

GIS capabilities

What is a GIS?

a system of hardware, software and procedures designed to support the **capture, management, manipulation, analysis, modeling** and **display** of spatially referenced data for solving complex planning, management and research problems

GIS Capabilities

- **data capture / input:**
 - input data by digitizing, scanning, or direct coordinate entry
 - edit data in the GIS to correct errors or add features
 - label the spatial features so they can be identified (names or codes)

GIS Capabilities

- **management:**

- link attribute data to spatial objects

- link to external databases

- make changes in existing databases

- update database features

- import and export from/to other GIS or DBMS

- combine map sheets to create large databases

- match the edges of neighboring map sheets

GIS Capabilities

- **manipulation:**

**make maps from different sources compatible
so that they can be drawn on top of each other**

transformation of coordinates

projection change

GIS Capabilities

- **analysis:** query

select features by their attributes:

“find all districts with literacy rates $< 60\%$ ”

select features by geographic relationships

“find all family planning clinics within this district”

combined attributes/geographic queries

“find all villages within 10km of a health facility that have high child mortality”

GIS Capabilities

- **analysis (cont.):**

buffer: find all settlements that are more than 10km from a health clinic

point-in-polygon operations: identify for all villages into which vegetation zone they fall

polygon overlay: combine administrative records with health district data

geocoding/address matching: match an address list with a street map

network operations: find the shortest route from village to hospital

GIS Capabilities

- **modeling**: identify or predict a process that has created or will create a certain spatial pattern

diffusion: how is the epidemic spreading in the province?

interaction: where do people migrate to?

what-if scenarios: if the dam is built, how many people will be displaced?

GIS Capabilities

- **display/output:**

exploratory

visualize pattern and identify anomalies

compare information in map space

and data space

cartography

produce high quality map output for

publication

create a digital or paper census atlas

export map output to other packages

Vector GIS functions

Vector GIS systems

- points, lines and areas
- high quality map output
- efficient representation of **spatial relationships**

Spatial relationships

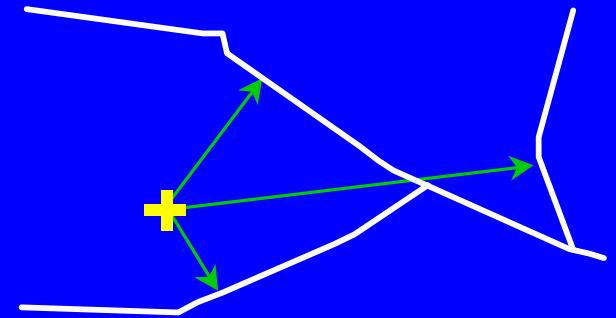
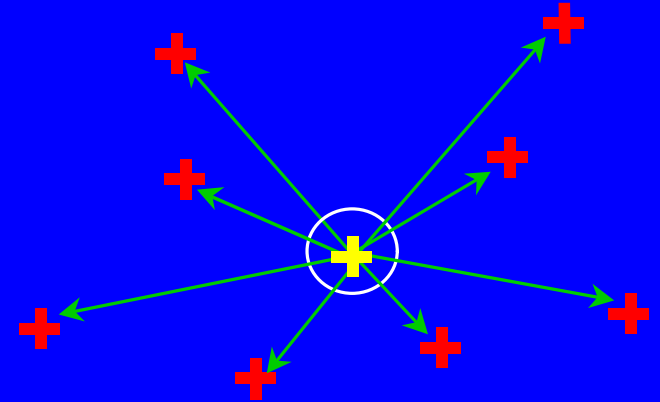
- “adjacent to”
- “connected to”
- “near to”
- “intersects with”
- “within”
- “overlaps”
- etc.

Spatial relationships

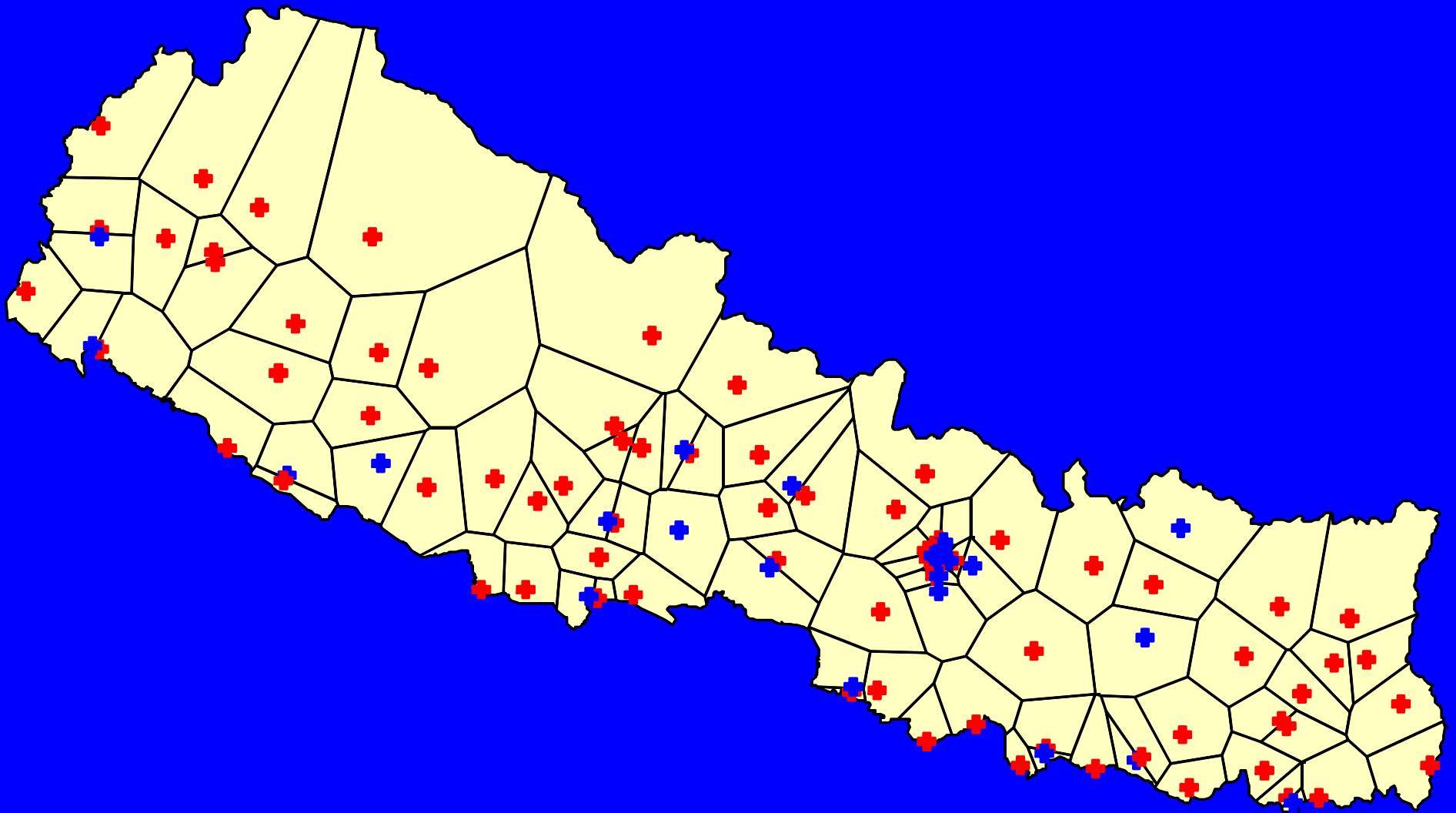
- **logical connections between spatial objects represented by points, lines and polygons**
- **e.g.,**
 - **point-in-polygon**
 - **line-line**
 - **polygon-polygon**

“is nearest to”

- **point/point**
 - which family planning clinic is closest to the village?
- **point/line**
 - which road is nearest to the village
- **same with other combinations of spatial features**

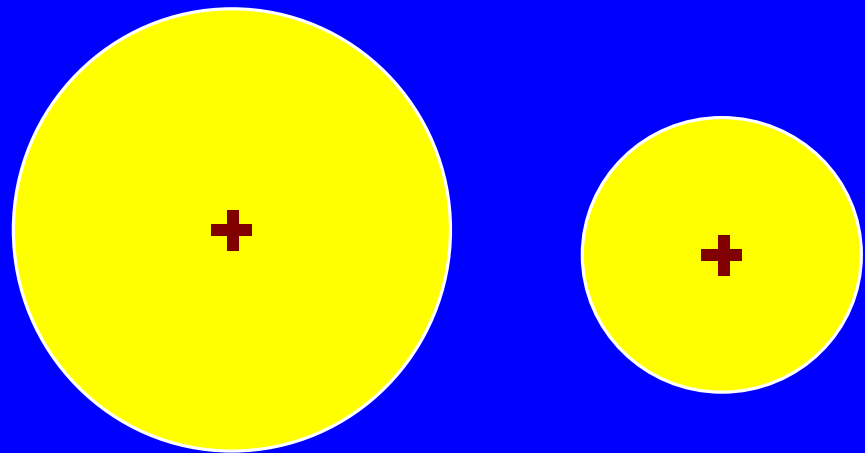


“is nearest to”: Thiessen polygons



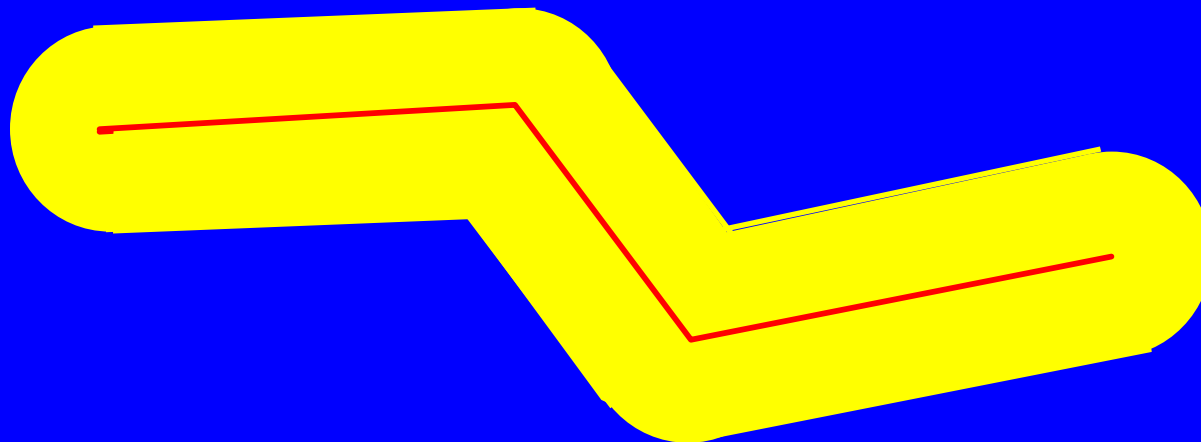
“is near to”: buffer operations

- **point** buffer
 - affected area around a polluting facility
 - catchment area of a water source



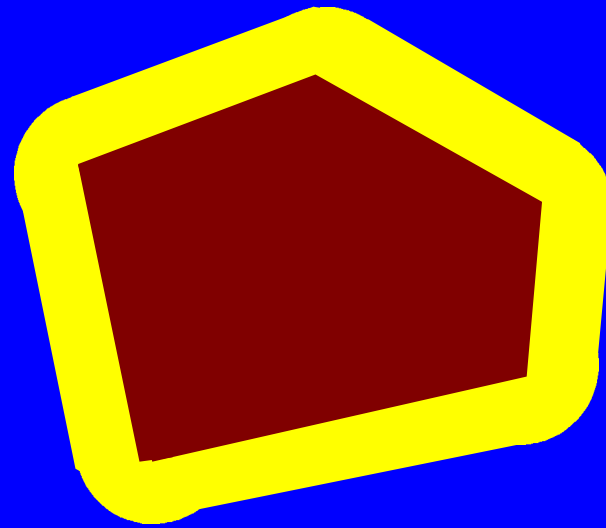
buffer operations

- **line** buffer
 - how many people live near the polluted river?
 - what is the area impacted by highway noise?



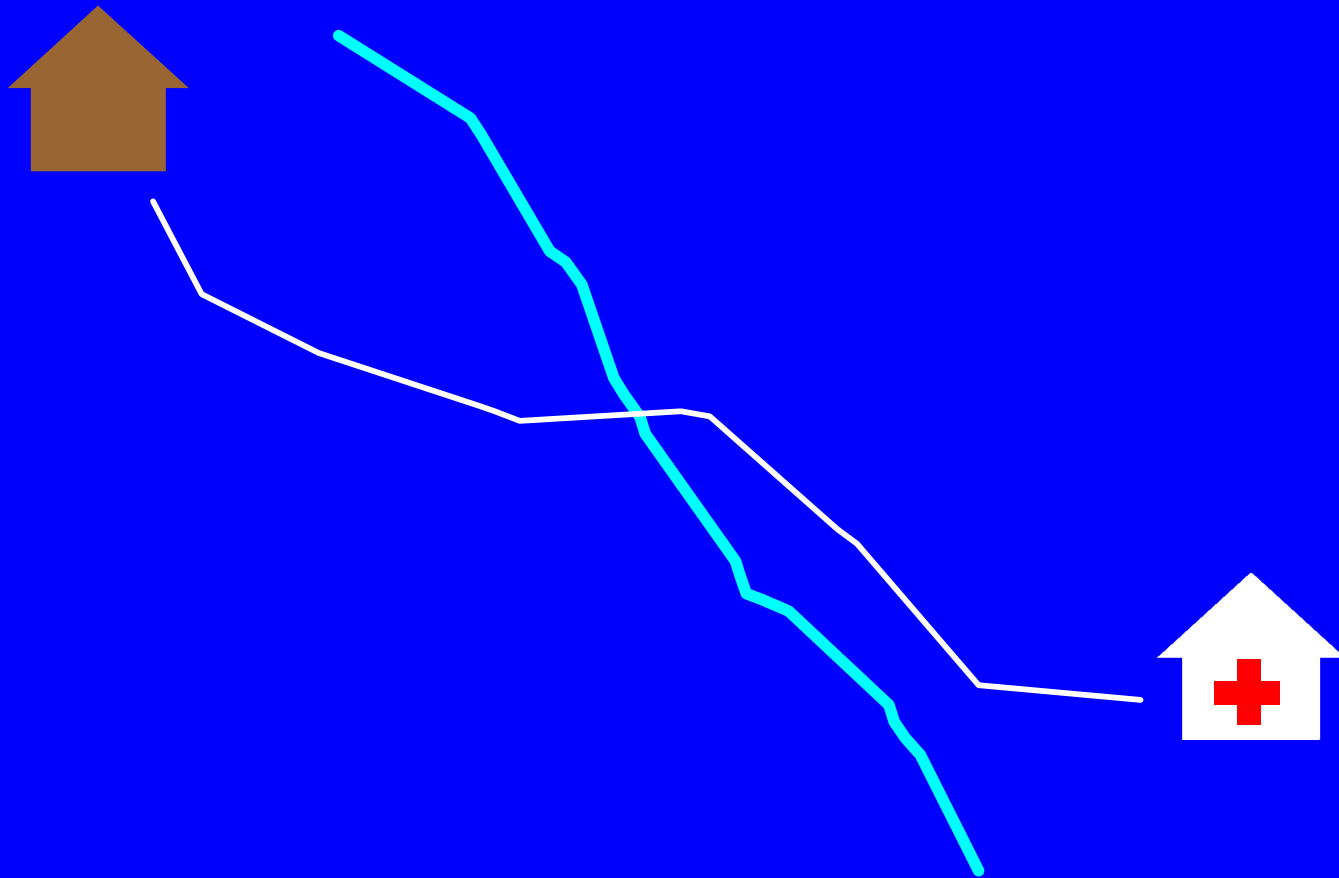
buffer operations

- **polygon** buffer
 - area around a reservoir where development should not be permitted



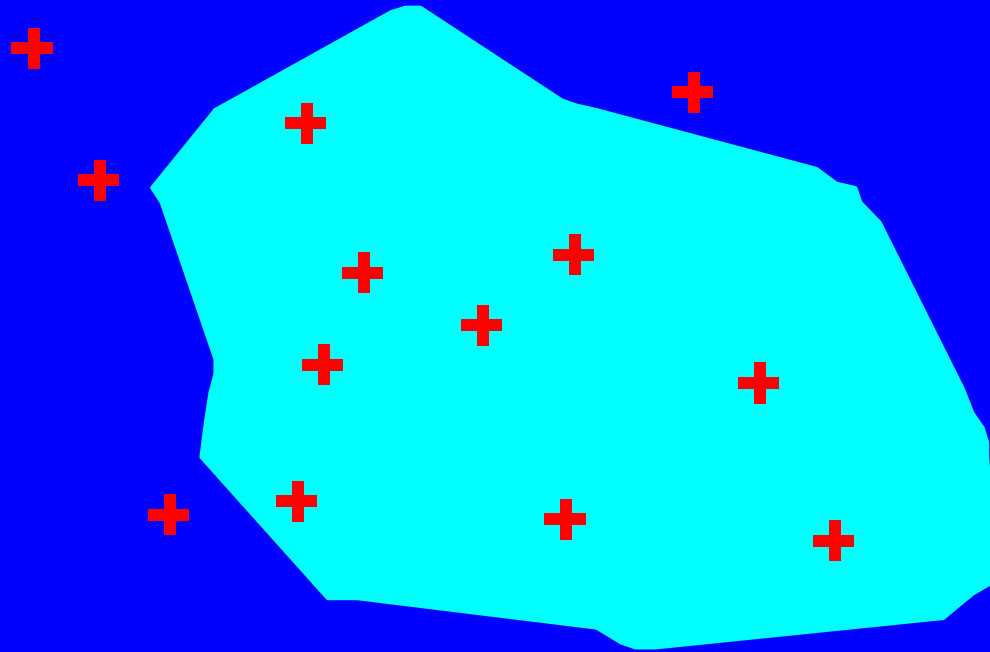
“crosses”: line intersection

- when traveling to the dispensary, do farmers have to cross this river?

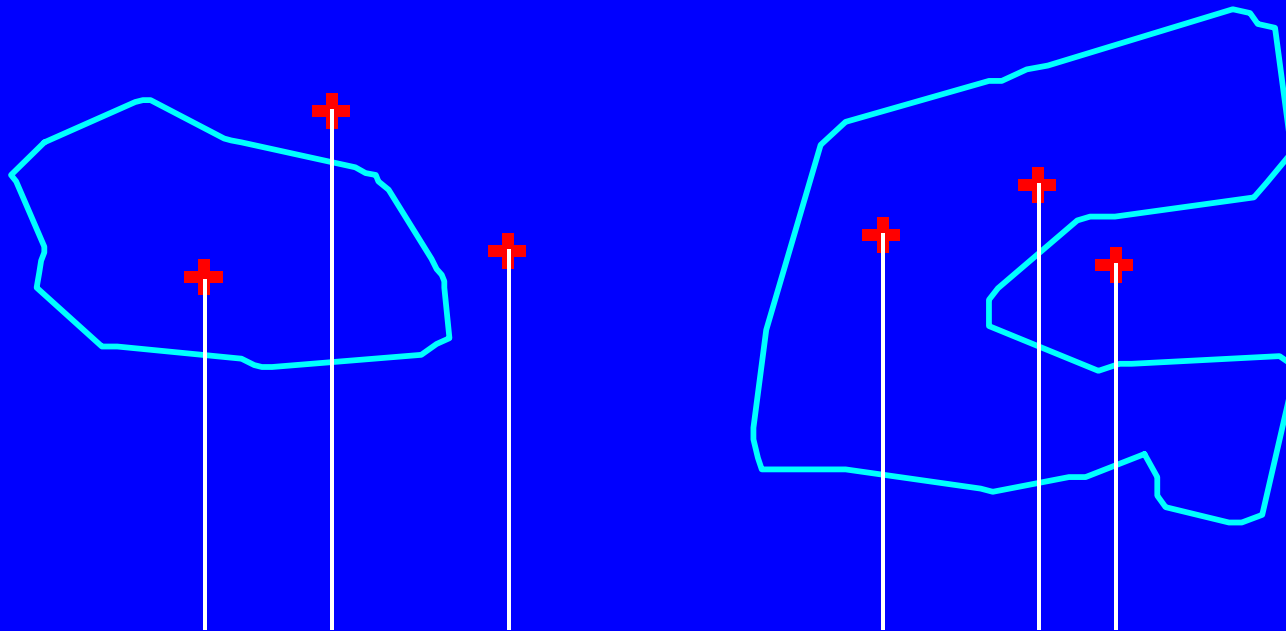


“is within”: point in polygon

- which of the cholera cases are within the contaminated water catchment area?

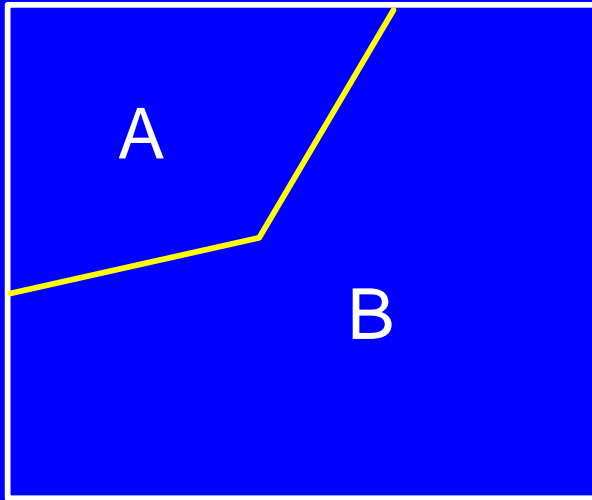


Point in polygon



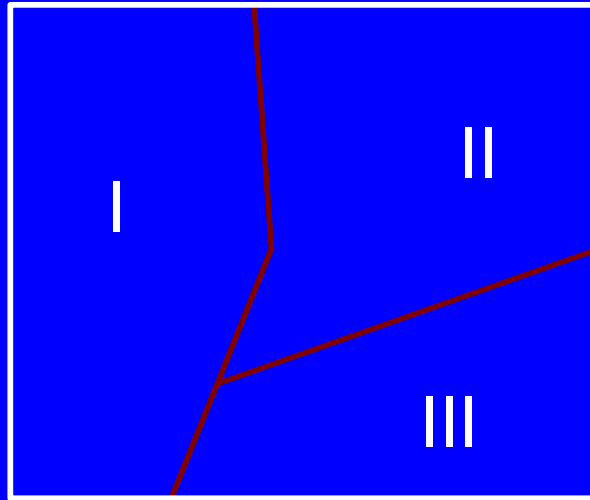
even number of intersections: point is outside
odd number of intersections: point is inside

“overlaps”: Polygon overlay



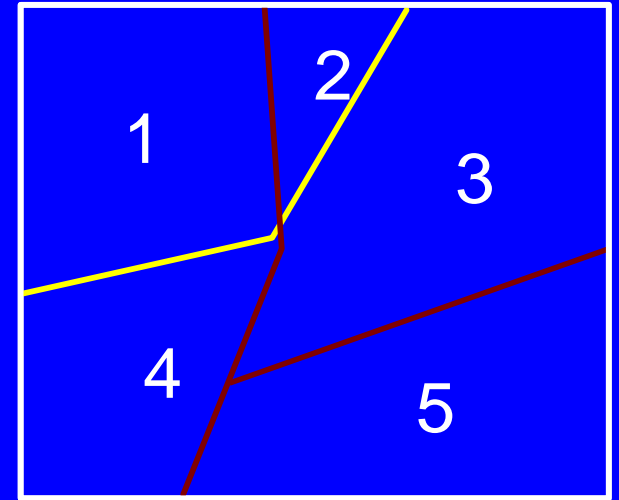
layer 1

1	A
2	B



layer 2

1	I
2	II
3	III



overlay

1	A	I
2	A	II
3	B	II
4	B	I
5	B	III

Output layer contains
all attributes from both input layers

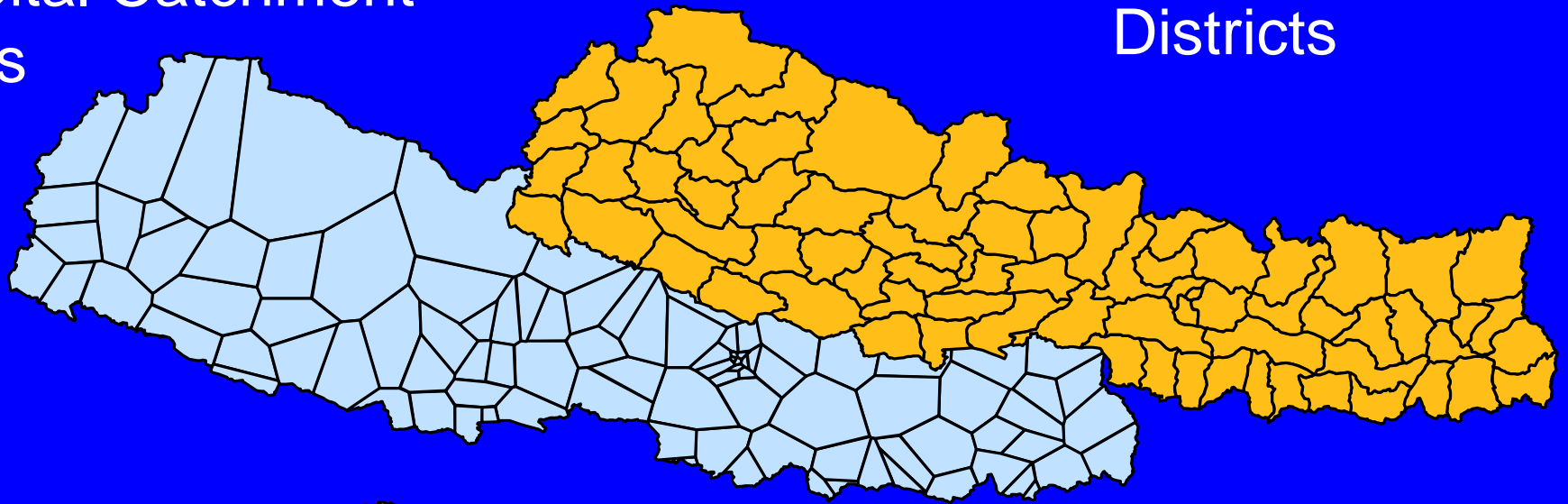
Areal interpolation problem

- data need to be transferred from one set of zones to another, where the boundaries are not compatible between the zones
- reporting zone change
- data for different sets of areas need to be combined

Polygon overlay

Hospital Catchment
Areas

Districts



Overlay

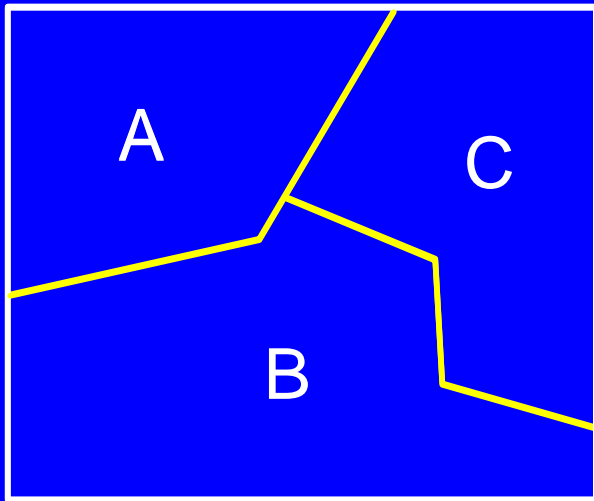


Areal weighting

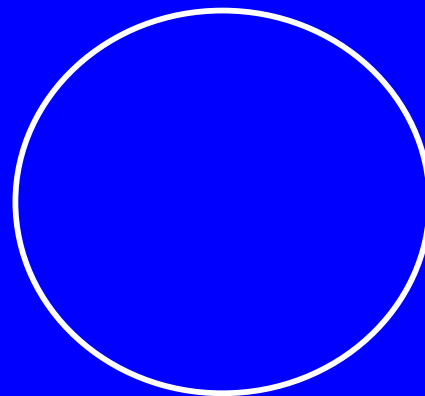
- if 30 % of district d overlaps with hospital zone z , then zone z will also receive 30% of district d 's population
- areas of overlap derived from a polygon overlay operation
- assumes that districts have constant densities

Creating subsets

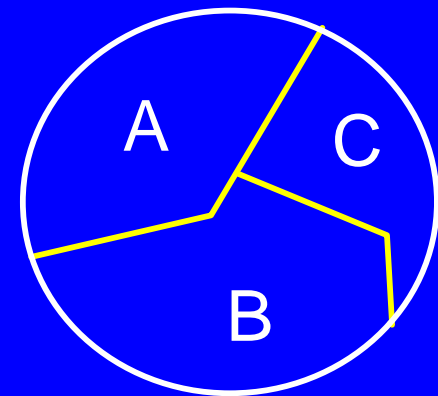
- create a subset of a data set using another incompatible set
- “cookie-cutting”



input



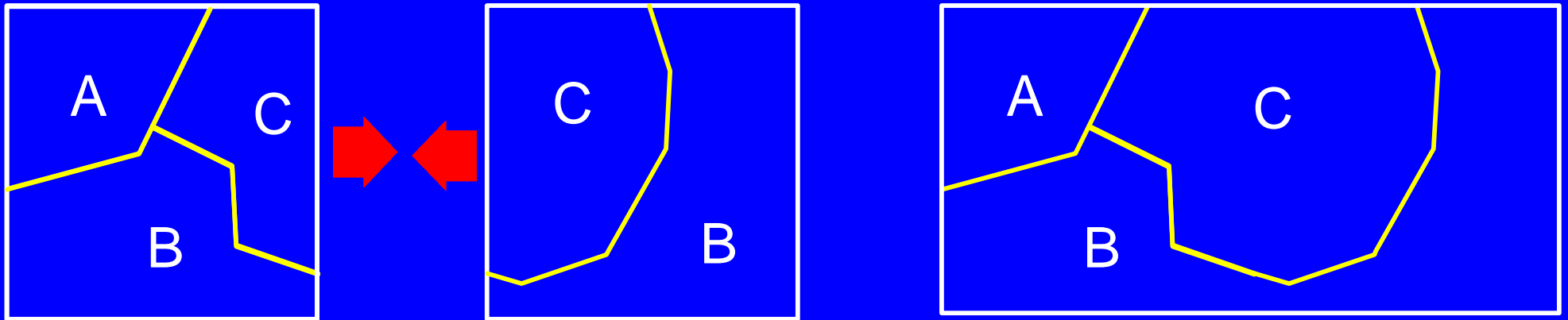
clip cover



output

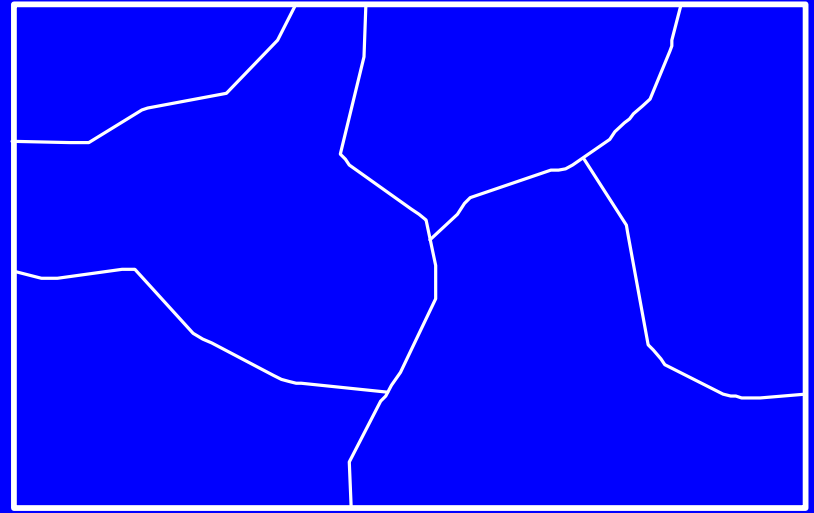
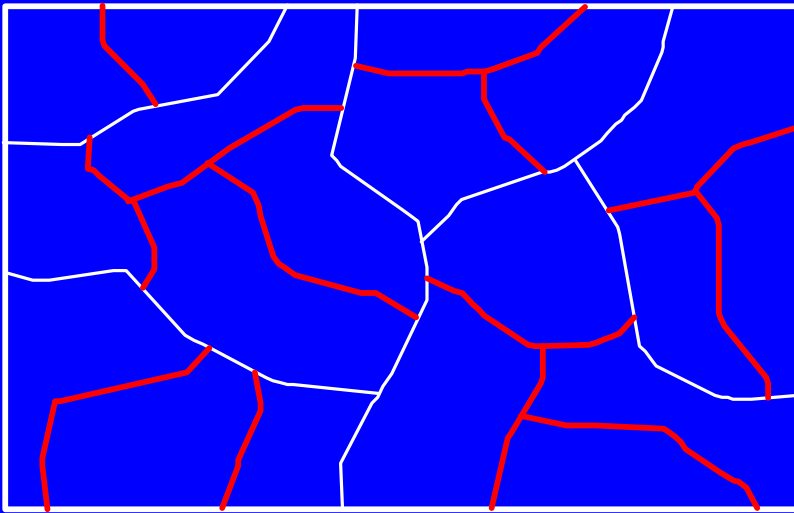
Appending data sets

- combine data sets that may have been digitized separately



Merging polygons

- aggregation by deleting internal boundaries



Editing functions

- **removal of sliver polygons**
- **line snapping**
- **rubber sheeting**
matching features using user-defined links (e.g., for removing distortions in GIS data sets)

Network functions

- **shortest route**
- **allocation**
- **accessibility**

**many functions are based on
optimization models**