B.Sc.(Information Technology)

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Principles of Geographic Information Systems

(USIT 604 Core)

University Paper Solution

By

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Question 1

Q1a. What is GIS? Explain any four application areas of GIS.
Ans: Defining GIS:
A GIS is a computer-based system that provides the following four sets of capabilities to handle georeferenced data:
1. Data capture and preparation
2. Data management, including storage and maintenance
3. Data manipulation and analysis
4. Data presentation

Application areas of GIS
• An urban planner might want to assess the extent of urban fringe growth in her/his city and quantify the population growth that some suburbs are witnessing. S/he might also like to understand why these suburbs are growing and others are not;

• A biologist might be interested in the impact of slash-and-burn practices on the populations of amphibian species in the forests of a mountain range to obtain a better understanding of long-term threats to those populations;

• A natural hazard analyst might like to identify the high-risk areas of annual monsoon-related flooding by investigating rainfall patterns and terrain characteristics;

• A geological engineer might want to identify the best localities for constructing buildings in an earthquake-prone area by looking at rock formation characteristics;

• A mining engineer could be interested in determining which prospective copper mines should be selected for future exploration, taking into account parameters such as extent, depth and quality of the ore body, amongst others;

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• A geoinformatics engineer hired by a telecommunications company may want to determine the best sites for the company's relay stations, taking into ac-count various cost factors such as land prices, undulation of the terrain;

• A forest manager might want to optimize timber production using data on soil and current tree stand distributions, in the presence of a number of operational constraints, such as the need to preserve species diversity in the area;

• A hydrological engineer might want to study a number of water quality parameters of different sites in a freshwater lake to improve understanding of the current distribution of Typhareed beds, and why it differs from that of a decade ago.

[Any 4 out of 9 application area can be specified.]

Q1b. What are Geospatial data, Geoinformation, quality and metadata? What are the key components of spatial data? Why do they play important role in assessment of data quality?

Ans: Geospatial data, Geoinformation:

By Geospatial data and geoinformation information, we mean data that has been interpreted by a human being. Humans work with and act upon information, not data. Human perception and mental processing lead to information, and hopefully understanding and knowledge. Geoinformation is a specific type of information resulting from the interpretation of spatial data.

Quality and metadata:

If data is to be shared among different users, these users need to know not only what data exists, where and in what format it is held, but also whether the data meets their particular quality requirements This 'data about data' is known as metadata.

Key components of spatial data quality include:

• Positional accuracy (both horizontal and vertical),

• Temporal accuracy (that the data is up to date),

• attribute accuracy (e.g. in labelling of features or of classifications), lineage (history of the data including sources),

• Completeness (if the data set represents all related features of reality), and

• Logical consistency (that the data is logically structured).

These components play an important role in assessment of data quality for several reasons:
1. Even when source data, such as official topographic maps, have been subject to stringent quality control, errors are introduced when these data are input to GIS.
2. Unlike a conventional map, which is essentially a single product, a GIS database normally contains data from different sources of varying quality.
3. Unlike topographic or cadastral databases, natural resource databases contain data that are inherently uncertain and therefore not suited to conventional quality.

Q 1c. Explain the concept of Spatial temporal data models. Explain the different concepts of time.

Ans: **The temporal dimension:**

Geographic phenomena are also dynamic; they change over time.
Examples of the kinds of questions involving time include:
• Where and when did something happen?
• How fast did this change occur?
• n which order did the changes happen?

Representing time in GIS:
• Spatiotemporal data models are ways of organizing representations of space and time in a GIS.
• The most common of these is a 'snapshot' state that represents a single point in time of an ongoing natural or man-made process.
• We may store a series of these snapshot states to represent change.

Different 'concepts' of time:
• Discrete and continuous time: Time can be measured along a discrete or continuous scale.

• Discrete time is composed of discrete elements (seconds, minutes, hours days, months, or years).
• In continuous time, no such discrete elements exist, and for any two different points in time, there is always another point in between. Derive temporal relationships between events and periods such as 'before', 'overlap', and 'after'
Valid time and transaction time: Valid time (or world time) is the time when an event really happened, or a string of events took place. Transaction time (or database time) is the time when the event was stored in the database or GIS.
• Linear, branching and cyclic time: Time can be considered to be linear, extending from the past to the present ('now'), and into the future Branching time—in which different timelines from a certain point in time onwards are possible—and cyclic time—in which repeating cycles such as seasons or days of a week are recognized.
• Time granularity: When measuring time, granularity is the precision of a time value in a GIS or database (e.g. year, month, day, second, etc.). Different applications may obviously require different granularity.

Q1d. Define Geographic Objects. Explain four parameters that define it.

Ans: **Geographic Objects:**

When a geographic phenomenon is not present everywhere in the study area, but somehow 'sparsely' populates it, we look at it as a collection of geographic objects. Such objects are usually easily distinguished and named, and their position in space is determined by a combination of one or more of the **following parameters**.

• Location (where is it?)
• Shape (what form is it?)
• Size (how big is it?)
• Orientation (in which direction is it facing?)

Location alone is enough to describe them in this particular context, and shape, size and orientation are not necessarily relevant. Shape is usually important because one of its factors is dimension. This relates to whether an object is perceived as a point feature, or a linear, area or volume feature. Collections of geographic objects can be interesting phenomena at a higher aggregation level: forest plots form forests, groups of parcels form suburbs, streams. It is sometimes useful to view geographic phenomena at this more aggregated level and look at characteristics like coverage, connectedness, and capacity.

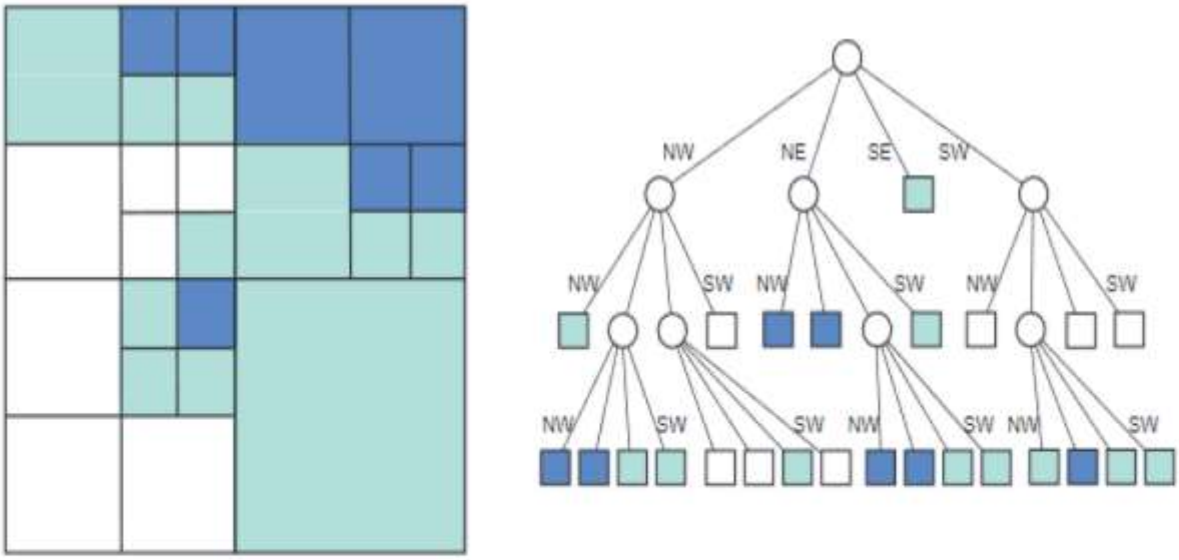
For example:
• Which part of the road network is within 5 km of a petrol station? (A coverage question)
• What is the shortest route between two cities via the road network? (A connectedness question)
• How many cars can optimally travel from one city to another in an hour? (A capacity question)

Q1e. Write a note on Irregular Tessellations.

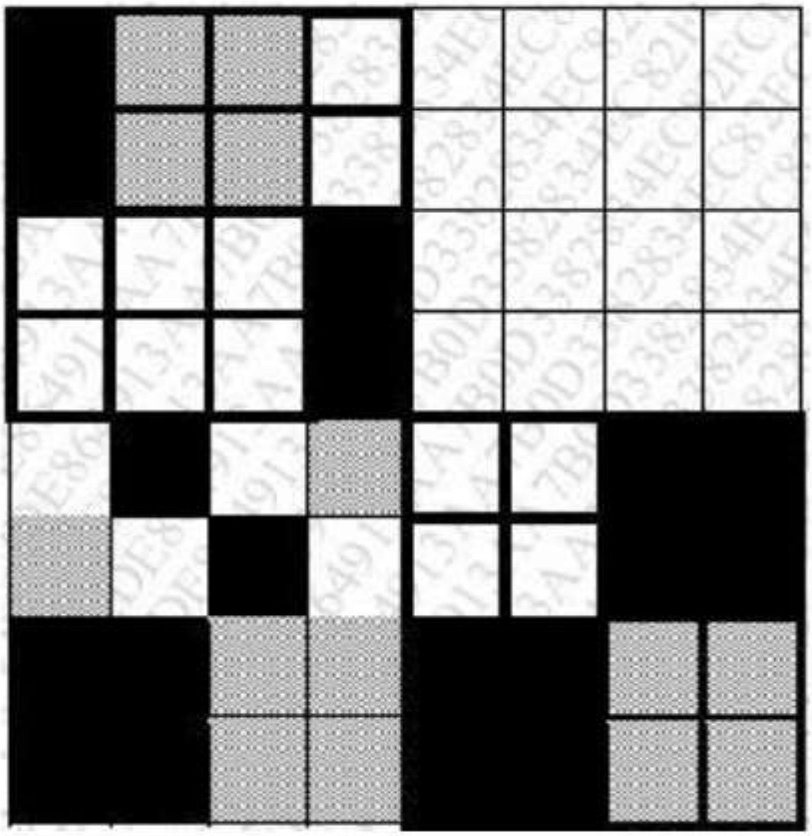
Ans: **Irregular tessellations:**

These are partitions of space into mutually disjoint cells, but now the cells may vary in size and shape, allowing them to adapt to the spatial phenomena that they represent. A well-known data structure in this family—upon which many more variations have been based—is

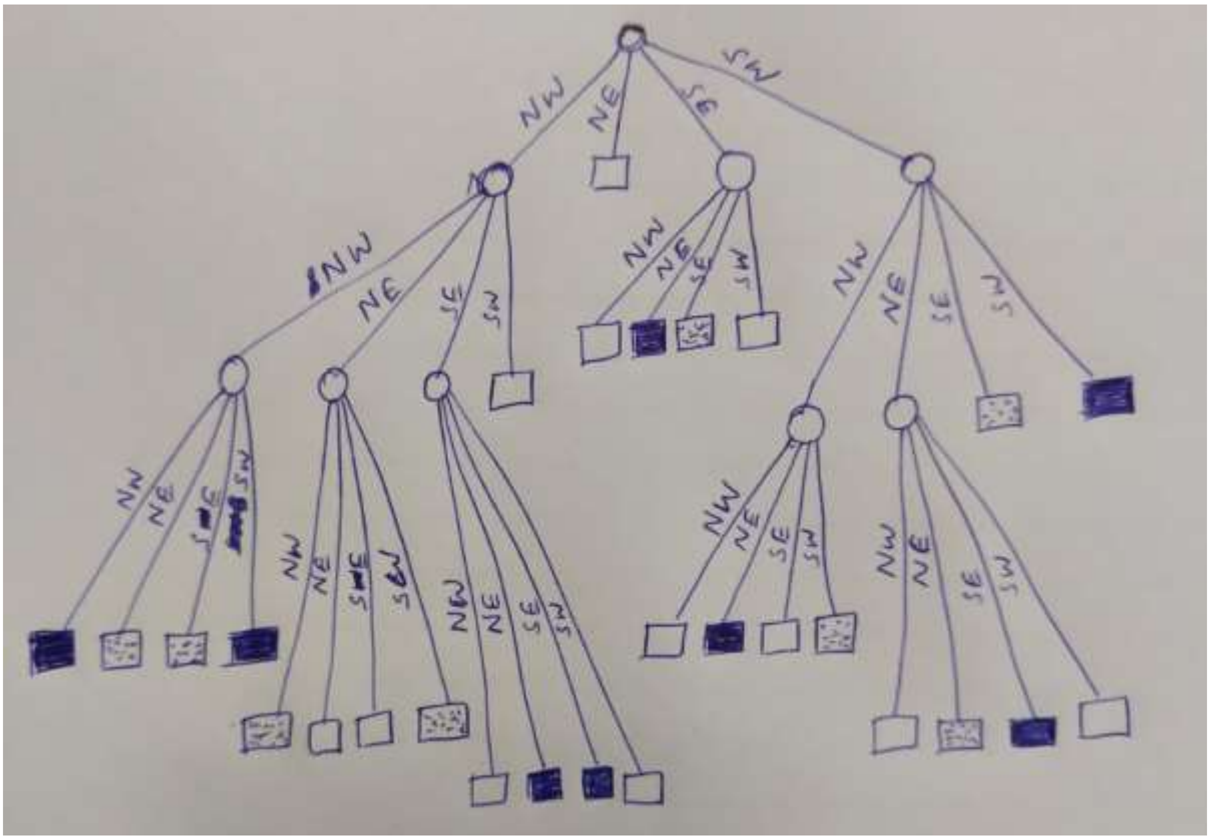
the region quad tree. It is based on a regular tessellation of square cells but takes advantage of cases where neighboring cells have the same field value, so that they can together be represented as one bigger cell. A simple illustration is provided in Figure. It shows a 8×8 raster with three possible field
values: white, green and blue. The quad tree that represents this raster is constructed by repeatedly splitting up the area into four quadrants, which are called NW, NE, SE, SW for obvious reasons. This procedure stops when all the cells in a quadrant have the same field value. The procedure produces an upside down, tree-like structure, known as a quad tree.



Q1f. Construct a quad tree for the following three valued raster.



Ans: Quad tree for the three valued raster:

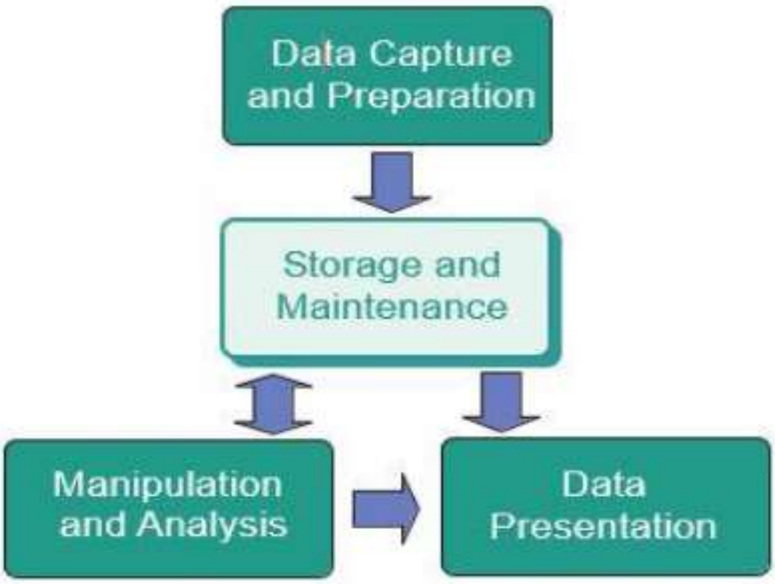


Question 2

Q2a. List the functional components of GIS. Explain any two of them in details.

***Ans*: Functional components of GIS**:

A GIS consists of several functional components—components which support key GIS functions. These are data capture and preparation, data storage, data analysis, and presentation of spatial data. Figure shows a diagram of these components, with arrows indicating the data flow in the system. For a particular GIS, each of these components may provide many or only a few functions.



Data storage and maintenance:

Data management refers to the storage and maintenance of the data transmitted by the buoys via satellite communication. This phase requires a decision to be made on how best to represent our data, both in terms of their spatial properties and the various attribute values which we need to store.

The data presentation:

The data presentation phase deals with putting it all together into a format that communicates the result of data analysis in the best possible way. Many issues arise in this phase. Among other things, we need to consider what the message is that we want to portray, who the audience is, what kind of presentation medium will be used, which rules of aesthetics apply, and what techniques are available for representation.

Q2b. What are the different ways of spatial data capture and preparation? Explain.

Ans: **Spatial data capture and preparation:**

The functions for capturing data are closely related to the disciplines of surveying engineering, photogrammetry, remote sensing, and the processes of digitizing, i.e. the conversion of analogue data into digital representations. Traditional techniques for obtaining spatial data, typically from paper sources, included manual digitizing and scanning. Table lists the main methods and devices used for data capture. In recent years there has been a significant increase in the availability and sharing of digital (geospatial) data.

Method	Devices
Manual digitizing	coordinate entry via keyboard digitizing tablet with cursor mouse cursor on the computer monitor (heads-up digitizing) (digital) photogrammetry
Automatic digitizing	Scanner
Semi-automatic digitizing	line-following software
Input of available digital data	CD-ROM or DVD-ROM via computer network or internet (including geo-webservices)

Q2c. Differentiate between Vector data and Raster Data.

Ans: **Vector data and Raster Data:** Vector data types describe an object through its boundary, thus dividing the space into parts that are occupied by the respective objects. The raster approach subdivides space into (regular) cells, mostly as a square tessellation of dimension two or three. These cells are called either cells or pixels in 2D, and voxels in 3D. The data indicates for every cell which real world feature it covers, in case it represents a discrete field. In case of a continuous field, the cell holds a representative value for that field.

Raster representation	Vector representation
Advantages	
simple data structure simple implementation of overlays efficient for image processing	efficient representation of topology adapts well to scale changes allows representing networks allows easy association with attribute data
Disadvantages	
less compact data structure difficulties in representing topology cell boundaries independent of feature boundaries	complex data structure overlay more difficult to implement inefficient for image processing more update-intensive

Q2d. Explain the relational data model using suitable example.

Ans: Relational data model:

A data model is a language that allows the definition of:

1. The structures that will be used to store the base data,

2. The integrity constraints that the stored data has to obey at all moments in time, and

3. The computer programs used to manipulate the data.

For the relational data model, the structures used to define the database are at-tributes, tuples and relations. Computer programs either perform data extraction from the database without altering it, in which case we call them queries, or they change the database contents, and we speak of updates or transactions.

A table or relation is itself a collection of tuples (or records). In fact, each table is a collection of tuples that are similarly shaped.
An attribute is a named field of a tuple, with which each tuple associates a value, the tuple's attribute value.
An attribute's domain is a (possibly infinite) set of atomic values such as the set of integer number values, the set of real number values etc.
When a relation is created, we need to indicate what type of tuples it will store. This means that we must
1. Provide a name for the relation,
2. Indicate which attributes it will have, and
3. Set the domain of each attribute.

PrivatePerson	TaxId	Surname	BirthDate
	101-367	Garcia	10/05/1952
	134-788	Chen	26/01/1964
	101-490	Fakolo	14/09/1931

Parcel	PId	Location	AreaSize
	3421	2001	435
	8871	1462	550
	2109	2323	1040
	1515	2003	245

TitleDeed	Plot	Owner	DeedDate
	2109	101-367	18/12/1996
	8871	101-490	10/01/1984
	1515	134-788	01/09/1991
	3421	101-367	25/09/1996

Q2e. What is the reason for using DBMS in GIS?

Ans: **Reasons for using a DBMS**

There are various reasons why one would want to use a DBMS for data storage and processing.

1. A DBMS supports the storage and manipulation of very large data sets.
2. A DBMS can be instructed to guard over data correctness.
3. A DBMS supports the concurrent use of the same data set by many users.
4. A DBMS provides a high-level, declarative query language.
5. A DBMS includes data backup and recovery functions to ensure data availability at all times.
6. A DBMS allows the control of data redundancy.

Q2f. Write a note on Spatial Data presentation.

Ans: Spatial data presentation:

By Spatial data, we mean representations that can be operated upon by a computer. More specifically, by spatial data we mean data that contains positional values, such as (x;y) co-ordinates. Sometimes the more precise phrase geospatial data is used as a further refinement, which refers to spatial data that is georeferenced. The presentation of spatial data, whether in print or on- screen, in maps or in tabular displays, or as 'raw data', is closely related to the disciplines of cartography, printing and publishing.

Method	Devices
Hard copy	printer plotter (pen plotter, ink-jet printer, thermal transfer printer, electrostatic plotter) film writer
Soft copy	computer screen
Output of digital data sets	magnetic tape CD-ROM or DVD the Internet

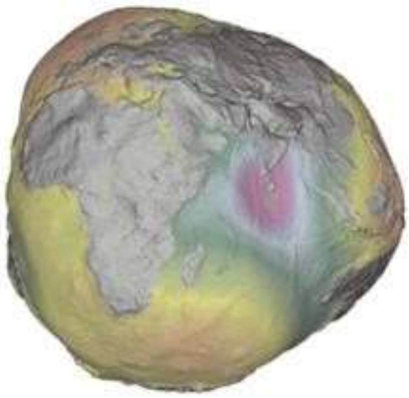
Question 3

Q3a. Write a note on the Geoid and vertical datum

Ans: The Geoid:

Imagining that the entire Earth's surface is covered by water, if we ignore tidal and current effects on this 'global ocean', the resultant water surface is affected only by gravity. This has an effect on the shape of this surface because the direction of gravity–more commonly known as plum line is dependent on the mass distribution inside the Earth. Due to irregularities or mass anomalies in this distribution the 'global ocean' results in an undulated surface. This surface is called the Geoid (Figure). The plumb line through any surface point is always perpendicular to it.

The Geoid is used to describe heights. In order to establish the Geoid as reference for heights, the ocean's water level is registered at coastal places over several years using tide gauges (mareographs). Averaging the registrations largely eliminates variations of the sea level with time. The resulting water level rep-resents an approximation to the Geoid and is called the mean sea level.

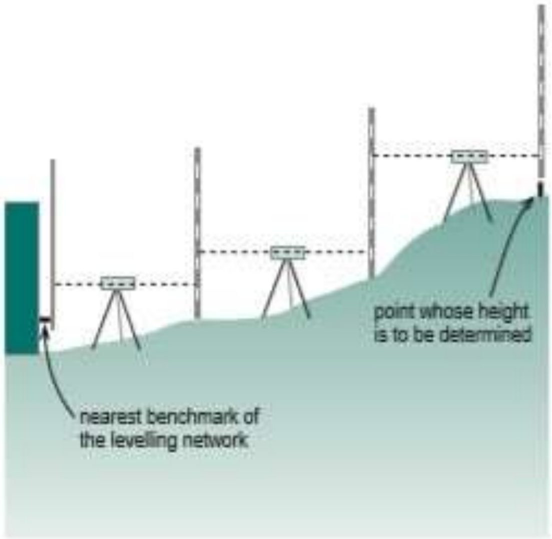


Vertical datum:

There are several realizations of local mean sea levels (also called local vertical datums) in the world. They are parallel to the Geoid but offset by up to a couple of meters. This offset is due to local phenomena such as ocean currents, tides, coastal winds, water temperature and salinity at the location of the tide gauge. Care must be taken when using heights from another local vertical datum.

The local vertical datum is implemented through a levelling network (see Figure (a)). A levelling network consists of benchmarks, whose height above mean sea level has been determined through geodetic levelling. The implementation of the datum enables easy user access. The surveyors do not need to start from scratch (i.e. from the Amsterdam tide-gauge) every time they need to determine the height of a new point. They can use the benchmark of the levelling network that is closest to the point of interest (Figure (b)).

(a)



(b)

Q3b. Explain 2D geographic coordinate system using suitable example.

Ans: 2D Geographic coordinates:

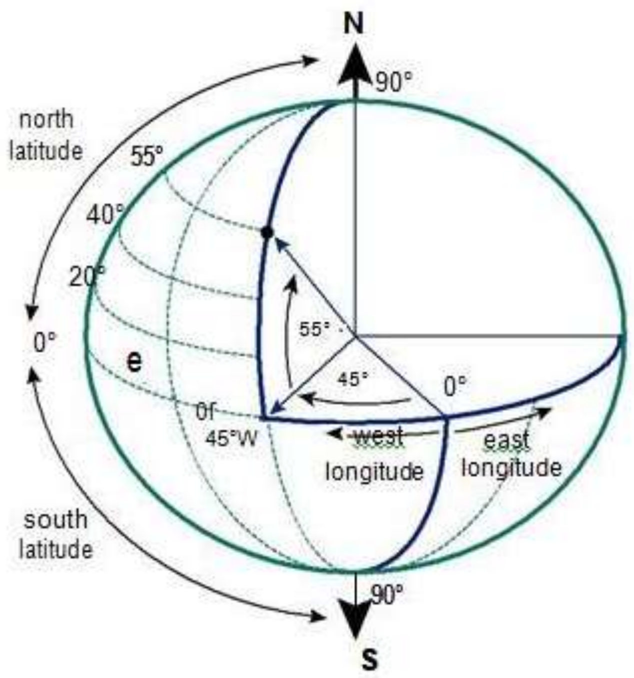
The most widely used global coordinate system consists of lines of geographic latitude (phi or or ') and longitude (lambda or). Lines of equal latitude are called parallels. They form circles on the surface of the ellipsoid4. Lines of equal longitude are called meridians and they form ellipses (meridian ellipses) on the ellipsoid.

Latitude is zero on the equator (= 0), and increases towards the two poles to maximum values of = +90 (N 90) at the North Pole and = -90 (S 90) at the South Pole.

The longitude ( ) is the angle between the meridian ellipse which passes through Greenwich and the meridian ellipse containing the point in question. It is measured in the equatorial plane from the meridian of Greenwich (= 0) either eastwards through = + 180 (E 180) or westwards through = -180 (W 180)

Latitude and longitude represent the geographic coordinates (;) of a point P ’ (Figure 10) with respect to the selected reference surface. They are always given in angular units. For example, the coordinates for City hall in Enschede are:
= 52 13026:200N; = 6 53032:100E

The graticule on a map represents the projected position of the geographic coordinates (;) at constant intervals, or in other words the projected position of selected meridians and parallels .The shape of the graticule depends largely on the characteristics of the map projection and the scale of the map.



Q3c. What is secondary data in GIS? Explain any two ways to obtain secondary data in GIS.

Ans: Spatial data can also be sourced indirectly. This includes data derived from existing paper maps. Secondary data through scanning, data digitized from a satellite image, processed data purchased from data capture firms or international agencies, and so on. This type of data is known as secondary data.

Two ways to obtain secondary data in GIS:

Digitizing

A traditional method data is through digitizing existing paper maps. This can be done using various techniques. Before adopting this approach, one must be aware that positional errors already in the paper map will further accumulate, and one must be willing to accept these errors.

There are two forms of digitizing: i) on-tablet and ii) on-screen manual digitizing.
In on-tablet digitizing, the original map is fitted on a special surface (the tablet), while in on-screen digitizing, a scanned image of the map (or some other image) is shown on the computer screen.

Scanning

An 'office' scanner illuminates a document and measures the intensity of the reflected light with a CCD array. The result is an image as a matrix of pixels, each of which holds an intensity value. Office scanners have a fixed maximum resolution, expressed as the highest number of pixels they can identify per inch;

Q3d. What is satellite based positioning? Explain

Ans: Satellite-based positioning

Satellites have allowed us to realize geocentric reference systems and increase the level of spatial accuracy substantially. They are critical tools in geodetic engineering for the maintenance of the ITRF. They also play a key role in mapping, surveying, and in a growing number of applications requiring positioning techniques. Nowadays, for fieldwork that includes spatial data acquisition, the use of satellite-based positioning is considered indispensable.

Satellite-based positioning was developed and implemented to address military needs, somewhat analogously to the early development of the internet. The technology is now widely available for civilians use. The requirements for the development of the positioning system were:

i) Suitability for all kinds of military use: ground troops and vehicles, aircraft and missiles, ships;

ii) Requiring only low-cost equipment with low energy consumption at the receiver end;

iii) Provision of results in real time for an unlimited number of users concurrently;

A satellite-based positioning system set-up involves implementation of three hardware segments:

i) The space segment, i.e. the satellites that orbit the Earth, and the radio signals that they emit,

ii) The control segment, i.e. the ground stations that monitor and maintain the space segment components, and

iii) The user segment, i.e. the users with their hard and software to conduct positioning.

Q3e. List the four issues in combining data from multiple sources. Explain any two of them.

Ans. Four issues in combining data from multiple sources:

A GIS project usually involves multiple data sets, so the next step addresses the issue of how these multiple sets relate to each other. There are four fundamental cases to be considered in the combination of data from different sources:

1. They may be about the same area, but differ in accuracy,
2. They may be about the same area, but differ in choice of representation,
3. They may be about adjacent areas and have to be merged into a single data set.
4. They may be about the same or adjacent areas but referenced in different coordinate systems.

A range of other data preparation functions exist that support conversion or adjustment of data to format requirements that have been defined for data storage purposes. These include

Format transformation functions: These convert between data formats of different representations, e.g. reading a DXF file into a GIS. Although we will not focus on here, the user should be warned that conversions from one format to another may the reason is that not all formats can capture the same information, and therefore conversions mean loss of information.

Graphic element editing: Manual editing of digitized features to correct errors, clean data set for topology building. Coordinate thinning. A process that is often applied to remove redundant or excess vertices representations, as obtained from digitizing.

Q3f. Write a note on GLONASS.

Ans: GLONASS :

At present, two satellite-based positioning systems are operational (GPS and GLONASS), and a third is in the implementation phase (Galileo). Respectively, these are American, Russian and European systems. Any of these, but especially GPS and Galileo, will be improved over time, and will be augmented with new techniques.

What GPS is to the US military, is GLONASS to the Russian military. The GLONASS space segment consists of nominally 24 satellites, organized in three orbital planes, with an inclination of 64.8◦ with the equator. Orbiting altitude is 19,130 km, with a period of revolution of 11 hours 16 min. GLONASS uses the PZ–90 as its reference system, and like GPS uses UTC as time reference, though with an offset for Russian daylight.

GLONASS radio signals are somewhat similar to that of GPS, but differ in the details. Satellites use different identifier schemes, and their navigation message use other parameters. They also use different frequencies: GLONASS L1 is at approximately 1605 MHz (changes are underway), and L2 is at approximately 1248 MHz. Otherwise, the GLONASS system performance is rather comparable to that of GPS.

Question 4

Q4a. Write a note on neighborhood functions.

Ans Neighbourhood functions:

There is another guiding principle in spatial analysis that can be equally useful. The principle here is to find out the characteristics of the vicinity, here called neighbourhood, of a location. After all, many suitability questions, for instance, depend not only on what is at the location, but also on what is near the location.
Thus, the GIS must allow us 'to look around locally'. To perform neighbourhood analysis, we must:

1. State which target locations are of interest to us, and define their spatial extent,
2. Define how to determine the neighbourhood for each target,
3. Define which characteristic(s) must be computed for each neighbourhood. Then, in the third step we indicate what it is we want to discover about the phenomena that exist or occur in the neighbourhood. This might simply be its spatial extent, but it might also be statistical information like:

- The total population of the area,
- Average household income, or
- The distribution of high-risk industries located in the neighbourhood.

Determining neighbourhood extent:

To select target locations, one can use the selection techniques. To obtain characteristics from an eventually identified neighbourhood, the same techniques apply. So what remains to be discussed here is the proper determination of a neighbourhood.

Q4b. What is Classification of data in GIS? Explain using suitable example.
Ans: Classification of data in GIS:

Classification is a technique of purposefully removing detail from an input dataset, in the hope of revealing important patterns (of spatial distribution). In the process, we produce an output data set, so that the input set can be left intact.

User-controlled classification:
In user-controlled classification, a user selects the attribute(s) that will be used as the classification parameter(s) and defines the classification method. The latter involves declaring the number of classes as well as the correspondence between the old attribute values and the new classes. This is usually done via a classification table.

Automatic classification:
User-controlled classifications require a classification table or user interaction. GIS software can also perform automatic classification, in which a user only specifies the number of classes in the output data set. The system automatically determines the class break points. Two main techniques of determining break points are in use.

1. Equal interval technique: The minimum and maximum values vmin and vmax of the classification parameter are determined and the (constant) interval size for each category is calculated as (vmax−vmin)/n, where n is the number of classes chosen by the user.
2. Equal frequency technique: This technique is also known as quantile classification. The objective is to create categories with roughly equal numbers of features per category.

1	1	1	2	8
4	4	5	4	9
4	3	3	2	10
4	5	6	8	8
4	2	1	1	1

(a) original raster

1	1	1	1	4
2	2	3	2	5
2	2	2	1	5
2	3	3	4	4
2	1	1	1	1

(b) equal interval classification

1	1	1	2	5
3	3	4	3	5
3	2	2	2	5
3	4	4	5	5
3	2	1	1	1

(c) equal frequency classification

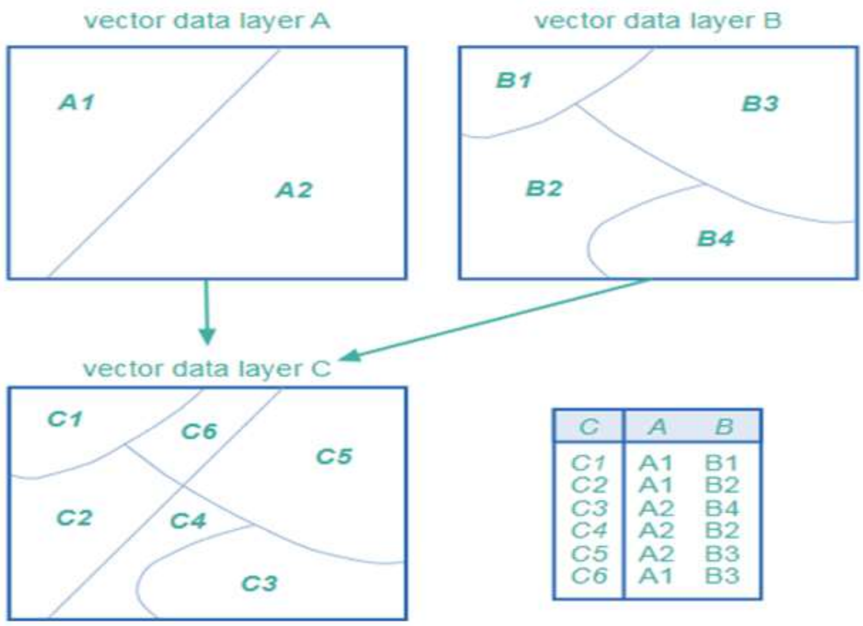
original value	new value	# cells
1,2	1	9
3,4	2	8
5,6	3	3
7,8	4	3
9,10	5	2

original value	new value	# cells
1	1	6
2,3	2	5
4	3	6
5,6	4	3
8,9,10	5	5

Q4c. Explain vector overlay operation using suitable diagram.
Ans: Vector Overlay Operation:
Standard overlay operators take two input data layers, and assume they are georeferenced in the same system, and overlap in study area. If either of these requirements is not met, the use of an overlay operator is senseless. The principle of spatial overlay is to compare the characteristics of the same location in both data layers, and to produce a result for each location in the output data layer.

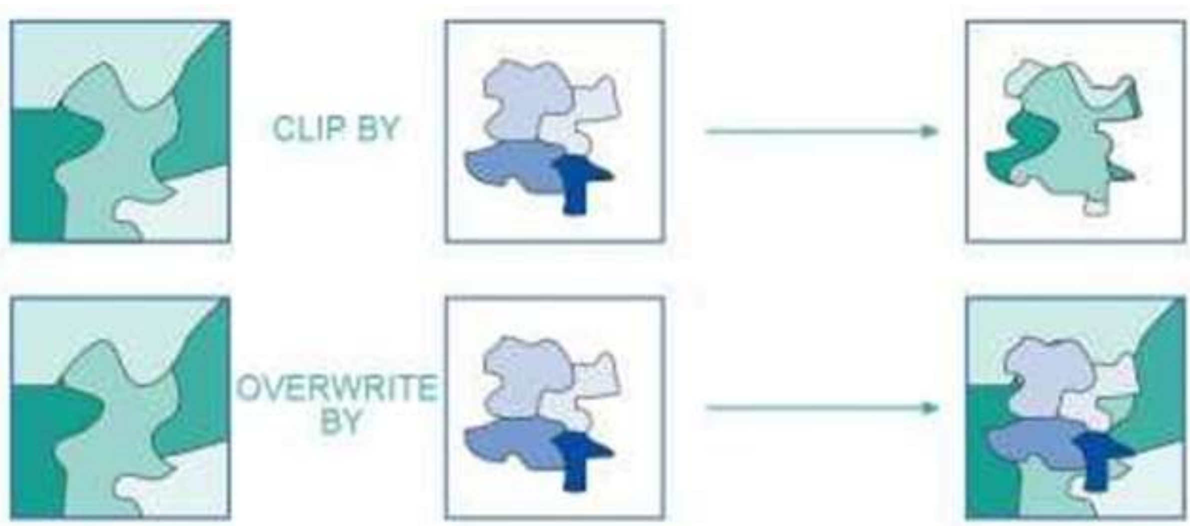
Vector overlay operators:
In the vector domain, overlay is computationally more demanding than in the raster domain. Here we will only discuss overlays from polygon data layers, but we note that most of the ideas also apply to overlay operations with point or line data layers.

Example



C	A	B
C1	A1	B1
C2	A1	B2
C3	A2	B4
C4	A2	B2
C5	A2	B3
C6	A1	B3

A second overlay operator is polygon overwrite. The result of this binary operator is defined is a polygon layer with the polygons of the first layer, except where polygons existed in the second layer, as these take priority.



Q4d. Perform the raster overlay operation to find R4 = R1 AND (R2 OR R3).

R1

1	1	0	1
0	1	0	0
0	0	1	1
1	0	1	0

R2

1	0	0	0
1	1	0	0
1	1	1	0
1	1	1	1

R3

1	1	1	1
0	1	1	1
0	0	1	1
0	0	0	1

Ans Raster Overlay Operation on R4 = R1 AND (R2 OR R3)

R2 OR R3

1	1	1	1
1	1	1	1
1	1	1	1
1	1	1	1

R4 = R1 AND (R2 OR R3)

1	1	0	1
0	1	0	0
0	0	1	1
1	0	1	0

Q4e Write a note on GIS and application models.

Ans: GIS and application models:

We define application models to include any kind of GIS based model (including so-called analytical and process models) for a specific real-world application. Such a model, in one way or other, describes as faithfully as possible how the relevant geographic phenomena behave, and it does so in terms of the parameters. The nature of application models varies enormously. GIS applications for famine relief programs, for instance, are very different from earthquake.

Risk assessment applications, though both can make use of GIS to derive a solution. Many kinds of application models exist, and they can be classified in many different ways. Here we identify five characteristics of GIS-based application models:

1. The purpose of the model,
2. The methodology underlying the model,
3. The scale at which the model works,
4. Its dimensionality- i.e. whether the model includes spatial, temporal or spatial and temporal dimensions, and
5. Its implementation logic- i.e. the extent to which the model uses existing knowledge about the implementation context.

4f. How error propagates in data processing? Explain.

Ans. Error propagation in spatial data processing:

A number of sources of error may be present in source data. It is important to note that the acquisition of base data to a high standard of quality still does not guarantee that the results of further, complex processing can be treated with certainty. As the number of processing steps increases, it becomes difficult to predict the behavior of error propagation. These various errors may affect the outcome of spatial data manipulations. In addition, further errors may be introduced during the various processing steps.

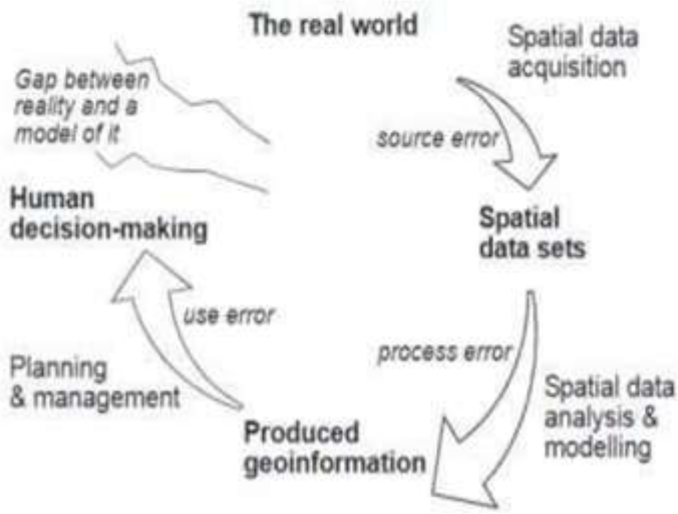


Table lists common sources of error introduced into GIS analyses:

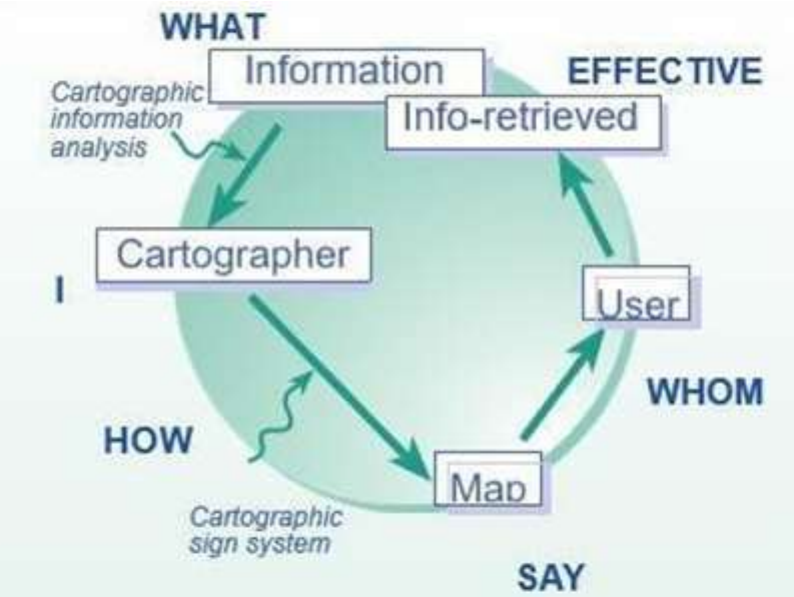
Coordinate adjustments	*Generalization*
rubber sheeting/transformations	linear alignment
projection changes	line simplification
datum conversions	addition/deletion of vertices
rescaling	linear displacement
Feature Editing	*Raster/Vector Conversions*
line snapping	raster cells to polygons
extension of lines to intersection	polygons to raster cells
reshaping	assignment of point attributes to raster cells
moving/copying	
elimination of spurious polygons	post-scanner line thinning
Attribute editing	*Data input and Management*
numeric calculation and change	digitizing
text value changes/substitution	scanning
re-definition of attributes	topological construction / spatial indexing
attribute value update	dissolving polygons with same attributes
Boolean Operations	*Surface modelling*
polygon on polygon	contour/lattice generation
polygon on line	TIN formation
polygon on point	Draping of data sets
line on line	Cross-section/profile generation
overlay and erase/update	Slope/aspect determination
Display and Analysis	*Display and Analysis*
cluster analysis	class intervals choice
calculation of surface lengths	areal interpolation
shortest route/path computation	perimeter/area size/volume computation
buffer creation	distance computation
display and query	spatial statistics
adjacency/contiguity	label/text placement

Question 5

Q5a. What do you mean by "How do I Say What to Whom and is it effective?" in GIS? Explain.

Ans: The sentence "How do I say what to whom and is it effective?" guides the carto-graphic visualization process and summarizes the cartographic communication principle. Especially when dealing with maps in the realm of presentation cartography (Figure 7.9), it is important

to adhere to the cartographic design rules. This is to guarantee that the resulting maps are easily understood by their users. How does this communication process work.
It starts with information to be mapped (the 'What' from the sentence). Before anything can be done, the cartographer should get a feel for the nature of the information, since this determines the graphical options. Cartographic information analysis provides this. Based on this knowledge, the cartographer can choose the correct symbols to represent the information in the map. S/he has a whole toolbox of visual variables available to match symbols with the nature of the data.

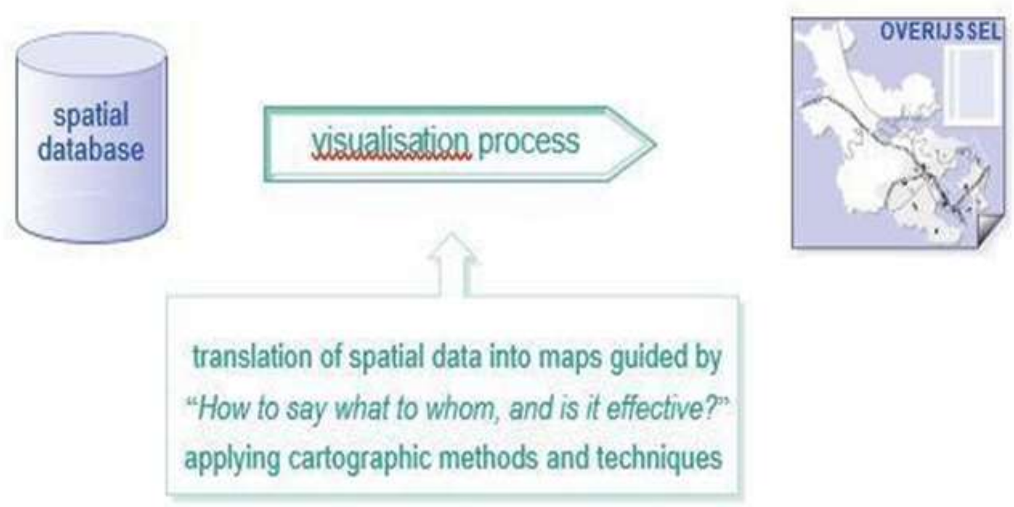


Q5b. Explain the visualization process in GIS.

Ans: The visualization process in GIS:

The characteristic of maps and their function in relation to the spatial data handling process was explained in the previous section. In this context the carto-graphic visualization process is the translation or conversion of spatial data from a database into graphics.
These are predominantly map-like products. During the visualization process, cartographic methods and techniques are applied. These can be considered to form a kind of grammar that allows for the optimal design and production for the use of maps, depending on the application.

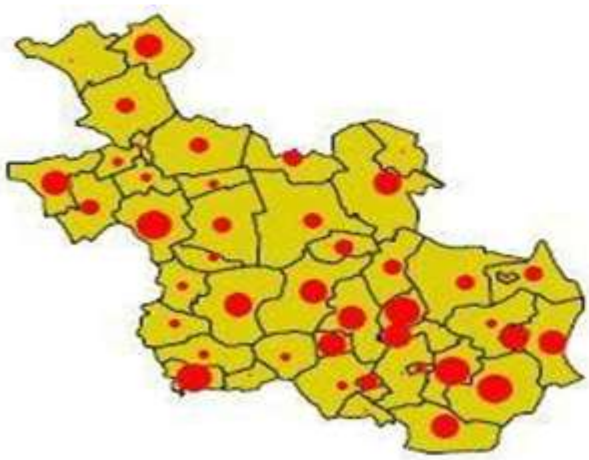
The visualization process can vary greatly depending on where in the spatial data handling process it takes place and the purpose for which it is needed. Visualizations can be, and are, created during any phase of the spatial data handling process as indicated before. They can be simple or complex, while the production time can be short or long.



Q5c. How to map quantitative data? Explain.

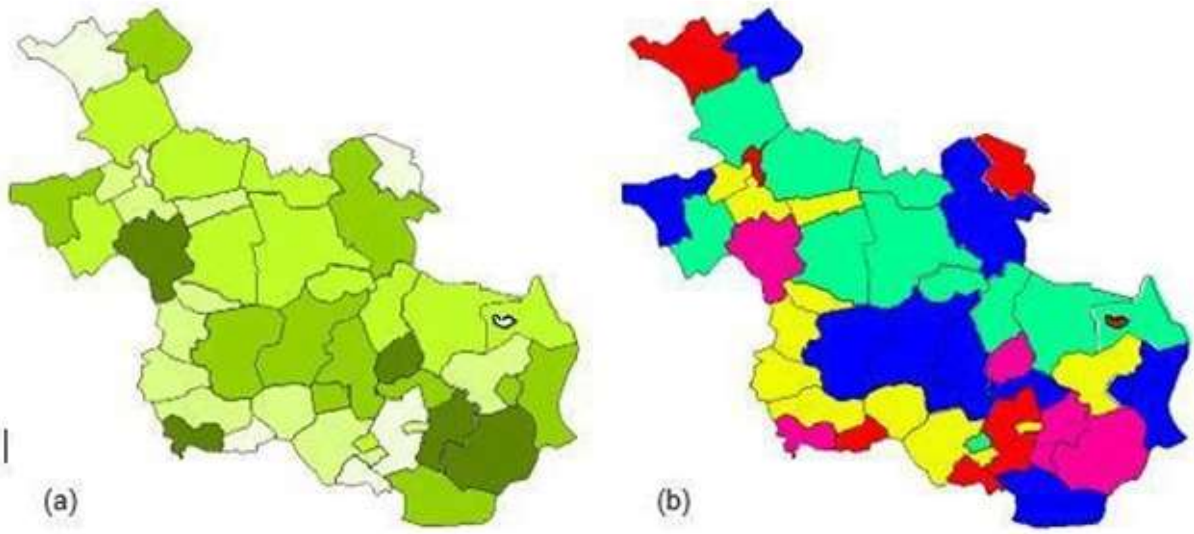
Ans: Map quantitative data:

After executing a census, one would for instance like to create a map with the number of people living in each municipality, one deals with absolute quantitative data. The geographic units will logically be the municipalities. The final map should allow the user to determine the amount per municipality and offer an overview of the geographic distribution of the phenomenon. To reach this objective, the symbols used should have quantitative perception properties. Symbols varying in size fulfil this demand. Figure shows the final map for the province of Overijssel.



The reader might get a reasonable impression of the individual amounts but not of the actual geographic distribution of the population, as the size of the geographic units will influence the perception properties too much. Imagine a small and a large unit having the same number of inhabitants. The large unit would visually attract more attention, giving the impression there are more people than in the small unit. Another issue is that the population is not necessarily homogeneously distributed within the geographic units. Colour has also been misused in Figure(b). The applied four-colour scheme makes it is impossible to infer whether red represents more populated areas than blue.

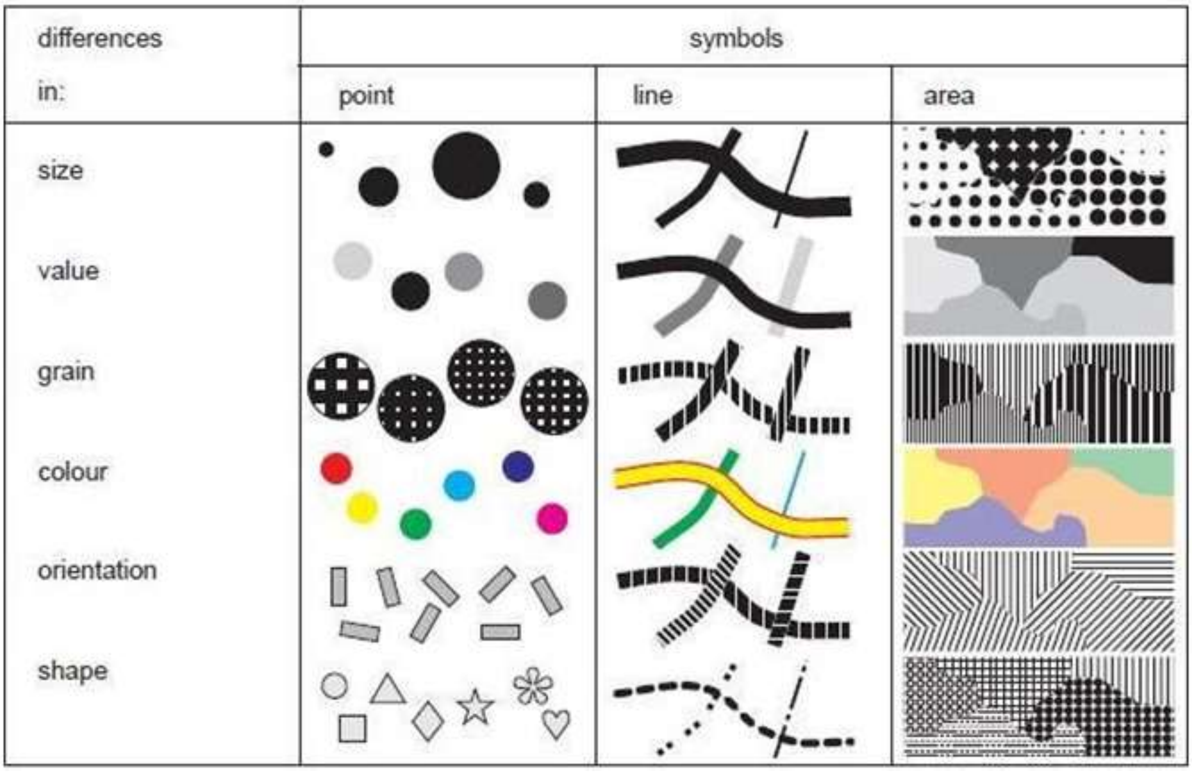
(a) wrong use of green tints for absolute population figures; (b) incorrect use of colour



Q5d. What are Bertin's six categories of visual variables?

Ans: Bertin's six categories of visual variables:

The variations in symbol appearance are only limited by the imagination they can be grouped together in a few categories. Bertin distinguished six categories, which he called the visual variables, and which may be applied to point, line and area symbols.



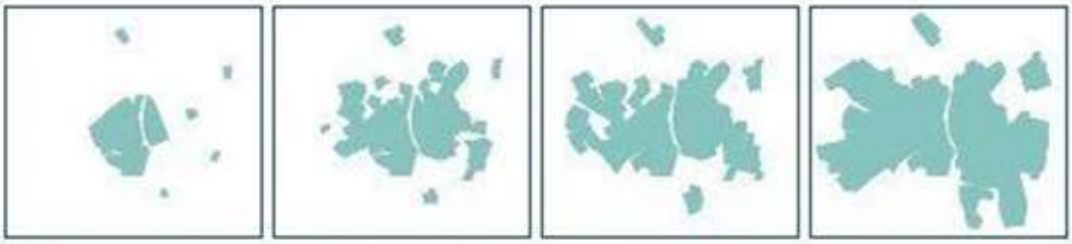
These visual variables can be used to make one symbol different from another. In doing this, map makers in principle have free choice, provided they do not violate the rules of cartographic grammar. They do not have that choice when deciding where to locate the symbol in the map. The symbol should be located where features belong. Visual variables influence the map user's perception in different ways.

Q5e. How to distinguish between three temporal cartographic techniques? Explain.

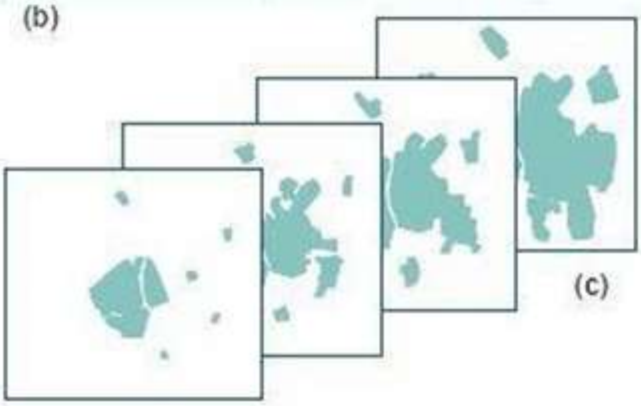
Ans Temporal cartographic techniques:

1. Single static map: Specific graphic variables and symbols are used to indicate change or represent an event. Figure (a) applies the visual variable value to represent the age of the built-up areas;
2. Series of static maps: A single map in the series represents a ‘snapshot’ in time. Together, the maps depict a process of change. Change is perceived by the succession of individual maps depicting the situation in successive snapshots. It could be said that the temporal sequence is represented by a spatial sequence, which the user has to follow, to perceive the temporal variation.
3. Animated map: Change is perceived to happen in a single image by displaying several snapshots after each other just like a video cut with successive frames. The difference with the series of maps is that the variation can be deduced from real ‘change’ in the image itself, not from a spatial sequence.

(a)



(b)

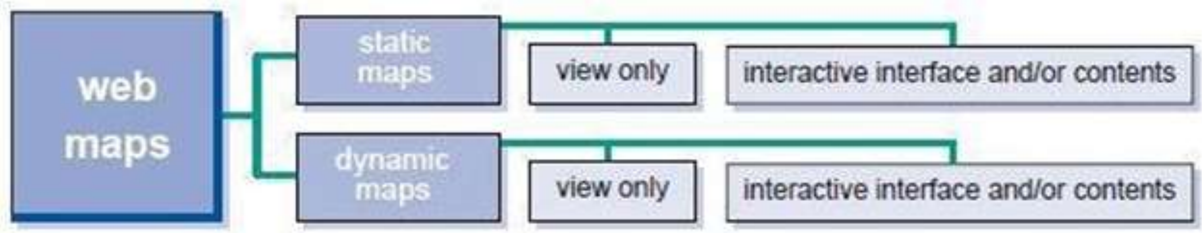


(c)

Q5f. Write a note on Map Disseminations.

Ans: Map dissemination:

On-screen maps:
Currently, most maps are presented on screen, for a quick view, for an internal presentation or for presentation on the WWW. Compared to maps on paper, on-screen maps must be smaller, and therefore their contents should be carefully selected. This might seem a disadvantage, but presenting maps on-screen offers very interesting alternatives. A mouse click could also open the link to a database, and reveal much more information than a paper map could ever offer.



Multimedia maps:

Maps and multimedia (photography, sound ,video ,animation) can be integrated. Some of today's electronic atlases, such as the Encarta World Atlas are good examples of how multimedia elements can be integrated with the map. Pointing to a country on a world map starts the national anthem of the country or shows its flag. It can be used to explore a country's language; moving the mouse would start a short sentence in the region's dialects.

Static maps:
Organizations, such as map libraries or tourist information providers, often make their maps available in this way. This form of presentation can be very useful, for instance, to make historical maps more widely accessible. Static, view-only maps can also serve to give web surfers a preview of the products that are available from organizations, such as National Mapping Agencies.

Dynamic maps:
Dynamic maps are about change in one or more of the spatial data components. On the WWW, several options to play animations are available. The so-called animated-GIF can be seen as a view-only version of a dynamic map.

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