# AI

There is NO Magic

Agenda

- AI/ML/DL overview
- Problems to solve
- Machine Learning methods and algorithms
- Deep Learning magic
- AI how-to for newbie
- Recent NLP researches and applications
- Q&A

What is the "AI" that everybody is talking about?

- AI
  - Machine solving human problems
  - Strong AI can do anything
- Machine Learning
  - Teach machine to do a specific task
  - Automatically "learning" from data
- Deep Learning
  - Originally deep neural networks
  - Nowadays any deep structured model

AI

Machine
Learning

Deep
Learning
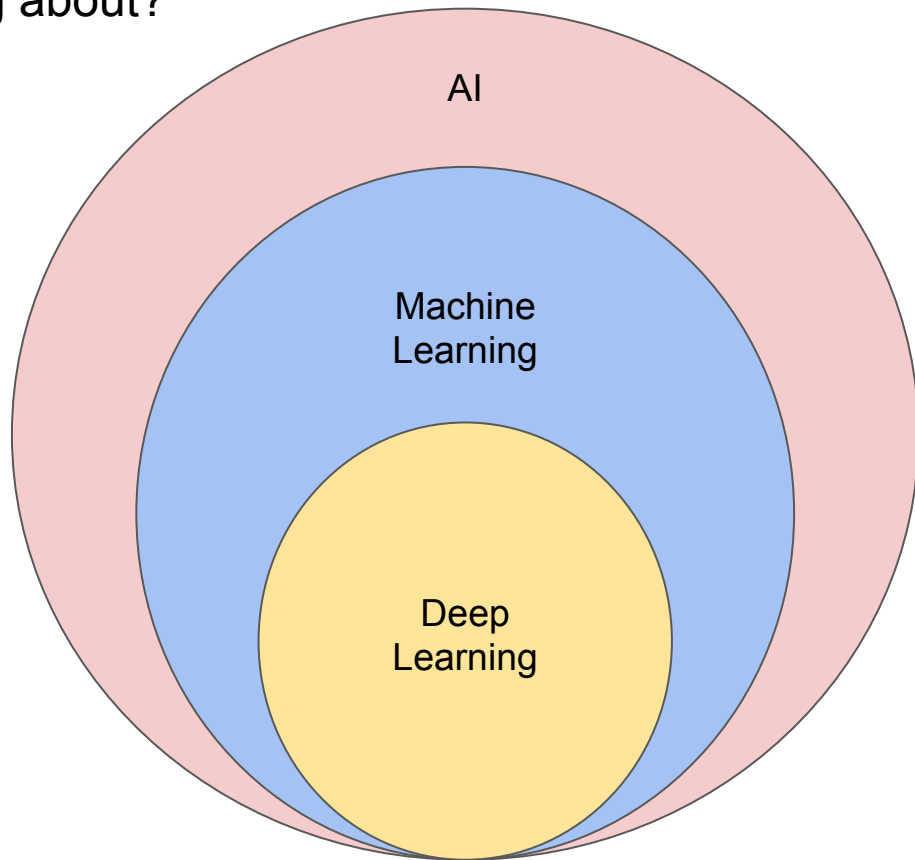
Black tea or green tea? (Machine learning tasks)

- Data:
  - Randomly picked people around the world with information like: name, sex, age, residence, occupation, weight, height, …, etc.

Diana	F	Paradise Island	Green	5 cups per day
Bruce	M	Gotham City	Black	20 cups per day
Clark	M	Krypton	Black	1 cups per day

- Classification problem:
  - To predict if a person likes black tea or green tea
- Regression problem:
  - To predict tea consumption
- Clustering problem:
  - To group people with "similar features"

Types of learning methods and algorithms

- Supervised learning
  - Can solve the classification and regression problems
  - Human knowledge is involved. E.g. we know people's black-or-green tea preference
  - Linear regression, Support vector machines, multilayer perceptron, etc.
- Unsupervised learning
  - Can solve grouping and clustering problem
  - For data that has not been labeled, classified or categorized
- Reinforcement learning
  - Teach computer agent to take actions in an environment
 - Game AI, self-driving car

Deep Learning

- Learning "deep" (multi-layer) neural networks
- Different architectures of NN:
    - Multi-layer perceptron (MLP)
        - multiple layers of linear projection and non-linear activation
    - Convolutional neural network (CNN)
        - convolutional layers, applying convolution operations to input
        - 2-D CNN for computer vision problems
    - Recurrent neural network (RNN)
        - use internal state (memory) to process sequences of inputs
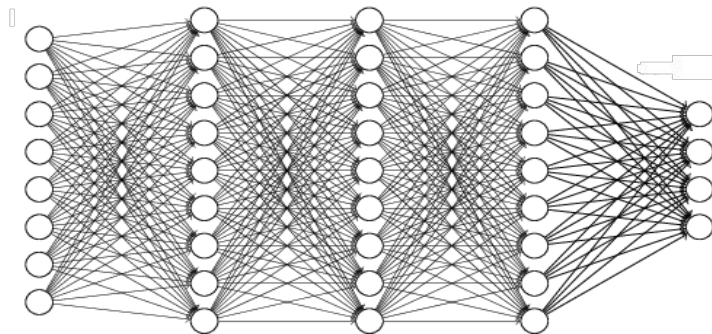   - For sequential data like: stock, text, voice, etc.

Going deeper and deeper

- Neural Network
  - A simple fully-connected MLP: --->
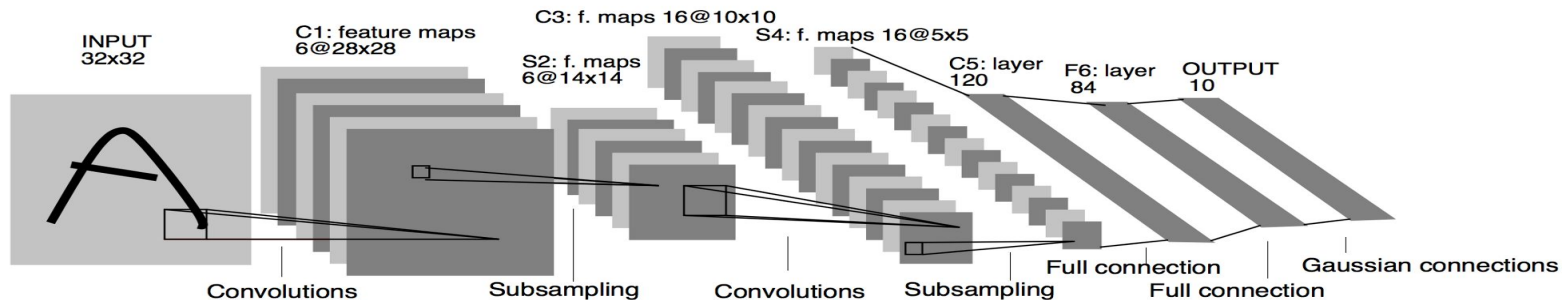 - Werbos's (1975) backpropagation algorithm to train neural network
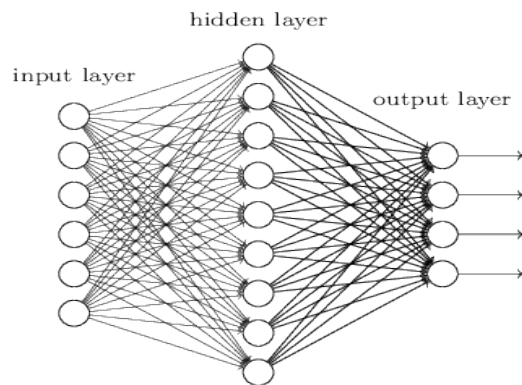
  - Multi-hidden-layer neural network:--->
  - Hinton et al. (2006) proposed an efficient way to train stacked restricted Boltzmann machines
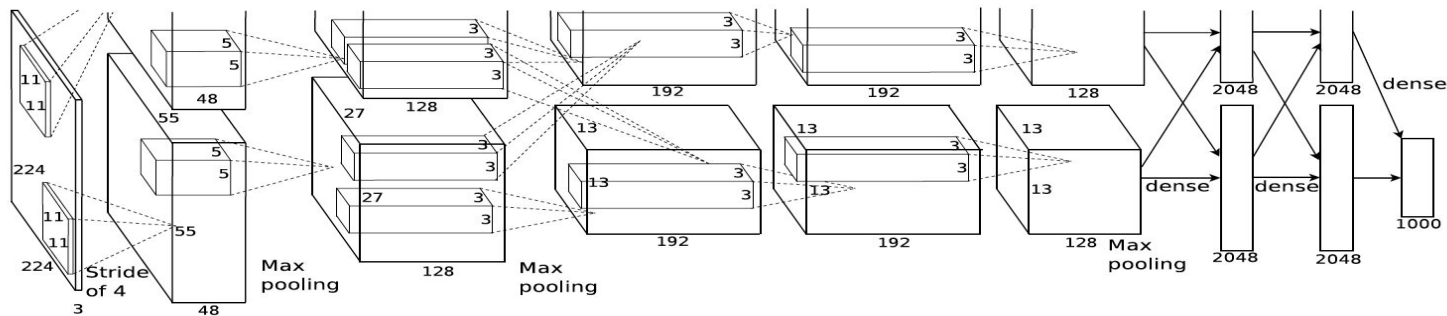
Deep Learning

- Convolutional Neural Network (CNN)
  - LeNet-5, a pioneering 7-level convolutional network by LeCun et al. in 1998

Deep Convolutional Neural Network

- AlexNet
  - Alex Krizhevsky et al. (2012)
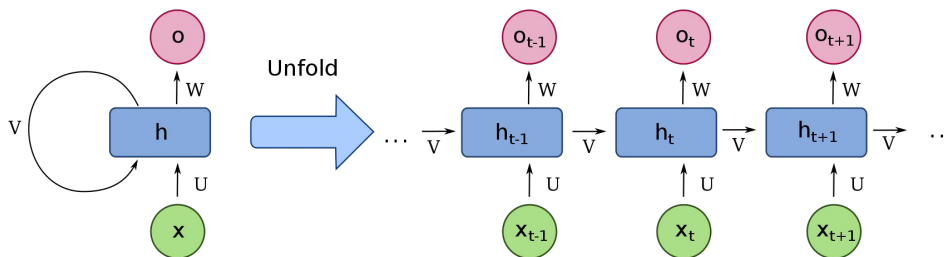 - 5 conv layers, 3 fully-connected layers

- ResNet (Residual Network)
  - Kaiming He et al. (2015)
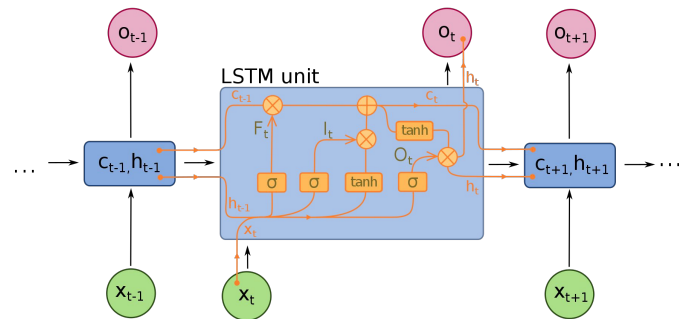 - Can be more than 1000 layers, usually 50/101/152 layers

RNN for NLP

- ## RNN:
  - based on David Rumelhart's work in 1986

- ## LSTM (long short-term memory)
  - proposed in 1997
  - modified and effectively trained since 2005
  - its variants revolutionize NLP problems from 2014:
    - Sequence to Sequence Learning
    - speech recognition, machine translation, language modeling, etc.

AI/ML/DL - Where to start?

- Specify a task(s)
- Understand the problems
- Prepare the data
- Design and train a model
- Evaluation

Specify a task

- What do you want computer to do?
- Can this task be able to handle by humans?
- E.g. "computer, show me the summary of MOHLTC funds and disbursement for FY 2016-17"
  - This is not a single machine learning task
  - 1) show me a doc related to MOHLTC (RG67-5)
  - 3) show me a report (classification)
  - 2) show me a doc with summary table or chart (classification)
  - 3) show me a doc with key words "funds", "disbursement", "FY", "2016-17" (search engine)

Understand the problems

- Find a doc that is a report
  - Text feature extraction: tf-idf, doc2vec, etc
  - Feature vector to train classifier (can also do clustering)
- Find a doc with summary table or chart (classification)
  - Natural language processing or Computer Vision?
  - If NLP, use sentence(s) which describes the table or chart to train RNN
  - If CV, convert page to image then train CNN to do object detection, or classification
- Find a doc with key words "funds", "disbursement", "FY", "2016-17" (search engine)
  - Reduce the complexity by searching "description" instead of full article (text summarization)
  - contains as much "useful" keywords as possible (extract v.s. abstract)
  - search keyword is missing in the "description" (similar words, word2vec, etc)

Design and train a model

- Machine learning skill levels (high to low)
  - Design a model from scratch and train
  - Modify a model and train
  - Train a model and converge
  - Fine-tune a pre-trained model
  - Run a pre-trained model
- Train a model and converge is not easy
  - Model is not designed to handle your dataset
  - Dataset is not big enough
- Transfer learning: Pre-training + Fine-tuning
  - Many startup companies do transfer learning and succeed
  - E.g. Pre-train ResNet on ImageNet dataset and fine-tune with own data
  - Improving language understanding by generative pre-training (e.g. BERT)

Recent NLP researches and applications

- Tasks:
  - Language Modeling
  - Machine Translation
  - Question answering and commonsense reasoning
  - Semantic Similarity
  - Text Summarization
  - ……
- Popular base models:
  - Sequence to Sequence Learning (LSTM)
  - Transformer
  - CNN based
- Popular training methods:
  - Semi-supervised Sequence Learning (w/ LSTM, 2015)
  - Unsupervised Pre-training + Supervised fine-tuning (w/ Transformer, 2018)