Geographical Intelligence

Michael F. Goodchild
University of California
Santa Barbara
Traditional geographic information

- Maps, atlases, globes
  - highly synthesized, compiled, abstracted
  - often rich quantitative attributes

Maps, atlases, globes are maps that are highly synthesized, compiled, and abstracted from a large number of observations.
Hidden synthesis

- By experts in traditional authoritative production of geographic information
- Every polyline or polygon is a highly compressed form of observational data
  - all points within the polygon, or all points along the line, possess the spatially intensive attributes of the polygon or polyline
  - all point observations are of the form \( <x,z> \)
  - the process by which observations are synthesized into statements about polylines or polygons is typically hidden
New geographic information

- Volunteered geographic information
  - produced by non-experts
  - e.g., OpenStreetMap, Flickr
  - integrated by software
GIS Today: Data

• Massive quantities of geographic data from:
  – satellite remote sensing
  – ground-based sensors
  – administrative records
  – volunteers

• Much of it real-time
• Much of it 3D
• Precise geo-location
Interoperability of geolocation

- 34 deg 24 min 42.7 sec North, 119 deg 52 min 14.4 sec West (3m)
- 909 West Campus Lane, Goleta, CA 93117, USA (20m)
- 3811560N, 236150E, Zone 11, Northern Hemisphere (10m)
- NE 1/4, Section 12, Township 23 Range 5 of the Second Principal Meridian (300m)
- National Grid reference 11SKU36151156 (10m)
- Visual identification on a georegistered base map (20m)
- “Mike Goodchild's house” (20m)
Volunteered geographic information

- Created by citizens
- Recording observed facts about the Earth’s surface
  - the locations and attributes of recognizable features
- Up to date
  - a dense network of intelligent observers
- Frequently more accurate than available sources
Articles with geotags

# of articles per unit area (log scale, 0.1° resolution)

988,522 articles
103,291 distinct locations
Crandall et al. 2009. Mapping the world’s photos.
http://www.cs.cornell.edu/~crandall/papers(mapping09www.pdf)
Tracks inferred from Flickr postings

See also
http://www.flickr.com/photos/walkingsf/sets/72157624209158632/
Cyberscape: Placemarks in post-Katrina New Orleans

Flooding Reports (via Scipionus) in New Orleans, Sept. 2005

Who was able to or interested in using this new technology?

Which places were they interested in?

Crutcher and Zook. 2009. *GeoForum*
Density of geo-located tweets in Los Angeles, Jan1 to Feb 25, 2011
Density differences between Flickr photos and tweets

Legend
- Red: Higher photo density
- Blue: Higher tweet density
The general problem

- Consider an atom of unary geographic information \(<x,z>\)
- All such atoms are incomplete
  - measurement error in coordinates
  - classification uncertainty
    - “this location is oak savanna”
  - attribute error
    - misnamed street
- Synthesis attempts to resolve incompleteness
  - and to integrate atoms into polygons, polylines
Where am I? (missing x)

UNO geologist: Video tells bin Laden's hiding place

Omaha World-Herald Posted on Tuesday, October 16, 2001

“The image of Osama bin Laden that flickered on Jack Shroder's TV was grainy and brief, but it was all he needed. Jack Shroder, a University of Nebraska at Omaha geologist who has done research in Afghanistan, says a videotape of Osama bin Laden gives important clues to where he might be hiding...he is certain that the type of sedimentary rock visible in the videotape is found only in Paktia and Paktika, two provinces in southeastern Afghanistan about 125 miles from Kabul.”

http://www.freerepublic.com/focus/f-news/549291/posts
Flickr photographs tagged “Eiffel Tower” (Linna Li)
The Search for Blandings

- **Blandings Castle** is a recurring fictional location in the stories of British comic writer P. G. Wodehouse, being the seat of Lord Emsworth (Clarence Threepwood, 9th Earl of Emsworth), home to many of his family, and setting for numerous tales and adventures, written between 1915 and 1975

http://en.wikipedia.org/wiki/Blandings_Castle
Literature


  – GIS analysis
  – viewshed
  – driving times
  – railway timetables
Finder Goals

Where in the world were these photos/videos taken?

- Geolocate ground level outdoor scenes in any region of the world
- Any type of camera
- Any season, time of day, or weather conditions
- Accuracy and speed are important
The new synthesis

- Software
- Actions of volunteers
- Scraped from the Web
- Disparate purported facts of varying quality and reliability
- Daniel Sui, Is mashup the new spirit of GIS and geography? GeoPlace.com, posted 1/19/2010
The quality problem

• No quality control, no metadata, no standards
  – none of the guarantees of authoritative data
  – no prospect of conventional analysis
• What can we do to assure quality?
• Three solutions
The crowd solution

• Linus’s Law
  – the more eyes to review, the more accurate
  – works for popular facts

• Geographic facts may be obscure
  – little-known areas of the world
    • or not so obscure
Glen Annie Golf Course (Goleta)

405 Glen Annie Rd.
Santa Barbara, CA 93117
(805) 968-6400

www.glenanniegolf.com/golf/proto/glenanniegolf/

Glen Annie Golf Club is a championship golf course with first class amenities situated in the rolling foothills of scenic Santa Barbara. This challenging golf layout is enhanced by breathtaking panoramic views of the Pacific Ocean and Channel Islands and is always maintained with the highest standards.

This article is protected.
Category: golf course

Address: Glen Annie Road, 405

Permalink to this place
The social solution

• Who can be trusted?
• A hierarchy of moderators and gate-keepers
  – all volunteered facts referred up the hierarchy
• A social structure
  – promotion based on track record
  – heavy, accurate contributors promoted
  – e.g., Wikipedia, OSM
  – top levels of Google MapMaker reserved for Google staff
The geographic solution

- How can we know if a purported geographic fact is false?
  - because it violates the rules by which the geographic world is constructed
  - the syntactic rules
  - compare language rules, the sentence structure of English

- What are those rules?
  - essential, fundamental geographic knowledge
The coastline of Alloastea

Analysis by Linna Li
Some sample rules

• Tobler’s First Law
  – “…but nearby things are more similar than distant things”
  – horizontal context
  – a geographic fact should be consistent with its surroundings

• “All things are related…”
  – vertical context
  – a geographic fact should be consistent with other things that are known about that location
Rules of feature geometry

- Curvature of rivers, roads related to capacity
- US Public Land Survey System imposes a 1-mile grid
- Many Roman and 19th-century cities have gridiron streets
- On-ramp intersects a freeway at a small angle
- Central place theory prescribes the spacing of market towns
Geographic (not geospatial) intelligence

• The process of synthesizing disparate, incomplete geographic facts
  – into complete facts
  – into higher-level structures
  – into wall-to-wall geographic coverage

• How we know if a purported fact is likely to be true

• Based on knowledge of how the geographic world is constructed
  – its basic syntax