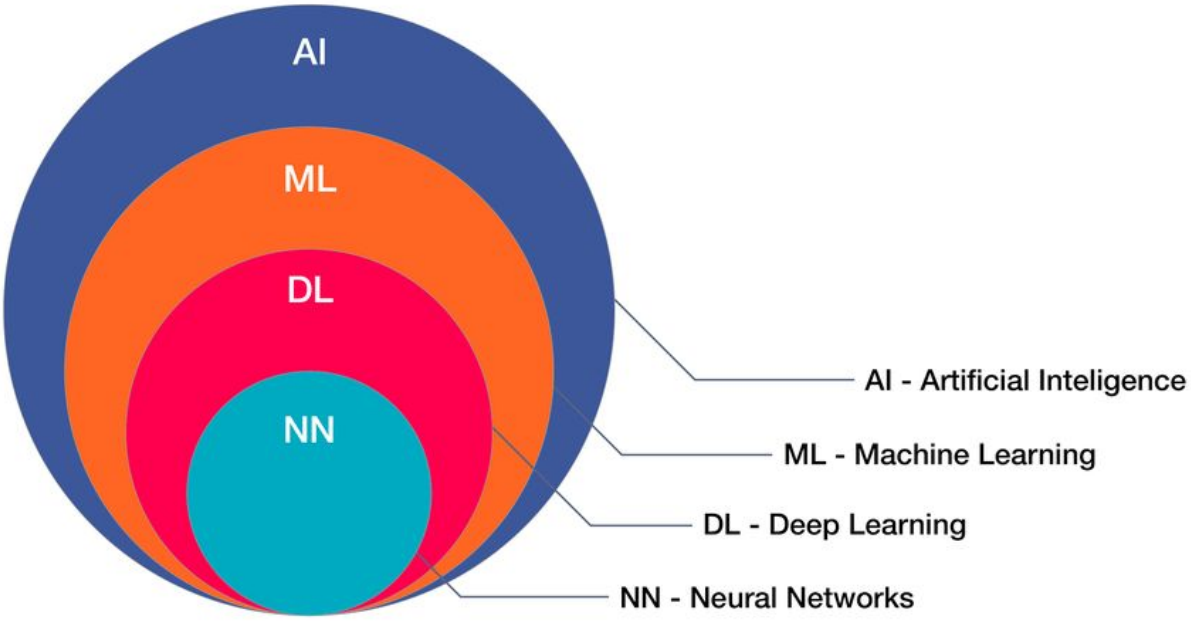
Sheet 1

Q1) List four applications of neural networks in autonomous driving

1. Environment Mapping (Detection & Tracking)
2. Path Planning
3. Driver Distraction Recognition
4. Traction Control and Self-parking

Q2) How are neural networks related to machine learning?

1. A neural network is a machine learning model, more precisely it is a deep learning model which is a subset of machine learning
2. Machine Learning applies a prediction function to a feature representation of the image to get the desired output.
3. Neural Network is one set of algorithms used in machine learning for modeling the data using graphs of Neurons.



Q3) Describe the input and outputs of the four machine learning problems.

data: (images, sequences, etc)

1. Classification:
    a. Input: data
    b. Output: Class or Category
2. Clustering
    a. Input: data
    b. Outputs: Set of Learned Categories (Clusters)
3. Regression
    a. Input: data
    b. Output: Continuous Value representing a prediction
4. Dimensionality Reduction:
    a. Input: data with X dimensions
    b. Output: data with Y dimensions (where Y < X)

Q4) What are the factors that made the deep learning applications represent the state of the art trends in computer vision?

1. Features are learned rather than hand-crafted.
2. More layers capture more invariances
3. More data to train deeper networks.
4. Technological break-through in computation devices (ex: GPUs and TPUs)
5. Better regularization: Dropout.
6. New nonlinearities (Max pooling, Rectified linear units (ReLU)).
7. Better optimization techniques
8. Several learning libraries have emerged as winners which provide a lot of support and convenience to train deep learning models for visual recognition and other visual tasks

Q5) Visual recognition is one of the most challenging problems in machine learning. Explain and list the challenges. What are the inputs and outputs?

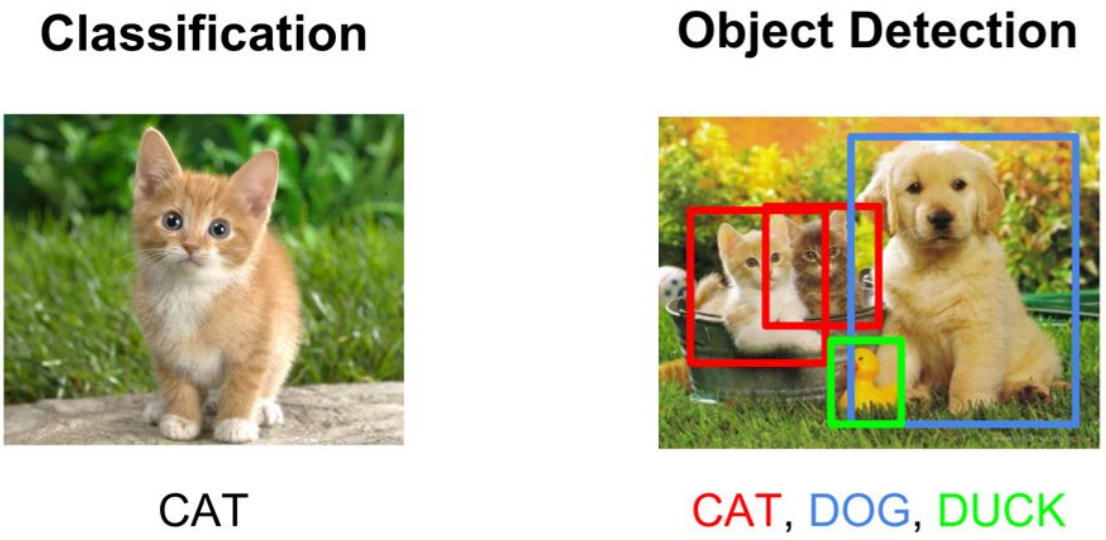
1. Viewport Variation
2. Illumination Conditions
3. Scale Variation
4. Deformation
5. Occlusion
6. Background Clutter
7. Intra-class Variation

- Inputs: Image, Outputs: Classes

Q6) Object classification and object detection are two different machine learning problems. Explain in brief. Show how the precision of each process is computed?

1. Object Classification: Is the task of classifying some image into some category (ex: in: <Cat Image>, out: "Cat")
2. Object Detection: Is the task of classifying and localizing an object (ex: in: <Cat on shelf in a room Image>, out:"Cat" & coordinates of the cat in the image)

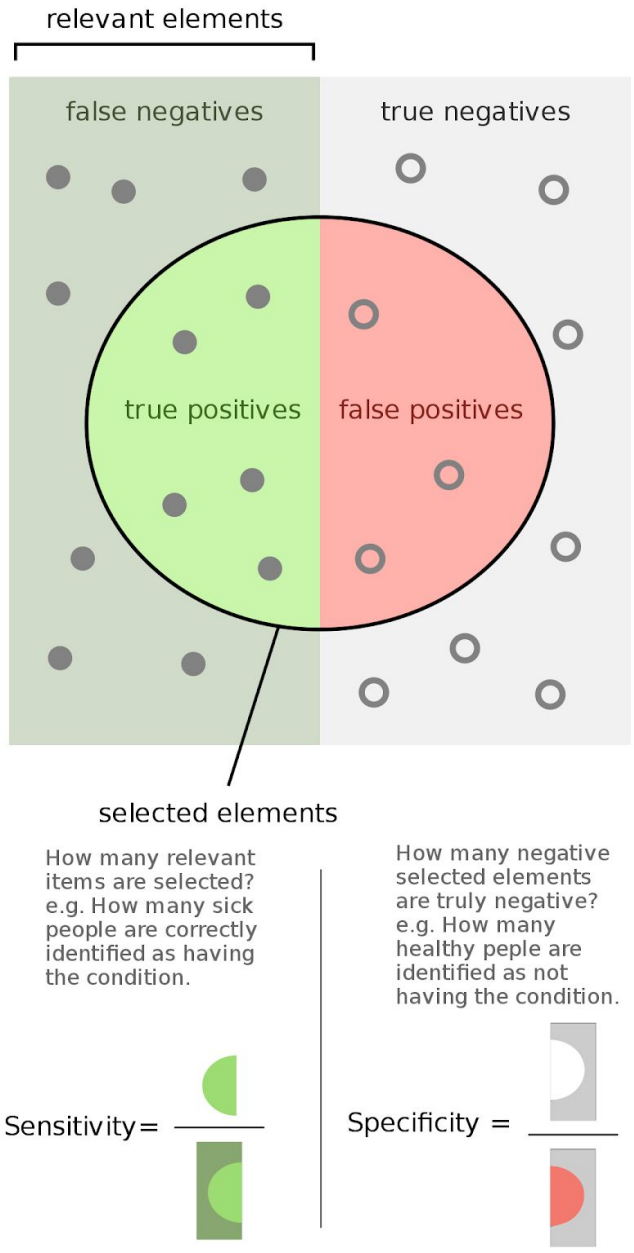
3. Precision is computed with this formula: TP/(TP + FP), the difference between classification and detection is in the definition of TP and as in the classification task TP is simply the number of correct positive predictions whereas in object detection TP is decided based on the IOU between the prediction and the ground truth



Q7) Define TP, TN, FP, and FN. What is the relation with precision and accuracy?

1. TP: True Positive - Number of times the model predicts positive and the actual label is positive
2. TN: True Negative - Number of times the model predicts negative and the actual label is negative
3. FP: False Positive - Number of times the model predicts positive and the actual label is negative
4. FN: False Negative - Number of times the model predicts negative and the actual label is positive

Precision: TP/(TP+FP)
Accuracy: (TP + TN)/(TP + TN + FP + FN)



Q8) Explain in detail the difference between CNN and conventional NN?

1. CNN is a specialized Neural Network that uses kernels filters to preprocess data and extract features.
2. Conventional Neural Networks use a more "brute force" way for learning where they process the data as is and predict the result vs the CNN where the data gets preprocessed.
3. Conventional neural networks have a large number of parameters, and so do not scale well in comparison with a CNN
4. CNN benefits more from spatial features than conventional NN