MACHINE LEARNING and AI with PYTHON **Updated Mar 14,2021**

Lesson 1 Introduction to Machine Learning and AI

These machine learning programming lessons will teach you most of the codes to solve most machine learning applications to solve Artificial Intelligence applications . Machine learning is all about applying mathematical equations to solve human thinking problems. Machine learning has not replaced the human brain yet, but new techniques in Artificial Intelligence one day, it will be possible. Machine Learning is very mathematical oriented applying statistics and advanced mathematics to solve human thinking problems. Machine learning is also very programming oriented as well. Machine Learning combines mathematics and programming together. We use the Python programming language since it is easy to use and has many readily available libraries to enable machine learning. If you do not know Python we suggest you take our Python lessons first, available on our web site or take individual lessons with one our personnel tutors on Skype. We will use the python Spyder IDE, that is bundled with Jupiter notebook. Although Jupiter note book is quite popular, but it is very difficult to use as a standalone application. Spyder allows you to have separate program files that you can store and run anywhere on your computer where as Jupiter forces to put all your files in a note book. You can download Spyder from the following link. Spyder is bundled with Jupiter notebook.

https://www.anaconda.com/distribution/

Spyder is good to use because it has all the python libraries built in to it. You do not need to waste countless hours downloading Python libraries and finding out you have so many version mismatches.

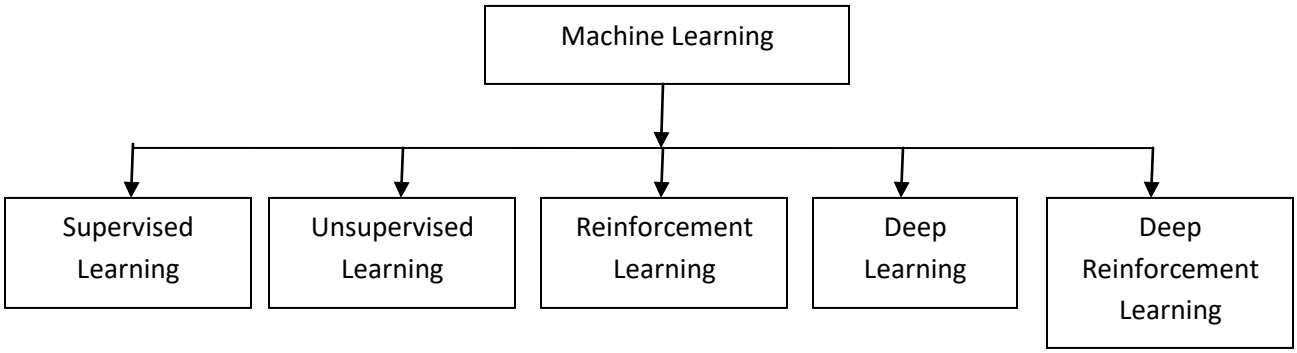
Machine learning algorithms had first started with statically analysis such as:

- Regression
- Classification
- Clustering
- Probability Theories
- Decision Trees

But now machine learning algorithms have evolved to more sophisticated algorithms like neural networks that use algebraic and calculus mathematical operations. New advances in programming algorithms will depends less on mathematics and more on programming algorithms, to provide more of a natural decision making process.

TYPES OF MACHINE LEARNING

Machine Learning can be categorized into the following types:



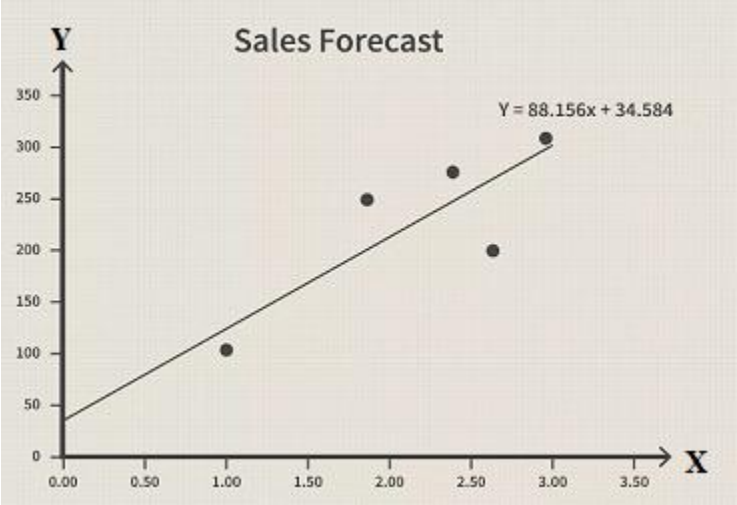
Supervised Learning

Supervised learning is used to train a machine to learn using test data. The program is "trained" on a pre-defined set of "training examples", which then facilitate its ability to reach an accurate conclusion when given new data. The test data is used to develop a relationship between x y data points. A mathematical relationship is determine from these data point. It may be a linear or non linear relation. Once a mathematical relationship is developed then the output can be predicted with real data.

Techniques in supervised learning are **Linear Regression** and **Classification**.

Linear regression

Linear regression is used in predicting, forecasting, and finding relationships between quantitative data. A good example is finding the relationship between company's advertising budget and its sales.

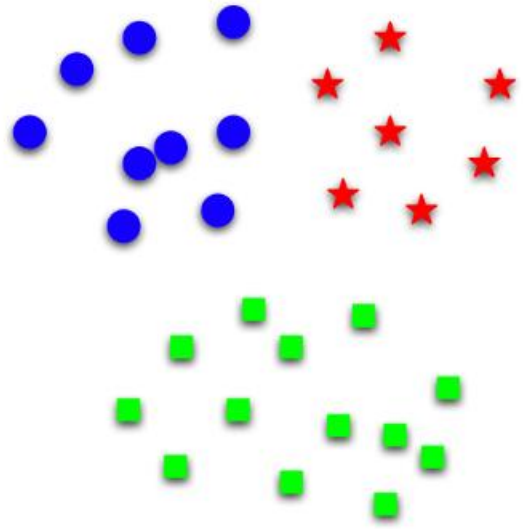


The x values are the advertising budget and the y values are the sales for the advertising budget. The dots represent the advertising budget for the corresponding sales. The straight line between the dots is the regression line used to predict the Y values from the X values. The straight line is an estimation between the dots having a equation y = mx + b. The slope of the line is m where as b is the y-intercept. The y-intercept is where the line crosses the y axis, which is 34.584 in our graph. The equation y = 89.156x + 34.584 lets you predict the sales for an advertising budget. Example with x = 1.5 the predicted sales would be:

Y = 88.166 (1.5) + 34.584 = 166.83

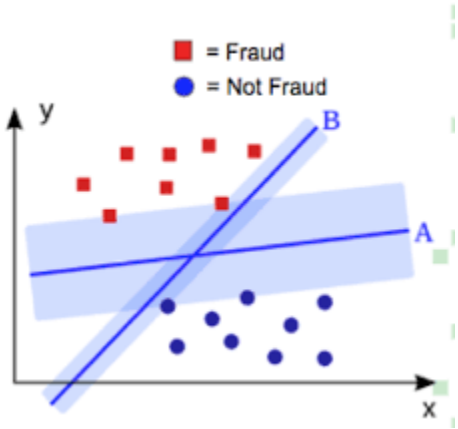
Classification

Classification is the process of grouping things together accordingly to shared properties structure and characteristics.



Classification focuses on predicting a qualitative response by analyzing data and recognizing patterns.

A good example is to classify whether or not a credit card transaction is fraudulent.



There are many classification techniques we will study. Classification algorithms are also known as classifiers.

We will study the following classifiers:

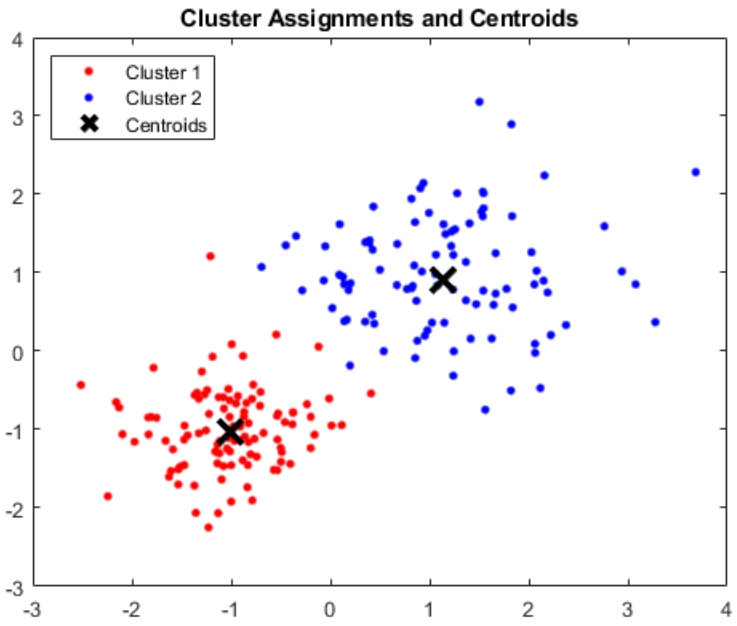
k-Nearest Neighbors
Decision Trees
Naive Bayes
Logistic Regression
Support Vector Machines

Unsupervised Learning

In unsupervised learning, the machine is made to learn on its own without any supervision. In unsupervised learning patterns and relationships are automatically found in the test data. Unsupervised learning problems can be divided into the following kinds **Clustering** and **Association.**

Clustering

Clustering discovers similar data items and groups them together. For example, grouping customers by their purchasing behavior.



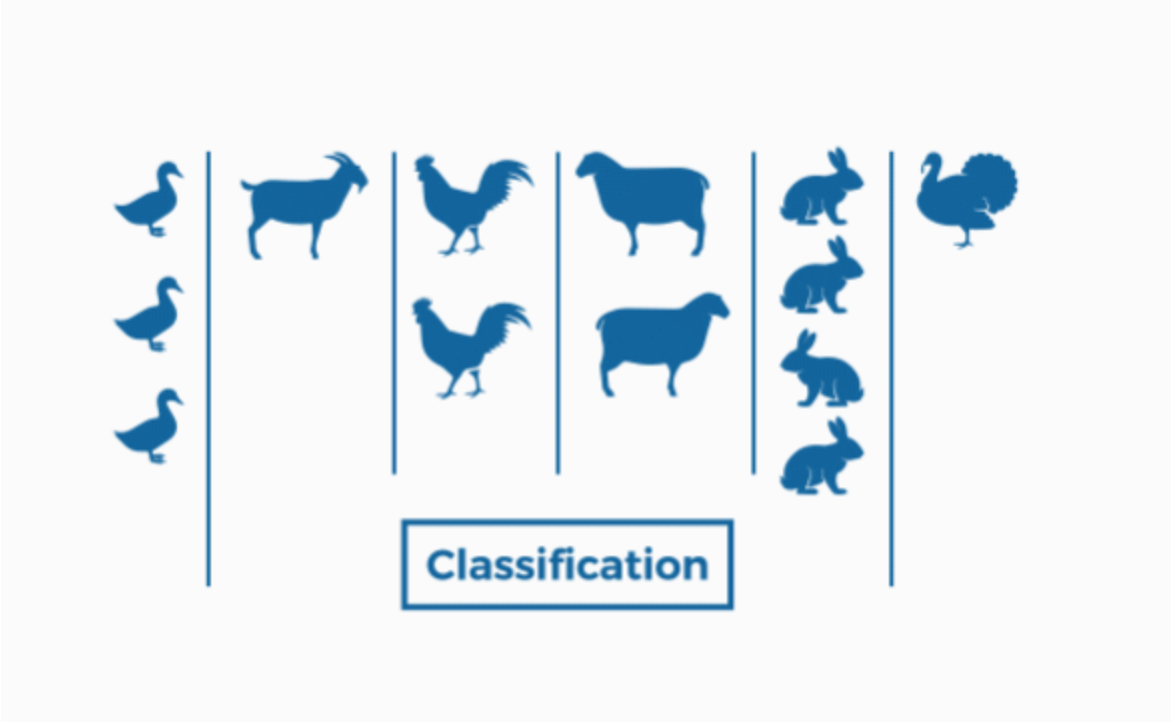
The centroids are the middle of each cluster.

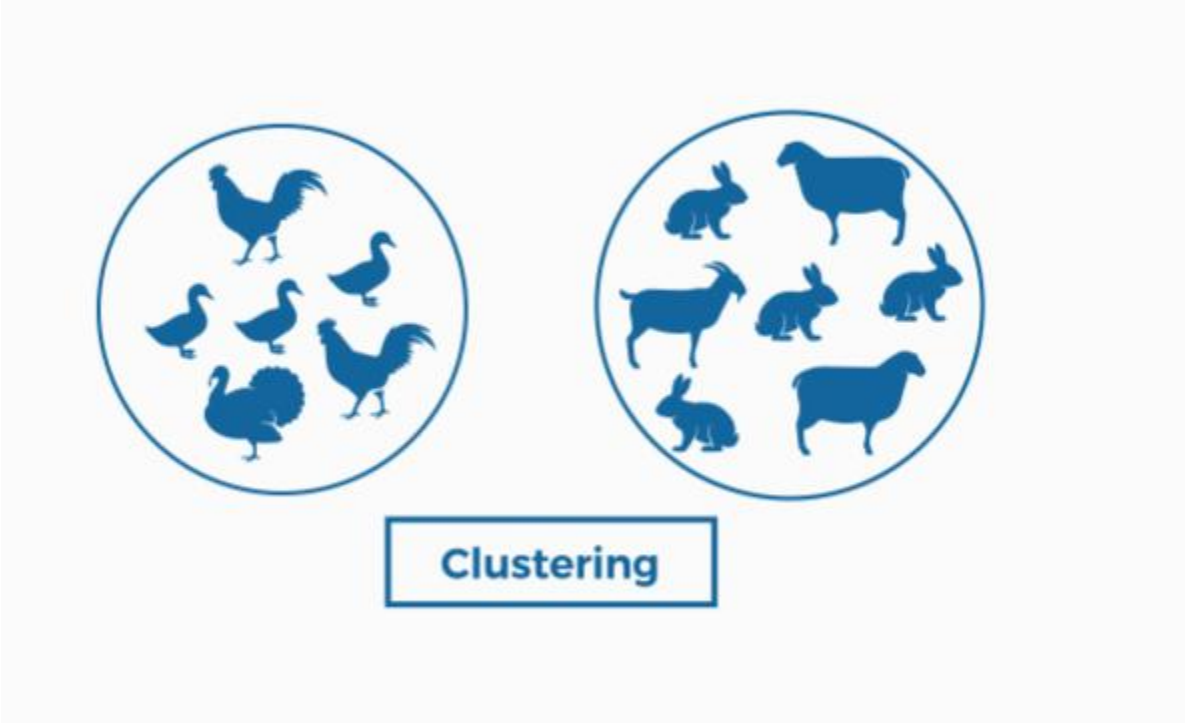
Clustering algorithms are:

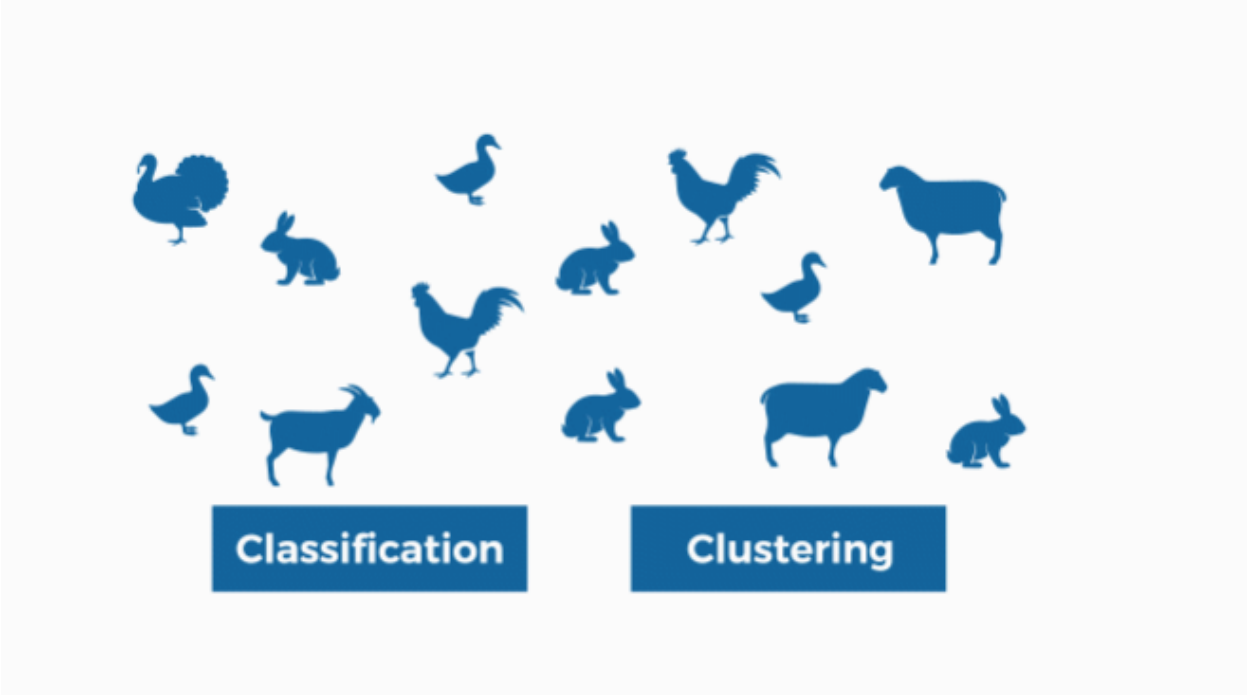
K-means clustering
Mean-Shift Algorithm
Hierarchical Clustering
Cluster Identification

Difference between Classification and Clustering

Classification and clustering are two methods of pattern identification used in machine learning. Although both techniques have certain similarities**.** Classification uses **predefined classes** in which objects are **assigned**, while clustering **identifies similarities between objects**, which it **groups** according to those characteristics in common and which differentiate them from other groups of objects. These groups are known as "**clusters**".







Association

Association analysis is the task of finding interesting relationships in large datasets. These interesting relationships can take two forms: frequent item sets or association rules. *Frequent item sets* are a collection of items that frequently occur together. The second way to view interesting relationships is *association rules*. Association rules suggest that a strong relationship exists between two items. Association discovers the rules that describe large portions of data. For example, finding the customers who buy both **x** and **y**.

Association algorithms are:

Apriori algorithm

The Apriori principle helps us reduce the number of possible interesting itemsets. The Apriori principle says that if an itemset is frequent, then all of its subsets are frequent. This means that if A,B is frequent, then A and B have to be frequent.

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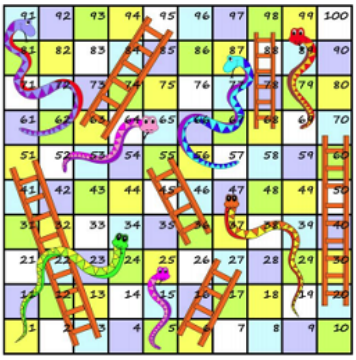
Reinforcement Learning

Reinforcement learning rewards the machine when it does the job the expected way .Reinforcement learning's algorithms train the systems to make specific decisions. The machine is exposed to an environment where it trains itself continually using a trial and error method. These algorithms learn from past experience and tries to capture the best possible knowledge to make accurate decisions. Markov Decision Process is an example of reinforcement machine learning algorithm

A **Markov process** is a random **process** in which the future is independent of the past, given the present.

A good example is a snake and ladders game, where the present state depends on the prior state.

- Simplified version of snakes and ladders
- Start at state 0, roll dice, and move the number of positions indicated on the dice. If you land on square 4 you teleport to square 7
- Winner is the one who gets to 11 first

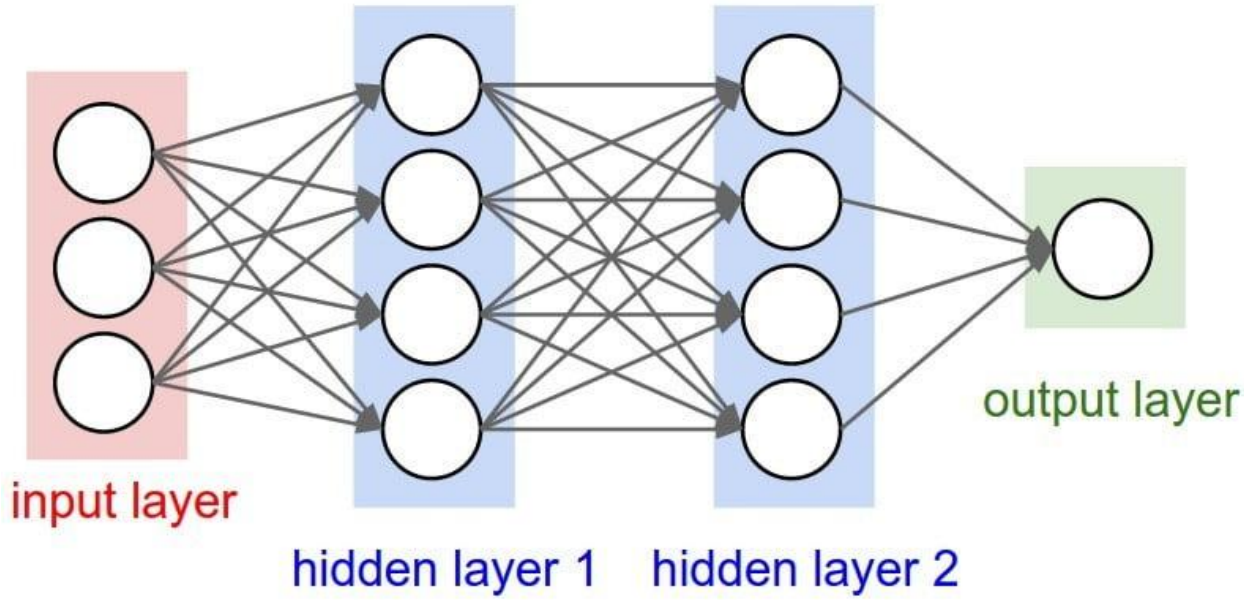


11	10	9	8	7	6
0	1	2	3	4	5

Deep Learning

Deep learning simulate the human brain with Artificial Neural Networks (ANN), Convolutional Neural Networks for Computer Vision and Recurrent Neural Networks (RNN)s for Natural Language Processing. Deep Learning allows us to train an ANN to predict outputs, given a set of inputs. Learning can be supervised, semi-supervised or unsupervised. Artificial Neural Networks (ANN) uses nodes that store values that are interconnect with weight values. The weight values are adjusted until the outputs are correct accordingly to the input values. The interconnected weight are represented by a matrix of values.

The Artificial Neural Networks (ANN) may have 1 hidden layers or many layers. The Artificial Neural Networks (ANN) may also have 1 or many outputs depending on the application.



The circles represent the brain cells in the brain, where the lines interconnect the brain cells. The interconnections are numeric weight values that are adjusted during the training, so that the desired output is reached for the required inputs. Input s and output usually have values been 0 and 1 that are tabulated in a truth table as follows:

X0	X1	X2	Y0
0	0	0	0
0	0	1	1
0	1	0	1
1	0	0	0

When the inputs are 000 the output is 0
When the inputs are 001 the output is 1
When the inputs are 010 the output is 1
When the inputs are 100 the output is 0

The input may represent things such as days of the week, hours of the day, any thing with discrete (yes/no) inputs looking for discrete outputs (yes/no)

Examples using Artificial Neural Networks (ANN) are handwriting, voice and image recognition.

Deep Reinforcement Learning

Artificial Neural Networks (ANN), combine with **reinforcement learning** algorithms to create something more powerful. Reinforcement learning refers to goal-oriented algorithms, which learn how to attain a complex objective (goal) or maximize along a particular dimension over many steps; for example, maximize the points won in a game of chess over many moves. These algorithms are penalized when they make the wrong decisions and rewarded when they make the right ones – this is reinforcement.

Homework Questions

Question 1

What are the 5 machine learning categories?

Question 2

What are the two techniques used in supervised learning.

Question 3

What is the purpose of a regression line.

Question 4

What are the two techniques used in unsupervised learning.

Question 5

What is the difference between Classification and Clustering.

Question 6

When would you use regression?

Question 7

When would you use classification?

Question 8

When would you use clustering?

Question 9

What is a good problem to solve using Artificial Neural Network (ANN)?

Question 10

How can you super charge a Artificial Neural Network (ANN)?

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