Geo Spatial Analysis in Urban Planning
Prof. Saikat Kumar Paul
Department of Architecture and Regional Planning
Indian Institute of Technology, Kharagpur

Lecture - 15
Service or Trade Area Analysis in an Urban Area

Welcome back dear students, in the last lecture we had seen application of GIS for network analysis. In today's lecture that is lecture 15th, we would be looking into a Service or Trade Area Analysis in the context of Urban Area.

(Refer Slide Time: 00:33)

Now, we have the different concepts that we are going to cover today, we shall include what is a service or a trade area, I mean we would talk about a descriptive trade area there is also a

prescriptive service area, but we will stick for this particular lecture to the descriptive trade area and we will have another lecture the next lecture on prescriptive service area.

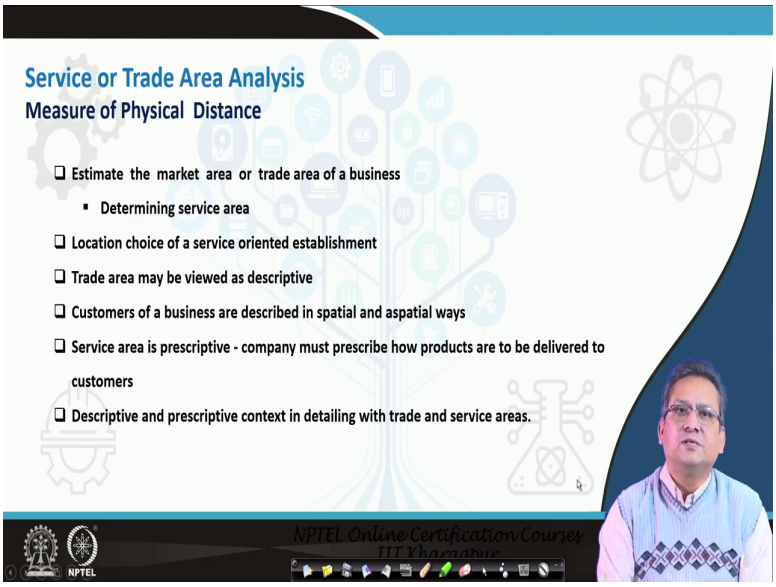
So, we would look into the mathematical representation of a service or trade area and then we will see what are the different equations to how we can implement or I mean do a mathematical representation of the descriptive trade area.

Now, we will also be working on the spatial interaction. So, there are different ways of quantifying this spatial interaction; the first method is a gravity model, the second way that we can identify this interaction is through Reilly's law and the third one is to identify the spatial interaction or identify the strength of the spatial interaction through Huffs law.

So, generally most of these models are interaction models, they work or calculate what is the interaction between different zones in a given city you can have multiple zones. So, between different zones what is the kind of interaction and that interaction would help us in identifying the boundary of trade area. So, this concept of trade area can also be used when you are having some kind of services.

So, when you are having a social service or you are having schools or you are having other I mean services or say your markets or industrial areas I mean these kind of areas I mean opportunities like banks, so, accessibility to banks so, or post offices. So, there we would be able to identify the influence area of these particular type of services in an urban area using these kind of models the special interaction model.

(Refer Slide Time: 03:09)



Now, the measure of physical distance, I mean we can create the market area or estimate the trade area of business by I mean measuring the its influence in terms of say physical distance. So, this would help us in determining the location choice of a service oriented establishment, we can also find out the trade area using descriptive methods. So, we shall look into it how we can do that.

So, the customers of the business are I mean could be described in different ways; one of it could be we can describe it in a spatial manner, where in we do not locate them in a geographical space or we can also put this customers and the business opportunities in a spatial domain and do the analysis.

So, when your service area is prescriptive, the company must prescribe how the products their products are to be delivered to different customers in that catchment in that influence zone or

in the service area. Now, when we are talking about the different context that is your descriptive and prescriptive context, I mean in detailing trade and service areas, I mean we have two different approaches principally.

(Refer Slide Time: 04:47)

.

So, first let us see the descriptive trade area and we have said we will have a follow up lecture, wherein we will see the prescriptive service area. So, first we can choose from a range of potential choices if you are staying somewhere and you have say suppose lot of different types of shops. So, you can choose different types of shops. So, I mean you can decide to choose from a particular case or particular shop like say Big Bazaar or some other shop.

So in this case say if you have Big Bazaar, it gives you some customer cards I mean it gives you some preferential cards by which you can pay upfront money and they give you some kind of benefits. But there is I mean your the company collects data about you about who its customers are based on these customer card information and it also knows where you live in a geographical space through these customer cards, they would also be able to verify your location. So, in a very I mean certain manner the company or the business establishment would be able to generate a map of their trade area.

Now, you can also find out if a seasonally or temporally there are any changes in terms of your customer base or if you introduce a different type of a product line, does it have an impact on the customer base. So, you can analyze that and then what we can do is we can also find out what is the extent of the market area and your the size or the number of people who subscribe to such kind of your shopping establishments depends on the location of the store particular store whether there are competitors around this particular store and how the different customers are distributed.

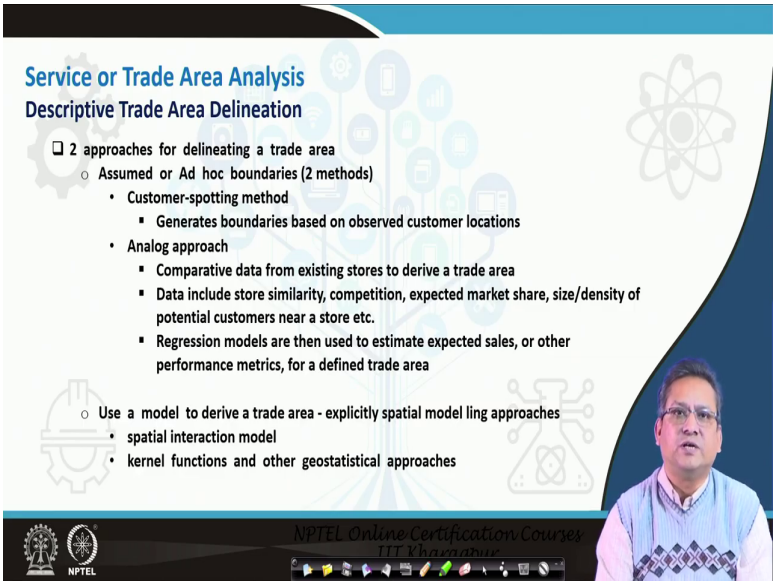
So, it would also be a factor of whether you have parking available in that particular area, in that particular shopping complex when you go for shopping; when you are shopping whether it gives you ample opportunities that your family or your kids can relax over there. So, those kind of experiential things are also included in these type of analysis and we code a utility function which includes all these different parameters or functions.

So apart from the size of the store the location of the store, the distribution of the your competitors the distribution of your potential customers, we also look into the kind of products that are I mean a venture or a business house is selling. So, I mean that product diversity also would attract a bigger customer base. So, we also include that in our calculations.

Now, your urban areas are also cyclical I mean we say we can compare urban areas to a system, which has I mean which would grow which would change I mean over time, which would I mean witness profused growth in some areas or decline in some areas. So, for a

business house it is very important that they can sense these kinds of changes so, that they can thrive in that given environment and make it a profitable venture.

(Refer Slide Time: 08:57)



So, there are two broad approaches when it comes to delineating at trade area, one is we can find out the assumed or Ad hoc boundaries. So, in this method again there are two approaches; one is the customer spotting method which creates a boundary based on the observed customer location. So, either you can do surveys or like we had said we have subscription cards, which will help you in identifying the customer location boundaries. So, we can create a Ad hoc or assume boundaries.

The second approach for assumed Ad hoc boundary is a analog approach. So, in this analog approach what we do is we have a comparative data from the different stores to identify the

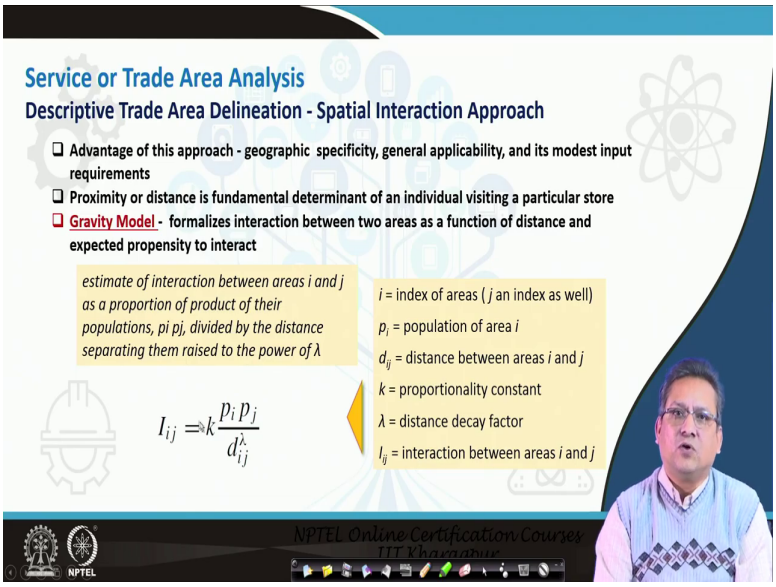
trade area of the different business establishments. So, this is a analog approach where in we already have some kind of data from the existing stores.

Now, these data would generally include a competition the share of the market the potential customer base near a store, its size and density and I mean the similarity in terms of the commodities that is being sold in their I mean retail establishments. So, this data that is being used in analog approaches a approach would encompass these different areas ok.

So, now, how do we solve this problem in an analog using an analog approach? We create a regression model and we can find out the sales depending on we can have the sales as a dependent parameter or a dependent variable and we can have the other variables as independent variables and we can establish a regression based model so, depending on the different types of metrics that we have performance metrics. Now, we can also have a model which can be used to identify or delineate a trade area.

So, we can use explicitly a spatial modeling approach. So, that is the second approach in delineating a trade area wherein, we can work out the spatial interaction between the customers and the business establishments. So, we can find out interaction we can model the. So, we can use kernel functions and different types of geo statistical approaches I mean to identify the trade area.

(Refer Slide Time: 12:00)



Now, the advantage for this type of approach is that, you can identify us region specific or geographic specific trade area and you can use it in any context. So, there is a general applicability of this particular approach and the input requirements are really minimal, its very modest. So, you do not have very exorbitant I mean input requirements. So, its a very simplistic in a way.

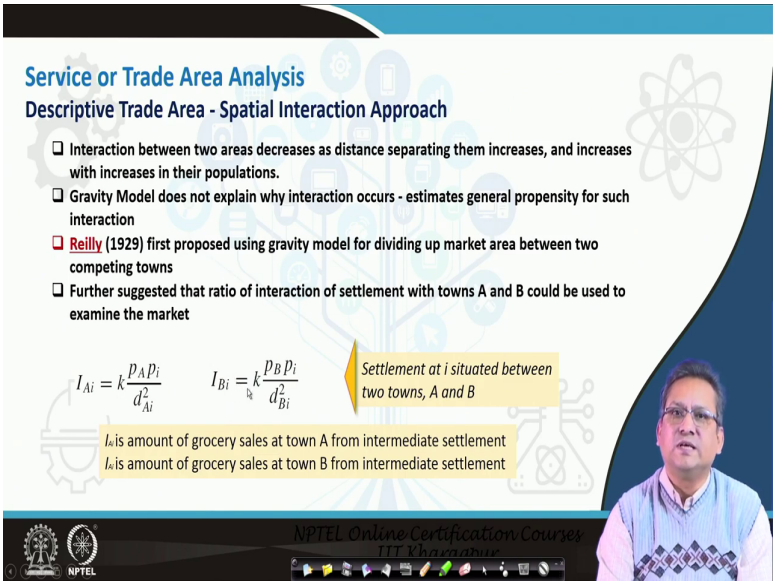
So, the proximity or the distance criteria is the determinant in this particular case and it is measured as a function of the distance. So, in most of these spatial interaction modeling approaches that we would be discussing henceforth are based on proximity or a distance as a function of interaction.

So, first one that we would discuss is a gravity model. So, most of you would have encountered this model in your basic physics, where we tend to calculate the attraction

between two masses. So, we have an analogy of this in a urban area urban context wherein we try to formalize the interaction between two areas as a function of the distance. So, in this case what we do is, using this particular function that is a I mean interaction between areas say i and j which are two areas we try to work out the interaction potential.

So, this is basically the expected propensity of interaction between say population p 1 and population p i and p j and it is inversely proportional to the distance between this ith and jth centroid and is and is raised to the power lambda. Now, this lambda is a distance decay function, it is ah it depends on the distance. So, this power I mean is an indicator of the distance decay. So, in different contexts we would have to derive this lambda and this k is known as the constant of proportionality.

(Refer Slide Time: 14:45)



Now, we can also work out the interaction between two areas which would logically start decreasing if we increase the distance between these two populations centroid and a given facility. So, if the distance is more then the cost travel cost would be more or the time travel time to travel to this particular facility would be more. So, as a result logically would be we would be seeing that the footfall with will start decreasing with increase in the distance.

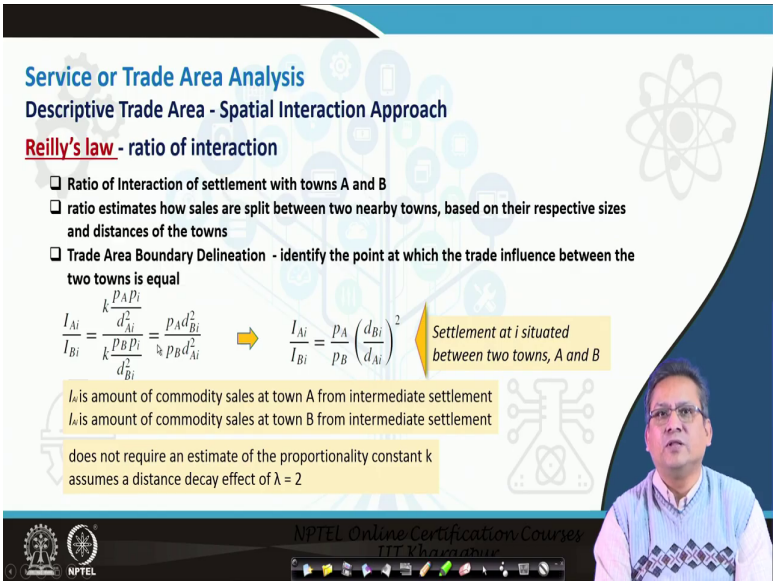
But the basic lacuna or limitation of this gravity model is that, it does not explain why this interaction occur, it is only giving you the I mean quantifying the interaction between two zones, but it is not giving you an explanation why this interaction is happening. So, really I mean he gave this particular model in 1929, which was used I mean which is I mean advancement of this gravity modeling approach for dividing the area and you would be able to find out a crisp demarcation kind of a boundary between two trade zones, two business zones influence areas. So, how we do that? So, what we do is, we work out the ratio of interaction.

So, suppose there are two towns A and B we will see it in the figure and there I mean some establishment or some shops are there, which are selling identical I mean similar type of commodities in town A and town B. And suppose we are located somewhere in between not exactly in the middle, but not exactly I mean located at a equidistance from town A and town B, but we are located in between town A and town B. And we would like to see the kind of interaction between this settlement to this towns A and B for say purchase of different type of commodity.

Now, the interaction for A to the settlement at i can be given by this particular equation we had seen the gravity model. So, in this case we had seen a value of lambda, so you can see instead of lambda now really had suggested that we use a value of 2 substitute a value of 2 for lambda. So, similarly for the town B the interaction can be calculated using this particular gravity model function that is a p B into pi subscript i into ah I mean coefficient I mean proportional anti coefficient k divided by d square Bi that is the distance between the centroid of the town or that particular store and your location of the settlement i.

Now, I mean we had said the settlement is located somewhere between the towns A and B and we know that this Ai I Ai is the grocery sales from town A for this particular intermediate settlement where we are located and a Bi I Bi this particular town is the amount of grocery sales from term from a intermediate location.

(Refer Slide Time: 18:28)



Now, we get the ratio of interaction using the Reilly's law. So, what we how do we get the I mean interaction we will see it as a ratio. So, this ratio would estimate the how your sales what is the proportion of sales between two terms two towns based on their sizes or the distances from the town to this particular settlement. So, as we had said earlier that this process helps us in the delineation of the trade area boundary.

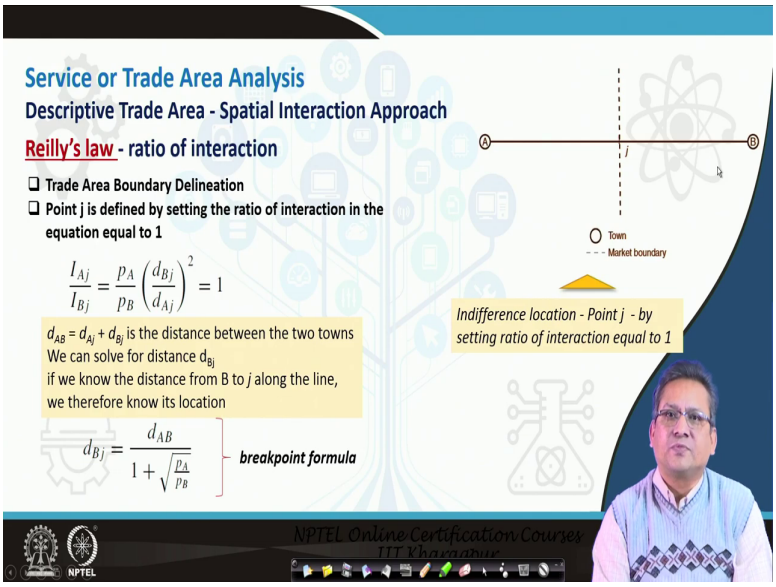
So, we can identify the trade influence, I mean between the two towns I mean we can identify a point where the influence is exactly equal. So, we what we do is we take a ratio of I Ai from

the gravity model. So, we write the equation in the numerator and in the denominator I write I subscript Bi and we write the equation from the gravity model. So, this k cancels out, you will have these terms d Bi going to the numerator and d i A i square going to the denominator.

So, we can your p i is the term which gets cancelled again both are in the numerator. So, we can simplify it and we can write it in this way. So, we can find out the ratio of influence of your town A and B on a settlement i when it comes to purchase of some kind of commodity or sale of some kind of commodity.

So I mean in this case we said that the distance decay function that is lambda, we are using the square terms we are using a value of two for substituting the value of lambda and this constant of proportionality which otherwise would have to be determined would have to be calculated for your gravity model in this case it cancels out. So, we do not even need to estimate the proportionality constant k.

(Refer Slide Time: 20:53)



Now, when we are talking about this delineation. So, let us see and equate this particular equation that is that particular ratio equated to 1. So; that means, that the influence of your town A and town B at that given point is equal.

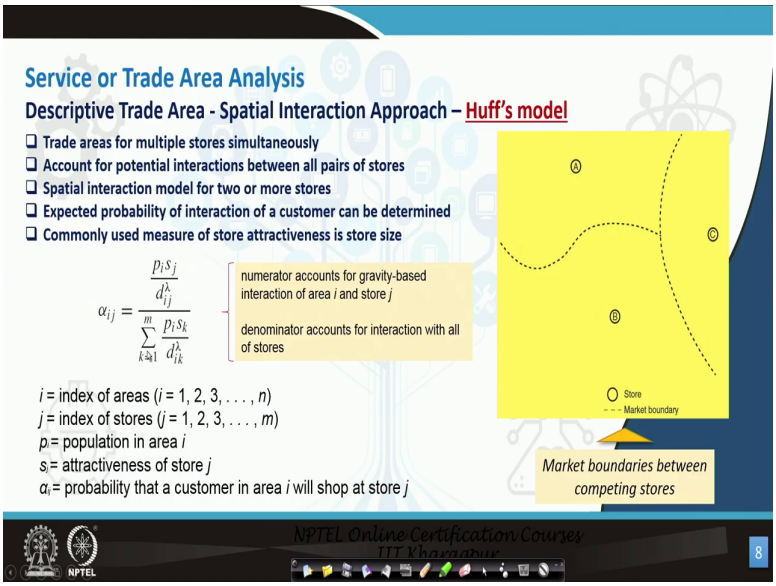
So, this would help us in working out the value of d Bj and d Aj. So, the d AB is the total distance. So, if we can we know this particular distance we know the value of p A and p B, we know the value of Aj and I Aj and I Bj. So, we can find out if we know the value of d Aj or in this case your d AB is d Aj plus d i B. So, we can find out the value of either d Bj or d Aj from this particular equation. So, we know at what distance from B or A, I mean this we can get the break point.

So, if we open up this particular equation. So, we can substitute the other values and this equation assumes this particular form which is d Bj equals to d AB the distance between A and

B divided by 1 plus square root of p A over p B that is a population of A over population of B. I mean in this case you can have some kind of a cost associated some kind of a utility associated with those two services. So, in that case you can substitute this different values.

Now, this is your break point, this is the calculation of the break points. So, you can calculate the distance in this case we have worked out the d i B or d B i. So, this is the indifference location where in a person residing out in this particular location is indifferent, he may choose to go either to a location A or location B for his purchasing. So, this point is known as the indifference point.

(Refer Slide Time: 23:20)



Now, the next model that we use is the Huff's model. So, in this particular model in the Reilly's model that we have discussed, we have seen that we can identify the boundary the equi potential point only between two locations, two I mean points, two towns or two I mean

establishments business establishments. But in a geographical area we may have multiple stores which I mean might exert some kind of I mean trade area boundary around it, which may have some trade area boundary and it would also have its inflection points.

So we can account for the I mean interaction between all these pair of stores using a approach, which is known as Huff's model. Now, we can find out the expected probability of interaction. So, we can these gives the attractiveness of the store and we try to use a utility function. So, we find out this probability of a person or customer interacting with a particular store as a function alpha i j that is given shown here in this particular equation.

So, it is a ratio of the interaction of a given customer to this particular store to summation of the interaction of all the I mean customers, index of the areas and the number of stores. So, I mean you take a ratio of that. So, in this case we work out the S j or S k which are basically the attractiveness of the store.

So, these attractiveness would be calculated based on say the footprint of the store. So, if we have a big store; that means, I mean you can take it for granted that they might be having a more I mean varieties of things that you would want to buy, they would have better facilities. So, I mean the total area that is the floor area of the store is a major I mean a consideration when we are trying to find out the attractiveness or utility of the store in this particular case.

So, we in this case your numerator you can see is a gravity based interaction within your area i and your store j. So, we have the area i and we have the store j. So, we can have different areas I mean different zones and we can have different stores. So, we can find out this interaction using this gravity potential model again you see that lambda has come up over here. So, the denominator would account for the interaction with all the different stores of different locations.

(Refer Slide Time: 26:48)

So, a recap of what we had done today. We had introduced the concept of service or trade area, we said there could be a descriptive trade area and there could be a prescriptive trade area, we have talked about the descriptive trade area today in the lecture and in the subsequent lecture we will be talking about or discussing about the prescriptive service area.

We had done a mathematical representation of the service area and we had done our descriptive trade area wherein, we model the spatial interaction first by using the gravity model, but we said gravity model has a limitation in a way that it gives you the interaction, but it does not give you the nature of interaction and also finding out the value of k and lambda is a issue.

Now, in the Reilly's law, we said we can find out the boundary between the trade areas I mean the if there are two competing stores, you can find out the exact boundary wherein you can

find out a point of indifference a person located over there would be indifferent to purchasing goods from either of these two stores located on at two different locations.

Then, we had said that Reilly's law has a limitation because we can only identify the trade boundaries between two establishments. Now, what happens if there are multiple establishments and we want to code this interaction the spatial interaction. So, we had further worked on or we had seen the Huff's model or the Huff's law wherein, we have seen that we can code the interaction as a function alpha for different zones or different areas and we can calculate a ratio to find out what is the I mean propensity of interaction or between say zone i to a store j. So, I mean this is what we had covered today and we shall be continuing with this lecture in the next class.

Thank you so, much.