

GIS DEFINED

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DIGITAL MAP INFORMATION

- ✧ GIS contains map information stored in digital form
 - ✧ Map is one of GIS products
 - ✧ Data base created from many map types
- ✧ Map – created by selecting desired data and plotting/displaying them

NONGRAPHIC ATTRIBUTE DATA

- ✧ Descriptive information about features and phenomenon/incidents
 - ✧ Features – buildings, street pavement, etc.
 - ✧ Phenomenon – crime, election returns, etc.
- ✧ Logical structuring requires spatial reference (location attribute)
 - ✧ Ex: parcel no., address, etc.
 - ✧ Linked to geodetic reference system
- ✧ Topological relationships
 - ✧ Proximity, connectivity, adjacency, etc.

GIS TOOLS

- ✧ Automate service-delivery procedures
- ✧ Summarize data for managers
- ✧ Provide new technologies for analyzing data for
 - ✧ Management
 - ✧ Planning
 - ✧ Policy-setting

GIS TOOLS INCLUDE:

- ✗ Automated mapping technology – manipulating map information
- ✗ Data-base management – managing attribute data
- ✗ Land records information – deals with interests in land
- ✗ Topological data structures – defines spatial relationships
- ✗ Spatial analysis capabilities – retrieve, manipulate and display data

AUTOMATED MAPPING TECHNOLOGY

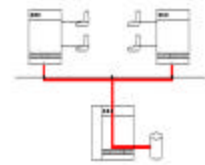
- ✗ Hardware/Software allows user to convert, maintain, and display digital map information

CENTRAL PROCESSING UNIT (CPU)

- ✗ Controls access to computer
- ✗ Monitors security
- ✗ Compiles programs
- ✗ Controls communication
- ✗ Performs system accounting and diagnostics
- ✗ Executes program commands

CENTRAL PROCESSING UNIT (CPU)

- ✗ CPU classification
 - ✗ Centralized – one host processor performing all processing functions
 - ✗ Distributed – several processors performing some of the work
- ✗ Contains
 - ✗ Arithmetic logic unit
 - ✗ Temporary storage areas
 - ✗ Control unit
- ✗ Computer works with 1s and 0s



CONVERTING FROM BASE 10 TO BINARY (BASE 2)

$$\begin{array}{r} 4386 \\ -1024 \\ \hline 3362 \\ -2048 \\ \hline 1314 \\ -1024 \\ \hline 290 \\ -256 \\ \hline 34 \\ -32 \\ \hline 2 \end{array}$$

$$\begin{array}{r} 17 \\ -16 \\ \hline 1 \\ -1 \\ \hline 0 \end{array}$$

2^{12}	2^{11}	2^{10}	2^9	2^8	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
4096	2048	1024	512	256	128	64	32	16	8	4	2	1
1	0	0	1	0	0	1	0	1	1	0	0	0

COMPUTER SYSTEMS

- ⌘ Main memory
 - ⌘ Called core memory or random access memory (RAM)
 - ⌘ Holds programs and data during computer operation
 - ⌘ More memory, more programs can be run at one time
- ⌘ Buses
 - ⌘ High speed data paths between computer components

AUXILIARY STORAGE DEVICES

- ⌘ Used to store large volumes of data
- ⌘ Categorized as off-line or direct access
- ⌘ Examples: tape drives, magnetic disks, CD-ROMS

TAPE DRIVES

- ⌘ Useful for archival storage and transport of large volumes of data
- ⌘ Used frequently to perform routine backups
- ⌘ Relatively low cost
- ⌘ Problem: data stored sequentially

CLASSES OF REEL-TO-REEL TAPE DRIVES

- ⚡ **Streaming method** – data written without physical gaps between files or records
 - ⚡ No directory structure
 - ⚡ Efficient and fast for routine backups
 - ⚡ Difficult to find where a particular data record exists
- ⚡ **Start/Stop method** – puts physical delineation between files
 - ⚡ Slower
 - ⚡ More efficient if particular record is to be retrieved

MAGNETIC DISK

- ⚡ Best combination of data access speed and capacity
- ⚡ Data stored by use of magnetized fields on disk surface
- ⚡ Electromagnetic head reads data
- ⚡ Data stored in tracks and sectors on rotating disk
- ⚡ Random access medium
- ⚡ Susceptible to: corruption by strong magnetic fields, and head crashes
 - ⚡ Collapse of read/write head on magnetic surface

OPTICAL DISK TECHNOLOGY



- ⚡ **WORM** – write once, read many
 - ⚡ Burn small impressions onto disk with lasers
 - ⚡ Layer creates patterns of pits and bubbles
 - ⚡ Represent stored data
 - ⚡ Highly reflective surface sandwiched between 2 plastic layers
 - ⚡ Low powered laser reads data – measures reflection of laser light beam off reflective surface
 - ⚡ High storage capability

OPTICAL DISK TECHNOLOGY

- ⚡ Erasable optical disk
 - ⚡ Two technologies used
 - ⚡ Magneto-optical
 - ⚡ Phase change
- ⚡ Digital versatile disk (DVD)
 - ⚡ Generally read-only devices

PERSONAL DIGITAL ASSISTANT (PDA)

- ✧ Portable computers
- ✧ User friendly interface
- ✧ Include applications like address and appointment books, web browser, et.
- ✧ Can be connected to regular computer directly or through wireless communications



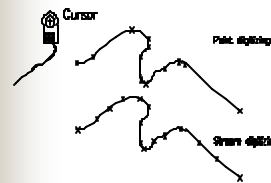
SURVEYING INSTRUMENTATION

- ✧ Total stations – measures angles/distances
 - ✧ Data downloaded onto computers
 - ✧ Use coordinate geometry and CAD
- ✧ GPS Receivers
 - ✧ Different accuracies == sub-meter receiver common in GIS data collection
 - ✧ Surveying – high accuracy but labor intensive and time consuming

PHOTOGRAMMETRIC WORKSTATIONS

- ✧ Mapping is labor intensive
- ✧ Still very economical
- ✧ Offers high degree of accuracy over line area
- ✧ Future: feature extraction, increased utilization of digital orthophotography, meter-level resolution from the satellites, hyperspectral imagery, etc.

DIGITIZING



- ✧ Point mode – each point digitized by operator
- ✧ Stream mode – operator starts digitizing line then follows it with the cursor
 - ✧ Digitizer automatically records points based on distance traveled or

SCANNERS

- ✗ Sense variation in reflected light
- ✗ Any marks which exceeds a given content threshold are encoded
- ✗ Result is raster data-set
- ✗ Raster often converted to vector form.

TYPES OF SCANNERS

- ✗ Flat-bed – document laid on table
 - ✗ Scanning head moves along x and y axes
 - ✗ Disadvantages
 - ✗ Takes up more space
 - ✗ Slower performance
 - ✗ Advantage: more accurate
- ✗ Drum scanner – document mounted on cylinder
 - ✗ Cylinder rotates while scan head moves horizontally across the cylinder
 - ✗ May slip
 - ✗ Factor with small error rate & occupies less space
- ✗ Line scanner
 - ✗ Operator places scanner on line and it automatically follows the line

SOFTWARE MAPPING FUNCTIONALITY

- ✗ Coordinate geometry – translate textual data to graphic data by means of keyboard input
- ✗ Edge-matching – adjusts features at edges of adjacent map sheets to fit them logically into continuous features across the map sheet boundaries
- ✗ Coordinate transformation – camera coordinates from one reference frame to another
- ✗ Zoom display – magnify a portion of a map
- ✗ Curve fitting – filtering or thinning

SOFTWARE MAPPING FUNCTIONALITY

- ✗ Area calculation – area of polygon easily measured
- ✗ Line-length calculator – length of line identified by user
- ✗ Scale conversion – change from one map scale to another
- ✗ Text placement – placement of letters/numbers where user wants
- ✗ Snapping – makes 2 lines meet mathematically
- ✗ Copy parallel – id one line and copy it as at a certain distance, creating 2 parallel lines

DATA BASE STRUCTURE

- ✦ Flat file – each record has same data fields with one designates as a “key”
- ✦ Hierarchical file – more than one type of record in data base utilizing a parent-child relationship
- ✦ Network file – provides a “many-to-many” relationship
- ✦ Relational data base – stored in 2-D arrays

FLAT FILES CHARACTERISTICS

- ✦ All records contain same data items
- ✦ Records ordered sequentially by a data item designated as a key
- ✦ Records accessed on key
 - ✦ Sequential search
 - ✦ Binary search
 - ✦ Reference to index
- ✦ All data times functionally dependent on key

FLAT FILES

Parcel Number	Parcel Address	Block	District	Tract	Owner #1 Name	Owner #1 Address	Owner #2 Name	Owner #2 Address	Value
008	501 N Sadowski St.	1	A	101	Sadowski, M.G.	501 N Sadowski St			105450
009	590 N Sadowski St.	2	B	101	Adams, Julie A.	590 N Sadowski St	Adams, M	590 N Sadowski St	89780
036	1001 W Adnan Rd	4	B	105	Sadowski, M.G.	501 N Sadowski St			101500
075	1175 W Dadez Dr	12	E	202	Kroeger, Ross	592 N Tierney Pl	Bertrand, K	1087 W Bertrand Dr	98000

FLAT FILE SEARCHES

- ✦ Sequential search
 - ✦ Files usually ordered sequentially by values in key field
 - ✦ Search on key is fast because once found the search ceases
 - ✦ Search other than key field requires re-sequencing the entire file or else read every record
- ✦ Binary search
 - ✦ Start in middle
 - ✦ Compares value in key with > or < condition
 - ✦ Eliminates ½ of file each time
 - ✦ Goes to middle of remainder
 - ✦ Process continues
 - ✦ Entire file must be re-sequenced if different field is used as key

FLAT FILE SEARCHES

- ✦ Indexed search
 - ✦ Separate table containing key of every record & address pointing to location of data record for each key
 - ✦ Index sequenced & search (usually binary) is used on index
 - ✦ Faster since size of table smaller than data file
 - ✦ New data can be added at end of file without need to re-sequence entire file

ADVANTAGES OF FLAT FILES

- ✦ Data retrieval fast when using the key to find a record
- ✦ Applications easy to program because file structure is simple

DISADVANTAGES OF FLAT FILES

- ✦ Multiple values of data item for given record
 - ✦ Difficult to process
 - ✦ Complex to program
- ✦ Substantial program modification required when
 - ✦ Adding new data items
 - ✦ Expanding the length of any data item
- ✦ Data retrieval on any data item other than key is cumbersome and slow

HIERARCHICAL DATA FILE CHARACTERISTICS

- ✦ Data items contained in more than one record type
- ✦ Each record associated with one higher-level record in a different file
- ✦ Pointers used to associate records of lower level with their higher-level record

ADVANTAGES OF HIERARCHICAL DATA FILES

- ✗ Multiple sets of like records allowed to be associated with record of different file
- ✗ Adding and deleting records easy
- ✗ Data retrieval fast if access is through the higher-level record

DISADVANTAGES OF HIERARCHICAL DATA FILES

- ✗ Access to data restricted to path established by pointers
 - ✗ Must first go through higher-level record
- ✗ Same data in lower level records must be repeated for every association they have with higher-level record
- ✗ Use of pointers can require large amounts of storage space in large data bases

NETWORK DATA MODEL CHARACTERISTICS

- ✗ Data items contained in more than one type of record
- ✗ Records can be associated with more than one record in other files
- ✗ Pointers used to associate related records of different files

ADVANTAGES OF NETWORK DATA MODELS

- ✗ Access to records in different files allowed in many different paths
- ✗ Like data items not repeated in multiple associations
- ✗ Changes in records of one file do not affect programs that use other files
- ✗ Pointers defining associations between records of different files automatically changed when records are added or deleted

DISADVANTAGES OF NETWORK DATA MODELS

- ✗ Expansion of use over time increases the complexity of associations and can cause system to be cumbersome and inflexible
- ✗ New associations difficult to establish because data must be restructured for new associations
- ✗ Complex networks with large data bases require extensive storage for pointers

RELATIONAL DATA MODEL CHARACTERISTICS

- ✗ Data items contained in different flat files called tables
- ✗ Each entry in a table is one data item
 - ✗ There are no repeating fields
- ✗ Tables can be related by values in columns that are common to the tables
- ✗ New applications developed by forming new relations between tables

ADVANTAGES OF RELATIONAL DATA MODEL

- ✗ Data easy to access by non-technical users
- ✗ New uses and unanticipated inquiries can be easy to implement
- ✗ Adding new records, new data items, and new relationships between records do not affect existing programs
- ✗ Physical data storage can change without affecting data or logical relationships between records

DISADVANTAGES OF RELATIONAL DATA MODEL

- ✗ New relations between large tables require substantial processing time
- ✗ Access to records in a table is sequential and can be slow
- ✗ How data is stored physically on disks has significant impact on processing time
- ✗ High degree of flexibility in relating records of different tables can allow logical mistakes to be made when user forms new relations on invalid combinations of data items