

Agenda

- Administrative
- What is GIS?
- Representing geography

What is GIS?

- Geographic: related to the Earth's surface
- Information: data and metadata (context)
- System: functional components & connections

Burrough and McDonnell, 1998:

“a set of tools for collecting, storing, retrieving at will, transforming, and displaying spatial data from the real world”

Geographic is ...

- Location: where?
 - x = longitude
 - y = latitude
 - z = elevation
- Resolution: how precise?
- Accuracy: how reliable?
- Distance: how close?
- Area: how big?
- Distribution: how likely?
- Scale: how relevant?

Geographic data is...

- Multidimensional: x, y, z?, t?, attributes ...
- Projected: 3d Earth → 2d workspace
- Displayed: render results as maps

Location Information

- What's here?
 $\{ \text{obj} \dots \} = f(x, y, z)$
- Where's this?
 $\{ (x, y, z) \dots \} = f(\text{obj})$
- Everything GIS does is an elaboration of these two functions

GIS software

- ESRI, Inc.'s ArcGIS
 - ESRI founded 1969
 - many UCSB connections
- Open-source GIS
 - QGIS (ArcGIS work-alike)
 - more at OSGeo ...
- Google Earth
 - (map display; not a GIS)

Representing geography

- What is representation?
- Paper maps
- Digital representations
- The fundamental problem
- Discrete objects and fields

Representing the World

- Representation standardizes and simplifies ...
 - complex information encoded in simple structures
 - BUT: information that doesn't fit the structure may be
 - discarded
 - misrepresented
- the indirect and remote ...
 - space: maps, images, ...
 - time: recorded history
- to extend the direct and personal ...
 - space: here → horizon (~5 km)
 - time: 1 human lifetime

The Paper Map

- long and rich history
- scale (aka representative fraction)
 - ratio map distance : ground distance
- but: what about direction? area?
stay tuned ...
- major (historic) GIS data source
 - digitize or scan
 - register to Earth coordinates



The Digital Representation

- Digital data are binary
 - logically: 2 values (0|1, true|false, present|absent, ...)
 - physically: bistable device (on|off, +|-, N|S, ...)
- N bits $\rightarrow 2N$ distinct values
 - e.g. 8 bits $\rightarrow 256$ values
 - integer: 0..255, -128..127
 - code: character, attribute, ...
- Formats: how bit patterns are interpreted
 - JPEG: photos
 - MP3: music
 - GIS data formats: stay tuned ...

The Digital Advantage

- Economies of scale
 - One technology for all information
- Simplicity
 - Everything is a sequence of bits
- Reliability
 - Perfect copies
- Easy to detect and (usually) correct errors
- Speed
 - Closer to c than to H

The Fundamental Geographic Information Problem

Geographic information links:

- Objects
 - things located in space-time
 - {point,line,area,cell} is-a {tree,road,city,...}
 - 1:1
- Attributes
 - physical, social, economic, demographic, environmental, ...
 - {tree,road,city,...} has-a {DBH,route-number,population,...}
 - 1:many

For example: On 2013-03-01 at 3 pm local time, the north wall of Bren Hall had a brightness temperature of 288.7°K

The Fundamental Problem (cont'd.)

- Given potentially infinite
 - n places
 - n times
 - detail (The more closely we look at the world, the more detail it reveals)
- How do we represent
 - spatial objects
 - discrete features
 - continuous fields
 - and their attributes

Features

- Points, lines, and areas
 - single location: point
 - implicitly connected sequence of locations
 - open: line
 - closed: ring -> Polygons
 - countable
 - persistent (through time)
 - perhaps mobile

For example:

- biological organisms (animals, trees, ...)
- human-made objects (vehicles, houses, fire hydrants, ...)

Fields

- Phenomena that vary continuously in space
 - value is a function of location
 - property can be any attribute type (including direction)
- Canonical example: elevation
 - single value at every point on Earth's surface
 - how we speak about fields:
“high”, “low”, “steep”, “peak”, ...
- Other examples
 - soil moisture
 - atmospheric pressure
 - albedo

Feature or Field?

- Population density
 - depends on scale
- Land ownership
 - continuous, but defined in terms of features
- Lake
 - how defined?
- Weather
 - systems, fronts, ...