Volunteered Geographic Information

- Generation of geographic information, typically by non-professionals, via Web technologies
- Production is largely unregulated
  - “Asserted”, not “Authoritative”
- Web 2.0: Users generate and publish content
  - Not really evolutionary technologically
  - Social implications?

Ubiquitous GIS*

- Online anywhere, or at least somewhere
- Easy to use Web interfaces to GI services
- Vast amounts of imagery and spatial data
- Limited but powerful set of analysis tools
  - Spatial DB selections
    - “Hotels in downtown Kansas City”
  - Address Geocoding
  - Routing
    - Increasingly multimodal routing

Outline

- Context
- Positional Uncertainty
- Web Mapping
- Implementation and Examples
- Discussion

Enabling Technologies

- GPS, location-aware devices
- Address Geocoding
  - Via API
- Heads up Digitizing
- Integrated content generators
  - Smartphone/Camera/GPS
  - Web mapping APIs
- Web Access – preferably ‘remote’

WWW VGI Questions

- Geotagging Queries
  - Content Integration
  - Mashups

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WWW VGI Tasks
- Locating yourself & others
  - FourSquare, Gowalla, Latitude
- Situating Content

Positional Uncertainty
- In Points, Lines, and Polygons
- Much research over many years
  - Field measurement error & imprecision
  - Processing/Conversion contributions
    - Example: Points on a paper map
      - Map scale: the 0.5mm rule
      - Distortion of Paper Map surface
      - Registration error
      - Digitization error
  - Vagueness
    - Difficulty in identifying specific location

WWW VGI Analysis
- Basic analysis on locations
  - Store and display my content there
  - How to get from here to there?

Web 2 VGI Positional Uncertainty
- My location-aware device is inaccurate
- GPS/WiFi/Cell tower triangulation (e.g., Zandbergen 2009, 2011)
- Precision? What’s that? limits of precision
- I am only vaguely aware of “where”
  - I took this photo / that good restaurant was
    - “on the beach”, “in Grant Park”, “400 block of Main”
  - the boundaries of my property are
    - “image resolution isn’t so hot”
  - I want to go
    - “downtown Santa Barbara”, “Ohio”, “near a river”

Quality of VGI
- “Instead of creating masterpieces, the millions of exuberant monkeys are creating an endless digital forest of mediocrity” - Andrew Keen
- Positional Quality typically unknown
- Users may know little formally about positional accuracy
- Though people make (spatial) decisions accounting for uncertainty every day

Kirk Goldsberry’s Trip to the Ballpark
The World Wide Web

- Internet has been around for a long time
- WWW is an Internet service (early 1990's)
  - HTTP networking protocol / Locations
    - Universal Resource Locators (URLs)
  - HTML spec drives how browsers present data and navigate from site to site
    - Hypertext tabs

A Personal Digression

- NCGIA-SB cubicle farm, Fall 1994: Danette Coughlin introduced me to Mosaic
  - On UNIX!
  - My first comment on the WWW:
    - Oh, so it's like Gopher?

Error Propagation

- Beyond visualization
  - Though this is also an application
- What are the implications of positional error?
  - For the things people do
- Rich literature
  - Little or no evidence of diffusion beyond academy

Implementation

- Web Programming
  - Client-Server Model
  - Where does processing occur?
    - Server-Side
      - (Geo)Django
    - Web-Map Stack
      - Mapserver, PostGIS, SQL/Python/PHP...
    - Client-Side
      - Javascript
Goals

- Javascript Approach
- Project Goals
  - Develop error models
  - Make them readily accessible
  - Enable VGI producers to assess positional uncertainty and its impact
    - Multiple visualization methods
    - Error propagation
  - Revolutionize the Web

Example 1 - Points

- Bouncing points around
- Uses OpenError() class
- Uses extension functions to render

```javascript
// create a new openerror object
oe = new OpenError();
// defaults.pts is geoJSON variable
oe.setStandardDeviation(defaults.sd); //1609.344);
//oe.setCorrelated( false );
//oe.set
...;
var data = oe.generateDataset(); // new coords w/ offset errors
```

Example 2 – Points with Charts!

- Bouncing points around
- Track realization metrics
- Histograms and Sparklines
  - Spatial sparklines?

Example 3 – OpenLayers!

- Add realizations to screen manually
- Uses OpenError() class
- Renders in OpenLayers

```javascript
//Create an openError object, give it the points, and jiggle them
oe = new OpenError();
//oe.setDataSet(myPts);
//oe.setCorrelated( false );
...;
var newPts = oe.generateDataset(); // Output coords are GeoJSON
```
Example 4 – Routing!

- Propagate positional error to a route
- Error is in route start and end point
- Uses GMaps routing API
  - Also the Geocoding API

What We've Learned: Modeling

- Client-side processing limits complexity of positional error models
  - Kriging on a phone?
  - Ignorance of error context limits complexity of positional error models
  - Graphical output tools are very powerful
  - Potential users are a bit baffled!
  - But they like moving markers!

Example 5 – Routing and Charts!

- Explore and present error propagation metrics
- How does uncertainty in start and end points propagate to
  - Distance traveled
  - Time of travel

What We've Learned: Coding

- Javascript programming is not that fun
  - Debugging, Style
- Software Development Mindset
  - Not my strength or training!
- Ability to use (attach to) other frameworks and APIs is powerful
  - OpenLayers, Google Maps, Jquery, Sparklines
- Scalability may be limited
  - Clever workarounds to large numbers of geofeatures?

What We've Learned: Meta Stuff

- Unfunded side projects can be rewarding
  - Involve undergrads
  - Learn new skills
  - My kids like the bouncing markers
- Creeping GIScience
  - Insight and education
  - Utility for real-world applications
  - Bringing Spatial Data Uncertainty to the Masses