CHAPTER 1 INTRODUCTION

Applications: Introduction

GIS

- A geographic information system (GIS) is a computer system for capturing, storing, querying, analyzing, and displaying geospatial data.

- geospatial technology is listed by the U.S. Department of Labor as one of the three emerging industries, along with nanotechnology and biotechnology.

http://www.careervoyages.gov/

Components of GIS

- Hardware
- Software
- People
- Infrastructure

Examples of GIS Applications

- The U.S. Geological Survey (USGS), a leading agency in the early development and promotion of GIS, provides nationwide geospatial data for applications in natural hazards, risk assessment, homeland security, and many other areas through its National Map program. http://nationalmap.usgs.gov
- The Incident Information System, an interagency system, catalogs wildland fire incidents and provide information on active fires. http://www.inciweb.org/
- The Bureau of Land Management maintains a publication website for the distribution of data on land parcels, minerals, and mining claims. http://www.geocommunicator.gov/GeoComm/index.shtm
- The National Weather Service offers weather data such as precipitation estimates, hydro-meteorological data, and radar imagery in GIS compatible format at its website http://www.weather.gov/gis/, and delivers tropical cyclone wind speed probabilities and historical track data through its Hurricane Center at http://www.nhc.noaa.gov/.

Examples of GIS Applications

- The U.S. Census Bureau maintains an On-Line Mapping Resources website, where Internet users can choose American Fact Finder or TIGER Map Server. http://www.census.gov/geo/www/maps/
- The U.S. Department of Housing and Urban Development has an online "map your community" service that lets users map housing development information with environmental data, flood hazards, census geographies, and other data. http://egis.hud.gov/egis/
- The National Institute of Justice uses GIS to map crime records and to analyze their spatial patterns by location and time. http://www.ojp.usdoj.gov/nij/maps/
- The U.S. Department of Health and Human Services warehouse provides access to information about health resources including community health. centers http://datawarehouse.hrsa.gov/
- The Federal Highway Administration offers census transportation planning package, national highway planning network, and other data resources for GIS in transportation. http://www.gis.fhwa.dot.gov/gisData.asp
- The National Geospatial Technology Extension Network promotes precision farming by linking GIS to site-specific farming activities such as applications of herbicides, pesticides, and fertilizers. http://www.csrees.usda.gov/nea/ag_systems/in_focus/precision_if_crop.html

Geospatial Data

Geospatial data are data describing both the locations and characteristics of spatial features such as roads, land parcels, and vegetation stands on the Earth's surface.
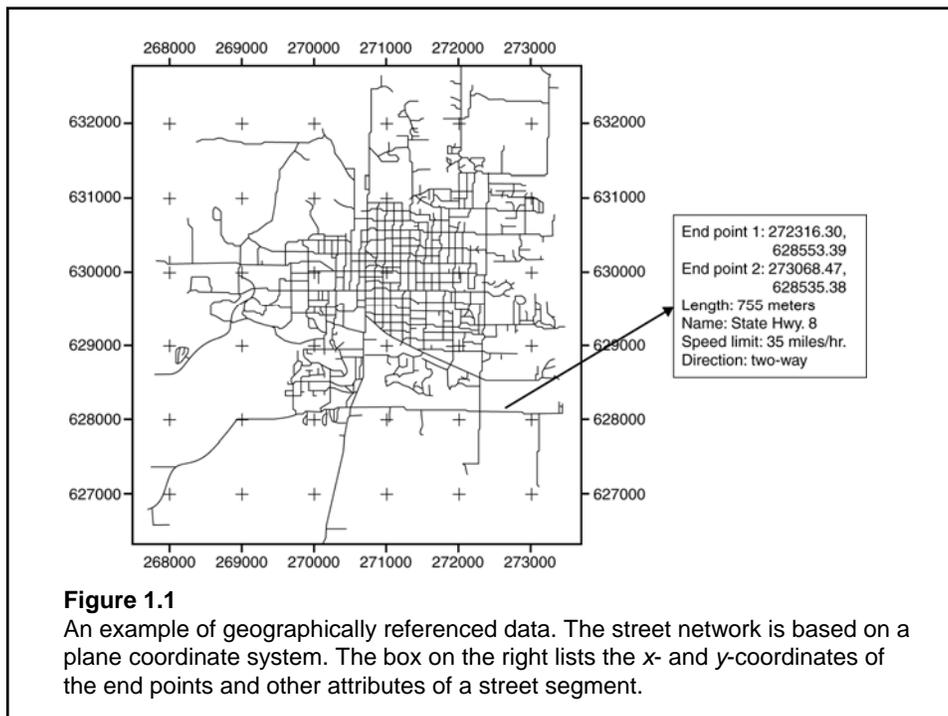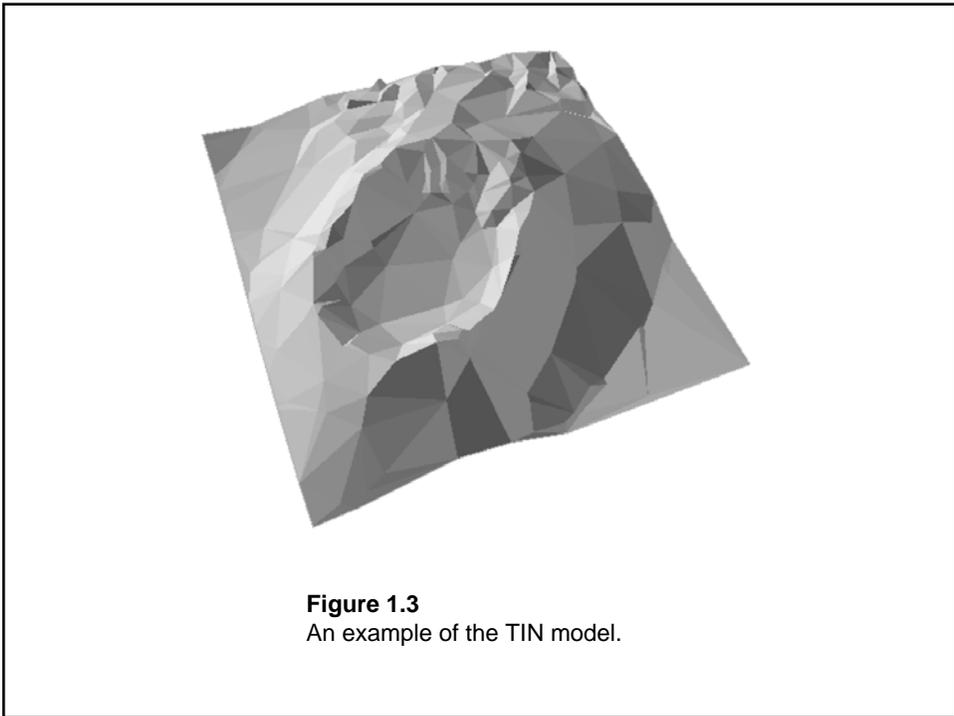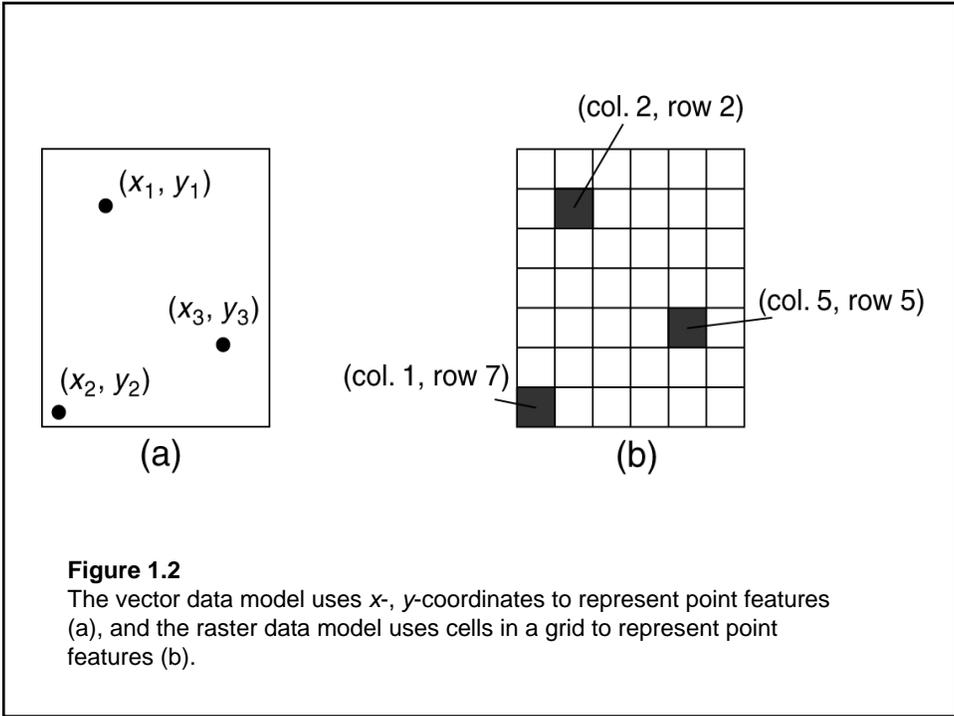
Figure 1.1
An example of geographically referenced data. The street network is based on a plane coordinate system. The box on the right lists the *x*- and *y*-coordinates of the end points and other attributes of a street segment.

Coordinate System

● Spatial features on the Earth's surface are referenced onto a geographic coordinate system in longitude and latitude values.

● When displayed on maps, spatial features are typically based on a projected coordinate system in x-, y-coordinates.

● Geographic and projected coordinate systems are connected by the process of *projection*, which transforms the Earth's spherical surface onto a plane surface.

● Thousands of geographic and projected coordinate systems are in use.

Vector Data Model

● The vector data model uses points and their x-, y-coordinates to represent discrete features with a clear spatial location and boundary, such as streams, land parcels, and vegetation stands.

● Depending on the data structure, a vector data model can be georelational or object-based, with or without topology, and simple or composite.
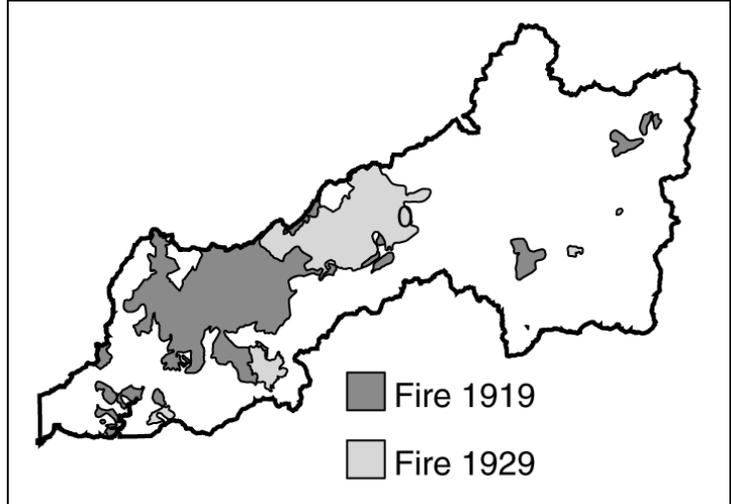
Figure 1.2
The vector data model uses x-, y-coordinates to represent point features (a), and the raster data model uses cells in a grid to represent point features (b).

Figure 1.3
An example of the TIN model.

Figure 1.4
The map shows two regions layers, one for burned areas in 1919 and the other for burned areas in 1929. Both layers consist of spatially disjoint polygons. Additionally, polygons on the 1929 layer overlap polygons on the 1919 layer.
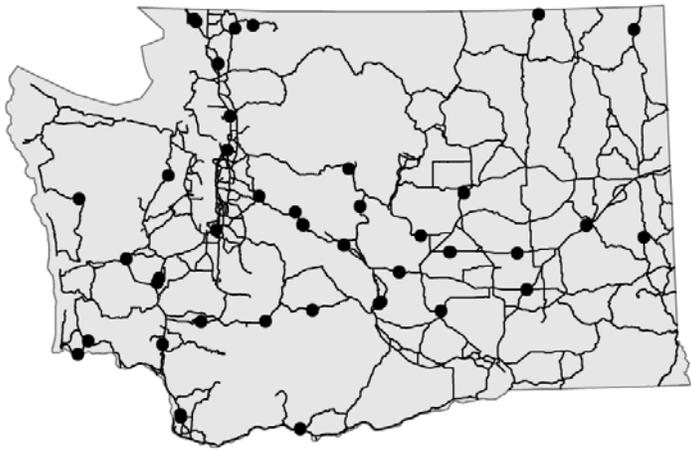

Figure 1.5
Dynamic segmentation allows rest areas, which are linearly referenced, to be plotted as point features on highway routes in Washington State.

GIS Operations

GIS activities can be grouped into spatial data input, attribute data management, data display, data exploration, data analysis, and GIS modeling.

Spatial data input	1. Data entry: use existing data, create new data 2. Data editing 3. Geometric transformation 4. Projection and reprojection
Attribute data management	1. Data entry and verification 2. Database management 3. Attribute data manipulation
Data display	1. Cartographic symbolization 2. Map design
Data exploration	1. Attribute data query 2. Spatial data query 3. Geographic visualization
Data analysis	1. Vector data analysis: buffering, overlay, distance measurement, spatial statistics, map manipulation 2. Raster data analysis: local, neighborhood, zonal, global, raster data manipulation 3. Terrain mapping and analysis 4. Viewshed and watershed 5. Spatial interpolation 6. Geocoding and dynamic segmentation 7. Path analysis and network applications
GIS modeling	1. Binary models 2. Index models 3. Regression models 4. Process models

Figure 1.6
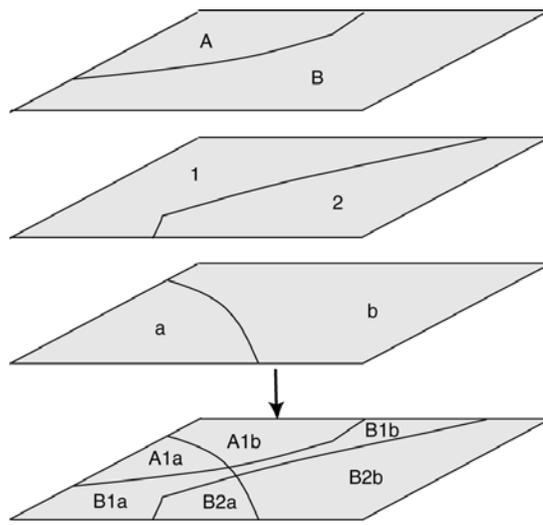A classification of GIS operations.

Figure 1.7
A vector-based overlay operation combines geometries and
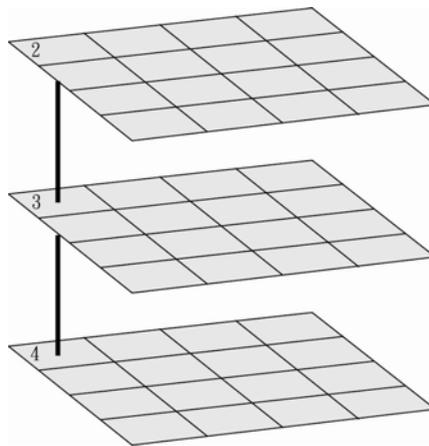attributes from different layers to create the output.

Figure 1.8
A raster data operation with multiple rasters can take advantage of
the fixed cell locations. For example, a local average can be easily
computed by dividing the sum of 2, 3, and 4 (9) by 3.

U.S. Department of Labor: emerging fields
http://www.careervoyages.gov/
National Geospatial Technology Extension Network
http://geospatialextension.org/
GIS Certificate Program
http://www.gisci.org/
Salary Survey of GIS Professionals
http://www.urisa.org/2007_salary_survey
Oracle
http://www.oracle.com/
IBM: Spatial DataBlade
http://www-306.ibm.com/software/data/informix/blades/spatial/
U.S. Geological Survey National Map
http://nationalmap.usgs.gov
Incident Information System
http://www.inciweb.org/
Bureau of Land Management
http://www.geocommunicator.gov/GeoComm/index.shtm
National Weather Service
http://www.weather.gov/gis/
Hurricane Center
http://www.nhc.noaa.gov/

U.S. Census Bureau On-Line Mapping Resources
http://www.census.gov/geo/www/maps/
U.S. Department of Housing and Urban Development
http://egis.hud.gov/egis/
National Institute of Justice: crime mapping
http://www.ojp.usdoj.gov/nij/maps/
U.S. Department of Health and Human Services
http://datawarehouse.hrsa.gov/
Federal Highway Administration
http://www.gis.fhwa.dot.gov/gisData.asp
Federal Emergency Management Agency: flood insurance rate map
http://www.fema.gov/plan/prevent/fhm/mm_main.shtm
Precision Farming
http://www.csrees.usda.gov/nea/ag_systems/in_focus/precision_if_crop.html
ESRI
http://www.esri.com/
ESRI Knowledge Base
http://support.esri.com/index.cfm?fa=knowledgeBase.gateway
Wikipedia
http://www.wikipedia.org/
Autodesk
http://www3.autodesk.com/
Baylor University: GRASS
http://grass.osgeo.org/

Bentley Systems, Inc: Microstation
http://www.bentley.com/
Cadcorp: Cadcorp SIS – Spatial Information System
http://www.cadcorp.com/
Caliper Corporation: TransCAD, Maptitude
http://www.caliper.com/
CARIS: CARIS system
http://www.caris.com/
Clark Labs: IDRISI
http://www.clarklabs.org/
Intergraph Corporation: MGE, GeoMedia
http://www.intergraph.com/
International Institute for Aerospace Survey and Earth Sciences,
the Netherlands: ILWIS
http://www.itc.nl/ilwis/
Land Management Information Center at Minnesota Planning: EPPL7
http://www.lmic.state.mn.us/EPPL7/
Manifold.net
http://www.manifold.net/

MapInfo Corporation
http://www.mapinfo.com/
Orbit: Orbit GIS
http://www.orbitgis.com/
PCI Geomatics: Geomatica
http://www.pcigeomatics.com/
SAGA User Group: SAGA GIS
http://www.saga-gis.uni-goettingen.de/html/index.php
Terrain International: Terraview
http://www.terralink.co.nz/
Google Maps Mania
http://www.googlemapsmania.blogspot.com/