# Location for Location-based services

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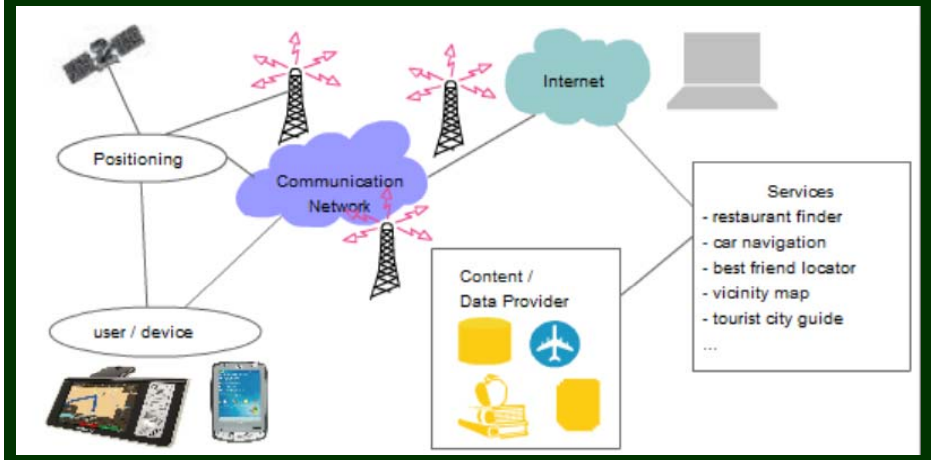
## What is a location based service?

- 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

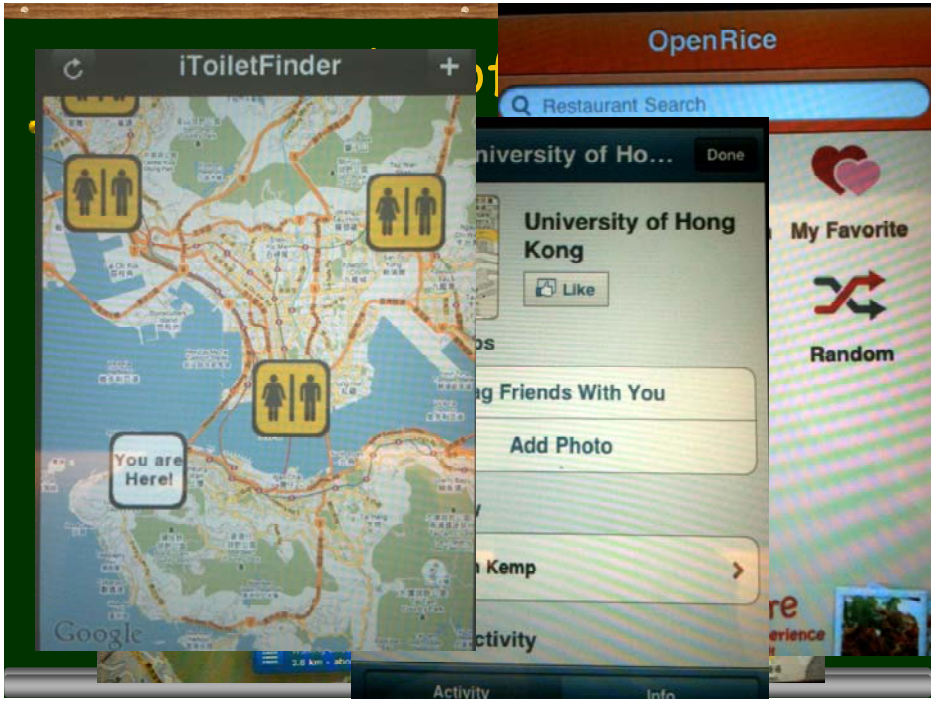



From http://www.e-cartouche.ch/content_reg/cartouche/LBSbasics/en/html/index.html



## 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)

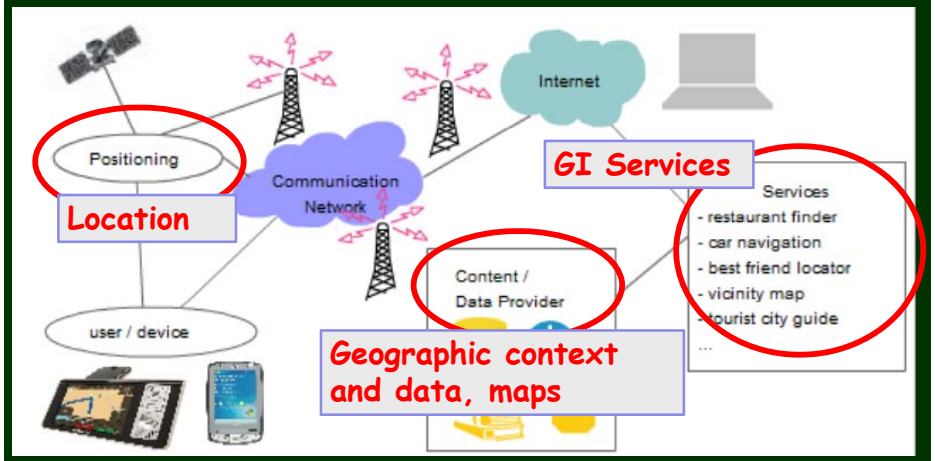





# Two distinct communities

- 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

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# 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

# Mobile Location



# 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

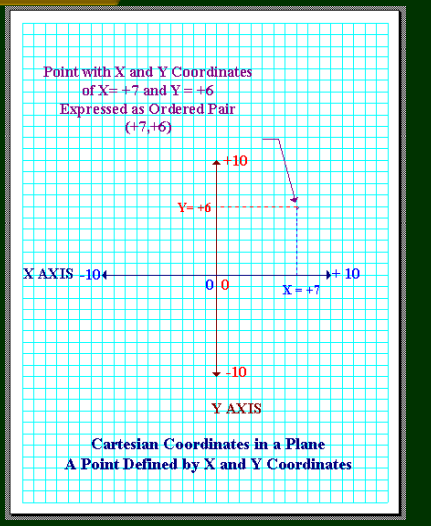


## Direct georeferences - coordinates

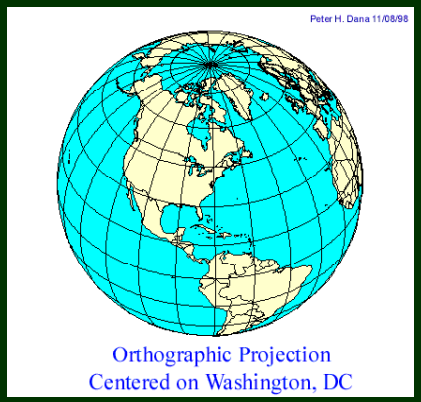
*Rectangular systems*

- 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°



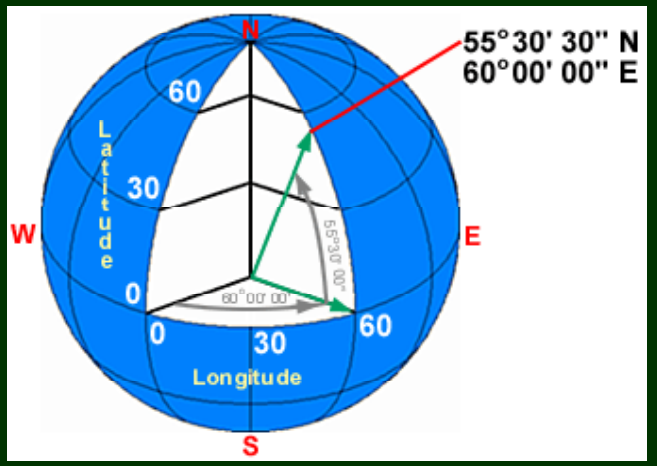
# But the earth is a sphere!




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



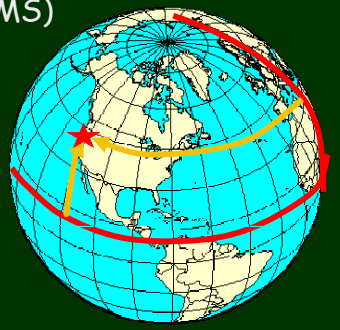
# Latitude and Longitude






# Location as geographic coordinates

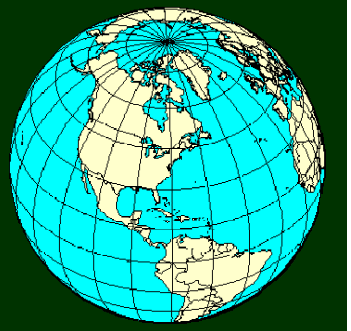
- Redlands?
  - 34° 1′ 52″ N,
    117° 10′ 43″ W
    (in degrees minutes seconds, DMS)
- In Decimal degrees?
  - 34.03119, -117.17868
- Graduate House, HKU
  - 22° 16′ 54.44″ N,
    114° 8′ 14.45″ E





# 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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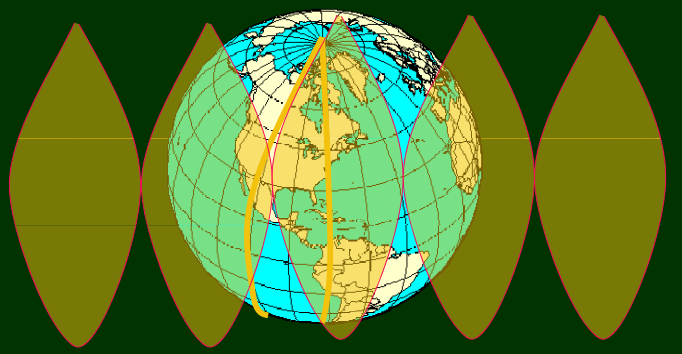
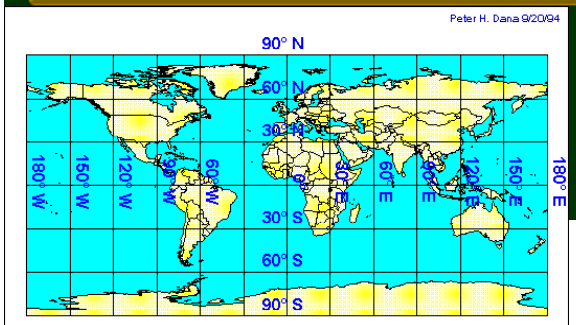
# How to put the Earth on paper?

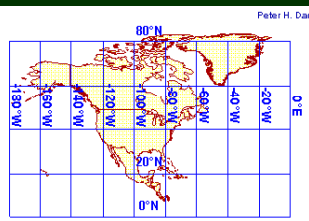




# Plate Carrée (unprojected)




Unprojected Latitude and Longitude

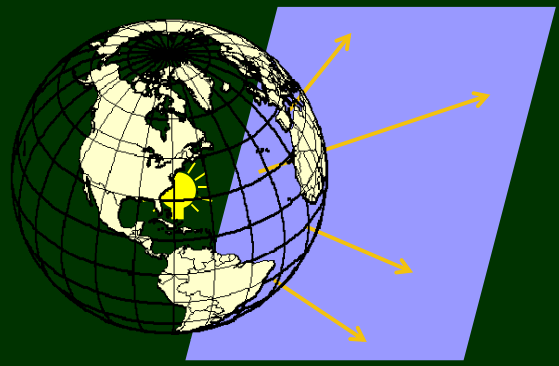



North America
Unprojected Latitude and Longitude



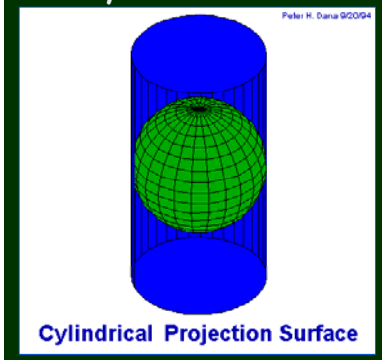
# Projection

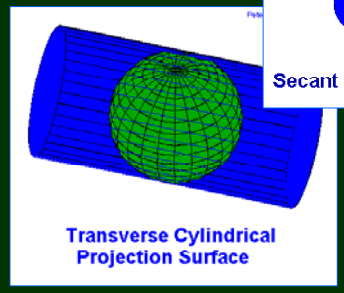
- "Project" the curved surface of the earth on a flat surface

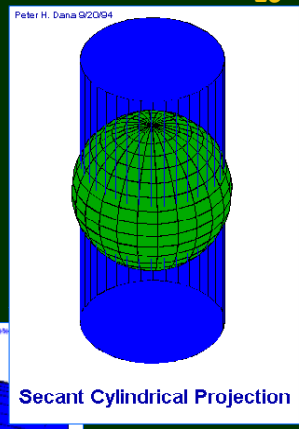


# Cylindrical projections

- projecting a sphere onto a cylinder

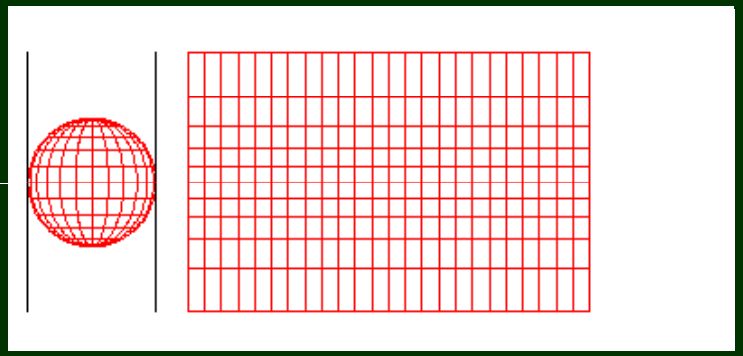




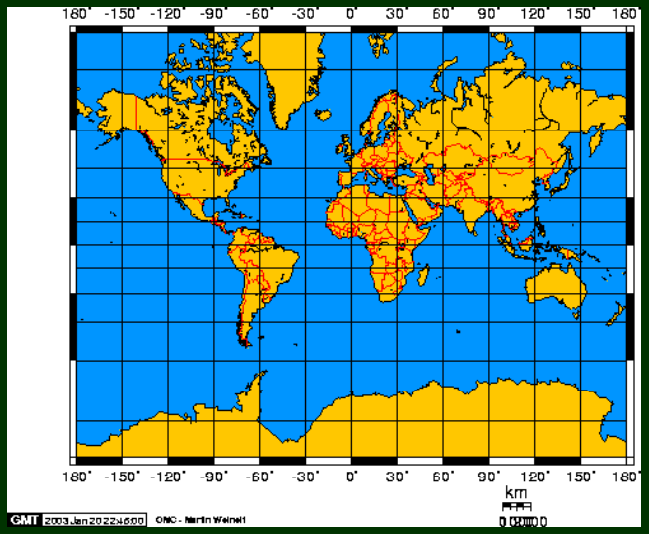

# Mercator



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



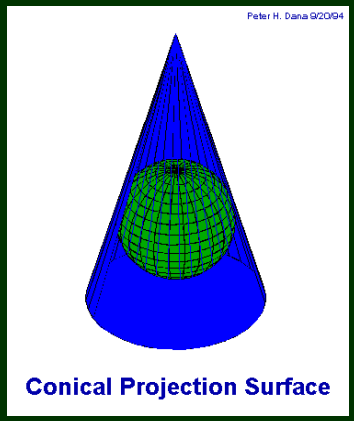
# Mercator

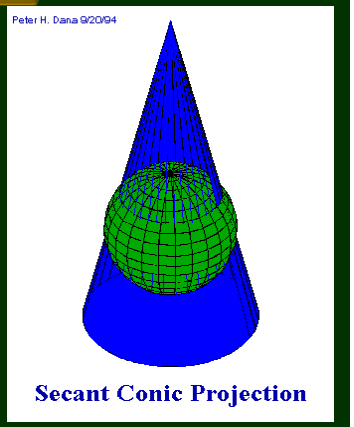





# Conic projections

project a sphere onto a cone



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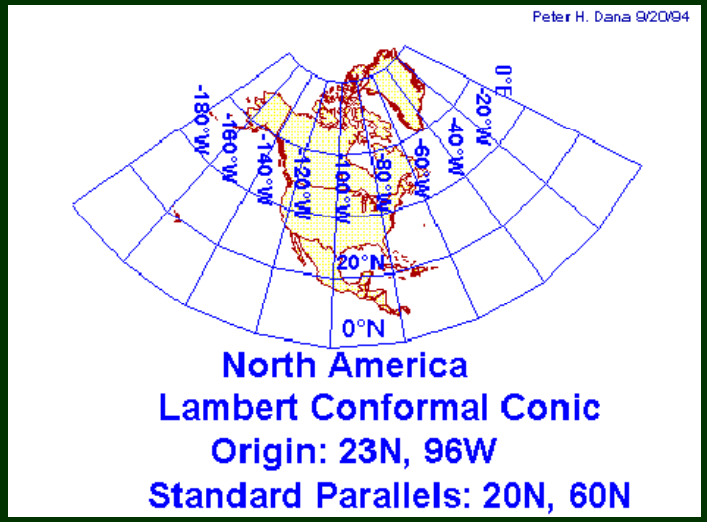
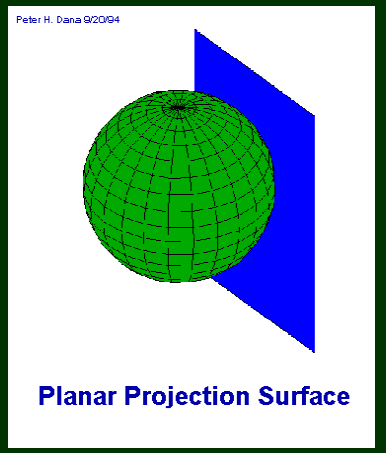
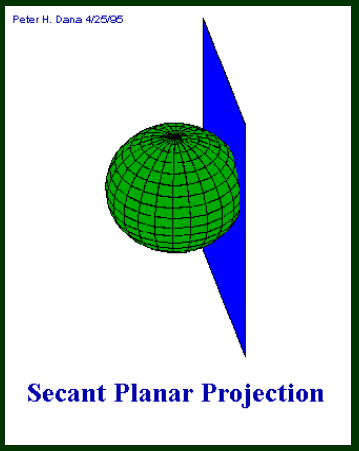





# Azimuthal projections

- project a sphere onto a plane

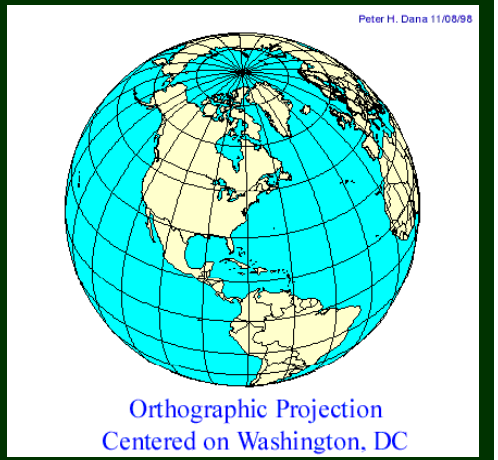





# Orthographic

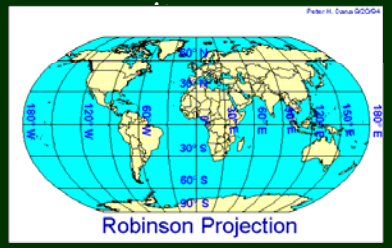
- used for perspective views of hemispheres
- area and shape are distorted
- distances are true along the equator and other parallels

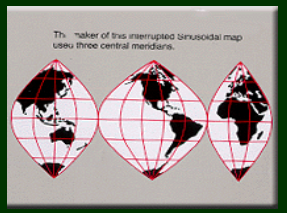


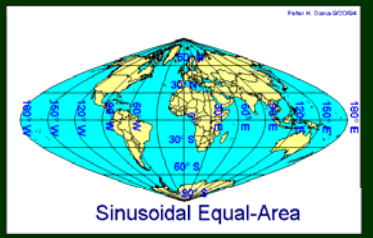



# Other projections

- based on mathematical transformations

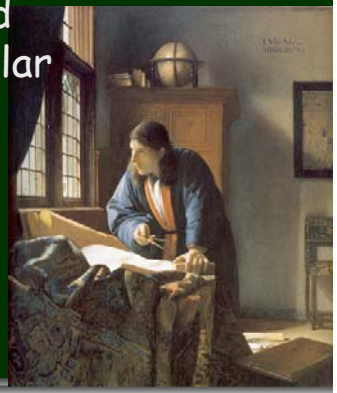




# Why have projections?

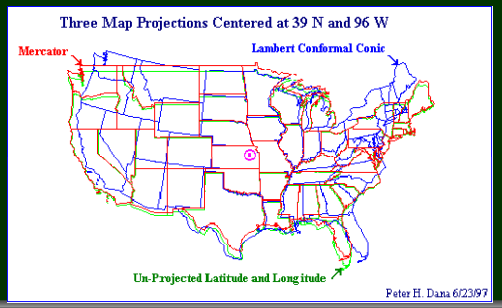
- Were developed for creating paper maps
- Provide mathematical transformations between lat/long values and x/y locations on a rectangular grid on the paper
- Works great if you are making one map at a time





# 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.



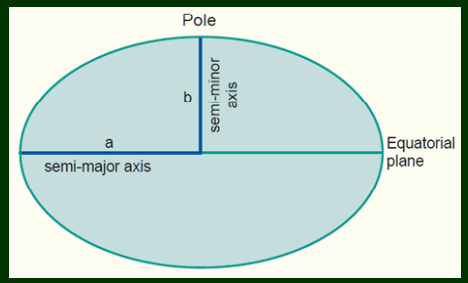

You have to know what projections are used with digital data!

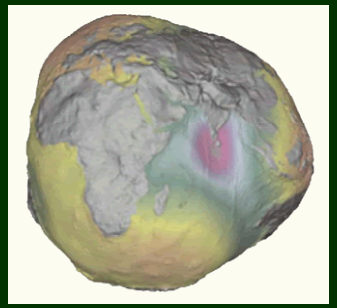
http://www.colorado.edu/geography/gcraft/notes/mapproj/mapproj_f.html



# AND, the earth is not a sphere

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

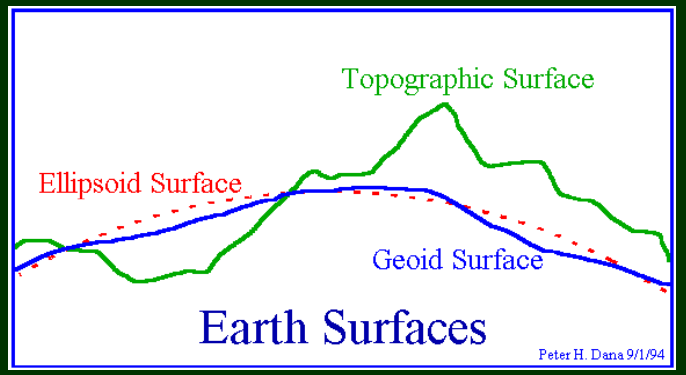


http://www.kartografie.nl/geometrics/reference%20surfaces/refsurf.html



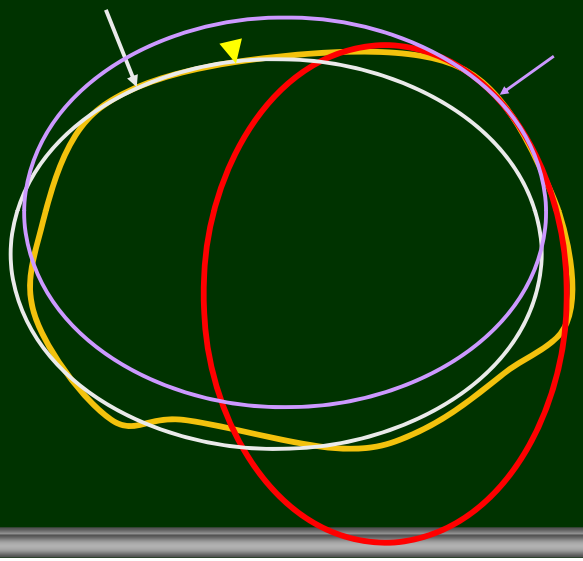
# Ellipsoids, geoids and topography

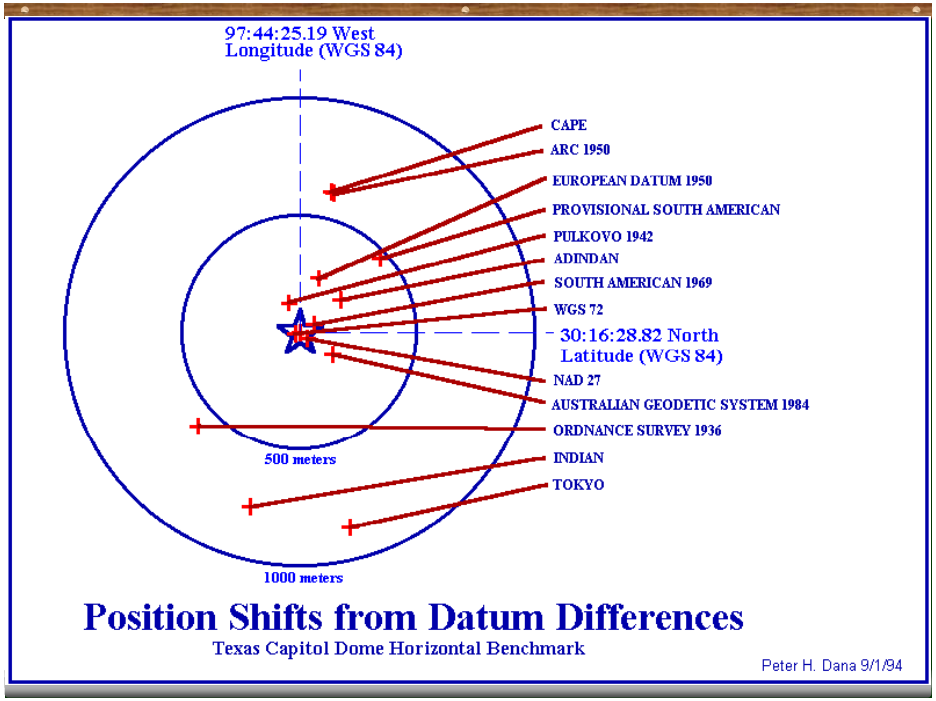



- Ellipsoid is a mathematical approximation of the earth's surface
- Geoid is the gravity surface

# Geodetic datums

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








# WGS 84

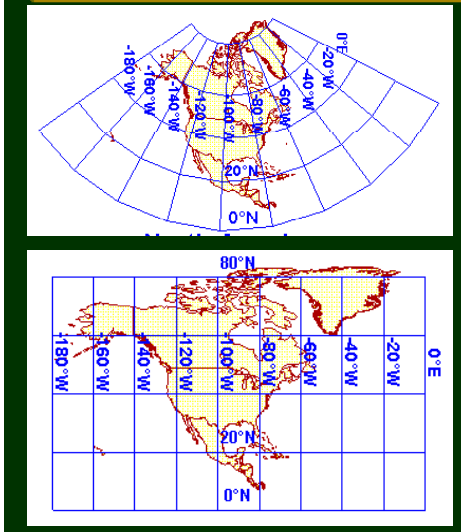
- If you know only one datum, know WGS 84 (World Geodetic System 1984)
- It comprises
  - a standard coordinate frame for the Earth,
  - a standard spheroidal reference surface (the datum or reference ellipsoid) for raw altitude data, and
  - a gravitational equipotential surface (the geoid) that defines 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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    - i.e. *relates* a name to a place…

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# 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

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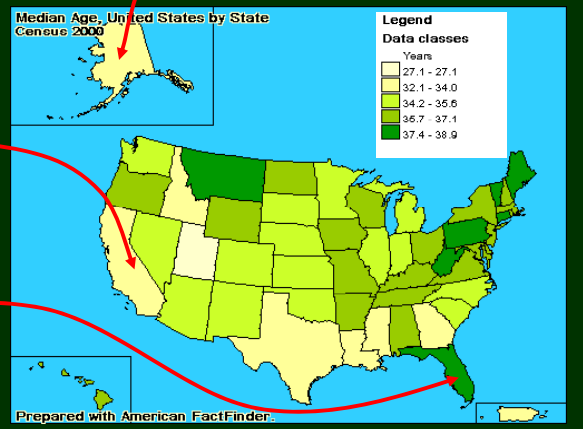
# Relationships in GIS

| Geographic area | Median age (years) |
|---|---|
| Alabama | 35.8 |
| Alaska | 32.4 |
| Arizona | 34.2 |
| Arkansas | 36 |
| California | 33.3 |
| Colorado | 34.3 |
| Connecticut | 37.4 |
| Delaware | 36 |
| District of Columbia | 34.6 |
| Florida | 38.7 |
| Georgia | 33.4 |
| Hawaii | 36.2 |
| Idaho | 33.2 |
| Illinois | 34.7 |
| Indiana | 35.2 |

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# 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!

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# 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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- What is there?
  - 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?

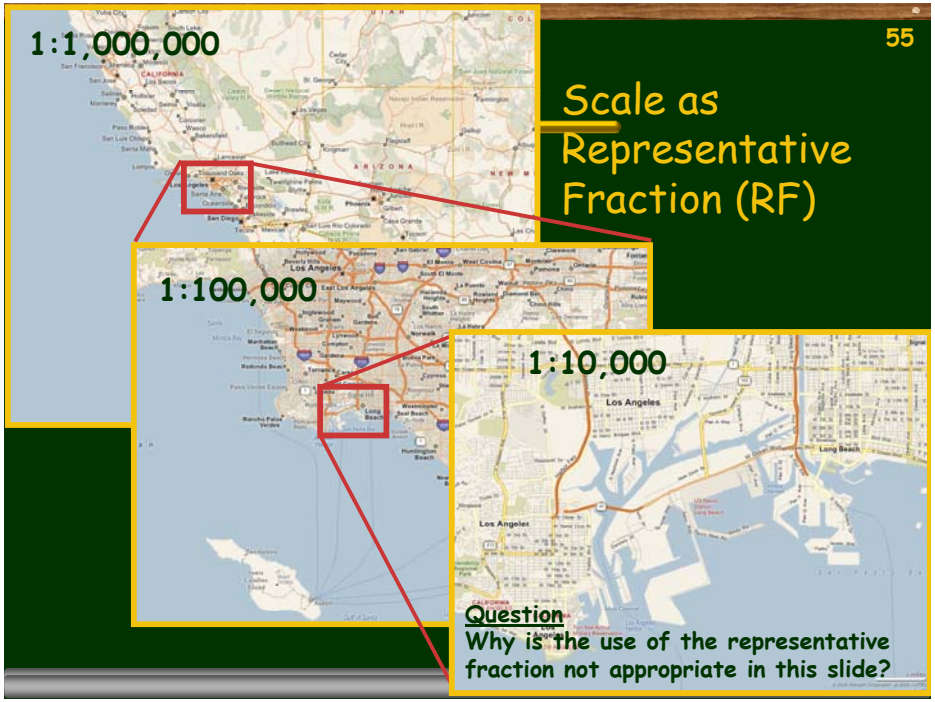
There are several ways we describe scale.



# 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 as Representative Fraction (RF)



# 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…




# Scale in GIS

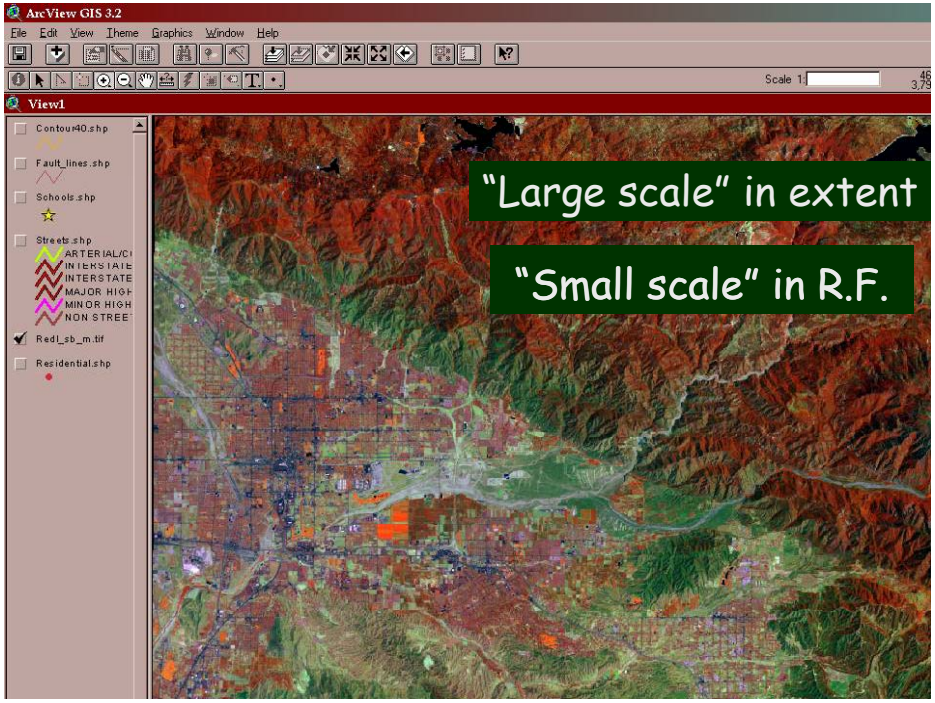
- In GIS, you often see an RF scale associated with data
- This is not really the data's scale, since
  - digital data doesn't have a mapped scale
  - you can zoom data to any level
- When scale is mentioned with respect to GIS data, it usually means the "*source map scale*"
  - Thus, it is expresses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

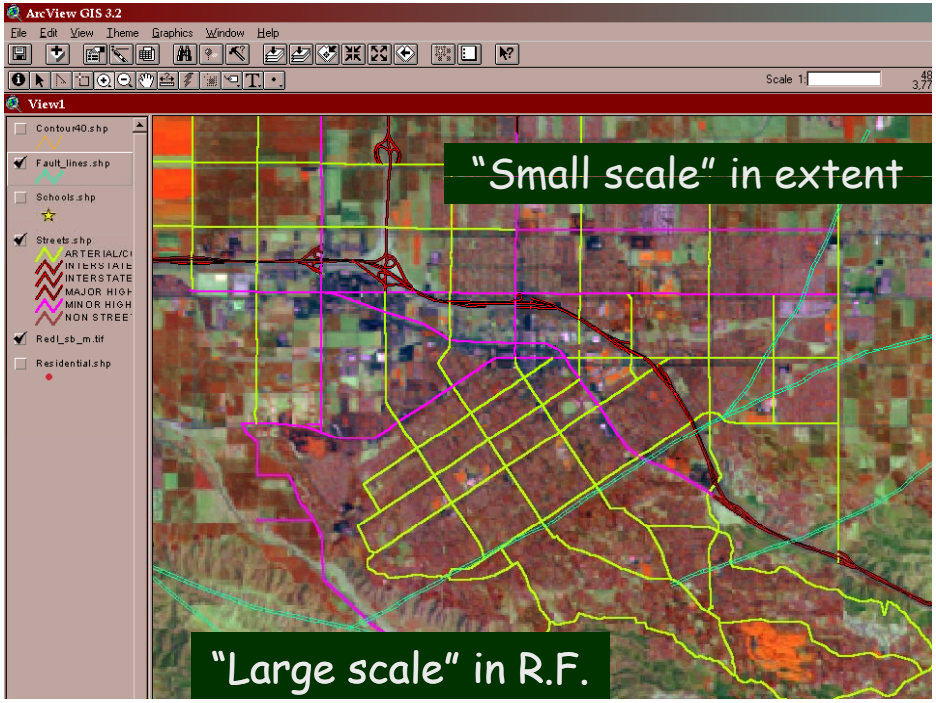





# What is "scale"?

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



## 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

# Location for Location-based services

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