A GLOSSARY OF GIS TERMINOLOGY

A comprehensive alphabetical listing of technical terms and their common meanings and an alphabetical list of acronyms related to geographic information systems (GIS) and related technologies, with an introduction and listing of source documents and references.

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I. Introduction.

Geographic Information Systems (GIS) are a relatively new and dynamic technology (or more properly suite of interrelated technologies). Since this whole field is undergoing rapid growth and change, the associated terminology is in a constant state of flux. The appearance of new GIS-related concepts and functions produces new terms and altered meanings for existing terms whose definitions are frequently in dispute. This situation creates an environment of uncertainty and confusion for users and potential users and represents an impediment to the adoption and dissemination of GIS. This troubling situation is compounded by several factors.

Firstly, much GIS terminology is the result of the development of functionalities by software vendors. For example, a *coverage* in the ARC/INFO GIS from ESRI is roughly equivalent to a *level* in the MGE GIS from Intergraph and may be referred to as a *layer* in another system. The fact that these terms may not be exactly (mathematically) equivalent in terms of the functional characteristics and manner in which they are generated complicates discourse. For trade purposes, vendors may choose to coin their own name for a given GIS function or capability. The user of only one GIS system will be confused when confronted with a new set of terms, some synonymous, when exposed to another GIS system.

Secondly, the computer science field is notorious for the development of a highly abbreviated and unique jargon which can be intimidating to the uninitiated. For example, the following quotation is fairly typical of the language employed in GIS documentation provided by vendors: "The SUBMIT command submits a plot request to a server node from an NQS client (host) node by constructing a NQS QPR command line and sending it to the pipe queue specified in IPARM". Every aspect of each GIS system will have its own set of terminology. For example, the operating system (e.g., DOS, UNIX, VMS) will have a host of commands and special terms, plotting and printing involve many terms some specific to the output device, and the field of database management systems involves numerous terms, concepts, and software-specific commands.

Thirdly, GIS draws on many disciplines which have their own lexicons. Not only will the GIS user have to learn at least a modicum of the language of remote sensing or cartography, but he or she must become familiar with the terms and special meanings given to those terms in GIS. For example, the term *resolution* may not mean the same thing to someone talking about spatial data and someone taking about color graphics monitors. A user with a specialized background in forestry, hydraulic engineering, surveying, tax assessment, environmental assessment, or urban planning will have to learn the appropriate GIS terms relevant to their needs while others involved in a GIS project will have to learn the specialized terminology of one or more specific applications.

Furthermore, their are a host of terms either unique to GIS or having a very special connotation in GIS. For instance the terms *object*, *entity*, *attribute*, *polygon*, or *buffering* have meanings in ordinary discourse that are very different from their GIS-specific meanings. Even for terms specific to GIS, the problem of developing an accepted definition of GIS terms is confounded by disagreement among the experts in the field. To use an example, the term *Spatial Decision Support System(s)* (SDSS) implies the concept of a computer based technology designed to solve poorly structured problems involving a spatial aspect; however, this is a necessary and not a sufficient definition. Typically, the term *SDSS* also implies a system which incorporates a fully functional GIS, specialized modeling functions, a link to a sophisticated data base management system, and a user interface. However one of the authors (Leipnik) has attended meetings where several internationally recognized experts in SDSS disagree on what constitutes a Spatial Decision Support System (Need it have artificial intelligence or expert system features? Need the current decision making modalities be incorporated in the product? Does the database need to be relational? Does the user interface need to be customized and fully graphical? Do the models need to run inside the GIS or can the GIS serve as a pre- and/or postprocessor for a separate model?). A similar litany of questions would confront someone trying to develop a rigorous and all encompassing definition for GIS itself. For example, does a GIS need to store the topology of graphical objects? What analytical functions must a GIS have? How must attribute data be stored? What differentiates GIS from LIS or from AM/FM?

The authors recognize that in such an environment one cannot hope to develop a glossary that defines all possible GIS related terms exactly as all users would construe them. However, the authors have consulted with a number of other GIS experts and relied on numerous commonly used sources in developing this glossary. In particular the authors have relied on the following sources:

- GIS World, Inc (1990) *The 1990 GIS Sourcebook*, GIS World, Inc., Fort Collins CO.
- Burrough, P.A. (1986) *Principles of Geographical Information Systems for Land Resources Assessment*, Clarendon Press, Oxford.
- Ripple, W.J., ed. (1987) *GIS for Resource Management, a Compendium*, American Society for Photogrammetry and Remote Sensing, Falls Church VA.

This glossary of GIS was prepared with the encouragement of Dr. Walter Greyman, Chairman of the GIS Task Force of the Water Resources Planning and Management Division, American Society of Civil Engineers. Originally it was a

compilation of the independent efforts of Leipnik and Padmanabhan to prepare a glossary of GIS terminology as a task of the ASCE GIS Task Force and for possible publication as an ASCE article. Leipnik's glossary originated as an appendix to an article on GIS published by the Academy of Sciences of the Commonwealth of Independent States; the glossary was included in the expectation that Russian readers would be even more mystified by GIS terminology than American or Western European readers. However, discussions with many GIS users, particularly those associated with water resources management, indicated that widespread confusion existed in this country as well. When Leipnik's and Padmanabhan's glossaries were combined and expanded to include relevant terminology from computer science, cartography, remote sensing, database management, and other facets of GIS, the glossary proved too long for inclusion in the ASCE special issue devoted to GIS. Dr. Michael Goodchild, Director of NCGIA, was generous enough to offer the good offices of the NCGIA as a sponsor for publication of this glossary and list of acronyms and a special introduction was prepared.

Questions or comments pertaining to this document can be addressed to either Padmanabhan or Leipnik. In particular, the authors are eager to solicit new terms and expanded definitions. However, the authors feel strongly that a glossary (as imperfect as any such document must be) is a valuable tool. This is particularly true for the recent user of GIS. Moreover, the availability of such a glossary will help break down the barriers associated with dissemination of this powerful technology by helping GIS users understand technical discourse and by encouraging the development of consensus over terminology across the boundaries which currently divide many new and future GIS
users, so that GIS can fulfil its promise of becoming a unifying rather that a dividing technology.

The intent of the glossary is to provide a useful resource to GIS practitioners, but it should not be seen as an effort at standardization. The definitions given in the glossary reflect the meanings of terms in current practice. Standardization of terminology must be much more proactive than reactive, and grounded not in practice but in good theory. The recently adopted Federal Information Processing Standard (FIPS) 173, also known as the Spatial Data Transfer Standard, includes standardized definitions for many terms. This glossary must not be seen as competing with or undermining that important effort at standardization of GIS terminology in any way.

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GLOSSARY

A/UX - A UNIX system variant developed by Apple for use on Macintosh computers and workstations.

Absolute accuracy - A measure of the difference between the location of an object as specified in a GIS, and its true location in the real world.

Acceptance test - A test for evaluating a newly purchased system's performance and conformity to specifications.

Access path - A description of the hierarchical chain of directories that define the logical location of a file.

Access time - A measure of the time interval between the instant that the data are called from storage and the instant that delivery is complete.

Accuracy - Degree of conformity with a standard, or the degree of correctness attained in a measurement. Accuracy relates to the quality of a result and is distinguished from precision, which relates to the quality of the operation by which the result is obtained.

Adaptive sampling - A data sampling technique that uses accumulated knowledge from samples already taken to direct future sampling. For example, redundant sample points may be rejected during the sampling process on the grounds that they carry too little extra information.

Additive color - Colors seen by the human eye that are created by mixing different colors of visible radiation (light) are produced in an additive manner. Colors on a display screen and colors projected onto a white screen are examples of additive color. When all wavelengths, or colors, of visible light are mixed, white light is produced. A prism separates white light into the spectrum of colors which compose it. Mixing complementary colors can also produce white light. Absence of radiation or relatively low radiation at all wavelengths of human visual sensitivity yields black. A predominance of radiation in a particular range of wavelengths yields a color whose intensity is proportional to the level of radiation. (See also *Subtractive color*)

Address - 1) A number referring to a location in computer memory, 2) A name that identifies a location on a computer network so that other machines can communicate with it.

Address geocoding - Process of assigning alphanumeric locational identifiers (such as the municipal address or physical location) to spatially related information. For example, an address may be matched to an address range on a street segment, or a given spatial area (i.e., the limits of a polygon, a line segment, a point along the segment, or an absolute point that has been coordinated). The process implies a geographic base file which can be used to pass addresses in order to find out characteristics about the geometry.

Addressability - The number of pixels in the x and y axes on a screen.

Addressable point - A position on a visual display unit that can be specified by absolute coordinates.

Addressable space - The memory size of a display board. This area may be the same as or larger than the viewable area shown on the display screen, depending on the display board.

Adobe - A software company, developer of the Postscript language and interpreter. (See *PostScript*)

Aerial photograph - A photograph taken vertically downward from the air. Aerial photograph images may be in the form of paper prints, often 9" x 9", or transparent film.

AGIS - A GIS marketed by Delta Data Systems, Inc. It has both raster and vector data acquisition and attribution capabilities in a single operating environment. The user can link dBASE III to its relational database.

Airslide - A 35mm slide taken vertically downward from the air.

Airvideo image - An image acquired vertically downward from the air with a color, monochrome, or color-infrared video camera and recorder.

Airvideography - Making measurements from digitized frames of vertical airvideo images.

AIX - A UNIX system variant developed by IBM for use on IBM minicomputers and workstations.

Albedo - The ratio of the light reflected by a planet or a satellite to that received by it. This definition can be generalized to any object, such as a part of the Earth's surface or atmosphere, a leaf, a soil element, etc.

Aliasing - The appearance of jagged lines on a raster display.

Alpha-test/Alpha version - A preliminary version of software, evaluated for bugs by its developer and selected external evaluators.

Alphanumeric - Consisting of both letters and numbers, and possibly including other symbols such as punctuation marks.

AM/FM - **A**utomated **M**apping/**F**acilities **M**anagement. The use of a computer-aided mapping or geographic information system for public works and utility information management and similar applications. Software specifically developed for AM/FM generally lacks spatial analysis and COGO functions.

Analog - Information stored and processed with signal intensity or other measurement of a continuous physical variable. Analog information processing has the advantage of being able to translate and represent slight increments in data easily. Analog information (video, audio, or field and laboratory measurements of temperature, pressure, voltage, radiation, etc.) can be converted to its digital equivalent. (See also *Digital*, *Digitizer*).

Analog/Digital conversion - The process of converting data from analog to machine usable digital format via processes such as digitizing or scanning.

Anti-aliasing - Anti-aliasing removes or greatly smoothes the jagged, stair-step appearance of a digital line by filling in some of the intermediate and flanking cells in lower-intensity colors. (See also *Aliasing*)

Application program/package - A set of computer programs designed for a specific task.

Arc - A portion of the perimeter of a two-dimensional closed figure lying between two nodes at which two or more arcs intersect. An arc usually represents a continuous common boundary between two adjoining mapping units.

Arc data - Data representing the location of linear entities or the borders of polygon entities.

ARC/INFO - A vector-based GIS developed and marketed by ESRI, Inc.

Archival storage - Magnetic or optical media used to store programs and data outside the normal addressable memory units of the computer.

Arcsecond - The sixtieth part of a minute of angular measure often represented by the " symbol, as in 30", which is read "30 seconds". (See also *Minute*)

Area - A level of spatial measurement referring to a two-dimensional defined space. A polygon on the earth as projected onto a horizontal plane is an example of an area.

Argument - A component, such as a filename, that is part of a command line. The shell interprets arguments for commands to see if the syntax is correct before executing the command.

ARIES - An image processing and analysis package developed by DIPIX Technologies. Its features include advanced display and image processing for image analyses.

Arithmetic operator - In a GIS, operations performed on attributes of objects or entire maps, such as add, subtract, multiply, and divide.

ARPANET - A network created by DARPA that connects approximately 150 sites at universities and corporations doing research for the U.S. government. The ARPANET uses the TCP/IP protocol suite. It is part of the Internet. (See also *DARPA*, *TCP/IP*, *Internet*)

Array - A data structure that treats contiguous element in the form of a grid or matrix as a series of addressable repeating patterns. Each element in an array is referenced by an index which gives the location of the element in relation to other elements.

Array processor - A computer designed to operate simultaneously, or in *parallel*, on many elements of an array.

ASCII - **A**merican **S**tandard **C**ode for **I**nformation **I**nterchange (pronounced "askee"). The 256 characters that comprise a computer's alphabet. The character set encoded into digital values between 0 and 127 includes the lowercase and uppercase letters, the numerals 0-9, punctuation marks, special symbols (such as @#$%^&*), and non-displaying characters often used as printer control codes. Values from 128 to 255 are not standardized, and are not part of the basic ASCII code. However, most PCs use a common *extended* ASCII character set for values from 128 to 255. (See also *ASCII file*)

ASCII file - A text-only file. Documents in most word processors are not text-only files, since they include coded header information and formatting characters. However, most word processors import ASCII files and have an Export, Save/Text-only, or print-to-file utility that converts a document into an ASCII format. (See also *ASCII*)

Aspect - A parameter that is associated with a feature of a topographic or other three dimensional surface that tells which direction the surface slopes. Aspect is the compass direction (usually from North) for the of the line of steepest slope at some selected point.

Aspect ratio - The ratio of horizontal scale to vertical scale for printing or display. For graphics and image processing, square cells/pixels are best (aspect 1:1). Some display devices have a non-square aspect, which causes images to appear stretched or distorted. Standard broadcast video has an aspect ratio of 4:3, which must be corrected in any framegrabbing or other digitization process.

Assembler - A computer program that converts programmer-written instructions into computer-executable (binary) instructions.

Assembly language - A low-level (primitive) programming language that uses mnemonics rather than English-like statements.

Associated data - See *Attribute*.

Association - A variety of relationships among two or more entities.

ATLAS GIS - A GIS marketed by Strategic Mapping. It is a PC-based, non-topological vector GIS, and has interfaces to dBASE III or compatible databases.

Attribute - An attribute is a set or collection of data that describe the characteristics of real world entities or conditions. Attribute data are usually alphanumeric. Small amounts of attribute data are frequently used to describe the graphic representation of an entity on a map as a label, e.g., a polygon label. Large amounts of attribute data are usually maintained as separate attribute data sets, related to a map by names or codes.

Attribute query - A process to select data items from a file system based on the values of specific attributes or combination thereof, defined by arithmetic, relational, and logical expressions.

Audit table - In a GIS, a table of information describing a map's subjects, items, perimeters and areas.

AutoCAD - A commercial Computer Aided Design (CAD) software package, developed and distributed by Autodesk, Inc.

Autocarto - Congresses dedicated to computer-assisted cartography and geographic information systems, particularly those sponsored by the American Cartographic Association.

Autocorrelation - Statistical concepts expressing the degree to which one value of an attribute covaries with other values of the same attribute. Particularly in the spatial case, the degree to which the values of an attribute of two objects covary with the distance

separating them. Mathematical autocorrelation techniques can be applied to overlapping image segments in processes such as mosaicking and raster-to-raster registration. For example, autocorrelation can automatically find the best seam between adjacent overlapping image segments.

AUTOEXEC.BAT - A special DOS batch file in the root directory of the boot drive that contains a list of commands that DOS executes automatically at startup.

Automated cartography - The process of drawing maps with the aid of computer driven display devices such as plotters and graphics screens. The term does not imply any information processing.

Automated Mapping/Facilities Management (AM/FM) - See *AM/FM*.

Auxiliary storage - Addressable memory devices outside the main memory of the computer such as disks and tape units.

AVHRR imagery - **A**dvanced **V**ery **H**igh **R**esolution **R**adiometer imagery produced by NOAA satellites.

AVIRIS imagery - **A**irborne **V**isible/**I**nfra**R**ed **I**maging **S**pectrometer imagery. Multispectral images of approximately 240 coregistered spectral bands collected by NASA aircraft.

Azimuth - Particularly for a class of map projections, the angle defined by the intersection of a map's central line of projection with any meridian. If a map projection uses a central line that is oriented to true north, such as a standard meridian, the azimuth is zero.

Azimuthal projections - A class of map projections on which the directions of all lines radiating from a central point are the same as the directions of the corresponding lines on the sphere. Azimuthal projections are formed onto a plane which is usually tangent to the globe at a pole (a *polar projection*), at a point on the equator, or at any selected intermediate point. Most azimuthal maps do not have standard parallels or standard meridians. Each map has only one standard point--the center. Thus, the azimuthals are suitable for minimizing distortion in a somewhat circular region, such as Antarctica, but not for an area with predominant length in one direction.

B-Spline - The sums of other splines that by definition have the value of zero outside the interval of interest, therefore, allow local fitting from low-order polynomials in a simple way. B-Splines are often used for smoothing digitized lines to display, such as the boundaries on soil and geological maps, where cartographic conventions expect smooth, flowing lines.

B/W photo, B/W image, or B/W display (or B&W) - A black and white photograph or some other monochrome image rendered in black, white, and shades of gray.

Background processing/mode - Tasks such as printing are given a lower priority by the computer than those requiring direct user interaction.

Backup - Making a copy of a file or whole disk for safe keeping in case the original is lost or damaged.

Band or spectral band - A range of wavelengths of electromagnetic radiation. Remote sensing devices commonly collect images in discrete bands, such as visible red, green, and blue, and the invisible near-infrared.

Bandwidth - For monitors, bandwidth refers to the highest signal frequency a monitor's circuit can display. The higher the bandwidth, the higher resolution and the sharper the image will be.

Barriers - Static or dynamic factors such as physical features, time, season, speed, direction and accumulation, which must be considered when performing distance analyses.

Base data - Basic level of map data on which other information is placed for purposes of comparison or geographical correlation.

Base map - Mapped data that seldom changes and is used repeatedly.

BASIC - **B**eginner's **A**ll-purpose **S**ymbolic **I**nstruction **C**ode. A simple high-level programming language.

Batch (DOS) - A DOS batch file is a text file with the extension .BAT that contains one DOS command on each line. When the name of the batch file is entered at the DOS prompt, the system performs each command in turn.

Batch processing - The collection of programs in a queue for later processing, perhaps with priorities assigned according to estimates of the processing time required.

Baud rate - The number of signal elements sent over a communications line in one second.

Bearing - The horizontal angle of a line of direction, measured in the quadrant of the line as degrees east or west of the meridian of reference. Northeast, for example, has a bearing of 45 degrees east of north, whereas southwest has a bearing of 45 degrees west of south.

Bearing between points - To calculate the bearing with respect to true north from a given point to another point.

Benchmark test - A series of tests for ensuring that hardware and/or software meets user needs.

Best Linear Unbiased Estimate - The product from an interpolation function, which was optimized with chosen interpolation weights, of the value of a variable at a given point.

Beta-test/Beta version - A preliminary version of software before the official release. Most of bugs were fixed through Alpha test, but still not completely. Usually sent to selected suite, which is larger than Alpha testing sites, for final evaluation. (See also *Alpha test*)

Bezier curve - A polynomial curve bounded by four points, which form a *bounding box*. Manipulating the position of the bounding points lets a user stretch and position a smooth curved line in the design of a graphic shape.

Bicubic spline - See *B-Spline*.

Bilinear interpolation - A mathematical method for interpolating a new cell's value within a 2 x 2 neighborhood of cells. Bilinear interpolation is used in resampling a raster object to create a new raster object with a different cell size, orientation, or internal geometry. (See also *Interpolation*)

Binary - A base 2 number system that uses only the data values 0 and 1. Each place represents a power of 2, so, for example, the decimal number 13 is represented in base 2 as 1101 (= 1x8 + 1x4 +0x2 + 1x1).

Binary arithmetic - The mathematics of calculating in powers of two.

Binary coded decimal - The expression of each digit of a decimal number in terms of a set of bits.

Binary data model - Among relational data models, the binary data model is that each binary relation represents a single atomic fact: a correspondence between a key and nonkey attribute, where the key consists of only one attribute.

Binary file - A file containing characters that are in machine-readable form.

Binary raster object - A raster object whose cells contain only the values 0 or 1. Binary raster objects can contain a scan of black lines on white paper, the results of thresholding a byte-oriented raster object into two data ranges, a threshold of a particular color range, or a data mask.

Bit - Abbreviation for **bi**nary digi**t**. A single value of either 1 or 0. A contraction of the two words *Binary* and *digit*. The smallest unit of computer data. Computers normally manipulate bits at least 8 at time. A group of 8 bits is called a *byte*. A computer's processing power is often measured by the number of bits it handles at once. The earliest PCs were 8-bit machines. More recently processors and data structures for 16-bit, 24-bit and 32-bit data have become common.

Bit plane - A part of a data structure of superimposed grids of cells having the values 0 or 1.

Bitmap - An image stored as a pattern of dots (or *pels*).

Bitmapped font - A text font in which the individual characters are defined by the positions of pixels in a reference grid. Bitmapped fonts process quickly, but when they are enlarged, they lose the illusion of smooth edges and look blocky. (See also *Vector/scalable font*).

Bits per pixel or pixel depth - The number of data bits each pixel represents. In 8-bit contexts, the pixel depth is 8, and each display pixel can be one of 256 possible colors or shades of gray. With a 24-bit raster (or with three coregistered 8-bit rasters) the pixel depth is 24, and 16,777,216 colors are possible.

Block - 1) A group of bytes treated as one unit of information during input/output operations, sometimes called a physical record. Disk and tape devices are called *block devices*, meaning that they read and write blocks of data at one time, 2) (CAD) A block is a grouping of CAD elements and attributes that can be manipulated as a whole. All CAD objects contain at least one block, the Main Block. When a block (such as the detail for a door frame) is used many times in a drawing, the block description is stored once, and each location point refers to that source.

Block transfers - A high-speed data transfer technique between disk files and computer memory that bypasses the CPU. It can reduce the number of physical disk reads or writes required by an operation.

Board or interface board - An electronic circuit board installed in a microcomputer to add hardware features. (See also *Display board*).

Boolean operations - Logical combinations of data, involving union, intersection, complement and exclusion.

Boot - The process of starting up a microcomputer and initializing its operating system environment. DOS microcomputers follow an automatic boot sequence every time they are turned on. A DOS microcomputer can be rebooted by holding down the <Ctrl> and <Alt> keys and pressing <Del>.

Boot drive (PC) - The DOS device (commonly hard drive C) that contains the system and configuration definition files required at startup. The microcomputer automatically looks in the root directory of the boot drive to load DOS from COMMAND.COM and two hidden DOS files; to configure the system hardware from CONFIG.SYS; and to execute a sequence of startup commands from AUTOEXEC.BAT.

Bound variable - In tuple relational calculus, an occurrence of a variable in a formula is bound if that variable has been introduced by a *for all* or *there exists* quantifier.

Boxcar classification or boxcar interpretation - The simplest form of automated image interpretation whereby three data ranges are selected for three coregistered images (like red, green, and blue). The three data ranges define a three-dimensional cube, or boxcar shape if plotted on three perpendicular axes that represent possible data values in red, green, and blue. The ranges are usually selected to represent the color variation in the three rasters for a feature of interest (like all the dark brown areas representing baresoil).

BPI - **B**its **P**er **I**nch. The density of bits recorded on a magnetic tape: 800, 1600 and 6500 are common standards.

Bridge - A hardware/software device that permits high-speed communication between two local or remote networks with similar or dissimilar protocols. Contrast with Gateway. (See *Gateway*).

Brightness - The physical property indicating how much electromagnetic radiation is being reflected or radiated by a chosen point. Brightness can be computed from LANDSAT MSS or TM images by Kauth's greenness, brightness, wetness transformations. (See also *Kauth's greenness, brightness, wetness transformations*)

Browsing - To search the database to answer simple locational queries, including pan and zoom.

BSD - **B**erkeley **S**oftware **D**istribution. A series of UNIX System implementations developed at the University of California, Berkeley. Features of 4.2 BSD are included in UNIX System V Release 4 (UNIX SVR4).

Buffer - A portion of computer memory set aside for quick temporary storage. A buffer is commonly used to store data on its way to or from a hardware device such as a disk drive. The buffer lets the computer save up access operations and not be slowed down by

waiting on the hardware to respond at every step.

Buffer zone - A border area that acts as a barrier separating or surrounding an area designated for special protection. Some states have legislated buffer zones around certain wetlands to prevent damage to the local ecosystem.

Bug - An error in a computer program or in a piece of electronics that causes it to function improperly.

Building nodes - Creating and/or adding nodes in a vector object from imported coordinate data (like text files that contain pairs of coordinates, or database files with fields representing pairs of coordinates).

Built-in-functions - A set of commands available in the systems to perform some limited arithmetic and statistical functions such as average, standard deviation, etc.

Bulk memory - An electronic device such as disk or tape that allows the storage of large amount of data.

Bus - The circuit channel or path a computer uses to move data and send signals between devices. A microcomputer's bus architecture determines what kinds of peripheral circuit cards can be plugged into its expansion slots. DOS and OS/2 computers have four varieties of bus architecture - PC, AT (also called ISA), EISA, and MicroChannel. The original PC bus handles 8-bit data. The AT bus doubled the data width to 16-bits and became the industry standard (thus ISA, for Industry Standard Architecture). IBM introduced the PS/2 with a proprietary bus, the 32-bit MicroChannel. Other vendors countered with a 32-bit Extended ISA (the EISA). The PC/ISA/EISA buses are backward compatible--that is, expansion cards designed for an older bus will normally work in a newer bus slot. Thus, an 8-bit display board from a PC bus works in a 16-bit ISA slot or a 32-bit EISA slot, but a 16-bit display board for an ISA bus does not work in an 8-bit PC.

Byte - A data element made up of 8 bits and having 256 possible values. In text-oriented processes, each byte represents one character of text. In 8-bit raster processes, each byte represents one cell value and may correspond to one grayscale pixel on the image display.

Byte-oriented or 8-bit raster object - A raster in which each cell is represented by one byte (8 bits) and can therefore assume 256 possible values.

C - A widely used, general-purpose programming language, developed by Dennis Ritchie of Bell Laboratories in the late 1960s. C is the primary programming language used to develop applications in UNIX system environments.

C++ - An enhanced, object-oriented version of the C language, developed by Bjarne Stroustrup of Bell Laboratories.

CAD - **C**omputer **A**ided **D**rafting/**D**esign/**D**rawing. CAD originated on larger, dedicated workstations and minicomputers and has now migrated to microcomputers. In its simplest sense, CAD is used for computerized drafting. Many CAD systems also provide more advanced features like solid modeling and simulation. CAD generally lacks topology of objects and direct links to an attribute database, which are essential features in GIS modeling and analysis operations.

CAD object - A CAD object describes coordinate data. A CAD object has a free-form topology, so it may be useful for applications that do not require an exact description of the relationships between the elements in the object. CAD object topology does not reconcile things like line intersections, polygon overlapping, and polygon islands.

CAD/CAM/CAE - **C**omputer **A**ided **D**esign/**C**omputer **A**ided **M**anufacturing/**C**omputer **A**ided **E**ngineering. Differs from a GIS in that the system can only create displays. It cannot analyze or process the base data.

Cadastral layer - A set of information depicting the pattern of land ownership rights in an area. The layer is typically based on legal descriptions tied to elements of the geodetic control network available in an area.

Cadastral Mapping - A mapping endeavor with ownership and value being the primary concerns. Principal usage is for tax analysis.

CADkey - A popular commercial microcomputer Computer Aided Design (CAD) software package from CADkey, Inc. It has vector data structure.

Calculate - Particularly in GIS, the ability to perform the following operations: **arithmetic -** to perform arithmetic, algebraic and Boolean calculations separately and in combination; **bearings between points** - calculate bearing (with respect to true north) from a given point to another point; **slopes of areas** - given a digital elevation model and the boundary of a specified region (a part of a watershed), calculate the average slope of the region; **vertical distance or height** - in a digital elevation model, calculate the vertical distance (height) between two points; **volume** - compute the volume under a digital representation of a surface.

Calibrate - Particularly geographic calibration, to bring a raster or vector object into alignment with some geographic coordinate system. Geographic calibration may be established when creating an object (like extracting an image map from a LANDSAT or SPOT satellite image). Calibration can be added to an existing object either by entering control points or by associating it with some calibrated object (like overlaying a calibrated vector to calibrate a raster).

Calibrated image map (also image map) - An image that has been processed to be like a map in appearance, scale, geometry, boundary, and projection with a degree of precision that satisfies the user. Measurements made from an image map yield results equal to those made from the corresponding planimetric, topographic, or other map. Similarly, either the image map or the conventional map can be overlaid and matched with the other. For example, a 7.5' image map prepared in a GIS from LANDSAT or SPOT satellite images can accurately match the corresponding USGS topographic map. Similarly, the color scan of a topographic map that has been assembled by tiling and calibrated to map coordinates is an image map.

Calibration - The process of determining certain specific measurements for comparison with a standard.

Capture - To freeze and digitize a standard video input signal (such as VHS tape or broadcast video). Some microcomputer display boards offer video capture. (See also *Frame-grabbing*).

Cardinal direction - The four principal directions: North, South, East and West.

Cartesian coordinates - A coordinate system in which the locations of points in space are expressed by reference to three perpendicular axes, called the *coordinate axes* (x,y,z).

Cartogram - A map projection with areas or distances distorted, according to a transforming variable, to communicate by relative distance or size such concepts as travel time or population size.

Cartographic model - A flow diagram depicting a process of combining and analyzing multiple layers of mapped information to create a new synthesized map.

Cartography - The art or science of making maps.

Cartridge - or Erasable Optical (EO) cartridge - A two-sided removable storage unit that typically holds between 300 and 500 megabytes per side. Data on EO cartridges can be erased so the cartridge can be updated or re-used.

Cartridge font - A font contained in a cartridge that physically plugs into the printer. Font cartridges are often used by laser printers such as those in the HP LaserJet family, but some dot-matrix printers also use font cartridges.

Cascade - A way of arranging open windows on the screen so that they overlap each other, with the title bar of each window remaining visible.

Cascading menu - A menu that opens from a command on another menu. A command that opens a cascading menu has a right arrow next to it.

Categorical data - In GIS, data represented by a discontinuous or stepped surface, since intermediate terms cannot be derived with meaningful results. Example 1 - soil type data cannot be interpolated, since soil types 14 and 15 cannot sensibly be averaged to derive a soil type 14.5. Example 2 - feature classification data cannot be interpolated, since a cell assigned membership in the feature *corn* cannot sensibly be used in any process that averages it with a cell assigned membership in the feature *wheat.* Do not confuse the terms *categorical data* and *category*--they have different and distinct meanings.

Category - In the context of feature mapping, a subdivision within a segment that allows a site to be divided geographically. For example, if a segment has been defined as the wetland duck habitat along a river floodplain, one might want to divide the wetlands

into categories--perhaps ownership areas (like refuge lands, private ownership, and easement areas). Do not confuse the terms *categorical data* and *category*--they have different and distinct meanings.

CD ROM - **C**ompact **D**isk, **R**ead-**O**nly **M**emory. A 5" optical disk containing prerecorded data sets that may be read and used as DOS files.

Cell - One value in a raster that corresponds to a specific area on the ground. A raster cell may contain a value that describes the elevation above sea level at one position in a survey site or the intensity of red radiation for a pixel in a video image. For convenience, a raster cell is usually thought of as square or rectangular, although many image collection devices actually measure circular or elliptical areas.

Cell size - The dimensions of the area on the ground to which a raster cell value applies. A cell size of 30 meters signifies that the value in each cell of the raster object applies to a 30 x 30 meter area in the study site.

Central meridian - The north-south meridian of a map projection around which the map is centered.

Centroid - The point that may be considered as the center of a one- or two-dimensional figure, the sum of the displacements of all points in the figure from such a point being zero.

Centroid calculation and sequential numbering - Calculate a contained, representative point in a polygon and assign a unique number to the new object.

CGA - **C**olor **G**raphics **A**dapter. An early microcomputer graphics subsystem developed for the IBM PC. The CGA was hampered by low resolution and limited color selection. It has been largely superseded by the EGA and the newer VGA. (See also *EGA*, *VGA*)

Chain - A sequence of coordinates defining a complex line or boundary.

Chain coding - A method of reducing the storage requirements of a raster.

Change image - An image produced using raster algebra that shows change over time between coregistered images (multitemporal image processing). For example, subtracting the old raster object from the new raster object could show the difference between early-season crop development and mid-season development; or between pond surface area from year to year.

Channel - (GPS) A channel of a GPS receiver consists of the circuitry necessary to tune the signal from a GPS satellite.

Character - A letter, symbol or digit; usually a byte.

Check box - A small, square box that appears in a selection dialog box and that can be selected or cleared. When the check box is selected, an X appears in the box. A check box represents an option that the user can turn on or off.

Chip - 1) Commonly, any integrated circuit logic component of a computer. The two broadest categories of chips are memory chips and processor chips. Most DOS microcomputers use main processor chips developed by Intel Corporation (the 8088, 8086, 80286, 80386, 80486 series). 2) (GPS) The transition time for individual bits in the pseudo-random sequence.

Choropleth map - A map with areas colored or shaded so that the darkness or lightness of an area symbol is proportional to the density of the mapped phenomenon. More generally known as a map of uniform values separated by abrupt boundaries, that is, adjacent areas are not necessarily close in value.

CIR image - **C**olor-**I**nfrared **I**mage. Color-infrared images may be collected by an electronic scanner or a camera that uses special film with sensitivity from green through infrared. The photographic infrared radiation just beyond the range of human vision is then displayed as red. Normal red from the scene becomes green, and green becomes blue. Normal blue in the scene is filtered out and not recorded. CIR images are used to show the vigor of plant life. Healthy vegetation appears red, while distressed or damaged vegetation may look pink, tan, or yellow. (See also *Color-infrared image*)

Class (raster) - A set of all image features of the same type. As part of the interpretive process, the user names a class to identify the type of material it contains, like *corn*, *bare soil*, *wetland*, or *urban*.

Class (vector) - One of the possible attributes that may be assigned to a vector element, like *intermittent stream* or *highway*. Element classes can be assigned directly or taken from a selected field in an associated database object.

Class - (Object-oriented programming) A collection of objects which have similar characteristics.

Class list - A subobject containing a list of classes associated with a vector object.

Classification - Grouping cells (often by spectral characteristics) from one, or more characteristically, from a set of coregistered raster objects to isolate and name image features (crop varieties, wetlands, forest, or other surface cover).

Clipboard - In image processing, a temporary storage location used to transfer data between windows and between applications. Typically, the user transfers data to the clipboard by using an application's *copy* command, and inserts data from the clipboard by using the application's *paste* command.

Close - To remove a window or dialog box, or quit an application.

Clump - A set of contiguous line, node, and polygon elements in a vector object.

Cluster analysis - Reduction of the complexity of the data set by assigning objects to classes in a classification system. Because these clusters are derived from an analysis of the original data, they would represent *natural* groupings that should be more representative of reality than exogenous, hierarchical classes imposed from without.

Cluster labeling - Identifying and grouping the clusters in the cluster map raster object that results from any kind of automated image interpretation.

Cluster map - The output raster object created by clustering or by unsupervised classification. The clusters are usually identified or labeled as some useful type of material (e.g. an agricultural crop, a body tissue type, a soil type, etc.). It is important to note that this raster contains categorical data--its values cannot be subjected to further mathematical analysis because the clusters and their re-identification as material or area types do not represent data values that are mathematically continuous. For example, cells in a cluster arbitrarily assigned the value of 4 (belonging to cluster number 4) by the clustering process do not thereby represent twice as much of something as a cell assigned to cluster 2.

Clustering - A process in which multiple, spatially coincident, coregistered raster objects are reduced to a single raster object, called a cluster map. The input rasters contain analytical data (such as spectral images and elevations). In general, each clustering method compares the values in corresponding cells to all other cell values, and assigns the output cell to the group (or cluster) it most resembles.

CMY or Cyan-Magenta-Yellow - The standard set of subtractive, processing colors used in printing. Color printing devices use discrete dots of cyan, magenta and yellow (and black) to present the appearance of a full-color image to the human eye.

Code - A set of specific symbols and rules for representing data and programs so that they can be understood by the computer.

COGO - **Co**ordinate **Geo**metry. The set of mathematical tools and functions for encoding and converting bearings, distances, angles, etc. into coordinate information. This operation is normally done on an alphanumeric screen into which data is entered and the geometry is determined analytically.

Cold start - Re-boot a DOS microcomputer by turning off and turning on again.

Color balancing - Adjusting the intensities and distribution of red, green, and blue to create an image with a particular color appearance for display or printing.

Color composite - In satellite imagery, a color negative, transparency or print produced by allowing the reflectance recorded for each band of a multispectral image to be represented by a proportionate intensity of one of the primary colors.

Color depth or pixel depth - The number of data bits each pixel represents. In 8-bit contexts, the pixel depth is 8, and each display pixel can be one of 256 possible colors or shades of gray. With a 24-bit raster (or with three coregistered 8-bit rasters) the pixel depth

is 24, and 16,777,216 colors are possible.

Color display - A CRT capable of displaying maps and results in color.

Color scheme - A predefined combination of colors that an GIS uses for its screen elements. Also, refers to the graduation of color for the GIS output display. (See also *Color table* or *Color map*)

Color separation - Manipulating a full-color image in order to extract features of one color or range of colors. The color separation process can be used to create a binary raster object from a composite color raster object (or a set of three RGB raster objects) to lift out blue line images, for example, leaving behind background colors and lines images of other colors. Printers use related color separation techniques to prepare process color separates from full-color originals.

Color table or color map - A table of values that a computer system can use to look up and assign display colors to the digital values stored in the display refresh memory of a display board.

Color-infrared (also CIR) - Color-infrared images may be collected by an electronic scanner or a camera that uses special film which is sensitive to spectral bands from green through infrared. The photographic infrared radiation just beyond the range of human vision is displayed as red. Normal red from the scene becomes green, and green becomes blue. Normal blue in the scene is filtered out and not recorded. Any physical or biological damage to growing plants which begins to cause a deterioration in their vigor (their water and/or chlorophyll content) causes a rapid decrease in their reflectance of photo-infrared radiation, and increases in their red reflectance. CIR photographs show these changes much sooner and more dramatically than normal photographs or human eyesight. Healthy, green vegetation appears in bright red, while damaged, diseased, or dying vegetation appears in shades of pink, tan, and yellow. This knowledge was first used during the Second World War when color-infrared film was called camouflage detection film. It provided pre-visual detection of the changes in vegetation that was cut or damaged by military activity and it could very easily separate color-camouflage materials (like olive drab canvas) from live foliage.

Column - A vertical list of data values or display cells in a raster object or display. (See also *Row*)

Command - An instruction sent from the keyboard or other control device to execute a computer program.

Command interpreter - A program that evaluates and executes the user input. The *shell* is a command interpreter.

Command language - Instructions controlling the activity of a computer system; consisting of imperative words or phrases with modifying phrases; normally entered via the operator's console and acted upon immediately.

Command line - The commands the user types to run an application or invoke an action. Usually typed in at the prompt.

Compiled map - A map based on information used primarily in the preparation of other maps. Most small-scale maps of large areas are compiled maps.

Compiler - A program for translating instructions written in a high-level computer language into machine instructions.

Complex correlation - The ability to compare maps representing different time periods, extracting differences or computing indices of change. Multitemporal analysis function.

Complex generalization - Generalization that may require change in the type of an object or relocation in response to cartographic rules.

Composite color raster object - (8-bit data and device contexts) A raster object in which each cell contains a data value representing one of the 256 colors. Composite color rasters are usually compressed from a red/green/blue raster set that retains a wider range of color information. The composite raster still produces near photographic quality color displays. (see also *Pseudo-color image*).

Composite color video - The standard color video output of a VCR or video camera that adheres to the NTSC video standard. All the color information is contained in one composite signal (instead of in three separate RGB color signals).

Composite map - A single map created by joining together several separately digitized or scanned maps.

Compression - A method of reducing file size for storage. Image file contents are often compressed using a run-length coding algorithm.

Computer architecture - The design of a computer system's memory, peripherals, central processor, and especially the circuitry for control, logic, storage and retrieval.

Computer graphics or Computer graphic systems - Systems that are concerned with the display and manipulation of visual material. They do not pay much attention to the non-graphic attributes that the visual entities might or might not have, and which might be useful data analysis.

Computer-aided mapping system - A system that focuses on map design, creation, and maintenance.

Computing environment - The total range of hardware and software facilities provided by a given make of host computer and its operating system.

Conditional map element - A piece of the map upon which society places conditions such as land use, zoning, historic district, etc.

CONFIG.SYS - A DOS startup file that the contains a list of statements that tell DOS how to assign and access the hardware resources of a computer (such as file and memory buffers, mouse drivers, RAM disks).

Configuration - The way various computer system devices are electronically connected.

Confirmation message - A message that appears after the user specifies certain actions, prompting the user to confirm to continue with the action or not. For example, an application will displays a confirmation message before deleting a file.

Connectivity analysis - The ability to identify areas or points that are (or are not) connected to other areas or points by linear features.

Console - A device that allows the operator to communicate with the computer.

Constant - A word in memory identified by a level in the program and, in contrast to a variable, assigned a value that generally does not change during the execution of the program.

Contiguity analysis - Concerned with adjacency relationships between any given polygon and its neighbors. Typically this involves summarizing and relating the attributes of neighboring polygons to the polygon being examined.

Continuous data - Data in a raster object is said to be continuous if it can be represented by a three-dimensional surface such that intermediate values can always be derived with meaningful results. Example--an elevation raster has continuous data because an elevation of 400 and an elevation of 500 can fairly be averaged to assign an intermediate elevation of 450.

Contour - (noun) An imaginary line on the ground, all points of which are at the same elevation above or below a specific datum surface, usually mean sea level.

Contour - (verb) Given a set of regularly or irregularly spaced point values, interpolate contours at user specific intervals.

Contour map - A topographic map that uses contour lines to portray relief. Contour lines join points of equal elevation.

Contrast - The difference between bright and dark values in the display or printout of a continuous tone (usually grayscale) image. The stronger the contrast, the more difference between the brightest and darkest values. Most images benefit from a process of contrast enhancement which artificially increases the contrast. Many images look better when they are produced with the Normalized contrast model, which assigns intensity increments according to a normal distribution curve.

Control point - Points and/or cells which are used to establish map coordinate control for uncalibrated objects. In the manual mosaic process, a control point is a feature in a piece of the mosaic (such as a road intersection) for which the map coordinates are known. In the raster-to-vector calibration process, a control point is a feature that is colocated between the uncalibrated raster object, and the calibrated vector object overlay. A control point may be something like a bend in a river or road intersection that shows on both a raster object and an overlying vector object.

Control point list - One type of map registration subobject (Regist) that contains a paired list of map coordinates and cell coordinates. (See also *Linear transform*)

Conventional memory - (DOS) The first 640 kbytes of memory that DOS uses to run applications.

Convolution - Mathematically determining the data value for a new cell in an m x n neighborhood of cells. Raster filtering, resampling, and other raster processes use convolution. Convolution processes should never be applied to raster objects that contain categorical data. Convolution is only appropriate for continuous data.

Coordinate - A value measured along an axis of a coordinate system.

Coordinate filtering - A process of weeding out superfluous coordinates. It is used to generalize maps and to reduce requirements for computer storage. (See *Run-length coding*).

Coordinate pair - Set of cartesian coordinates describing the location of a point, line or area (polygon) feature in relation to the common coordinate system of the database.

Coordinate systems - A particular kind of reference frame or system, such as plane rectangular coordinates or spherical coordinates, which use linear or angular quantities to designate the position of points within that particular reference frame or system.

Coordinate transformation - Conversion of coordinates from one system to another system.

Coprocessor - Microcomputers used for heavy computational tasks often have a second microprocessor, called a math co-processor. To speed things up, the main CPU assigns its tedious arithmetic to this helpful specialist in much the same way that modern accountants use calculators for the computations their grandfathers did by hand. In the Intel CPU series, the main processor's chip number ends with the digit 6 and the coprocessor's chip number is the same except for the final digit 7 - 80286/80287; 80386/80387. With the 80486, Intel included the math coprocessor in the basic design.

Core - The main memory of a computer.

Coregistration - The condition in which associated raster and/or vector objects overlay each other with correct orientation and geometry so that corresponding internal features align.

Corridors generation - To generate corridors of given width around existing points, lines, or areas.

CPS code - (GPS) A sequence of 1023 pseudo-random, binary, C modulations on the GPS carrier at a chip rate of 1.023 MHz. Also known as the *civilian code*.

CPU - **C**entral **P**rocessing **U**nit. The main computing engine of a computer.

Create lists and reports - A GIS ability to create lists and reports on objects and their attributes in user-defined formats and to include totals and subtotals.

Cross section - A section taken normal to the direction of a proposed centerline that can be used to determine new contour or altered contour plots or volumes from cross sections taken at regular intervals or break points.

Cross section generation - Given a digital elevation model, show the cross section along a user-specified line.

Cross-hatching - The technique of shading areas on a map with a given pattern of lines or symbols.

CRT - **C**athode **R**ay **T**ube. An electronic screen for displaying information or graphics.

Cubic convolution or cubic interpolation - A computationally intense type of convolution used in raster resampling which determines a new cell value by fitting a cubic polynomial surface to a 4 x 4 neighborhood of cells. The simpler and faster bilinear interpolation process normally produces results that are almost as good.

Culture - Features constructed by humans that are under, on, or above the ground and which are delineated on a map. These include roads, trails, buildings, canals, and sewer systems.

Cursor - A shape on a video display that indicates position. A cursor may appear as a blinking line on the text screen or as a crosshair on an image display screen. The cursor usually represents the point at which some action will take place.

Cursor coordinate - 1)The current coordinate where the cursor locates; 2) Addressable coordinate range of the cursor which might or might not be the entire screen area.

Cursor hot spot - The pixel location on a cursor shape at which the cursor activity takes place. For example, the hot spot on an arrow cursor is at the point of the arrow, while the hot spot for a cross-hair cursor is at the intersection of the cross-hairs.

DARPA - (**D**efense **A**dvanced **R**esearch **P**rojects **A**gency) A military agency whose network, the ARPANET, was the first to use the TPC/IP protocol over its wide area network (WAN). (See also *ARPANET, TCP/IP*)

Data - Things known about real world entities; results of observations or measurements of such features. A single datum has three potential components: attribute information that describes the substance, characteristics, variables, values and similar qualities of the datum; geographical information that describes the position of the datum in space relative to other data; and temporal information that describes the instant or period of time for which the datum is valid.

Data coverage - The data set of one data type that covers the whole of the management jurisdiction concerned, e.g., the whole of a national forest.

Data Definition Language (DDL) - Repository of information about the definition, structure, and usage of data. It does not contain the actual data.

Data dictionary - (**DD**) Repository of information about the definition, structure and usage of data. It does not contain the actual data.

Data element - A specific item of information appearing in a set of data.

Data entry - A process of key entering tabular data into a structured file. This is typically accomplished by using a CRT terminal with a formatted screen.

Data file - A database file containing attribute data.

Data format - The way in which data elements are represented and stored in computer records.

Data fragmentation - In relational databases, data may be partitioned into row-and column subsets (called subrelations) of a given relation by means of projection and selection. This is necessary if logical data elements are replicated in physical storage. A subrelation is called a horizontal or a vertical fragmentation according as it is derived from the parent relation through selection or projection, respectively. The parent relation can be constructed from its subrelations by join or union operations.

Data input - Entering data into a computer; geographic data is generally entered into a GIS database via a digitizer or a scanner.

Data item - (Data element) The smallest unit of named data in a data set.

Data layer - Refers to data having similar characteristics being contained in the same plane or overlay (e.g., roads, rivers). Usually information contained in a data layer is related and is designed to be used with other layers.

Data link - The communication lines and related hardware and software systems needed to send data between two or more computers over telephone lines, optical fibers, satellite networks, or cables.

Data mask - (Image processing) A processing barrier that only allows data values in a chosen range to pass. User might choose a data mask to block all values outside a selected color range, eliminating all image features except those of the color the user wants to use in

a process. The mask blocks off the parts that the user wants to exclude from the current analysis.

Data records - Data items are represented and stored in data records, e.g., a single map, a single sheet of statistics, a fixed or variable length machine-readable record.

Data redundancy - Identical data are distributed over various files.

Data security - The techniques involved in preventing unauthorized access to data.

Data set - (Data file) A named collection of logically related data records arranged in a prescribed manner. The physical set of data of one data type being referred to or being used in the context of a data processing operation.

Data structure - (Data schema) The organization in memory of data, and, in particular, the reference linkages among data elements.

Data type - (Map layer) The name of a data set based on the nature of the real world entities or conditions described by the data; e.g., forest stand data, soil type data, campsite location data, habitat type data, insect damage map, ownership boundaries, etc. When the data are represented and stored on maps the term *map layer* is synonymous with *data type*.

Database - A collection of interrelated data sets stored together and controlled by a specific schema. A consistent and specified set of procedures is used in adding data to a database and in changing or retrieving existing data from a database.

Database administration - The job of Database Administrator (DBA). The DBA is responsible to ensure data independence, data security and privacy, system backup and recovery, and database restructuring.

Database Management System - (DBMS) A systematic approach to maintaining, accessing and manipulating database files. A DBMS may consist of a single program or a collection of task-specific programs.

Database object - A database is a group of computer files and programs that are related to tabular data sets. A database file is one of the tabular data sets which can be formed and searched by a database management system (DBMS).

Database or Data Base - A collection of inter-related data sets stored together in an organized manner.

Datum - A mathematical description of a smooth surface that closely fits the mean sea-level surface for an area of interest. A datum is derived from a chosen ellipsoid, and provides the surface to which a cartographer refers ground control measurements. Maps of large extent must use consistent parameters for ellipsoid and datum to insure consistency between the map projection and ground control. (See also *Ellipsoid*).

DB2 - A relational database management system marketed by Microsoft Corporation in Redmond, Washington.

DBA - Database Administrator. The person who performs database adminstration.

dBASE III, III Plus, IV - A popular PC-based database management system marketed by formerly Ashton-Tate, now by Borland. It runs adequately on the XT-class computers, and on an AT-class machine with a hard disk, it is suitable for applications involving thousands of records. The latest version, dBASE IV supports SQL to create and maintain SQL databases.

Dead ends - Topological errors in the boundary of a simple polygon such as incomplete linkages.

Debug - To detect and correct errors in a program or computer system.

Debugger - A program that helps a programmer to remove programming errors. A debugger shows the logic path and values of registers and variables during execution of a process or program to determine where a failure occurs.

Dedicated server - Refers to a network machine consisting of a conventional general-purpose computer running a particular application (i.e., GIS or DBMS). The primary goal is improve performance by increasing throughput, although the response time gets longer due to additional communications between the host computer and server.

Default printer/plotter - The printer/plotter that is used if the user invokes a *print/plot* command without first specifying which printer/plotter to use.

Defaults - The start-up control option settings for a system or process. In other words, a value automatically assigned, or an action automatically taken, unless otherwise specified.

Degree - A unit of measurement equal to 1/360 of a circle. A degree of latitude on the Earth's surface is about 69 miles. A degree of longitude varies from about 69 miles at the equator to zero at the poles, but any point on the surface rotates through a degree of longitude in about 4 minutes of time.

DEM - Digital **E**levation **M**odel. A file with terrain elevations recorded for the intersection of a fine-grained grid and organized by quadrangle as the digital equivalent of the elevation data on a topographic base map. USGS geographic elevation data distributed in raster form on open reel magnetic tapes. There are 2 basic types - 1) The DMA type created by the Defense Mapping Agency in both a fixed cell size and a 3 x 3 arcsecond cell size distributed in 1 x 1 degree files. 2) A newer format for those 7.5' USGS quadrangles that have been processed into 1 x 1 arcsecond elevation cells.

Demographic map - Any map that shows primarily political or social data such as political divisions, populations or occupations.

Denormalization - Normalization of the database may be regarded as optimizing for update at the cost of retrieval. A fully normalized database tends to require less processing on update but more on retrieval. To avoid this problem, denomalization can be performed so that retrieval processing becomes faster.

Depressionless elevation - (watershed analysis) A version of the elevation surface that has all depressions (puddles, ponds, and potholes) filled.

Derived map - A map created as the result of analyzing, altering or combining maps for a master database.

Desktop publishing - The use of personal computers or workstations and high-resolution printers, coupled with software capable of producing images and text, to produce formatted output previously available only from large computing environments.

Device - A piece of equipment external to the computer designed for a specific function such as data input, storage, or output.

Device driver - Software that controls how a computer communicates with a device, such as a printer or scanner or mouse. For example, a printer driver translates information from the computer into information the printer can understand.

Device independent - Not constrained by idiosyncrasies of hardware environment. For example, device independent software is designed so that all of its procedures look and work the same way across a variety of hardware configurations.

Dialog - A display containing a message requesting information from the user.

Dialog box - A user interface feature in which a window pops into the screen, shows the current process option settings, and allows the user to change them. Generally, dialog boxes replace repetitive sequences of response user input, which repeat questions whether or not the answers have changed.

Dichotomous data - Data comprised of only one subject, which is either present or absent.

Differential positioning - (GPS) Precise measurement of the relative positions of two receivers tracking the same GPS signals.

Digital or Digital data - Information stored and processed with numerical digits, often in base 2. Digital information processing is constrained by the finite set of numbers a system uses, such that every data value is forced into its nearest representation. For example, a digital temperature sign at the local bank may have no way to deal with fractions of a degree: it can show 75 or 76, but not 75 and 2/3. At some point, every digital system faces the same kind of limit of accuracy. On the other hand, digital information is easy to copy, store, manipulate and reproduce dependably. (See also *Analog*).

Digital Line Graph - See *DLG*.

Digital tablet - A device used to determine and communicate to a computer the coordinates of points sensed electronically by a cursor and a tablet bed on which a map or other graphic image is placed.

Digital Terrain Model - See *DTM*.

Digitizer - A generic term for any device that converts an analog signal into digital form. Different kinds of digitizers work with input from video, audio, or field and laboratory measurements of temperature, pressure, voltage, radiation, etc. (See also *Analog*, *Video digitizing board*, *X-Y digitizing tablet*, and *Scanner*)

Digitizer accuracy - The maximum error in either axis between a point's true coordinates and recorded coordinates.

Digitizing - Process of converting an analog image or map into a digital format usable by a computer.

DIME file - A geographic base file with **D**ual **I**ndependent **M**ap **E**ncoding, with the linear elements in a network coded to represent both their bounding by areal units and their cobounding by the points at which the linear links meet.

Dimensionality - An image contained in one color composite raster has a dimensionality of one. An image contained in a three-raster RGB set has a dimensionality of three. A LANDSAT TM image map for a single date will have a dimensionality of up to seven.

DIP switch - (**D**ual **I**n-**P**lace switch) A small manual on-off switch on a microcomputer circuit board that controls setup and configuration options.

Direct access - A computer data access mode in which users can directly interact with the CPU for data retrieval, file updating and analytical functions.

Directory - A look-up table indicating the storage locations in a file of various data records and used for gaining access to these records.

Dirichlet tesselation or cell - Process of splitting up a study area such that all points in the sample area are grouped into tiles according to the minimum distance between them and a set of previously sampled points. Also known as Thiessen or Voronoi polygons.

Discrete data - Non-interpolatable data comprised of multiple subjects, each subject is clearly distinct from all other subjects on a map.

Disk - A data storage device, similar to a phonograph record, which is magnetized. A *hard* disk is made of thin metal wafers coated with ferrite oxide and stores large amounts of data. A *soft* or *floppy* disk is made from plastic type material and has limited storage capabilities.

Disk cache - A portion of memory set aside for temporarily holding information read from a disk to enhance the operation speed.

Disk drive - A mechanical component of a computer that allows data to be read from or written to a spinning magnetic or optical disk.

Display - Graphic presentation of the output data of any device or system.

Display board or display card or video card, or display adapter - An electronic circuit board installed in a microcomputer that translates the computer's display data into video signals for the monitor. Different display boards can display different numbers of colors simultaneously at different resolutions.

Display resolution - The amount of image detail or sharpness determined by the number of pixels in a display area. Display resolution is expressed as the number of rows and columns of pixels in the display area. General ranges are low resolution (320 x 200); medium resolution (640 x 400); high resolution (1280 x 1040).

Dissolve lines and boundaries/Merge attributes - Boundaries between adjacent polygons with identical attributes are dissolved to form larger polygons.

Distance analysis - Geographic computations based on Euclidean and/or non-Euclidean distances between items in a mapped area.

Distance districting - Process to measure distance and accumulate distance data through a network radiating out from a given point, associating these distance values to the point through which the measurement are taken. This procedure is used to define contour distances away from known points, and to determine districts which are created from a variety of such processes. It may be considered as proximal mapping on a network time/proximity/districting rather than distance basis.

Distortion elimination - The ability to remove various types of systematic distortion generated by different input methods.

Distributed database - Database with unique components in geographically dispersed locations linked through a telecommunications network. The approach uses Structured Query Language (SQL) to build a database distributed over many computers. Thus a network of PCs or UNIX workstations can equal or exceed the power and capacity of a large mainframe.

Distributed processing - The placement of hardware processors where needed, instead of concentrating all computing power in a large CPU.

Dither, Dithering - A method of printing that simulates continuous tone or full-color images by using patterns of discrete dots of black or cyan, magenta, yellow, and black. The dots are so small that the eye resolves them into a continuous-color image.

Dithered raster - A printer-ready 4-bit raster object in which each cell corresponds to one dot on the printer.

DLG - **D**igital **L**ine **G**raph. A digital computer file containing lists of point coordinates describing boundaries, drainage lines, transportation routes and other linear features, organized by quadrangle as the digital equivalent of the linear hydrographic and cultural data on a topographic base map. A USGS map format usually used to distribute topographic maps in vector form.

Documentation - The written specifications of a program indicating the program's goals, memory requirements, data structures and algorithms; the description and format for the data to be entered; and the description and format of the results.

Domain - A pool of values from which an attribute takes its values. Thus a domain consists of values that are all of the same type, the data type of the attribute. The elements of a domain are atomic in nature in that they are not decomposable as far as the relation is concerned.

DOS - **D**isk **O**perating **S**ystem. DOS for personal computers is developed and marketed by IBM and Microsoft. It provides management utilities for the files and other resources of the microcomputer.

Dot matrix plotter - A plotter of which the printing head consists of many, closely spaced (100-400 per inch) wire points that can write dots on the paper to make a map. Also known as an electrostatic plotter or matrix plotter.

Dot pitch - The distance of one phosphor dot of a monitor to the nearest phosphor dot of the same color on the adjacent line. Usually the smaller the dot pitch, the sharper the image will be.

Dot-distribution map - A map showing geographic variations in density with dot symbols, each of which usually represents a constant, specific amount of the mapped phenomenon.

Double precision - Typically refers to the use (in 32-bit computers) of a double word of 64 bits to represent real numbers to, in this case, a precision of approximately 16 significant digits.

Down-load - The process of transferring data and/or programs from a mainframe or a remote computer to a personal computer.

dpi - **D**ots **p**er **i**nch. A measure of scanner, screen, and printing resolution. The more dots per inch, the more detail a device can process for a given area of page or display. On the other hand, the more dots per inch, the higher the demands on machine storage and processing (files get large and processing slows down).

Drag - To move an item on the screen by selecting the item and then pressing and holding down the mouse button while moving the mouse.

Drift - In Kriging, drift is defined as a systematic increase or decrease in the value of the regionalized variable in a particular direction. Drift occurs at all scales, but it is important in universal kriging for the drift to be seen to be continuous and slowly varying at the scale of working so that it can be represented by an analytical expression. (See *Kriging*)

Driver - A set of computer commands that control some input or output process for a particular type of hardware. Usually, drivers are written in assembly language. They tend to be small, very efficient translators of general program features into the specific communication protocol required by a particular manufacturer's device.

Drop-Line - (drop-arc) The process of removing boundaries between map units with the same label. Used in integrated systems to create parametric maps.

Drum plotter - A device with a rotating cylindrical drawing surface and paper reels for plotting graphic images on a long roll of paper.

Drum scanner - A device for converting maps to digital form automatically.

DTM - **D**igital **T**errain **M**odel. A land surface represented in digital form by an elevation grid or lists of three-dimensional coordinates. Elevation data in a 3 x 3 arcsecond grid form or a similar rectilinear form created by the Defense Mapping Agency.

DXF - A spatial data format developed by Autodesk, Inc. for its popular AutoCad system. The DXF (Drawing Exchange Format) format is also used by several mapping programs that are based on AutoCad.

Easting - A rectangular (x,y) coordinate measurement of distance east from a north-south reference line, usually a meridian used as the axis of origin within a map zone or projection. False easting is an adjustment constant added to coordinate values to eliminate negative numbers.

Edge - A line linking two nodes in a graphic representation of a data structure; also called a *side*, or an *arc* in graph theory.

Edge matching - The comparison and graphic adjustment of features to obtain agreement along the edges of adjoining map sheets.

Edit and display on input - A GIS function allowing continuous display and editing of input data, usually in conjunction with digitizing.

Edit and display on output - A GIS ability to preview and edit displays before creation of hard copy maps.

Editing - The detection and correction of errors.

EGA - **E**nhanced **G**raphics **A**dapter. A graphics subsystem capable of 64 colors and widely used in DOS-based microcomputers. The EGA was developed in 1984 to solve the poor resolution and limited color selections of the CGA. Most game software requires EGA, but the 64-color limit is unsuitable for serious image processing. (See also *CGA*, *VGA*).

ELAS - A public domain, first-generation mini- and microcomputer image processing system developed by NASA at the Stennis Space Center (SSC - formerly NSTL) in Slidell, Louisiana.

Elastic box - A rectangle in the image display monitor that can be moved or resized with the mouse. Elastic boxes are used to select areas on the display monitor in processes like measuring and drawing.

Elastic circle - A circle on the image display monitor that can be moved or resized with the mouse. Elastic circles are used to select circular areas on the display monitor in processes like measuring and drawing.

Electromagnetic spectrum - The entire spectrum, considered as a continuum, of all kinds of electromagnetic and visible radiation, from gamma rays having a wavelength of 0.001 angstrom to long waves having a wavelength of more than 1 million km. Remote sensing devices typically record electromagnetic bands in the region of optical light and may include the near infrared. (See also *Spectral band*)

Electrostatic printer or plotter - A device for printing/plotting graphic images by placing small electrical charges on the paper so that a dark or colored powder, or toner, will adhere in these spots. (See also *Dot matrix plotter*)

Element - A vector object is made up of three different classes of elements: 1) nodes, which are single coordinate pairs (or triplets) that define a point (such as a spring); 2) lines, which are curvilinear strings of coordinates which define a curved line (such as a stream); and 3) polygons, which are collections of lines which inscribe an area (such as a lake).

Elevation polygons - Areas of uniform or near-uniform elevation derived from a digital elevation model.

Ellipsoid - An ellipse rotated about its shorter axis. Since the earth is an irregular ellipsoid, and not a true sphere, many methods have been developed to describe its ellipsoidal deviations. Cartographers have a selection of ellipsoids from which to choose; most of which have *best-fit* properties for certain portions of the globe. In 1924, an International ellipsoid was defined which described the Earth ellipsoid as a flattening of 1 part in 297. Historically, ellipsoids were derived from careful surface measurements. More recently, satellite data has been used to construct ellipsoid models that relate coordinate measurements to the Earth's center of mass.

Embedded SQL - A feature of RDBMS that allows a programmer to write programs in the host languages such as C, COBOL and FORTRAN using blocks of SQL statements for retrieval or update purposes embedded within the programs. (See *4GL*)

EMS memory - Expanded memory that can be accessed by using Expanded Memory Specification. (LIM EMS or Lotus/Intel/Microsoft Expanded memory specification)

Enclosing rectangle - The smallest size rectangle which encloses the entire element, particularly when the rectangle's sides are aligned with the coordinate axes.

Encoding - Converting to machine readable format. (See also *Digitizing*)

Engineering map - A map that shows information essential for planning and estimating the cost of an engineering project or development. Usually a large-scale map of a comparatively small area or of a route.

Entity subtype/supertype - An entity type Y is a subtype of entity type X if every instance of Y is always an instance of X. In this case, the entity type X is a supertype of entity type Y.

EO cartridge - **E**rasable **O**ptical **C**artridge. A two-sided removable storage unit that typically holds between 300 and 500 megabytes per side. Data on EO cartridges can be erased so the cartridge can be updated or re-used.

EO drive - A 5 1/4" high-capacity storage device that uses removable double-sided cartridges, which typically store between 300 and 500 megabytes per side. EO drives are similar to WORM drives, with the difference that EO cartridges can be erased and re-used, while data on WORM disks is permanent and cannot be erased. (See also *WORM drive*).

EPPL7 - **E**nhancement of **E**nvironmental **P**lanning and **P**rogramming **L**anguage. A raster-based GIS that operates on grid-cell files stored in a combination of raster and run-length formats. It is a PC-based GIS and was developed by the Land Management Information Center, Minnesota State Planning Agency.

Equalized histogram - A histogram whose distribution has been mathematically adjusted so as to come as close as possible to having an equal number of cells of each data value.

Erasable optical cartridge - See *EO cartridge*.

Erasable optical drive or EO drive - A 5 1/4" high-capacity storage device that uses removable double-sided cartridges, which typically store between 300 and 500 megabytes per side. EO drives are similar to WORM drives, with the difference that EO cartridges can be erased and re-used, while data on WORM disks is permanent and cannot be erased. (See also *WORM drive*).

ERDAS - **E**arth **R**esources **D**ata **A**nalysis **S**ystem. A first-generation, raster-oriented microcomputer image processing and GIS system marketed by ERDAS, Inc.

Error message - A code or diagnostic message displayed when the computer detects a mistake or inconsistency while a program is being compiled, interpreted or executed.

Ethernet - A local area network (LAN) protocol, commonly used to network computers, that conforms to industry specifications.

Euclidean distance - The shortest distance joining two points in the plane.

Executable file - A binary file that has permissions set to allow execution by simply typing its name.

Exogenous class - The intervals (such as population density, landform gradient, air pollution levels, etc.) are fixed according to threshold values that are relevant to, but not derived from, the data set under study. Exogenous classes are widely used in soil survey and land evaluation classification systems that have been set up for national or international purposes. They have the advantage of universal applicability, but the great disadvantage that they may fail to resolve the variations in any specific area.

Expanded memory - (DOS) Memory in addition to conventional memory that is available for applications. Expanded memory is an older standard being replaced by the use of extended memory. Only EMS-compatible software can use expanded memory. It is allocated in 16 Kbytes clocks.

Expanded-memory emulator - (DOS) A program that converts extended memory into expanded memory for EMS-compatible software.

Expansion slot - A socket for an optional circuit card on the main circuit board of a microcomputer (the motherboard).

Expert system - A computer system that can perform at, or near, the level of a human expert.

Export - Process of transferring data or software from one system to another system.

Exporting vector or raster objects - Exporting an object from an original data file, converting it to a format recognized by other image processing or GIS software. Color schemes, arc, node, and polygon structure, geographic calibration, and any other supporting data used in the target format are included.

Extended memory - (DOS) Physically installed memory in addition to conventional memory that is not readily accessible to DOS or DOS applications. A special memory managing program or driver is required to access this memory. Extended memory cannot be used on 8086/88 computers.

Extended-memory manager - (DOS) A program that prevents different applications from using the same part of extended memory at the same time.

External database file - A database file that has only been linked to an internal database file and is being maintained as a separate file. An external database file may still be processed by the user's database programs. (See also *Internal database file*)

External program - A program that is not part of a GIS or image processing program. It may be commercially produced or written by the user.

Extrapolation - Process of extending results of sampling beyond the extent of sample points.

Facet - A typical mapping sheet. A subset of the entire mapped area.

Facilities Management (FM) - See *Automated Mapping/Facilities Management*.

Facility network - Both above ground and below, a vast network of water, sewer, gas, cable TV, electric and telephone transmission lines which are tracked by the GIS.

False easting - An adjustment constant added to easting coordinate values to eliminate negative numbers. (See also *Easting*)

False northing - An adjustment constant added to northing coordinate values to eliminate negative numbers. (See also *Northing*)

Feature - A feature is a contiguous area (it may have holes in it) of homogeneous material, distinct from other areas of the same material. When two features of the same type touch they are considered a single larger feature. Features may represent anything the user chooses to isolate and identify, like ponds, lakes, agricultural fields, a biological entity in an NMR scan, or bones in a CAT scan. All of the instances of a named feature in an image form a class.

Feature mapping - A classification process for isolating, identifying, and classifying areas in multivariable images. Some GIS and image processing package can do most of the classification automatically for high-quality materials like satellite multispectral images. With more user interaction, the process may also successfully map features in images created from 35mm slides or even noisy airvideo.

Federal Information Processing Standards (FIPS) - Official source within the Federal Government for information processing standards. Particularly, FIPS 173 establishes standards for the formatting and exchange of spatial data.

Field - A group of characters or words that is treated as a unit of data.

File - A stored collection of related material (programs and data) analogous to a physical file folder that is used to store a collection of papers on a particular subject.

File format - A particular, pre-described layout pattern for data in a computer file so it may be used or acted upon by a program.

File structure - The arrangement of data items in a data file.

Fill pattern - The drawing pattern for the interior of a polygon for display or printing. A fill pattern can be as simple as a solid color, or as detailed as a repeated image of a duck or tree. Soil types can be represented by traditional color cross-hatching.

Film recorder - An output device that works like a printer but produces slides or prints, usually on 35mm film.

Filter - In raster graphics, mathematically defined operation for removing long range (high-pass) or short range (low-pass) variation. Used for removing unwanted components from a signal or spatial pattern.

Filtering - Clarifying detail, sharpening contrast, smoothing edges, and otherwise enhancing image quality.

Flat file - A two-dimensional array of data items.

Flatbed plotter - A device with a flat drawing surface for plotting a graphic image from a list of point coordinates and pen codes.

Floating point - A technique for representing numbers without using a fixed-position decimal point in order to improve the calculating capability of the CPU for arithmetic with real numbers.

Floating-point board - A printed circuit board placed in the CPU in order to speed up arithmetic operations for real numbers. The alternative is to use special software, which is usually much slower. Math coprocessor chips such as 80287/80387 function similarly.

Floppy disk - (also called floppies, diskettes, and flexible disks) A thin, circular, flexible magnetic disk for computer program and data files. Floppies are inserted into a computer's floppy disk drive much like a cassette tape is loaded into a tape player. Floppy disks come in different sizes and capacities, and must be used in the right kind of drive and computer. Floppies are slower and hold less data than a hard disk. (See also *Hard disk* and *RAM disk*).

Flow accumulation - In a raster-based watershed analysis, the number of cells that drain into some selected cell.

Flow control - Processes and procedures used to regulate the rate at which data is transferred from one device to another. Also known as *handshake*.

Flow direction - In a raster-based watershed analysis, each cell is assumed to drain into one of its eight neighbors (left, right, up, down, plus the four diagonals). The flow direction of a cell is expressed in degrees - left=0, up=90, right=180, down=270; and the

diagonals - 45, 135, 225, 315.

Flow path - The drainage path through a watershed that begins at any selected point (called the flow path *seed*) and runs to one of the outlets of the study site.

Flow path seed - (watershed analysis) Any point selected to be the origin or highest point in a flow path.

Flow simulation - Process to dynamically simulate movement of a collection of entities through a network. The technique is typically used to simulate vehicle flow on street, pedestrian movement through a pedestrian network, water moving through a pipe network, electricity moving through a concrete network, etc.

Font - A graphic design applied to all numerals, symbols, and characters in the alphabet. A font usually comes in different sizes and provides different styles, such as bold, italic, and underlining for emphasizing text.

Format - The preparation of storage media (like optical, floppy, or hard disks; or tape cartridges) with basic locational information so that the media can be used. Some manufacturers provide pre-formatted media for their specific devices, such as hard drives. Other generic media, such as floppy disks, are usually not formatted when purchased. Some media, usually those with a serial recording format, such as open reel tape, are automatically formatted as they are used.

FORTRAN - **FOR**mula **TRAN**slation. A high-level programming language. Widely used in science and engineering fields.

Fourier transform (Fourier analysis) - A type of two-way frequency transform for identifying and removing unwanted spatial frequency components in an image. The Fourier process is normally used to identify and remove systematic noise *spikes*, such as regular lines that may have been introduced by a faulty image collection device. The process works as a two-way operation. First the forward transform creates a pair of intermediate raster objects that reveal abnormal data variability. After the values in those raster objects have been edited to remove the data spikes, the inverse transformation creates a raster object with the same image as the original, but with lines or other noise removed.

Fourth generation language (4GL) - A high-level programming language used to develop customized database management applications. (See *4GL*)

Fractal - An object having a fractional dimension and exhibiting self-similarity at all scales. One in which the final level of detail is not reachable by increasing the scale (the length of the sea coast of Maine is an example).

Frame or video frame - A complete video image which consists of two interlaced fields. Odd lines of the frame are contained in the primary field which is alternated with the secondary field which contains the even lines. The primary field lasts 1/60 of a second in standard broadcast video. The secondary field follows in the next 1/60 of a second. The entire frame takes 1/30 of a second to display. There is a difference of 1/60 of a second between alternate lines in the image.

Frame space - The portion of the display board that dictates which part of the screen contains an image or drawing. Frame space can be as large as a board's addressable space and thus, for more advanced display boards, it can be larger than a monitor's display area.

Frame-grabber and frame-grabbing - Composite video and U.S. standard broadcasts repeat each field every 1/60 of a second. Two interlaced fields, each containing alternate lines of the image, make up one video frame that lasts 1/30 of a second.

A video frame-grabber is a microcomputer interface board that accepts a video input signal and passes it to a color monitor.

A program signals the video frame-grabber to both freeze and digitize one video frame. Digitizing a video frame transforms each picture element in the frame to a digital representation - either a single byte, or more commonly, the video's separate red, green, and blue color values. Some frame-grabbers can be set to grab only a single field to avoid the relative movement between a frame's two fields. If the video comes from a camera that has high-speed electronic shuttering (like 1/1000 of a second), movement in the 1/30 of a second between the primary field and the secondary field causes saw-toothed edges on alternate lines in straight features like road edges, and vertical poles. As soon as the video is saved in the board memory (1/30 or 1/60 of a second), picture motion on the monitor freezes (even if the live video input continues) while the data in the board memory is converted into a display image. Frame-grabber boards should not be confused with video digitizing boards, which gradually sample and construct a digital representation of a still scene video image. Sampling video boards represent an older technology, but are still used for non-standard, higher resolution video sources. (See also *Video digitizing board*)

Frequency range - (CRT) The high and low limits of the frequencies that can be used with the monitor. Usually pertains to horizontal and vertical synchronization ranges.

Frequency transform - An operation that breaks down an image into its fundamental spatial frequency components for subsequent analysis or filtering.

FTP - **F**ile **T**ransfer **P**rotocol. A protocol used to transfer files between machines in a TCP/IP network. This protocol is a DARPA protocol, created for use on the ARPANET. (See also *Protocol*, *TCP/IP*, *DARPA* and *ARPANET*)

Functionality - The capability of a system to execute a desired operation, for example raster to vector conversion is a functionality present in ARC/INFO but not in AutoCAD.

Fuzzy C-means - An unsupervised classification or clustering process developed by Robert Cannon et al. and documented in: Robert L. Cannon, Jitendra V. Dave, James C. Bezdek, and Mohan M. Trivedi (1986) *IEEE Transactions on Geoscience and Remote Sensing* GE-24(3):400-408.

Gap - The distance between two graphic entities (usually lines) on a digitized map. Gaps may arise through errors made while digitizing or scanning the lines on a map.

Gateway - A hardware/software device that permits communication between two similar local or remote area networks. Contrast with *Bridge*.

Generate - The ability to generate following items: **circles -** circles defined by the center point and radius; **grid and cell nets** - a network of grid cells given a point of origin, grid cell dimension and orientation; **latitude/longitude** - graticules for a variety of map projections; **lines**, **points**, **polygons**; and to insert them into the database.

Genlock - To synchronize two video signals (usually NTSC - see *NTSC video*) to match the color video frames. Genlocking is necessary to mix and combine two signals, like a live video image and a graphic overlay. Some display boards can output an NTSC signal but cannot genlock, or mix, that signal with another video signal.

Geo/SQL - A GIS marketed by Generation 5 Technology, linking AutoCAD graphics and the SQL database standard. It can be linked to Oracle, RBase, and INGRES databases.

Geocode - A data value, assigned to a spatial object, that provides information on the geographic location of the object and is used as a key to access data relating to the object.

Geocoding - Translating geographic coordinates for map units, lines and points into (x,y) digits or grid cells.

Geodesy - Investigation of scientific questions connected with the shape and dimensions of the earth.

Geodetic Elevation Model of Planetary Relief - A method for modeling planetary relief based on a recursive tesselation of a regular octahedron (8 faces) or icosahedron (20 faces) into equilateral triangular facets. Horizontal coordinates are implicit in the hierarchy of nested triangles and only elevations are stored, using single bit flags to quantize height changes.

Geodetic referencing - Using latitude and longitude as a geographic reference.

Geographic calibration - Bringing a raster or vector object into alignment with some geographic coordinate system. Raster and vector objects in a GIS file may have attached subobjects that contain the information needed to relate every raster cell or vector coordinate point to some geographic coordinate system (like a particular map projection). Geographic calibration may be established when creating an object (like extracting an image map from a LANDSAT or SPOT satellite image), or an image may be calibrated by entering control point lists or by associating it with some calibrated object (like overlaying a calibrated vector to calibrate a raster).

Geographic data - A geographic data set is a collection of data that are individually or collectively attached to geographic location. Spatial data is often used synonymously with geographic data.

Geographic direction - Direction measured relative to a north meridian, in contrast to direction based upon magnetic north or grid north.

Geographic entity - (Geographic feature) A geographic entity is something that occupies a position in space about which data describing the attributes of the entity and its geographic location are recorded.

Geographically referenced data - See *Geographic data*.

Geophysics - The branch of physics concerned with the forces that act in and on the Earth and with the changes caused by these forces.

Geoprocessing - The automated manipulation and/or analysis of geographic data.

Georeference system - An (x,y) or (x,y,z) coordinate system that locates points on the surface of the earth as a reference to points on a map. Systems include latitude-longitude, Universal Transverse Mercator, and State Plane Coordinates.

GeoVision - A GIS marketed by GeoVision Corporation. It has raster, vector, and quadtree data structure, and operates on UNIX operating systems. It can be linked to the Oracle relational database management system.

GFIS - **G**eographic **F**acilities **I**nformation **S**ystem. A set of software that can be used to interactively create, manipulate, and maintain models of facilities or events that are geographically oriented. GFIS is developed by IBM.

Gigabyte, Gbyte, or Gb - A computer unit of measurement for 1,000,000,000 bytes.

GIS - **G**eographic **I**nformation **S**ystem. A Geographic Information System is a computer system designed to allow users to collect, manage, and analyze large volumes of spatially referenced and associated attribute data. The major components of a GIS are: a user interface system; data base management capabilities; data base creation/data entry capacity; spatial data manipulation and analysis packages; and display/product generation functions.

GKS - **G**raphics **K**ernal **S**ystem. A set of software primitives for allowing device-independent graphics programming.

Gnomonic projection - A type of perspective azimuthal map projection. The point of the projection is the center of the sphere. Gnomonic is the only projection on which all great circles represented are straight lines.

GPIB - **G**eneral **P**urpose **I**nterface **B**oard. An interface standard for computers and peripheral devices, such as scanners or printers.

GPS - **G**lobal **P**ositioning **S**ystem. A network of radio-emitting satellites deployed by the U.S. Department of Defense. Ground-based GPS receivers can automatically derive accurate surface coordinates for all kinds of GIS, mapping, and surveying data collection.

Gradient analysis - Process to determining the maximum rate of change of surface altitude in a DEM.

Gradient filtering - A method of edge detection using two filters. One filter enhances horizontal edges and the other enhances vertical edges. The results are then combined into a single output cell value. Gradient filtering usually produces better results than a single high-pass filter. (See also *Filtering*)

Graph generation - An ability to create a graph illustrating attribute data by symbols, bars or fitted trend lines.

Graphic entity - The graphic representation of a point, line segment, arbitrary regular area or irregular polygon on a map in either hardcopy or machine-readable form.

Graphic overlay - The ability to superimpose graphically one map on another and display the result on the screen or on a plot.

Graphic tablet - A small digitizer used for interactive work with a GIS or CAD/CAM system.

Graphical User Interface (GUI) - A user interface that uses such objects as icons, menus, pointers, and scroll bars to allow the user to choose various options and run programs using graphical interactions such as moving, pointing, and clicking.

GRASS - **G**eographic **R**esources **A**nalysis **S**upport **S**ystem. A public domain GIS system developed at the U.S. Army's Construction Engineering Research Laboratory (CERL) in Urbana, Illinois. It is now managed by an inter-agency governmental committee. The system was designed for minicomputers and has since been implemented on various microcomputers. It is a raster-based system that can interface to vector data sets for data preparation and import/export.

Graticule - Network of parallels and meridians on a map or chart.

Graytone or grayscale - An image or raster object that contains tone levels and intensities that grade gradually from black (no intensity) to white (high intensity). Differences between one tone level and another correspond to differences between one data level and another.

Greenness - The biophysical property of the surface of the Earth that indicates its greenness in a biological sense and gives a qualitative estimate of green biomass. It measures plant vigor, water wellness, and chlorophyll content. Greenness can be computed from LANDSAT MSS or TM images by Kauth's greenness, brightness, wetness transformations. (See also *Kauth's greenness, brightness, wetness transformations*)

GRID - 1) A GIS database being developed by the UN Environment Program, 2) a raster module in the ARC/INFO GIS package.

Grid map - A map in which the information is carried in the form of grid cells. (See *Raster*)

Grid or Grid format - A data structure in which data is encoded and stored as a regular unit of area, usually square or rectangular in shape, and called grids or cells. Data are somewhat generalized.

Ground resolution - The limit of detail clarity in an image of the Earth's surface collected by some remote sensing device, usually measured in meters. An image with a ground resolution of 10 meters shows no ground features smaller than 10 x 10 meters. Each data cell in such an image contains a value for a distinct 10 x 10 meter surface area.

Ground truth - Information collected at the same site and at the same time as a remote sensing system is collecting data. Ground truth is considered more accurate, and is used to interpret and calibrate remotely sensed observations.

Handshake - A flow-control, or *go-ahead*, signal sent by a local computer to a remote computer when working with a communication program. XON/XOFF is the standard software handshaking method, although it cannot be used with remote systems that use a hardware handshaking method.

Hard copy - A permanent image of a map or diagram, for example, a paper map produced on a line printer or pen plotter.

Hard disk or hard drive - A mechanical, magnetic storage device for computer data and program files. Internal hard disks (sometimes called fixed disks) are mounted inside the computer chassis and so are not removable. An external hard disk is an enclosed unit that is connected to a computer by appropriate cables. A hard disk is much faster and holds much more than a removable floppy disk, but like any mechanical device, it is slower than an electronic RAM disk. (See also *Floppy disk* and *RAM disk*)

Hardware - The physical components of a GIS - the computer, plotters, printers, CRTs, and so on.

Hardware key - A small device that contains sealed circuitry and is attached to a microcomputer (as through a parallel port) to verify and authorize software and hardware system configuration. Also called a *dongal*.

Heap - The *heap* is the area of a computer's memory not used by a program's data and code segments. It is commonly used for storage of dynamic variables. The more RAM the computer has, the larger the heap.

Heights along streams - The ability, given a digital elevation model and hydrology net, to interpolate points along streams at fixed increments of height.

Heuristic - A rule-of-thumb or other device or simplification that allows its user to draw conclusions without being certain. Unlike algorithms, heuristics do not guarantee correct solutions.

Hidden line removal - A technique in three-dimensional perspective graphics for suppressing the appearance of lines that would ordinarily be obscured from view.

Hierarchical - A classification scheme that goes from general to specific labels. Often used in multiple scale mapping systems where the labeling system for each scale can be generalized or subdivided into the labeling system for a different scale.

Hierarchical database structure - A method of arranging computer files or other information so that the units of data storage are connected by a hierarchically definded pathway. From above to below, relations are one to many.

High Memory Area (HMA) - (DOS) The first 64K of extended memory. This area is used by some applications.

High-boost filter - A process that enhances and sharpens spatial features in a continuously varying raster object. (See also *Filtering*)

High-level language - A computer programming language using command statements, symbols, and words that resemble English-language statements. Examples are FORTRAN, PASCAL, C, PL-1, COBOL, and BASIC.

High-pass filter - A process that enhances and sharpens the boundary edges in the spatial features of a continuously varying raster object. (See also *Filtering*)

HIS - **H**ue, **I**ntensity, and **S**aturation. Sometimes called HLS, for Hue, Luminance and Saturation. The system of defining video output color from hue, intensity and saturation characteristics. HIS controls are commonly used with color television sets. Most computer displays use RGB (red/green/blue) color mixing information instead. The hue-intensity-saturation color model uses a double cone (with its greatest circumference at the midpoint of the z-axis) to describe specific colors. On any horizontal slice of the cone, the hue varies around the slice and the saturation increases outward from the center. Intensity is the z-axis of the model. The shades of gray are found along the z-axis, where hue and saturation equal zero.

Histogram - A graph of the number of times a value occurs across a range of possible values. One axis of a raster histogram shows how many times a cell value is found in the raster. The other axis shows the range of possible data values (like 0 to 255 for 8-bitcell values).

Home range - The area defined by a swarm of spatial observation events. Classically, the home range is the area defined by wildlife sightings that an animal or community of animals uses under normal conditions. Environmental stresses may cause a preferred home range to shrink, enlarge, or be abandoned.

Horizontal frequency - (CRT) The inverse of the time it takes for a monitor to scan from the beginning of one line to the beginning of the next line; typically stated in KHz.

Host computer - The primary, or controlling computer in a data network.

Hot spot - The pixel location on a cursor shape at which the cursor activity takes place. For example, the hot spot on an arrow cursor is at the point of the arrow, while the hot spot for a cross-hair cursor is at the intersection of the cross-hairs.

Hotkey - A keyboard equivalent to a window button on the display monitor. Knowing the assigned hotkeys for a process can give an extra level of control, and bypass multiple-step mouse operations.

Hue - One of the three coordinates needed to specify a color in the HIS color domain. Hue tells the color such as red, blue, or green. (See also *HIS*)

Hypsometric curve - Set of contour lines that describe the altitude surface.

Hypsometry - The measurement of the elevation of the Earth's surface with respect to sea level.

I/O address - Locations within the input/output address space of computer used by a device such as a printer or scanner. The address is used for communication between software and a device.

Icon - Graphical representations of various elements in a graphical user interface (GUI), such as applications, files, and disk drives.

IDIMS - A minicomputer, raster-based image processing system originally developed by NASA.

Idiographic class - Refers to the interval which is chosen with respect to specific aspects of the data set. Contrast with the Exogenous class. (See *Exogenous class*)

IDRISI - A public domain, raster-based GIS system from Clark University. Also the name of a cartographer and geographer of major significance during the medieval period.

IGES - **I**nitial **G**raphic **E**xchange **S**pecifications for digital data exchange. IGES is being used extensively for the exchange of CAD and CAM data. It was developed by joint industry/government representatives in 1979-1980 and adopted as an ANSI standard in September 1981. It supports free field formatting representation and plotting of the information. The format is limited for exchanging digital cartographic data in that it can only handle one attribute per feature. Since IGES is designed for CAD/CAM data, the format requires unnecessary information for digital cartographic data exchange.

Image - Any analog or digital two-dimensional array of values whose spatial interconnections convey useful information. Image has a wider sense than photographs, TV, or human vision. A photographic print is an image but an image is not necessarily a photograph. What a human sees can be called an image but image is not restricted to describing human vision. The raster scan of a color map is an image, but not its converted vector object derivative. However, the display of a vector object on the monitor creates an image of that vector file. Properly, that which is stored in a raster object can be called an image, but that which is stored in a vector, CAD, text, or database object cannot.

Image analysis - A technique to locate edges or boundaries in digital image data.

Image map or calibrated image map - An image that has been processed to be like a map in appearance, scale, geometry, boundary, and projection with a degree of precision that satisfies the user. Measurements made from an image map yield results equal to those made from the corresponding planimetric, topographic, or other map. Similarly, either the image map or the conventional map can be overlaid and matched with the other. For example, a 7.5' image map prepared in MIPS from LANDSAT or SPOT satellite images will accurately match the corresponding USGS topographic map. Similarly, the color scan of a topographic map that has been assembled by tiling and calibrated to map coordinates is an image map. (See also *Nominal image map*)

Image processing system - A set of analytical routines designed for the restoration, enhancement and computer-assisted interpretation of digital images, most particularly of remotely sensed data.

Import - Process of bringing data or software from another system into a system.

Importing vector, CAD, or raster objects - Decoding the raster data values or the vector coordinates in another system's format and converting them to user's GIS file objects. Color schemes, arc, node, and polygon structures, geographic calibration, and all other supporting data is converted into the appropriate subobject as long as their format can be decoded from their original files by the host GIS.

INFO - The database program used by ARC/INFO. (See also *ARC/INFO*)

INFORMAP - A GIS marketed by Synercom Technology, Inc. It has both raster and topological vector data structures, and runs on multiple operating environments. The user can link INFORMAP with Oracle or another relational database.

INFORMIX - A relational database management system by Informix Software, Inc. It has both menu-driven and command-oriented interfaces, and has RDSQL, a SQL-based query language for relational database handling.

INGRES - **IN**teractive **G**raphics and **RE**trieval **S**ystem. A relational database management system

by Relational Technology, Inc. (RTI) of Berkeley, California. Mainframe and PC-based versions are available. INGRES has two query languages: SQL and QUEL for database handling.

Inheritance - (Object-oriented programming) The data and methods (member functions) of the parent class are passed down (made accessible to) children classes.

Initial Graphic Exchange Specifications - See *IGES*.

Initialize - To set program variables to their starting values, commonly zero, at the beginning of a program.

Ink-jet plotter - A printing device in which the cells in the data array are used to guide electrostatically charged ink drops onto paper.

Input - (noun) Data entered to a computer system.

Input device - A hardware component for data entry.

Integer - A number without a decimal component; a means of handling such numbers in the computer which requires less space and proceeds more quickly than with numbers having information after the decimal point.

Integrated map - A natural features map where each map unit has multiple labels addressing a variety of geographic subjects. For example, one map unit may contain Bedrock Geology, Soil Type A, Vegetation Type 1, Slope 5%-10%, etc.

Intensity - One of the three coordinates needed to define a color in the HIS color domain. Intensity represents a color's brightness or average luminance, or radiance level. Intensity data is very similar to the information in black and white representations of color images. (See also *HIS*)

Interactive - Refers to a system allowing two-way electronic communication between the user and the computer.

Interactive graphics system - A computer system consisting of a central computer (usually minicomputer) and a number of workstations at which an operator can draft maps and drawings interactively.

Interface - The type of signal protocol for connecting computer devices. One can only connect a peripheral device to a microcomputer through a matching interface. Common interface types include serial, parallel, SCSI and GPIB.

Interface board or interface card - Any electronic circuit board installed in a microcomputer that handles translation between the computer and some particular hardware device. For example, an interface board may translate output data into display signals for an image display monitor, or translate input signals from a color scanner into digital data for the computer.

Interlaced video - Background - The image seen on a TV screen is made from a set of about 480 horizontal lines. The lines are projected in two passes of the signal beam. Each pass only projects every other line of the image - the odd lines in one pass, and the even lines in the next pass. One scan takes 1/60 of a second, so the whole picture (the frame) is refreshed every 1/30th of a second. There is a time difference of 1/60 of a second between any pair of adjacent lines in a frame. Thus, a single, still video image of 1/30 of a second duration consists of two interlaced fields of the source video signal. Displaying a single frame of interlaced video causes vertical jitter. This jitter is especially pronounced when an image contains horizontal lines. This is called umpire shirt jitter on conventional broadcast TV and can be seen along the black and white edges of an umpire's shirt or along the sharp horizontal edges of large letters. This effect can cause eyestrain. Interlace jitter is
best overcome by using a monitor with long-persistence phosphor. This phosphor holds each line longer until it can be refreshed by the next scan.

Internal data structure - Organization within the system of data, and particularly, the reference linkages among data elements.

Internal database file - A database file created within and maintained by a GIS.

Internet - The DARPA network using the Internet protocol suite for connectivity. The Internet connects several different networks, including the ARPANET. It is used to share information and resources among its sites and to provide a way to test new networking developments. (See also *ARPANET, DARPA*)

Interpolation - Applying mathematical estimation techniques to sets of numbers to find intermediate values. (See also *Convolution*)

Interpretation - Identifying and grouping classes of features in an image.

Interpreter - A program that translates a source program written in a high-level programming language to machine code, instruction by instruction, as the source program is being processed or as the operator of an interactive system enters instructions.

Interpretive matrix - A table containing detailed characteristics of mapped features that is used to supplement data on a map. For example, a soils interpretive matrix may hold drainage or permeability data for each mapped soil type.

Interrupt - A signal that a device sends to the computer when the device is ready to accept or send information.

Interrupt request lines (IRQ) - Hardware lines over which devices can send interrupts (signals indicating that the device is ready to accept or send information). Typically, each device connected to the computer uses a separate IRQ.

Island - A closed two-dimensional figure. In GIS systems, an island is a unit of land cover lying completely within another land-cover unit.

Island polygon - A separate, individual polygon such as a lake.

ISO - **I**nternational **S**tandards **O**rganization. The ISO defines and publishes standards that can be adopted by many manufacturers. For example, one ISO standard defines the format for erasable optical disks, so they can be used on drives from any manufacturer that supports the standard.

Isoline - line connecting points of equal value.

Isoline map - A map with the form of a surface shown by lines connecting points of equal value. A contour map is also an isoline map.

Isometric mapping - A function that preserves distances between certain points. Also called length-preserving mapping.

Isopleth map (Isoline map) - A map displaying the distribution of an attribute in terms of lines connecting points of equal value.

Jaggies - Jargon term for curved lines that have a stepped or saw-tooth appearance on a display device.

Join - To connect two or more separately digitized maps.

Jumper - An electrically conductive part, and the manual connector on a microcomputer circuit board that bridges two neighboring terminal posts. The jumper is either slid down onto the posts or removed according to the configuration options described in the documentation that came with the device.

Justification - The relative position of a text string or symbol on the map to the location at which it has been digitized.

K-means - An iterative method of unsupervised classification (clustering). The n-dimensional raster space is divided into K clusters. The cluster means are used to determine cluster membership. After all cells are processed, new cluster means are determined and the process is repeated a predetermined number of times or until convergence is achieved.

Kauth's Tasseled Cap or Kauth's greenness/brightness/wetness - A set of linear combinations of the LANDSAT TM spectral bands which computationally reduce the images to maps of a site's greenness, brightness, and wetness. Kauth, a scientist at the Environmental Research Institute of Michigan, extended the green biomass concepts developed by Lee D. Miller to extract more biophysical information from LANDSAT MSS and TM multispectral images. The plots of the data distribution in the original spectral bands resemble a tasseled cap - hence the general name of these transformations.

Kernal - The contents of command-interpreting templates is collectively known as a kernel. Also known as a *shell* or *command shell.*

Key file - In some CAD/CAM systems, a file containing the codes defining the operation of certain keyboard functions, or menu commands. In DBMS, a file containing information about the search paths or indexes used to access data.

Keyboard - A device for typing alphanumeric characters into the computer. The arrangement of the keys resembles that of a typewriter, but often has more capabilities.

Kill (a process) - To stop the execution of a process. This capability is often used to stop time- or resource-consuming processes.

Kilobyte or Kbyte or K - A unit of measure equal to 1024 bytes (2 to the 10th power), but loosely used for 1,000 bytes. So also with its multiples - megabyte (loosely 1,000,000 bytes), gigabyte (loosely 1,000,000,000 bytes) and terabyte (1,000,000,000,000 bytes).

Kilohertz or KHz - (CRT) A unit of frequency equal to one thousand cycles per second.

Knowledge base - The portion of an expert system that consists of the facts and heuristics about a domain. The knowledge may be in the form of examples, facts, rules, or objects.

Kriging - An interpolation procedure for obtaining statistically unbiased estimates of surface elevations from a set of control points. This is based on the stochastic aspects of spatial variation, and originally used to estimate the location of ore deposits.

Label - A vector element that contains text used to identify a node, line, or polygon element.

Labeling (raster context) - Identifying and grouping the clusters that result from any kind of automated image interpretation. Users choose labels (names for types of features) based upon their knowledge of the areas or materials in the image.

Labeling (vector context) - Process to transfer labels describing the contents (attributes) of polygons and the characteristics of lines and points to the digital system.

LAN - **L**ocal **A**rea **N**etwork, which links user PCs, workstations, minicomputers, mainframes, computer servers, file servers, and shared peripherals by a common transmission medium, including coaxial cable or twisted-pair wiring.

Land cover - The materials that cover a study site, such as vegetation, bare soil, rock, sand, and water.

Land information system (LIS) - A geographic information system having, as its main focus, data containing land records. Land records are broadly defined to include resource, land use, environmental impact, and fiscal data.

LANDSAT satellite - An American satellite series that collect multispectral images. At various times LANDSAT uses 1) a Return Beam Vidicon (RBV) device, 2) the Multispectral Scanning (MSS) device, and 3) the Thematic Mapping (TM) scanning device. LANDSAT also relays data from ground observation stations. LANDSAT was originally called the ERTS or Earth Resource Technology Satellite.

Laptop - Usually refers to Laptop computers. A laptop computer is a portable computer operating on a rechargeable battery with passive or active matrix screen, and weighs less than 6 lb. Smaller computers are called notebook computers, and the smallest computers are called palmtop computers.

Large scale - A map scale that covers a relatively small area on the ground and has detailed labels. The term *large* refers to the fraction represented by the ratio of map distance to ground distance. For example, 1:500 (one map unit = 500 ground units.)

Laser plotter - A plotter in which the information is written onto light-sensitive material using a laser.

Latitude - The angular distance in degrees of a point on the Earth north or south of the Equator.

Layer - Refers to the various *overlays* of data, each of which normally deals with one thematic topic. These overlays are registered to each other by the common coordinate system of the database.

Least squares - A mathematical method for fitting a line or curve to a set of data points. Least squares minimizes the sum of the squares of the error term at each point.

Legend - The part of the drawn map explaining the meaning of the symbols used to code the depicted geographical elements.

Library - A collection of standard, often used computer subroutines, or symbols in digital form.

Light pen - A hand-held photosensitive interactive device for identifying elements displayed on a refreshed CRT screen.

Limit line - An adjustable graphic line on a process control screen that defines the boundary between values that are used and values that are not used in the process.

Line - A level of spatial measurement referring to a one-dimensional defined object having a length and direction and connecting at least two points. Examples are roads, railroads, telecommunication lines, streams, etc.

Line follower - A semi-automatic device in which a laser beam is used to trace out lines from a source map and convert them to digital form.

Line in polygon - To superimpose a set of lines on a set of polygons, and determine which polygons (if any) contain each line.

Line length calculation - A procedure for computing the distance between successive coordinate pairs forming a straight line or following an irregular path.

Line mapping - A process to create a cartographic display of linear features by means of (x,y) coordinate pairs.

Line of sight - The ability to determine the intervisibility of two points, or to determine those parts of pairs of lines or polygons which are intervisible.

Line on polygon overlay - To superimpose a set of lines on a set of polygons, breaking the lines at intersections with polygon boundaries.

Line pattern - The drawing style of a line for display or printing.

Line printer - A printer that prints a line of characters at a time.

Line smoothing - Automatically smoothing lines to a user-defined tolerance, creating a new set of points.

Line thinning (Weeding) - Process to reduce the number of points defining a line or set of lines to a user defined tolerance.

Linear transform (map registration) - One kind of map registration subobject (Regist) that contains an object's mathematical representation for its calibration solution (least squares) derived from a control point list.

Link - To combine individual modules into an executable program. Common subroutines contained in libraries can be linked to user programs at compilation time.

LIS - See *Land Information System.*

Local printer - A printer that is directly connected to one of the ports on a computer. (See also *Network printer*)

Locations from traverses - Given a direction and distance from a given point, calculate the end point of the traverse.

Logical operation - An operation involving program variables that is either true or false. Three examples of logical operations are A equal to B, C greater than D, and A equal to B and C greater than D.

Login - To establish a session on a system by providing a valid user ID and password to the operating system.

Longitude - The angular distance in degrees of a point on the Earth east or west of the Prime Meridian.

Look-up table - An array of data values that can be quickly accessed by a computer program to convert data from one form to another.

Low-pass filter - A process that smooths or reduces the spatial variability or detail in a continuously varying raster object. (See also *Filtering*)

MacGIS - A user-friendly GIS that operates on Apple Macintosh computers.

Machine language - Instructions coded so that the computer can recognize and execute them.

Macintosh - Computer hardware manufactured by Apple. It is based on Motorola chips and has a proprietary 32-bit multitasking operating system *System xx* where *xx* is the version number (latest version number is 7).

Macro - A series of instructions that may be executed with a single command.

Magnetic media - Tape or disks coated with a magnetic surface used for storing electronic data.

Mainframe - A large computer supporting many users.

Map - (Cartography) A hand-drawn or printed document describing the spatial distribution of geographical features in terms of a recognizable and agreed symbolism. (Digital) The collection of digital information about the a part of the Earth's surface.

Map generalization - Process of reducing the detail of spatial features in a map layer. Often undertaken in conjunction with a reduction in map scale. This process is relatively easy for humans and relatively difficult for computers.

Map grid - A grid superimposed on a map to provide a coordinate system more convenient than that provided by the graticules.

Map projection - A device for representing all or part of a rounded surface on a flat sheet. Since this cannot be done without distortion, the cartographer must choose the map characteristic (area, shape, scale, direction) which is to be shown accurately at the expense of others. The map projection geometrically or mathematically generates the grid of lines of latitude and longitude. (See also *Ellipsoid*)

Map quadrangle or map quad - The geographic area covered by a map. One kind of map quadrangle is the 7.5' x 7.5' area that is covered by a standard USGS 7.5' topographic map. Referring to a 7.5' map quadrangle does not imply the presence of an actual paper map. The term may simply designate the area covered by electronically stored materials.

Map scale - The relationship that exists between a distance on a map and the corresponding distance on the Earth. It may be expressed as an equivalence, one inch equals 16 statute miles; as a fraction or ratio, 1:1,000,000; or as a bar graph subdivided to show the distance that each of its parts represents on the Earth.

MapGrafix - A computerized mapping system offering graphic and database management capabilities for digital mapping and GIS application. It operates on Apple Macintosh computers, developed by ComGrafix, Inc.

MapInfo - A vector-based desktop GIS marketed by MapInfo Corporation. It operates on DOS, Windows, and Unix, and can be linked to dBASE databases.

Mapping unit - A set of areas drawn on a map to represent a well-defined feature or set of features. Mapping units are described by the map legend.

Mask or data mask - A processing barrier or boundary that only allows selected data values (perhaps in a chosen range or area) to pass. Users might choose a data mask that blocks all values outside a selected color range, eliminating all image features except those of the color they want to use in a process. A mask can also be used to confine the effects of a process to a selected area of an image. (See also *Processing mask*)

Mass storage - Auxiliary, large capacity memory for storing large amounts of data. Usually magnetic disk or tape.

Matrix printer - A display device that forms characters and prints gray tones with a pattern of dots from, say, a 10 by 10 grid of available dots for each character position.

Maximum-likelihood classification - A supervised (semi-automatic) image classification process usually applied to multivariate images that have a dimensionality greater than 3. The maximum-likelihood process computes the statistical properties of these features, and the statistical characteristics which separate feature types. After this identification model has been built, the process tests each cell to determine in which prototype group it most probably belongs.

Mb, megabyte, or Mbyte - A unit of measurement for 1,000,000 bytes.

Measure - The ability to measure the following items: **angles and distances along linear features** - given a prescribed linear feature, generalize its shape into a set of angles and distances from a start point, at user-set angular increments, and constrained to any known points along the linear feature; **distance along straight and convoluted lines** - measure distances along a prescribed line; **length of perimeter of areas** - measure the length of the perimeter of a polygon; **size of areas** - measure the area of a polygon; **slopes along line (gradients)** - measure the slope between two points of known height and location or calculate the gradient between any two points along a convoluted line that contains two or more points of known elevation.

Measure number of items - To count the number of objects in a class.

Measure volume - To compute the volume under a digital representation of a surface.

Megabyte, Mbyte, or Mb - A unit of measurement for 1,000,000 bytes.

Member function - (Object-oriented programming) A procedure in the class that implements a message.

Memory - An organized set of locations in which a computer can store and find data and instructions.

Memory resident software - See *TSR*.

Menu - A list of choices displayed on a computer screen in text form. One generally selects an item on a menu by pressing the indicated key(s) or clicking on it with a pointing device such as a mouse.

Mercator projection - A map projection centered along the equator with evenly spaced meridians perpendicular to parallels spaced progressively farther apart poleward so that compass bearings are not distorted. A transverse mercator projection uses the same system of projection, but with the projection centered along a meridian to provide low distortion within a zone around the central meridian.

Merge - To combine items from two or more similarly ordered sets into one set that is arranged in the same order. In a GIS, to splice separate but adjacent mapped areas into a single data set.

Meridian - A great circle on the Earth's surface that passes through the terrestrial poles.

Message - (Object-oriented programming) A command request sent to an object for that object to be executed appropriately on the data.

MHz or Megahertz - (CRT) A unit of frequency equal to one million cycles per second.

Microcomputer - A small, low cost computer (very often a single-user machine).

Microstation GIS - A GIS marketed by Intergraph Corporation, which has the combination of the graphics capabilities of Microstation 32 with a user-selected relational database management system (Informix, Oracle, or Ingres). It has a core product, Microstation GIS Environment (MGE) which organizes and manages all information for the GIS operations.

Minicomputer - A medium sized, general purposes single processor computer often used to control GIS.

Minute or ’ - The sixtieth part of a degree of angular measurement, often represented by the sign ’, as in 30’, read "30 minutes". USGS quadrangle maps are common in both 15 and 7.5 minute sizes. (See also *Arcsecond*)

MIPS - 1) Million Instructions per Second - A processor speed performance parameter. 2) **M**ap and **I**mage **P**rocessing **S**ystem - A GIS marketed by MicroImages, Inc. It has both raster and vector data structure, and can be linked to a dBASE database.

Modeling - 1) Representation of the attributes of the Earth’s surface in a digital database. 2) The study of landscape processes using mathematical algorithms written in computer codes.

Modem - **MO**dulator-**DEM**odulator. A translating device that links a terminal to a telecommunications network. An acoustic coupler is a modem that permits a terminal to communicate through the handset of a standard telephone instrument.

Module - A separate and distinct piece of hardware or software that can be connected with other modules to form a system.

Monitor - A display device. Usually either CRT type or Active Matrix display type.

Monochrome image - An image displayed in a single color or shades of a single color. Most monochrome computer displays use white, green, or amber, although any one color is possible.

Monument - Permanent physical structure marking the location of a survey point.

Mosaic - A large image assembled from raster object segments. Each segment may come from a different source and have a different cell size and angle of orientation. In automatic mosaicking, all the segments must be geometrically rectified and calibrated to a common coordinate framework. In manual mosaicking, the calibration framework can be established from control points in certain pieces, as long as the relative positions of the pieces that do not have control points can be inferred from pass points. (See also *Tiling*)

MOSS - **M**ap **O**verlay and **S**tatistical **S**ystem. A pioneer vector-based geographic information system (GIS) developed and still widely used by groups in the USDI, especially the USF&WS and BLM. MOSS vector data files contain strings of coordinate pairs which describe closed polygonal areas, lines, and single point features. Common boundaries between adjacent polygons are duplicated in this data structure, once with each polygon.

Motherboard - The main circuit board in a microcomputer. The motherboard normally contains the main processor, logic chips, memory, and expansion slots for optional circuit cards.

Motif - A graphical user interface (GUI) introduced by the Open Software Foundation (OSF).

Mouse - A computer graphics pointing device. As a mouse is moved across the desktop, the mouse cursor moves on the screen. With it, the user points, selects, and draws.

Mouse cursor - A symbol on the image display monitor that indicates the point of a process’s activity and is controlled by the mouse. As the mouse moves on the desktop, the mouse cursor moves on the screen. With it, the user points, selects, and draws.

Mouse menu - A standard graphic that appears in the menu area of the text monitor when the mouse is active on the display monitor.

MSS - **M**ulti-**S**pectral **S**canner. A sensing device on the LANDSAT satellite that collects simultaneous images over multiple ranges of the spectrum.

Multi-user - The capability of a computer to support more than one user connected to the system simultaneously and provide access to the same files or programs.

Multimedia - A combination of various media, such as sound, graphics, animation, and video.

Multipurpose cadastre - The basic components of a multipurpose cadastre are a geodetic reference frame, a base layer that uses the geodetic reference frame for control, and a cadastral overlay that is controlled by references to both the geodetic reference frame and features on the base layer. Multipurpose cadastre systems also integrate a large number of other parcel records keyed to a unique

parcel identifier. These ancillary records may include information used for legal reference (legal cadastre), data related to land valuation and taxation (fiscal cadastre), and information used for resource and facility management (resource cadastre).

Multisensor images - Coregistered images with the same cell size collected by different sensing devices. For example, a 10-meter SPOT panchromatic image can be coregistered with a resampled LANDSAT TM image so that their cells correctly match. This combination is called a multisensor image.

Multispectral images - Images optically acquired in more than one spectral or wavelength interval. Each individual image is usually of the same physical area and scale but of a different spectral band. The MSS and TM sensors aboard the LANDSAT satellite both collect simultaneous multispectral images. The TM sensor scans and stores seven individual images in spectral bands ranging from the blue wavelengths up to those in the thermal infrared.

Multitasking - The ability of a computer, operating system, or application to perform more than one task or operation at the same time. For example, a multitasking operating system might let the user simultaneously use the computer to process an image, download information from a remote computer with a modem, print out a file, and sort a database.

Multitemporal images - Coregistered images collected at different times by the same device. For example, airvideo images collected one year apart, digitized, and warped to the same geometry are called multitemporal images and can be analyzed to map the changes between the dates.

Multivariable images - An image stored on more than one independent, coregistered raster. For example, a framegrabbed video image stored as independent red, green, and blue rasters is a multivariable image. So too, is any multitemporal, multispectral, or multisensor image.

NAPP aerial photographs - **N**ational **A**erial **P**hotography **P**rogram aerial photographs. USGS CIR high altitude aerial photographs. The NAPP series replaces the NHAP series. (See also *NHAP*)

NCGIA - **N**ational **C**enter for **G**eographic **I**nformation and **A**nalysis. A research center with sites at the University of California, Santa Barbara, University of Maine, and the State University of New York at Buffalo dedicated to research into GIS.

ND, ND6 and ND7 - **N**ormalized **D**ifference. Vegetation index computations developed for use with LANDSAT MSS. These vegetation indices are now commonly used with any image that has the required spectral bands. The bands required are approximately equivalent to the red and the photo-infrared spectral bands measured by color-infrared film. The ND6 index used MSS band 6, and ND7 uses band 7. Since these two LANDSAT MSS infrared bands are so highly correlated, similar results are possible using either of the computations or with any images that have an equivalent photo-infrared spectral band. Good color-infrared image sources for processing into an ND or green biomass raster include LANDSAT MSS and TM, SPOT CIR, 35mm CIR film, 9" CIR film, and CIR video.

Nearest neighbor sampling/interpolation - Resampling a source raster to yield a new raster with a different cell size, raster orientation, and/or internal geometry by computing the distance between the centers of each cell in the output raster and the 4 nearest cells in the input raster. The data value for the closest input cell is assigned without alteration to be the data value of the output cell. Therefore, the input value of one input cell maybe assigned to more than one output cell. It also means that some input cells may not be transferred at all to the output raster. These undersampling and oversampling situations occur when the cell sizes of the input and output raster are different. For example, a resampled output raster which is coparallel to the input raster but which has cells half as big, will repeat the input values in a 2 x 2 cell pattern. However, since nearest neighbor resampling does not mathematically compute the new cell's value, it is the only suitable choice for rasters with categorical data (data that is not mathematically continuous) such as land cover maps.

Neighborhood analysis - In a GIS, a type of analytic process run on cell data in which a new value is assigned to each cell as a function of the values in surrounding cells.

Network - A group of computers connected by cables and using special software that allows them to share equipment such as printers and exchange information.

Network analysis - Analytical techniques concerned with the relationships between locations on a network, such as the calculation of optimal routes through road networks, capacities of network systems, best location for facilities along networks, etc.

Network database structure - A method of arranging data in a database so that explicit connections and relations are defined by links or pointers of a many-to-many type.

Network disk drive - A disk drive that is available for public use on a network. Network disk drives are often used to store data files for many people in a work group.

Network printer - A printer shared by multiple computers over a network. (See also *Local printer*)

NHAP aerial photographs - **N**ational **H**igh **A**ltitude **P**rogram. NHAP is underwritten by the USGS and provides a publicly available collection of CIR aerial photographs covering the United States in print or transparency format.

Nibble - A data element made up of 4 bits and having 16 possible values. Nibbles are stored two to a byte.

Node - A point at which two or more lines meet; called an edge or vertex in graph theory.

Node element - A single point defined by a set of coordinates in space, and one of the types of elements in a vector object. Nodes may be lone points, or may occur as the terminal point at the end of (never in the middle of) one or more line elements.

Noise - Irregular variation, usually short range that cannot be easily explained or associated with major mapped features or processes.

Nominal image map - A preliminary map form that approximates an image map and that can usually be prepared using fully automated procedures. For example, image processing software can automatically extract a 7.5' nominal image map from LANDSAT or SPOT satellite images in less than a minute using the positional and angular properties provided with the images. However, to convert it to an accurate image map, the user must introduce ground control points. A topographic map that has been scanned and assembled with a tiling process (but not yet calibrated) is another example of a nominal image map. (See also *Image map*)

Non-graphic information - See *Attribute.*

Non-interlaced video - Video signal formats used in some new display boards and monitors. A non-interlaced video display board refreshes the whole display every 1/60 of a second. It does not intersplice fields but paints each successive line from top to bottom of the screen. Since the line refresh is twice as fast as standard video technology, the picture and lines do not noticeably decay between frames.

Nonsolid color - A color produced by a pattern of differently colored dots that simulate the desired color. A solid color on one device (such as a 256-color monitor) may be nonsolid on another device. Also known as dithered color. (See *Solid color*)

Normalized histogram - A histogram whose distribution has been adjusted so as to have as close to a normalized (bell-shaped) distribution as possible. The data value that occurs most frequently will be near the center of the histogram. Multimodal histograms are those which have two or more significant peaks in their distribution and thus usually cannot be normalized satisfactorily.

Northing - A rectangular (x,y) coordinate measurement of distance north from an east-west reference line, usually the Equator or other parallel used as the axis of origin for a map zone or projection. False northing is an adjustment constant added to coordinate values to eliminate negative numbers.

NTSC video - **N**ational **T**elevision **S**tandards **C**ommittee video. The standard 525-line 60-field format used by all American home video equipment (like VCR recorders and television sets). All the necessary color information is encoded in a single interlaced signal which is often called composite color video.

Nugget variance - In a kriging procedure, the nugget variance is a spatially uncorrelated noise. It combines the residual variances of measurement errors together with spatial variations that occur over distances much shorter than the sample spacing, and that consequently cannot be resolved.

Numerical taxonomy - Quantitative method for classifying data using computed estimates of singularity.

Object code - A computer program that has been translated into machine-readable code by a compiler.

Object-based programming - A language that allows direct modeling of objects in the real world, such as parts, machines, cars, ships, people, or bank accounts.

Object-oriented database - Ordinary drawings and CAD systems represent data as lines, points and circles. An object-oriented database represents data as roads or steel pipe, adding so-called intelligence to the system.

Object-oriented programming - (OOP) A programming technique that is object-based and supports classes which allow inheritance.

Objects - 1) A digital representation of all or part of an entity. 2) In object-oriented programming, an encapsulated module containing data and procedures.

Octree - A data structure designed to minimize storage for three-dimensional raster data.

Off-line - The transmission of information between a computer and a peripheral unit before or after, but not during processing, in contrast to on-line processing.

On-line - The transmission of information between a computer and a terminal or display device while processing is occurring, in contrast to off-line processing.

Opaque color - When a new color feature completely masks out an earlier feature in an image, the new feature is composed of opaque (non-transparent) color. For example, a polygon can be overlaid or drawn in opaque color upon an image so as to completely obliterate the original features in that portion of the image.

OPEN LOOK - A graphical user interface (GUI) developed by AT&T and Sun Microsystems, built around the X window system. (See also *X window system*)

Open reel tape - Medical images and satellite images from mainframe and minicomputers are commonly distributed on 12-inch reels of magnetic tape in standard format. A microcomputer with an open reel tape drive can copy image files directly from tape.

Operand - A parameter that designates an object's identification and location in an algebraic expression.

Operating System - (OS) The master control program that governs the operation of a computer system, running job entry, input/output services, data management, and supervision or housekeeping.

Operator - The function in an algebraic expression that describes an action upon an object or the process by which objects, or operands, are to be combined.

Optical disk - A high-capacity medium for computer file storage that uses removable optical disk cartridges that function like removable hard disks. Each side of a two-sided optical disk typically holds from 300 to 500 megabytes of data. Some optical disks (WORM disks) record data permanently - once data has been written on a WORM disk it cannot be erased or changed. More recently, erasable optical (EO) disks have been developed. (See also *Erasable optical disk, WORM drive*)

Optimal estimator - An estimator for minimizing the value of a given criterion function; in kriging this is the estimation variance.

Optimal path selection - Process of using a network database of roads and road intersections to select the optimal path based on specified time/distance relationships.

Optimization - (In GIS display) The process by which a GIS chooses and assigns the best 256 display colors for the display of a three-raster RGB set in 8-bit contexts. With three 8-bit rasters (one with red spectral values, one with green, and one with blue), over 16 million colors are possible (far fewer typically occur). A GIS might then condense the set of actually occurring colors to a set of 4096, reserving 64 standard annotation colors, and then filling the remaining 192 positions in the color table with the most frequently occurring colors. The left-over colors from the 4096 might be assigned to their closest match in the color table. Optimization produces an excellent visual representation of most natural-color scenes.

ORACLE - A relational database management system marketed by Oracle Corporation of Belmont, California. ORACLE was the first commercially available relational DBMS offering SQL as the query language. The DBMS runs on a variety of hardware and

operating systems such as IBM/MVS, IBM/VM-CMS, VAX/VMS, VAX/ULTRIX, PRIME/PRIMOS, and PC.

Ordination - Process of reducing complex multivariate data in order to bring understanding. Because many environmental variables are quite often correlated with each other, it is possible that the data could be simplified by looking for sets of related variables. Principal component analysis is the most commonly used method of examining data measured on ratio scales for intercorrelations. (See *Principal components analysis*)

Orthographic perspective - A perspective display technique that displays a surface as a dense set of parallel profiles yielding a three-dimensional display.

Orthophoto quad - A photomap made from an assembly of orthophotographs.

Orthophotograph - An aerial photograph that has been scanned, rectified, and reconstructed so as to represent its features in a map projection or at least in a flat rectangular form without the usual distortions of geometry and perspective. Usually orthophotos are prepared from very high resolution stereo pairs.

Orthovideo - Airvideo images always include some geometric distortion from the camera, lens, movement, and perspective. Orthovideo images have been geometrically corrected with control points from a corresponding vector object. The control points are used to rubbersheet or warp the airvideo frame to yield a new raster with more map-like geometric properties.

OS/2 - (Operating System/2) A multitasking operating system for personal computers.

OSF - Open Software Foundation. A consortium of vendors dedicated to interoperability between their respective products.

Output - The result of processing data in a GIS; maps, tables, screen images, tape files.

Overlay - A transparent layer placed on an underlying layer or image. The overlay is where symbols, annotations, or image traces can be created or displayed without changing the underlying image.

Overlay analysis - The process of combining spatial information from two or more maps to derive a map consisting of new spatial boundaries.

Package - A set of computer programs that can be used for a particular generalized class of applications.

Page layout - The process of selecting, sizing, and positioning multiple items to compose a page for printing.

Paint - To fill an area with a given symbolism on a display device.

PAL color video - A video standard generally used outside the United States and Canada that is not compatible with NTSC.

Palette - Refers to the combination of colors that can be displayed at one time. Many display devices allow the composition of a palette from a wide range of color choices. For example, the EGA adapter allows palettes of 16 colors to be defined from 64 possible colors.

Panchromatic image - An image collected in the broad visual wavelength range but rendered in graytone (black and white). The term has historically referred to a black and white photograph of a color scene. Since the SPOT satellite 10-meter images are collected over this broad visual spectral band and are usually rendered in black and white, these images are called panchromatic.

PARADOX - A popular PC-based database management system marketed by Borland. It has menu-driven interfaces.

Parallel port or parallel interface - A physical connection between a computer and a peripheral device, such as a printer. A parallel or Centronics port uses a connection that has more than eight wires. Eight of the wires simultaneously convey the eight bits in a byte of data, while the remaining lines control status information such as "send me more" and "stop sending." DOS currently allows the use of three different standard parallel ports, which are named LPT1, LPT2, and LPT3.

Parallelepiped classifier or decision rule - A simple form of automated computer interpretation slightly more complex than boxcar interpretation (see *Boxcar classifier*). For parallelepiped classification, the boundaries between classes need not be rectangular or

parallel to the axes. A parallelepiped representing the location of each material sought is prism-shaped in the 2-, 3-, or n-dimensional distribution of the available multivariable images.

Parallels - Circles on the Earth's surface, or lines on a map that are perpendicular to the axis of the earth, and mark latitude north or south of the Equator.

Parametric map - A map with certain criteria that, as a whole, describe a statistical population.

Parity - An error-checking procedure in which the number of 1s must always be the same - either even or odd - for each group of bits transmitted without error.

Partition - An assignable segment of disk space on a machine.

PASCAL - A high-level programming language.

Pass point - A point that is co-located on two raster objects that have an overlapping geographic extent. Pass points are used in the manual mosaic process to establish the relationship between adjacent pieces of the mosaic that provide no absolute ground control information, but do show some common ground feature in each piece. For example, multiple frames of airvideo can be tied together with pass points (farm buildings, field corners, bushes, rock outcroppings, bends in streams) even if the map coordinates are not known for such features. Then, the map calibration for the entire sequence can be established from control points sparsely located in the mosaic sequence (such as road intersections) for which the map coordinates are known. (See also *Control points*).

Patch method - Mathematical methods of surface fitting rely on continuous three-dimensional functions that are capable of representing complex forms with a very high degree of smoothness. The local methods split a complete surface into square cells or irregularly shaped patches of roughly equal area and the surface are fitted to the point observations within the patch. Weighting functions are used to ensure that the surface patches match at the edges.

Path - A DOS path is a description of the hierarchical chain of directories that define the logical location of a file.

Pattern matching - A technique to determine the occurrence of a particular pattern or feature by overlaying two or more images.

pcARC/INFO - A vector-based Geographic Information System developed and marketed by ESRI, Inc.

PCIPS - A raster-based microcomputer image processing system. This is a menu-oriented entry-level system that runs on standard color display cards such as CGA and EGA.

Pel or picture element - The smallest graphic unit that can be displayed on the screen, usually a single-colored dot. Different display hardware allows for more or fewer pels on the screen, determining the display resolution that is possible. The more rows and columns of pels, the finer the image detail that can be resolved. (See also *Pixel*)

Pen plotter - An output device for line drawings that mechanically moves an ink pen over the drawing surface.

Performance - The degree to which a device or system fulfills its specifications.

Perimeter/area measurement - A procedure for geometrically computing the perimeter or area of a polygon feature.

Peripheral - Any device which is attached to or installed in the system unit. Examples include printers, modems, image scanners, and pen plotters.

Perspective view generation - From a digital elevation model, generate a three-dimensional block diagram.

Photo interpretation - Analyzing, measuring, and categorizing chosen features from aerial photographs.

Photogrammetry - Obtaining precise measurements from images.

Physiographic - Describing the characteristics of a site's physical geography.

Pit - A depression in the digital surface of a DEM, often caused by noise. The noise may result from short range variations on the digitized land surface (e.g., resulting from a cleared patch in a forest) or from the quantization of the original data.

Pixel depth or color depth - The number of data bits each pixel represents. In 8-bit contexts, the pixel depth is 8, and each display pixel can be one of 256 possible colors or shades of gray. With a 24-bit raster (or with three coregistered 8-bit rasters) the pixel depth is 24, and 16,777,216 colors are possible.

Pixel or picture element - The smallest element of an image that can be individually processed in a video display system. The text and images on a computer display are created by combinations of individual dots (pixels). Different display hardware allows for more or fewer pixels on the screen, determining the display resolution that is possible. The more rows and columns of pixels, the finer the image detail that can be resolved.

Plane coordinates - Coordinates specifying the locations of points in a plane. In cartography the plane usually is a projection of the Earth's surface onto a flattenable cone or cylinder, and the x and y values scaled along the rectangular axes are called eastings and northings, respectively.

Planimeter - An instrument for measuring mechanically the area of plane figures.

Planimetric map - A map designed to portray the horizontal positions of features; vertical information is specifically ignored.

Plat map - A map representing property, subdivision, and political boundaries.

Platform - A combination of hardware and software that a user employs in his or her endeavors.

Plotter - A device for drawing maps and figures.

Plotter font - A font created by a series of dots connected by lines that can be scaled to different sizes (used by plotters). Also known as *vector font*.

Point - A level of spatial measurement referring to an object that has no dimension. Examples include wells, weather stations and navigational lights.

Point data - In a vector structure, data consisting of single, distinct (x,y) coordinates. In a raster structure, point data is represented by single cells.

Point in polygon - The ability to superimpose a set of points on a set of polygons and determine which polygons (if any) contain each point.

Point mapping - The depiction of attributes with graphic symbols or alphanumeric values as per user specifications.

Point size - The vertical size of a text font is expressed in points. There are 72 points in an inch, so a 12-point font would be 12/72, or 1/6 of an inch tall, while a 36-point font would be 36/72, or 1/2 inch tall. Of course the heights of different letters vary (L is taller than e). The point size refers to the distance between the highest ascender in a font's character set (the part above the line in a letter like l or b), and the lowest descender in the set (the part below the line in a letter like g or y). (See also *Vector font*, *Bitmapped font*)

Pointer - The tool used to select a graphic element.

Polygon - A two-dimensional figure with three or more sides intersecting at a like number of points. In GIS systems, an *area*.

Polygon data - In a vector structure, data defined by an enclosing line or lines. In a raster structure, a group of contiguous cells containing identical values.

Polygon mapping - A cartographic display of regularly or irregularly shaped polygons and their attributes. Typically, this capability includes shading, symbology and numeric labeling, as well as a variety of other map cosmetic functions for generating alphanumeric

labeling of polygons.

Polygon merge/dissolve - The capability to merge/dissolve two or more polygons which share common attributes by eliminating the shared boundaries.

Polygon overlay - A function which allows the processing of one or more sets of polygons which have been overlaid to form a combined set of polygons.

Polygonization - Process of connecting arcs or *spaghetti* to form polygons.

Polynomial - An expression having a finite number of terms of the form $ax+bx^{2}+?..+nx^{n}$.

Pop-up program - A memory-resident program that is located in memory but isn't visible until the user press a certain key combination or until a certain event occurs, such as receiving a message. (See also *Memory-resident program*)

Popup - Information or a set of choices that appears on the text screen when a function key is pressed. Popups provide access to temporary and lateral processes, such as making a quick measurement from the screen. After a popup process is finished, the system returns to the same state and location as when the popup was invoked.

Port - A physical and logical interface for connecting a computer to a peripheral component (such as a printer or a modem).

Portability - The ability to move software code from one machine environment to another with no (or minimum) changes.

Post-processor - A computer program that is used to convert the results of another operation into a standard format ready for the analysis.

PostScript - A standard page-description computer language developed by Adobe Systems, Inc. that tells PostScript language interpreter equipped printers (PostScript printers) how text, images, and graphics should appear on the printed page. It is used in many computerized phototypesetting systems.

Potential - An estimate of the interaction between one location and all other locations in a region, based on the magnitudes of some phenomenon at each of those locations, such as pressure potential, hydraulic potential, etc.

Pour point - (watershed analysis) The low point on the boundary ridge between two neighboring watersheds. It is the point through which water from one watershed would begin spilling over into its neighbor if it were completely filled.

Precision - Degree of detail in the reporting of a measurement. Generally refers to the number of significant digits of information.

Prime Meridian - The meridian on the Earth's surface from which longitude is measured; generally the meridian of Greenwich, England.

Principal components analysis - A statistical technique for reducing an image's dimensionality. Principal components chooses uncorrelated linear combinations of a set of rasters in such a way that each successively extracted linear combination, called a principal component, has a smaller variance. If the rasters have significant linear intercorrelations, the first few components will account for a large part of the total variance. (See *Ordination*)

Print queue - A list of files that have been sent to a printer. The list indicates the file currently printing and those waiting to be printed.

Print raster object - A raster object that contains a dot-by-dot representation of a color print page. For example, each cell in this raster object might be a nibble (1/2 a byte) and might specify 16 data levels. These level values are used to define one color composite dot on the printed page. Printers create each color composite dot from dots of cyan, magenta, and yellow (and possibly black) or red, green, and blue (and possibly black). Combinations of the three colors together with black and white are specified by each nibble's data levels. When a raster object is sent to a color printer, the printer driver for that device translates each nibble to a bit-by-bit map that controls each color's printing mechanism (ink jet, transfer head, or pin). (See also *Nibble*, *Printer driver*)

Printer driver - Special software that controls how the computer and printer interact and share information such as the printing interface, descriptions of fonts, special features, etc.

Printer font - Fonts that are stored in the printer's memory, or soft fonts that are sent to the printer before a file is printed.

Probability - A statistical description of the relative possibility that an event will occur. Probability is expressed as a ratio of the number of actual occurrences to the total number of possible occurrences.

Processing mask - The user defines a processing mask in the feature mapping process to identify which portions of an image to include in the feature mapping analysis, and which to exclude. For instance, a user can outline an irregular area in an airphoto to include, but exclude lake surfaces in that area, and yet include islands in the lakes. (See also *Data mask*, *Feature mapping*)

Program - A precise sequential set of instructions directing the computer to perform a task.

Progressive sampling - A data sampling technique. Sampling and data analysis are carried together, the results of the data analysis dictating how the sampling should proceed. Sampling can be manual - i.e. guided by a human operator.

Projection change - The ability to transform maps from one map projection to another.

Projection or map projection - A device for representing all or part of a rounded surface on a flat sheet. Since this cannot be done without distortion, the cartographer must choose the map characteristic (area, shape, scale, direction) which is to be shown accurately at the expense of others. (See also *Ellipsoid*)

Prompt - A screen display, such as a blinking underline or a question mark that may be accompanied by a beep, indicating the need for a keyboard response by the user.

Protected mode - A computer's operating mode that is capable of addressing extended memory directly.

Protocol - 1) A set of rules established between two devices to allow communications to occur. 2) A set of rules that define how computers communicate with each other.

Proximity analysis - A procedure which involves the creation of polygons or areas around randomly spaced point locations. It is carried out by dividing equally the distance between paired points, then generating perpendicular lines to these mid-way points which are then extended to intersect and form areas. This process is used for creating polygons, mapping, and analyzing qualitative data where a continuous coverage map is desired, but where contouring is not appropriate. It is possible to obtain pictorial displays of discontinuous data using this method.

Proximity map - A map that shows the distance from selected features by gradient shades of color.

Pseudo-color image - A color image that does not directly render the colors of the original image from individual red, green, and blue color values. A pseudo-color image could result from such processes as assigning colors to the gray levels in a grayscale image or assigning colors to a cluster map. (See also *Composite color raster object*)

Pseudo-random - (GPS) A signal with random-noise-like properties. It is a very complicated but repeated pattern of 1s and 0s.

Puck - A hand-held pointing device. For mapping, where considerable accuracy is required, a puck consisting of a coil embedded in plastic with an accurately located window with cross-hairs is used. The coordinates of a point are digitized by placing the cross-hairs over it and pressing a control button on the puck.

Purposive sampling - A data sampling technique. Sampling may proceed in various modes, depending on the product required. For example, in creating a DEM, contour lines, form lines, profiles and morphological lines can be used.

Quad or quadrangle map - (Also *Map quad* and *Map quadrangle*). The geographic area covered by a map. One kind of map quadrangle is the 7.5' x 7.5' area that is covered by a standard USGS 7.5' topographic map. Referring to a 7.5' map quadrangle does not imply the presence of an actual paper map. The term may simply designate the area covered by electronically stored materials.

Quadrant - A quarter of a circle, 90 degrees.

Quadratic polynomial - One in which the highest degree of terms is 2.

Quadtree - A data structure used to reduce the storage requirements of a raster by coding contiguous homogenous areas singly. A raster of 2^n by 2^n cells is recursively divided into four equal squares. Subdivision continues in each square until the square is homogeneous or subdivision is no longer possible.

Qualitative - In mapping, *qualitative* refers to feature labels that are not quantitative. For example, a "10" representing the land use category *residential.*

Quantitative - In mapping, *quantitative* refers to feature labels that are real numbers, such as population per square mile, elevation, etc.

Quantization - Dividing a continuous range into a finite set of discrete values called quantization levels. If too few quantization levels are used, false contours may appear in an image. Quantization levels are often referred to as *gray levels*, but the concept can also apply to color images.

Query - To find specific information in a database.

Query language - A language employed by database users to retrieve, modify, add, or delete data, such as Structured or Standard Query Language (SQL). (See also *SQL*)

RAM - **R**andom **A**ccess **M**emory. Read/write memory for programs and data that the computer uses as a general work area. The more RAM in a computer, the more general work space it has and the larger the projects it can handle. High speed RAM can be added to a computer with memory expansion boards. The RAM work area is accessed by numbered addresses that point to chunks of 1024 bytes (a kilobyte or K). The original DOS-based PC architecture limits the RAM a computer can directly access to 640K. Display boards generally have their own memory (elements in the display board's memory array correspond to display pixels) and do not use system RAM. There are two basic types of RAM chips: Static RAM (SRAM) and Dynamic RAM (DRAM). SRAM chips are faster, but are also more expensive than DRAM. When the computer is turned off, all information in the RAM is lost.

RAM cache - A method of storing frequently-accessed data in static RAM that is much faster than the system's main memory, resulting in a significant increase in system speed.

RAM disk - RAM beyond the standard 640K that is reconfigured to work like a very high speed disk drive.

Random-access file - A file, such as a disk or drum file, for which the time required for access is independent of the location of the information most recently stored or retrieved.

Range extraction - A method of converting a grayscale raster object into a binary version. In range extraction, two boundary values are selected to bracket the desired range of grayscale values. Everything above and below the boundary values is set to 0 (black), while everything between the boundary values is set to 1 (white).

Raster algebra - Manipulations and functions that operate on raster objects cell by cell. Any raster object can be used as a variable, or operand, in a raster algebraic expression. A combination of operands is assembled in an equation and then a raster object is assigned to each operand. The result of the operation is stored in a new raster object.

Raster cell - One value in a raster defined by its row and column position. A raster cell value may be the elevation above sea level at one position in a survey site or the intensity of red radiation for a pixel in a video image. For convenience, a raster cell is usually thought of as square or rectangular, although many image collection devices actually measure circular or elliptical areas.

Raster display - A device for displaying information in the form of pixels on a CRT.

Raster map - A map encoded in the form of a regular array of cells.

Raster or raster object - A raster is a data structure (logically, a 2-dimensional array) that contains rows and columns of numbers of a single data type. Each number represents the value of some parameter (like elevation or red spectral intensity). Each number (or

cell value) is often used to control the color and intensity of one pixel on a computer's display screen. A complete computer image can be displayed from the values in a raster that has as many rows and columns as the computer has pixels for the screen.

Raster-to-vector - The process of converting an image made of cells into one described by lines and polygons.

Raster/vector conversion - The ability to convert data between vector and raster forms with grid cell size, position and orientation selected by user.

Rasterize reclassify - To convert data from vector format to cell format. In GIS, a type of data analysis entailing reassignment of values to existing spatial data.

RDBMS - See *Relational database management system*.

Real numbers - Numbers that have both an integer and an decimal component.

Real-time - Any process that occurs rapidly enough to provide the impression of instantaneous response.

Reclassify attributes - Reclassification is the change in value of a set of existing attributes based on a set of user-specific rules.

Record - A group of items in a file treated as a unit. For example, all data items for a census tract can be grouped as a record and assigned to a single segment of a magnetic tape file for convenient storage and retrieval.

Rectification - Removing geometric distortion from a raster or a vector object. Rectification is usually achieved by aligning raster features or vector coordinate positions with features in a base map or other coordinate reference framework. Rectification may be used to bring several distorted image segments into a common framework so they can be combined into a larger image.

Redundancy - The inclusion of data in a database that contribute little to the information content.

Reference image - An image on the display monitor used for visual reference that is generated by (or otherwise corresponds to) a raster object or set of raster objects.

Refresh rate or Vertical scanning frequency - Describes how often the monitor paints a complete screen (or refreshes the screen). Vertical frequencies are measured in Hz. Higher vertical frequencies are associated with less flicker.

Region - An identified subset of the geographic database. Regions may be permanently defined and named subsets, such as a watershed, or interactively defined by the user through such methods as outlining an area on the display screen or by searching for an area of the database with common attribute values.

Registration - Geometrically aligning sets of image data so that corresponding features are coincident. (See also *Coregistration*)

Regression - A statistical technique that allows one to examine the relationship between two or more quantitative variables. This relationship is expressed in terms of the correlation between the variables,
i.e., the degree of association, and a best fit trend line that express mathematically the character of the relationship.

Relational database - A method of structuring data in the form of sets of records or tuples so that relationships between different entities and attributes can be used for data access and transformation.

Relational database management system - (**RDBMS**) Any database management system that can access a relational database, generate responses to ad hoc queries and preformatted reports by using relational algebra or calculus, and perform routine update operations.

Relational operators - In GIS, phrases such as *greater than*, *less than*, *maximum*, *minimum*, used to compare values associated with spatial data.

Relief (as in shaded relief) - The variation in a raster object's values that shows differences between a surface's higher and lower parts in elevation and slope.

Remote sensing - The act of detection and/or identification of an object without having the sensor in direct contact with the object. Includes satellite imagery and aerial photography.

Report generation - A mechanism by which information is identified, extracted, ordered and displayed in tabular form, based upon access from a single file or a set of files.

Resample - To interpolate cell values in a raster object and create a raster with larger or smaller cells. (See also *Interpolation*)

Residual variance - In GIS spatial analysis, a spatially independent Gaussian noise term having zero mean and variance.

Resolution - The level of image detail or sharpness determined by how many picture elements compose an area of a display or corresponding raster object. Resolution may refer to sensors, raster objects, or displays. Low resolution display devices produce images with a grainy visual texture. High resolution displays use such small picture elements that they can produce a near-photographic quality image. (See also *Ground resolution*)

Response time - The time that elapses between sending a command to the computer and the receipt of the results at the workstation.

RGB - **R**ed, **G**reen, and **B**lue. The red-green-blue color model uses position within a cube to describe colors. The axes of the cube are the red, green, and blue values. The shades of gray are found along the diagonal from the origin of the cube, where red, green, and blue values are zero and the apparent color is black, to the opposite corner, which appears white (red, green, and blue values are 100%). (See also *HIS*)

RGB video - A video image composed of separate red, green, and blue signals. RGB video is a general term that applies to different technologies (analog or digital) and standards (like TTL and RS-170).

ROM - **R**ead **O**nly **M**emory. A microcircuit containing programs or data that cannot be erased. When new data or programs can replace old ones, the microcircuit is called an EROM, for erasable ROM, or PROM, for programmable ROM.

Router - A designated machine on a network that enables communications between a machine on that network and one using another protocol, such as a machine on a TCP/IP network using X.25 talking to one using Ethernet. (See also *Network*, *Protocol*, *TCP/IP*, *Ethernet*)

Row - A horizontal list of data values or display cells in a raster object or display.

RS-170 video - A standard for RGB analog video in the USA that governs the form of the RGB color signals. RS-170 video has a 15.7khz horizontal scan rate and a 30 cycle-per-second frame rate. It is not modulated with a carrier as is broadcast video.

Rubbersheeting - Any process in which a raster is stretched differentially to match a new set of geometric constraints. This shape change could be defined by any one of many transformations such as changing a map projection, trilateration to change the absolute position of cells within a raster, fitting a polynomial to a surface, least squares movement of control cells, and so on.

Run-length coding - A method of reducing the storage requirements of a raster.

Sample - A group of cells in an image selected to represent one feature type or land cover of interest.

Sampling - The process of approximating an object such as an image using a selection of subobjects such as pixels. Sampling is usually done at constant intervals. Generally, as the number of samples increases, the quality of the object increases.

Saturation - One of the three coordinates that the HIS color domain uses to define a display color. Saturation designates how far away a color is from a gray or neutral color of equal intensity. (See also *HIS*)

Scale change - To perform the operations associated with change of scale, which may include line thinning and generalization.

Scale or map scale - The relationship that exists between a distance on a map and the corresponding distance on the Earth. It may be expressed as an equivalence, one inch equals 16 statute miles; as a fraction or ratio, 1:1,000,000; or as a bar graph subdivided to show the distance that each of its parts represents on the Earth.

Scanner - A digitizing input device somewhat like a photocopy machine that produces an image (raster object) from flat input material such as photographs, maps, and drawings.

Scanning - Process of using an electronic input device to convert analog information such as maps, photographs, overlays, etc., into a digital format usable by a computer.

Scene generation - The ability to simulate an image of the appearance of an area from map data. The image would normally consist of an oblique view, with perspective.

Schema - Data schema. The organization in memory of data, and, in particular, the reference linkages among the data elements.

Scroll - To move the current text or image up, down, or across the monitor so that new text or image appears on one edge of the screen as it disappears from the other.

SCSI port - **S**mall **C**omputer **S**ystems **I**nterface (SCSI is pronounced "skuzzy"). A physical connection between a computer and a peripheral device, such as an external hard drive or optical drive.

Seam - The junction in the area of overlap between raster objects combined by tiling or mosaicking.

Search by attribute - The ability to search the database for objects with certain attributes.

Search region - The area around a point containing all data points to be used in estimating a value, such as surface elevation, at that point. A circular search region may be defined by its search radius.

Sections of land - The U.S. Public Land Survey System divided much of the U.S. into square sections of land with an area of approximately 1 square mile (sides 1 mile long). Since most of this survey was completed in the late 1800s, these sections vary greatly in area and shape. In some areas survey adjustments have created sections as large as 2 square miles. Sections are the basic unit of land ownership in the central and western U.S. They are usually bounded by roads that give rise to the checker board land patterns characteristic of these areas.

Segment - (in the context of feature mapping) The area selected for analysis and measurement within a study site. The raster object(s) a user selects for processing may contain areas that the user does not want to include in his/her study. In segmentation the user uses a set of drawing tools to turn cells "on" and "off" for the subsequent processing steps. For instance, if one is interpreting airphotos to measure wetland features of duck habitat along a river floodplain, one can create a segment to restrict the feature mapping analysis to the floodplain, excluding other areas contained in the processing raster(s). If one does not define segments, the entire area covered by the raster object(s) is considered to be the processing segment. Segments may be larger than the display screen, may be discontinuous, and may have holes.

Selection query (in database queries) - A selection query is constructed from one or more comparison expressions. Only if the entire query evaluates to "true" (non-zero) for an element, is the element included.

Selective sampling - One of the data sampling techniques (e.g., for constructing DEMs). Sample points are selected prior to or during the sampling process which is from ground or aerial survey.

Semivariogram - A figure relating the variance of the difference in value of an attribute at pairs of the sample points to separation distance.

Serial class - Refers to the intervals which have limits that are in direct mathematical relation to one another. If these limits are chosen to be independent of the characteristics of the particular data set, then results from different samples or data sets will be strictly comparable. Examples are normal percentiles, standard deviation, mean, etc. (See *Exogenous class*, *Idiographic class*)

Serial port - A physical connection between a computer and a peripheral device, such as a plotter via RS232 interfaces. A serial port uses a connection that has at least three wires. (The standard IBM AT serial port uses nine wires.) The eight bits in a byte are

transmitted serially, one after another, through a single line while the remaining lines contain status information such as "send me more" and "stop sending." DOS currently allows the use of two different standard serial ports named COM1 and COM2.

Serial printer - A printer using a serial interface to communicate with the computer.

Server - See also *Network disk drive.*

Shaded relief map - A relief map with shades according to the altitudes of the relief from a certain perspective.

Shadow RAM - A method of relocating the system and/or video BIOS from slower ROM chips to faster RAM to improve system performance.

Shell - See *Kernal*.

Similarity matrix - A matrix which has the size of ½N(N-1), where N is the number of items in the data set.

Simulation - Using the digital model of the landscape in a GIS for studying the possible outcome of various processes expressed in the form of mathematical models.

Skeletonizing - A method for storing the outline of an area in the minimum space by contracting the area to a central line.

Sliver - A gap between two lines, created erroneously by a scanner and its raster-vector software.

Sliver polygon removal - To detect automatically the small sliver polygons that result from a polygon overlay operation when certain polygon lines on the two maps represent different versions of the same physical line.

Slope - A measure of how steeply a surface or line inclines. Slope is computed by dividing a line's vertical rise or fall by the distance the line travels on the surface (the "rise over the run") - usually expressed as a percentage.

Small scale - A mapping scale which covers a relatively large area and has generalized labels. The term *small* refers to the fraction represented by the ratio of map distance to ground distance. For example, 1:500,000 (one map unit equals 500,000 ground units.)

Smart line following - An interactive process for converting raster line images to line elements in a vector object. The user clicks on a line image, and the process follows the line, overtracing a vector line. The process stops at the edge of the raster, at the end of the line, or at a spaghetti junction of lines that the user must guide it across.

Smart terminal - A computer terminal with a minicomputer able to perform its own computations as well as provide communication with a host computer.

Smoothing - A set of procedures for removing short-range erratic variation from lines, surfaces, or data series.

Soft copy - A temporary image of a map or diagram, for example, on the screen of a CRT display.

Soft font - A font, usually provided by a font vendor, that must be installed on a computer and sent to the printer before it can be printed. Also known as a *downloadable font.*

Software - General name for computer programs and programming languages.

Solid color - A color that appears on a display when all pels are the same color. On a monochrome display, there are only two solid colors: black and white. (See *Nonsolid color*)

Solid modeling - The process of rendering a 3D surface from vector type data. This process is widely used in CAD software packages to prepare a realistic color presentation of a component part, a building, or other solid object from complex vector-oriented engineering drawings. In GIS vector-oriented software, contours of the surface of the land stored as vectors might be used to render a solid model of the land's surface.

Source code - A computer program that has been written in an English-like computer language. It must be compiled to yield the object code before it can be run on the computer.

Source document - Document that provides information for conversion.

SPANS - A GIS marketed by TYDAC Technologies Corporation. It has raster, vector, and quadtree data structures, and operates on PCs and workstations as a self-contained desktop GIS.

Spatial - Refers to phenomena distributed in two or three dimensional space and therefore having physical dimensions.

Spatial autocovariance - The characteristic that loci close together are more likely to have similar values than loci that are far apart.

Spatial correlation - The spatial association among objects.

Spatial query - A process of the extraction of cartographic data based on user specified windows, such as a circle, or other regular and irregular shapes.

Spatial resolution - Measure of the ability of an imaging system, such as LANDSAT, to separate the images of closely adjacent objects. Also, the smallest area identified as a separate mapping unit.

Special character - Characters not found on computer's keyboard.

Special-purpose map - Any map designed for special rather than general use. Usually the information on a special-purpose map is emphasized by omitting or subordinating other information of a general character. A word or phrase such as *geological* or *hydrologic* is usually used to describe the type of information which a special-purpose map is designed to contain.

Spectral band or spectral region - A well-defined, continuous wavelength range in the spectrum of reflected or radiated electromagnetic energy. Red, green, and blue are all spectral regions within the portion of the spectrum that is visible to humans as light. Color-infrared images are composed of red, green, and a spectral region commonly called the photoinfrared, which is not in the visible portion of the electromagnetic spectrum. (See also *Electromagnetic spectrum, Color-infrared*)

Spike - An overshoot line created erroneously by a scanner in its raster-vector software.

Spline - An interpolating polynomial for a set of coordinate points used to fit a curve that connects the points. (See also *Bezier curve* and *Bicubic spline*)

Spool - To print a file in the background while working on something else.

SPOT - The **S**ysteme **P**robatoire d'**O**bservation de la **T**erre. A French multispectral satellite with pointable sensors first operational in 1986. There are two kinds of SPOT images - one with 10 meter ground resolution in a single panchromatic spectral region; the other with 20 meter resolution in the three spectral regions used for color-infrared maps. SPOT satellites may be pointed at an angle off-axis or off-nadir to collect forward and rearward images, a technique that yields stereoscopic image pairs from which accurate elevation rasters can be computed.

Spot heights - Given a digital elevation model, interpolate the height at any point.

Spur - A false line segment that extends a short distance beyond a T-junction of two lines.

SQL - **S**tructured or **S**tandard **Q**uery **L**anguage. A standard for relational database schema.

Standard - An agree-upon model. There are standards for operating systems, communications techniques, data storage, data representation, and so on. There are *de facto* standards, which become so by a large number of people adhering to them, and *de jure* standards, which are set by standards groups such as ANSI, ISO, and IEEE.

Standard parallel - A parallel of latitude used as a control line in the computation of a map projection, and which is therefore, true to scale. Some map projections have no defined standard parallel, others have one, while others have two.

State Plane Coordinate System or SPCS - The **S**tate **P**lane **C**oordinate **S**ystem (SPCS) defines map coordinates by zone for the United States. Each zone has one central meridian and scale factor, which permits all USGS quadrangle maps in a zone to be mosaicked exactly. Zones with north-
south extent use the Transverse Mercator projection, while those with east-west extent use Lambert Conformal Conic. (The panhandle of Alaska is the only exception, and uses Oblique Mercator).

Statistical functions - The ability to carry out simple statistical analyses and tests on the database.

Stepwise linear classification - A supervised (semi-automatic) image interpretation process applied in the same fashion as maximum likelihood classification using training sets, or prototypes. This method applies the classical techniques of stepwise linear discriminant analysis to set up the classification model and map the materials desired from the input raster objects. (See also *Maximum likelihood classification*)

Stereo elevation - An elevation surface derived from stereo pairs of remote sensing imagery. For example the SPOT satellite can collect an *off nadir* image and then in a subsequent fly-over collect its counterpart to make a stereo pair. The stereo elevation process takes the 3D effect of that stereo pair to derive an accurate raster object of elevation values.

Stereo plotter - A device for extracting information about the elevation of the land surface from stereoscopic aerial photographs. The results are sets of (x,y,z) coordinates.

Storage - The parts of the computer system used for storing data and programs.

Stretch - A method to match a frequency distribution to a theoretical distribution, e.g., in image processing. For a whole map or part of an area, the image is recomputed so that its values match the theoretical distribution.

String - A consecutive sequence of characters.

Subdivide area according to a set of rules - Given the corner points of a rectangular area, topologically subdivide the area into four quarters, or some other prescribed geometric pattern.

Subroutine - A programmed routine that can be *called* from a main program, or some other subroutine, at a point to which the computer returns after executing the subroutine; also called a subprogram.

Subtractive color - Creating color by using absorption or scattering to selectively remove some of the colors of light, or radiation, reaching the human eye is a subtractive process. The use of pigments, such as color printing or painting, demonstrate this subtractive color process. The greater the number of different colored pigments mixed together, the darker a pigmented object appears. This darkness results from an increased absorption of visible light by the pigments and, consequently, less light reflected to the eye. The presence of fewer pigments or their absence altogether results in greater reflectance of visible light. Selective absorption removes a color(s) from the reflected radiation and results in the perception of the complementary color.

Suits-Wagner classification - A simple form of supervised (semiautomatic) classification that operates much like boxcar (or parallelepiped) classification. This method defines the sides of the box for each class as plus and minus one standard deviation from the mean of the values of the prototype, or sample, values selected to represent that class. This method has the advantage that like a simple boxcar classifier, it is very fast to apply the resulting decision rule to the unknown pixel values.

SunOS - Sun Microsystems' version of the UNIX system for its SPARC workstations. It is called *Solaris*.

Supervised classification - A type of semiautomatic multi-spectral image interpretation in which the user supervises feature classification by setting up prototypes (collections of sample points) for each feature, class, or land cover to be mapped.

Suppress - The ability to exclude objects by attribute (the converse of selecting by attribute).

Surface fitting - Techniques that use 3-dimensional vector point data to create a raster object containing an elevation surface. Various methods such as polynomial and piecewise triangulation techniques can be used to fill the gaps between the vector points and

derive the elevation values for the intermediate raster cells.

Surface mapping - A process to create a cartographic display of three-dimensional information in terms of two-dimensional or three-dimensional forms. This can be achieved through contour mapping of three-dimensional relief displays, or color, shading, hatching or other techniques.

SVGA or Super Video **G**raphics **A**rray - A VGA display mode that has a resolution of 1024x768. The SVGA is an enhancement of the VGA. (See also *VGA, CGA, EGA*)

SVHS video - **S**uper **VHS** video. A newer video standard for cameras and recorders. SVHS equipment achieves a higher resolution than conventional VHS equipment. SVHS overcomes some of the VHS band width limitations by maintaining the video in two separate components and signals. (See also *VHS video*)

Sybase - A relational database management system marketed by Sybase Inc., in Emeryvile, California.

Symbol overlay - A vector object can have symbol shapes assigned to some or all of its nodes. When this vector object is displayed over (or overlaid on) an image, a user can also choose to display the symbols over the top of the features in the underlying image. Such symbols may also be attached to database records and used to retrieve such reference information graphically. For example, a symbol overlay that uses ducks to represent nesting sites could be shown over a habitat map. A click on a particular duck symbol could retrieve a record from an associated database and display it on the text screen to provide such information as the date of first occupancy, number of eggs, number of fledglings, etc. (See also *Overlay*)

Syntax - A set of rules governing the way statements can be used in a computer language.

Synthetic resolution - An apparent increase in spatial resolution achieved either by resampling image rasters or by combining images from different sensors of varying resolutions (such as 10-meter SPOT panchromatic and 30-meter LANDSAT-TM multispectral).

Tablet - A small digitizer used for interactive work on a graphics workstation.

Tape drive - A device for reading and writing computer files on magnetic tape.

TARGA file - **T**ruevision **A**dvanced **R**aster **G**raphics **A**dapter file. A file saved or loaded from an ICB, TARGA, or VISTA display board in one of several related TARGA formats. These formats are widely used with other boards and software to transport color images between microcomputer software and systems.

Terabyte, Tbyte, or Tb - A unit of measurement for 1,000,000,000,000 bytes.

Terminal - A device for communication with a computer, usually including a keyboard and either a CRT display or a printer.

Tesselation - The process of splitting an area into tiles. (See also *Dirichlet tesselation*)

Text - A string of characters grouped in a file on a display screen, or printer.

Text editor - An interactive program enabling the user to enter and edit text, as well as retrieve files and print text. A word processor is a text editor.

Text file - A file containing only letters, digits, and symbols. A text file usually consists of characters coded from the ASCII character set. Also known as a data file. (See also *Binary file*)

Text object - Anything from a simple string of ASCII characters to a more complex, formatted page description.

Thiessen polygons - Methods of dividing areas into tiles according to minimum distance between sample points. Also known as *Dirichlet tesselation* or *Voronoi polygons*.

Thematic map - A map related to a topic, theme or subject of discourse. Also called geographic, special purpose, distribution, parametric, or planimetric maps. Thematic maps emphasize a single topic such as vegetation, geology, or land ownership.

Thematic topics - Overlays consisting of a single type of data that are intended to be used with base data.

Theme - The overall topic of a map in which the spatial variation of a single phenomenon is illustrated (e.g., a vegetation theme map might illustrate vegetative areas such as pinyon juniper, Douglas fir, and sage).

Thinning (rasters) - To remove cells from wide line images in a raster object. When a scanner creates a raster object, the lines in the drawing typically are several cells wide in the result. Before automatic vectorization techniques can work on the data, the line images in the raster object must be thinned to make the line images just one cell wide.

Thinning (vectors) - Reducing the number of coordinate pairs that describe a vector's line and polygon elements. The process discards some of the coordinate pairs as straight line lengths replace curved or noisy segments in the original lines.

Third party software/vendor/developer - A software module or interface specially developed for popular software package users, or the seller or developer of such software.

Three-dimensional (3-D) data - Volumetric data representing measurements in three dimensions, as angular or linear measures such as phi-lambda-kappa, latitude-longitude-elevation, etc.

Threshold (binary) - The separation point for converting grayscale raster cell data into binary (black and white) data. For a raster object scanned with 256 levels of gray, a threshold might be set at 180. Then the output binary raster object would have a 1 for every cell in the input raster object that had the value 180 or higher, and 0 everywhere else.

Thresholding - Setting a data conversion separation limit such that any incoming value above the designated limit, or threshold, is assigned one value (in binary thresholding, a 1) and any incoming value below or equal to the limit is assigned another value (in binary thresholding, a 0). Thresholding can be used to generate a binary raster from a grayscale scan, and to find feature edges during the steps of raster to vector conversion.

TIFF - **T**agged **I**mage **F**ile **F**ormat. A series of standard color image file formats adopted by Microsoft, Aldus, and others to transfer images between different software packages.

TIGA - **T**exas **I**nstruments **G**raphics **A**rchitecture. 1) A display subsystem that provides a standard set of display primitives and can be used to interface with several manufacturers' image display boards; 2) A software interface that standardizes communication between application software and display boards that use one of the 32-bit processing TMS340x0 chips. TIGA divides tasks between the TMS340x0 display processor and the CPU of the host microcomputer to improve performance.

TIGER files - **T**opologically **I**ntegrated **G**eographic **E**ncoding and **R**eferencing files compiled and distributed by the U.S. Census Bureau.

Tile - 1) Raster object image segments that are assembled and trimmed in the tiling process. 2) A way of arranging open windows so that no windows overlap but all windows are visible. Each window takes up a portion of the screen.

Tiling - Assembling large images from smaller segments that have common angular orientations, cell sizes, and map projections. The process is similar to that of assembling floor tiles, except that the raster tiles may have areas of overlap. (See also *Mosaics*)

Time districting - Process to measure time and accumulate time data through a network radiating out from a given point, associating these distance values to the point through which the measurements are taken. This procedure is used to define contour distances away from known points, and to determine districts which are created from a variety of such processes. It may be considered as proximal mapping on a network.

Time sharing - The use of a common CPU by several users in such a way that each user should be able to feel that he or has the whole computer. Time-sharing systems are usually not capable of supporting the massive computing demands of interactive GIS and CAD/CAM systems.

Time slice - The amount of processor time allocated to an application or a task, usually measured in milliseconds. Each application or task can run for this specified amount of time before the next application/task is given control.

TIN - (**Triangulated Irregular Network**) A system designed for digital elevation modeling that avoids the redundancies of the altitude matrix and which at the same time would also be more efficient for many types of computation (such as slope) than systems that are based only on digitized contours. A TIN is a terrain model that uses a sheet of continuous, connected triangular facets, usually based on a Delaunay triangulation of irregularly spaced nodes or observation points.

TM - **T**hematic **M**apper. A sensing device on the LANDSAT satellite that scans and stores 7 individual images in spectral bands ranging from the blue wavelengths up to those in the thermal infrared.

Tool - A program or process that makes performing a task easier.

Topographic map, or topo map - A map that uses colors and symbolic patterns to represent the general surface features of the earth, such as grassland, forest, marsh, agricultural, urban, and barren rock.

Topography - The features of the actual surface of the Earth, considered collectively according to their form (grassland, cultivated, desert, forest, swamp, etc.). A single feature, such a one mountain or one valley, is called a topographic feature.

Topological - Referring to properties of geometric figures, such as adjacency, that are not altered by distortion as long as the surface is not torn.

Topological codes (Topological relationships) - Codes that define the locations of data elements in space with respect to one another, but without reference to actual distances. Topological codes can be used to specify such relationships as point connectivities, grid cell contiguities, networks, polygon boundary segment chains, and area adjacencies. For a label to be topologically related to a graphic entity, an explicit logical connection between label and entity must be contained in the data record.

Topological overlay - The intersection of two or more topologically coded data sets that produces one data set that is uniformly topologically coded with respect to graphic entities and to attribute data.

Topological relationships - See *Topological codes*.

Topologically linked database - A database containing linked forms of digitized polygons and non-spatial attributes.

Topology or vector topology - A description of the relationship between node, line, and polygon elements in a vector object.

Trace - To create a vector line element by manually or interactively tracing over line images in a raster object.

Tracker ball - An interactive, hand-controlled device for positioning the cursor on a CRT.

Training set or prototype - A group of sample cells in an image known to represent a feature type or ground cover of interest defined by the user from knowledge of the site (perhaps through ground visitation or detailed aerial photograph interpretation).

Transaction - Refers to an activity that causes an update of the database or involves data retrieval from the database in consequence of an inquiry.

Transcoder - A device that converts video signal formats from an input type (like SVHS) to an output type (like RGB analog).

Transformed Vegetation Index or TVI - A commonly used vegetation index derived from images of certain spectral bands. The TVI is equal to the square root of the quotient of the photo-infrared minus the red band, and the photo-infrared plus the red band.

Transect - A set of sampling points arranged along a straight line.

Transfer function - A mathematically defined method of transferring spatial data from one projection to another.

Transformation - Mathematical expressions used to convert coordinate data within one frame of reference to coordinate data in another frame of reference. It is used for a variety of applications including changing from one map projection to another map projection, or converting from one set of coordinates captured on a digitizer to UTM ground coordinates.

Translation curve - The curve used to adjust a raster object's cell values to the brightness values used for display.

Transparent color - The ability to overlay one color image over another image or map so that the spatial details of both are revealed for comparison is achieved with transparent color. The colors that result from such an overlay depend on whether the color in the images is additive or subtractive.

Transparent patterns - Patterns that only partially obscure the image upon which they are superimposed are transparent. For example, a pattern could consist of a drawing of a duck that leaves the remainder of the pattern design area transparent. When this pattern is used to fill a polygon that contains a lake, the lake colors and features will be visible through the transparent portions as the pattern is repeated across the area.

Trend surface analysis - The simplest way to describe gradual long-range variations is to model them by polynomial regression. The idea is to fit a polynomial line or surface, depending on whether the data are in one or two dimensions, by least squares through the data points. It is assumed that the spatial coordinates (x,y) and their powers and products are the independent variables, and that z, the property of interest, is the dependent variable.

True scale - At large sizes, every map projection distorts the scale of distance, especially towards the edges. The location of the true scale of a projection identifies the position where map measurements correctly correspond to actual surface distances.

TSR - **T**erminate and **S**tay **R**esident. A software process that becomes resident in memory when executed and then allows other programs or system functions to run normally. A TSR monitors input or other conditions in the computer and performs some special activity when the appropriate conditions are detected. For example, A TSR program may be loaded to memory and wait for the user to enter a special combination of keystrokes and then pop-in a calculator or appointment calendar.

Tuple - A set of values of attribute pertaining to a given item in a database. Also known as a *record*.

Turn-key system - A GIS or CAD/CAM system of hardware and software that is designed, supplied, and supported by a single manufacturer ready for use for a given class of work.

TVI or Transformed Vegetation Index - A commonly used vegetation index derived from images of certain spectral bands. The TVI is equal to the square root of the quotient of the photo-infrared minus the red band, and the photo-infrared plus the red band.

Two point five dimensionality/2.5 D - The concept of representing a three-dimensional object by its upper surface, whose elevation is a single-valued function of x and y. All 2-D GIS systems today represent three-dimensional objects in 2.5 dimensions.

Two-dimensional (2-D) data - Areal data in two dimensions, such as northing-easting, latitude-longitude, etc.

TYDAC - The corporate developer of a raster-based GIS, SPANS.

Universal kriging - A kriging technique which is used to represent local trends, or drift. (See *Drift*)

Universal Transverse Mercator map projection - (**UTM**) A system of plane coordinates based upon 60 north-south trending zones, each 6 degrees of longitude wide, that circle the globe.

UNIX - A modern, general purpose computer operating system.

UNIX SVR4 - UNIX System V Release 4. The most recent release of the UNIX system V. It is a combination of UNIX System V, SunOS, the BSD System, and the XENIX System.

Unsupervised classification, also automatic interpretation - A multispectral image interpretation process (like K-means) that statistically clusters cells into similar collections. When the classification is complete, the user identifies and labels the ground features or conditions that the clusters represent.

Updating - Updating of the digital database with new points, lines, polygons and attributes.

Upper memory area - (DOS) the 384K area of address space adjacent to the 640K of conventional memory. This area is usually reserved for running the system's hardware, such as the monitor, and is not considered part of total memory because applications

cannot store information in this area. By using memory managing software, unused portions of this area can be accessed by applications.

Upper memory blocks (UMB) - (DOS) Areas of the upper memory area that contain general-purpose memory and can be used to hold device drivers or other memory-resident programs in order to leave more conventional memory available for applications.

User interface - Method by which the human operator communicates with the various databases and applications modules.

Utility - A term for system capabilities and features for processing data.

Utility mapping - A special class of GIS applications for managing information about public utilities such as water pipes, sewerage, telephone, electricity, and gas network.

Variable - (in database queries) A named entity that has an assigned value.

VAX (VMS) - A line of minicomputers from DEC and their associated operating system.

Vector - A data structure for representing point and line data by means of 2- or 3-dimensional geometric (Cartesian x,y or x,y,z) coordinates. In connection with GIS and computer graphics, *vector* can refer to a set of line segments joined end to end to make a curved path in space.

Vector elements (Vector data) - A vector object is made up of three different types of elements - 1) nodes, which are single sets of coordinates which define a point (such as a spring); 2) lines, which are curvilinear strings of coordinates which define a curved line (such as a stream); and 3) polygons, which are collections of lines which inscribe an area (such as a lake).

Vector font or outline font - A text font in which a description of lines or equations defines each character's outline. Vector fonts do not process as quickly as bitmapped fonts, but they can be scaled and rotated without looking blocky or getting jagged edges. (See also *Bitmapped font*)

Vector topology - A description of the relationship between node, line, and polygon elements in a vector object.

Vectorize - A general term for any technique that converts raster data into vector data.

Vegetation index - The output from standard manipulations of multispectral image raster objects. The system processes the input spectral information and creates output raster objects whose cell values represent the site's biophysical properties - amount of vegetation, leaf area, greenness, brightness, and wetness.

Venn diagram - A visual portrayal of simple Boolean logic operations using AND, OR, XOR and NOT.

VersaCAD - A popular, commercial microcomputer Computer Aided Design (CAD) software package.

Version - The specific release of a software package. In case of minor upgrade or bugfix, a specific number will be added after the decimal point. For example, the original release version is 2.0, and after some modifications, the new version number would be 2.1 or 2.01.

Vertex - The endpoint or intersection of lines or arcs.

Vertical distance - Given a digital elevation model, calculate the vertical distance between two points.

Vertical frequency - (CRT) The inverse of the time it takes for a monitor to scan the whole screen; typically stated in Hertz.

VESA - See *Video Electronics Standards Association.*

VGA - **V**ideo **G**raphics **A**rray. A microcomputer video subsystem introduced by IBM with the PS/2

microcomputer in 1987 with support for 256 simultaneous colors and 640x480 resolution. The VGA is an enhancement of the older EGA and is also available for other AT bus based microcomputers. (See also *CGA*, *EGA*)

VHS - **V**ideo **H**ome **S**ystem. A popular format for low-cost video recording and playback, common in home video systems.

Video capture - Some image display boards have the ability to display live broadcast or taped programming and then freeze and grab an image, storing it in the computer's memory or on disk.

Video card or display board or display card, or display adapter - An electronic circuit board installed in a microcomputer that translates the computer's display data into video signals for the monitor. Different display boards can display different numbers of colors simultaneously at different resolutions.

Video digitizing board - A video interface circuit board that samples or frame-grabs a video frame and constructs a digital image. Video digitizing boards are slower than video capture boards, but can be used for non-standard, higher resolution video sources. (See also *Frame-grabbing*)

Video Electronics Standards Association - (VESA) A non-profit organization dedicated to facilitating and promoting personal computer graphics through graphics standards.

Video field - The image seen on a standard TV screen is composed of a set of about 480 horizontal lines. The lines are projected in two passes of the signal beam. Each pass only projects every other line of the image - the odd lines in one pass, and the even lines in the next pass. One scan takes 1/60 of a second, so the whole picture (the frame) is refreshed every 1/30th of a second. A field contains every other line of the complete video image. The primary field contains the odd lines; the secondary field contains the even lines.

Video frame - A complete video image, which consists of two interlaced fields. Odd lines of the frame are contained in the primary field which is alternated with the secondary field which contains the even lines. The primary field lasts 1/60 of a second in standard broadcast video. The secondary field follows in the next 1/60 of a second. The entire frame takes 1/30 of a second to display. There is a difference of 1/60 of a second between alternate lines in the image.

View port - A user-selected window through which part of the map database can be interactively accessed.

Viewable space - The maximum portion of the memory of a display board that can be viewed at one time. The viewable space is often equal to the maximum size of image that can be loaded to the memory of the display board. However, newer and more expensive display boards can have more image storage memory than is used to refresh the display screen. These boards are said to have an addressable space larger than the viewable space. If the loaded image fills up the memory of such a display board, a portion of the image will be seen in the viewable space and the remaining area can be viewed by panning and/or scrolling to it using the mouse or the keyboard. The viewable space is always equal to or smaller than the addressable space.

Viewshed - The boundaries of sight from a single vantage point, assuming an unobstructed surface (disregard trees and buildings).

Viewshed map generation - Given a digital elevation model and the locations of one or more viewpoints, generate polygons enclosing the area visible from at least one viewpoint.

Vignetting - Darkening at the edges and corners of an optical image. Vignetting occurs because lenses are physically unable to pass as much light to the fringe of an optical field as they do to its center. Several techniques compensate for vignetting, but it is almost always present to some degree.
For color rasters, vignetting means that the color of a feature at the edge or corner of an image may not match the color of that same feature in the center.

Virtual display - A display management scheme that displays as much of an image as will fit on the monitor, while buffering the rest of the image in a temporary file from a RAM disk or the hard drive. The user never needs to give new file information in order to access another portion of the image. A virtual display works like a window that can slide anywhere on a raster object. How quickly it moves depends on the hardware available (with a RAM disk, fast; with a hard disk, slower).

Virtual memory - A *virtually unlimited* memory obtained by dividing a program and its associated data into segments called *pages*, only some of which reside in internal memory at any time. When a particular page not in main memory is needed, it exchanges places

with a page in internal memory.

Visual Display Unit or Video Display Unit - (VDU) Otherwise known as a terminal.

Volume - An individual storage device such as a tape or floppy disk.

Voronoi polygon - See *Dirichlet tesselation*.

Wait state - When a system's memory is slower than the CPU, the system's CPU delays, or *waits* for a portion of the processing cycle to avoid outrunning the memory. Some CPUs run with one or more wait states. Others run with 0 wait states, which means that the CPU dose not have to slow down and wait for memory.

Warm start - A DOS microcomputer that is already on can be re-booted by holding down the <Ctrl> and <Alt> keys while pressing <Del>.

Warping - Any process in which an object is stretched separately so as to change its internal geometry. This shape change could be defined by any one of many transformations, such as changing a map projection, trilateration to change the absolute position of specified nodes in a vector object, fitting a polynomial to a surface, least squares movement of control nodes, and so on.

Watershed - The entire area above a given point (called the watershed seed) that drains into that point.

Watershed boundaries - Given a digital elevation model and a hydrology net, interpolate the position of the watershed between basins.

Watershed seed - The point at the base of a watershed into which all points in the watershed drain; often taken as the mouth of a stream or river.

Weeding - See *Line thinning*.

Weighted average - An arithmetic mean of a numerical series adjusted to give appropriate significance to each item in relation to its importance.

Weighted modeling - The ability to assign weighting factors to individual data sets according to a set of rules and to overlay those data sets and carry out reclassify, dissolve and merge operations on the resulting concatenated data set.

Weird polygon - A polygon that has topologically inadmissible loops within itself.

Wetness - The physical property mapped by Kauth's greenness, brightness, wetness transformations on LANDSAT TM images. It measures how wet the combined vegetation and soil surface is, including the water suspended in the vegetation biomass.

Window - (1) A subsection of a raster or vector object selected for display or analysis. A window may be stored as a new, smaller raster or vector object. (2) A pop-in user interface graphic on the display monitor that presents process options by means of buttons, sliders and dials. (3) A desktop graphical user interface (GUI) for DOS, developed by Microsoft.

Windowing - The ability to clip features in the database to some defined polygon.

Wireframe - A graphical representation of a three-dimensional solid or surface by means of regularly-spaced, connected line segments. The wireframe surface looks as if it has been molded by a flexible wire mesh. Computer systems use wireframe representations for many intermediate 3-D renderings because they take much less processing time to create and manipulate than a continuous-surface representation.

Word - A group of bits or bytes that can be stored or retrieved as a unit.

Workstation - The desk, keyboard, digitizing tablet and CRTs connected together as a unit for working with maps or graphics in interactive GIS and CAD/CAM. Usually Unix-based minicomputers.

WORM drive - **W**rite **O**nce, **R**ead **M**any drive. A type of drive that reads and writes to non-erasable optical disks, which are used for permanent, high-capacity file storage. WORM disks are empty when purchased, and the user can write files to them until they are full. Data is recorded with reflective pits in the coating laid on the surface of a glass or metal disk. Once the pits have been burned into the coating, they cannot be removed, which makes this medium non-erasable.(See also *Optical disk, Erasable optical drive, Erasable optical cartridge*)

X window system - A graphical windowing system (also called *X windows*), developed at MIT. X windows is available on many UNIX operating systems.

X-Y digitizing tablet - A peripheral device for manually translating line and point data (like engineering and technical drawings) into some computer format (usually vector or CAD). The drawing is secured to the tablet, and the operator positions the device's cursor (which may look like a pen or a computer mouse with a crosshair lens) over lines and other elements, clicking a button or pressing a key to record a coordinate.

X.25 - An ISO packet network transmission protocol used in many wide area networks(WANs). (See also *ISO, Protocol, WAN*)

XENIX - A UNIX system variant developed for use on personal computers.

XGA - E**x**tended **G**raphics **A**dapter. IBM's graphics standard that includes VGA and extended resolutions up to 1024 pixels by 768 lines interlaced resolution.

XMS memory - (DOS) Extended memory that can be accessed by using Expanded memory specification. Applications work with an extended-memory manager, which makes sure only one application is using a portion of memory at any one time.

Zero - The origin of all coordinates definded in an absolute system. Where x, y, and z axes intersect.

Zoom - A capability for proportionately enlarging or reducing the scale of a figure or maps displayed on a CRT.

Zoom Transfer Scope or ZTS - An optical-mechanical device. With it one can view and overlay two images through separate optical paths. Usually one eye views a reference map and the other a portion of a color aerial photograph. The scale, position, and orientation of either optical path can be changed so that the aerial photograph matches the map in some local area. One then refers to the aerial photograph and marks interpretation lines on the map or on a transparent overlay. As the aerial photograph is moved slightly to register another subsection, one compiles a map that has a minimum amount of distortion introduced by the aerial photograph.

16-bit raster object - A raster in which each cell is represented by two bytes (16 bits) and can therefore assume 65,536 possible values. Elevation data commonly is expressed in 16-bit data. When color composite images are stored in 16-bit rasters, 5 bits represent the intensity level for red, 5 bits green, and 5 bits blue (the 16th bit is typically unused). With this scheme (32 possible levels for each color), each cell in a 16-bit composite color raster can take any one of 32,768 possible colors.

24-bit raster object - A raster in which each cell is represented by three bytes (24 bits) and can therefore assume 16,777,216 possible values. When color images are stored in 24-bit rasters, 8 bits represent the intensity level for red, 8 bits green, and 8 bits blue. With this scheme (256 possible levels for each color), each cell in a 24-bit color raster can take any one of 16,777,216 possible colors.

2D histogram - A two dimensional histogram can be created from two single histograms to give a visual sense of the similarity between the source raster objects.

3D surface modeling - Rendering a 3D surface from raster objects. Either a single object can be used to control both the height and the graytone in the display, or an elevation raster can be matched with a set of color image rasters for a real-world 3D image. (See also *Solid modeling*)

4GL - **Fourth G**eneration **L**anguage. A 4GL is built to facilitate easy interaction between users and data stored in the computer. It has three characteristics: 1) a visual programming capability; 2) a host language interface; and 3) interactive operational mode.

5-5-5 composite color conversion method - 16-bit composite color data uses 15 of the 16 bits to store the color intensity information - 5 bits to represent the intensity level for red, 5 bits for green, and 5 bits for blue (the 16th bit is typically unused). With this scheme (32 possible levels for each color), each cell in a 16-bit raster can take any one of 32,768 possible colors. Therefore, display boards

that handle 16-bit color display data do not use color tables, since they have no need to map all the actually occurring colors into a limited set of 256 display colors.

7.5' map - A standard topographic map quadrangle size that covers 7.5 minutes of latitude and 7.5 minutes of longitude. (See also *Minute*)

8-bit raster object - A raster in which each cell is represented by one byte (8 bits) and can therefore assume 256 possible values. Multi-spectral imagery uses 8 bits to represent the intensity of each spectral band.

8514/A - An IBM graphics standard for 1024 pixels by 768 lines interlaced resolution.

ACRONYMS

AAG - **A**ssociation of **A**merican **G**eographers
ACAD - **A**uto**CAD**
ACSM - **A**merican **C**ongress on **S**urveying and **M**apping
AI - **A**rtificial **I**ntelligence
AKCLIS - **A**ustralian **K**ey **C**enter for **L**and **I**nformation **S**tudies
AM/FM - **A**utomated **M**apping/**F**acilities **M**anagement
ANSI - **A**merican **N**ational **S**tandards **I**nstitute
APA - **A**merican **P**lanning **A**ssociation
ARS - **A**gricultural **R**esearch **S**ervice
ASCE - **A**merican **S**ociety of **C**ivil **E**ngineering
ASCII - **A**merican **S**tandard **C**ode for **I**nformation **I**nterchange
ASCS - **A**gricultural **S**tabilization and **C**onservation **S**ervice
ASPRS - **A**merican **S**ociety for **P**hotogrammetry and **R**emote **S**ensing
AVHRR - **A**dvanced **V**ery **H**igh **R**esolution **R**adiometer
BLM - **B**ureau of **L**and **M**anagement of the USDI
BM - **B**ureau of **M**ines
BOR - **B**ureau **o**f **R**eclamation of the USDI
BPI - **B**its **P**er **I**nch
CAD - **C**omputer **A**ided **D**rafting/**D**rawing
CADD - **C**omputer **A**ided **D**rafting and **D**esign
CAE - **C**omputer **A**ided **E**ngineering
CAFM - **C**omputer **A**ided **F**acility **M**anagement
CAG - **C**anadian **A**ssociation of **G**eographers
CAM - **C**omputer **A**ided **M**anufacturing
CAM - **C**omputer **A**ided **M**apping
CAT - **C**omputer **A**ided **T**omography
CCA - **C**anadian **C**artographic **A**ssociation
CD ROM - **C**ompact **D**isk, **R**ead-**O**nly **M**emory
CERL - US Army Corps of Engineers, **C**onstruction **E**ngineering **R**esearch **L**aboratory
CGA - **C**olor **G**raphics **A**dapter
CIA - **C**entral **I**ntelligence **A**gency
CIR image - **C**olor-**I**nfrared **I**mage
COE - US Army **C**orps **o**f **E**ngineers
COGO - **Co**ordinate **Ge****o**metry
CPU - **C**entral **P**rocessing **U**nit
CRRL - **C**old **R**egions **R**esearch **L**ab
CRT - **C**athode **R**ay **T**ube
DBMS - **D**atabase **M**anagement **S**ystem
DDL - **D**ata **D**efinition **L**anguage
DEA - **D**rug **E**nforcement **A**dministraion
DEM - **D**igital **E**levation **M**odel
DIME - **D**ual **I**ndependent **M**ap **E**ncoding
DLG - **D**igital **L**ine **G**raph
DMA - **D**efense **M**apping **A**gency of the U.S. Department of Defense
DOC - **D**epartment **o**f **C**ommerce
DOD - **D**epartment **o**f **D**efense
DOE - **D**epartment **o**f **E**nergy
DOS - **D**isk **O**perating **S**ystem
DOT - **D**epartment **o**f **T**ransportation
DPI - **D**ots **p**er **i**nch
DRAM - **D**ynamic **R**andom **A**ccess **M**emory
DTM - **D**igital **T**errain **M**odel
DXF - **D**rawing **E**xchange **F**ormat
EDM - **E**lectronic **D**istance **M**easuring
EGA - **E**nhanced **G**raphics **A**dapter
EOSAT - **E**arth **S**atellite **C**orporation

EPA - **E**nvironmental **P**rotection **A**gency
EPROM - **E**rasable **P**rogrammable **R**ead **O**nly **M**emory
EROM - **E**rasable **R**ead **O**nly **M**emory
FAA - **F**ederal **A**viation **A**dministration
FCC - **F**ederal **C**ommunications **C**ommission
FEMA - **F**ederal **E**mergency **M**anagement **A**gency
FHA - **F**ederal **H**ighway **A**dministration in DOT
FIPS - **F**ederal **I**nformation **P**rocessing **S**tandard
FORTRAN - **FOR**mula **TRAN**slation
FWS - US **F**ish and **W**ildlife **S**ervice in USDI
GB - Gigabyte
GBF/DIME - **G**eographic **B**ase **F**ile/**D**ual **I**ndependent **M**ap **E**ncoding
GCBD - **G**eographic **C**oordinate **D**ata **B**ase
GEMS - **G**lobal **E**nvironmental **M**onitoring **S**ystem
GIS - **G**eographic **I**nformation **S**ystem
GKS - **G**raphics **K**ernal **S**ystem
GPIB - **G**eneral **P**urpose **I**nterface **B**oard
GPS - **G**lobal **P**ositioning **S**ystem
GRASS - **G**eographic **R**esources **A**nalysis **S**upport **S**ystem
GRID - **G**lobal **R**esource **I**nformation **D**atabase
GSFC - **G**oddard **S**pace **F**light **C**enter
ICA - **I**nternational **C**artographic **A**ssociation
ICAM - **I**ntegrated **C**omputer **A**utomated **M**anufacturing
IGES - **I**nitial **G**raphic **E**xchange **S**pecifications
IRM - **I**nformation **R**esource **M**anagement
ISO - **I**nternational **S**tandards **O**rganization
ITC - **I**nternational **T**raining **C**enter for Aerospace Survey and Earth Sciences (Netherlands)
IUFRO - **I**nternational **U**nion of **F**orestry **R**esearch **O**rganizations
JPL - **J**et **P**ropulsion **L**aboratory, Pasadena CA
JSC - **J**ohnson **S**pace **C**enter, Houston TX
KB - Kilobyte or Kbyte
KHz - Kilohertz
LAN - **L**ocal **A**rea **N**etwork
LANDSAT - US satellite system for assessment of land resources
LIS - **L**and **I**nformation **S**ystem
MB - Megabyte, or Mbyte
MC&G - **M**apping, **C**harting and **G**eodesy
MHz - Megahertz
MIPS - **M**illion **I**nstructions **p**er **S**econd
MMS - **M**inerals **M**anagement **S**ervice
MODEM - **MO**dulator-**DEM**odulator
MOSS - **M**ap **O**verlay and **S**tatistical **S**ystem
MSS - **M**ulti-**S**pectral **S**canner
NASA - **N**ational **A**eronautics and **S**pace **A**dministration
NASS - **N**ational **A**gricultural **S**tatistics **S**ervice
NCGA - **N**ational **C**omputer **G**raphics **A**ssociation
NCGIA - **N**ational **C**enter for **G**eographic **I**nformation and **A**nalysis
NCIC - **N**ational **C**artographic **I**nformation **C**enter (USGS)
NGS - **N**ational **G**eographic **S**ociety
NHAP - **N**ational **H**igh **A**ltitude **P**rogram
NIST - **N**ational **I**nstitute of **S**tandards and **T**echnology
NOAA - **N**ational **O**ceanographic and **A**tmospheric **A**dministration
NOAA/NESDIS - **NOAA/N**ational **E**nvironmental **S**atellite, **D**ata & **I**nformation **S**ervice
NOAA/NGDC - **NOAA/N**ational **G**eophysical **D**ata **C**enter
NOAA/NMFS - **NOAA/N**ational **M**arine **F**isheries **S**ervice
NORDA - **N**aval **O**cean **R**esearch and **D**evelopment **A**ctivity (United States Navy)
NOS - **N**ational **O**ceanic **S**urvey
NOSC - **N**ational **O**cean **S**ystems **C**enter
NPS - **N**ational **P**ark **S**ervice in USDI

NSF - **N**ational **S**cience **F**oundation
NSTL - **N**ational **S**pace **T**echnology **L**aboratory, now SSC
NTSC - **N**ational **T**elevision **S**tandards **C**ommittee
OOP - **O**bject-**O**riented **P**rogramming
ORNL - **O**ak **R**idge **N**ational **L**aboratory
OS - **O**perating **S**ystem
PC - **P**ersonal **C**omputer
PLSS - United States **P**ublic **L**and **S**urvey **S**ystem
PROM - **P**rogrammable **R**ead **O**nly **M**emory
RAM - **R**andom **A**ccess **M**emory
RDBMS - **R**elational **D**ata**b**ase **M**anagement **S**ystem
ROM - **R**ead **O**nly **M**emory
RS - **R**emote **S**ensing
SCS - **S**oil **C**onservation **S**ervice
SCSI - **S**mall **C**omputer **S**ystems **I**nterface
SIF - **S**tandard **I**nterchange **F**ormat (Intergraph)
SMSA - **S**tandard **M**etropolitan **S**tatistical **A**rea
SPCS - **S**tate **P**lane **C**oordinate **S**ystem
SPOT - **S**ysteme **P**robatoire d'**O**bservation de la **T**erre (French satellite system)
SQL - **S**tructured or **S**tandard **Q**uery **L**anguage
SRAM - **S**tatic **R**andom **A**ccess **M**emory
SSC - **S**tennis **S**pace **C**enter (formerly NSTL)
TIFF - **T**agged **I**mage **F**ile **F**ormat
TIGA - **T**exas **I**nstruments **G**raphics **A**rchitecture
TIGER files - **T**opologically **I**ntegrated **G**eographic **E**ncoding and **R**eferencing files
TIN - **T**riangulated **I**rregular **N**etwork
TM - **T**hematic **M**apper (on LANDSAT satellite)
TSR - **T**erminate and **S**tay **R**esident
TVA - **T**ennessee **V**alley **A**uthority
UGISA - **U**niversity **G**eographic **I**nformation **S**ystem **A**lliance
UNEP - **U**nited **N**ations **E**nvironment **P**rogram
UNIX - A multi-user operating system
URISA - **U**rban and **R**egional **I**nformation **S**ystem **A**ssociation
USDA - **U**nited **S**tates **D**epartment of **A**griculture
USDI - **U**nited **S**tates **D**epartment of the **I**nterior
USFS - **U**nited **S**tates **F**orest **S**ervice of the USDA
USFWS - **U**nited **S**tates **F**ish and **W**ildlife **S**ervice of the USDI
USGS - **U**nited **S**tates **G**eological **S**urvey of the USDI
UTM - **U**niversal **T**ransverse **M**ercator projection
VESA - **V**ideo **E**lectronics **S**tandards **A**ssociation
VGA - **V**ideo **G**raphics **A**rray
VHS - **V**ideo **H**ome **S**ystem
WORM - **W**rite **O**nce, **R**ead **M**any
WRS - **W**orldwide **R**eference **S**ystem
XGA - E**x**tended **G**raphics **A**dapter