geography

our global network
The Vector Model

- Vector data model evolved into the arc/node variation in the 1960s.
- Points in sequence build lines.
- Lines have a direction - nodes or ordering of the points.
- Lines in sequence build polygons.
Vector Model
Featuring Arcs and Nodes
## Vector Feature Types

<table>
<thead>
<tr>
<th>Feature Type</th>
<th>Single Part</th>
<th>Multi-Part</th>
</tr>
</thead>
<tbody>
<tr>
<td>Point</td>
<td><img src="image1" alt="Point Single Part" /></td>
<td><img src="image2" alt="Point Multi-Part" /></td>
</tr>
<tr>
<td>Line</td>
<td><img src="image3" alt="Line Single Part" /></td>
<td><img src="image4" alt="Line Multi-Part" /></td>
</tr>
<tr>
<td>Area</td>
<td><img src="image5" alt="Area Single Part" /></td>
<td><img src="image6" alt="Area Multi-Part" /></td>
</tr>
<tr>
<td>Annotation</td>
<td><img src="image7" alt="Annotation" /></td>
<td><img src="image8" alt="Annotation" /></td>
</tr>
</tbody>
</table>
Vectors and Topology

- Vectors without topology are *spaghetti* structures.
- Points, lines, and areas
  - stored in their own files, with links between them.
  - stored w/ topology (i.e. the connecting arcs and left and right polygons).
- Relationships are computed and stored
“Rasters are Faster, but Vectors are Correcter...”

- Vectors can represent point, line, and area features very accurately.
- Far more efficient than grids.
- Work well with pen and light-plotting devices and tablet digitizers.
- Not as good at continuous coverages or plotting that fill areas.
Rasters and Vectors

Vector-based line

Raster-based line

Flat File
4753456  623412
4753436  623424
4753462  623478
4753432  623482
4753405  623429
4753401  623508
4753462  623555
4753398  623634

Flat File
0000000000000000
0000000000001000
0011000010000000
1010100010100000
1101000010100000
0000100010001000
0000100010000100
0000100010000010
0000100010000001
0111001000000000
0000111000000000
0000000000000000

Now YOU!
Attribute data

- Attribute data are stored logically in flat files.
- i.e., matrix of numbers and values stored in rows and columns, like a spreadsheet.

<table>
<thead>
<tr>
<th>ID</th>
<th>Name</th>
<th>Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>White</td>
<td>1250</td>
</tr>
<tr>
<td>B</td>
<td>Blue</td>
<td>3245</td>
</tr>
<tr>
<td>C</td>
<td>Green</td>
<td>2111</td>
</tr>
<tr>
<td>D</td>
<td>Yellow</td>
<td>5435</td>
</tr>
</tbody>
</table>
GIS “Layers,” “Themes,” “Overlays”
Analysis or “Geoprocessing”
Definition 1: A GIS is a toolbox

“a powerful set of tools for storing and retrieving at will, transforming and displaying spatial data from the real world for a particular set of purposes” (Burrough, 1986, p. 6).
Definition 2:
A GIS is an Information System

“An information system applied to geographical data”

• a System
  – a group of connected entities and activities

• an Information System
  – a set of procedures, executed on raw data, to produce information for decision-making

• a Geographic Information System
  – an IS using geographically referenced data,
    – composed of primitive tuples <x,z> where x is a location in space-time and z is some general property, class, measurement, feature, person, structure…
Duecker’s 1979 definition has survived the test of time.

“A geographic information system is a special case of information systems where the database consists of observations on spatially distributed features, activities or events, which are definable in space as points, lines, or areas. A geographic information system manipulates data about these points, lines, and areas to retrieve data for ad hoc queries and analyses” (Duecker, 1979, p 106)
Definition 2:
The Feature Component
This notion divides a mapped landscape up into features, that can be points, lines, or areas.
Distinguishing Characteristics of GIS vs. Other Systems

• provides links between points, lines, areas, grids and their attributes in a database
• provides algorithms for analysis of spatial data
• "spatially intelligent" - "thinks" points, lines, areas, grids are actual spots on earth's surface - e.g., switching projections, computing distances

GIS GENERIC QUESTION: AREAL RELATIONSHIPS

MEASUREMENT

DISTANCE

PERIMETER

AREA/SIZE

Definition 3: GIS is an approach to science

Geographic Information Science is research both on and with GIS.

“the generic issues that surround the use of GIS technology, impede its successful implementation, or emerge from an understanding of its potential capabilities.” (Goodchild, 1992)
“GISci”

- **Geographic information science**
  - U.S., geography, UCGIS
  - to GIS as statistics is to the statistical packages
- The science behind the systems
- Fundamental issues arising from use
- The science that is done with the technology
- Systematic study of geographic information using scientific methods
A New Discipline?

• Symptoms of a science
  – journals, terms, books, conferences, departments, heroes, cultural artifacts
  – grand challenges

• What would we say to Albert Einstein or Stephen Hawking?
  – “As young man, my fondest dream was to become a geographer. However, while working in the customs office I thought deeply about the matter and concluded that it was far too difficult a subject. With some reluctance, I then turned to physics as a substitute.”
Contributing Disciplines

- Geography
- Remote Sensing
- Surveying
- Statistics
- Computer Science
- Information Science
- Cartography
- Photogrammetry
- Geodesy
- Operations research
- Mathematics
- Management science
Definition 4: GIS is a multi-Billion dollar business.

- ESRI’s 1996 sales were over $200 million, in a GIS software market of ~$591 million
- Ranked 34th among world’s top 50 software companies
- GIS industry now at $7 BILLION
• Based in Troy, NY
• Great for Macintosh users
• Mapping functions, not as much analysis
• Limited GIS functionality
• Uses Visual Basic ("MapBasic")
• Many applications ("mapplications")
• Ease of use
MapGrafix

- Mac users rejoice!
- www.comgrafx.com
Explore Manifold® System

Manifold is an entire new world for you to explore and use, providing a new system of unprecedented power and scale. This web site gives you point and click access to hundreds of pages of information to reveal all facets of the system. We've even put the complete User Manual on-line for your review. Searching for something specific? Check out the Manifold web site's Search Engine.

See the Release 4.50 Highlights Page for a quick introduction to our current product. You won't believe all you get for only $145! Comparing Manifold to some other GIS product? Don't miss the Windows Integration Sanity Test to see how alternatives compare to Manifold for use in Microsoft operating systems. Experienced GIS users may wish to see Manifold in Thumbnail Dialogs, which provides a thumbnail listing of main Manifold dialog. Click on a thumbnail to see the full dialog and be amazed at how much more Manifold does than ESRI or Mapinfo. Click the Solver Listing for a complete listing of all solvers provided with Manifold System. You'd have to spend thousands of dollars with competitors and still not get the capability shipped by default with Manifold. Using Mapinfo?

See the Manifold vs MapInfo summary that was written by a Mapinfo reseller. Also, see the Case Studies page for an overview of key benefits, and the Specifications page for accessory packages that work with Manifold.

What is Manifold? Manifold is much, much more than simply a cool new GIS or networking analysis package. Here it is in a nutshell.

Screen Shots We comprehend data best when it can be captured by visual metaphors, so we've provided this gallery of screen shots to pique your interest.

Case Studies Visit this page for step-by-step examples of using Manifold in real-life business applications. This is oriented for people who already have Manifold on their systems, but the examples provide many screen shots and a detailed sequence of "real life" use for everyone.

See the Release 4.50 Demographic Data page for complete information on the Thousands of data fields you get for US cities, states, counties, metro areas and hundreds of fields for world countries. Fresh data, too! Detail (left): Larger cities by educational attainment.

Specifications Compare this
ATLAS*GIS

- PC DOS & Windows
- Spreadsheet DBMS
- Simple functionality
- Menu-based
- Bought by ESRI
- Has draw software
- Award for value and ease of use
- Map Style Sheets
IDRISI

• Developed at Clark University, Worcester MA
• Most widely used raster GIS
• United Nations
• Windows/DOS
• Great spatial statistics
“The growth of GIS has been a marketing phenomenon of amazing breadth and depth and will remain so for many years to come. Clearly, GIS will integrate its way into our everyday life to such an extent that it will soon be impossible to imagine how we functioned before”
Review

- *Spatial* data are key (not just maps)
- Major GIS Concepts - raster vs. vector, analysis
- Definition 1 - Toolbox
- Definition 2 - Information System of Features
- Definition 3 - An Approach to Science
- Definition 4 - Big Bucks
Sources of Information on GIS

- Amount is overwhelming.
- Journals and magazines, books, professional societies...
- Web pages, network conference groups, professional organizations, and user groups...
- GIS courses are now offered at almost all levels.
Major GIS Journals/Mags.

- International Journal of Geographical Information Science
- Cartography and Geographic Information Science
- Geographical Systems
- Transactions in GIS
- Geo Info Systems
- GEOWorld (formerly GISWorld)
Specialty Journals

- Business Geographics
- GIS Law
- Mapping Awareness
- GrassClippings
- Arc User
- Intergraph News
- GIS Asia/Pacific
- GIS World Report/CANADA
- GIS Europe
Regular GIS Scholarly Papers

- Photogrammetric Engineering and Remote Sensing
- Annals of the Association of American Geographers
- Cartographica
- Computers, Environment, and Urban Systems
- Computers and Geosciences
- IEEE Transactions on Computer Graphics and Applications
Occasional GIS Scholarly Papers

- International Journal of Remote Sensing
- Landscape Ecology
- Cartographic Perspectives
- Cartographica
- Journal of Cartography
- Geocarto International
- IEEE Geosciences
- Remote Sensing Review
- Mapping Science and Remote Sensing
- Infoworld
Professional Organizations

- **AAG**: The Association of American Geographers.
- **GITA**: Geospatial Information & Technology Assoc. (formerly AM/FM)
- **URISA**: Urban and Regional Information Systems Association.
- **ACSM**: American Congress on Surveying and Mapping.
- **ASPRS**: American Society for Photogrammetry and Remote Sensing.
- **UCGIS**: University Consortium for Geographic Information Science
Willamette Valley GIS User Group

www.orurisa.org/wgisug/
Conferences

• **ESRI User Conference.** Every year in San Diego.
  – regional meetings as well

• **2002 Summer Internship** Program
  www.esri.com/company/jobs/intern.html
  – Applications due **March 3, 2003**

• **User Conference Student Asst.** Program
  www.esri.com/company/jobs/uc_student_prog.html
  – Applications due by **April 11, 2003**
Conferences (cont.)

GIS in Action - Oregon URISA
April TBD in Portland (no abstracts due)

NE Oregon GIS Conference
March 27 in Pendleton (abstracts due early March)

• ACSM. Held previously in Portland.
• AUTOCARTO International Symposium on Automated Cartography.
• Proceedings International Symposium on Spatial Data Handling. IGU Commission on GIS.
• SSD, Advances in spatial databases
geography
our global network