MACHINE LEARNING FOR MEDICAL IMAGING

SUMMARIZED BY PETER CARRAS

Machine Learning vs Deep Learning

Machine Learning

- A type of artificial intelligence
- Teaches computers how to learn to do a task instead of telling the computer explicitly how to do that task

Deep Learning

- A type of machine learning
- Uses artificial neural networks based on the structure of neurons from the human brain
- Deep refers to having many layers in your neural network

Convolutional Neural Networks

- CNNs assume that inputs have a geometric shape like the rows and columns of pixels in an image
- Layers are organized into 3 dimensions, width, height, and depth
- Final output is reduced to a single vector of probability scores organized along the depth dimension
- Input layer has neurons arranged to produce a **convolution** of a small image
  - ***Convolution:*** *mathematical combination of two functions to produce a third function i.e. it merges to sets of information*
- Features are found by the algorithm not by the user

Important Terms

- **Classification:** Assigning a label to a group of pixels or a piece of data
- **Model:** The resulting weights or decision tree learned by through machine learning.
- **Algorithm:** A series of steps taken to create a model
- **Labeled Data:** A set of examples that have already been labeled
- **Training:** The phase in which the algorithm is a validation set and learning occurs through modifying the weights or decision points to improve accuracy
- **Validation/Training set:** The set of examples used during training
- **Testing:** Data that the algorithm has never seen before in the training set is used to see how well your algorithm may work in a real world scenario

More Terms

- **Node:** A element of a neural network that takes two or more inputs and an activation function and decides on an output
- **Layer:** A collection of nodes that compute outputs from previous layers or from the data
- **Weights:** The value multiplied by the input feature to help determine when a node should be activated

Types of Machine Learning

Supervised

- Uses labeled data
- Good for classification or categorization
- Can overfit data

Unsupervised

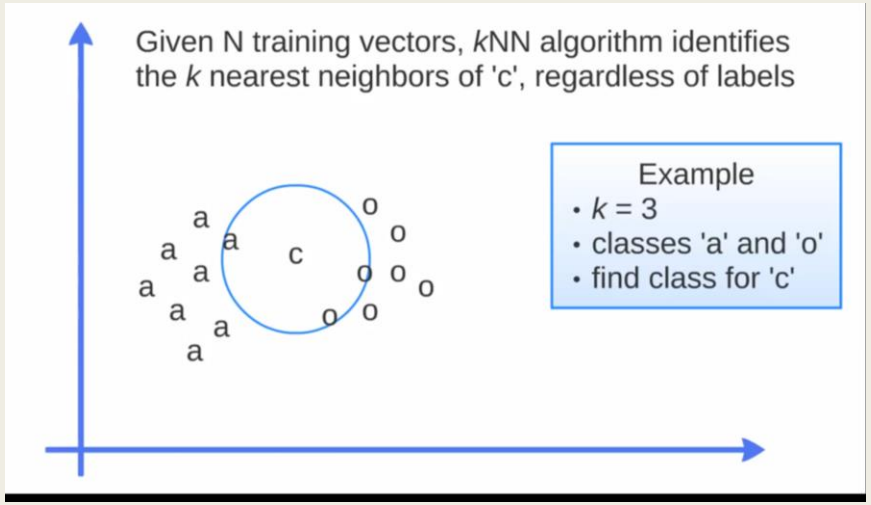
- Unlabeled data
- Good at clustering data
- Gives structure to data without labels

Reinforcement

- Learns through rewards and penalties
- Tries to maximize rewards
- Ex. Meta MarIO getting coins and smashing Goombas

K-Nearest Neighbors

- Given the classes a and o we can find the class of c by taking the k nearest neighbors. In the example shown this is 3
- There are 2 o elements and only 1 a element so we can conclude that the class of c is o
- As a result we would rewrite c as o

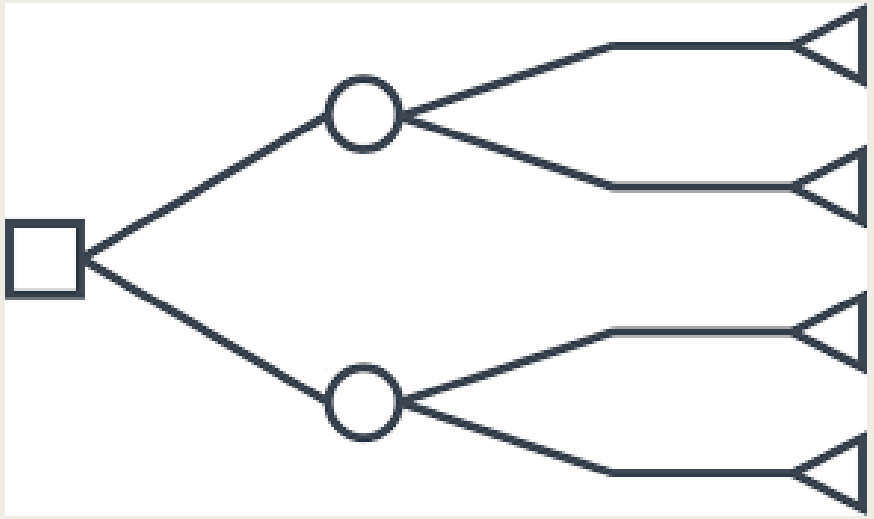


Support Vector Machines

- Support vector machines find the hyper-plane that separates training data that maximizes distance between the hyper plane and the closest points from each class.
- They can be used when you have very little data and relatively high number of features
- Support vector machines classify data and do not give any information about the probability it is in one class or anoter

Decision Trees

- Decision trees are built using recursive binary splitting that picks the question/features that maximizes accuracy
- Decision trees provide quantifiers that we can interpret as humans



Naïve Bayes Algorithm

- Naïve Bayes Classifier assumes the presence of a particular feature in a class is unrelated to the presence of any other feature, this is why it is referred to as naïve
- Calculates posterior probability equation to determine the probability of an outcome
  - $P(y|x) = [P(y) * P(x|y)]/P(x)$
- Probability P(y) given x equals the probability of y times the probability of x given y divided by the probability of x
  - *Note that the probabilities are not accurate and you should instead look only at the highest probability outcomes*
- Used mostly to classify text and with problems that have multiple classes