AI in Digital Economy

Hiecheol Kim
Daegu University, KOREA

hckim@daegu.ac.kr

1. AI & ML :Technology review
2. AI & Digital Economy
3. Closing comment

대구대학교 DAEGU UNIVERSITY

1. AI & Machine Learning

1.1 AI & ML (Machine Learning) Overview
1.2 ML Methodology
1.3 ML Performance
1.4 Neural Network Overview
1.5 Learning algorithm for Neural Network

1.1 AI & ML Overview

- AI Overview
- ML Overview
- Deep Learning Overview

AI Overview

AI definition

- Academic definition (Nils Nilsson, 2010, "The quest of AI")
  - Enable machines to possess Intelligence
  - 'Intelligence' is appropriately and expectively in the environemnt
  - Problem : the concept of 'Intelligence' is very vast !

INTELLIGENCE

AI Overview

Practical definition of AI

- Try to define AI based on what AI achieves (Inductively)

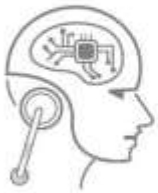
Define AI according to achievement

- Any technology that makes machines acts smartly
- AI area is what AI researchers do researches (Stanford AI 100년 Report)

Define AI according to composition of technology

- Ultimate benchmarking is human

Problem : 'AI effect' 또는 'AI paradox'



AI(Artificial Intelligence

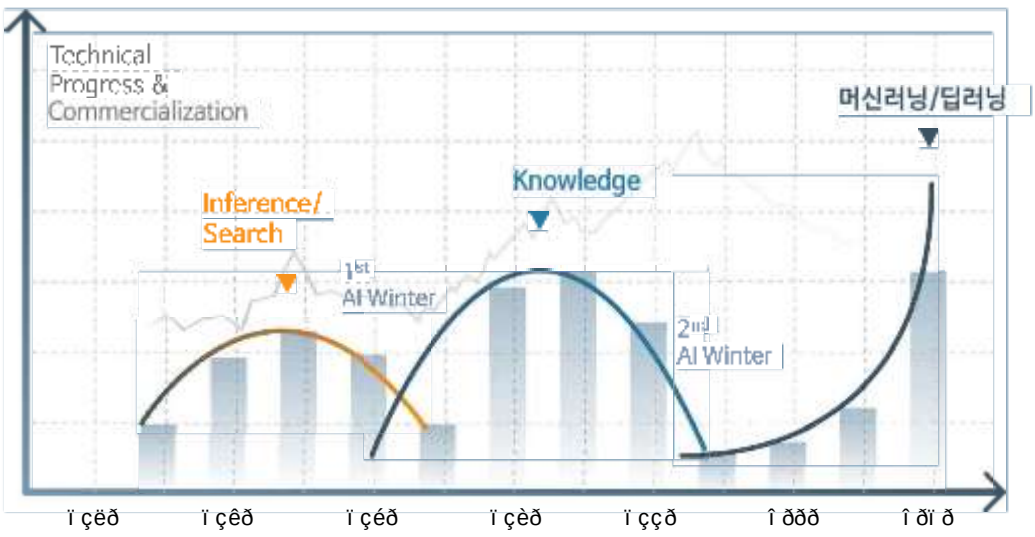
- Machine learning
  - Deep learning
  - Uns upervised
  - Supervised
- Natural language processing
  - Text generation
  - Question answering
  - Context extraction
  - Classification
  - Machine translation
- Expert systems
- Speech
  - Speech to text
  - Text to speech
- Vision
  - Image recognition
  - Machine vision
- Planning
- Robotics

AI Overview

AI History

Long history

- 1956, an workshop held in Dartmouth Univertity
- AI(Artificial Intelligence) is coined for "Machines that think as a human", (John McCarthy)



AI Overview

Technolgies

Despite AI winters, researches have conducted uninterrupted !

	주요 AI 기술
1960년대	▪ Neural networks: Perceptron ▪ Pattern recognition ▪ Minsky and Papert's proof for the limitations of Perceptron
1970년대	▪ Symbolic concept induction ▪ Expert systems & the knowledge acquisition ▪ Mathematical discovery with AM
1980년대	▪ Explanation-based Learning (EBL) ▪ Learning and planning and problem solving ▪ Resurgence of neural networks (backpropagation)
1990년대	▪ Data mining ▪ Reinforcement learning (RL) ▪ Inductive Logic Programming (ILP) ▪ Ensembles: Bagging, Boosting, and Stacking
2000년대	▪ Support vector machines ▪ Kernel methods ▪ Graphical models ▪ Transfer learning ▪ Deep learning

1.1 AI & ML Overview

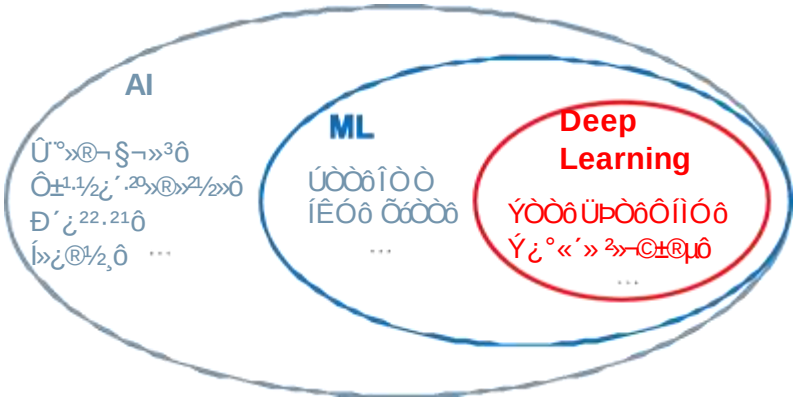
AI Overview

대구대학교 DAEGU UNIVERSITY

Relation between AI, ML and, Deep Learning

Inclusion relation

- Machine learning
  - An area to make makes learn some features and apply the knowledge to solve some problems(such as prediction, identification, classification)
- Deep learning
  - A subarea of the machine learning which automates from feature extraction to problem solving (a kind of end-to-end learning)
  - A dominant role for the current AI boom



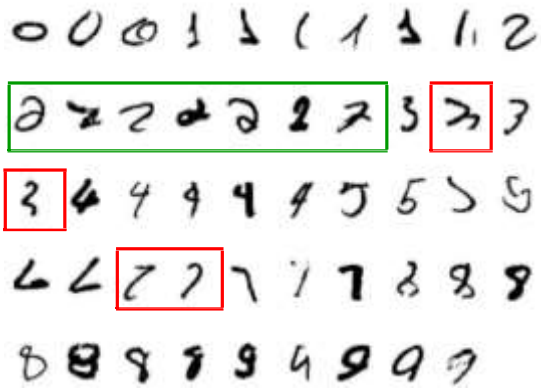
Ý±°§®·¹¸¬ ¾§Ø·»½¸»±´Õ·³

Machine Learning Overview

Motivation of ML

- There are many problems that are hard to program

Hand-written digit recognition



Face regonition

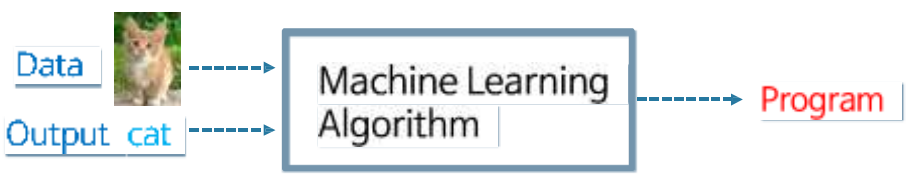
Machine Learning Overview

Think reversely : Machine Learning

How about automatic generation of 'program' using Input & Solution (Example)

Traditional programming

Machine learning

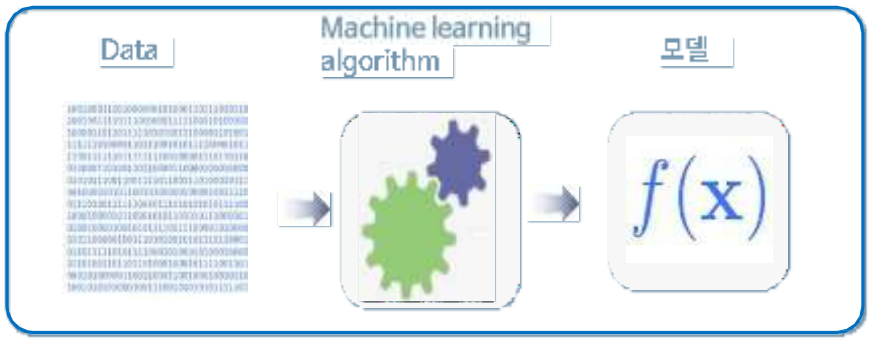


Machine Learning Overview

Definitin of Machine Learning

- AI subarea that makes computers to possess such capabilities as
  - Learning empirical data) & Taking intelligent actions (Inference, classification, prediction, etc.,)

- "Learning denotes changes in a system that ... enable a system to do the same task ··· more efficiently the next time." – Herbert Simon
- "Learning is constructing or modifying representations of what is being experienced." – Ryszard Michalski
- "Learning is making useful changes in our minds." – Marvin Minsky



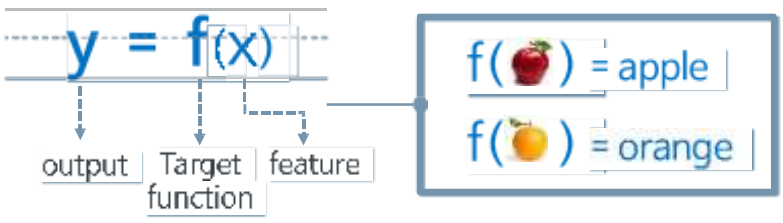
1.1 AI & ML Overview

Machine Learning Overview

대구대학교 DAEGU UNIVERSITY

Mathmatical explanation of ML

- Function



- ML Algorithm
  - Find approximation function h(•) of f(•) using S = {(x,y)}

Ý±°§®·¹¸¬ ¾§Ø·»½¸»±´Õ·³

Machine Learning Overview

ML Scenario

Heart disease decision : ① Collect medical data (sample)

Age: 67
Sex: male
Chest pain type: typical angina
Resting blood pressure: 160mm Hg
Serum cholestoral: 286mg/dl
Fasting blood sugar: ⟨ 120mg/dl
…

Heart disease YES

Age: 63
Sex: male
Chest pain type: asymtotic
Resting blood pressure: 145mm Hg
Serum cholestoral: 233mg/dl
Fasting blood sugar: ⟩ 120mg/dl
…

Heart Disease NO

Machine Learning Overview

Machine scenario (cont'd)

Heart diseage dicision : ② Data preprocessing & Training

Feature definition
Symbol/Enumeration

ß¹»ã êéôÍ»¨ã ï
Ý¸»¬ °¿·² ¬§°»ãì
Î»¬·²¹ ¾¼±¼°®»«®»ãïêð
Í»®«³ ½¸±¬®¿ãîèê
Ú¿¬·²¹ ¾¼±¼«¹®¿ãð
…

Heart Disease Yes

M O D E L

Trained Model

ß¹»ã êíôÍ»¨ã ï
Ý¸»¬ °¿·² ¬§°»ãï
Î»¬·²¹ ¾¼±¼°®»«®»ãïìë
Í»®«³ ½¸±¬®¿ãîíí
Ú¿¬·²¹ ¾¼±¼«¹®¿ãï
…

Heart Disease No

Machine Learning Overview

Machine scenario (cont'd)

- Heart disease decision : ③ Use

ß¹»æ êë
Í»¨æ ³¿´»
Ý¸»¬ °¿·² ¬§»æ¿§³°¬±³¿¬·½ Î»-
¬·²¹ ¾¼±¼¯®»«®»æï ê ð ³ ³ Ø¹
Í»®«³ ½¸±¬®¿æîçð³¹ñ¼´
Ú¿¬·²¹ ¾¼±¼«¿®æâ ïì ð³¹ñ¼´
…

Trained Model → ?

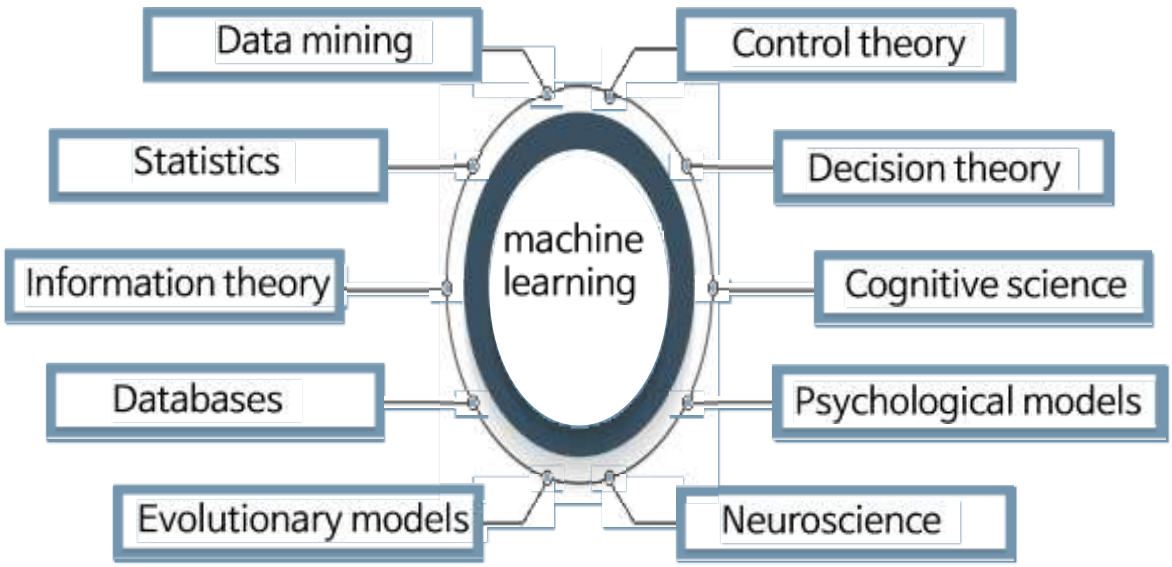
1.1 AI & ML Overview

Machine Learning Overview

대구대학교 DAEGU UNIVERSITY

Related fields

- ML is a multidisciplinary research area

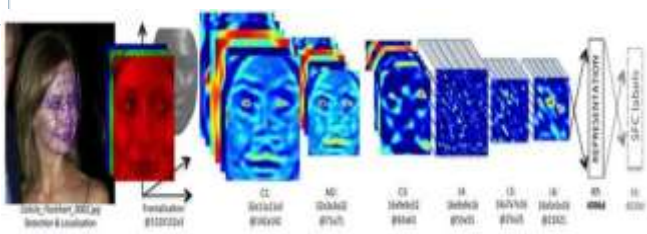


Ý±°§®·¹¸¬ ¾§Ø·»½»±´Õ·³

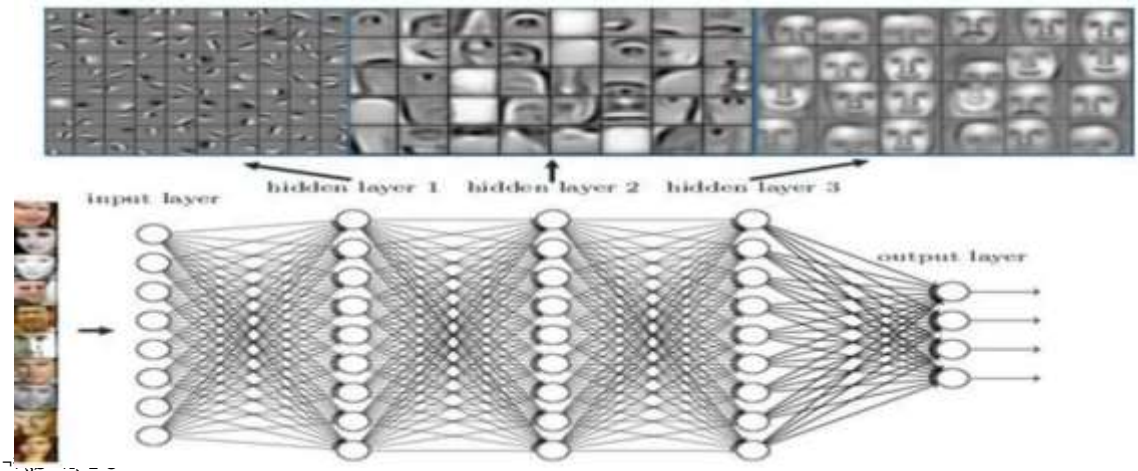
Deep Learning Overview

Deep learning

- Mostly multi-layer neural network
  - Large-scale feature extration
    - Deepface 120 million parameters
- Hierarchical feature extraction



Ú¿½»³⁄₄±µÚ»»°º¿½» æ®»½±¹².¬·±²çéòîëû ø¸«³¿² çéòëíû÷



© Ý±°§®¹¸¬ [illegible]

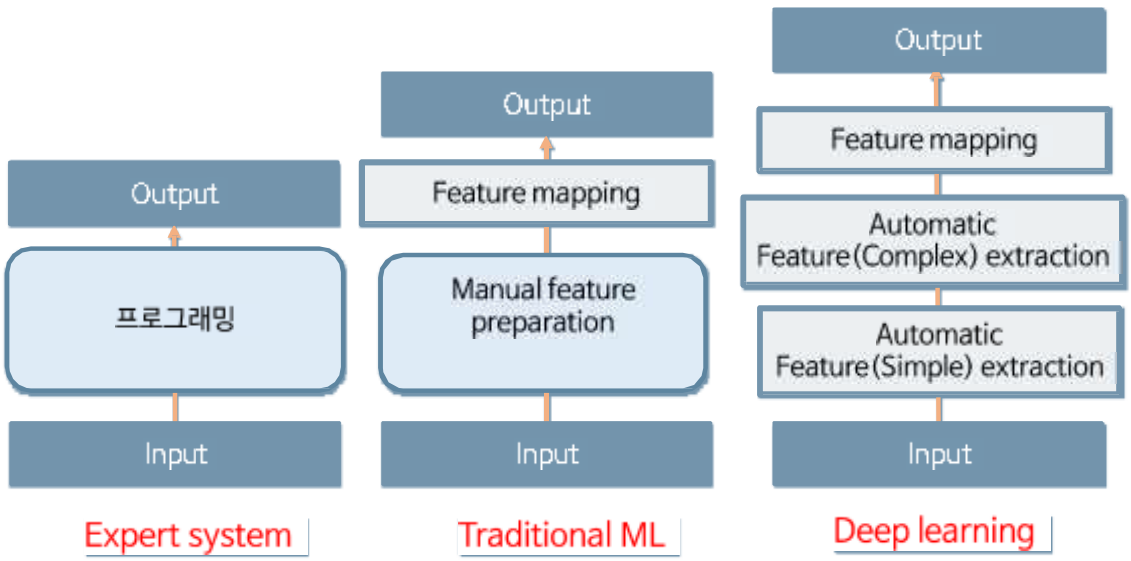
1.1 AI & ML Overview

Deep Learning Overview

대구대학교 DAEGU UNIVERSITY

Potential of Deep learning

- End-to-End Learning
  - Automatic feature extraction from 'ra data → 'small' expert interruption



© Ý±°§®·¹¸¬ ¾§Ø·»½¸»±´Õ·³

Deep Learning Overview

Deep learning scenario

- Similar to traditional machine learning scenario

Animal detection ① Training a model

② Utilize

Ý±°§®·¹¸ ¾§Ø·»½¸»±´Õ·³

대구대학교 DAEGU UNIVERSITY

1.2 ML Methodology

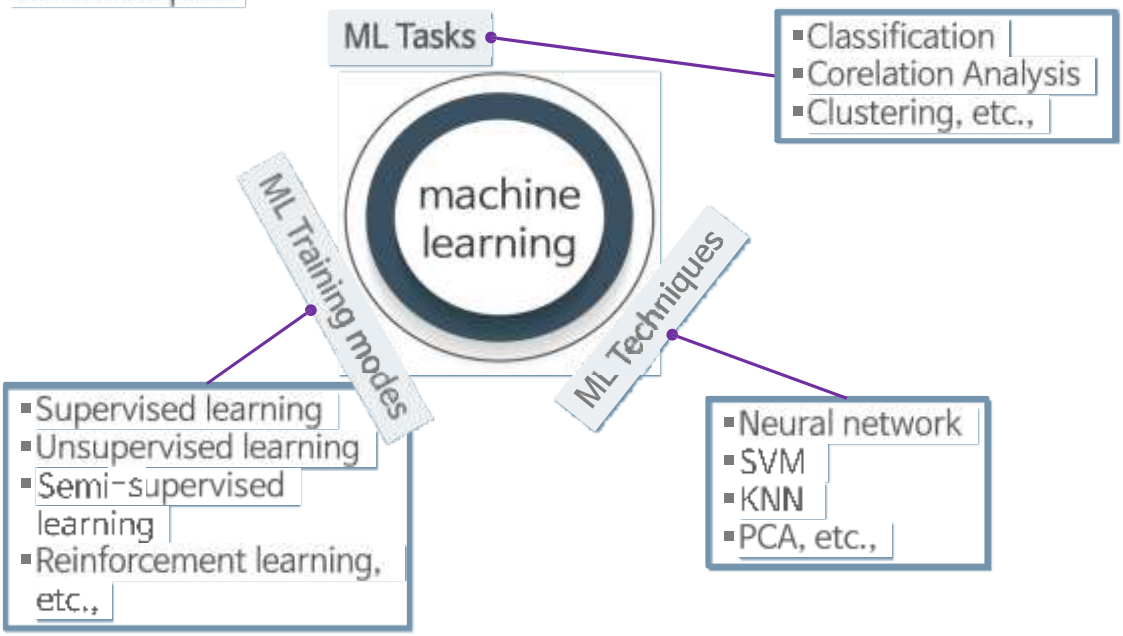
- ML Tasks
- ML Training modes
- ML Techniques

Prolog

ML is a very wide and complex area

Machine learning (informal) framework

- ML Tasks
- ML Training modes
- ML Techniques

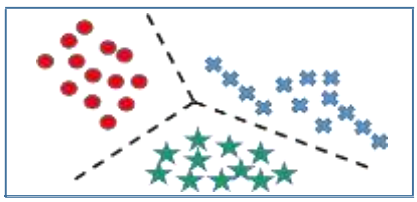


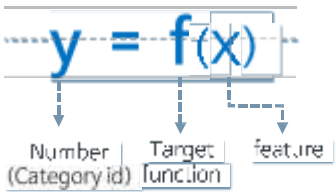
ML Tasks

Tasks realized by ML are numerous

- Classification, Corelation analysis, Clustering, Frequency distribution modelling, Prediction, etc.,

Classification





- Classify each individual data into a specific category
- The number of category is predetermined
  - Hand-written digit recogonition, object recognition, sound recognition
- Classification sometimes means identification

Machine Learning Tasks

Correlation analysis

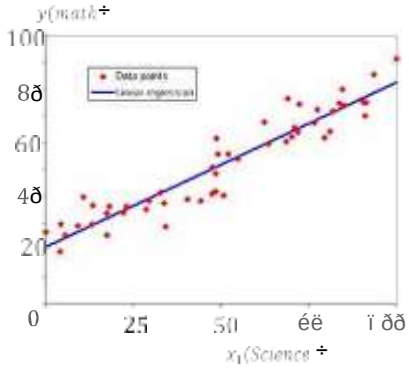
Linear regression

$$y = f(x)$$

Dependent variable (Real value) | Target function | Independent variable (feature)

$$\mathbf{x}_k = \begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ \vdots \\ x_q \end{bmatrix}$$

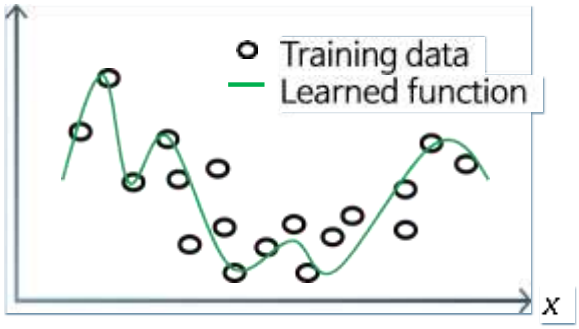
$$\hat{y} = \mathrm{f}(\mathbf{x}) = \sum_{i=0}^{q} \beta_i x_i = \beta_0 + \beta_1 x_1 + \cdots + \beta_q x_q \quad ; x_0 = 1$$



$$\hat{y} = \mathrm{f}(\mathbf{x}) = \beta_0 + \beta_1 x_1$$

$$\hat{y} = 22 + 0.65 x_1$$

Nonlinear regression



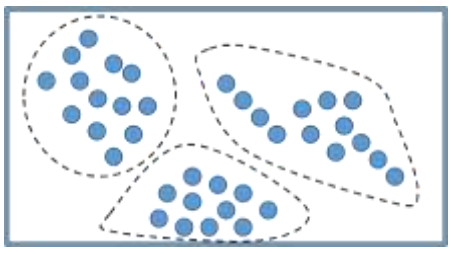
Machine Learning Tasks

대구대학교 DAEGU UNIVERSITY

Clustering

Grouping data by extracting features internal to data

- Cluster is a set of similar data in terms of color, position, density, etc.,
- Cluster number is not pre-determined.



$$y = f(x)$$

Fixed number (Cluster id) | Target function | feature

응용

- Document clustering based on keyword frequency
- Image clustering based on colors

ML Learning Mode

Supervised Learning

- ⟨Teacher, Student⟩ relation
- Data(x)+Label(y) : Training data

- During training, construct a prediction mode which maps x to y
- Use the prediction model

Major tasks using supervised learning

- Classification), Regression, etc.,

응용 사례

- Object detection, Hand-written digit
- CT image analysis

1.2 ML Methodology

ML Learning Mode

대구대학교 DAEGU UNIVERSITY

Unsupervised Learning

- Training only with data without label
- Based on extraction of common features and phenomena
- Need more intense future research
  - Human learning prototype

Major tasks using unsupervised learing

- Clustering
- Density estimation

Application

- Customer segmentation in CRM
- Image compression: Color quantization
- Bioinformatics: Learning motifs (250K proteins from 25 amino acid)

Ý±°§®·¹¸ ¾§Ø·»½¸»±´Õ·³

ML Learning Mode

Reinforcement learning

- Practically used in recent years, the technology was developed in 1990
- Produce policy π which maximizes long-term reward
  ※ π is a series actions in a certain situation

Model (Markov Decision Process)

- State set S
- Action set A
- Reward function R : S × A → ℜ
- State transition function T : S × A → Π(S)
  - T(s, a, s') : the probability reaching state a' when taking action a in state s

응용

- Games(Atari, AlphaGo), Robot navigation, Multi-agent system

ML Learning Technique

Machine learning techniques

Many ML techniques are avaiable(due to reasearches over 30 year)