

June 1954

**REPORT
TO THE
ASSOCIATION FOR COMPUTING
MACHINERY**

**FIRST GLOSSARY
of
PROGRAMMING TERMINOLOGY**

Committee on Nomenclature

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This "programmer's glossary" had its inception in a glossary compiled by Dr. Grace Murray Hopper for the Workshops on Automatic Coding held in 1953 under the sponsorship of the Bureau of Census, the Office of the Air Comptroller, and Remington Rand, Inc. The answers to the plea for criticisms and suggestions made in that first version were most generous. Every effort has been made to include all of them or to arbitrate fairly those in conflict. Both versions have borrowed heavily from the "Standards on Electronic Computers: Definitions of Terms, 1950", Proceedings of the I.R.E., Vol. 39 No. 3, pp. 271-277, March 1951, and from the "Glossary", Computers and Automation, Vol. 2, Nos. 2, 4 and 9, March, May, and December, 1953. The committee extends its thanks to the authors of those glossaries and to the many others who have contributed their time and thoughts to the preparation of this glossary.

Committee on Nomenclature
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REPORT to the ASSOCIATION FOR COMPUTING MACHINERY

We submit herewith our first attempt at a glossary of the terms which are used in discussing the applications of digital computers to science, engineering and industry.

For convenience in comparison, all related compound terms have been listed under the noun rather than the adjective; and, for brevity, no extensive cross-referencing has been provided. For example, erasable storage is found under storage, and there is no entry at all under erasable.

The list does not attempt to include the common terms of business, mathematics, or logic unless they have acquired an added meaning. Neither are the words which are used in the design, construction and maintenance of computers given unless they are also terms used regularly by the programmers. Terminology used in the applications of punched card and analog systems is omitted since it is not clear whether these should be included in one general list or in several separate ones.

Even in the light of these restrictions, this glossary is at best tentative and incomplete. It will improve as it is used--provided that those who use it will make known their comments, mild or violent. The committee will continue to collect opinions, arbitrate disagreements, and publish the results (next edition goal: May, 1955). But supplying the opinions, correcting the mistakes, and accepting the compromises needed to make a truly satisfactory glossary is the responsibility of every ACM member and every computing machine user.

To encourage the reticent and assist the indolent, a questionnaire has been enclosed on which may be recorded an opinion of any or all of the words defined here. Specific suggestions of new terms and revised meanings are especially encouraged. Extra copies of the questionnaire may be obtained by sending a stamped, self-addressed envelope to the committee chairman. Continued interest and help from all who are concerned should enable the approximation to a definitive glossary to converge rapidly.

June 2, 1954

Committee on Nomenclature
Grace Murray Hopper, Chairman

Access Time - (1) the time interval between the instant at which information is: (a) called for from storage and the instant at which delivery is completed, i.e., the read time; or (b) ready for storage and the instant at which storage is completed, i.e., the write time.

(2) the latency plus the word-time.

Accumulator - the zero-access register (and associated equipment) in the arithmetic unit in which are formed sums and other arithmetical and logical results.

Accuracy - "correctness", or freedom from error. Accuracy contrasts with precision; e.g., a four-place table, correctly computed, is accurate; a six-place table containing an error is more precise but not accurate.

Adder - a device capable of forming the sum of two quantities.

Address - a label such as an integer or other set of characters which identifies a register, location, or device in which information is stored.

Absolute Address (Specific Address) - the label(s) assigned by the machine designer to a particular storage location.

Relative Address - a label used to identify a word in a routine or subroutine with respect to its position in that routine or subroutine. Relative addresses are translated into absolute addresses by the addition of some specific "reference" address, usually that at which the first word of the routine is stored.

Symbolic Address (Floating Address) - a label chosen to identify a particular word, function or other information in a routine, independent of the location of the information within the routine.

Arithmetic Unit - that portion of the hardware of an automatic digital computer in which arithmetical and logical operations are performed.

Assemble; Assembler, Assembly Routine; Assembly - see Routine.

Base (radix) - a number base; a quantity used implicitly to define some system of representing numbers by positional notation.

Binary - involving the integer 2, as in a binary number system (base 2), a binary choice (between 2 alternatives), or a binary operation (combining 2 quantities).

Bit - a binary digit; a quantum of information; a single pulse in a group of pulses.

Block - a group of words considered or transported as a unit. See also Item and Message.

Breakpoint - a point in a routine at which the computer may, under the control of a manually-set switch, be stopped for a visual check of progress.

Bus - a path over which information is transferred; a trunk.

Calculator - see Computer.

Call-number - a set of characters identifying a subroutine and containing information concerning parameters to be inserted in the subroutine, information to be used in generating the subroutine, or information related to the operands.

Call-word - a call-number which fills exactly one word.

Capacity - the upper and lower limits of the numbers which may be processed in a computer register, e.g., in the accumulator. Quantities which exceed the capacity usually interrupt the operation of the computer in some fashion.

Carry - (1) the digit to be added to the next higher column when the sum of the digits in one column equals or exceeds the number base;
(2) the process of forwarding the carry digit.

Cell - storage for one unit of information, usually one character or one word. More specific terms (column, location, and block), are preferable since there is no uniformity in the use of the term cell.

Channel - a path along which information, particularly a series of digits or characters, may flow. In storage which is serial by character and parallel by bit (e.g., a magnetic tape or drum in some coded-decimal computers), a channel comprises several parallel tracks. In a circulating memory, a channel is one recirculating path containing a fixed number of words stored serially by word. See also Group and Track.

Character - (1) one of a set of elementary symbols such as those corresponding to the keys on a typewriter. The symbols may include the decimal digits 0 through 9, the letters A through Z, punctuation marks, operation symbols, and any other single symbols which a computer may read, store, or write.
(2) a pulse-code representation of such a symbol.

Check - a means of verification.

Built-in Check - any provision constructed in hardware for verifying the accuracy of information transmitted, manipulated, or stored by any unit or device in a computer.

Duplication Check - a check which requires that the results of two independent performances (either concurrently on duplicate equipment or at a later time on the same equipment) of the same operation be identical.

Twin Check - a continuous duplication check achieved by duplication of hardware.

Mathematical Check - a check making use of mathematical identities or other properties, frequently with some degree of discrepancy being acceptable; e.g., checking multiplication by verifying that $A \cdot B = B \cdot A$, checking a tabulated function by differencing, etc.

Redundant Check - a check which uses extra digits, short of complete duplication, to help detect malfunctions or mistakes.

Summation Check - a redundant check in which groups of digits are summed, usually without regard for overflow, and that sum checked against a previously computed sum to verify accuracy.

Parity Check - a summation check in which the binary digits, in a character or word, are added (modulo 2) and the sum checked against a single, previously computed parity digit; i.e., a check which tests whether the number of ones is odd or even.

Clear - to replace information in a storage device by zero as expressed in the number system employed. See Erase.

Code (noun) - a system of symbols and of the rules for their use in representing information.

Computer Code (Machine Code) - the code representing the operations built into the hardware of the computer.

Instruction Code - the symbols, names, and definitions of all the instructions which are directly intelligible to a given computer or a given executive routine.

Operation Code - that part of an instruction which designates the operation to be performed.

Pseudo-code - an arbitrary code, independent of the hardware of a computer, which must be translated into computer code if it is to direct the computer.

Pulse-code - sets of pulses to which particular meanings have been assigned; the binary representations of characters.

Code (verb) - to prepare problems in computer code or in pseudo-code for a specific computer.

Coding - the list, in computer code or in pseudo-code, of the successive computer operations required to solve a given problem.

Absolute, Relative, or Symbolic Coding - coding in which one uses absolute, relative, or symbolic addresses, respectively.

Automatic Coding - any technique in which a computer is used to help bridge the gap between some "easiest" form, intellectually and manually, of describing the steps to be followed in solving a given problem and some "most efficient" final coding of the same problem for a given computer. Two basic forms, defined under Routine, are Compilation and Interpretation.

Collate - to combine two or more similarly ordered sets of items to produce another ordered set composed of information from the original sets. Both the number of items and the size of the individual items in the resulting set may differ from those of either of the original sets and of their sums.

Column (Digit Column) - one of the character or digit positions in a positional notation representation of a unit of information. Columns are usually numbered from right to left column, zero being the rightmost column if there is no point, or the column immediately to the left of the point if there is one.

Command - a pulse, signal, or set of signals initiating one step in the performance of a computer operation. See Instruction.

Comparator - a device for comparing two different transcriptions of the same information to verify the accuracy of transcription, especially of one copy of tape from another.

Compare - to examine the representation of a quantity for the purpose of discovering its relationship to zero, or of two quantities for the purpose of discovering identity or relative magnitude.

Comparison - the act of comparing and, usually, acting on the result of the comparison.

Compile; Compiler, Compiling Routine; Compilation - See Routine.

Complement - a quantity which is derived from a given quantity, expressed to the base n , by one of the following rules and which is frequently used to represent the negative of the given quantity.

- (a) Complement on n : subtract each digit of the given quantity from $n-1$, add unity to the least significant digit, and perform all resultant carries. For example, the twos complement of binary 11010 is 00110; the tens complement of decimal 456 is 544.
- (b) Complement on $n-1$: subtract each digit of the given quantity from $n-1$. For example, the ones complement of binary 11010 is 00101; the nines complement of decimal 456 is 543.

Computer - (1) any device capable of accepting information, applying prescribed processes to the information, and supplying the results of these processes;
 (2) sometimes, more specifically, a device for performing sequences of arithmetic and logical operations;
 (3) sometimes, still more specifically, a stored-program digital computer capable of performing sequences of internally-stored instructions, as opposed to calculators on which the sequence is impressed manually (desk calculator) or from tape or cards (card programmed calculator).

Conditional - subject to the result of a comparison made during computation; subject to human intervention.

Contents - the information stored in any storage medium.

The symbol () is used to indicate "the contents of"; e.g., (m) indicates the contents of the storage location whose address is \underline{m} ; (A) indicates the contents of register A; (T₂) indicates the contents of the tape on input-output unit two.

Control Sequence - the normal order of selection of instructions for execution. In some computers, one of the addresses in each instruction specifies the control sequence. In most other computers the sequence is consecutive except where a jump occurs.

Control Unit - that portion of the hardware of an automatic digital computer which directs the sequence of operations, interprets the coded instructions, and initiates the proper commands to the computer circuits to execute the instructions.

Convert; Converter, Conversion Routine; Conversion - see Routine.

Copy - to reproduce information in a new location replacing whatever was previously stored there and leaving the source of the information unchanged.

Counter - a device, register, or storage location for storing integers, permitting these integers to be increased or decreased by unity or by an arbitrary integer, and capable of being reset to zero or to an arbitrary integer.

Control Counter or Program Counter, Cycle-counter or B-box
- special counters constructed of hardware and contained in the control unit.

Cycle (noun) - (1) a set of operations repeated as a unit;
(2) a non-arithmetic shift in which the digits dropped off at one end of a word are returned at the other end in circular fashion; cycle right and cycle left.

Major Cycle - the maximum access time of a recirculating serial storage element; the time for one rotation, e.g., of a magnetic drum or of pulses in an acoustic delay line. A whole number of minor cycles.

Minor Cycle - the word time of a serial computer.

Cycle (verb) - to repeat a set of operations a prescribed number of times including, when required, supplying necessary address changes by arithmetic processes or by means of a hardware device such as a B-box or cycle-counter.

Cycle Index - the number of times a cycle has been executed; or the difference, or the negative of the difference, between that number and the number of repetitions desired.

Cycle Count - to increase or decrease the cycle index by unity or by an arbitrary integer.

Cycle Criterion - the total number of times the cycle is to be repeated; the register which stores that number.

Cycle Reset - to return a cycle index to its initial value.

Debug - to isolate and remove all malfunctions from a computer or all mistakes from a routine.

Define - to isolate, uniquely identify, and describe an operation or a set of operations such as a subroutine.

Diagram - a schematic representation of a sequence of subroutines designed to solve a problem; a coarser and less symbolic representation than a flow chart, frequently including descriptions in English words.

Digit - one of the n symbols of integral value ranging from 0 to $n-1$ inclusive in a scale of numbering of base n , especially one of the ten decimal digits 0, 1, 2, 3, 4, 5, 6, 7, 8, 9.

Check Digit - one or more redundant digits in a character or word, which depend upon the remaining digits in such a fashion that if a digit changes, the malfunction can be detected.

Coded Decimal Digit - one of ten arbitrarily-selected patterns of ones and zeros used to represent the decimal digits.

Double-precision Quantity - a quantity having twice as many digits as are normally carried in a specific computer.

Dump - to withdraw all power accidentally or intentionally.

DC Dump - the condition resulting when DC power is withdrawn from a computer which uses volatile storage, i.e., loss of stored information.

Dummy - an artificial address, instruction, or other unit of information inserted solely to fulfill prescribed conditions (such as word-length or block-length) without affecting operations.

Edit - to rearrange information. Editing may involve the deletion of unwanted data, the selection of pertinent data, the insertion of invariant symbols such as page numbers and typewriter characters, and the application of standard processes such as zero-suppression.

Erase - to replace all the binary digits in a storage device by binary zeros. In a binary computer, erasing is equivalent to clearing, while in a coded decimal computer where the pulse code for decimal zero may contain binary ones, clearing leaves decimal zero while erasing leaves all-zero pulse codes.

Error - the amount of loss of precision in a quantity; the difference between an accurate quantity and its calculated approximation.

(see next page)

Truncation Error - the error resulting from the use of only a finite number of terms of an infinite series, or from the approximation of operations in the infinitesimal calculus by operations in the calculus of finite differences.

Inherited Error - the error in the initial values; especially the error inherited from the previous steps in the step-by-step integration.

Rounding Error - the error resulting from deleting the less significant digits of a quantity and applying some rule of correction to the part retained.

Errors occur in numerical methods; mistakes occur in programs, coding, data transcription, and operating; malfunctions occur in computers.

Exchange - to interchange the contents of two storage devices or locations.

Extract - to replace the contents of specific columns of a quantity (as indicated by some other quantity called an extractor) by the contents of the corresponding column at a third quantity; to remove from a set of items of information all those items that meet some arbitrary criterion.

Field - a set of one or more characters (not necessarily all lying in the same word) which is treated as a whole; a unit of information. See also Item, Key.

Card Field - a set of card columns fixed as to number and position into which the same unit of information is regularly entered.

File - a sequential set of items (not necessarily all of the same size).

Fixed-point Representation - a notation or system of arithmetic in which all numerical quantities are expressed by a predetermined number of digits with the point implicitly located at some predetermined position.

Floating-point Representation - a notation in which a number x is represented by a pair of numbers y and z (and two integers n and m which are understood parameters in any given representation) with y and z chosen so that $x = y \cdot n^z$ where z is an integer, ordinarily either $m > |y| \geq m/n$, or $y = 0$ (where n is usually 2 or 10 and m is usually 1). The quantity y is called the fraction or mantissa; the integer z is called the exponent or characteristic.

Flow Chart - a graphical representation of a sequence of operations, using symbols to represent the operations such as compute, substitute, compare, jump, copy, read, write, etc. A flow chart is a more detailed representation than a diagram.

Flow Diagram - a diagram. See Diagram and Flow Chart.

Force - to intervene manually in a routine and cause the computer to execute a jump instruction.

Function Table - two or more sets of information so arranged that an entry in one set selects one or more entries in the remaining sets; a dictionary; a device constructed of hardware, or a subroutine, which can either (a) decode multiple inputs into a single output or (b) encode a single input into multiple outputs.

Generate; Generator, Generative Routine; Generation - see Routine.

Hardware - the mechanical, magnetic, electrical, and electronic devices from which a computer is constructed.

Ignore - a typewriter character indicating that no action whatsoever be taken. (In Teletype or Flexowriter code, all holes punched is an ignore).

Information - a set of symbols or an arrangement of hardware that designates one out of a finite number of alternatives; an aggregation of data which may or may not be organized.

Input - information transferred from secondary or external storage into the internal storage of the computer.

Instruction - a set of characters which defines an operation together with one or more addresses (or no address) and which, as a unit, causes the computer to operate accordingly on the indicated quantities. The term "instruction" is preferable to the terms "command" and "order"; command is reserved for electronic signals; order is reserved for "the order of the characters" (implying sequence) or "the order of the interpolation", etc.

Breakpoint Instruction - an instruction which, if some specified switch is set, will cause the computer to stop.

Conditional Breakpoint Instruction - a conditional jump instruction which, if some specified switch is set, will cause the computer to stop, after which either the routine may be continued as coded or a jump may be forced.

Zero-address Instruction - an instruction specifying an operation in which the location of the operands are defined by the computer code, so that no address need be given explicitly.

(see next page)

One-address Instruction (Single-address Instruction) - an instruction consisting of an operation and exactly one address. The instruction code of a single-address computer may include both zero- and multi-address instructions as special cases.

Two-, Three-, or Four-address Instruction - an instruction consisting of an operation and 2, 3, or 4 addresses, respectively.

One-plus-one-, or Three-plus-one-address Instruction - a two- or four-address instruction, respectively, in which one of the addresses always specifies the location of the next instruction to be performed.

Multi-address Instruction - an instruction consisting of an operation and more than one address.

Interpret, Interpreter, Interpretive Routine, Interpretation - see Routine.

Item - a set of one or more fields containing related information; a unit of correlated information relating to a single person or object.

Jump - an instruction or signal which, conditionally or unconditionally, specifies the location of the next instruction and directs the computer to that instruction. A jump is used to alter the normal sequence control of the computer. Under certain special conditions, a jump may be forced by manual intervention.

Key - a set of characters, forming a field, used to identify an item.

Latency - in a serial storage system, the access time less the word time, e.g. the time spent waiting for the desired location to appear under the drum heads or at the end of an acoustic tank.

Library - an ordered set or collection of standard and proven routines and subroutines by which problems and parts of problems may be solved, usually stored in relative or symbolic coding. (A library may be subdivided into various volumes, such as floating decimal, double-precision, or complex, according to the type of arithmetic employed by the subroutines.)

Location - a unit storage position in the main internal storage, storing one computer word; a storage register.

Loop - the repetition of a group of instructions in a routine. See also Cycle.

Closed Loop - repetition of a group of instructions indefinitely.

Malfunction - a failure in the operation of the hardware of a computer. See also Error.

Memory - see Storage.

Merge - to produce a single sequence of items, ordered according to some rule (i.e., arranged in some orderly sequence), from two or more sequences previously ordered according to the same rule, without changing the items in size, structure, or total number. Merging is a special case of collation.

Message - a group of words, variable in length, transported as a unit. See also Item.

Mistake - a human blunder which results in an incorrect instruction in a program or in coding, an incorrect element of information, or an incorrect manual operation. See also Error.

Modifier - a quantity, sometimes the cycle index, used to alter the address of an operand.

Modify - (1) to alter in an instruction the address of the operand.
(2) to alter a subroutine according to a defined parameter.

Notation, Positional Notation, Number System - a systematic method for representing numerical quantities in which any quantity is represented approximately by the factors needed to equate it to a sum of multiples of powers of some chosen base n . That is, a number x

$$= a_q n^q + a_{q-1} n^{q-1} + \dots + a_1 n + a_0 + a_{-1} n^{-1} + \dots + a_{-p} n^{-p}$$

$$= \sum_{i=p}^{i=q} a_i n^i, \text{ with } n > a_i \geq 0 \text{ for all } i, \text{ is represented by}$$

~~$a_q a_{q-1} \dots a_1 a_0 a_{-1} \dots a_{-p}$~~

$a_q a_{q-1} \dots a_1 a_0 a_{-1} \dots a_{-p}$, with a point to the right of a_0 to identify it. For example, in decimal notation familiar to all, in which n equals ten, $x = 371.426$ represents $3 \cdot 10^2 + 7 \cdot 10 + 1 + 4 \cdot 10^{-1} + 2 \cdot 10^{-2} + 6 \cdot 10^{-3}$.

(continued on next page)

Similarly in binary notation, in which n equals two, $x = 1101.01$ represents $1 \cdot 2^3 + 1 \cdot 2^2 + 0 \cdot 2 + 1 + 0 \cdot 2^{-1} + 1 \cdot 2^{-2}$, which equals 13.75 in decimal notation. In writing numbers, the base is sometimes indicated as a subscript (itself always in decimal notation) whenever there is any doubt about what base is being employed (e.g., $1101.11_2 = 13.75_{10}$).

Binary, Ternary, Quaternary, Quinary, Octal (Octonary), Decimal, Duodecimal, Sexadecimal (Hexadecimal), or Duotricenary Notation - notation using the base 2, 3, 4, 5, 8, 10, 12, 16 or 32 respectively.

Coded Decimal Notation (Binary-coded Decimal) - decimal notation in which the individual decimal digits are represented by some binary code.

Bi-quinary Notation - one of any number of mixed-base notations in which the term n^i in the definition above is replaced by the product $\prod_{j=0}^{i-1} m_j$. In the biquinary system, m_j is two for j odd, ~~four~~ for j even.

Normalize - see Standardize.

Operand - any one of the quantities entering or arising in an operation. An operand may be an argument, a result, a parameter, or an indication of the location of the next instruction.

Operation - (1) a defined action;
(2) the action specified by a single computer instruction or pseudo-instruction;
(3) an arithmetical, logical, or transferal unit of a problem, usually executed under the direction of a subroutine.

Computer Operation - the electronic operation of hardware resulting from an instruction.

Complete Operation - an operation which includes (a) obtaining all operands from storage, (b) performing the operation, (c) returning resulting operands to storage, and (d) obtaining the next instruction.

Arithmetical Operations - operations in which numerical quantities form the elements of the calculation (e.g., addition, subtraction, multiplication, division).

(see next page)

Logical Operations - operations in which logical (yes-or-no) quantities form the elements being operated on (e.g., comparison, extraction). A usual requirement is that the value appearing in a given column of the result shall not depend on the values appearing in more than one given column of each of the arguments.

Transfer Operations (Storage Operations) - operations which move information from one storage location or one storage medium to another (e.g., read, record, copy, transmit, exchange). Transfer is sometimes taken to refer specifically to movement between different media; storage to movement within the same medium.

Red-tape Operations - operations which do not directly contribute to the result; i.e., arithmetical, logical, and transfer operations used in modifying the address section of other instructions, in counting cycles, in rearranging data, etc.

Although many operations fit the above definitions of two or more of the terms arithmetical, logical, transfer, and red-tape, these terms are frequently used loosely to divide the operations of a given routine or of a given instruction code into four mutually distinct classes depending on the primary function intended for the given operation in the case at hand.

Operation Number - a number indicating the position of an operation or its equivalent subroutine in the sequence forming a problem routine. When a problem is stated in pseudo-code each step must sometimes be assigned an operation number.

Order - a defined successive arrangement of elements or events. See also Instruction.

Output - (1) information transferred from the internal storage of a computer to secondary or external storage.
(2) information transferred to any device exterior to the computer.

Overflow (over capacity) - in an arithmetic operation, the generation of a quantity beyond the capacity of the register or location which is to receive the result.

Pack - to combine several different "short" elements of information into one word; e.g., storing one man's pay number, pay rate, tax exemptions, etc., in different sets of digit columns in one word, or storing several different payments in one word.

Parallel - handled simultaneously in separate facilities. See also Transfer and Storage.

Parameter - (1) in a subroutine, a quantity which may be given different values when the subroutine is used in different main routines or in different parts of one main routine, but which usually remains unchanged throughout any one such use.

(2) in a generator, a quantity used to specify input-output devices, to designate subroutines to be included, or otherwise to describe the desired routine to be generated.

Preset Parameter - a parameter incorporated into a subroutine during input.

Program Parameter - a parameter incorporated into a subroutine during computation. A program parameter frequently comprises a word stored relative to either the subroutine or the entry point and dealt with by the subroutine during each reference. It may be altered by the routine and/or may vary from one point of entry to another.

Patch - a section of coding inserted into a routine (usually by explicitly transferring control from the routine to the patch and back again) to correct a mistake or alter the routine.

Point (base point, radix point) - the dot that marks the separation between the integral and fractional parts of a quantity; i.e., between the coefficients of the zero and the minus one powers of the number base. It is usually called, for a number system using base two, a binary point; for base ten, a decimal point, etc. See Notation.

Post Mortem - a routine which, either automatically or on demand, prints information concerning the contents of the registers and storage locations at the time the routine stopped, in order to assist in the location of a mistake in coding. See Routine.

Precision - the degree of exactness with which a quantity is stated; a relative term often based on the number of significant digits in a measurement. See also Accuracy.

Prestore - (1) to set an initial value for the address of an operand or a cycle index; to restore.

(2) loosely, to store a quantity in an available or convenient location before it is required in a routine.

Program (noun) - a plan for the solution of a problem. A complete program includes plans for the transcription of data, coding for the computer and plans for the absorption of the results into the system. The list of coded instructions is called a routine, which see.

Program (verb) - to plan a computation or process from the asking of a question to the delivery of the results, including the integration of the operation into an existing system. Thus programming consists of planning and coding, including numerical analysis, systems analysis, specification of printing formats, and any other functions necessary to the integration of a computer in a system. See Code (noun).

Automatic Programming - any technique in which the computer is used to help plan as well as to help code a problem. See Coding.

Optimum Programming - improper terminology for minimal latency coding, i.e., for producing a minimal latency routine. See Routine.

Pseudo-code - see Code (noun).

Pseudo-random Sequence (Pseudo-random Numbers) - a sequence of numbers produced by a definite recursive rule but satisfying one or more of the standard tests for randomness.

Quantity - a positive or negative real number in the mathematical sense. The term quantity is preferred to the term number in referring to numeric data; the term number is used in the sense of natural number and reserved for "the number of digits", the "number of operations", etc.

Random Access - access to storage under conditions in which the next position from which information is to be obtained is in no way dependent on the previous one.

Range - the set of values over which a function may vary.

Read - to copy, usually from one form of storage to another, particularly from external or secondary storage to internal storage; to sense the meaning of arrangements of hardware.

Real-time Operation, On-line Operation, Simulation - processing data in synchronism with a physical process in such a fashion that the results of the data-processing are useful to the physical operation.

Record (Reference Record) - (1) a listing of information, usually in printed or printable form.

(2) one output of a compiler consisting of a list of the operations and their positions in the final specific routine and containing information describing the segmentation and storage allocation of the routine.

Record (verb) - to copy or set down in reusable form for future reference.

Register - the hardware for storing one or more computer words. Registers are usually zero-access storage devices. See Storage.

Rerun (noun, verb) - use of a rerun routine; to make use of a rerun routine. See Routine.

Reset - to return a device to zero or to an initial condition.

Restore - (1) to return a cycle index, a variable address, or other computer word to its initial value. See also Reset.

(2) periodic regeneration of charge, especially in volatile, condenser-action storage systems.

Rewind - to return a magnetic tape to its beginning.

Rollback - equivalent to rerun when referring to tape-sequenced computers; to recapture tape-inscribed data.

Routine - a set of coded instructions arranged in proper sequence to direct the computer to perform a desired operation or series of operations. See also Subroutine.

Executive Routine (Master Routine) - a routine designed to process and control other routines. A routine used in realizing "automatic coding".

Compiler (Compiling Routine) - an executive routine which, before the desired computation is started, translates a program expressed in pseudo-code into machine code (or into another pseudo-code for further translation by an interpreter). In accomplishing the translation, the compiler may be required to:

Decode - to ascertain the intended meaning of the individual characters or groups of characters in the pseudo-coded program.

Convert - to change numerical information from one number base to another (e.g., decimal to binary) and/or from some form of fixed point to some form of floating-point representation, or vice versa.

(see next page)

Select - to choose a needed subroutine from a file of subroutines.

Generate - to produce a needed subroutine from parameters and skeletal coding.

Allocate - to assign storage locations to the main routines and subroutines, thereby fixing the absolute values of any symbolic addresses. In some cases allocation may require segmentation. See Segment.

Assemble - to integrate the subroutines (supplied, selected, or generated) into the main routine, i.e., to:

Adapt - to specialize to the task at hand by means of preset parameters.

Orient - to change relative and symbolic addresses to absolute form.

Incorporate - place in storage.

Record - to produce a reference record. See Record.

Interpreter (Interpretive Routine) - an executive routine which, as the computation progresses, translates a stored program expressed in some machine-like pseudo-code into machine code and performs the indicated operations, by means of subroutines, as they are translated. An interpretive routine is essentially a closed subroutine which operates successively on an indefinitely-long sequence of program parameters (the pseudo-instructions and operands). It may usually be entered as a closed subroutine and exited by a pseudo-code exit instruction.

Diagnostic Routine - a specific routine designed to locate either a malfunction in the computer or a mistake in coding.

General Routine - a routine expressed in computer coding designed to solve a class of problems, specializing to a specific problem when appropriate parametric values are supplied.

Minimal Latency Routine - especially in reference to serial storage systems, a routine so coded, by judicious arrangement of data and instructions in storage, that the actual latency is appreciably less than the expected random-access latency.

(see next page)

Rerun Routine (Rollback Routine) - a routine designed to be used in the wake of a computer malfunction or a coding or operating mistake to reconstitute a routine from the last previous rerun point.

Rerun Point - that stage of a computer run at which all information pertinent to the running of the routine is available either to the routine itself or to a rerun routine in order that a run may be reconstituted.

Service Routine - a routine designed to assist in the actual operation of the computer. Tape comparison, block location, certain post mortems, and correction routines fall in this class.

Specific Routine - a routine expressed in specific computer coding designed to solve a particular mathematical, logical, or data-handling problem.

Test Routine - a routine designed to show that a computer is functioning properly.

Run (noun) - one performance of a program on a computer; performance of one routine, or several routines automatically linked so that they form an operating unit, during which manual manipulations are not required of the computer operator.

Scale - to change the scale (i.e. the units) in which a variable is expressed so as to bring it within the capacity of the machine or routine at hand. See also Standardize.

Segment (noun) - in a routine too long to fit into internal storage, a part short enough to be stored entirely in the internal storage and containing the coding necessary call in and jump automatically to other segments. Routines which exceed internal storage capacity may be automatically divided into segments by a compiler.

Segment (verb) - to divide a routine in parts each consisting of an integral number of subroutines, each part capable of being completely stored in the internal storage and containing the necessary instructions to jump to other segments.

Sense - (1) to examine, particularly relative to a criterion.
(2) to determine the present arrangement of some element of hardware, especially a manually-set switch.
(3) to read holes punched in paper.

Sentinel - a symbol marking the beginning or the end of some element of information such as a field, item, block, tape, etc; a tag.

Serial - handled one after the other in a single facility.
See also Transfer and Storage.

Shift - to move the characters of a unit of information column-wise right or left.

Arithmetic Shift (Numerical Shift) - to multiply or divide a quantity by a power of the number base.

Cyclic Shift (Logical or Non-arithmetical Shift) - a shift in which the digits dropped off at one end of a word are returned at the other in circular fashion.

Skip - an instruction to proceed to the next instruction; a "blank" instruction.

Sort - to arrange items of information according to rules dependent upon a key or field contained by the items.

Standardize - to adjust the exponent and mantissa of a floating-point result so that the mantissa lies in the prescribed normal range. See Floating-point Representation.

Storage - (1) any device into which units of information can be copied, which will hold this information, and from which the information can be obtained at a later time.
(2) devices, such as plugboards, which hold information in the form of arrangements of physical elements, hardware, or equipment.
(3) the erasable storage in any given computer.

The term "memory" is one of the last remaining words of the "magic brain" class. The term storage is preferred.

Internal Storage - storage facilities forming an integral physical part of the computer and directly controlled by the computer. See also Location and Register.

Secondary Storage - storage facilities forming not an integral part of the computer but directly linked to and controlled by the computer; e.g., magnetic drum, magnetic tapes, etc.

External Storage - storage facilities divorced from the the computer itself but holding information in the form prescribed for the computer; e.g., magnetic tapes, magnetic wire, punched cards, etc.

(see next page)

Erasable Storage - storage media which can be erased and reused; e.g., magnetic tapes.

Non-erasable Storage - storage media which cannot be erased and reused, such as punched paper tapes, and punched cards.

Parallel Storage - storage in which all bits, or characters, or (especially) words are essentially equally available in space, without time being one of the coordinates. Parallel storage contrasts with serial storage. When words are in parallel, the storage is said to be parallel by words; when characters within words (or binary digits within words or characters) are dealt with simultaneously, not one after the other, the storage is parallel by characters (or parallel by bit respectively).

Serial Storage - storage in which time is one of the coordinates used to locate any given bit, character, or (especially) word. Storage in which words, within given groups of several words, appear one after the other in time sequence, and in which access time therefore includes a variable latency or waiting time of zero to many word-times, is said to be serial by word. Storage in which the individual bits comprising a word appear in time sequence is serial by bit. Storage for coded-decimal or other non-binary numbers in which the characters appear in time sequence is serial by character; e.g., magnetic drums are usually serial by word but may be serial by bit, or parallel by bit, or serial by character and parallel by bit, etc.

Dynamic Storage (Circulating or Recirculating Storage) - storage such that information at a certain position is moving in time and so is not always available instantly; e.g., acoustic delay line, magnetic drum.

Static Storage - storage such that information is fixed in space and available at any time; e.g., flip-flop, electrostatic, or coincident-current magnetic-core storage.

Volatile Storage - storage media such that if the applied power is cut off, the stored information is lost; e.g., acoustic delay lines, electrostatic tubes. (see next page)

Non-volatile Storage - storage media which retain information in the absence of power; e.g., magnetic tapes, drums, or cores.

Buffer Storage - (1) a synchronizing element between two different forms of storage, usually between internal and external.

(2) an input device in which information is assembled from external or secondary storage and stored ready for transfer to internal storage.

(3) an output device into which information is copied from internal storage and held for transfer to secondary or external storage.

Computation continues while transfers between buffer storage and secondary or internal storage or vice versa take place.

Temporary Storage - internal storage locations reserved for intermediate and partial results.

Working Storage - a portion of the internal storage reserved for the data upon which operations are being performed.

Zero-access Storage - storage for which the latency (waiting time) is negligible at all times.

Store - to transfer an element of information to a device from which the unaltered information can be obtained at a later time.

Subroutine - the set of instructions necessary to direct the computer to carry out a well defined mathematical or logical operation; a subunit of a routine. A subroutine is often written in relative or symbolic coding even when the routine to which it belongs is not.

Closed Subroutine - a subroutine not stored in its proper place in the linear operational sequence, but stored away from the routine which refers to it. Such a subroutine is entered by a jump, and provision is made to return, i.e., to jump back to the proper point in the main routine at the end of the subroutine.

Open Subroutine - a subroutine inserted directly into the linear operational sequence, not entered by a jump. Such a subroutine must be recopied at each point that it is needed in a routine.

(see next page)

Library Subroutine (Standard Subroutine) - a member of a subroutine library.

Static Subroutine - a subroutine which involves no parameters other than the addresses of the operands.

Dynamic Subroutine - a subroutine which involves parameters, such as decimal point position or item size, from which a relatively coded subroutine is derived. The computer itself is expected to adjust or generate the subroutine according to the parametric values chosen.

Substitute - to replace an element of information by some other element of information.

System - an assembly of components united by some form of regulated interaction; an organized whole.

Number System - see Notation.

Tag - a unit of information, whose composition differs from that of other members of the set so that it can be used as a marker or label; a sentinel.

Tank - a unit of acoustic delay line storage, containing a set of channels each forming a separate recirculation path.

Track - in a serial magnetic storage element, a single path containing a set of pulses.

Transcribe - to copy, with or without translating, from one external storage medium to another.

Transfer - (1) to transfer data; to copy, exchange, read, record, store, transmit, transport, or write data;
(2) to transfer control; to jump.

Serial Transfer - a system of data transfer in which the characters of an element of information are transferred in sequence over a single path in consecutive time positions.

Parallel Transfer - a system of data transfer in which the characters of an element of information are transferred simultaneously over a set of paths.

Transform - to change information in structure or composition without altering the meaning or value; to normalize, edit, or substitute.

- Translate - to change information (e.g., problem statements in pseudo-code, data, or coding) from one language to another without significantly affecting the meaning.
- Transmit - to reproduce information in a new location replacing whatever was previously stored and clearing or erasing the source of the information.
- Transport - to convey as a whole from one storage device to another.
- Trouble-shoot - to search for a coding mistake or the cause of a computer malfunction.
- Trunk - a path over which information is transferred; a bus.
- Unconditional - not subject to conditions external to the specific instruction.
- Unpack - to decompose packed information into a sequence of separate words or elements. See Pack.
- Unwind - to code explicitly, at length and in full, all the operations of a cycle thus eliminating all red-tape operations in the final problem coding. Unwinding may be performed automatically by the computer during assembly, generation or compilation.
- Validity - correctness; especially the degree of the closeness by which iterated results approach the desired correct result.
- Verifier - a device on which a manual transcription can be verified by comparing a retranscription with it character-by-character as it is being retranscribed.
- Verify - to check a data transfer or transcription, especially those involving manual processes.
- Word - a set of characters which occupies one storage location and is treated by the computer circuits as a unit and transported as such. Ordinarily a word is treated by the control unit as an instruction, and by the arithmetic unit as a quantity. Word lengths are fixed or variable depending on the particular computer.
- Word-time - especially in reference to words stored serially, the time required to transport one word from one storage device to another. See also Access Time.

Write - (1) to transfer information to an output medium.
(2) to copy, usually from internal storage to external storage.
(3) to record information in a register, location or other storage device or medium.

Zero - positive binary zero is indicated by the absence of digits or pulses in a word; negative binary zero in a computer operating on one's complements by a pulse in every pulse position in a word; in a coded decimal machine, decimal zero and binary zero may not have the same representation. In most computers, there exist distinct and valid representation both for plus and for minus zero.

Zero Suppression - the elimination of non-significant zeros to the left of the integral part of a quantity before printing operations are initiated; a part of editing.

Zone - a portion of internal storage allocated for a particular function or purpose.

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QUESTIONNAIRE ON THE ACM FIRST GLOSSARY OF PROGRAMMING TERMINOLOGY

It will be of great assistance to the Committee on Nomenclature if you will complete this questionnaire and return it to the Chairman, Dr. Grace Murray Hopper, Remington Rand, Inc., 1624 Locust Street, Philadelphia 3, Pa.

1. On the back of this sheet are listed all of the terms defined in the First Glossary. Please indicate on each any feeling you have about it, using the following key or any legible notation you desire.

no mark : I have not studied this, or else I have no opinion to offer.

✓ : The definition is ok as it stands.

✗ : The meaning is ok but the wording should be improved.

word : The meaning given is incorrect or incomplete; I submit another.
(circle the word and supply a revised definition below)

~~word~~ : This word should be dropped from the glossary.
(draw a line through the word, and indicate a substitute if any)

X : I find the term and/or its meaning unfamiliar and incomprehensible. It needs to be revised, but I cannot say how.

2. What other areas should be covered?

- a) What other areas would you like to see covered in this glossary, bearing in mind that a comprehensive glossary including engineering terminology is being prepared by an I.R.E. committee?

Business? Math? Logic? Engineering? Punched Cards? Analog Syst.?

Other:

- b) What other areas would you like to see covered in a separate glossary?

Business? Math? Logic? Engineering? Punched Cards? Analog Syst.?

- c) Can you name any existing glossaries which include terms in the added areas you suggest? If so what are they?

- d) If you would like to assist actively in expanding the ACM glossary in a new area, what area(s) would you be interested in?

3. What new terms should be defined in the area of the present glossary? How? How do you redefine those terms that you circled on the back of this questionnaire? Use additional sheets if necessary.

Submitted by :
Company :
Address :

CWA:cf
June 2, 1954

Please send ___ questionnaires to me.

access time	debug	red-tape operations	shift
accumulator	define	operation number	arith. shift
accuracy	diagram	order	(numerical shift)
adder	digit	output	cycle shift
address	check digit	overflow (over capacity)	(logical or non-
absolute address	coded dec. digit	pack	arith. shift)
(specific address)	double-prec. quant.	parallel	skip
relative address	dump	parameter	sort
symbolic address	DC dump	preset parameter	standardize
(floating address)	dummy	program parameter	storage
arithmetic unit	edit	patch	internal storage
base	erase	point	secondary storage
(radix)	error	(base pt., radix pt.)	external storage
binary	truncation error	post mortem	erasable storage
bit	inherited error	precision	non-erasable stor.
block	rounding error	prestore	parallel storage
breakpoint	exchange	program (noun)	serial storage
bus	extract	program (verb)	dynamic storage
call-number	field	auto. programming	(stor) (circ. or recirc.)
call-word	card field	optimum programming	static storage
capacity	file	pseudo-random sequence	volatile storage
carry	fixed-point repres.	(pseudo-random numbers)	non-volatile storage
cell	floating-point repres.	quantity	buffer storage
channel	flow chart	random access	temporary storage
character	flow diagram	range	working storage
check	force	read	zero-access storage
built-in check	function table	real-time oper., on-	store
duplication check	hardware	line oper., simul.	subroutine
twin check	ignore	record	closed subroutine
mathematical check	information	(reference record)	open subroutine
redundant check	input	record (verb)	library subroutine
summation check	instruction	register	(standard subro)
parity check	breakpoint instruc.	rerun (noun, verb)	static subroutine
clear	cond. breakpt. instr.	reset	dynamic subroutine
code (noun)	zero-address instruc.	restore	substitute
computer code	one-address instruc.	rewind	system
(machine code)	(single-address instr.)	rollback	tag
instruction code	two-, three-, or four-	routine	tank
operation code	address instruc.	executive routine	track
pseudo-code	one-plus-one, or three-	(master routine)	transcribe
pulse-code	plus-one ad. instruc.	compiler	transfer
code (verb)	multi-address instruc.	(compiling routine)	serial transfer
coding	item	decode	parallel transfer
abs., rel., symb. c.	jump	convert	transform
automatic coding	key	select	translate
collate	latency	generate	transmit
column	library	allocate	transport
(digit column)	location	assemble	trouble-shoot
command	loop	adapt	trunk
comparator	closed loop	orient	unconditional
compare	malfunction	incorporate	unpack
comparison	merge	record	unwind
complement	message	interpreter	validity
computer	mistake	(interpreting routine)	verifier
conditional	modifier	diagnostic routine	verify
contents	modify	general routine	word
control sequence	notation, posit. not.,	min. latency routine	word-time
control unit	number system	rerun routine	write
copy	binary, ternary, quat.,	(rollback routine)	zero
counter	quin., octal, dec.,	rerun point	zero-suppression
control counter or	duodec., sexadec.,	service routine	zone
program counter,	duotri. notation	specific routine	
cycle-counter or B-box	coded dec. notation	test routine	
cycle (noun)	(binary coded dec.)	run (noun)	
major cycle	bi-quinary notation	scale	
minor cycle	operand	segment (noun)	
cycle (verb)	operation	segment (verb)	
cycle index	computer operation	sense	
cycle count	complete operation	sentinel	
cycle criterion	arith. operations	serial	
cycle reset	logical operations		
	transfer operations		
	(storage operations)		