Computer Integrated Manufacturing
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Lecture 48
Computers in Manufacturing Industry, current scenario (part 1 of 3)

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Okay, welcome to the last lecture on Computers in Manufacturing Industry this will be the last phase of this entire course. I would like to present how is computer being used in the current scenario. Computers are very powerful we have been going through all in this course about how computers revolutionized manufacturing. I would like to repeat how did computer help us in mass customization which is need of the hour?

So, here I will try to tell you the latest developments which are happening using these computers which is very common in other fields, but in manufacturing also the same concept is getting in bite.

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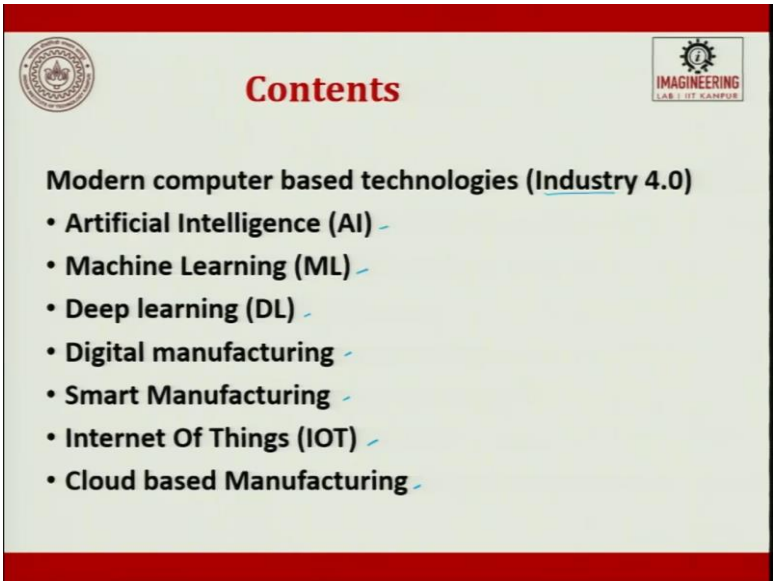

So, in this lecture, I would like to cover modern computer-based technologies, industry 4.0 what is it? And what are the tools which are used under industry 4.0? Like Artificial Intelligence, Machine Learning, Deep learning, Digital manufacturing, Smart Manufacturing, Internet of things, and Cloud-based Manufacturing.

Today All these things have got implemented, today you do not need to buy a very powerful server to do your high-end computations, which is more demanding in manufacturing for example if your trying to do optimization if you are trying to do analysis, so there today we using cloud for all the computation, and all the storage and take only the results for you for further analysis. So, all these things though it is sell latest but all these things have today got implemented in the manufacturing scenario.

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First, lets us see what is Industry 4.0? The Fourth Industrial Revolution represents a new technological paradigm, where digital systems, digital is a word which is very commonly used and we push digital technology in a large way, why? Because digital makes the data universal, when I and you talk with varying languages we have a difficulty of understanding each other's languages because of that lot of noise signal gets into or miscommunication happens.

When I and you talk in a same language call English and we can share our data through English then it becomes universal, everybody can have an access to the data and start using the data. So, digitizing plays a big way in reducing the error increasing transparency and sharing of data between multiple sources with one data set.

So, digital system, this means the technological paradigm shift to happen, and in parallel when the data become universal internet also started growing, and conventional industry were merged together, leading to a transformation of manufacturing system

So, conventional industries are now merged together and earlier we use to talk companies as several independent verticals, today companies are talking about can we collaborate, if I have this and you have other complementary knowledge can we join hands to do it. Big giants in manufacturing are joining hands because they understood each other's complementary knowledge and they are trying to use it.

So, in the Industry 4.0, the complementary knowledge sharing has become part of it, sharing of data has become also part of it, using internet to communicate across the globe is also

happening in Industry 4.0. It is a set of emerging technologies that allow hardware and devices to communicate autonomously to each other along the production networks.

So, you are autonomously trying to communicate understand the status, take preventive measures, take precautionary measures, and make the production very successful. It leads to the creation of the smart factories, where computer-driven systems will control production processes, computers controlling production process, how is these happening? Knowing what customer wants these computers schedule.

The computers schedule the production and they monitor the production they deliver what is manufactured without keeping any inventory. Create virtual copies of physical products/contexts/processes, and or make decisions based on self-organization mechanisms. So, these are all some of the points of industry 4.0.

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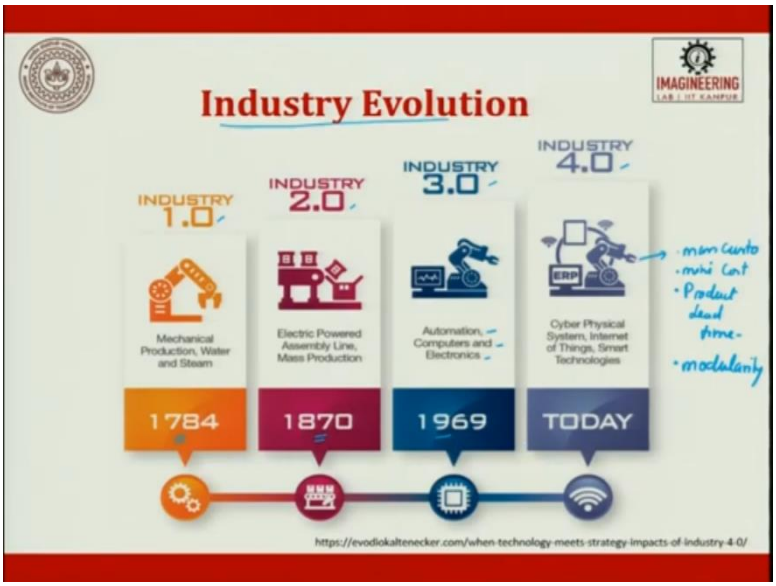

So, how did this Industry evolve? Initially, it was 1.0 then it went to 2.0, 3.0, and today we are sitting in an era of 4.0. Industry 1.0 happen way back in the 17th century, 1784 we were thinking of doing mechanization and what was our prime focus was, mass production to meet out the customer needs and in parallel energy like steam energy was generated.

Industry 2.0 happened somewhere close to 1870 wherein which electric powered assembly lines and mass production became in a very big way. The third industry 3.0 happened in 1969 wherein which Automation computers and electronics came up in a big way. Miniaturization started, computers were robust, so they started doing many activities, automation we were

talking about here is more towards hard automation this started coming up that was industry 3.0 and what is today happening is industry 4.0 or industry 4.O they call it.

Here we are using cyber-physical systems, internet of things, smart technologies to be integrated as part of manufacturing and meet out to customer requirement, the most predominant thing is mass customization with minimum cost is a prime focus today and we have reduced the product lead time drastically? And we have started using modularity as one of our major concepts in developing things. Look at all these things, all these things evolve towards industry 4.0.

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So, this is a video which shows industry 4.0. You can see here a bot linked plant, so here it says yes there is a cap which is laid and then the bottle goes inside the filling station happens here, it checks for the level if the level is of the specified limits then the bottle keeps going and then you start printing the label on top of it and then it checks for the level and finally it gets packed.

So, now which bottle to be filled? What quantity to be filled? And what is the timing of what should be the production rate? Everything is dictated by a computer here and all the sensors tries to take the preventive actions whatever it is required. For example, if let us assume a defective bottle enters inside when it goes here without even analyzing if the filling happens on a defective bottle it is waste.

Then if the same defective bottle keeps moving and stamping happens here a second waste, then let us assume a led dispute on top of it, and then finally it goes to this level and a man takes the decision that the entire thing is waste. So, here in this system what happens is right

upfront every stage they decide if this bottle is not good then that model is A marked all the functions which is undergoing in that particular bottle will be nullified and it will lead to the final station.

So, immediately the operator who is standing there rejects the bottle, so here though it looks like green colour the compositional changes can be there and in the compositional changes you can have multiple composition all those information are given by a computer to the filling station and assembly station.

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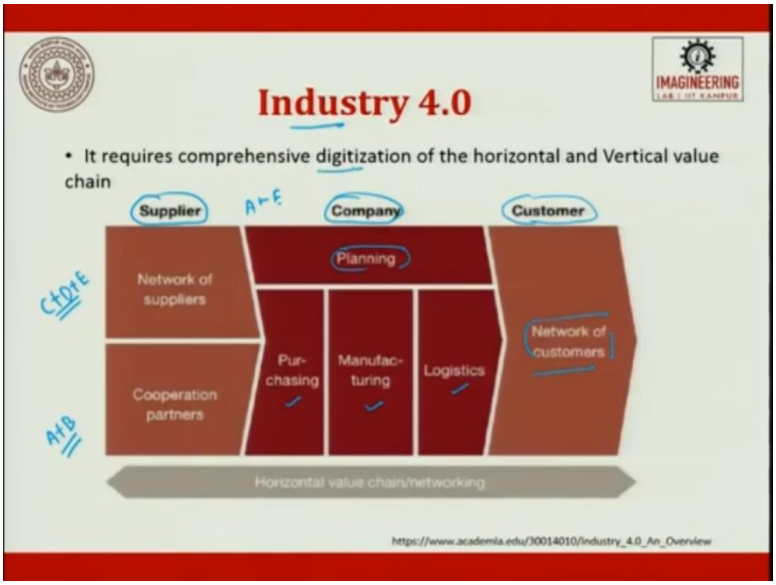

So, when we look at Industry 4.0, it requires comprehensive digitization of the horizontal and vertical value chain. This is the horizontal value chain and this is the vertical value chain. There are 3 major components, one is supplier, next one is company, and the third one is the customer. Supplier, company, and the customer, we are customers a place where it is getting fabricated is the company, for a company input raw material, is given by the supplier.

So, there are two things in the supplier end, network of suppliers and cooperation of suppliers, for example, A plus B job is done here, C plus D job and E job is done here and then the entire component of A to E is fed into the company for processing. So, this can be like a casting process, this can be like a missioning process you try to supply. Okay?

So, when we talk about the company, you have major job is planning, in the planning you have purchasing, you have manufacturing and you have other logistics. So, now put together what we generated to meet out the customer demand happens this year on network of customers. So,

these are the vertical components and this is the horizontal component which is getting done which is all getting integrated because of digitization.

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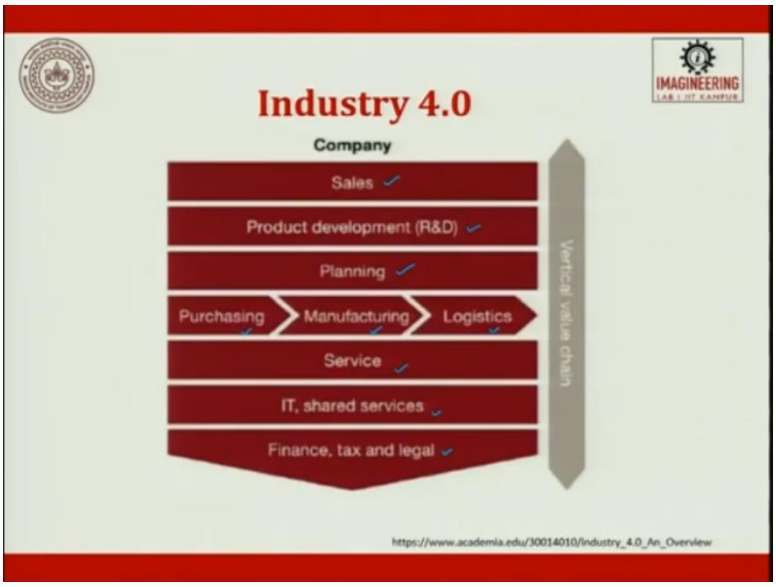

So, in the vertical value chain, you can see sales, then you can see R&D happening, planning, so purchasing, manufacturing, logistics all these things comes together, servicing, IT share and finance tax, and legal. All these things are vertical value chain which are all seamlessly having digital information crisscrossing amongst them to meet the customer requirement.

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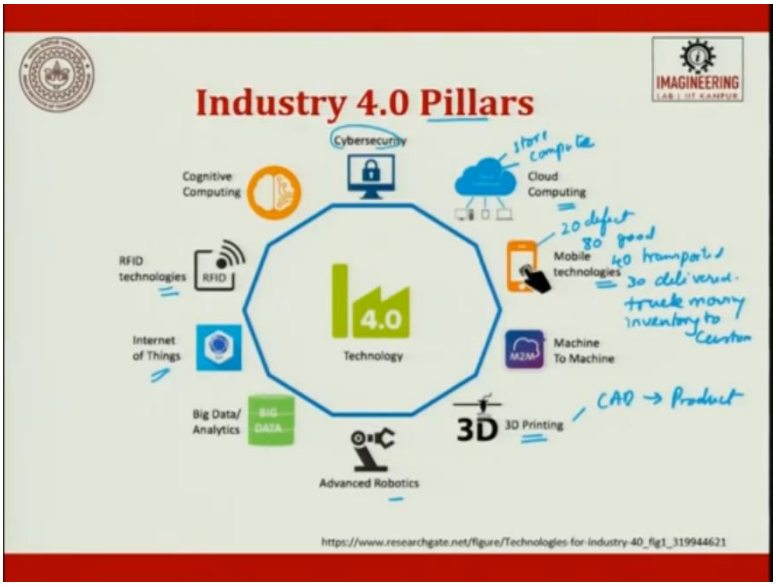

So, if we talk about pillars of Industry 4.0, these are all the pillars let's start from here. Cloud Computing is a pillar, so this tries to make because of digitization and now what is happening is there is a unique or universal platform where multiple systems can run on it, so here is a

memory space where it can store, it can compute, okay? It can compute to meet out the requirements, so here, now onwards what will happen you do not need a large server but everything will be done at one place. However, when you use this you have to pay money for this it is not free of cost.

Next is mobile technology, so now mobile technology there are certain apps which will try to keep on updating on your smartphone what is the current status of the company, for example, it can say 20 defective products, 80 good products, 40 which are transported, 30 which are delivered. Where is the truck moving from the inventory side warehouse to the customer, so all this information's are getting integrated and online you can monitor it using this mobile technology.

So, machine to machine, so till now we had a big challenge a computer talking to a CNC machine, a computer talking to a CMM machine, a computer talking to a robot, so now what is happening is all these machine inside manufacturing have started talking to each other, moment they can talk to each other they can try to take preventive measures if at all there is a product which is to be produced needs some tinkering work to be done.

So, that even the first product becomes the best product and second thing is, when the orders are placed for example if there is bag size and if there is an analysis if there is an optimization to be done currently it happens in two different verticals and there is a wall in between now when machine to machine learning happens it quickly say okay this is the raw material you have, this is what you have to print this is the size of my work volume and this is what is the part size can I split it up into two parts then if I split it up into two parts, then how do I make it? How do I assemble it?

So, machine to machine learning then 3D printing is coming up in a big way, so 3D printing is nothing but CAD to product, so the CAD is given, slicing is done and then all the information is given to printing, to earlier which was all talked about like polymers today we talk about elastomers printing, ceramic printing, metal printing, metal combination with ceramic printing, all these things are possible today.

So, jobs which were not possible by doing conventional machines are made possible by using 3D printing and more than that the bag size of a 3D product can be one, there are many products which are developed without using fixtures, so this is a big boon, 3D printing is a big boon which is a big pillar in Industry 4.0.

Then we have Robotics for assembly disassembly and for welding operations for joining, so all these things advanced robotics for painting these robotics play very important role and certain hazardous places at getting an access placing at exactly to the precise location where a man cannot do can be done very easily by a robotics system.

Then Big Data and analysis is very important, earlier we were not having so much of data today we have generated so much of data and we have accumulated all these data now what is next required is analyze the data. Why is this data doing like this? Why the behaviour of machine at 4 o clock is in the evening is always producing defects to the parts? Maybe it needs a cooling cycle. Why is the operator always making mistakes exactly at 5 o clock, maybe it's a time to go home?

So, what we should do is we should truncate his production by 4:30, 4:30 to 4:45 or 5'O clock you should allow him to produce thin production or you should allow him to clean the machine and leave, and suppose if there are products which are produced during humid season, so then what happens is the reactions might not happen properly the food products which are produced needs a temperature control.

So, now that all this analysis are been done with the big data, today we are able to talk more about the industry 4.0 is only because we have so much of data which is getting generated and we have so many analytical tools which are being used to analyze the data. Today they even say that before entering into the shop floor, looking into the status of your raw material you can decide which are all machines to be used, so that you can meet out to the customer requirements.

Internet of things Internet has helped us in connecting so many people around so many pillars around is only because of internet. Internet of things is, there are so many sensors these sensors will be connected to each other by using internet and we are able to control the manufacturing scenario. RFID tags for presence-absence, status monitoring RFID tags have become a big way.

A simple example is every time when the flight lands and the flight takes off it need yet switch over time or preparatory time of 1 hour, so within that 1 hour if they have to check all the ingredients in the plane whether they are all at the required space, then it is very hard to check manual.

For example, if you trying to travel by a plane, they say your life jacket is below your seat and many of us never ever tried to check whether our life jacket is below our seat, but every time the flight before it takes off they should make sure that all the seats have a lifesaving jacket. So, how do I do it? I check RFID I tag, I have an RFID tag reader swipe it below the aeroplane try to get the data complete data of all raw materials, all the spares, all the things which are there in one short. So, RFID is helping us in a big way presence, absence, status monitoring, everything is done by RFID.

Then Cognitive computing which is coming up in a big way, so this in turn is getting little bit overlapped with your big data analytics, so then cybersecurity is one of the biggest challenge, today we do so much of transaction of data, data is getting universal, data is getting accessed, so we want to make sure that we protect all our data in a very secured manner, and there is no signal pushing into the a noise getting pushed into the signal so that we have erratic data.

So, cybersecurity is also very much talked about today when we talk about internet we are not only talking about only data sharing, it is also a finance sharing with the data related to manufacturing plus finance which is related to manufacturing all are getting transacted between the pillars.

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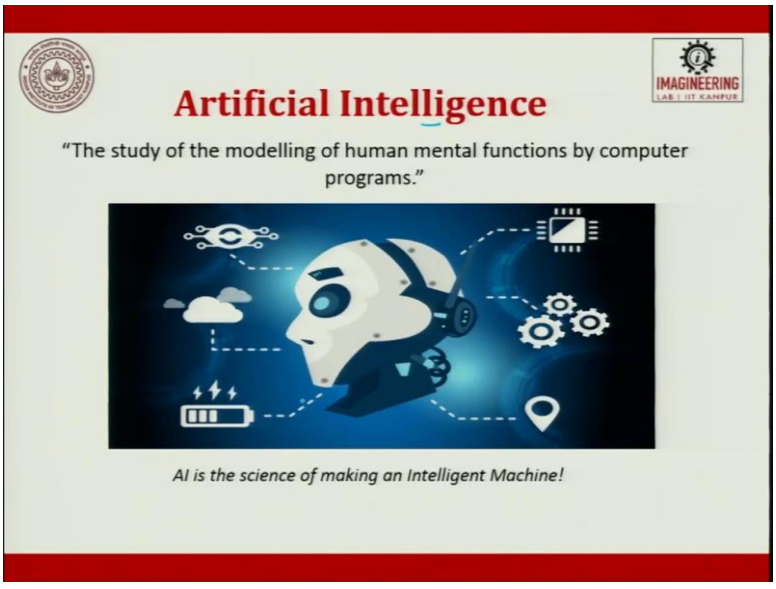

So, Artificial Intelligence is the first tool which we have taken for discussion, so the study of the modeling of the human mental function by computer programming is nothing but Artificial Intelligence. AI is the science of making an intelligent machine. Today AI has got integrated in all your applications, today when you use a Google search, AI is used. Today when you try to look for any data, AI is used.

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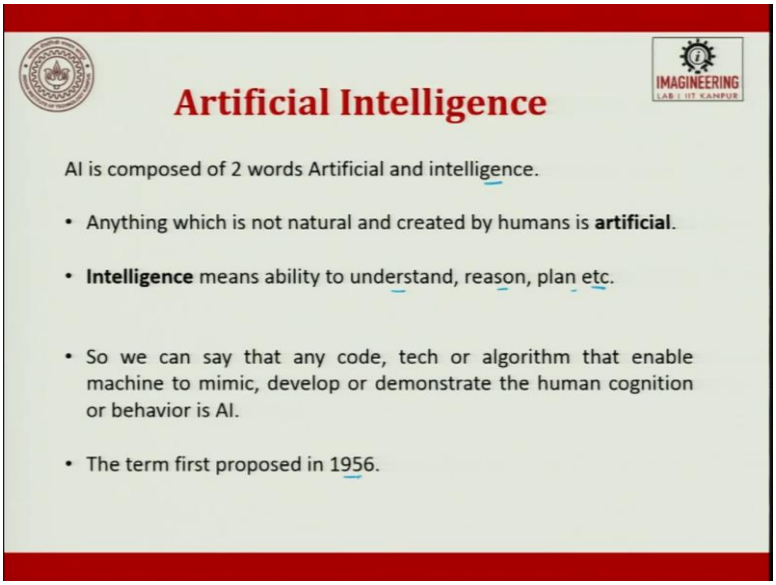

So, let's start looking more about AI. Al is composed of 2 words Artificial and intelligence. Anything which is not natural and created by humans is called artificial. So, we have created an artificial. Intelligence means ability to understand, reason, plan, etc. is intelligence. So, there is a famous author who says that in the next 10 years there will be only 2 set of people 1 set of people to use Artificial intelligence in very brilliant manner, the second set of people will be those who created this Artificial intelligence.

There will be only 2 set of people's rest all people will not be there that's what the author says. So, interesting, so Intelligence means is the ability to understand, reason, and plan. So, we can say that any code, tech, or algorithm that enables machine to mimic, develop, or demonstrate the human cognition or behaviour is Al. The first term proposed was in 1956.

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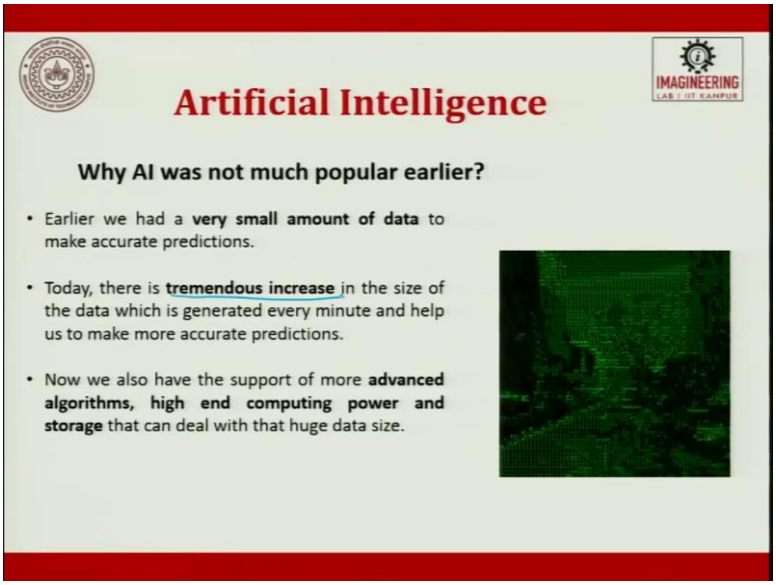

When Al was not much popular earlier? We had a very small amount of data to make accurate predictions. Today, there are a tremendous increase in the size of the data which is generated every minute and help us to make more accurate predictions. I was earlier thinking like if GPS would have not been there we use when we use to travel we use to stop at several places check with people many a times there be no people available for you checking so we will be stuck in finding out the location.

General thing what we use to do is we use to call somebody to guide us all through the direction only to take us to the destination place, today after GPS coming, GPS is also able to calculate and tell you what will be the time you will reach the destination, understanding the traffic sense, understanding your speed it predicts and then it tells this will be the tentative time of reach, so it is all today integrated with Artificial intelligence.

How they can do? It is because of the tremendous amount of data which they have and they do analysis and then they predict. Now, we also have the support of more advanced algorithms, high end computing power, and storage that can lead with that huge data size.

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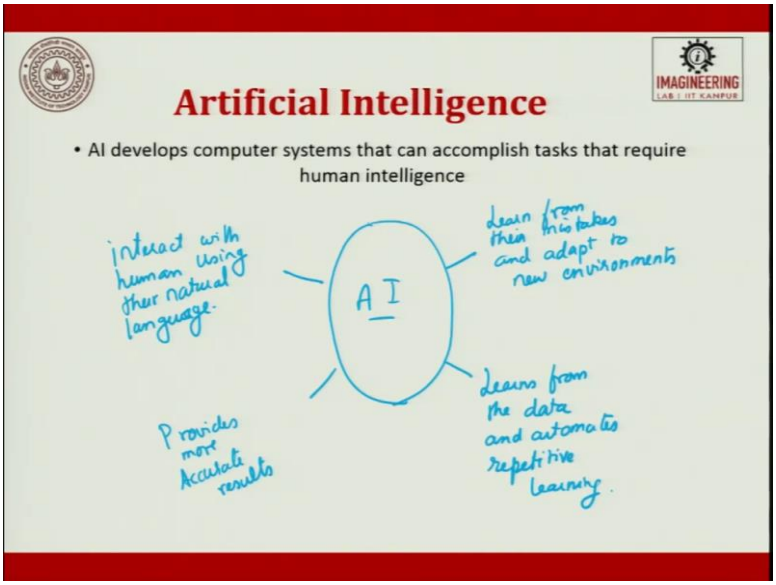

AI develops computer systems that can accomplish tasks that require human intelligence. So, this is AI, there are 4 components of AI, so one is, interact with human using their natural language. The next one is, AI provides more accurate results, then learn from their mistakes and adapt to new environments, and here learns from the data and automates repetitive learning.

These are the 4 jobs which AI does. AI interacts with human using their natural language, provides more accurate results, learn from their mistakes, and adapt to new environments, learns from the data and automates repetitive learning.

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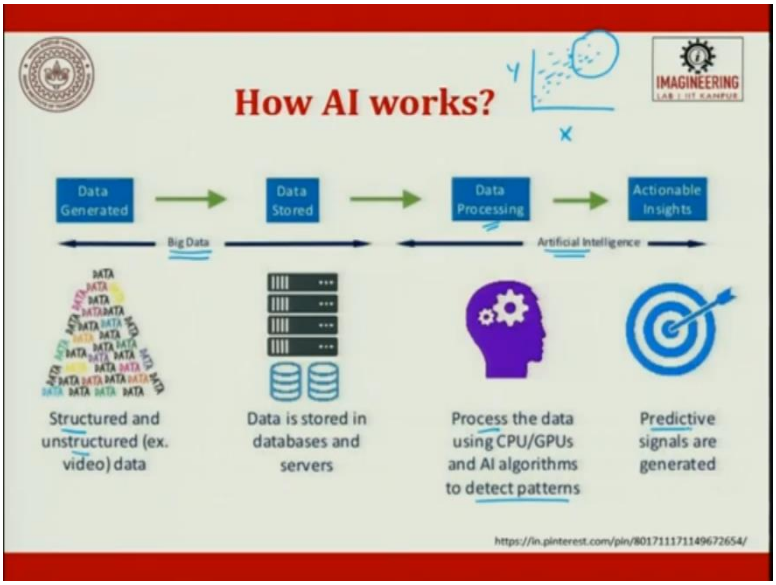

How AI Works? There is a huge set of data these data can be structured or it can be unstructured data. Unstructured data means there are some points which you keep noting it down or there

will be lot of data which is not processed, so all these data structured data means at every phase for the same part you get all those things are structured data.

Structured data unstructured data put together all these things are data, so the data is generated and then what all the data which is generated is now stored in database and servers. All these data generated is stored here, so this is the second stage which is data storage. The third stage what we do is we start processing the data. So, when we start processing the data process the data using CPU or GPU's and Artificial intelligence algorithms to detect patterns.

So, from the data, you generate pattern recognition so there will be several clusters which are formed in a given, so for example you will take XY data and then you will put all the data and you will see whether there is any similarity in the data. So, that is what is detect patterns okay? And interestingly earlier we were talking about 2D XY plot, now people are talking about 3D plots XYZ plots.

So, now at the plane what they do is they try to take section of these planes along the Z direction and at each section they see that data and they see the cluster of that data so when they see this cluster of the data at some point they will see along the Z direction there is huge set of clustering happening so then they say okay if so many times you do a derivate of whatever it is now I am able to see that.

So, that is nothing but deducting patterns which are done in data processing, and finally what you do is actionable insights from the predictive signals are generated and now you demonstrated in front of a person to take a call or the system itself takes a call. The front portion is called as the big data this is what I was talking to you about big data analytics and here is where Artificial intelligence is involved for processing and predicting the signals.

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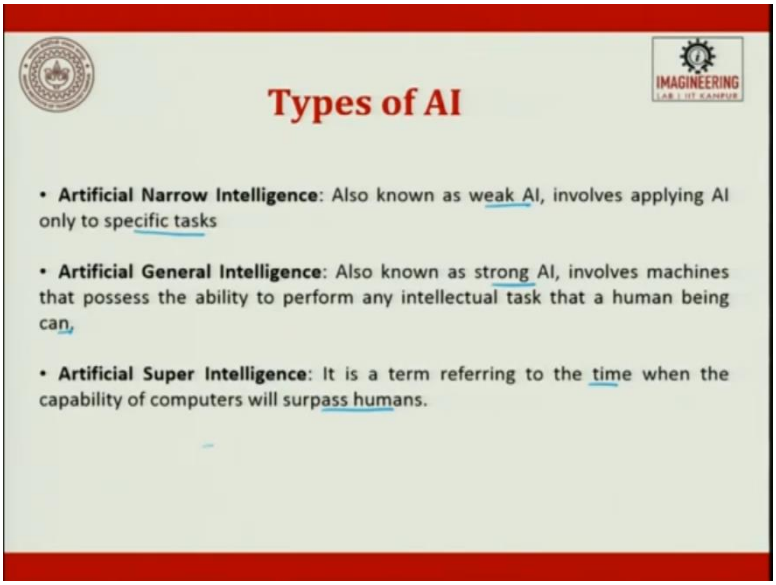

There are different types of AI; Artificial Narrow Intelligence, Artificial General Intelligence, Artificial Super Intelligence. Artificial intelligence itself was evolving now you have started making three classification in it. So, Artificial Narrow Intelligence also known as weak Al involves applying Al only for a specific task. It does data analysis for only a small set of data or only for missioning operation or only for a four-sensor or from temperature sensors that is called as Narrow sensor Artificial intelligence.

The next one is called as General Intelligence also known as strong AI, involves machines that possesses the ability to perform any intellectual task that a human being can. You are a multi-tasking personality, so in the multi-tasking personality we are able to perform several different jobs, several different analysis and understanding planning happens, so our system a human being is called as Artificial General Intelligence.

Then we have Artificial Super Intelligence, it is a term referring to the time when the capability of computers will surpass human beings is called as Artificial Super Intelligence. When you have a huge storage space, huge processor then that systems are called as Artificial Super Intelligence, where you have so much of ground data to be processed, so much of satellite image to be processed you need Artificial Super Intelligence.

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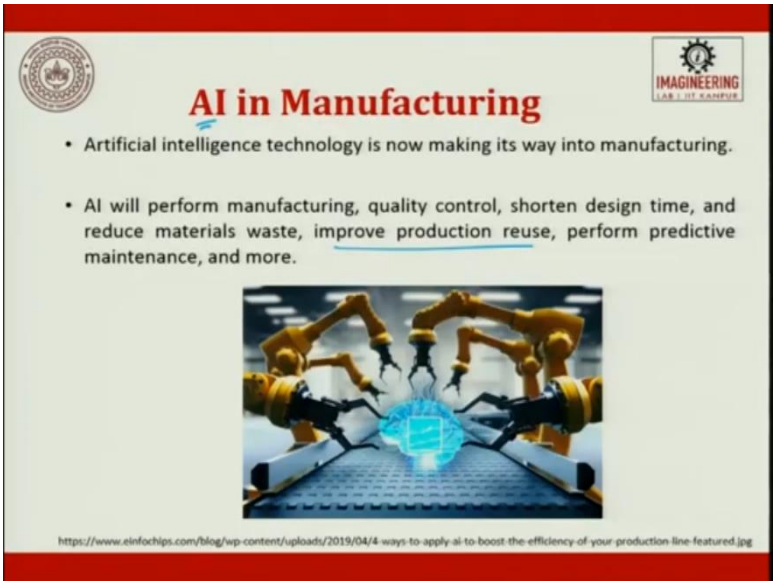

Artificial intelligence in Manufacturing. Artificial intelligence technology is now making its way into manufacturing also till now it was all data I was talking but it has got into manufacturing also, AI will perform manufacturing, quality control, shorten design time and reduced material waste, improve production reuse, perform predictive maintenance and more.

Today, Artificial intelligence is exhaustively used in cooking also, I was discussing with my family, my wife said, I have an atta which is made the dough which is made for making chapattis 3 days old now immediately there is a tool in artificial intelligence which is run on top it and tells you okay, today this is what is the food item you have to manufacture here is the recipe, here is the processing sequence, here is the dish which you have to use and this can be done in so much of time and then it also says this is what is available in your kitchen, ingredients which is available use this to make a better dinner.

All these things are today told in Artificial intelligence. So, if it could be done for kitchen then it can also done for manufacturing, so that's what it is. Improving production reuse whatever you have done, suppose it is not consumed in this particular product what should be salvaged such that the same thing can be used in the next product that is what it is.

And when we talk about what the material waste, so how are we going to process it, for example, so when the waste which is getting generated can we give it like this itself for processing, can we take it to a smelting furnace, smelt it and then use it. So, these are some of the things which Artificial intelligence use exhaustively in manufacturing.

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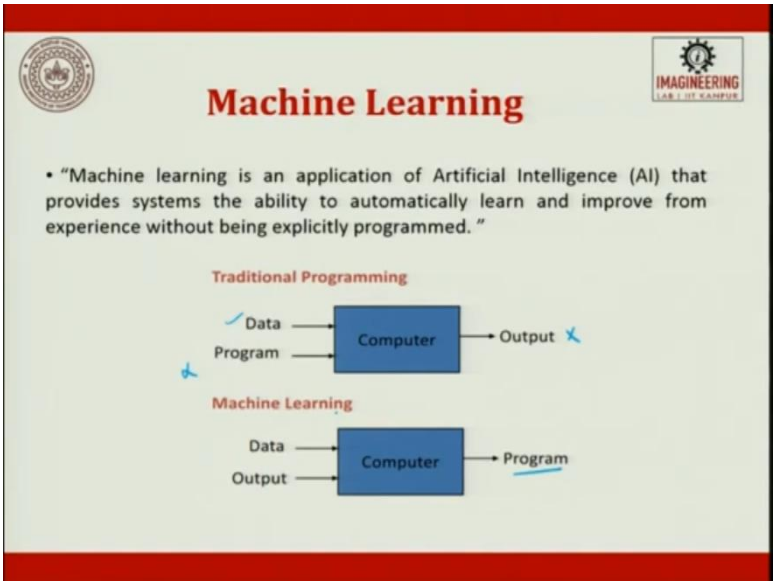

Next, let's move to Machine Learning, first was Artificial intelligence next is machine learning. Machine learning is an application of Artificial Intelligence that provides systems the ability to automatically learn and improve from experience without being explicitly programmed. So, when I was going through a road, I know there is a pothole in the road the first time I went with the speedy I just hit at the pothole.

I lose my stability and then I realized okay there is a pothole. Second day also I did not registered it properly I just ran through the same pothole, the third day also I did not registered it I ran through the same pothole. Now, if you take me as a machine, I have not learned from my mistakes but whereas when you do a Machine learning the Artificial intelligence tool perfectly tells you that okay, yesterday when you went through this you saw a pothole and that pothole would have not get filled today.

So, when you start moving it, 20 meters ahead of that you will have to reduce the speed then you negotiate over the pothole, and then start going. So, now this is what machine learning does. It automatically learns from the data point, improves the experience without writing a program. So, technical program is data program computer output, in machine learning data output, and then program. Look at it how it has changed this, this and this have interchanged. Output has given for the computer to learn then it learns and it generates a program.

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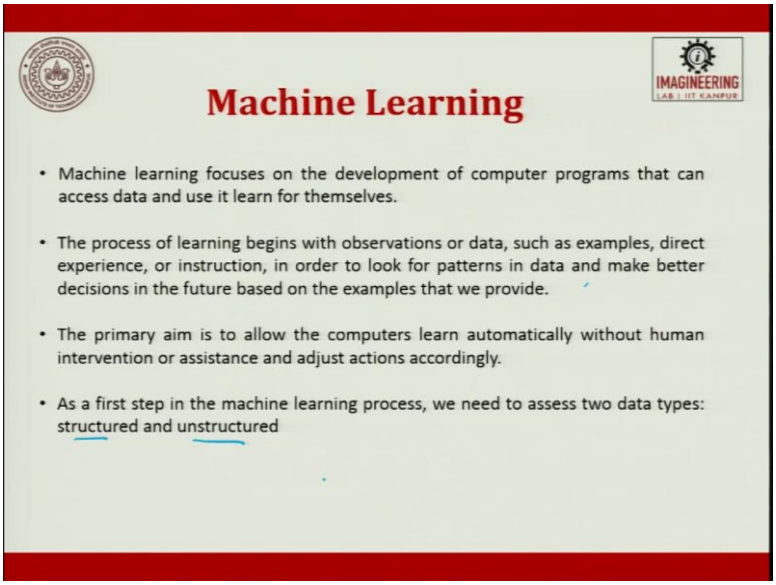

So, Machine learning focuses on the development of computer programs that can assess data and use it learn for themselves. The process of learning begins with observations or data, such as examples, direct experience, or instructions, in order to look for patterns in data and make better decisions in the future based on the examples that we provide.

So, it need not be repeat of same data, for example, I was traveling on a rainy day at 60 kilometres per hour when I applied break my scooter skid. So, moment it started drizzling my machine learning will say "Ram there is enough amount of water the thickness of the water is going to be this when you travel at 60 kilometres speed I assure you are going to fall down, so please go at 40 kilometres speed.

Rigid information and this need not be in the same road it can be on another road, I can plug in and say on a rainy day what should be the speed I travel, and please understand when you drive scooter it is your scooters weight, your weight, your imbalance, the CG of the scooter, and that day environment plus the wind velocity all these things will be considered and the prediction will be made. Which is not possible by a human being, so that is what it is and for one road you did, it will extrapolate and tell you for the other road also.

So, direct experience or instruction in order to look for patterns and data and make better decisions in the future base on the regular that is that we provide. For example on a rainy day a Chai wala dukan makes instead of 50 Samosas 80 Samosas he is pretty sure that day he will sell it but if the rain is continuously all his 80 samosas or 50 Samosas will not be sold, so now his sale depends upon the rain if there is a rain and a sun yes his Samosas are going to be consumed that is what is machine learning.

The primary aim is to allow the computers learn automatically without human intervention or assistance and adjust actions accordingly. Here the human will not intervene the human will not override or supersede the learning. So, the data what is there we learned. Many interesting things are there, you look at a car then immediately after looking at the car you can do pattern recognition of the car and then find out what is the worth of the car, when was it done and how much it has driven, everything.

Today everything can be done okay? As a first step in the machine learning process, we need to assess two data types, structured and unstructured data. I said in the Artificial intelligence also data there are two types of data, structured data, and unstructured data.

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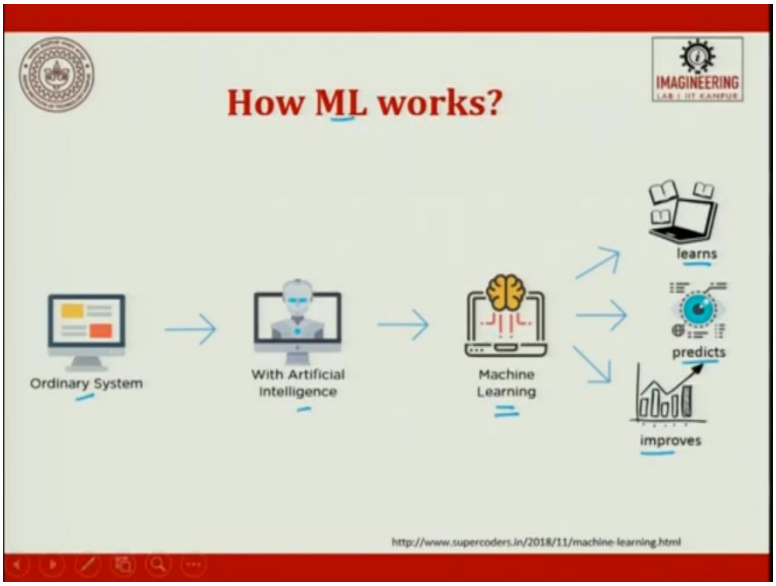

How does a machine learning works ordinary system with Artificial intelligence is there, so there as then which has Artificial intelligence I do Machine learning, I have three things. I learned, I Predict and then I Improve. All these things will be done by Machine Learning. I will learn with the data which is available, I will predict and see how close I am to the error and then I try to improve my learning exercise and next time when I do, I will try to use the advanced learning version to do the processing.

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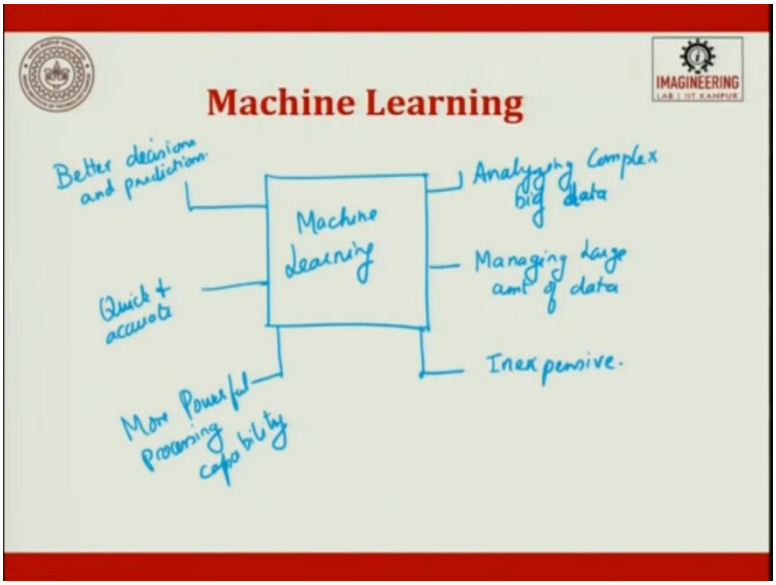

So, the when we talk about the Machine learning, it analyses complex big data. See if your data is small then it is not worth trying Artificial intelligence, Machine learning, and all but other way around if you have very minimum data but other supporting data in a large way then you can do.

Machine learning also manages large amount of data, it analyses, it manages large amount of data. It is inexpensive, because you study the data through a software and then get it done. It is better decisions and predictions are done, it is very quick and it is accurate. Quick and Accurate, and then more powerful processing capability. So, these are the things which are the advantages of machine learning which we saw.

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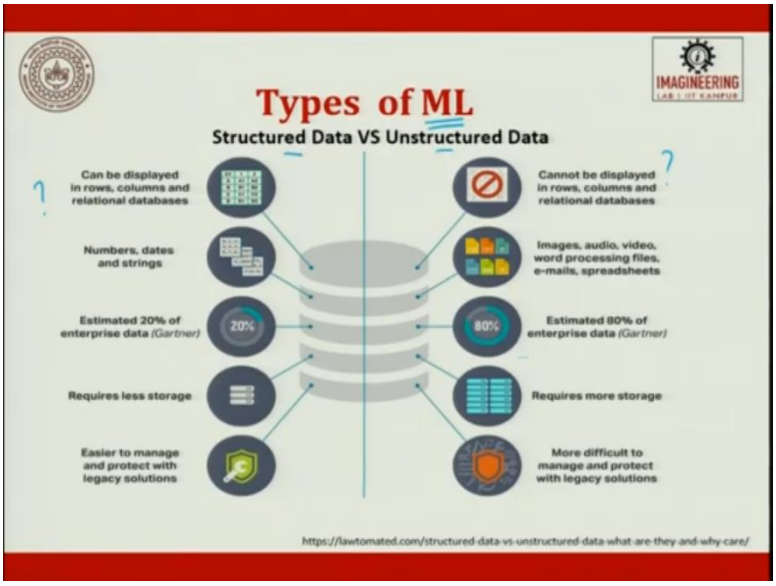

So, when we talk about these structured data, unstructured data it might go in your mind what is this structured and unstructured data. When we talk about structured data here what happens you can be able to store the data in an excel file, you have multiple rows and multiple columns, so there can be an interaction which can be established between a row and column can be displayed in rows and columns and relational database.

Then it has numbers, structured data has numbers, dates, and strings. Estimated 20 percent of enterprise data is structured data, it requires less storage space because you go on through excel file for storing and relational database to be used. It is easier to make and protect with legal solutions these are all the structured data which is part of machine learning.

When we talk about unstructured data, it cannot be displayed in rows and columns and relationship data is unstructured data that means to say you are not able to convert the data into a form such that it can be placed in a excel format. Images, audio, video, word processing files, emails, spreadsheets, all are part of unstructured data.

Suppose you do a machining operation, and there is a roughness data, you take a photo of it and then that data is stored that is unstructured data that cannot be represented on an excel file. Then Estimated 80 percent of the enterprise data falls in this. Unstructured data, so it requires a huge storage space and it is more difficult to manage and protect it legally also this is all about unstructured data, this is about the structured data. This is a very important point which you have to ponder how is this data acquired and how is it stored?

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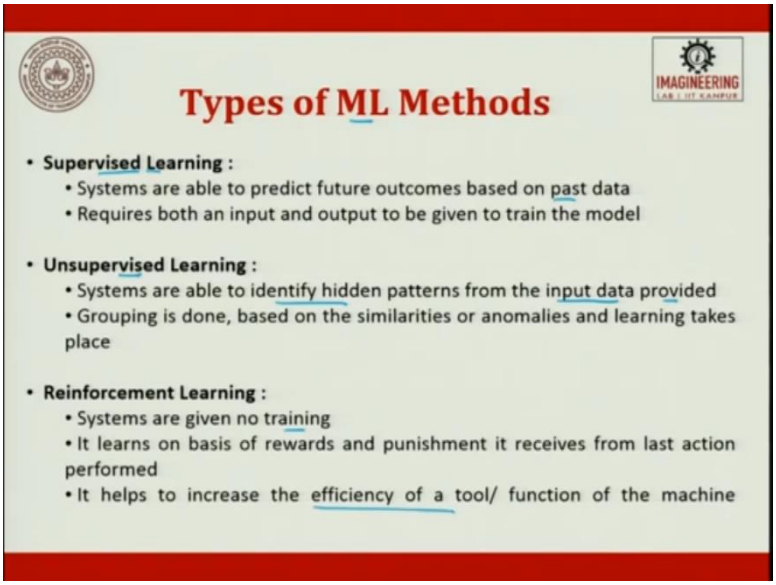

There are different types of Machine Learning methods one is called as Supervised Learning, another one is called as Unsupervised Learning, the third one is called as Reinforced Learning. Supervised Learning is systems are able to predict future outcomes based on the past data is Supervised Learning. It requires both an input and output to be given to train the model.

So, here supervised is you have a set data based on the data the system is getting trained, you have that data is the past data it can be anything last month prediction, production of cars, last month's defect generated by a machine, last month's humidity, last month's what was the fluctuation in the dollar price? Last month's what was the pollution in the environment? So, it is all, understanding from the past data, you predict how will be the future. Like your Sensex what they predict every day. Tomorrow it is going to rise you invest in this it is all this based on the past data a prediction will be made

What is Unsupervised Learning is, systems are able to identify hidden patterns from the input data provided. So, that is Unsupervised it analyses and it tries to figure out a hidden pattern inside it and that hidden pattern is now used for learning and that is used for predicting future. Grouping is done, basically, clustering, based on the similarities or anomalies and learning takes place.

What is Reinforced Learning? The systems are given no training. It learns on basis of rewards and punishment, it requires from last action performed. So, here what we do is there is no training as in one it takes good decision it is assume as it is a dog. It learns on the bases of rewards, so as soon as you ask a dog to do an operation the dog does it, so the dog immediately what you do is you give reward to the dog, so dogs takes it and thinks okay this is the best thing and if you stare at the dog while training then it thinks it is a punishment, so it will not repeat the same action in same way.

It learns on the basis of rewards and punishment it receives from last action performed. So, that is Reinforced Learning. It helps to increase the efficiency of a tool and function of a machine. So, these are different types of machine learning.

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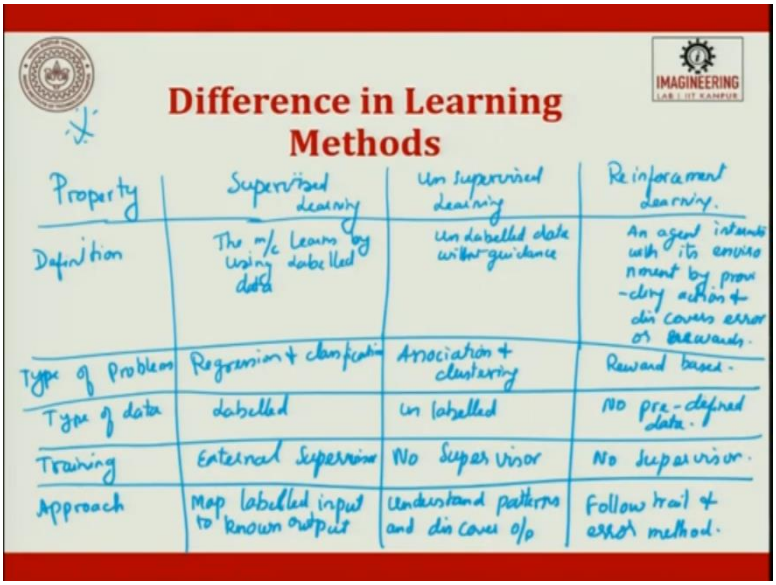

Now, that we have learned different methods, so let us see the advantage, the disadvantage of these Supervised, Unsupervised, and Reinforced Learning. So, let me write down the property then this is Supervised Learning, this is Unsupervised Learning, and the last one is Reinforced Learning.

The first property is let us define, definition, supervised is the machine learns by using labelled data. Here machine is trained by unlabelled data excel file you remember? Unlabelled without guidance without guidance okay? So, here and an agent interacts with its environment by providing action and discovers error or rewards. This is the definition.

So, next one is type of problems, so here it follows regression and classification, here it is association and clustering, here it is reward-based. Then type of data labelled, unlabelled and here it is no predefined data. Next training, it is external supervisor is required, then it is no supervisor, then it is also again here no supervisor, the next one is approach, so it is map labelled input to known output, here, it is understand patterns and discover output, so here it is follow trial and error method.

So, these are the comparison when we take properties with Supervised, Unsupervised, and Reinforced Learning. Very important graph, very important table please try to understand this. This will try to give you more insight.

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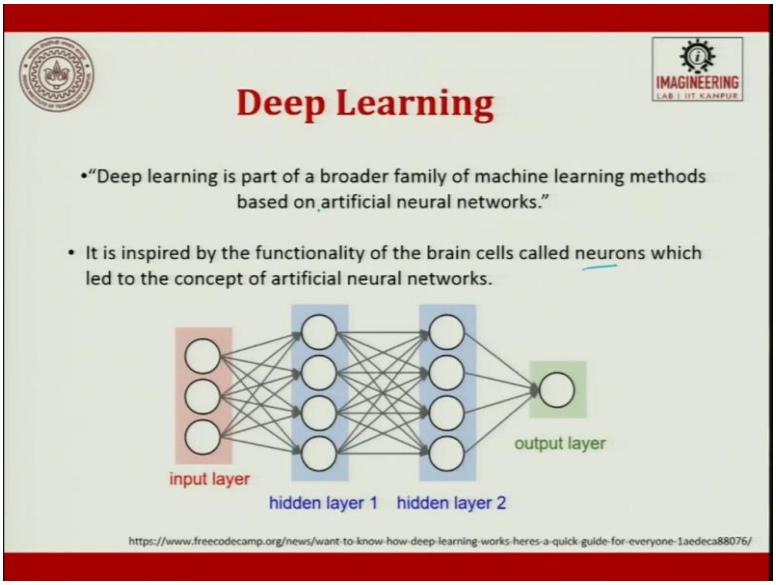

So, now let us get into the next, so first we started Artificial Intelligence we saw machine Learning, now we will get into the topic of Deep Learning. Deep learning is part of a broader family of machine learning method, ML, DL is the subset of ML, based on artificial neural networks. It is inspired by the functionality of the brain cells called neurons this are all neurons which led to the concept of artificial neural networks.

You will have an artificial neural networks input, output and then you will have hidden layers and then in each layer, you will have neurons. So, this number of neurons have to optimised number of hidden layers to be optimised, so then between these things you will have weights based on the weight optimization how close you go to the output you will try to figure out what is the best architecture which is used.

So, Deep Learning is part of a broader family of machine learning methods based on artificial neural networks.

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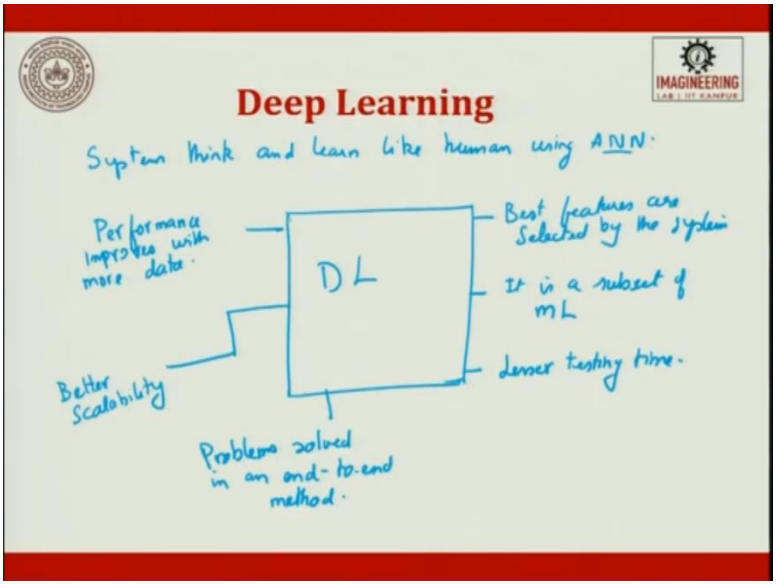

So, deep learning is nothing but a system think and learn like human using artificial neural networks. If you talk about DL, best features are selected by the system, it is a subset of ML, DL lesser testing time is required in DL, DL has an advantage of performance improves with more data, so it is better scalability, it is problems solved in an end to end method. So, these are the advantage of Deep learning, system think and learn like a human being using ANN. That's what is Deep Learning.

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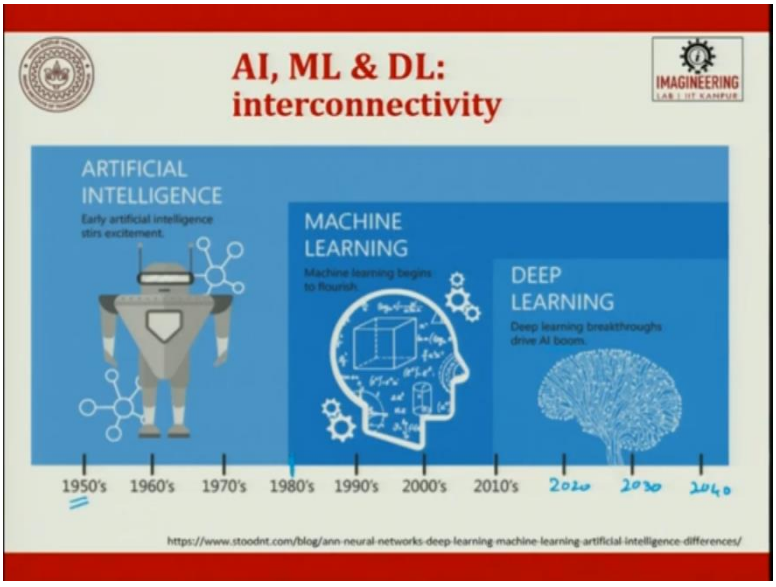

So, if you look at the interconnection between AI, ML, and DL the broader one is AI. It started from 1950 even today it is continuing, so early artificial intelligence stirs excitement, so this

started in 1950 and it is keep continuing today 2020 then it is going to 2030 and then it is going to be 2040.

The subset of AI you will have Machine Learning. Machine Learning begins to flourish which started from 1980 onwards which started flourishing, and today what we are talking about is Deep Learning which is again a subset of ML. Deep Learning breaks through driven AI boon. So, this started from 2010 approximately which is keep continuing, so now you will be able to see the linkage between AI, ML, and DL.

AI is a superset, subset is Machine Learning, Machine Learning subset is Deep Learning. So, all the three are linked, today we are moving towards Deep Learning using artificial neural networks understanding, predicting the results in a much reliable and faster manner and for all these things how did all these evolution happened? It is only because of the tremendous data which got generated in the manufacturing scenario.

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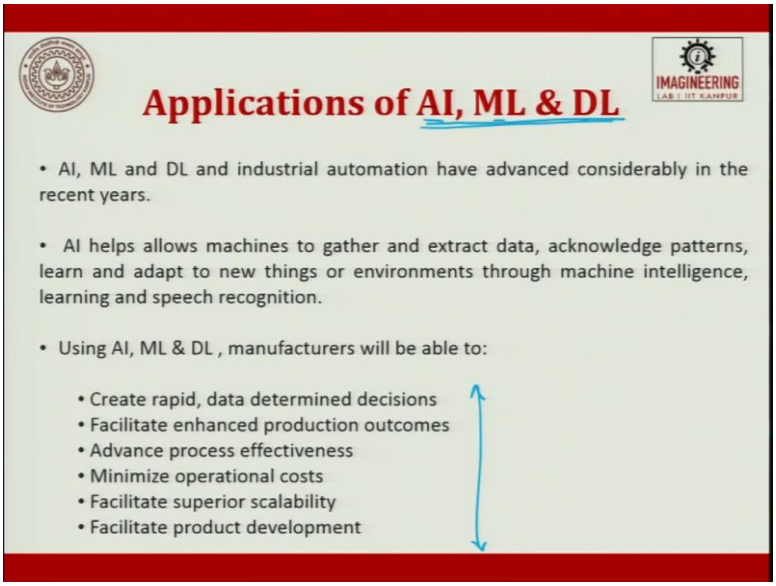

So, the application of AI, ML, and DL. AI, ML, and DL and industrial automation have advanced considerably in the recent years. AI helps allows machines to gather and extract data, acknowledge patterns, learn and adapt to new things or environments through machine intelligence, learning, and speech recognition. Using AI, ML, and DL, manufacturers will be able to create rapid, data determined decisions.

Facilitate enhanced production outcomes, Advance process effectiveness, Minimize operational costs, Facilitate superior scalability, and finally Facilitate product development. All these things can happen because of AI, ML and DL getting used. If AI can be used in

determining what happens after the product is given to the customer, or if it can predict and tell what is the entire product life cycle.

So, then that becomes very useful information for the manufacturing guy. Initially, manufacturing was thought of like producing it and giving it to the customer, today we are trying to work on producing it, using it by the customer and then putting it in the coffin that means, end of the product assessments is also done the initial product is revived, is redefined to the looking into the after service use by the customer what happens to the product and design accordingly the same.

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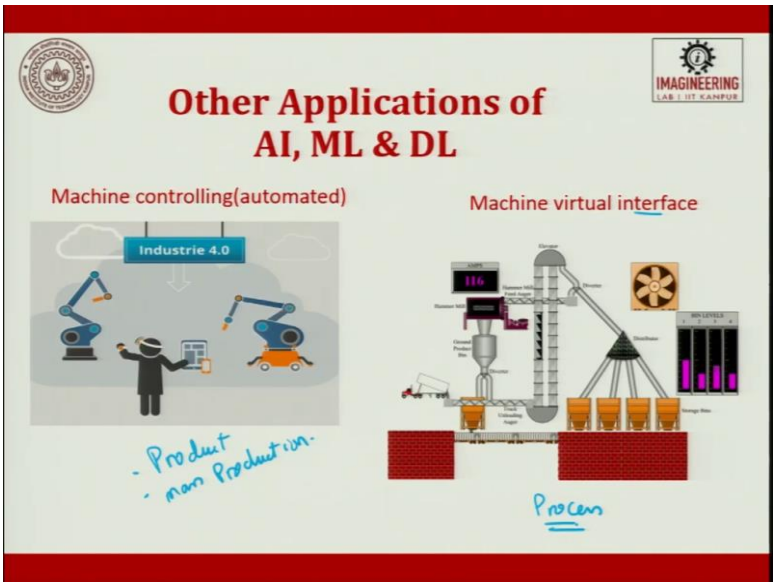

So, the other application for AI, ML, and DL is going to be machine controlling for automation then it is machine virtual interference which is given interfaces which is given. So, all these things are other application, these happens in process industry, these happens in product industry, or this happens in mass-production industry, so here it is process, so processes continues product it can be a cement, it can be a paint or whatever it is.

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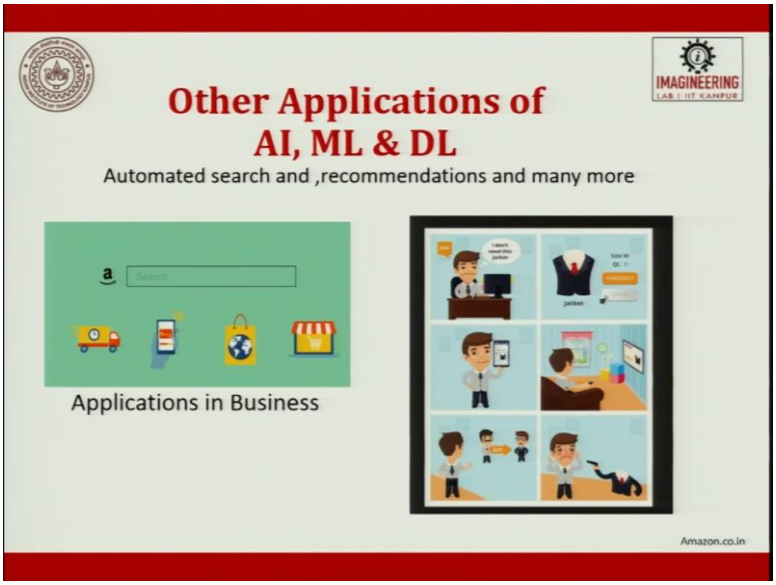

So, the automated search and recommendations, and many more can be done by using AI, ML, and DL. So, the application in business is going to be like Amazon uses it in very big way and here decision making is also done and it is also giving recommendations on the decision making is happening today. Today judiciary system uses Artificial Intelligence in a big way.

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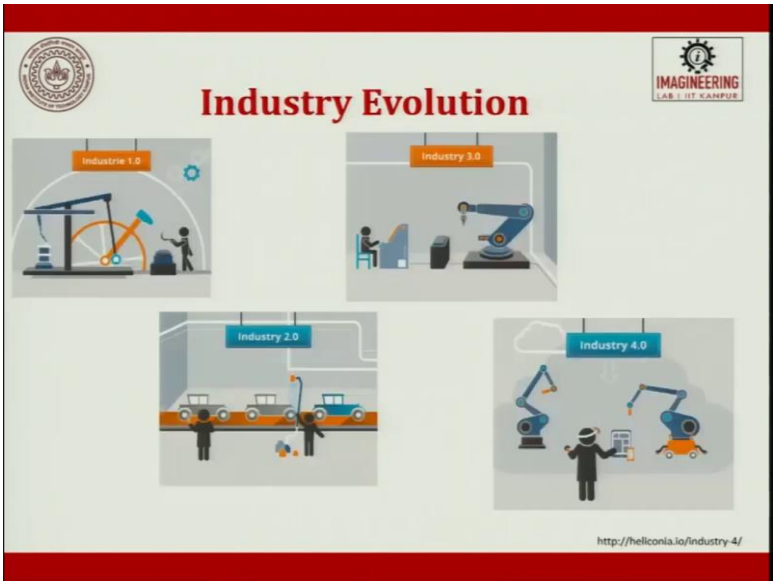

So, the industrial evolution which we saw earlier industry 1.0, industry 2.0 where assembly cars have come, industry 3.0 more towards electronics, industry 4.0 where it is happening more towards cyber and physical production, so we will continue the rest in the next lecture. Thank You.