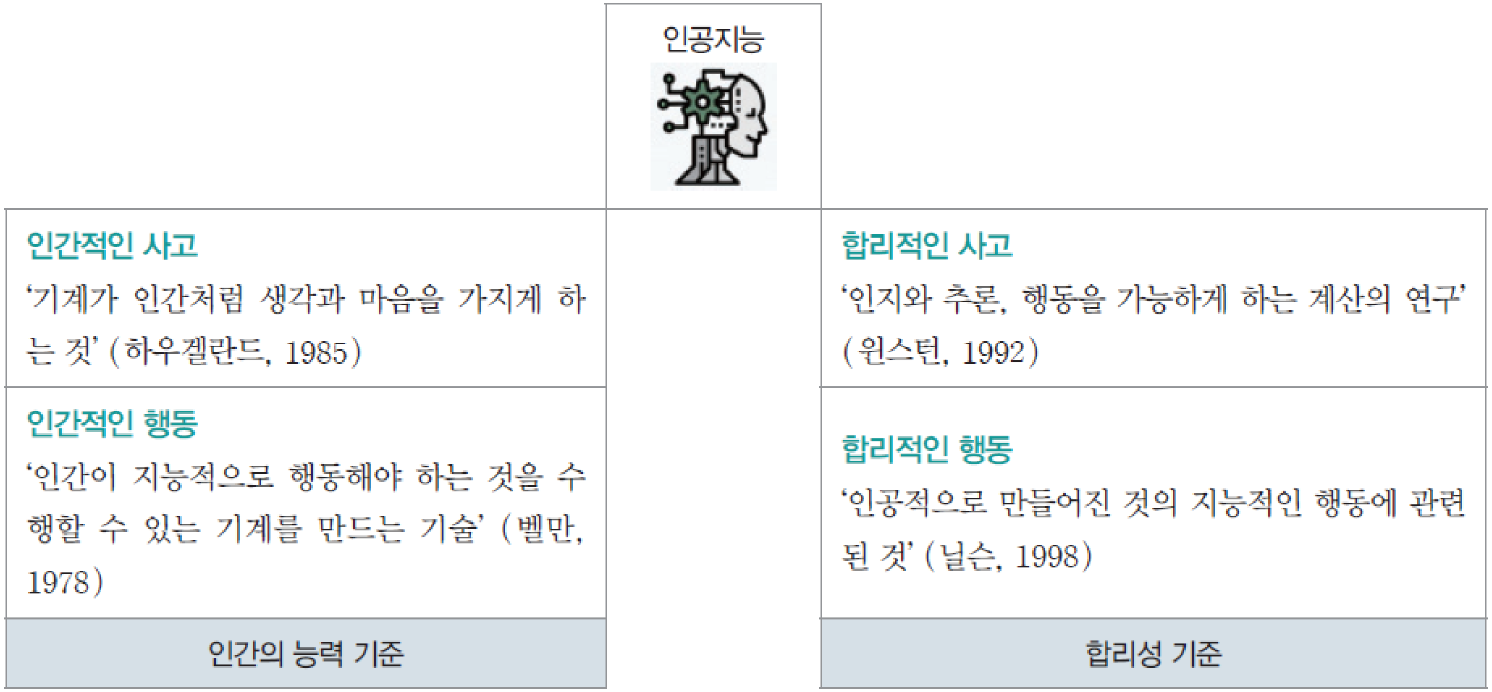
SME3006 Machine Learning – 2025 Fall

Introduction to ML

INHA UNIVERSITY

What is artificial intelligence?

- An agent that can learn and make decisions through perception, reasoning and inference.



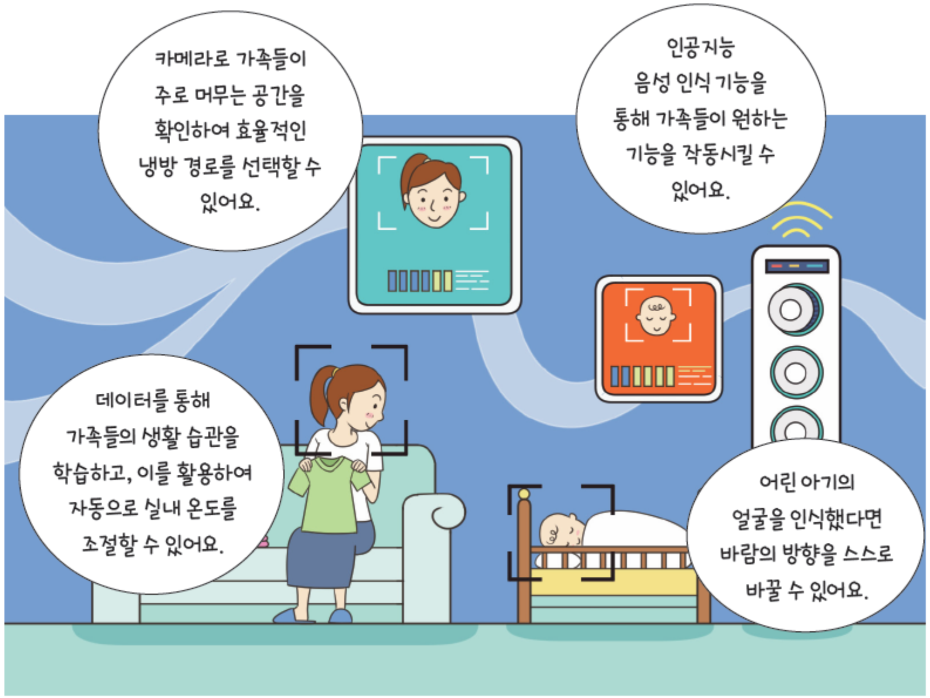
	인공지능	
인간적인 사고 ‘기계가 인간처럼 생각과 마음을 가지게 하는 것’ (하우겔란드, 1985)		**합리적인 사고** ‘인지와 추론, 행동을 가능하게 하는 계산의 연구’ (윈스턴, 1992)
인간적인 행동 ‘인간이 지능적으로 행동해야 하는 것을 수행할 수 있는 기계를 만드는 기술’ (벨만, 1978)		**합리적인 행동** ‘인공적으로 만들어진 것의 지능적인 행동에 관련된 것’ (닐슨, 1998)
인간의 능력 기준		합리성 기준

▲ 인공지능의 여러 가지 정의

What is artificial intelligence?

- An agent that can learn and make decisions through perception, reasoning and inference.

- Difference between a regular air conditioner and an AI air conditioner


카메라로 가족들이 주로 머무는 공간을 확인하여 효율적인 냉방 경로를 선택할 수 있어요.
인공지능 음성 인식 기능을 통해 가족들이 원하는 기능을 작동시킬 수 있어요.
데이터를 통해 가족들의 생활 습관을 학습하고, 이를 활용하여 자동으로 실내 온도를 조절할 수 있어요.
어린 아기의 얼굴을 인식했다면 바람의 방향을 스스로 바꿀 수 있어요.

Acting humanly: the Turing test approach

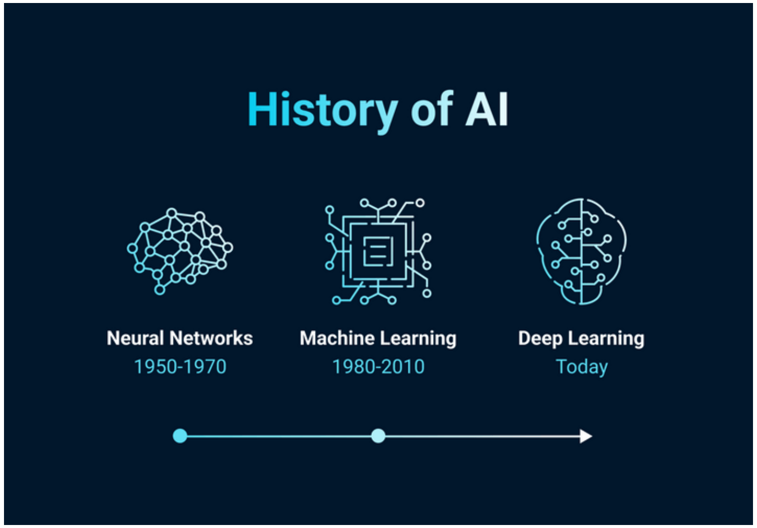
- Can a machine think?

- Turing Test
  - **Natural language processing** to communicate successfully in a human language
  - **Knowledge representation** to store what it knows or hears
  - **Automated reasoning** to answer questions and to draw new conclusions
  - **Machine learning** to adapt to new circumstances and to detect and extrapolate patterns

- Total Turing Test
  - **Computer vision** and speech recognition to perceive the world
  - **Robotics** to manipulate objects and move about

History of AI

- 1950s Perceptron
- 1980s Back-propagation, Bayesian Network, **Decision Tree**
- **1990s SVM, Ensemble, EM, RL**
- **2000s Kernel Methods**
- 2010s AlexNet, RNN, GAN
- 2020s Transformer, LLM


History of AI
Neural Networks
1950-1970
Machine Learning
1980-2010
Deep Learning
Today

What is machine Learning?

- Extracting knowledge from data

- Think of a spam filter
  - Make up a blacklist of words
  - Lots of ‘if’ and ‘else’ decisions to process data

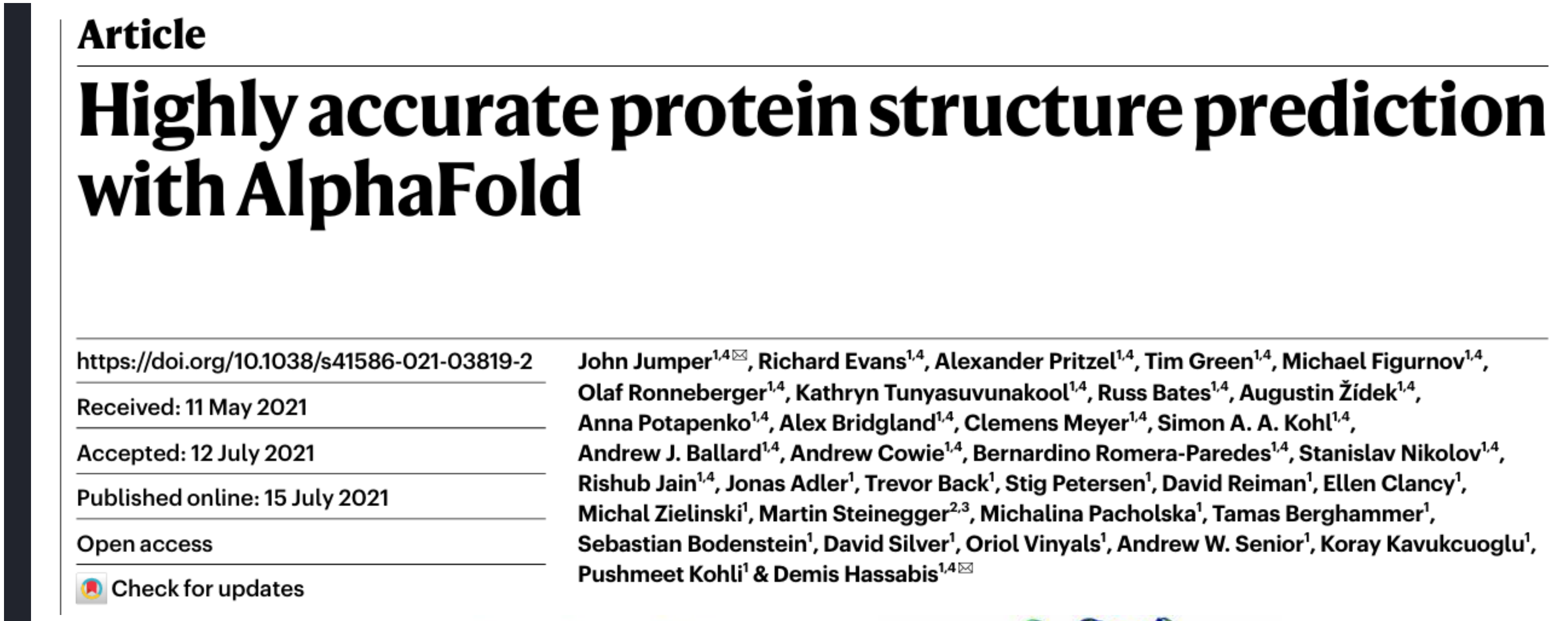
- Disadvantages
  - The logic required to make a decision is specific to a single domain and task
  - Designing rules requires a deep understanding of how a decision should be made by a human expert

- Detecting faces in images.

What can we do with ML?

- https://quickdraw.withgoogle.com/
- First image of a black hole
- Early detection of pancreatic cancer
- OpenAI defeats Dota2 world champions
- AlphaFold – prediction of a protein’s 3D shape (Nobel Prize)

What can we do with ML?



Article

Highly accurate protein structure prediction with AlphaFold

https://doi.org/10.1038/s41586-021-03819-2

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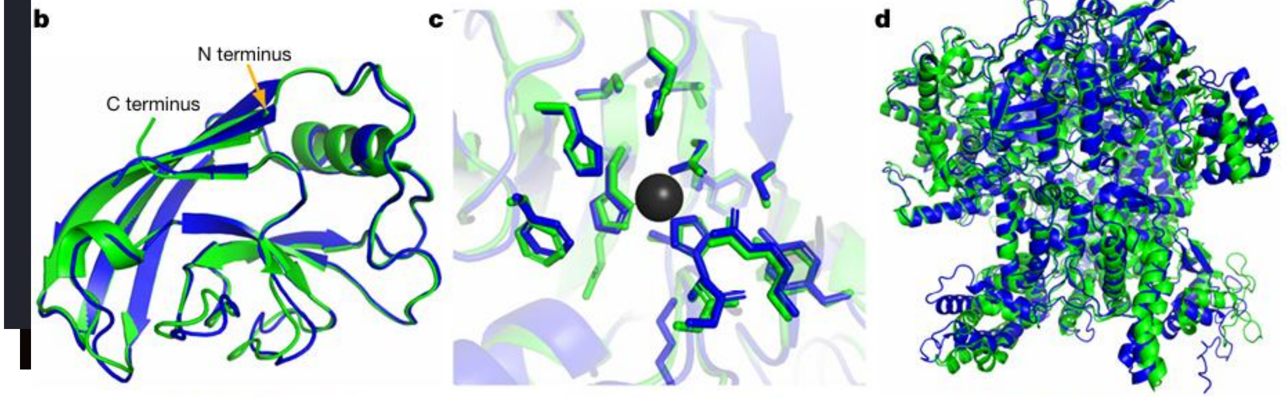
Check for updates

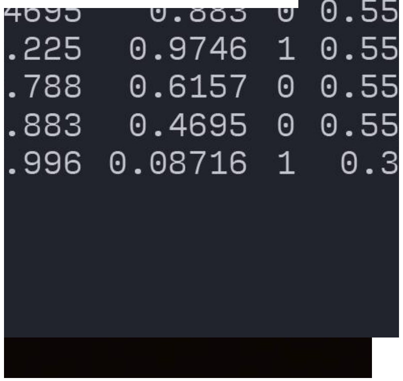
John Jumper[1,4]✉, Richard Evans[1,4], Alexander Pritzel[1,4], Tim Green[1,4], Michael Figurnov[1,4], Olaf Ronneberger[1,4], Kathryn Tunyasuvunakool[1,4], Russ Bates[1,4], Augustin Žídek[1,4], Anna Potapenko[1,4], Alex Bridgland[1,4], Clemens Meyer[1,4], Simon A. A. Kohl[1,4], Andrew J. Ballard[1,4], Andrew Cowie[1,4], Bernardino Romera-Paredes[1,4], Stanislav Nikolov[1,4], Rishub Jain[1,4], Jonas Adler[1], Trevor Back[1], Stig Petersen[1], David Reiman[1], Ellen Clancy[1], Michal Zielinski[1], Martin Steinegger[2,3], Michalina Pacholska[1], Tamas Berghammer[1], Sebastian Bodenstein[1], David Silver[1], Oriol Vinyals[1], Andrew W. Senior[1], Koray Kavukcuoglu[1], Pushmeet Kohli[1] & Demis Hassabis[1,4]✉



AlphaFold Experiment
r.m.s.d.$_{95}$ = 0.8 Å; TM-score = 0.93

AlphaFold Experiment
r.m.s.d. = 0.59 Å within 8 Å of Zn

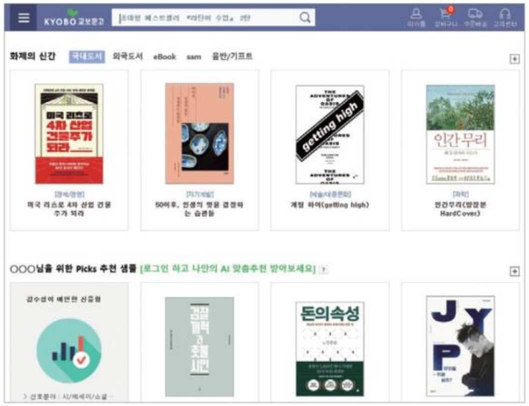
AlphaFold Experiment
r.m.s.d.$_{95}$ = 2.2 Å; TM-score = 0.96



```
                          0.84
                          0.82
                          0.78
                          0.86
                          0.82
                          0.74
                          0.66
                          0.72
                          0.68
                          0.68
                          0.55
4695    0.883  0  0.55
.225   0.9746  1  0.55
.788   0.6157  0  0.55
.883   0.4695  0  0.55
.996  0.08716  1   0.3
```

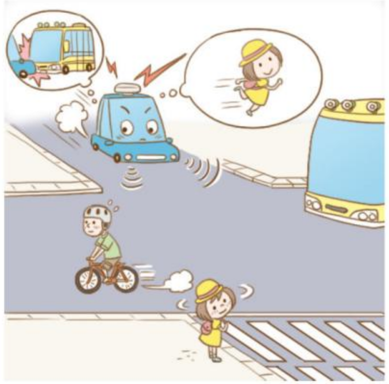
What can we do with ML?

Recommendation system


KYOBO 교보문고
화제의 신간
국내도서
외국도서
eBook
sam
음반/기프트
미국 리츠로 4차 산업 건물주가 되라
50이후, 인생의 멋을 결정하는 습관들
게팅 하이(getting high)
인간무리(양장본 HardCover)
OOO님을 위한 Picks 추천 샘플 [로그인 하고 나만의 AI 맞춤추천 받아보세요]
돈의속성
JYP

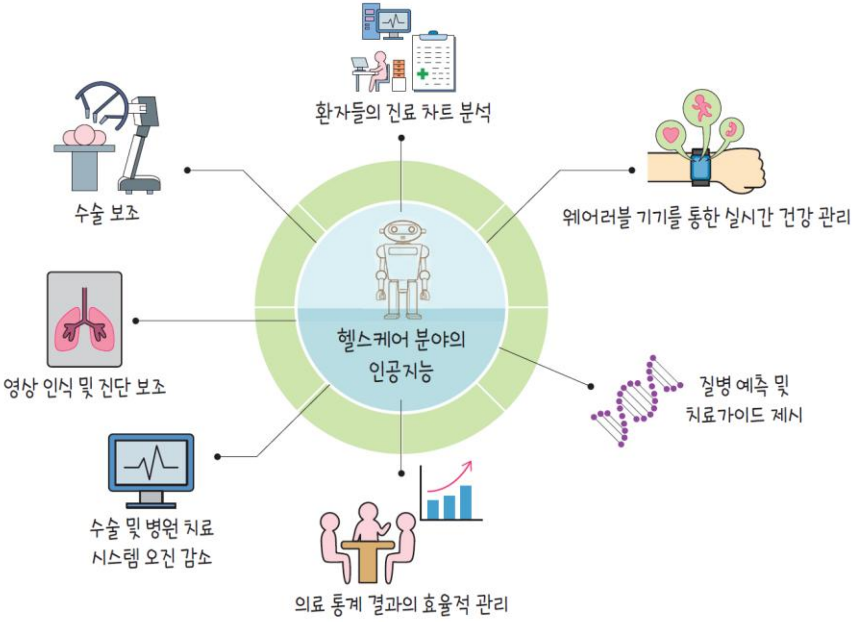
▲ 교보문고 추천 시스템

Self-driving cars



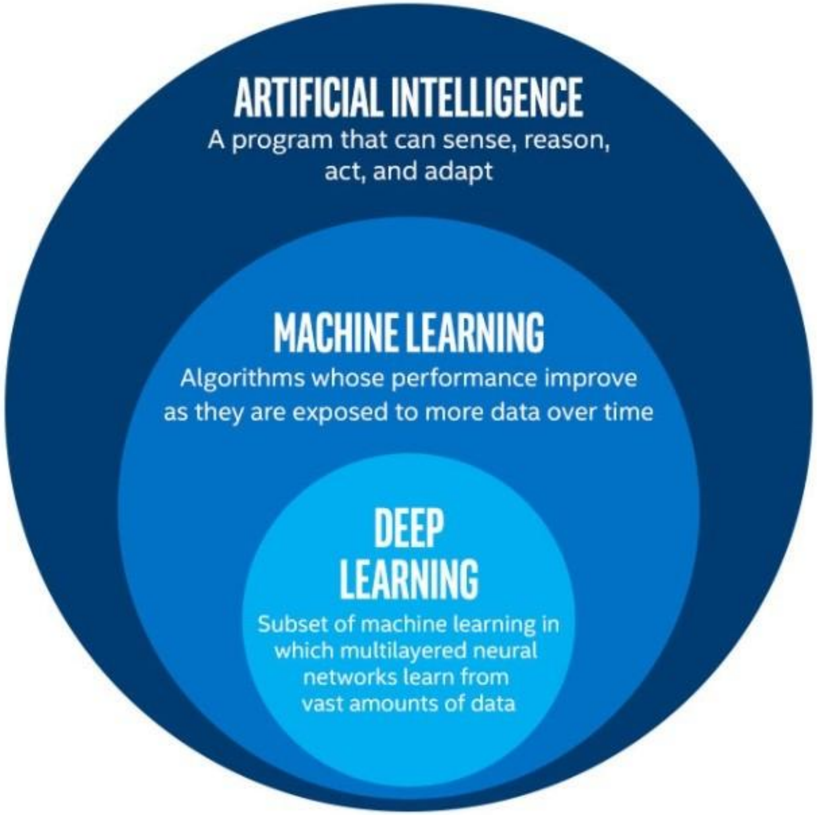
▲ 자율 주행 자동차

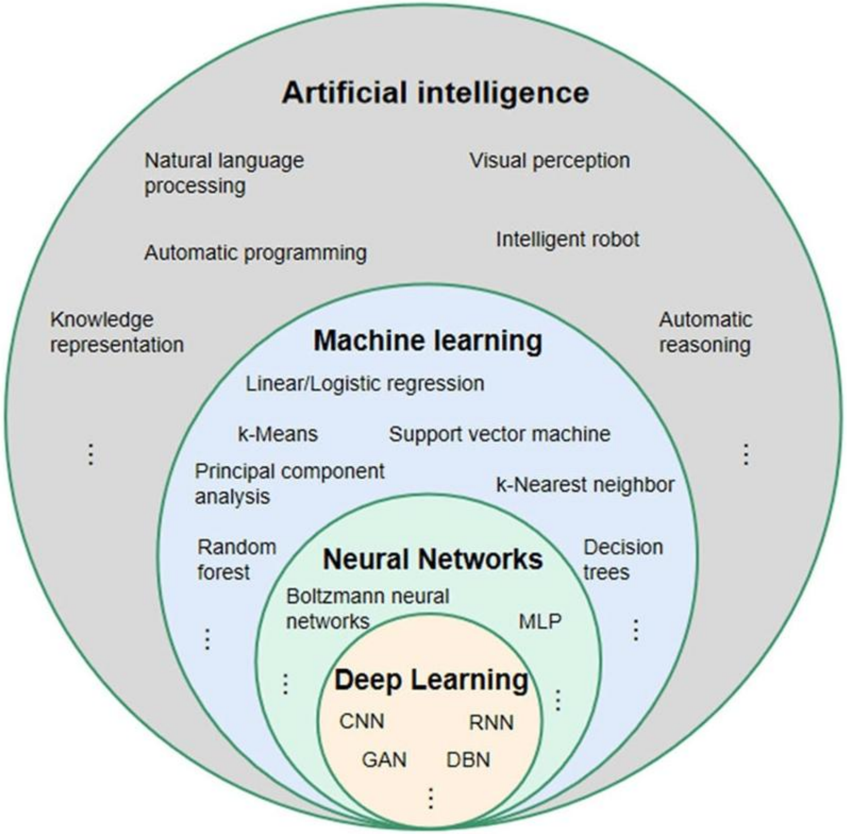
Healthcare and medical treatment


환자들의 진료 차트 분석
수술 보조
웨어러블 기기를 통한 실시간 건강 관리
헬스케어 분야의 인공지능
영상 인식 및 진단 보조
질병 예측 및 치료가이드 제시
수술 및 병원 치료 시스템 오진 감소
의료 통계 결과의 효율적 관리

▲ 의료와 헬스 케어 분야의 인공지능 기술

Level of AI


ARTIFICIAL INTELLIGENCE
A program that can sense, reason, act, and adapt
MACHINE LEARNING
Algorithms whose performance improve as they are exposed to more data over time
DEEP LEARNING
Subset of machine learning in which multilayered neural networks learn from vast amounts of data

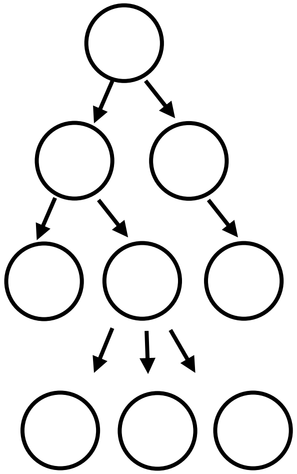

Artificial intelligence
Natural language processing
Visual perception
Automatic programming
Intelligent robot
Knowledge representation
Automatic reasoning
⋮
⋮
Machine learning
Linear/Logistic regression
k-Means
Support vector machine
Principal component analysis
k-Nearest neighbor
Random forest
Decision trees
⋮
⋮
Neural Networks
Boltzmann neural networks
MLP
⋮
⋮
Deep Learning
CNN
RNN
GAN
DBN
⋮

Level of AI

Artificial Intelligence

Symbolic AI

If then ..

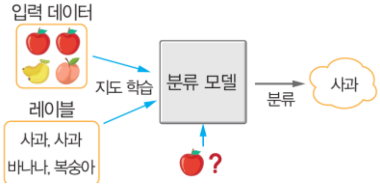


PDDL
Prolog
Expert
Systems

Machine Learning

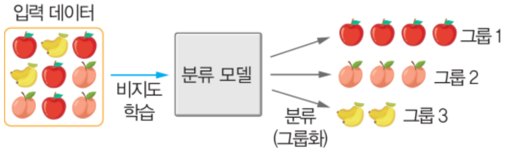
Supervised Learning

We have labels


입력 데이터
레이블
사과, 사과
바나나, 복숭아
지도 학습
분류 모델
?
분류
사과

Unsupervised Learning

No labels


입력 데이터
비지도
학습
분류 모델
분류
(그룹화)
그룹 1
그룹 2
그룹 3

Reinforcement Learning

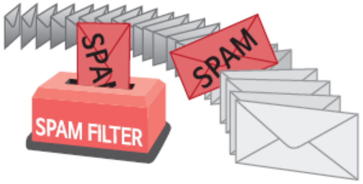
Learn from experiencing

Types of ML

기계 학습

지도 학습

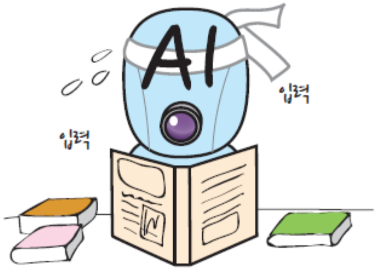
입력된 문제와 정답 데이터를 바탕으로 스스로 학습하는 방법


SPAM
SPAM
SPAM FILTER

분류, 회귀

비지도 학습

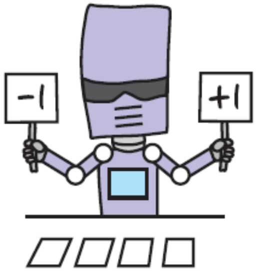
정답이 없는 데이터를 바탕으로 숨은 패턴을 스스로 찾아내는 학습 방법



군집화

강화 학습

주어진 상황에서 보상은 최대화하고, 처벌은 최소화하도록 스스로 학습하는 방법



보상과 처벌

Examples of learning problems

- Recognizing digits in images
- Identifying tumor in an x-ray
- Classifying email as spam or not
- Diagnosing disease from symptoms
- Predicting the price of a stock 6 months from now
- Predicting selling price for individual houses
- Netflix problems – predict rating of a movie by a customer
- Determining credit-worthiness for mortgages or credit cards
- Predicting 3D forces on a molecule from molecular formula

Types of learning problems

- Classification problems – output is a label from a finite set
- Regression problems – output is real-valued (continuous)
- Ranking problems – output only ranks examples relative to one another
- Unsupervised problems – such as ChatGPT, often used for generative AI

Syllabus

Week 1	Introduction to ML	Week 9	Decision trees and ensemble methods
Week 2	Data preprocessing / visualization	Week 10	Uncertainty quantification and Gaussian Process
Week 3	Linear and logistic regression	Week 11	Expectation Maximization and GMM
Week 4	Optimization and Gradient descent	Week 12	Generative learning / Hyperparameter tuning
Week 5	Dimension reduction and PCA	Week 13	Anomaly detection
Week 6	SVM and Kernel methods	Week 14	MDP and RL
Week 7	K-means and unsupervised learning	Week 15	Final project presentation
Week 8	Mid-term		

Lectures will be..

- Lecture recordings will be provided on YouTube.
- Language: Python
- Env. recommendation: Google Colab or Anaconda

Prerequisite

- Probability theory
- Linear algebra
- Python

Lecture plan

- 0 Assignments
  - TA: 허성원 (wen10413@inha.edu)
- Grade
  - Attendance - (No grade if absences reach one-quarter of total class days.)
  - Assignment 50%
  - Mid-term 20%
  - Final-project 30%

Recommended reading

- 수학과 함께하는 고교 AI 입문
  - https://www.ebssw.kr/info/intrcn/infoTchmtrHeaderView.do?bookCode=5&tabType=AI

Reference

> Book

- [1] 알고리즘 중심의 머신러닝 가이드, Stephen Marsland
- [2] 머신러닝 교과서 파이토치편, Sebastian Raschka
- [3] AI Modern Approach, Stuart Russel

> Lecture Notes

- [4] Stanford CS229, Andrew Ng,
- [5] UC Berkeley, Concise Machine Learning, J.R. Schewchuk
- [6] NYU Machine Learning: a lecture note, Kyunghyun Cho