Geographic information systems
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Module no. #04
Lecture no. #16
Quering and Georeferencing

Hello, namaste, I am back with the next text of module wherein we start with looking at how do we do a query, how do we look at geo-referencing. Georeferencing is to tell you that which portion of the earth's surface that a particular picture belongs to which means that I am trying to tie the coordinates tie the map to certain part of the earth's surface which means as soon as you click on the map it has to say where actually belongs to through using certain references system.

So today we will look at how do we do a georeferencing, what kind of different systems are there and this entire week could be you would be looking at different projections, how geoid, what is a geoid, what kind of geoid are there and how we look at the geoid as a reference point, then what are the datums, how do we look at datums, and then we would also look at certain coordinate systems and probably at may be the end of this week, or the next week would also look at we will start looking at how to use the software and GIS space software for example we will take up with QGIS as first.

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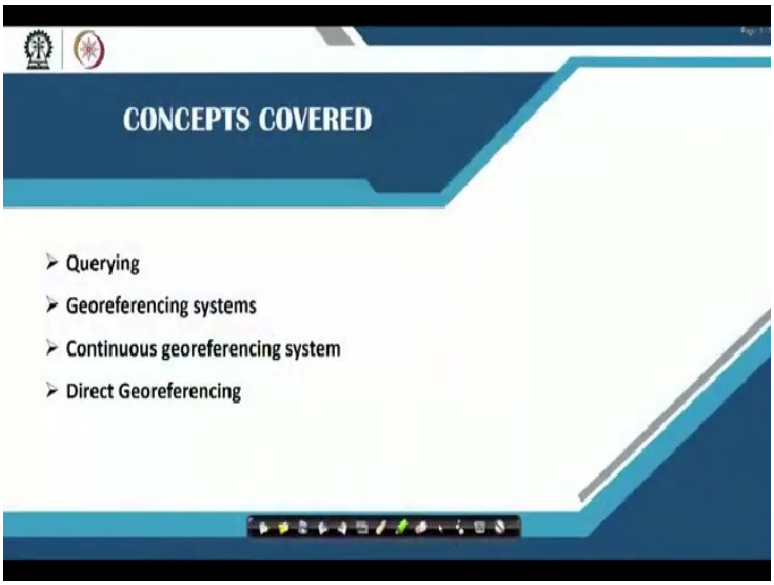

So, in today's class we would do look at query first, then we would go into georeferencing system, different georeferencing systems that we have like the continue georeferencing system under direct discrete georeferencing system.

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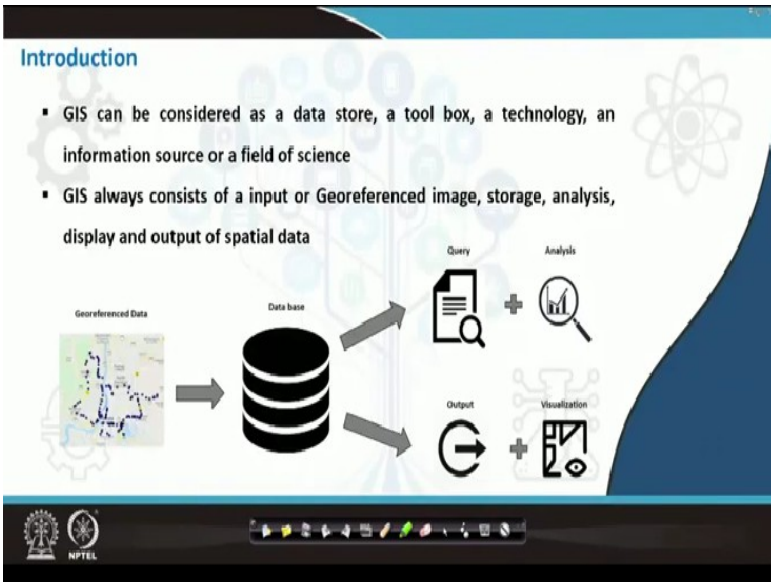

Now, when I in the previous class, I did may be the first set of lectures on the second set of lectures I did define GIS as a data store at toolbox and the technology and science behind the technology that is actually driving the entire set of information to be stored, retrieved at any point of time. So, this is what I informed it I define GIS as defined but many GIS telescope microscope and also you can say that it has a storage of information in certain set of databases.

So that it can be retrieved at will, analyze at will, and also produce output at will using certain data manipulation techniques are data inference techniques. So GIS always consists of an input or a georeferenced image okay. So when you are looking at any data, this has to have certain reference of the earth's surface. So that is how we call that a georeference, geo-means earth, earth reference image.

So, then you should have a storage, then you look at the analysis that you do a query or analysis or you do statistical techniques, then you have a display and output of the spatial data. So that is data depends on how do you want to present the output data in whatever presentable form that you need.

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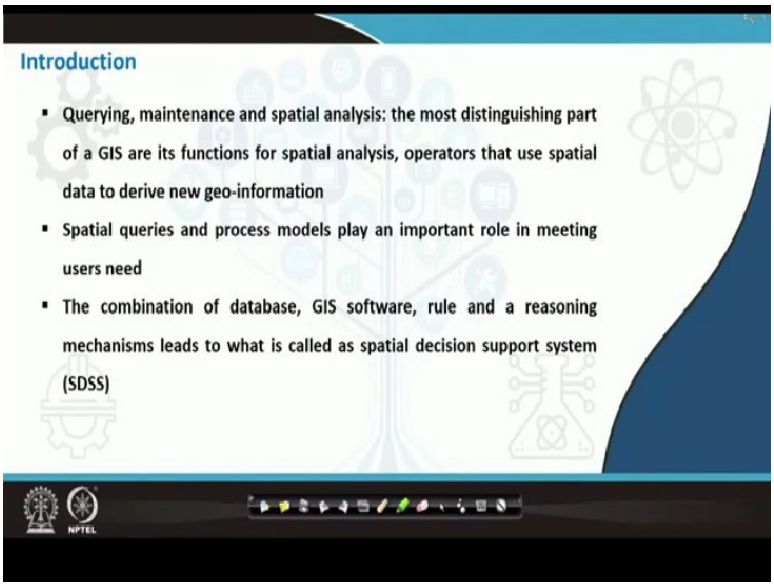

So, when we look at the querying, querying maintenance and spatial analysis is the most distinguishing part of the any GIS. So that is how it is different from any of the static functions that you may find in any other the kind of systems. GIS is that is why it is the most distinguishing part it contains all the 3 systems in it, it starts with querying, it start with maintenance, it also ends with the spatial analysis and output of data, but no other systems which is comparable to GIS has all 3 parts together.

So when you look at a GIS it is functions for spatial analysis operators that we use for spatial analysis data to retrieve new geo-information, when I say new geoinformation, these are information that we can get from clubbing 1 or 2 sets of data 1 or 2 sets of information that is already stored in the database using those data sets we derive a new information, that is what I defined here as a new geo-information.

New geo-outputs, spatial queries and process models play a very important role in meeting the user needs, whenever you are looking at it all the models that we look that using those models those type of data models, we try to do the spatial query and these query yields whatever the results that is necessary for information that on the real world in the form of data model. When we look at the combination of a database a GIS software the rule and the reasoning mechanism this leads to something called as a spatial decision support system.

Now, for example let me tell you, let me give an example. Now, let us say government wants to build a new township, how does it understand, what are the real factor that is influencing that particular region and how the outgrowth may be after maybe after 15 20 30, 40 years. So how you look at it basically. So the first thing you would look at this, how the city has grown over a period a time.

And how it may grow if that township has come into that effort. So, if you have to look at it, you will look at what are the different plans the government has in around the township, maybe, if it is closer to the city along the roads that lead to that township or along the links that lead to the township. Then if there are certain other plans that happen up or if there are industries that are already there.

If there are certain other basic requirements that are already there. So, you have to look at all of this aspect. Once you look at this, then you can easily understand visualize how a decision can be taken. So now you know spatially what is there at what place. Now, using those spatial features you try to decide how a particular township have to be located, where it has to be located, what may be that the maximum capacity or the maximum population of the township okay.

Such kind of analysis can be done and what may be next 20 years 30 years down the link, if this township grows at this particular rate as a city has grown over a period of time, what may be the the population or the outgrowth at that particular stage, it may have outgrown or it may be have a confinement to that region. But what is the kind of growth that it may have and what else very importantly is that if these are the growth poles for example industries.

If there are certain industries, if there are some hospitals if there is some other social economic, activities based agents in that particular region, how are these agents actually playing an important role in developing that, it will play an important role in next 10 to 15 years in developing that entire township. So all of these decision can be taken spatially visualized and then the plan can be made, doing such a thing would actually help in providing all the basic amenities that most of our cities lakhs.

So what we do normally is that we buildup, we built the entire urban system, then look at what is the necessity, keep on adding the necessity and finally when the threshold is heat, you will not be to satisfy any necessity of that particular city. Because the city starts expanding, start growing and making it a confined place or making it looking at a certain amenities to the citizens may be extremely difficult, that how that what made majority of our cities are facing today.

So, if you understand the concept, how it the decision can be taken spatially, then it would be easy for us to develop that particular part of urban system. So now I gave you an example of urban system. This can be applied in the huge number of applications whether it is forest management, whether it is water management or whether it is any of the other aspect, this spatial distance support system can provide an important input in terms for planning.

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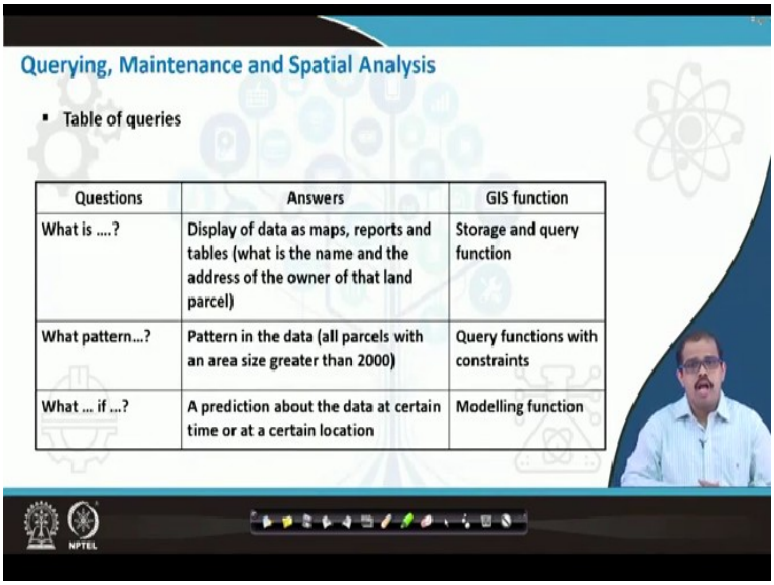

The next thing that we would look at is query, maintenance and spatial analysis. So, when I say certain things for example in general way if I say what is, so it is actually when we are displaying a map report or a table we are trying to define what may be his name or what may the address of a particular or maybe a particular building or a particular place in that particular mapp, that is what we are trying to query in the English form.

But in a GIS function we are trying to look at the storage and querying that particular function. okay, where that particular data has been stored and what is the quality of the data. So we are trying to do that, but when we look at other query like what pattern. Now in a normal English we are looking at when I say pattern, pattern in that particular data whether all parcels in the area size is greater than 2000 okay. So but in a GIS function that query functions with constraints.

It mean to say there are certain constraints for the particular query, and you are making a query, for example, the constraint here is greater than 2000, anything that is greater than 2000 is query able okay. So, if let us say in a general way what if, so now we are trying to say that what would be the situation if this is the pattern okay, so that is nothing but a modelling function, we are trying to see if there is a scenario change in this particular pattern and what would be the result of that particular change.

So that is what is how the querying is done. So, why I have given you this example is to make you understand in a real English the way you speak and how the querying happens. So, it has to be translated from the real kind of language to the queriable form in GIS functions. So, this just an example for you guys to understand how it has to be done.

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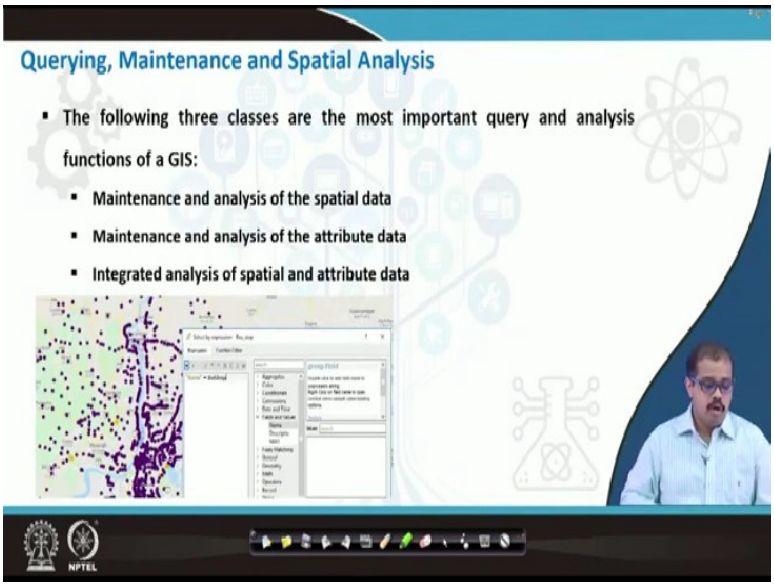

Now when we have a GIS querying 3 classes are most important for querying an analysis that is maintenance, the maintenance analysis of the spatial data, so when I say spatial data these are the

data that is actually is associated with the geo-information of the earth's surface right, so then maintenance analysis of the attribute data. The data that is related to the spatial data which is of information and which is of the thing that you need for your analysis is stored as a attribute data.

So it has to be maintained and analyzed okay, then integrated analysis of both spatial and attribute data. So that is extremely important when you are actually looking at the entire database.

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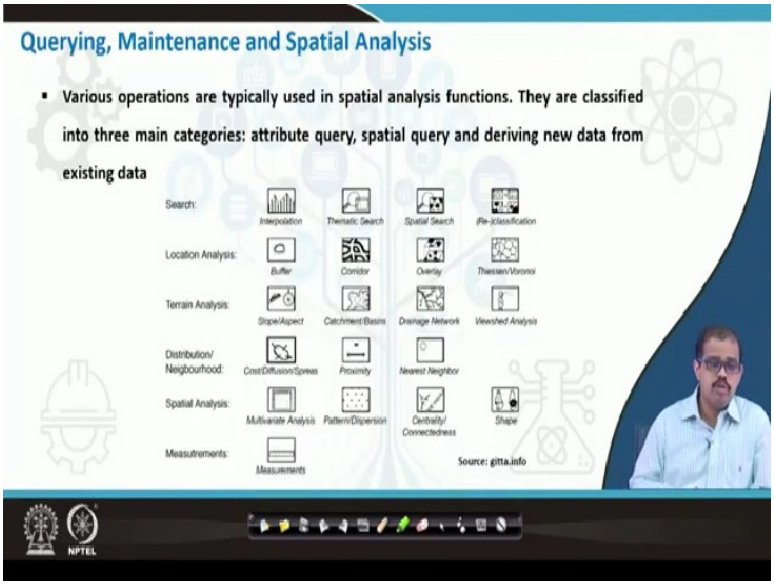

So we can do various operations when I say this so you have attribute data, you have maintained attribute data, you have a special data then using both you can do several operations on your database through the spatial analysis. So, for example, you have a search operation wherein it can be a thematic search, it can be up a it can be a spatial search etc., you have a location analysis, when you are looking at a buffer or a corridor etc..

You have terrain analysis when you are looking at the slope or aspect you say, why the slope is greater than on so so, so this has to be threshold, so that can of analysis can be done if the slope is greater than this so the region only this region can be used for a certain kind of maybe developments. So then distribution of neighborhood functions like cost, diffusion, spread, the proximity.

For example, you say let us say that there is a particular industry in the proximity of that industry next 5 km it may be may not be feasible or it is not good to have human habitation there, so, if it has remarked spatially as the non-habitable regions. So, you will have to draw it spatially and say such kind of proximity analysis can be made the nearest neighbor analysis can be made which is if there are huge number of parcels around.

And you want to find out for a particular parcel which is nearest neighbor such analysis can be made much easily by just a small query. So then is the measurement, measurement query wherein you can do the measurement of a certain region. If you have a polygon you can even measure the area, if you have a line length of that particular line etc. So these queries are defined based on attribute, based on the spatial queries and deriving new data from already existing data that you may have, so such kind of analysts also can be made.

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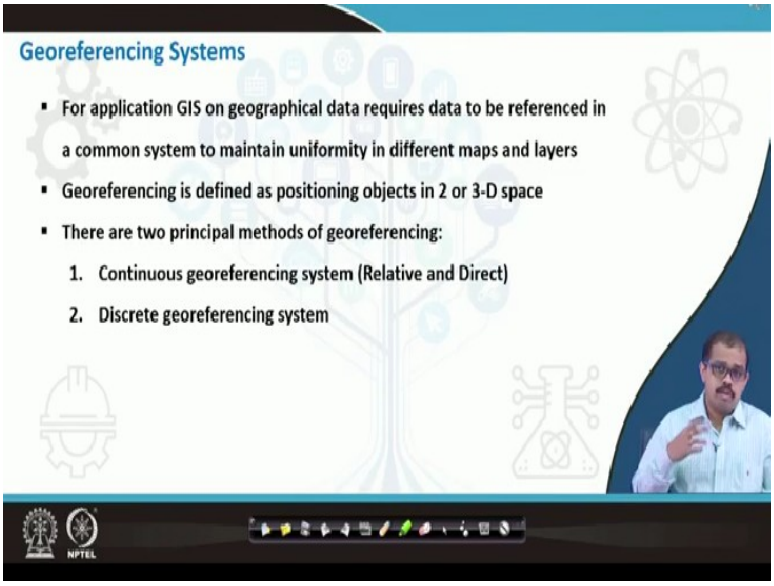

Now once you understood what is a query, so will do certain queries when we are looking at the database functions in the software, will first what will do is that will take up a system will show you how you geo-reference a particular file, then how do you add attributes to a particular file. Then, if you want to do certain analysis inside the attribute table how you do it, then how do you retrieve that information how you show it as a thematic data, how do you query a thematic data.

So all of these things we will learn when we look at our practice sessions, may be in the 9th or in the 10th and 11th week. So till then will understand all the concepts of GIS then once we have understood everything, then probably we can look at how the software works, but next week we would look at an introduction to the QGIS. So you would understand how the software works, so you can download it and install it so that the practice sessions can start parallel.

So next, we look at georeferencing systems, when I am speak about georeferencing system whenever you look at any geographical data okay, it requires a referencing system to for a common system of a maintenance or uniformity okay for example, let us say I develop a georeference map and someone else developed a georeference and there is someone else the third person who is again developing a georeference map.

Now all 3 of this maps if it has to be compared, it has to be in the same referencing system okay. Otherwise, one map sits somewhere, and the somewhere else on earth surface, whereas as the map may sit somewhere else. So comparative analysis of all these 3 maps will not be possible, if it has to be possible, it has to be in the same georeference style. So, it is to say that when you are converting a 3D map into 2D a 3D earth surface into 2D earth's surface, you will follow a certain way of georeferencing style.

So, this referencing style is actually pinpointing that particular area on the earth's surface using certain ways and methods of referencing when you start pinpointing we are saying that this is the way I am looking at the earth's surface. So that is why you need a georeferencing system. Next georeferencing is defined as questioning objects in a 2 or a 3D space. So I gave an example of 3D earth putting it in a 2D but you can always look at georeferencing system as the one where in you positioning your object.

It may be in 2D space or in a 3D space, there are 2 types of georeferencing system and when we look at the very principal method it is continues georeferencing system it is also called as relative and direct we have different types I will speak about this, then we have discrete georeferencing system. So we look at the continuous georeferencing system and discrete georeferencing system in our next set of slides.

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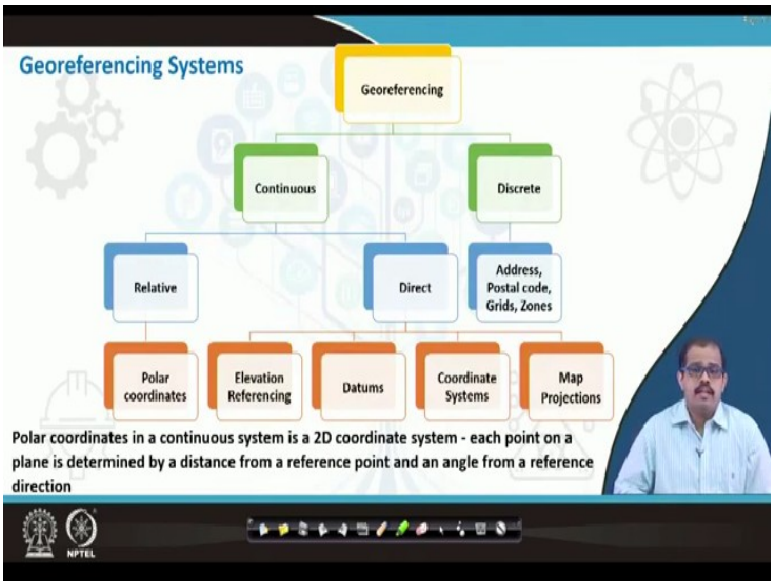

So, when we look at georeferencing as I said we have 2 types one is a continual georeferencing, other one is a discrete georeferencing and when we look at continuous georeferencing it is divided into 2types. One is relative, other one is direct okay. So when we look at relative it is based on polar coordinates okay, when I say polar coordinates, polar coordinates is a continuous system in a 2D coordinate system each point on plane is determined by the distance from a reference point.

And a angle from the reference direction, so which means to say that you have a reference point okay from which you are trying to find out the distance to a reference point okay and then you are also trying to have a angle from a reference directions or a referenced line or a reference region. So, using this you do a polar coordinates. If you look at your cartesian coordinate system you use the reference system in order to look at what the angular or the point position at a particular plane.

So that is nothing but your planar coordinate. Now, when you look at the other way of looking at it as a direct referencing that is using an elevation referencing you can look at the datums, I will speak about the datums in the next class then the coordinate systems, which is extremely important. This is where people actually have do not understand the difference between a

coordinate system or projection a datum etc. which is extremely important when you are looking at any GIS system okay.

If you look at discrete, it can be just like to address, your postal code, your grids, your zones. So, all of these are an example of a discrete system okay, and when there is a discrete system it is actually referring to a certain point on the earth surface defined globally okay. So, if I say my pin code is 721302 there is no other pin code which is actually 721302 on the earth's surface defined okay.

So that is how it is very discreet in terms of representations. So discreet is basically your the representation that you have given find from address, pin code, etc. when you look at continuously have 2 types, relatives and direct and when you look at direct we have a elevation referencing, datum coordinates and map projections. So, all of these things has to be looked that so you have to be extremely careful when you are handling all of the systems okay.

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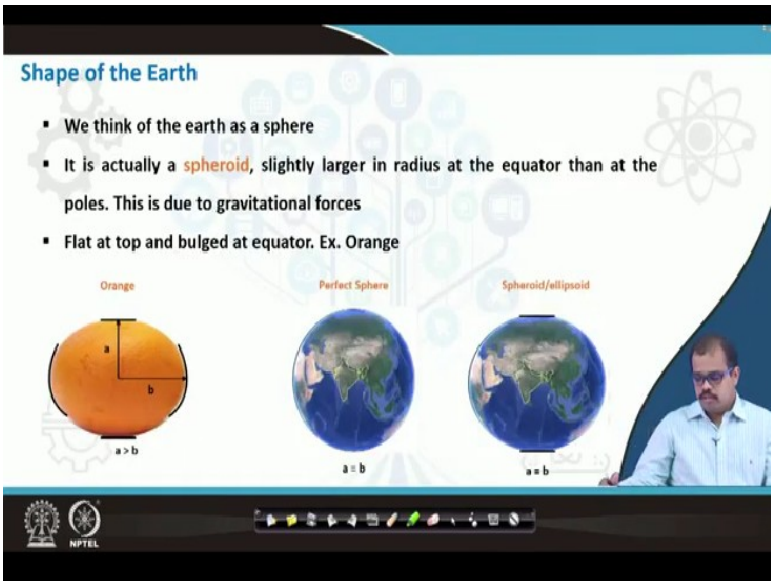

So, first let us understand certain very important aspect. So, when we normally look at earth okay the way we are thought is earth is a sphere right, so but when you look at earth's surface earth is basically not a sphere, it is a spheroid okay. So when I say spheroid if you look at here the sphere is a complete round shaped whereas the spheroid here you do not have a round shape

but it is bulged at the centre, flat at the bottom okay, that is called a spheroid okay, spheroid has a major axis and minor axis, that is what is represented here okay.

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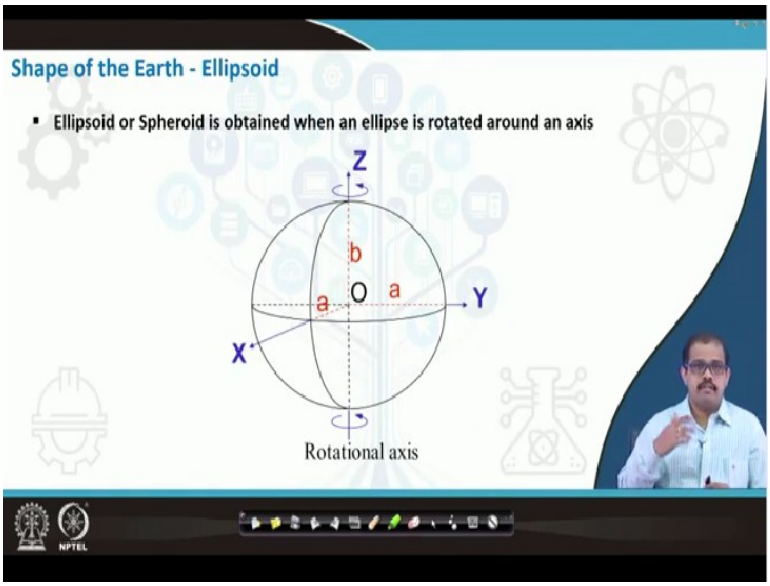

If you want to represent a spheroid so if ellipsoid or the spheroid is obtained when please be very specific here, ellipse is rotated around an axis, you have an axis that is passing to the centre of the earth's surface you rotate an ellipse across the rotational axis, you get the output as spheroid. So, your earth is basically a spheroid and not a sphere okay.

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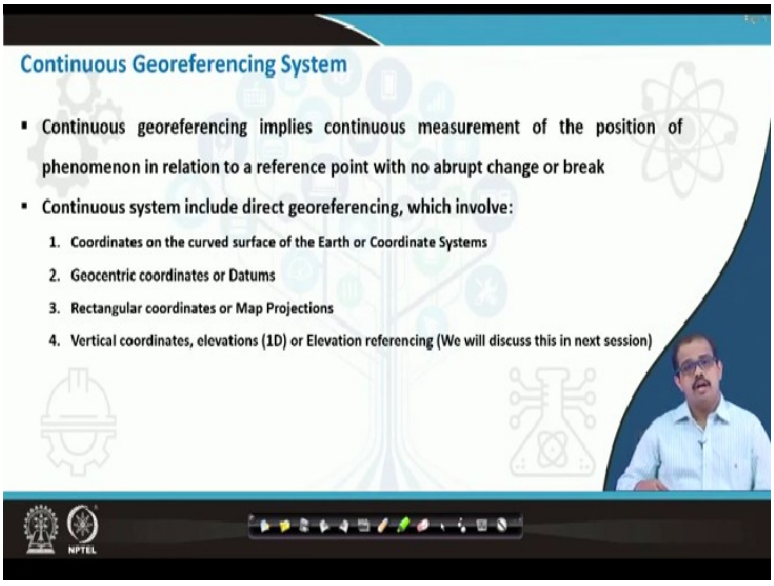

So now once you have understood earth is the spheroid so we look at what are different georeferencing system. The first thing is continuous referencing. So continuous referencing

implies continuous measurement of the position of the phenomena in relationship to the reference point with no abrupt change or a break okay. So when I say continuous there is continuous value that is referred without any break and also the phenomena is in relation to the reference point.

So always we have a reference that we use in a continuous system. And when we look at continuous system it includes direct georeferencing which involves coordinates on the third surface of the earth are its called as coordinate system okay, then the geocentric coordinates or datums, datums are extremely important, then rectangular coordinates or it is called as map projections, please remember the coordinate system datums, map projections and also as the vertical coordinate or elevations or elevation referencing. So we will discuss all of these in the next session okay.

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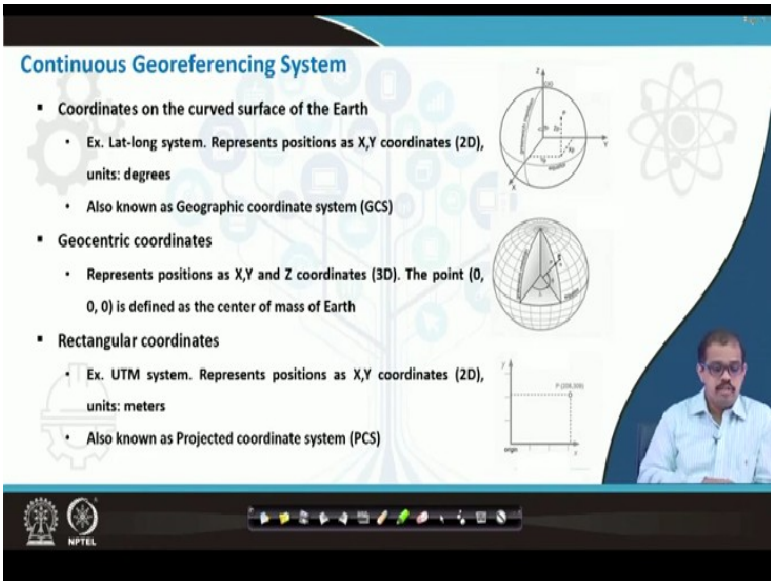

So, when we look at continuous georeferencing system so coordinates on the earth surface of x, y. So, it can be a lat-long system where represent these positions. For example if I am looking at this point is represented by the x and y coordinates okay, when you have a 2D representation. So normally if you have looked at a lat-long system it can be in a degree decimals, it can been in degrees minutes, seconds.

So, any of those formats that normally use is belongs to lat-long system, it is dependent on the user what kind of system used. So then also it is known as geography coordinate system or a GCS okay, then you have geocentric coordinate which represent the position as a x y and z coordinates it is in a 3D, so it is called the geocentric the point, 0, 0 is defined as if you see this okay is the centre of the earth okay.

If this particular point that is being referred here in the centre of the earth, 0, 0, 0 has to move here all your points are mentioned in terms of x, y and z okay, that is relatively reference from the centre, then you have rectangular coordinates. So, this is for example let us say, a UTM universe transfer marketer system, which represents a position as x y coordinates okay. But its unit is in meters is extremely easy for us.

If it is in meters because it will help us in easily calculating the distances etc. So the one of the systems is called as UTM coordinate system. This is also known as a projected coordinate system. So now we have understood what is a coordinate system, what is a datum, what is projected coordinate system right.

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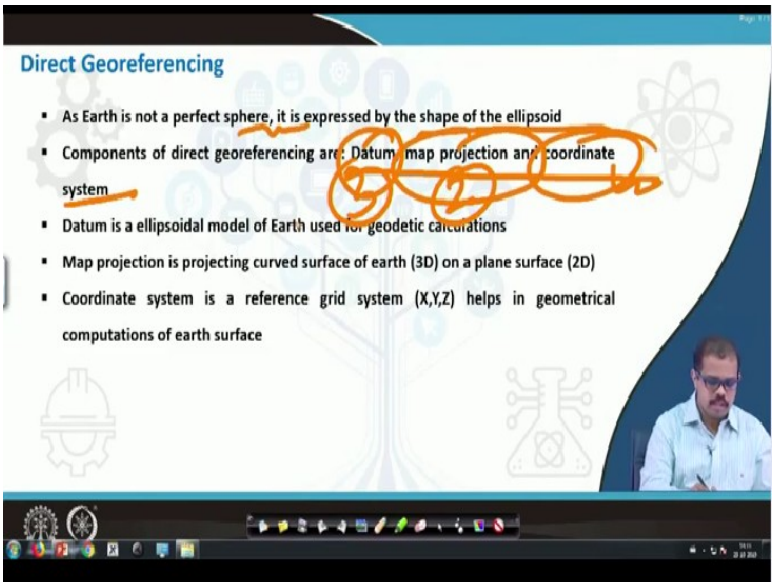

So now let us get into directly georeferencing, so directly georeferencing is defined as I said the first thing that it always looks at as the earth is not a perfect spear okay, so it goes into saying that earth is not a perfect sphere, it is expressed in a as a shape of an ellipsoid okay ellipsoid or a

spheroid. Now the components of georeferencing map. Please be extremely sure about this, you have datum, you have map projections and you have coordinate systems.

So looking at all of these 3 things are extremely important when you are looking at any of the maps okay. What coordinate system this particular map is, what is the projection of a map, and what is the datum of a map. So if you understand these 3 things then you will be able to successfully read a map and look at the map details in much better way. Datum is an ellipsoidal model I am repeating the previous slide. Datum is an ellipsoid model of the earth used for geodetic calculations okay.

Map projection is a projected curve surface of the earth into a 2D for example, if this is the earth's surface a circular earth surface, it is a 3D datum. Now, if you put a light here in front of this earth surface and projected, keep a paper here. So now we are projecting a circular earth onto a paper, so you are projecting it a paper. So, now it becomes a 2D because you have only the reflections, you cannot look at the third dimension of the earth's surface.

So you are projecting it on a 2D, so this kind of projecting system is necessary for us to convert a 3D data into a 2D data for us to understand the details on the earth's surface. Then you have coordinate system it is a reference grid system, it helps in geometrical computation of the earth's surface. Otherwise, you will not be able to compute exactly the geometrical region where you are located, the x y z a components okay. So keep all these 3 things in mind the first thing as soon as you look at any of the digital map as if it is georeferenced.

Please look at its coordinate system, it is a map, it is projection system and then datum because most of the students even today I work whatever I see is that first as soon as they get map they will be enthusiastically looking for what data I can gather, but the first thing up to look at where it is if it is not in a proper coordinate system or projection that you basically need so please projected into that particular system, then use that map for any kind of analysis okay. So, this is about the **geo** direct geo referencing.

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Now let us look at the next part of the slide, wherein we have 3 types of transformations such as cylindrical transformation, conical transformation and an azimuthal transformations. So, these are the transformation which convert the earth's surface here form a 3D to 2D. So this is to represent a curved surface of the earth into a planar surface of the map as I explained previously.

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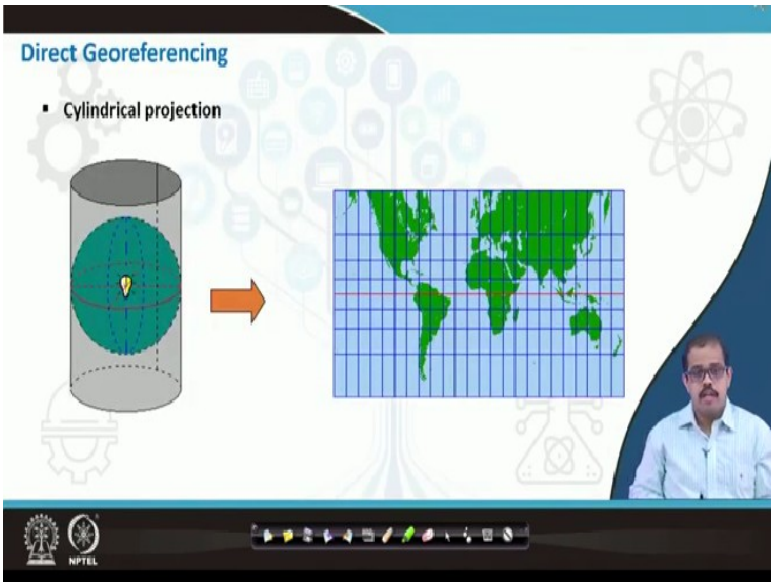

Now when I look at the cylindrical surface, so if let us say I consider this as an earth surface whatever this particular thing is there, so if this is the earth's surface that I am considering now I roll a paper across this something like this okay. Now print whatever is represented on the earth's surface and open the paper, that becomes your cylindrical projection, you are opening a paper like the cylindrical boundary.

So, now whatever is printed from the earth's surface to the cylindrical boundary we that is what is projected from your 3 D surface on a 2 D paper map, that is nothing but you call as cylindrical projection.

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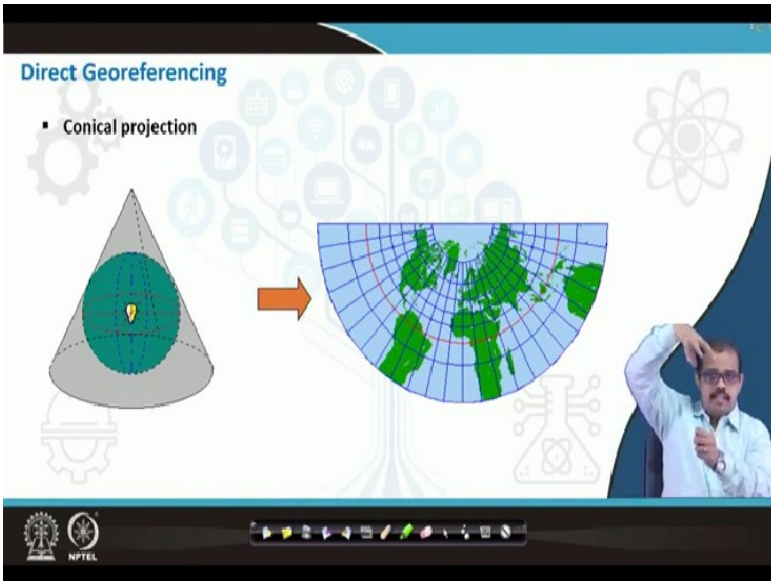

And when you look at a conical projection you have your earth surface like this, then now put a cone like this. Normally, you know about your ice cream cones right, so when you put a cone on this okay. Now you are the conical shape the sharp shape is here and the bottom is the most widest part. Now I have a light that is beaming like this. I open up the entire space okay.

Whatever is that is printed here on from the 3 D earth surface on a 2 D earth surface is a representation from the 3 D towards 2 D. This mean to say that your data is now projected in a form of a conical projections okay, I will discuss each of these in details. I will also say what is the advantage and what is the disadvantage in my next coming lectures.

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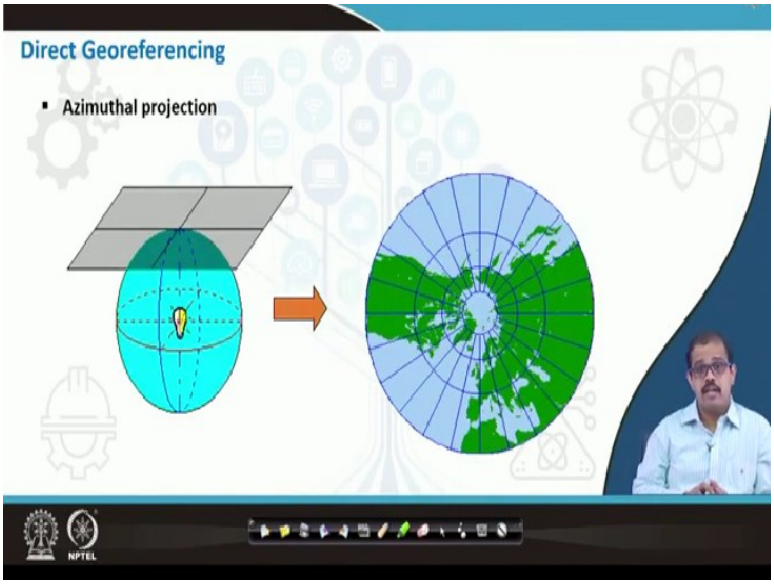

Then the third one is called the azimuth projection. Now you have your earth surface like this okay I keep either paper like this or like this or like this okay, the way you want. If it is near the poles slanted or below near the south pole. Now once you have done add a light opposite to where the paper has been kept, whatever the projections that you see is nothing but the projection on from that point on the earth's surface.

For example, if this is your earth surface and your kept a paper like this put the light across like this. So now with this light the entire earth is projected on the paper, that is nothing but azimuthal projection okay. So you have 3 types of projections you looked at cylindrical, conical and azimuthal projections.

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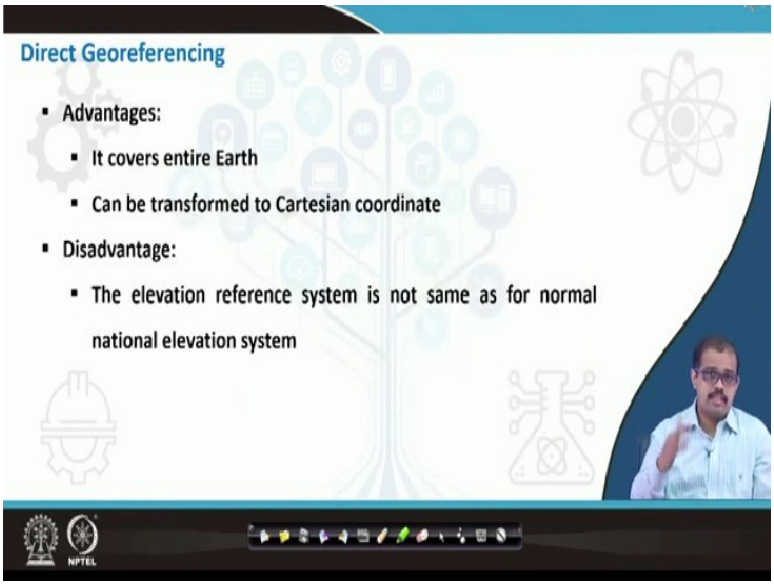

We will look at certain things, certain more details about all of these projections, what is advantages of direct georeferencing is it covers the entire earth's surface, it can be transformed to any coordinate system okay. But, yes it is accompanied by a disadvantage, the elevation referencing system is not the same for a normal national elevasion systems. So I will speak about this and again in my next class.

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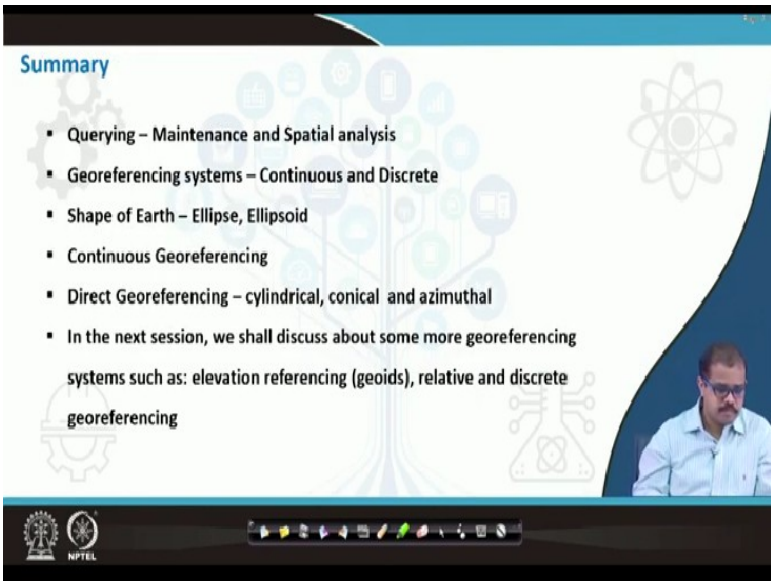

We will be able to better understand what it means. So to summarize this particular lecture, we look at query, as I said querying is about maintenance and spatial analysis, you can do huge lot of spatial analysis just like your English language. But the query defines it in its own way of how the data has to be analyzed, then you have georeferencing system. There are 2 types one is continuous, one is this discrete.

Continuous you have a continuous value where the data is a reference, discreet as it is own representation for example, like a postal code or an address. Then we define shape of a earth, shape of earth is nothing but a spheroid and it is not as sphere as we would think all the time. Then, we have 2 types of georeferencing the continuously georeferencing we look at, then discrete georeferencing we look at the projections, the cylindrical, the conical and azimuthal projections.

In the next class we would look and discuss more about georeferencing system. For example what you mean by elevation referencing which I spoke at a disadvantage in my previous slide, then the relative referencing and the discrete georeferencing. So when you compare all of these would be able to understand what kind of referencing system should look at and why elevation referencing system is extremely important okay, with this I would end this particular lecture. Thank you very much have a nice day.