CE432A- Geographical Information System
Introduction

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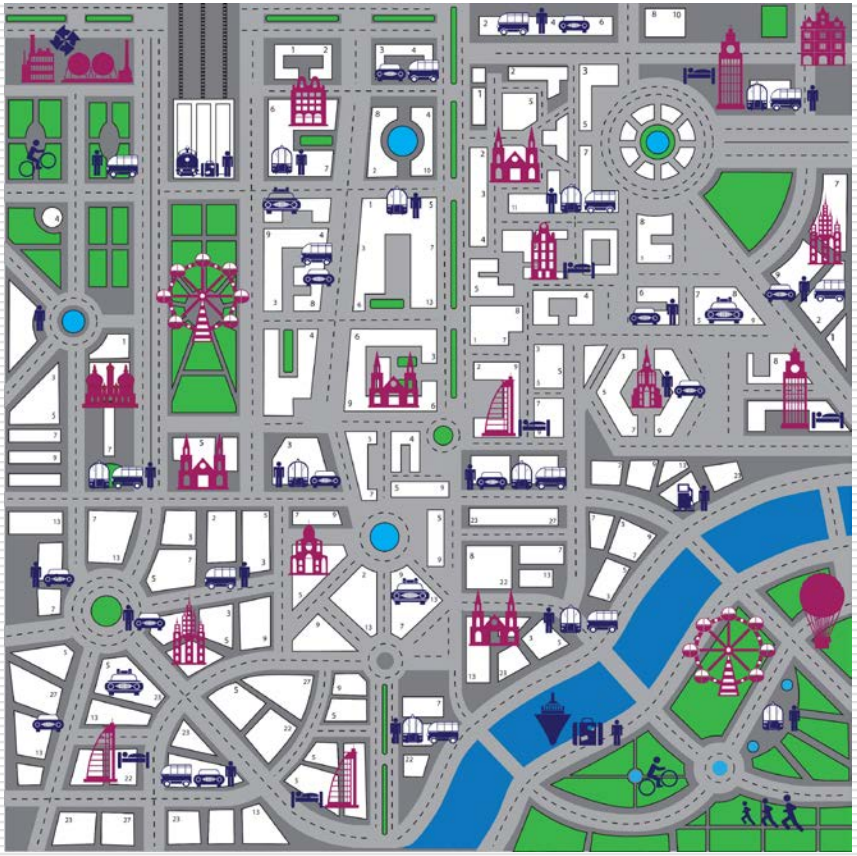
Why GIS? (Geographical Information System)

Let's solve a problem:

- A student at IIT Kanpur wants to set up his experimental system at a location with the following requirements:
  - He needs a patch of at least a 5 m by 5 m area in the open space (i.e. there is no construction yet of a building, or road)
  - The land parcel should be a minimum of 20 m away from the center lines of the roads on the campus (all types of the road). The farther the patch from roads better is the patch.
  - The land parcel should be within the academic area.
  - The land parcel should be away from the building by a minimum distance of 10 m. The larger the separation better is the patch.
  - The patch should be as near as possible to the boundary wall of the academic area, as the experiment will need to drain an effluent out of the boundary through an underground pipe.

Why GIS? (Geographical Information System)

- Let's solve a problem:
  - Find a location for a sports store which is:
    - Well connected with main road <10 m
    - Near to stadium <100m
    - Near to schools/colleges <200m
    - Near to gyms <100m
    - Near the main market < 20m
    - Away from existing sports stores >1000 m
    - Near to ATM <200m
    - Near to middle-class households <200 m
    - East facing, as far as possible
    - Many more: water, electric line, telephone line, cheaper land, parking space etc.



Problems with solutions given

- How to guarantee an optimal solution
- No unique solutions
  - All groups might have a different solution
- Not suitable for large data
- Alternate solutions may take long
- Not suitable for more complex queries
  - Add some more constraints on the query
    - It will be preferred if the patch is nearer to a brick road
    - The area should not be used by IWD for construction for the next year
    - The effluent should drain out of the boundary under gravity
    - Patch should be frequented by wild animals
    - Patch should be sunlit as far as possible throughout the year

What other way problem could have been solved

- Using tracing paper
  - Decide weights for distance from buildings
    - Create buffer
  - Find those areas away by 20 m from roads
    - Create buffer
  - Intersect these buffers to locate open space available
  - Overlap academic area map see where intersection lies
  - Draw buffers around academic area boundary wall in multiple of 5 m to locate the first site that is intersected by buffer
  - Assess if the size is 5 m by 5 m

Requirements ?

- What we need to answer this query?
  - Would you like to visit entire town and try to solve this problem?
  - Information about city (Map or Maps showing all the above parameters)
  - What after all information is available?
  - Analysis of information to arrive at the answer

Geographical Information System can help !

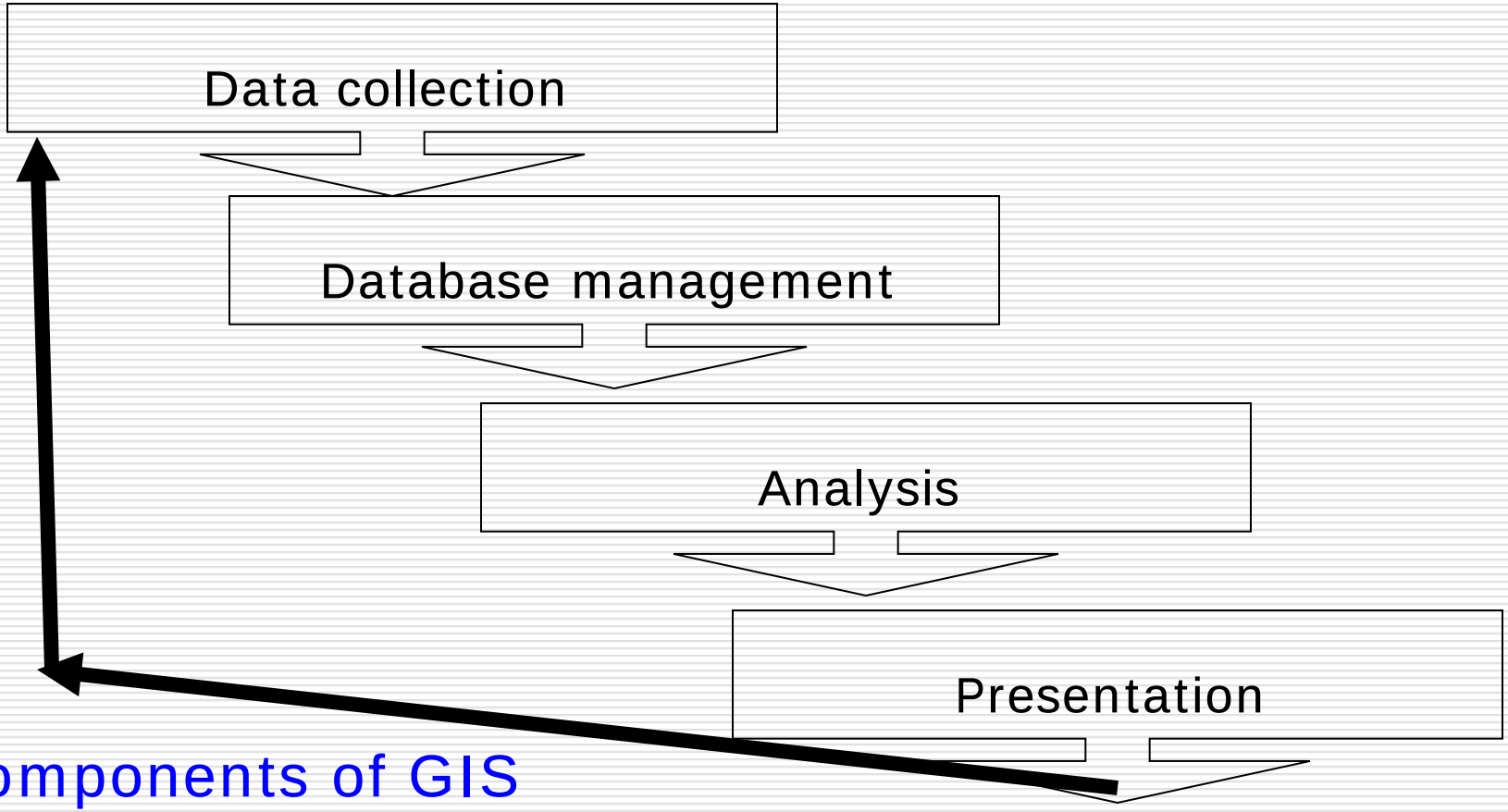
- Somehow put data in computer
- Somehow make computer understand geometry and relative geometrical arrangements of various data types
- Somehow make computer understand the property of different data types
- Somehow make computer carryout desired analysis in efficient and accurate manner
- Somehow present the result in user required format

- All above are possible within GIS

GIS helps

- The queries in previous slides are called spatial queries
- The technology encompassing the entire process to answer spatial queries is called GIS.

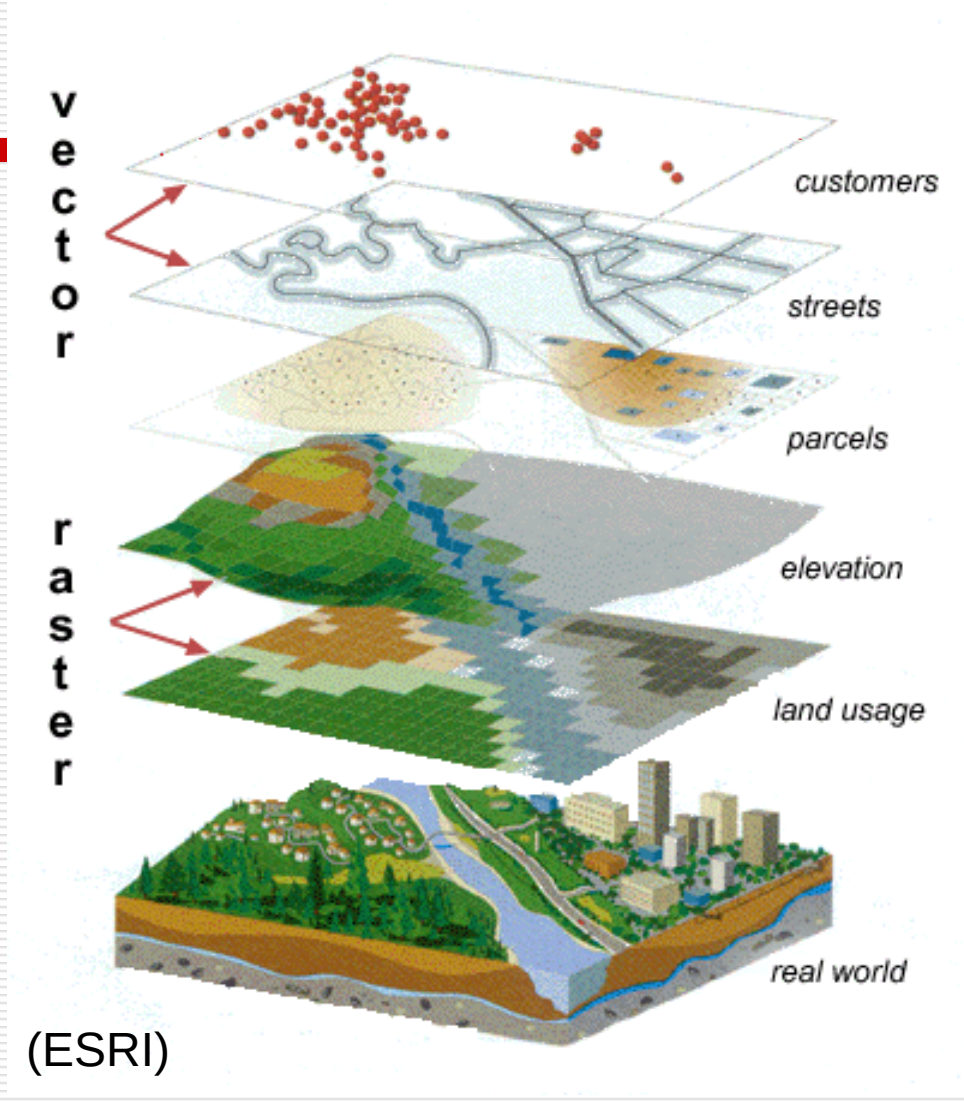
What went to answer the query?



Components of GIS

GIS definition

A computerised system to capture, store, update, manipulate, analyse, and display geographically referenced information



(ESRI)

Contd.

- Is a database management system a GIS?
- “80% of human activities have bearing on geographic location…” Any guess?

Examples/queries

- **Determine where to provide relief after flood**
  - Which were inundated most
  - Where housings are of mud
  - where no pucca roads are there
  - where food supplies are least
  - Where there are depressions for water to remain
  - Where no hospital is in nearby areas
- **Determine the site for a bridge**
  - Narrower cross-section of river
  - Stable river banks
  - Hard rock available at a depth of 3m
  - Nearest to towns A and B on either site

Examples/queries

- **Determine a route for a road for which**
  - Joins towns A, B, and C
  - Passes through villages in a, b, c, d, and e
  - Smaller length of road
  - Construction material available locally
  - Does not cross a gradient of > 30 degree
  - Does not Cross a river or nala for d > 10 m
  - Avoids going closer to schools > 100 m
  - Avoids use of agricultural land
  - Avoids deforestation as much as possible

Examples/queries

- **Two kinds of queries**
  - **Static (using time invariant data) All above discussed.**
  - **Dynamic (using time variant data)**

- **Determine the route of school bus to**
  - Cover area in least time.
  - Cover with least distance.
  - Senior students picked up first.
  - Avoid the passage from polluted area.
  - Avoid the traffic jam.
  - Avoid the areas where there are fairs or political rallies.
  - Avoid going to those places where the students have submitted an absence application.
  - The query is evaluated at every node and accordingly the further action is taken.

Contd.

- Not just maps –drawings, animations, analytical results, tables, charts, photographs, field data, satellite images, voice, videos all can be input to GIS.

- Philosophically, GIS has four basic parts:- hardware; software; data and a ***user.***

- *GIS extends the human capabilities of geographic analysis well beyond his inherent limitations.*

- ‘Basically, GIS is just a tool’
- Information management tool/technology-but-’not science’
- GIS is based on mathematics, computer H/S & S/W technologies.
  - Not physics, biology, chemistry etc. as in the case of remote sensing
  - Though a science related model can be run on GIS.
- A framework which helps processing of geo-data to arrive a desired outcome.

Geospatial thinking

- Develop spatial thinking !
  - To answer spatial queries.

- Thinking spatially
  - Relating events to their locations
  - Seeing spatial patterns in data
  - Developing theories based on spatial distribution of data

The History of GIS

Why examine the history?

- History is NOT a narrative of events but the study of the structure that effects and affects events.
- Important to learn from past failures and successes.

Phase 1: 1960s to mid 1970s

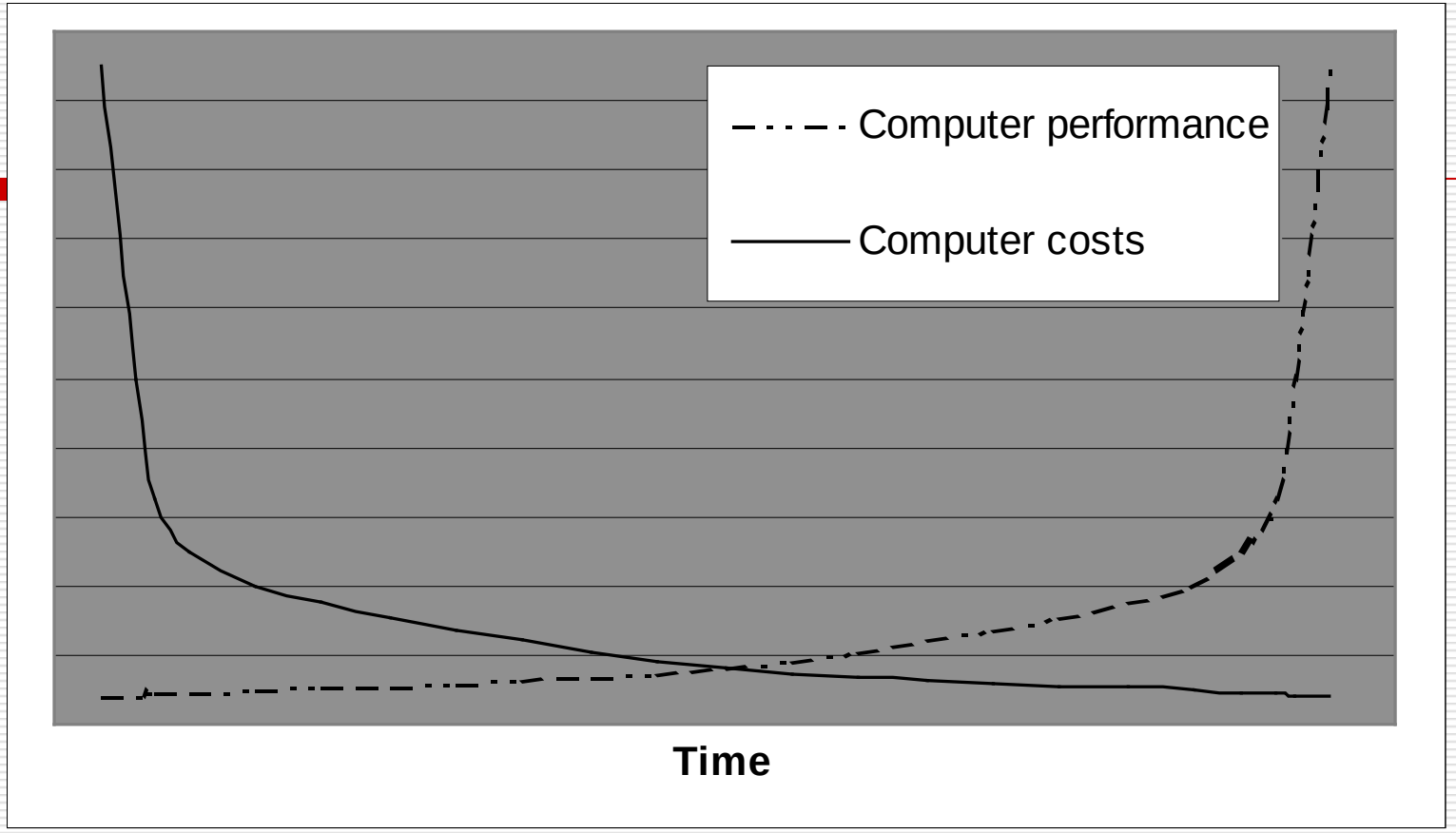
- Pioneering individuals
  - R. Tomlinson & Canada Geographic Information System (CGIS)
  - H. Fisher & SYMAP mapping package
- Systems ‘number crunches and lacked sophisticated graphical features

Phase 2: mid 1970s to early 1980s

- Period of diffusion not innovation
- Government research

Phase 3: mid 1980s to late 1990s

- Growing commercial awareness
- Growing acceptance of GIS
- ArcInfo developed in 1982 by ESRI (Environmental Systems Research Institute)
- Take-off fuelled by technological change



- The relative increase in computer performance compared to declining costs of both hardware and software, in the 1980s

Phase 4: late 1990s to 2000

- Computer performance and cost trends continued
- User dominance occurred
- Numerous, diverse, affordable and customisable systems emerged as the importance of flexibility developed
- Market no longer ‘specialised’

Phase 5- post 2000

- Large number of GIS packages in market
- Google Earth arrives
  - Changes public perception
  - Makes GIS a commodity
- Development of Open Source GISes

- Wide use of Open Source GISes
- Enterprise GIS
- WebGIS
- GIS for navigation – commodity level
- Nationwide GIS development

Phase 6- post 2010

- GIS with AI/ML tools
- Big data handling
- 3D City Models
- GIS-BIM integration