Introduction to Industry 4.0 and Industrial Internet of Things
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Lecture – 38
IIoT Analytics and Data Management: Machine Learning and Data Science - Part 2

In the previous lecture, we got an overview of machine learning. We have also seen what data sciences and how it relates to fields of computer science mathematics and machine learning. So, here in this particular lecture, we are going to go little bit further.

We have already understood in the previous one, what are the different techniques for machine learning, the broad classifications of machine learning? And how it could be used for IIoT scenarios? And we have also seen a few examples of the use of IIoT and machine learning combined for addressing some real life problems in industrial settings we have already seen that.

So, in this, we are going to continue further. And first we are going to start with understanding how machine learning compares with something also very popular nowadays which is known as the deep learning. So, how machine learning compares with deep learning and how machine learning, deep learning; they compared together with artificial intelligence.

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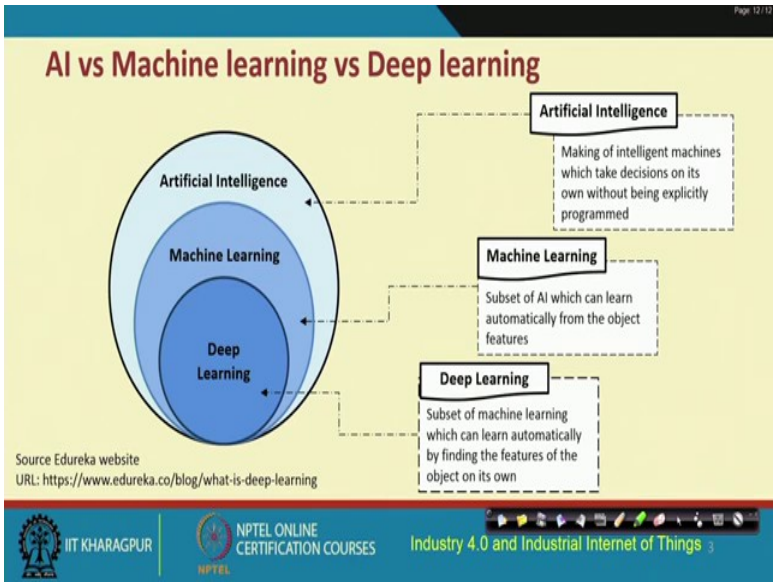

So, this is this overall comparison. So, this is AI versus machine learning versus deep learning. So, holistically it is like this that, deep learning you can think of is a subset of machine learning. And machine learning itself is a subset of artificial intelligence. So, finally, what we have is something like this, you can think of deep learning to be part of machine learning and machine learning again part of artificial intelligence.

So, artificial intelligence, we have gone through it in a previous lecture. So, artificial intelligence talks about making intelligent decisions. Intelligent machines, which will take their own decisions without being explicitly programmed to do so. On the other hand, machine learning focuses on learning automatically from certain object features. So, features may be present, may not be present. In deep learning, for exam example this is where you do not take help of any manually identified features and automatically the features are going to be found out on their own?

So, this is how this deep learning, machine learning, and artificial intelligence is compared to one another. And again, like I said in the previous lecture, if you are interested to know more about deep learning, there are courses you should basically do semester long courses on deep learning, semester long courses on machine learning, and semester long courses on artificial intelligence.

This particular course is scoped only to give you an overview of what is what, not beyond that. So, that you feel yourself empowered and knowledgeable in order to implement if required the different AI, ML or DL techniques for improving your IIoT implementations in your respective industries.

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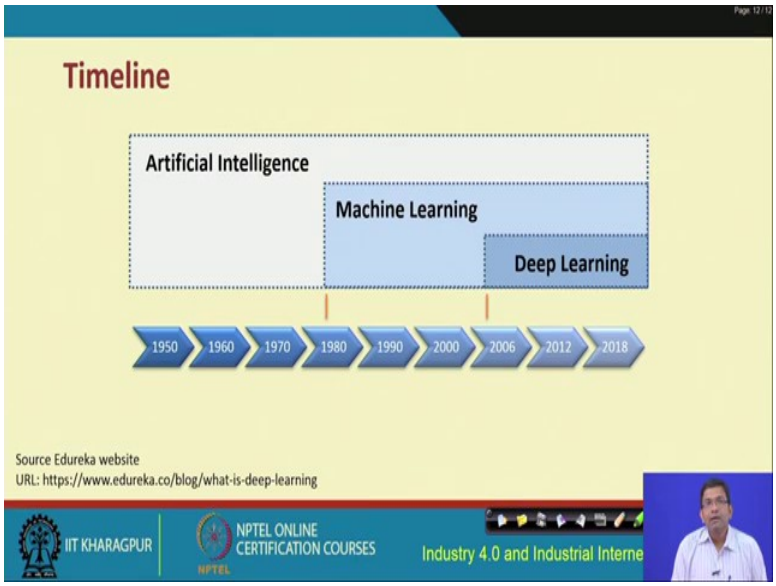

So, this is just the history. AI has been popular since 1950's, it is still popular. ML has been popular since the 1980's, it continues to be and deep learning, since last few years may be 2006, 2007 onwards and so on. But ML, so all these things have been there. You know, AI has been there. ML has been there, but in the only in the recent times these have become more and more popular due to a variety of reasons.

Due to the advent, the popularity of IoT for instance, due to the popularity of autonomous systems for example, autonomous cars, self-driving cars which basically use a combination of all of these technologies AI, ML, DL plus different IIoT technologies are used. And that is where this AI, ML, or DL are becoming even more popular

So, these are 2 examples that I told you. You know there are many more examples in the current day world, where you have to fall back on your previously known technologies such as AI, ML and so on. So, these are not new. ML has been there, AI has been there for even more for a longer time. But only in the recent times, because of the newer applications that are coming up, these technologies have got renewed attractiveness and are being used popularly in the industries.

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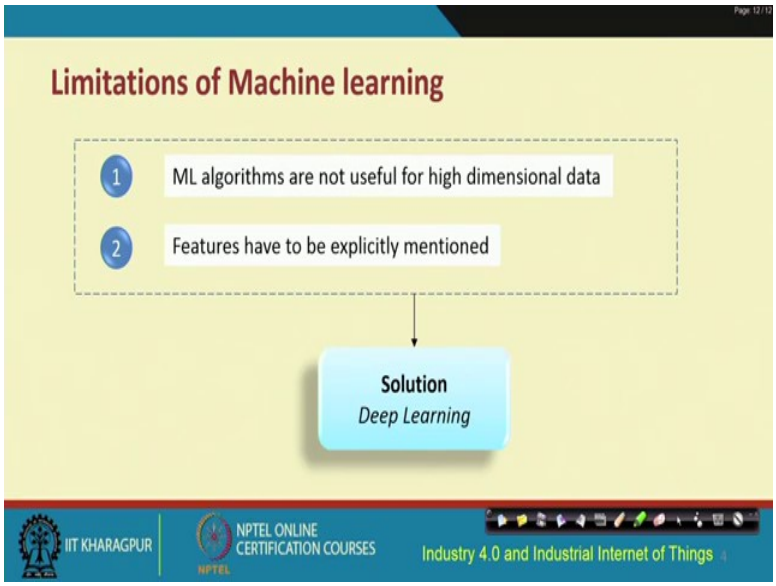

So, we have understood the benefits of machine learning. But machine learning has its own limitations. Machine learning algorithms are not useful for high dimensional data. So, clustering I have shown you x and y that is fine, but if you want to increase the number of dimensions then machine learning will gradually become less useful. Features will have to be explicitly mentioned in machine learning, a type of machine learning.

But if you are talking about deep learning, this is a newer technique where you do not have to do these two. This is basically a new learning technique, the deep learning technique which is again based on machine learning, but it tries to overcome some of the drawbacks of the, limitations of machine learning.

Particularly DL is able to deal with high dimensional data and that is where also the utility of DL becomes much more eminent. And also feature extraction, manual and explicit provisioning of these features and so on those do not have to be done in the case of DL.

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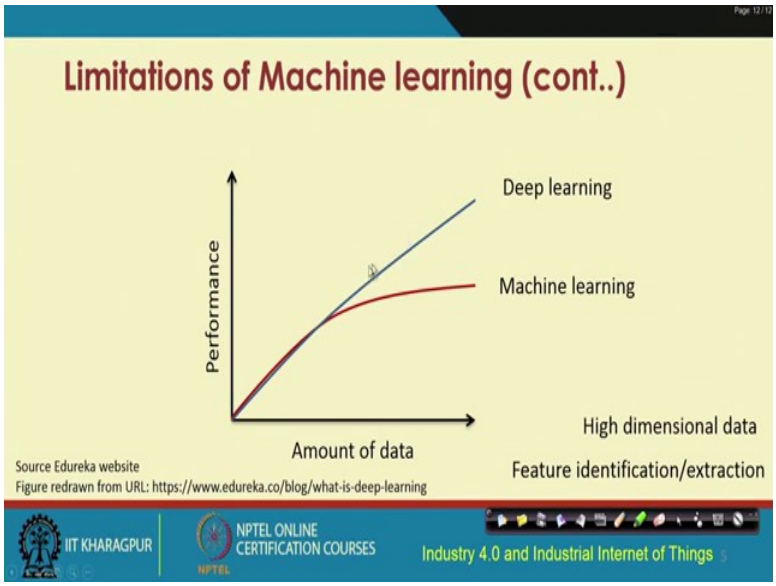

So, this is basically how these ML and DL; they compared with one another with respect to the volume of data. So, if you see that ML and DL with the increase in the number of amount of data, volume of data, and the dimensionality of the data rather. DL gradually becomes more and more popular and useful the performance improves whereas, ML the performance of ML will gradually come to a stagnation. So, also the other limitation was that feature identification and extraction is required in ML whereas, it is not required explicitly in DL.

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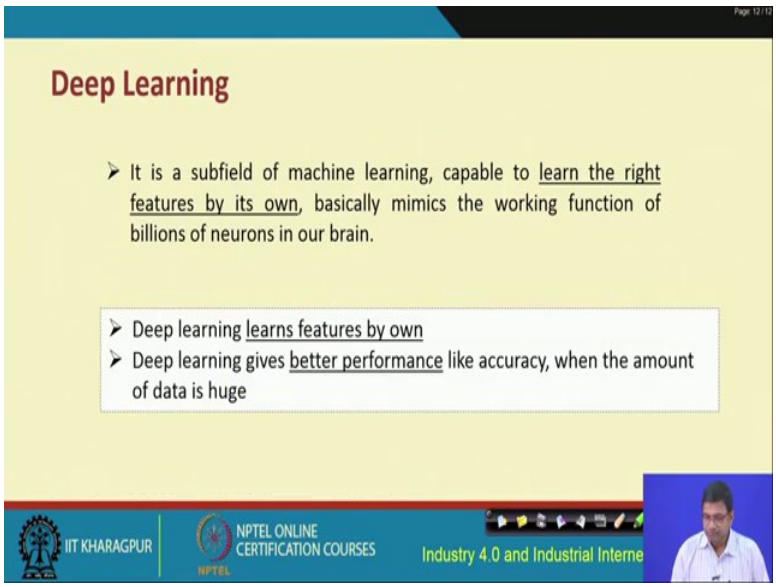

So, deep learning, it is a subfield of machine learning which is capable of learning the right features on its own. On its own, it is able to learn the features. Basically, it mimics the working function of billions of neurons in our brain deep. So, if you look at the neuron, neural structure of the brain it is a very complicated neural structure. So, inspired from that neural structure, the deep neural structure that is underneath different layers etc. Deep learning has been inspired by that and it builds upon that; it is little different understanding brain is not very easy.

So, it is inspired, but not exactly brain-based neural structure that is followed. It is inspired, but its bit different, but what DL does? It learns the features on its own. And this DL, gives improved performance with respect to accuracy when the data volume increases and the dimensionality of the data also increases.

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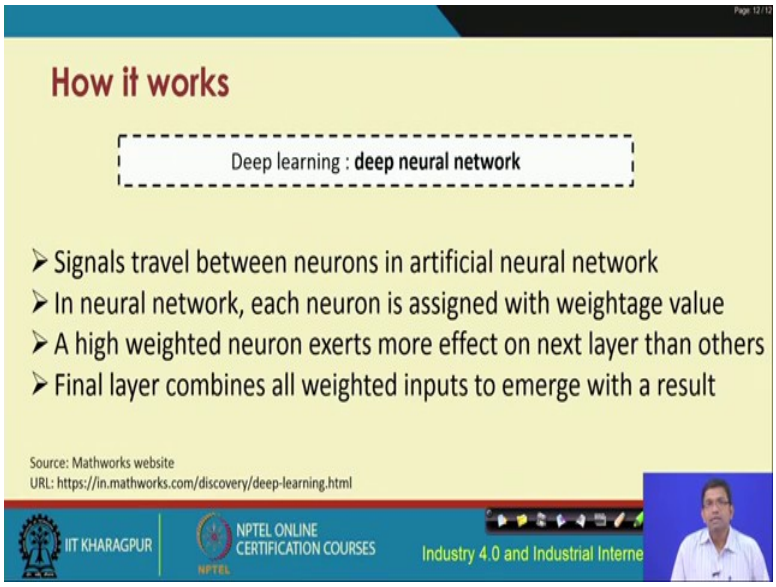

So, one of the very popular techniques in deep learning is to use deep neural network. You know, so it deep in your network is again based on neural network ANN's, but its again with deep. I will show you how a deep neural network looks like schematically, shortly. But before that, so in a deep neural network, the signals basically travel between different neurons and layers of neurons in artificial neural network. In neural network, each neuron is assigned with some weighted value, a weighted, a high weighted neuron exerts more effect on the next layer than the others and the final layer combines all the weight inputs to emerge with a result. This is how it works.

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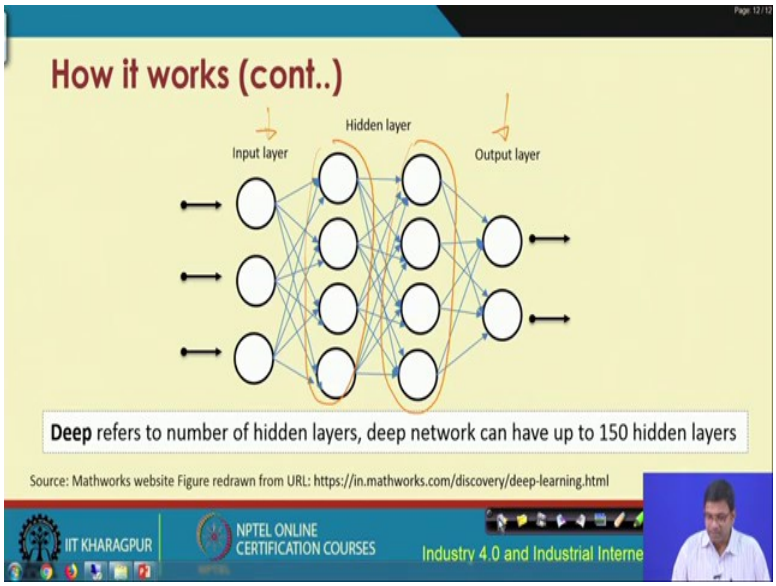

So, diagrammatically I show you over here that this DNN which is the deep neural network. As you can see here, you have an input layer and you have an output layer. So, input layer basically takes the inputs, the output through this optimization process is basically passed from the output layer. You can get the output from the output layer.

Now, in between are all these hidden layers, these are the hidden layers where lot of you know integrate relationships are there which does these computations. And you can increase the number of these hidden layers and the more and more you increase, the more and more computations will be there. The, but it is going to give you more accuracy in general, but not in all cases, but in most cases it is going to give you more and more accuracy.

So, deep basically refers to the number of hidden layers. So, the more number of layers you have, the deeper structure you are going to have of the neurons. So, it is said that the deep neural network can have up to 150 hidden layers. So, here we show only 2 hidden layers, but in a DNN up to 150 hidden layers can be implemented.

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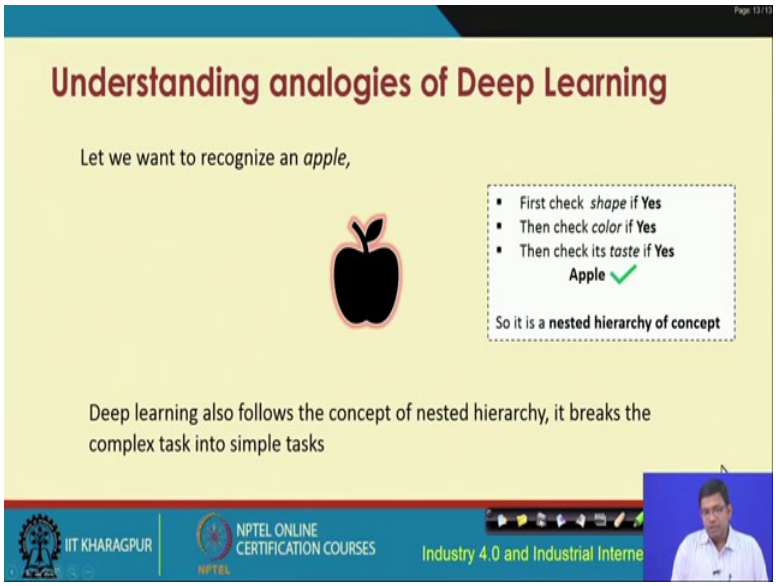

So, let us take an analogy from real life about how deep learning works. Let us say that, we have to recognize whether this is an apple or not. So, first you check the shape. If you see that the shape is what is desirable, if yes, if you after checking that the shape is ok, then you check the color, if the color is ok, then you check its taste, you bite on the apple and then you check how it tastes. If you see that the taste is ok, then you confirm that it is an apple. Right?

So, you make this confirmation or recognition of an apple based on its shape, color, and the taste. And that is basically the nested hierarchy concept. So, deep learning also follows the concept of nested hierarchy. And it makes the complex tasks into simpler tasks. So, this is just an analogy to make you understand deep learning better.

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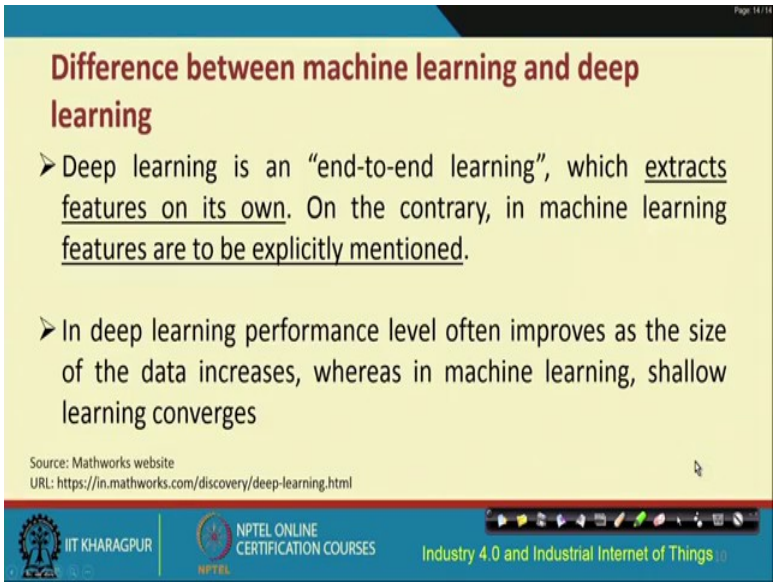

So, difference between machine learning and deep learning. Deep learning is an end-to-end learning which extracts features on its own. This is the key thing, extraction of features on its own. On the other hand, in machine learning features are to be explicitly manually mentioned. In deep learning, the performance level often improves as the size of the data increases. Whereas, in machine learning, the shallow learning basically converges.

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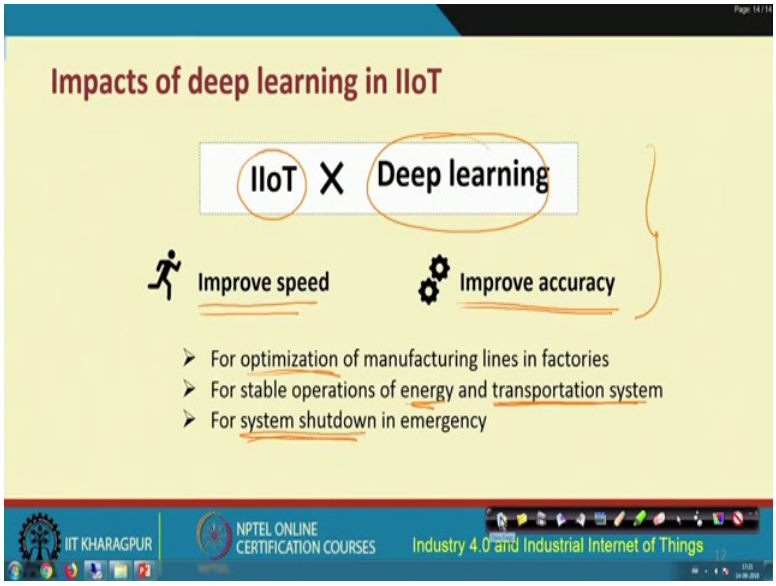

So, we have 2 things. We have IIoT, and we have deep learning. Both are very powerful technologies. IIoT is helpful for improving the speed; whereas, deep learning is useful for improving the accuracy. Now, if you put them together, what you get is a multiplicative effect.

So, this multiplicative effect becomes a very powerful thing which can help these manufacturing industries in the factories to optimize their product lines. It can help in optimizing the energy consumption, and to improve the transportation operations. It can also help for systems shut down in the case of any kind of emergency or eventualities.

So, IIoT, deep learning together makes things multiplicative in terms of the benefits that can be obtained and together you get a very powerful technology.

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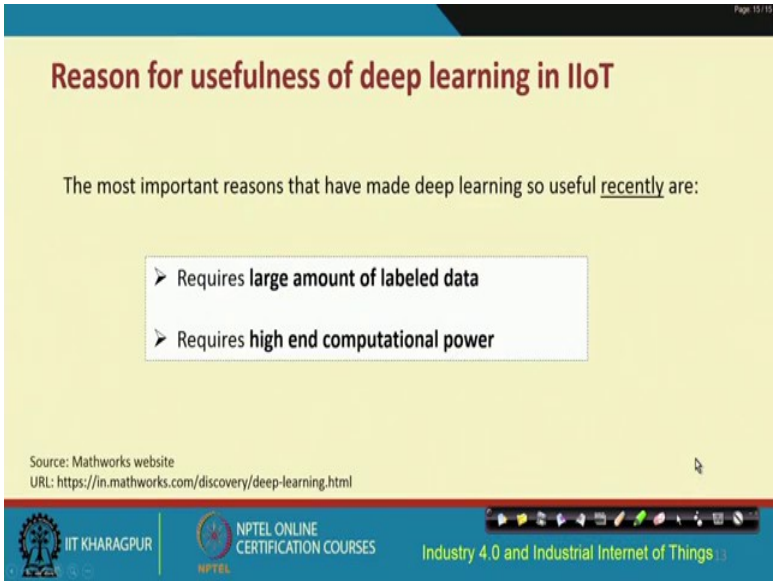

So, the reason for the usefulness of deep learning in IIoT is like this. So, the most important reasons that have made deep learning so useful in the recent times is, that only in the recent times, the amount of labeled data that is required has increased manifolds. So, it has increased and is also available. And at the same time, in the recent times, the high end computational power have also become quite high and at the same time cheap.

So, high end computational power cheaper, but available at low cost and coupled with that the amount of large amounts of data have the availability of that data has also increased and the requirements for both of these has also increased. And consequently

what we have is that together people have realized nowadays that deep learning has lot of benefits because of these necessities.

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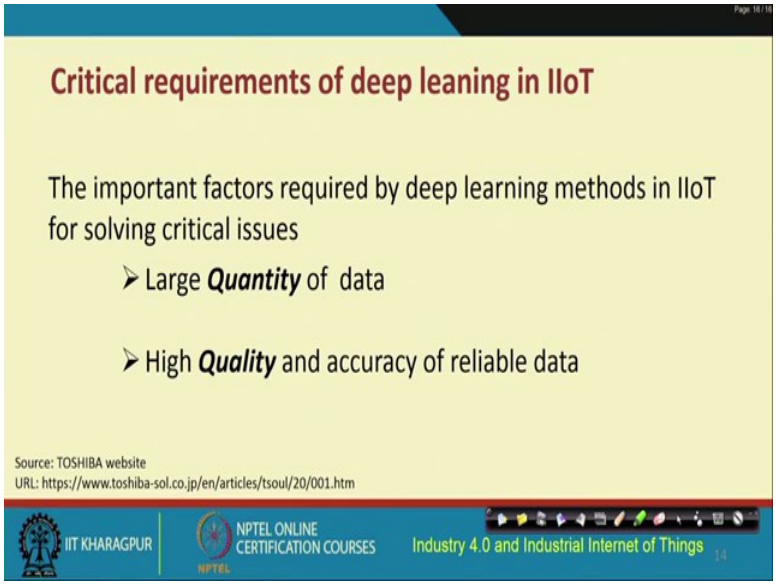

So, the critical requirements of deep learning in IIoT are that nowadays we are talking about solving critical issues such as, dealing with large quantity of data and also dealing with higher accuracy requirements higher quality and so on.

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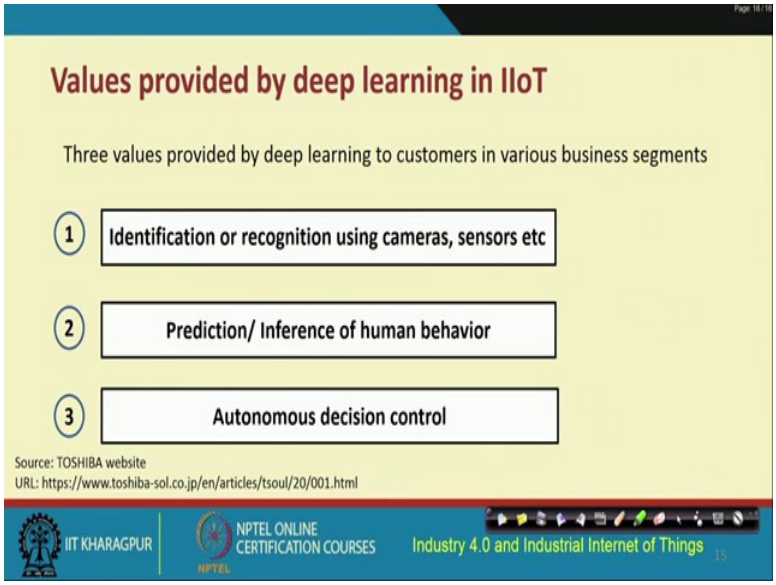

So, deep learning basically provides the values in terms of enabling the customers for identification or recognition using technologies such as cameras, sensors, etc., prediction

or inference of human behavior and autonomous decision control. So, these are the different benefits that deep learning gives to the customers in different business segments.

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So, deep learning, there are uses of deep learning a lot in the industries. The company Toshiba of which we are very much familiar, Toshiba uses something known as the collaborative distributed deep learning technology. So, that is a technology that is used between the edge and the cloud. Edge means, some gateway device which can perform certain processing.

So, between the edge and the cloud, this Toshiba came up with a collaborative distributed deep learning framework. So, we are using this framework. The learning process is performed in the cloud for high end processing whereas; the inferencing process is conducted in the edge for real time processing. Basic analytics will be done at the edge whereas the deeper ones which require a lot of computation and so on. The higher in processing, higher in computation will be done will be done at the cloud.

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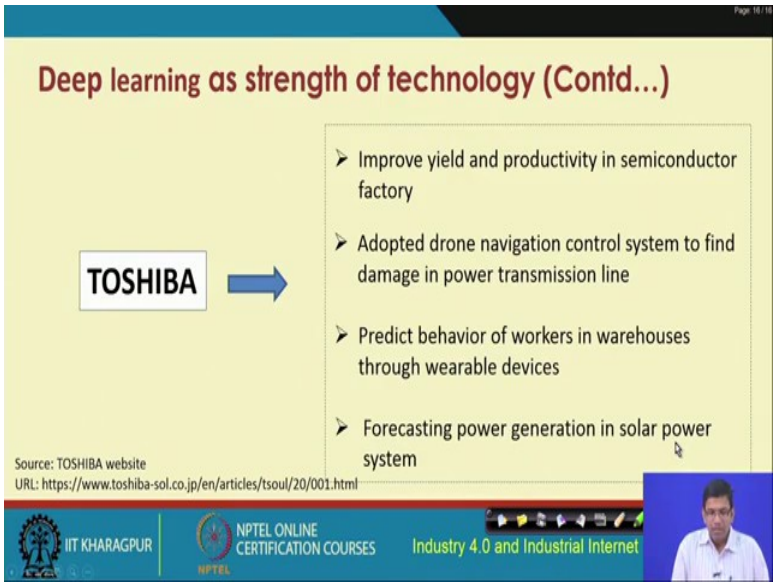

So, the Toshiba technology leads to improved yield and productivity in the semiconductor factory. They adopted the drone navigation control system to find damage in power transmission lines, predicting behaviors of workers in the warehouses through different wearable devices, and forecasting power generation in a solar power system.

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So, another example is H2O platform that also uses the deep learning framework. Intel's Nervana is a deep learning processor. Zebra medical vision system, they are using deep learning techniques for different problems in the medical domain.

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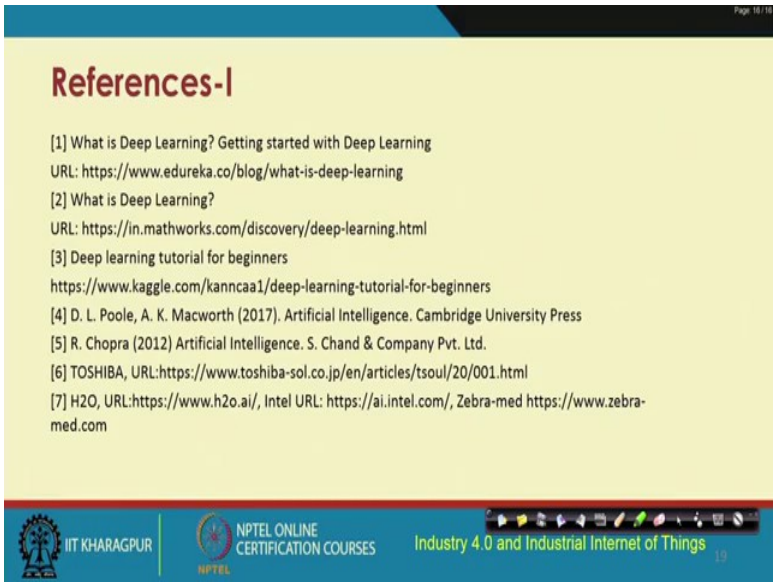

So, these are some of these examples of deep learning and where it is finding popularity. Deep learning has become very popular in autonomous driving vehicles. Nowadays, deep learning along with IoT has become very popular together. They make these the self-driving cars a reality.

So, like this, there are many different utility of machine learning, deep learning, and artificial intelligence and they are handshaking with IoT and IIoT, which make them powerful together in addition to having their individual strengths.

So, with this, we come to an end. Here are these different references like before you are encouraged to go through these different references and with this we come to an end of the getting an overview of machine learning and data science for IIoT.

Thank you.