ML UNIT 1 PART A Material

COMPUTER SCIENCE ENGINEERING (Jawaharlal Nehru Technological University, Kakinada)

Dr K N MADHAVI LATHA
ASSOCIATE PROFESSOR
DEPT OF CSE
SIR CRRCOE

MACHINE LEARNING UNIT 1

Unit I SYLLABUS:

Introduction: Artificial Intelligence, Machine Learning, Deep learning, Types of Machine Learning Systems, Main Challenges of Machine Learning.

Statistical Learning: Introduction, Supervised and Unsupervised Learning, Training and Test Loss, Tradeoffs in Statistical Learning, Estimating Risk Statistics, Sampling distribution of an estimator, Empirical Risk Minimization

1. INTRODUCTION

1.1 Overview of Artificial Intelligence:

What is AI ?

- **A**rtificial Intelligence (AI) is a branch of *Science* which deals with helping machines find solutions to complex problems in a more human-like fashion.
- This generally involves borrowing characteristics from human intelligence, and applying them as algorithms in a computer friendly way.
- A more or less flexible or efficient approach can be taken depending on the requirements established, which influences how artificial the intelligent behavior appears
- Artificial intelligence can be viewed from a variety of perspectives.
  - ✓ From the perspective of **intelligence** artificial intelligence is making machines "intelligent" -- acting as we would expect people to act.
    - The inability to distinguish computer responses from human responses is called the Turing test.
    - Intelligence requires knowledge
    - Expert problem solving - restricting domain to allow including significant relevant knowledge
  - ✓ From a **business** perspective AI is a set of very powerful tools, and methodologies for using those tools to solve business problems.
  - ✓ From a **programming** perspective, AI includes the study of symbolic programming, problem solving, and search.
    - Typically AI programs focus on symbols rather than numeric

processing.

- Problem solving - achieve goals.
- Search - seldom access a solution directly. Search may include a variety of techniques.
- AI programming languages include:

– LISP, developed in the 1950s, is the early programming language strongly associated with AI. LISP is a functional programming language with procedural extensions. LISP (LISt Processor) was specifically designed for processing heterogeneous lists -- typically a list of symbols. Features of LISP are run- time type checking, higher order functions (functions that have other functions as parameters), automatic memory management (garbage collection) and an interactive environment.

– The second language strongly associated with AI is PROLOG. PROLOG was developed in the 1970s. PROLOG is based on first order logic. PROLOG is declarative in nature and has facilities for explicitly limiting the search space.

– Object-oriented languages are a class of languages more recently used for AI programming. Important features of object-oriented languages include: concepts of objects and messages, objects bundle data and methods for manipulating the data, sender specifies what is to be done receiver decides how to do it, inheritance (object hierarchy where objects inherit the attributes of the more general class of objects). Examples of object-oriented languages are Smalltalk, Objective C, C++. Object oriented extensions to LISP (CLOS - Common LISP Object System) and PROLOG (L&O - Logic & Objects) are also used.

- Artificial Intelligence is a new electronic machine that stores large amount of information and process it at very high speed
- The computer is interrogated by a human via a teletype It passes if the human cannot tell if there is a computer or human at the other end
- The ability to solve problems
- It is the science and engineering of making intelligent machines, especially intelligent computer programs. It is related to the similar task of using computers to understand human intelligence

Importance of AI

- **Game Playing**

You can buy machines that can play master level chess for a few hundred dollars.

There is some AI in them, but they play well against people mainly through brute force computation--looking at hundreds of thousands of positions. To beat a world champion by brute force and known reliable heuristics requires being able to look at 200 million positions per second.

- **Speech Recognition**

  In the 1990s, computer speech recognition reached a practical level for limited purposes. Thus United Airlines has replaced its keyboard tree for flight information by a system using speech recognition of flight numbers and city names. It is quite convenient. On the other hand, while it is possible to instruct some computers using speech, most users have gone back to the keyboard and the mouse as still more convenient.

- **Understanding Natural Language**

  Just getting a sequence of words into a computer is not enough. Parsing sentences is not enough either. The computer has to be provided with an understanding of the domain the text is about, and this is presently possible only for very limited domains.

- **Computer Vision**

  The world is composed of three-dimensional objects, but the inputs to the human eye and computers' TV cameras are two dimensional. Some useful programs can work solely in two dimensions, but full computer vision requires partial three-dimensional information that is not just a set of two-dimensional views. At present there are only limited ways of representing three-dimensional information directly, and they are not as good as what humans evidently use.

- **Expert Systems**

  A ``knowledge engineer'' interviews experts in a certain domain and tries to embody their knowledge in a computer program for carrying out some task. How well this works depends on whether the intellectual mechanisms required for the task are within the present state of AI. When this turned out not to be so, there were many disappointing results. One of the first expert systems was MYCIN in 1974, which diagnosed bacterial infections of the blood and suggested treatments. It did better than medical students or practicing doctors, provided its limitations were observed. Namely, its ontology included bacteria, symptoms, and treatments and did not include patients, doctors, hospitals, death, recovery, and events occurring in time. Its interactions depended on a single patient being considered. Since the experts consulted by the knowledge engineers knew about patients, doctors, death, recovery,

etc., it is clear that the knowledge engineers forced what the experts told them into a predetermined framework. The usefulness of current expert systems depends on their users having common sense.

- **Heuristic Classification**

  One of the most feasible kinds of expert system given the present knowledge of AI is to put some information in one of a fixed set of categories using several sources of information. An example is advising whether to accept a proposed credit card purchase. Information is available about the owner of the credit card, his record of payment and also about the item he is buying and about the establishment from which he is buying it (e.g., about whether there have been previous credit card frauds at this establishment).

- **The applications of AI are shown in Fig 1.1:**
  - ✓ Consumer Marketing
    - Have you ever used any kind of credit/ATM/store card while shopping?
    - if so, you have very likely been "input" to an AI algorithm
    - All of this information is recorded digitally
    - Companies like Nielsen gather this information weekly and search for patterns
      - general changes in consumer behavior
      - tracking responses to new products
      - identifying customer segments: targeted marketing, e.g., they find out that consumers with sports cars who buy textbooks respond well to offers of new credit cards.
    - Algorithms ("data mining") search data for patterns based on mathematical theories of learning
  - ✓ Identification Technologies
    - ID cards e.g., ATM cards
    - can be a nuisance and security risk: cards can be lost, stolen, passwords forgotten, etc
    - Biometric Identification, walk up to a locked door
      - Camera
      - Fingerprint device
      - Microphone
      - Computer uses biometric signature for identification
      - Face, eyes, fingerprints, voice pattern

- This works by comparing data from person at door with stored library
- Learning algorithms can learn the matching process by analyzing a large library database off-line, can improve its performance.

✓ Intrusion Detection

- Computer security - we each have specific patterns of computer use times of day, lengths of sessions, command used, sequence of commands, etc
  - would like to learn the "signature" of each authorized user
  - can identify non-authorized users
- How can the program automatically identify users?
  - record user's commands and time intervals
  - characterize the patterns for each user
  - model the variability in these patterns
  - classify (online) any new user by similarity to stored patterns

✓ Machine Translation

- Language problems in international business
  - e.g., at a meeting of Japanese, Korean, Vietnamese and Swedish investors, no common language
  - If you are shipping your software manuals to 127 countries, the solution is ; hire translators to translate
  - would be much cheaper if a machine could do this!
- How hard is automated translation
  - very difficult!
  - e.g., English to Russian
  - not only must the words be translated, but their meaning also!

Dr K N MADHAVI LATHA
ASSOCIATE PROFESSOR
DEPT OF CSE
SIR CRRCOE

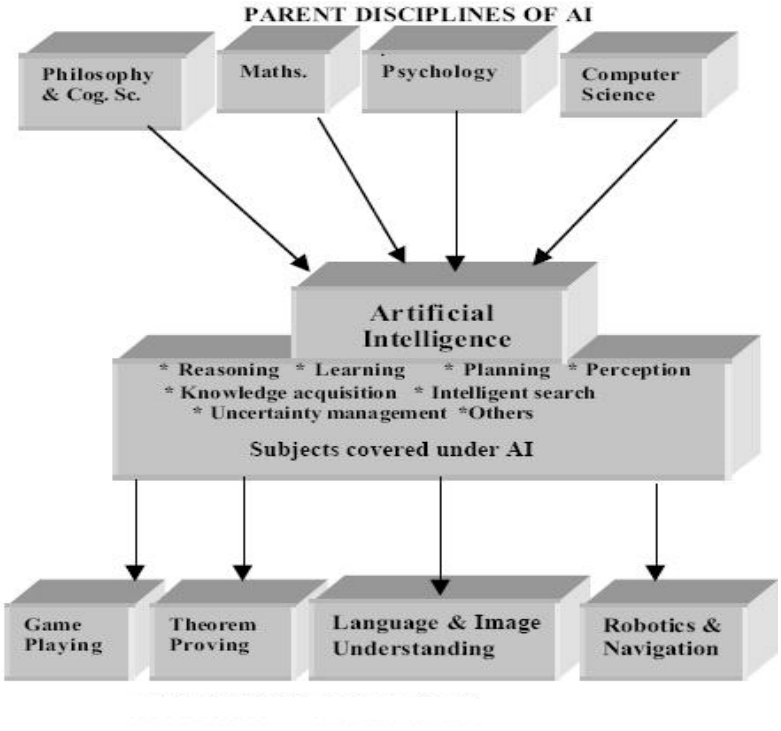


Fig : Application areas of AI

1.2 Overview of Machine Learning:

The term Machine Learning was first coined by Arthur Samuel in the year 1959. Looking back, that year was probably the most significant in terms of technological advancements.

If you browse through the net about 'what is Machine Learning', you'll get at least 100 different definitions. However, the very first formal definition was given by Tom M. Mitchell:

"A computer program is said to learn from experience E with respect to some class of tasks T and performance measure P if its performance at tasks in T, as measured by P, improves with experience E."

In simple terms, Machine learning is a subset of Artificial Intelligence (AI) which provides machines the ability to learn automatically & improve from experience without being explicitly programmed to do so. In the sense, it is the practice of getting Machines to solve problems by gaining the ability to think.

But wait, can a machine think or make decisions? Well, if you feed a machine a good amount of data, it will learn how to interpret process and analyze this data by using Machine Learning Algorithms, in order to solve real-world problems.

Dr K N MADHAVI LATHA
ASSOCIATE PROFESSOR
DEPT OF CSE
SIR CRRCOE

Before moving any further, let's discuss some of the most commonly used terminologies in Machine Learning.

1.2.1 Machine Learning Definitions

Algorithm: A Machine Learning algorithm is a set of rules and statistical techniques used to learn patterns from data and draw significant information from it. It is the logic behind a Machine Learning model. An example of a Machine Learning algorithm is the Linear Regression algorithm.

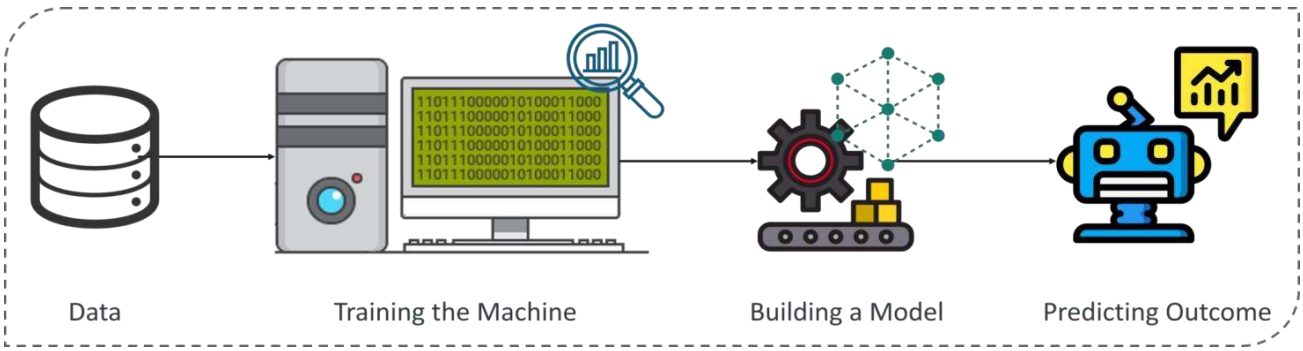
Model: A model is the main component of Machine Learning. A model is trained by using a Machine Learning Algorithm. An algorithm maps all the decisions that a model is supposed to take based on the given input, in order to get the correct output.

Predictor Variable: It is a feature(s) of the data that can be used to predict the output.

Response Variable: It is the feature or the output variable that needs to be predicted by using the predictor variable(s).

Training Data: The Machine Learning model is built using the training data. The training data helps the model to identify key trends and patterns essential to predict the output.

Testing Data: After the model is trained, it must be tested to evaluate how accurately it can predict an outcome. This is done by the testing data set.

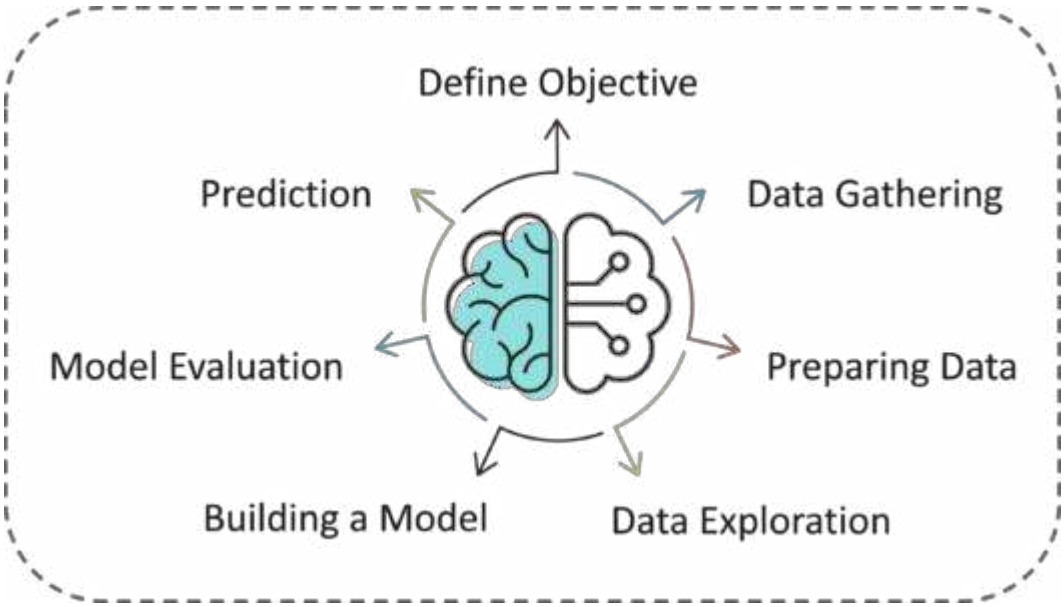


To sum it up, take a look at the above figure. *A Machine Learning process begins by feeding the machine lots of data, by using this data the machine is trained to detect hidden insights and trends. These insights are then used to build a Machine Learning Model by using an algorithm in order to solve a problem.*

Dr K N MADHAVI LATHA
ASSOCIATE PROFESSOR
DEPT OF CSE
SIR CRRCOE

1.2.2 Machine Learning Process:

The Machine Learning process involves building a Predictive model that can be used to find a solution for a Problem Statement. To understand the Machine Learning process let's assume that you have been given a problem that needs to be solved by using Machine Learning.



Machine Learning Process – Introduction To Machine Learning – Edureka

The problem is to predict the occurrence of rain in your local area by using Machine Learning.

The below steps are followed in a Machine Learning process:

Step 1: Define the objective of the Problem Statement

At this step, we must understand what exactly needs to be predicted. In our case, the objective is to predict the possibility of rain by studying weather conditions. At this stage, it is also essential to take mental notes on what kind of data can be used to solve this problem or the type of approach you must follow to get to the solution.

Step 2: Data Gathering

At this stage, you must be asking questions such as,

What kind of data is needed to solve this problem?

Is the data available?

How can I get the data?

Dr K N MADHAVI LATHA
ASSOCIATE PROFESSOR
DEPT OF CSE
SIR CRRCOE

Once you know the types of data that is required, you must understand how you can derive this data. Data collection can be done manually or by web scraping. However, if you're a beginner and you're just looking to learn Machine Learning you don't have to worry about getting the data. There are 1000s of data resources on the web, you can just download the data set and get going.

Coming back to the problem at hand, the data needed for weather forecasting includes measures such as humidity level, temperature, pressure, locality, whether or not you live in a hill station, etc. Such data must be collected and stored for analysis.

Step 3: Data Preparation

The data you collected is almost never in the right format. You will encounter a lot of inconsistencies in the data set such as missing values, redundant variables, duplicate values, etc. Removing such inconsistencies is very essential because they might lead to wrongful computations and predictions. Therefore, at this stage, you scan the data set for any inconsistencies and you fix them then and there.

Step 4: Exploratory Data Analysis

Grab your detective glasses because this stage is all about diving deep into data and finding all the hidden data mysteries. EDA or Exploratory Data Analysis is the brainstorming stage of Machine Learning. Data Exploration involves understanding the patterns and trends in the data. At this stage, all the useful insights are drawn and correlations between the variables are understood.

For example, in the case of predicting rainfall, we know that there is a strong possibility of rain if the temperature has fallen low. Such correlations must be understood and mapped at this stage.

Step 5: Building a Machine Learning Model

All the insights and patterns derived during Data Exploration are used to build the Machine Learning Model. This stage always begins by splitting the data set into two parts, training data, and testing data. The training data will be used to build and analyze the model. The logic of the model is based on the Machine Learning Algorithm that is being implemented.

In the case of predicting rainfall, since the output will be in the form of True (if it will rain

tomorrow) or False (no rain tomorrow), we can use a Classification Algorithm such as Logistic Regression.

Choosing the right algorithm depends on the type of problem you're trying to solve, the data set and the level of complexity of the problem. In the upcoming sections, we will discuss the different types of problems that can be solved by using Machine Learning.

Step 6: Model Evaluation & Optimization

After building a model by using the training data set, it is finally time to put the model to a test. The testing data set is used to check the efficiency of the model and how accurately it can predict the outcome. Once the accuracy is calculated, any further improvements in the model can be implemented at this stage. Methods like parameter tuning and cross-validation can be used to improve the performance of the model.

Step 7: Predictions

Once the model is evaluated and improved, it is finally used to make predictions. The final output can be a Categorical variable (eg. True or False) or it can be a Continuous Quantity (eg. the predicted value of a stock).

In our case, for predicting the occurrence of rainfall, the output will be a categorical variable.

So that was the entire Machine Learning process. Now it's time to learn about the different ways in which Machines can learn.

1.3 Overview of Deep Learning:

Deep learning is one of the only methods by which we can overcome the challenges of feature extraction. This is because deep learning models are capable of learning to focus on the right features by themselves, requiring little guidance from the programmer. Basically, deep learning mimics the way our brain functions i.e. it learns from experience. As you know, our brain is made up of billions of neurons that allow us to do amazing things. Even the brain of a one year old kid can solve complex problems which are very difficult to solve even using super-computers. For example:

- Recognize the face of their parents and different objects as well.
- Discriminate different voices and can even recognize a particular person based on his/her voice.

- Draw inference from facial gestures of other persons and many more.

Actually, our brain has sub-consciously trained itself to do such things over the years. Now, the question comes, *how deep learning mimics the functionality of a brain?* Well, deep learning uses the concept of artificial neurons that functions in a similar manner as the biological neurons present in our brain. Therefore, we can say that Deep Learning is a subfield of **machine learning** concerned with algorithms inspired by the structure and function of the brain called artificial neural networks.

Now, let us take an example to understand it. Suppose we want to make a system that can recognize faces of different people in an image. If we solve this as a typical machine learning problem, we will define facial features such as eyes, nose, ears etc. and then, the system will identify which features are more important for which person on its own.

Now, deep learning takes this one step ahead. Deep learning automatically finds out the features which are important for classification because of deep neural networks, whereas in case of Machine Learning we had to manually define these features.

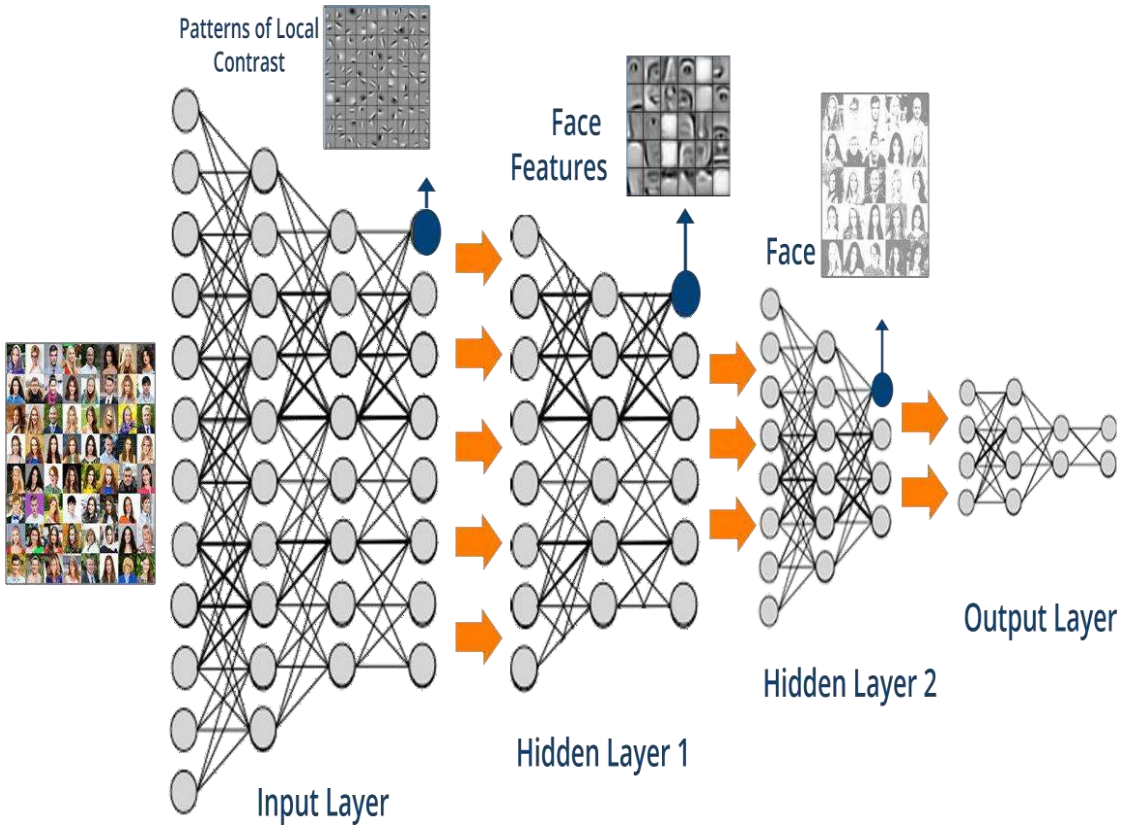


fig: Face Recognition using Deep Networks

As shown in the image above Deep Learning works as follows:

- At the lowest level, network fixates on patterns of local contrast as important.
- The following layer is then able to use those patterns of local contrast to fixate on things that resemble eyes, noses, and mouths
- Finally, the top layer is able to apply those facial features to face templates.
- A deep neural network is capable of composing more and more complex features in each of its successive layers.

Have you ever wondered how Facebook automatically labels or tags all the person present in an image uploaded by you? Well, Facebook uses Deep Learning in a similar fashion as stated in the above example. Now, you would have realized the capability of Deep Learning and how it can outperform Machine Learning in those cases where we have very little idea about all the features that can affect the outcome. Therefore, Deep network can overcome the drawback of Machine Learning by drawing inferences from data set consisting of input data without proper labeling.

Applications of Deep Learning

Moving ahead in this what is deep learning blog, let us look at some of the real-life applications of Deep Learning to understand its true powers.

- **Speech Recognition**

All of you would have heard about Siri, which is Apple's voice controlled intelligent assistant. Like other big giants, Apple has also started investing on Deep Learning to make its services better than ever.

In the area of speech recognition and voice controlled intelligent assistant like Siri, one can develop more accurate acoustic model using a deep neural network and is currently one of the most active fields for deep learning implementation. In simple words, you can build such system that can learn new features or adapt itself according to you and therefore, provide better assistance by predicting all possibilities beforehand.

- **Automatic Machine Translation**

We all know that Google can instantly translate between 100 different human language, that too very quickly as if by magic. The technology behind *Google Translate* is called **Machine Translation** and has been savior for people who can't communicate with each other because of

the difference in the speaking language. Now, you would be thinking that this feature has been there for a long time, so, what's new in this? Let me tell you that over the past two years, with the help of deep learning, Google has totally reformed the approach to machine translation in its Google Translate. In fact, deep learning researchers who know almost nothing about language translation are putting forward relatively simple machine learning solutions that are beating the best expert-built language translation systems in the world. Text translation can be performed without any pre-processing of the sequence, allowing the algorithm to learn the dependencies between words and their mapping to a new language. Stacked networks of large recurrent neural networks are used to perform this translation.

- **Instant Visual Translation**

As you know, deep learning is used to identify images that have letters and where the letters are on the scene. Once identified, they can be turned into text, translated and the image recreated with the translated text. This is often called **instant visual translation**.

Now, imagine a situation where you have visited any other country whose native language is not known to you. Well, no need to worry, using various apps like Google Translate you can go ahead and perform instant visual translations to read signs or shop boards written in another language. This has been possible only because of Deep Learning.

Note: You can go ahead and download Google Translate App and check out the amazing instant visual translation using the above image.

- **Behavior: Automated Self Driven Cars**

Google is trying to take their self-driving car initiative, known as WAYMO, to a whole new level of perfection using Deep Learning. Therefore, rather than using old hand-coded algorithms, they can now program system that can learn by themselves using data provided by different sensors. Deep learning is now the best approach to most perception tasks, as well as to many low-level control tasks. Hence, now even people who do not know to drive or are disabled, can go ahead and take the ride without depending on anyone else.

Dr K N MADHAVI LATHA
ASSOCIATE PROFESSOR
DEPT OF CSE
SIR CRRCOE

Dr K N MADHAVI LATHA
ASSOCIATE PROFESSOR
DEPT OF CSE
SIR CRRCOE

DIFFERENCE BETWEEN AI, ML, AND DL

Artificial Intelligence	Machine Learning	Deep Learning
AI, is a subfield of computer science, that was created in the 1960s with the aim of creating machines that are intelligent, basically which can do any tasks humans are capable of doing too, but taking lesser time than a human might take.	One of the subfields of AI - in the past, it covered all types of data science algorithms, supervised, unsupervised, segmentation, classification, or regression but presently this term refers to unsupervised pattern recognition.	It is a proper subset of Machine Learning, essentially a set of techniques that help you to parameterize deep neural network structures i.e. neural networks numerous layers and parameters.
Making machines intelligent may or may not need high computational power as it depends on the nature of the task that needs to be learnt by the machine or in better terms, needs to be automated.	These algorithms can work easily on normal low performance computers without GPUs as there isn't a need for lot of memory storage and saving of trained models.	Algorithms are dependent on high performance hardware components that include GPUs (and now TPUs too) that can efficiently optimize operations like matrix multiplication
Based on the triviality or complexity of the task, a suitable algorithm is chosen so as to minimise the overall cost of solving the problem in as less time as possible.	Generally, they follow the Divide and Conquer concept i.e. breaking down the problem into different parts, solving them individually and combining them to get the output.	Based on solving the problem end-to-end, training the model with high level features derived from low leve features.
Tasks can be anything that has a solution in reality based on the appropriate type and amount of data, and the features may or may not be available. Machines can solve a problem only if they have the right kind of data as input.	Most of the required features need to be identified and coded manually therefore take more time in the testing phase than the training phase of the model.	Algorithms try to learn high-level features from data based on the low-level features identified by them therefore take more time in the training phase as compared to testing phase.
Problems to be solved by AI need data to work on, maybe a lot or very less, which needs to be found, cleaned, checked for outliers and then be used to obtain results for the problem.	Algorithms perform well and even better than Deep Learning models when the amount of data available for training and testing is less.	These models necessarily need huge amounts of data to learn from it and give better accuracy in their predictions.
AI is a vast field containing several algorithms that may not necessarily be easy to understand based solely on logical thinking. Sometimes, the only way is to mathematically understand particular concepts.	Understanding how certain results are given by these algorithms is very easy as they work on a set of defined rules.	It is very difficult to understand why the predicted values are the way they are. We can derive the reason behind the predictions mathematically but that's very complicated.

Dr K N MADHAVI LATHA
ASSOCIATE PROFESSOR
DEPT OF CSE
SIR CRRCOE

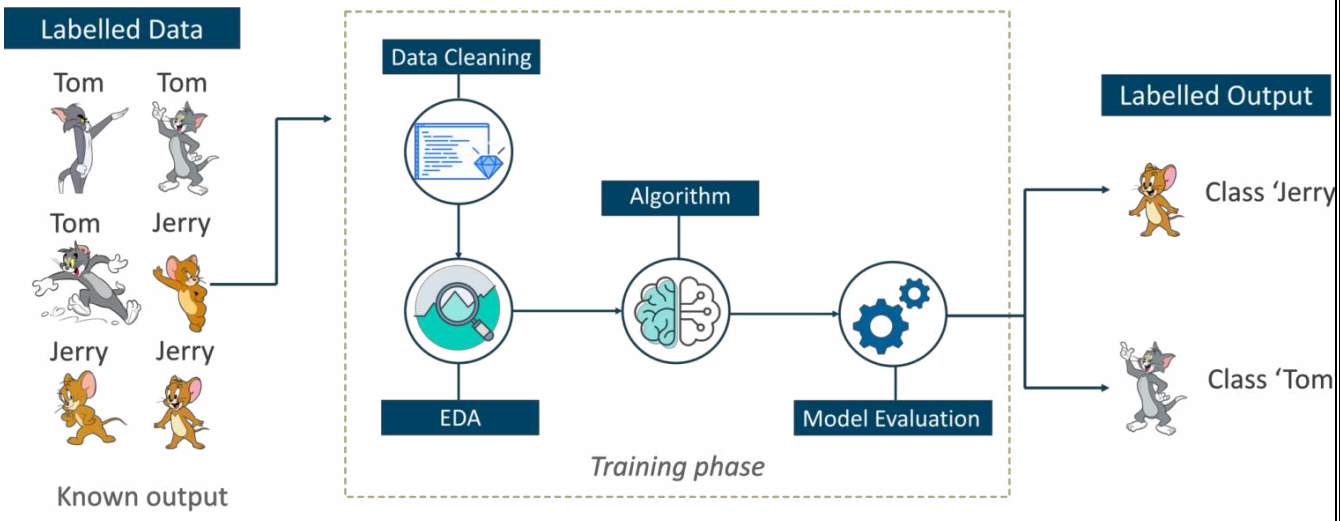
1.4 Types of Machine Learning Systems:

Machine Learning Types
A machine can learn to solve a problem by following any one of the following three approaches. These are the ways in which a machine can learn:

1. Supervised Learning
2. Unsupervised Learning
3. Reinforcement Learning

Supervised Learning:

Supervised learning is a technique in which we teach or train the machine using data which is well labeled.
To understand Supervised Learning let's consider an analogy. As kids we all needed guidance to solve math problems. Our teachers helped us understand what addition is and how it is done. Similarly, you can think of supervised learning as a type of Machine Learning that involves a guide. The labeled data set is the teacher that will train you to understand patterns in the data. The labeled data set is nothing but the training data set.

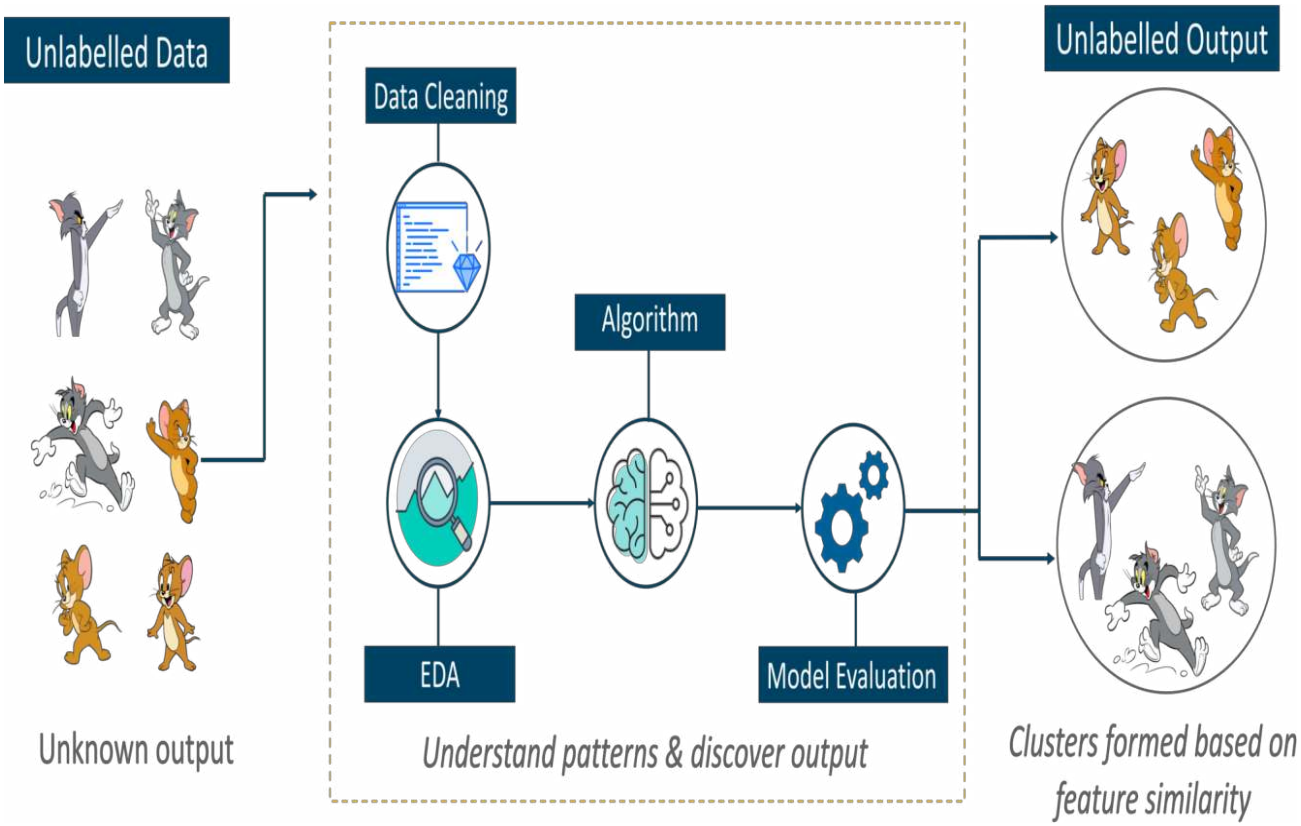


Supervised Learning – Introduction To Machine Learning – Edureka

Consider the above figure. Here we're feeding the machine images of Tom and Jerry and the goal is for the machine to identify and classify the images into two groups (Tom images and Jerry images). The training data set that is fed to the model is labeled, as in, we're telling the machine, 'this is how Tom looks and this is Jerry'. By doing so you're training the machine by using labeled data. In Supervised Learning, there is a well-defined training phase done with the help of labeled data.

Unsupervised Learning:
Unsupervised learning involves training by using unlabeled data and allowing the model to act on that information without guidance.
Think of unsupervised learning as a smart kid that learns without any guidance. In this type of Machine Learning, the model is not fed with labeled data, as in the model has no clue that 'this

image is Tom and this is Jerry', it figures out patterns and the differences between Tom and Jerry on its own by taking in tons of data.



Unsupervised Learning – Introduction To Machine Learning – Edureka

For example, it identifies prominent features of Tom such as pointy ears, bigger size, etc, to understand that this image is of type 1. Similarly, it finds such features in Jerry and knows that this image is of type 2. Therefore, it classifies the images into two different classes without knowing who Tom is or Jerry is.

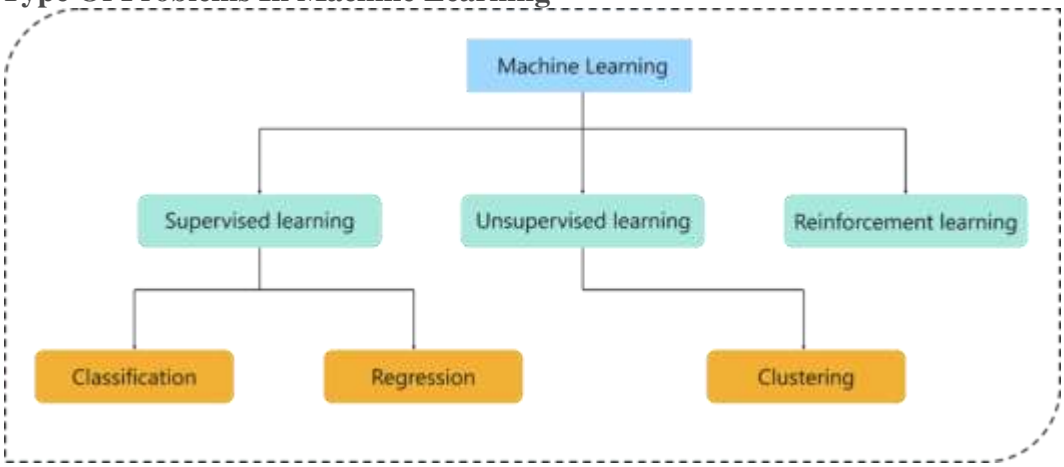
Reinforcement Learning:
Reinforcement Learning is a part of Machine learning where an agent is put in an environment and he learns to behave in this environment by performing certain actions and observing the rewards which it gets from those actions.

This type of Machine Learning is comparatively different. Imagine that you were dropped off at an isolated island! What would you do?
Panic? Yes, of course, initially we all would. But as time passes by, you will learn how to live on the island. You will explore the environment, understand the climate condition, the type of food that grows there, the dangers of the island, etc. This is exactly how Reinforcement Learning works, it involves an Agent (you, stuck on the island) that is put in an unknown environment (island), where he must learn by observing and performing actions that result in rewards.

So that sums up the types of Machine Learning. Now, let's look at the type of problems that are solved by using Machine Learning.

Dr K N MADHAVI LATHA
ASSOCIATE PROFESSOR
DEPT OF CSE
SIR CRRCOE

Type Of Problems In Machine Learning



Type of Problems Solved Using Machine Learning – Introduction To Machine Learning – Edureka

Consider the above figure, there are three main types of problems that can be solved in Machine Learning:

1. **Regression:** In this type of problem the output is a continuous quantity. So, for example, if you want to predict the speed of a car given the distance, it is a Regression problem. Regression problems can be solved by using Supervised Learning algorithms like Linear Regression.
2. **Classification:** In this type, the output is a categorical value. Classifying emails into two classes, spam and non-spam is a classification problem that can be solved by using Supervised Learning classification algorithms such as Support Vector Machines, Naive Bayes, Logistic Regression, K Nearest Neighbor, etc.
3. **Clustering:** This type of problem involves assigning the input into two or more clusters based on feature similarity. For example, clustering viewers into similar groups based on their interests, age, geography, etc can be done by using Unsupervised Learning algorithms like K-Means Clustering.

Here's a table that sums up the difference between Regression, Classification, and Clustering.

Regression	Classification	Clustering
• Supervised Learning	• Supervised Learning	• Unsupervised Learning
• Output is a continuous quantity	• Output is a categorical quantity	• Assigns data points into clusters
• Main aim is to forecast or predict	• Main aim is to compute the category of the data	• Main aim is to group similar items clusters
• Eg: Predict stock market price	• Eg: Classify emails as spam or non-spam	• Eg: Find all transactions which are fraudulent in nature
• Algorithm: Linear Regression	• Algorithm: Logistic Regression	• Algorithm: K-means

Dr K N MADHAVI LATHA
ASSOCIATE PROFESSOR
DEPT OF CSE
SIR CRRCOE

1.5 Major Challenges Faced By Machine Learning:

In Machine Learning**, there occurs a process of analyzing data for building or training models. It is just everywhere; from Amazon product recommendations to self-driven cars, it beholds great value throughout. As per the latest research, the global machine learning market is expected to grow by 43% by 2024. This revolution has enhanced the demand for machine learning professionals to a great extent. AI and machine learning jobs have observed a significant growth rate of 75% in the past four years, and the industry is growing continuously. A career in the Machine learning domain offers job satisfaction, excellent growth, insanely high salary, but it is a complex and challenging process.**

There are a lot of challenges that machine learning professionals face to inculcate ML skills and create an application from scratch. What are these challenges? we will discuss Nine major challenges faced by machine learning professionals. Let's have a look.

1. Poor Quality of Data:

Data plays a significant role in the machine learning process. One of the significant issues that machine learning professionals face is the absence of good quality data. Unclean and noisy data can make the whole process extremely exhausting. We don't want our algorithm to make inaccurate or faulty predictions. Hence the quality of data is essential to enhance the output. Therefore, we need to ensure that the process of data preprocessing which includes removing outliers, filtering missing values, and removing unwanted features, is done with the utmost level of perfection.

2. Under fitting of Training Data:

This process occurs when data is unable to establish an accurate relationship between input and output variables. It simply means trying to fit in undersized jeans. It signifies the data is too simple to establish a precise relationship. To overcome this issue:

- *Maximize the training time*
- *Enhance the complexity of the model*
- *Add more features to the data*
- *Reduce regular parameters*
- *Increasing the training time of model*

3. Over fitting of Training Data:

Overfitting refers to a machine learning model trained with a massive amount of data that negatively affect its performance. It is like trying to fit in Oversized jeans. Unfortunately, this is one of the significant issues faced by machine learning professionals. This means that the algorithm is trained with noisy and biased data, which will affect its overall performance. Let's understand this with the help of an example. Let's consider a model trained to differentiate between a cat, a rabbit, a dog, and a tiger. The training data contains 1000 cats, 1000 dogs, 1000 tigers, and 4000 Rabbits. Then there is a considerable probability that it will identify the cat as a rabbit. In this example, we had a vast amount of data, but it was biased; hence the prediction was negatively affected.

We can tackle this issue by:

- *Analyzing the data with the utmost level of perfection*
- *Use data augmentation technique*
- *Remove outliers in the training set*
- *Select a model with lesser features*

4. Machine Learning is a Complex Process

The machine learning industry is young and is continuously changing. Rapid hit and trial experiments are being carried on. The process is transforming, and hence there are high chances of error which makes the learning complex. It includes analyzing the data, removing data bias, training data, applying complex mathematical calculations, and a lot more. Hence it is a really complicated process which is another big challenge for Machine learning professionals.

5. Lack of Training Data

The most important task you need to do in the machine learning process is to train the data to achieve an accurate output. Less amount training data will produce inaccurate or too biased predictions. Let us understand this with the help of an example. Consider a machine learning algorithm similar to training a child. One day you decided to explain to a child how to distinguish between an apple and a watermelon. You will take an apple and a watermelon and show him the difference between both based on their color, shape, and taste. In this way, soon, he will attain perfection in differentiating between the two. But on the other hand, a machine-learning algorithm needs a lot of data to distinguish. For complex problems, it may even require

millions of data to be trained. Therefore we need to ensure that Machine learning algorithms are trained with sufficient amounts of data.

6. Slow Implementation

This is one of the common issues faced by machine learning professionals. The machine learning models are highly efficient in providing accurate results, but it takes a tremendous amount of time. Slow programs, data overload, and excessive requirements usually take a lot of time to provide accurate results. Further, it requires constant monitoring and maintenance to deliver the best output.

7.Irrelevant Features:

As the saying goes: garbage in, garbage out. Your system will only be capable of learning if the training data contains enough relevant features and not too many irrelevant ones. A critical part of the success of a Machine Learning project is coming up with a good set of features to train on. This process, called *feature engineering*, involves:

• *Feature selection*: selecting the most useful features to train on among existing features.

• *Feature extraction*: combining existing features to produce a more useful one (as we saw earlier, dimensionality reduction algorithms can help).

• Creating new features by gathering new data.

Now that we have looked at many examples of bad data, let's look at a couple of examplesof bad algorithms.

8. Stepping Back

By now you already know a lot about Machine Learning. However, we went through so many concepts that you may be feeling a little lost, so let's step back and look at the big picture:

Machine Learning is about making machines get better at some task by learning from data, instead of having to explicitly code

rules.

• There are many different types of ML systems: supervised or not, batch or online, instance-based or model-based, and so on.

• In a ML project you gather data in a training set, and you feed the training set to a learning algorithm. If the algorithm is model-based it tunes some parameters to fit the model to the training set (i.e., to make good predictions on the training set itself), and then hopefully it will be able to make good predictions on new cases as well. If the algorithm is instance-based, it just learns the examples by heart and

generalizes to new instances by comparing them to the learned instances using a similarity measure.

• The system will not perform well if your training set is too small, or if the data is not representative, noisy, or polluted with irrelevant features (garbage in, garbage out). Lastly, your model needs to be neither too simple (in which case it will underfit) nor too complex (in which case it will overfit).

There's just one last important topic to cover: once you have trained a model, you don't want to just "hope" it generalizes to new cases. You want to evaluate it, and finetune it if necessary. Let's see how.

9. Imperfections in the Algorithm When Data Grows

So you have found quality data, trained it amazingly, and the predictions are really concise and accurate. Yay, you have learned how to create a machine learning algorithm!! But wait, there is a twist; the model may become useless in the future as data grows. The best model of the present may become inaccurate in the coming Future and require further rearrangement. So you need regular monitoring and maintenance to keep the algorithm working. This is one of the most exhausting issues faced by machine learning professionals.