

Agenda

- Adminstrivia
 - <https://purl.org/ucsb-bren/ESM263>
- What is GIS?
- Representing geography

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- Adminstrivia
- **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 \rightarrow 2d workspace
- **Displayed:** render results as maps

Location \leftrightarrow Information

- What's here?

$$\{ obj \dots \} = f(x, y, z)$$

- Where's this?

$$\{ (x, y, z) \dots \} = f(obj)$$

- 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)

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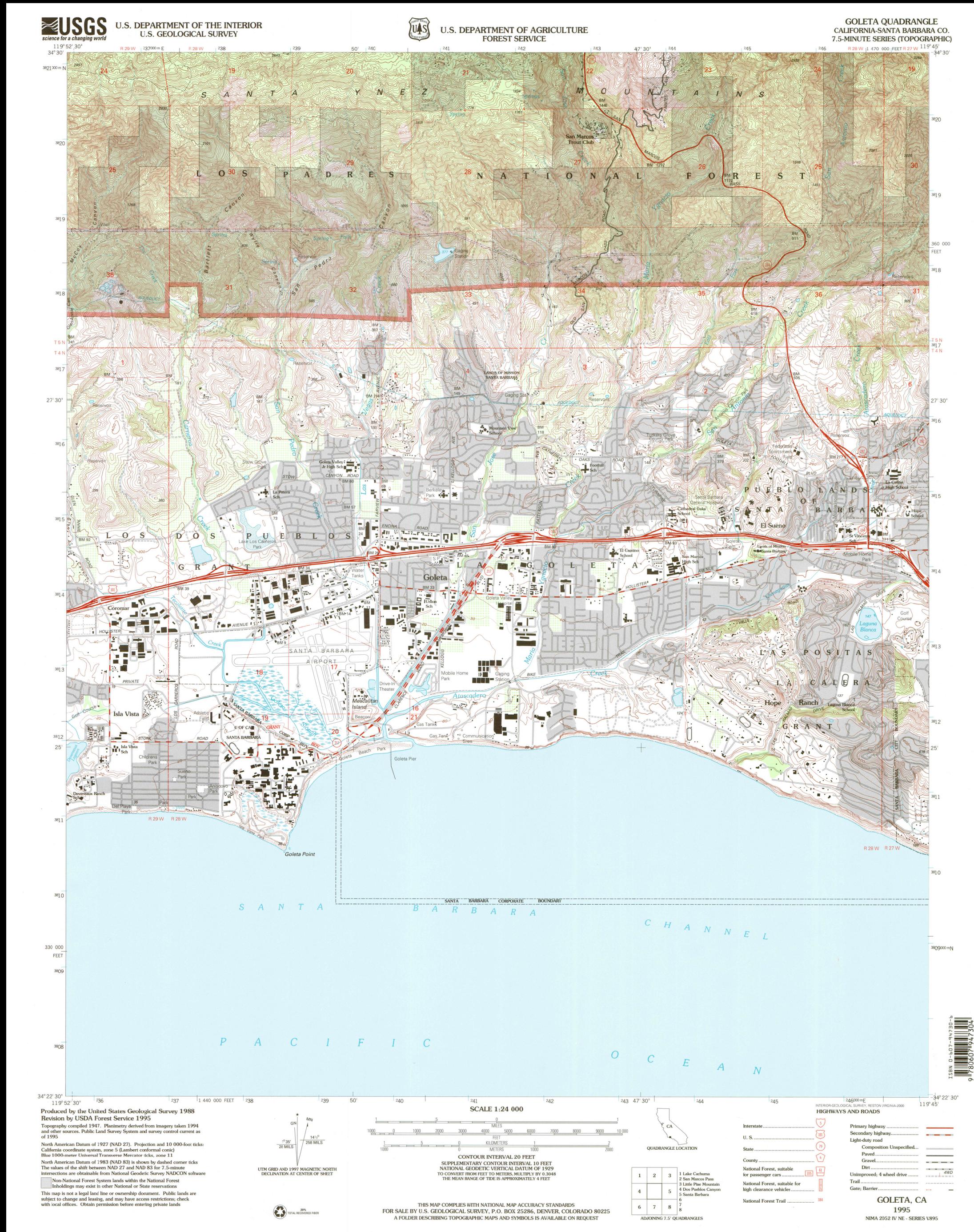
- Adminstrivia
- What is GIS?
- **Representing geography**
 - What is representation?
 - Paper maps
 - Digital representations
 - The fundamental problem
 - Discrete objects and fields

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

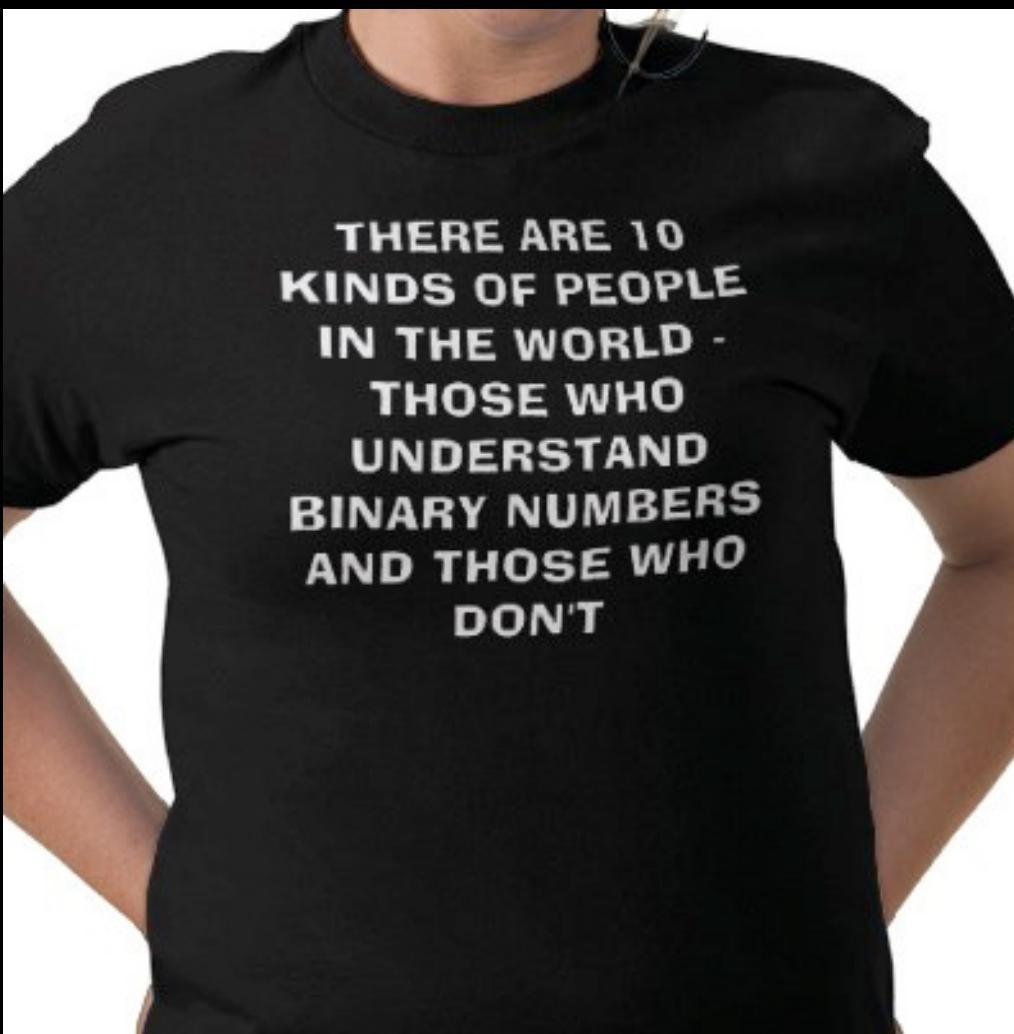
The Paper Map

- 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



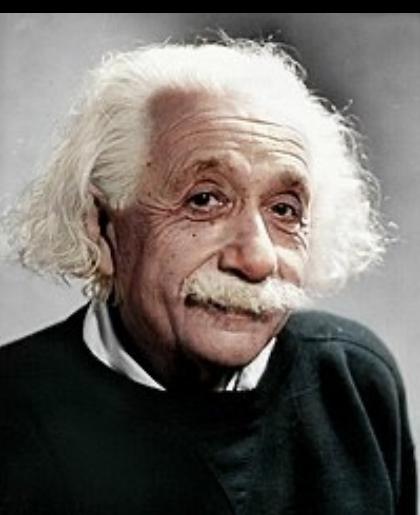
The Digital Representation

- Digital data are **binary**
 - logically: 2 values (0|1, true|false, present|absent, ...)
 - physically: bistable device (on|off, +|-, N|S, ...)
 - **bit**
- N bits $\rightarrow 2^N$ 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
 - # places
 - # 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: **polygon**
 - 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, ...