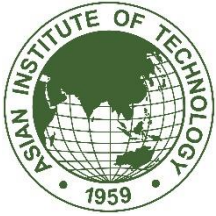


The secret of getting ahead is to get started

Mark Twain

Workload

- 1 project at the end of the semester (group 1-2 students)

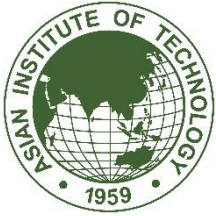
submit project topic + team members by the end of August

The project must use local test dataset only to get the points

- 1 paper presentation (individual)

submit the paper title by the end of August

- Homework is assigned weekly



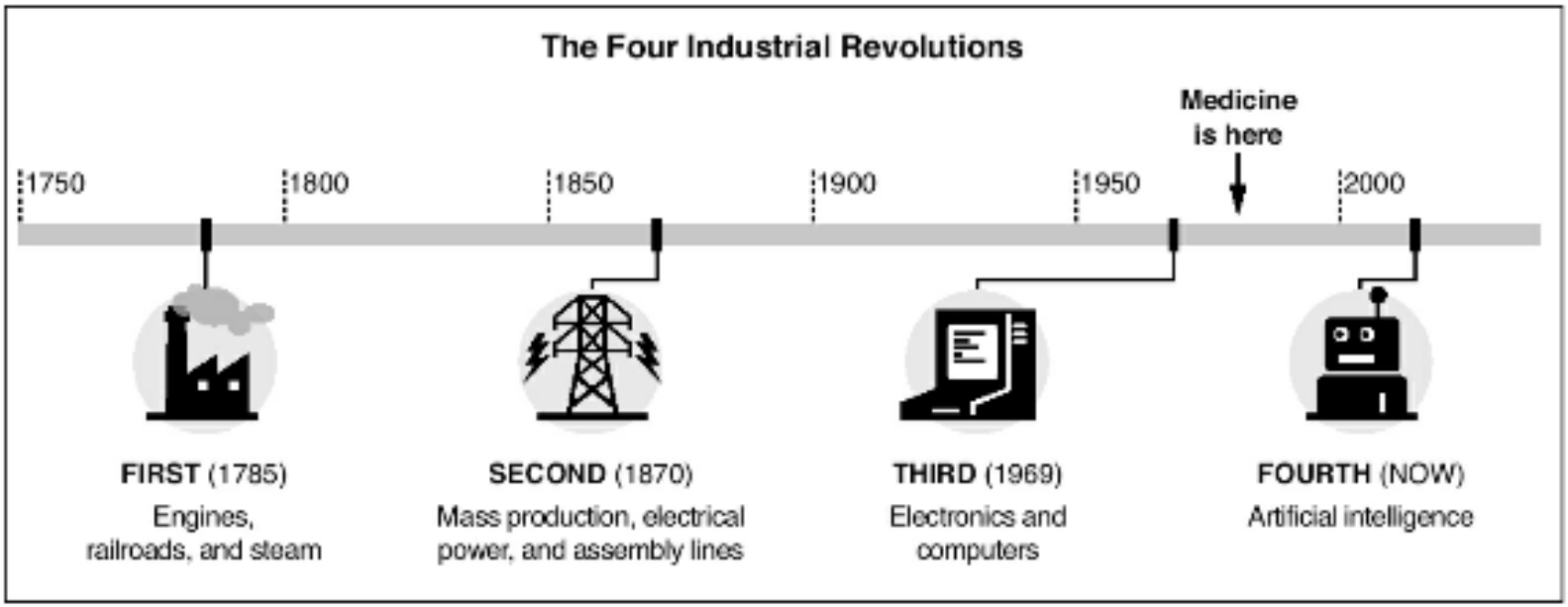
Introduction

Dr. Mongkol Ekpanyapong

What's this?

The first photograph in the world
Joseph Nicéphore Niépce, *View from the Window at Le Gras*, France 1826.

Fourth Industrial Revolutions



Artificial Intelligence (AI)

Definition: AI is intelligence demonstrated by machines

The field of AI research was found at a workshop in the campus of Dartmouth College during the summer of 1956

Golden years: 1956-1974

First AI winter: 1974-1980

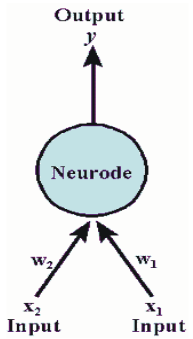
AI Research History

- 1936: Alan Turing published a paper titled “On Computable Numbers, with an Application to the Entscheidungsproblem” (later known as Turing machine)

- 1950: he published another paper “Computing Machinery and Intelligence” where he asked “Can machines think?”

AI Research History

- 1943: Computational math model based on neural network was introduced by McCulloch and Pitts (first ANN)



- 1949: Donal Hebb published a book “Organization of Behavior” talking about relationship between neural
- 1959: Machine learning field was introduced from IBM
- 1959: first commercial application of neural network called ADALINE by Stanford Professor
- 1969-1980: first AI winter(Paper by Minsky and Papert about XOR problem)

A simple Perceptron

- First Artificial Perceptron published by Ronsenblatt in 1950

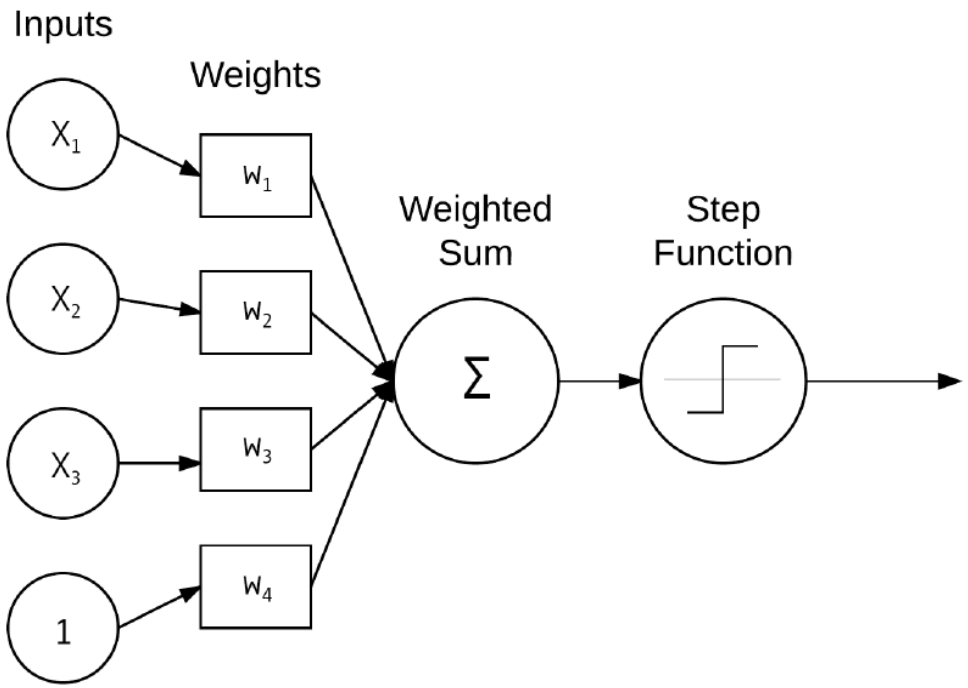


Image from DeepLearning with Computer Vision book

XOR problem

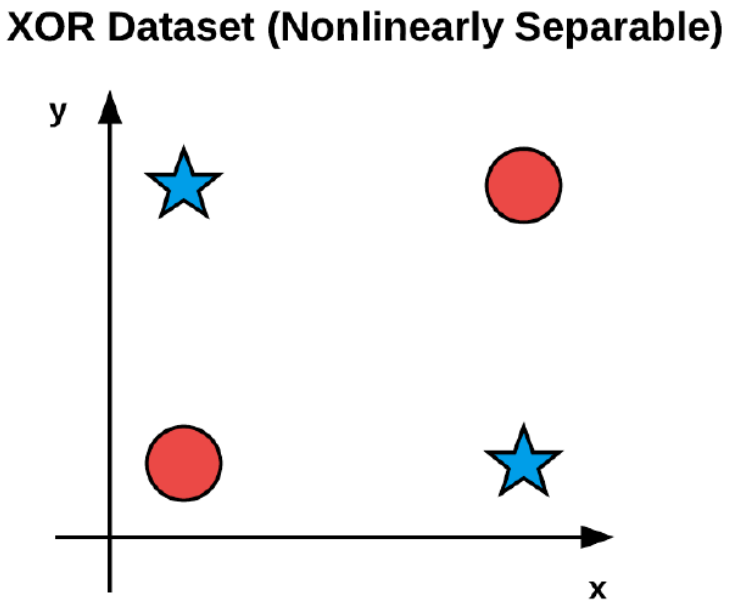


Image from DeepLearning with Computer Vision book

AI Research History

- Second boom: 1980-1987 on expert system
- Backpropagation is introduced by Rumelhart in 1986
- Second winter: 1987-1993
- 1996: IBM’s DeepBlue won over the Chess world champion Gary Kasparov
- Third boom: starting form 2007

Multi-layer ANN

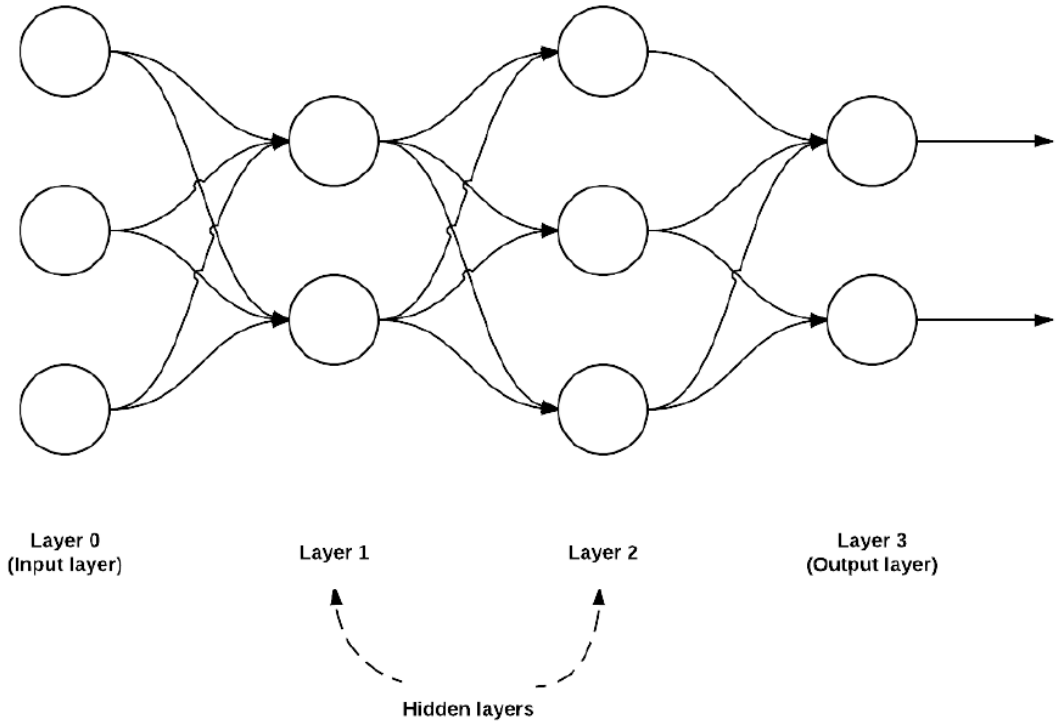
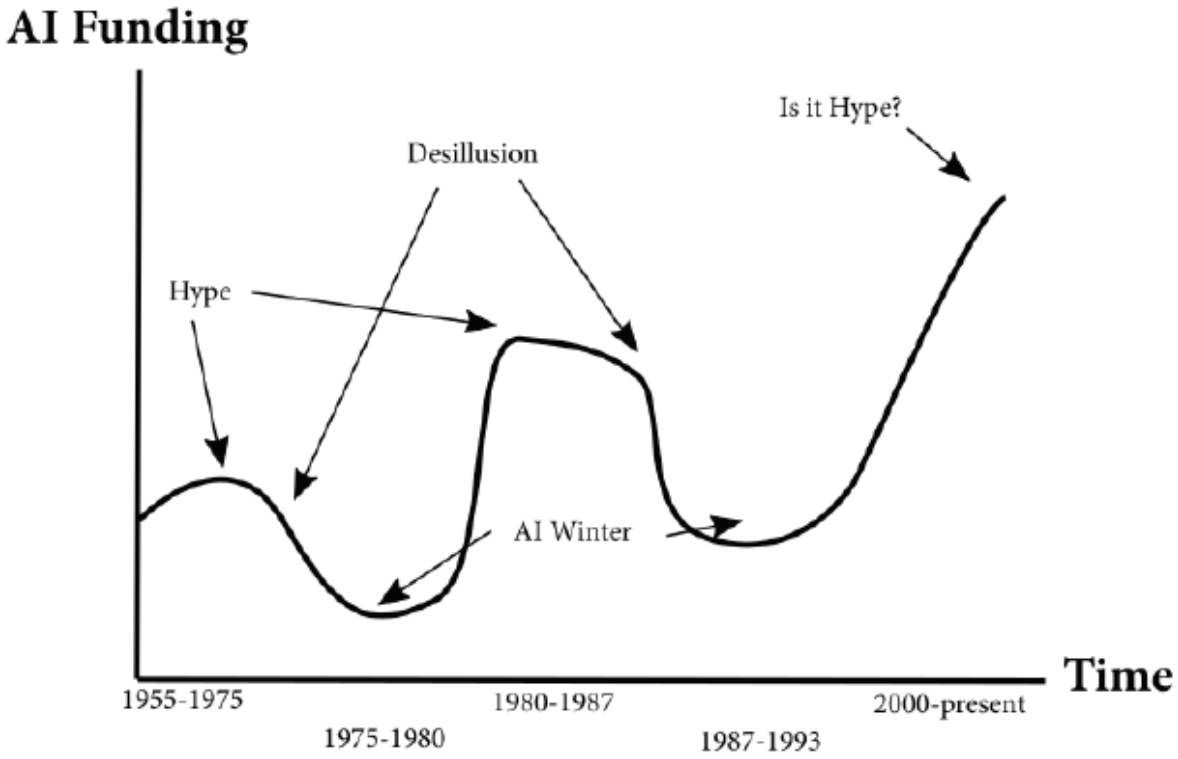


Image from DeepLearning with Computer Vision book

AI Winter


AI Funding
Is it Hype?
Desillusion
Hype
AI Winter
Time
1955-1975
1975-1980
1980-1987
1987-1993
2000-present

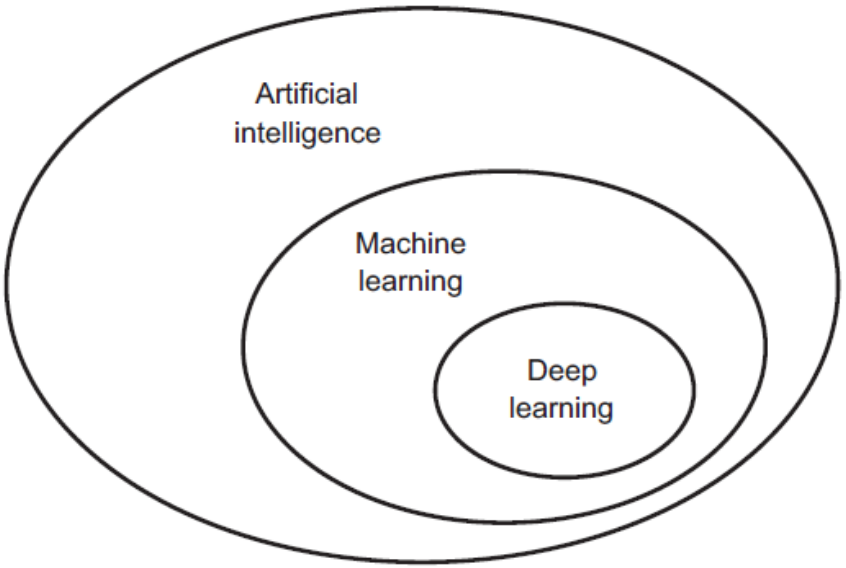
AI Research History

- 1997: Deep blue won the world chess champion
- 2005: Stanford robot won DARPA Challenge on self driving car
- 2007: CMU won DARPA Challenge on urban self driving car
- 2016: AlphaGo won 9-Dan Go playing

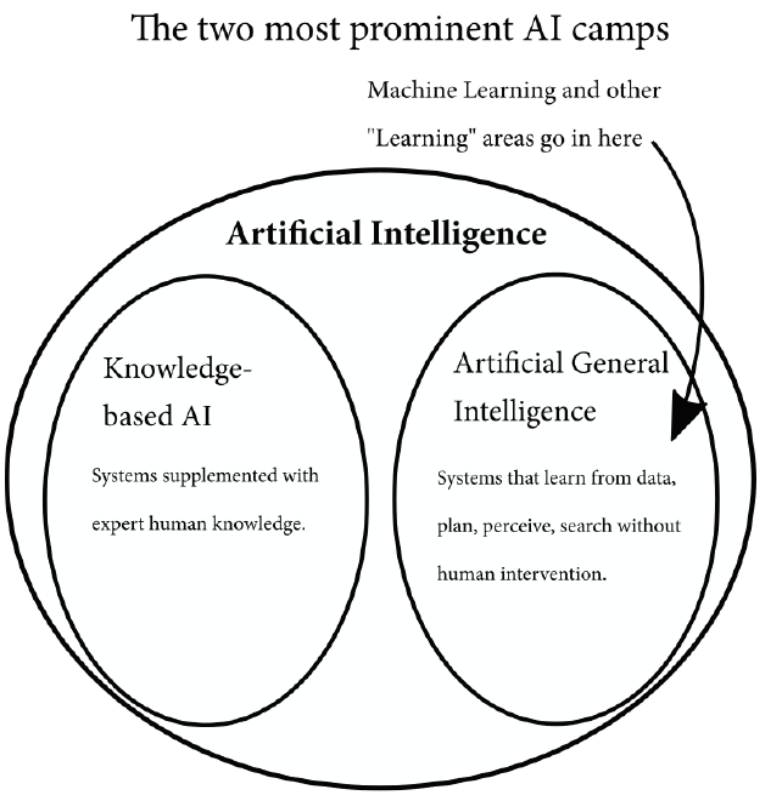
2012 is the year for the third AI boom

Deep Learning

- Artificial Intelligence
- Machine Learning
- Deep Learning



AI camps



Don't be mislead, though.

Lots of great success stories have relied heavily on both!

Machine Learning

- Machine learning is a field of computer science that uses statistical techniques to give computer systems the ability to "learn" (e.g., progressively improve performance on a specific task) with data, without being explicitly programmed

Machine Learning (ML)

- Machine Learning is characterized by software that learns from previous experiences
- E.g., A computer program improves performance as more and more examples are available
- Another name is inductive learning because the code try to infer structure from data alone

Feature, parameter, model

- A feature is an individual measurable property or **characteristic** of a phenomenon being observed
- In machine learning paradigm, the undecided values are called parameters, and the description is referred as a model
- A model refers to a mathematical expression of model parameters along with input place holders for each prediction, class and action for regression, classification and reinforcement categories respectively.
- A hyperparameter is a parameter whose value is set before the learning process begins. By contrast, the values of other parameters are derived via training

Feature Engineering

- Find important features such as color, texture, and shape

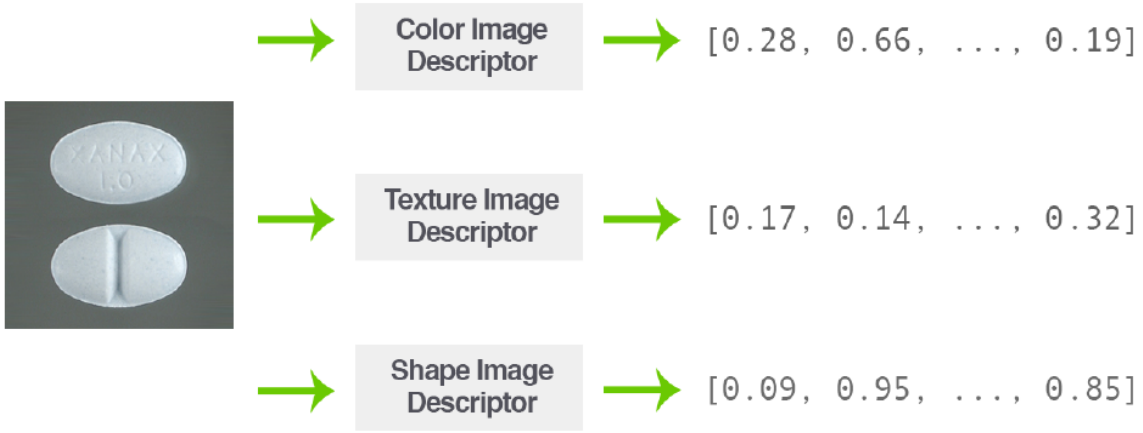
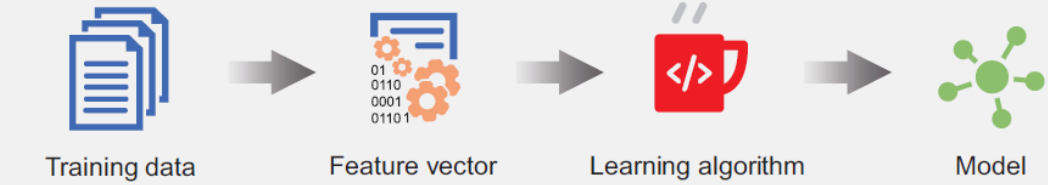


Image from DeepLearning with Computer Vision book

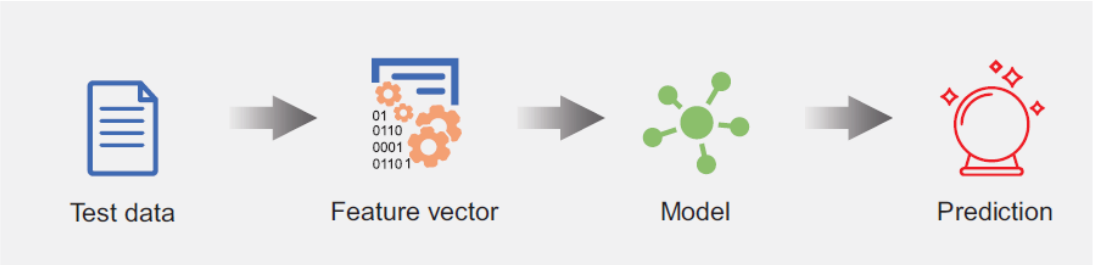
Learning/Training Approach

- Features: a practical simplification of data
- Hyper parameters: Undecided values
- Model:



Inference stage

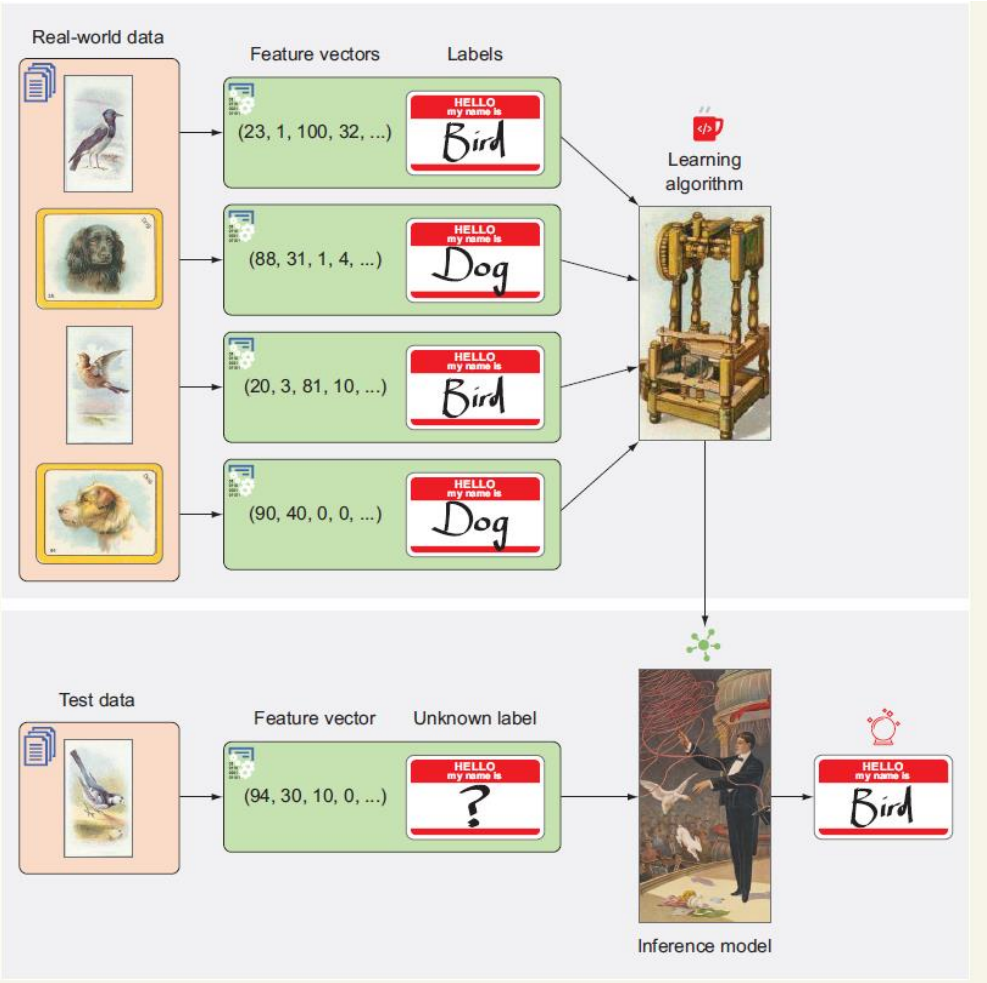
- Make the prediction on never-before-seen data
- It can be classification or regression



Feature Engineering

- Feature engineering is the process of selecting relevant features for the task e.g., predict the price

Feature vectors and data prediction



Traditional ML vs. Deep Learning

- The feature extraction is done automatically

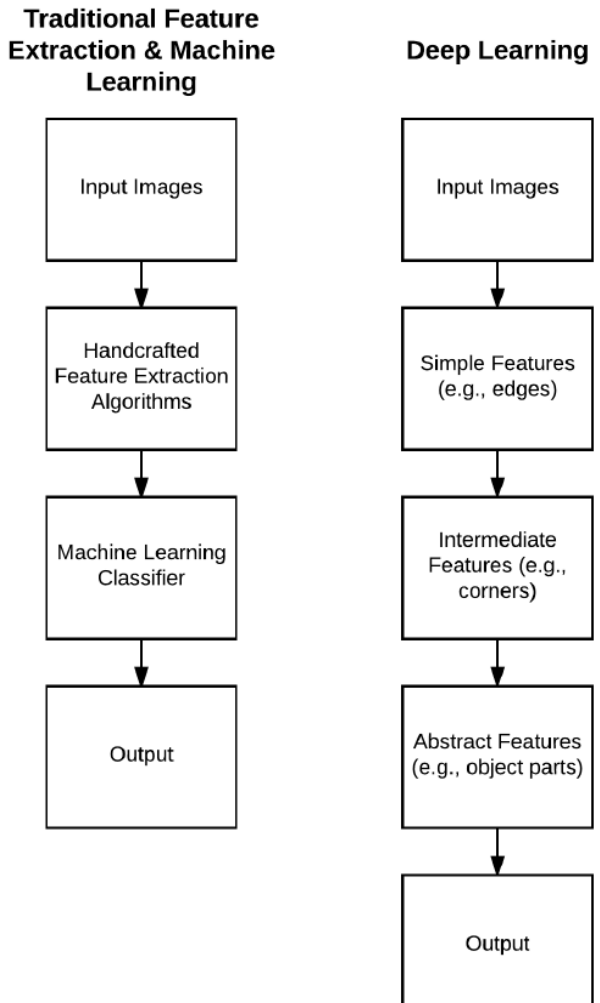


Image from DeepLearning with Computer Vision book

Performance Comparison

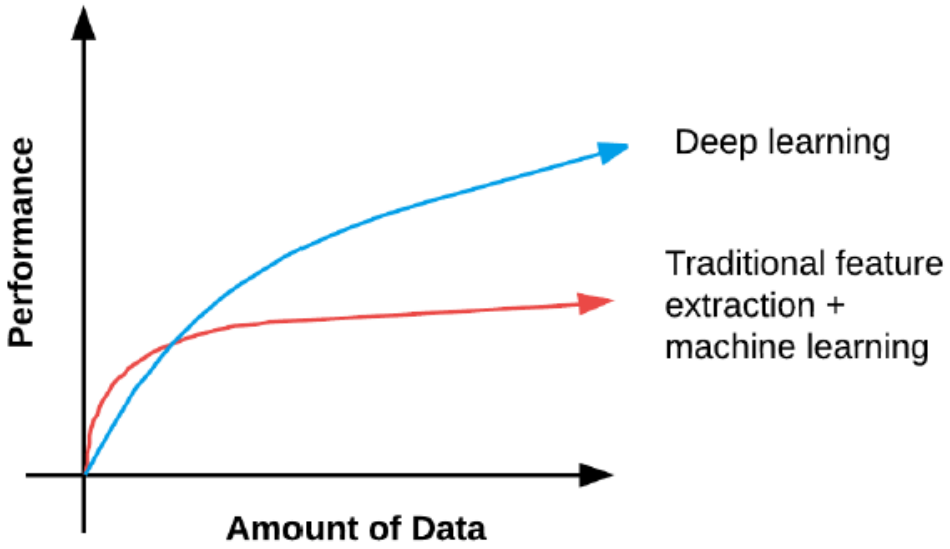
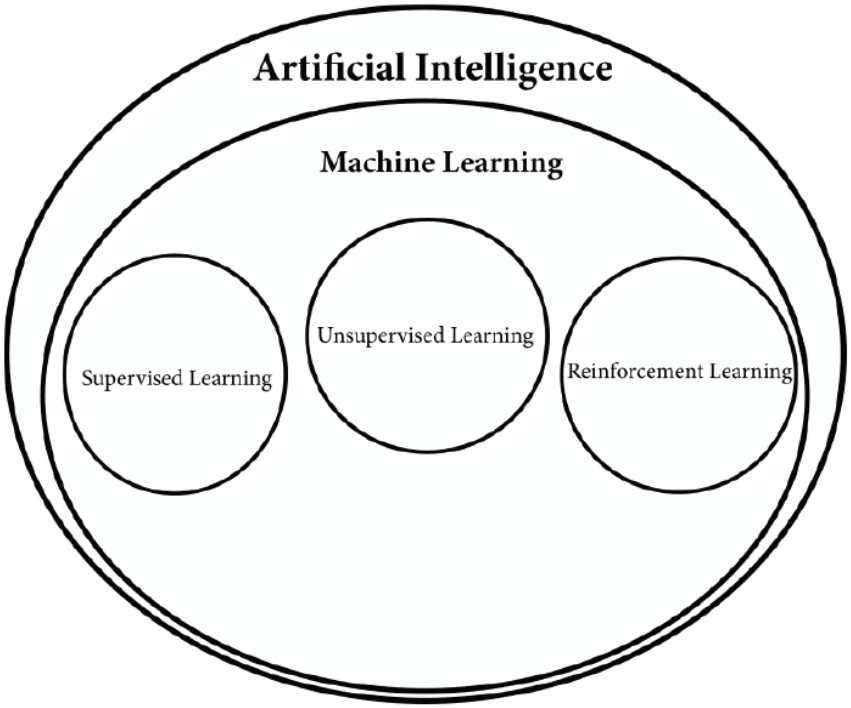


Image from DeepLearning with Computer Vision book

Machine Learning

Main branches of machine learning



Type of Machine Learning

- Supervised learning
- Unsupervised learning
- Reinforcement learning

Supervised learning

- Supervised learning is a learning by example laid out by a supervisor
- The system needs labeled data to develop a model
- In another word, a model is a function that assign a label to data
- The collection of previous labeled data is called training data set
- Example of labeled data is photographed of people

Mathematics Definition

Let x be a feature vector

$y = f(x)$ when f is the model

If y is discrete, then the model is classifier

If y is continuous, the model is regressor

Unsupervised learning

- is a model that comes without corresponding labels
- With enough data, it may be possible to find patterns, and structure
- Unsupervised learning are based on clustering algorithm, and dimension reduction

Reinforcement learning

- It is also called feedback system
- The learning system receives feedback on its action
- Reinforcement learning is a type of machine learning that interacts with the environment to learn which combination of actions yields the most favorable results
- Sometimes, the system is referred to as an autonomous agent

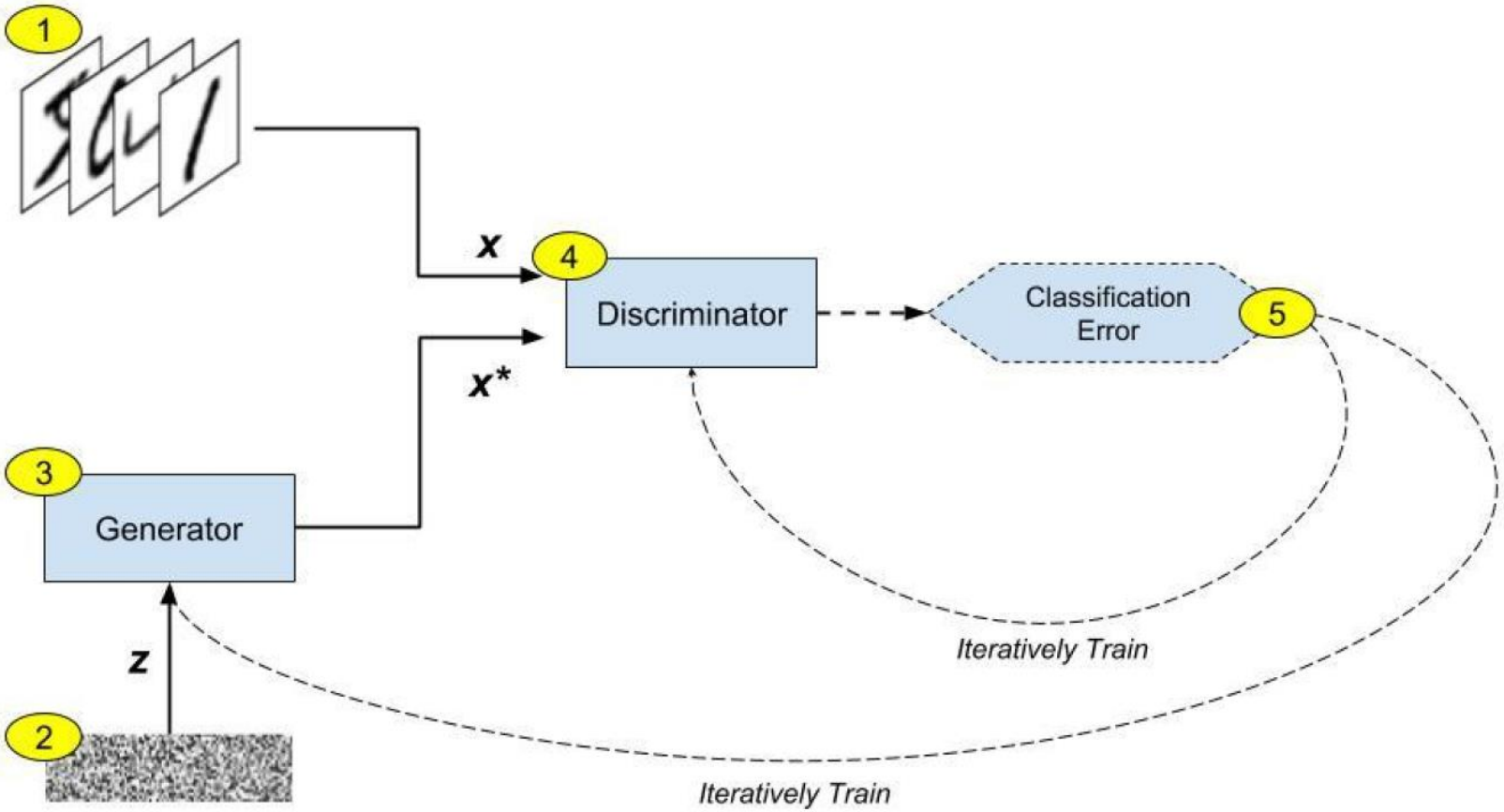
Reinforcement learning

- A state is the status of the world frozen at a particular time
- An Agent may perform one of many actions to change the current state
- To drive an agent to perform actions, each state yields a corresponding reward
- An agent eventually discovers the expected total reward of each state, called the value of a state

Generative Adversarial Network (GAN)

- A machine learning technique that use a game-like competitive between two neural networks
- The two network are called Generator and Discriminator
- The Generator’s goal is to produce data that is indistinguishable from the training dataset
- The Discriminator is to correctly determine whether a particular example is real

GAN Architecture



Please describe machine learning to solve these problems

a) Organize various fruits in three baskets based on no information
b) Predict the weather based on sensor data
c) Learn to play chess well after many trial-and-error attempts

Please describe machine learning to solve these problems

a) Organize various fruits in three baskets based on no information Unsupervised

b) Predict the weather based on sensor data Supervised

c) Learn to play chess well after many trial-and-error attempts Reinforcement

A brief history of machine learning algorithm

1. Probabilistic modeling
2. Early neural networks (ANN = Artificial Neural Network)
3. Kernel methods
4. Decision trees, random forests, and gradient boosting machines
5. Back to neural networks (Deep Learning model)

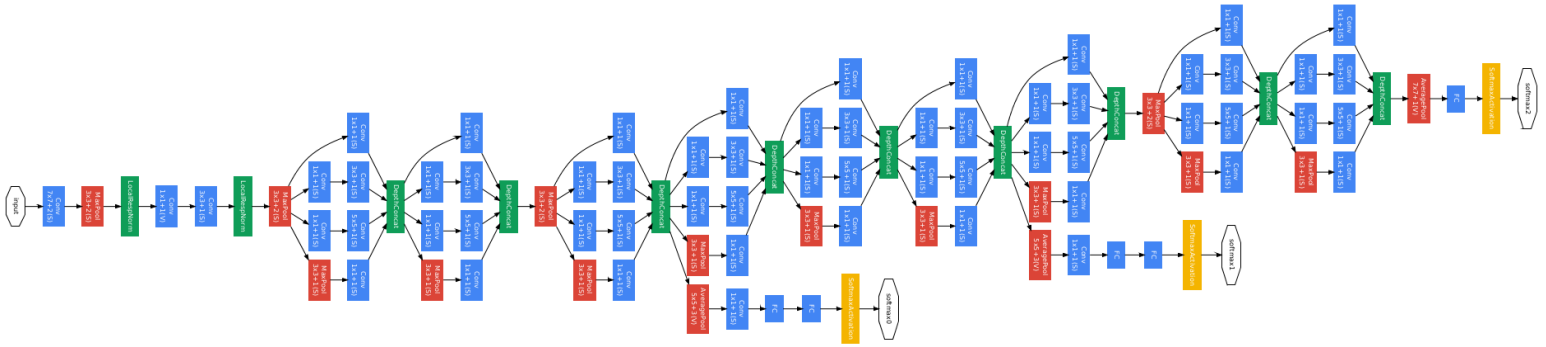
Deep learning

- Around 2010, the group of Geoffrey Hinton, Yoshua Bengio, and Yann Lecun started to make important breakthroughts (First paper in 2006)
- In 2011, Dan Ciresan began to win academic image-classification competitions with GPU-trained deep neural networks
- In 2012, Hinton's group has demonstrated its deep-learning performance on ImageNet competition

Deep Learning

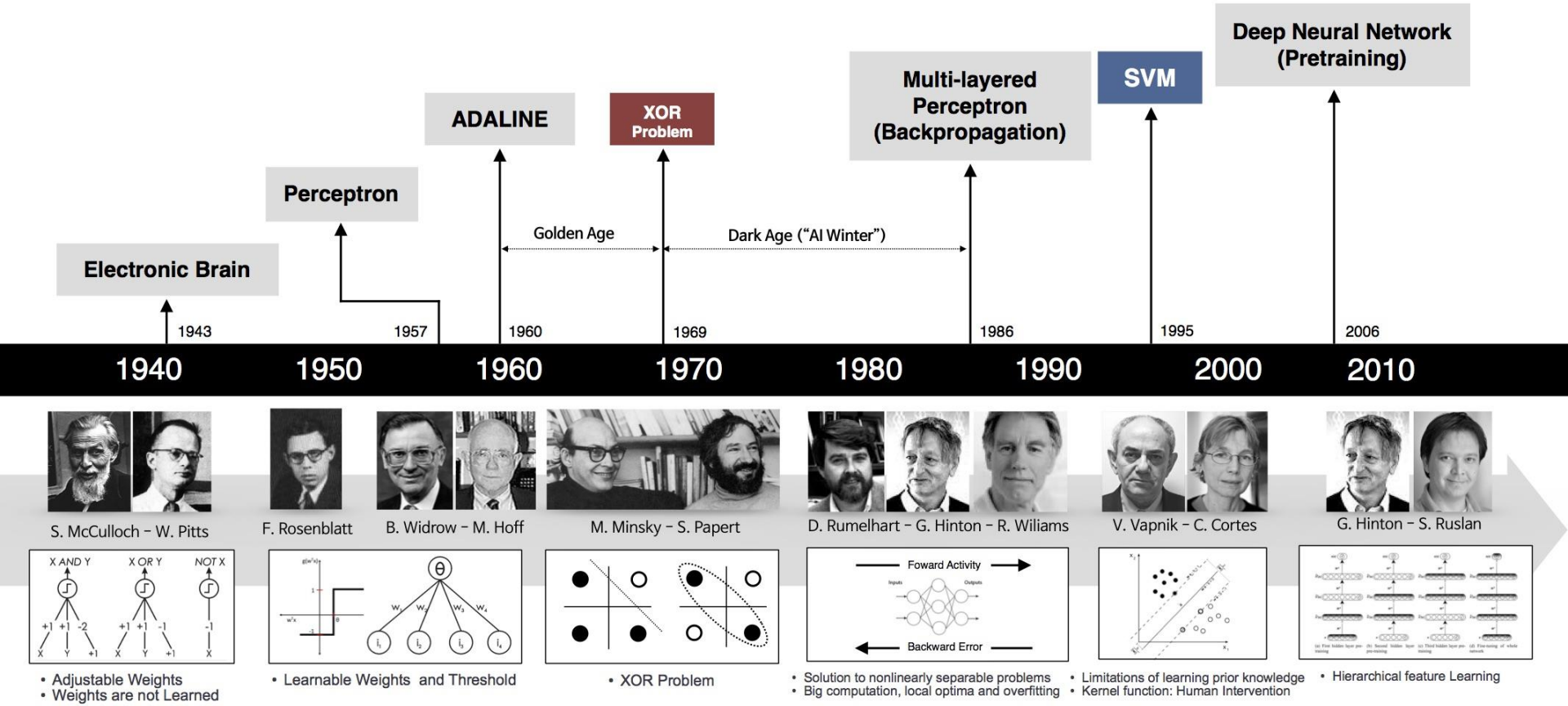
"Deep learning methods are representation-learning methods with multiple levels of representation, obtained by composing simple but nonlinear modules that each transform the representation at one level (starting with the raw input) into a representation at a higher, slightly more abstract level. [...] The key aspect of deep learning is that these layers are not designed by human engineers: they are learned from data using a general-purpose learning procedure" – Yann LeCun, Yoshua Bengio, and Geoffrey Hinton, Nature 2015. [9]

Google Net Model



Source: https://ai.googleblog.com/

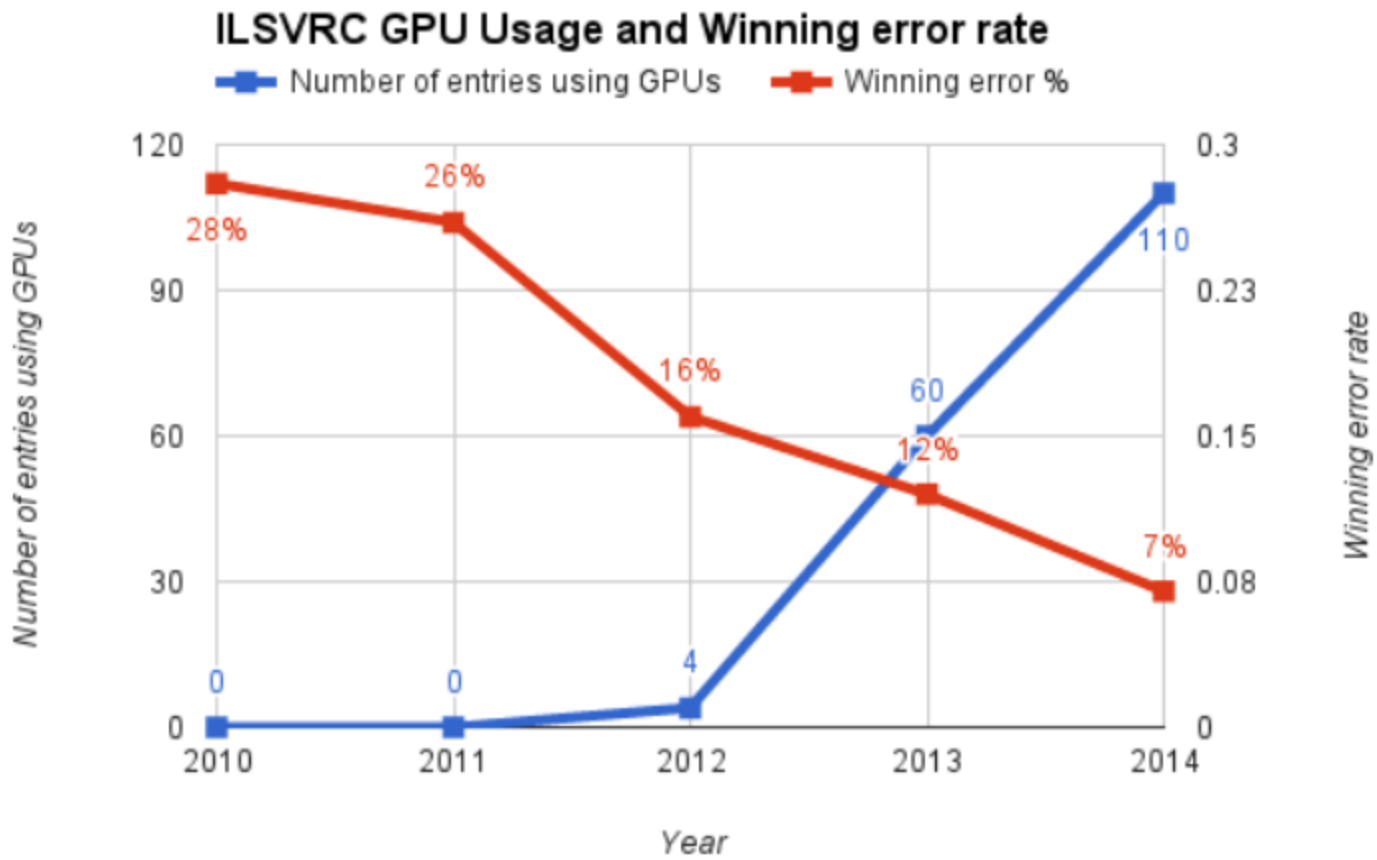
Deep learning History



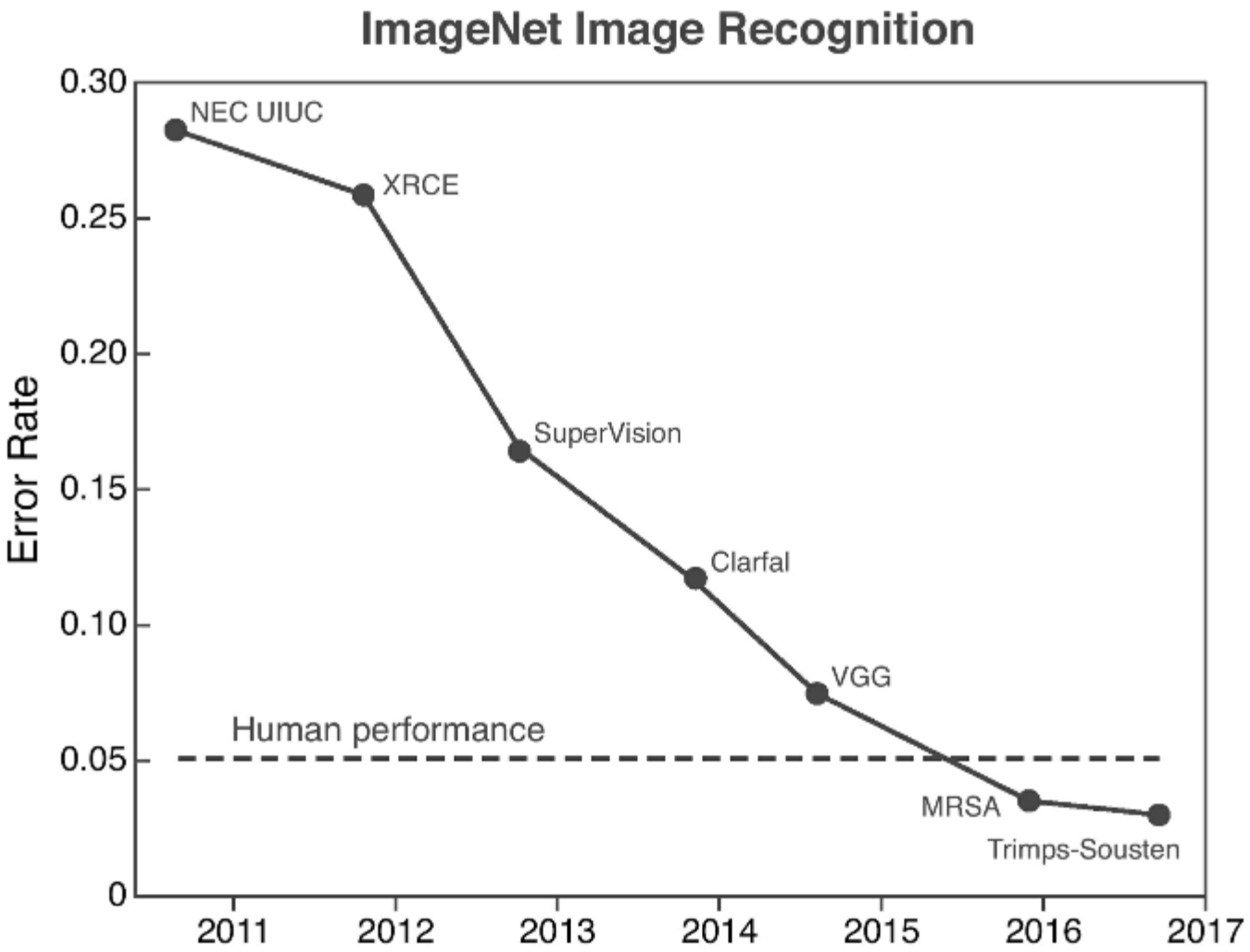
Deep Learning History

- 1957: the creation of perceptron
- 1986: the backpropagation is proposed
- 2006: the introduction of deep learning and the pretraining (how to take the large network)
- 2012: AlexNet wins the Large Scale Visual Recognition Challenge (LSVRC)
- 2013: Then, ZFNet
- 2014: GoogleNet, (VGGNet is runner up)
- 2015: Then, comes the ResNet

The Error Rate

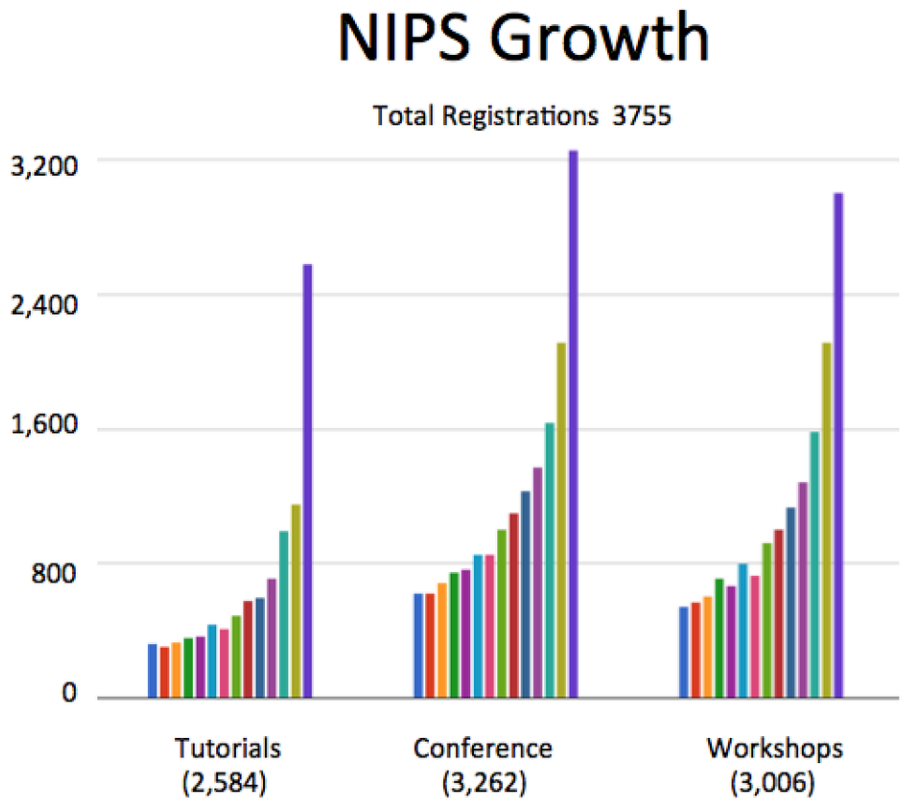


ImageNet Image Recognition

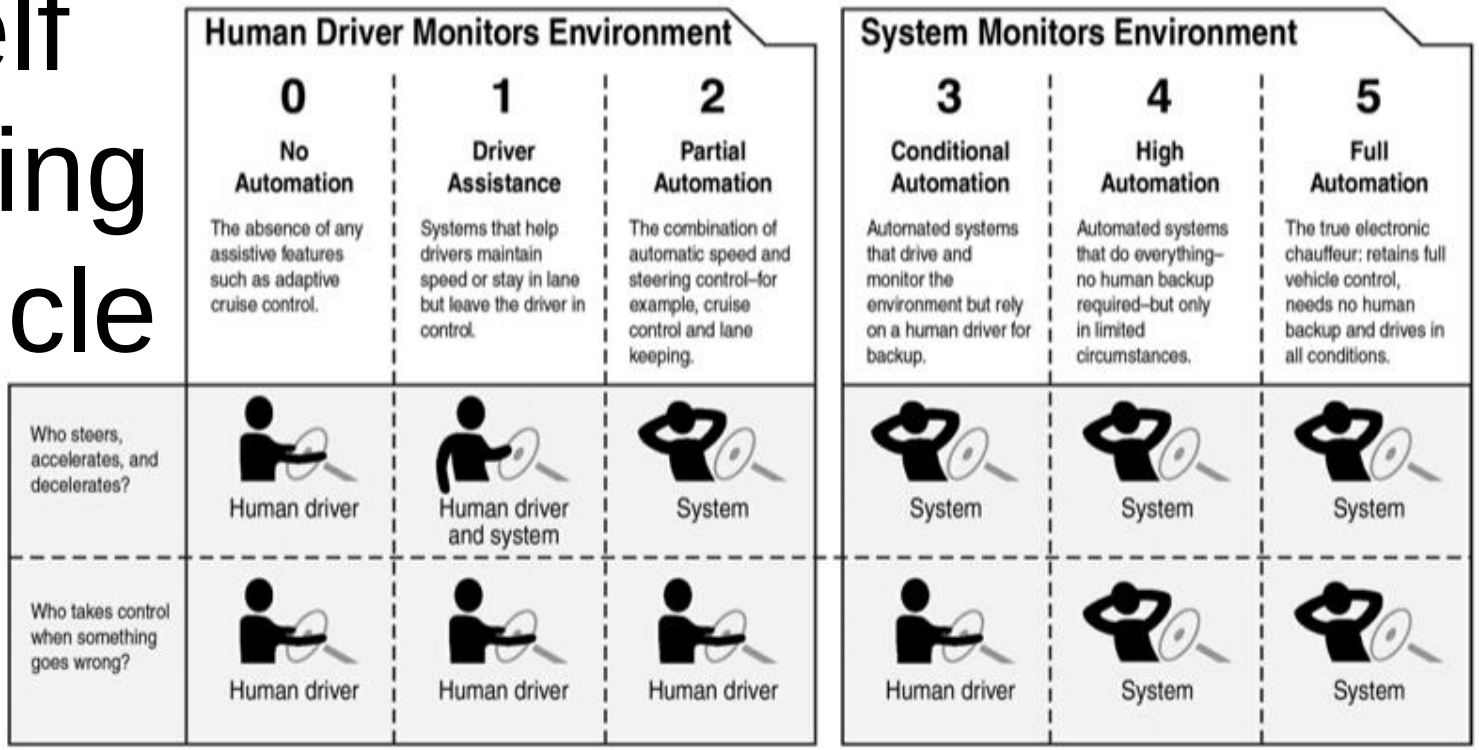


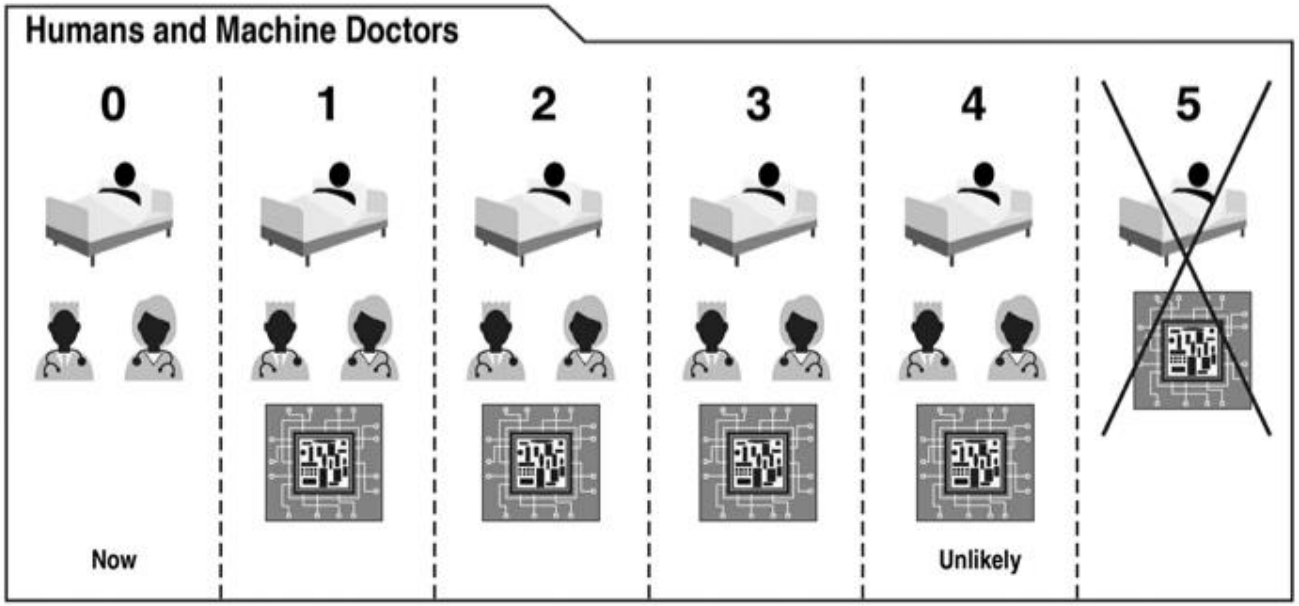
NIPS conference attendance

- Neural Information Processing Systems (NIPS)
- From 2001-2015, Neural Information Processing Systems conference



Self Driving Vehicle





Can we have full automation In medicine (Level 5)

OpenAI [July, 2024] defines 5 steps towards Artificial General Intelligence

1. Conversational AI
2. Reasoning AI
3. Autonomous AI
4. Innovating AI
5. Organizational AI

The “deep” in deep learning

- The deep in deep learning stands for this idea of successive layers of representation
- The number of layers contribute to a model of the data is called the depth of the model
- For one or two layers of representation including SVM sometimes called shallow learning

Deep Learning Guideline

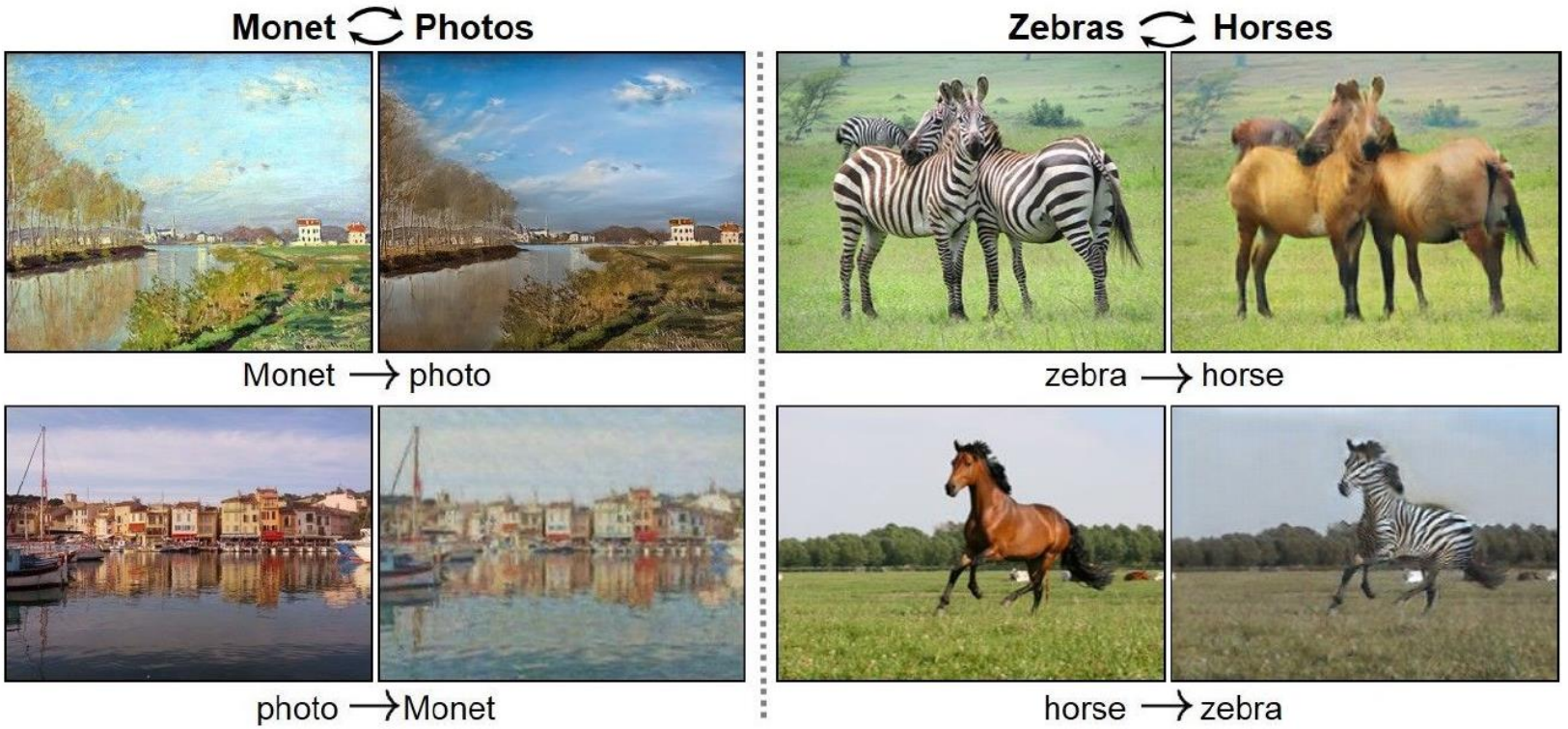
1. Are you using a specialized network architecture such as Convolutional Neural Networks?
2. Does your network have a depth (hidden layer) > 2?
3. Does your network have a depth (hidden layer) > 10? (very deep)

Applications in Deep Learning

- Face recognition
- Object recognition
- Speech recognition
- Text understanding
- Game playing e.g., Go
- Painting creation
- Auto Image description

Which Faces are real

Image-to-Image Translation



The recent success of Deep Learning

- The background knowledge of traditional machine learning
- Faster computers and GPU machines
- Large, labeled datasets in the order of millions of images

Things to do

- Install Python, OpenCV-python, TensorFlow, Keras or PyTorch and related libraries (numpy, pandas, scikit-learn)
- Pycharm is optional, but can help in python debugging

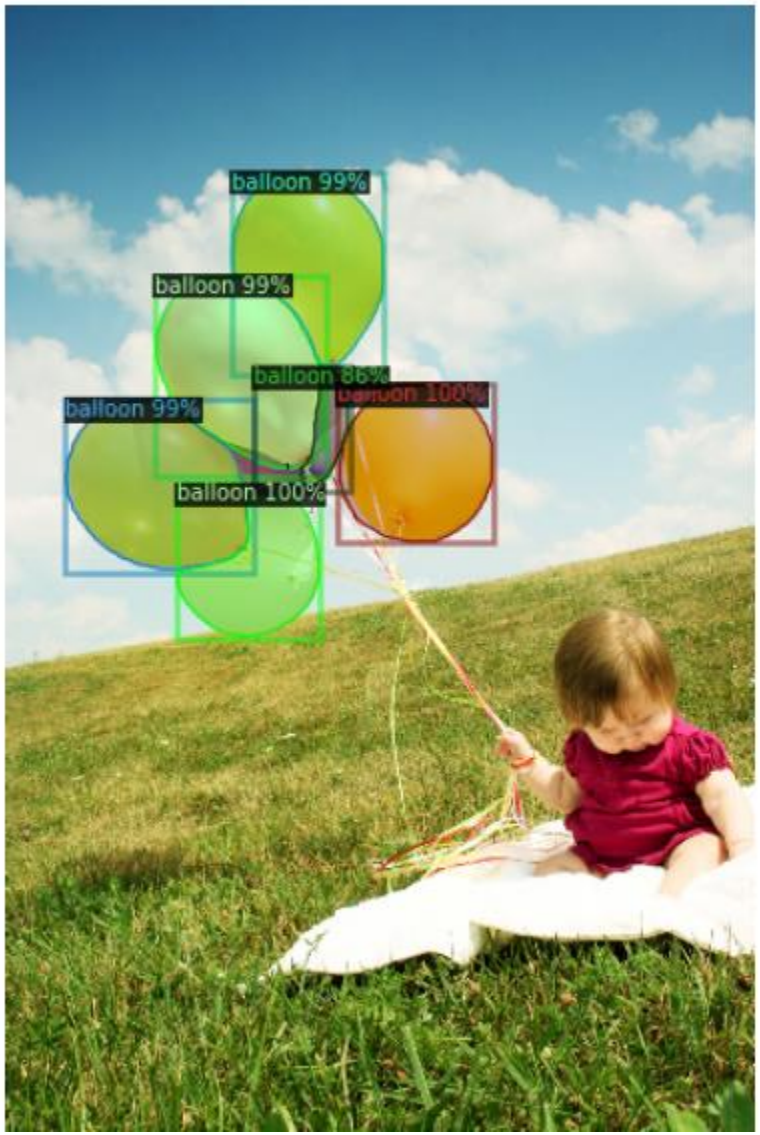
List of Cool Applications

- Automatic CAPTCHA
- Create new musical instruments
- Determine art history
- Solve Rubik’s cube
- Mange stock portfolios
- Write Wikipedia articles
- Lip reads
- Design websites

List of Applications

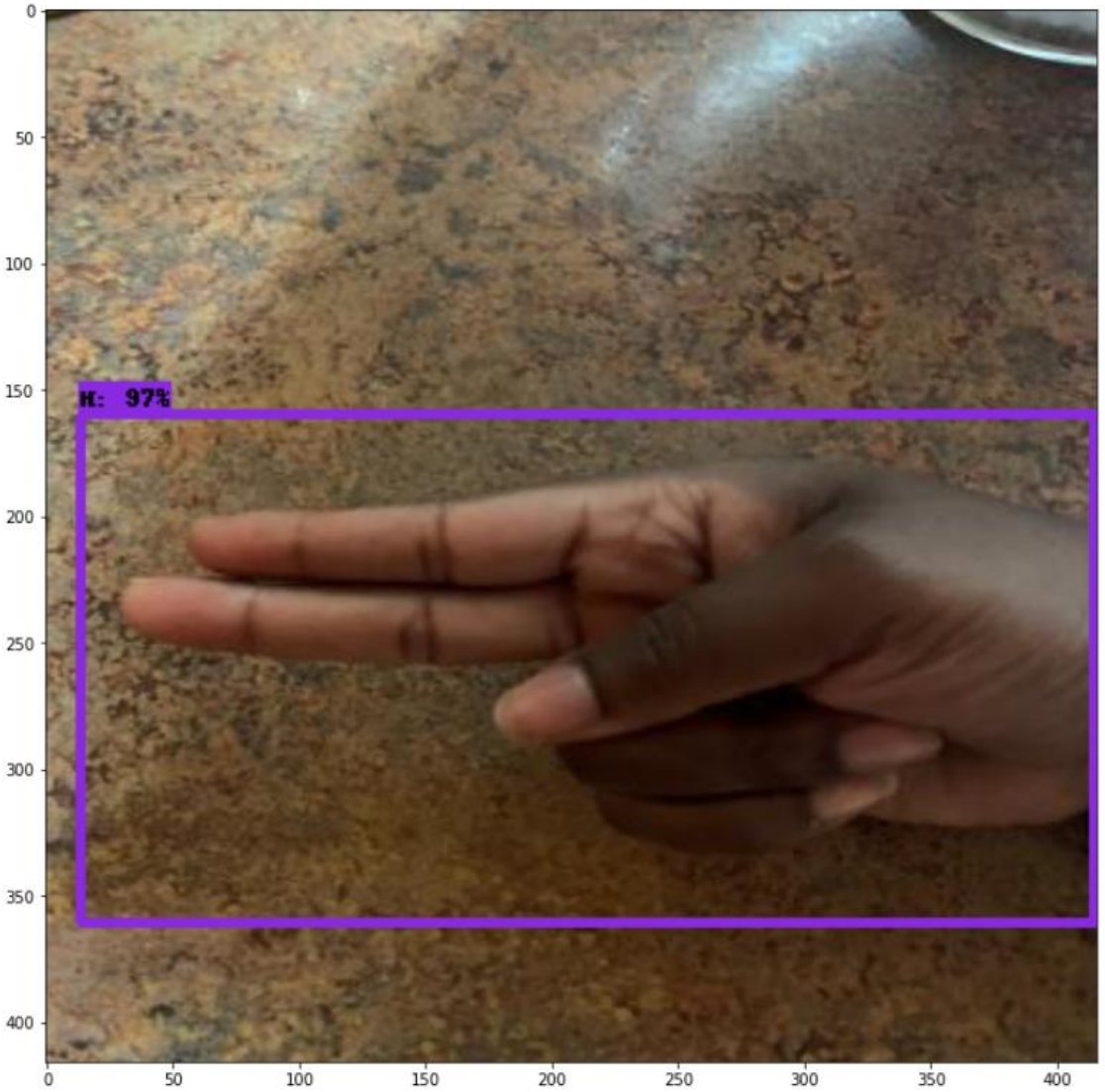
- Tailor clothes
- Write songs
- Find energy materials
- Write text
- Autonomous stores
- Sort LEGO pieces
- Make fake videoes
- Pick ripe fruit

Object Detection

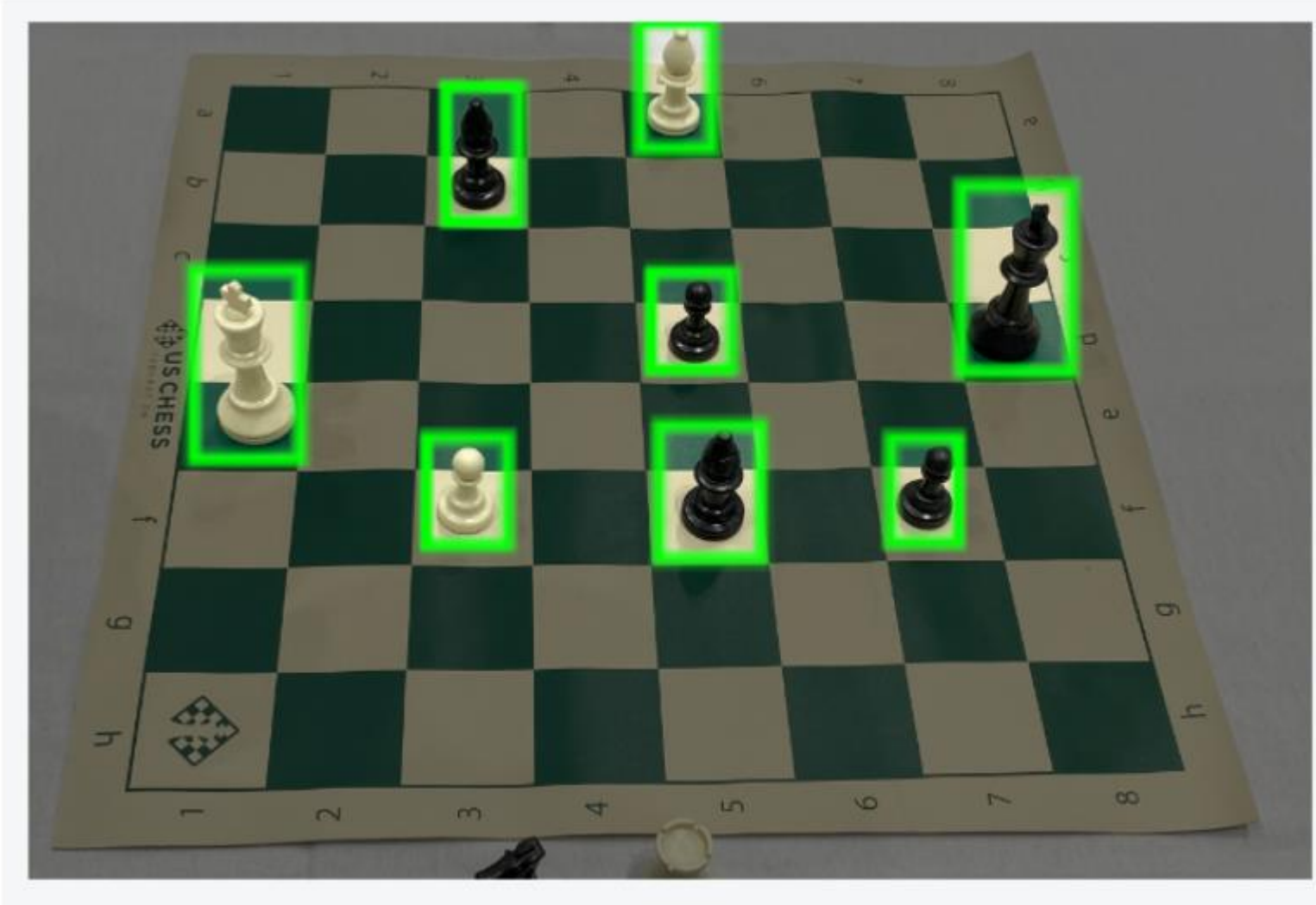


Gun Detector

Sign Language Detector

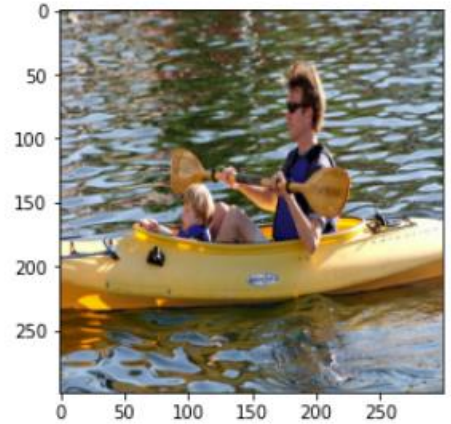


Chess Pieces Detector



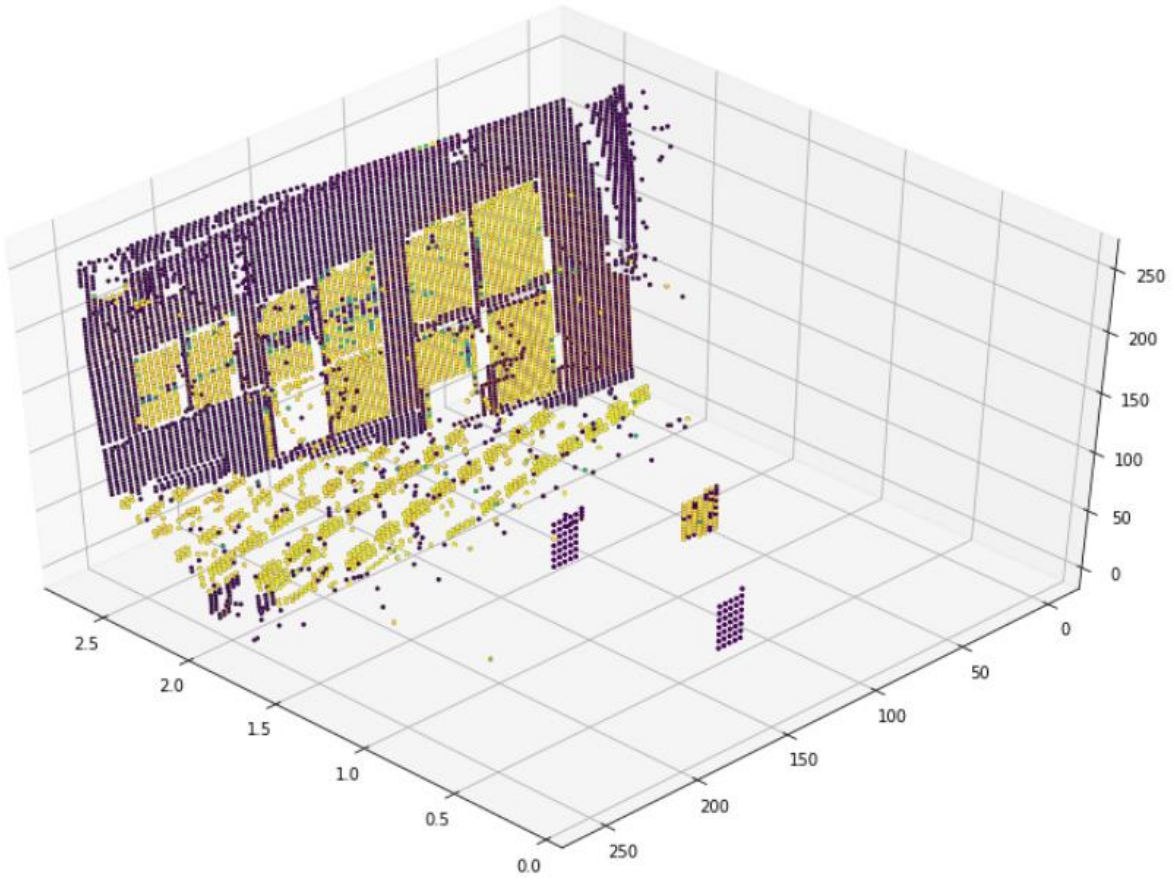
Automatic Image Captioning

Predicted Caption: a group of dogs race around a sled team of dogs

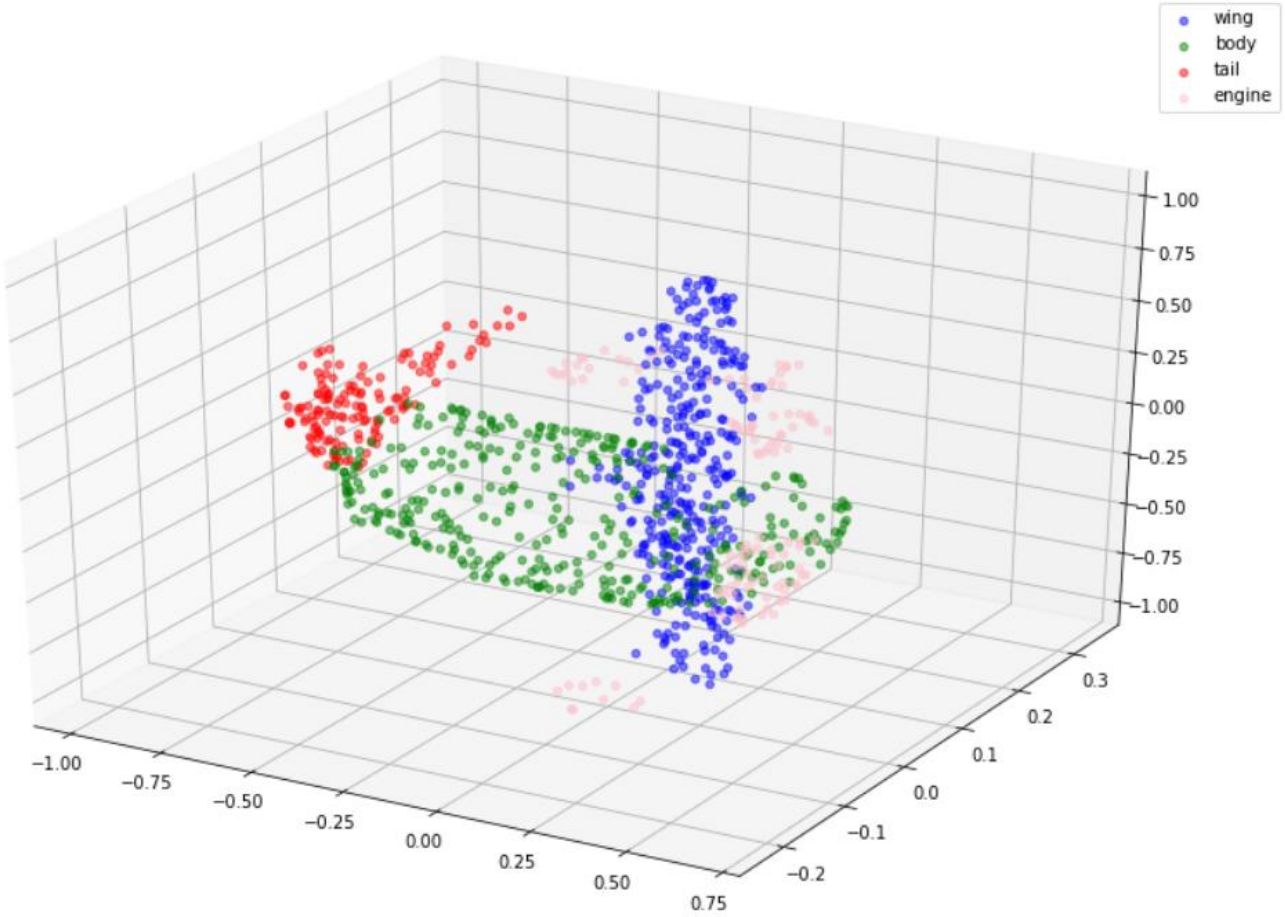


Predicted Caption: a man in a boat paddling a boat

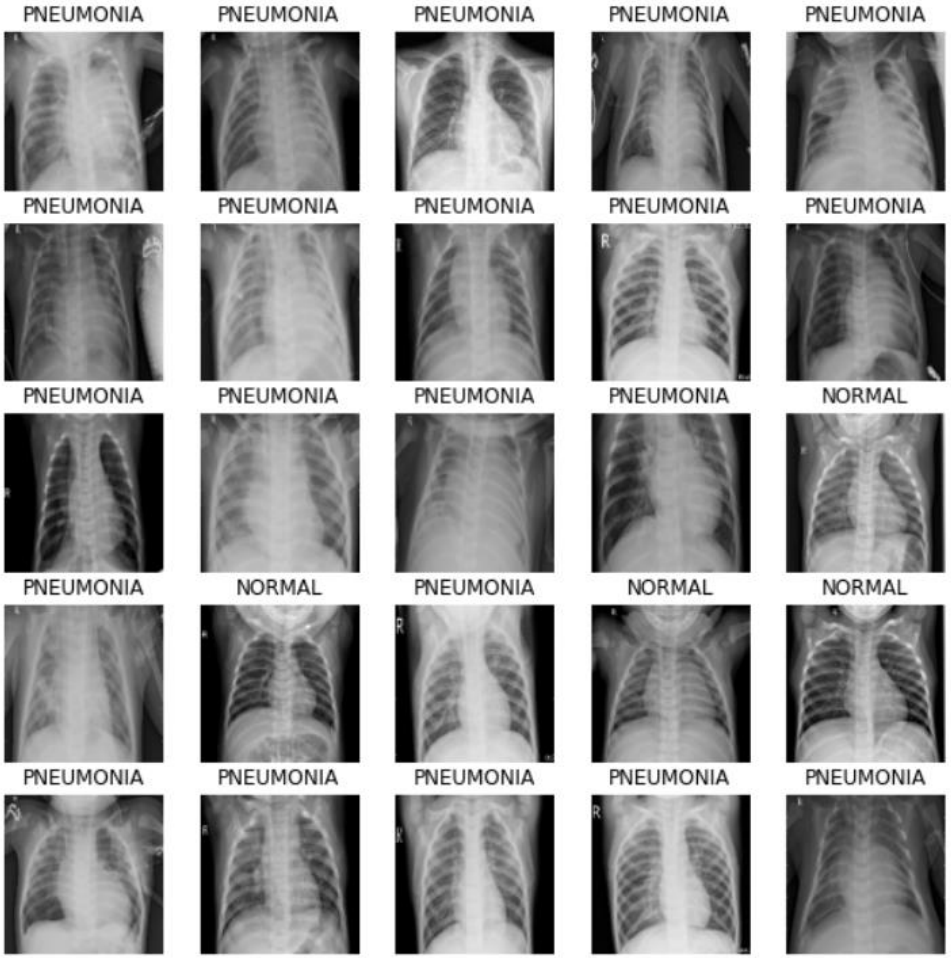
Depth Estimation



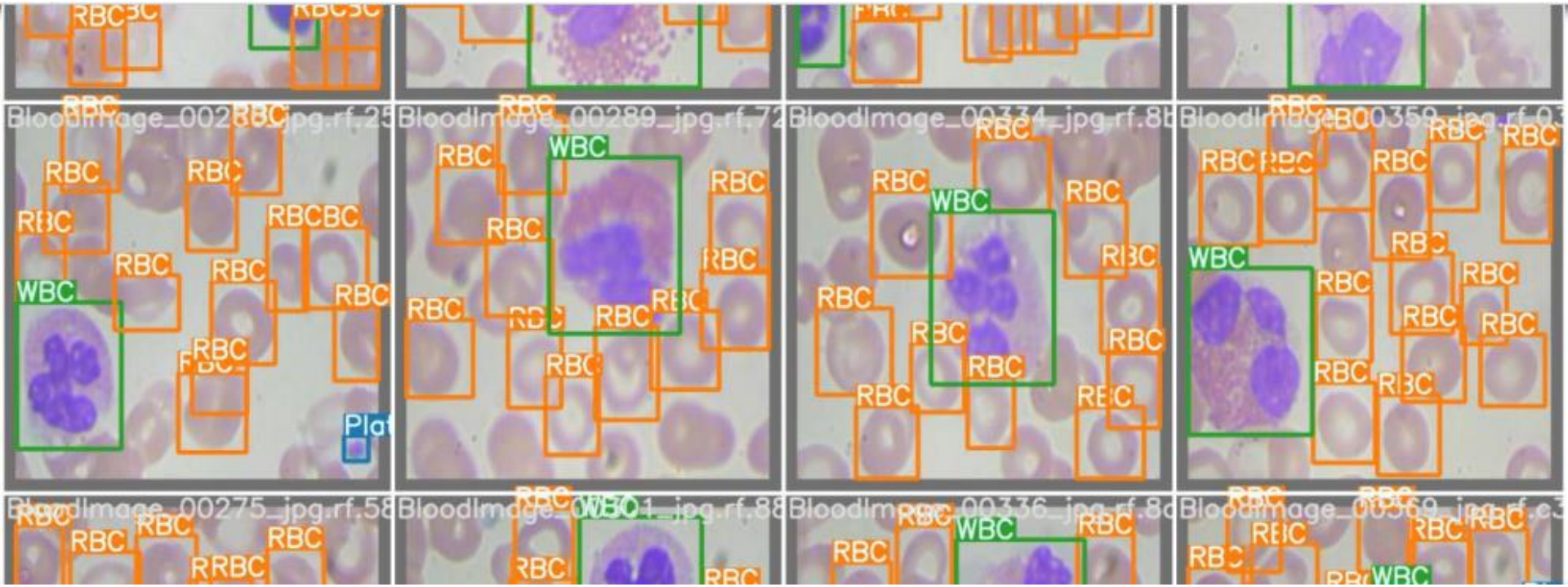
Point Cloud Classification



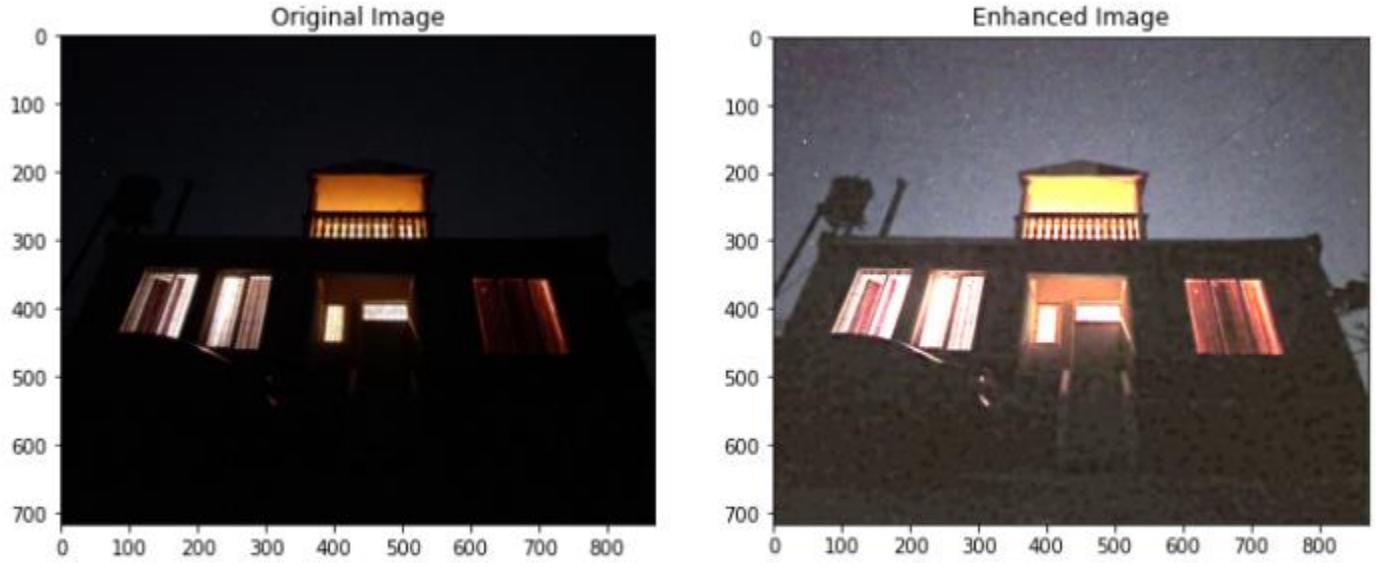
Pneumonia Detection



Blood Cell Classification



Enhancing Low-light images



Input Image and Enhanced Image(Source: By Author)

Arcane GAN

What is your application?

Homework

- Write one page paragraph of what do you think AI can do with images (no right or wrong answer)

Assumptions

- Familiar with Python
- Can use Pytorch or Keras
- Already installed OpenCV for Python

Questions?