GIS overview
Current systems and applications

- Data models
- Data structures and access methods
- Architectures
- Interfaces
- Applications
Data models

• Fields
  - Locational distributions
  - E.g. DEMs, distribution of rainfall, disease, social groupings
  - Operations taking fields as arguments

• Objects
  - Populations of entities in an information space
  - Objects usually have a spatial (and temporal) references
  - E.g. houses, cars, roads, cities
Some spatial object types

• 1-dimensional

  simple arc
  arc
  simple loop
  loop

• 2-dimensional

  cell
  region
  area
  area
Data structures

- **Raster**: arrays of pixels
  - images from scanners, aerial photography, satellites
  - naturally implements the field model

- **Vector**: points, lines and polygons
  - digitized maps
  - naturally implements the object model
Spatial search in two dimensions

POINT QUADTREE
Hybrid system (relational DB + graphics engine) connected to an external database
Unified system in distributed environment
Interacting with GIS

- Data capture
- Data management
- Data selection
  - GUI
  - query languages (e.g. spatial extensions to SQL)
  - identification of entities by location, name or basic spatial relationship
- Spatial analysis
- Visualizing results
Applications

• Operational
  - utilities and telecomms
  - transportation
  - emergency management
  - land administration
  - urban planning
  - marketing
  - defence
  - in libraries

• Social and environmental
  - health and healthcare
  - politics
  - geodemographics
  - monitoring land-cover and land-use
  - agriculture
  - environmental monitoring and assessment
Review of current GIS

- Data capture bottleneck
- Dichotomous data model: vector vs. raster
- Efficient spatial indexing techniques
- Spatial analysis functionality
- No standard interface languages
- The standard geometry
Success and failures of current GIS

- Two dimensional
- Static
- Good at capturing quantitatively physical position, attributes, spatial relationships between objects
- Diverse and separate set of data models
- Still dominated by the map metaphor
- Interface
The map metaphor

- The map metaphor has dominated the representation and presentation of GI.
- An overlay of 'themes' on a 2-D projection of the surface of the Earth.
- Context independent: user location in space, user location in time, user role.
- A snapshot in time.
Moving beyond the map metaphor: new possibilities

- Context dependence
- New geometries
- More dimensions
- Spatio-temporal information handling
Challenges for GIS (and for theory)

- Representing error, imprecision, vagueness
- Handling multiplicity of scales
- Handling 'common-sense' views of space and time (including the 'non-standard' geometries that result)
- Integrating space and time
A multiresolution model

• allows the data and processes associated with geographic phenomena to be represented at a multiplicity of resolutions

• provides a means of moving between resolutions

• provides methods for reasoning and manipulating the imprecise (rough) entities and processes represented at heterogeneous resolutions
Handling ‘common-sense’ views of space and time

- US NCGIA Research Initiative ‘Formal models of common-sense worlds’
  - Identify and develop a framework for basic elements of common-sense conceptualizations of geographic space, entities and processes.
  - Relate the above to current GIS technology.
Mental maps

• People have very different conceptions of the geographic space that they inhabit.
• Designers of interfaces could recognize this.
Travel-time spaces ...

• ... may in some circumstances model more closely a commonsense view of the world
• ... are almost metric spaces, but not necessarily symmetric.

How to visualize/reason about these types of spaces?