GEOSPATIAL DATA

- Representation of Geographical Data in GIS
- Geospatial Data : Structure and Formats
- Data Models : Raster and Vector Data Models

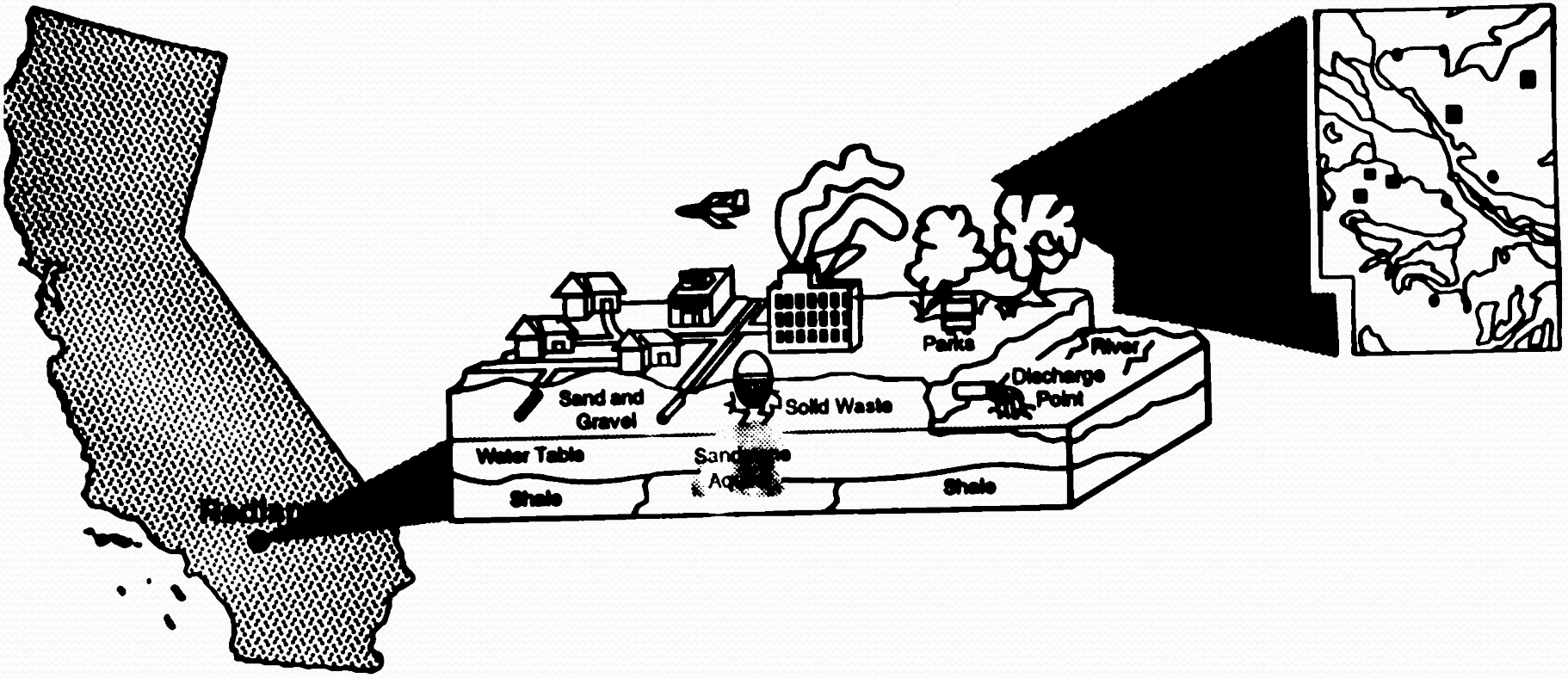
DIGITAL GEOSPATIAL DATABASE

- Digital geospatial data are numerical representations that describe real-world features and phenomenon, coded in specific ways to support GIS and mapping applications using the computer

- Geospatial database allows a range of functions for organizing, storing, processing, analyzing, and visualizing spatial data. It is dynamic, rather than a static, view of specific aspects of geographic space together with necessary tools that allow users to interact with the data to achieve their specific application objectives.

The GIS Data Model: Purpose

allows the geographic features in real world locations to be digitally represented and stored in a database so that they can be abstractly presented in map (analog) form, and can also be worked with and manipulated to address some problem.

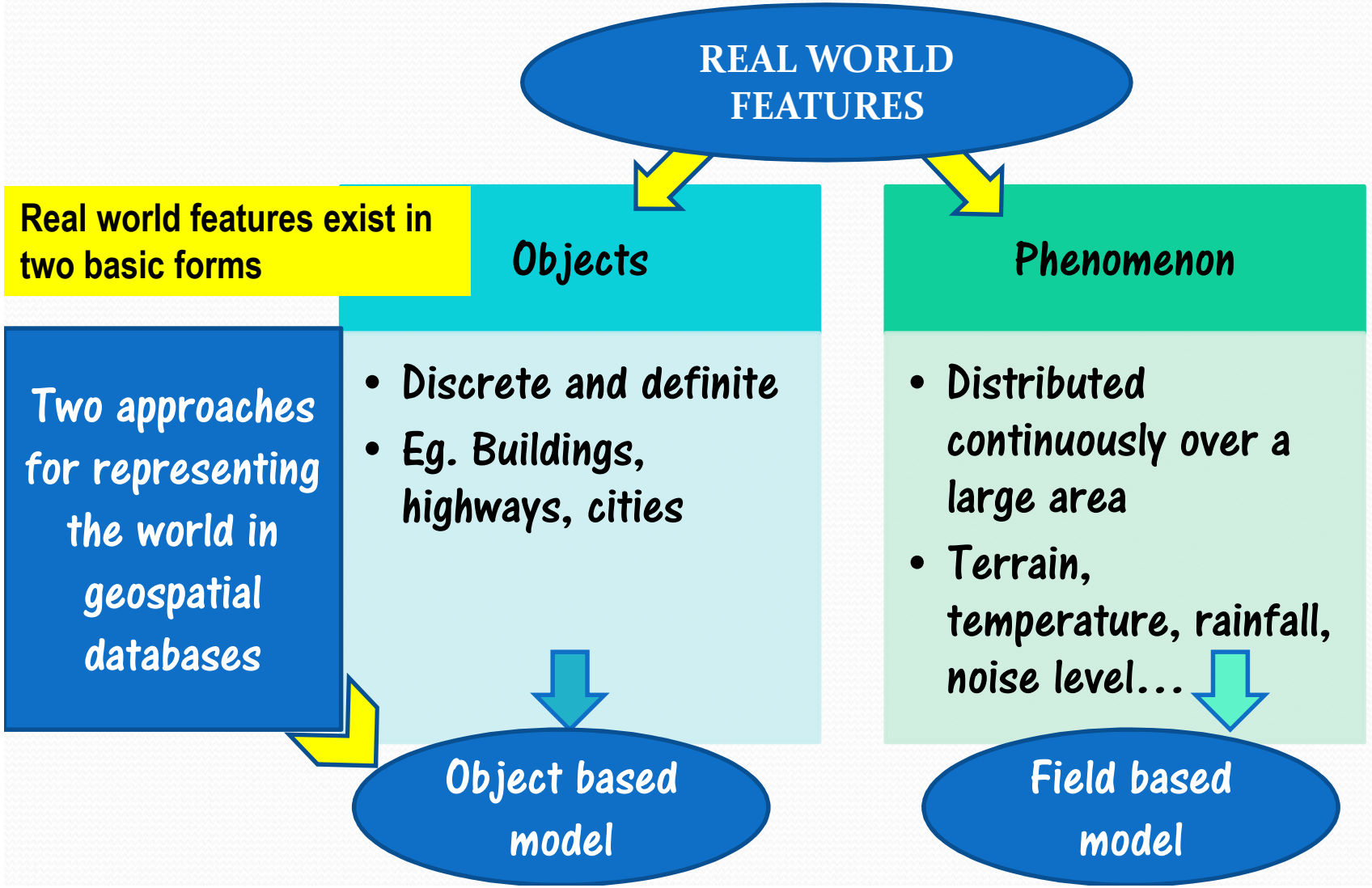


■ Real-world locations

■ Geographic features

■ Abstract representatio

REPRESENTING GEOGRAPHIC SPACE



OBJECT BASED MODEL

An object based model treats geographic space as space populated by discrete and identifiable objects

An object is a spatial feature which –

1. Has identifiable boundaries or spatial extent
2. Is relevant to some intended application
3. Is describable by one or more characteristics commonly referred to as attributes.

Objects may be Exact or Inexact

Exact objects – Boundaries are well defined. Eg. Buildings, land parcels

Inexact objects also c/a Fuzzy entities – Boundaries are identifiable but not well defined. Characteristics of objects are transitional across assumed boundaries between neighbouring objects. Eg. Landform features, natural resource features- soil type etc.

OBJECT BASED MODEL

Data in object based model are obtained by –

1. Field surveying
2. Photogrammetric mapping
3. Map and air photo interpretation
4. Remote sensing image analysis
5. Map digitizing

Representation as graphical elements (depending on nature of object and geographical scale at which they are recorded)

1. Points
2. Lines
3. Polygon

Vector Data Model

FIELD BASED MODEL

Treats geographic space as space populated by one or more spatial phenomenon, i.e. real world features that vary continuously over space with no obvious or specific boundary

Data can be obtained either directly or indirectly

Direct acquisition- Aerial photography, remotely sensed imagery, map scanning, field measurements at sampled locations

Indirect acquisition- Data is generated by applying mathematical functions – interpolation, reclassification, resampling - to measurements made at selected or sampled locations

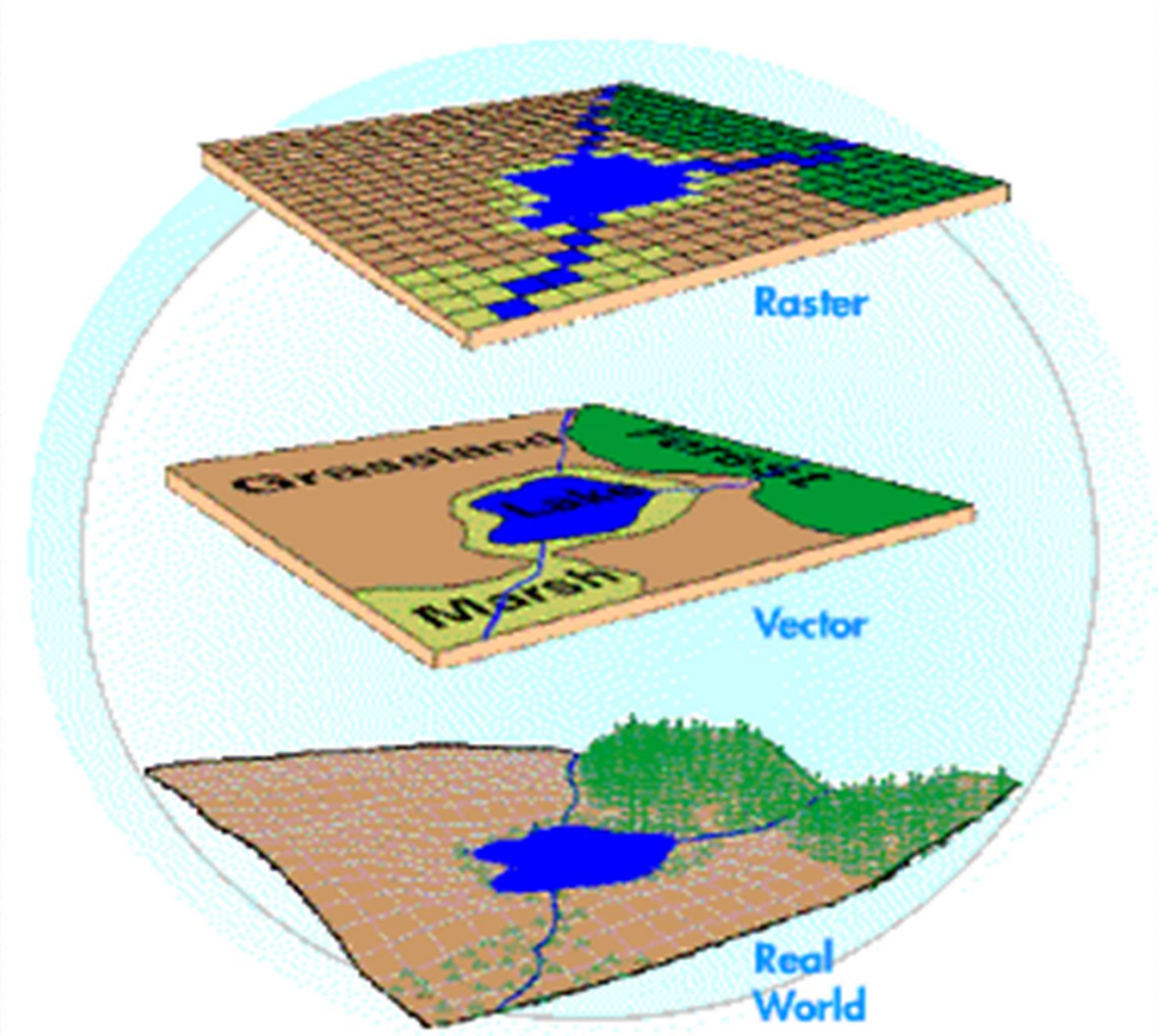
Represented as surfaces which can be conceptualized as being made up of spatial data units in form of regular tesselations or irregular point values

AS MOST COMMON TESELLATION IS A FINITE GRID OF SQUARE OR RECTANGULAR CELLS, FIELD BASED DATABASES ARE GENERALLY C/a RASTER DATA MODEL

The way in which information is represented affects

- ✓The type of analysis that can be performed
- ✓The type of graphical display that can be performed
- ✓The type of analysis that can be obtained

DATA MODELS – Spatial Information



SPATIAL INFORMATION

Three types

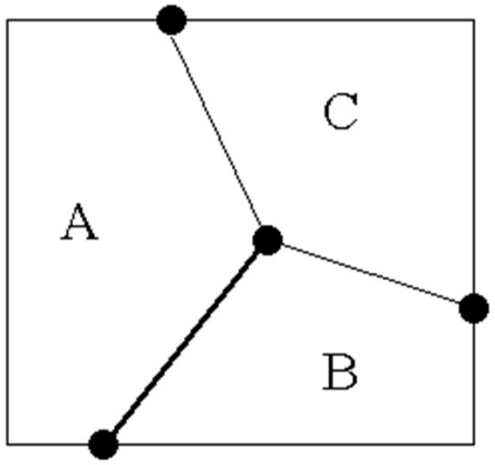
- **Location -** reference position, spatial units , spatial relationships

- **Form –** qualitative and quantitative descriptions of shape and structure

- **Topology –** associations and interactions between different phenomenon

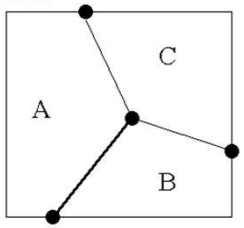
The **DATA MODEL** represents a set of guidelines to convert the real world (called entity) to the digitally and logically represented spatial objects consisting of the attributes and geometry. The attributes are managed by thematic or semantic structure while the geometry is represented by geometric-topological structure.

Vector



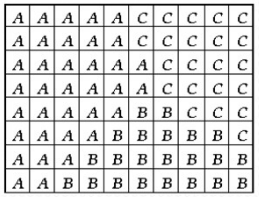
A	A	A	A	A	C	C	C	C	C
A	A	A	A	A	C	C	C	C	C
A	A	A	A	A	A	C	C	C	C
A	A	A	A	A	A	C	C	C	C
A	A	A	A	A	B	B	C	C	C
A	A	A	A	B	B	B	B	B	C
A	A	A	B	B	B	B	B	B	B
A	A	B	B	B	B	B	B	B	B

Raster



VECTOR MODEL

- Uses discrete point , lines and/ or areas corresponding to discrete objects with name / coding/ special symbols for attributes.
- Point – Meteorological Station
- Line – Highway
- Area – Agricultural field

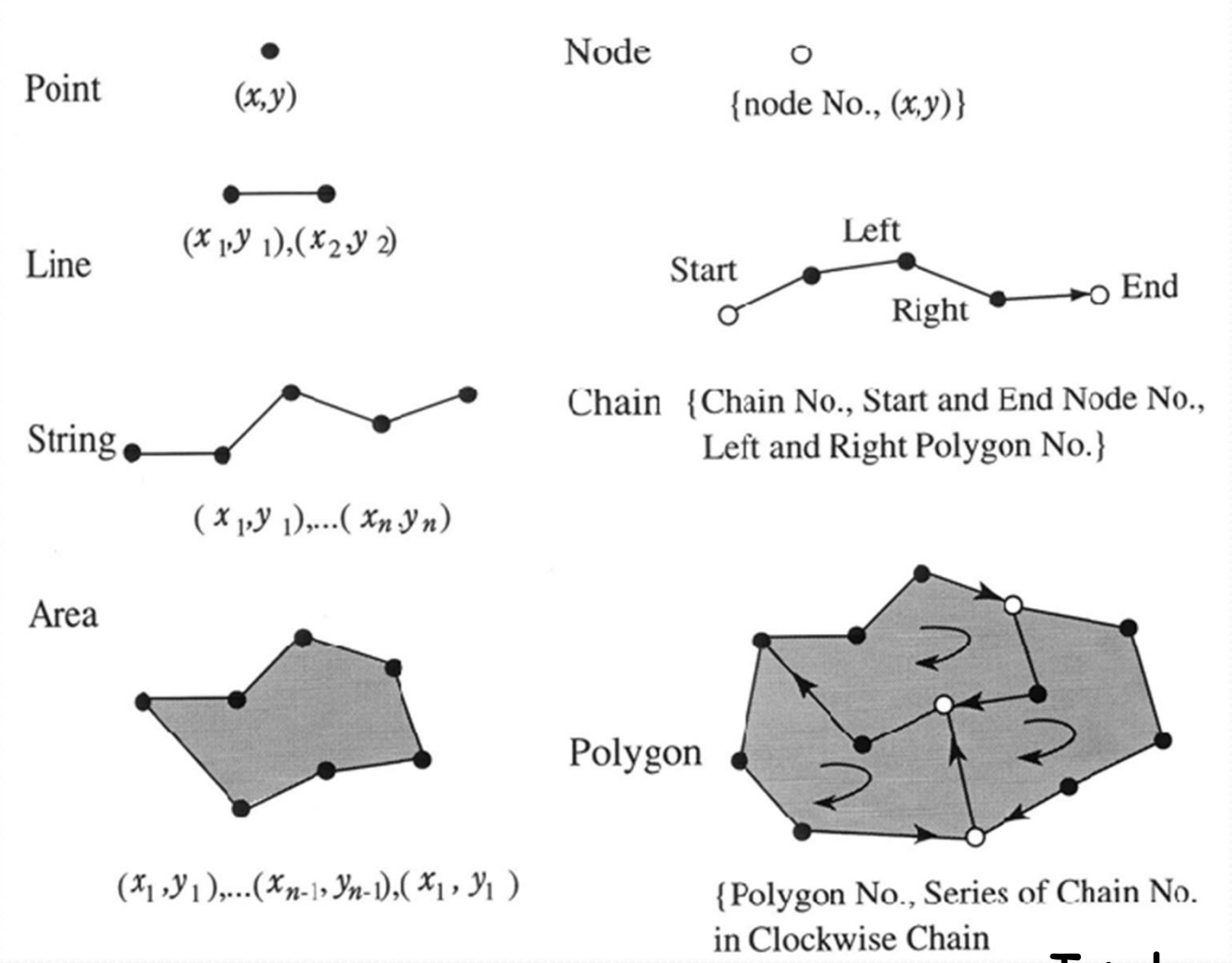


RASTER MODEL

- Uses regularly spaced grid cells in a specific sequence
- An element of the grid is called a pixel
- Conventional sequence is row by row from left to right then line by line from top to bottom.
- Every location is given in 2D image coordinates; pixel number and line number which contains a single value of attributes.

Topology

For spatial analysis in GIS, only the geometry with the position, shape and size in a coordinate system is not enough but the topology is also required.



The GEOMETRY of a point is given by two dimensional coordinates (x, y), while line, string and area are given by a series of point coordinates

TOPOLOGY defines additional structure

- **Node : an intersect of more than two lines or strings, or start and end point of string with node number .**
- **Chain : a line or a string with chain number, start and end node number, left and right neighbored polygons**
- **Polygon : an area with polygon number, series of chains that form the area in clockwise order (minus sign is assigned in case of anti-clockwise order).**

Possible topological relationships between spatial objects

a. Point-Point Relationship

"is within" : within a certain distance

"is nearest to" : nearest to a certain point

b. Point-Line Relationships

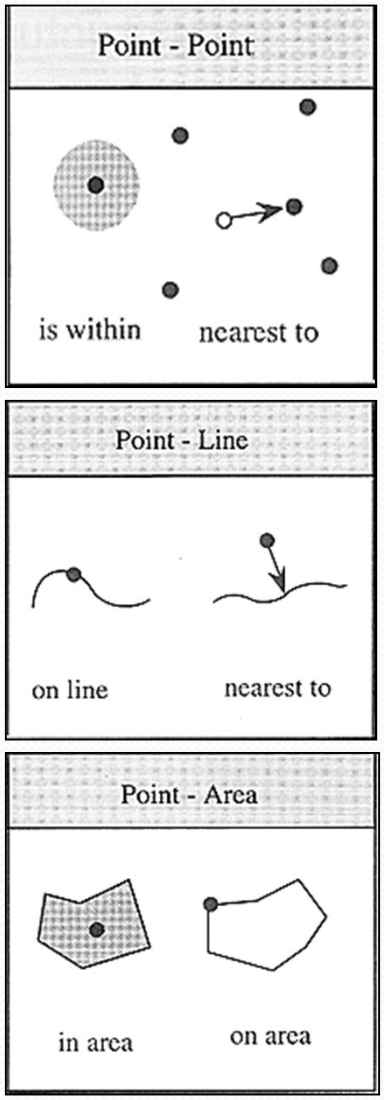
"on line" : a point on a line

"is nearest to" : a point nearest to a line

c. Point-area Relationships

"is contained in" : a point in an area

"on border of area" : a point on border of an area



d. Line-Line Relationships

"intersects" : two lines intersect

"crosses" : two lines cross without an intersect

"flow into" : a stream flows into the river

e. Line-Area Relationship

"intersects" : a line intersects an area

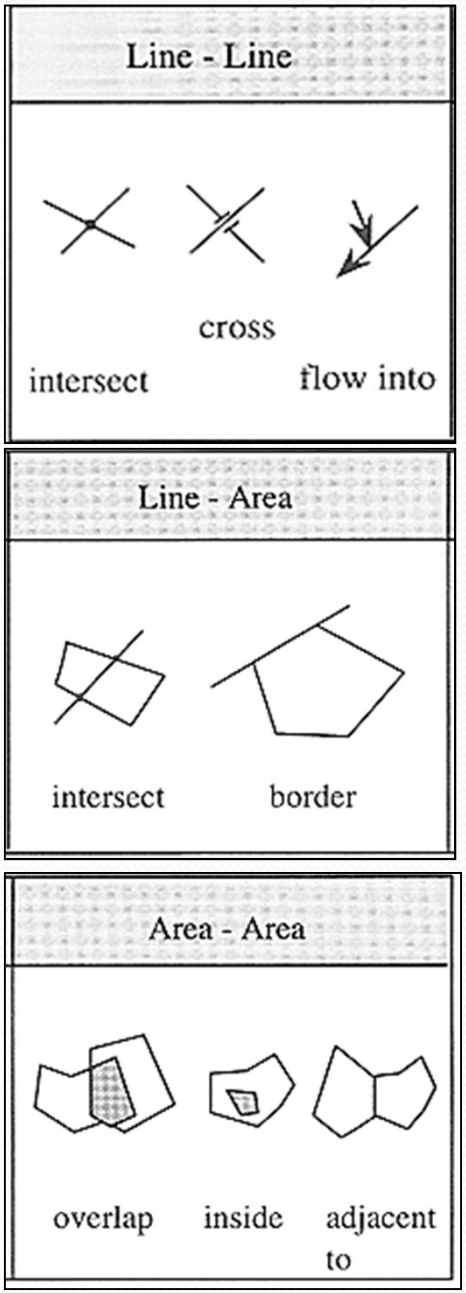
"borders" : a line is a part of border of an area

f. Area-Area Relationships

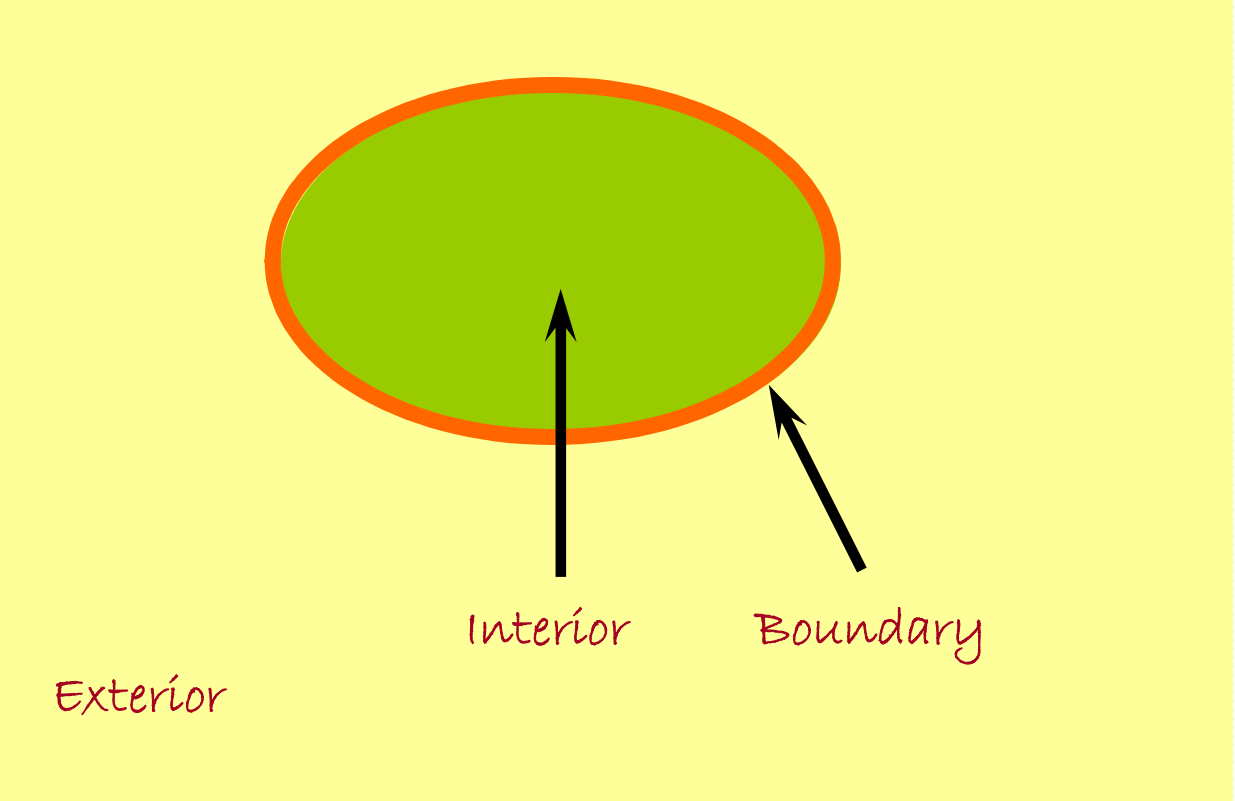
"overlaps" : two areas overlap

"is within" : an island within an area

"is adjacent to" : two area share a common boundary

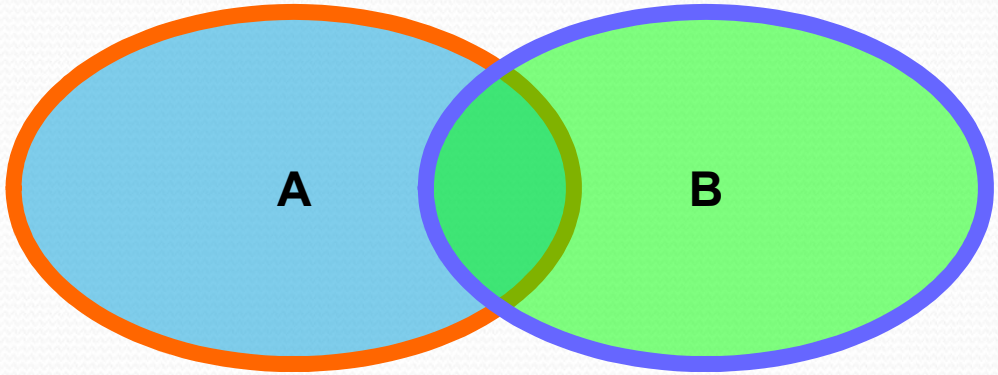


Topological Invariants

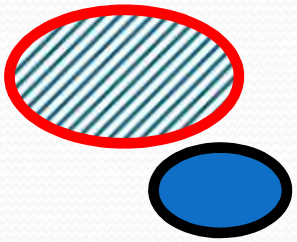


Topological Relationships

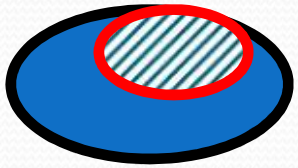
Relationships between two regions can be determined based on the intersection of their boundaries and interiors.



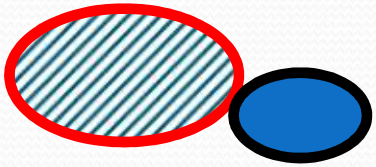
Spatial Relationships



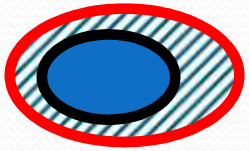
disjoint



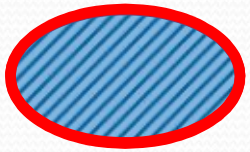
covered by



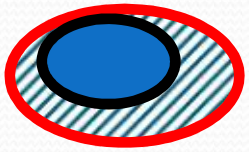
meet



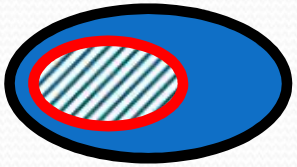
contains



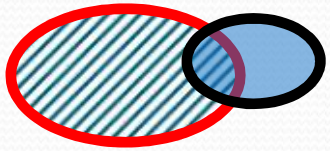
equal



covers



inside



overlap

LAYERS and GEODATABASE

Requirement is to access data on the basis of one or more classes.

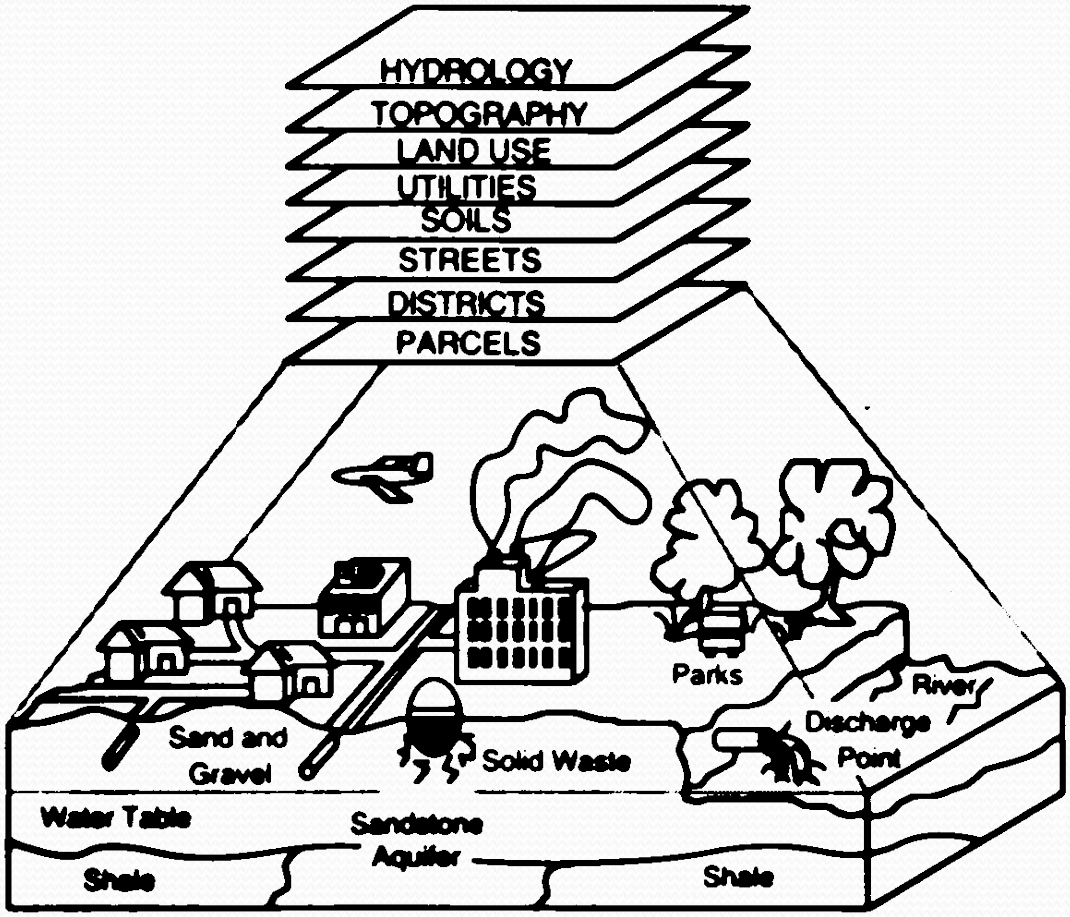
Layers: Organizational scheme of data in which all data of a particular level of classification are grouped together.

- Both raster and vector GIS organize data into spatial layers
- Typical layers represent information belonging to a particular class
- Layers can be combined with each other in various ways to create new layers that are a function of individual ones.
- Any layer does not contain any areal regions that are overlapping.

GEODATABASE

- The characteristic of each layer within a layer-based GIS is that all locations with each layer may be said to belong to a single aerial region or cell, whether it be a polygon bounded by lines in vector system, or a grid cell in a raster system. Such database bundle is called Geodatabase.
- it is possible for each region to have multiple attributes corresponding to multiple perspectives on the meaning of that region.

A layer-cake of information



A number of related data layers can represent the many geographies of the real world.

Layers are comprised of two data types

- *Spatial data* which describes location (where)
- *Attribute data* specifying what, how much, when

Layers may be represented in two ways:

- in *vector* format as points and lines
- in *raster(or image)* format as pixels

All geographic data has 4 properties:

Projection, Scale, Accuracy and Resolution

Spatial and Attribute Data

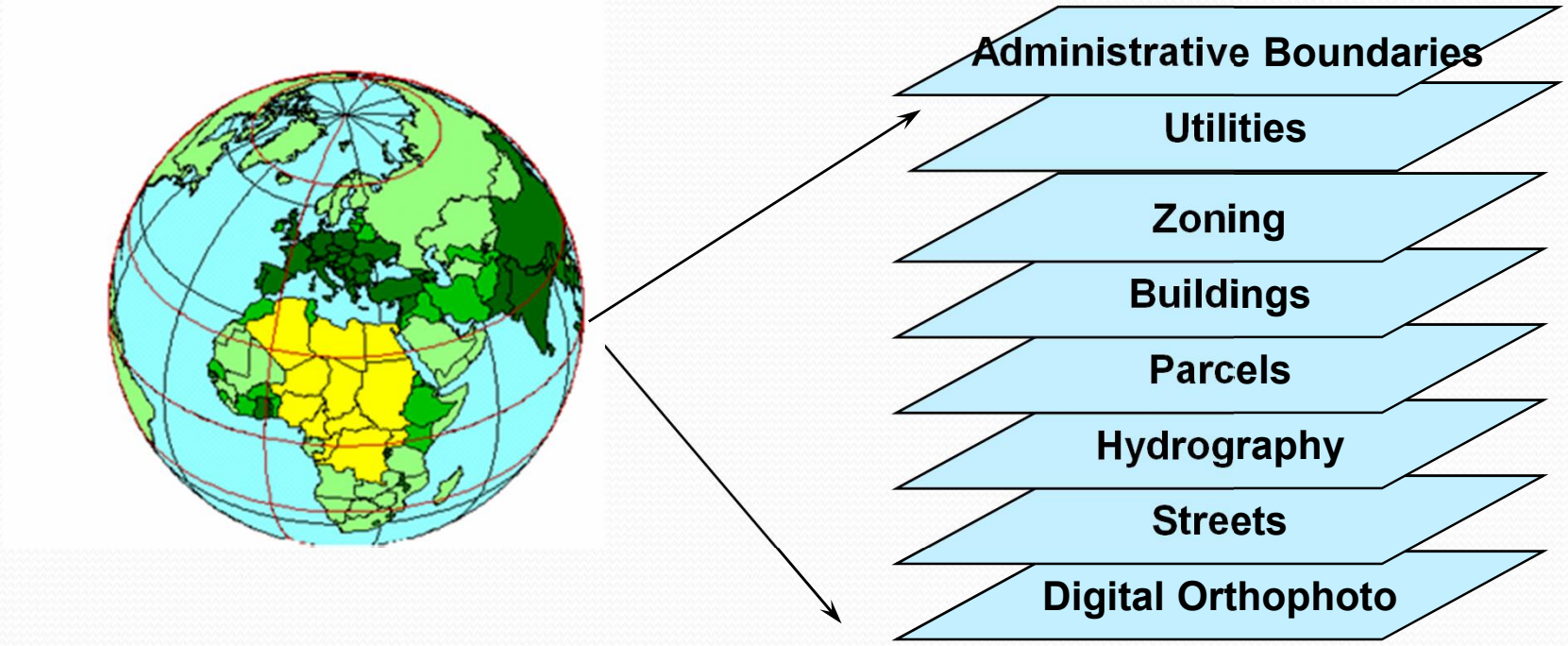
- **Spatial data *(where)***
  - **specifies location**
  - **stored in a *shape file, geodatabase* or similar geographic file**
- **Attribute (descriptive) data *(what, how much, when)***
  - **specifies characteristics at that location, natural or human-created**
  - **stored in a data base *table***

GIS systems traditionally maintain spatial and attribute data separately, then "join" them for display or analysis

- **For example, in ArcView, the *Attributes of …* table is used to link a *shapefile* (spatial structure) with a *data base table* containing attribute information in order to display the attribute data spatially on a map**

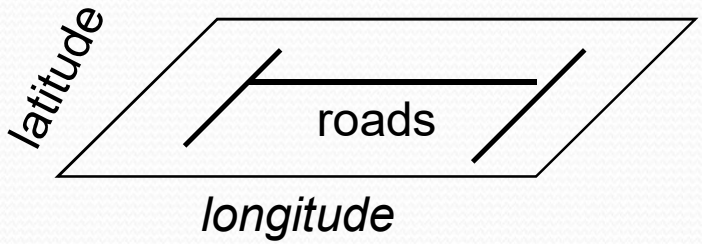
The GIS Data Model: Summary

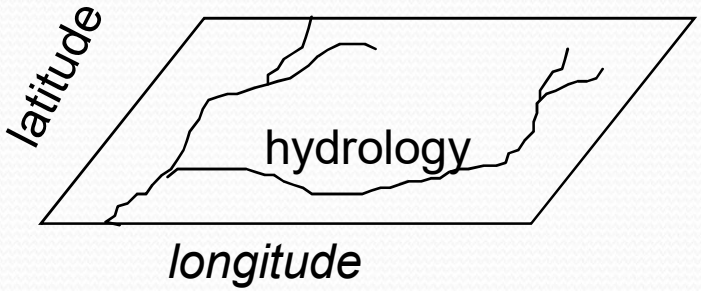
Geographic Integration of Information

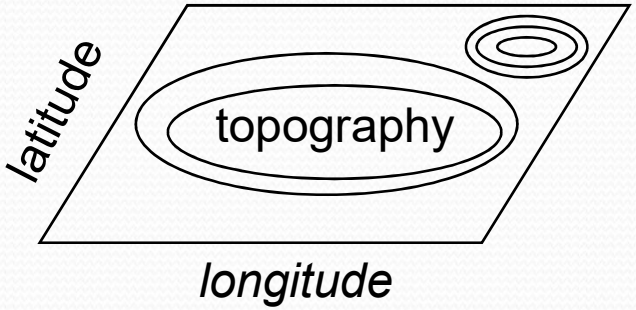


- **Data is organized by layers, coverages or themes (synonomous concepts), *with each layer representing a common feature*.**
- **Layers are integrated using explicit location on the earth's surface, *thus geographic location is the organizing principal*.**

The GIS Model: Example







Here we have three <u>layers</u> or themes:

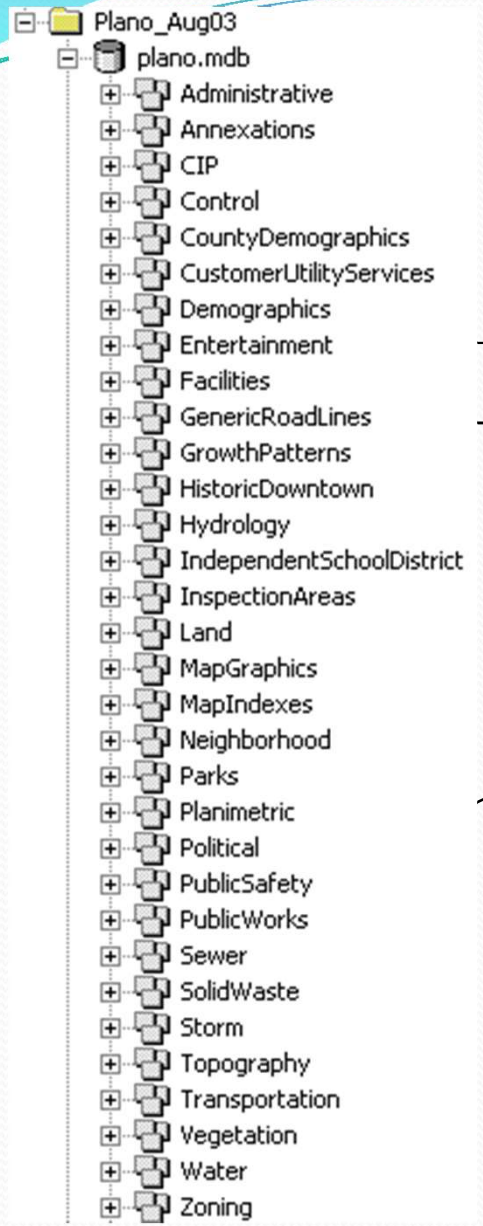
--roads,

--hydrology (water),

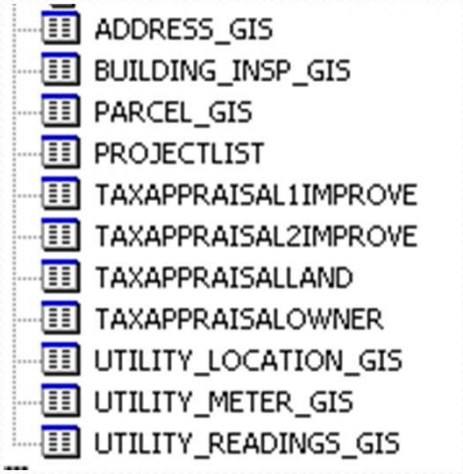
--topography (land elevation)

They can be related because precise geographic coordinates are recorded for each theme.

Vector Layers



Attribute Tables



Raster Layers

Anatomy of a GIS Database:
City of Plano

The presentation is a compilation of information acquired from various text books of GIS. The illustrations have been taken from online sources and images accessed through Google images. All sources are thankfully acknowledged.