Introduction to Remote Sensing
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Lecture 16
Image Classification Techniques

Hello everyone welcome to 16th lecture in the this series of introduction to remote sensing and in this particular lecture we will be discussing image classification techniques there are various types of image classification techniques exist and some are also evolving so few of them we will see which are most popular but before that we would like to focus why would we want to classify.

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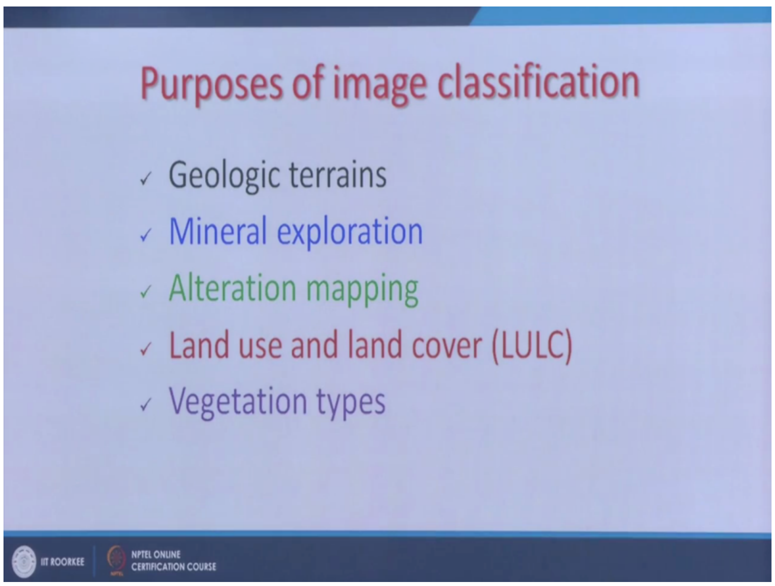

As you know that image is a continuous data, it is not discreet data like a simple map say may be a land use map or a lithological map or soil map where the boundaries are distinct and one unit is there for one soil, one type of soil and another and within in one unit you do not have the variations but an image is a continuous data not a discreet data, so sometimes it becomes very difficult to use continuous data and therefore from continuous to discreet one way of doing this thing is to perform image classification.

Ultimately what we tied to go for image classification to say for a lithological mapping for maybe for mineral exploration maybe for alteration mapping to find mineral deposit or very popular application of image classification that is land use and land cover, LULC in brief we mention. Maybe for vegetation types maybe based on density, maybe based on the species type, similarly in agricultural fields also we also use image classification to show different types of crops, their condition and so on. So basically any image can be classified, can be discretised into certain number of classes as per our requirements and the variability which exists within an image. So this is the not an exhaustive list, it is a everyday new applications and new classification techniques are.

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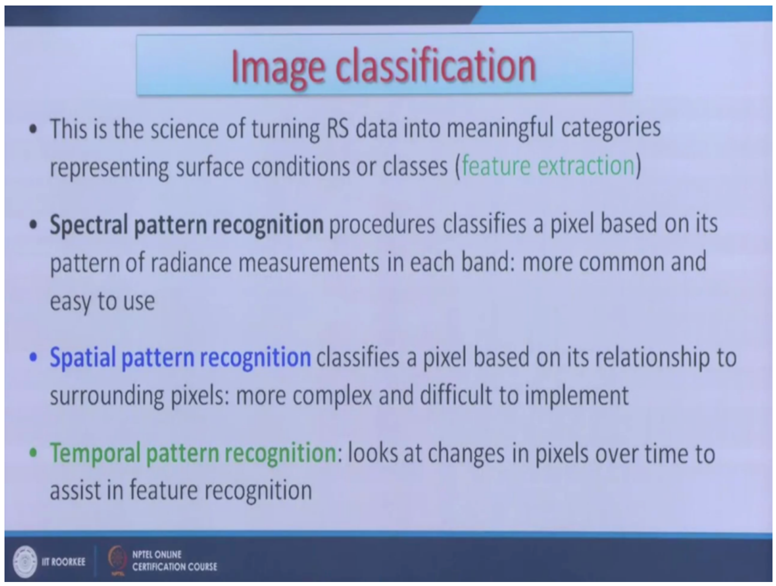

So if you look the different types of classification here basically the as I have mentioned that we would like to covert that continuous remote sensing data into, into discreet form and by (meani) so that we get the some meaningful categories representing surface condition or classes. Also some people call as a instead of image classification they call as feature restriction also some little different terms are also used like better recognition. 6

So there are 3 types of these recognitions 1st is spectral pattern recognition and the (proce) procedures classify pixel based on its pattern of radiance measurement in the each band more common and easy to use this spectral pattern recognition. Then the 2nd one is the special pattern recognition in which this under this the classification is based on those pixel but it build relationship with surrounding pixels. In the previous one each pixel will be treated independently but here the surrounding pixels, neighbouring pixels are also considered. So this one is more complex as compared to spectral classification more complex and difficult to implement.

And the 3rd type is the temporal pattern recognition this is becoming more popular now a days because of lot of data through archives, so look at changes in pixel overtime to assistant feature recognition, so if you are having a time series data, you want to classify, you want to create some maps which can tell lot many things, meaningful, or extract meaningful features than temporal recognitions are possible.

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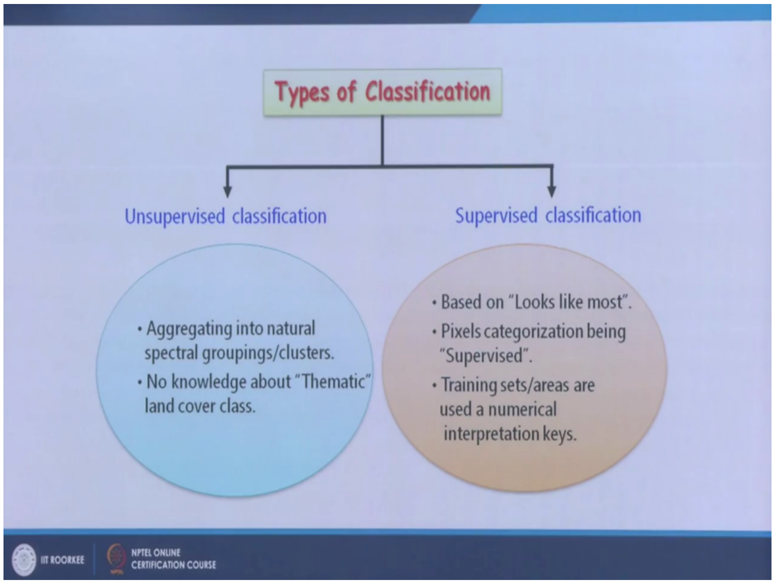

Now different types of classification that was based on the pixel, neighbouring pixels or in the chain detection but in the other way most popular one which you would find in the books of remote sensing or digital image processing is especially this 2 types, 1 is unsupervised classification which we will take little later which is very simple one and popular one as well and supervise class represent which requires certain inputs by the user so that it involves a lot of work and therefore it is more accurate and it will use a both types of this one.

Now in unsupervised classification basically what we do, instead of a continuous data we aggregate this continuous data to natural spectrum grouping or clusters based on their spectral radiance and no knowledge of about thematic cover class, then we perform supervise classification, we do not have basically the ground information much available. Whatever we are seeing on that images based on the spectral radiance based on the spectral districts one can classify under this unsupervised classification.

Not much, not many inputs are required except that if suppose I am having an image I want to instruct the computer or the software that a please classify in it classes, so based on their spectral radiance it classes will be generated but and these maps though it is a one of the very popular way of doing classification but still it is having lot of limitations and they are not that accurate either. But in supervised classification which is like a we identify certain areas that this is per my interpretation skill, this is the forest area, so consider the spectral characteristics of this area and implement this throughout he image wherever the similar characteristics, spectral characteristics exist then consider this as a forest cover.

And if I choose another area like bear soil or bear rocks or sand bodies, water bodies so similarly I train the software or train the system to classify images according to the spectral characteristics available there. So we will see here and that pixel look like most based on that trading set pixel categorisation and because this is being supervised by an user who is going to do classification that is why it is called supervised classification training set of areas are used as a numerical interpretation keys.

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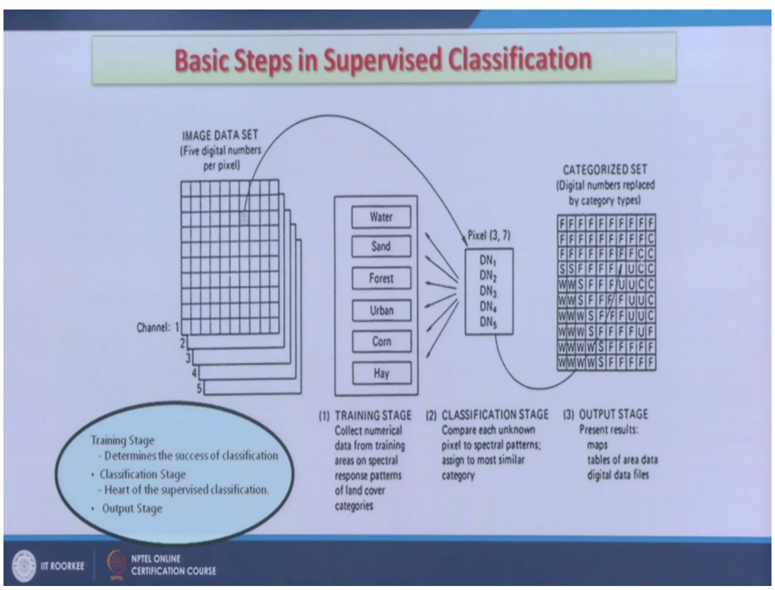

So this is how that if I am having a say false composite of an area and I have, I am having some skill of identifying different ground features then I will train the system that as per my understanding this is water body, this is land you know bear soil rock, forest agriculture land and sand part and other things. Like here in this example that water, sand, forest are one and corn field, hay field and all these things are there as per their you know pixel values in different bands these, these training sets will instructs to classify this image, this color composite or different bands.

So likewise ultimately I will had, so first, first step in this basic basic step in supervise classification is to train that is training stage, collecting numerical data that is means pixel values from different bands, from training areas where I am sure that this is dense forest, so I will select from there, collect the training area and then depending on the spectral response patterns of land cover categories and the second stage is classification stage compare each unknown pixel to spectral patterns assigned to the most similar categories. So wherever the computer will find the similar spectral characteristics that area will get forest and so on so forth. Better the training we give to the system, better the classification we can achieve.

So here the input from user are very very important and then here once a I once these classes have been compared the training sets have been compared with the remaining spectral patterns than the classification is achieved and then in output stage you have a map like if I have classify they say band and then image, a color composite image using these number of classes I will have a map maybe a land use map, forest density map, lithological map, maybe soil map and so on. So likewise I will have a map, I will have table of areas which will tell you, tell us the statistics that how much different categories are covering, what are their percentage and we create the digital files so that we can use elsewhere.

So training stage is very important and it is that is the determines the success of classification, if training sets are very reliable and if I user is having prior information about that area then it becomes very good, if it is not then if I have to do a very accurate classification then one has to go in the field really check whether I the area which I am identifying as a dense forest is really exist in the field or not. So likewise if I have collected field data or training sets from the field and then I input in the image then my classification is going to be very accurate. So classification is still which is the heart of the supervise classification and the output, three stages are there.

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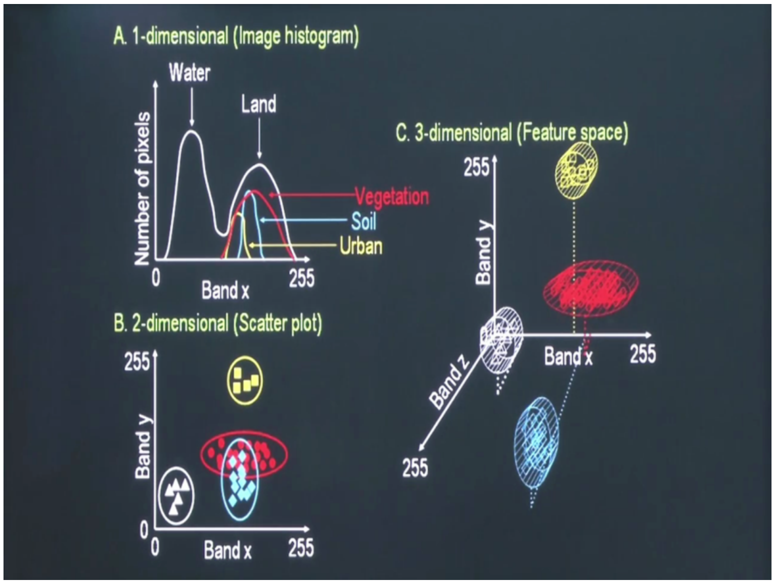

Now the spectral characteristics which we have seen some spectral curves for different types of ground features like vegetation, water, bear soil and all those things. So now there that understanding will really play very important role, like here one way of looking is through this you know this graph like I am having different bands here or plotting against this EM spectrum number of pixels, so what I find that for water there is a one curve for land, there is a another curve vegetation and other thing, so I can distinguish this.

The other way instead of doing this thing I can go for a 2D scatter plot and a I may get clustering of pixels like this, so then I can train after looking such scatter plots. I can train my image for classification in a much better way. But if I am having the facilities to go for 3 dimensional plotting then my like here the red areas which is vegetation in this schismatic and the bear soils, so there is some overlap in 2D, in 2 dimensional space I am seeing but in fact they are altogether different, they there is no overlap so here in the 2D there is a overlap but in 3D I can discollate very easily.

So I can train to, to my software that this area where in this these 2 bands or in 3 bands this is the characteristics of water body these are the spectral characteristics of vegetation there is the characteristic of urban area and or built up area this the characteristics of water and likewise then I can classify more reliably, so instead of 1 dimensional image histogram, we generally we prefer 3 dimensional histogram or even a in sometimes 2 dimensional histogram for scatter plot can serve proper. The best thing whatever is available if we plot here then we can discriminate features based on 3 bands characteristics and they are generally like we perform on a color composite, so there 3 bands will have their plottings, spectral characteristics and then classification can be done.

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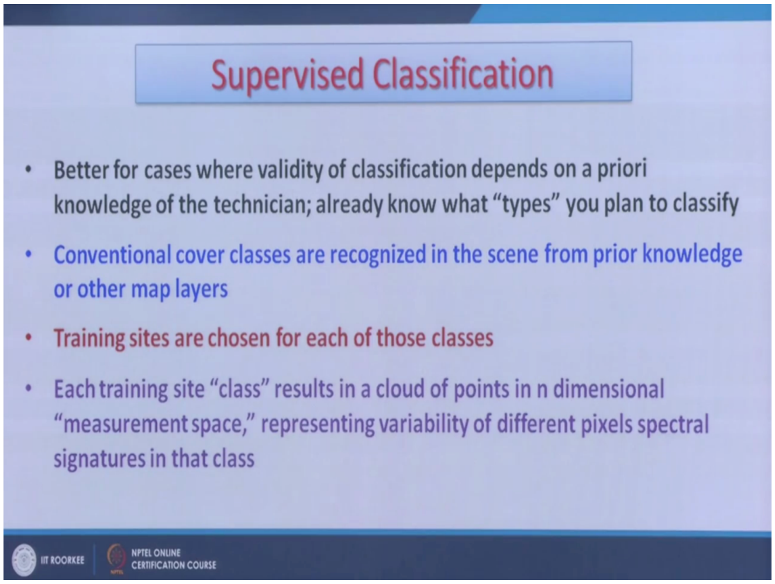

So better as we mentioned that better we train the system, better for the cases we are validity of classification depends on a primary knowledge of the technician or a whoever the user who is going to classify the image. So if we are having some ground information about that area then it is going to be much better way and conventional cover classes are recognised in the scene from prior knowledge after certain experience one.

One becomes a expert on interpretations, image interpretations and therefore one can train the system very easily about different classes and training sets for each class are chosen, then each training site that is class results in a cloud of points in a end dimensional as I have shown in a 3 dimensional space. And then you assign different colors just to represent different classes maybe like for vegetation you may assign green color, water body you may assign blue color and so on so forth.

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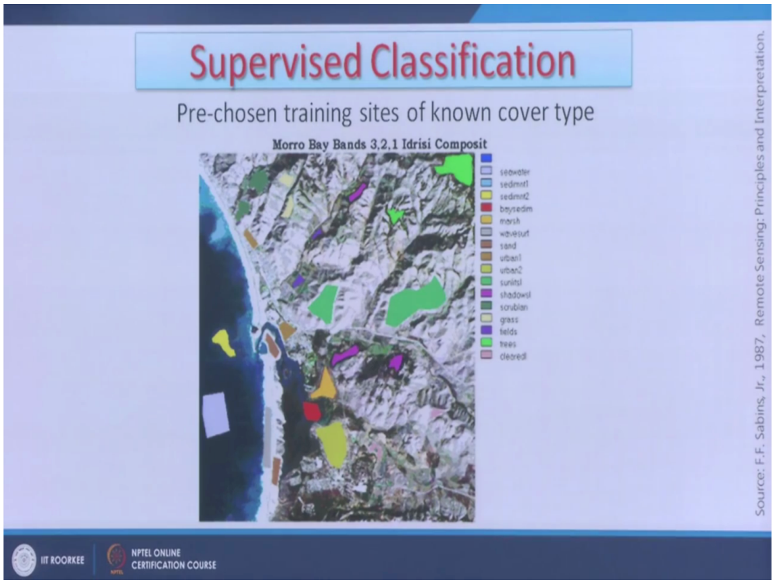

Like here this is an real example that the in main aim is to classify this image as per the land use or land cover type, these 2 terms are used land use and land cover, land use when we use land use word when human interventions are prevailing in that area or prevalent in that area but land cover we use the word when a, when we feel it is a natural territory, not much human interventions are there in that area then we use the word land cover instead of land use.

So in this one, in the land cover analysis these are the different training sites have been identified, how these have been done as explained like if there is a forest or different types of even green patches which you are seeing, these are the training sites, so like like this like green color which is this area, so based on image interpretation or might be priory knowledge about the area, I am sure that this area is having trees big trees.

So this area is been, this much spectral characteristic have been collected and assigned a color and declaring to the system that wherever you find a similar characteristics, the similar characteristics within that image classify it as a trees, similarly for water bodies or sea water like for sea water so this area it is found that ok this is good at training set for the water or sea water, so wherever the spectral characteristics will match within this image that entire area will be classified as sea water.

Maybe for sediments, different type of concentration of sediments which is visible can be classified urban areas and so on so forth. And once these training sets have been collected then rest of the thing has to be expended in the entire image by the computer or by the software that wherever this similar characteristics for each classes will be match, those areas will be assigned the same color and then you get the result which we will see little later.

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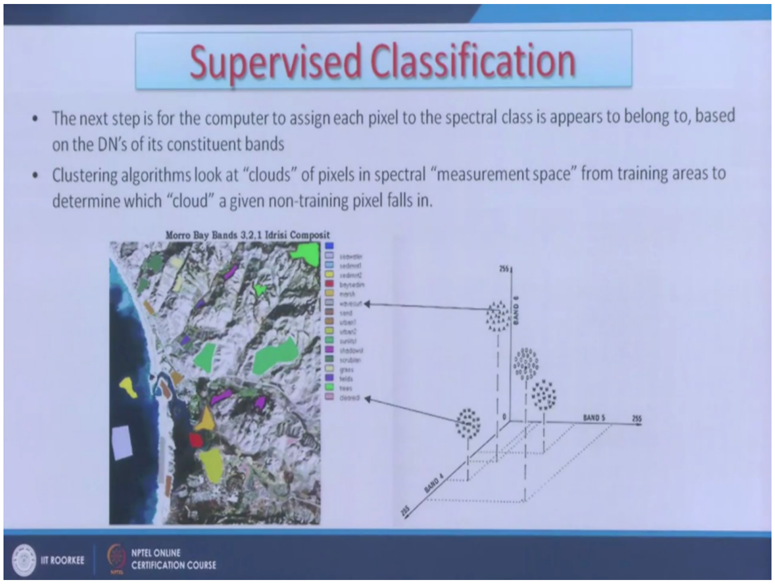

So the after the training sets the next step is for the computer to assign each class to spectral class is appears to belong to these digital number of pixel values of the bands which are being used and clustering aluminium looks at clouds or pixels in spectral measure, measurement space that is in 3D space from the training to determine the cloud or the clustering for a given training samples. Likewise here of this is schematic not these are the like this is a the this color is indicating that these areas have been cleared off, so they are having different spectral characteristics these area waves (())(17:18) which are having like this one having different characteristics and these clusters in 3D space can be seen. So once it is done then algorithm is used different algorithms are there which we will discuss one by one.

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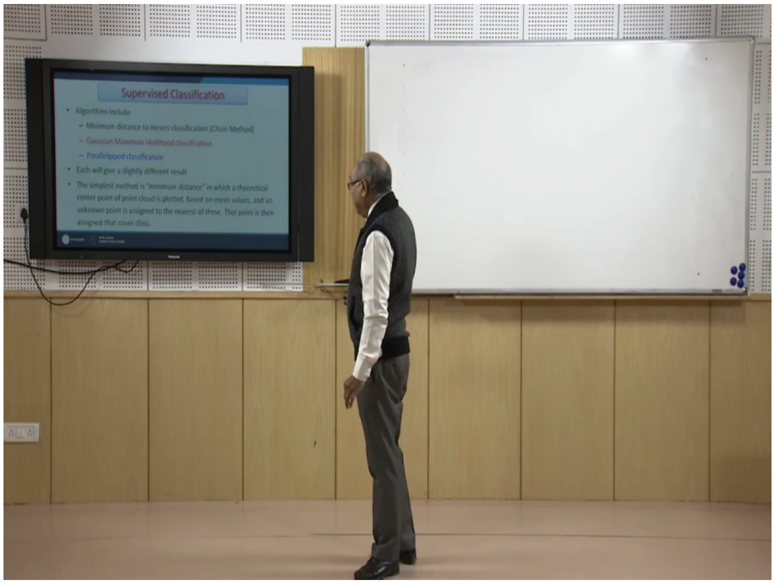

The first one the very popular one is the minimum distance to means classification also called the chain method, another ne is the Gaussian maximum likelihood classification or classifier early piped classification and each will give a slightly different results and we will see some results and we compare how they create different outputs. The simplest method is as I have mentioned is the minimum distance in which a theoretical centre point for each cluster is plotted based on the mean values and an unknown point is assigned to the nearest of these and the point is then assigned to that cloud class, so all these here first minimum distance to mean.

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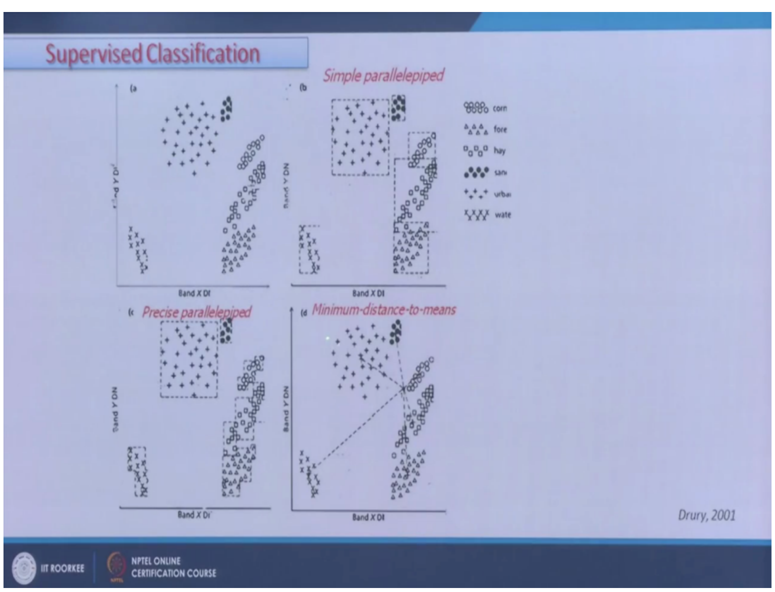

So for each class as mentioned for each cluster there will be a mean and for entire there will be a mean so this is minimum distance to mean, that is the area and the distances are measured and then clusters are decided that these pixels belong to a particular class. Here in this schematic these like these plus symbols are belonging to the urban class and so on so forth. So this way if we go for classification use that algorithm after training sets that is the minimum distance to mean.

Then in there is a parallely piped classification or a where instead of determining the mean a box are drawing drawn and wherever these pixels are falling having the same spectral characteristics according the their they are assigned. As you can realise that here the plotting is same in 2D space, plotting is same like here but I can draw a box so that some more pixels will be included of some other areas but if I draw a circle or a maximum likelihood then I will have a altogether different and therefore there will be some difference in the results.

More precise instead of simple parallely piped classification where only the rectangles or squares are drawn I can draw some other types of boundaries and can have more precise parallely piped based algorithm based classification. So different methods of spectral classification can be represented diagrammatically as here I have just shown.

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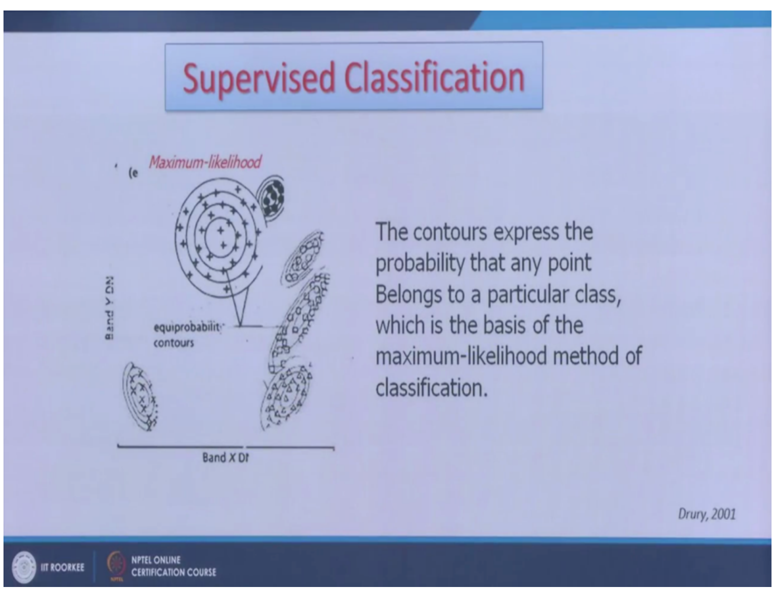

And this is another is maximum likelihood classification the third type that the contours here the contuse are drawn and these are based on the probability that the contours express the probability that any point belongs to a particular class which is bases of maximum likelihood method classification and likewise that the centre of this cluster or having plus symbol is having the maximum likelihood as you go away away then that likelihood intensity decreases and there might be some mixed pixels scenario as well that whether those pixels can be classified at one type of land cover or another type, so these mixed scenarios might be there in certain areas.

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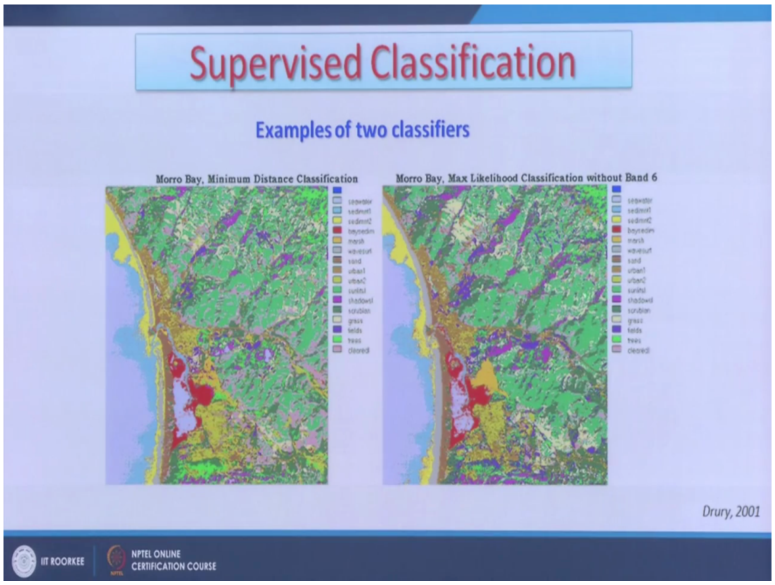

So if a like 2 examples are given, 1 is minimum distance classification based on the training set which we have discussed earlier. Then this is how the output map that is land cover map will look but instead of using a different algorithm rather than minimum distance classification a maximum likelihood which is based on the probability then this is how the map will look, so at several places there are some changes one can notice specially like a this set of areas in this one are much more in maximum likelihood which have been classified here less.

And maybe about this areas, this is the Mercyland which is less classified here but more uniform classification has been done. Now how to, how to judge that which one is the better, so again one is one wants to really check that which one out of these four, three four (ba) algorithm based classification is giving better results than it is always good to go again in the field and check whether the it is the same way it has been classified or there are some spectral or there are some mismatches and then one can come back again and correct it, so these, in this way the classification accuracies can be improved.

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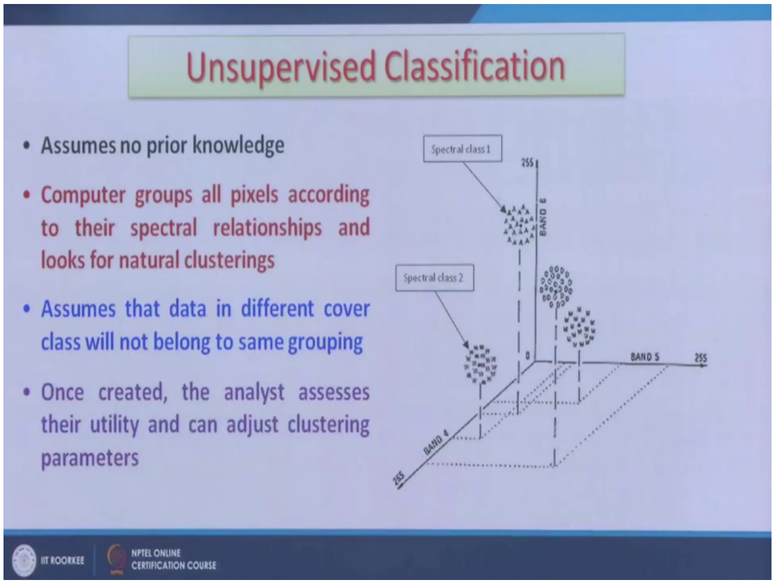

Now initially if we put in 2 categories 1 is unsupervised classification and supervise, supervise we have discussed now come to the unsupervised classification which is completely a software based or computer based classification. Our input is required whether we want to classify that map or that satellite image in 8 classes, 7 classes, 5 classes.

Now this input will come through our image interpretation skill that we interpret the image and find that there are major 8 classes suppose, so then we will assign to the computer that classify this image based on the 8 categories of different land cover so but the concept wise rim that you can think that a in 3D these are the these are the, these are the plots then initially we assign spectral class 1, spectral class 2 that means the clustering of the pixel values in a 3D space and based on that then later on you can assign different clusters of different colors ultimately which will come to different category of land cover.

So here the, the basic assumption that we don't have any prior knowledge about the area, so local information is not available so computer what the software will do, it will group all pixels according to their spectral relationships and look for natural clustering, so wherever it will find the cluster, it may assign 1 class. Now you have to identify whether the class it has assigned is a water body or not and in (convence) in natural convention we will assign blue color to the water body, so in this way we achieve unsupervised classification.

So here assumes that the date data in different cover class will not belong to the same grouping and once created once we have given this to the computer the analyst later on assesses the utility and can adjust a clustering parameter, so later on once we realise that water body is being or bear soil is being classified along with the sand bodies but then some adjustment or accuracy can be introduced if I am share that computer is wrongly classified, so based on their spectral characteristics these things can be adjusted later.

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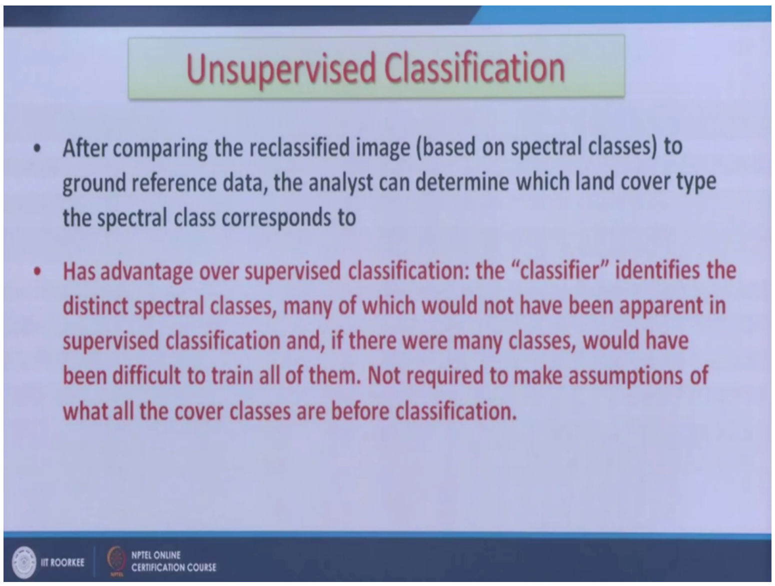

So after a when this comparison is done the reclassified image based on the spectral classes to ground reference data the analyst can determine which land cover type the spectral class correspond to and has the advantage over this technique and supervise classification is having advantage over supervise because here it is done by the computer, so sometimes we might be in supervise classification, we might be choosing a wrong area as a training site.

Training site has to be a very exclusive area when are sure that this is definitely is dense forest or bare soil or you know bare rocks or water body, sand body then only it would assign, so we there we are introducing a bias to the system but in case of unsupervised classification we are at initial stage, no bias being introduced except that we are giving number of classes so that image can be classified. But both are, both types of classifications are having their advantages and disadvantages and this clustering algorithms in unsupervised classification includes like K means textural classification and other thing.

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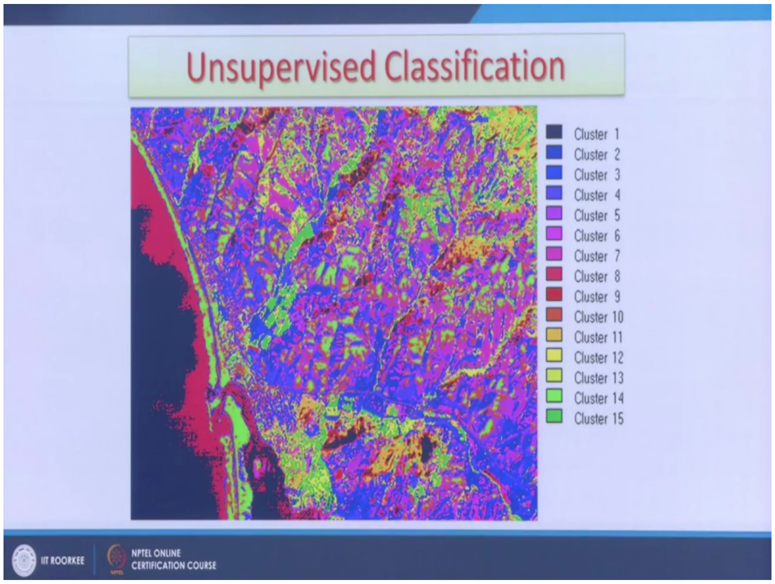

This is the same image was subjected to the same number of 50 number of classes these are the clusters. Now like if I realise that this is the sea water so instead of mentioning cluster I will just put a remove this and I will put a sea water and similarly if I find this color is showing the high sediment concentration then I will say the you know turbidity or high sediment concentration.

If I find that this is a water body then I will assign easily water or whatever, if I find that the green color is the forest area then I will and how I will find, very simple you, you will have one classified image and same time you will have a color composite, so by comparing that one you can assign a to this different clusters, different classes, you may merge, you might realise. So initially what we do in case of unsupervised classification the best practice is to classify in low number of classes than you think so I realised that probably there might be only 8 classes. So first I will instructs the system to classify in 12 classes then I can do the grouping as well and that will make sometimes this iteration makes the classification results much better.

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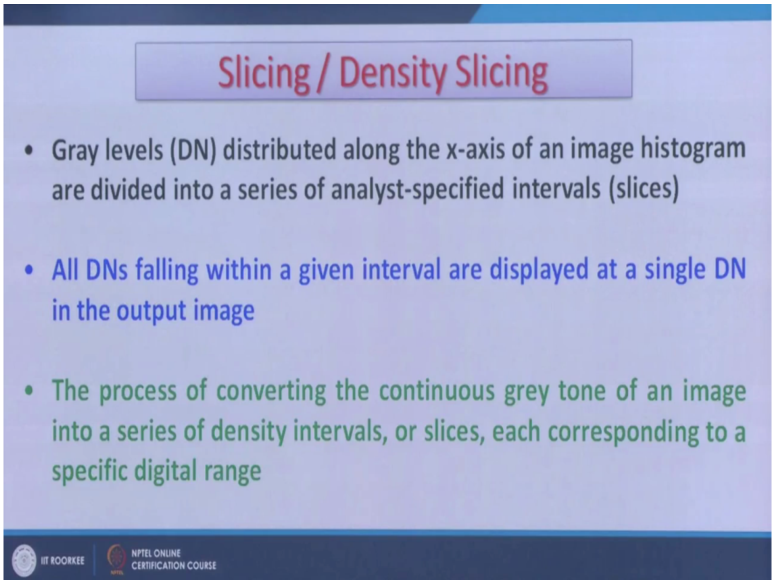

There is another simple unsupervised classification technique on a single band if we perform or maybe at a color composite can be performed which is called slicing or density slicing. Generally it is performed on a single band that is why grey levels or digital numbers distributed along X axis of an image histogram are divided into series of analyst specified interval of slices so it is something like like you are having loaf of bread.

Now you want to classify on equal thickness of slices of the bread or maybe depending on the distribution that means the histogram based on the frequency you want to classify or make the different thickness of the bread as per the requirement. So all digital numbers, pixel values falling within a given interval are displayed as a single DN that means a different color in the output image and the process of converting the continuous grey tone to an image into a series of density intervals or slices which is correspond to a specified in specific digital image.

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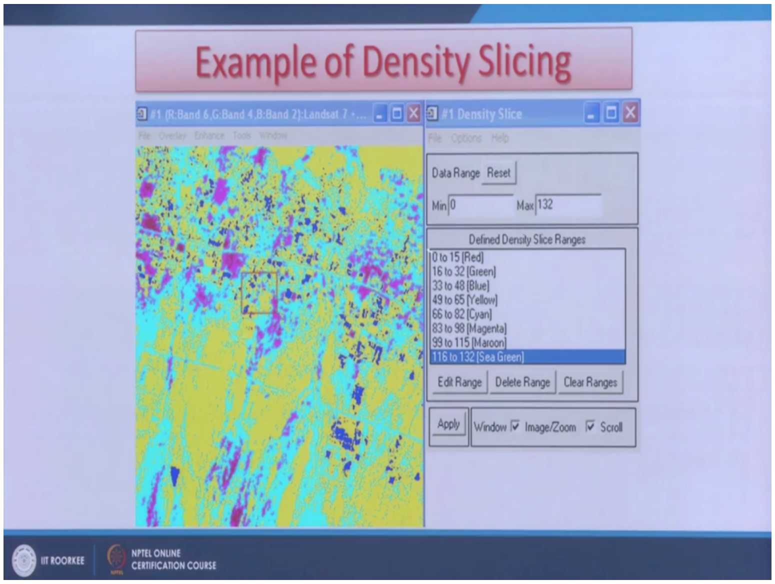

Like for example here that pixel values within 1 band, band 6 example here or that pixel values within 0 to 15 should be assigned red color, 16 to 32 should be assigned 32 and green color and so on so forth. So again this is a simple discretisation instead of having a continuous image the same image is being classified based on so this this distribution of or the thickness of the width maybe different depending on depending on your requirements or you may involve some statistical techniques like equal interval or natural breaks or a quintile there are many such methods are available which can be used to classify a single band image.

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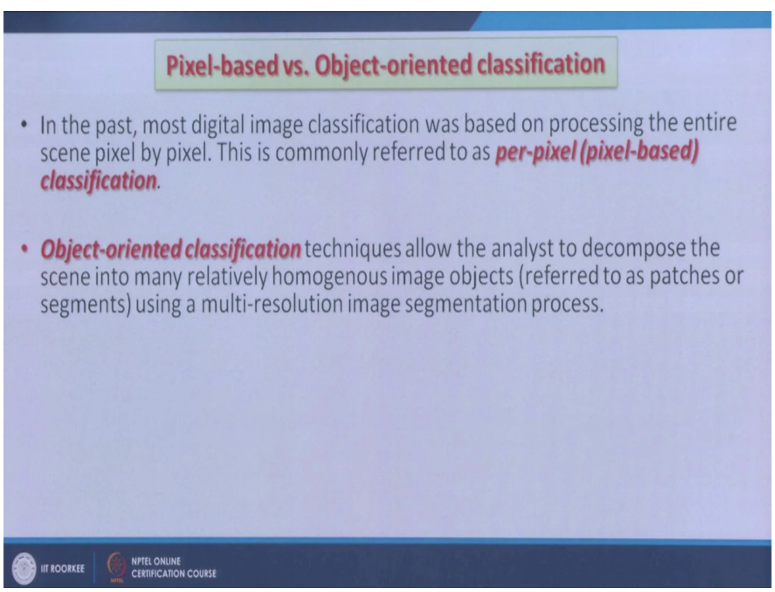

There are some other classification techniques are evolving recent times they have become popular which are pixel based so we compare with these object oriented classification versus pixel based classification, so far what we have been discussing is pixel based.

Now so we can improve on this in the past most digital image classification were based on the processing the entire scene pixel by pixel. So instead of now we may thing about identifying the objects and then going for classification, so object oriented classification techniques allow the analyst to decompose the scene into many relatively homogenous image objects revert as a patches or segments using a multi resolution image segmentation process. So this brings to the end of this presentation, thank you very much.