The many ways of GIS for digital humanities

Summer School on Digital Humanities

Course material available at
https://github.com/AugustoCiuffoletti/DHSS_2025

Augusto Ciuffoletti

17 marzo 2025

What is digital cartography (aka GIS)

- Digital cartography is similar to classical cartography
  - It records the position on the territory of objects or conventional points
  - It represents morphological characteristics of the territory
  - It represents travel paths
  - It associates properties and characteristics to objects
  - It represents territories that are imaginary, or projected into the past, or into the future

Why do we use digital cartography?

- Also the purpose of digital and conventional cartography are similar
- Both of them are useful to:
  - Compute geometric dimensions relative to objects and areas
  - Determine and register borders of states and properties
  - Determine routes to reach destinations
  - Document trips and other kinds of travel
  - Geographically place human or natural events to find relationships
  - Describe (teach) places that are beyond our reach
- Such utilizations may be in the present, or projected in the future, or in the past

The advantages of digital cartography

- Digital and classical cartography differ for the support on which a map is registered
  - a digital map is recorded on a digital support, accessible via a suitable device
- Such difference carries important advantages
  - dematerialization of the map, which is easily shared
  - possibility of automatic acquisition of positions and movements
  - possibility to merge data coming from different maps
  - possibility to link multi-media information to the map
  - simplicity of creation, re-utilization

Cartography and public history

- History is strongly related with cartography
  - History is the record of events and places
- The way we see the world tells a lot about us
- A medieval geographer that draws a map for his king is a public historian?
  - ...public engagement with the past...
  - ...putting history to work...
  - ...fostering critical reflection...
- The T-and-O map is a public history document?
- A map of our world today is (going to be) a public history document tomorrow?
- Who has the ability to produce such documents?
- Digital cartography gives new answers to this question
  - that depend on its diffusion

Diffusion of digital cartography

- Digital cartography depends on
  - powerful graphic processors,
  - high definition displays
- Both inaccessible to personal computers in Pentium era
  - ...curtailing advantages previously listed
- Digital cartography becomes affordable after 2005 (approx)
- Today everybody has a pocket-size GIS engine
- There are still many ways to represent the same item (standardization is ongoing)
- Today, cartography is accessible to anybody with appropriate technical skills
- The present challenges:
  - simplify access
  - unify representation (for merging)
- The future:
  - create autonomous things that record our history
  - enhance communication of history

Web Mapping

- Web is a powerful way to share resources
- Web mapping technology emerges a few years after the creation of the WWW, in 1989
- Web evolution marked a parallel evolution of Web mapping
- Initially the map is presented as such, with limited possibilities of interaction/layering (early '90s)
- A further step consists of allowing users to manipulate maps and to build new ones (late '90s)
  - ... the heavy task is off-loaded to the server
- The evolving Web technology fosters the creation of Web mapping services (2000-2005)
  - ... allowing their integration with othes services through standard interfaces
  - ... the definition of standard representations and interfaces becomes crucial

Web Mapping in Web 2.0

- Faster personal computing devices allow technologies for real time interaction with the Web mapping server
  - ... maps produced as a mashup of data from several databases
- The Web 2.0 (2005) allows croud-sourcing geospatial data
- Faster personal computers allow client side manipulation of map features
  - ... supported by cloud storage and servers for authentication and sharing.

Access: open vs closed digital cartography

- An alternative which is always present on the Internet:
  - the content may be publicly accessible, or kept private
- Same option is present in cartography

Examples:

- Open source: Open Street Map
  - Maps are in the public domain
  - Anyone can add features to the maps
  - Maps can be reused
- Free cartography: Google Maps
  - Access to the map is through a private service
  - Anyone can add his own map
- Private maps: mapbox
  - Maps are delivered for a fee
  - Fee increases with number of views

Fundamental Core Concepts

- Those that *simplify access*
- Coordinates (latitude and longitude)
- Features:
  - A point (linked to a coordinate pair)
  - A segment (defined by two points)
  - A line (formed by multiple segments)
  - An area (a region enclosed by a closed line)
- Vector Data Model (a collection of features with attributes)
- Raster Data Model (a grid of cells containing attributes)
  - Often derived from graphic formats like JPEG
- Attributes (linked to features and cells)
- Layers (organized sets of maps)
- A suite of tools facilitates handling these concepts

Geographic Coordinate Systems

- A Geographic Coordinate System is a way to represent a point on Earth System
- A standard GCS has a fundamental role in sharing meaningful informations about positions, tracks, distances
- The standard evolves in response to changing needs and improved technology
  - latitude originaly computed from the maximum length of a day

World Geodetic System of 1984

- Today, A widely adopted GCS is `WGS84` (for World Geodetic System 1984)
- A further label attached with it is `EPSG4326` to refer to its "non projected" version
  - e.g., `EPSG:3856` stands for its Pseudo-Mercator projection on a square surface
- `WGS84 EPSG4326` used by the Global Positioning System (GPS) and for data storage (GeoJSON)
- `WGS84 EPSG3856` used by Google Maps and computer visualizatios tools
- Facts about `WGS84 EPSG4326`
  - coordinates are expressed in latitude (north), longitude (east) (in that order)
  - coordinates are expressend in degrees (decimal form)

Goals

- This tutorial aims at giving the **basic** skills to update and create GIS maps
- We treat GIS from various perspectives (local, server based, cloud)
- We learn the basics for:
  - creating new features
  - creating new rasters
  - tracking an itinerary with a GPS receiver
  - uploading our track on a GIS map
  - creating a new service

A glimpse on GIS databases

- Specialized databases register features and attributes
- An example in Postgis:

```
INSERT INTO places (name, coord)
    VALUES ('Pisa', ST_GeographyFromText ('SRID␣=␣4326;␣POINT␣(10.41␣43.72)'));
```

- Legend:
  - places is a table that I created earlier
  - it has two columns that describe the name of a point and its coordinates
  - With the INSERT command I enter a new registration
  - The name of the new point is *Pisa*
  - The coordinates are entered with a specific Postgis function: STGeographyFromText
  - The text string contains an SRID parameter that identifies the Coordinate system
    - `4326 = WGS84 EPSG:4326`
  - and the indication of a point: first the longitude, then the latitude (yes, reverse wrt `WGS84`)

GeoJSON is gaining momentum

- An extension of the JSON object desctiption language
- Flexible, programmer-friendly
- Hosted by NoSQL databases
- An example in GeoJSON:

```
{ "type": "Feature",
  "properties": {},
  "geometry": {
    "type": "Point",
    "coordinates": [ 12.338194, 45.433048 ]
  }
}
```