Machine Learning (CS 306)
Machine Learning Lab (CS 360)

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Machine Learning (ML)

- Machine learning is the science of getting computers to act without being explicitly programmed
- It means “computer can learn something apart from for which it can be programmed”

Formally

- Suppose, we have design a model to carry out some task (e.g. for object recognition)

➢ <u>What is the role of ML here?</u>

Study the algorithms that

- improve their performance P
- at some task T
- with experience E

Well defined learning task has three tuples: <P, T, E>

Where ML is necessary?

- Human expertise does not possible
- Humans are unable to explain their expertise (speech recognition)
- Solution changes in time
- Solution needs to be adapted to particular cases (user biometrics)

Straight forward mathematical model not available or input /output relation not known a proiri

Application of ML

- Self-driving car (run-time learning requires)
- Speech recognition
- Earth observation
- Efficient web search

ML helps us to move towards human-level AI

Task

Handwritten character recognition

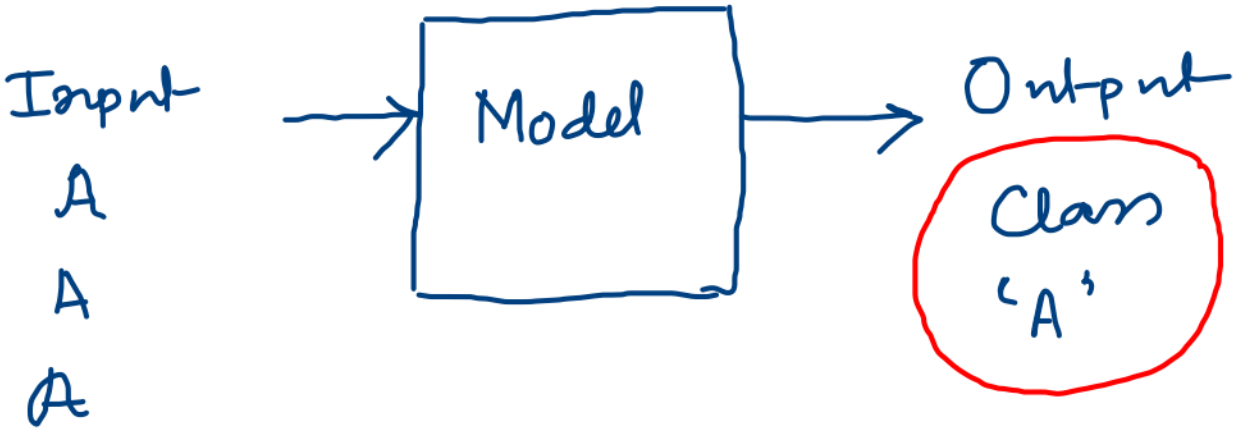
What are the challenges?

Handwritten character recognition

Student 1 A, B, C, D

Student 2 A, B, C, D

Student 3 A, B, C, D



Challenges

- How can we feed Handwritten character in the model?
- Input-output relation is not straight forward. For different handwritten format of A as input , the model should recognize it as A.
- No fixed mathematical model exists.
- How can we design such model?

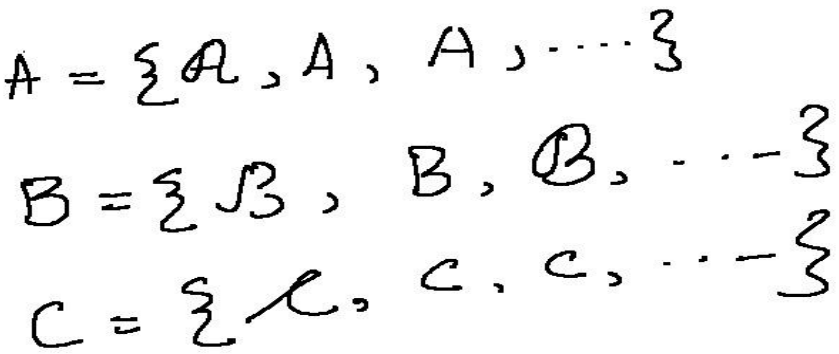
We need to enter the scenario of approximation. The designed model should able to say “This input handwritten character is most similar to A”

Solution

- Collect different set of handwritten samples
- Make model learn from such samples (learning phase/training phase)
- What is the meaning of learning?
  - Extract knowledge from available information
  - The model should able to learn from experience
  - Here, the experience can gather by learning from different set of handwritten samples
  - Different model (learning algorithms) have different capability to learn (like different human)
  - We need to design acceptable learning algorithm

Training samples

Designing a good learning algorithm is a open scope of research



Learning algorithm should able to improve its performance from experience (extracted from training samples)

Testing phase/generalization phase

- If we have a trained model, then we need to pass the unknown samples to the model
- Model can provide a score for each of the possible categories
- Finally, we need to assign the best matched category to the samples

Model is now capable to learn the input-output relation

Performance measure

- Designing of learning model is mostly motivated from human learning strategy
- For same task, we need to apply different learning models to choose the best one
- Need to check the performance of the model
- There are different ways to measure the performance

Pattern and Feature

- Need to input handwritten character (named as pattern/object) in model
- Extract some useful information from pattern to describe it to the model
- It means that we need to find some features to represent the pattern
- Here, features may be the pixel values of the image corresponding to handwritten character.

New challenges

- Design learning algorithm
- Collect suitable features to represent the pattern
- Choose the measuring indices to assess the performance of model (after and during training)
- Collect samples (data-driven model) to learn the behavior of patterns

Major Topics

- Introduction to Machine Learning
- Polynomial curve fitting problem
- Linear regression
- Gradient descent algorithm
- Logistic regression
- Regression vs. classification
- K-fold cross validation (train, test, validation set)
- Introduction to artificial neural networks
- Singlelayer perceptron
- Multilayer perceptron
- Supervised vs. unsupervised learning

(Continued…)

Major Topics

- Clustering algorithms (hard and soft clustering)
- Elbow method for k means clustering
- Different evaluation matrices for clusters (Silhouette Coefficient)
- Self-organizing feature maps neural networks
- Decision Trees
- K-nearest neighbor classifier and Min distance classifier
- Bayesian classifier and Bayesian networks
- Gaussian mixture models and EM algorithm
- Support vector machine
- Radial basis function neural networks
- Dimensionality reduction and principal component analysis
- Statistical significance test: T test
- Introduction to Markov decision process