data

進藤光 v.s. 社清春

黑: 5之五 → 白: 天元 → 黑: 五之5

一堆棋譜
Classification - Deep Learning

- Playing GO

Next move
Each position is a class
(19 x 19 classes)

Training Data

進藤光 v.s. 社清春

黑: 5之五 → 白: 天元 → 黑: 五之5

Input:
黑: 5之五

Output:
天元

Input:
黑: 5之五、白: 天元

Output:
五之5
Learning Map

Supervised Learning

Regression

Linear Model

Deep Learning

SVM, decision tree, K-NN...

Non-linear Model

Classification

Semi-supervised Learning

Training Data:
Input/output pair of target function
Function output = label

Hard to collect a large amount of labelled data
Semi-supervised Learning

For example, recognizing cats and dogs

Labelled data

Unlabeled data (Images of cats and dogs)
Transfer Learning

For example, recognizing cats and dogs

Labelled data
- cat
- dog

Data not related to the task considered (can be either labeled or unlabeled)
- elephant
- tiger
- Haruhi
- Haruhi
Learning Map

Regression

Linear Model

Deep Learning

SVM, decision tree, K-NN ...

Non-linear Model

Classification

Supervised Learning

Semi-supervised Learning

Transfer Learning

Unsupervised Learning

Structured Learning
Unsupervised Learning

• Machine Reading: Machine learns the meaning of words from reading a lot of documents
Unsupervised Learning

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

Supervised Learning
- Regression
  - Linear Model
  - Deep Learning
    - Non-linear Model
      - SVM, decision tree, K-NN ...
      - Structured Learning
      - Classification
        - Supervised Learning
Structured Learning
- Beyond Classification

Speech Recognition

Machine Translation

人臉辨識
Learning Map

Supervised Learning
- Regression
  - Linear Model
  - Deep Learning
  - SVM, decision tree, K-NN ...
- Semi-supervised Learning
- Transfer Learning
- Unsupervised Learning
- Reinforcement Learning

Unsupervised Learning

Reinforcement Learning

Structured Learning

Classification

Supervised Learning
Reinforcement Learning
Supervised v.s. Reinforcement

- **Supervised**
  - Learning from teacher
    - "Hello"
    - Say "Hi"
    - "Bye bye"
    - Say "Good bye"

- **Reinforcement**
  - Learning from critics
    - Hello 😊
    - Agent
    - .....
Supervised v.s. Reinforcement Learning

- Supervised:
  
  Next move: “5-5”

- Reinforcement Learning
  
  First move ...... many moves ...... Win!

Alpha Go is supervised learning + reinforcement learning.
Learning Map

Learning Theory

- Regression
  - Linear Model
    - Deep Learning
    - SVM, decision tree, K-NN ...

Classification

Supervised Learning

- Semi-supervised Learning
- Unsupervised Learning
- Transfer Learning
- Reinforcement Learning

Structured Learning
Why we need to learn Machine Learning?

AI 即將取代部分的工作？新工作：AI 訓練師
AI 訓練師

機器不是自己會學嗎？為什麼需要 AI 訓練師

戰鬥是寶可夢在打，為什麼需要寶可夢訓練師？
神奇寶貝第5集 尼比市的決鬥

https://www.youtube.com/watch?v=uUOZz8eJ_k
寶可夢訓練師
• 寶可夢訓練師要挑選適合的寶可夢來戰鬥
  • 寶可夢有不同的屬性

AI 訓練師
• AI訓練師要挑選合適的 model, loss function
  • 不同 model, loss function 適合解決不同的問題

Step 1: define a set of function
Step 2: goodness of function
Step 3: pick the best function
神奇寶貝第106集 噴火龍·就決定是你了

https://www.youtube.com/watch?v=4G_a0KiCDc4
寶可夢訓練師
- 寶可夢訓練師要挑選適合的寶可夢來戰鬥
  - 寶可夢有不同的屬性
- 召喚出來的寶可夢不一定聽話
  - E.g. 小智的噴火龍
  - 需要有經驗的寶可夢訓練師

AI 訓練師
- AI訓練師要挑選合適的model, loss function
  - 不同model, loss function適合解決不同
    的問題
- 不一定能找出best function
  - E.g. Deep Learning
  - 需要有經驗的AI訓練師
大家還記得寶可夢的開場嗎？

https://www.youtube.com/watch?v=NyCNkq4ByzY
AI 訓練師

• 厲害的 AI ， AI 訓練師功不可沒
• 讓我們一起朝 AI 訓練師之路邁進