Location for Location-based services

Karen K. Kemp, PhD GISP
Professor of the Practice of Spatial Sciences
University of Southern California

What is a location based service?

- An information service
  - provided by a device that knows where it is
  - capable of modifying the information it provides based on that knowledge

LBS components


What can LBS do?

- Resource tracking
  - Taxis, service people, rental equipment, doctors, fleet scheduling, packages, shipping containers

- Finding someone or something
  - Businesses, navigation, weather, traffic, room schedules, stolen phone, emergency calls, friends

- Proximity-based notification
  - Targeted advertising, profile matching (dating)

- Proximity-based actuation
  - Payment based upon proximity (highway tolls), automatic airport check-in
LBS is HOT!

- Where 2.0 conference, Santa Clara CA, April 2011
  - “where the grassroots and leading-edge developers building location-aware technology intersect with the businesses, marketers, and entrepreneurs seeking out location apps, platforms, and hardware to gain a competitive edge.” (where2conf.com)

Two distinct communities

- Location-aware technology and business
- Developers and businesses
- Make it work now and attract more users

- Academic Geographic Information Science
- Geography - cartography, spatial analysis
- GIS - technology, geospatial data, mobile and WebGIS
- Understand it, do it correctly, for all cases
The GISci in LBS

Some GISci things to know
- How does the mobile device know where it is?
  - Determining Location
- Where is that?
  - Geographic coordinates
- Where is it on a map?
  - Projections
- How do “they” determine where that is?
  - Datums
- What place is it?
  - Indirect georeferencing
- What is there?
  - Scale

Determining mobile location
- GPS
- GSM (cell tower locations)
- WiFi
- GeoIP
- Short Range - WLAN, Bluetooth, RFID

Results in a location value such as: 22.279088°, 114.165596°
What IS that number???
Your georeference!

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Two types of georeferences
- Direct georeferences
  - Provide a value that expresses location in some coordinate system
- Indirect georeferences
  - Use a unique ID which links one table (attribute) to another (geography)
  - Relates a "name" to a place

Direct georeferences - coordinates

Rectangular systems
- René Decartes (1596-1650) introduced systems of coordinates based on orthogonal (right angle) axes.
- Often referred to as Cartesian systems

So where is 22.279088°, 114.165596°
But the earth is a sphere!

What is the most common coordinate system we use for the earth?
- Latitude/Longitude

Latitude and Longitude

Location as geographic coordinates
- Redlands?
  - 34° 1' 52" N, 117° 10' 43" W (in degrees minutes seconds, DMS)
- In Decimal degrees?
  - 34.03119, -117.17868
- Graduate House, HKU
  - 22° 16' 54.44" N, 114° 8' 14.45" E

Remember
- Lines of latitude are parallel
  - Near the equator, 1 degree of latitude is approximately 111 km
- Lines of longitude converge at the poles
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How to put the Earth on paper?

Plate Carrée (unprojected)

Projection

“Project” the curved surface of the earth on a flat surface
Cylindrical projections

projecting a sphere onto a cylinder

From http://www.math.ubc.ca/~israel/m103/mercator/mercator.html

Mercator

Conic projections

project a sphere onto a cone

Secant Conic Projection
Conic Projections

North America
Lambert Conformal Conic
Origin: 23N, 96W
Standard Parallels: 20N, 60N

Azimuthal projections
- project a sphere onto a plane

Orthographic
- used for perspective views of hemispheres
- area and shape are distorted
- distances are true along the equator and other parallels

Other projections
- based on mathematical transformations
Why have projections?

- Were developed for creating paper maps
- Provide mathematical transformations between lat/long values and x/y locations on a rectangular grid on the paper
- Works great if you are making one map at a time

The problem with projections

- When digital data is projected (from lat/long to be displayed at x/y locations in a rectangular image) then places in different projections will not line up.

AND, the earth is not a sphere

- It is squished into an oblate ellipsoid
- But it is actually a geoid determined by gravity variations.

Ellipsoids, geoids and topography

- Ellipsoid is a mathematical approximation of the earth's surface
- Geoid is the gravity surface

http://www.colorado.edu/physics/notes/mapproj/mapproj_f.html

http://www.kartografie.nl/geometrics/reference%20surfaces/refsurf.html
Geodetic datums

Datums determine the shape and location of the ellipsoid upon which the longitude and latitude grid are drawn.

WGS 84

- If you know only one datum, know WGS 84 (World Geodetic System 1984)
- It comprises
  - a standard coordinate frame for the Earth,
  - a standard spheroidal reference surface (the datum or reference ellipsoid) for raw altitude data, and
  - a gravitational equipotential surface (the geoid) that defines the "nominal sea level".
- WGS 84 is the reference coordinate system used by the Global Positioning System.

The moral of this story

- Direct georeferences using a coordinate system are dependent upon the geodetic datum and projection used
- ...
The moral of this story

If you use lat/long coordinate data, you need to know the datum and projection in order to integrate it with other data from other sources.

WebGIS and LBS note

- With the popularity of Google Earth, their use of the Web Mercator projection is becoming a defacto standard
- If you need to mix your own digital geographic data with data from Google and, now, Microsoft Bing, you will need to work with the Web Mercator projection
- IMPORTANT - it uses a spherical earth!

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Two types of georeferences

- Direct georeferences
  - Provide a value that expresses location in some coordinate system
- Indirect georeferences
  - Require a unique ID which links one table (attribute) to another (geography)
    - i.e. relates a name to a place...
Indirect georeferencing

- Allow connections to be made between data and places
- Include:
  - Place names
  - Census zones
  - Zip codes, Postal codes
  - Administrative districts
  - Telephone area codes
- Local referencing systems
  - Hong Kong’s slope management system

<table>
<thead>
<tr>
<th>Geographic area</th>
<th>Median age (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alabama</td>
<td>35.8</td>
</tr>
<tr>
<td>Alaska</td>
<td>32.4</td>
</tr>
<tr>
<td>Arizona</td>
<td>34.2</td>
</tr>
<tr>
<td>Arkansas</td>
<td>36</td>
</tr>
<tr>
<td>California</td>
<td>33.3</td>
</tr>
<tr>
<td>Colorado</td>
<td>34.3</td>
</tr>
<tr>
<td>Connecticut</td>
<td>37.4</td>
</tr>
<tr>
<td>Delaware</td>
<td>36</td>
</tr>
<tr>
<td>District of Columbia</td>
<td>34.6</td>
</tr>
<tr>
<td>Florida</td>
<td>38.7</td>
</tr>
<tr>
<td>Georgia</td>
<td>33.4</td>
</tr>
<tr>
<td>Hawaii</td>
<td>36.2</td>
</tr>
<tr>
<td>Idaho</td>
<td>33.2</td>
</tr>
<tr>
<td>Illinois</td>
<td>34.7</td>
</tr>
<tr>
<td>Indiana</td>
<td>35.2</td>
</tr>
</tbody>
</table>

What does this mean to LBS?

- When you search for a location in, say, Google Maps, you expect to get a place marker
- Place databases are BIG business
- All the big players are building them
  - Google
  - Facebook
  - Foursquare
- The company with the best database wins!

And you are helping them!

- When you check-in at a location that is not yet in the database, you are encouraged to make a new place
- You provide its name, your phone provides the location and the company has a new place/location pair in their database
- Attract lots of people to check-in using YOUR site and you get lots of places!
What does a place database do?
- Provides for indirect georeferencing
  1. Allows you to put a dot on the map for any place in the database
  2. Allows you to associate those dots with lots of other information through their common place names
- For example
  - What's at "Admiralty Centre"?
    - = stores at this named address
    - = buses at the named stop in front
    - = pictures with this in their name...

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    - Context and Scale

Context enhances LBS
- LBS are user focused and task specific
  - providers need to supply services that are viewed as having a high level of utility
- Context-awareness in LBS is used to
  - identify relevant content
  - enhance communications
  - deliver services

What is context
- Any information that can be used to characterize the user situation in a LBS interaction
- Context includes
  - Where you are (location)
  - Who you are with (social)
  - What is nearby (geographic)
Scale constrains context

- Scale determines how much is “nearby” and how much information is needed
- Is your user interested in
  - What is around this bus stop?
  - What is in this city?

There are several ways we describe scale.

Geographer's scale

- Representative Fraction
  - 1 unit on map represents x units on the ground
  - Expressed as a ratio such as 1:50,000

- Important:
  - 1:50,000 is LARGER than 1:1,000,000
  - More detail but smaller area covered

Scale in GIS

- In GIS, you often see an RF scale associated with data
  - This is not really the data’s scale, since
    - digital data doesn’t have a mapped scale
    - you can zoom data to any level...

Question
Why is the use of the representative fraction not appropriate in this slide?
Scale in GIS

- In GIS, you often see an RF scale associated with data.
- This is not really the data's scale, since:
  - digital data doesn't have a mapped scale
  - you can zoom data to any level.
- When scale is mentioned with respect to GIS data, it usually means the "source map scale".
  - Thus, it is expresses the level of generalization of the data.
  - Highly generalized means less detail.

What is "scale"?

1. Map scale (Representative Fraction)
   - 1:50,000 is LARGER than 1:1,000,000
   - More detail but smaller area covered
2. Extent
   - large area vs small area
   - or large number of people or large cost...
What does this have to do with LBS?

- What is "in context" depends on scale
- Whether two different layers of contextual geospatial data will "lineup" depends on the scale of the source data

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kakemp@usc.edu