Computer Aided Decision Systems Industrial Practices using Big Analytics

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Lecture 28

Introduction to Industrial Internet of Things (IIoT)

Welcome to week 7 of the course Computer Aided Decision Support Systems, big data analytics and practice. Where we are trying to learn how to implement Big Data, how do we handle the Big Data. These query languages are discussed in the first few weeks and you also had a brief introduction on the markup language HTML, PHP would be discussed by Professor Deepu Philip in the coming weeks.

I have discussed an introduction to the life cycle of big data analytics. What are the various steps? What are the various stages? What decisions could be taken and what kinds of data could be put in?

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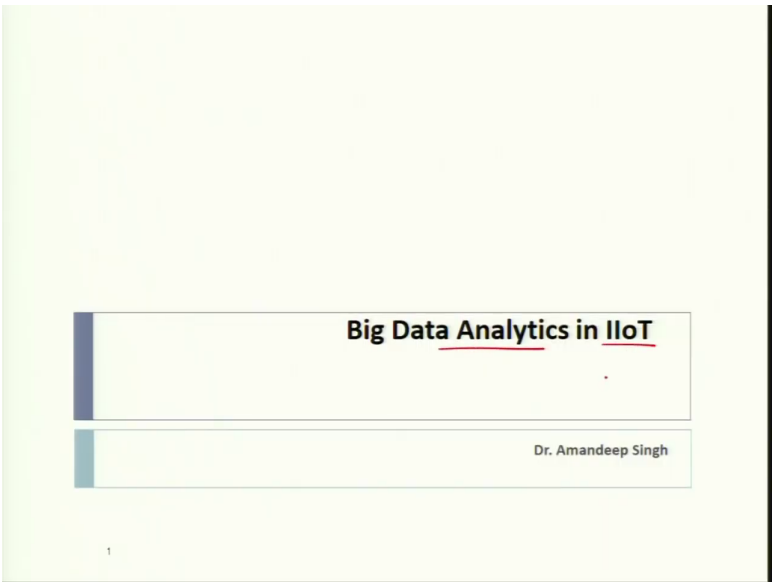

An important discussion to be taken in this week is big data analytics and IIoT. IIoT is the Industrial Internet of Things.

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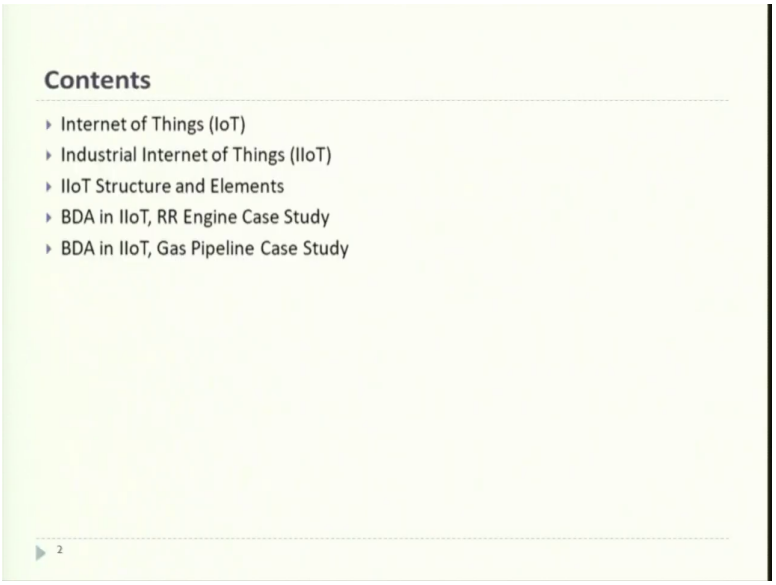

This week would flow through the

- Internet of Things,
- Industrial Internet of Things
- Structure of an IIoT system and its elements,
- Big Data Analytics in IIoT

in general and a case study on the Rolls Royce engine, where the service or the product is taken as a service. So, performance per hour bottle or PBP model (Pay By Performance model), so, how is that possible while using the internet of things that we will see and how is big data analytics helpful in creating this kind of the service that Roll Royce is now sync it.

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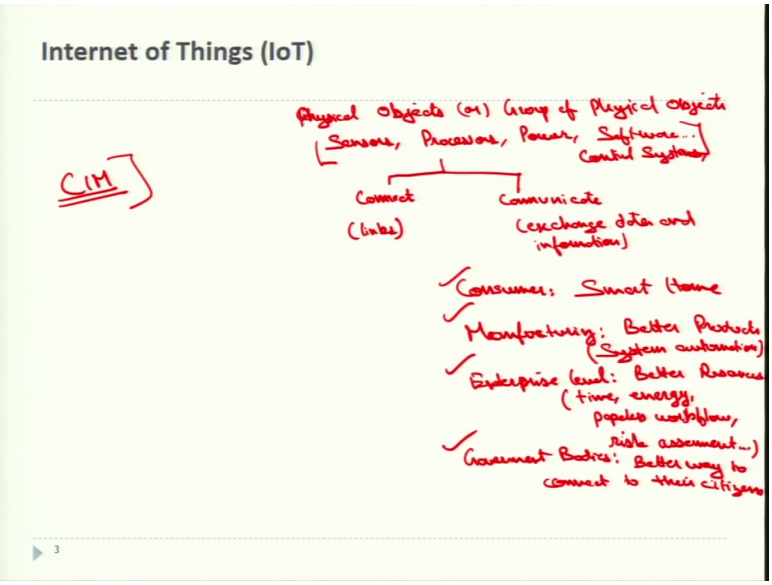

Let us have a brief introduction of the Internet of Things. Internet of Things as the name describes, it is a connection of various objects or groups. If you take the example of Alexa, a home managing system, which supports Google, which supports Apple Siri pair, where you try to switch off the lights, where you try to have the weather information, where you try to have anything yet you like to access in the Google itself, your computers can switch on by itself. How is this connected?

The idea of Internet of Things was provided way back in late 90s maybe in 1987, when Dr. Hong Tan created a pipeline system in which he wanted to control or have the information from the different control points in a pipeline system. However, this case was published in the late 90s, maybe in 1999, but the Internet of Things took its trajectory only when the RFID came into existence, that is Radio Frequency Identification.

In 2005 from there it reached what it is now in Industry 4.0. So, what is the Internet of Things? If I need to put a definition of it, the

- Internet of Things is physical objects or groups of physical objects that are equipped or connected with sensors, processing power, software and other Technologies, so that they communicate or connect with each other and exchange data over the Internet or other communication networks. So, these objects try to have any periphery of sensors, then processors or Power Systems, the software and so on. They try to

i) Connect

ii) Communicate

When I say connect, they are trying to have links between them. When I say communicate, they try to exchange data and information. The type Internet of Things has been used now, when we try to connect most of the sophisticated objects. Such as, we might have machine learning algorithms connected with them between some expensive sensors even but inexpensive sensors the potent embedded systems are also part of it. So, IoT is enabled by the traditional fields of embedded systems, wire sensor networks, Control Systems, And, maybe automation of all these systems. IoT products are often more associated with us as a normal consumer. It is a Smart Home, the Alexa data example I gave to you.

- So, it can be when we say for a consumer, it could be a smart home system for a general consumer, for the people who are into industry or maybe in manufacturing internals of things, means something else to them. It means better products or system automation.
- For a big Enterprise in manufacturing, it is fine, we need to produce better products. We need to produce the products with a better quality and automation of the system material handling. What are the number of materials or number of the units, those are there from one point to another, maybe from the machining centre to the finishing centre. What is the number of units that are there? This all could be there, in a manufacturing concern.
- At an Enterprise level, the Internet of Things means they need to have better resources in a way. Here, what are the connections or what are the elements we need to work upon? Time, energy, time could be saved when we try to have a minimum latency between the transfer of the material, the minimum latency between the storage on where, what to store, like cross talking in the Walmart case study that will be discussed by Professor Philip. How the cross talking of the trucks help to have less number of trucks even. So, time between the delivery or for the delivery was also reduced. So, time energy means it could be energy that it is embodied, if it is cross talking the fuel that is saved, that is also energy saving. And energy saving in bringing or purchasing less number of trucks or so. That is all, that will also be a cost saving or so, or cost saving here means it is energy saving as well. So, it is also for an Enterprise level if they wanted to have a paperless workflow. In the corona era, we had digital signatures, maybe very streamlined by many of the applications the documents which were processed by a few professors, maybe at IIT, Kanpur, the PHD Baba was or the defence of the people, who were conducting their MedTech or PG

thesis State at IIT, Kanpur. Their assessment happens at Zoom or some other platforms like those then signatures happen in a digital way. And, at Enterprise level this is always targeted because it also reduces your work or reduces your time to access everything.

Then at the Enterprise level, one of the important factors Internet of Things helps us to do is, risk assessment and so on. Government bodies also like to have the Internet of Things, where it provides them an ability to track different kinds of resources and an improved way to connect to their citizens. For example, for the MSME's companies, there is an app or there is a photo known as 'Udyami Mitra', where the people would like to log on their problem. They have to apply for a loan or maybe the kind of technical queries that they have. That could be addressed by the people who have expertise in the CDB bank itself. CDB Banks provides loans to MSME's companies who also apply through Udyami Mitra. This is connected to the people. Then, people have different mobile phones. They are Android applications which Farmers also use to update the status or the health of their crops or so. So, those things also help the people to connect between themselves. So, this is a general introduction to the Internet of Things.

So, there are certain challenges and literature of things is still facing because there is still a skill shortage, there is a major skill Gap that needs to be limited and only a limited number of professionals have expertise or skills in the field and it is expected to grow. That is why these courses are being introduced, so that you have a basic introduction of how we connect from the start. Being very ingesting the data to develop the final web base using a markup language, so that we can develop the applications, even the applications which are existing in the market. One should be able to understand what is the GUI of them and try to work upon them, try to improve them, try to give the feedback from them. So, the Internet of Things helps in all these sectors.

Next comes the Industrial Internet of Things. When I say Internet of Things, it is just a connection but that happens in computer integrated manufacturing. It was a very basic term, which has now become a very generic term which we are trying to work upon for the last 30 years or so.

So, when we say CIM (Computing Internal Manufacturing), it includes computer edit design, computer editing engineering, then computer editor manufacturing, flexible manufacturing

systems, process planning and so on. Multiple things are there. Now, with the induction of the RFID, QR codes or small systems that can connect small sensors with each other, this has also taken a big pace.

So, this was basically a small internal thing only, that can happen at the house level only or at a government body that would like to connect to them.

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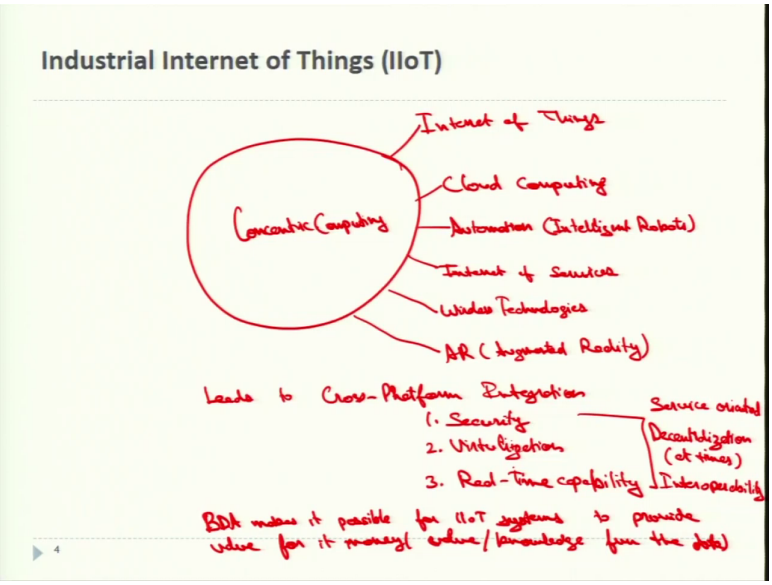

When I say Industrial Internet of Things, here the word industry comes into play. In IIoT, it is not only the internet of things, but we also have cloud computing.

- Cloud computing that is the Computing happens at Cloud, there is no requirement of much storage at the computer or the physical system itself.
- Then we have Automation, such as, we have intelligent robots. In production robots are intelligent enough to identify in the food industry itself. So, what is the kind of the guava that is coming, what is the colour of the guava whether it is acceptable or not, then there is a penetration test, the robot would like to have a penetration test with the sensor is there, Piezo Electro sensors kinds of things are there, but they try to sense whether the pressure that is being made on that fruit that is being acceptable or not. So, what is the pulp or what is the weight of the fruit per volume? All these things could be identified by the robots itself. So, the robots are intelligent enough. I am talking about the food industry because it is very tough to really replicate or try to imitate what humans could do in artificial intelligence, otherwise in manufacturing concern, trying to see the size of a box or so. For example, this size, whatever the

radius, is correct or not, height is correct or not? This is ok. This is why a Vernier calliper, a robot inducted with a Vernier Calliper kind of a system could measure it.

But in the food industry itself, there is automation. The robots are intelligent enough like humans and this could be reprogrammed and we can also have different kinds of setups Advanced algorithms such in them.

- Then along with intelligent robots, we have the Internet of services. Internet of services mean anything that is required to use a technology or a soft application and that is available as a service on the internet. For example, Windows itself is the internet of services now. For example, any Drive program that you try to run to scan a sheet of your notes or so, that uses internet of services as well. How do you connect that, where do you connect that, so that is the internet of services. Along with the internet of services, we also have Wireless Technologies, then AR (Augmented Reality). That is what we call concentric computing. That is Central level, Computing is there, which is connected to different systems and we have an Industrial Internet of Things. So, this helps to cross platform integration. Leads to which IoT systems must ensure three major parts.

1) Security
2) Virtualization
3) Real-time capability.

These are the verticals of it. So, this happens while we have a good service orientation or oriented service. And, at some point, decentralization of these are also required at times only and Interoperability.

So, few traits like the system should be self-aware, self-predicting, self-comparing, self-maintaining, self-organizing, so, these are sometimes completely not fully available or completely imitating the human is not possible, but yes to whatever extent, we can integrate internet of things could help or Industrial Internet of Things could help.

So, in real time capability, let us consider a Rolls-Royce engine that we will take as a case study as well. If suppose the temperature is going to be monitored or the pressure is going to be monitored. And each second we have to recall in the real time sense and that is to be connected to where the rest of the other points whether, how the temperature varying, according to that what is the fuel injection that is coming and according to that how the engine operation should go, what is the maximum speed that the jet could fly or so. Rolls

Royce engines are being used in jet fly or so. For each second, if it is recorded in 60 Seconds, 60 data points for only one parameter and for one hour 3600 data points and if it is to monitor for 10 hours consider 36000 data points only for the temperature at one point. The engine may be the surface of the body or the surface of the fins of the propeller that is there. So, do we really need all these data points and how could this be connected? So, this makes big data as an in evident or Irreplaceable element or the part of the Industrial Internet of Things. Because, we have big data, we have programs which should be able to retrieve the data, though the data is there in the cloud most of the times, but still to run a program, to get the data from there, then map reduce, then sometimes we need to have more complicated testing done on them, so that we have proper regression models run on that. What are the significant temperature points where we could record or so.

So, all these things are there in the Internet of Things. So, what I can write here is that,

- BDA makes it possible for IIoT systems to provide value for its money from how we create value or knowledge from the data.

So, this knowledge is created from the data and the data that is collected through cross platform integration. So, Data available in high volume, maybe coming at high velocity and variety of the data is also there, velocity could also be there. Big data analytics refers to the process of gathering, managing, processing or maybe visualizing the data that is continuously evolving. So this creates unrestricted internal and external activities.

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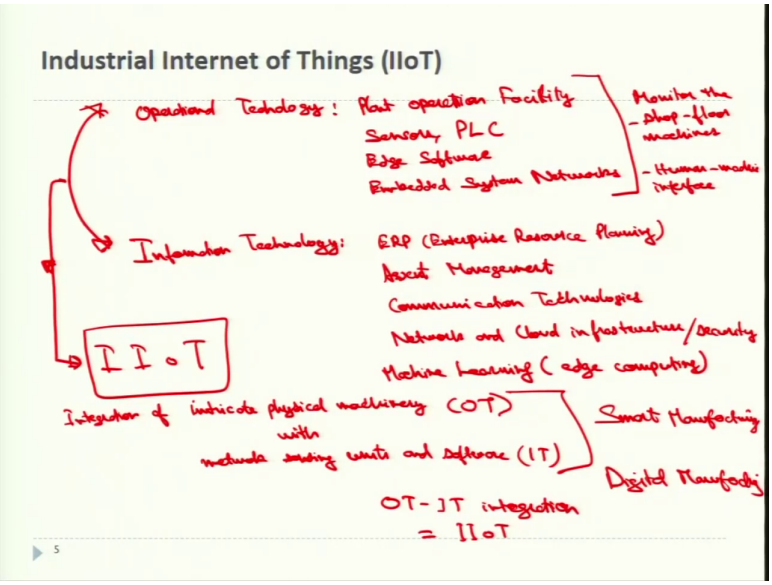

So, what technology we generally have, we call it Operational Technology. Operational Technology means, it is something that makes certain that a company efficiently turns inputs to the outputs and in an efficient way. So, it is a collection of the gadgets that are developed through work together and how we operate the system also.

So, operational technology may include the:

1) Plant operation facility,
2) Sensor or PLC,
3) Edge Software,
4) Embedded System Networks.

Here, this is all taken to monitor these shop floor machines. There could also be a human machine interface here as well.

Another thing that we have been talking about since the beginning is Information Technology, where the information is processed, and where the data is processed, actually. The data is processed to get something useful out of it, that gives us information.

The pieces of information are collected and we try to gather them and we have to collect them and make clusters out of them, so that we try to have a good knowledge developed out of that. That knowledge helps us to develop the small programs for our artificial intelligence which is taken through the big data analytics only.

So, information technology and operational technology together form the mingle to form the Internet of Things. We have on this side monitoring the operational technology. We have monitoring the shop floor machines with human machine interface as well, which is the plant operation facility, sensors, PLC's software, embedded system and networks and information technology.

- We have the ERP systems or so, which are Enterprise Resource Planning systems,
- Asset management
- Communication technologies
- Network and Cloud infrastructure/security,
- Machine learning as well.

So, operation technology and information technology interact with each other to develop a system, in which sensors are all operational and systems are there which connect to the information and makes us to have an Industrial Internet of Things.

So, in operational technology and information technology have relatively separate roles within an Enterprise, till the point, the Internet of Things as a concept came into play. The product and non-plant managers in reality operated in industrial control systems in a separate network previously, literally set apart from each other and secured from the other areas like their production, environment or enterprise system for safety or security reasons sometimes.

So, with the introduction of the IIoT, this allowed the integration of the integrated physical machinery with network sensing units. So, this allowed the integration of intricate physical machinery with network sensing units and software. That is OT, this is connected to IT. Now, the connection between the operation technology domain which entails automation of the shop floor, supply chain monitoring, Enterprise asset tracking, so where information is produced, the information technology domain entails the business process automation, where data is consumed.

Now, the conglomeration of OT and IT is a key factor to achieve smart manufacturing or I would say digital manufacturing. So, emerging technologies like machine learning and artificial intelligence are driving the OT-IT integration. If I say OT-IT, it is OT-IT integration. This is equal to IIoT. So, this allows us straight control and complete tracking with more controlled evaluations of data, of the Enterprise manufacturing facility which is distributed across the complete globe in a way. Integrated OT-IT Systems result in efficient processes and efficient operations.

So, I would like to discuss case studies in the next lecture, where we will see how industrial IIoT is being supported by big data analytics to have an output, which industry has proven to be very helpful or very profitable to them. Thank you.