

Software: Systems and Application Software

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Computer Software

Computer hardware cannot work without software. Software refers to programs, which are instruction codes that direct the computer to perform some actions.

Software or programs are also used to perform certain activities or data processing for a user. In general, there are two basic types of software: system software and application software.

System Software

System software is the set of programs designed to coordinate the activities and functions of the hardware and various programs throughout the computer system. A particular system software package is designed for a specific CPU design and class of hardware.

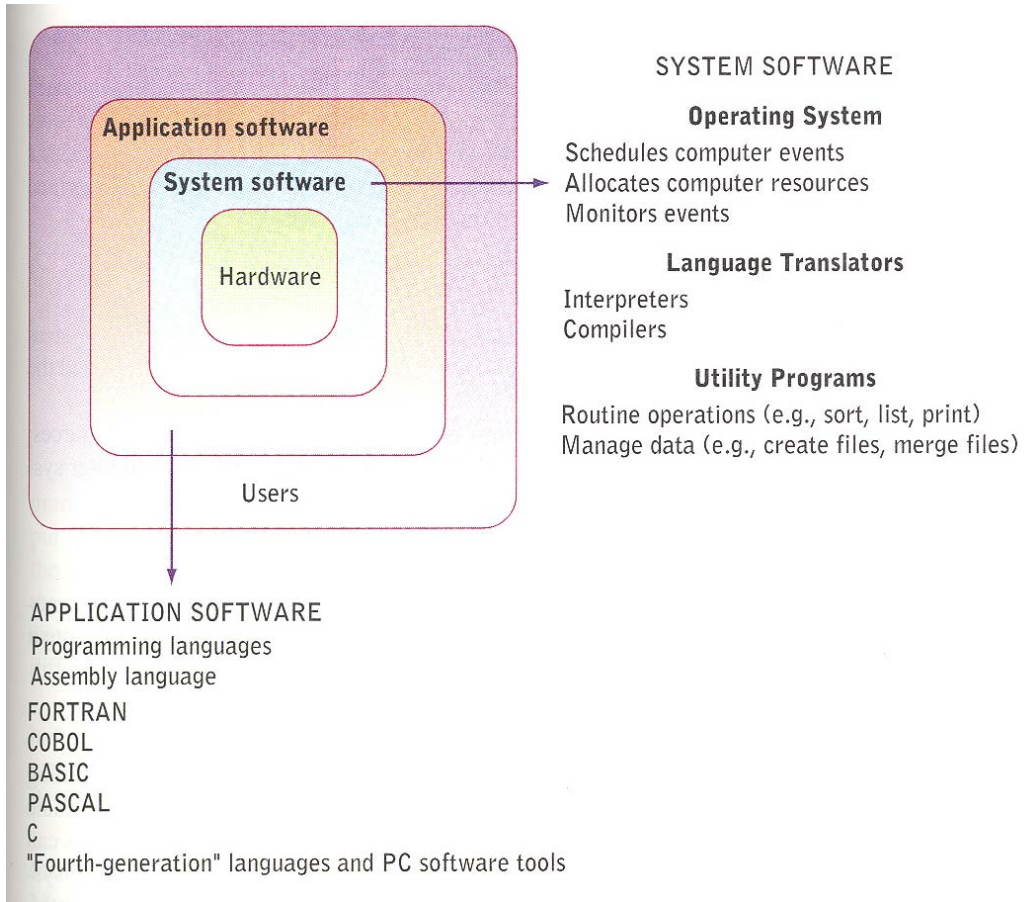
System software includes three types of programs:

- *Operating System:* The combination of a particular hardware configuration and system software package is known as a computer system platform. System platforms are commonly termed as operating system (OS). Some common operating systems are DOS, Unix, Mac, and Windows platform.
- *Language Translators:* These are interpreters and compilers for programs such as Pascal, BASIC, COBOL, C, and C++.
- *Common Utility Programs:* Communication tools, disk formatter, etc.

Application Software

Application software consists of programs that help users solve particular computing problems. Application software is designed to address the need of a particular organizational activity or function.

Application software includes packaged software such as word processing, spreadsheet, database, and programming languages such as BASIC, COBOL, C, Visual Basic, and other commercial and custom software.



Operating System

The operating system is a set of computer programs, which controls the operations of computer hardware. It also supports software development of a user by acting as an interface between the application program and the hardware.

It usually resides on a disk. After a computer system is started, or “booted up”, portions of the operating system are transferred to memories as they are needed.

Some of the activities of an operating system are as follows:

- Performing common hardware functions
- Providing a user interface
- Providing a degree of hardware independence
- Managing system memory
- Managing processing tasks
- Providing network capability
- Controlling access to system resources
- Managing files

These are described below.

Common Hardware Functions

An operating system must perform some common hardware tasks such as:

- Getting input from the keyboard or other input device
- Retrieving data from disks
- Storing data on disks
- Display information on a monitor or printer

When an application program wants to read or write a chunk of data, the instruction is passed onto the operating system, which in turn breaks the job into multiple small hardware instructions. A typical operating system performs hundreds of such functions.

User Interface

A user interface allows individuals to access and command the computer system. Command-based user interface (MS-DOS) requires use of text commands to perform certain basic computer activities. Examples are: cut, copy, delete, and save.

A graphical user interface (GUI) uses pictures (command buttons) and menus displayed on the computer screen to send commands to the computer. Most common user interface is Windows from Microsoft.

Hardware Independence

As the application program communicates with the hardware through the operating system, the operating system works as an agent between the application program and the hardware.

Thus any application software written for a particular operating system works independent of the hardware, as long as the operating system and the hardware are compatible.

All software written for Windows '98 work in computers loaded with Windows '98 operating system, but they will not work in a Mac operating system.

Memory Management

Memory management programs that are part of the operating system, are needed to convert a user's request for data or instructions (called a logical view of data) to the physical location where the data or instructions are stored.

A computer understands only a physical view of data, which is the specific location of data in storage or memory and the techniques needed to access the data. This concept is termed as logical versus physical access.

For example, to find the Last Name = “Smith” of a particular person in a database table, the system needs to find the actual physical location of “Smith” in the memory or disk. Thus data need to be arranged in the memory in a particular way, so that it can be retrieved in a logical fashion.

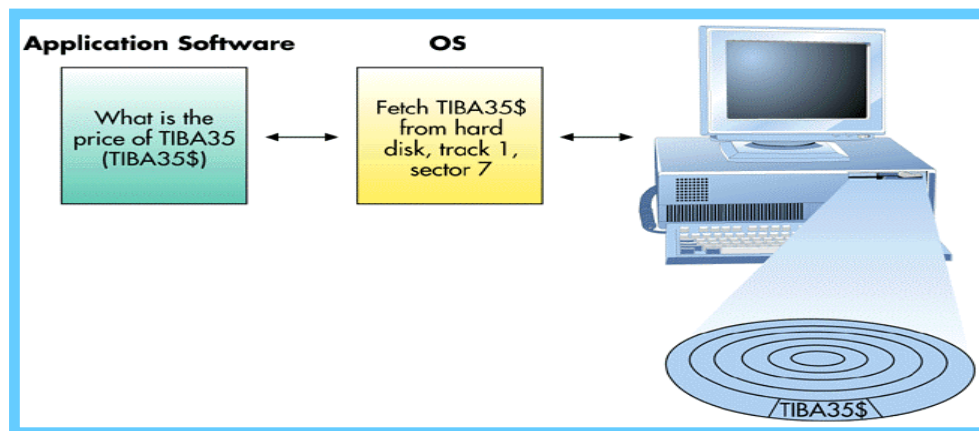
Memory management is important because memory can be divided into different segments or areas.

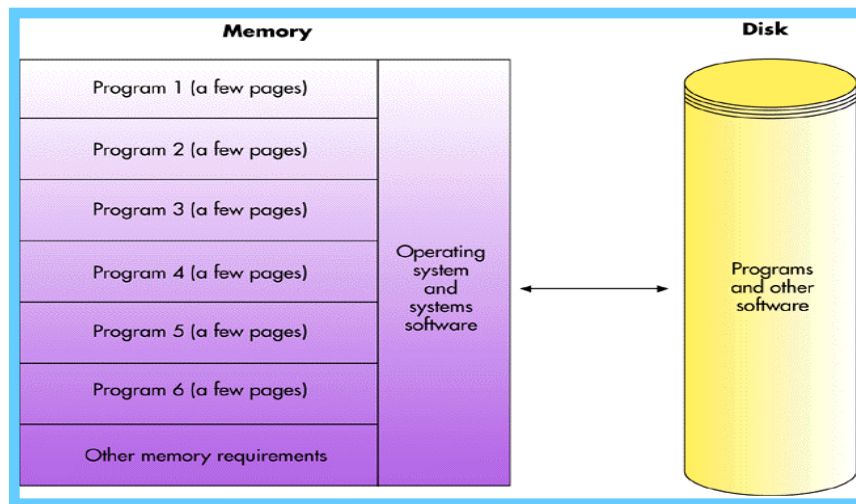
- *Virtual Memory:* Some operating systems support virtual memory, which increases the functional capacity of primary memory (RAM) of a computer in the central processor.

It works by dividing each program in the secondary storage into a number of small segments or *pages*. The computer then loads only the currently needed pages of multiple programs into the RAM. This increases the operating efficiency of the computer.

The number of program segments held in the RAM at one time depends on the sizes of those segments and the computer’s RAM capacity.

- *Paging:* Breaking a large program into small segments and then swapping them between the RAM and secondary storage is called paging.





Processing Tasks (Scheduling)

Task management allocates computer resources to make the best use of each system's assets. Task management software can permit one user to run several programs or tasks at the same time (multi-tasking) and allow several users to use the same computer at the same time (time-sharing).

- *Multitasking:* It allows a user to run more than one application at the same time. For example, a user can run a word processing, a spreadsheet, and a database program. Data can be copied and paste among the various documents.
- *Multithreading:* Multithreading is basically multitasking within a single application - that is, several parts of the program can work at once.
- *Time-sharing:* Time-sharing allows more than one person to use a computer system at the same time. Many customer service representatives in a company may enter and review data from a database located in a central database in a server computer. This is time-sharing.

It works by dividing CPU processing time into small segments (of the order of milliseconds to microseconds) to a process or user. Because the CPU processing time slices are small, it appears that all processes are running concurrently. In reality, the user is sharing time with other users.

Network Capability

The operating system can provide features and capabilities through which a user can share resources (files, database, e-mail, security) in other computers. Windows '98 and NT are examples of network operating systems.

File Management

The operating system performs file management such that the files in the secondary storage are stored in a particular sequence, that the files in the are available when needed, and they are secured from unauthorized users.

Popular Operating Systems

Operating systems are needed to support the computing needs of an individual, a group of workers, and for an enterprise.

PC Operating Systems

Like any other software, PC software is based on specific operating systems and computer hardware. A software package written for one PC operating system generally can not be run on another system. Table below compares the leading PC operating systems.

Operating System	Features
Windows 98 and Windows 95	32-bit operating system with a streamlined graphical user interface. Has multitasking and powerful networking capabilities and can be integrated with the information resources of the Web.
Windows NT (Windows 2000)	32-bit operating system for PCs, workstations, and network servers not limited to Intel micro-processors. Supports multitasking, multiprocessing, intensive networking.
Windows CE	Pared-down version of the Windows operating system for handheld computers and wireless communication devices.
OS/2	Operating system for IBM PCs that can take advantage of the 32-bit microprocessor. Supports multitasking and networking.
UNIX	Used for powerful PCs, workstations, and minicomputers. Supports multitasking, multi-user processing, and networking. Is portable to different models of computer hardware.
Linux	Free, reliable alternative to UNIX and Windows NT that runs on many different types of computer hardware and provides source code that can be modified by software developers.
Mac OS	Operating system for the Macintosh computer. Supports networking and multitasking and has powerful multimedia capabilities. Supports connecting to and publishing on the Internet.
DOS	Operating system for IBM (PC-DOS) and IBM-compatible (MS-DOS) PCs. Limits program use of memory to 640 K.

MS-DOS

Developed by Microsoft for the IBM-compatible computers in the 1980s, this Microsoft disk operating system (MS-DOS) was designed for a single user and single-task processing. It used commands like COPY, DELETE, RENAME, and FORMAT to perform file and disk activities.

DOS with Windows

The original Windows 3.1 was not a complete operating system, rather it was a layer written on top of the DOS operating system. Windows added a graphical user interface (GUI) to make file and disk activities simpler for the users. It also added multi-tasking capability.

Windows 95 and 98

Windows 95 is true 32-bit, multi-tasking, and multi-threaded operating system. In a 32-bit architecture data moves in 32 bits or 4 bytes, thus increasing the speed of the computer. One can work on many documents of the same software such as word processing. There are other improvements and capabilities such maximum 255-character filename, networking, fax, e-mail, Internet connecting tools, and etc.

Windows NT/2000/XP

Windows NT is the true network operating system providing services to many client computers in an enterprise. It is designed to run on multiple platforms; thus it is portable. For example, NT can run on DEC's Alpha and MIP's R4000 RISC microprocessors.

It has built-in networking to support several communication protocols. NT also has a centralized security system to monitor various system resources.

There are two versions of Windows NT – a workstation version and a server version. The workstation supports users of standalone or client desktop computers and the server is designed to provide network management functions. Windows NT server also supports a Web server (Internet Information Server) and database server (SQL Server).

OS/2

Operating System 2 (OS/2) is a robust 32-bit operating system developed by IBM for personal computers. It works very similar to Windows NT.

It is used for complex, memory-intensive applications or those require networking, multi-tasking, or large programs such as those handled by mainframe operating systems.

OS/2 supports applications that run under Windows and DOS and has its own graphical user interface.

Unix

Unix is a powerful operating system originally developed by AT&T to solve scientific programs. Many people can use Unix simultaneously to perform the same kind of task, or one user can run many tasks on Unix concurrently.

It was developed to connect various machines together and is highly supportive of communications and networking. Unix was designed for minicomputers but now it has versions for PCs, workstations, and mainframes. It is often used for workstations and server computers.

Unix is considered powerful but it has a complex user interface. There are many variations of Unix – including HP/UX from Hewlett-Packard, AIX from IBM, Ultrix from DEC, Solaris from Microsystems.

Linux

Linux is Unix-like operating system that is capable of running on Intel, Motorola, Digital Alpha, SPARC, and Mips processors. Because of that, it is becoming popular to develop applications in Linux.

Mac OS

Used for Macintosh computers, Mac operating system features multi-tasking, powerful multimedia and network capabilities, and GUI capability.

Main-Frame Computer Operating Systems

Most mainframe computer manufacturers provide proprietary operating systems with their specific hardware.

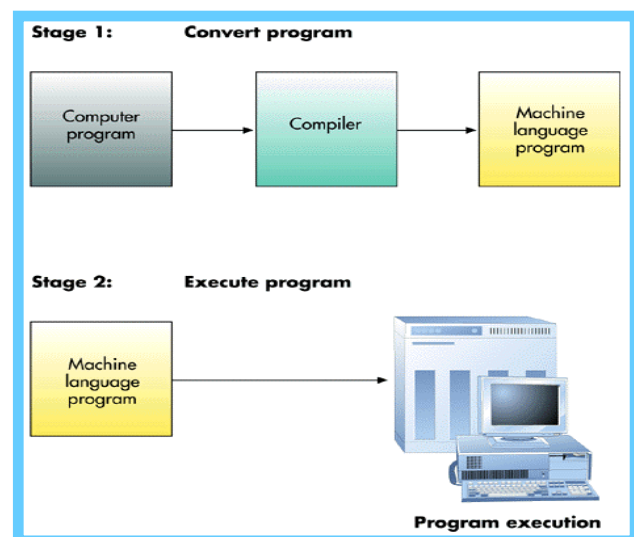
For example, ESA/370 (Enterprise Systems Architecture 370) and MVS/ESA (Multiple Virtual Storage/Enterprise Systems Architecture) are operating systems used on larger IBM mainframe computers.

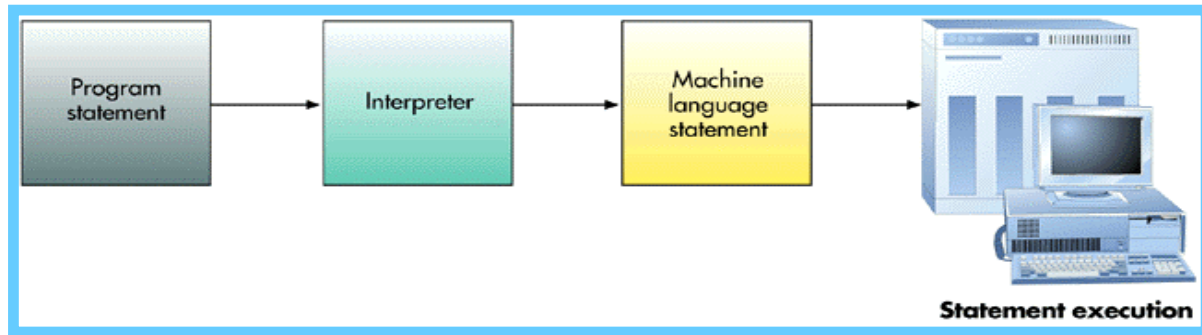
Hewlett-Packard (HP) and Digital Equipment Corporation (DEC) are also popular enterprise systems.

Language Translators

When computers execute programs written in high-level languages such as COBOL, FORTRAN, or C, the computer must convert these human-readable instructions into a form that it can understand.

- *Compiler*: System software includes special language translators that translate high-level language into machine language.
- *Source Code*: The program in the high-level language before translation is called source code.
- *Object Code*: Compiler translates source code into a language called object code. When a computer executes a program, it really executes the object code.
- *Interpreter*: Some programming language such as BASIC do not use a compiler but an interpreter, which translates one statement at a time into machine code, as the computer executes the program.





Interpreter

Utility Programs

System software also includes small utility programs. They are used to merge and sort sets of data, keep track of computer jobs being run, compress files, formatting disk, scan for viruses, and perform other important tasks.

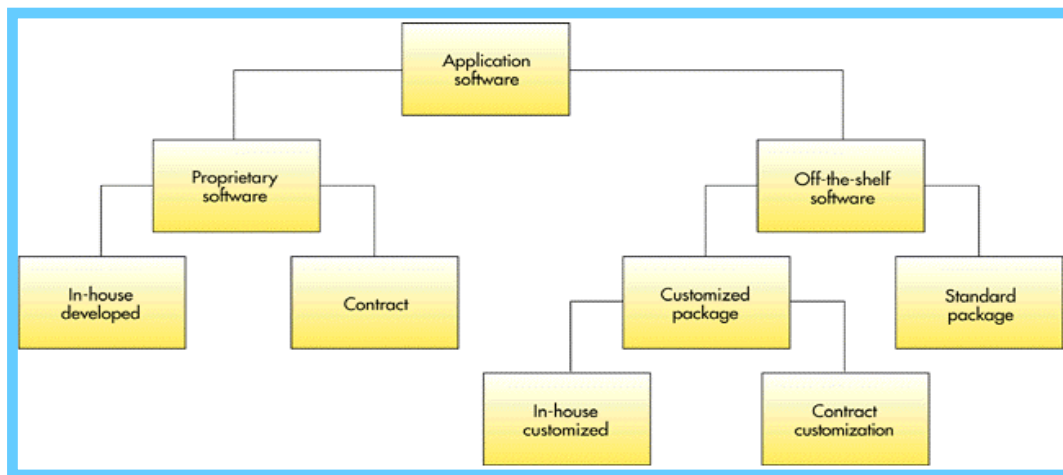
Personal	Workgroup	Enterprise
Software to compress data so that it takes less hard disk space	Software to provide detailed reports of work-group computer activity and status of user accounts	Software to archive contents of a database by copying data from disk to tape
Screen saver	Software that manages an uninterruptable power source to do a controlled shutdown of the work-group computer in the event of a loss of power	Software that compares the content of one file with another and identifies any differences
Virus detection software	Software that reports unsuccessful user log-on attempts	Software that reports the status of a particular computer job

Application Software

As mentioned before, the primary function of application software is to apply the power of the computer to give users the ability to solve business and scientific problems. Many different languages can be used to develop application software, each having strengths and weaknesses.

Types of Application Software

To solve a particular business requirement, a company can either develop its own software or purchase off-the-shelf software. It is also possible to modify some off-the-shelf software, to tailor it such that it satisfies business of the company.



Proprietary Application Software

Software that solves a unique or specific business problem of a company is called proprietary application software. This type of software is either built in-house using programmers or it can be contracted to an outside software development company. There can not be any duplication of this type of software.

Off-the-Shelf Application Software

A software package is a pre-written, precoded, commercially available set of programs that eliminates the need for individuals or organizations to write their own software programs for certain functions.

Application software packages are marketed commercially. These packages perform certain functionality of a business that is required by many companies, and they are available for mainframe, minicomputers, and PCs.

Examples of standard packages are, accounting, finance, auto body shop, human resources, university registration, library catalog, payroll, physician insurance claim, fax, e-mail, tax, and so on.

Customized Packages

In some cases, companies modify of-the-shelf software to accommodate business requirements of the company. Software vendors must provide the opportunity to modify their software. Again modification can be done in house or contracted to an outside company.

Personal Application Software

Personal application software includes general purpose tools and programs such as word processor, spreadsheet, graphics, database, desktop publishing, project management, computer aided design, financial management, fax, e-mail, web-browser, and so on.

These software are purchased as off-the-shelf software. Multiple software vendors may offer any type of software.

Workgroup Application Software (Groupware)

Groupware provides functions and services to support the collaborative activities of workgroups. It includes software for information sharing, electronic meeting, scheduling, and e-mail and a network to connect the members of the group as they work on their desktop computers.

Lotus Notes (renamed Domino) is a groupware, which provides companies to the capability of using one software, and one user interface, to integrate many business functions. For example, it can provide a global team to

work on a shared set of documents or have electronic discussion following threads. A *thread* is a series of messages in an on-line discussion that have been posted as replies to each other.

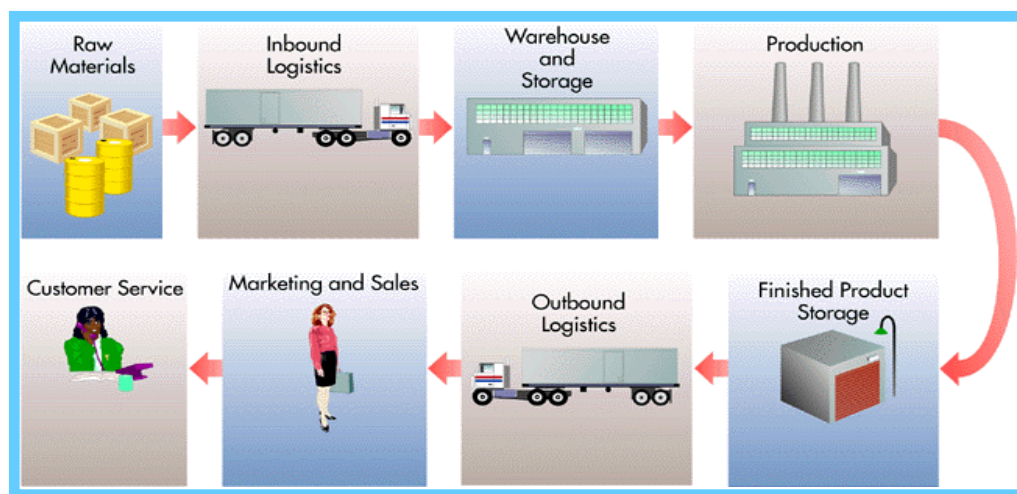
Enterprise Application Software

This type of software benefits the entire organization. A fast-food chain might develop a materials ordering and distribution program to make sure that each fast-food franchise gets the necessary raw materials and supplies during the week.

Many organizations are moving to integrated enterprise software that supports supply chain management, such as, movement of raw materials from suppliers through shipment of finished goods to customers.

- *Enterprise Resource Planning (ERP)*: ERP software is a set of integrated programs that manage vital business operations for a global enterprise. ERP supports multiple languages, multiple currencies, and multiple legal entities.

Most ERP systems support manufacturing and finance. SAP and PeopleSoft, and Oracle are leading ERP software.



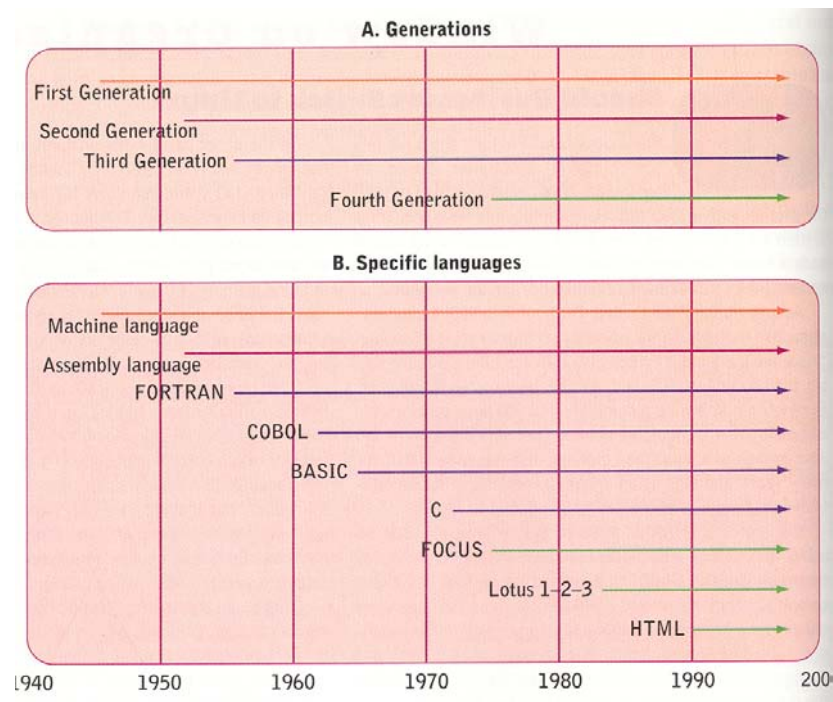
Programming Languages

A programming language is a computer language with its own syntax and grammar. Both systems and application software are written in programming languages.

There are two types of programming languages: procedural and non-procedural.

- *Procedural Language*: A procedural language tells the computer in a step-by-step fashion how to accomplish a given task.
- *Non-Procedural Language*: Tasks are divided into small, unrelated procedures.

There are four generations of computer languages.



First Generation (Machine Language)

In early years of computer revolution, programs were written in machine language, using the binary symbols 1 and 0. All numbers, characters and special symbols were represented by eight-bit codes.

This is also considered a low-level language because there is no programming scheme less sophisticated than the binary code.

Example: 00000010 00100101 00000011 == 2 + 3

Second Generation (Assembly Language)

Assembly language replaced binary digits with symbols such as ADD, SUB for addition and subtraction, so that programming became more understandable to humans. Operating systems and utility programs were written in an assembly language.

- *Assembler*: An assembler is a special program that converts assembly language into machine-readable language (1 and 0).

Third Generation Languages: 3GLs (High-Level Languages)

These languages were easier to use than assembly and machine language because they relied on natural language (such as English) and used fewer lines of code to execute an instruction.

Some high-level languages are BASIC, COBOL, FORTRAN, and C. These languages are called high-level languages.

3GLs are machine-independent languages. That is, they are portable from one machine to another.

- *Compiler*: A special program that converts a high-level language into machine language.

Fourth Generation Languages: 4GLs (Very-High-Level Languages)

4GLs are less procedural and even more English-like than third-generation languages. These are user-friendly and easy to learn. Examples are: FOCUS, SQL, HTML, and SAS.

- *Structured Query Languages (SQL)*: A standardized language often used to perform database queries and manipulations.

Example: SELECT ALL FROM Employee WHERE EmpID = 1000

Employee

EmpID	LastName	FirstName	MddleInit	MonthSalary
1000	White	James	W	\$3000
2000	Smith	Mark	S	\$4000

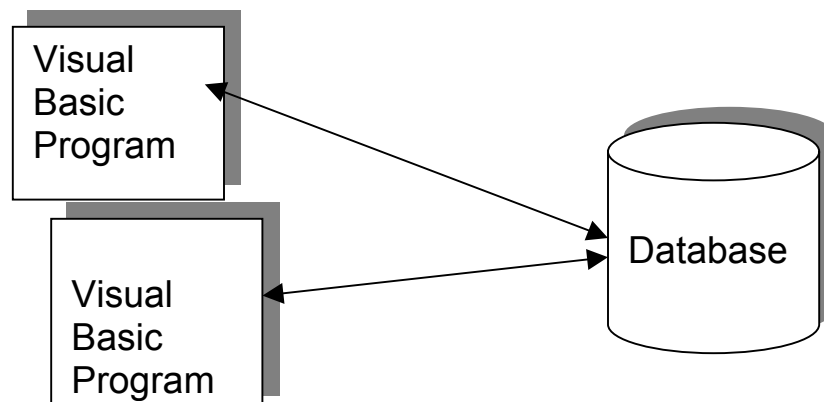
Result:

EmpID	LastName	FirstName	MddleInit	MonthSalary
1000	White	James	W	\$3000

- *Visual Programming Languages*: Visual programming helps users create powerful and less error-prone applications in a shorter time span. It allows users to write special programs that in turn help users to select menus, buttons, and other graphical elements.

Features of these languages include query and database abilities, and code-generation abilities. Examples are Visual C++, C#, Visual Basic, ASP.

Microsoft Visual Basic is the most popular business language used to develop client-server applications in the PC environment.



Object Oriented Languages

Languages that allow interaction of programming objects, including data elements and the actions that will be performed on them.

An object-oriented language the world is looked as a set of objects. Each object interacts with another object based on the messages it receives.

Encapsulation

The process of grouping items into an object.

Polymorphism

A process allowing the programmer to develop one routine or set of activities that will operate on multiple objects.

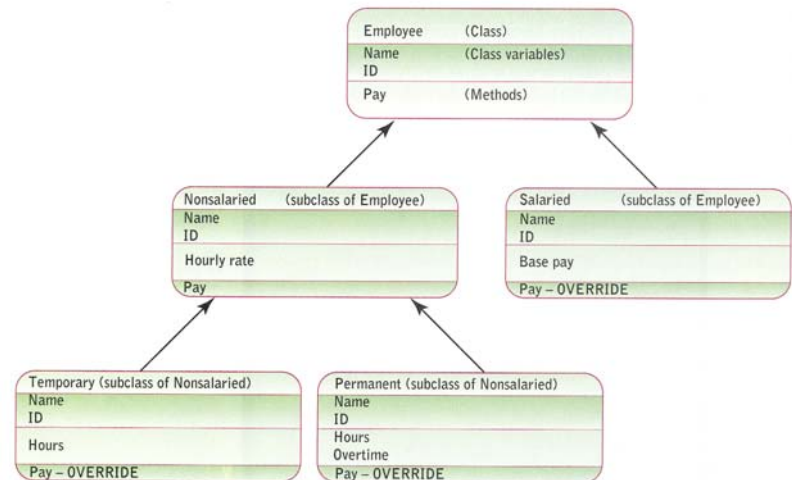


Figure 7-13 Class, subclasses, inheritance, and overriding. This figure illustrates how a message's method can come from the class itself or an ancestor class. Class variables and methods are shaded when they are inherited from above.

Inheritance

Property used to describe objects in a group of objects taking on characteristics of other objects in the same group or class of objects.

Reusable Code

The instruction code within an object that can be reused in different programs for a variety of applications.

Object Oriented Languages

Small Talk, C++, C#, Java