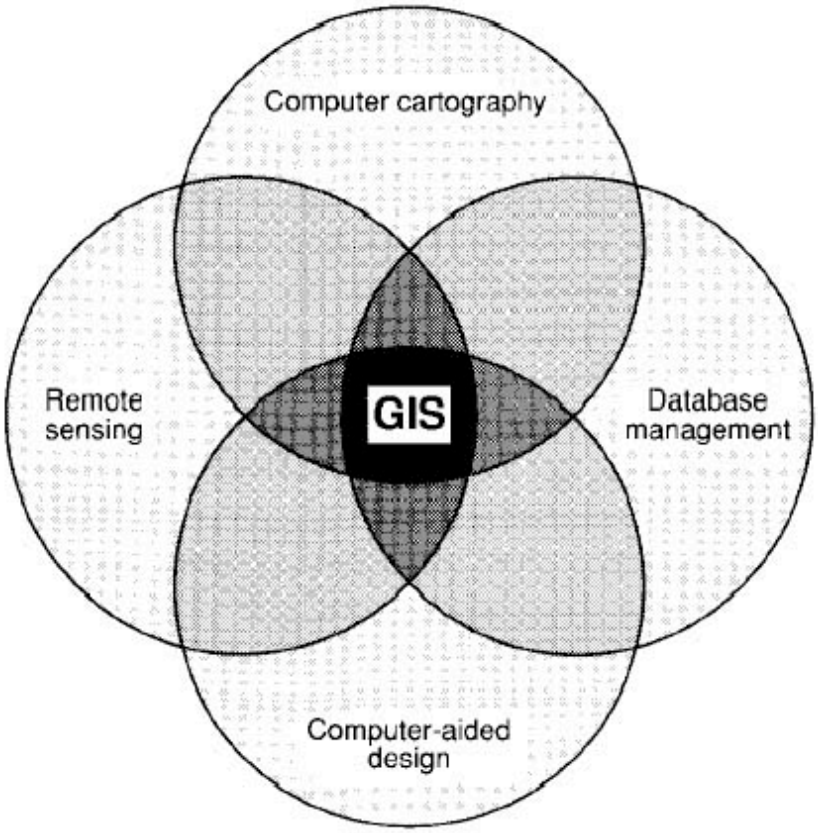
Basics of GIS

Geographic Information Systems (GIS)

"simultaneously the telescope, the microscope, the computer, and the xerox machine" of geography

- technology (computers, software, printers, networks)
- data (base maps, graphic elements, text and numerical attributes)
- people (developers, trainers, field workers, analysts)



GIS = data + pictures

- each geographic element is allocated one object on a picture (a point, line, or area)
- each geographic element is also allocated one record in a database (with textual and numeric information)
- each layer (or "theme") of the map is made up of a picture (many objects) plus a database (many records)

what can you do with GIS?

- store, duplicate, and exchange maps
- assemble and publish maps
- assemble and publish data visualizations (charts)
- query the data behind the map (sort, sum)
- query the picture of the map (distance, overlap)
- use the GIS as a clickable "front end" interface (web pages, pictures, movies)

Table 2.1 GIS applications in local government (simplified from O'Looney 2000)

	Inventory Applications (locating property information such as ownership and tax assessments by clicking on a map)	**Policy Analysis Applications (e.g. number of features per area, proximity to a feature or land use, correlation of demographic features with geological features)**	**Management/Policy-Making Applications (e.g. more efficient routing, modeling alternatives, forecasting future needs, work scheduling)**
Economic Development	Location of major businesses and their primary resource demands	Analysis of resource demand by potential local supplier	Informing businesses of availability of local suppliers
Transportation and Services Routing	Identification of sanitation truck routes, capacities and staffing by area; identification of landfill and recycling sites	Analysis of potential capacity strain given development in certain areas; analysis of accident patterns by type of site	Identification of ideal high-density development areas based on criteria such as established transportation capacity
Housing	Inventory of housing stock age, condition, status (public, private, rental, etc.), durability, and demographics	Analysis of public support for housing by geographic area, drive time from low-income areas to needed service facilities, etc.	Analysis of funding for housing rehabilitation, location of related public facilities; planning for capital investment in housing based on population growth projections
Infrastructure	Inventory of roads, sidewalks, bridges, utilities (locations, names, conditions, foundations, and most recent maintenance)	Analysis of infrastructure conditions by demographic variables such as income and population change	Analysis to schedule maintenance and expansion

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Health	Locations of persons with particular health problems	Spatial, time-series analysis of the spread of disease; effects of environmental conditions on disease	Analysis to pinpoint possible sources of disease
Tax Maps	Identification of ownership data by land plot	Analysis of tax revenues by land use within various distances from the city center	Projecting tax revenue changes attributable to land-use changes
Human Services	Inventory of neighborhoods with multiple social risk indicators; location of existing facilities and services designated to address these risks	Analysis of match between service facilities and human services needs, and capacities of nearby residents	Facility siting, public transportation routing, program planning and place-based social intervention
Law Enforcement	Inventory of location of police stations, crimes, arrests, convicted perpetrators and victims; plotting police beats and patrol car routing; alarm and security system locations	Analysis of police visibility and presence; officers in relation to density of criminal activity; victim profiles in relation to residential populations; police experience and beat duties	Reallocation of police resources and facilities to areas where they are likely to be most efficient and effective; creation of random routing maps to decrease predictability of police beats
Land-use Planning	Parcel inventory of zoning areas, floodplains, industrial parks, land uses, trees, green space, etc.	Analysis of percentage of land used in each category, density levels by neighborhoods, threats to residential amenities, proximity to locally unwanted land uses	Evaluation of land-use plan based on demographic characteristics of nearby population (e.g. will a smokestack industry be built upwind of a respiratory disease hospital?)

Table 2.1 (*Continued*)

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Parks and Recreation	Inventory of park holdings/ playscapes, trails by type, etc.	Analysis of neighborhood access to parks and recreation opportunities, age-related proximity to relevant playscapes	Modeling population growth projections and potential future recreational needs/playscape uses
Environmental Monitoring	Inventory of environmental hazards in relation to vital resources such as groundwater; layering of nonpoint pollution sources	Analysis of spread rates and cumulative pollution levels; analysis of potential years of life lost in a particular area due to environmental hazards	Modeling potential environmental harm to specific local areas; analysis of place-specific multilayered pollution abatement plans
Emergency Management	Location of key emergency exit routes, their traffic flow capacity and critical danger points (e.g. bridges likely to be destroyed by an earthquake)	Analysis of potential effects of emergencies of various magnitudes on exit routes, traffic flow, etc.	Modeling effect of placing emergency facilities and response capacities in particular locations
Citizen **Information/ Geodemographics**	Location of persons with specific demographic characteristics such as voting patterns, service usage and preferences, commuting routes, occupations	Analysis of voting characteristics of particular areas	Modeling effect of placing information kiosks at particular locations

"raster is faster, but vector is correcter"

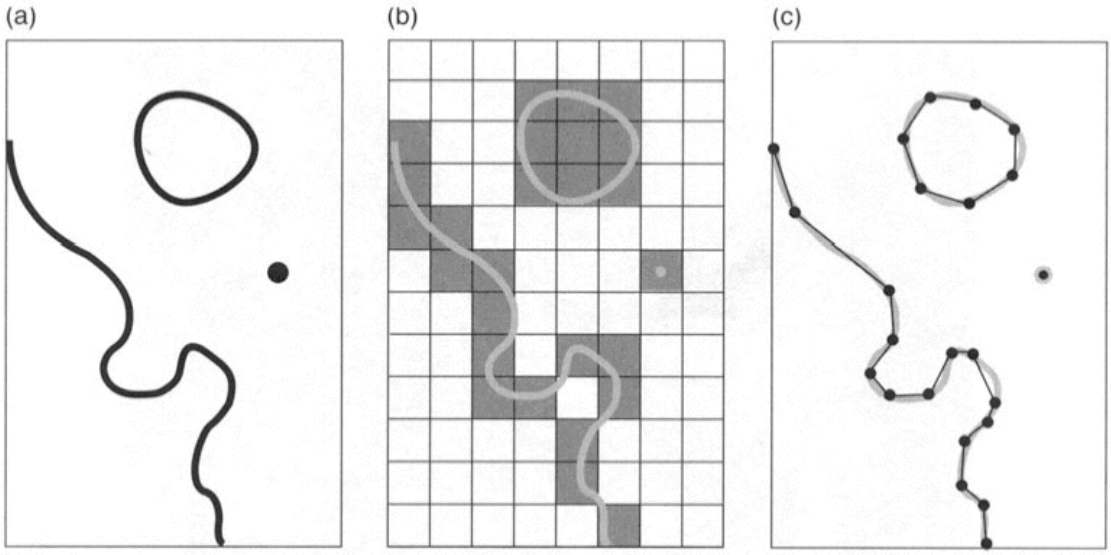

Figure 6.10 (a) Reality, modelled in (b) raster, and (c) vector form.

"georeferencing"
or
"geocoding"

- linking information about an object to a particular place on the earth's surface
- the most labor-intensive part of GIS data creation

Table 4.1. Some commonly used systems of georeferencing

System	Domain of uniqueness	Metric?	Example	Spatial resolution
Placename	varies	no	London, Ontario, Canada	varies by feature type
Postal address	global	no, but ordered along streets in most countries	909 West Campus Lane, Goleta, California, USA	size of one mailbox
Postal code	country	no	93117 (US ZIP code); WC1E 6BT (UK Unit Postcode)	area occupied by a defined number of mailboxes
Telephone calling area	country	no	805	varies
Cadastral system	local authority	no	Parcel 01452954, City of Springfield, MA, USA	area occupied by a single parcel of land
Public Land Survey System	Western USA only, unique to Prime Meridian	yes	Sec 5, Township 6E, Range 4N	defined by level of subdivision
Latitude/ longitude	global	yes	119 degrees 45 minutes West, 34 degrees 40 minutes North	infinitely fine
Universal Transverse Mercator	zones six degrees of longitude wide, and N or S hemisphere	yes	563146E, 4356732N	infinitely fine
State Plane Coordinates	USA only, unique to state and to zone within state	yes	55086.34E, 75210.76N	infinitely fine

geographic data can get very, very big

Table 1.1. Potential GIS database volumes for some typical applications (volumes estimated to the nearest order of magnitude). Strictly, bytes are counted in powers of 2 – 1 kilobyte is 1024 bytes, not 1000

1 megabyte	1,000,000	Single dataset in a small project database
1 gigabyte	1,000,000,000	Entire street network of a large city or small country
1 terabyte	1,000,000,000,000	Elevation of entire Earth surface recorded at 30 m intervals
1 petabyte	1,000,000,000,000,000	Satellite image of entire Earth surface at 1 m resolution

libraries discover GIS

- Long history of both map librarianship and government documents librarianship
- 1990: *Government Information Quarterly* special issue on GIS
- 1992: Association of Research Libraries (ARL) GIS Literacy Project began, providing participating libraries with ArcView software, datasets, and training opportunities.
- 1995: *Journal of Academic Librarianship* first special issue GIS and academic libraries

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- 1996: Special University of Illinois volume
  Linda C. Smith and Myke Gluck, eds., *Geographic Information Systems and Libraries*.
- 1997: *Journal of Academic Librarianship* second special issue GIS and academic libraries
- 2000: Non-research libraries begin to consider offering GIS
- 2001: After 9/11, much publicly-available spatial data is restricted