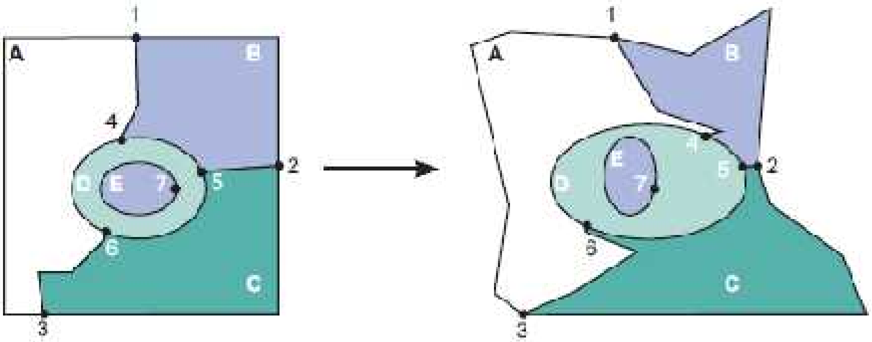
Q1/ What different between continuous fields and discrete fields?
Solution:
In a Continuous fields, the underlying function is assumed to be continuous, such as is the case for temperature, barometric pressure or elevation. Continuity means that all changes in field values are gradual. A continuous field can even be differentiable. In a differentiable field it can determine a measure of change (in the field value) per unit of distance anywhere. If the field is elevation, this measure would be slope, i.e., the change of elevation per meter distance; if the field is soil salinity, it would be salinity gradient, i.e., the change of salinity per meter distance.
Discrete fields cut up the study space in mutually exclusive, bounded parts, with all locations in one part having the same field value. Typical examples are land classifications, for instance, using geological classes, soil type, land use type, crop type or natural vegetation type.

Q2/ What will be happened when pull a sheet of rubber on edges but don't tear or break it?
Solution:
The figures will change in shape and size. Some properties, however, do not change:

- E is still inside D,
- The neighborhood relationships between A, B, C, D, and E remain, and the boundary lines have the same start and end points, and
- The areas are still bounded by the same boundary lines, only the shapes and lengths of their perimetry have changed.



Q3/ Explain the scale and resolution when applied it with spatial data.
Solution:
When applied to spatial data, the term resolution is commonly associated with the cell width of the tessellation applied. Digital spatial data, as stored in a GIS, is essentially without scale: scale is a ratio notion associated with visual output, like a map, not with the data that was used to produce the map.

Q4/ Geographic phenomenon can defined by three parameter, what it. And speak about it when missing one of them.
Solution:
It might define a geographic phenomenon as that:
• can be named or described.
• can be georeferenced.
• can be assigned a time (interval) at which it is/was present.
Observe do not claim that all relevant phenomena come as triplets (description, georeference, time interval), though many do. If the georeference is missing, it seems to have something of interest that is not positioned in space: an example is a legal document in a cadastral system. It is obviously somewhere, but its position in space is considered irrelevant. If the time interval is missing, it seems to have a phenomenon of interest that is considered to be always there, i.e., the time interval is infinite. If the description is missing, it has something funny that exists in space and time, yet cannot be described.

Q5/ The more natural way to represent geographic objects is by vector representations, discuss that.
Solution:
These objects are represented as area representations in a boundary model. Nodes and vertices of the polylines that make up the object's boundaries are not illustrated, though they obviously are stored.

Q6/ There are two ways using to represent geographic phenomenon in computer memory, speak about it. And speak about their disadvantages.
Solution:
• try to store as many (location, elevation) pairs as possible, or
• try to find a symbolic representation of the elevation function, as a formula in x and y—like ($3.0678x^2 +20.08x-7.34y$) or so—which after evaluation will give us the elevation value at a given (x, y).
Both approaches have their disadvantage. The first suffers from the fact that will never be able to store all elevation values for all locations, there are infinitely many locations. The second approach suffers from the fact that have no clue what such a function should be, or how to derive it, and it is likely that for larger areas it will be an extremely complicated function.

Q7/ Define geographic field and geographic object and type examples for everyone.
Solution:
A (geographic) field is a geographic phenomenon for every point in the study area, a value can be determined. The usual examples of fields are temperature, barometric pressure and elevation. These fields are actually continuous in nature. Examples of discrete fields are land use and soil classifications. Again, any location is attributed a single land use class or soil class.
Many other phenomena do not manifest themselves everywhere in the study area, but only in certain localities. The array of buoys of the previous chapter is a good example: there is a fixed number of buoys, and for each can know exactly where it is located. The buoys are typical examples of (geographic) objects.
(Geographic) objects populate the study area, and are usually well distinguishable, discrete, bounded entities. The space between them is potentially empty.

Q8/ The spatiotemporal models have characteristics for every model, what it for the snapshot model and event-based model.
Solution:
The snapshot model
In the snapshot model, layers of the same theme are time-stamped. For every point in time that we would like to consider, we have to store a layer and assign the time to it as an attribute. We do not have any information about the events that caused different states between layers. This model is based on a linear, absolute, discrete time. It supports only valid time and multiple granularity. The spatial domain is fixed (field-based) and the attribute domain is variable. As many current GIS systems lack support for temporal data, the snapshot model is the most commonly used model. GIS end-users, however, have to build their (time-stamped) data layers themselves, and commonly the GIS system is no built-in awareness of time issues. This means that analysis-for instance for change detection-has to be hand-coded by the end-user as well.
The event-based model
In an event-based model, we start with an initial state and record events along the time line. Whenever a change occurs, an entry is recorded. This is a timebased model. The spatial and thematic attribute domains are secondary. The model is based on discrete, linear, relative time, and supports only valid time and multiple granularity.

Q9/ The software technology used in spatial data are geographic information systems. Discuss that.
Solution:
Typical planning projects require data sources, both spatial and non-spatial, from different institutes, like mapping agency, geological survey, soil survey, forest survey, or the census bureau. These data sources may have different time stamps, and the spatial data may be in different scales and projections. With the help of a GIS, the maps can be stored in digital form in a database in world coordinates (meters or feet). This makes scale transformations unnecessary, and the conversion between map projections can be done easily with the software. The spatial analysis functions of the GIS are then applied to perform the planning tasks. This can speed up the process and allows for easy modifications to the analysis approach.

Q10/ Networks are sets of interconnected lines through which resources can flow. What Classic networking problems, discuss that.

Answer: Classic networking problems:

- Shortest path
- Traveling salesman problem (visit many locations in a day – what is the quickest route to them all?)
- Location-Allocation modeling (e.g., matching supply of services with demand through a road network)
- Route tracing (ability to trace the flow of goods, people, services or information through a network of lines)

Q11/ Barriers very important when create network dataset; define it and type the various types of barriers then explain one of them.

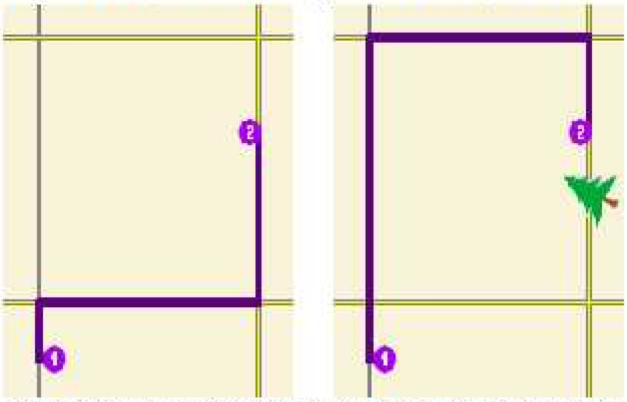
Answer:
Barriers are feature classes in network analysis layers that restrict or alter impedances of the underlying edges and junctions of the associated network dataset. Barriers are split into three geometry types (point, line, and polygon) and are designed to model temporary changes to the network. The various types of barriers are introduced below:

- A restriction point barrier
- An added cost point barrier
- A restriction line barrier
- A scaled cost line barrier
- A restriction polygon barrier
- A scaled cost polygon barrier

Barriers

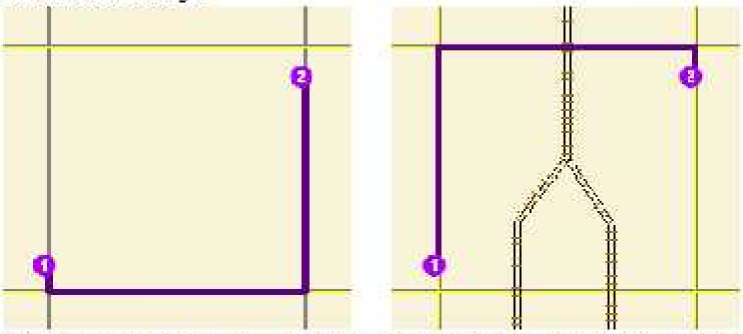
Barriers are feature classes in network analysis layers that restrict or alter impedances of the underlying edges and junctions of the associated network dataset. Barriers are split into three geometry types (point, line, and polygon) and are designed to model temporary changes to the network. The various types of barriers are introduced below:

- A **restriction point barrier** can model a fallen tree, an accident, a downed electrical line, or anything that completely blocks traffic at a specific position along the network. For point barriers located on edges, travel can be permitted on the edge but not through the barrier. Optionally, travel can be prohibited anywhere on the edge the restriction point barrier is located on.



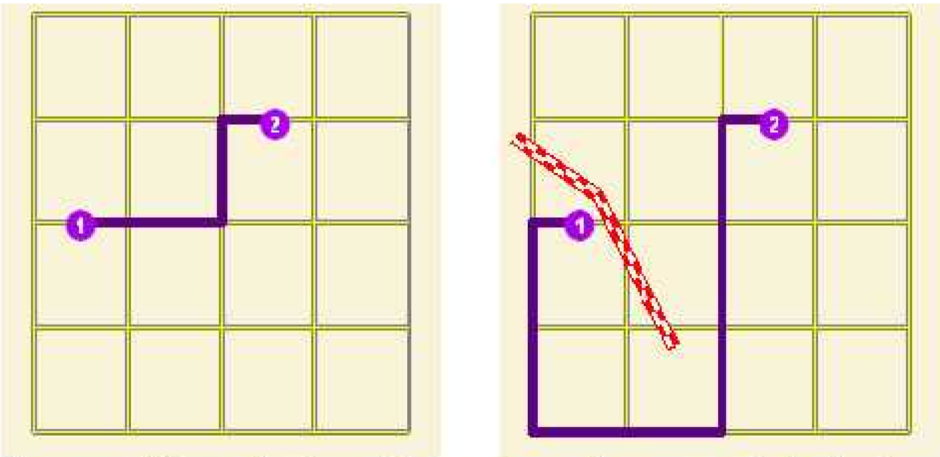
The map on the left shows the shortest path between two stops without any restriction point barriers. The map on the right has a road that is blocked by a fallen tree, so the shortest path between the same points is longer.

- An **added cost point barrier** permits travel through the barrier, but going through it incurs a cost that you specify, such as one minute. Added cost point barriers can be used to model the delay caused by a car accident or the extra time required for a truck carrying hazardous materials to stop at railroad crossings.



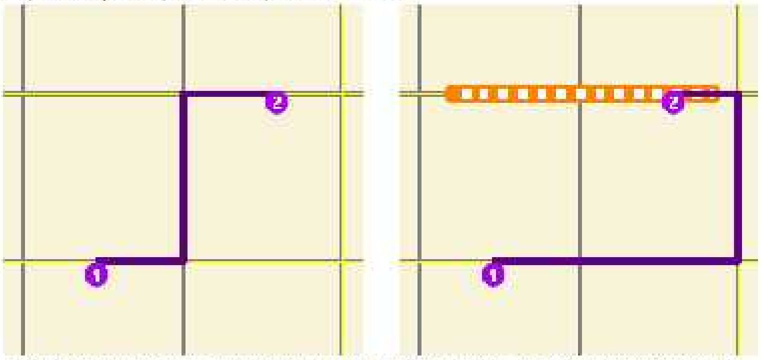
The travel time from stop one to stop two would be the same whether going around the north end of the block or the south end; however, since crossing railroad tracks incurs a time penalty (modeled with added cost point barriers), the route with only one railroad crossing is chosen. The cost of crossing the barrier is added to the accumulated cost of the resulting route.

- A **restriction line barrier** prohibits travel anywhere the barrier intersects the network. For example, a parade or protest that blocks traffic across several street segments can be modeled with a restriction line barrier. This type of barrier can also quickly fence off several roads from being traversed, thereby channeling results away from undesirable parts of your network.



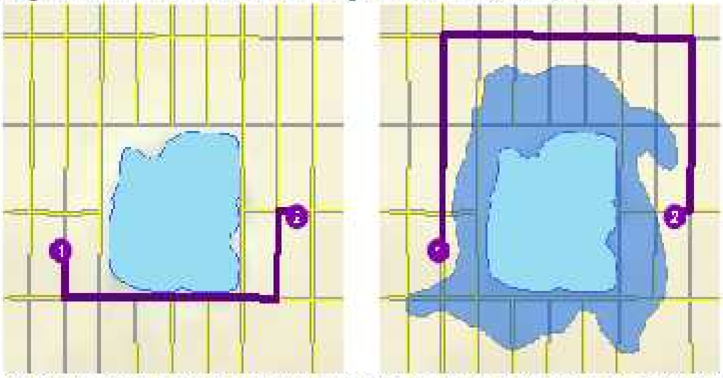
The map on the left displays the shortest path between two points. The map on the right shows the shortest path when several streets are blocked by a restriction line barrier.

- A **scaled cost line barrier** doesn't restrict travel on the edges and junctions it covers; rather, it scales the cost of traversing the covered edges and junctions by a factor you specify. Assigning a factor of 0.5 would mean travel is expected to be twice as fast as normal. A factor of 2.0 would mean it is expected to take twice as long as normal. You might want to increase travel time with a scaled cost line barrier when a stretch of highway is temporarily slowed by construction.



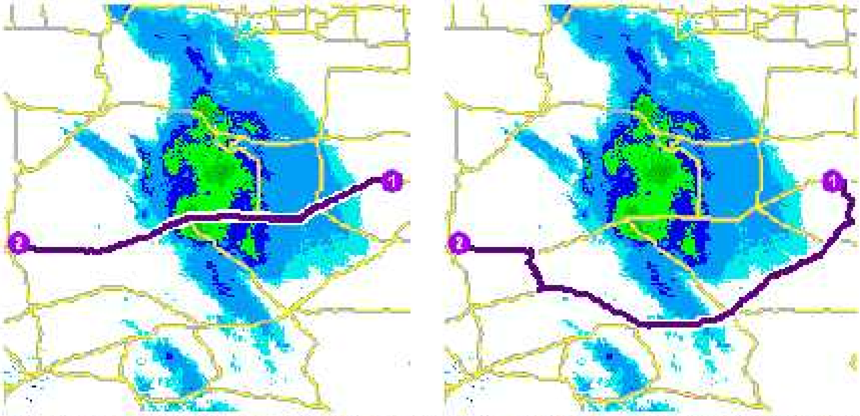
The shortest path between two points is shown on the left. On the right, a scaled line barrier increases the cost of traveling on the roads it covers. Unlike the restriction barrier, the route is able to travel on the barrier but with a modified cost. The solver uses the modified cost in calculating the best route; furthermore, the modified cost is included in the accumulated cost of the results.

- A **restriction polygon barrier** prohibits travel anywhere the polygon intersects the network. One use of this type of barrier is to model floods covering areas of the network and making road travel there impossible.



The left side depicts the shortest path between two points. On the right, a polygon barrier blocks flooded streets, so the shortest path between the same two points is different.

- A **scaled cost polygon barrier** doesn't restrict travel on the edges and junctions it covers; rather, it scales the cost of traversing the covered edges and junctions by a factor you specify, such as 0.25, which would mean travel is expected to be four times faster than normal. A factor of 3.0 would mean it is expected to take three times longer than normal. This type of barrier might be used to model storms that reduce travel speeds in specific regions.



The map on the left shows a route that goes through inclement weather without regard for the effect poor road conditions have on travel time. On the right, a scaled polygon barrier doubles the travel time of the roads covered by the storm. Notice the route still passes through the southern tip of the storm since it is quicker to spend more time driving slowly through a small part of the storm rather than driving completely around it. Like the scaled-cost line barrier, the solver uses the modified cost in calculating the best route; furthermore, the modified cost is included in the accumulated costs of the results.

Barriers are part of the network analysis layer, not the network dataset. Therefore, barriers only have an effect on the network analysis layer that contains them. If barriers are needed in other analyses, they should be loaded into the appropriate network analysis layer. Alternatively, the network dataset could be edited instead of using barriers.

Q12/ Three common types of network analyses: one of them Traffic Modeling, explain it.

Answer:

- Streets represented by links and centers.
- Attributes associated with links define travel speed and direction

- Node attributes indicate turns and time or cost required for each turn. Illegal turns have infinite cost.
- Traffic is placed in the network and movement modeled.
- Try to identify bottlenecks, transit items, and under-used routes.

Q13/ There are two ways using to represent geographic phenomenon in computer memory, speak about it. And speak about their disadvantages. (20 marks)

Answer:
When we want to represent such a phenomenon faithfully in computer memory, we could either:
• try to store as many (location, elevation) pairs as possible, or
• try to find a symbolic representation of the elevation function, as a formula in x and y—like ($3.0678x^2 + 20.08x - 7.34y$) or so—which after evaluation will give us the elevation value at a given (x, y).
Both approaches have their disadvantage. The first suffers from the fact that will never be able to store all elevation values for all locations, there are infinitely many locations. The second approach suffers from the fact that have no clue what such a function should be, or how to derive it, and it is likely that for larger areas it will be an extremely complicated function.

Q14/ Define geographic field and geographic object and type examples for everyone.
Answer:
A (geographic) field is a geographic phenomenon for every point in the study area, a value can be determined.
The usual examples of fields are temperature, barometric pressure and elevation. These fields are actually continuous in nature. Examples of discrete fields are land use and soil classifications. Again, any location is attributed a single land use class or soil class.
Many other phenomena do not manifest themselves everywhere in the study area, but only in certain localities. The array of buoys of the previous chapter is a good example: there is a fixed number of buoys, and for each can know exactly where it is located. The buoys are typical examples of (geographic) objects.
(Geographic) objects populate the study area, and are usually well distinguishable, discrete, bounded entities. The space between them is potentially empty.

Q15/ Spatial Analysis in many ways the core of GIS, show that. What mean spatial analysis and what methods of spatial analysis, Explain that.
Solution:

Spatial analysis is defined as a collection of techniques for analyzing geographical phenomena, and it requires information both on attribute values and the geographical locations of the objects. It is used to represent the objects of real world through a set of layers. GIS is a powerful tool for spatial analysis. It stores, manipulates, analyzes and displays geographic data and generates cartographic and statistical outputs and then used in making effective decisions.
Spatial Analysis interacts with a GIS to answer questions, support decisions, and reveal patterns. Spatial analysis tools include all of the transformations, manipulations, and methods that can be applied to geographic data to turn them into useful information. *Spatial analysis is in many ways the crux (heart, essence, central point, main point, core, center) of GIS* because it includes all of the transformations, manipulations, and methods that can be applied to geographic data to add value to them, to support decisions, and to reveal patterns and anomalies that are not immediately obvious – in other words, spatial analysis is the process by which we turn raw data into useful information, in pursuit of scientific discovery, or more effective decision making. If GIS is a method of communicating

information about the Earth's surface from one person to another, then the transformations of spatial analysis are ways in which the sender tries to inform the receiver, by adding greater informative content and value, and by revealing things that the receiver might not otherwise see.
Methods of spatial analysis may be very sophisticated and may also be very simple; ranging from the simplest types that occur very quickly and intuitively when the eye and brain look at a map, to the types that require complex software and sophisticated mathematical understanding. Spatial analysis is best seen as a collaboration (the action of working with someone to produce or create something) between the computer and the human, in which both play vital roles. Through GIS analysis, it allows to see patterns and relationships within the geographic data. The results of analysis give insight into a place and help focus actions and make predict. The beauty of GIS is its ability to perform spatial analysis. *Types of Spatial Analysis* varies from simple to sophisticate. Spatial Analysis will be divided into six categories: queries and reasoning, measurements, transformations, descriptive summaries, optimization, and hypothesis testing.

Q16/ The Spatial Analysis functions can be used for many different forms to answer questions or issues related to location. Discuss the idea of using functions and what the important functions that use.
Solution:

The Spatial Analysis functions can be used for many different forms to answer questions or issues related to location. These questions can range from simple calculative questions, such as the distance between two locations, to more complex problems, such as the most suitable location of a new school.
GIS use to perform spatial analysis. There are many functions that used in GIS, here used simple functions. It arranged as the following:

- Straight Line Distance Function: The Straight Line Distance Function measures the straight line distance from each cell to the closest source (The source identifies the objects of interest, such as house, roads, or a school). The distance is measured from cell center to cell center. The outputs from the Straight Line Distance Function are normally used directly and as alone function for many applications. This function can be used when needing to include data representing the distance from an object.
- Reclassification Function: reclassification operations involve the reassignment of thematic values to categories of an existing map. Therefore this function creates a new raster dataset by replacing the input cell values with new output cell values, new cell values are based on new information or grouping existing values together. There are many reasons that lead to reclassify the data. Some of the most common reasons are;
    1. To replace values based on new information.
    2. To group values together.
    3. To set specific values to NoData (Symbology in Arc Map) or to set NoData cells to a value.
- Raster Calculator Function: Raster Calculator is a very useful function when it comes to analyzing. It had ability to perform mathematical calculations using operators and functions that type in Map Algebra. Inputs can be raster layers, shapefiles, tables, and numbers.
- Converting from features to raster: Polygons, Polylines, and Points can be converted to a raster. There are three types of Converting from features to raster that arranged as the following:

1. Polygon features to raster: When converting polygons, cells are given the value of the polygon found at the center of each cell.
2. Polyline features to raster: When converting polyline, cells are given the value of the line that intersects each cell.
3. Point features to raster: When converting points, cells are given the value of the points that found within each cell.

Q17/ What mean spatial interpolation, for what use it, what the idea from it and what methods of spatial interpolation, explain two from this methods ?

Solution

Spatial interpolation is a process of intelligent guesswork, in which the investigator (and the GIS) attempt to make a reasonable estimate of the value at places where the field has not actually been measured.

Spatial interpolation finds applications in many areas:

- In estimating rainfall, temperature, and other attributes at places that are not weather stations and where no direct measurements of these variables are available.
- In estimating the elevation of the surface between the measured locations of a DEM.
- In resampling rasters, the operation that must take place whenever raster data must be transformed to another grid.
- In contouring, when it is necessary to guess where to place contours between measured locations.

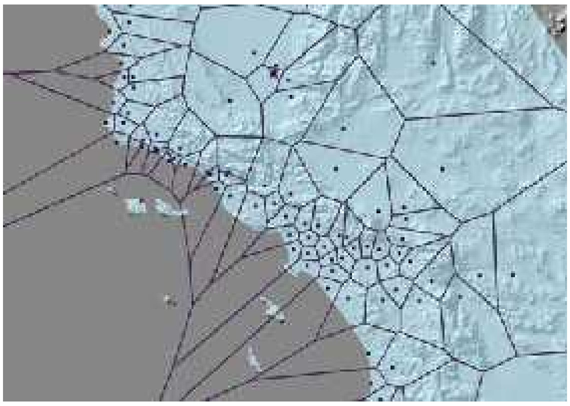
Spatial interpolation is the GIS version of intelligent guesswork.

There are three methods of spatial interpolation are : Thiessen polygons; inverse-distance weighting (IDW), which is the simplest commonly used method; and Kriging, a popular statistical method that is grounded in the theory of regionalized variables and falls within the field of geostatistics.

a. *Thiessen polygons*

Thiessen polygons were suggested by Thiessen as a way of interpolating rainfall estimates from a few rain gauges to obtain estimates at other locations where rainfall had not been measured. The method is very simple: to estimate rainfall at any point take the rainfall measured at the closest gauge. This leads to a map in which rainfall is constant within polygons surrounding each gauge, and changes sharply as polygon boundaries are crossed. They have many other uses besides spatial interpolation:

- Thiessen polygons can be used to estimate the trade areas of each of a set of retail stores or shopping centers.
- They are used internally in the GIS as a means of speeding up certain geometric operations, such as search for nearest neighbor.
- They are the basis of some of the more powerful methods for generalizing vector databases.



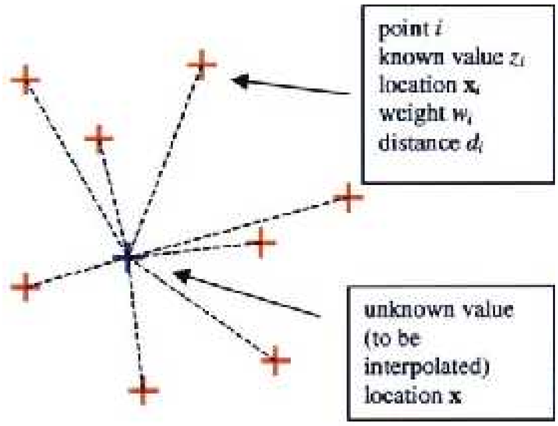
b. *Inverse-distance weighting*

IDW is the workhorse of spatial interpolation, the method that is most often used by GIS analysts. IDW employs by estimating unknown measurements as weighted averages over the known measurements at nearby points, giving the greatest weight to the nearest points.

IDW provides a simple way of guessing the values of a continuous field at locations where no measurement is available.

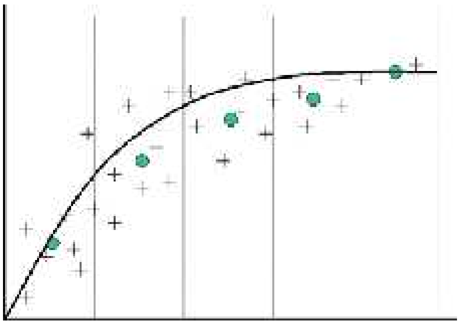
IDW achieves the desired objective of creating a smooth surface whose value at any point is more like the values at nearby points than the values at distant points.

The results of IDW are not always what one would want. There are many better methods of spatial interpolation that address the problems that were just identified, but the ease of programming of IDW and its conceptual simplicity make it among the most popular. Users should simply beware, and take care to examine the results of interpolation to ensure that they make good sense.



c. *Kriging*

Of the common methods of spatial interpolation, Kriging makes the most convincing claim to be grounded in good theoretical principles. The basic idea is to discover something about the general properties of the surface, as revealed by the measured values, and then to apply these properties in estimating the missing parts of the surface. Smoothness is the most important property, and it is operationalized in Kriging in a statistically meaningful way. There are many forms of Kriging.

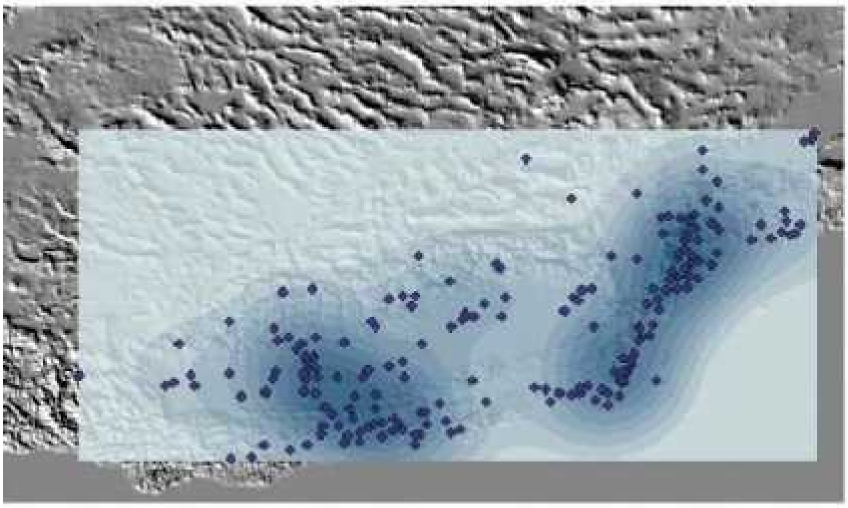


Kriging responds both to the proximity of sample points and to their directions .

Unlike IDW, Kriging has a solid theoretical foundation, but it also includes a number of options that require attention from the user. In that sense it is definitely not a black box that can be executed blindly and automatically, but instead forces the user to become directly involved in the estimation process. For that reason GIS software designers will likely continue to offer several different methods, depending on whether the user wants something that is quick, despite its obvious faults, or better but more demanding of the user.

d. *Density estimation*

Density estimation is in many ways the logical twin of spatial interpolation – it begins with points and ends with a surface. But conceptually the two approaches could not be more different, because one seeks to estimate the missing parts of a continuous field from samples of the field taken at data points, while the other creates a continuous field from discrete objects.



Q19/ Route Selection operation involves finding the best route based on a specified set of criteria. What it and Clarify the important of network for GIS and what Requirement of Network Analysis.

Solution:

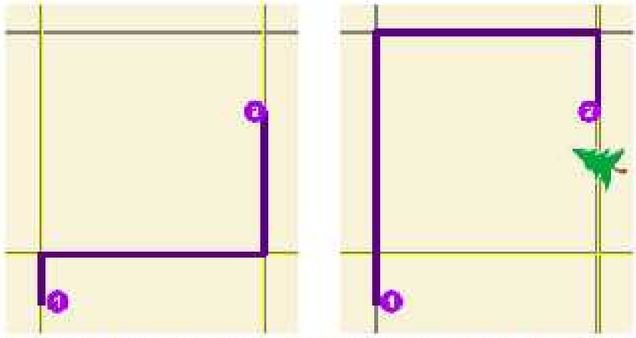
Important of network for GIS:

A network can be defined as a set of linear features through which resources flow. Nodes (the end points of lines) are used as origins and destinations, and links (lines) travel from one node to the other. Nodes can have properties but in network analysis we are usually more concerned with the characteristics of the links. These include: length, direction, connectivity (lines must connect at least two points), and pattern. Networks are all around us. Roads, railways, cables, pipelines, and streams are phenomena that frequently need to be represented and analyzed as a network. Networks are used to move people, transport goods, communicate information and control flow of matter and energy. It is not surprising then that techniques have been developed to analyze these most geographical phenomena. Network analysis enables you to solve problems, such as finding the most efficient travel route, generating travel directions, finding the closest facility, defining service areas based on travel time. Network analysis in GIS is often used to find solutions to transportation problems by using either vector or raster models to represent the real world. The vector-based model appears to be more suited to analysis of precisely defined paths such as roads and rivers. The raster based model seems best suited for analysis of problems where paths are not pre-defined.

Requirement of Network Analysis:

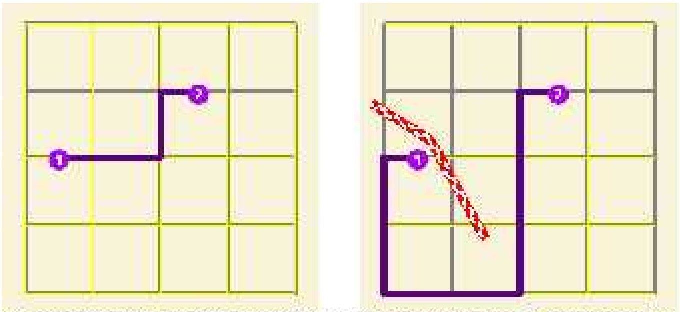
Barriers are feature classes in network analysis layers that restrict or alter impedances of the underlying edges and junctions of the associated network dataset. Barriers are split into three geometry types (point, line, and polygon) and are designed to model temporary changes to the network. The various types of barriers are introduced below:

A restriction point barrier can model a fallen tree, an accident, a downed electrical line, or anything that completely blocks traffic at a specific position along the network.



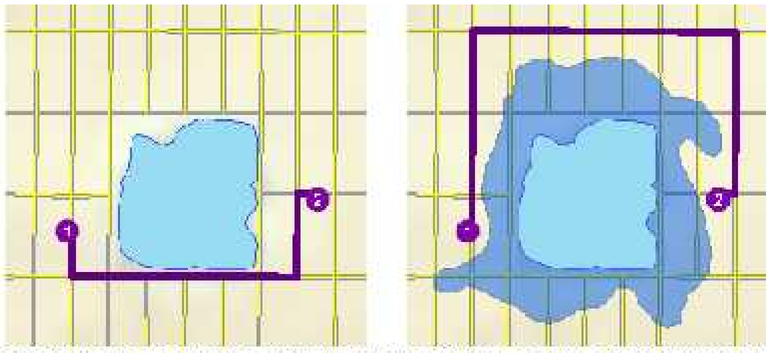
The map on the left shows the shortest path between two stops without any restriction point barriers. The map on the right has a road that is blocked by a fallen tree, so the shortest path between the same points is longer.

A restriction line barrier prohibits travel anywhere the barrier intersects the network. For example, a parade or protest that blocks traffic across several street segments can be modeled with a restriction line barrier.



The map on the left displays the shortest path between two points. The map on the right shows the shortest path when several streets are blocked by a restriction line barrier.

A restriction polygon barrier prohibits travel anywhere the polygon intersects the network. One use of this type of barrier is to model floods covering areas of the network and making road travel there impossible.



The left side depicts the shortest path between two points. On the right, a polygon barrier blocks flooded streets, so the shortest path between the same two points is different.

Q20/ The geographic phenomena come in so many different types. first make the observation that the representation of a phenomenon in a GIS requires to state what it is, and where it is. A second fundamental observation is that some phenomena manifest themselves essentially everywhere in the study area. What meaning that?

Solution:

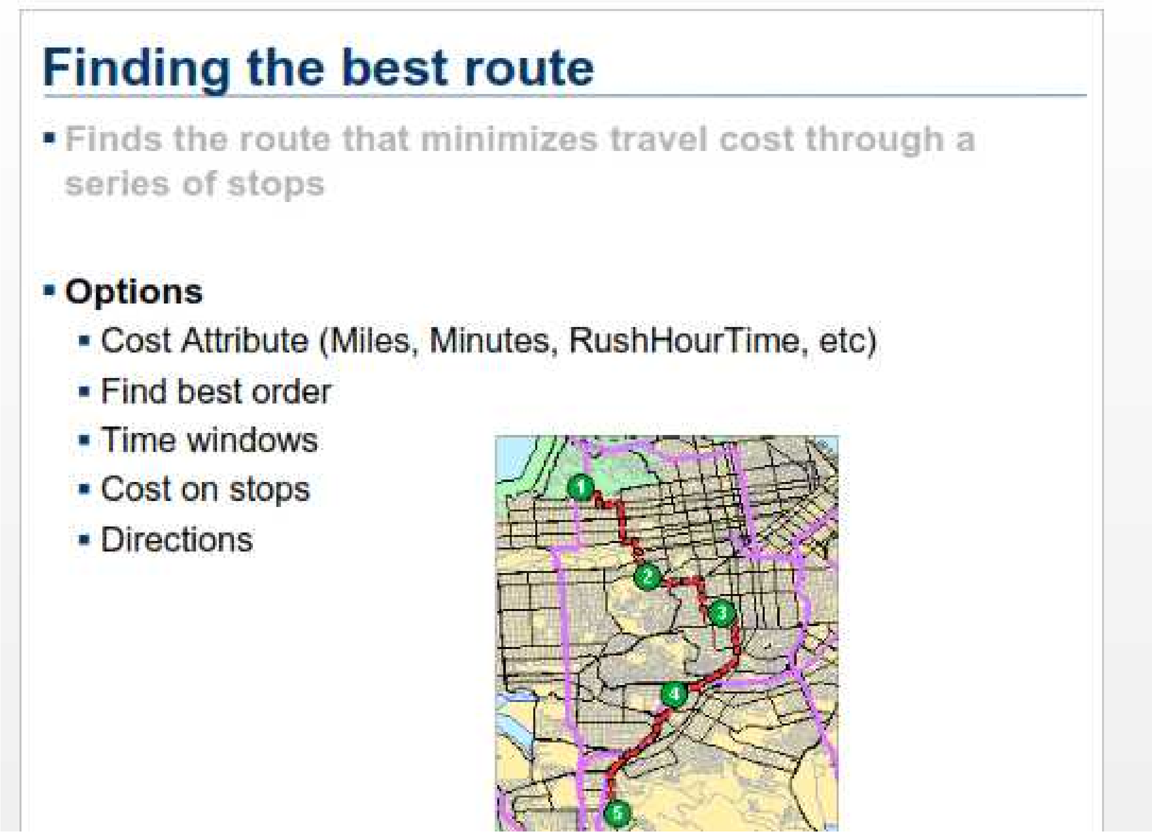
- The geographic phenomena come in so many different types. first make the observation that the representation of a phenomenon in a GIS requires to state what it is, and where it is. It must provide a description-or at least a name-on the one hand, and a georeference on the other hand.
- A second fundamental observation is that some phenomena manifest themselves essentially everywhere in the study area, while others only occur in certain localities. A (geographic) field is a geographic phenomenon for every point in the study area, a value can be determined.

- The usual examples of fields are temperature, barometric pressure and elevation. These fields are actually continuous in nature. Examples of discrete fields are land use and soil classifications. Again, any location is attributed a single land use class or soil class.
- Many other phenomena do not manifest themselves everywhere in the study area, but only in certain localities. (Geographic) objects populate the study area, and are usually well distinguishable, discrete, bounded entities. The space between them is potentially empty.
- A general rule is that natural geographic phenomena are more often fields, and man-made phenomena are more often objects. Many exceptions to this rule actually exist, so one must be careful in applying it.

Q21/ What the problem that can be solved by using Network analyst with our system GIS?
Solution:
Three common types of network analyses

- Route selection
- Resource allocation.
- Traffic modeling.

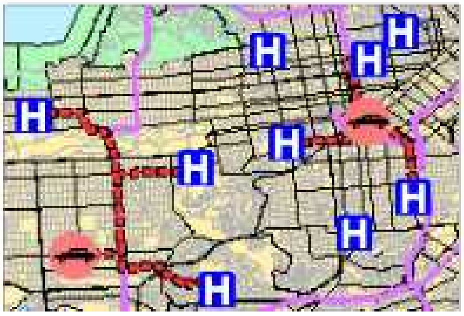
Many other types of analyses are also possible.



Finding the closest facility

- Finds the routes that minimizes travel cost between incidents and multiple facilities

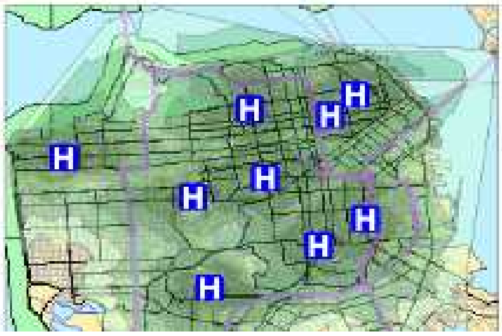
- **Options**
  - Cost Attribute (Miles, Minutes, RushHourTime, etc)
  - Number of facilities to find
  - Cutoff value
  - Direction of travel
  - Costs on incidents and facilities
  - Directions



Finding service areas

- Find the lines or area that can be traversed within a specified cost
  - Create polygons around specified locations
  - Create service area lines

- **Options**
  - Cost Attribute (Miles, Minutes, RushHourTime, etc)
  - Multiple Break values
  - Direction of travel
  - Polygon generation options
  - Line generation options

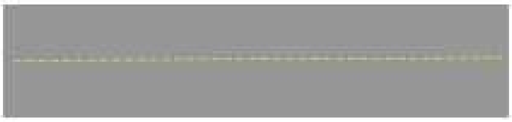


More network analysis options

- **Other parameters include**
  - Barriers

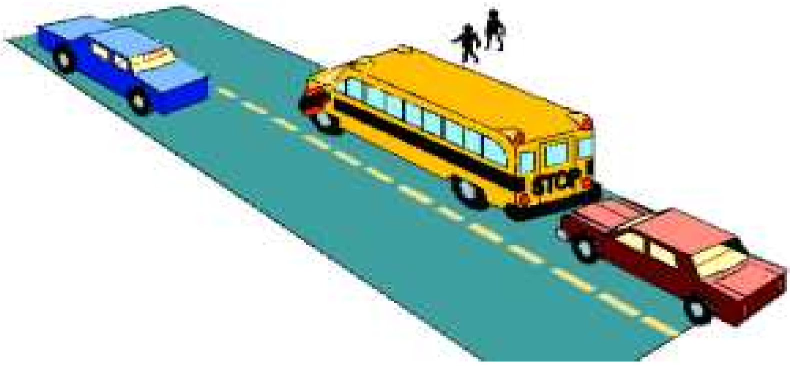
More network analysis options

- **Other parameters include**
  - Barriers
  - U-Turn policy



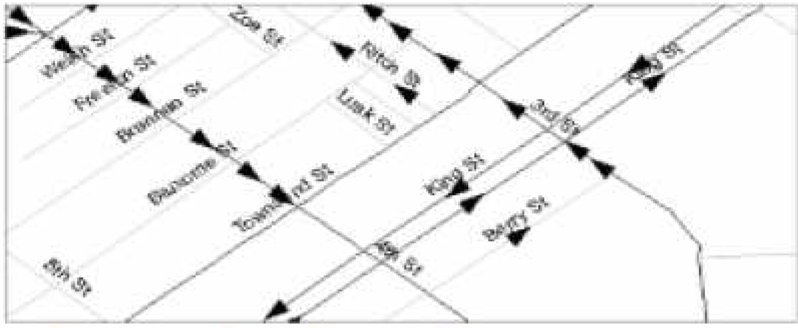
More network analysis options

- Other parameters include
  - Barriers
  - U-Turn policy
  - Curb approach



More network analysis options

- Other parameters include
  - Barriers
  - U-Turn policy
  - Curb approach
  - Restrictions



More network analysis options

- Other parameters include
  - Barriers
  - U-Turn policy
  - Curb approach
  - Restrictions
  - Exact route vs. Hierarchical route

Exact route

Hierarchical route
(major roads)

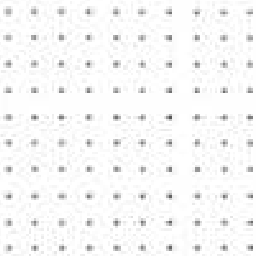
Q22/ Define Grid Surface Data Model and TIN Surface Data Model and with the different between it. Support your answer by example and figure.

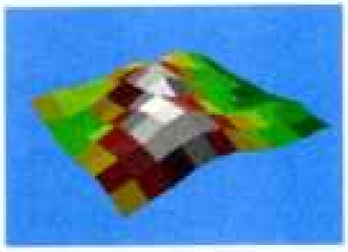
Representing Digital Surface / Terrain Modeling (DTM)

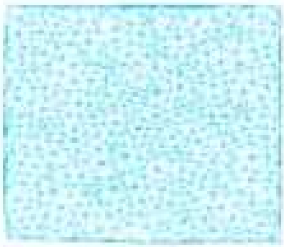
Grid	- only stores z value
fixed x,y	- easy to understand
variable z	- not efficient for even plane
Contour	- conform to mapping practice
fixed z	- large data volume
variable x,y	- inefficient data storage
Irregular point	- effective if points are selected
variable x,y,z	intelligently
TIN	- effective if points are selected
variable x,y,z	intelligently
(*Triangulated Irregular Network*)	

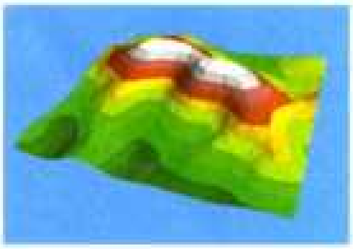
Surface Model Data Structure

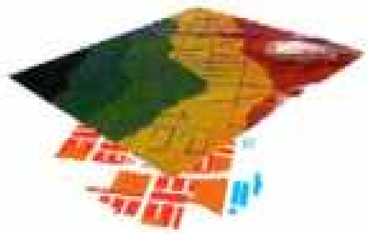
- Grid
  - Regulated square cells
- 2D shapes
  - X, Y
- TIN
  - Triangulated Irregular Network
- 3D shapes
  - X, Y, Z (Elevation)



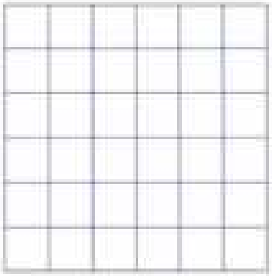






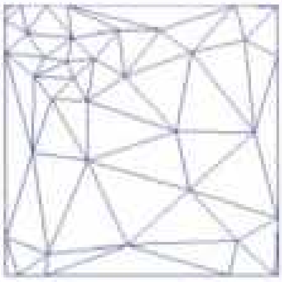


Grid Surface Data Model



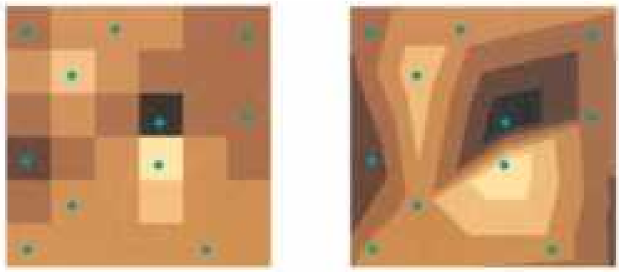
- Grid Surface Model
  - Raster data model using a mesh of regularly spaced points
  - Simple and easy to process, take a lot of storage space
  - Fixed-resolution determined by the cell size as a result of interpolation
  - Rigid mesh structure does not adapt to the variability of terrain
  - Source data may not be captured, which may cause lose of information
  - Prevent linear features from being represented sufficiently

TIN Surface Data Model



- TIN
  - Vector data model using continuous, nonoverlapping triangle facets.
  - Elevation values (z) along with x, y coordinates are stored as node of the triangles
  - Take less storage space but difficult to process
  - Variable-resolution adapt to the variability of terrain and perform interpolation on the fly
  - More detailed when surface is complex, less detailed when simple
  - Source data maintained as part of triangulation, no information lose
  - Can represent linear features by enforcing them as triangle edges (breakline)

Conversion between TIN and Grid



- **Convert (TIN) to Grid**
  - **Specify horizontal accuracy (cell size)**
  - **All the nodes of the triangles will be interpolated.**
- **Converting Grid to TIN**
  - **Specify vertical accuracy (Z-value tolerance)**
  - **3D Analyst will automatically select the subset of the grid cell centers and use them as nodes to create TIN so that the difference between the original elevation and estimated elevation from TIN is within the maximum Z-value tolerance**

Q23/ What mean spatial interpolation, for what use it, what the idea from it and what methods of spatial interpolation, explain two from this methods?

Solution

Spatial interpolation is a process of intelligent guesswork, in which the investigator (and the GIS) attempt to make a reasonable estimate of the value at places where the field has not actually been measured.

Spatial interpolation finds applications in many areas:

- In estimating rainfall, temperature, and other attributes at places that are not weather stations and where no direct measurements of these variables are available.
- In estimating the elevation of the surface between the measured locations of a DEM.
- In resampling rasters, the operation that must take place whenever raster data must be transformed to another grid.
- In contouring, when it is necessary to guess where to place contours between measured locations.

Spatial interpolation is the GIS version of intelligent guesswork.

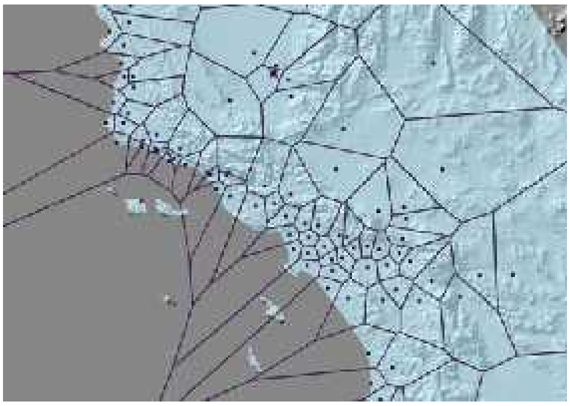
There are three methods of spatial interpolation are : Thiessen polygons; inverse-distance weighting (IDW), which is the simplest commonly used method; and Kriging, a popular statistical method that is grounded in the theory of regionalized variables and falls within the field of geostatistics.

e. *Thiessen polygons*

Thiessen polygons were suggested by Thiessen as a way of interpolating rainfall estimates from a few rain gauges to obtain estimates at other locations where rainfall had not been measured. The method is very simple: to estimate rainfall at any point take the rainfall measured at the closest gauge. This leads to a map in which rainfall is constant within polygons surrounding each gauge, and changes sharply as polygon boundaries are crossed. They have many other uses besides spatial interpolation:

- Thiessen polygons can be used to estimate the trade areas of each of a set of retail stores or shopping centers.

- They are used internally in the GIS as a means of speeding up certain geometric operations, such as search for nearest neighbor.
- They are the basis of some of the more powerful methods for generalizing vector databases.



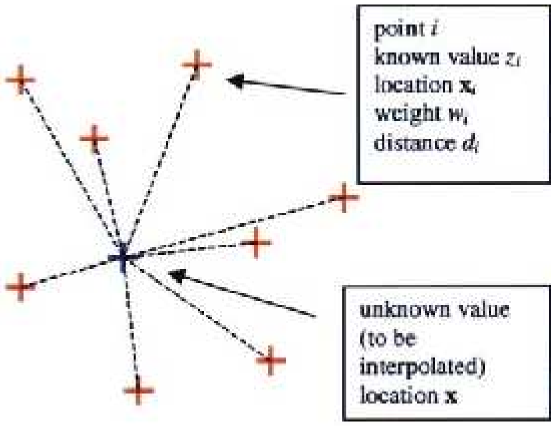
f. *Inverse-distance weighting*

IDW is the workhorse of spatial interpolation, the method that is most often used by GIS analysts. IDW employs by estimating unknown measurements as weighted averages over the known measurements at nearby points, giving the greatest weight to the nearest points.

IDW provides a simple way of guessing the values of a continuous field at locations where no measurement is available.

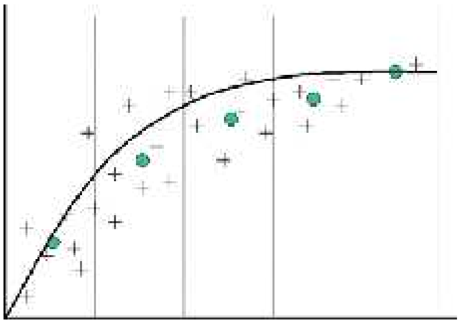
IDW achieves the desired objective of creating a smooth surface whose value at any point is more like the values at nearby points than the values at distant points.

The results of IDW are not always what one would want. There are many better methods of spatial interpolation that address the problems that were just identified, but the ease of programming of IDW and its conceptual simplicity make it among the most popular. Users should simply beware, and take care to examine the results of interpolation to ensure that they make good sense.



g. *Kriging*

Of the common methods of spatial interpolation, Kriging makes the most convincing claim to be grounded in good theoretical principles. The basic idea is to discover something about the general properties of the surface, as revealed by the measured values, and then to apply these properties in estimating the missing parts of the surface. Smoothness is the most important property, and it is operationalized in Kriging in a statistically meaningful way. There are many forms of Kriging.

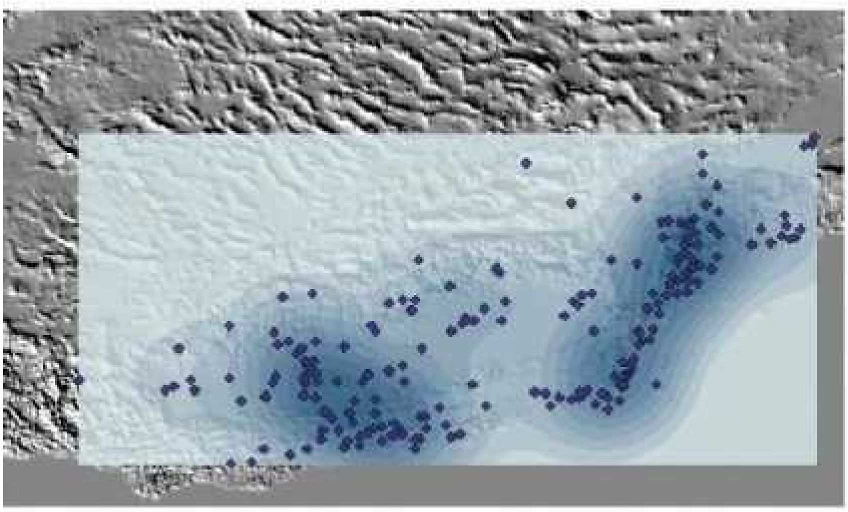


Kriging responds both to the proximity of sample points and to their directions .

Unlike IDW, Kriging has a solid theoretical foundation, but it also includes a number of options that require attention from the user. In that sense it is definitely not a black box that can be executed blindly and automatically, but instead forces the user to become directly involved in the estimation process. For that reason GIS software designers will likely continue to offer several different methods, depending on whether the user wants something that is quick, despite its obvious faults, or better but more demanding of the user.

h. *Density estimation*

Density estimation is in many ways the logical twin of spatial interpolation – it begins with points and ends with a surface. But conceptually the two approaches could not be more different, because one seeks to estimate the missing parts of a continuous field from samples of the field taken at data points, while the other creates a continuous field from discrete objects.



Q24/ The Spatial Analysis functions can be used for many different forms to answer questions or issues related to location. Discuss the idea of using functions and what the important functions that use.

Solution:

The Spatial Analysis functions can be used for many different forms to answer questions or issues related to location. These questions can range from simple calculative questions, such as the distance between two locations, to more complex problems, such as the most suitable location of a new school.
GIS use to perform spatial analysis. There are many functions that used in GIS, here used simple functions. It arranged as the following:

- Straight Line Distance Function: The Straight Line Distance Function measures the straight line distance from each cell to the closest source (The source identifies the objects of interest, such as house, roads, or a school). The distance is measured from cell center to cell center. The outputs from the Straight Line Distance Function are normally used directly and as alone function for many applications. This function can be used when needing to include data representing the distance from an object.
- Reclassification Function: reclassification operations involve the reassignment of thematic values to categories of an existing map. Therefore this function creates a new raster dataset by replacing the input cell values with new output cell values, new cell values are based on new information or grouping existing values together. There are many reasons that lead to reclassify the data. Some of the most common reasons are;
  4. To replace values based on new information.
  5. To group values together.
  6. To set specific values to NoData (Symbology in Arc Map) or to set NoData cells to a value.
- Raster Calculator Function: Raster Calculator is a very useful function when it comes to analyzing. It had ability to perform mathematical calculations using operators and functions that type in Map Algebra. Inputs can be raster layers, shapefiles, tables, and numbers.
- Converting from features to raster: Polygons, Polylines, and Points can be converted to a raster. There are three types of Converting from features to raster that arranged as the following:

1. Polygon features to raster: When converting polygons, cells are given the value of the polygon found at the center of each cell.
2. Polyline features to raster: When converting polyline, cells are given the value of the line that intersects each cell.
3. Point features to raster: When converting points, cells are given the value of the points that found within each cell.

Q25/ Route Selection operation involves finding the best route based on a specified set of criteria. What it and Clarify the important of network for GIS, What the problem that can be solved by using Network analyst with our system GIS?
Solution:
Important of network for GIS:
A network can be defined as a set of linear features through which resources flow. Nodes (the end points of lines) are used as origins and destinations, and links (lines) travel from one node to the other. Nodes can have properties but in network analysis we are usually more concerned with the characteristics of the links. These include: length, direction, connectivity (lines must connect at least two points), and pattern. Networks are all around us. Roads, railways, cables, pipelines, and streams are phenomena that frequently need to be represented and analyzed as a network. Networks are used to move people, transport goods, communicate information and control flow of matter and energy. It is not surprising then that techniques have been developed to analyze these most geographical phenomena. Network analysis enables you to solve problems, such as finding the most efficient travel route, generating travel directions, finding the closest facility, defining service areas based on travel time. Network analysis in GIS is often used to find solutions to transportation problems by using either vector or raster models to represent the real world. The vector-based model appears to be more suited to

analysis of precisely defined paths such as roads and rivers. The raster based model seems best suited for analysis of problems where paths are not pre-defined.

Three common types of network analyses

- Route selection
- Resource allocation.
- Traffic modeling.

Many other types of analyses are also possible.