KSR INSTITUTE FOR ENGINEERING AND TECHNOLOGY

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DEPARTMENT OF INFORMATION TECHNOLOGY

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DIGITIMES

MACHINE LEARNING

KSR INSTITUTE FOR ENGINEERING AND TECHNOLOGY

Vision

To become a globally recognized Institution in Engineering Education, Research and Entrepreneurship.

Mission

M1	Accomplish quality education through improved teaching learning process
M2	Enrich technical skills with state of the art laboratories and facilities
M3	Enhance research and entrepreneurship activities to meet the industrial and societal needs

DEPARTMENT OF INFORMATION TECHNOLOGY

Vision

To produce competent Information Technology Professionals and Entrepreneurs with ethical values to meet the global challenges.

Mission

MD1	Impart quality education with ethical values in Information Technology through improved teaching learning process
MD2	Provide an ambient learning environment using state of the art laboratories and facilities
MD3	Encourage research and entrepreneurship activities to meet the dynamic needs of Information Technology industry and society

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PEO	Key Words	Description
PEO 1	**Core Competency**	Graduates will be successful professionals in career by applying the knowledge of mathematics, science and engineering with appropriate techniques and modern tools.
PEO 2	**Professionalism**	Graduate will exhibit soft skills, professional and ethical values and thrust for continuous learning to maintain professionalism in the IT industries.
PEO 3	**Higher Studies and Entrepreneurship**	Graduates will engage in higher studies and outshine as entrepreneurs through life-long learning which leads to societal benefits.

DIGITIMES

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Editorial

We would like to wholeheartedly thank our honorable Chairman, **Lion.Dr.K.S.Rangasamy** and vice chairman **Mr.R.Srinivasan**, and Principal **Dr.M.Venkatesan** and Director Academics **Dr.P.Meenakshi Devi** for their continuous encouragement and constant support for bringing out the magazine. We profoundly thank our Head of the Department **Dr.S.Russia** for encouraging and motivating us to lead the magazine a successful one right from the beginning. **DIGITIMES** serves as a platform for updating and enhancing upcoming technologies in Information Technology. We are also grateful to all the contributors and faculty coordinator to bring this magazine.

By,

Editorial Board

CONTENTS

MACHINE LEARNING

Machine Learning has become one of the mainstays of information technology and with that, a rather central, albeit usually hidden, part of our life. With the ever increasing amounts of data becoming available there is good reason to believe that smart data analysis will become even more pervasive as a necessary ingredient for technological progress.

By,

ASHOK R II/IT

WHY MACHINE LEARNING?

When you tag a face in a Facebook photo, it is AI that is running behind the scenes and identifying faces in a picture. Face tagging is now omnipresent in several applications that display pictures with human faces. Why just human faces? There are several applications that detect objects such as cats, dogs, bottles, cars, etc. We have autonomous cars running on our roads that detect objects in real time to steer the car. When you travel, you use Google Directions to learn the real-time traffic situations and follow the best path suggested by Google at that point of time. This is yet another implementation of object detection technique in real time.

By,

DIVYASHRUTHI S II/IT

MACHINE LEARNING – TRADITIONAL AI

Statistical Techniques

The development of today's AI applications started with using the age-old traditional statistical techniques. we must have used straight-line interpolation in schools to predict a future value. There are several other such statistical techniques which are successfully applied in developing so-called AI programs. We say "so-called" because the AI programs that we have today are much more complex and use techniques far beyond the statistical techniques used by the early AI programs.

Some of the examples of statistical techniques that are used for developing AI applications in those days and are still in practice are listed here:

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

Here we have listed only some primary techniques that are enough to get you started on AI without scaring you of the vastness that AI demands. If

you are developing AI applications based on limited data, you would be using these statistical techniques.

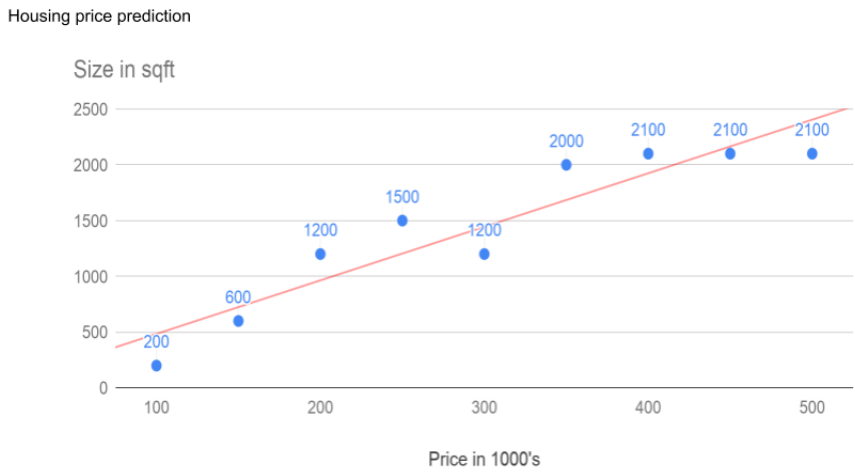
However, today the data is abundant. To analyze the kind of huge data that we possess statistical techniques are of not much help as they have some limitations of their own. More advanced methods such as deep learning are hence developed to solve many complex problems.

By,

JAMES SALOMAN J II/IT

WHAT IS MACHINE LEARNING

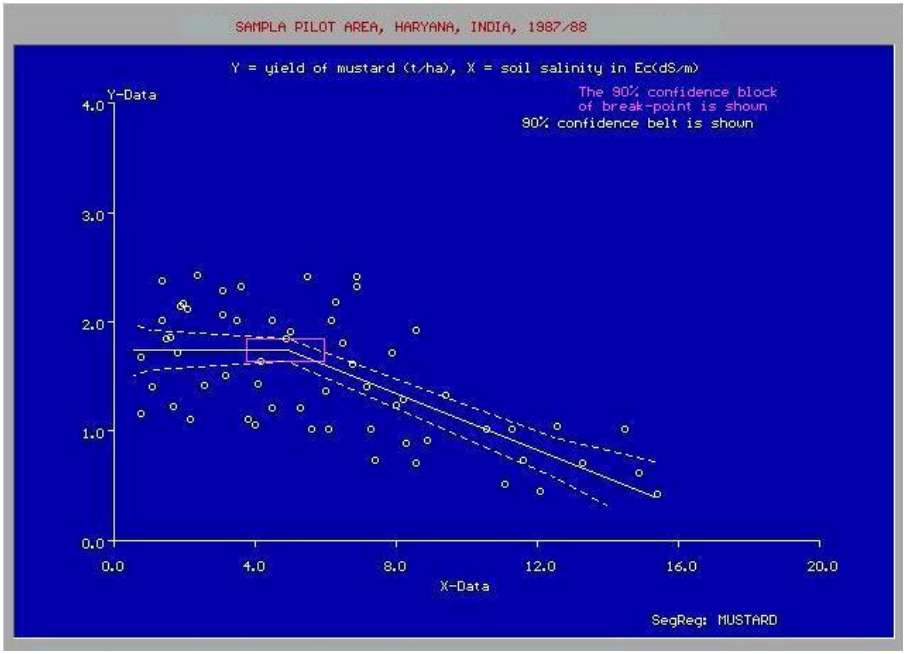
Consider the following figure that shows a plot of house prices versus its size in sq. ft.



After plotting various data points on the XY plot, we draw a best-fit line to do our predictions for any other house given its size. You will feed the known data to the machine and ask it to find the best fit line. Once the best fit line is found by the machine, you will test its suitability by feeding in a known house size, i.e. the Y-value in the above curve. The machine will now return the estimated X-value, i.e. the expected price of the house. The diagram can be extrapolated to find out the price of a house which is 3000 sq. ft. or even larger. This is called regression in statistics. Particularly, this

kind of regression is called linear regression as the relationship between X & Y data points is linear.

In many cases, the relationship between the X & Y data points may not be a straight line, and it may be a curve with a complex equation. Your task would be now to find out the best fitting curve which can be extrapolated to predict the future values. One such application plot is shown in the figure below.

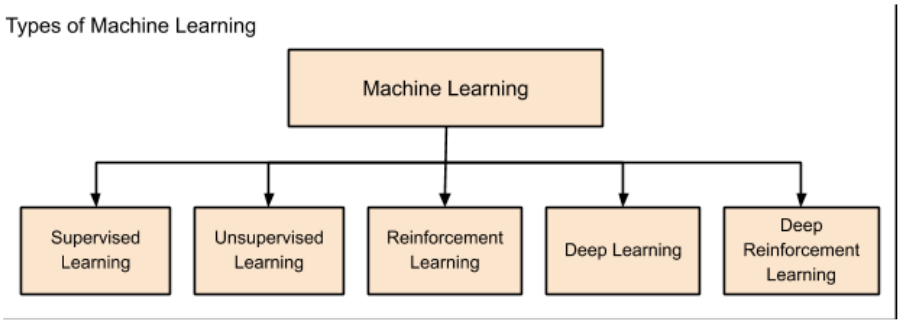


By,

MANOJ KUMAR E II/IT

CATEGORIES OF MACHINE LEARNING

Machine Learning is broadly categorized under the following headings:



Machine learning evolved from left to right as shown in the above diagram.

- Initially, researchers started out with Supervised Learning. This is the case of housing price prediction discussed earlier.
- This was followed by unsupervised learning, where the machine is made to learn on its own without any supervision.
- Scientists discovered further that it may be a good idea to reward the machine when it does the job the expected way and there came the Reinforcement Learning.

- Very soon, the data that is available these days has become so humongous that the conventional techniques developed so far failed to analyze the big data and provide us the predictions.
- Thus, came the deep learning where the human brain is simulated in the Artificial Neural Networks (ANN) created in our binary computers.
- The machine now learns on its own using the high computing power and huge memory resources that are available today.
- It is now observed that Deep Learning has solved many of the previously unsolvable problems.
- The technique is now further advanced by giving incentives to Deep Learning networks as awards and there finally comes Deep Reinforcement Learning.

By,

KABISH S II/IT

SUPERVISED LEARNING

Supervised learning is analogous to training a child to walk. You will hold the child's hand, show him how to take his foot forward, walk yourself for a demonstration and so on, until the child learns to walk on his own.

Regression

Similarly, in the case of supervised learning, you give concrete known examples to the computer. You say that for given feature value x1 the output is y1, for x2 it is y2, for x3 it is y3, and so on. Based on this data, you let the computer figure out an empirical relationship between x and y.

Once the machine is trained in this way with a sufficient number of data points, now you would ask the machine to predict Y for a given X. Assuming that you know the real value of Y for this given X, you will be able to deduce whether the machine's prediction is correct.

Thus, you will test whether the machine has learned by using the known test data. Once you are satisfied that the machine is able to do the predictions with a desired level of accuracy (say 80 to 90%) you can stop further training the machine.

Now, you can safely use the machine to do the predictions on unknown data points, or ask the machine to predict Y for a given X for which you do not know the real value of Y. This training comes under the regression that we talked about earlier.

Classification

You may also use machine learning techniques for classification problems. In classification problems, you classify objects of similar nature into a single group. For example, in a set of 100 students say, you may like to group them into three groups based on their heights - short, medium and long. Measuring the height of each student, you will place them in a proper group.

Now, when a new student comes in, you will put him in an appropriate group by measuring his height. By following the principles in regression training, you will train the machine to classify a student based on his feature – the height. When the machine learns how the groups are formed, it will be able to classify any unknown new student correctly. Once again, you would use the test data to verify that the machine has learned your technique of classification before putting the developed model in production.

Supervised Learning is where the AI really began its journey. This technique was applied successfully in several cases. You have used this model while doing the hand-written recognition on your machine. Several algorithms have been developed for supervised learning.

Supervised learning is one of the important models of learning involved in training machines.

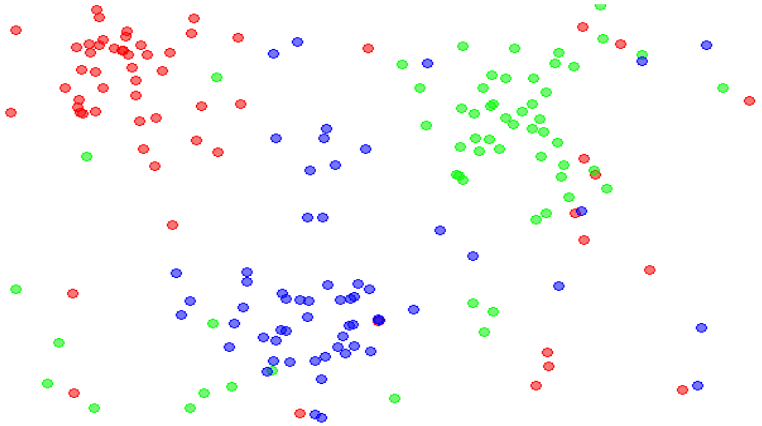
Algorithms for Supervised Learning:

There are several algorithms available for supervised learning. Some of the widely used algorithms of supervised learning are as shown below:

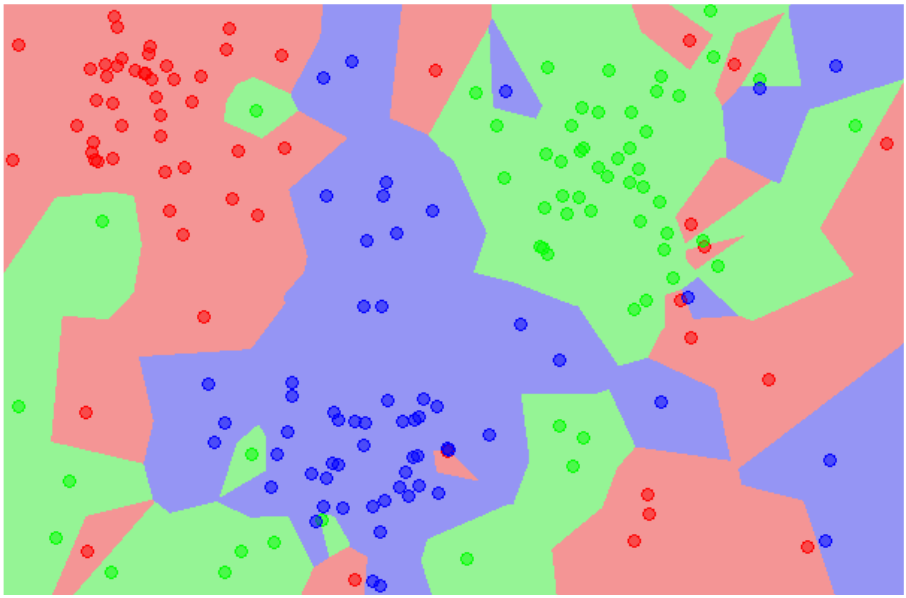
- k-Nearest Neighbours
- Decision Trees
- Naive Bayes
- Logistic Regression
- Support Vector Machines

k-Nearest Neighbours:

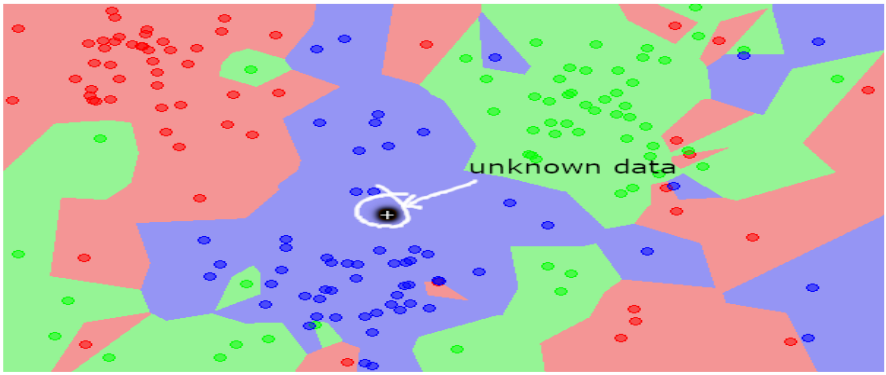
The k-Nearest Neighbours, which is simply called kNN is a statistical technique that can be used for solving for classification and regression problems. Let us discuss the case of classifying an unknown object using kNN. Consider the distribution of objects as shown in the image given below:



The diagram shows three types of objects, marked in red, blue and green colors. When you run the kNN classifier on the above dataset, the boundaries for each type of object will be marked as shown below:



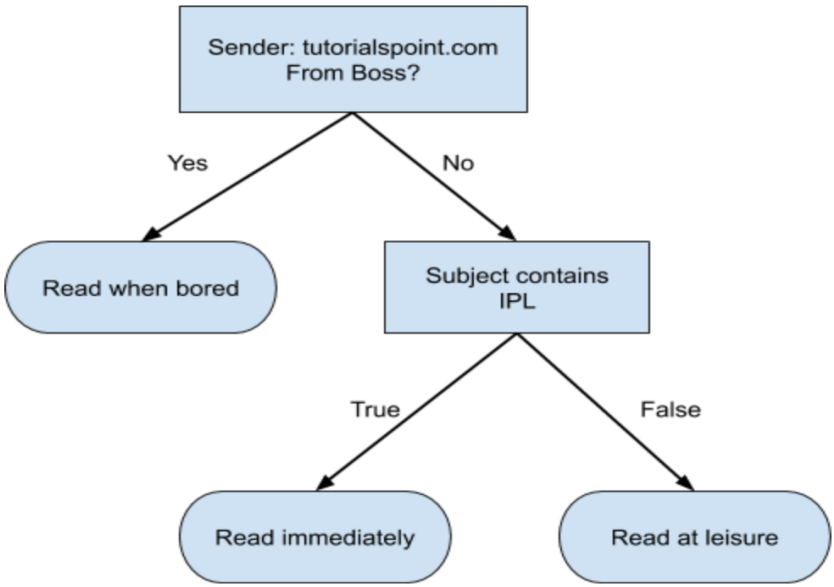
Now, consider a new unknown object that you want to classify as red, green or blue. This is depicted in the figure below.



As you see it visually, the unknown data point belongs to a class of blue objects. Mathematically, this can be concluded by measuring the distance of this unknown point with every other point in the data set. When you do so, you will know that most of its neighbours are of blue color. The average distance to red and green objects would be definitely more than the average distance to blue objects. Thus, this unknown object can be classified as belonging to blue class. The kNN algorithm can also be used for regression problems. The kNN algorithm is available as ready-to-use in most of the ML libraries

Decision Trees:

A simple decision tree in a flowchart format is shown below:



You would write a code to classify your input data based on this flowchart. The flowchart is self-explanatory and trivial. In this scenario, you are trying to classify an incoming email to decide when to read it.

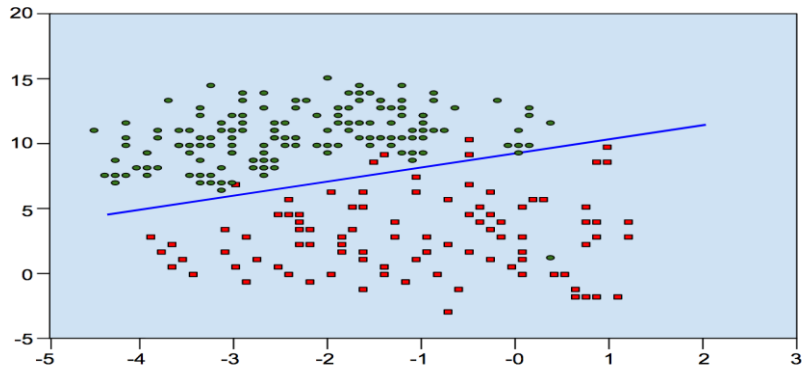
In reality, the decision trees can be large and complex. There are several algorithms available to create and traverse these trees. As a Machine Learning enthusiast, you need to understand and master these techniques of creating and traversing decision trees.

Naive Bayes

Naive Bayes is used for creating classifiers. Suppose you want to sort out (classify) fruits of different kinds from a fruit basket. You may use features such as color, size and shape of a fruit, For example, any fruit that is red in color, is round in shape and is about 10 cm in diameter may be considered as Apple. So to train the model, you would use these features and test the probability that a given feature matches the desired constraints. The probabilities of different features are then combined to arrive at a probability that a given fruit is an Apple. Naive Bayes generally requires a small number of training data for classification.

Logistic Regression

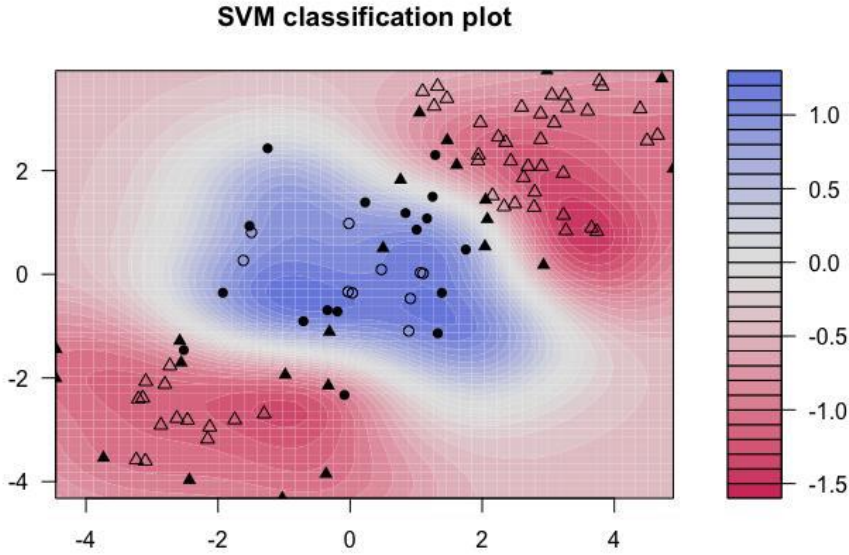
Look at the following diagram. It shows the distribution of data points in XY plane.



From the diagram, we can visually inspect the separation of red dots from green dots.

Support Vector Machines

Look at the following distribution of data. Here the three classes of data cannot be linearly separated. The boundary curves are non-linear. In such a case, finding the equation of the curve becomes a complex job.



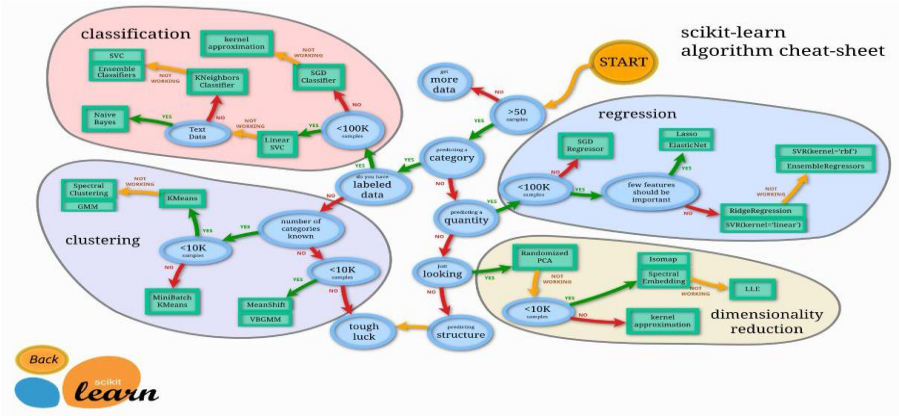
The Support Vector Machines (SVM) comes handy in determining the separation boundaries in such situations.

By,

GOBIKA M IV/IT

SKIT LEARN ALGORITHM

Fortunately, most of the time you do not have to code the algorithms mentioned in the previous lesson. There are many standard libraries which provide the ready-to-use implementation of these algorithms. One such toolkit that is popularly used is scikit-learn. The figure below illustrates the kind of algorithms which are available for your use in this library.



The use of these algorithms is trivial and since these are well and field tested, you can safely use them in your AI applications. Most of these libraries are free to use even for commercial purposes.

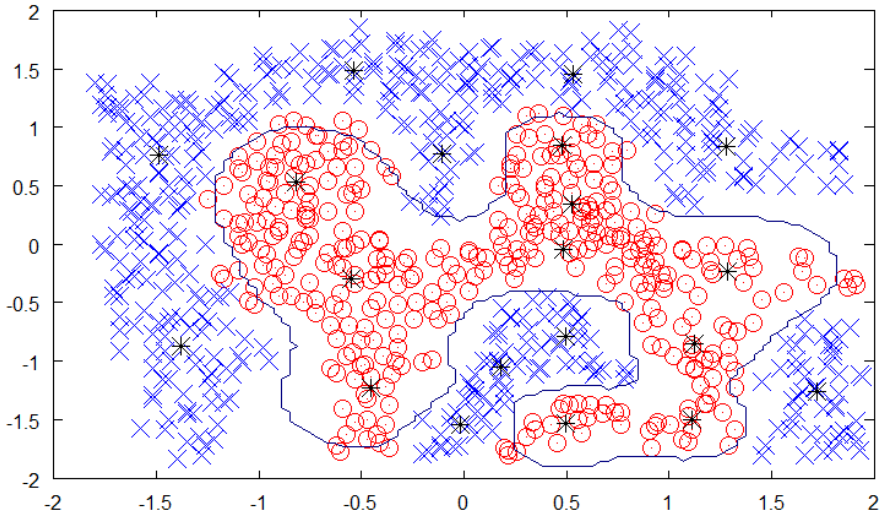
By,

NANDHINI S IV/IT

UNSUPERVISED LEARNING

In unsupervised learning, we do not specify a target variable to the machine, rather we ask machine "What can you tell me about X?". More specifically, we may ask questions such as given a huge data set X, "What are the five best groups we can make out of X?" or "What features occur together most frequently in X?". To arrive at the answers to such questions, you can understand that the number of data points that the machine would require to deduce a strategy would be very large. In case of supervised learning, the machine can be trained with even about few thousands of data points. However, in case of unsupervised learning, the number of data points that is reasonably accepted for learning starts in a few millions. These days, the data is generally abundantly available. The data ideally requires curating. However, the amount of data that is continuously flowing in a social area network, in most cases data curation is an impossible task.

The following figure shows the boundary between the yellow and red dots as determined by unsupervised machine learning. You can see it clearly that the machine would be able to determine the class of each of the black dots with a fairly good accuracy.



The unsupervised learning has shown a great success in many modern AI applications, such as face detection, object detection, and so on.

Algorithms for Unsupervised Learning

Let us now discuss one of the widely used algorithms for classification in unsupervised machine learning.

k-means clustering

The 2000 and 2004 Presidential elections in the United States were close — very close. The largest percentage of the popular vote that any candidate received was 50.7% and the lowest was 47.9%. If a percentage of the voters were to have switched sides, the outcome of the election would have been different. There are small groups of voters who, when properly appealed to, will switch sides. These groups may not be huge, but

with such close races, they may be big enough to change the outcome of the election. How do you find these groups of people? How do you appeal to them with a limited budget? The answer is clustering.

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Let us understand how it is done.

- First, you collect information on people either with or without their consent: any sort of information that might give some clue about what is important to them and what will influence how they vote
- Then you put this information into some sort of clustering algorithm
- Next, for each cluster (it would be smart to choose the largest one first) you craft a message that will appeal to these voters.
- Finally, you deliver the campaign and measure to see if it's working

Clustering is a type of unsupervised learning that automatically forms clusters of similar things.

Cluster Identification

Cluster identification tells an algorithm, “Here’s some data. Now group similar things together and tell me about those groups.” The key difference from classification is that in classification you know what you are looking for. While that is not the case in clustering.

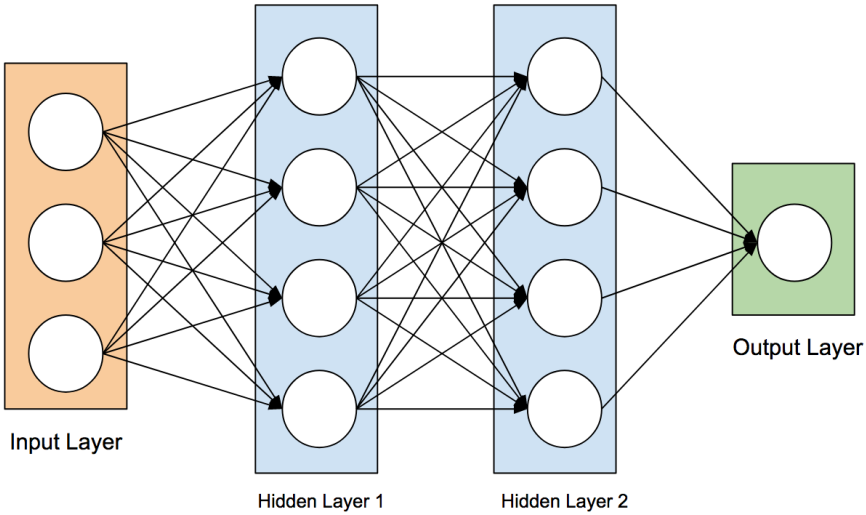
Clustering is sometimes called unsupervised classification because it produces the same result as classification does but without having predefined classes.

By,

KARTHIK T IV/IT

ARTIFICIAL NEWRAL NETWORKS

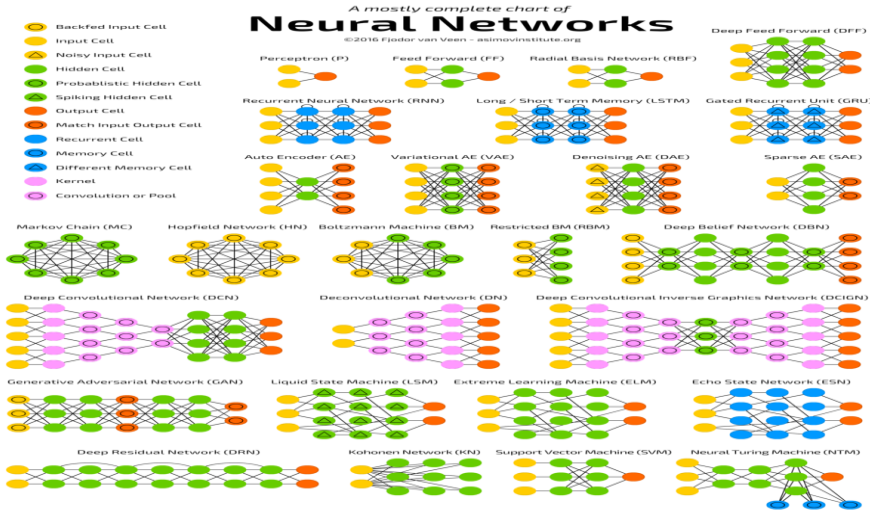
The idea of artificial neural networks was derived from the neural networks in the human brain. The human brain is really complex. Carefully studying the brain, the scientists and engineers came up with an architecture that could fit in our digital world of binary computers. One such typical architecture is shown in the diagram below:



There is an input layer which has many sensors to collect data from the outside world. On the right hand side, we have an output layer that gives us the result predicted by the network.

ANN Architectures

The diagram below shows several ANN architectures developed over a period of time and are in practice today.



Each architecture is developed for a specific type of application. Thus, when you use a neural network for your machine learning application, you will have to use either one of the existing architecture or design your own. The type of application that you finally decide upon depends on your application needs.

By,

HARIPRASATH K IV/IT

DEEP LEARNING

Deep Learning uses ANN and will look at a few deep learning applications that will give an idea of its power.

Applications

Deep Learning has shown a lot of success in several areas of machine learning applications.

Self-driving Cars: The autonomous self-driving cars use deep learning techniques. They generally adapt to the ever changing traffic situations and get better and better at driving over a period of time.

Speech Recognition: Another interesting application of Deep Learning is speech recognition. All of us use several mobile apps today that are capable of recognizing our speech. Apple's Siri, Amazon's Alexa, Microsoft's Cortena and Google's Assistant – all these use deep learning techniques.

Mobile Apps: We use several web-based and mobile apps for organizing our photos. Face detection, face ID, face tagging, identifying objects in an image – all these use deep learning.

Untapped Opportunities of Deep Learning

After looking at the great success deep learning applications have achieved in many domains, people started exploring other domains where machine learning was not so far applied. There are several domains in which deep learning techniques are successfully applied and there are many other domains which can be exploited.

- Agriculture is one such industry where people can apply deep learning techniques to improve the crop yield.

- Consumer finance is another area where machine learning can greatly help in providing early detection on frauds and analyzing customer's ability to pay.
- Deep learning techniques are also applied to the field of medicine to create new drugs and provide a personalized prescription to a patient.

The possibilities are endless and one has to keep watching as the new ideas and developments pop up frequently.

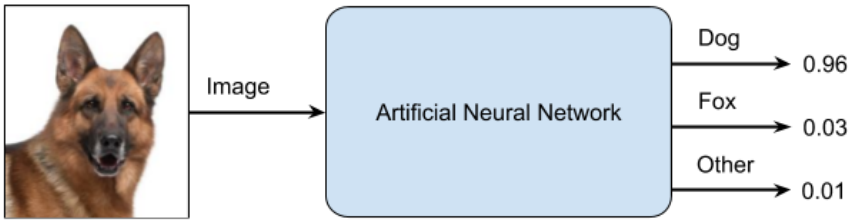
Deep Learning - Disadvantages

Some of the important points that you need to consider before using deep learning are listed below:

- Black Box approach
- Duration of Development
- Amount of Data
- Computationally Expensive

Black Box approach

An ANN is like a blackbox. You give it a certain input and it will provide you a specific output. The following diagram shows you one such application where you feed an animal image to a neural network and it tells you that the image is of a dog.

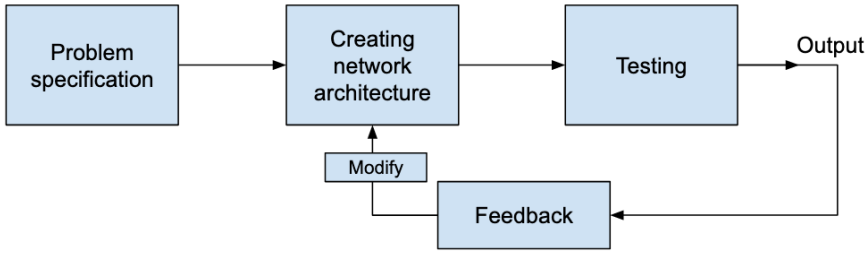


Why this is called a black-box approach is that you do not know why the network came up with a certain result. You do not know how the network concluded that it is a dog? Now consider a banking application where the bank wants to decide the creditworthiness of a client. The network will

definitely provide you an answer to this question. However, will you be able to justify it to a client? Banks need to explain it to their customers why the loan is not sanctioned?

Duration of Development

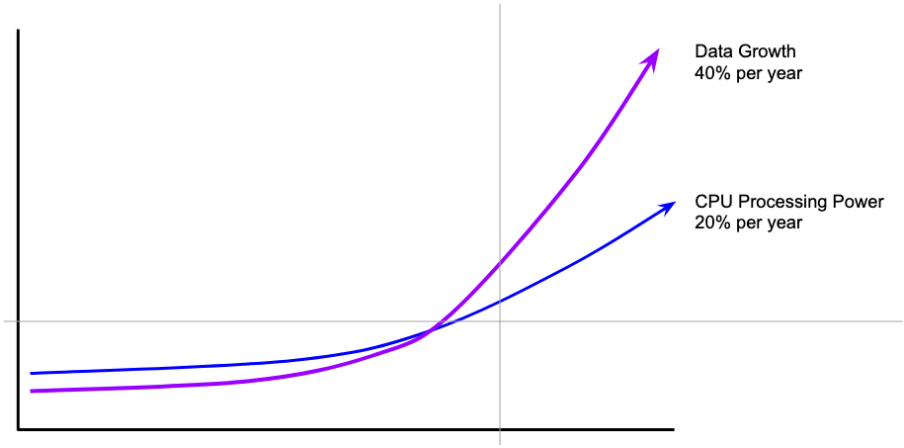
The process of training a neural network is depicted in the diagram below:



First define the problem that want to solve, create a specification for it, decide on the input features, design a network, deploy it and test the output. If the output is not as expected, take this as a feedback to restructure your network. This is an iterative process and may require several iterations until the time network is fully trained to produce desired outputs.

Amount of Data

The deep learning networks usually require a huge amount of data for training, while the traditional machine learning algorithms can be used with a great success even with just a few thousands of data points. Fortunately, the data abundance is growing at 40% per year and CPU processing power is growing at 20% per year as seen in the diagram given below:



Computationally Expensive

Training a neural network requires several times more computational power than the one required in running traditional algorithms. Successful training of deep Neural Networks may require several weeks of training time.

In contrast to this, traditional machine learning algorithms take only a few minutes/hours to train. Also, the amount of computational power needed for training deep neural network heavily depends on the size of your data and how deep and complex the network is?

After having an overview of what Machine Learning is, its capabilities, limitations, and applications, let us now dive into learning "Machine Learning".

By,

JESSICA COLLINS IV/IT

SKILLS FOR MACHINE LEARNING

Machine Learning has a very large width and requires skills across several domains. The skills that you need to acquire for becoming an expert in Machine Learning are listed below:

- Statistics
- Probability Theories
- Calculus
- Optimization techniques
- Visualization

Necessity of Various Skills of Machine Learning

i) Mathematical Notation

Most of the machine learning algorithms are heavily based on mathematics. The level of mathematics that you need to know is probably just a beginner level. What is important is that you should be able to read the notation that mathematicians use in their equations. For example - if you are able to read the notation and comprehend what it means, you are ready for learning machine learning. If not, you may need to brush up your mathematics knowledge.

$$f_{AN}(net-\theta)=\begin{cases}\gamma & \text{if } net-\theta \geq \epsilon \\ net-\theta & \text{if } -\epsilon < net-\theta < \epsilon \\ -\gamma & \text{if } net-\theta \leq -\epsilon\end{cases}$$

$$\max_{\alpha}\left[\sum_{i=1}^{m}\alpha-\frac{1}{2}\sum_{i,j=1}^{m} label^{(i)}\cdot label^{(j)}\cdot a_i\cdot a_j\langle x^{(i)},x^{(j)}\rangle\right]$$

$$f_{AN}(net-\theta)=\frac{e^{\lambda(net-\theta)}-e^{-\lambda(net-\theta)}}{e^{\lambda(net-\theta)}+e^{-\lambda(net-\theta)}}$$

Probability Theory

Here is an example to test your current knowledge of probability theory: Classifying with conditional probabilities.

$$p(c_i|x,y)=\frac{p(x,y|c_i)p(c_i)}{p(x,y)}$$

With these definitions, we can define the Bayesian classification rule:

- If P(c1|x, y) > P(c2|x, y) , the class is c1 .
- If P(c1|x, y) < P(c2|x, y) , the class is c2 .

Optimization Problem

Here is an optimization function

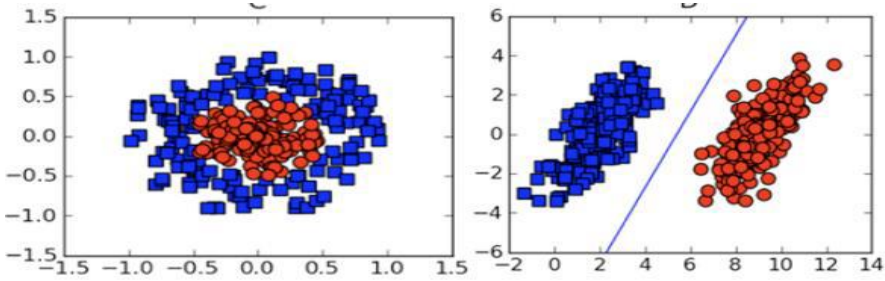
$$\max_{\alpha}\left[\sum_{i=1}^{m}\alpha-\frac{1}{2}\sum_{i,j=1}^{m}label^{(i)}\cdot label^{(j)}\cdot a_i\cdot a_j\langle x^{(i)},x^{(j)}\rangle\right]$$

Subject to the following constraints:

$$\alpha\geq 0, and \sum_{i-1}^{m}\alpha_i\cdot label^{(i)}=0$$

Visualization

In many cases, you will need to understand the various types of visualization plots to understand your data distribution and interpret the results of the algorithm's output.



By,

MUKESH KANNA R III/IT

IMPLEMENTING MACHINE LEARNING

To develop ML applications, you will have to decide on the platform, the IDE and the language for development. There are several choices available. Most of these would meet your requirements easily as all of them provide the implementation of AI algorithms discussed so far.

If you are developing the ML algorithm on your own, the following aspects need to be understood carefully:

The language of your choice – this essentially is your proficiency in one of the languages supported in ML development.

The IDE that you use – This would depend on your familiarity with the existing IDEs and your comfort level.

Development platform – There are several platforms available for development and deployment. Most of these are free-to-use. In some cases, you may have to incur a license fee beyond a certain amount of usage. Here is a brief list of choice of languages, IDEs and platforms for your ready reference.

Language Choice

Here is a list of languages that support ML development:

- Python
- R
- Matlab
- Octave
- Julia
- C++
- C

This list is not essentially comprehensive; however, it covers many popular languages used in machine learning development. Depending upon your comfort level, select a language for the development, develop your models and test.

IDEs

Here is a list of IDEs which support ML development:

- R Studio
- Pycharm
- iPython / Jupyter Notebook
- Julia
- Spyder
- Anaconda

Platforms

Here is a list of platforms on which ML applications can be deployed:

- IBM
- Microsoft Azure
- Google Cloud
- Amazon
- MLflow

The above list is not essentially comprehensive. Each one has its own merits and demerits. The reader is encouraged to try out these different IDEs before narrowing down to a single one.

By,

PAVITHRA S III/IT

MACHINE LEARNING - CONCLUSION

Machine Learning is a technique of training machines to perform the activities a human brain can do, albeit bit faster and better than an average human-being.The machines can beat human champions in games such as Chess, AlphaGO, which are considered very complex and machines can be trained to perform human activities in several areas and can aid humans in living better lives.

Machine Learning can be a Supervised or Unsupervised. If you have lesser amount of data and clearly labelled data for training, opt for Supervised Learning. Unsupervised Learning would generally give better performance and results for large data sets. If you have a huge data set easily available, go for deep learning techniques. You also have learned Reinforcement Learning and Deep Reinforcement Learning. You now know what Neural Networks are, their applications and limitations. Finally, when it comes to the development of machine learning models of your own, you looked at the choices of various development languages, IDEs and Platforms

By,

PRIYADHARSHINI P III/IT

Program Outcomes (POs)

PO1	**Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the IT enabled solution of complex engineering problems.
PO2	**Problem Analysis:** Identify, analyze and provide solutions to the problems reaching substantiated IT enabled conclusions.
PO3	**Design/Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet the desired needs within realistic constraints.
PO4	**Conduct Investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	**Modern Tool Usage**: Create, select and apply appropriate techniques, resources and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	**The Engineer and Society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	**Environment and Sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.
PO9	**Individual and Team Work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	**Communication:** Communicate effectively on engineering activities with the engineering community and with society.
PO11	**Project Management and Finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	**Life Long Learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes(PSOs)

PSO1	**Programming Skill**	Work as Software Engineers for providing solutions to real world problems using programming languages and open source software.
PSO2	**Web Designing Skill**	Ability to use the web designing skill to establish new solutions for the societal needs.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