

GIS4101 Intro to Vector GIS

- Course Overview
- Lecture – What is GIS?

Course Outline

- Available on ACSIS and Blackboard
- Course Description
- Course Learning Outcomes
- Texts and Resources
- Teaching Methods, Assessments and Evaluations
- Pertinent College Policies
- Use of Blackboard and Email
- Prime Document for the course – ***keep it!***

Course Schedule (CSI)

- Available on Blackboard
- Follows Chapters in 'Mastering ArcGIS Ed 6'
 - Concepts, summary and review questions
 - A Teaching Tutorial (class work)
 - A set of exercises (selected questions to be submitted through Blackboard)
- Exercises due as specified - submitted through Blackboard
- Midterm and Final Exam dates

GIS4101 Intro to Vector GIS

- Course Overview
- Lecture – What is GIS?

What is GIS ? many defns...

A geographic information system (GIS) integrates hardware, software, and data for capturing, managing, analyzing, and displaying all forms of geographically referenced information

http://www.esri.com/what-is-gis/overview.html#overview_panel

Set of computer tools which allow people to work with data that are tied to particular location on the earth

Price, Ed 6, page 1

What is GIS? – component view (I)

- Computer Hardware Platform
- Software
 - local or networked
- Data storage
 - local or networked
- Data Input Hardware
 - Typically heads-up digitizing
- Information Output Hardware
- GIS (and other)Data
- GIS Personnel

Price, Ed 6, page 2

What is GIS? – component view (2)

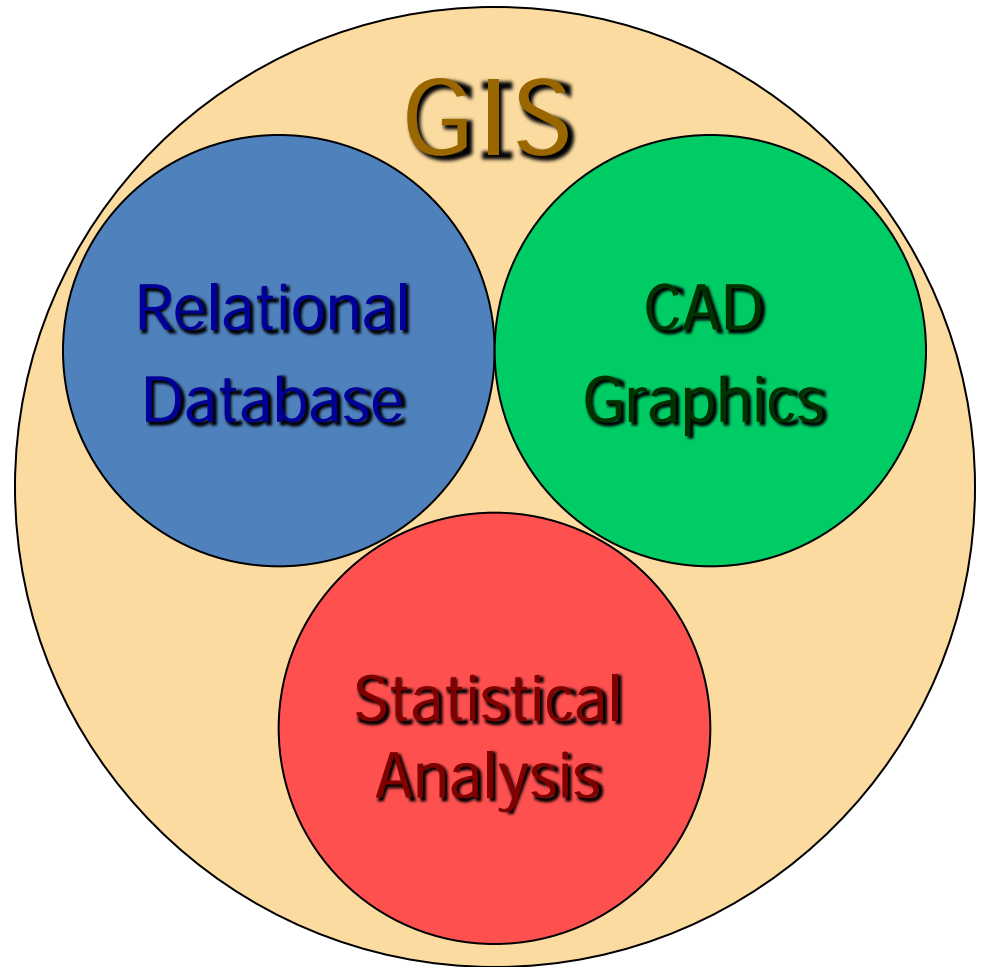
- People
use
- Applications
that require
- Data
and this is manipulated by
- Software
all of which requires
- Hardware

Harmon and Anderson, (2003) *Design and Implementation of GIS* p3

GIS is a Hybrid Technology

GIS borrows from other software technology:

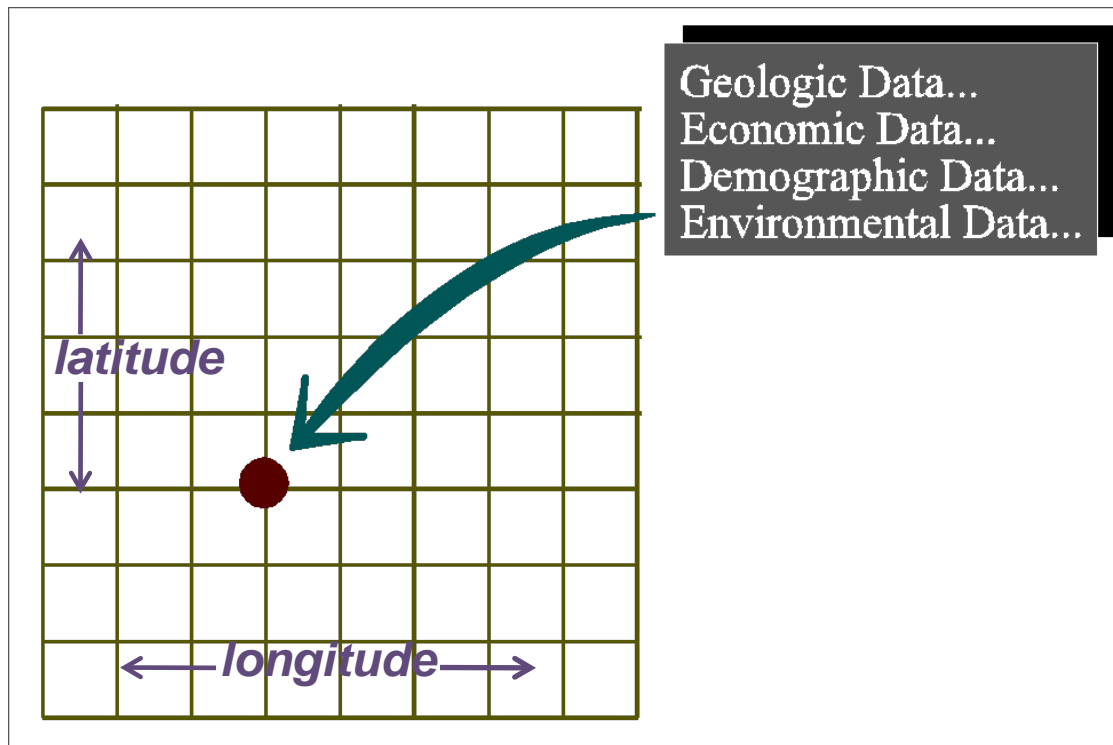
- Relational Database Management Systems
- Computer Assisted Design and Graphics Software
- Statistical Analysis and Reporting Packages
- ***Other technologies?***



Georeferencing

In a GIS, any spatial feature is georeferenced and is located at its world coordinates

Unprojected (Longitude, Latitude) or projected (x , y)



Elements of GIS, Sequencing

- Data Input
 - Source of data, method of input, accuracy, currency
- Data Management
 - Storage and retrieval
- Information Manipulation and Analysis
 - Attribute Classification Neighborhood functions
 - Overlay Connectivity functions Query

Elements of GIS, Sequencing

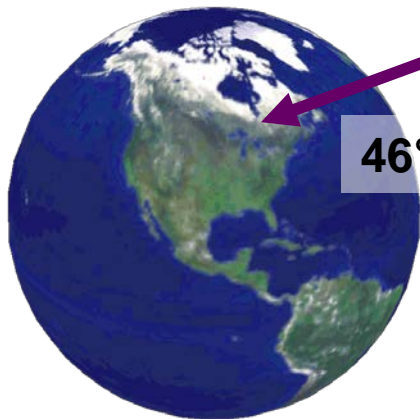
- Information Visualization
 - Displaying one or several layers
- Information Integration and Modeling
 - Combining layers of information by different models
- Information Output
 - Transfer the result(s) into another program
 - Save as file and/or print

Price, Ed 6, Introduction

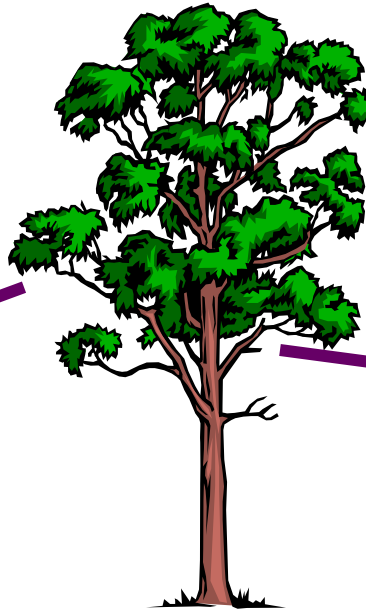
Modeling Our World

We describe any element of our world in two ways:

Location
Information:
Where is it?



46°N, 84°W



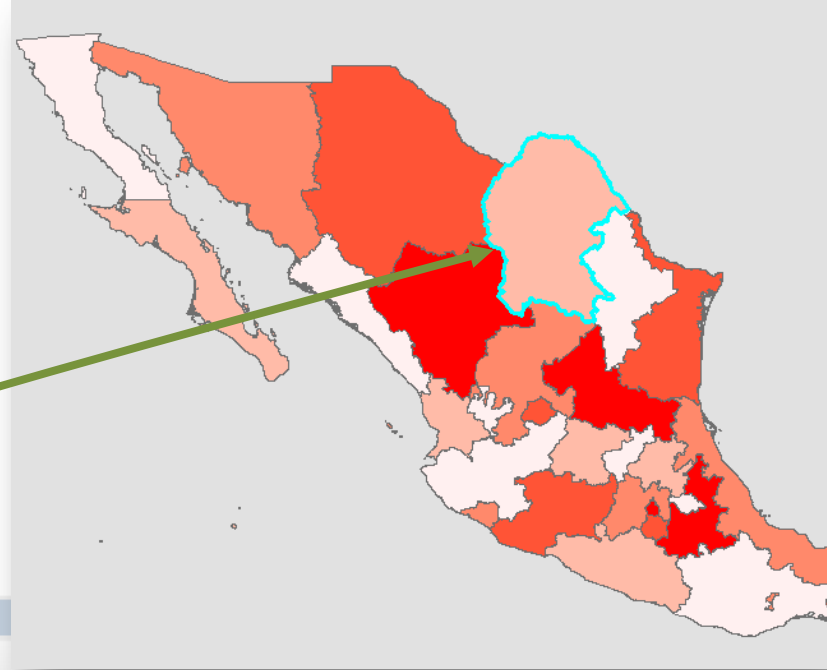
Attribute
Information:
What is it?

Species: Oak
Height: 15m
Age: 75 Yrs



GIS Links Data

GIS software links the **location** data and the **attribute** data:



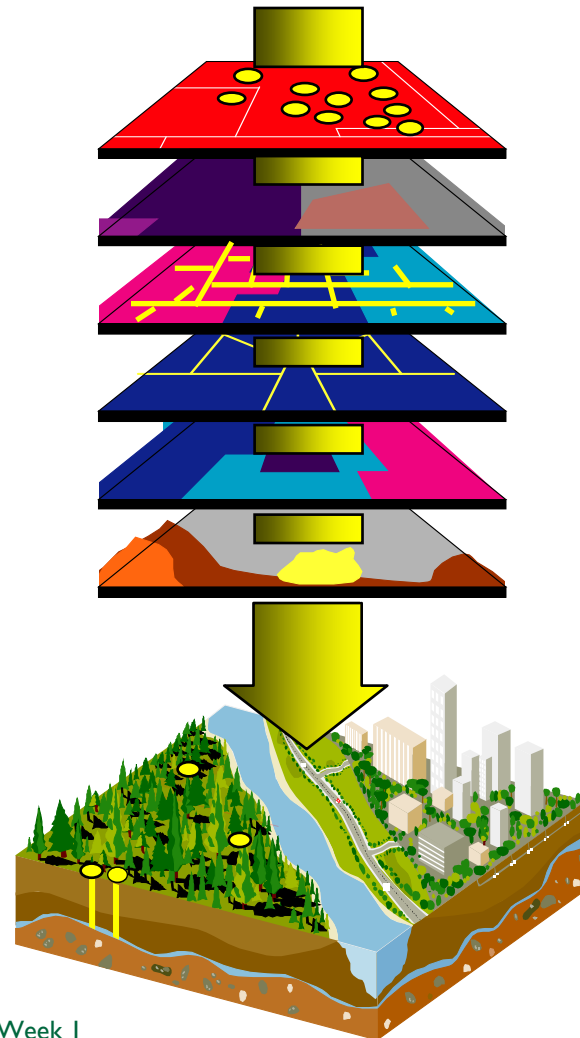
Table

Mexican states using ESRI color ramp

ObjectID *	Shape *	ST_NAME	FIPS_10_4	ST_ID	SQKM	COLORMAP
0	Polygon	Aguascalientes	MX01	1	5621.739	4
1	Polygon	Baja California	MX02	2	73210.75	1
2	Polygon	Baja California Sur	MX03	3	72205.327	2
3	Polygon	Campeche	MX04	4	56199.468	1
4	Polygon	Chiapas	MX05	7	73934.406	4
5	Polygon	Chihuahua	MX06	8	246454.703	4
6	Polygon	Coahuila	MX07	5	150983.905	2
7	Polygon	Colima	MX08	6	5619.036	3
8	Polygon	Distrito Federal	MX09	9	1505.78	5
9	Polygon	Durango	MX10	10	123384.202	5
10	Polygon	Federally Administered Territory	MX09	9	167.13	2
11	Polygon	Guanajuato	MX11	11	30415.561	2
12	Polygon	Guerrero	MX12	12	63771.858	2
13	Polygon	Hidalgo	MX13	13	20986.09	2

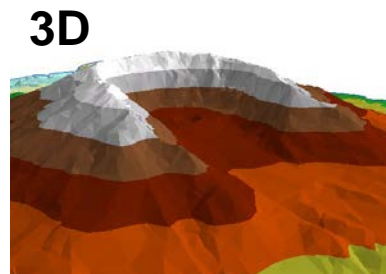
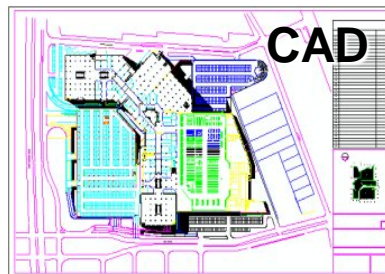
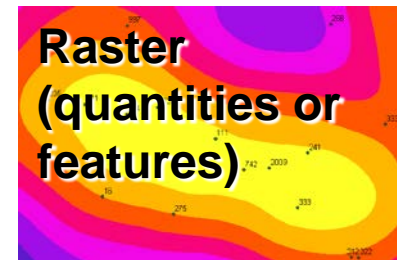
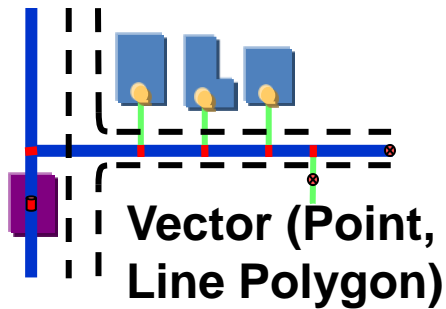
Representing the World as Layers of Information or Themes

- Ownership
- Streets
- Zoning
- Utilities
- Districts
- Environmental
- Incidents
- ...



GIS Data Types

GIS uses wide variety of data types



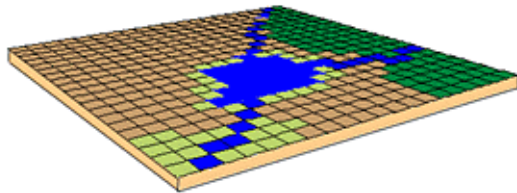
Tabular

PRFEDEA	C96TOTPOP	C96TOTPOPS	C96MALES	C96MO_4
10001001	0	0	0	0
10001002	734	725	375	20
10001003	0	0	0	0
10001005	761	760	380	15
10001006	1157	1150	555	25
10001007	87	90	20	0
10001008	569	590	285	10
10001009	0	0	0	0
10001010	393	395	195	15
10001011	704	705	350	15
10001012	987	990	490	30
10001013	1319	1320	675	35
10001014	1027	1025	490	20
10001015	1290	1290	610	40

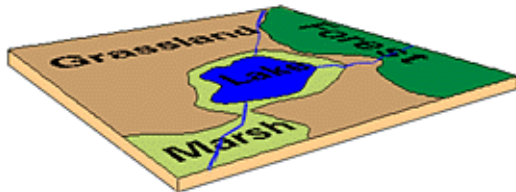
Record: 14 | Show: All Selected | Records (of 49361)

Spatial Data Models

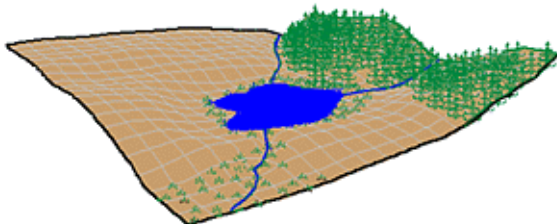
- Simplification and selection of reality according to a given ontology
- A geographic database is a computer representation of the 'real' world



Raster Model

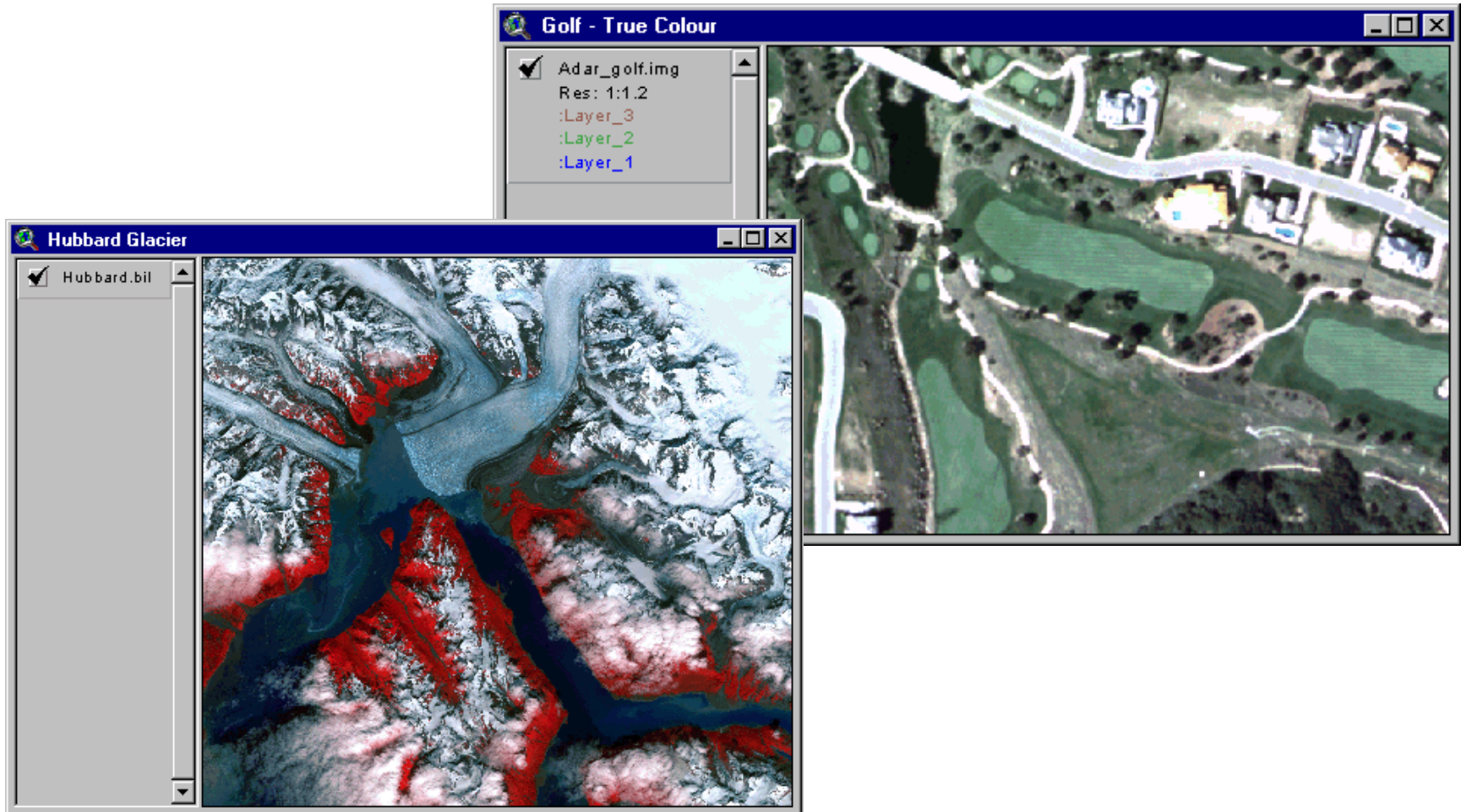


Vector Model



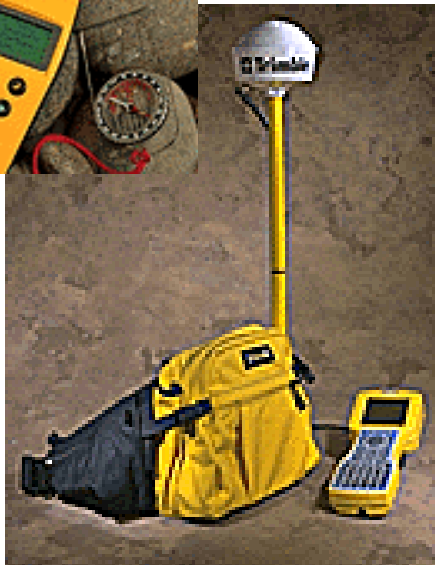
'Real' World

GIS Data Sources: Earth Observation



GIS Data Sources: Global Positioning Systems

- GPS is a navigation System
 - (ca. 30) satellites orbiting the earth
 - Provide location within metres anywhere on the globe
 - Now available in many cars, on many personal devices

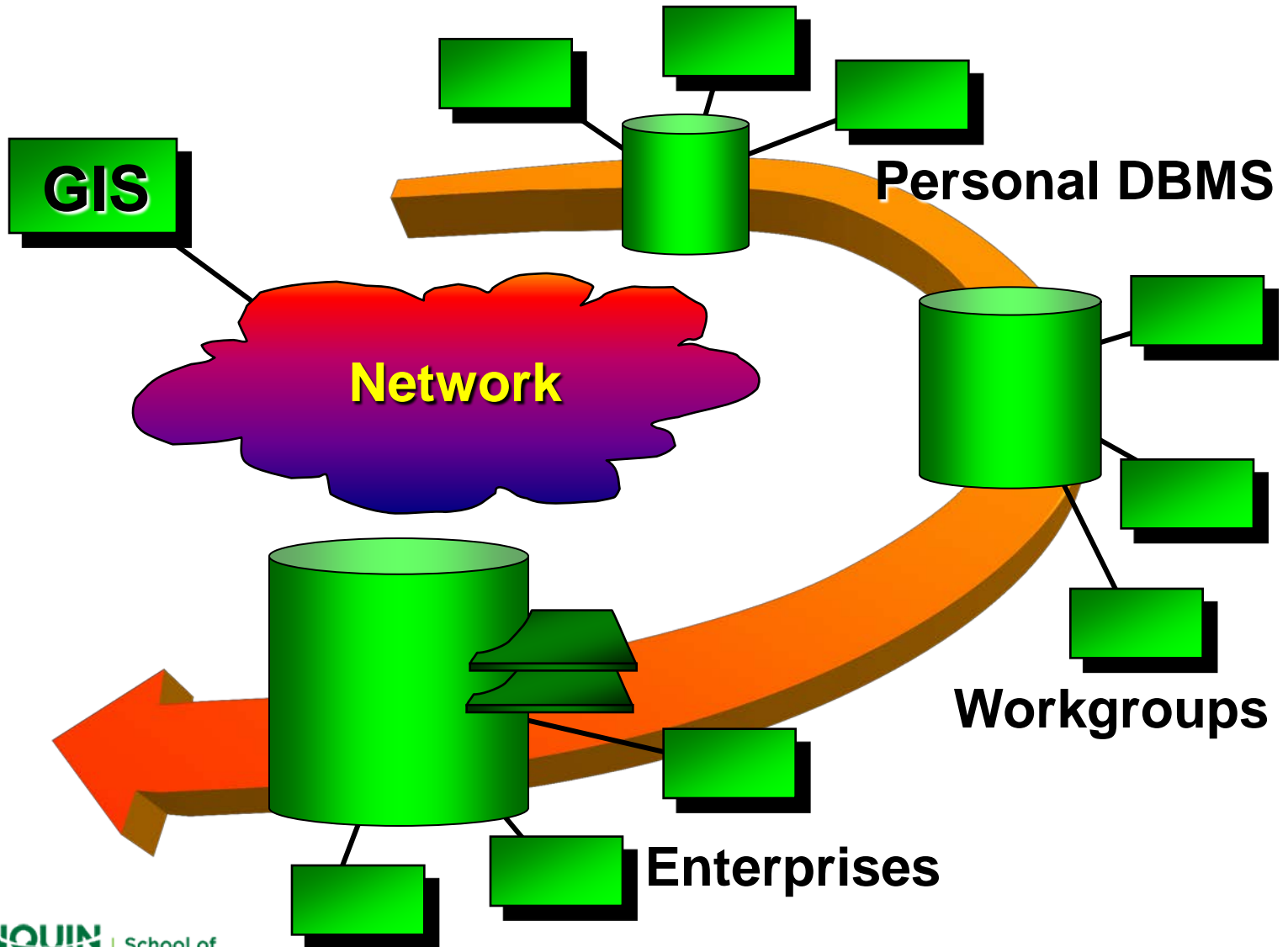


Editing, Digitization

The screenshot shows the ArcMap interface with a map of a residential area. A circular road with a radius of $R=14.00$ is highlighted. Several building footprints are shown with dimensions: 20.59 m , 20.83 m , 14.64 m , 19.75 m , 10.69 m , 19.47 m , and 10.05 m . A 'Dimensioning' dialog box is open, showing 'Angle/Length' with values 45 and 20. A 'Dimensioning' dropdown menu is also visible, listing options like 'Simple Aligned', 'Aligned', 'Free Aligned', 'Free Linear', 'Linear', 'Rotated Linear', and 'Simple Aligned'. A keyboard shortcuts menu is overlaid on the right side of the screen.

Angle...	Ctrl+A
Deflection...	Ctrl+F
Length...	Ctrl+L
Change Length	
Absolute X, Y...	F6
Delta X, Y...	Ctrl+D
Angle/Length...	Ctrl+G
Parallel	Ctrl+P
Perpendicular	Ctrl+E
Segment Deflection...	F7
Replace Sketch	
Tangent Curve...	Ctrl+T
Streaming	F8
Delete Sketch	Ctrl+Delete
Finish Sketch	F2
Square and Finish	
Finish Part	

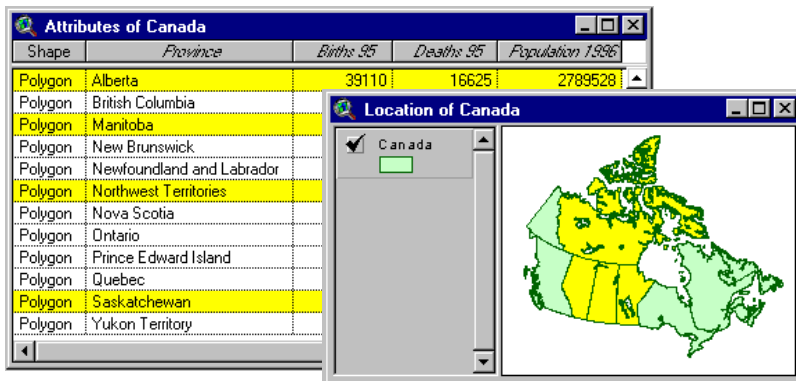
GIS uses RDBMS



GIS – Simple Data Query

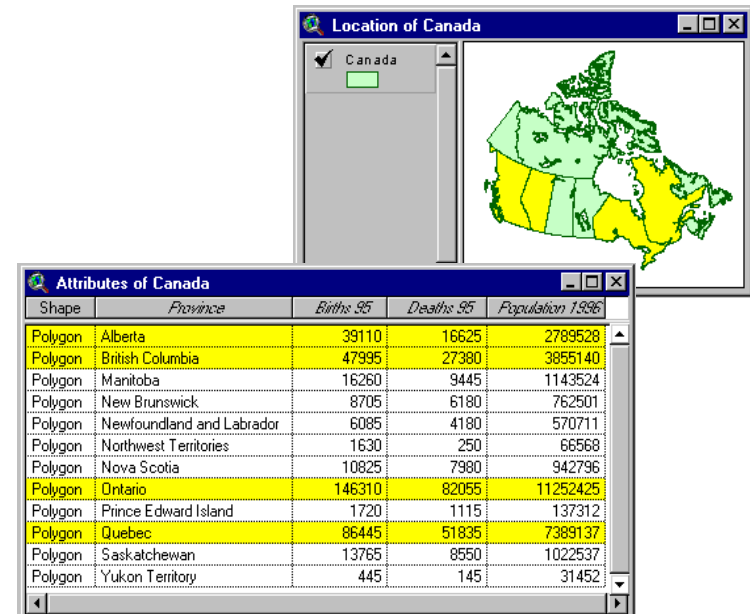
Spatial Questions

What provinces border Saskatchewan?



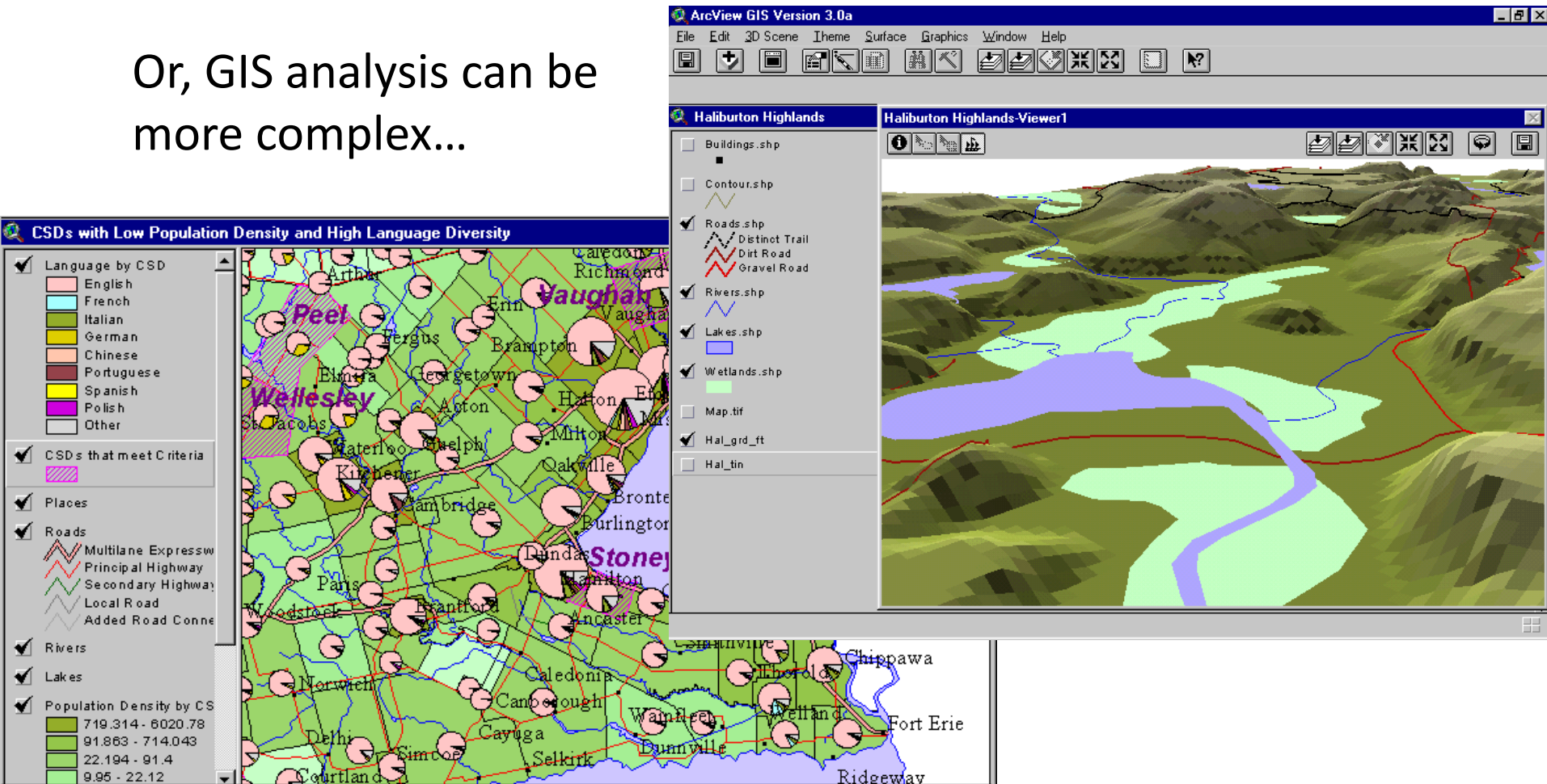
Attribute Questions

What provinces have more than 1.5 million people?

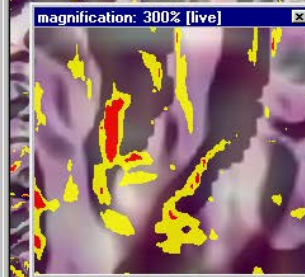
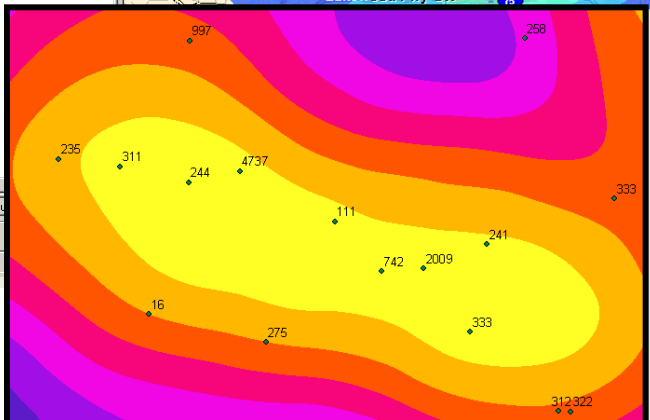
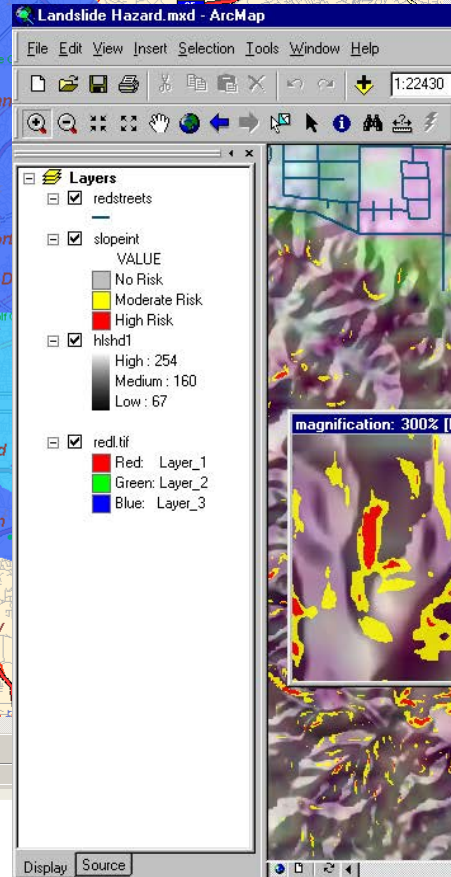
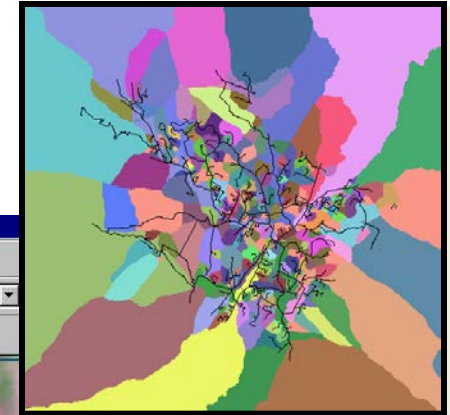
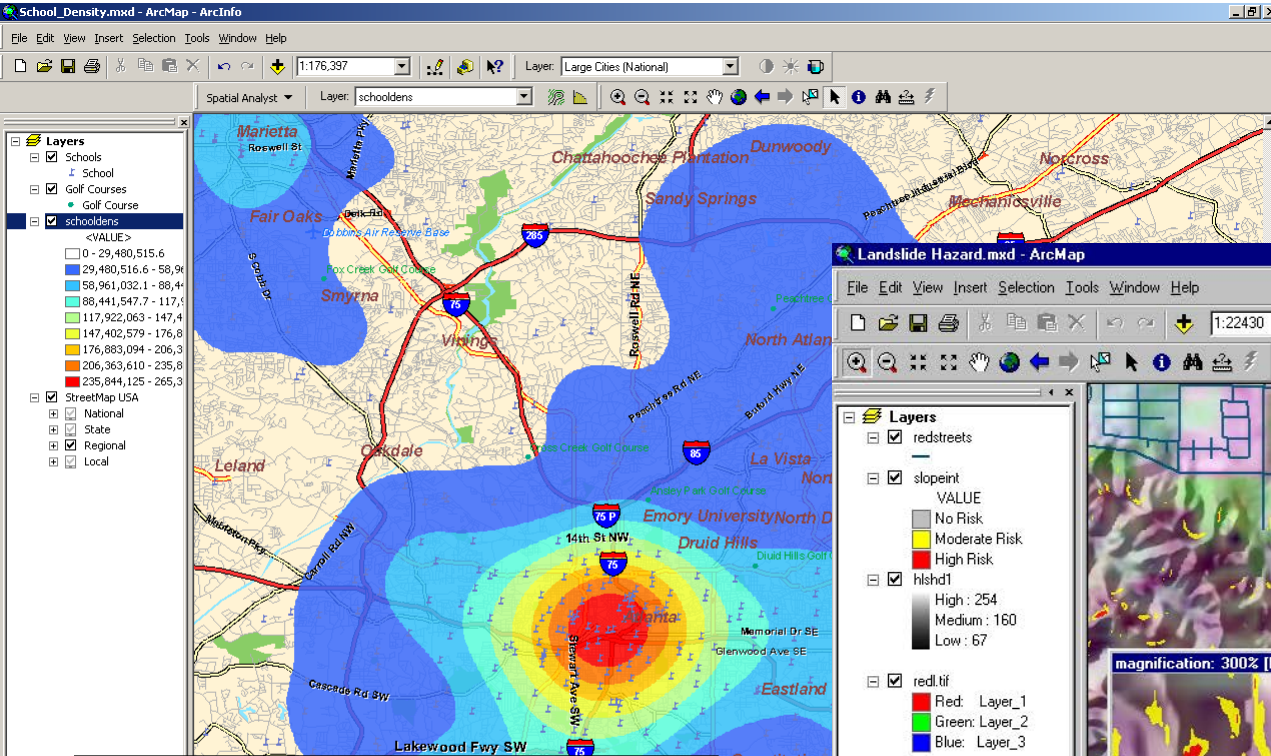


GIS - Analysis

Or, GIS analysis can be more complex...



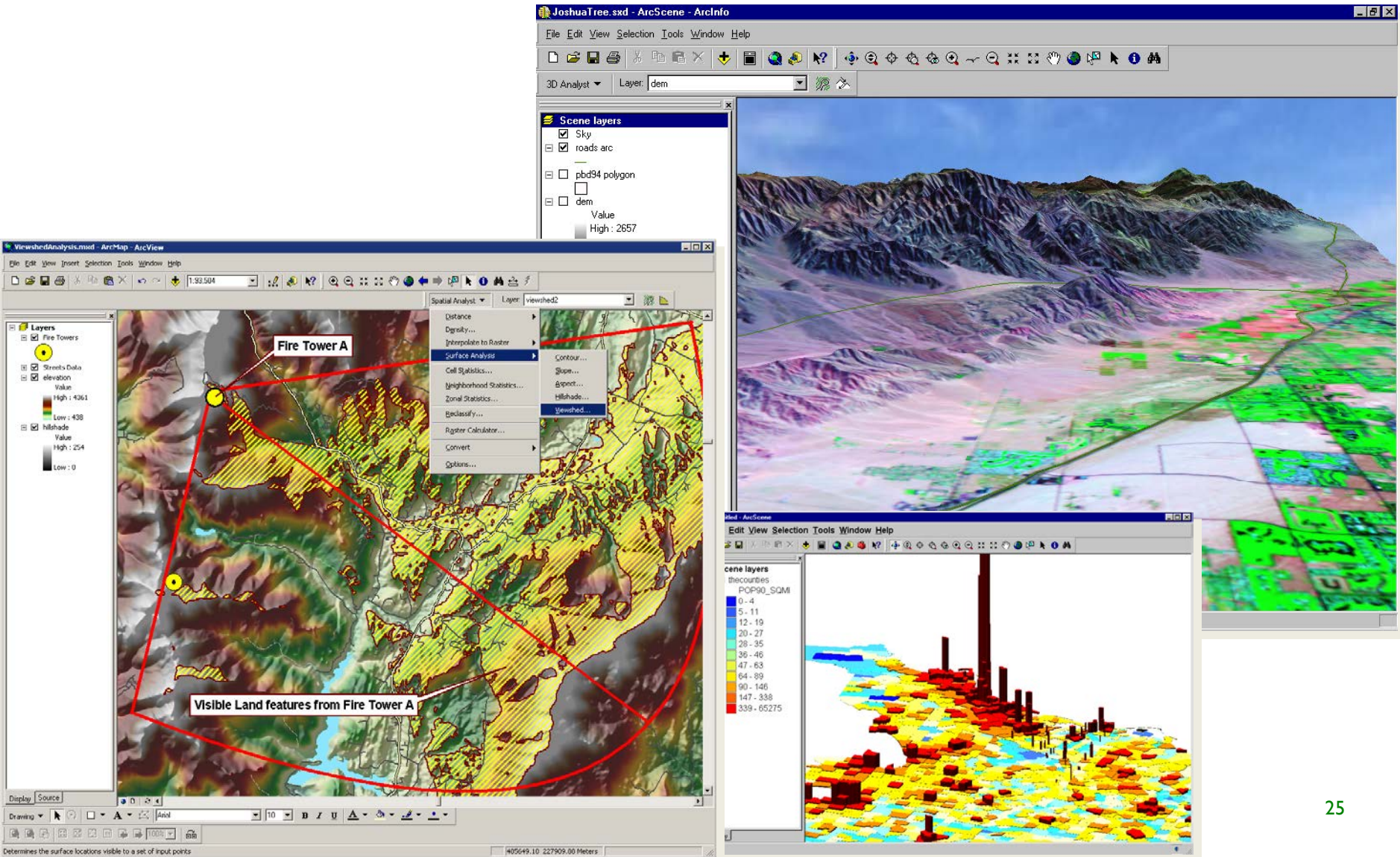
Spatial Analysis



3D Analysis

- Terrain modeling, analysis and visualization
 - Create surface models
 - ‘Real’ (physical) world - Terrain
 - Data – population, characteristics
 - Surface analysis
 - Cut and fill, volume
 - Synthetic world viewer
 - View shed analysis
 - Fly-through

3D Analysis



Network Analysis

- Shortest path computation and route optimization
 - Driving directions
 - Allocation
- Flow / load modeling
- Network trace analysis
 - Upstream / downstream
 - Common ancestors
- Natural and human networks

Network Analysis

Driving Directions

Depart 14100 San Pedro AVE , 78232
Arrive near DAYTON HUDSON CORPORATION
Total: 0.9 mile(s) - less than a minute

DIRECTIONS

- 1 Depart San Pedro Ave, go North
- 2 Drive 0.1 mile(s) - less than a minute
- 3 Turn right on Ramp
- 4 Drive less than 0.1 mile - less than a minute
- 5 Go North East on San Pedro Ave
- 6 Drive less than 0.1 mile - less than a minute
- 7 Go North on Us Hwy 281
- 8 Drive 0.2 mile(s) - less than a minute

Warning: Applet Window

Arrive	Order No.	Address	Service Time
9:00 AM	77132864	1400 S GRAND AV...	20
9:22 AM	77078778	1111 E 10TH ST, L...	20
10:06 AM	77088749	1354 NEWTON ST...	20
10:28 AM	77140198	1526 S LOS ANGE...	20
10:49 AM	77079128	1945 S HILL ST, L...	20
11:10 AM	77116384	2615 S HILL ST, L...	20
11:32 AM	77111358	555 E JEFFERSON...	20
11:52 AM			45
12:39 PM	77122395	4619 S CENTRAL ...	20
1:03 PM	77096726	6333 S ALAMEDA ...	20
1:23 PM	77091593	1929 E 64TH ST, L...	20
1:47 PM	76942256	6400 AVALON BLV...	20
2:09 PM	77141196	6700 S MAIN ST, L...	20
2:30 PM	77070588	7676 S SAN PEDR...	20
2:54 PM	77147838	942 W 70TH ST, L...	20
3:16 PM	77099181	6301 S NORMAND...	20
3:42 PM	77040271	3620 S VERMONT ...	20
4:04 PM	76304381	746 W ADAMS BL...	20
4:26 PM	77000003	775 W WASHINGTON...	20

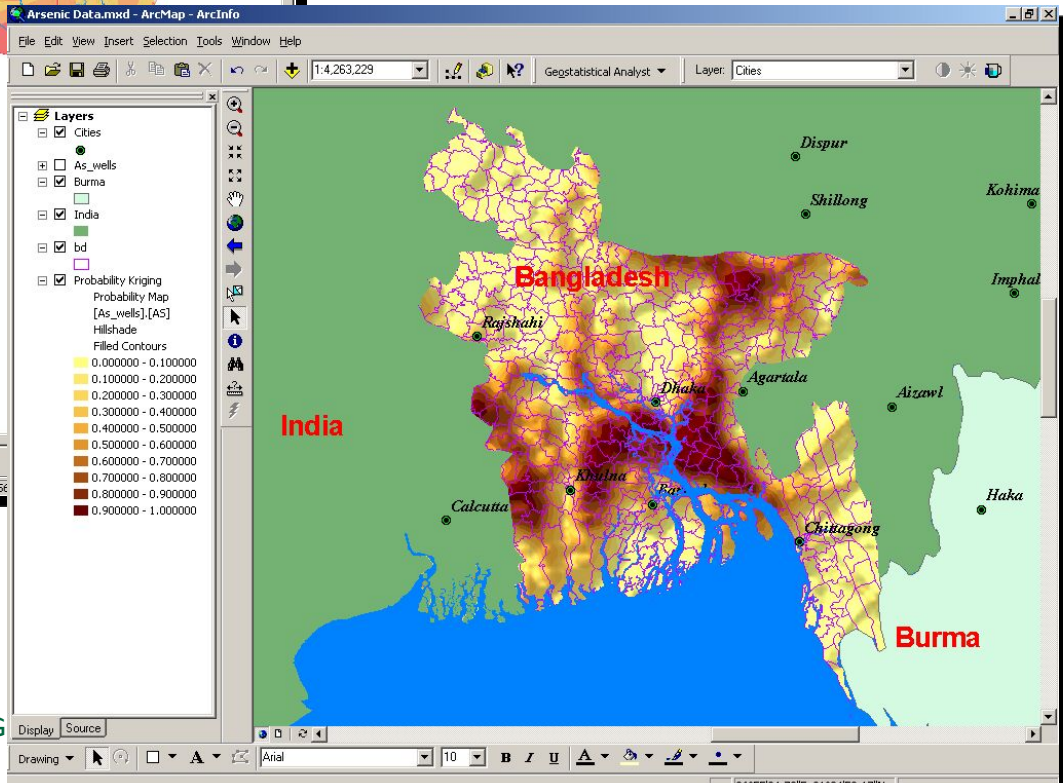
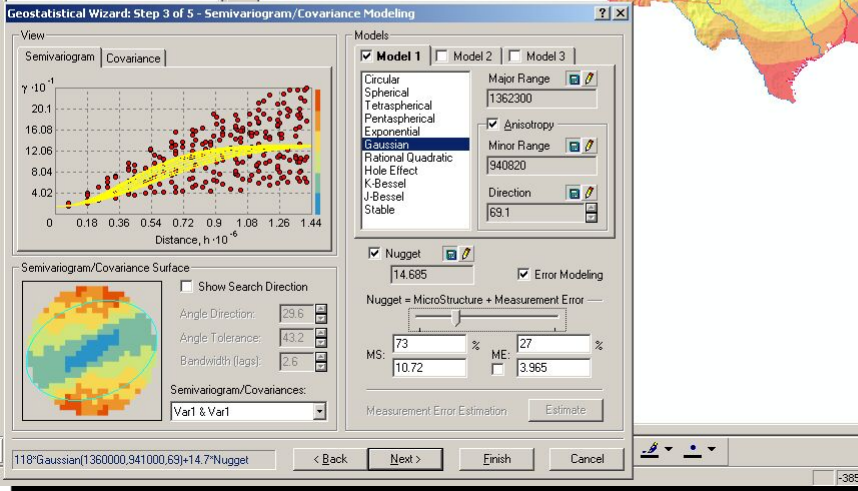
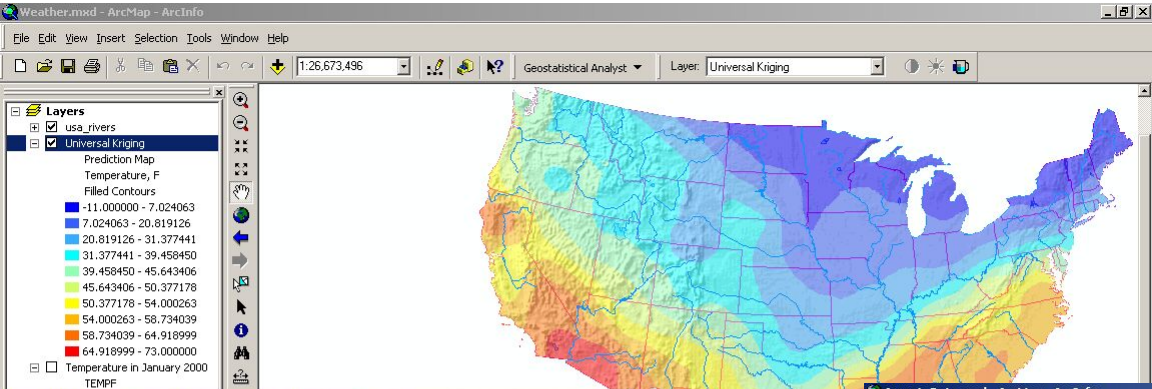
Geometric Network

- Meter Secondary
 - SubtypeCode
 - MeterSecondaryS
- Fused Switch Primary
 - SubTypeCode
 - FusedSwitchPrimaryS
- Voltage Regulator Primary
- Termination Primary
- Electric Net Junctions
- Substation Transformer Prim
 - SubTypeCode
 - SubstationTransformerPri
- Street Light Relay
- Splice Primary Underground
- Solid Blade Switch Primary
- Secondary Equipment UG
 - SubTypeCode
 - SecondaryEquipmentUG
- Recloser Primary
 - SubTypeCode
 - RecloserPrimaryS
- Polemount Transformer Prim
 - SubTypeCode
 - PolemountTransformerPri

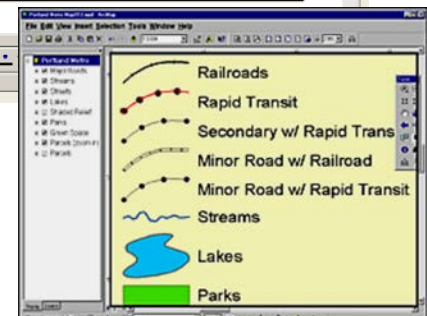
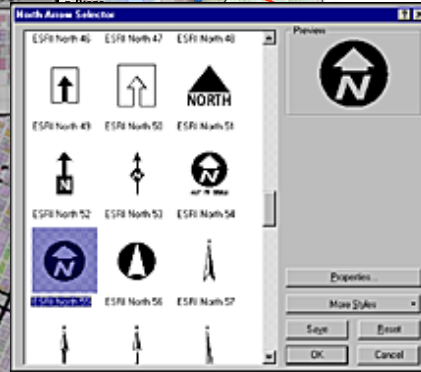
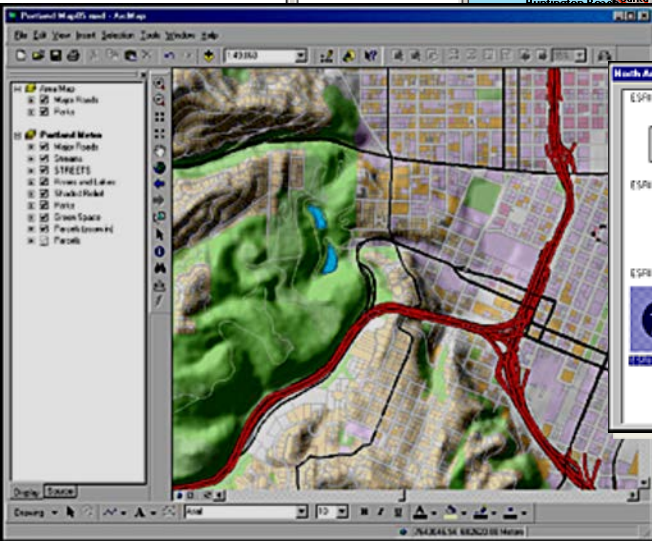
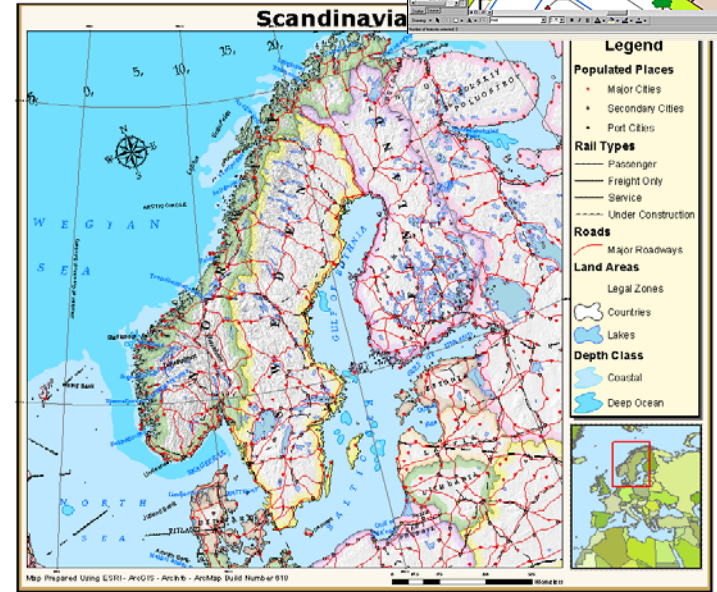
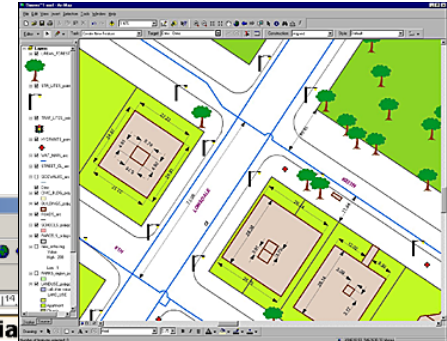
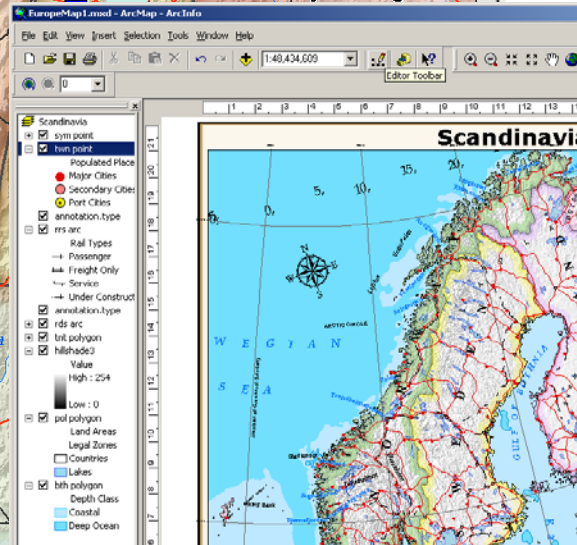
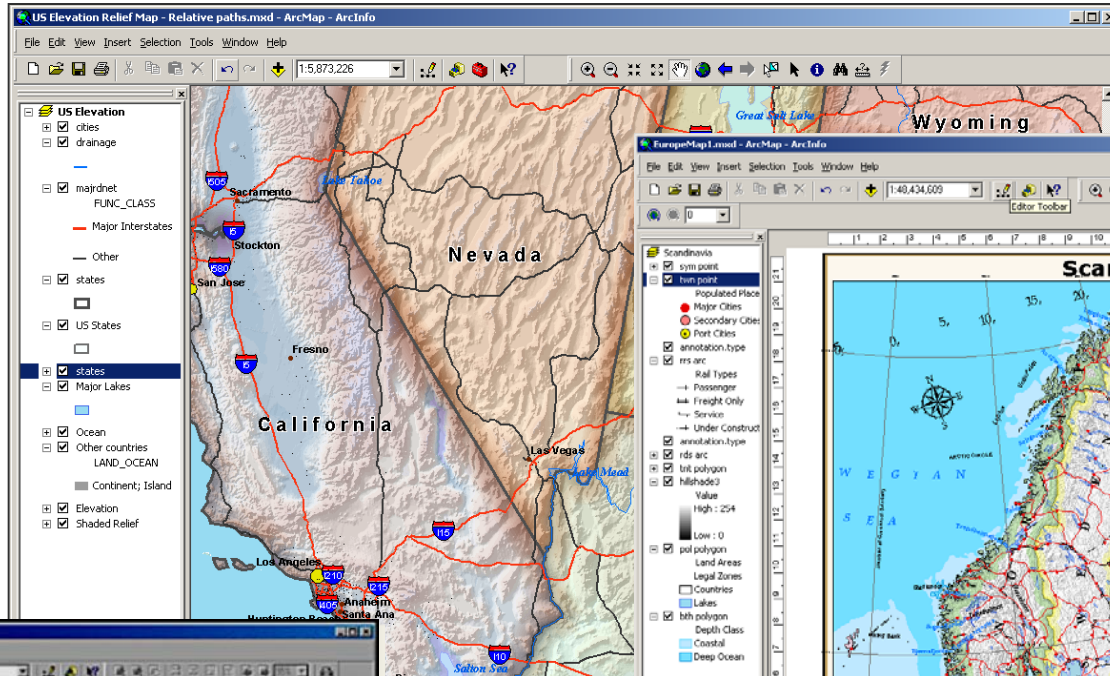
Geostatistics

- Advanced mathematical surface modeling
 - Exploratory spatial data analysis (ESDA)
 - Statistical diagnostics
 - Model error and uncertainty
 - Surface prediction and analysis

Geostatistics



Cartography



Reporting

Report Viewer

Sugar Cane Field Loss Report
Central Oahu, Hawaii

Zoning Description	Area (sq. meters)
A-1 Apartment	3022165
A-2 Apartment	264438
B-1 Neighborhood Business	104299
B-2 Com	
BMX-3 Cor	
F-1 Military	
I-1 Limited	
I-2 General	
I-3 Waterfr	
IMX-1 Indu	
P-1 Restrict	
P-2 Generz	
R-5 Reside	
Resort	

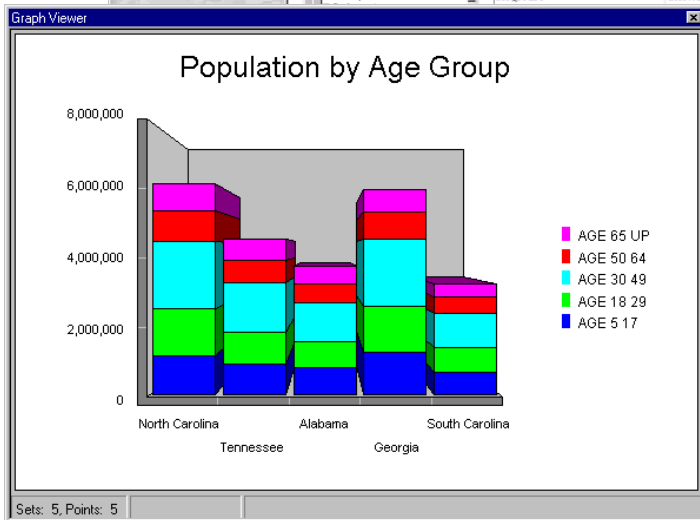
USA.mxd - Arc Map

Population by Races

Report Viewer

European City Population Density

NAME	AREA	POPDENKM	POPTOTAL
ANDORRA	846.91	122.3	91
SHQI PEH	28339.49	118.3	3463
		25	26.6
		76.6	133.8
		68.1	100.2
		69.5	243.3
		71.2	239.7
		113.4	139.5
		38.8	225.1
		50.9	122.8
		91	235.8
		187.9	277
		3782.2	1369.6
		129.6	262.9
		31.9	131.1
		47.4	140
		250.2	260.1
		25.2	82.3
		27.3	136.5
		79.3	266
		85	388.9



Routing Assistance

Narrative
Total Distance: 1.4 mi.
Estimated Time: 2.9 min.

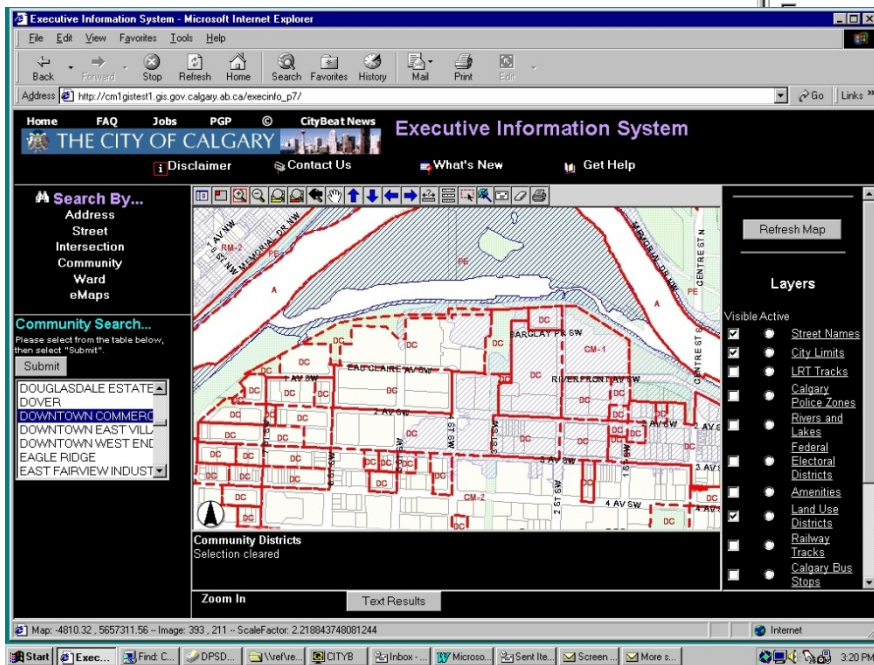
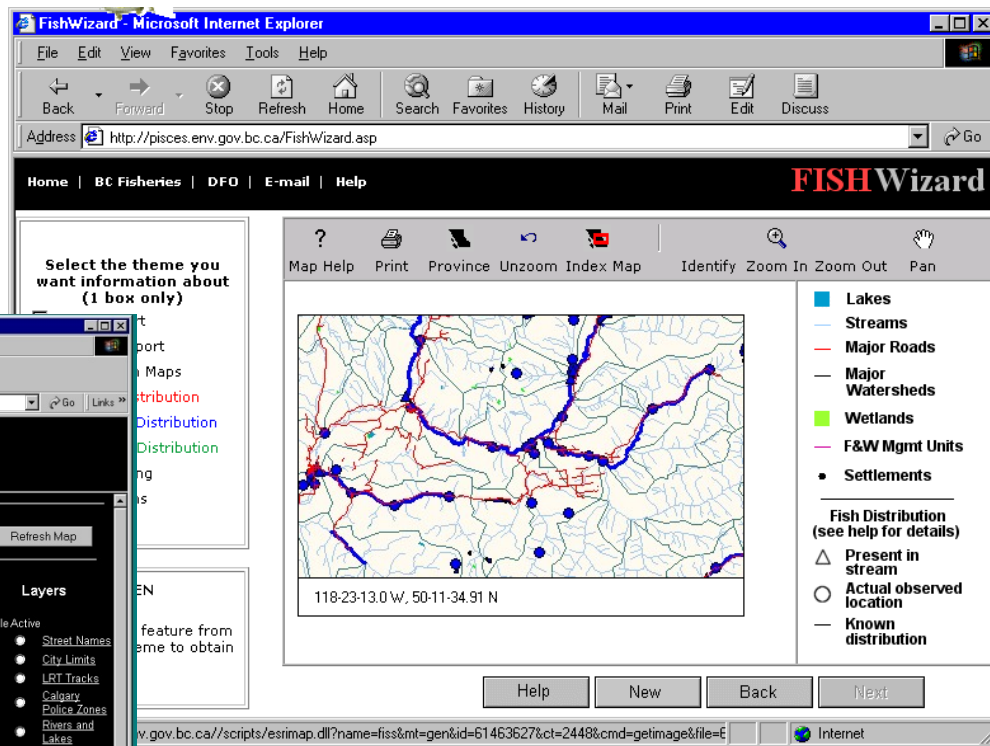
Routing Directions from B St to W Harbor Dr

Direction	Road Name	Distance
1. Go left (W)	B ST	0.1 mi.
2. Go left (S)	10TH AVE	0.4 mi.
3. Go right (W)	MARKET ST	0.5 mi.
4. Continue (W)	W MARKET ST	0.1 mi.
5. Go left (S)	FRONT ST	0.2 mi.
6. Go left (SE)	W HARBOR DR	0.1 mi.

Source: Primary Display Road Labels

Accept Reject

GIS on the Web



Selected GIS software

- Desktop Software
 - [ESRI](#) ArcGIS for Desktop (10.1, 10.2 in use next semester)
ArcGIS Explorer Desktop
 - AutoDesk AutoCAD, [AutoCad Map 3D](#)
 - [Intergraph](#) GeoMedia (acquired by Hexagon)
 - MapInfo [Map Info Professional \(Pitney Bowes\)](#)
 - [Open Source](#) [Quantum GIS](#), [Saga](#), [Whitebox](#), [PostGIS](#), ...
- Server Software
 - [ESRI](#) [ArcGIS for Server](#)
 - AutoDesk [Infrastructure Map Server](#)
 - [Open Source](#) MapGuide Open Source, MapServer ...
- Developers Components
 - [ESRI](#) Constantly and quickly evolving
- Spatial DBMS
 - [PostgreSQL](#) [PostGIS](#) [Oracle Spatial](#)...

Related Software

- CAD and Drawing
- Contouring & Surface Mapping
- Database Management Systems (DBMS)
- Remote Sensing and Image Processing
- Statistical & Geostatistical packages
- Spreadsheets
- Other Information Systems ([ERP](#), [BIM](#))

50 Year History of GIS

- [Brian Klinkenberg's take on the origins of GIS](#)
- 1960s: First general purpose computer mapping packages
 - SYMAP, SYMVU, GRID: Laid foundation for raster-based GIS
- [1963: World's first Full Scale GIS: CGIS \(Canadian GIS\)](#)
 - Data collected by Canada Land Inventory (CLI): Land capability for rural Canada,
 - Themes: soils, agriculture, recreation, wildlife, waterfowl, forestry, present land use
 - Project leader Dr. Roger Tomlinson 'father of GIS'
 - Data still available through Geogratis

<http://geogratis.gc.ca/api/en/nrcan-rncan/ess-sst/cafbce5f-c81a-57e2-9504-c987ec3b50f1.html>

- 1969: First commercial mapping software (Intergraph)

50 Year History of GIS

- 1980s: 'The GIS decade'
- 1981: Release of Arc/Info
 - First GIS to utilize new mini computers; Incorporated features from the CGIS,
 - First release of IBM Personal Computer ... [spread of home and office computers]
- Real growth occurred with standard Unix workstations and personal computers
- First GIS textbook and journal (1986), magazines and conferences(1987)
- Unix and DOS/Windows -> 'stable' platforms for GIS
- Rapid increase in available GIS software packages

50 Year History of GIS

- 1990s: Rapid growth of GIS
 - Geometric increase in power of GIS software, decrease in costs.
 - Windows NT and 95 as alternative to Unix
 - Growth of GIS applications in different fields

Trends and Directions in GIS

- Many Options for GIS Data Sharing
 - NSDI - National Spatial Data Infrastructure
 - Internet Map Servers
- Many Options in Working with GIS Data
 - Desktop Options
 - Server GIS
 - Simple, complex or seamless interfaces
- GIS and Wireless Technology
 - Location based GIS
 - Smart Wireless Devices

Price, Ed 6, Introduction

Trends and Directions in GIS

- Open Source Solutions
 - Sometimes based on commercial database platforms
 - Better interoperability between systems
- Customization
 - Creation of custom apps based on GIS tool subsets
 - Focus on ease-of-use
 - Growing jobs in this sector
- Enterprise GIS
 - Typically server based, multiple access modes
 - Enterprise database management issues

Price, Ed 6, Introduction

Trends and Directions in GIS

- New Satellite Data
 - high resolution and relatively low cost data from commercial satellites
- GeoVisualization
 - Taking advantage of faster cheaper personal computers for 3D animation, time series animation
- Wiki GIS
 - Volunteered Geographic Information (VGI)
 - Google Earth and Google Maps, Bing Maps
 - Mashups

Who Needs GIS?

- Anybody who works in a field that manages and analyzes spatially distributed data

Earth Sciences

Mining and Mineral Exploration

Civil Engineering

Architecture and City Planning

Agricultural Engineering

Environmental Engineering

Health Sciences

Hydrology and Water Resources

Ecology

Business and Marketing

Geodemographics

Forestry

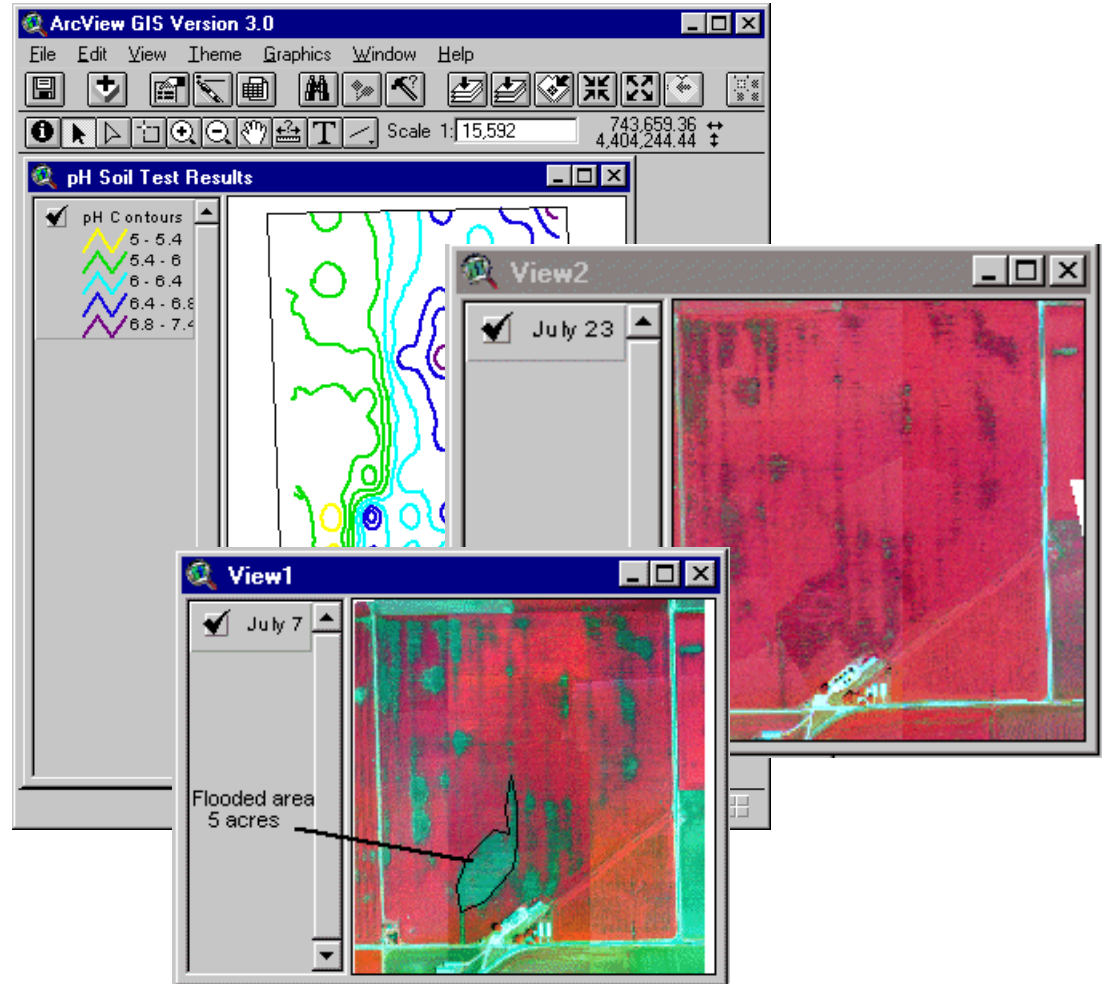
Municipal Management

How Can GIS Help?

- Support for decision making based on spatial data
- Support general research in a discipline or cross-disciplines
- Search for relationships between different characteristics of the spatial which may not be obvious based on a single map

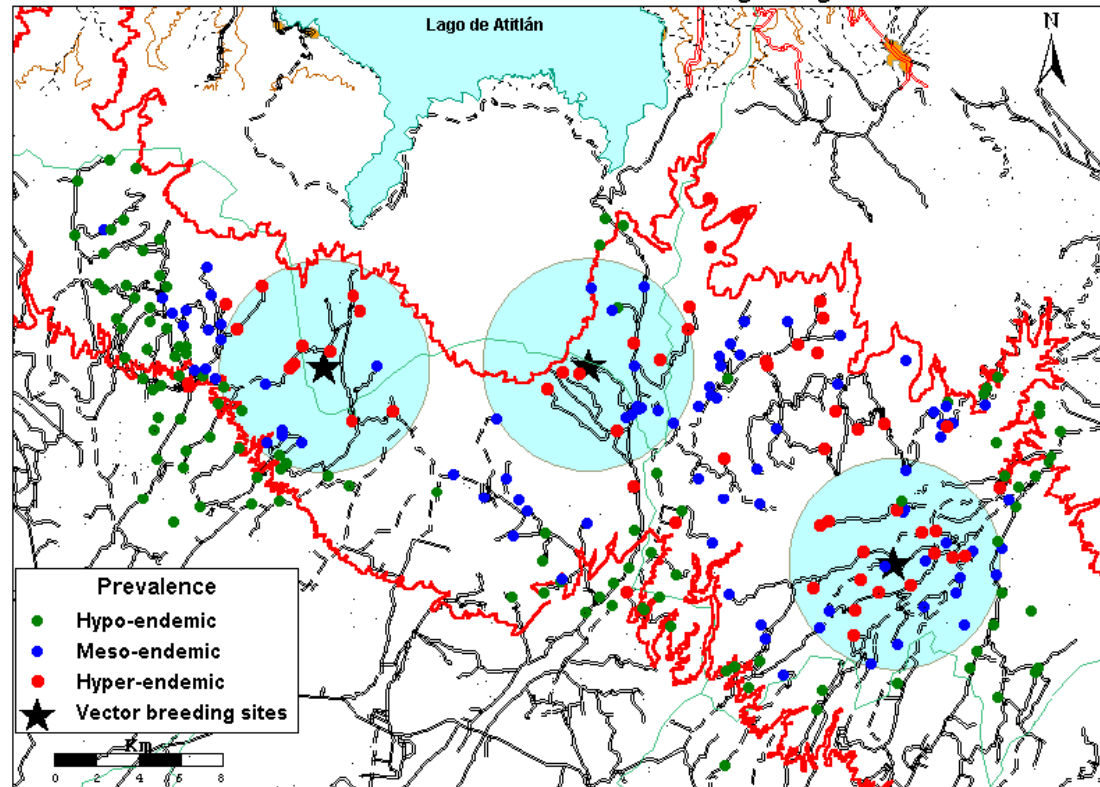
Agriculture

- How can I improve food production?



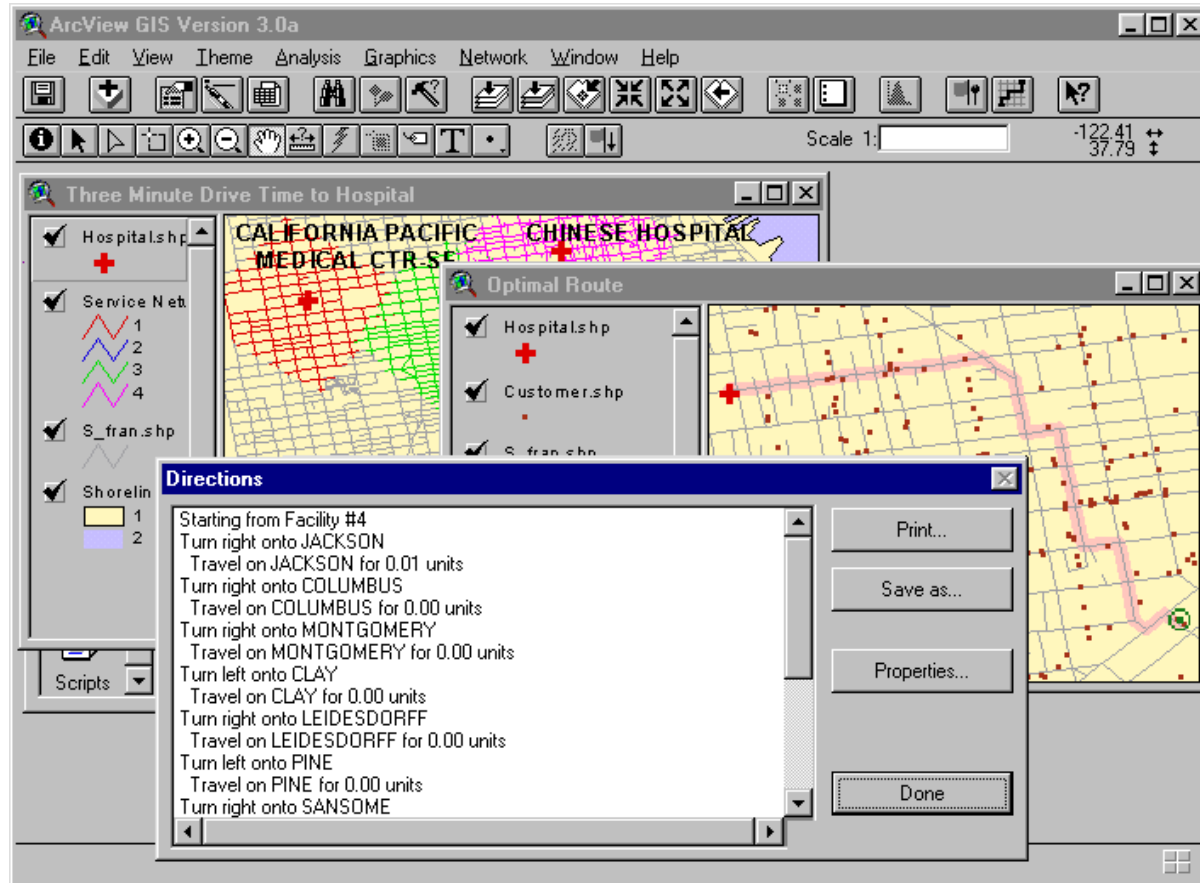
Health Care

Central focus of Guatemala: risk areas based on 5 km flight range of the vector



- What communities are at risk from disease?
- Where to provide service?

Emergency 911



- Which station should send fire trucks?
- What's the quickest route?

Property and Real Estate

The screenshot displays the ArcView GIS interface. The main map window, titled 'City Map', shows a street grid with property parcels colored by year built and zoning. The legend indicates that yellow parcels are built between 1900 and 1934, and are zoned C2. The 'Comparable' window shows the following data for a selected parcel:

Field	Value
Prop_cod	301
Stuct_code	301
Yr_built	1953
Full_stories	1
Gross_area	984
Area	726

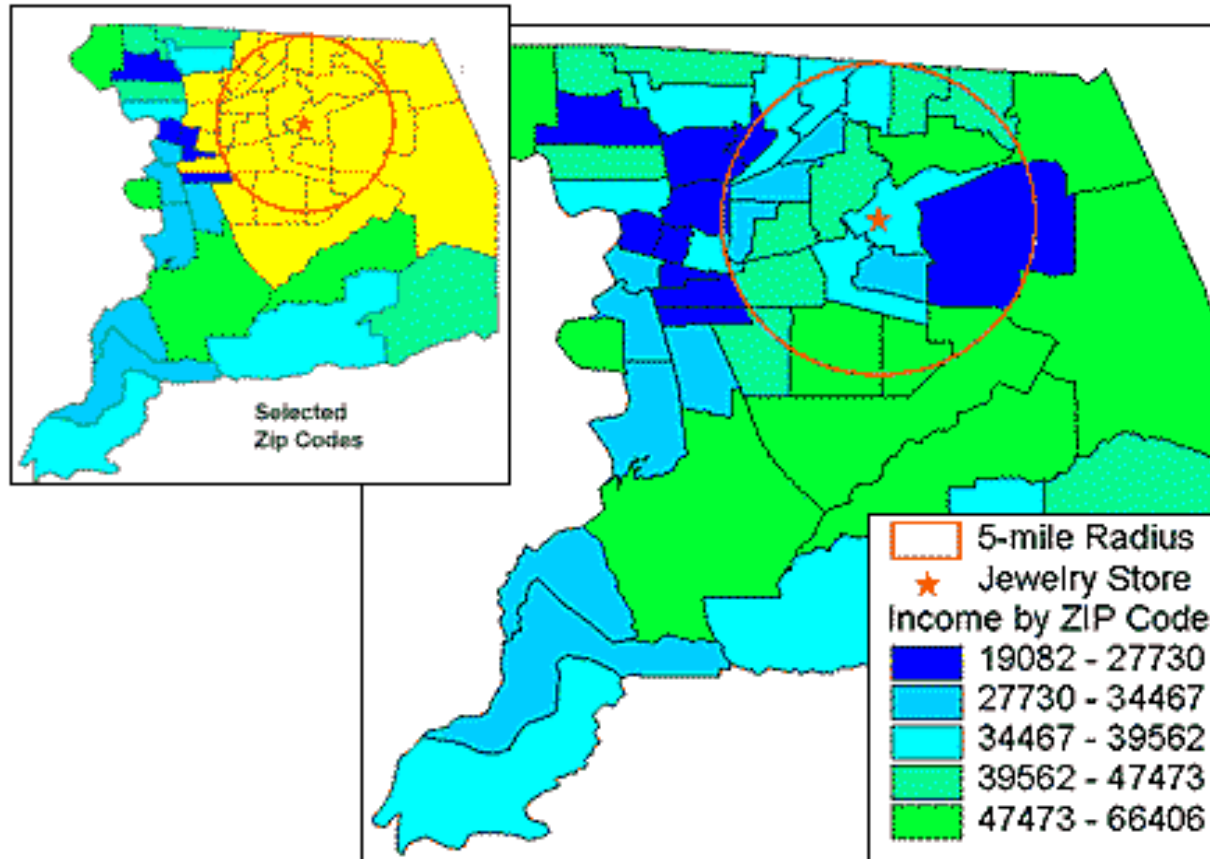
The 'Attributes of Zoning' window shows the following data for the selected parcel:

Prop_cod	Zoning	Zcode	Service
301	SR-3	SR-	A
311	SR-25	SR-	A
100	SR-342	SR-	A
301	SR-3	SR-	A
301	SR-3	SR-	A
311	SR-25	SR-	A
301	SR3	SR3	A
311	SR-25	SR-	A
301	SR-3	SR-	A
311	SR-25	SR-	A

Two image windows are open: 'image\2416hig.bmp' showing a large, multi-story house with a porch, and 'image\1r10080.bmp' showing a smaller house with a prominent white porch and stairs. Both image windows have a 'Scale Image' checkbox.

- Who owns what?
- Taxation?
- Where is my dream home?

Business Marketing



- How can I optimize my marketing campaign?

GIS4101 Intro to Vector GIS

- Course Overview
- Lecture – What is GIS

Questions?