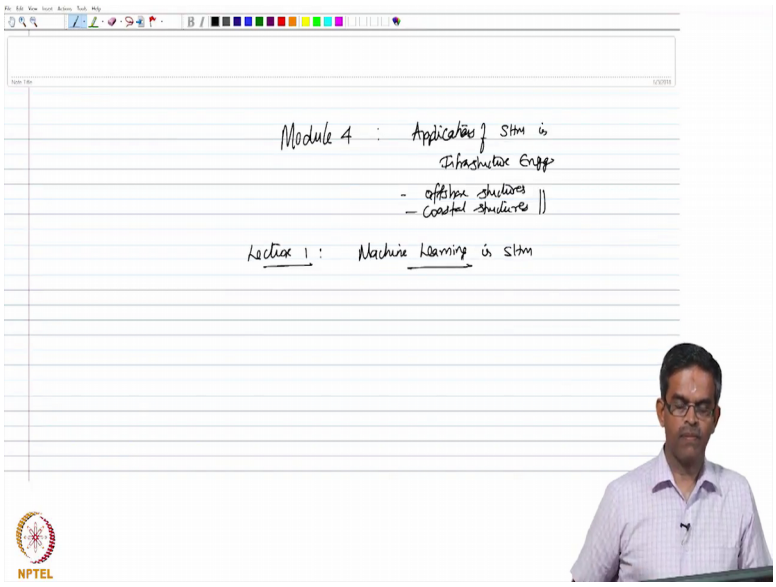
Structural Health Monitoring (SHM)
Prof. Srinivasan Chandrasekaran
Department of Ocean Engineering
Indian Institute of Technology, Madras

Lecture - 65
Application of SHM in Infrastructure Engineering-Part 1

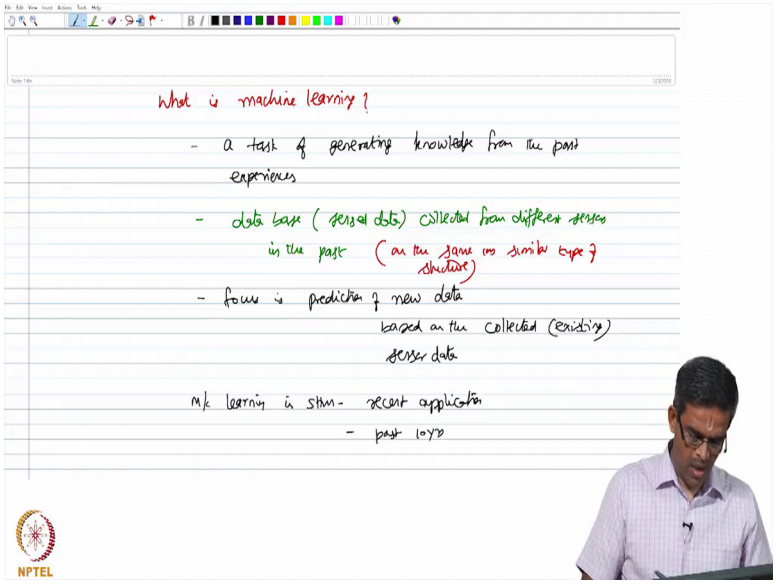
Friends welcome to the last module lectures of this course on structural health monitoring.

(Refer Slide Time: 00:23)



We are going to talk about lectures in module four, module four will be speak about applications of structural health monitoring. In infrastructure engineering; however, the specific applications will deal with offshore structures and coastal structures. In this lecture which is the first lecture in module four we are going to talk about machine learning.

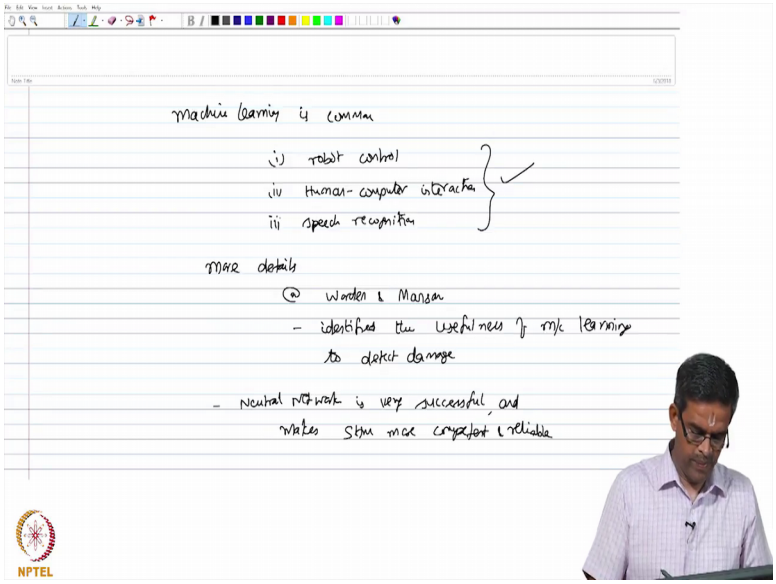
(Refer Slide Time: 01:26)



In structural health monitoring, now what is machine learning first we will try to answer this. Then we will try to answer how machine learning is done, machine learning is described as a task of generating knowledge, from the past experiences now the question comes how machines can get experience.

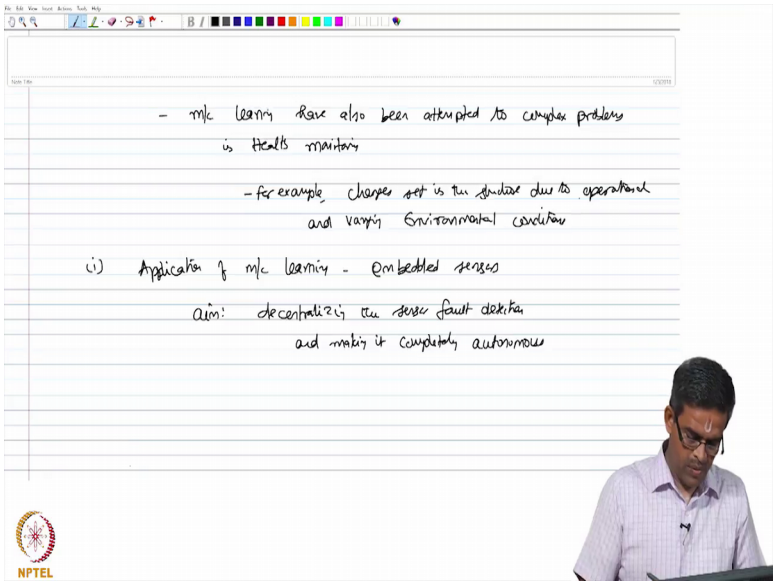
Interestingly the experience here does not refer to the working kind of the machinery, but it is a database or sensed data collected from different sensors, in the past more interestingly on the same or similar type of structure that is very important. So, what should be the focus of machine learning, the focus is prediction of new data based on the collected or existing sensor data. It is a very recent application machine learning, in SHM is a very recent application maybe past ten years.

(Refer Slide Time: 03:45)



However machine learning is very common in the following fields robo control, studies related to human computer interaction speech recognition etcetera. These fields we have been using machine learning training the machine for existing data very commonly. However, their applications in terms of structural health monitoring is a very recent attempt in the literature of course, you can see more details at worden and manson, where they identify the usefulness of machine learning to detect damage. Their application in neural networks is very successful and makes SHM more competent and reliable to the great extent of understanding.

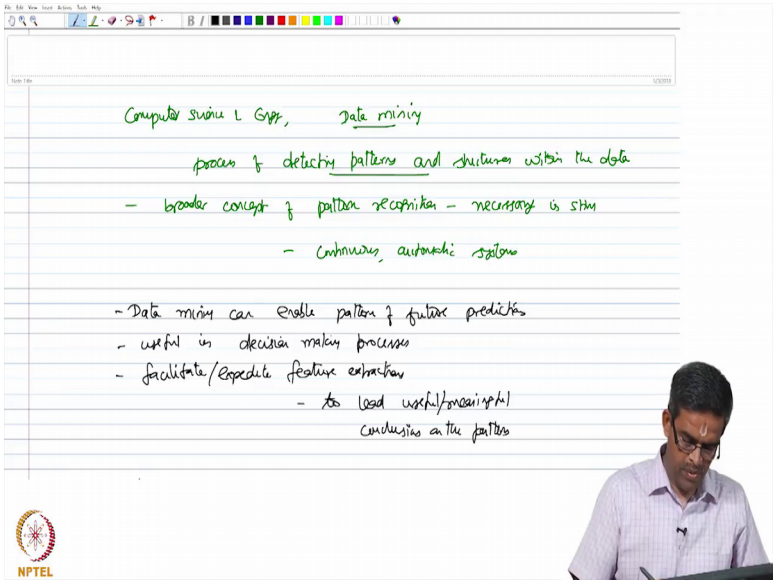
(Refer Slide Time: 05:42)



Machine learning have also been attempted to complex problems in health monitoring for example, changes set in the structure due to operational and varying environmental conditions.

Interestingly one of the successful application of machine learning is in embedded sensors with an objective of decentralizing, the sensor fault detection and making it completely autonomous.

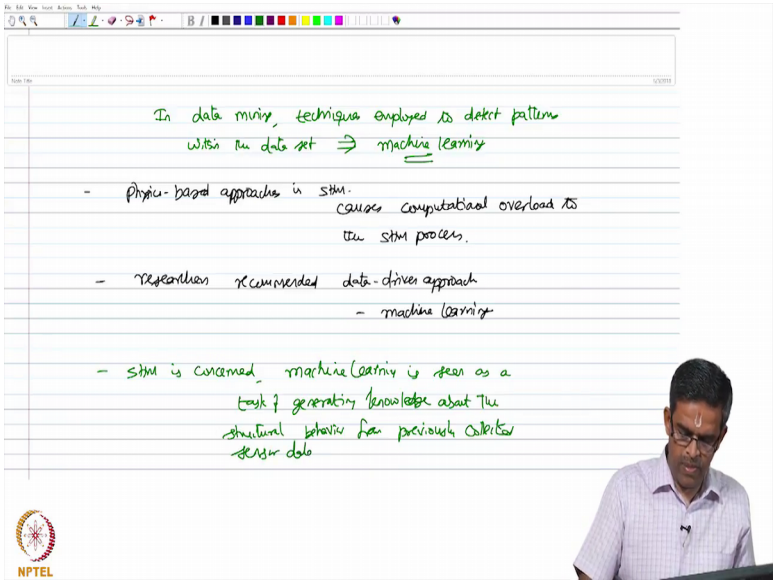
(Refer Slide Time: 07:43)



In computer science and engineering, we use a common term called data mining, now what is data mining data mining actually is the process of detecting patterns and structures within the data ok. So, essentially data mining is a broader concept of outfitting pattern recognition which is very highly necessary, in structural health monitoring essentially when you use continuous automatic systems.

So, data mining can enable pattern of future predictions and can be useful in decision making processes, it can facilitate and expedite feature extractions to lead useful or let us say meaningful conclusions on the patterns.

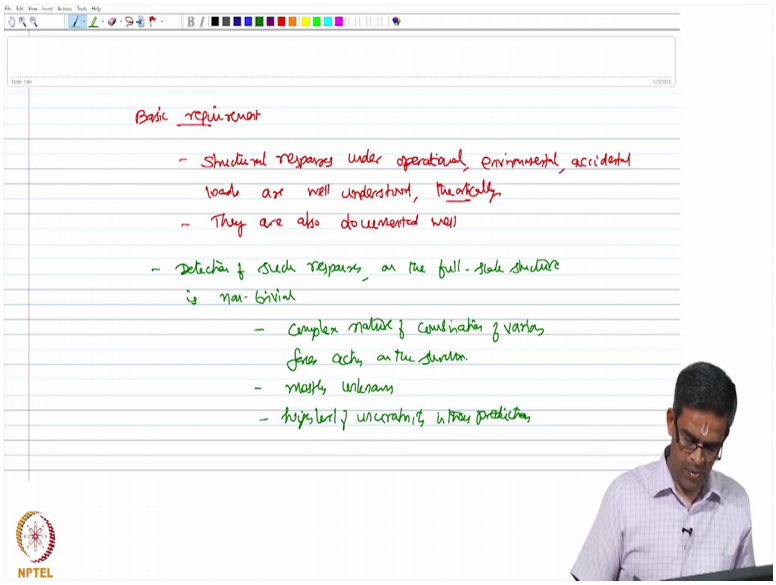
(Refer Slide Time: 10:00)



In the nutshell in data mining techniques employed to detect patterns, within the dataset is referred to as machine learning that is machine learning.

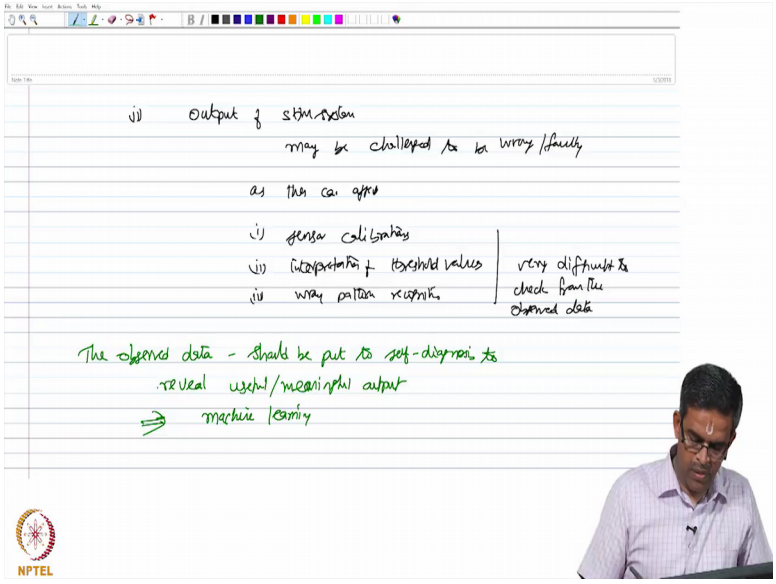
We already saw in the last lecture that physics based approaches in structural health monitoring, causes computational overload to the SHM process therefore, researchers recommended data driven approach which is machine learning. So, therefore, as far as SHM is concerned machine learning is seen as a task of generating knowledge about the structural behavior from previously collected sensor data.

(Refer Slide Time: 12:36)



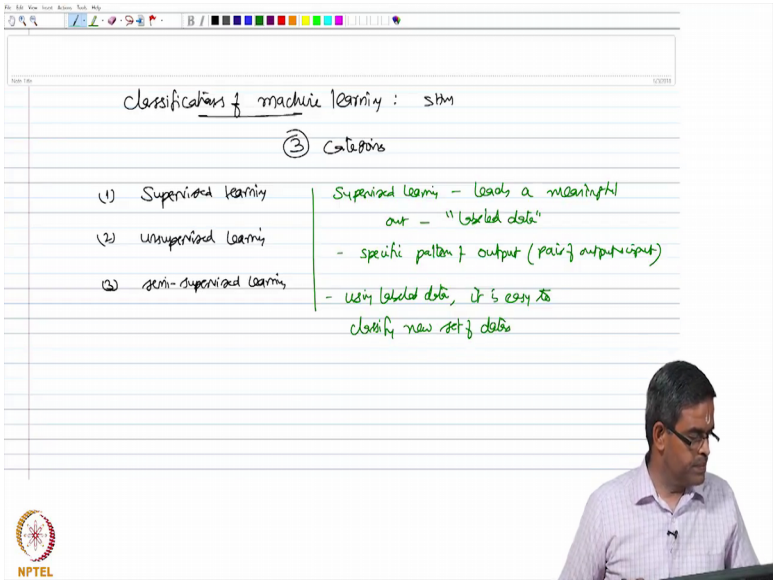
Now, the basic requirement of machine learning is that as follows structural responses under operational environmental and accidental loads are well understood theoretically they also documented. Well, but detection of such responses on the full scale model this is essentially due to the complex nature of combination of various forces acting on the structure which are mostly unknown and they have very high level of uncertainty in their predictions.

(Refer Slide Time: 14:40)



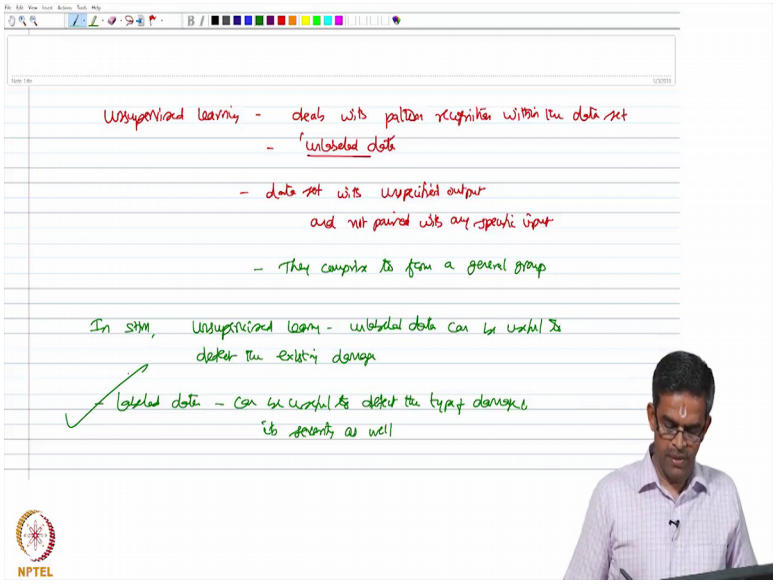
That is the first necessity the second necessity is the output of structural health monitoring systems may be challenged to be wrong or faulty as they can affect one the sensor calibrations interpretation of threshold values, wrong pattern recognition which may be very difficult to base to check from the observed data. The observed data should be put to self diagnosis to reveal, useful and meaningful output that is actually the objective of machine learning.

(Refer Slide Time: 16:30)



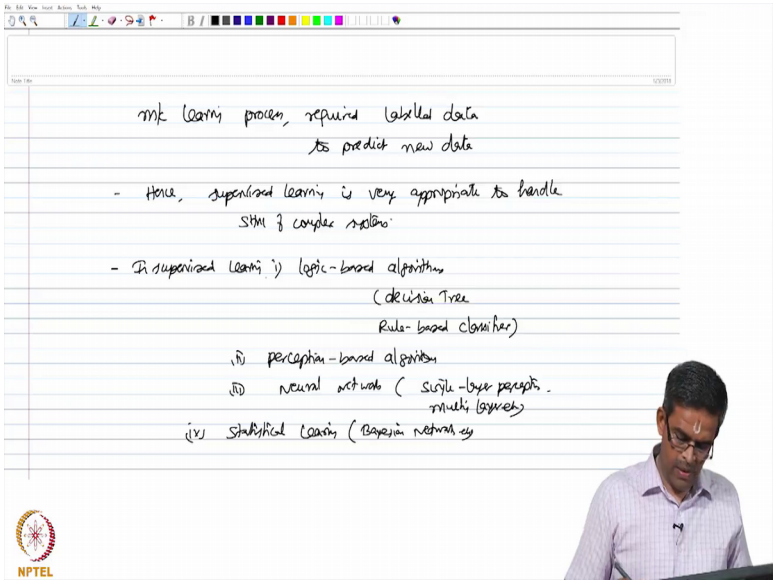
There are many classifications of machine learning as applicable to structural health monitoring they can be broadly classified into three categories, one supervised learning, two unsupervised learning and three semi supervised learning, out of all the three supervised learning leads to a meaningful output which is called as labeled data. So, this includes specific pattern of outputs that is pair of output and input that is called the pattern are generated. Therefore using such labeled data's it is easy to classify new set of data's.

(Refer Slide Time: 18:35)



Whereas, unsupervised learning, deals with pattern recognition within the dataset. Which is now called as unlabeled data that is data set with unspecified output and not paired with any specific input, but; however, they comprise to form a general group. So, in SHM perspective unsupervised learning that is unlabeled data can be useful to detect the existing damage, whereas labeled data can be useful to detect the type of damage and its severity as well. So, one can say that labeled data is an extended advantage of machine learning process when you employ it in structural health monitoring.

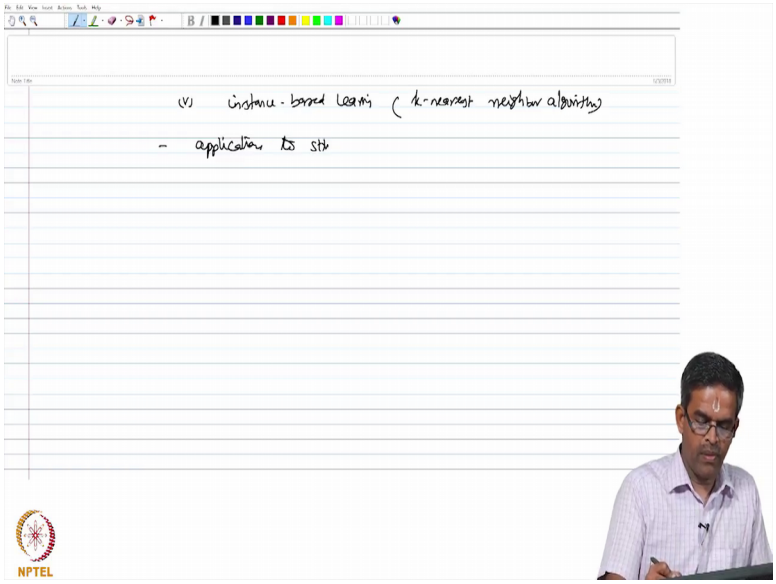
(Refer Slide Time: 20:50)



So, the machine learning process requires set of labeled data to predict new data. Supervised learning is very appropriate to handle structural health monitoring of complex systems. In supervised learning logic based algorithms, like decision tree rule based classifiers to perception based algorithm like neural networks like single layer perception multi layer perception etcetera.

The fourth one can be also applied to this which is the statistical learning for example, Bayesian networks etcetera.

(Refer Slide Time: 23:06)



The next one could be instance based learning which can be k nearest algorithm, neighbor algorithm which can be very useful in applications to structural health monitoring.