LIKE LION

1강

AI, 머신러닝, 딥러닝, 어떻게 다를까요?

WHATEVER YOU WANT, MAKE IT REAL.

강사 최윤호

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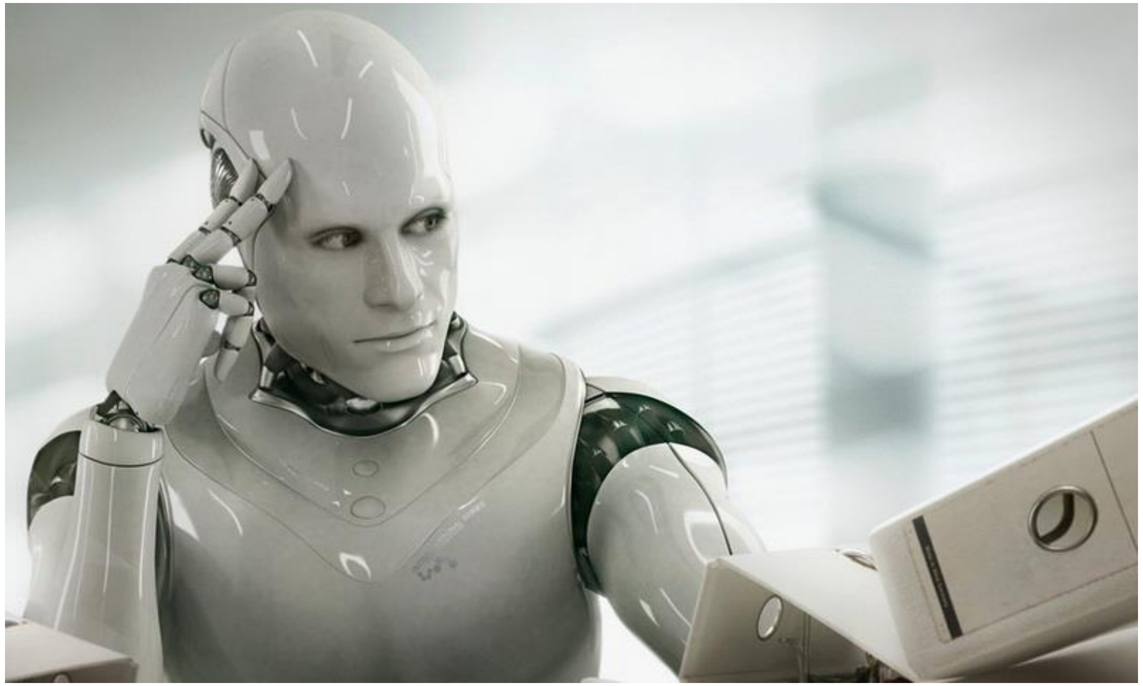
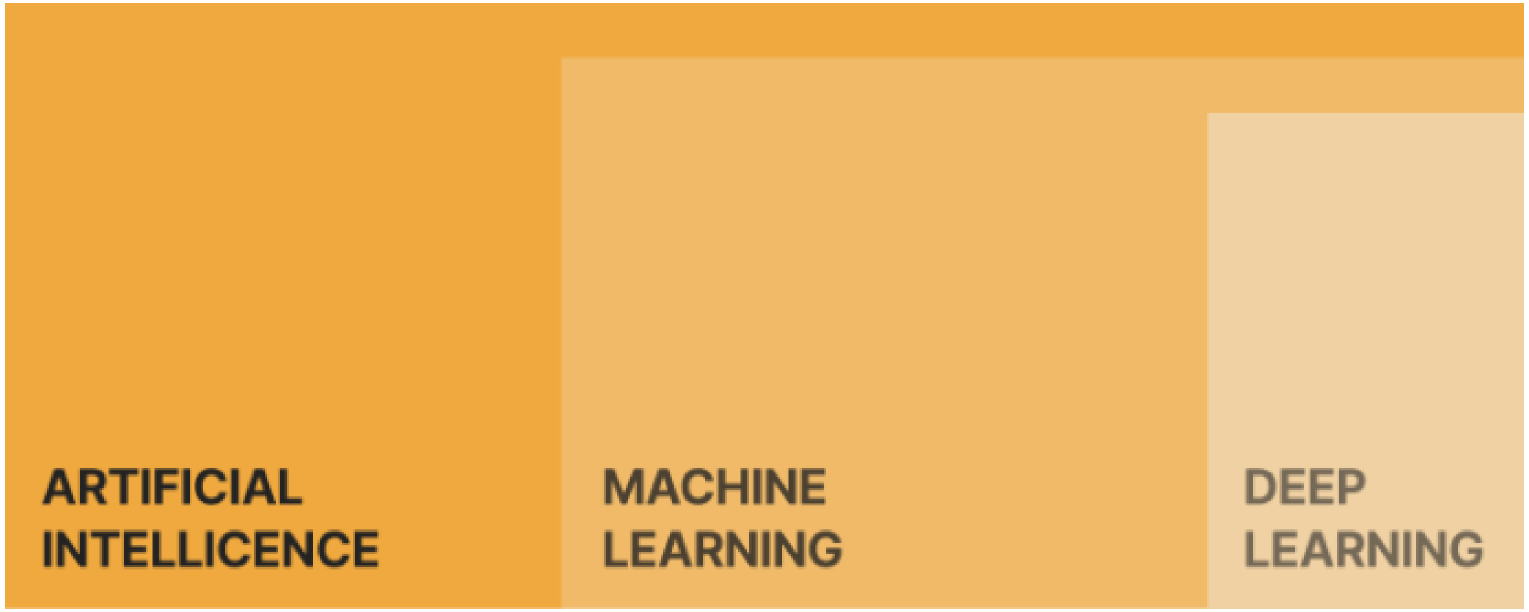
1. AI, 머신러닝, 딥러닝의 차이 이해
2. 머신러닝 Basics
3. 머신러닝 문제의 분류
4. 학습 방법의 분류
5. (실습) Colab, Python, NumPy 튜토리얼

{ 1. AI, 머신러닝, 딥러닝의 차이 이해 }

Artificial Intelligence?



Thinking Robot – Image by Blutgruppe/Corbis



AI ⊃ Machine Learning ⊃ Deep Learning

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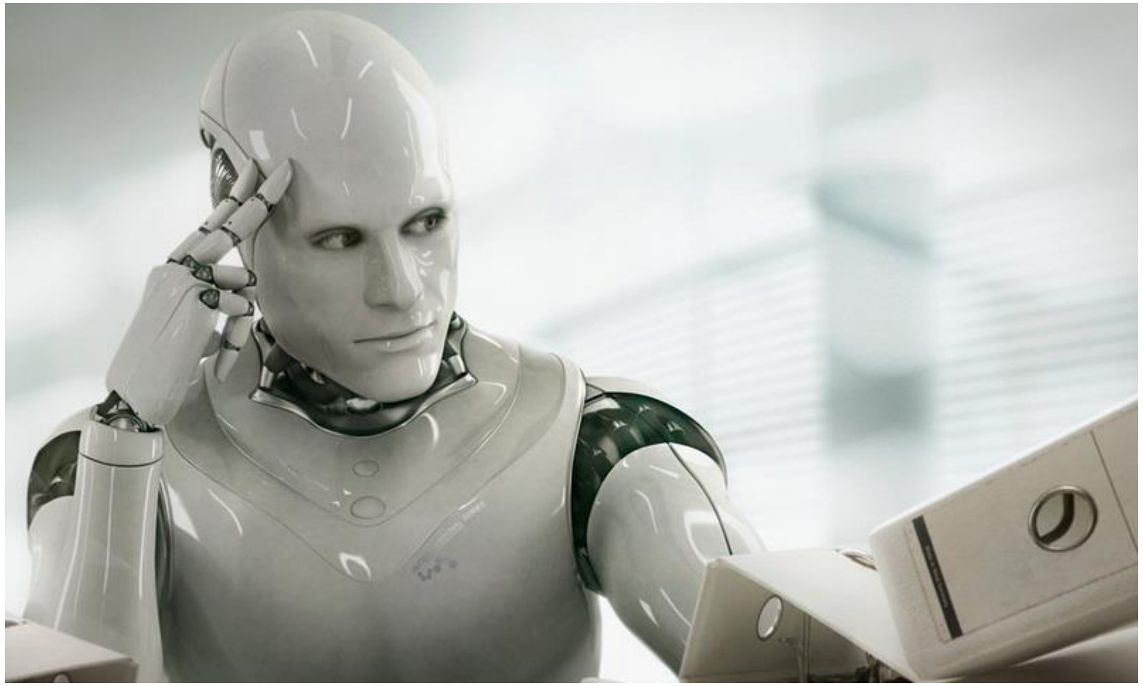
Artificial Intelligence (AI)

Definition: (Wikipedia) Intelligence demonstrated by machine

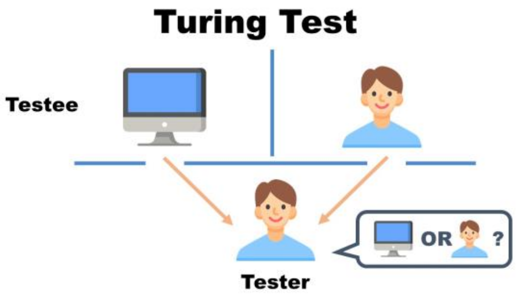


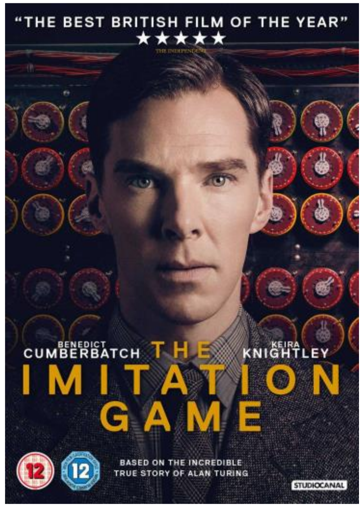
Thinking Robot – Image by Blutgruppe/Corbis

A program that can { think / act } { like human. / rationally. }

(Russell & Norvig)

- **Acting Humanly**





- **Thinking Humanly**
  - Cognitive science
  - Theories of internal activities of the brain

- **Thinking Rationally**
  - Laws of Thought
  - Logic

- **Acting Rationally**
  - Doing the right thing; which maximizes expected utility.
  - Engineering mind-set

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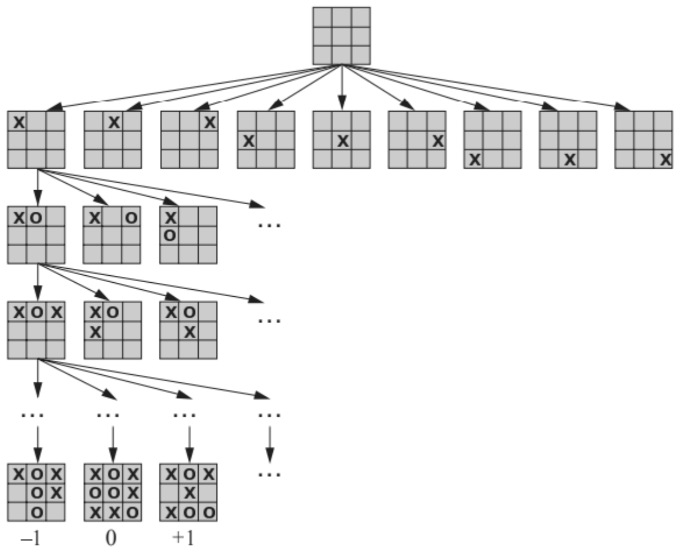
Traditional AI

Avengers: Infinity War, (2018), from IMDb

Traditional AI

- Search Algorithms. ex) IBM Deep Blue
- Propositional Logic
- First-Order Logic
- Planning



$$
\begin{aligned}
&Init(On(A, Table) \land On(B, Table) \land On(C, A)\\
&\quad \land Block(A) \land Block(B) \land Block(C) \land Clear(B) \land Clear(C))\\
&Goal(On(A, B) \land On(B, C))\\
&Action(Move(b, x, y),\\
&\quad \text{Precond: } On(b, x) \land Clear(b) \land Clear(y) \land Block(b) \land Block(y)\\
&\qquad \land (b \neq x) \land (b \neq y) \land (x \neq y),\\
&\quad \text{Effect: } On(b, y) \land Clear(x) \land \neg On(b, x) \land \neg Clear(y))\\
&Action(MoveToTable(b, x),\\
&\quad \text{Precond: } On(b, x) \land Clear(b) \land Block(b) \land (b \neq x),\\
&\quad \text{Effect: } On(b, Table) \land Clear(x) \land \neg On(b, x))
\end{aligned}
$$

sources: http://aima.cs.berkeley.edu/figures.pdf

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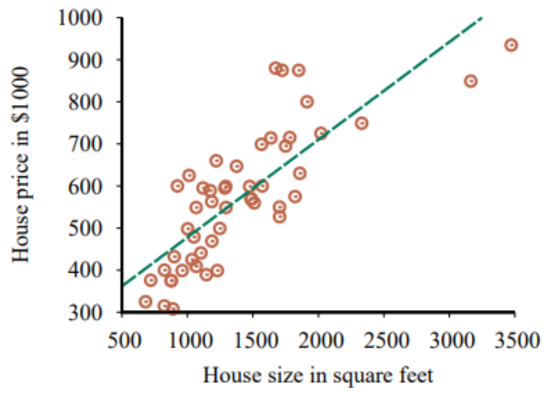
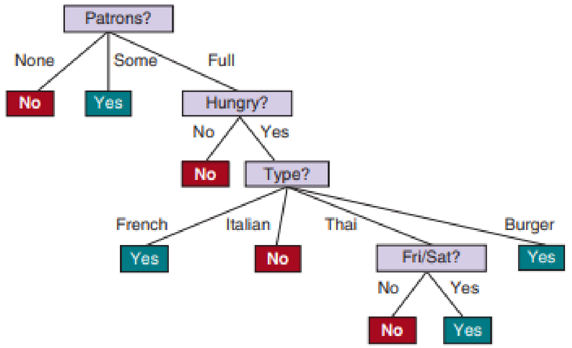
Machine Learning

- Limitations of explicit programming
  - ex) 자율주행
- Machine Learning: Learning from Data
- Learning: To improve its performance on future tasks after making observations about the world.
- Ex) Linear regression, Decision tree, K-means Clustering
- Its performance improves as they are exposed to more data over time.

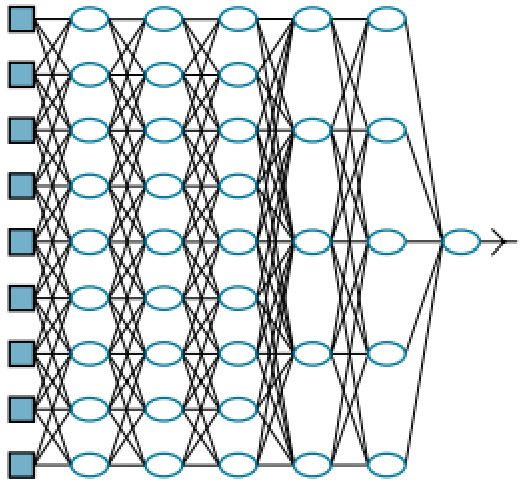




source: http://aima.cs.berkeley.edu/figures.pdf

Deep Learning

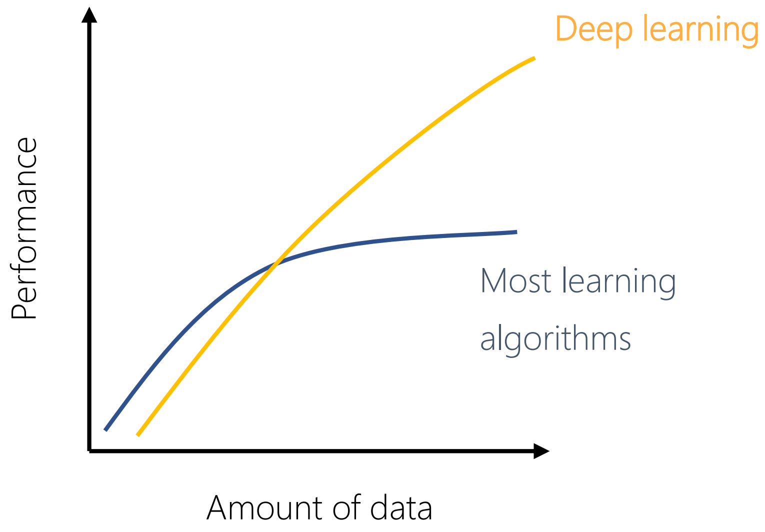
- Deep learning: Hierarchical representation learning
- representation: feature at each layer in neural networks
- Three key components
  - Deep Neural network
  - Big data
  - Hardware: GPU, Memory



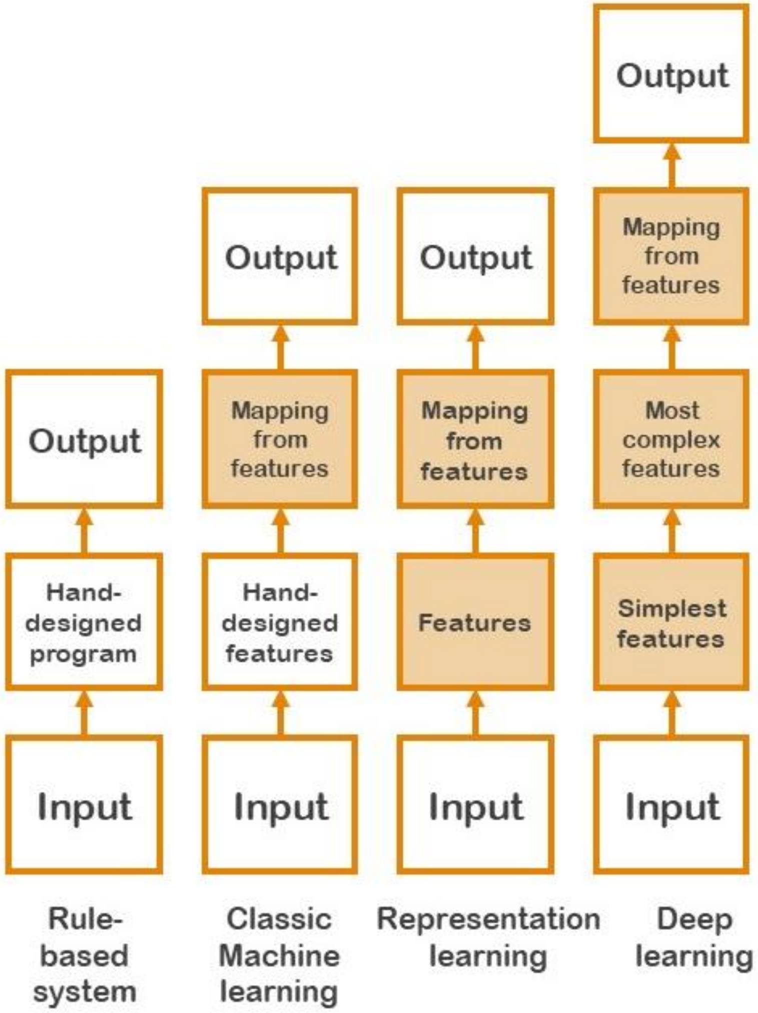
source: http://aima.cs.berkeley.edu/figures.pdf

Deep Learning의 현 주소

- 인간 이하의 성능
  - 범용 인공지능
  - 데이터가 귀하고, 전문가에 의존하는 분야. ex) medical
- 인간 수준의 성능
  - 일부 perception 문제: visual / speech recognition
- 인간 이상의 성능
  - Structured big data가 있는 분야. ex) 추천알고리즘
  - 일부 perception 문제, Game play



Wrap-up



Shaded boxes:

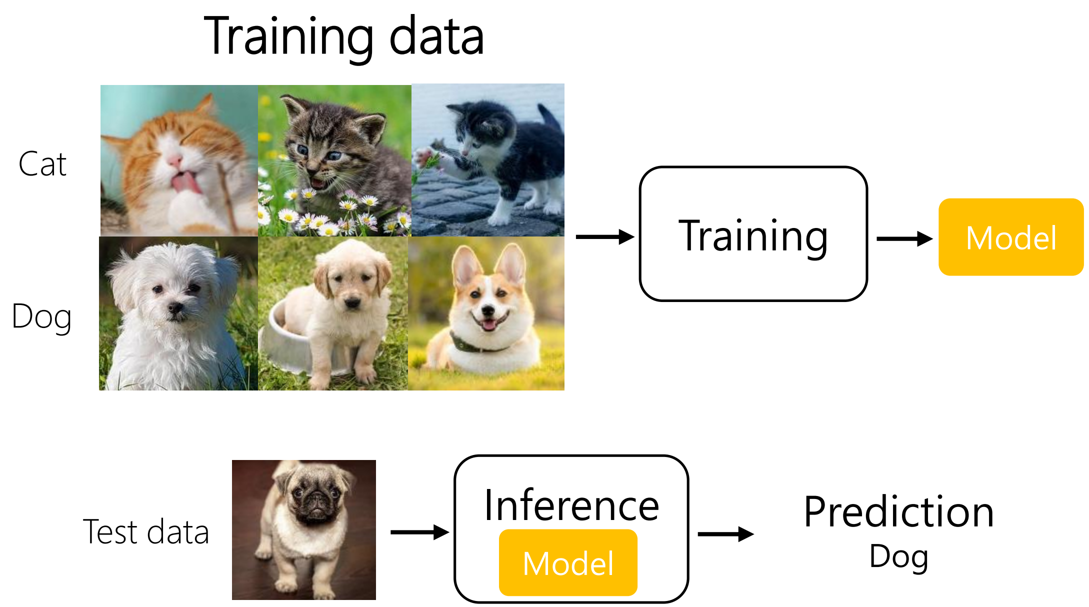
데이터로 부터 학습하는 요소

{ 2. 머신러닝 Basics }

Machine Learning Basics - (1)

- Two steps of machine learning (ML)
  - Training (learning): Fit a model with training data.
  - Test (Inference): Apply the trained model with test data, measure the performance.

- Data set
  - training set: for fitting
  - validation set (dev set): for model selection
  - test set: for generalization



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Machine Learning Basics - (2)

- k-fold cross validation: Useful when the number of training data are not sufficient.
  1. Spilt the data k into k equal subsets.
  2. Perform k rounds of learning:

     On each round, 1/k of the data is held out as a test set and the remaining examples are used as training data.
  3. Compute the average test set error of the k rounds.

- Performance measure: Loss function, Task에 따라 다름
  - ex) classification: accuracy or error rate E
  - training/dev/test sets에서 성능 측정 $\rightarrow \mathrm{E}_{train}, \mathrm{E}_{dev}, \mathrm{E}_{test}$

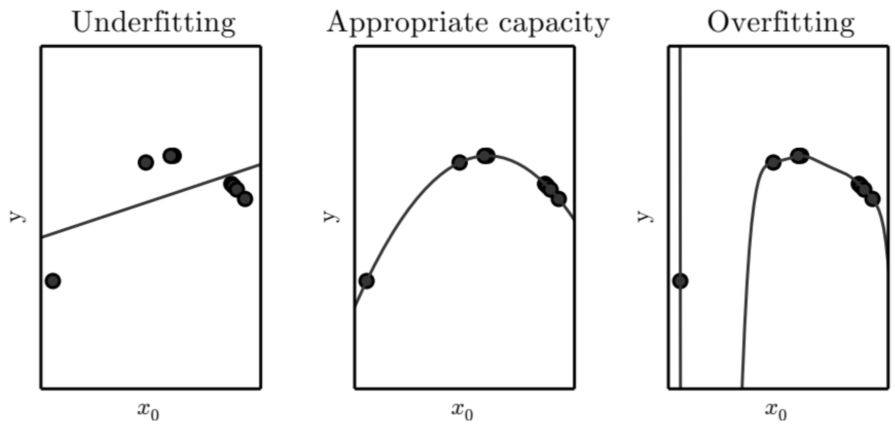
Absolute value loss:	$L_1(y, \hat{y}) = \lvert y - \hat{y} \rvert$
Squared error loss:	$L_2(y, \hat{y}) = (y - \hat{y})^2$
0/1 loss:	$L_{0/1}(y, \hat{y}) = 0$ if $y = \hat{y}$, else 1

Objective of ML

- ML의 목표: Perform well on unseen data
  - Generalization error $\mathrm{E}_{gen} = 0$ in theory
  - $\mathrm{E}_{test} \simeq 0$ in practice
  - Split into two objectives: $\mathrm{E}_{train} \simeq 0, \; \mathrm{E}_{test} \simeq \mathrm{E}_{train}$
- Objective 1: $\mathrm{E}_{train} \simeq 0$
  - optimization, more complex model
  - failure: underfitting → high bias
- Objective 2: $\mathrm{E}_{test} \simeq \mathrm{E}_{train}$
  - regularization, more data
  - failure: overfitting → high variance

How to choose a model?

- **Capacity of a Model:** The ability of the model to fit various functions
- Choosing a model: Occam's razor
  - Prefer the simplest hypothesis consistent with the data.



source: Goodfellow 2016

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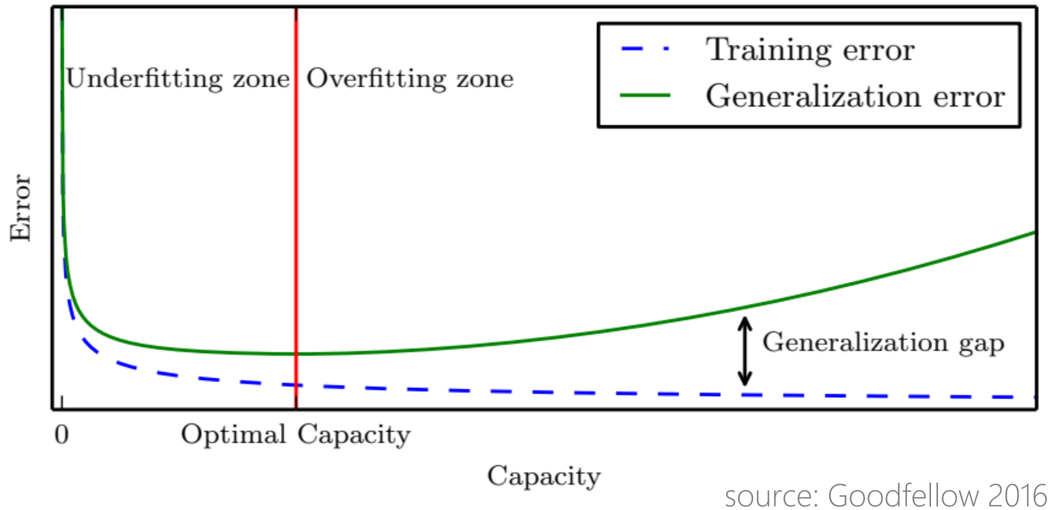
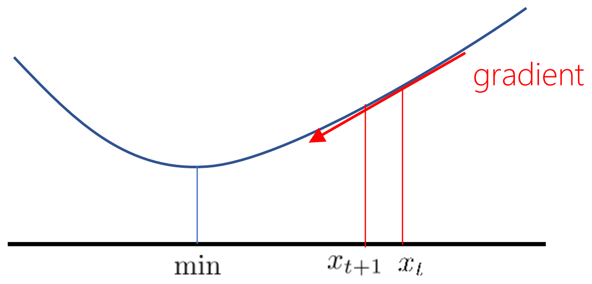
A tradeoff in ML

- approximation-generalization tradeoff or bias-variance tradeoff
- $$\underbrace{E_{test} \simeq E_{train}}_{\text{simple model is better}} \overbrace{\simeq 0}^{\text{complex model is better}}$$
- 해결책:
  - optimization: bias reduction (better approximation)
    - finds model parameters that minimize error
  - regularization: variance reduction (better generalization)
    - constrains model capacity
- complex model + effective regularization + big data



source: Goodfellow 2016



{ 3. 머신러닝 문제의 분류 }

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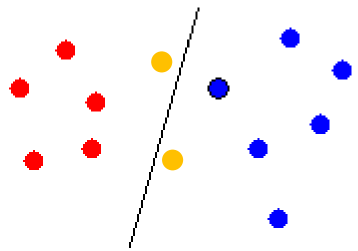
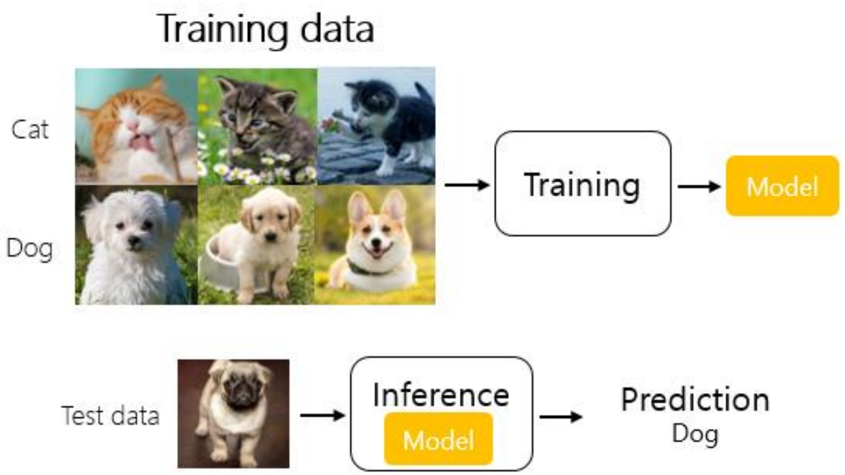
Classification

- Classification
  - Data set: $\{(x_i, y_i) : i=1,\ldots,N\}$
  - x_i : input data, y_i : class label
  - Given a new input data, classify its label.





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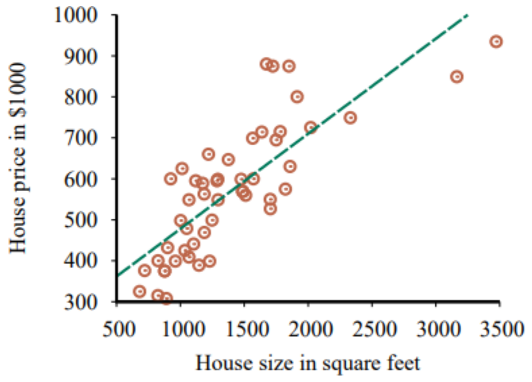
Regression

- Regression
  - Data set: $\{(x_i,\, y_i)\colon\ i{=}1,\ldots,\mathrm{N}\}$
  - x_i: input data, y_i : output data
  - Given the data set, find a function f such that $f(x_i) \approx y_i$.
- Linear regression, Logistic regression



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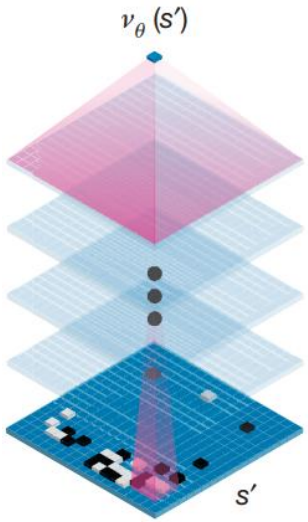
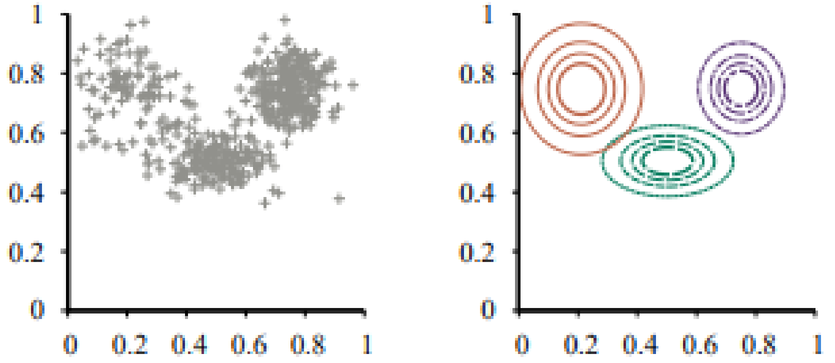


D. Silver, et al., 2016

Density Estimation

- Density Estimation
  - Data set: $\{x_i: i=1,\ldots,\mathrm{N}\}$
  - x_i: input data
  - Given the data set, find the distribution (or a simpler description) of x_i.

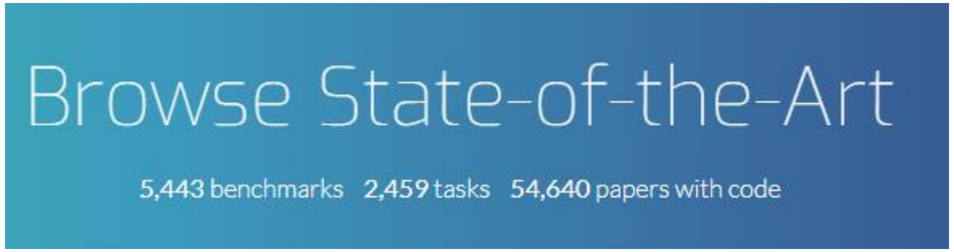


source: http://aima.cs.berkeley.edu/figures.pdf

and so on..

- Computer Vision: semantic segmentation, object detection, image generation
- Natural Language Processing: Language Modelling, Machine Translation, Question Answering
- Speech Recognition, Speech Synthesis, Playing Games

- State-of-the-art papers with code
  - https://paperswithcode.com/sota



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{ 4. 학습 방법의 분류 }

Types of ML

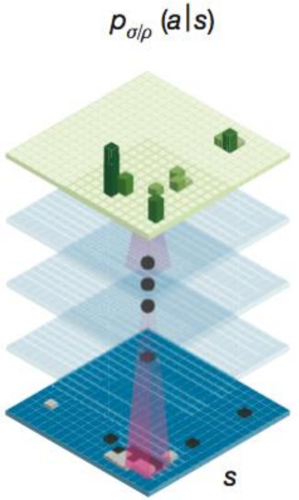
- Training data의 형태에 따라 분류
- Supervised Learning (지도학습)
  - Training with labeled datasets
- Unsupervised Learning (비지도학습)
  - Training with unlabeled datasets
- Reinforcement Learning (강화학습)
  - Learns from a series of reinforcements – rewards or punishments

- Semi-supervised learning, Self-supervised learning

source: http://aima.cs.berkeley.edu/figures.pdf

Supervised Learning

- Most common, successful so far
- A labeled training set $\{(x_i, y_i): i=1,...,N\}$
  - where each y was generated by an unknown function $y = f(x)$
  - discover a function $h \in \mathcal{H}$ (hypothesis) that best approximates the true function.
- Classification, Regression
- Supervison is pricey, but priceless.
- AlphaGo, Siri, Google Translator



D. Silver, et al., 2016

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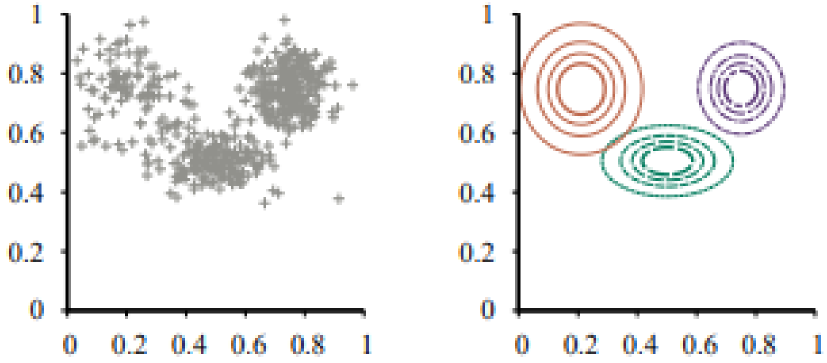
Unsupervised Learning

- An unlabeled training set $\{x_i:\ i=1,\ldots,N\}$
  - Learn patterns in the input data.
- Clustering, Dimensionality reduction (PCA, Autoencoder)
- Lower accuracy
- For pre-training, feature extraction



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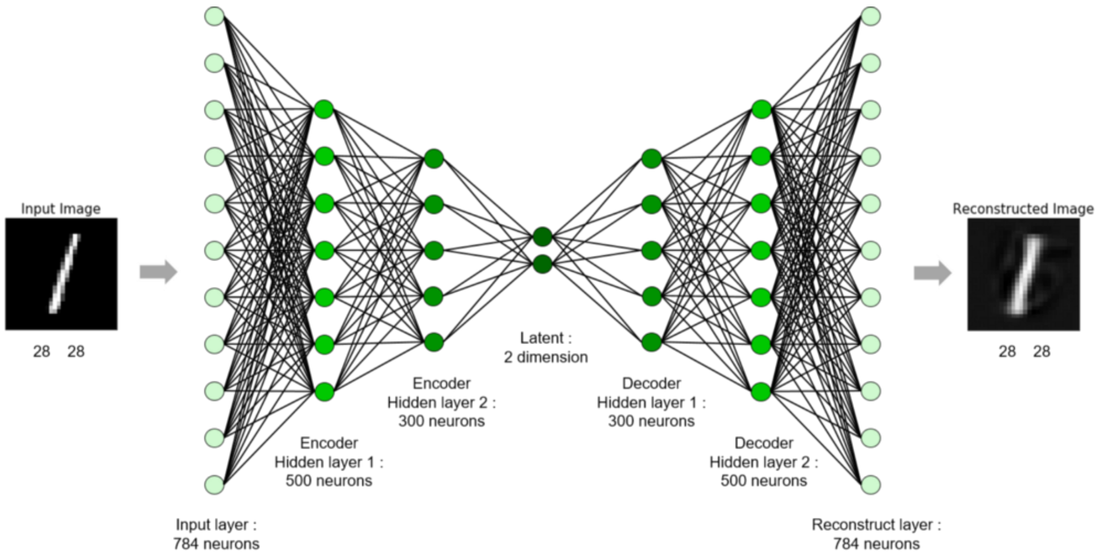

https://techblog-history-younghunjo1.tistory.com/130

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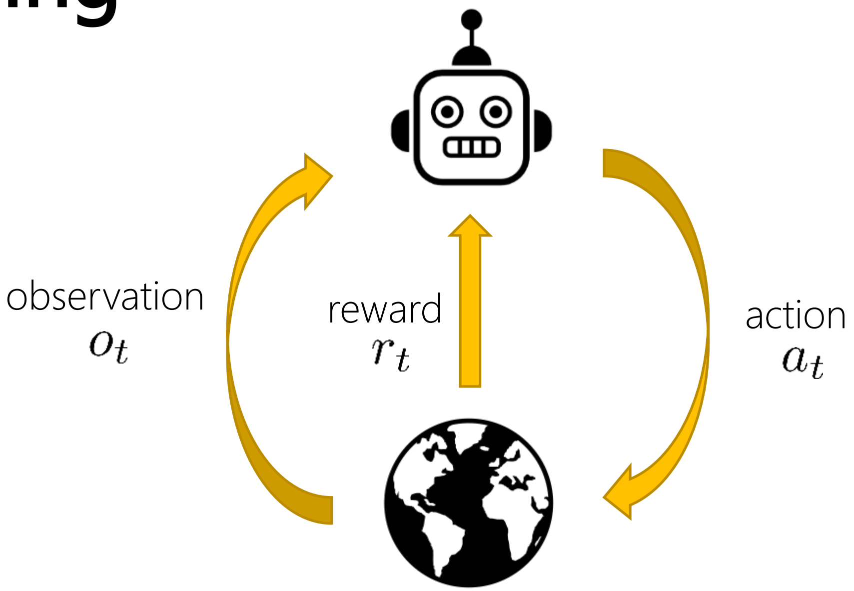
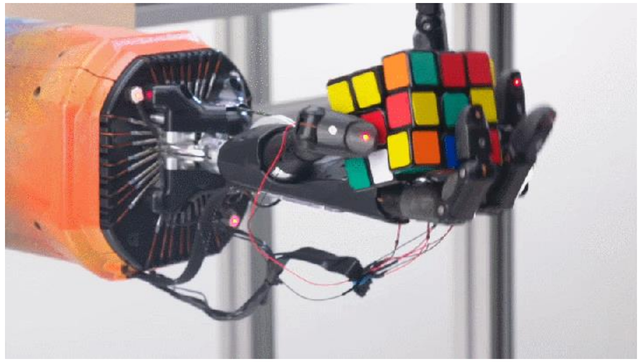
Reinforcement Learning

- Similar to how a dog learns.
- No supervisor, only a reward signal.
- Sequential decision making
- Playing Go games, Atari games
- Robotics





source: https://openai.com/blog/solving-rubiks-cube/

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{ 5. (실습) Colab, Python, NumPy 튜토리얼 }

Google Colaboratory

- colab.research.google.com
- Colab ≈ Google Drive + Jupyter Notebook
- 브라우저에서 Python을 작성하고 구글 클라우드 서버에서 실행
- 구글 서버의 GPU, TPU까지 무료로 사용!
- Free of 설치 문제: preinstalled packages
- 간편한 공유
- 단, 최대 12시간까지 세션 유지 (Free version)

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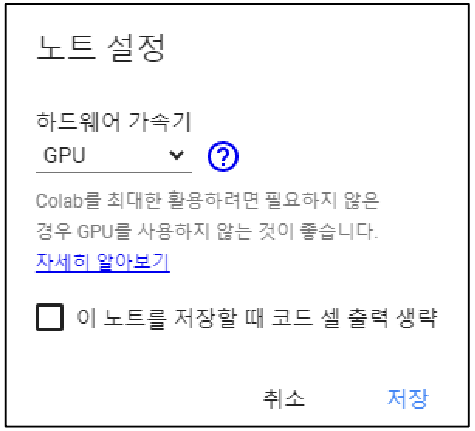
Google Colaboratory - Tips

- Resources aren't guaranteed.
  - idle for some amount of time or connection time exceeds → Session disconnects.
  - 자주 저장하는 습관!
- GPU 사용
  - 상단 메뉴바의 런타임 → 런타임 유형 변경 → 하드웨어 가속기 GPU로 변경 후 저장
  - 최근에 GPU를 사용한 경우 GPU 할당 우선순위가 밀려나므로 사용하기 직전에 변경 추천



Let's get started!

- 과제 파일 다운로드 후 로컬에서 압축해제
- 자신의 구글 드라이브에 아래의 디렉토리로 두 개의 노트북 파일 및 데이터 폴더 업로드
  - MyDrive/Colab Notebooks/Lab 1-1. Python, Numpy.ipynb
  - MyDrive/Colab Notebooks/Lab 1-2. Linear Regression.ipynb
  - MyDrive/Colab Notebooks/data