ARTIFICIAL INTELLIGENCE

Artificial Intelligence is the science of making machines do things that would require intelligence if done by men.

-Marvin Minsky

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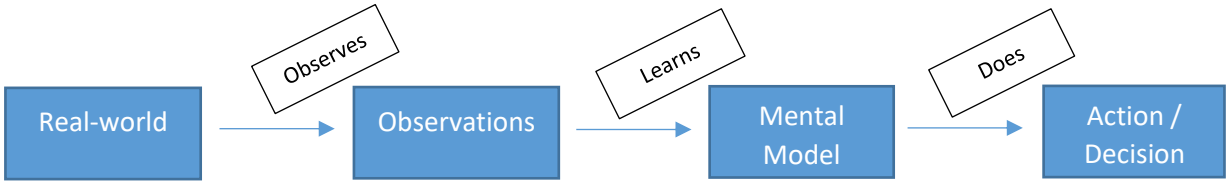
Part I

These days few phrases such as Artificial intelligence, Machine learning, Deep learning, Neural Networks, Reinforced learning, Data science etc. are spoken about in every strategic discussion meets, students meets or any business functions. More so, it has gained its prominence specifically for last half a decade and the COVID-19 pandemic has done the fuelling job. Before we get onto the topic, let us bear in mind that Deep Learning (DL) is a sub set of Machine Learning (ML) and Machine Learning is a sub set of Artificial Intelligence (AI).

Artificial Intelligence word is combination of two words **a) Artificial and b) Intelligence**. Let us dwell sometime on the word 'Intelligence' before we get onto the aforementioned jargons.

Intelligence is an ability to acquire knowledge, learn out of it and apply such knowledge and skills in real life cases. We, humans are known for it.

So, how do we humans acquire knowledge? What a brain does? A human does a group of things before he/she takes any decision. It observes, learns, and apply such learnings to do an action or make a decision. Therefore, it will not be wrong to say that it travels the path from real world observation till it takes an action such as which route to take to office, what to eat in which restaurant, which seminars to attend etc.



When, humans in real world observe, get observations (using senses), learn using these observations and once we learn about the real world, then we take actions, they subconsciously capture image of how a real-world works, which works for them and which does not. Such models are called as Mental Model.

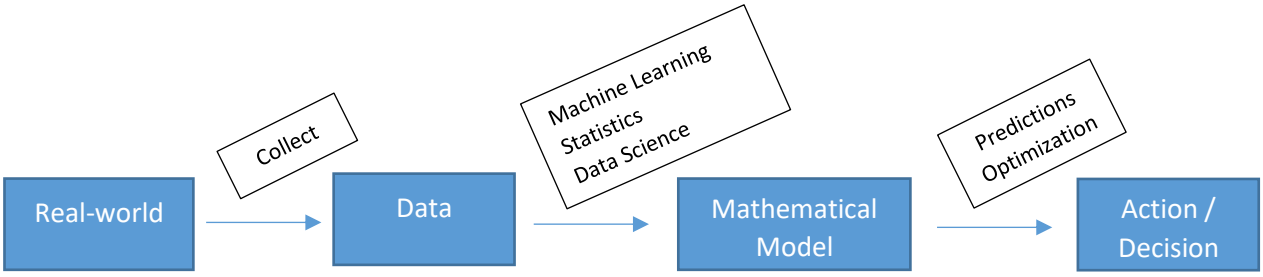
Example - *Out of two routes to office, which route should one take to office? One uses route A for few times, and route B for few times and keeps the observations in mind, learns from observation and create mental model. Let us say, Route A less risk but takes more time while Route B takes lesser time but somewhat riskier. Depending on urgency or need, one choses route. Our brain uses the mental model and guides us the action to take.*

Artificial Intelligence:

The above, if we do artificially, we call it artificial intelligence. We would do exact same things in similar way. We start with real world and arrive at decision using some models, not a mental model, but we call it a mathematical model.

Let us draw analogy from the human intelligence to artificial intelligence using the same process flow of real world to decision making.

Artificial Intelligence system would require huge amount of precise and detailed data unlike mental model where observations are fuzzy in mind and not detailed. Let us take an example to differentiate the word 'data' from 'observation' in our context. *E.g., When we listen to a speech in any seminar and tell our friends about what we listened, it is more of an observation. However, if we get the speech recorded for him to listen, it is data.*



In AI, we collect data, learn from it using some mathematical models. Example, if one wishes to know if a particular customer will default in payment, how long would it take for collecting the receivables, would any employee attrite etc.

Mathematical Models could be developed using machine learning models, Statistics and Data Science. Unlike mental model, a mathematical model is used to solve complex real-world problems such as Predictions, Optimization, Simulations etc. *For example, a self-driven car uses millions of images to understand world around it, and take decisions. It needs to understand, every object, signal, weather, temperature, rain etc. to understands world around it. Such data would help in optimizing action such as, when to accelerate, decelerate, when to turn on/off wiper, when to turn on/off lights etc.* This is called as model building for decision making.

Hence, AI may be simply summarized as machines exhibiting the "Intelligence" to travel from Real world cases to Decision making/Action taking. While we observe in human intelligence (HI), we use data in AI; while we call mental model in HI, we use mathematical model in AI; while we use certain actions in HI, we take business decisions using AI.

The key aspects of AI are,

a) Data - Collecting data arguably is not that difficult, but cleansing is.
b) Model building - It is extremely hard by reading the data and understanding the data, to arrive at model.
c) Decision making - It is relatively easy.

Example 1: *Identifying spam in mail box. Need to have tens of thousands of mails, need to map them spam or not spam, use ML to train a model, then test the model and improve it before the same is deployed. This may not be difficult. Decision making is easy in this case. It uses classification.*

Example 2: *In call centres, who to route a customer call? Collect a ton of data over the course of years. Label the data, label the voice, words spoken, then train the machine learning model and testing and improving before deployment. It uses neural network.*

Example 3: *In Retail industry, what should be optimum assortment of the merchandise? Need to know lots of data such as customer history, store sales history, demography of store, economy, weather,*

traffic, trending merchandises from the market etc. for defining an appropriate and optimum level of merchandise. It uses a blend of clustering, regression, computer vision, recommendation model etc.

Why is AI being talked about so much?

The answer is computational advantage (cost and computational power) which we see these days wasn't available two decades ago.

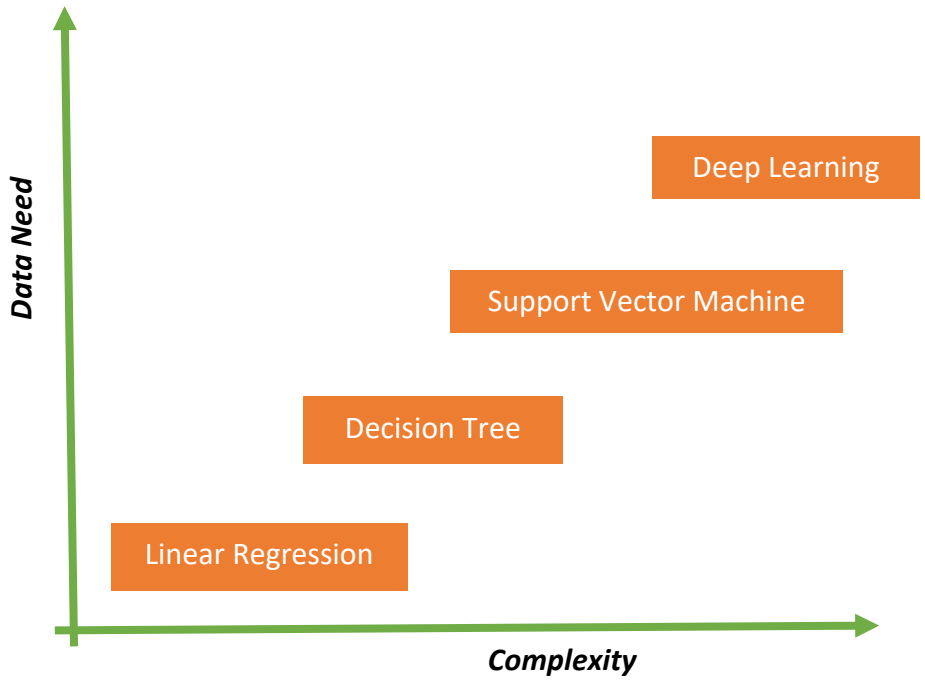
For last two decades, cost of data acquisition and cost to store data has gone down drastically. Example - Sensors (to sense hot or cold), storage (cloud, hard disc etc.). Due to such advantage, we started storing and using more and more data. Computational power has increased and amount of money that is needed to achieve such speed too has become less expensive. Hence, our ability to build complex model has become talk of the town.

Understanding Data need & Complexity of a Model

We knew of the data, we knew of the decision, statistics was used then and is used now in computer models, but one thing that has improved phenomenally is model building. We are trying to learn the world around us using data using machine learning models.

Let us assume, the table of data came from specific family of models, namely, Linear models. Question for one to answer is m and c in 'y = mx + c'. Statistician's job is simple here as he needs to find only m and c. Using excel file, we can find these.

However, a machine learner will do something different here. He would not assume on where the data came from (data generating model). It would try different models namely linear, quadradic, decision trees, etc. a machine learner and will find the best model. Therefore, ML desperately needs lots of computing power and data to try different iterations. The more the complexity of a model, the more data is needed and hence, more noise too gets attached to data set.



Data = Information + Noise

If one starts modelling the noise as well, it is called as overfitting the data, which is bad for the prediction; If one starts modelling with limited or lesser data, it is called underfitting the data, which too is bad for prediction.

Hence, more complex models which need more data and hence need to focus on eliminating noise. Therefore, the data is chopped off to training set and testing set. Both training set of data and test set of data have information plus noise. Information repeats itself in test data set, but noise won't. Further, the more a complex model is evaluated / tried out, more the noise is eliminated and hence the result improves.

Is yield directly proportional to complexity of a model?

A simple linear regression model (y = mx + c), such as what would be the impact on sale, if the prices are increased, would call for comparatively lesser data than any deep learning model would otherwise call for. Example, Expected Sales impact = 1000 - 10 x Price (Every rupee price increase may give rise to 10 times reduced sales). This can be computed in excel file too.

Needless to say, that a validation needs to be put in place to evaluate what value would the ML model add to business. Just because one has data and computing power, one need not build a ML model, sometimes, a simple model is sufficient. We discussed a business case of how the volume is sensitive to the price. Increase in model complexity does not guarantee improved business value.

Let us understand more about AI by answering to few questions such as, where does AI stand today? What are the business problems solved through AI? What are the limitations? How to choose an AI model?

AI Types and use cases:

a. **Artificial Narrow Intelligence** - Play chess, recognize images etc. This again may be classified into 3 categories namely;
    i. Assisted AI - Simple task are carried out faster and better. E.g., Translating voice to text, Translating one language to other, Routing calls, Robotic Process Automations etc.). This improves the productivity. We interfere in these models in between if there are some changes in the decision-making process.
    ii. Augmented AI - Enable the models to do more than what they currently do. E.g., Driver less car under human watch.
    iii. Fully autonomous AI - Trucks in coal mines in Australia are fully autonomous, Grocery stores by amazon without any human assistance.
b. **Artificial General Intelligence** - We humans have general AI. In sci-fi movies we see a robot performing any intelligent task like human.
c. **Artificial Super Intelligence** - What if we build computer which is way more intelligent than the most intelligent human being.

Business Applications:

a. Process Automations - E.g., Chat bots, detecting spam mails, managing Dash board etc.
b. New product and service - E.g., Creating an automatic quoting system (price estimate), Alexa placing order and settling the payment, Designing Risk Dashboard with alert system
c. New business models - E.g., Amazon Grocery stores without human beings (only with cameras and phones)

Limitations:

a. Data Needs - The models would need voluminous data, labelling of such data.
b. Explainability - It becomes an issue. Linear regression is easy, but for example, in a neural network model, each of the nodes have different mathematical models, (if a resume is sent in through model, the model tells whether to hire or not. Similarly, if a loan application form is passed through the model, it would suggest to approve or decline). Though reasons can be listed but precise explainability becomes challenging.
c. Generalisation - AI systems are trained to perform specific task with specific sets of data. But, if there are any changes in input data, this does not adapt immediately unless it is retrained and retested.
d. Bias - Most AI systems are trained based on historical data. Humans have been involved in such data and decision making and many a times had used bias (or intuition) at varied degree. Therefore, the then decision used for labelling or as a desired output, may also be biased to some extent.

Machine Learning and use cases:

Machine learning is a subset of AI. We may classify it into two broader categories namely classical machine learning and reinforcement learning.

a. Classical machine learning:

This is based mainly on statistics and are very popular. These are used to identify patterns, proximities, recommendations etc. They may further be classified into two categories, Supervised and unsupervised.

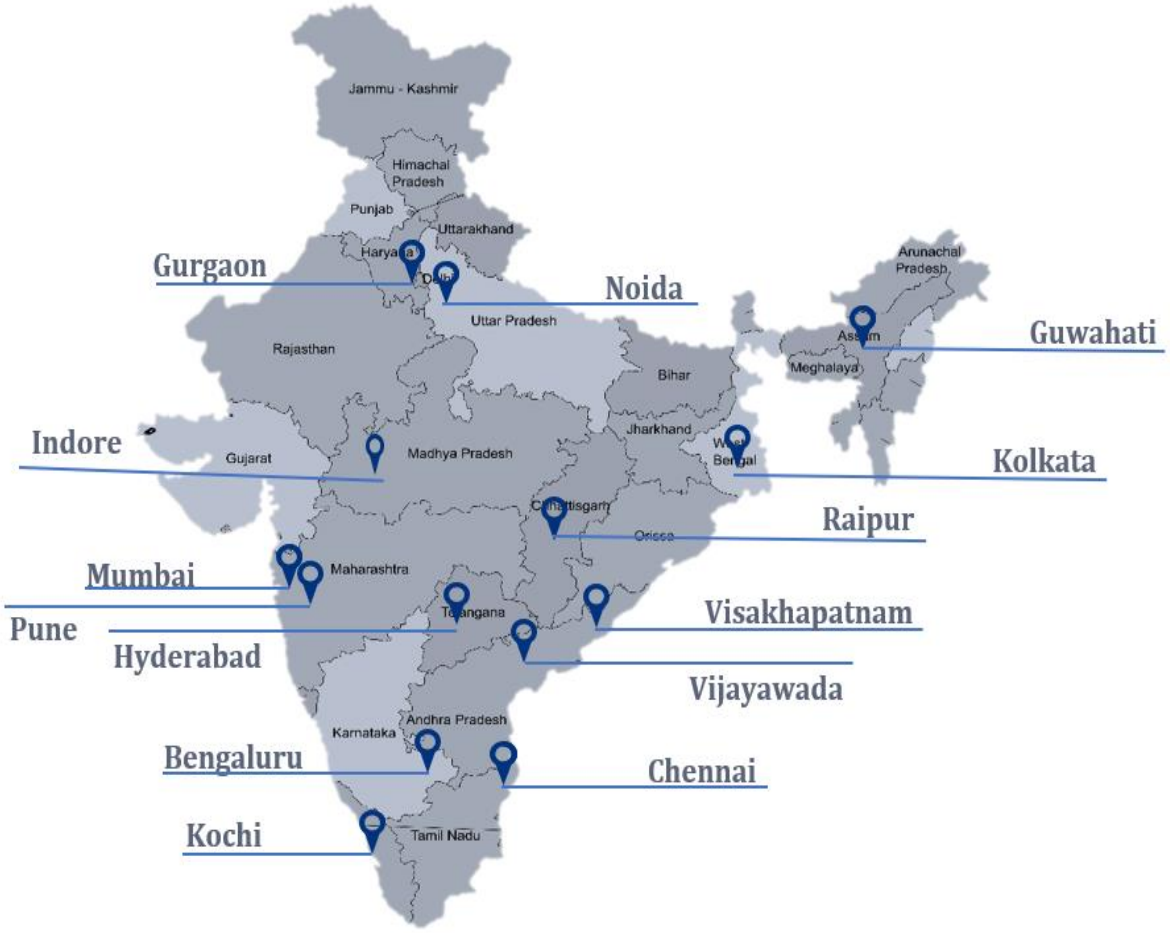
i. **Supervised Learning:** Building a mathematical model using data which contains both input and desired output. *Example - If an image is of a horse or donkey, spam mail vs no spam mail, predicting if the customer will default on payment, if an employee may attrite.* As we have a desired output and the same is used for evaluation of the result of our ML model, hence the name supervised learning. Some methods are Regression, classification etc.
ii. **Unsupervised Learning:** Building a mathematical model using data that contains only input and no desired output. *Example - Grouping of customers based on their behaviours of purchase, Clustering of stores to cater the right needs of customers in that location, designing advertising needs for segments of product based on demography, customer taste etc.* As no labels are provided to compare with, it is called

unsupervised learning. Some methods are Clustering, Dimensionality reduction, Association Rule etc.

b. Reinforcement learning:

It is used in cases where the problem is not associated to the data entirely, but there is a real world to live in. *Example - how much ever data is collected, road rules are built in, when a driverless car is plied on a road, it is hard to auto pilot as there might be lots of new and unprecedented cases that might come up. The object is to minimise error and not to predict everything. Hence, simulation in real life world is used to train all that is needed before deploying in real life world. The robot to be rewarded for good actions and be punished for bad actions. The robot when gains reasonable confidence, it is put to test in real road street roads.*

Let us pause here and discuss further on machine learning models, examples, use cases in subsequent release of this series.



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