Lecture 20 – Deep Learning & Biomedical Imaging

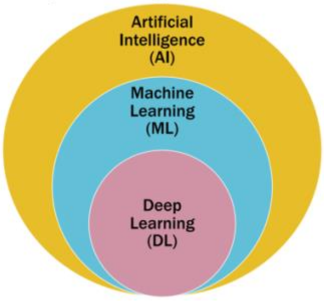
Agenda

- Artificial Intelligence Vs Machine Learning Vs Deep Learning
- Deep Learning and Biomedical Imaging

Why Do We Care About Health Data?

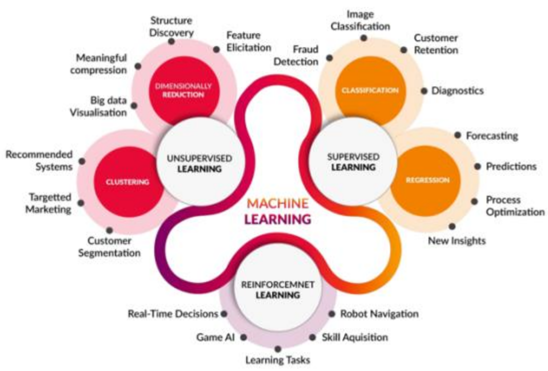
- For Doctors:
  - Diagnosing based on symptom and lab tests
  - Cure the disease based on the diagnosis results and the patient's situation
  - Without the data, doctors cannot diagnose precisely
- AI + Health Data:
  - AI-assisted disease diagnosing and curing

Artificial Intelligence Vs Machine Learning Vs Deep Learning



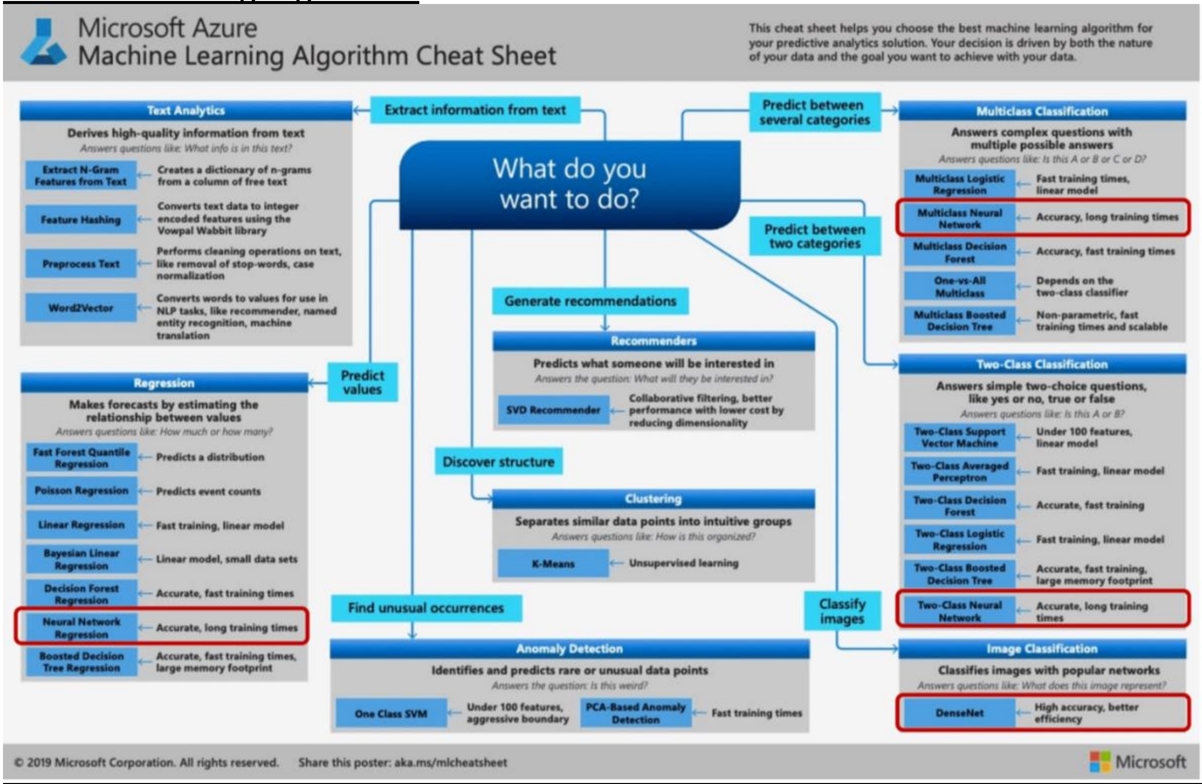
- Artificial Intelligence (AI): any techniques which enable computers to mimic human behavior
  - Ex) robot arms in factory: require very specific instructions for it to work
- Machine Learning (ML): a subset of AI, which effectively perform a specific task without using explicit instructions, relying on patterns and inference from the data
- Deep Learning (DL): a subset of ML, which takes advantages of multi-layer neural networks

Machine Learning Tasks

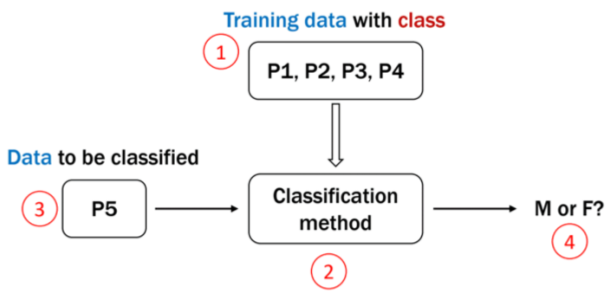


- Compared to AI, machine learning has very specific tasks
  - Unsupervised learning: no predefined label
  - Supervised learning: have predefined label
  - Reinforcement learning: system can interact with the environment and adjust the learning system by itself based on the feedback

Machine Learning Algorithms

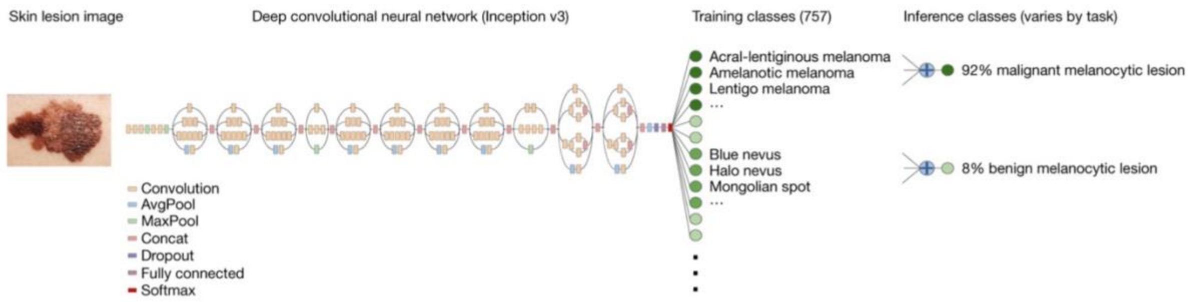


Deep Learning for Disease Screening



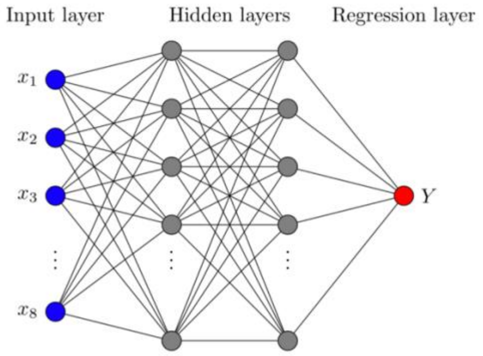
The basic paradigm for deep learning is same as what we have learnt so far for real-life implementation

Ex) inputting a skin lesion image and predicting whether it is benign or malignant



- Skin lesion image is the input
- Deep convolutional neural network is the training module
- And based on that and the training classes, make predictions

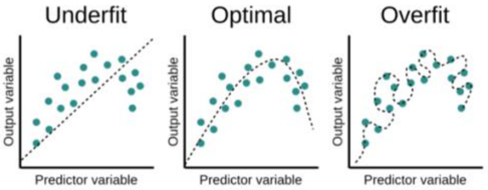
Fully-Connected Networks



- For resolving complicated problems:
  - Increase the number of nodes
  - Increase the number of layers
  - Add non-linear function
- Fully-connected layers:
  - A general function approximator
  - We can approximate any function if we have enough nodes and layers

Problems of Fully-Connected Networks

- Overfitting:
  - If the model is too complicated, it may fit some noise into the data



  - Ex) if we have an image of [(256*256*3) → no. of nodes for input] and 3 layers for binary classification and internal layer has 1000 nodes; we will have (256*256*3+1)*1000 + (1000+1)*1 number of parameters. This model is too complex. (+1 for biased nodes)
- Difficult to determine the number of nodes and layers
- Too large data to store
- Running time is too long
- Hard to train
- Prior Knowledge is ignored:
  - Especially for image. We have prior knowledge that if the two pixels are close together, it is very likely that the pixel values are similar to each other. But for fully-connected networks that prior knowledge is ignored and each pixel are considered as separate node.

Images are Different from Data Matrix

- For data matrix, if you shuffle entire row or column, you will not change the data at all
- But for images, there is spatial information, and we should design models based on that.