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COMPUTER STUDIES

Standard 9

PLEDGE

India is my country.
All Indians are my brothers and sisters.
I love my country and I am proud of its rich and varied heritage.
I shall always strive to be worthy of it.
I shall respect my parents, teachers and all my elders and treat everyone with courtesy.
I pledge my devotion to my country and its people.
My happiness lies in their well-being and prosperity.

રાજ્ય સરકારની વિનામૂલ્યે યોજના હેઠળનું પુસ્તક

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PREFACE

The Gujarat State Secondary and Higher Secondary Education Board has prepared new syllabi based on the open source operating system and compitible open source software tools for various topics of Computer Studies. These syllabi are sanctioned by the Government of Gujarat.

It is a matter of pleasure for the Gujarat State Board of School Textbooks to place this textbook of **Computer Studies** before the students of **Standard 9** prepared according to the new syllabus.

Before publishing the textbook, its manuscript has been fully reviewed by experts and teachers teaching at this level. Carrying out suggestions given by teachers and experts, we have made necessary changes in the manuscript and then have published the textbook.

The board has taken special care to ensure that this textbook is interesting, useful and free from errors. However, we welcome suggestions to enhance the quality of the textbook.

Dr. Bharat Pandit
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Date : 3-3-2015

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FUNDAMENTAL DUTIES

It shall be the duty of every citizen of India :

(a) to abide by the Constitution and respect its ideals and institutions, the National Flag and the National Anthem;

(b) to cherish and follow the noble ideals which inspired our national struggle for freedom;

(c) to uphold and protect the sovereignty, unity and integrity of India;

(d) to defend the country and render national service when called upon to do so;

(e) to promote harmony and the spirit of common brotherhood amongst all the people of India transcending religious, linguistic and regional or sectional diversities; to renounce practices derogatory to the dignity of women;

(f) to value and preserve the rich heritage of our composite culture;

(g) to protect and improve the natural environment including forests, lakes, rivers and wild life, and to have compassion for living creatures;

(h) to develop the scientific temper, humanism and the spirit of inquiry and reform;

(i) to safeguard public property and to abjure violence;

(j) to strive towards excellence in all spheres of individual and collective activity so that the nation constantly rises to higher levels of endeavour and achievement;

(k) to provide opportunities for education by the parent or the guardian, to his child or a ward between the age of 6-14 years as the case may be.

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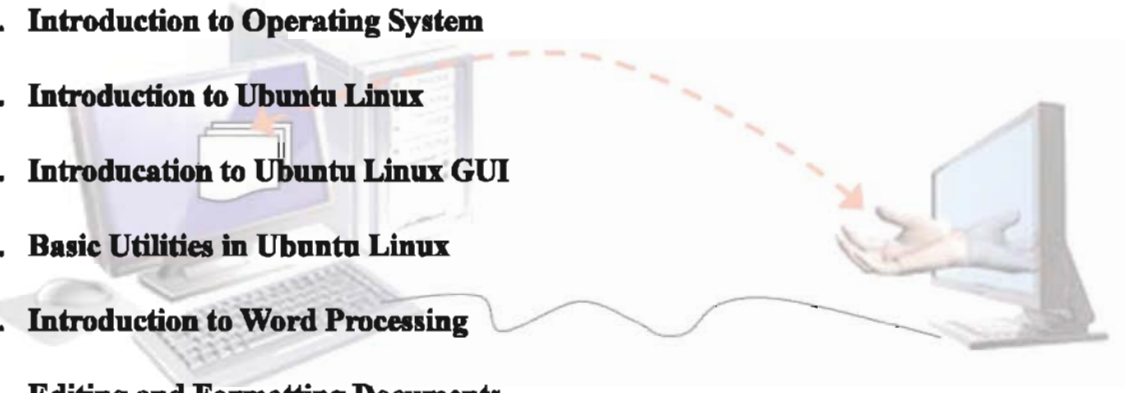


About This Textbook...

Dear Teachers,

With a mission to spread computer literacy on a fast track, the Gujarat Government has provided latest computer equipment to more than 6000 aided schools under the ICT@School program. As a new policy initiative all the schools are given the Ubuntu (a variant of Linux) Operating System and other Open Source software packages so that schools can freely use and exchange the software without bothering about the licensing issues. Since earlier textbooks were largely based on proprietary software, there was a need to rewrite the textbooks based on new syllabus. This was also necessary in view of the fact that the 8th standard has been transferred to primary section. Therefore, new content has been provided for 9th to 12th standard in a phased manner based on the open source Operating System and compatible open source software tools for various topics of computer studies.

This textbook for 9th standard is the first in series for the subject of 'Computer Studies'. The aim has been to provide elementary knowledge of computers, introduction to Open Source Operating System-Ubuntu, Open Office Word Processor known as Writer, Presentation tool Impress and some concepts of Internet surfing, searching, email, file downloading etc. as well as security. An attempt has been made to create a good base for the students to learn other topics as well as open source software in later years. It is worth to mention that no assumption has been made about students having any prior knowledge of computers.

We hope the coverage will be useful to the students and you will enjoy teaching and conducting practicals using open source Ubuntu operating system.

Dear Students,

We assume that you are learning the subject of computer studies based on open source software for the first time. As a beginner, you will need to know various definitions around computers, hardware and software. This will be followed by introduction to open source operating systems as well as other operating systems available in public domain. You will also be learning Open Office components of

word processing and presentation tools. Finally, exposure to Internet and its uses will be covered so that you become quite comfortable in working with computers and Internet.

The chapters 1 to 4 cover introduction, history and evolution of computers, input output devices as well as memory and data representation techniques. In chapters 5 to 8 introductory details about functions and types of operating systems, Ubuntu Linux, graphical user interface GNOME and basic utilities such as command line interface (CLI), text and image editors, media players etc. are discussed. Chapters 9 to 11 introduce all the basic functionalities of word processor Writer. Another component of Open Office which is a presentation tool Impress is covered in chapter 12. Finally, basic terminologies of Internet, its applications, security threats and cryptography have been covered in chapters 13 and 14.

It is expected that if you study the text carefully and practice the laboratory exercises, you will develop reasonable confidence in working with quite user friendly Ubuntu Linux operating system and OpenOffice components for word processing and presentation.

Introduction to Computers

Computers are multi-purpose machines that can be used to solve variety of problems in different fields. Computers have changed the way we live, work and communicate. Computers are useful in industries, government, education, research as well as entertainment sectors. From routine business activities in a given area to a spectacular task, computers are applicable everywhere. That is why a computer is called multi-purpose machine.

Working of a Typical Computer

Just as a calculator calculates, a driver drives and a painter paints, computer computes. The computing here is not restricted to only mathematical computing but to a variety of logic based tasks. One only needs to systematically design step by step clear guidelines for the task to be solved. These guidelines generally written in simple English language are called **algorithm.** Computer once given proper set of instructions can perform operations like generating bills, reserving tickets, printing mark-sheets, printing business reports or communicating messages. Computer can also deal with audio, video, graphs and animations besides texts and numbers.

Once the computer is given data and step by step instructions, it then performs computations and generates result or performs an action as an output. The set of data and instructions provided by a user to the computer is called an **input**. Computer processes this input and presents results to the user. The result is called an **output**. Computer can remember these data, instructions and calculated results for future use by storing the details in memory. This simple flow of working of computer is shown in figure 1.1.

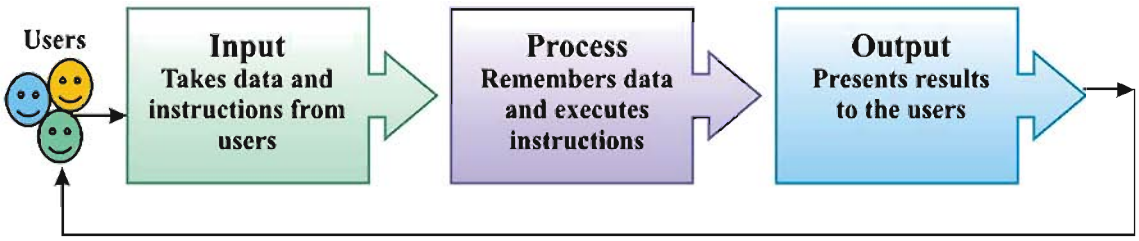


Figure 1.1 : Working of a Typical Computer

Further, it is not compulsory to repeat the instructions and enter large amount of data every time we use the computer. We can store the data and instructions within the computer itself in such a way that it can be understood by machine; that is, in machine readable language. Storing such set of instructions is useful for repetitive performance of the tasks. Once the set of instructions in machine readable format called program is stored in the computer, it can be used many times with different sets of data. This concept is known as **stored program concept**.

Following sample list presents some sample applications to highlight use of computers in different areas :

- Ticket reservations
- Bank operations
- Inventory management and manufacturing support
- Entertainments such as playing games, composing music and editing movies
- Teaching
- Financial Accounting
- Correspondence and publishing (composing newspapers, writing letters, books etc.)
- Space applications
- Robotics
- Email and chatting
- Website development etc.

Simple Model of a Computer

The simple model of a typical computer is based on the working of computer shown in the figure 1.1. As we have discussed, instructions are needed to make computers perform some actions. To obey instructions provided by the user and perform computations, a computer needs to have a mechanism to input. The input mechanism helps in feeding data as well as instructions into the computers. This mechanism is called **input unit**. Devices used for the input purpose are known as input devices. Typically input devices such as mouse and keyboards are used for this purpose.

Input provided through the input mechanism is stored in memory of the computer and further processed by a mechanism called **processing unit** or processor. Results are presented to the user through output mechanism called **output unit**. Typical output devices are monitor and printer. In short the input, memory, processor and output are the basic components of a typical computer.

Input Unit

The **input unit** provides a facility to enter data and instructions into the computer. Input mechanism supports many devices such as keyboard, mouse, joystick, barcode reader, universal serial bus (USB) devices, hard disk and compact disks (CDs). Different input devices take data in different forms and send it to the computer memory. For example, use of keyboard to enter data and instructions is very much similar to the use of a typewriter. Another way to input data is reading through barcode reader. Barcode reader is normally seen at superstore. Remember when you purchase a pack of biscuits, the shopkeeper uses a small device and presses a button on the device. With sound of a beep, the barcode printed on a tag of the biscuit pack is read and copied to the computer in order to generate bill. Mouse is also used to input data into computer. Mouse is a device that

controls movement of the pointer (also known as cursor) on the display screen. It is a small object with a few buttons (keys) which you can roll on a hard surface. As mouse is moving on the surface, the pointer on the display screen is also moved. A mouse must have at least one button. Most of the input devices convert the data into machine readable form.

Memory and Control Unit

Once input is collected via input devices, the input is needed to be stored into the computer memory. Computer memory retains data, instructions and processed output for a while (short duration) or for a long time. There are different types of computer memories. Some computer memories are capable of remembering the content for very short duration; say till the work is in progress and continuous supply of power is ensured. Such memory is called volatile memory. Such memory forms primary storage of a computer, hence it is known as **primary memory**. It is also called as temporary memory or main memory. The input from different devices goes first to the main memory and will be retained into the memory electronically. The content will remain in the main memory till the computer is switched off. When computer is switched off or reset, the content will be lost. To preserve the content for a long, we need **secondary** or **auxiliary storage**. The secondary storage memory is not volatile and content can be preserved for long time. Devices that use secondary memory are called secondary storage devices. Hard disk and compact disks are the most popular secondary storage devices. Unlike the primary memory, the secondary storage is non-volatile, slow (in comparison with primary memory), less expensive, and large in capacity.

As mentioned, once the data and instructions are entered into the memory, instructions are executed and result is prepared. As per the requirement of the user, the result is preserved in the memory or sent to the output unit. To execute instructions, the computer needs to perform some arithmetic and logical computations. The arithmetic and logical computations are performed by a unit called **Arithmetic Logic Unit** (ALU). Besides the ALU, there is a **Control Unit**, which manages execution of instructions and control operations of other components of the computer. ALU and control units together form **Central Processing Unit** (CPU), which is also called the brain of a computer. Some high speed (cache) memory can also be a part of the CPU.

Output Unit

The **output unit** is normally a visual screen called monitor. The monitor actually refers to a whole box of the visual output mechanism of a computer. Display screen is part of the monitor. Many times we use monitor and display screen as synonyms. The older monitors used to provide black, white and grey-shade outputs, which usually was the text and numbers. Presently, colour monitors that are capable of presenting variety of information such as high quality graphics and animations are available. To output sound, special devices such as speakers and headphones are used. To print the output printers are used. Optionally, output is directly published on the website or sent as a file via Internet. Basic components are shown in figure 1.2.

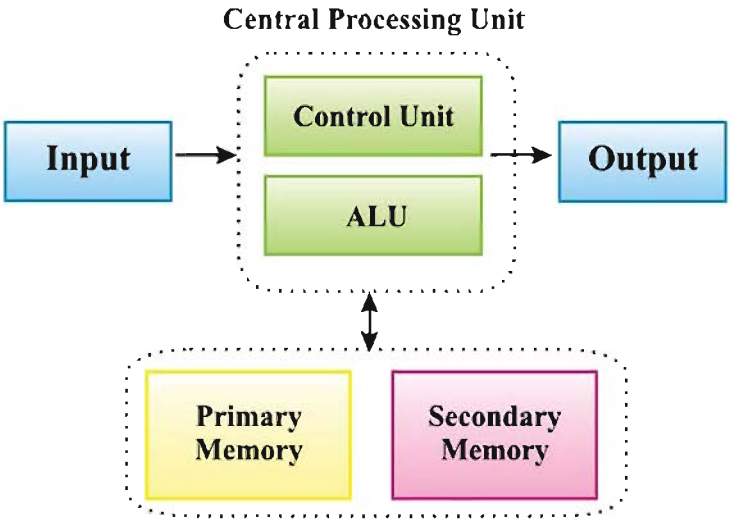


Figure 1.2 : Basic Components of Computer

The input, output and processing mechanism are discussed in detail in later chapters.

Characteristics and Advantages of a Computer

Computers are very useful because of their characteristics like automation, accuracy, long term storage, consistency, and programmability. These characteristics describe the efficiency of the machine to execute the given task. Hence, these characteristics are also known as efficiency oriented characteristics. These characteristics are described below:

Automation : Computer can automatically perform a given task. Once data and necessary instructions are stored into the computer memory, human intervention is not required. Some jobs such as searching from a large repository of data (or from Internet) are nearly impossible without such automation.

Accuracy : Computers are able to perform complex arithmetic and logical computations with the highest accuracy. Properly designed computers provide highly accurate results. However, it is obvious that garbage (bad) results are produced by garbage (bad) input entered knowingly or unknowingly. This is called **Garbage In Garbage Out** (GIGO).

Long term storage : Computers can store large amount of data in its secondary storage for long time. The stored content can be recalled easily on request. Unless specifically asked, the content will be preserved in the memory.

Ability to perform mechanical and repetitive tasks : computers are able to perform mechanical tasks in consistent manner. They do not posses human oriented limitations such as loss of interest, likings, and physical capacity.

Programmability : Computers can be programmed to execute predefined set of instructions. Writing program once and executing it many times saves lot of time and cost. The program once written can be modified later for the revised task. Therefore, computers are versatile to perform any activity, provided a step by step program is given.

Figure 1.3 demonstrates prominent characteristics of a computer.

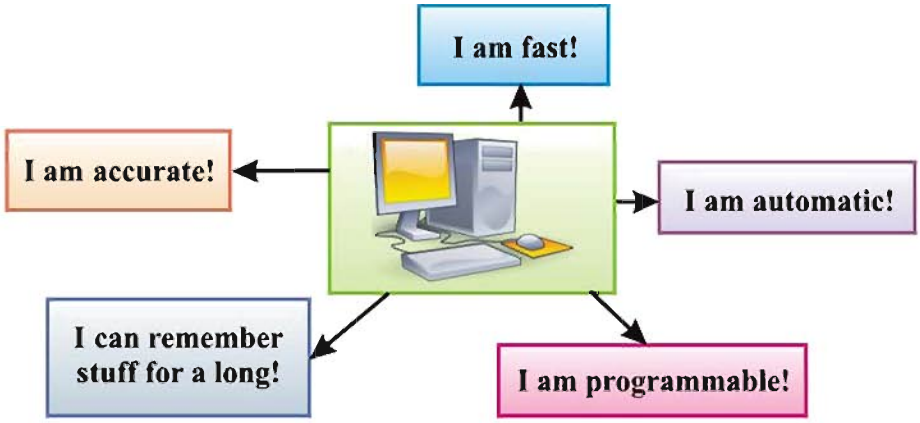


Figure 1.3 : Characteristics of Computer

Software

So far, we have learnt that computer is a multi-purpose machine and cannot perform any task on its own. It needs data and step by step machine understandable instructions to perform the intended tasks. This set of instructions is called a program. Development of the program becomes easier if a step by step guideline to solve the given tasks called algorithm is designed. The logic prepared for getting the given task done using an algorithm is known as software. Software refers to organized collection of computer programs, data and related documentation (such as comments) about the computer programs. Figure 1.4 illustrates the components of software.

Hardware

Unlike software, the hard entities such as keyboard, mouse, central processing unit and other peripheral devices are considered as physical entities and hence called **hardware**. Hardware is a comprehensive term for all physical parts of a computer.

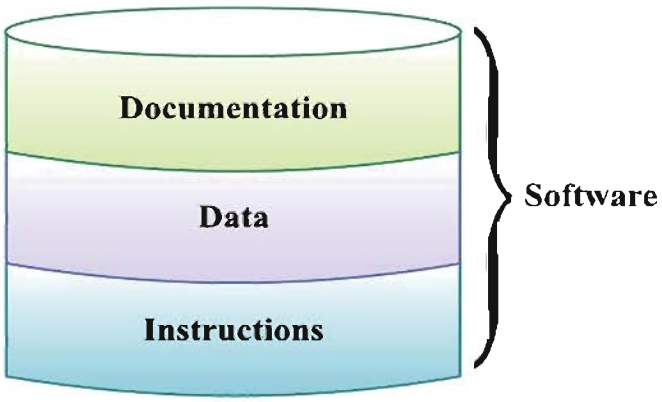


Figure 1.4 : Components of Software

Firmware

Software instructions many times come integrated along with hardware. Since such software is closely coupled with hardware, it is known as firmware. The software embedded with the hardware usually facilitates use and application of the hardware. It also provides utility to work with other hardware and communicate data when needed. Usually such firmware are developed by the hardware manufacturing company and provided free when one purchases the hardware. For example, washing machine, traffic lights, digital camera and microwave oven have some software

programs inbuilt in the devices. Later you will learn what type of memory is used for firmware designing.

Summary

Computers are machines that take data and instructions, store them into its memory and execute them on demand. In this chapter we saw working of typical computers. We learnt about different input, output and processing units with examples. Because of the characteristics like speed, accuracy, and storage capacity, computers are used for many applications. In this chapter we saw highlights of the important characteristics of computers along with some applications. Finally we discussed the concepts of hardware, software and firmware.

EXERCISE

1. List the basic components of a computer. Describe each in brief.
2. Draw a block diagram of a computer containing basic components of a computer. Explain the diagram.
3. What are the popular input devices ?
4. What are the popular output devices ?
5. Differentiate primary and secondary memory.
6. What is ALU ? Give full form and explain work of the ALU in one line.
7. What is CU ? Give full form and explain work of the CU in one line.
8. Which component is called brain of the computer ? Why ?
9. What are the characteristics of computers ?
10. Define software. What are the main components of software ?
11. Define hardware. Give two examples of hardware.
12. **Choose the most appropriate option from those given below :**

(1) Which of the following is the typical work flow of a computer ?

(a) Input, output and process (b) Input, process and output

(c) Output, process and input (d) Any of these

(2) Which of the following identifies the concept of a computer itself remembering the set of data and instructions to be executed ?

(a) Stored program concept (b) Fixed source concept

(c) Automatic source concept (d) Variable source concept

(3) Which of the following refers to a set of step by step instructions to perform a given task written in machine understandable format ?

(a) Program (b) Algorithm

(c) Instruction (d) Data

(4) Which of the following devices converts the given data into machine readable form while entering data into the computer ?

(a) Output (b) Input

(c) Memory (d) All of these

(5) Which of the following does a computer memory retains ?

(a) Data (b) Instructions

(c) Results (d) All of these

(6) Which of the following memory types is costly, fast and limited in size ?

(a) Primary (b) Secondary

(c) Temporary (d) All of these

(7) What is the other name of primary memory ?

(a) Non-volatile (b) Volatile

(c) Fragile (d) Non-Fragile

(8) Which of the following are characteristics of secondary memory ?

(a) Cheaper and slower than the primary memory.

(b) Cheaper and faster than the primary memory.

(c) Volatile and slower than the primary memory.

(d) Volatile and slower than the primary memory.

(9) Hard disk and compact disks (CDs) are examples of which of the following device types ?

(a) Primary (b) Secondary

(c) Temporary (d) None of these

(10) Which of the following unit performs the arithmetic and logical computations ?

(a) Arithmetic logic unit (b) Advanced mathematical logic unit

(c) Alternative logic unit (d) Logic unit

(11) Which of the following unit manages execution of instructions and controls operations of other components of the computer ?

(a) Memory (b) Input

(c) Control (d) Output

(12) Which of the following does ALU and control units together form ?

(a) Central processing unit (b) Control processing unit

(c) Memory (d) Input/Output unit

(13) Which is an example of an output mechanism ?

(a) Keyboard (b) Barcode reader at superstore

(c) Printer (d) Mouse

(14) Which component of a computer is known as the brain of a computer ?

(a) Input unit (b) Output unit

(c) Central processing unit (d) Memory unit

(15) Which of the following is full form of GIGO ?

(a) Garbage in garbage out (b) Global input in global output

(c) Garbage out garbage in (d) Get Input Get Output

(16) Which of the following is a component of Software ?

(a) Instructions (b) Data

(c) Documentations (d) All of these

(17) Which of the following does the term hardware refers to ?

(a) Soft parts of computers. (b) Logical parts of computers.

(c) Physical parts of computers. (d) Any of these

History and Evolution of Computers

The earliest known device for calculation is Abacus. With 10 beads strung into the wires attached to a frame, the Abacus used to perform simple calculations. In 1642, Blaise Pascal developed the first basic calculator which would do only limited jobs. In 1690 Leibnitz developed a machine that could perform addition, subtraction, multiplication, division and calculate square roots. However, the instructions were hardcoded into the machine and could not be changed once written.

Charles Babbage in 1822 designed and built a model called difference engine. His invention could perform calculations without human intervention. After that, in 1833, Babbage designed a machine called analytic engine. Technology of the analytic engine provided base to the technology of modern computers. The analytic engine had an arithmetic unit to perform calculations and mechanism to store results and instructions. Because of such contributions Babbage is known as the father of the modern day computers. During late 1940's, Jon Von Neumann found a way to encode instructions in the language. He was the force behind the development of the first stored-program computer.

In 1946, J. Presper Eckert and John W. Mauchly invented giant ENIAC machine at the University of Pennsylvania. ENIAC (Electrical Numerical Integrator and Calculator) was the first machine to use large number of vacuum tubes. The machinery required a big space and lot of energy to keep it cool. Further, it had punched-card input and output. The instructions had to be fed into the machine by way of switches because there was no internal memory within the machine. Figure 2.1 shows the ENIAC machine.

Generations of Computers Based on Hardware

Computers may be classified into a number of generations. The classification may be based on the hardware technology used in building a computer or based on its application/software used. First, we will discuss about classification of computer considering various hardware technologies.

First Generation Computers (1945-55)

The first generation of computers started with ENIAC. It was then followed by the IBM UNIVAC I (Universal Automatic Computer) built by Mauchly and Eckert in 1951. This machine could perform business data processing. The first generation computers used vacuum tubes. Because of vacuum tubes, the first generation computers were very large, required lot of energy, slow in input/output, and suffered with heat and maintenance problems. Further, the vacuum tubes needed to be replaced often as they had short life span. Figure 2.2 shows the vacuum tubes.

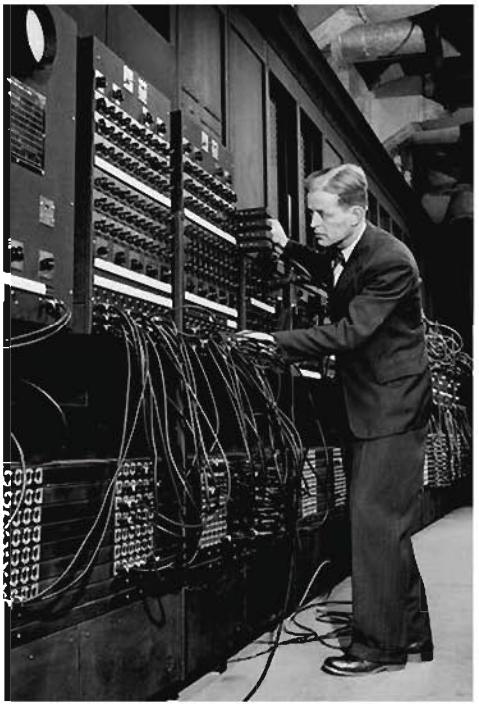


Figure 2.1 : The ENIAC machine

Figure 2.2 : Vacuum tubes

Second Generation Computers (1955-65)

To overcome difficulties faced in the first generation computers due to the use of vacuum tubes, transistors were used in the second generation computers. Transistor is a small component made of semiconductor material. With transistors, the problem of heat was minimized and computers size was reduced. The computers now could perform operations comparatively faster. The storage capacity was also improved. Instead of working with machine language now the machine could work with higher level languages such as ALGOL and FORTRAN. An example of a second generation computer is IBM 1620. Figure 2.3 shows the transistors.

Figure 2.3 : Transistors

Third Generation Computers (1965-80)

Third generation computers used Integrated Circuits (ICs) instead of transistors. These circuits are fixed on silicon chip. A silicon chip consumes less than one-eighth of an inch square on which

many electronic components like diodes, transistors, capacitors etc. can be fixed. Figure 2.4 illustrates an integrated circuit on a chip. As the wired interconnections about the circuit components are minimised, these computers were smaller, faster, and more flexible in terms of input and output. Third generation computers satisfy need of a small business. These computers soon became popular as mini computers. Example of third generation computer is IBM 360, PDP 8 and PDP 11 machines.

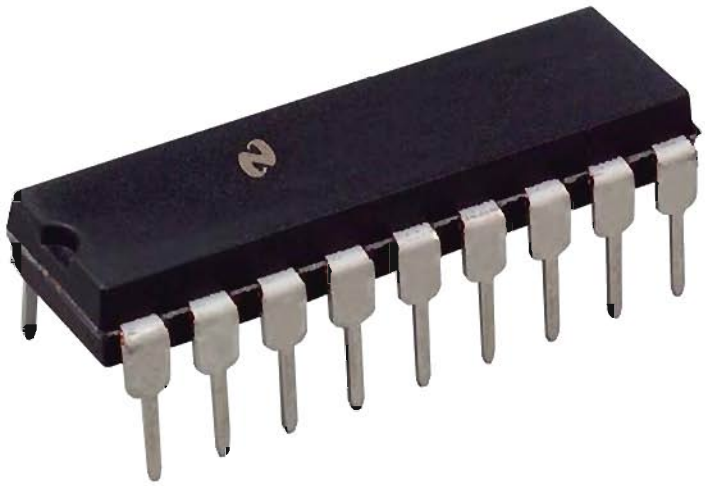


Figure 2.4 : Integrated Circuit

Fourth Generation Computers (1980-89)

Fourth generation computers used large scale ICs called VLSI (Very Large Scale Integration). Because of this, these computers were faster, smaller, and reliable. The fourth generation computers soon evolved as interactive general purpose machines that allow rapid application development. These generation computers became more user-friendly (easier to use) and can be used widely for personal applications. Hence such machines were called Personal Computers (PCs). Examples are IBM PC and Apple II. The fourth generation computers also include super computers such as CRAY series computers. Super computers are the best in terms of processing capacity and cost. These computers can process billions of instructions per second. They are used for applications which require intensive numerical computations such as stock analysis, weather forecasting and other similar complex applications. The spread of computer network was also observed during this time period.

Fifth Generation Computers (1989-till date)

Fifth generation computers are further made smarter in terms of processing speed, user friendliness and connectivity to network. These computers are portable and sophisticated. Powerful desktops, notebooks, variety of storage mechanism such as optical disks, and advanced software technology such as distributed operating system and artificial intelligence are key features of the fifth generation computers. IBM notebooks, Pentium PCs and PARAM 10000 are example of the fifth generation computers.

Table 2.1 enlists important characteristics of different computer generations.

Generation	Characteristics	Examples
First	Used Vacuum tubes Bigger, slower and less efficient Used punch cards Not commercially used	IBM UNIVAC I
Second	Used Transistors Faster and smaller than previous generation Worked with higher level languages	IBM 1620
Third	Used Integrated circuits Flexible and smaller Well suited for commercial applications Known as mini computers	IBM 360 PDP 8 PDP 11
Fourth	Used Very Large Scale Integrated Circuits (VLSI) Interactive general purpose machines Allow rapid application development Easier to use for personal application Can be easily used in network	IBM PC Apple II Super computers such as CRAY series computers
Fifth	Portable and sophisticated Superior in processing speed, user friendliness and Connectivity to network Supports artificial intelligent techniques	IBM notebook Pentium PCs PARAM 10000

Table 2.1 : Computer Generations and Their Characteristics

Generations of Computers Based on Software

Just like five hardware generations, there are software generations too! The very **first generation** is machine level language or machine language, which is a two state language having symbols 0 and 1. This is also called binary language. Computer being mainly an electronic device understands this language.

To avoid difficulties working with the machine level language, assembly language was introduced. Assembly Language uses 'mnemonic codes' or 'symbols'. The assembly language is considered as **second generation** computer language.

Whether it is a machine language or assembly language, it was still tedious to provide data and instructions. We are more comfortable with English like language. It would be much more comfortable if the data and instructions can be provided to computers in English like higher level language (or subset of English language) and computers can be trained to translate it into machine readable form. Taking this idea as an inspiration, the **third generation** languages as a subset of English language

were designed. These third generation languages are also known as higher level languages. To make machine automatically translate the content written in higher level language, special utility called **translator** (such as compiler and interpreter) is used. The translator written in machine understandable form converts data and instructions provided into the English like higher level language into machine understandable form. Examples of such higher level languages are C, COBOL, and Java programming languages.

After exploration of such third generation programming languages, more sophisticated programming environments called fourth generation languages are introduced. The **fourth generation** programming languages reduce programming effort by just specifying what to do instead of how to do. Structured Query Language (SQL) is an example of the fourth generation programming language.

While fourth generation programming languages are designed to quickly develop applications by specifying only what to do, **fifth generation** languages are designed to make the computer solve a given problem without the programmer. Some examples of applications that require such support is fault finding, voice recognition and intrusion detection. Such tasks are carried out in transparent fashion from users in order to avoid complexity and to facilitate user friendly interactions with the systems. Fifth generation programming languages use artificial intelligence techniques to meet their goal. The Artificial Intelligence (AI) techniques can handle imprecision and supports human like self learning and problem solving. These characteristics help putting the AI based applications a step ahead with added intelligence in comparison with the application developed in other programming languages or tools.

Types of Software

As we have seen, software plays a vital role in computer systems by creating a bridge between the computer hardware and computer users. Computer software can be considered as soul of computer, without which computer cannot work. Software is organized collection of data and instructions given to computers in order to perform a given task. We have seen some components of computer software in figure 1.4 of chapter 1. These components are data, instructions and documents about the software (written description of software functions) such as comments. The set of instruction is also called computer program. The process of writing (or coding) programs is called programming, and individuals who perform this task are called programmers.

There are two major types of software: systems software and application software. **Systems software** manages computer hardware and act as an interface between computer hardware and software developed for business application. Systems software provides important functionalities like booting computers properly, managing memory, channeling data from secondary memory to primary memory, managing printers and other resources. Example of system software is an operating system. The translator programs mentioned in this chapter are also examples of system software. Some translator programs transform whole source code written in a programming language (the source language) into another computer language (the target language, mainly machine/binary language) at once. The transformed (translated) code is later executed to obtain the desired results. These programs are called **compilers**. Some translator programs transform the source code into the target code in line by line fashion and produce the result simultaneously. These programs are called **interpreters**. Since

interpreters try to convert the source program line by line, they can concentrate on a single line, hence it is not possible to analyze the source code fully. Further, the interpreters are generally slow in comparison with the compilers.

Computer also support business applications such as printing reports from data stored, calculating bills, generating pay-slips, marking attendance, printing students' mark-sheets, etc. Special software need to be developed for this type of application specific support. Such software is known as **application software**. Application software is a set of computer instructions that provide application specific functionalities to a user. These functionalities may be general purpose such as word processing (that every business need) or may be very narrow, such as an organization's payroll program that generates pay-slips in company's format, on company's preprinted stationery.

The relationship among hardware, systems software, and application software is illustrated in figure 2.5.

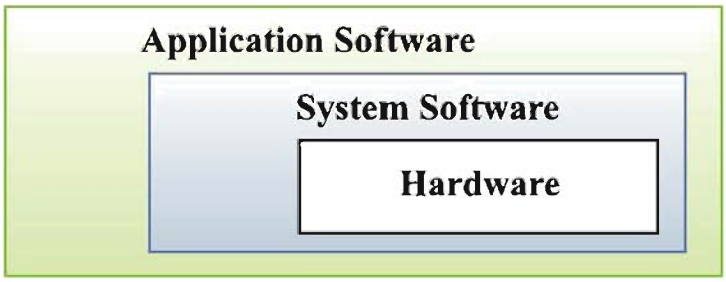


Figure 2.5 : Relationship Amongst Various Components

Popular Computers

So far we have discussed that the computers operate on binary digits 0 and 1. Even if the instructions are given in any generation programming language, ultimately they are to be represented into sequence of digits 0's and 1's. Hence, the computers are also known as **digital computers**. Analog computers use linear combinations of voltage amplitude (or currents or frequencies or phases) instead of digits. That is why they are called **analog computers**. Some computers use mixture of these technologies and hence known as hybrid computers.

Personal or Desktop Computers

These computers are the most popular computer systems. They are easier to use and more affordable. They are normally used by individuals for their routine business activities. Figure 2.6 shows a sample desktop computer. Desktop computer is used for regular computing operation from a specified place such as an office. Modern desktop are accompanied with monitor, key board and a mouse along with a system box.

Figure 2.6 : Desktop Computer

Laptop Computers

Laptop computers are portable and lightweight computers with a thin screen. They are also called **notebook** computers because of their small size. They can operate on batteries and hence are very popular with travelers. Figure 2.7 shows a typical laptop computer. A laptop computer is actually a personal computer for mobile use. A laptop has most of the same components as a desktop computer, including a display, a keyboard, a pointing device such as a touchpad (also known as a trackpad) and/or a pointing stick, and speakers into a single unit. Now a day's thin version of laptop called ultrabook is becoming popular. The ultrabook size and weights are thinner in comparison with the typical laptops. Ultrabook computing technology use high-powered low-voltage processors with long battery life. Figure 2.8 shows a typical ultrabook.

Figure 2.7 : Laptop

Figure 2.8 : Ultrabook

Handheld Computers

Handheld computers are also known as Personal Digital Assistants (PDAs). They are small in comparison with laptop and can be carried anywhere. They use a pen like stylus and accept handwritten input directly on the screen. The screen is generally a touch screen. They are useful in applications like scheduling appointments, storing contacts and addresses and playing games. Figure 2.9 shows a typical handheld computer.

Figure 2.9 : Handheld Computer

Tablet Computer

A tablet computer is a portable and mobile computing tool. It is a mobile computer like a bigger mobile phone with a touch screen facility. It generally uses onscreen virtual keyboard, a passive stylus pen, or a digital pen. Typically, such tablet computers do not require keyboard. There are two popular categories of the tablet PCs. These categories are (i) a slate tablet PC and (ii) a convertible tablet PC. The slate tablet is a type of tablet where keyboard is not attached. However, on demand, the keyboard can be added. A convertible tablet PC is basically a laptop computer with a screen that can swivel and fold onto the keyboard to create the tablet. Figure 2.10 shows a typical tablet computer.

Figure 2.10 : Tablet Computer

Wearable Computers

Wearable computers are also known as body-borne computers. These are tiny computing devices that are worn by the bearer. The wearable computers are small and light weight as they need to be carried on human body. The wearable computers come in the form of bracelet, pendent, spectacles and rings. Wearing such devices enables constant interaction with the computing system. There is less need to turn the device on or off. Further, such devices are multi-tasking. You may do other routine job in parallel. Often such device is considered as an extension of the user's mind and/or body. Variation of wearable computers such as a small programmed chip, is used for monitoring animal movement. A pre-programmed light weight micro-processor chip is stapled on animal's body part like ears. Such a chip monitors movement of animal in a given region.

Summary

In this chapter we have discussed the history and evolution of computers. We have considered two aspects namely hardware generations and software generations. We have provided brief discussion on their components and technologies. We further learnt about different types of software such as system software and application software. Finally we saw popular computing machines such as desktop, laptop and tablet computers along with wearable devices.

EXERCISE

1. Write a short note on history of computers. Also explain why Charles Babbage is known as the father of the modern day computers.
2. Discuss characteristics of the first generation computers. What are the major drawbacks of these computers ?
3. Discuss characteristics of the second generation computers. What are the major drawbacks of these computers ?
4. What is machine level language ?
5. What is an assembly language ?
6. What are the difficulties associated with the machine level and assembly languages ?

7. Define higher level languages. Also provide two examples of higher level languages.
8. What are translators ? In which language the translators should be written ?
9. What is fourth generation language ? Give an example of it.
10. What is system software ?
11. What is application software ?
12. Distinguish system software and application software.
13. Write a short note on modern/popular computers.
14. Define the terms :
    (a) Digital computer
    (b) Analog computer
    (c) Hybrid computer
    (d) Notebook computer
    (e) Personal digital assistants
15. Write a short note on wearable computers.
16. **Choose the most appropriate option from those given below :**

(1) Who of the following is known as father of modern day computers ?
(a) Charles Babbage
(b) Blaise Pascal
(c) Jon Von Neumann
(d) Jon Von Pascal

(2) Which of the following is full form of ENIAC ?
(a) Electrical Number Integrator and Converter
(b) Electrical Numerical Integrator and Calculator
(c) Electrical Numerical Inverter and Calculator
(d) Electrical Number Inverter and Converter

(3) Which of the following are bulky, slow and suffered with heat and maintenance problems ?
(a) Transistors
(b) Radios
(c) Vacuum tubes
(d) Integrated circuits

(4) Third generation computers used which of the following technologies ?
(a) Transistors
(b) Integrated circuits
(c) Vacuum tubes
(d) Very large Integrated circuits

(5) Which of the following computers are costly and can process billions of instructions per second ?
(a) Super computers
(b) Laptop computers
(c) Hybrid computers
(d) Any of these

(6) In which of the programming language mnemonic codes are used ?
(a) Assembly
(b) Higher level
(c) Machine level
(d) User level

(7) Java, C and COBOL are examples of which of the levels of languages ?

(a) Assembly (b) Higher level

(c) Machine level (d) User level

(8) Which of the following generations of programming languages reduce programming effort by just specifying what to do instead of how to do ?

(a) First (b) Second

(c) Third (d) Fourth

(9) Which of the following language generations use artificial intelligence techniques for problem solving and meeting their goal ?

(a) Second (b) Third

(c) Fourth (d) Fifth

(10) Operating system is an example of which of the following type of software.

(a) Applications (b) System

(c) Business (d) User created

(11) In which category of the software does the payroll application fit ?

(a) Applications (b) System

(c) Control (d) Any of these

(12) Which of the following software manage computer hardware and act as an interface between computer hardware and software developed for business application ?

(a) Applications (b) System

(c) Control (d) Any of these

(13) What do you call a computer that operates on binary digits 0 and 1 ?

(a) Digital (b) Analog

(c) Hybrid (d) Any of these

(14) What do you call a computer that uses linear combinations of voltage amplitude (or currents or frequencies or phases) instead of digits ?

(a) Digital (b) Analog

(c) Hybrid (d) Any of these

(15) Which of the following is also referred to as a handheld computer ?

(a) Portable Digital Assistants (PDAs)

(b) Personal Digital Assistants (PDAs).

(c) Personal Digital Applications (PDAs)

(d) All of these

Input and Output Devices

To solve a given task, computer needs to interact with its user. Computer requires data and instructions to be provided by user. On the other hand, users also require results from the computer. When data and instructions are given to a computer, it is considered as input. When computer provides results, it is known as output. The devices that allow such input and output are known as input/output devices (in short I/O devices) or peripherals. Input/output devices are means of communication between the user and computer.

Input Devices

An input device is a device that provides input to the computer. The most common input devices are keyboard and mouse. Every key you press on the keyboard and every movement or click you make with the mouse sends a specific input signal to the computer. Besides keyboard and mouse, several input devices are available. Following is the list of different input devices used with computers:

- Keyboard
- Point and draw devices
- Scanning devices
- Electronic card based devices
- Speech recognition devices
- Vision based devices

Let us now discuss about each of these input devices in brief.

Keyboard

Keyboard is the most popular and commonly used input device. A keyboard allows entering alphabets, digits and symbols into the computer. Figure 3.1 shows a typical keyboard. Keyboard generally has more than 100 keys. Keyboard is also known as the text based input device. A Keyboard generally contains keys as follows:

- English alphabets (a…z)
- Digits (0…9), mathematical operators (+,-, *, etc), punctuation marks and signs
- Function keys (F1, F2…F12) for various functions
- Enter (or return) key used for execution of an instructions
- Spacebar (to enter a space)
- Backspace (to move cursor one position back)
- Delete (to delete a character or an object at the right side of cursor position)
- Shift (to type capital letters and the special characters located on the upper-side of a key)
- Caps Lock (to toggle between the capital lock features)
- Tab (to move the cursor to the next tab position – for indentation)
- Control (to be used in conjunction with other keys to provide additional functionality)
- Alt (used in combination with other keys to perform specific tasks)
- Esc (to cancel or abort executing)

- Cursor Movement Keys (to move cursor in the direction indicated by the arrow - up, down, left, and right)

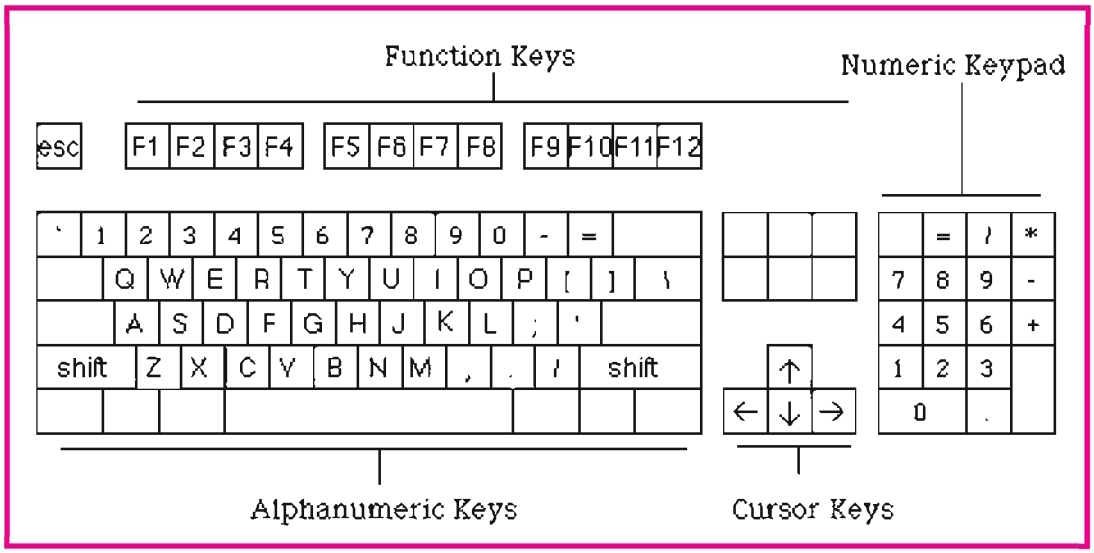


Figure 3.1 : Keyboard

Point and Draw Devices

Instead of typing, directly some items can be selected from computer screen - for example "print" or "close" button. This can be done using point and draw devices such as mouse. This type of interface is called graphical user interface. Not only to select, but drawing of line, curve and shapes is also possible with such devices. Other example of point and draw devices are joystick, light pen, touch pad or track ball and touch screen.

Mouse

Mouse is a small device used to point a particular place on the screen and select in order to perform one or more actions. Figure 3.2 shows a typical mouse. It can be used to select menu commands, resize windows, selecting actions from screen icons, etc. The most conventional kind of mouse has two or three buttons on its top. These buttons are used for different actions.

Figure 3.2 : Mouse

Typical mouse actions are as follows :

- Left Click: Used to select an item.
- Double Click: Used to start a program or open a file or trigger an action.
- Right Click: Usually used to display a set of commands and available options.
- Drag and Drop: It allows you to select and move an item from one location to another.
- Scroll: Many applications provide scrollbars on right side of screen if the page length is more than the monitor / screen length. Instead of using page down key or arrow keys, one can use scroll key of a mouse to scroll up or down. If the scroll key is not available, one can click on the scroll bar on the application screen with the left button of the mouse.

Joystick

The joystick is a vertical stick which moves the graphic cursor in a direction of the stick when the stick is moved. It has a button on top that is used to select the option pointed by the cursor. Joystick is used as an input device primarily used with video games, training simulators and controlling robots. Image of joystick is shown in figure 3.3.

Figure 3.3 : Joystick

Scanning Devices

Scanning devices directly "look" at the input and enters the collected data into the computers. There is no need to enter anything from keyboard or select anything from the screen. Only "scan" command is to be given and the data entry is done directly. It saves time and reduces typing errors. Photos, maps and high quality documents can be directly scanned to the computer.

Figure 3.4 : Image Scanner

The image scanner shown in figure 3.4 is just like copier machine in which the document needs to be placed and photo of the document will be stored in a computer memory in digital form. The document is now converted into an electronic image. This image can be sent to other computer, copied, and printed.

You might have seen scanner in shopkeeper's hand which reads barcode in a shop. This type of scanner is known as handheld scanner. See figure 3.5 for the image of barcode scanner. Barcode is made up of parallel strings of different thickness. There is a standard coding system called Universal Product Code (UPC). Scanners read this barcode printed in UPC format and convert it into appropriate values.

Figure 3.5 : Barcode Scanner

Some scanners have facility to recognize character from the image. That is, from the scanned image of a character, computer can identify the character. This is done by matching image of a scanned character with the stored image of the character. With this facility the document image can be converted into a document which can be further modified (editable document). This type of scanner is known as optical character reader.

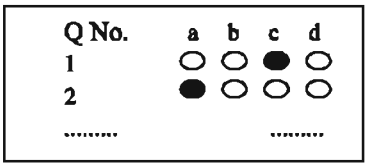


Figure 3.6 : Sample OMR Sheet

Some scanners identify marks done by special type of pen or pencil. This type of scanner is known as optical mark reader. Figure 3.6 demonstrates an OMR sheet that consists of answers marked on the sheet for a multiple choice question paper.

Magnetic Ink Character Recognition (MICR)

Magnetic ink character recognition is a technology that is prevalent in banking industry. It is used for faster processing of cheques. This technology allows reading of information such as account numbers directly from the printed documents. MICR codes can be easily read and understood by humans, while barcodes though easily read cannot be easily understood by humans. Here, the content is written using special magnetic ink (prepared from iron oxide).

Electronic Card Reader

Electronic card reader reads content from small plastic cards called electronic card. The data is read from the card and transferred to the computer. Bank ATM (Automatic Teller Machine) cards and credit cards are such small plastic cards that contain information about the card holder. The information about the current transaction (say current bill/purchase) is added from the card reader device. Figure 3.7 shows an example of electronic card reader.

Figure 3.7 : Electronic Card Reader

Speech and Vision Devices

Beside these popular input devices, speech and vision input devices system is also popular. Speech input is used for long dictation of text for correspondence as well as to develop fully automated system that operates on speech. Instead of entering commands by typing, selecting or scanning, direct voice commands can be given. Consider you have fully electronic house that opens doors for you when you say "khul ja sim sim"!

Vision input is used for robots performing risky tasks like driving plane and performing surgery. Such input mechanism is very useful for people who are differently abled and generally finds difficulties in operating typical computer systems. Camera is also used as input device, like in laptops for automatic authentication of user through facial recognition. It is also used for deciphering QR code or reading bar code.

Output Devices

Computer calculated results must be provided to its users. The devices that provide output to the users are called output devices. Commonly used output devices are monitor and printer. Following list presents different output devices:

- Monitor
- Printer
- Projector
- Plotter
- Voice response

The output devices need to be connected with computer (with or without wires) in order to present the output to the users.

Monitor

Monitors are commonly used output devices. The output is presented on computer visual (television like) screen. This output is just for viewing purpose and hard copy (print on paper) cannot be taken. That is why it is called soft copy output. The Cathode Ray Tube (CRT) monitors and flat monitors are used to display information. Figure 3.8 shows typical monitors. At present, flat monitors are very popular because they are thinner in size and lighter in weight. Flat monitors use technology of Liquid Crystal Display (LCD) and Light Emitting Diodes (LED).

Figure 3.8 : CRT and LCD Monitor

Printers

Printer provides hard copy output (output on paper). There are varieties of printers that print content in different way. Some printers print content character by character hence called character printer or dot matrix printer. These printers are cheaper and slow. Other printers print line by line and are called line printers. Another category of printers print content by spraying small drops of ink; such printers are called inkjet printers. Inkjet printers are slower and costlier than the dot matrix printers. Similarly there are printers available that create the image of whole page and print the full page at a time using laser technology. This type of printers is called laser printer. Laser printers are fastest and costly in comparison with other printers. Figure 3.9 shows a typical laser printer.

Figure 3.9 : Typical Laser Printer

Projector

You might have seen your teacher projecting teaching material on wall of your classroom or white board/curtain. Output of computer is projected on a bigger flat surface like wall or screen through an output device called projector. Teaching material with text, image, sound, graph and animation can be prepared and projected on the surface for better viewing. Such projectors are very useful for learning, demonstrating and presenting content. Software that helps in preparing such content for presentation are available.

Voice Response

Stored voice and converted voice (from given text) can be presented to users who do not want to see or read output on monitor, projector or printer. Video games, automatic answering machines, alarms and signals, etc. are the applications that need voice output.

Summary

In this chapter we learnt about different input and output devices. Beside the most popular input devices such as mouse and keyboard, some latest devices joy stick, card readers, scanners were also looked at. We also learnt about output devices like monitor, printer, projector and voice response systems.

EXERCISE

1. List popular input devices. Explain structure of a typical keyboard.
2. What is a point and draw device ? Give an example of it.
3. What are the typical mouse actions ? List and explain in brief.
4. List popular output device. Explain various types of printers.
5. Which different types of monitors do you know ? List all with one line description of each.
6. **Choose the most appropriate option from those given below :**

(1) Which of the following refers to data and instructions that are given to computer ?

(a) Input (b) Output
(c) Both input and output (d) Processing

(2) Which of the following is the other name of Input / Output devices ?

(a) Properties (b) Peripherals
(c) Parts (d) None of these

(3) A keyboard is considered as which of the following device ?

(a) An input (b) An output
(c) Both input and output (d) Processing

(4) A keyboard works on which of the following concepts ?

(a) Point and draw (b) Text entry
(c) Visual (d) Virtual

(5) A mouse can also be used as which of the following device ?

(a) An input (b) An output
(c) Processing (d) Any of these

(6) Which of the following refers to the mouse ?

(a) Point and draw device (b) Text based device
(c) Visual device (d) Virtual device

(7) Which of the following is a standard coding system for product price and other information related to the product ?

(a) Universal product code
(b) Uniform print code
(c) Universal print code
(d) Uniform product code

(8) Which of the following is the process of recognizing characters written with special magnetic ink ?

(a) Multipurpose ink character recognition
(b) Magnetic ink character recognition
(c) Multifold character recognition
(d) Multifold ink character recognition

(9) Which of the following technologies do flat monitors use ?

(a) CRT
(b) LCD
(c) LED
(d) Both b and c

4 Memory, Storage Devices and Data Representation

Like human beings need to memorize things, which can be retained and recalled on need, computers also need to store data and instructions for future use. Memory is a part of computer where data and instructions are stored. A computer deals with different type of memories. Two major types of computer memories are (i) primary (main) memory and (ii) secondary (auxiliary) memory. Information in a memory of a digital computer is stored in form of binary digits (0 and 1). These binary digits in short are known as bits. A bit is a binary digit, which is either 1 or 0. A group of 8 bits is known as byte. Storage capacity of a computer memory is measured in terms of the bytes in form of kilo bytes (KB), mega bytes (MB) and giga bytes (GB). Consider Table 4.1 that shows the relationship between these terms.

1 bit = a single digit, either 1 or 0

8 bits = 1 byte, combination of 1's and 0's

2^{10} Bytes = 1024 Bytes = 1 KB (kilobyte)

2^{20} Bytes = 1024 Kilobytes = 1 MB (megabyte)

2^{30} Bytes = 1024 Megabytes = 1 GB (gigabyte)

2^{40} Bytes = 1024 Gigabytes = 1 TB (terabyte)

Table 4.1 : Storage Capacity Measures of Computer Memory

Primary Memory

Primary memory, also known as main memory, is an important part of a computer in which data is stored for quick access by the computer's processor. It is made of larger number of cells. Each cell is identified by a number called an address of the cell. Each cell contains a piece of data. When there is a requirement of the data, the cell address is used to retrieve the data. The primary memory is organized in such a fashion that the time required to store or retrieve data from a cell is independent of the cell addresses. That is, any location of the memory can be chosen randomly for use. This is known as Random Access Memory (RAM). There are other access methods which are not random. For example sequential access, First In First Out (FIFO) access and Last In First Out access (LIFO). In sequential access memory, data is stored serially or sequentially in a long string. When you want to access some part of the string, you have to pass through the previous part of the string. Just like in an audio tape, if you want to hear the third song, first two songs must be fast forwarded. FIFO is just like queue, where first entry will be served first and last will be entertained at last. LIFO is like tray (or pile) of papers. The paper which you had put at last will come out first. Figure 4.1 shows FIFO and LIFO access mechanisms.

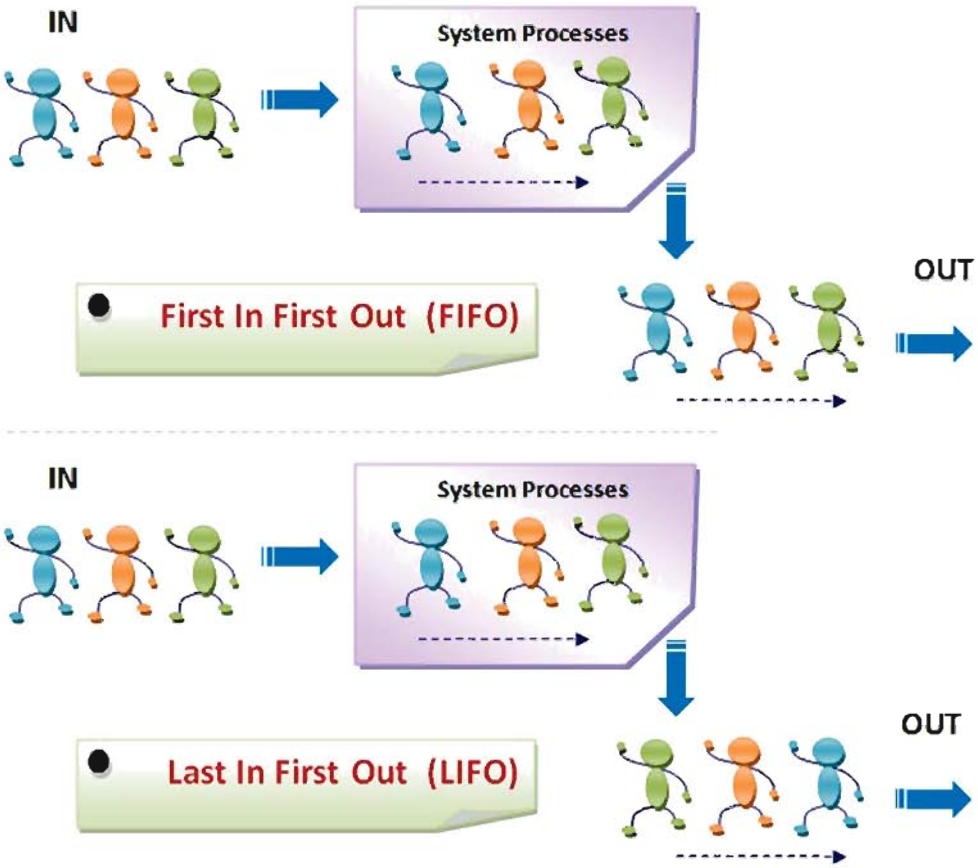


Figure 4.1 : LIFO and FIFO Access Mechanism

RAM is volatile memory. The content written in RAM requires continuous power supply to retain it into the memory. On modern computers the term RAM - or just memory - is used instead of primary or main storage, and the hard disk, diskette, CD, and DVD collectively describe secondary storage or auxiliary storage. Figure 4.2 shows a RAM chip.

Figure 4.2 : A RAM Chip

There are two basic types of the RAM. The first one is static and second is dynamic. Dynamic RAM (DRAM) needs to be refreshed thousands of times per second. Static RAM (SRAM) does not need to be refreshed, which makes it faster; but it is more expensive than dynamic RAM. Both types of RAM are volatile, meaning that they lose their contents when the power is turned off.

Computers also contain Read Only Memory (ROM) which are used to permanently record data and instructions. Content of ROM can only be read. Unlike RAM, ROM retains its content even

when the computer is turned off. ROM is an ideal memory to store critical instructions into the computers such as boot programs (programs that start up the computer system), printer driver files, and fonts. A variation of a ROM is a Programmable Read Only Memory (PROM). PROMs are manufactured as blank chips on which data/program can be written with a special device called a PROM programmer. There is a special type of PROM called Erasable PROM (EPROM). An EPROM allows the content of PROM erased by exposing it to ultraviolet light. Instead of ultraviolet lights, electric signals are used to erase content of PROM. Such memory is called Electrically Erasable PROM (EEPROM). EEPROMS are very useful in manufacturing USB pen drives, cellular phones (memory card in mobile phone), digital cameras, portable MP3 players and microSD cards. Figure 4.3 shows typical microSD (memory) card. Special readers are available that read directly from the card.

Figure 4.3 : A MicroSD Card and Card Reader

The concept of the Read Only Memory (ROM) can be utilized to create a firmware- hardware utility with some software instructions in an integrated fashion. Firmware is to be stored on non-volatile memory devices such as ROM, EPROM, or flash memory. As mentioned in the previous chapter, such firmware are developed by the hardware manufacturing company and provided free while one purchases the hardware. Another alternative is to download such firmware from company's online store or website. Many times firmware needed to be updated as and when you change the hardware device. Many mobile phones use Firmware Over The Air (FOTA) to update the mobile firmware which makes the activity independent of cables, computers and third party software.

The firmware normally supports functions such as controlling the hardware and facilitating use of the hardware. Because of this reason users are not generally allowed to change the firmware. Most of the companies would like to store firmware in hidden fashion in order to make the system transparent from user and reduces complexity to work. For example, washing machine, traffic lights, digital camera and microwave oven have some utilities such as quick wash in washing machine and alarm in microwave oven. These basic utilities are not to be changed. However, users may add their contacts, messages, videos and pictures into the mobile phone memory. On the other hand, software programs written by users such as super store bills, pay-slip and mark-sheet printing can be changed by the users provided they have source code for the software.

There is a special high-speed storage mechanism called cache. Cache memory is small and high speed memory within the computer central processing unit for frequent access. The purpose of such memory is to increase speed of computer processor. When the processor needs to perform any read write operations, it first checks the cache memory. Table 4.2 shows differences between RAM and ROM.

RAM	ROM
RAM is random access memory.	ROM stands for read only memory.
RAM supports reading and writing operations into the computer.	ROM supports only read option.
Data and instructions are stored into it during its operation.	Instructions are stored into it during its manufacturing.
It is volatile memory.	It is non-volatile memory.

Table 4.2 : Differences Between RAM and ROM

Secondary Memory

Primary memory is generally costly and has capacity limitation, further it cannot retain data for longer period of time. However, we need to store data and instructions for long time so that they can be used later. For this purpose, secondary memory /secondary storage is used. The secondary storage stores large amounts of data, instructions, and information permanently. The popular secondary storage devices are hard disk, compact disks (CDs), digital versatile disks (DVDs), and pen drives.

Secondary memory is not directly accessible to processor of a computer but requires use of computer's input/output channels. Such memory is usually slower than primary memory but it always has higher storage capacity. Further, the secondary storage memory is non-volatile. Data remains unchanged even after switching off the computer. Secondary memory/storage is also known as auxiliary memory/storage. Figure 4.4 represents memory hierarchy.

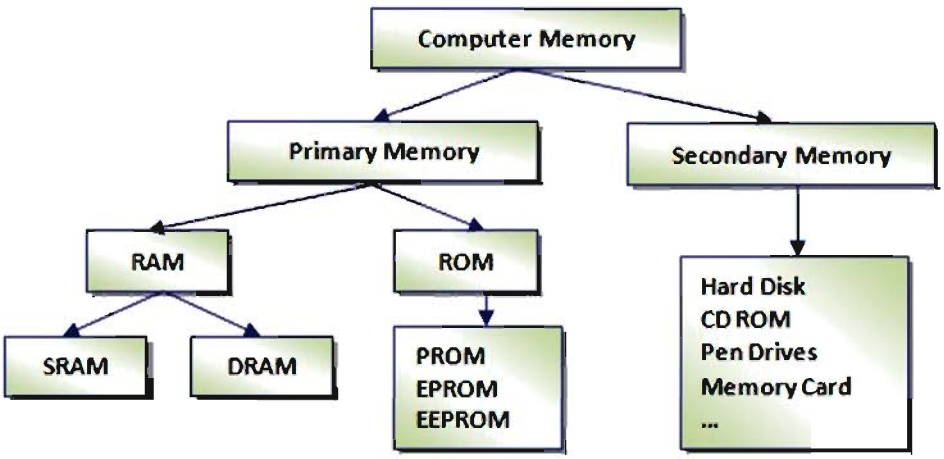


Figure 4.4 : Memory Hierarchy

Let us now have a look at some of the secondary storages.

Hard Disk

A hard disk consists of one or more rigid metal (or glass) plates coated with a metal oxide material that allows data to be magnetically recorded on the surface of the platters. Figure 4.5 shows a typical hard disk. Data and instructions are recorded on the oxide based surface by magnetising selected particles of the surface. The particles retain their magnetic orientation until that orientation is changed. Thus, hard disk allows modification once the content is stored. A hard disk platters spin at a high rate of speed, typically 5400 to 7200 revolutions per minute (RPM). Along with one or more platters, a hard disk also contains some read-write heads which read and write data on the disk platters.

Figure 4.5 : Hard Disk

Storage capacities of hard disks for personal computers range from 10 GB to 500 GB. The disk provides storage area within the computer itself. Hard disk is also known as a hard drive. Most of the hard disks are the part of computer. However, external hard disks of different sizes and capacities (such as 350 GB, 500 GB, and 1 TB) are also available. Figure 4.6 shows view of some such external drives.

Figure 4.6 : External Hard Disks

Compact Disk (CD)

A compact disk (CD) is also called an optical disc. It is a flat, round, and portable storage medium that is usually 4.75 inches in diameter. You might have seen the audio CD for music. CD can contain other types of data such as text, graphics, and video. The typical capacity of a CD is 650 MB of data.

Unlike hard disk, CD supports optical storage. Here, data is burned into the storage medium using beams of laser light. The burns form patterns of small pits in the disk surface to represent data. The pits on optical media are permanent, so the data cannot be changed. Optical media are very

durable, but they do not provide the flexibility of magnetic media such as modification of data. Figure 4.7 shows typical compact disk.

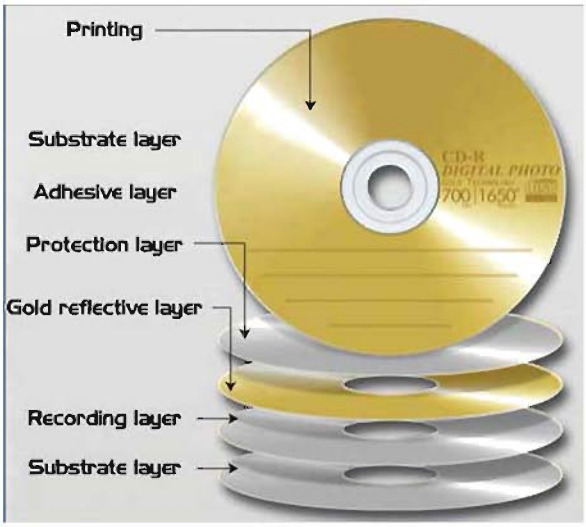


Figure 4.7 : Compact Disk

There are three popular types of optical disks; namely CD ROM, CD R and CD RW. CD-ROM is the most popular type among them. CD-ROM stands for Compact Disc Read Only Memory. CD-ROMs usually come with data already written onto them.

It is possible for users to write data to an optical disk. Once data is written on it with a special utility, many times it can be read from the CD. Hence such CDs are known as 'Write Once Read Many' (WORM) disks. These CDs are known as CD re-recordable (CD-R).

There is a third type of optical disk which can be erased and used to rewrite new information. These are sometimes known as EO (erasable optical) disks or CD-RW (CD rewritable).

Digital Versatile Disks

Digital Versatile Discs are popularly known as DVDs. It is an optical disc storage media format that can be used for data storage, including movies with high video and sound quality. DVDs resemble Compact Discs (CDs) as their physical dimensions are the same but they are encoded in a different format at a much higher density. DVD generally offers more storage capacity (4 GB) as compared to CD.

USB Pen Drives

USB Flash drives are also known as pen drives or thumb drives. They are small, portable and rewritable. They are flash memory data storage devices integrated with a Universal Serial Bus (USB) interface. Figure 4.8 shows a typical USB. They come in different capacities like 2GB, 4GB, 8GB, 16GB, 32GB and 64GB.

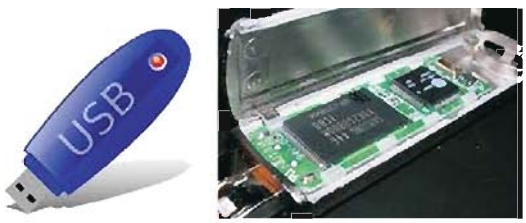


Figure 4.8 : USB Pen Drive

Pen drives are most popular as they are very portable, available in various sizes and capacities as well as very efficient for storing the important data. Many instruments like television and MP3 players have USB ports to allow direct use of pen drive. That is, if you have a movie clip or photos in your pen drive, it can be directly attached to the television to see the movies and photos.

Data Representations into Computer Memory

We are familiar with decimal number systems for our routine business. The decimal number system is a positional number system. For example, number 916 is alternatively represented as 900 + 10 + 6. We use ten symbols called digits in the decimal number system, which are 0 to 9. Further, we use alphabets in language such as A…Z. Beside numbers, alphabets and mixture of both of these (called as alphanumeric), special characters such as punctuation marks, operators (<, >, +, -, etc.) and currency symbols ($, £, rupee symbol, etc.) are also used. All these digits, characters and symbols must be arranged in some meaningful way using laws of grammar. This is the main way how we communicate using languages. Besides these, we have sign languages, brail language, body language and facial expression for differently abled people.

Computer, being an electronic device, is not comfortable with these entities. Being mainly an electronic device, it operates on electricity which has only two states 'on' and 'off'. Hence, it requires a special bi-state language having only two symbols; one to represent 'off' and another to represent 'on'. The binary number system is such a bi-state number system that can represent the two states called 'on' and 'off' in an efficient way. Following section represents an introductory concept of a binary number system.

Binary Number System

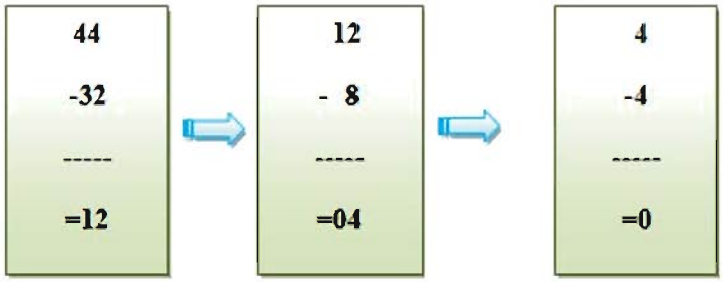
The binary number system has two symbols 0 and 1. Single binary digit is called a bit. A valid binary number example is 101. Since the binary number system uses only two symbols, 102 is not a correct binary number. However, it is a correct decimal number. To quickly identify the given number as binary number, we use suffix B or b. Some representations use 2 as suffix. Hence the binary 101 number is represented as 101_B or 101_b. Alternative representation of the same number is 101_2.

The number 101 represented in a decimal number system can be written as 101_D, 101_d or 101_{10}. This number has meaning 100+00+1. The binary number system also uses such positional notation like the decimal number system. That is, the position of a bit has some significance. The binary number 101_2 has meaning (in decimal) $1*2^2+0*2^1+1*2^0 = 4 + 0 + 1 = 5$. The binary number can be converted into decimal using this method.

A decimal number is converted into its equivalent binary by successively dividing it by the base 2. An alternative method is to first subtract the largest possible power of two, and keep subtracting the next largest possible power from the remainder, marking 1s in each column where this is possible and 0s where it is not. Here is the example.

Example : Convert 44 into the binary.

Here, the largest possible power of the base 2 is 5. 2^5 is 32. Subtract 32 from the given number. It will leave remainder 12. The immediate power of 2 is 2^4; which is 16. The remainder 12 is less than 16, hence it is not possible to go for subtraction that yields a positive number or zero (non-negative). We then choose power of 2^3; which is 8. It is possible to subtract the number 8 from the last remainder and get a non-negative number. Figure 4.9 shows the complete calculation.



Power of the base 2	$2^5=32$	$2^4=16$	$2^3=8$	$2^2=4$	$2^1=2$	$2^0=1$
Remainder	12	---	4	0	---	---
Subtraction Possible or not	Yes	No	Yes	Yes	No	No
Binary digits	1	0	1	1	0	0

Figure 4.9 : Decimal to Binary Conversion

The final answer is $(101100)_2$.

Conversion of Decimal Number to Binary Number

Let us do the procedure again with another similar method. This time we consider conversion of a decimal 125 number into its equivalent binary number. See Figure 4.10.

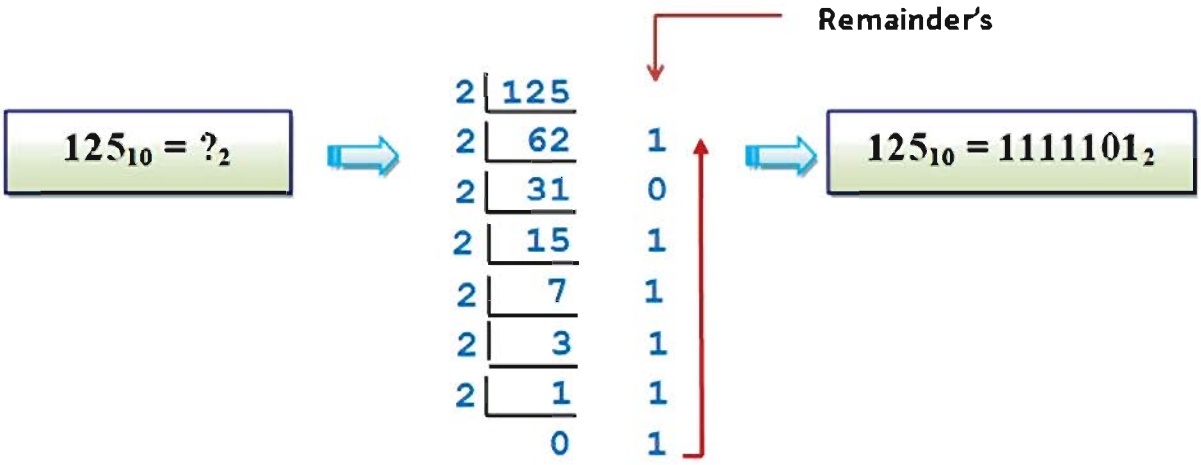


Figure 4.10 : Conversion Example

Unsigned Integer Number Representation

Any unsigned integer number (that is 0 and positive integer number) can be represented into the computer by converting the number into its equivalent binary number. See Figure 4.11 for unsigned integer representation into the computer for the number 5_{10}, which is equivalent to 101_2. **This representation uses 8 bits.**

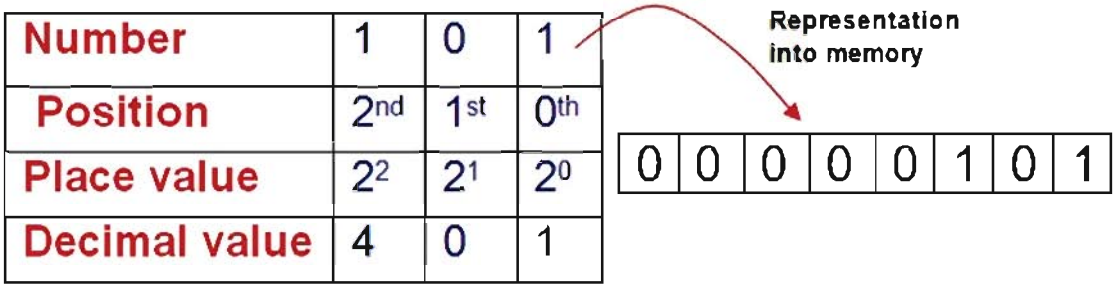


Figure 4.11 : Unsigned Integer Representation

Figure 4.12 illustrates some more examples.

Number in Binary (to be represented into memory)	Sum of Digit *2^Place Value	Decimal value
$(0)_2$	$0*2^0$	$=(0)_{10}$
$(1)_2$	$1*2^0$	$=(1)_{10}$
$(11)_2$	$1*2^1 + 1*2^0$	$= 2 + 1$ $=(3)_{10}$
$(110)_2$	$1*2^2 + 1*2^1 + 0*2^0$	$= 4 + 2 + 0$ $=(6)_{10}$
$(10110)_2$	$1*2^4 + 0*2^3 + 1*2^2 + 1*2^1 + 0*2^0$	$= 16 + 0 + 4 + 2 + 0$ $=(22)_{10}$
$(11011)_2$	$1*2^4 + 1*2^3 + 0*2^2 + 1*2^1 + 1*2^0$	$=16 + 8 + 0 + 2 + 1$ $=(27)_{10}$

Figure 4.12 : Examples of Unsigned Integer Representation

Arithmetic operation such as addition, subtraction, etc can be done on such numbers. Here, such simple representations cannot store negative numbers. To store positive as well as negative integer numbers in a computer memory 2's complement method is used.

Signed Integer Representation

To represent 0, positive and negative integers, three different representation schemes are used. These methods are

(1) Sign magnitude method

(2) 1's complement method and

(3) 2's complement method

In a sign magnitude method, a prefix 0 for indicating positive number and a prefix 1 to indicate negative number is used. That is, if number (-5_{10}) is to be stored into memory, first it is converted into its equivalent binary number, which is 101_2. The first bit is 1 and remaining bits are the binary digits representing the number. However, this method has some limitation. For example, the number 0 has two possible representations according to this method, a positive 0 and a negative 0!

1's complement refers to the presentation of a binary number by converting 1's into 0's and vice versa. Here also, one can get two representations of 0 : 00000000 (+0) and 11111111 (-0).

Among methods to represent numbers into computer memory, the 2's complement method is very popular. This system is similar to above mentioned unsigned integer representation except the most significant bit. The most significant bit has negative value. Figure 4.13 show some examples represented using the 2's complement method.

2's complement number	Conversion	Decimal number
$(01000)_2$	$0*2^4 + 1*2^3 + 0*2^2 + 0*2^1 + 0*2^0$ $= 0+8+0+0+0$	$(8)_{10}$
$(11000)_2$	$-1*2^4 + 1*2^3 + 0*2^2 + 0*2^1 + 0*2^0$ $= -16+8+0+0+0$	$(-8)_{10}$
$(10000)_2$	$-1*2^4 + 0*2^3 + 0*2^2 + 0*2^1 + 0*2^0$ $= -16+0+0+0+0$	$(-16)_{10}$
$(10111)_2$	$-1*2^4 + 0*2^3 + 1*2^2 + 1*2^1 + 1*2^0$ $= -16+0+4+2+1$	$(-9)_{10}$

Figure 4.13 : Conversion of 2's Complement Number into Decimal

The above table shows conversion of a 2's complement number into decimal number. To find a two's complement number from a given decimal number do the following:

(1) Consider the binary representation of a number
(2) Invert the bit of the binary number (make 0 to 1 and vice versa). This is also known as 1's complement number of a given binary number.
(3) Add 1 to it.

Consider the decimal number 9 represented as 9_D. This number can be represented in binary as 01001_B. Changing 0's to 1's and vice versa make the number as 10110_B. Adding 1 to it makes it 10111, which is -9.

It is to be noted that an *n*-bit 2's complement signed integer can represent integers from $-2^{(n-1)}$ to $+2^{(n-1)}-1$. See figure 4.14.

No of binary digits (bits)	Minimum number	Maximum number
8	$= -(2^7)$ $=-128$	$= +(2^7)-1$ $= +127$
16	$= -(2^{15})$ $= -32,768$	$= +(2^{15})-1$ $=+32,767$
32	$= -(2^{31})$ $= -2,147,483,648$	$= +(2^{31})-1$ $=+2,147,483,647$

Figure 4.14 : Range of Numbers

Floating Point Number Representation

To represent fractional number, floating point number representation is used. The IEEE 32 bit single precision method is commonly used to represent a real number. Here, IEEE represents Institute of Electrical and Electronics Engineers, which is the world's largest professional association dedicated to advancing technological innovation and excellence for the benefit of humanity (www.ieee.org).

According to the method, representation of a given number is divided into three parts as shown in figure 4.15.

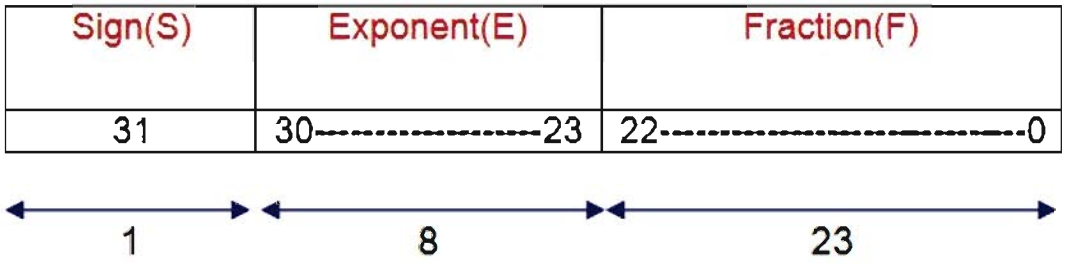


Figure 4.15 : IEEE 32 bit Single Precision Floating Point Number

The three parts are given below :

(a) The most significant bit is the *sign bit* (S), with 0 for negative numbers and 1 for positive numbers.

(b) The following 8 bits represent *exponent* (E).

(c) The remaining 23 bits represents *fraction* (F).

Consider the number shown in figure 4.16, the sign bit represents the sign of the number. If S=0 then the number is positive. If S=1 then the number is negative. In this example S=1, hence it is a negative number.

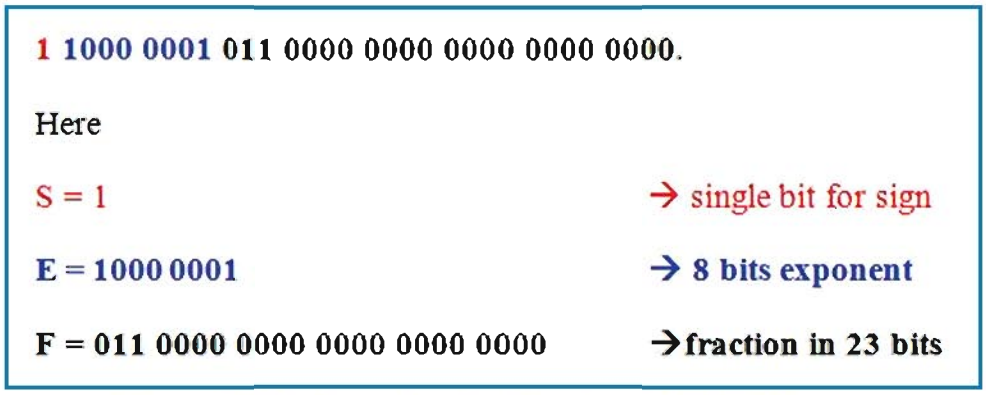


Figure 4.16 : Example of a Number in IEEE Format

The exponent given here is $1000\ 0001_B$. The decimal equivalent of this number is 129 or 129_D. In a normalized form the actual exponent is E-127, where E is exponent given, hence it is also called excess 127 notation. This is required to represent positive and negative number as exponent. That is, here actual exponent is $129\text{-}127=2_D$.

Similarly, the fraction is presented in a normalized form with a hidden 1.F form. The fraction given here is $011\ 0000\ 0000\ 0000\ 0000\ 0000_B$. That is, the actual fraction is $1.\ 011\ 0000\ 0000\ 0000\ 0000\ 0000_B$. The decimal equivalent for the number is 1.375 or 1.375_D.

Putting all these three components together, we have a number as $-1.375\times2^2=-5.5_D$.

Consider another example having representations :

1 01111110 100 0000 0000 0000 0000 0000.

Then the equivalent representation in decimal can be calculated as follows :

Sign bit S = 1 indicates negative number

$E = 0111\ 1110_B = 126_D$ (in normalized form)

Fraction is 1.1_B (with an implicit leading 1) = 1 + 2^-1 = 1.5_D

The number is $-1.5 \times 2^{\wedge(126-127)} = -0.75_D$

Character Representation

In computer memory, characters are represented using bit patterns. Group of 7, 8, 16 or 32 bits can be used to represent each character. The rules that determine such bit patterns in a specific length are known as coding schemes. Historically 7 bit American Standard Code for Information Interchange (ASCII) code, 8 bit American National Standards Institute (ANSI) code and Extended Binary Coded Decimal Interchange Code (EBCDIC) were used. These coding schemes represent characters into 7 or 8 bit binary code. Table 4.3 illustrates ASCII representation of selected characters.

Symbol	Decimal	Binary
7	55	00110111
8	56	00111000
9	57	00111001
:	58	00111010
;	59	00111011
<	60	00111100
=	61	00111101
>	62	00111110
?	63	00111111
@	64	01000000
A	65	01000001
B	66	01000010
C	67	01000011

Table 4.3 : Characters Represented into ASCII

One can represent maximum 256 possible patterns using the size of 8 bits, where each pattern represents a specific character. Hence, we may represent limited number of characters. Further, these character schemes do not represent all the characters in all the languages in uniform format. Presently, Unicode scheme is used to represent characters into the computer memory. Unicode provides universal and efficient character presentations and hence evolved as modern character representation scheme. Unicode scheme is developed and maintained by a non-profit organization called Unicode consortium (www.unicode.org). Unicode is also compatible with other coding schemes like ASCII. Unicode use either 16 or 32 bits to represent a character. Unicode has capability to represent characters from all the major languages across the world. The 16 bit Unicode scheme allows 65,536 (64K) unique patterns. That is, it can represent 65,536 characters uniquely. Further, 44,949 more characters were added into the scheme in May 2001. The added characters were from Chinese, Japanese, and Korean language and culture. Presently, the Unicode latest standard (32 bits) can represent more than 1 lakh characters in unique pattern. Table 4.4 illustrates some sample Unicode characters formation.

Unicode	Character	Description
U+0030	0	Digit Zero
U+0031	1	Digit One
U+0032	2	Digit Two
U+003A	:	Colon
U+003B	;	Semicolon
U+003C	<	Less-than sign
U+003D	=	Equal sign
U+003E	>	Greater-than sign
U+003F	?	Question mark
U+0040	@	At sign
U+0041	A	Latin Capital letter A
U+0042	B	Latin Capital letter B

Table 4.4 : Unicode Character Formation

Image Representation into Computer Memory

Image represented in a computer memory is called digital image. The reason behind this is that the image is ultimately converted into sequence of 0's and 1's for its possible representation into the computer memory.

One way to describe an image using digits is to describe its contents using position and size of geometric forms and shapes such as lines, curves, rectangles and circles. Such representation is called vector image representation. A vector image can be easily enlarged or shrunk without affecting the quality of the image. Vector images are the preferred way to represent fonts, logos and many illustrations.

Another way to represent an image into computer memory is dividing the image into fix number of rows and columns. Each cell (intersection of a row and a column) is known as pixel (picture cell). Each pixel represents a value that represents the brightness of a given color at any specific point. If you divide the image using more number of rows and columns, very fine information about the image can be stored and hence quality of the image increases. The set of pixels, normally in the form of two dimensional array, is stored in computer memory as a raster image or raster map. To improve quality of an image, we really need to store high amount of data into computer memory.

An image that is 2048 pixels in width and 1536 pixels in height has a total of 2048×1536 = 3,145,728 pixels or 3.1 megapixels. One could refer to it as 2048 by 1536 or a 3.1 megapixel image. You might have observed some mobile phones or digital cameras with specification such as 3.1 mega pixel. That means, the image taken by the camera, has 2048×1536 resolution. The term resolution is often used for a pixel count in digital image.

Many times it is difficult to deal with such a bundle of data. An image takes a significant amount of memory to store all its pixels. And, we must remember that we may have to store number of images into computer memory. This problem becomes even harder to manage when we try to send the bunch of images via computer network. To avoid such memory management and image transferring problem, images are often stored and transferred in compressed forms.

For raster images following formats are popular :

- .bmp (Bit Map Image),
- .jpg (Joint Photographic Experts Group),
- .png (Portable Network Graphics),
- .gif (Graphics Interchange Format), and
- .tiff (Tagged Image File Format).

Just like images, audio and video information is also represented as digital information into computer memory. Computer represents sound as binary numbers. For this, parameters such as frequency and resolution are considered. The sound/audio files have formats like .Wav (Waveform audio file format), .mp3 (moving picture experts group), and .WMA (Windows Media Audio). Digital video is a type of digital recording system that works by using a digital rather than an analog video signal. Digital video consists of sequence of digital images displayed in continuous fashion at a constant rate. These images are identified as frames. In a second, typically more than 45 frames must have to be passed to generate effect of continuous scene. However, early silent films had frames up to 25-30 per second. Popular video file formats are .flv (flash video format), .avi (audio video interleave), .wmv (windows media video) and .mp4 (moving picture experts group) format.

Summary

In this chapter, we have learnt about how computer can store data and instructions. Basic units of computer memory such as bit and bytes, categories of memory such as primary and secondary memories, hard disks, compact discs and digital versatile disks are also illustrated here. We also learnt how to represent information such as integers, real numbers, characters and other multi-media information into computer memory.

EXERCISE

1. What is computer memory ?
2. What is primary memory ?
3. What is secondary memory ?
4. Define bit. What are the symbols used to represent a bit ?
5. What are the measurement units for computer memory ? What is the relationship between these units ?
6. Describe the following terms in one or two sentences :

   (a) RAM (b) ROM (c) PROM

   (d) EPROM (e) EEPROM (f) FIFO

   (g) LIFO
7. What is sequential access ?
8. What is RAM ? How many types of RAM exist ? Explain each in one line.
9. What is ROM ? Where ROM is useful ?
10. Distinguish between RAM and ROM.
11. What is cache ? For what purpose is it useful ?
12. List any three secondary storage devices. Explain any one in brief.
13. Explain how numbers are represented into computer memory ?
14. Write a short note on IEEE floating point number representation.
15. How images are represented into computer memory ?
16. **Choose the most appropriate option from those given below :**

   (1) What is an alternative name of a primary memory ?

   (a) Volatile (b) Permanent

   (c) Auxiliary (d) Any of these

   (2) For what amount of time does a secondary memory retain its content ?

   (a) Short duration (b) Long time

   (c) Never (d) Any of these

   (3) Which of the following is the unit of computer memory ?

   (a) Bit (b) Pit

   (c) Chit (d) Kit

   (4) How many bits form a byte ?

   (a) 4 (b) 8

   (c) 16 (d) 32

(5) Which of the following is a correct example of a LIFO ?

(a) A queue of people (b) Cars waiting for service

(c) Pile (tray) of paper (d) Jobs waiting for services

(6) Which of the following mechanism is used to erase content of An EPROM ?

(a) ultraviolet light (b) electric signal

(c) laser technology (d) magnetic field

(7) Which of the following type of memory is used by pen drives ?

(a) RAM (b) PROM

(c) EEPROM (d) Any of these

(8) Which of the following is a small and high speed memory within the computer central processing unit ?

(a) Secondary (b) Auxiliary

(c) Cache (d) ROM

(9) Which of the following is not a secondary storage device ?

(a) Cache memory (b) Compact disks

(c) DVDs (d) Pen drives

(10) Which of the following number system is most suitable for basic computer data representation into machine readable form ?

(a) Binary (b) Octal

(c) Ternary (d) Hexadecimal

(11) Which of the following number systems has 2 symbols 0 and 1 ?

(a) Decimal (b) Binary

(c) Hexadecimal (d) Octal

(12) Which of the following method is used to represent an integer number into computer memory ?

(a) Sign magnitude method (b) 1's complement method

(c) 2's complement method (d) All of these

(13) Which of the following method is used to represent characters into computer memory ?

(a) ASCII (b) Unicode

(c) EBCDIC (d) All of these

Introduction to Operating System

Even though the CPU is very fast, it can basically do simple operations like adding two numbers, multiplying two numbers, etc.; but not much more. Even simple operations like input of a number or output of a number or converting a string of characters to uppercase or displaying an image on the screen must be built on top of these basic capabilities by writing a series of basic instructions. Also, the computer has a large number of peripheral devices like keyboard, mouse, monitor, hard disk, optical disk, printers and other removable devices. Operating these devices require executing a long and complex series of basic instructions.

A modern computer system has a variety of resources like the CPU, memory, secondary storage, network, peripheral devices, etc. These are accessed by multiple programs running concurrently, sometimes on behalf of different users with different set of access rights. Clearly, there needs to be some "authority" that regulates and mediates access to these resources.

A computer without any kind of software for above operations is a practically unusable device, because it may not even have the basic user interface to interact with the user. In order to provide a consistent experience to the user, there needs to be a common framework for the common human-computer interactions. To make the computer easier to use, such framework should also provide several types of abstractions and metaphors. A file system metaphor is one such example that has been discussed in detail later in this chapter.

Thus an operating system exists to satisfy all these needs. Because it controls the whole system, it is always the first program to be started when the computer system is turned on.

What is an Operating System ?

An operating system is the controller, resource allocator and common services provider for a computer system. Like the government, it performs these functions to ensure smooth and mostly trouble-free operation of the computer.

The Startup Process of a Computer

When the computer is supplied power and turned on, the CPU takes control of the whole system. It initializes itself by bringing all its subcomponents in a known and ready-to-use state. Now it is like a vehicle whose ignition has been turned on and is ready to be "driven". But where is the "driver" (the instructions to be executed by the CPU) ? The computer has a type of permanent memory called ROM (on personal computers, this is often called ROM BIOS (Basic Input Output System or simply BIOS) that contains an initial program. This initial program, called POST (Power On Self Test), performs a basic check on all other components and peripheral devices in the computer and initializes them so they are ready for use. Hence the next step in this sequence is to locate

operating systems on the attached storage devices, select the one to be loaded in many memory, load it and start executing it. Once the operating system starts its execution, it takes control of the entire computer system. This entire process is called "booting" the computer to a particular operating system.

Functions of an Operating System

An operating system (OS) performs different set of basic functions as mentioned below :

- Providing hardware access as a common service.
- Controlling, Regulating and Supervising resources in the Computer
- Handling Multiprocessor Systems
- Starting and Stopping Program Execution
- Controlling Access to the Memory
- Serving Multiple Users at the Same Time
- Providing Security
- Providing Other Common Services

In this section we have described some common functions often performed by the operating systems.

Providing Hardware Access as a Common Service

In the earliest days of computing, each computer program would come with a set of instructions to handle a fixed set of devices like printers, etc. If a new kind of printer was added to a computer, it became necessary to add the necessary instructions to handle the new printer to each and every program to be executed on that computer. With the rapid increase in the number of devices and device manufacturers as well as the number of programs to be run, this approach soon became infeasible. Thus, the operating systems started providing a common service of handling the hardware devices. The code (instructions) to handle particular devices would be part of the operating system and the operating system would provide access to these devices to individual programs as a common service. When a new device came into use, the new instructions needed to operate it would only have to be added to the operating system and thousands of individual programs were spared of any modification.

Controlling, Regulating and Supervising Resources in the Computer

Modern computers are far more powerful than their humble predecessors and have access to far greater amounts of resources like processing power, main memory, storage, etc. As a result, they are now capable of running not just one program at a time, but many programs at a time. This ability is called multiprogramming. This creates new issues as well. When only one program is running at a time, it has full access to all the resources and there is no harm in it. But what happens when many programs are running at a time and two programs start printing to the same printer at the same time or start writing to the same location of the same storage medium at the same time ? Obviously, access to common resources must be controlled in such an environment. The operating system plays the crucial role of resource controller, regulator and supervisor for all hardware resources.

Handling Multiprocessor Systems

A computer system may have more than one CPU (processor) as well. A computer system having more than one processor is known as a multiprocessor system. Operating systems for such multiprocessor systems are considerably more complex than those designed only for single processor systems. Managing which processor to be used for execution is also job of operating system.

Starting and Stopping Program Execution

When the computer starts, initially it runs only the operating system. The operating system takes complete control of the computer system. It also runs a special program called the shell. The shell provides the user a user interface (UI) to work with. The user interface allows the user to indicate what they want to do. It accepts requests for performing operations from the user (these requests may be in the form of typing a command or clicking with a mouse, or touching on a touch panel, etc.) and initiates actions to fulfill those requests. If it is required to start a program to fulfill a request, it requests the operating system to do so. As the operating system has full control over the system, only the operating system can start or stop programs.

Controlling Access to the Memory

The main memory is an important resource for the computer system, because it is the only large-scale form of memory that can match the speed of the CPU and can be directly accessed by the CPU. Any program to be run must be loaded into main memory and any non-trivial data set to be manipulated must also be in main memory for the manipulation to occur. Hence it is very important that this resource be used judiciously. As a result, access to the main memory is also under complete control of the operating system, just like access to other resources. A process needing to get or release some amount of main memory must request the operating system to do so and no process is permitted to access memory not allocated to it by the operating system. This is known as memory protection.

Serving Multiple Users at the Same Time

An operating system may be designed for use by only one user at a time (a single user system) or by several users simultaneously (a multiuser system). With a multiuser operating system, it is actually possible to run the programs of many users on a single computer usually called server, with each user performing input/output through their "terminal" that may have keyboard, mouse and monitor. This is useful when all users cannot be provided with the powerful computers they need (due to the cost factor) and a single powerful computer must be shared among many of them.

A multiuser system also provides additional benefits of centralized management and resource (e.g. file) sharing. Sometimes, a computer system in a faraway corner of the world can be accessed remotely by users over the Internet. This enables travelling employees of large organizations to access their computers from anywhere in the world for doing their work. It also enables the technical support staff of the organization to access computers in different offices and to diagnose and solve their problems without wasting time on physical travel. Some companies even provide their employees the option to work from their home.

Providing Security

When multiple users are accessing the same computer system, the operating system must provide some level of isolation between the users so that one user cannot disturb the work of another user. At the same time, where users are collaborating on a joint project, they must be able to share some resources. Hence the operating system must provide a security mechanism that ensures that all authorized uses of a resource are permitted, while all attempts at unauthorized use are strictly denied. Modern operating systems are designed to provide such security.

With the heavy use of computer networks and the Internet, it is also possible to access and use a computer system remotely, possibly from thousands of kilometers away. While this facility is a boon for organizations having multiple offices around the world or for employees like sales persons and managers who have to travel a lot and still need to access their office computer, it can also be misused for gaining unauthorized access to someone's computer. Modern operating systems provide some basic mechanisms to protect against such hazards, though they may not be sufficient by themselves.

Providing Other Common Services

Apart from these functionalities, operating systems also provide many common services to make the operation of the computer systems easier. Many of these services remain hidden from the user because they are used by the other programs in the computer and not by the human users directly. Operating systems also often come with some companion programs (utilities or accessories) that are small and simple and yet useful to most users of the computer.

These include a utility to explore the information stored on the computer (a file browser), a basic text editor, a calculator, programs to view and edit images, programs to play audio and video, a web browser for surfing the Internet, etc. All operating systems, except for the embedded systems, must also provide at least one shell program to allow the user to interact with the computer system. Though these are not essential parts of an operating system, most operating systems come with some such utilities as an added bonus. Some operating systems, especially the free ones, come with a comprehensive set of software ready for daily use in different usage scenarios like homes, educational institutes and offices.

Typical Components of an Operating System

In this section we briefly discuss the components typically associated with an operating system and the full environment surrounding the operating system. Keep visiting figure 5.1 while reading the description. This figure provides a simplified layered view of the operation of the computer system in the context of operating system study.

The Device Drivers

At the lowest level is the raw hardware of the computer. As we have seen earlier, this part, often called the "raw iron", is an immensely powerful machine, but has no clue as to what to do. This layer also consists of a diverse set of devices, each requiring potentially different set of instructions to operate. The device drivers are small programs that contain the instructions

necessary for using these devices. While many of them come bundled with the operating system, some may have to be installed separately from a disk or the Internet. They are loaded and unloaded as and when needed by the kernel. The kernel uses them for operating and controlling the hardware.

The Kernel

The kernel is the core component or the main program of the operating system. A traditional kernel performs all the key functions of an operating system including detecting new hardware when attached and loading appropriate device drivers to access it, accessing and controlling all hardware devices (through the device drivers), resource allocation and management, creating, stopping and controlling program execution, scheduling program execution, providing CPU, I/O and memory protection, I/O management, memory management, security, etc. By some definitions, the kernel IS the operating system.

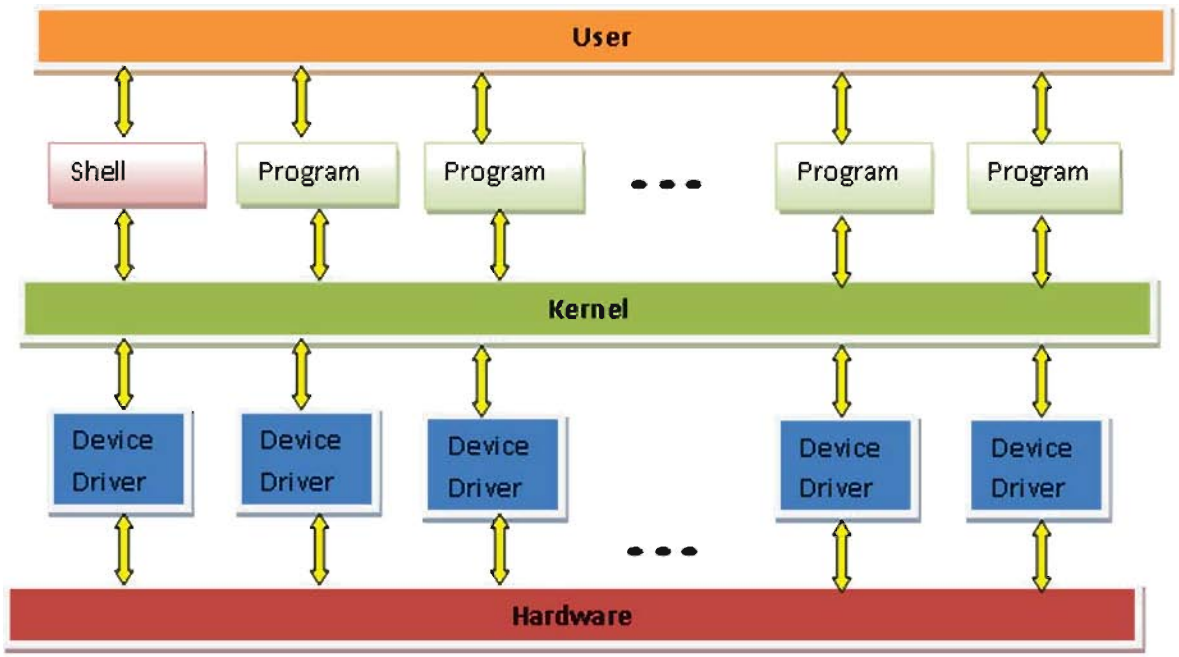


Figure 5.1 : The Operating System Context

The Shell

The shell is the most visible component of an operating system bundle; so much so that most people identify the operating system by the looks of the shell. The shell allows the user to express their wishes (what they want the computer to do) to the computer system by providing a user interface (UI). There are two main categories of user interfaces - a Command Line Interface (CLI) and a Graphical User Interface (GUI). The CLI expects only a low-cost low-power text-based terminal. It works by repeatedly accepting textual commands from the user and executing them. One needs to remember the commands (though help may be available) and a certain level of typing skills are needed to operate such a system. In the early days of computing when technology was not as advanced, the CLI was the only option. Later on the Graphical User Interface was developed.

In the GUI environment, the screen contains pictorial elements like a desktop that acts as a background for everything else, windows (a rectangular portion of the screen dedicated to a particular program or interaction), icons (small pictures representative of programs and other elements), menus (a list of actions from which the user may select one), buttons (small rectangular areas that react to a mouse click), etc. The latter elements belong to a particular window. The windows may hide behind other windows and reappear and can often be moved around or resized, minimized to a small part at the bottom of the screen, maximized to occupy the whole screen, etc. Apart from the keyboard for input, there is a mouse pointer that can be moved around using a mouse or track pad. There are one to three buttons that can be clicked and a scroll wheel or scroll area too.

The File System

The operating system provides a file system interface to secondary storage. The concept of a file system is modeled after the filing cabinets commonly found in offices, but with new twists. A file system chiefly contains two types of objects – files and directories (also known as folders). A file is the basic unit of secondary data storage on computers. Any data that the user wants to store will go in some file in the file system. The files are identified by their names, which are much easier for humans to remember than absolute addresses known as block numbers. As a disk may have a large number of files, directories are used to organize them. A directory is nothing but a container that may contain files as well as other directories known as its subdirectories. In fact, there is no theoretical limit to such nesting (putting one container object inside another). However, every file system starts with what is called its root directory and then the root directory may contain files as well as subdirectories and it can go on and on like that. Figure 5.2 illustrates this concept. Here the green nodes represent directories (indicated by d), while the blue ones represent files (indicated by f).

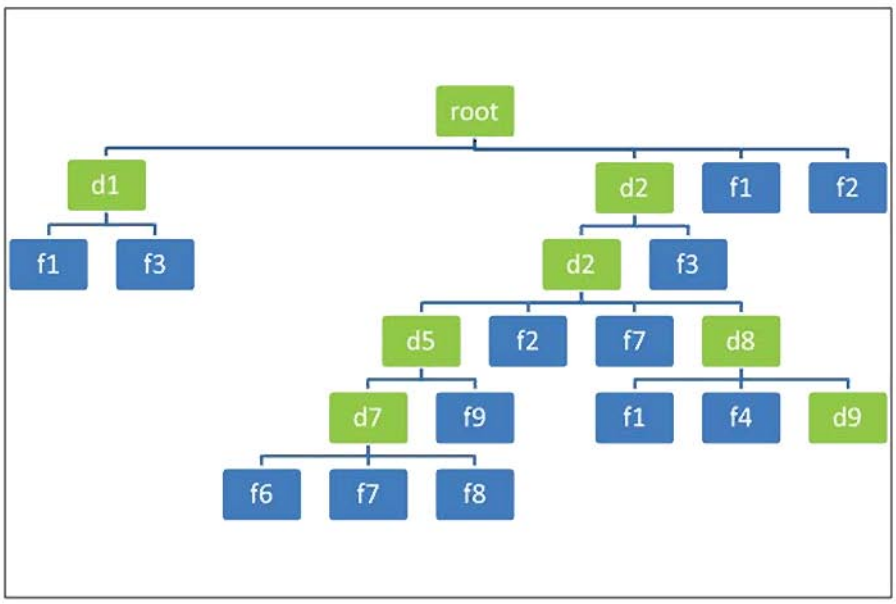


Figure 5.2 : The File System Structure

The file systems follow certain basic rules. Each file system has a single root directory that is the starting point of the file system. Each directory in the file system contains a number of objects (files and directories), each of which must have a name unique within that directory. Thus, there can never be two objects with the same name in the same directory. However, two different directories can have two different objects with the same name. As long as you know the directory containing the object you want to use, knowing its name may be enough as it is guaranteed to be unique within its directory. Otherwise, you will have to specify the absolute (or full) path leading to the object. That is, you start with the root directory, then the subdirectory, and so on, until you reach to the directory that contains the object in question and finally the object itself. Each of these components is separated by a special character that is not permitted in file or directory names. This uniquely identifies an object in the entire file system.

A blank disk initially contains no file system. The initial blank file system structure is created by an operation known as formatting the disk. Formatting a disk that already contains a file system destroys the existing file system and replaces it with a new blank one. Certain types of disks such as the hard disks can contain multiple partitions. Each partition may be formatted to contain a separate and independent file system. Formatting one partition does not affect the others. The operating system provides utilities for viewing, modifying and formatting the disks and their partitions.

File System of Linux Operating System

Linux generally uses some version of the extended file system (ext2, ext3 or ext4), though several others are also available and in use. These are quite powerful and feature rich file systems. The extended file system is case sensitive, i.e. capital and small letters are treated as two different characters. So you may have two files with the names f1 and F1 in the same directory. It uses the / (slash) character as the path separator. The concept of using the extension part of the filename to signify its type is not mandatory and is weakly used. USB flash disks and memory cards used with mobile phones usually come formatted with the FAT file system, but the former can be reformatted as NTFS to obtain the benefits of performance and some security. CDs generally use the ISO9660 file system, while DVDs use the UDF file system. These different file systems have different characteristics.

GUI and Components of Operating System

Everything that comes with the operating system is theoretically changeable, except the kernel. The device drivers, the shells, the libraries and the utility programs can all be changed without changing the operating system. In fact, some free and open source operating systems like Linux provide a number of choices for each of these. And though some proprietary operating systems do not offer a choice in shells or utilities, such choices are available from third party vendors as well as the open source community. Hence identifying an operating system based on these components would be a fallacy. These considerations have given rise to a definition that the kernel, and only

the kernel, is THE operating system. All other things are changeable; and hence are just auxiliary accessories.

Users often mistakenly associate a particular user experience with a particular operating system. But they forget that the user experience is provided by the shell and the shell is changeable. To emphasize this fact, just look at the four screenshots in figure 5.3 and try to identify the operating system in each case. We will not be able to differentiate between these screens to a large extent. Here the upper two screenshots were taken on Windows systems, while the lower two were taken on Linux systems.

Different Categories of Computing Devices and Operating Systems for Them

There is a wide array of computing devices serving a variety of purposes. Here we present them in order from the largest to the smallest.

Supercomputers

The largest and the most powerful computers ever built are known as supercomputers. These are computers that can perform millions of billions of floating point (real number) operations per second. For example, in November 2011, the K supercomputer of Japan (see figure 5.4) became the first super computer in the world to be able to perform 10 Peta FLOPS, i.e. 10^{16} FLOPS (Floating Point Operations Per Second). India is one of the few countries in the world to have developed her own supercomputers. Such computers are used on some of the most complex and computation-intensive problems in the world like weather forecasting, nuclear test simulation, molecular modeling, etc. These computers are vastly different from the common variety personal computers. They utilize the power of thousands of processors connected using very high speed channels and working on a single problem in parallel to achieve very high speed. The most critical aspects for an operating system for a supercomputer are performance optimization as well as distribution and coordination of both data and computation among the thousands of processors. The operating systems typically used are variants of lightweight kernels like CNK or CNL at individual node level, while using a Linux variant for managing the overall operations.

Mainframe Computers

The next class of computers is called mainframe computers (see figure 5.5). These are used in government and corporate environments where, apart from high performance, a very high level of reliability and compatibility with existing mainframe-based software are key aspects. The very high levels of reliability and availability are achieved by providing multiple redundant components for almost every aspect of the machine, so that if one component fails; another identical component can take on its responsibility and the computer continues working without a hitch. The duplication goes from CPUs all the way down to power supplies and even cooling fans. This makes these machines run continuously for years and years without any problems. Example operating systems are IBM z/OS and Linux variants.

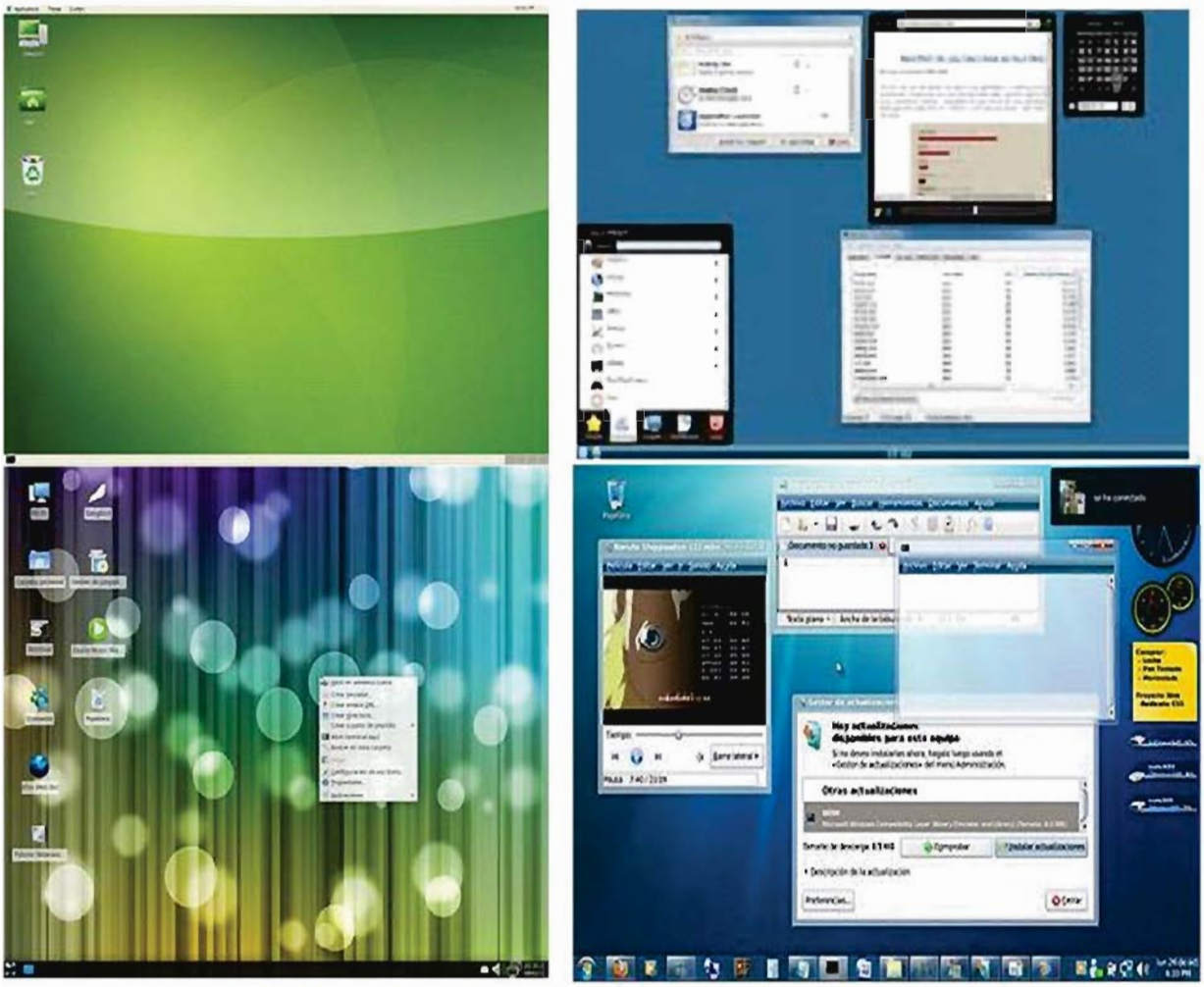


Figure 5.3 : GUI of Some Operating Systems

Figure 5.4 : The K Supercomputer of Japan

Figure 5.5 : The IBM Z Mainframe

Server Computers

Server computers are powerful computers that provide some computing or storage service to a large number of client computers. The critical aspects for these computers are performance, reliability, compatibility with already existing software and scalability, the ability to incrementally increase performance as and when needed by adding components, rather than replacing the whole computer. These computers most commonly use Unix or Linux as their operating systems. Some also use a Microsoft Windows server operating system.

High-end Workstations

High-end workstations are computers used for demanding scientific computing as well as multimedia applications like special effects in movies, making animated movies, 3D modeling, Computer Aided Design (CAD), Computer Aided Manufacturing (CAM), etc. these require very high graphics performance and an effective management of the larger amount of resources available (processing power, memory, disk space, network bandwidth). Here also Unix, Linux or Microsoft Windows is used as operating system.

Personal Computers

The category of computers most familiar to us is that of personal computers. These computers provide a general platform that caters to the widest possible range of uses and also to users with vastly different skill sets. For a large number of users, user-friendliness is a very important aspect. Subsequently, the operating systems in use are Microsoft Windows family operating systems, the OS X operating system (on the Apple Mac series computers) and Linux. All three provide rich graphical user interfaces.

Smartphones and Tablets

Though you may not have realized it yet, a smartphone is also a computer in its own right. Tablet PCs are a hybrid between the smartphones and personal computers. These devices pose unique challenges for operating system designers because they have severe constraints on processing power, memory, energy usage (because higher energy usage would mean the battery would drain out faster) and screen real estate (the screen size is quite small compared to the PC, and yet, most facilities of a PC are expected). They also have quite different input methods (numeric keypad or small QWERTY keypad with navigation keys or touch gestures and an onscreen keyboard on a touch screen or even voice input).

These characteristics demanded completely different solutions. As a result, most mobiles few years back used operating systems specially designed for them. However, with increasing processing power and memory, specialized versions of PC operating systems have now become the most popular choices for smartphones and tablets. Examples include Google Android and Apple iOS (both based on Linux/Unix) and Microsoft Windows Phone OS. Variants of full scale Linux for use on such devices are currently under development. A convergence of operating systems for touch screen based smartphones, tablets and ultraportable devices and operating systems for mainstream personal

computers is widely anticipated and both Microsoft Windows 8 and Linux variants using the GNOME 3 or Unity interfaces have started the process by redesigning their interfaces for touch input.

Embedded Systems

Even phones are not the smallest computers on the planet. There are hundreds of millions of tiny computers embedded in places we cannot even imagine; from industrial machines to car engines, from TV set top boxes and DVD players to washing machines and microwave ovens they are hidden everywhere. These computers are programmed for special purpose tasks. They typically have little or no user interface. They get their input from a variety of sensors in the form of electrical signals, process the input and send output in the form of electrical signals to actuators that may activate some physical action in the machine. They have extremely severe constraints on all resources, including processing power, memory, and, most importantly, price.

Since there is hardly any scope for changing the programming once the tiny devices are manufactured and fitted in their respective machines, correctness of the software is really very important. But the software for these embedded systems is developed on the PC and it is very difficult to simulate the real time behavior of the environment on the PC; so testing the software for correctness is very difficult. Embedded systems professionals use specialized tools for their work. The usage of embedded systems is growing at a rapid pace. The operating systems used include QNX and RTLinux.

In the above description of different categories of devices and their operating systems, you must have noticed that in spite of widely different characteristics and demands of the environments, Unix/ Linux variants is the only family of operating systems that is used on all these devices from the most powerful supercomputers to tiny embedded systems. In the next chapter we shall see the reasons for this as we explore the Linux operating system in more detail.

An Operating System for Smartphones: Android

We are going to discuss the Ubuntu Linux operating system in much more detail in the next chapter. In this chapter, we look at Android, a popular operating system for smartphones and tablet PCs.

Figure 5.6 : The Android Icon and Logo

Categories of Mobile Phones

A mobile phone that is only a mobile phone, and not much more, is called a basic mobile phone. A mobile phone that provides some additional features over the basic phone, like a music player, video player, simple games, limited web browsing, basic support for third party applications, etc. is called a feature phone. Even though there are no standard definitions of these terms, the key features of a smartphone are touch screen operations, full web browsing capability, the availability of office productivity applications, a powerful programming system that enables development of a rich and diverse set of software applications that go much beyond the functions of a mobile phone, one or more application stores from where new applications (free as well as paid) may be downloaded, a range of sensor devices for input, etc.

A smartphone or a tablet (or phablet) is actually a small computer and functions as a combination of a phone, a Personal Digital Assistant (PDA) providing secretary-like functions (calendar with scheduling, memos and notes, to-do lists, meeting reminders, access to office documents, messaging service or instant email notifications, etc.) and a portable entertainment hub. However, with improvement in technology, each category is moving up the features ladder and release of intermediate models by companies blurs the lines between these categories. Often, the distinction is made based on price, with the three categories mentioned above sporting successively higher price tags.

What is Android ?

Android is a free and open source operating system for smartphones that is being developed by the Open Handset Alliance, whose most prominent member is Google, Inc. Android uses a slightly modified version of the Linux kernel. It is designed to support a diverse set of devices. Even though the list of devices running Android include watches, phones with small screens and only numeric or qwerty keyboards, touch screen phones, mid-sized phablets (phone + tablet), larger sized tablet computers, TVs and even microwave ovens, the operating system is primarily designed to provide a rich and attractive user experience and a large number of small software applications ("apps") for smartphones and tablet computers. At the time of writing this, Android is world's No. 1 operating system for smartphones in terms of volume shipments (number of phones sold). Many leading mobile phone manufacturers make Android based smartphones.

Key Features of Android

Android provides several features and benefits as a smartphone or tablet operating system. It is free and open source and it is not tied to one particular device maker. Manufacturers also have the option of tweaking the operating system and making changes and/or improvements to distinguish their product from others because the source code is available. Because of competition among the manufacturers, prices are relatively lower and companies constantly try to add new features to their devices. It provides an attractive user interface and rich multimedia support. It has support for accessing and controlling almost all hardware features of the latest smartphones and tablets, like touch screen with multi-touch gestures, phone location information (positioning using satellite), motion sensors,

wireless networking (2G/3G/4G mobile network, Wi-Fi, Bluetooth, Near Field Communication or NFC), voice and video telephony, text messaging (SMS), Internet access, listening to podcasts (live audio on the Internet), watching webcasts (live video on the Internet) and Live TV programs, camera(s), microphones and speakers, etc. not only from the built-in applications but also from third party applications and our own applications. Clever use of inputs from these diverse set of sensors along with Android's built-in capabilities allows the development of innovative, highly interactive, very useful and visually stunning apps with creative modes of interacting with the device.

3G & 4G make it possible to make video calls where the two parties can see each other. The availability of positioning information (the mobile's current location) and information-rich worldwide maps makes it possible to create location aware applications that guide you with directions in an unknown city (both in the form of a map as well as voice guidance like "Now turn left…"), lead you to a restaurant when you are hungry, show you the nearest bank branch or ATM when you need some cash, then take you to the nearest shopping mall so you can use up that cash :-), tell you when one of your friends is by chance in the same area at that time so you may meet them and finally show you the bus/railway/metro routes on the map along with the schedule and guide you to the nearest station when you are ready to leave the city. The ability to access motion sensors is used by the operating system itself to switch between portrait and landscape modes when you rotate your phone. It is also used by games that are played by simply tilting and rotating the phone and applications that let you control the phone just by moving it. For example, if you are busy and your phone rings, you may simply turn it upside down to reject the call.

You may use your phone network or a public/home wireless network (Wi-Fi hotspot) to access the Internet. Using Bluetooth, you may exchange files with another phone or laptop, connect a headset, hands-free set or a keyboard with your phone, etc. Using NFC, you may exchange contacts, visiting cards or files or make payment by simply waving your phone at (or making it touch) another device. Access to the camera enables applications that allow you to take a picture and upload it to a social networking site instantly, or take the picture of a place or a product and obtaining more information about it (not very accurate yet), or scan bar codes or QR codes ("Quick Response" codes specially designed for mobile phones), etc. If your parents have a phone with a QR code reader (sometimes called barcode reader) application, scan the code in Figure 5.7 with it and uncover the message encoded in it!

Figure 5 7 : A QR Code

Voice recognition technology, though in early stages, not only enables you to issue voice commands to your phone, it also allows the user to dictate notes and messages and search the web simply by speaking out what you are looking for. Android also has security features. It provides a well-known programming system for developing apps with a large set of built-in functions. The biggest advantage Android enjoys is that it is backed by the search giant Google, it already has a large number of programmers developing apps for the platform and hundreds of thousands of apps have already been developed for it, including apps for various phone related functions, Internet surfing, email, chat, social networking, photo editing, audio and video playing and editing, office productivity (like word processor, spreadsheet, presentation), simple and highly demanding 2D and 3D games, etc. Generally, Android phones have access to Google's Google Play app store, which, at the time of writing, had 6,00,000 apps. Some other companies have their own app stores for their Android phones.

Android as an Operating System

In spite of the seemingly large differences, operating systems for mobile phones follow the same general principles that we discussed above. They perform similar functions, have analogous components and fit in the same general definition of an operating system. The tablets presently have 7 inches or 10 inches touch screens and therefore are comfortable to work with. They provide almost all features for users (not developers) which are available on normal PC or laptop. However, the challenges faced by the mobile phone operating systems is a resource-constrained environment (smaller screens, less processing power, less memory and the need to conserve battery power), need to support different set(s) of input/output devices and far greater variation in the hardware. In recent times, the fast pace of technological advancement has also made the job more difficult. But it is the same development that has enabled us to do things that were not even conceivable in the not-so-distant past. We are living in an exciting era.

Summary

In this chapter we were introduced to an operating system. We learnt about different characteristics of an OS. We came to know that an operating system performs several functions including management of processes, input/output and memory and all other resources. It also provides protection of resources and enforces policies on computer system usage and responsiveness. An operating system typically comes with many utility programs, though whether they form part of the operating system or not is a matter of debate. Operating systems form an essential ingredient of computer systems of all shapes and sizes.

Operating systems based on Unix/Linux are used across the whole spectrum of computing devices. We also learnt that though smartphone operating systems like Android have radically different user and device interfaces and face a different set of challenges, at the core they are still the operating systems.

EXERCISE

1. List the major functions of an operating system.
2. What is multiprogramming ?
3. What is a multiprocessor system ?
4. What is the role of the operating system with regard to resources in the system ?
5. How does a multiuser system work ?
6. Why is security important in multiuser systems ?
7. List the typical components of an operating system.
8. What is the kernel ? What are its main jobs ?
9. Differentiate between CLI and GUI.
10. What is a file system ?
11. Why do we need a file system ?
12. What is QR code ?
13. Which are the common features of tablets ?
14. **Choose the most appropriate option from those given below :**

(1) What is the full form of BIOS ?

(a) Best Input Output Software (b) Basic Input Output Software

(c) Best Input Output System (d) Basic Input Output System

(2) Which of the following component acts as an intermediary between the operating system and the hardware ?

(a) kernel (b) shell

(c) device drivers (d) utility programs

(3) Which of the following is a function of the operating system ?

(a) resource management (b) Time management

(c) memory management (d) All of these

(4) Which of the following component of the operating system interacts with the user ?

(a) shell (b) kernel

(c) device drivers (d) I/O devices

(5) The hardware devices are directly accessed by which of the following entity ?

(a) the operating system (b) the kernel

(c) the device drivers (d) the shell

(6) Which of the following is the core component of an operating system ?

(a) the shell (b) the kernel

(c) the device drivers (d) the GUI

(7) What is the full form of CLI ?

(a) Command Line Interface (b) Command Line Interaction

(c) Common Line Interaction (d) Common Line Interface

(8) What is the full form of GUI ?

(a) Graphical User Interaction (b) Graphical Understandable Interaction

(c) Graphical User Interface (d) Graphical Useful Interaction

(9) Which of the following cannot be an object in a file system ?

(a) directory (b) file

(c) user data (d) folder

(10) Which of these sometimes come with only the kernel and not much more ?

(a) proprietary OS (b) free OS

(c) embedded systems OS (d) super computer OS

(11) Which of the following is NOT a limitation on a smart phone ?

(a) processing power (b) power consumption

(c) memory (d) network

(12) Which are the smallest computers on the planet ?

(a) smartphones (b) tablet computers

(c) embedded systems (d) PDAs

(13) Which operating system family is present in all categories of devices ?

(a) Microsoft Windows (b) Unix/Linux

(c) i/OS (d) OS X

(14) Android is developed by -

(a) Microsoft (b) Google, Inc.

(c) Open Handset Alliance (d) Samsung

6 Introduction to Ubuntu Linux

The success of the UNIX system stems from its tasteful selection of a few key ideas and their elegant implementation. The model of the Unix system has led a generation of software designers to new ways of thinking about programming. In this chapter you will learn about the history of Unix, will be introduced to Ubuntu Linux and finally we will see some options of running Ubuntu Linux.

History of Unix

The Unix operating system developed at the AT&T Bell Laboratories in 1969 has become a turning point in the operating system development scenario. The key persons involved in this development were Ken Thompson, Dennis Ritchie, Brian Kernighan, Duglas McIlroy and Joe Ossanna. In the past three decades, the operating system has had tremendous influence on the way we think about and develop operating systems and computer programs in general. Unix as well as various Unix-like and Unix-derived operating systems continue to dominate the computer world even today. In the fast changing world of Information Technology, few computer programs have survived for such a long time while still retaining their essential characteristics.

The people who developed Unix were originally working on a joint project with General Electric (GE) and Massachusetts Institute of Technology (MIT) to develop a large ambitious multiuser operating system called Multics (Multiplexed Information and Computing Service). Though the project had many innovations to its credit, it was a large and unwieldy project that was not progressing as expected. When AT&T decided to pull out of the project, Thomson, Ritchie and others decided to develop a smaller operating system to keep alive some of the ideas of Multics. Ken Thomson had developed a game called Space Travel while still on the Multics project, but it was too expensive to run the game on a large machine in active use. He found a little used machine at Bell Labs and redeveloped Space Travel to run on it. He and his group gradually added the operating system ideas they had in mind and finally came out with a simple operating system that they initially called Unics, because it supported a single user; as opposed to Multics. When it was developed further and started supporting multiple users, the spelling of the name was changed to Unix. Figure 6.1 shows two of the main creators of the Unix OS.

Figure 6.1 : Ken Thomson (left) and Dennis Ritchie

Key Success Factors

The Unix developers gave out copies of the Unix operating system with source code and online manuals to others for free. Soon many universities, government agencies and private companies started using Unix. Because, the source code was available, it was easy to make the small amount of changes needed to run Unix on a new platform. It also allowed the universities and organizations to study the source code and enhance it with new features. Unix became phenomenally successful in the subsequent years. Denis Ritchie and Ken Thompson were awarded the Turing Award, considered to be the Nobel Prize of computing, in 1983.

The success of Unix can be largely attributed to the revolutionary concepts it pioneered or popularized for the first time. It was the first successful operating system to have been developed in a high level language. It also popularized the tree-like file system structure discussed in the previous chapter. With some modifications, it is still in use by all major operating systems. It simplified device access by treating devices also as files. Unix stored all configuration information in plain text files, making them easily accessible and modifiable. Unix also provided a very powerful command line environment that supported combining the power of existing commands in flexible ways to get a new job done. This major innovation dramatically changed the way people worked, improved their efficiency and continues to be a major strength of the platform. Unix started a new trend by providing an online manual with the system itself, so there was no need to walk to the library to fetch a printed manual if one forgot some command or option.

Free Software Movement

Around early 1980s, Richard Stallman, working at MIT, got increasingly frustrated by the various restrictions placed by commercial software vendors on use and sharing of computer software. His vision for software was to provide all kinds of freedom to the users. He outlined four fundamental types of freedoms for users of software as mentioned in table 6.1.

Freedom	Description
Freedom 0	The freedom to run the program, for any purpose
Freedom 1	The freedom to study how the program works, and change it so it does your computing as you wish. Access to the source code is a precondition for this.
Freedom 2	The freedom to redistribute copies so you can help your neighbor
Freedom 3	The freedom to distribute copies of your modified versions to others

Table 6.1 : Type of Freedom

To this end, he started the GNU project in 1983. He wanted GNU to be a Unix-like (in its working), but completely free operating system. To emphasize that GNU was not a *commercial* system like Unix, he chose the name GNU that stood for "GNU is *Not* Unix". By free, he meant all the freedoms mentioned above. He started a Free Software Foundation (FSF) for developing GNU and other entirely free software projects. By 1990, he and the volunteers of the FSF had created most of the major components of the proposed GNU operating system, including the compiler, the shell and the libraries. But the core component, the kernel, was unfinished. Work on the kernel was going on, but was slow.

Birth of Linux

In 1990, Linus Torvalds, a student from Finland, developed an experimental operating system kernel for the PC (personal computer) called the Linux kernel (Linux stood for "Linux is Not Unix"). After he opened communications with other programmers on the Internet, the project grew rapidly. With the help of these volunteers, finally the Linux kernel and the GNU components were combined to form the first completely free working Unix-like system. The combined system came to be known as GNU/Linux, or simply Linux and became widely popular after Linus granted all the freedoms to everyone (GNU had already done so) and a large community of volunteers, individuals, organizations and even commercial corporations, started supporting its development.

Freedom and Choice

Linux is a mass movement today. A large community spearheaded by Linus Torvalds himself looks after the development of the Linux kernel. Several other individuals and communities continually work towards providing better software solutions for all common requirements of users with liberal freedoms. In most cases, the freedom includes the rights to obtain the source code of the software, modifying it and contributing the changes back to the community or redistributing the modified software under a name of one's own choosing. As a result, there is a bewildering choice of software available for all the common requirements of computer users. Different people and organizations select bundles of software from this vast pool of software as per their own criteria and preferences and create a distribution of the Linux operating system that they distribute under their own name. Each distribution of Linux is a bundle of some version of the Linux kernel and a set of software applications selected with some goals in mind. Some of the more popular ones include Ubuntu Linux, Linux Mint, Fedora Linux, Debian GNU/Linux, Red Hat Enterprise Linux (this is a commercial, but open source, distribution), openSUSE Linux, Knoppix and many more. These distributions vary in their goals as well as contents.

Some Popular Operating Systems for Personal Computers

Microsoft Windows

Microsoft Windows is a proprietary OS and must be purchased for using it. When a new version comes out, one must again purchase an upgrade version to use it. It is easy to use OS. It also boasts of an excellent device driver support. Even though Microsoft has taken significant strides in improving its stability and security compared to early versions, lingering doubts about these issues still remain in users' mind. Being the early used OS on PCs has also made it the most popular target of attacks by crackers (highly skilled programmers with malicious intention). Microsoft Windows

also needs more hardware resources and higher-end configurations to run decently. As people run a mix of software from so many different sources on Microsoft Windows systems, the overall experience is somewhat varied and when there is a problem, it becomes difficult to pinpoint the exact source of the trouble.

Apple OS X

Apple OS X is also a proprietary operating system. It comes bundled with the machine manufactured by Apple and neither work without the other. The system is known for its high quality hardware and visual appeal and what ardent Apple fans believe to be *the best* user experience. The entire hardware, operating system and software environment is tightly controlled by Apple to provide a highly consistent and reliable user experience. Though the systems were considered quite secure earlier, a recent outbreak of malware has shown that it, too, is not immune from attacks. The major advantage of the system is its consistent, high-quality user experience. Against that, the user is confined to a narrow world controlled by Apple and third party application support is limited. Also, the product comes at a high premium.

Linux

Linux, just like its predecessor Unix, is known for its high performance, security, reliability and portability. No matter how old or low-end the hardware is, one can find a Linux distribution that would run on it. It is quite stable on most PC configurations. It combines the high-power CLI that has traditionally been Unix's strength with an impressive GUI that makes it almost as user-friendly as the other two OSs. Linux has a particularly strong presence in the Netbook (small notebook computer used primarily to access the Internet) category. Upgrades are as free as the base OS and it is just a matter of user's convenience when they want to upgrade their systems. Linux provide a number of choices for the CLI as well as GUI. The most common GUIs are KDE, GNOME and Unity. The newest versions of the GUIs provide a strong competition to the other two OSs as far as visual attractiveness is concerned, though they, too, require a bit higher configuration.

A major advantage of Linux is that not only is it free; it also provides us complete freedom in running the operating system. Linux provides excellent interoperability with Microsoft Windows and you can access the Windows partitions on your computer and the organization's Microsoft Windows servers as easily as from Windows. The office suite on Linux – openofficee.org or Libre Office provides good interoperability with the Microsoft Office suite. In essence, Linux meets all the basic needs of an average computer user and, once you settle down, can be as comfortable to use as it can get. And all this is yours, 100% free and 100% legal.

Introduction to Ubuntu Linux

Ubuntu Linux is a Linux distribution created by the UK based company Canonical Ltd., established by the South African entrepreneur Mark Shuttleworth. It is in turn based on the Debian GNU/Linux distribution. Ubuntu is an ancient African word meaning 'humanity to others'. It is a philosophy that emphasizes putting common goals and the community above individual interests and believes in helping

one another. As the open source software community also has similar philosophy, Ubuntu was chosen as the name of the distribution. Ubuntu is free and open source software. Canonical expects to earn money by providing paid support services. While Canonical is the main sponsor, Ubuntu is also supported by the Ubuntu Foundation and large developer and user communities. Ubuntu focuses on usability, security and stability. Its focus on usability (ease of use) and good device support has allowed it to gain and retain a place among the top Linux distributions. Figure 6.2 shows the Ubuntu logo.

Figure 6.2 : Ubuntu Linux Logo

Ubuntu Versions

Ubuntu has a fixed release cycle, with a new version being released in the April and October months of each year. The release numbers are denoted by two-digit year, followed by a dot, followed by two-digit month. Thus, Ubuntu 10.04 LTS was released in April 2010. The releases also have two-word names, with the first word being an adjective and the second the name of an animal. For example, Ubuntu 10.04 LTS was called Lucid Lynx, while Ubuntu 12.04 LTS is called Precise Pangolin. People often use only the first word to identify the release. The first words are chosen in alphabetic order, so one can know which version is newer just by looking at the first letter of the name. Each desktop edition release is officially supported for 18 months. Every two years, a Long Term Support (LTS) version is released. Earlier, the LTS versions for the desktop edition were supported for 3 years, but starting with Ubuntu 12.04 LTS, they are supported for 5 years.

The key strengths of Ubuntu are usability, good device support, support of large user and developer communities. It has been adopted by many manufacturers as well as some large organizations.

Basic Concepts of Ubuntu Linux

To use Ubuntu on a regular basis, one needs to install Ubuntu. Usually, installing a new operating system requires that a separate partition on the disk be made available for exclusive use by that OS. The installation procedure involves formatting the partition and creating a new file system on it. If we have a spare partition or want to use Ubuntu as our only OS, then we may install Ubuntu in a partition in this manner. However, sometimes users who already have Microsoft Windows OS on their computer do not have a spare partition or do not want to disturb their existing operating system setup. While it is certainly possible to have a multi-boot set up where the hard disk has different operating systems on different partitions and the user gets to select which OS they want to start at boot time, having such a set up requires some technical skills.

Ubuntu makes it very easy to install Linux on a Windows machine by providing a special installer called Wubi (Windows-based Ubuntu Installer). Wubi does not require a separate partition for Ubuntu and installs Ubuntu right inside the Windows partition by reserving a certain amount of disk space for it. Hence one may install and uninstall Ubuntu with minimum changes to one's Windows installation.

This is extremely convenient and useful for those Windows users who are not yet ready to take the plunge into Ubuntu. Ubuntu can also be installed to a USB flash disk (pen drive) or external hard disk and run straight from them, if the computer supports booting from USB (all newer computers do). In large organizations with a dedicated IT team, it is also possible to boot Ubuntu from the network without installing it on the local machine.

Figure 6.3 : Ubuntu Splash Screen

If we have a multi-boot configuration, the boot manager may display a choice of operating systems. Once we select Ubuntu, Ubuntu starts its own boot loader. It is also possible to have multiple Linux versions as well as other non-Linux operating systems on a single computer. Hence, depending on the configuration, Ubuntu may display a list of choices to allow us to select the OS or the Linux kernel version we want to boot to. After that, it displays a splash screen as shown in figure 6.3 while doing various startup activities.

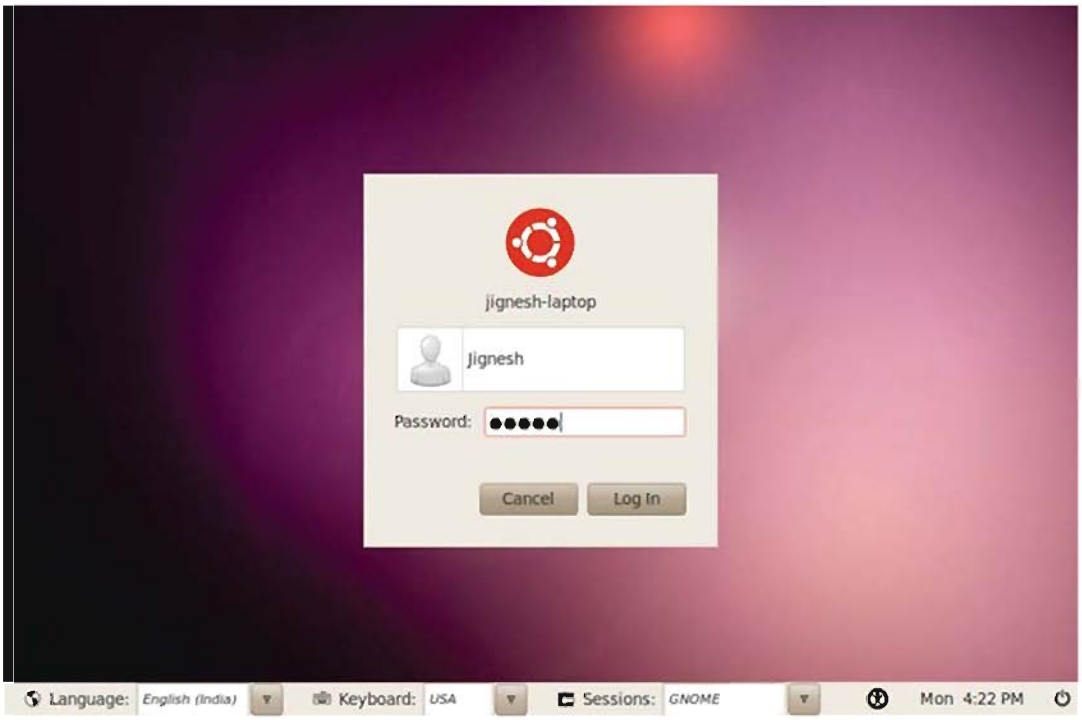


Figure 6.4 : Ubuntu Login Screen

Once the OS is fully loaded and ready to use, it may present us with a login screen as shown in figure 6.4. As Linux supports multiple users and implements security to ensure that one user cannot disturb the other user, this authentication (verifying who you are) becomes necessary. You will be accepted as a particular user only if you provide the correct password for the username selected by you. If you are the only user of the system, you may setup automatic login (without asking for the password).

You may also select here your language and the desktop (shell) you want to use because Linux supports multiple languages and desktops. If you are physically challenged in some way (like you cannot see or have difficulty in typing or using the mouse), you may select assistive technologies like a high-contrast screen for those with limited vision or a screen reader (a software that speaks aloud the text on the screen) for those who cannot see at all. Once you login to the system successfully, you will be greeted with the desktop similar to the one shown in figure 6.5.

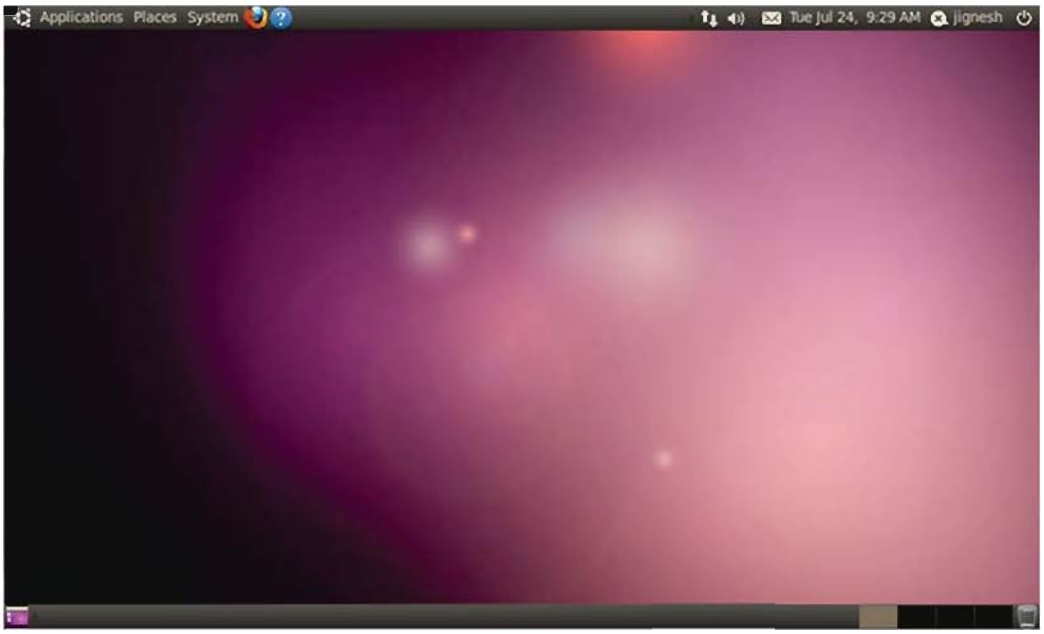


Figure 6.5 : Ubuntu 10.04 Desktop

Please note that the screens shown in the figures pertain to the Ubuntu 10.04 LTS version. Screens for other versions may look somewhat different. The first skills to be learnt for using any operating system are how to start the operating system and how to shut it down properly. Following the "proper" shutdown procedure is important, because if we just switch off the computer or if it shuts down unexpectedly because of a sudden power failure, the file system may get damaged or we may lose even the data we had saved. As hard disks are much slower than main memory, often, when we (or programs) write data to disk; operating systems actually write the data to main memory. At a convenient later stage, the data is written to the disk. This is known as caching or buffering and is done to improve performance.

When we shut down the operating system properly, all running programs are terminated and any unsaved data still in main memory are written back to the disk before turning off the computer (the latter process is known as flushing). But if we abruptly switch off the computer, such data

may get lost because, unlike the hard disk, main memory is volatile and loses its contents when the supply of power to it is stopped. With Ubuntu, clicking on the icon in the upper right corner brings up a menu of choices that includes the "shutdown" option. After selecting this option, we should wait until Ubuntu finishes its shut down process before switching off power.

On a modern computer, it is also possible to configure the power button, such that when we press it the shutdown procedure is automatically initiated. The computer turns off the power when the procedure finishes. It is also possible to put the computer into a "sleep mode" or "hibernate" mode. These modes preserve the currently running applications (programs) and unsaved file data and either put the computer to a very low power usage state or shut it down completely. When you restart the computer, its state is restored, including the currently running programs and open windows exactly as you left them; as if you never put the computer to sleep or hibernate mode. This saves power when you plan to take a break from your work. This feature is especially useful for laptop computers. Usually, closing the lid of the laptop computer while the OS is still running automatically causes a switch to sleep mode.

Sometimes, you want to move away from your computer for a short period but do not want to turn it off or put it to sleep mode, because you expect to come back soon. In these cases you should "lock" your computer so that no one else can use it in your name (because you are currently logged in). This option is also available along with the shutdown option. You may also use the shortcut key CTRL+ALT+L to lock your computer quickly. While the computer is in a locked state, others cannot work on it, but may leave a message for you on the computer. When you come back, you have to enter your password to unlock the computer and resume work. If you do not operate the keyboard and mouse for a certain period of time, then also the computer automatically gets locked.

Sometimes a user may want to handover the system to another user for some time without logging out, because they do not want to close the programs. In such a case the "switch user" option is selected. This option locks the current user's session (but does not close the session or terminate the programs) and displays the login screen to permit another user to login too. We may switch to another user's session by selecting the switch user option and providing password of that user. On switching back, the user returns to exactly the same screen. This allows multiple users to work alternately on the system.

Accessing data on Ubuntu

A computer system may have many storage devices in it. Also, removable devices may be inserted or attached and removed at any time. Each device has its own file system on it. A device that can have multiple partitions, like the hard disk, has a separate file system on each partition. How does one access these file systems ? Operating systems like Microsoft Windows assign a separate drive letter (like C:, D:, E:, etc.) to each file system. However, Linux and other Unix-like systems have a single file system tree starting with the root directory, denoted by / (the slash character). The file system contained on the partition from which Ubuntu boots is called the root file system. The root directory of this file system becomes / - the root of the entire file system tree. Initially this is the only file system available.

We may access any other file system by mounting it on any existing directory (this directory is called the mount point). Once mounted, the contents of that file system appear as the contents of the mount point directory. If the mount point previously contained some contents (files and subdirectories), they are masked (hidden) for the duration of the mount. Now we may access (and modify) the contents of that file system from the mount point directory. When we no longer need to use the file system, we may unmount it. At this point, the original contents of the mount point directory get unmasked (become visible again). This process is depicted in figures 6.6, 6.7, 6.8 and 6.9.

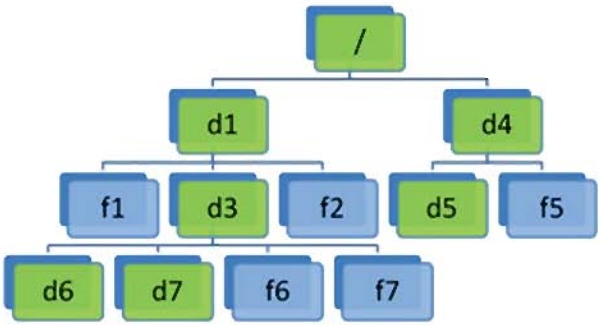


Figure 6 6 : Root File System

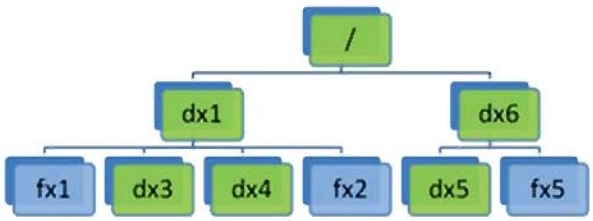


Figure 6.7 : File System on Another Device

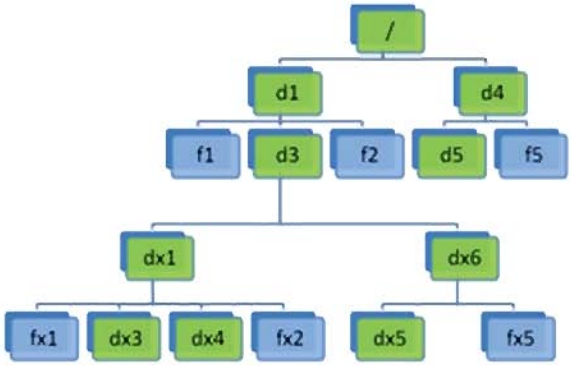


Figure 6 8: After mounting 2nd file system on d3

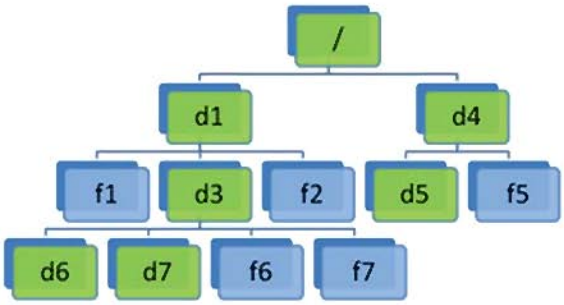


Figure 6. 9: After unmounting the file system

Figure 6.6 shows the root file system. Figure 6.7 shows the file system on another device. Figure 6.8 shows the situation after mounting the file system of figure 6.7 onto the directory d3 of Figure 6.6. The original contents of d3 are now masked and the contents of the file system mounted there appear as if they are the contents of d3. Figure 6.9 shows the situation after unmounting the second file system. The original contents of the directory d3 now become visible again.

However, the common practice is to mount file systems onto empty directories. In the default configuration, Ubuntu automatically detects other fixed devices in the system and shows them in the 'Places menu' and the left pane of the file browser. They are mounted when we first try to access them. The file browser shows a triangular icon ⏏ alongside all mounted file systems other than the root file system (see figure 6.10).

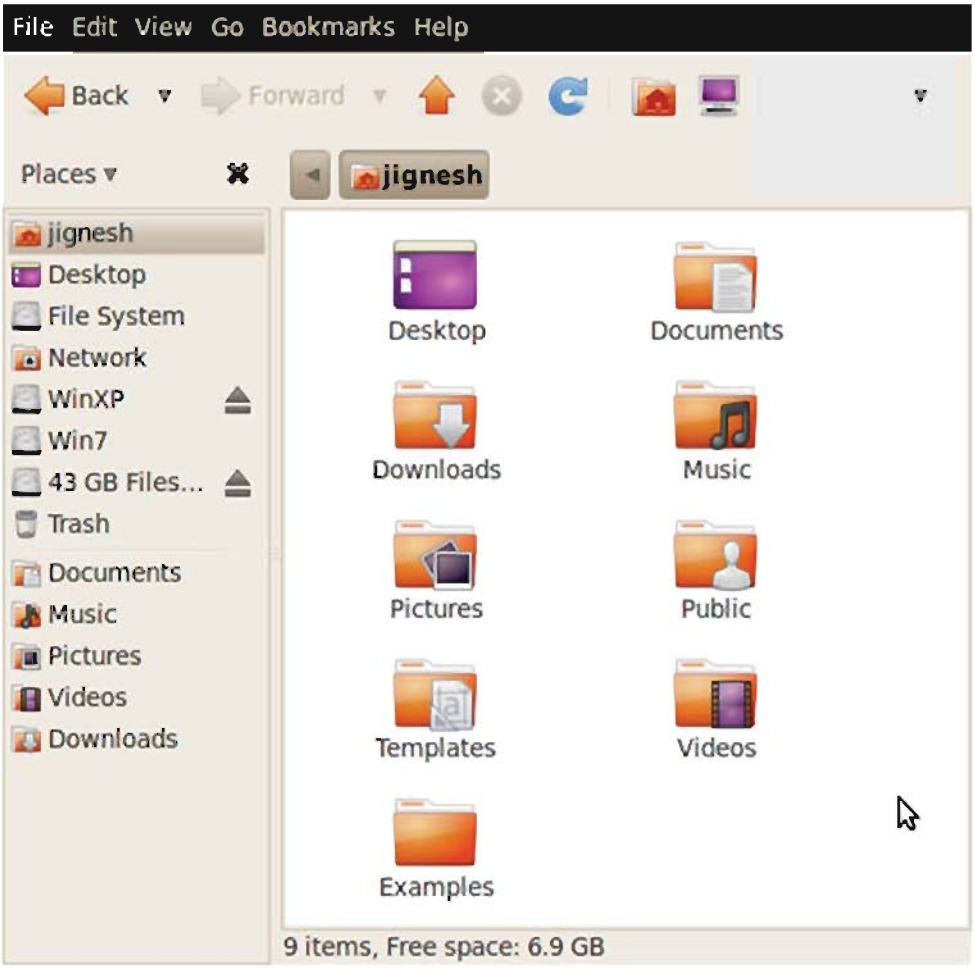


Figure 6.10 : GUI for Viewing File System

The file system can be unmounted by clicking on this icon. It may be mounted again when the user tries to access it again next time. The root file system cannot be unmounted. Removable devices are automatically mounted when they are inserted. Read-only media like optical disks can be unmounted by simply removing or ejecting them. Media on which writing is possible (like USB flash disks) must be unmounted by clicking the unmount icon in the file browser or by right clicking its icon on the desktop and selecting "safely remove device" option. This causes any data cached in main memory for improved performance to be flushed to the disk. A message at the end of this process announces that it is now safe to remove the device and the unmount icon disappears from besides the device's entry in the file browser's left pane. Only after this the device can be safely detached from the system. Failure to observe this procedure may result in loss of data or damage to the file system on the removable media. While this method of accessing the other storage devices in the system may sound unnecessarily complicated, it is more flexible and powerful and has several distinct advantages.

Of course, all these procedures can also be carried out using commands. It is also possible to configure the system to mount some file systems at particular mount points automatically every time the system boots. By default, the system mounts other fixed and removable devices in the system in directories under the /media directory.

X Windows System

Linux, like other Unix systems, uses the X Windows system for graphics. This system provides the basic graphics capabilities in a device independent way. It has two components. The X server provides graphical display facility as well as input facilities through keyboard, mouse, touch screen and other input media. The X client is any program that uses the capabilities of the X server for graphics. The client and server communicate through the networking system (even when both are on the same system). As a result, the X Windows environment is very flexible. Any client running on any computer can connect to any server running on any computer. This makes it very easy to provide the facility of accessing systems remotely, running graphical sessions on remote computers and even taking control of remote systems.

The X Windows system only provides the primitive graphics capabilities. The user interface elements like windows, buttons, menus, lists, text input boxes, panels, etc. are typically provided by a window manager component that uses the basic facilities provided by the X Windows system. Finally, a desktop manager (or simply desktop) built on top of the window manager acts as the graphical shell for the operating system.

Unlike most other operating systems, Linux provides us with multiple virtual screens to work with. In fact, we have access to 12 different virtual screens altogether. These can be accessed by pressing the shortcut keys CTRL+ALT+F1, CTRL+ALT+F2, CTRL+ALT+F3, etc. The first six of these screens are text mode screens, while the next six screens are graphics mode screens. By default, the login process is started on the first 6 text mode screens, so we may start working by providing out username and password. The default graphical session starts on the seventh screen. While no sessions are started by default on the other graphical screens, we are free to start graphical sessions on them. All text as well as graphical mode sessions are independent of one another – it is like having 12 computers in one!

Components of GUI Window

With most other operating systems, we are limited to using only one full screen window at a time. Thus, if your work calls for using multiple large windows at a time, you are forced to constantly juggle between the windows or to resize them to smaller sizes so as to be able to see multiple windows on the screen at a time. On the other hand, if you need to open a large number of windows, arranging these windows and switching between these windows becomes very tedious. Linux does not suffer from this problem. Apart from having multiple graphical screens, even a single graphical screen can have any number of workspaces. Each workspace is like a logical monitor on which to display our windows. Thus, we can have multiple full screen windows open in different workspaces at a time. If we open many windows, we may also group our windows according to type or use in different workspaces so that all the windows do not clutter a single workspace. Figure 6.11 shows various components of Ubuntu Window.

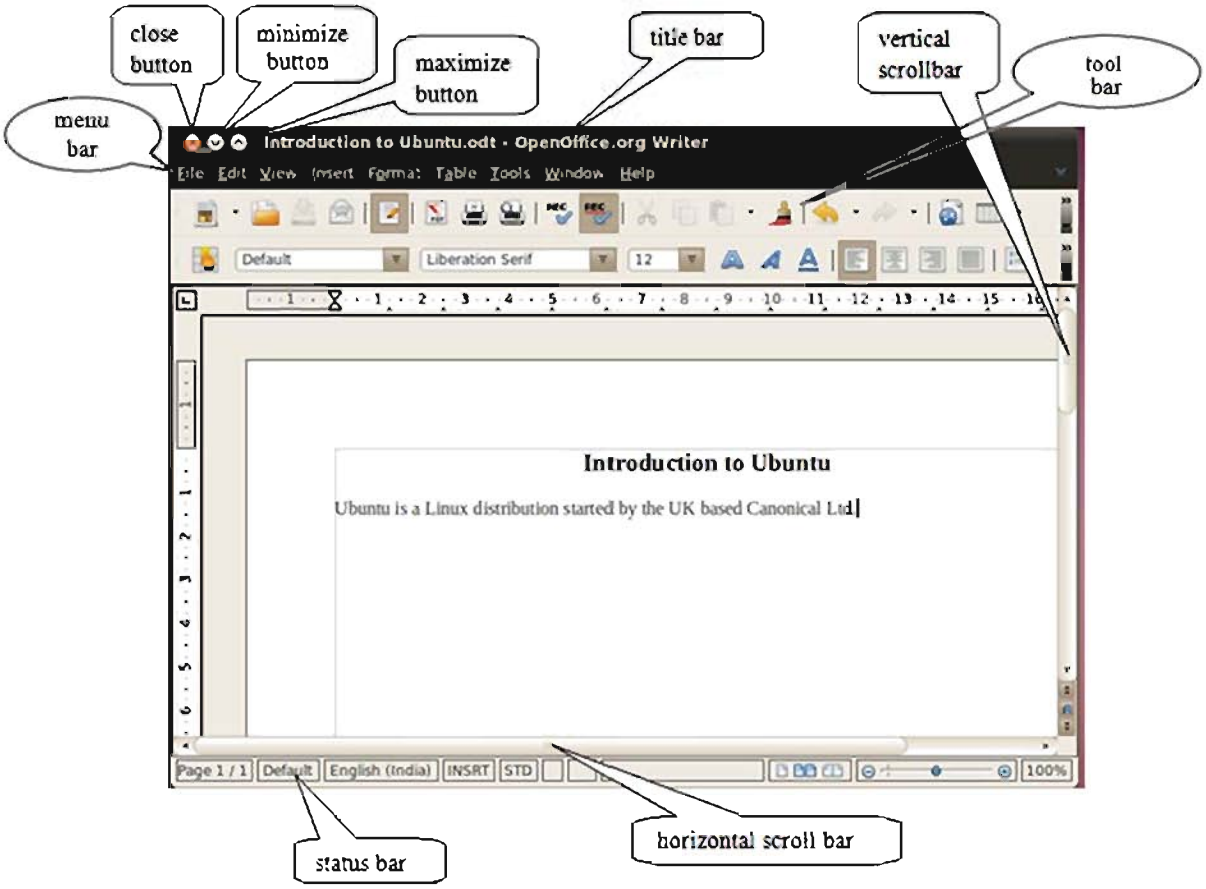


Figure 6.11 : Components of Ubuntu Window

A window on the screen usually represents a running program, though it is possible to have running programs with no associated window as well as a single running program that has opened multiple windows. A window has a title bar at the top that contains its title and some buttons. It usually has borders. A window may also have a status bar at the bottom for displaying status messages. If the contents in the window are wide and cannot be displayed entirely in the current width of the window, it automatically acquires a horizontal scrollbar at the bottom for moving the content horizontally. Some laptops provide a horizontal scroll region on the trackpad to operate the horizontal scroll bar. Similarly, if the contents of the window are too long to be displayed entirely in the current height of the window, it automatically acquires a vertical scroll bar on the right side that can be used to move the contents up or down. When the scroll wheel on the mouse is rotated, it operates this scroll bar. The vertical scroll region on the trackpad of a laptop also operates this scroll bar.

Unix-like systems, including Linux, expect a three-button mouse, i.e. a mouse having a left mouse button, a right mouse button and a middle mouse button. Some mice do actually have three buttons, while many others allow us to press the scroll wheel as if it were the middle mouse button. If your mouse does not have either of these options, or if you use a laptop that generally does

not have a middle button or scroll wheel, you may simulate the middle-click by pressing both the left and the right buttons at the same time. While in most cases where Linux does not detect a three-button mouse it automatically enables this three-button mouse simulation, in some specific cases we may have to enable it. The middle-click has several uses in the Linux environment.

Some windows are not resizable, i.e. their size cannot be changed. Most windows, however, can be resized. One may move the mouse pointer to any border or corner of the window, press the left mouse button, when the shape of the mouse pointer changes, drag the mouse pointer (i.e. move the mouse while keeping the button pressed) to change the size of the window. Similarly, windows can be moved around on the screen by pressing the mouse button on the title bar, and dragging the window when the mouse pointer changes shape.

Although Linux supports the use of multiple monitors with a single system, most people have a single display. And most of the times users tend to open multiple windows. This calls for effective management of the screen space by optimal positioning of windows and switching between windows when needed. In Ubuntu, a window can be minimized (a state in which it occupies no space on the desktop), restored (its size changes to the size it had before the last minimize or maximize operation), maximized horizontally (it occupies the full width of the desktop, while its height remains same), maximized vertically (it occupies the full height of the desktop, while its width remains same) or maximized in both the direction, in which case it occupies the entire desktop region. All these options are available in the system menu. Three buttons are also provided for this purpose, a minimize button, a maximize/restore button (if the window is not maximized in both the directions, it maximizes it, otherwise it restores it to its previous size) and a close button that terminates the corresponding program. These buttons are the three rightmost buttons in the title bar of the window (in later versions, they have been repositioned to the leftmost position for faster access, but it is possible to change the arrangement). It is also possible to perform the operations mentioned using system menu. Figure 6.12 shows the system menu.

Figure 6.12 : System Menu

One can minimize all open windows (and hence show the desktop) by pressing SUPER+D (the key on the newer keyboards with the Windows logo on it is known as the Super key in Linux) and the windows can later be restored by pressing SUPER+D again. If your keyboard does not have the super key, you may try CTRL+ALT+D. Linux also allows us to view and modify these shortcut keys.

Ubuntu versions up to and including 10.10 used the GNOME2 desktop by default. Subsequent versions use the newer Unity desktop by default. We may switch to a particular program by clicking its representation in the lower panel (GNOME2 interface). Alternatively, we may press ALT+TAB, which displays smaller versions of all open windows. Keep pressing TAB without releasing ALT until the program that you want to switch to is highlighted, then release the ALT key.

If we have a machine with better hardware and graphics capability, It is possible to get very attractive 2D and 3D effects when performing these windows related operations by using the Compiz window manager and enabling the extra effects.

Linux Terminal

While working with the GUI, often we feel the need to use the CLI to type some command or to run some scripts. Of course, we have six text mode screens at our disposal, but they are plain. We can also get the CLI in the graphical mode using a program known as xterm. xterm (also known simply as Terminal) is a graphical emulator of the text mode terminal. It provides several enhancements over the standard text mode screen like multicolour display (many text mode terminals also have this facility), the ability to select the default foreground and background colours, font style, font size, etc. It also allows us to select and copy text in any program (not just terminal) and paste it in a terminal. So if we find some complex command on a web page or in a manual, we may simply copy it and paste it in our terminal – we don't have to go for tedious and error prone retyping. We may also have two terminal windows side-by-side on the screen for comparison, copy-paste, etc. While working in one terminal, if we forget some option of a command, we may open another terminal to look up that command in the online manual. The terminal also allows us to use the mouse in a limited way. Figure 6.13 shows a terminal window.

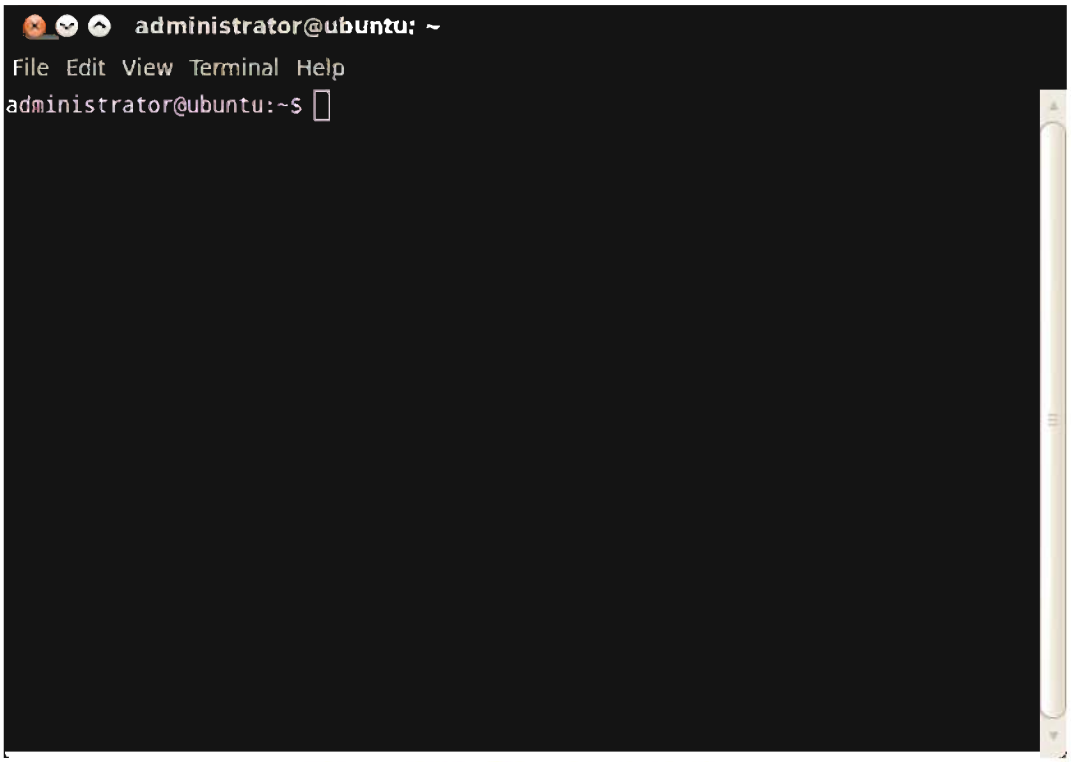


Figure 6.13 : Terminal Window

Home Directory

Every interactive user in Ubuntu is expected to have a home directory, typically a directory with the same name as the username inside the /home directory. A user has full rights to perform any operation on any file or directory inside one's home directory. Also, one user's home directory is generally not accessible to another user. A user is expected to store all one's work in one's home directory. The user's home directory is also used to store the user's personal preferences and configuration choices that apply only to that user and not to the whole system. The GUI in figure 6.10 shows a look of typical home directory.

User Types in Ubuntu

As Linux is a security conscious operating system, different users are given the privileges (rights) to perform different operations. Users can perform only those operations that they are authorized to perform. While each user can potentially have different privileges, there are three broad categories of users as follows :

- **The Super User :** Every Linux system has a super user, traditionally called root, who has all the privileges and can do anything and everything in the system. However, logging in and working as the super user is extremely risky, because in that case you have the potential to accidently cause serious damage to the system. For example, you may permanently delete some important file or directory by mistake, and the whole system may become unusable. Because of such dangers associated with super user login, the super user account is locked by default on modern Linux systems (i.e., no one is allowed to login as superuser).
- **The Normal Users :** The second type of users is normal users. These users can run common software and have modification rights only to their home directory. They may personalize or customize certain aspects of the system, but these configuration settings will be stored in their home directories and will only apply to them, not to other users or the whole system. They cannot see other user's home directories or interfere with their work. They also cannot install any software at the global (system) level.
- **The Administrative Users :** The third category of users is administrative users. To prevent unintentional damage, these users also start out as normal users only. However, when they have to perform some administrative operation in the CLI, they execute the program with either of the commands sudo (for text mode commands) or gksudo (for graphical mode commands).These commands, when run for the first time, prompt the user for their password as an additional security measure and remember the same for about 15 minutes, after which they prompt again for the password. Then they check whether the user is indeed an administrator user or not. If the user is indeed an administrator user, the indicated program is run with superuser privileges; otherwise an error message is displayed. In essence, even an administrator user remains an ordinary user

except for those commands that are run with sudo or gksudo. Both successful and unsuccessful attempts to run sudo or gksudo are logged in a log file that the administrator can examine to know who tried or did what. Graphical administrative programs directly started from the GUI also prompt for the password and check for authorization to perform the operation in a similar way.

The ordinary or normal users do not have the permission to run sudo or gksudo. These users can only run regular applications. They cannot perform any system administration task.

Getting Help

Learning new software often requires some help. Ubuntu comes bundled with some basic documentation accessible from the GUI. For most of the command in the CLI mode, it provides online manuals accessible straight from the CLI. Apart from this, extensive support is available on the Web. Though the support provided by Canonical's support team is commercial, and their chief source of income; they do have substantial online documentation. The Ubuntu user community also contributes to help others. Some examples of official Ubuntu or community support sites are mentioned below:

- https://help.ubuntu.com
- http://www.ubuntu.com/support/community
- http://ubuntuforums.org
- http://askubuntu.com

Apart from these, a large number of discussion forums, web sites and blog sites provide comments, discussions, suggestions, solutions to problems, tutorials, introductory as well as reference material, etc. For most problems a search engine and a little patience can find the solution for us. If we post our problem in the right forum in an appropriate way, chances of some kind-hearted and knowledgeable person helping us out are high.

While continuing to strengthen its position in the segments where it is also present, Ubuntu is also planning to chart new territories. Recently Mark Shuttleworth announced that Ubuntu 14.04 will also run on (Internet) TVs, smartphones and tablets. Already Ubuntu TV and Ubuntu for Android (a smartphone Operating System) are in trial stage.

Summary

In this chapter we discussed how the Unix and Linux operating systems evolved and their key features. How the battle of proprietary software v/s free software is shaping the computing landscape. What does free software mean, how does free software work and why even commercial entities are interested in free software. We saw how to run Ubuntu Linux and some basic working of Ubuntu Linux.

EXERCISE

1. Where was the Unix operating system developed ?
2. List the innovative ideas popularized by Unix.
3. What are the four fundamental freedoms in Richard Stallman's vision for free software ?
4. Write the advantages of the Linux operating system.
5. Why is it important to shutdown one's computer properly ?
6. Explain locking and unlocking of the computer.
7. Explain the use of the "switch user" option.
8. How can one move a window on the screen ?
9. How can one resize a window ?
10. Explain the minimizing, maximizing and restoring of windows.
11. Explain the three major types of users in Linux with their powers and typical working.
12. **Choose the most appropriate option from those given below :**

(1) The Unix system was developed at –

(a) AT&T, Bell Laboratories (b) Finland

(c) MIT (d) Free Software Foundation

(2) What was the full form of Multics ?

(a) Multiple User Information and Computing System

(b) Multiple User Information and Computing Service

(c) Multiplexed Information and Computing System

(d) Multiplexed Information and Computing Service

(3) Which game was instrumental in the development of Unix ?

(a) Space Wars (b) Space Travel

(c) Time Travel (d) War of the Worlds

(4) What was the original name of Unix ?

(a) Unics (b) Uniks

(c) Uniques (d) It was Unix from the beginning

(5) Who started the Free Software Foundation ?

(a) Ken Thompson (b) Richard Stallman

(c) Dennis Ritchie (d) Linus Torvalds

(6) Which of the following is not a freedom sought by the Free Software Foundation ?

(a) The freedom to delete the program

(b) The freedom to study the program

(c) The freedom to redistribute the program

(d) The freedom to modify the program

(7) What is the full form of GNU ?

(a) Great New Unix (b) Good New Unix

(c) GNU is New Unix (d) GNU is Not Unix

(8) Who developed the Linux kernel ?

(a) Linus Torvalds (b) Richard Stallman

(c) Ken Thompson (d) Denis Ritchie

(9) What is the full form of Linux ?

(a) Linux is New Unix (b) Linus's New Unix

(c) Linux is Not Unix (d) Linux is Next Unix

(10) Which of the following is not a major operating system family for the PC ?

(a) Microsoft Windows (b) OS X

(c) Apache (d) Linux

(11) On which Linux distribution is Ubuntu Linux based ?

(a) Debian GNU/Linux (b) Fedora Linux

(c) Red Hat Linux (d) Linux Mint

(12) What is the Windows-based Ubuntu installer called ?

(a) Wubu (b) Wibu

(c) Winubu (d) Wubi

(13) In Ubuntu, additional storage devices are accessed by -

(a) mounting them on an existing directory

(b) drive letters like D:, E:, F:, etc.

(c) mounting them on a non-existent directory

(d) booting the system from that device

(14) In Linux, the key with the Windows logo on it is known as -

(a) SUPER key (b) WINDOWS key

(c) SHORTCUT key (d) SPECIAL key

(15) Which key is used to switch between open windows ?

(a) CTRL+SPACE (b) ALT+SPACE

(c) ALT+TAB (d) ALT+TAB

(16) The graphical emulator of the text mode terminal is known as -

(a) gterm (b) gedit

(c) xterm (d) virtual terminal

LABORATORY EXERCISE

Perform the following operations under Ubuntu and note down the steps used to perform them :

1. Learn to startup and shut down the computer properly.
2. Learn how to login to the system, switch to another user while keeping your session open and how to come back to your session.
3. Learn to lock and unlock your computer.
4. Learn to switch between and operate different virtual screens (text mode and graphical).
5. Draw a figure of a typical program window and marks its various components.
6. Learn to perform the operations of minimize, maximize horizontally, maximize vertically, maximize and restore actions on a window and note down their effects on the window.
7. Start multiple programs and practice switching between them using the keyboard and the mouse.

Introducation to Ubuntu Linux GUI

We have already learnt that Operating System allows user to use two modes of interaction command line interface and graphical user interface. In this chapter we will introduce you to the GNOME2 desktop and its different panels. We will also see how to customize the appearance of the GNOME desktop.

GNOME2 Desktop

Open source software is all about freedom and choices. Linux is no exception. It provides multiple choices for most components of the operating system. The desktop manager or simply the desktop is no exception. Linux provides several desktop managers, including GNOME, KDE, Unity, Xfce, LXDE, and many more. While the first three desktops require more powerful systems with better graphics capability, the last two desktops are light-weight and can run even on quite low-end machines. GNOME2 (GNOME version 2) was the default desktop for Ubuntu Linux until Ubuntu 10.10. Ubuntu 11.04 onwards use the Unity desktop. You can install different desktops as per your choice but GNOME2 provides a very good desktop environment for personal computer users.

When the GNOME2 desktop starts, we get a screen as shown in figure 7.1. There are three major components of the screen – the top panel (a horizontal bar at the top of the screen), the bottom panel (a horizontal bar at the bottom of the screen) and the desktop (the part of the screen between these panels). In general, left-clicking an item selects it. Active items in the panels (like menus, indicators and application launchers) execute the corresponding action on single-click, while desktop shortcuts and executable program files in the Nautilus file browser get executed only on double-click. Right-clicking on an item brings up a floating menu of options specific to that item. It is known as the context menu. Hovering over an item (keeping the mouse cursor over that item for a little longer period) often brings up a small window called "tool tip" explaining that item in brief.

The Top Panel

The top panel contains the menu bar with three menu items (Applications, Places and System), the application launchers, the notification area and some applets, including one for the system date and time, the "Me Menu" and the session menu. The desktop is initially empty, but the user can place frequently used files, folders and application launchers there for quick access. The bottom panel contains a "Show Desktop" icon, mini representations of applications that are running, the Desktop Switcher and the Trash icon. These elements are explained below.

The Applications Menu

This menu presents a category wise submenu of the applications installed in the system as shown in figure 7.2. One can run an application by selecting it from this menu hierarchy.

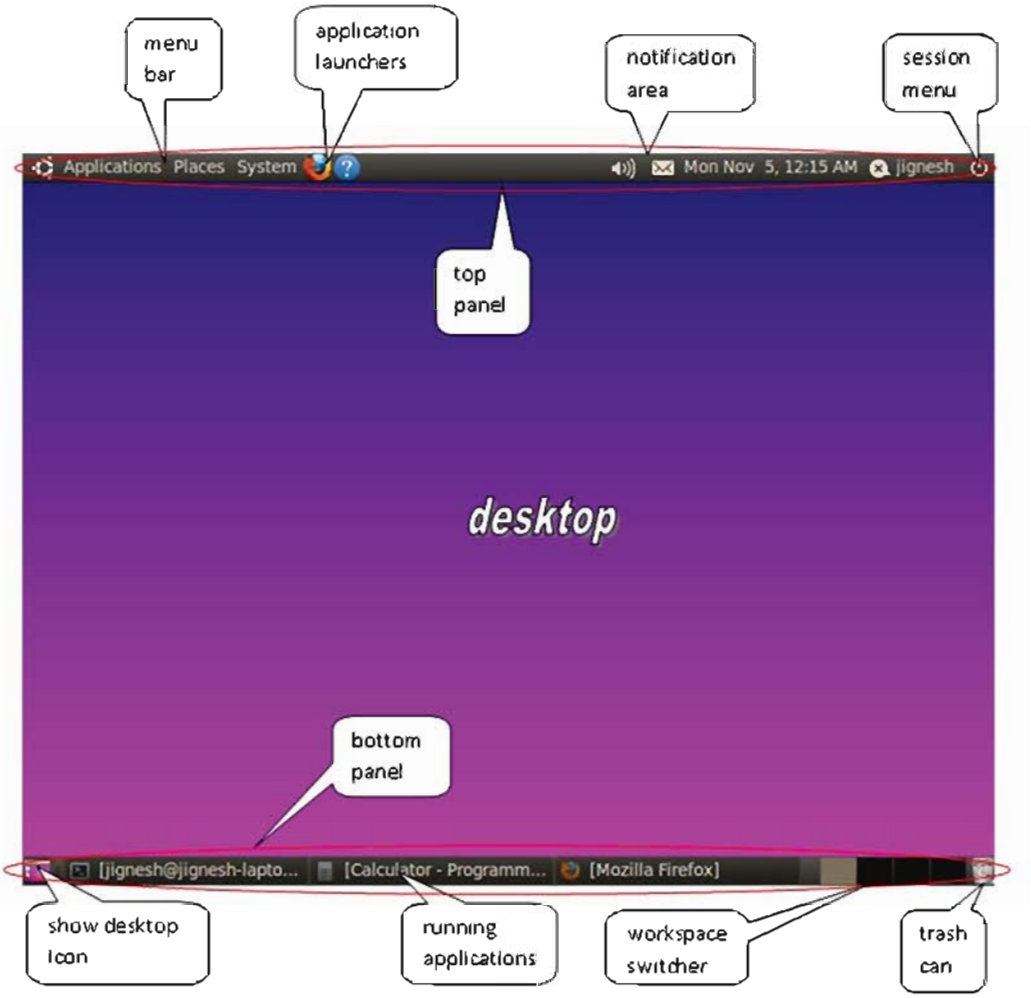


Figure 7.1 : GNOME2 Desktop

Figure 7.2 : Applications Menu

The categories and common preinstalled software are as mentioned :

- **Accessories :** Contains a calculator application for performing basic arithmetic as well as scientific calculations, CD/DVD Creator for writing to CD/DVD disks, Disk Usage Analyzer for analyzing the usage of disk space directory wise or file type wise, gedit text editor for creating and editing plain text files (without formatting), Manage Print Jobs to manage the jobs submitted for printing, Take Screenshot for capturing the current screen display in an image (picture) file, Terminal for using the CLI and Tomboy Notes for creating computer "notebooks" to note down your ideas and thoughts in an organized and searchable way.
- **Games :** Contains some computer games that you can play for relaxing.
- **Graphics :** Contains F-Spot Photo Manager for managing photographs taken using a digital camera or mobile phone camera, GIMP Image Editor for editing images (pictures), OpenOffice.org Draw for drawing and painting simple drawings and Simple Scan for scanning documents and pictures using a scanner.
- **Internet :** This category contains Empathy IM client for chatting with others on the Internet, Mozilla FireFox web browser for surfing the World Wide Web, Gwibber Social Client for social networking using sites like Facebook, Twitter and software to see and control another user's desktop screen from your machine and vice versa.
- **Office :** As the name suggests, this category gives access to the tools most commonly needed for office work. These include an online dictionary, an email client (Evolution) for accessing email and sharing your schedule (calendar) with your colleges, clients, etc., and the OpenOffice.org suit of free and open source office productivity applications that includes the Writer word processor, the Calc Spreadsheet program and the Impress presentation tool.
- **Sound and Video :** This category contains applications meant for entertainment. It also includes the Brasero Disk Burner for burning (writing) CD and DVD disks, Movie Player to play movies on the computer, Pitivi video editor for performing basic video editing tasks, Rhythmbox Music Player to play music and Sound Recorder to record your voice if you possess a microphone and, of course, a voice worth recording.
- **Ubuntu Software Center :** If you are not satisfied with the built-in applications provided, there are tens of thousands of applications (most of them free, but some paid as well) in the software repositories hosted and maintained by Canonical Ltd., its partners and affiliates, the Debian project (on which Ubuntu is based) and other communities and organizations. This option provides you access to host of application both for study and play.

The Places Menu

This menu as shown in figure 7.3, allows you to access various storage devices in your computer as well as on other connected computers.

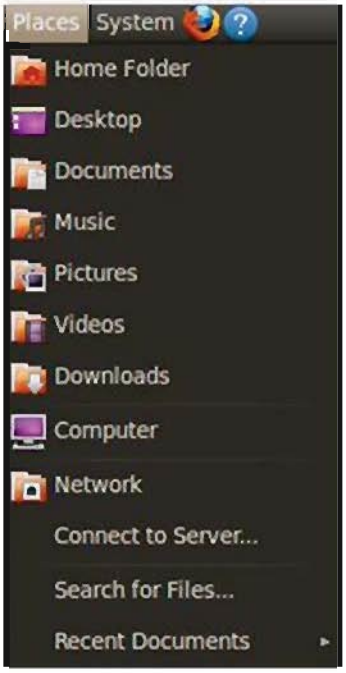


Figure 7.3 : Places Menu

The submenus of Places menu are as mentioned :

- **Home Folder :** Opens the currently logged-in user's home directory in the Nautilus file browser. This browser has been described in detail in the next chapter.
- **Desktop :** Opens the user's "Desktop" folder in the Nautilus file browser. This is a folder inside the user's home directory. Any file placed here is displayed on the user's desktop and any file placed graphically on the user's desktop lands up here.
- **Documents :** This is again a folder inside the user's home directory meant for storing the user's personal documents.
- **Music :** This folder inside the user's home directory can be used to store music files.
- **Pictures :** This folder inside the user's home directory can be used to store pictures.
- **Videos :** This folder inside the user's home directory can be used to store video files.
- **Downloads :** Files downloaded from the Internet are saved in this folder by default, if required this setting can be changed easily.
- **Computer :** Shows all the fixed and removable storage devices present in the computer.
- **Network :** Shows all the other computers (running Ubuntu or Windows operating system) on the same network. If sharing is enabled on some of these computers, one can easily copy and transfer files to and from those computers.
- **Connect to Server... :** This option can be used to connect to a variety of powerful "server" computers running any Unix-like or Windows operating system. Large organizations use server computers to provide common services to all computers on the network.

- **Search for Files... :** This option can be used to search for a file by their name when a user forgets in which directory the file was saved.
- **Recent Documents :** Shows a list of files opened recently. From here one can reopen a recently used file quickly without having to navigate the directory structure. This facility is also useful in cases where one forgets where one saved a recent file or when one has multiple versions of the same file in different directories and wants to open the latest version.
- **Bookmarks :** The places menu also displays the bookmarks you have created in Nautilus. If there are only few of them, they are displayed directly in the Places menu; otherwise they are clubbed together in a Bookmarks menu. These bookmarks let you open frequently accessed directories quickly.
- **Removable Devices and Discovered Partitions :** If any hard disk partition apart from the one containing the Linux root file system is discovered during the boot process, the same is listed in the Places menu. Opening the partition automatically mounts it. Similarly, any removable device (CD/DVD/flash disk/external disk) we insert is mounted automatically and displayed in the Places menu.

The System Menu

This menu, shown in figure 7.4, allows the user to customize one's Ubuntu installation and carry out system administration. This menu has two submenus, namely Preferences and Administration; it also has three other options.

Figure 7.4 : System Menu

Preferences Menu

The Preferences submenu as shown in figure 7.5, provides various ways of customizing our system. Some options of preferences menu are discussed herewith.

- **About Me :** allows the currently logged-in user to view and modify their profile (personal information).
- **Appearance :** allows the user to change the desktop background image (the picture displayed in the desktop area, also known as wallpaper), set the default font and font sizes for various categories and select a theme. Choosing and applying a theme applies a harmonious setting of desktop wallpaper, fonts, colors and appearances of different elements of windows, etc.

Apart from the built-in themes, more themes are available online. There is a tab for Visual Effects. here, three levels of visual effects are provided – none, normal and extra. The default is none. Depending on the graphics capability of your system, the other two options may or may not be permitted. Setting a higher level enables a wide range of 2D and 3D visual effects.

Figure 7.5 : Preferences Menu

- **Assistive Technologies :** provides special programs and settings to help physically challenged people use the computer.
- **Main Menu :** option allows us to decide which items appear in the menus and which items do not. Users with little more knowledge can also add or modify the menu items.
- **Monitors :** option can be used to set monitor options, particularly the display resolution – number of pixels in a row and the number of such rows.
- **Mouse Preferences :** option can be used to fine tune mouse settings.
- **Network Connections and Network Proxy :** options allow us to set network settings.
- **Power Management :** is used to set options that conserve power (and help save environment). These options cause the computer to turn off display or go into hibernate/sleep mode when not used for certain duration. You can also decide the action to be taken when a computer is running on battery backup (like a laptop computer running on battery or a desktop computer running on UPS) and the battery backup is critically low.
- **Preferred Applications :** lets you to choose your favorite applications for common Internet and multimedia tasks. Considering that there are many choices of applications for common tasks in Linux, this menu item allows you to specify your preferences.
- **Remote Desktop :** allows you to share your desktop with someone else. When you share your desktop with someone, both you and that user see your desktop on a continually updated basis. When anyone of you move the mouse or press a key, the effect will be seen by both. This facility has many uses like allowing a worker to work on office computer from home, allowing a technician to take control of a user's computer for troubleshooting and for solving problems and providing training through live demonstration of computer operation. Of course, appropriate security measures are present to prevent unauthorized access to your computer.

- **Screensaver :** is an application that springs into action when the user does not perform any action for certain duration. Generally it displays a constantly changing image on the screen. The original idea was to frequently change the display to prevent permanent damage to older monitors caused by the display of a bright pixel for an extended period of time. Even though modern monitors do not suffer from this problem, screensavers are still used for their visual appeal, to break the monotony and to draw the use's attention to the unused computer.
- **Sound :** allows the user to set volume level as well as other sound input/output related options.
- **Startup Applications :** controls which applications are automatically started when the computer starts. If you find that your computer takes too long to boot, you may check your startup applications and remove those that you can do without. But you need to be careful not to turn off some essential service.
- **Ubuntu One :** is Canonical's cloud (Internet) storage solution. It allows you to purchase music and store your files on Canonical's server computers. You may access them anywhere in the world from any Ubuntu computer, provided you have Internet connectivity.
- **Windows :** lets you set some basic options regarding the behavior of application windows. In particular, you may choose what action should be taken when you double-click the title bar of a window. The possibilities include maximizing the window, minimizing the window, maximizing the window vertically (so that it occupies the full screen height, but its width is not changed), maximizing the window horizontally (so that it occupies the full screen width, but its height is not changed), etc.

Administration Menu

The Administration submenu shown in figure 7.6 provides various tools for the control and management of the system. Important tools include disk utility (a graphical software that displays disks and disk partitions and allows the user to create, delete, edit and format disk partitions, mount and unmount file systems, etc.), Language Support (allows us to include support for various language, including Indian languages), Printing (to control print jobs), Software Sources (to set the repositories on the Internet from which to install software), Synaptic Package Manager (to install and uninstall software), Startup Disk Creator (to create a bootable flash disk/pen drive), Time and Date (to set the system date and time and time zone information), Update Manager (to get latest updated versions of the currently installed software) and Users and Groups (to manage the users and user groups on the computer).

Figure 7.6 : Administration Menu

- **Help and Support :** provides some basic documentation on how to start using Ubuntu.
- **About GNOME :** displays version and other information about the GNOME desktop in use.
- **About Ubuntu :** displays the Ubuntu version in use and some introductory material on it.

The Application Launchers

If you run some application frequently, you may find it tedious to navigate the hierarchical menu structure to reach and start the application every time. The part of the top panel between the menu and the notification area can be used to house application launchers for applications frequently used by you. These launchers are represented by small icons in the panel. Two launchers are already there by default – one for Mozilla Firefox web browser and another for Ubuntu's built-in help tool. There are two ways to add application launchers to the top panel. One is to locate the application in the Applications menu hierarchy, then right-clicking on it and selecting the option "Add this launcher to panel". Another way is to right-click in an empty area in the top panel, select the option "Add to panel…" and then select one of the predefined launchers from the list. The option "Application Launcher…" lets one select an application from the menu hierarchy, while the option "Custom Application Launcher" allows you to create your own launcher.

When you select the option "Custom Application Launcher", you get the dialog box shown in figure 7.7. There are three options for the type of the launcher – Application (a GUI application), Application in Terminal (a CLI application or a GUI application that needs to start initially in a terminal) and Location. To create a launcher for an application, you need to provide the executable program file corresponding to the application you want to run.

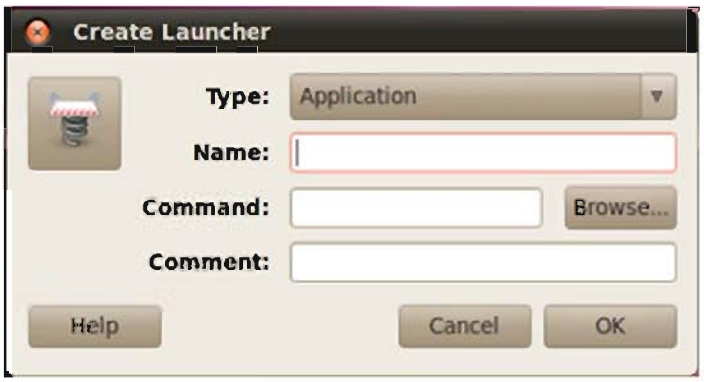


Figure 7.7 : Creating Custom Launcher

You may type it in the "Command" field or use the "Browse…" button to select the file. The browse button opens the standard file selection dialog box shown in figure 7.8, which can be operated in a manner analogous to using the Nautilus file browser described in the next chapter. To create a launcher for a location (a file) in the file system hierarchy, you select the file in the same way.

The "Name" and "Comment" fields are used to provide the name and description of for the launcher, with the latter being optional. The icon associated with the launcher can be changed by clicking

on the icon shown in the dialog box and selecting a new one. Most of the standard icons can be found in subdirectories of the directory /usr/share/icons. Alternatively, any small picture can be selected as the icon; we can even make our own icon using the GIMP image manipulation program discussed in the next chapter.

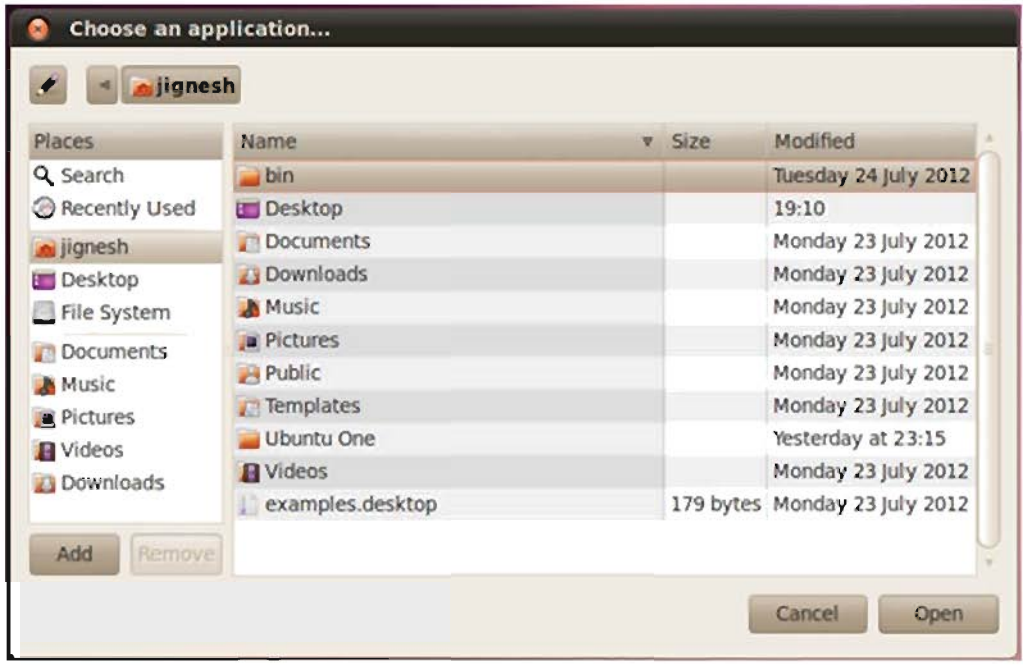


Figure 7.8 : File Selection Dialog Box

If you have populated your top panel with a large number of launchers, you may add one or more "separator" items available in the "Add to panel..." list to group and visually separate different sets of launchers. These items appear as vertical bars in the panel. The launchers can be easily rearranged using an operation known as "drag and drop". This maneuver is executed by positioning the mouse cursor on the item in question, pressing the left mouse button, then moving the mouse to the destination while keeping the left mouse button pressed and finally releasing the mouse button. To prevent accidental drag and drop of a launcher, a launcher can be "locked" to its position using the "Lock To Panel" option in the context menu that opens when you right-click the launcher. A checkmark besides the option text means the launcher is currently in the locked state. The launcher can be unlocked simply by opening and clicking on the same option again. "Remove From Panel" option available in the same context menu allows one to remove the launcher from the panel. Figure 7.9 shows the top panel after addition of some application launchers and separators.

Figure 7.9 : Left View of Top Panel with Some Application Launchers

Figure 7.10 shows the right side of the top panel containing the indicator applets, the "Me Menu" and the session menu.

Figure 7.10 : Right View of Top Panel

Both these views may differ on your computers depending upon the settings of your machine. Let us discuss the components on the right view of top panel.

The Notification Area : This area has several indicator applets (small applications) by default. The sound applet with the speaker icon allows you to control the sound level from the system's speakers and also lets you quickly mute and unmute sound.

The envelop icon next to it represents the Evolution Personal Information Management (PIM) tool. Evolution provides an email client that downloads and stores one's emails on the local system so that they can be accessed even when not connected to the Internet. Among other things, it also provides Internet Messaging (IM or chat) facility and a facility to manage your calendar (schedule of activities to be performed).

The next indicator is the date/time applet that displays the current date and time. Clicking on it opens a calendar for the current month as shown in figure 7.11.

Figure 7.11 : Calendar Applet

To see the day of the week from past or future, one may use the small triangles on the two sides of the month name and year name to change the month and year respectively. The map at the bottom indicates which parts of the planet are currently receiving day light and which ones are in the dark. Clicking for a second time on the date/time indicator closes the calendar.

The next applet shows the status of the network interface(s) in the computer and also allows one to connect or disconnect specific network interfaces (particularly useful for wireless networks). Selecting "Edit Connections…" from the context menu that opens when we right-click on the network indicator opens the same interface that is used to edit network connections from the preferences

menu. The icon of the network indicator itself indicates the current network state (not connected/ trying to connect/connected).

The "Me Menu": This menu, shown in figure 7.12, is identified by the currently logged in user's name. It is a quick access social networking and cloud access tool. The first few options (Available, Away, Busy, Invisible, and Offline) let you specify your status that will be shown to others on social networking platforms. Next two options allow you to set up access to your social networking accounts. Once these have been established, the indicator applet will notify you about new messages, chat requests, etc. that you receive on those sites. You can also send messages and chat requests.

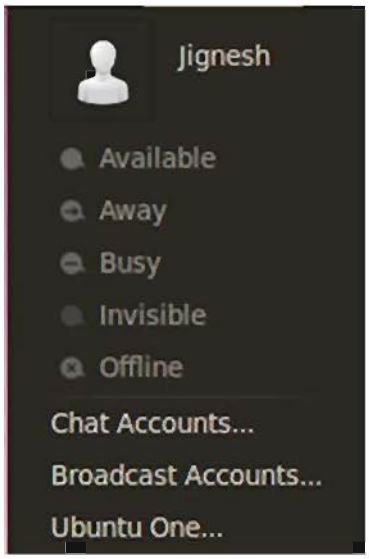


Figure 7.12 : Me Menu

The last option in the Me Menu allows you to register the computer that you use with Canonical's free cloud based service Ubuntu One. The meaning of "cloud based" here is that all the files and folders you store in Ubuntu One are actually stored on Ubuntu's server computers, not on your computer; and can be accessed over the Internet from any computer anywhere in the world. These can also be shared with others. One must have an account with the Ubuntu One service to use it. If you do not have one, creating a free account is a simple process.

Ubuntu also allows you to "sync" (synchronize) your contacts, browser bookmarks and files and folders on the local (current) computer with the same information stored on the server. The synchronization process automatically compares each and every item on the local computer with the corresponding item on the server computer and whenever it finds an item that has been added/modified/deleted more recently on one computer, it automatically applies the same operation to the other computer. At the end of the process, both the computers have identical and the latest record of the information. This way, if you synchronize from time to time, you always get the latest information irrespective of your geographical location and the current computer in use.

You may also synchronize one computer having a lot of data with the server, and then synchronize another fresh computer with the server. That would effectively transfer the data from one computer to another. Similarly, you may upload a file on the server from one computer and download and use the file on another computer anywhere in the world. This facility is a boon for people who have to travel a lot as there is no danger of forgetting to carry some important file with oneself. A lot of people keep a copy of their latest files on the cloud so that the same can be accessed from anywhere in the world or can be shared with others.

Ubuntu One also provides an online music store (currently not available in India) and the facility of instantly uploading and sharing photographs taken using an Android phone with friends and

relatives. Ubuntu One can be accessed from computers running Ubuntu, some other Linux/Unix operating systems and Microsoft Windows as well as Android and iOS mobile phones. The free account provides 5GB of storage. Additional storage, if needed, can be purchased. Advertisements and sale of storage space and music on this cloud service is one of the sources of revenue for Canonical.

The Session Menu

The rightmost item on the top panel is the session menu (see figure 7.13). This menu provides options for managing the user session. These include options to lock the system, log out of the system, switch to another user, put the system into sleep mode or hibernate mode and shut down the system. The "Guest Session" option opens a session meant for temporary or casual users. The guest user cannot make any permanent change to the system and all the changes made by the user in the temporary home directory (the concept of home directory is discussed in the previous chapter) created for them are lost when the session ends.

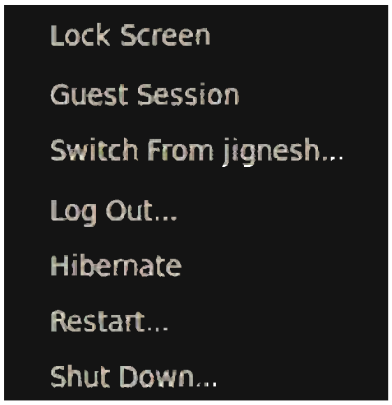


Figure 7.13 : Session Menu

The Bottom Panel

The bottom panel as shown figure 7.14 has the "Show Desktop" icon on the left side and the "Trash" icon on the right side. When the user clicks on the "Show Desktop" icon, all open windows are minimized, revealing the desktop. Clicking again on the same icon restores the windows to their previous state.

Figure 7.14 : Bottom Panel

The Trash Can (Trash) is provided for the user's safety. Any file or folder deleted by the user using the file browser is not deleted immediately; it is moved into the Trash Can. In case the user deletes some file or folder accidently or by mistake; the Trash folder provides an opportunity to bring the same back. At any time, the user may open the Trash by clicking its icon and see the deleted files and folders (see figure 7.15).

Right-clicking on any item in the Trash brings up a context menu that includes the options to open the item (to see what is there in it), cut or copy the item, copy or move the item to a selected directory, an option to delete the item permanently and a restore option that puts the item back in the directory from where it was deleted. There is also a button to empty the whole Trash near the top. Selecting this option deletes all items in the Trash permanently. Once an item is deleted permanently, it cannot be recovered. One important thing needs to be mentioned here though, only items deleted from the graphical file browser are moved to the Trash. Items deleted in other ways (from the terminal or some program, for example) are not moved to the Trash and are deleted permanently.

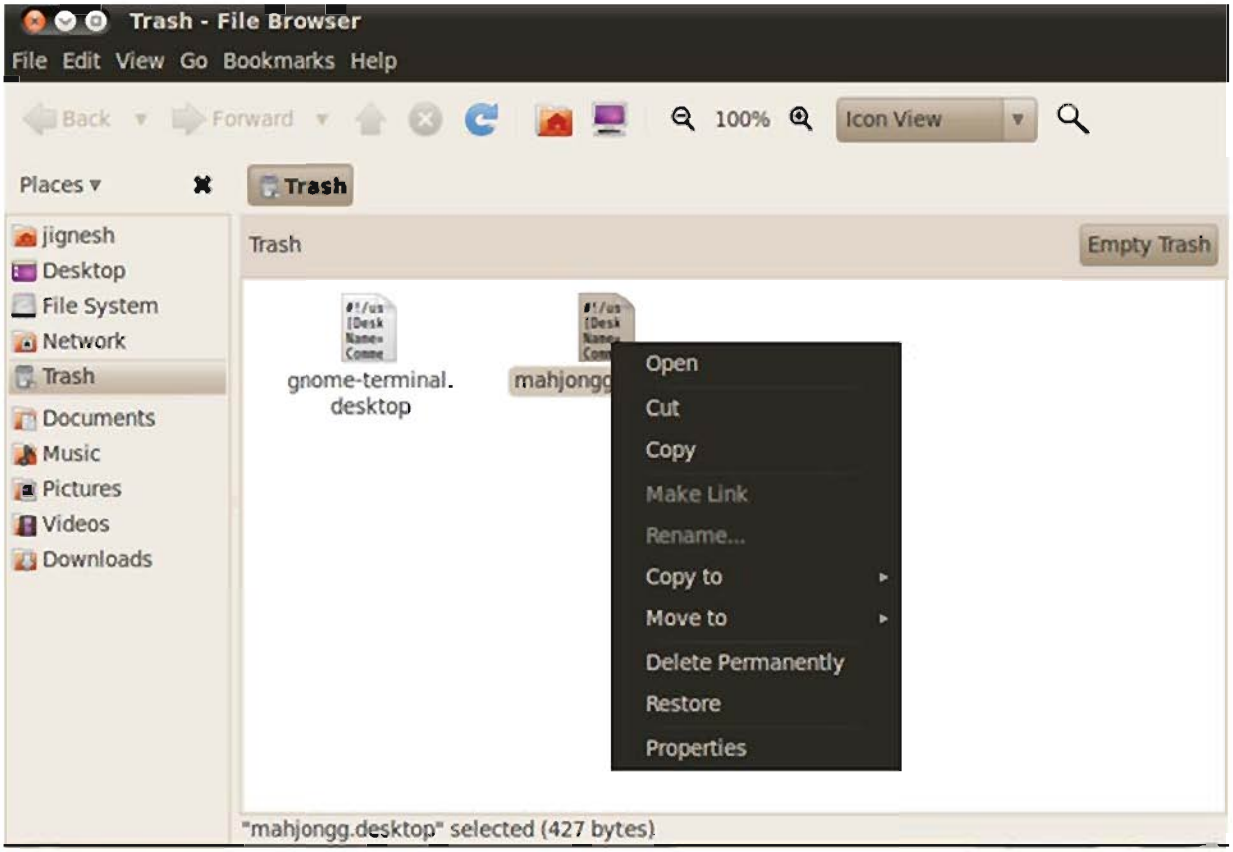


Figure 7.15 : View of Trash Folder

On the left side of the Trash icon is the Workspace Switcher. It displays a mini representation of each workspace in the panel. By default there are four workspaces in Ubuntu. The four workspaces are arranged in a 1 x 4 grid. It even tries to show how many and which windows are open in which workspace in such a small area. We may switch to any of the workspaces by clicking on its mini representation in the workspace switcher. We may also use the shortcut keys CTRL-ALT-arrow keys to switch between the workspaces.

The area between the "Show Desktop" icon and the workspace switcher in the bottom panel is initially empty. This area is used to display mini representations of all running applications, consisting of their icons and titles. As we open more and more applications, these shrink in size. We may switch to any application by clicking on its mini representation in the bottom panel. We may also use the key combination ALT-TAB to switch between running applications.

The Desktop

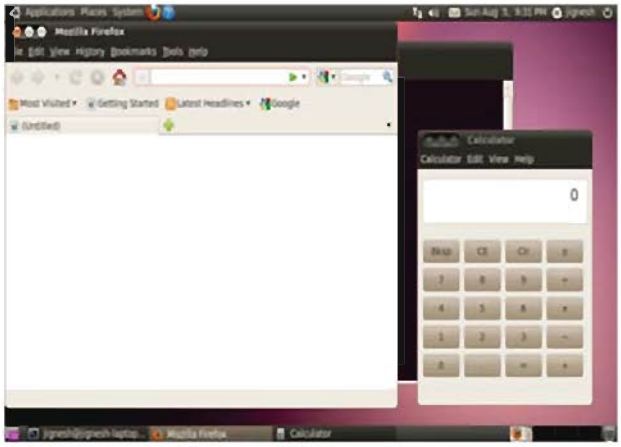
The desktop is the entire area between the top and bottom panels. A background picture is displayed on it. Any other item the user puts on the desktop will be placed in front of the background, obscuring that much portion of the background. Initially the desktop is empty, but the user may place frequently used files, directories as well as application launchers on the desktop for quick access.

In reality, all the items the user places on the desktop are actually stored in the subdirectory named "Desktop" in the user's home directory. Right clicking on any empty area of the desktop brings up a context menu that allows us to create folders, files and application launchers on the desktop. The process of creating an application launcher is same as the one for creating a custom launcher in the top panel described above. Alternatively, we may drag and drop files and folders from the Nautilus file browser onto the desktop or application launchers from the "Applications" menu or the top panel onto the desktop. The context menu also has an option to change the desktop background picture.

Whenever we insert a removable device, an icon for the same is displayed on the desktop. We may open it by double-clicking on it. When we right-click on the icon, we get a context menu item to unmount the device/safely remove the device/eject the media depending on the type of the device.

Customizing the Appearance of the GNOME Desktop

GNOME supports themes. A theme is a harmonious combination or bundle of various display settings. By changing the theme, we may switch from one set of settings to another. Switching the theme and background may result in substantially different look and feel (See figure 7.16).



a. The Ambience Theme

b. The Clearlooks Theme

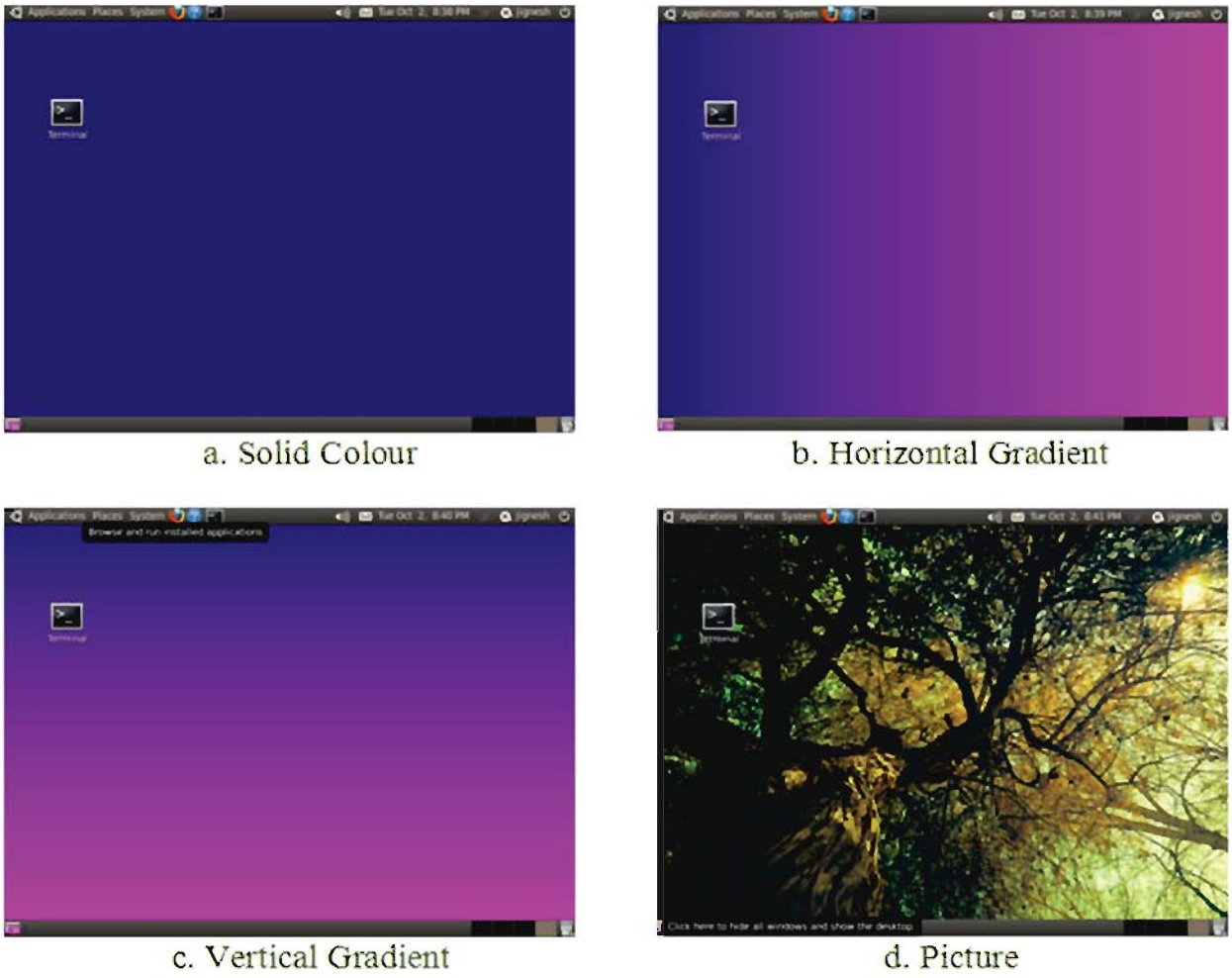
c. The Dust Sand Theme

d. The High Contrast Inverse Theme

Figure 7.16 : Some Ubuntu GNOME Desktop Themes

The High Contrast Inverse theme is for the visually challenged having limited vision. The high contrast ratio and light-on-dark colour scheme make it easy to read text.

The Appearance option in the Preferences menu has four tabs – Theme, Background, Fonts and Visual Effects. The Theme tab allows us to choose a theme from a list of installed themes. More themes are available online. The Background tab lets us choose the background. We may choose a solid colour that fills the whole desktop area, or a gradual transition from one colour to another (horizontal gradient or vertical gradient) or a picture as the background (See figure 7.17).



a. Solid Colour

b. Horizontal Gradient

c. Vertical Gradient

d. Picture

Figure 7.17 : Different Background

The Fonts tab can be used to select the default fonts. To modify the fonts click on fonts tab as seen in figure 7.18.

The Visual Effects tab has three levels of special effects to choose from – None, Normal and Extra (in increasing order of visual eye-candy provided). The default is none. Setting a higher level enables a wide range of 2D and 3D visual effects. Depending on the graphics

Figure 7.18 : Fonts Tab

capability of your system, the Normal and Extra options may or may not work. If some option cannot work on your system, trying to set that option will result in the message shown in figure 7.19.

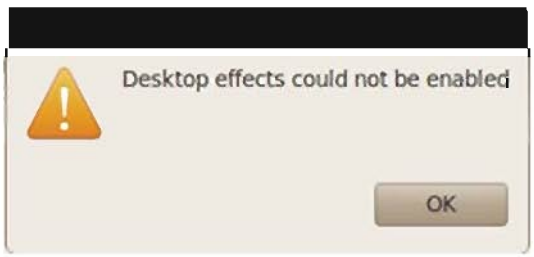


Figure 7.19 : Error Message

The list of some of the interesting special effects that you get is as mentioned below:

- **Desktop Wall** treats the workspaces as walls that the user can switch between
- **Desktop Cube and Rotate Cube** treat the workspaces as faces of a cube that the user can rotate, just like rolling a die
- **Magnifier** allows the user to magnify certain portion of the screen for better readeability, especially useful for demonstrations before a large audience using a multimedia projector
- **Enhanced Zoom Desktop** Allows the user to zoom in/out the desktop at the current location of the mouse pointer using the combination SUPER+mouse_scroll_wheel
- **Opacity** makes windows visible simply by hovering the mouse over (moving the mouse pointer over) any portion of the window

- **Window Previews** displays small preview window for an application when we hover the mouse over its mini representation in the bottom panel. The preview window shows the contents of the window
- **Blur Windows** makes windows translucent to show a light preview of what is behind them
- **Fading Windows** makes windows fade in (from an invisible state, become gradually more visible until fully visible) or fade out (from a fully visible state, become gradually less visible until invisible) when they are maximized or minimized respectively
- **Minimize Windows** makes windows decrease / increase their size in an animation when minimizing / unminimizing
- **Water Effect** displays effects as if the screen were a pond full of water and the mouse were a pebble thrown in
- **Wobbly Windows** makes the windows "wobble" (shake) when moved or maximized.
- **Animation** A combination of several window effects

Summary

In this chapter we discussed the GNOME2 desktop. We saw how to use the three major components of GNOME2 that is the top panel, the desktop and the bottom panel. We looked at the list of built-in software available under the Applications menu. We also learnt the use of the Places menu and the options available under the System menu. Finally we saw how to customize the appearance of the GNOME2 Desktop.

EXERCISE

1. What are the three major components of the GNOME2 desktop screen ?
2. Discuss the main components of the top panel in GNOME2.
3. List and discuss the menu items under the Places menu in Ubuntu using GNOME2.
4. List the menu items under the Administration submenu in Ubuntu using GNOME2.
5. What are application launchers ? Discuss the ways to put launchers in the top panel.
6. How can we create a custom application launcher ?
7. List and discuss the indicator applets installed by default in Ubuntu using GNOME2.
8. What is the "Me Menu" ? What is its use ?
9. Describe Ubuntu One. Discuss why Canonical might have started this service.
10. Explain the options in the session menu in detail.
11. What are the uses of the desktop ?

12. What are the contents of the bottom panel ?

13. What is Trash ? What benefit does it provide ? What is its major limitation ?

14. What is a theme ?

15. **Choose the most appropriate option from those given below :**

(1) Which of the following is NOT a Linux desktop manager ?

(a) KDE (b) LXDE

(c) Unity (d) Brasero

(2) Which of the following is a light-weight desktop manager ?

(a) KDE (b) LXDE

(c) Unity (d) GNOME2

(3) Right-clicking an item brings up -

(a) context menu (b) global menu

(c) tool tip (d) system menu

(4) Which of the following is not a menu in GNOME2's top panel under Ubuntu ?

(a) Applications (b) Places

(c) Preferences (d) System

(5) Which of the following is not a part of the top panel in Ubuntu with GNOME2 ?

(a) mini-representations of windows (b) application launchers

(c) session menu (d) notification area

(6) Which of the following is not a part of the bottom panel in Ubuntu with GNOME2 ?

(a) Show Desktop icon (b) Trash icon

(c) desktop/workspace switcher (d) notification area

(7) Which of the following is not an application category by default in the Applications menu ?

(a) games (b) administration

(c) graphics (d) office

(8) Which of the following applications is not available in the office category ?

(a) OpenOffice.org Writer (b) OpenOffice.org Draw

(c) OpenOffice.org calc (d) OpenOffice.org Impress

(9) Which of the following is not a folder inside the user's home directory ?

(a) Desktop (b) Music

(c) Documents (d) Computer

(10) Which of the following is a built-in application launcher in the top panel ?

(a) OpenOffice.org Writer (b) OpenOffice.org calc

(c) Help (d) All of these

(11) Launchers in the top panel can be separated by -

(a) line (b) vertical bar

(c) horizontal bar (d) separator

(12) Which menu is identified by the currently logged in user's name ?

(a) the Me menu (b) the User menu

(c) the Personalize menu (d) the session menu

(13) The cloud service from Ubuntu is known as -

(a) Ubuntu One (b) Ubuntu Music Store

(c) Ubuntu Cloud (d) Ubuntu Drive

(14) Files deleted from the Nautilus file browser go into -

(a) Recycle Bin (b) Recycle Can

(c) Trash Can (d) Trash Bin

(15) Which of the following is NOT a built-in theme for Ubuntu ?

(a) Ambience (b) ClearType

(c) Dust Sand (d) High Contrast Inverse

LABORATORY EXERCISE

Perform the following operations under Ubuntu and note down the steps used to perform them :

1. Create a launcher for the Terminal application in the top panel.
2. Create a launcher for the Calculator application on the Desktop.
3. Invoke the context menu on the desktop launcher created in step 2 above.
4. Start the Calculator application from the menu system.
5. Open your home directory from the menu system.
6. List the directories present by default under your home directory (excluding hidden directories explained in the next chapter).
7. List all storage devices currently available in your computer.
8. Open Network from the menu system and note if you can see other computers in your laboratory (the result depends on the laboratory setup).
9. Search for the file(s) containing the word "fstab" in its name in the file system. How many such files do you find ?

10. View a list of recently opened documents.
11. * Insert a removable device in the system and explore its contents.
12. * Safely remove/eject the media from the context menu of its desktop icon.
13. Apply different themes and backgrounds to your system and observe the results.
14. Change the default font sizes for different categories and observe the result.
15. Try to set Visual Effects to Normal and High. Observe the result.
16. Look at previews of available screen savers. Try a few that you like.
17. Set the title bar double click preference of windows to different values and observe the results.
18. Read the topic "New to Ubuntu ?" and its subtopics in the built-in help.
19. Note down the version of Ubuntu used on your system.
20. Add a separator to the top panel.
21. Add a custom launcher to the top panel for the GUI file browser program nautilus available in the bin directory inside the usr directory in the file system. Do not provide an icon and see what icon you get.
22. Move the nautilus launcher you created earlier around in the top panel.
23. Lock the position of the nautilus launcher you created earlier. Now try to move it around.
24. Swap the positions of the default launchers in the top panel.
25. Remove the nautilus launcher you created earlier.
26. Check the current system date, time and day of the week.
27. Find out the day of the week on 2nd October, 2012 and 15th August, 1947.
28. Find out the day of the week on the day you were born.
29. * Experiment with the options in the session menu.
30. Start a guest session. Open the home folder. Notice the title bar of the window. Create a document (empty file) in the home folder using the context menu. Logout, start a guest session again and see whether you still have the file.
31. Place a launcher on the desktop. See if you see it in the Desktop folder in your home directory. Delete the file in that folder (by selecting it and pressing the Delete key). Look at the desktop again.
32. Create an empty file in your home folder. Delete it. Locate it in Trash and restore it. Again delete the file; then empty the Trash.
33. Open different applications in different workspaces. Switch between the workspaces using the keyboard and the mouse.

34. Open different applications in the same workspace. Switch between the application using the keyboard and the mouse. If you have "Extra" effects enabled, find out the difference caused by them.

35. Cycle through the list of running applications in forward and reverse orders.

36. Note the position and order of the window buttons on your system.

NOTES TO TEACHERS

- Students are expected to undo the changes in preferences made by them before leaving the laboratory to the extent possible.
- Exercises marked with a * in the beginning may be demonstrated by the tutor rather than being performed by the students.
- The list of special effects under the subsection "Customizing the Appearance of the GNOME Desktop" are provided only for students to appreciate the power and visual attractiveness of Linux GUIs. They are not to be covered in examinations.

Basic Utilities in Ubuntu Linux

In the previous chapter we looked at how to operate a computer with Ubuntu Linux OS. We will further expand that discussion by looking at some basic utilities that Ubuntu Linux provides. In this chapter we will introduce you to terminal, gedit text editor; we will see how to manipulate files and directories. We will have a look at the calculator application. As mentioned earlier Linux also provides some inbuilt applications for entertainment. We will have a look at GNOME image viewer, rhythmbox music player, totem movie player and gimp image editor.

An Introduction to the Terminal

If you want to use the CLI in Ubuntu, there are two choices. You may use one of the 6 text mode virtual terminals in Ubuntu by pressing CTRL+ALT+F*n* key combination, where *n* is the terminal number (1-6). These virtual terminals provide you the original plain vanilla text mode experience, with the addition of a small number of colours for displaying the text. Here you cannot have your CLI session and the GUI programs side-by-side. Also the use of very convenient copy-paste functionality is not available here. It is generally used when for some reasons; you cannot start the graphical session. If we have already started a graphical session, we may also have a CLI session running as a GUI program using the GNOME Terminal (or the Terminal). It provides a CLI environment inside a GUI window. It provides much more attractive display and allows us to have multiple terminals. Other GUI programs on the screen can coexist at the same time. It allows us to resize and reposition the windows for simultaneous use. It also allows us to copy text from one program (GUI or Terminal) and paste in the other. In this section we discuss how to use this program.

Using the GNOME Terminal

The Terminal can be started by following the menu chain Applications → Accessories → Terminal or by pressing the shortcut key CTRL+ALT+T. The typical screen of the terminal will be somewhat similar to the one shown in figure 8.1.

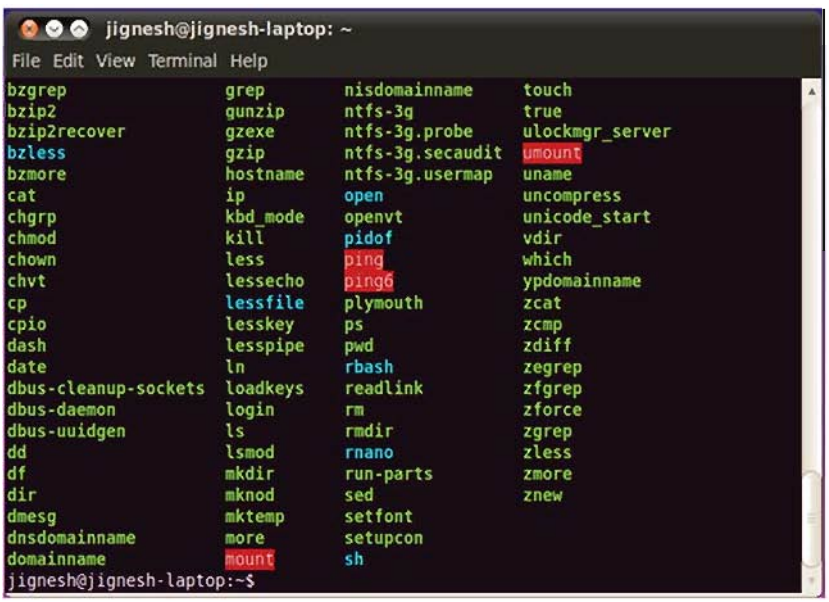


Figure 8.1 : The GNOME Terminal

As can be observed in figure 8.1 the appearance of the screen is not so attractive. We can tweak the appearance easily

to get different look as shown in figure 8.2. The Terminal, being a GUI window, can be moved, resized, minimized and maximized just like any other widow. When the entire contents of the CLI screen cannot be displayed in the window, it provides scrollbars; again, just like any other graphical program.

One major limitation of the text mode screens is that they can only display a fixed number of lines of text. If some command produces more output than can fit in the screen, the initial part of the output simply scrolls up and out of the screen and is lost (certainly, there are commands that display long output screen-by-screen, but using them means we have to type some extra characters. Also, the user has to anticipate that there will be more output than the screen can accommodate before running the commands and use this facility.). On the other hand, the Terminal stores the last several (512 by default) lines of output in memory and allows the user to scroll up and down through them.

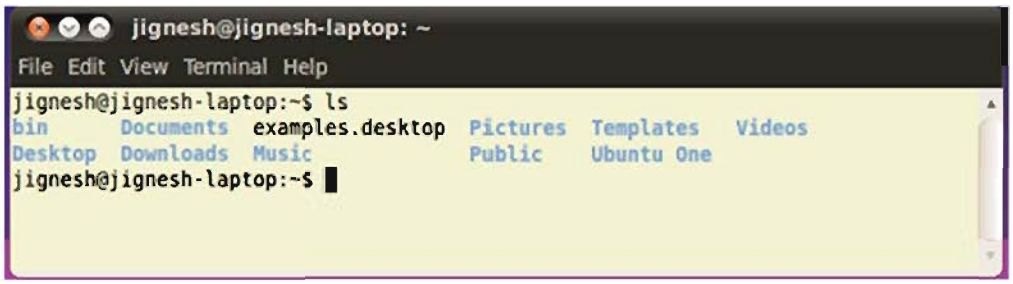


Figure 8.2 : Terminal After Changing Properties

Sometimes, we may want to have more than one terminals open. For example, while we are working in a terminal, we may need to use some command, but we might have forgotten how to use it. Fortunately, Unix and Linux has had online manuals from the early days. You may read the manual without disturbing the current session in a second terminal window (see figure 8.3).

The Terminal even supports multiple tabs as shown in figure 8.4. Each tab holds a separate terminal. We may create a new tab using the File → Open Tab option, or the SHIFT+CTRL+T shortcut key. We may switch between the tabs by clicking on the tab titles using the mouse or the CTRL+ALT+PgUp and CTRL+ALT+PgDn shortcut keys. We may also use the shortcut keys ALT+*n* to switch to the n^{th} terminal. A tab can be closed by clicking its close button using the mouse or the shortcut key SHIFT+CTRL+W.

We may copy text from one terminal and paste in another to save typing. We may even copy text from some other GUI program (like the OpenOffice.org Word Processor or the Firefox browser where you might have some valuable help document open) and paste in the Terminal. We may select these options from the Edit menu or use the Terminal's slightly-different-from-convention keyboard shortcuts SHIFT+CTRL+C and SHIFT+CTRL+V for copy and paste respectively.

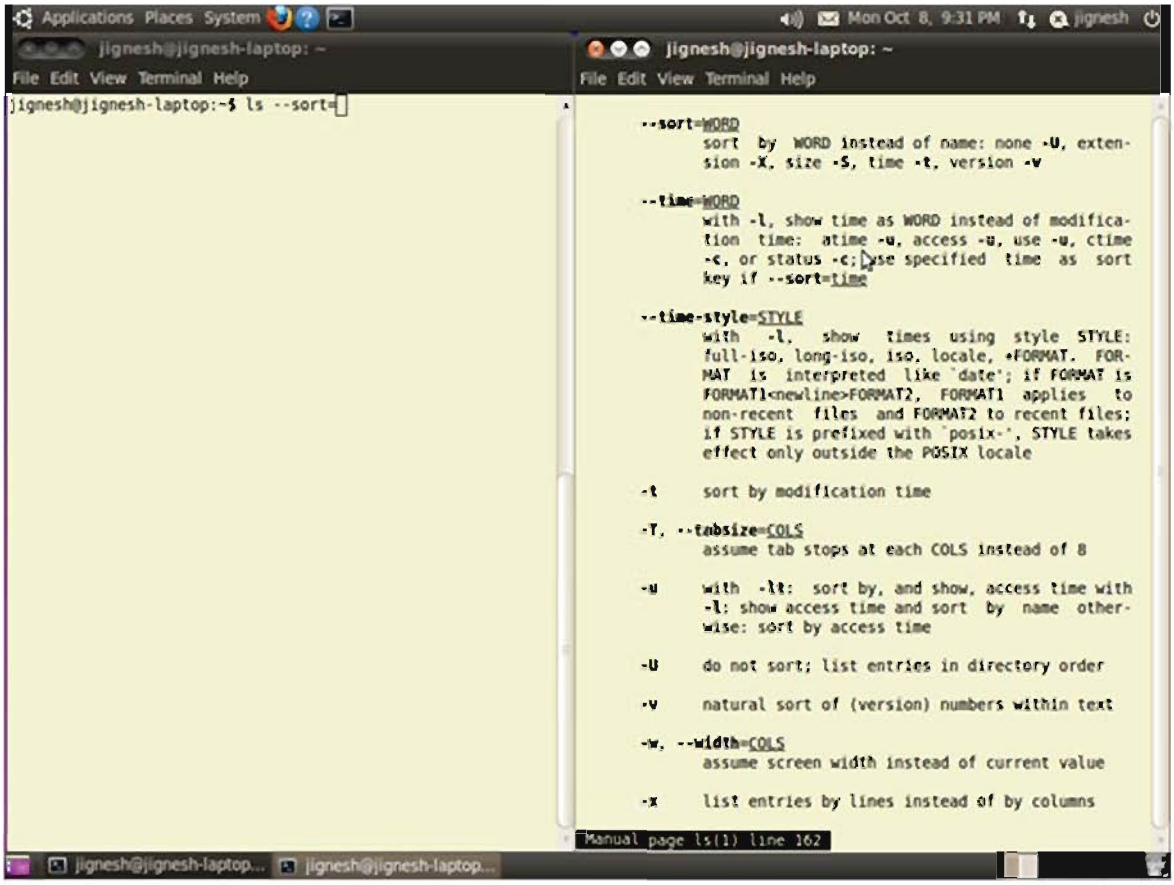


Figure 8.3 : Opening Multiple Windows

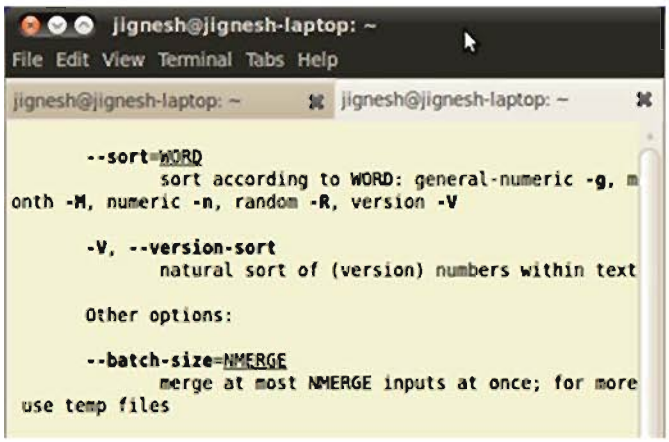


Figure 8.4 : Multiple Tabs in Terminal

The Terminal has the options "Keyboard Shortcuts" and "Profile Preferences" in the Edit menu. While the first option allows us to change the keyboard shortcuts, the second one gives us control over the appearance of the Terminal as well as the some other options like scrolling (see figure 8.5).

Figure 8.5 : Profile Preferences in Terminal

When we start the Terminal, a new Linux CLI session is started in it. Unlike the virtual text mode screens, you are automatically logged into the CLI session you open in a Terminal using the user name you used to log in to your GUI session. The CLI displays a short text known as the prompt. By default the prompt is username@systemname:current_directory$, but it is highly customizable. Observe that in figure 8.2 you are able to see prompt as jignesh@jignesh-laptop:~$. While it is beyond the scope of this book to go into the details, there are so many possibilities of having functional, colourful and fancy prompts that one may write a whole book on the topic!

After displaying the prompt, the CLI waits for you to type a command. When you type a command and press ENTER, the command is executed if there are no errors in the command. Figure 8.1 actually is showing the list of all files in current directory, the command used here is 'ls'. While the command executes, it may perform input/output. The CLI waits silently for the command to terminate. When the command terminates, it ones again springs into action and displays another prompt. This cycle goes on repeating until you exit the CLI by executing the "exit" command or by pressing CTRL+D (the Unix end-of-input marker) when you are at the prompt. If some command is running and you want to stop it for some reason, you have to press CTRL+C. You will learn more about the Linux commands later.

Manipulating Files and Directories

Ubuntu comes with file browser software called Nautilus. The name Nautilus here refers to the sea creature, the picture of which is the icon for the Nautilus software (you can see it in Nautilus by clicking Help → About). When you open any file system location (from the local computer or from the network) using the Places menu, it actually opens in the Nautilus file browser. It allows us to browse files as well as directories. Nautilus can be opened by selecting a local or remote (connected through network) file system from the Places menu. Figure 8.6 shows a sample Nautilus screen.

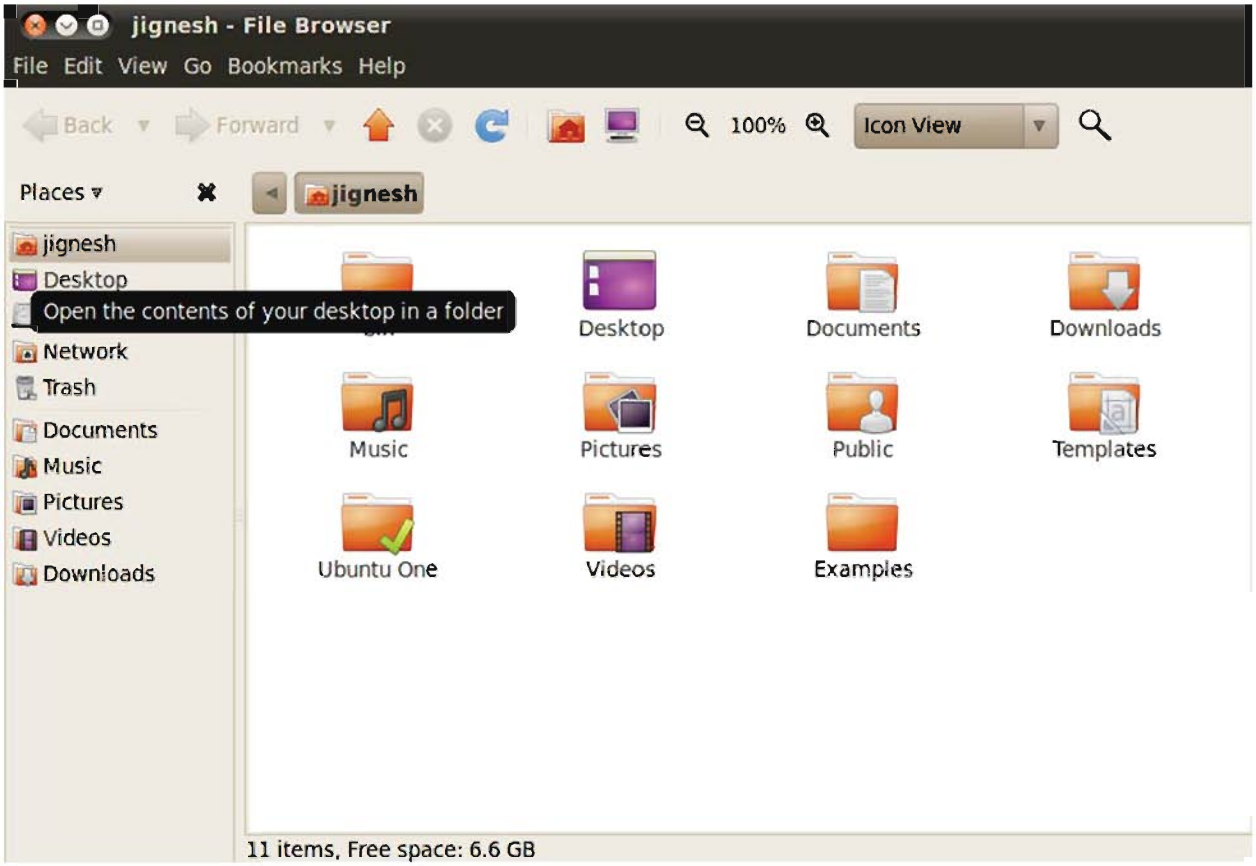


Figure 8.6 : Nautilus File Browser

Like many other GUI programs under Linux, it has a menu bar and a toolbar (a series of icons representing actions) at the top and a status bar at the bottom. Between them, there is a content pane that displays files and folders. The menu bar and the toolbar provide the ability to take various actions, while the status bar shows some information pertinent to the current display (for example, in figure 8.6, it says there are 11 items in the current directory and free space on the current partition is 6.6 GB). There is also a side pane on the left side of the content pane that displays some standard locations and bookmarks. One may open any of these locations simply by clicking on it. The standard locations include the user's home directory (identified by the user's name), the Desktop directory, the root file system (identified simply as "File System"), Network, which displays a list of other computers connected with this computer through a network (if configured for such use) and Trash.

Opening Files and Directories

You may double-click a file or folder to open it. A folder opens in the same Nautilus window, replacing the current display of the content pane with the contents of that folder. When you double-click a file, Ubuntu tries to find out the most appropriate program for opening it, launches that program and tells it to open the file. If it cannot find a suitable program, it displays a dialog box as shown in figure 8.7.

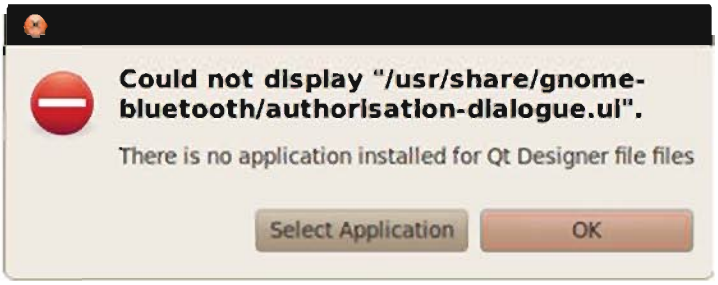


Figure 8.7 : Error Message

You may select the application to be used for opening the file or just click OK, in which case the attempt to open the file will be aborted. Right-clicking on a file gives us an option to open the file with the associated program (if there is any) as well as an option to open the file with an application of our choosing (See figure 8.8).

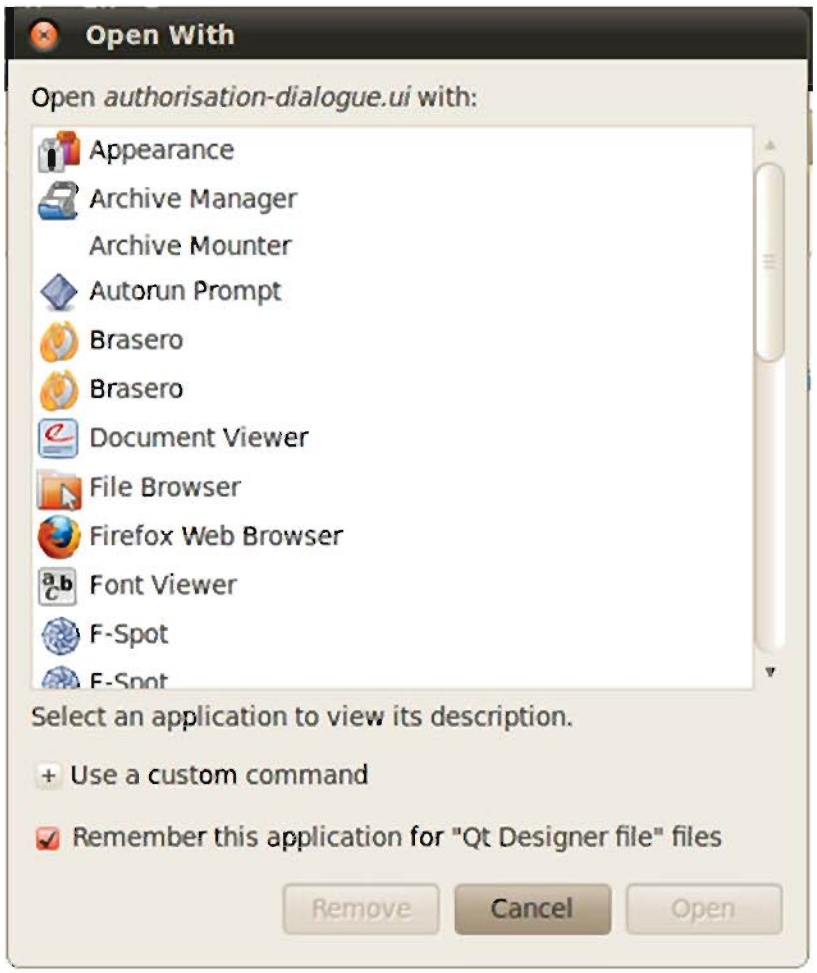


Figure 8.8 : Open with Dialog Box

Among the common file types, text files open in the gedit text editor, OpenOffice.org files open in their respective OpenOffice.org application, image files (pictures) open in the Eye of Gnome application, music files open with Rhythmbox music player and video files open with the Totem Movie Player. We shall discuss these programs in coming sections.

Once we have opened multiple folders the back button in the Nautilus file browser becomes enabled. We may use this button to go back to the previous folder. Once we go back the forward button becomes enabled, this button can be used to return to the folder from where we "went back". We may also use the Up button to open the parent directory of the current directory. Just above the content pane, you can see a list of directories that need to be traversed to reach the current directory from the root directory. You may click on any of these directories to directly open it. Even after you open a parent directory, Nautilus tries to retain the child directories in this list in case you may want to visit them again.

Different Views in Nautilus

We shall use the term file system object (or just object) in this section to mean a file or a directory. Nautilus offers three different ways to look at the list of files and directories in the current directory. These are the icon view, the list view and the compact view. The view can be selected by using the view selection tool near the right hand side of the toolbar, or the shortcut keys CTRL+1, CTRL+2 and CTRL+3 can be used.

In the icon view, each object is represented by an icon (depending on its type) and its name. For many types of objects, the icons may even provide a thumbnail (a small preview of the object's contents) also. The icons are arranged in a grid form. In the compact view, the objects are represented by very small icons (no preview) and name and are arranged in a vertical list. In the list view also the objects are represented by a small icon and name and arranged in a vertical list. However, the list view also displays several other details about the objects like its size, type and the date when the object was last modified (date of last modification). In this view, we may sort (arrange) the objects in the ascending or descending order of any of the displayed columns by clicking once or twice on the column heading. This is very useful to find, say, the largest file or the latest file. In the List View, there is a "+" (expand) icon just before a folder. Clicking this icon displays the contents of the folder as well, at the same time turning the "+" (expand) icon into a "-" (collapse) icon. Clicking on the "-" (collapse) icon hides the contents of the folder.

Creating Files and Directories

A directory can be created inside the current directory by either selecting the option "Create Folder" from the File menu or by selecting the same option from the context menu (this applies only to the icon view and compact view). One may also use the keyboard shortcut SHIFT+CTRL+N. While a new file can also be created in a similar way using the "Create Document" option, that option is only useful for creating plain text file. The common way of creating a new file is to use the corresponding software application. E.g. a new OpenOffice.org text document can be created using the software's Writer program; a new image file can be created using the GIMP image editor.

Selecting Files and Directories

An object can be selected by single-clicking on it. Multiple objects can be selected by single-clicking them while holding down the CTRL key. A range of objects can be selected by selecting

one end of the range and single-clicking the other end while holding down the SHIFT key. Our selection may include only files, only directories or a mix of both as well. The context menu on a single selection can be invoked by right-clicking the selected object. In case of multi-selection, right-clicking on any one of the selected objects will invoke a context menu applicable to all selected objects.

Deleting Files and Directories

After selecting one or more files or directories, pressing the Delete key on the keyboard will delete the selected objects. Deleting a folder deletes its entire contents, including subfolders, if any, as well. Normally, a deleted object is not physically removed from the system; it is simply moved to Trash folder, thus giving the user one more chance to recover it if they deleted the object unintentionally. There is no easy way to recover an object once it has been removed from Trash folder also. One may also use the "Move to Trash" context menu option to delete and move object(s) to Trash.

Renaming Files and Directories

To change the name of an object, select the object and select Rename from the context menu, or use the shortcut key F2. Then type the new name, and press ENTER. In case you press ESC in place of ENTER, the rename operation will be cancelled. Only one object can be renamed at a time.

Copy-Paste Operation

The X Window system maintains a common clipboard. The clipboard is capable of holding one object at any given point in time, irrespective of its size. Any X Window software may "copy" or place an object on the clipboard. Since the clipboard can hold only one object at a time, when another object is copied to the clipboard, the previous object is automatically removed from there (though it will remain in its original location). Any X Window program (including the one that copied the object) can "paste" or pick up this object from the clipboard. When a program pastes an object, it receives a copy of the object, while the copy on the clipboard remains there and the original object remains in place. Thus, a copied object may be pasted multiple times, each time a new copy of the object gets created.

In Nautilus, after selecting one or more objects, we may copy them either from the context menu item Copy or by pressing the shortcut key CTRL+C. The objects can be pasted in any folder by right-clicking in an empty area and selecting the Paste option. In list view, one may right-click on the directory's name just above the content pane and select the option "Paste Into Folder". Alternatively CTRL+V can also be used to paste the contents.

Object(s) copied from a folder can be pasted in the same folder also. This will result in their copies being generated in the same folder, with names suffixed with the text "(copy)", because there cannot be two objects with the same name in the same directory. Repeating this operation multiple times results in names ending in "(another copy)", "(3rd copy)", "(4th copy)", and so on.

The Copy-Paste operation is used to keep one copy of the object(s) at their original location, while creating another copy of them at the paste site. When both locations are same, the object(s) get duplicated in the same directory. Copy-pasting a directory results in its entire contents (including any files and subdirectories) getting copied.

Cut-Paste Operation

While copy-paste operation is used to create copies of the object(s) while retaining the original object(s) at their original location, cut-paste operation is used to remove object(s) from their original location and place them in the new location. Any X Window software may "cut" an object to place it on the clipboard. At this point, the object is not removed from its original location. If the user does not paste the cut object anywhere and closes the session or places another object on the clipboard, thereby removing the first object; then the "cut" operation has no effect. However, if after the "cut" operation any X Window software performs a paste operation elsewhere, the object is removed from its original location and placed at the new location (location of paste). Thus, with cut-paste, there is always only one copy of the object. The cut-paste operation essentially *moves* objects around. Cutting and then pasting in the same location has no effect. Once the cut object is pasted, the clipboard becomes empty and the paste operation cannot be used again until some object is placed on the clipboard. Cut-pasting a directory moves the directory with all of its contents.

In Nautilus, after selecting one or more objects, we may cut them either from the context menu item Cut or by pressing shortcut key CTRL+X. The objects can be pasted in any folder as described earlier.

The Drag-and-Drop Operation

Like the terminal, we may open multiple Nautilus windows. When we want to move some file system object(s) from an open folder in one window to an open folder in another, we may arrange the windows so that both are visible at the same time and then drag the object(s) from the first window and drop them on the second. Holding the CTRL key while performing drag-and-drop will copy the object(s).

Bookmarks and Searching

If you use some folder frequently, you may find it cumbersome to reach the folder starting from one of the built-in places. In such situations, you may open the folder once and select the option Bookmarks → Add Bookmark. This will add the folder permanently to the side pane as a bookmark. Now you can open the folder very easily, simply by clicking on the bookmark. The bookmark is added to the Places menu, too, so it can be selected from there also. And if you feel the side pane is occupying unnecessary space in the window, you may close it using its close button. The view menu has an option to show/hide the side pane. Nautilus also has an option to search for a file/directory in the currently open directory (including its subdirectory, sub subdirectory, and so on). Just click Go → Search for Files and enter a part of the name of the file you are looking for.

The Calculator

OK, so you need to perform some calculations but after purchasing the latest computer you don't have a single Rupee left in your pocket to purchase a calculator. You need not worry. Just as you used the Terminal to use your graphical system like a CLI system, you can use the calculator program to temporarily convert your millions of calculations per second machine into its poor little sibling. You can start the calculator program as shown in figure 8.9 by clicking on Applications → Accessories → Calculator.

Figure 8.9 : Calculator Program

As you can see in the calculator program looks strikingly similar to its hardware counterpart. As a result, it is probably the easiest program to learn even for computer novices – just use mouse in place of your fingers. If you are reasonably good at typing, you may use the number keys or the numeric keypad on the computer keyboard instead; because that will increase your speed dramatically. The operators (+, -, * for multiplication, / for division, C for ±, =, etc.) can also be entered from the keyboard. The CE and CLR keys both clear the display and reset the current value to 0. Bksp works just like the Backspace key on the computer keyboard – it deletes one character to the left of the cursor every time it is pressed.

Also, you may use the Undo facility in the Edit menu if you committed a mistake in entering the data or operation. Another nice touch, keeping in mind the needs of IT professionals, is the Insert ASCII Value option in Edit menu – it allows you to enter a character and inserts the ASCII code for that character in the display window. Thus, if you enter the character *a* (small a), you see 97 inserted in the display window.

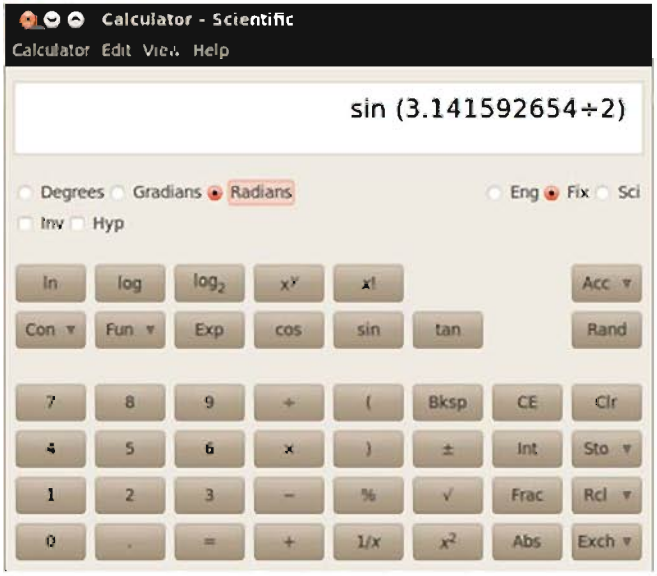


Figure 8.10 : Scientific Mode View

Some of you might have an elder brother or sister studying science or engineering. In that case you might have seen the scientific calculator. It has a large number of additional operations useful in science, mathematics and engineering. Don't be disheartened. Just click View → Scientific, and your calculator instantly morphs into a scientific calculator. (See figure 8.10) There are Advanced, Financial and Programming calculators as well (the last one provides conversions between different number systems, among other things).

The Gedit Text Editor

The gedit Text Editor (also known simply as Text Editor) is a graphical editor for plain (unformatted) text files and documents (see figure 8.11). As a plain text editor, it only saves the text in the file and never any formatting. The gedit program does allow us to change options like font, font size, colour scheme etc., but it is important to remember that these options are not saved in the file but they become the user's current gedit preferences for all files till they change these settings again.

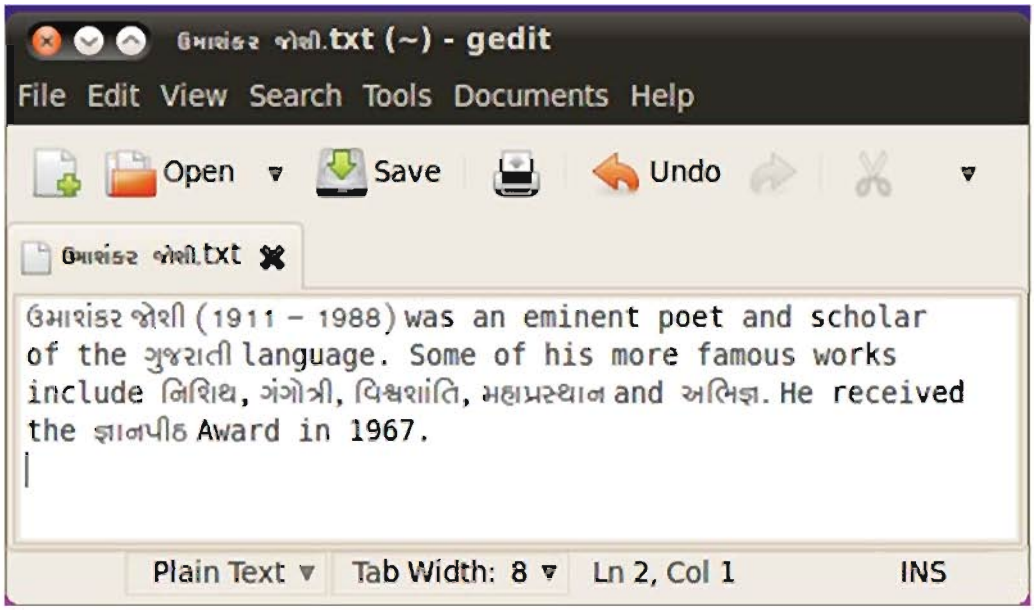


Figure 8.11 : Gedit Text Editor

Like other key components of the Linux system, gedit supports major portions of the Unicode character set, including major Indian languages and even substantially different languages like Arabic (written right-to-left) and Chinese (written by combining a large number of pictograms). While Ubuntu comes with Unicode fonts to display text in all these languages, support for input in languages other than English is not included on the installation CD itself to save disk space. Support for additional languages needs to be downloaded and installed. This process is shown in Appendix 1.

Some of the more commonly used menu options along with the corresponding shortcut keys are as under :

- **File**
  - **New (CTRL+N)** Create a new file
  - **Open... (CTRL+O)** Open an existing file
  - **Save (CTRL+S)** Save the current file
  - **Save As... (SHIFT+CTRL+S)** Save a copy the current file under a new name
  - **Print (CTRL+P)** Print the current file
  - **Close (CTRL+W)** Close the current file
  - **Quit (CTRL+Q)** Quit (terminate) the gedit program

- **Edit**
  - **Undo (CTRL+Z)** If something goes wrong while working on a file, this option can be used to reverse the effect of the last operation; when used repeatedly, the option goes on undoing our operations in reverse order
  - **Redo (SHIFT+CTRL+Z)** Reapply the most recently undone operation, this option can be repeated, too
  - **Cut (CTRL+X)** to cut the text selected with the mouse to the clipboard
  - **Copy (CTRL+C)** to copy the text selected with the mouse to the clipboard
  - **Paste (CTRL+V)** to paste the text in the clipboard at the current cursor location
  - **Preferences** In Ubuntu, the Preferences (options) menu is traditionally the last menu item in the Edit menu. It is this menu that provides options to change font, font size, colours, etc. for the gedit program

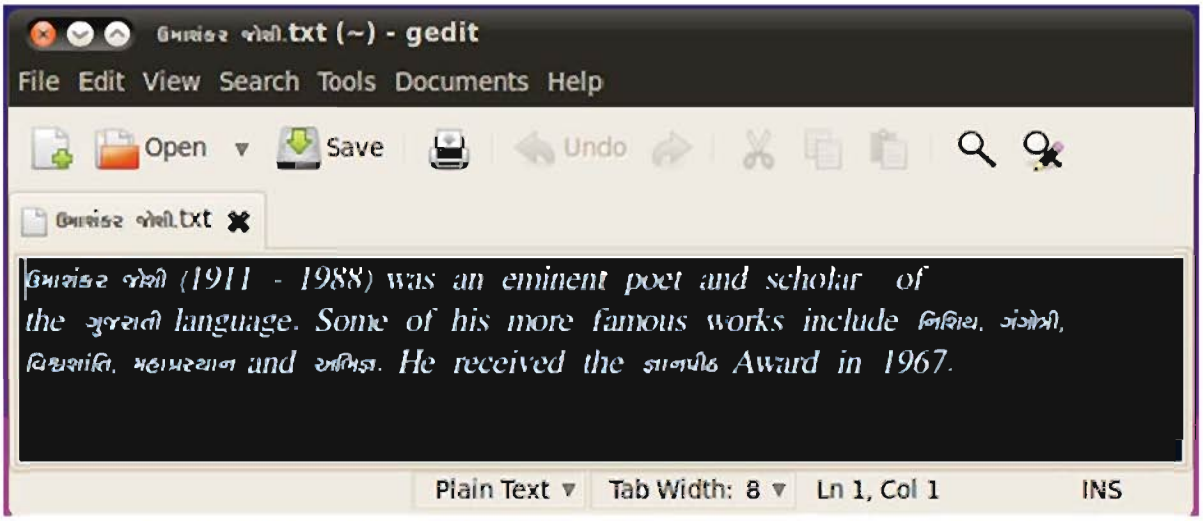


Figure 8.12 : The Gedit Text Editor After Changing Preferences

Figure 8.12 shows a gedit screen after these options have been changed from their defaults. Some of the commonly used options are also available as tools (icons) in the toolbar. The gedit Text Editor supports editing of multiple files at a time. There are two ways of doing this – to open multiple separate gedit windows (see figure 8.13), or to open the two files in two tabs of the same editor window (because gedit supports tabbed interface), as shown in figure 8.14.

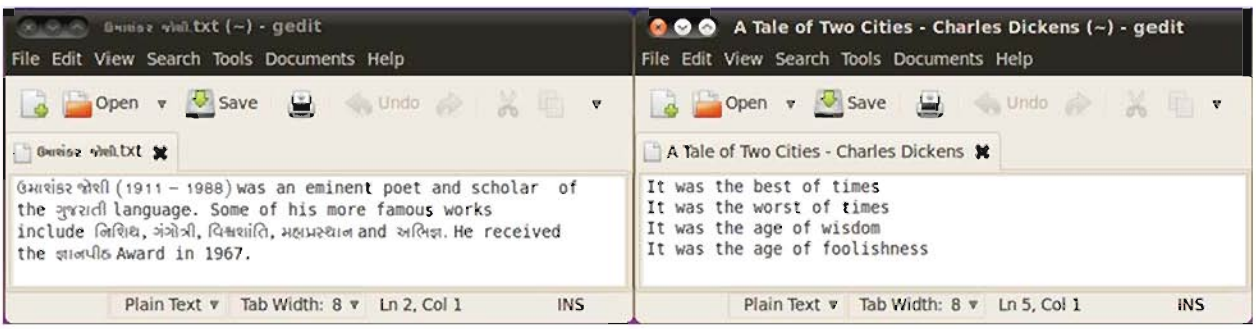


Figure 8.13 : Multiple Gedit Windows

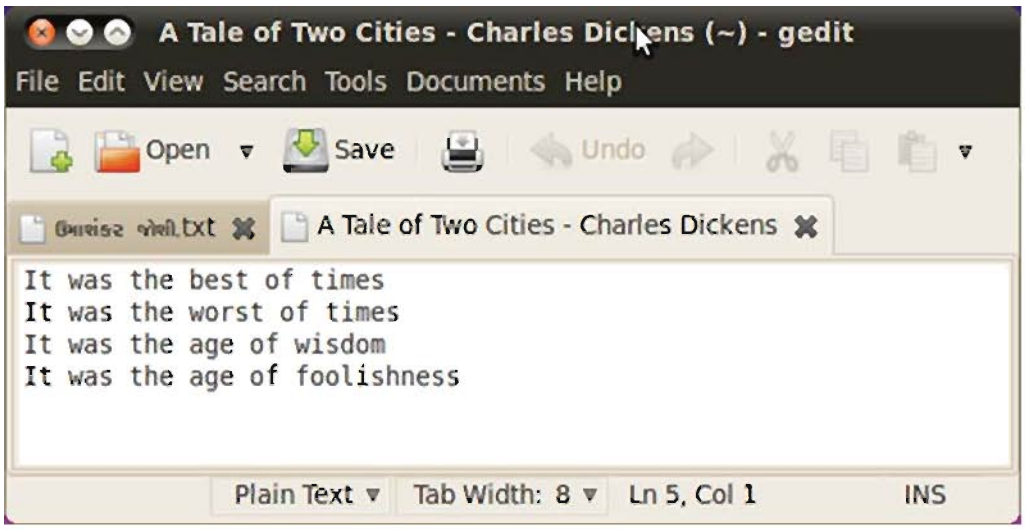


Figure 8.14 : Multiple Files in Different Gedit Tabs

The benefit of the first approach is that we can see multiple files at the same time on the screen and compare them or easily use one file as a reference while editing another. The advantage of the second approach is that it requires less screen space. Also, switching between the tabs (files) is not difficult – we may click the tab heading with the mouse to switch to any tab or use the shortcut keys ALT+*n* to jump to the n^{th} tab or CTRL+ALT+PgUp/CTRL+ALT+PgDn to move to the previous and next tabs respectively.

Another interesting feature is that dragging a tab title out of the window creates a new gedit window and moves the tab to it, while dragging a tab title into an existing gedit window moves the tab to that window.

If you are editing a large document and want to use the maximum screen space, you may select the "full screen" mode from the view menu. In this mode the entire screen will be occupied by the gedit window and only the content pane, where you type, will be visible hiding everything else including the title bar, the menu bar and the tool bar. The shortcut key for this is F11. You may return to the normal mode by pressing F11 again. Trying to move the mouse pointer slowly out of the screen from the top of the screen will make the toolbar visible as a floating window with one more option "Leave Full Screen" added to it. You may always switch to another program directly by pressing ALT+TAB.

The gedit Text Editor understands the syntax (grammar) of several computer languages and can highlight parts of the text using different colours depending on the grammatical roles they play. This makes reading and understanding easy and may help in identifying some common typing errors early. While no computer language is covered in your syllabus at this stage, figure 8.15 shows a demonstration of this capability. This option is provided in the View → Highlight Mode option. Of course, the files are saved as plain text only and not as formatted (colour-coded) text.

Figure 8.15 : Syntax Highlighting in Gedit

The Search menu provides options to find (search for) specific text in the (large) document. It allows us to find the occurrence repeatedly till we choose to exit the search. We may also search for occurrences of some text and replace them by another text. We may go for a one-by-one replacement of the occurrences, optionally skipping replacement of some occurrences; or we may replace all occurrences in the entire document if we are sure about doing it. The option "Incremental Search" continually goes on matching the text as soon as we type each character and highlights all occurrences of the current text (see figure 8.16). The shortcut keys for these operations are find (CTRL+F), replace (CTRL+H), find next (CTRL+G), find previous (SHIFT+CTRL+G) and incremental search (CTRL+K).

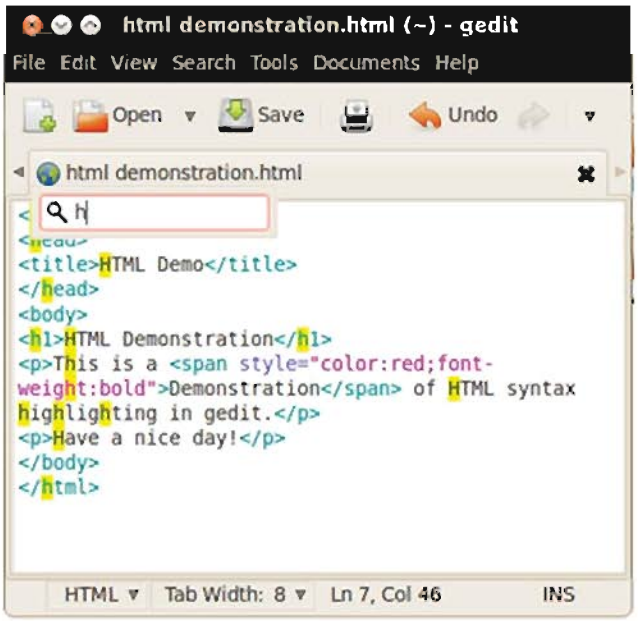


Figure 8.16 : Incremental Search in Gedit

The gedit Text Editor even has support for checking the spelling of words in your document. It has built-in dictionaries for some languages. When we choose the option Tools → Check Spelling, it checks the spelling of every word in our document from the beginning. For every supposed error that it finds, it suggests a list of words with similar spelling as possible alternatives. It offers options to ignore the supposed misspelling (only for this occurrence of the word or for all occurrences of the word) and to change the word with the selected suggestion from the list (for this occurrence of the word or for all occurrences of the word). Sometimes, a correct word may be flagged as incorrect spelling by gedit because it may not be there in its built-in dictionary. In such cases, we may ignore the word or add the word to the user dictionary, so that it never again treats the word as error even in other documents for this user of the system. The option Tools → Document Statistics provides information like number of characters, words and line for the current document. Like most other graphical programs, the Help menu is the last one in the menu bar and provides basic help in using the software.

The Eye of GNOME Image Viewer

The Eye of GNOME (also known as Image Viewer) is used to view images and picture files. It opens automatically when we double-click on any image file in the Nautilus file browser. By the way, it is not displayed in the Applications menu by default, but may be made to appear in the menu if we wish. Figure 8.17 depicts a picture open in the Image Editor.

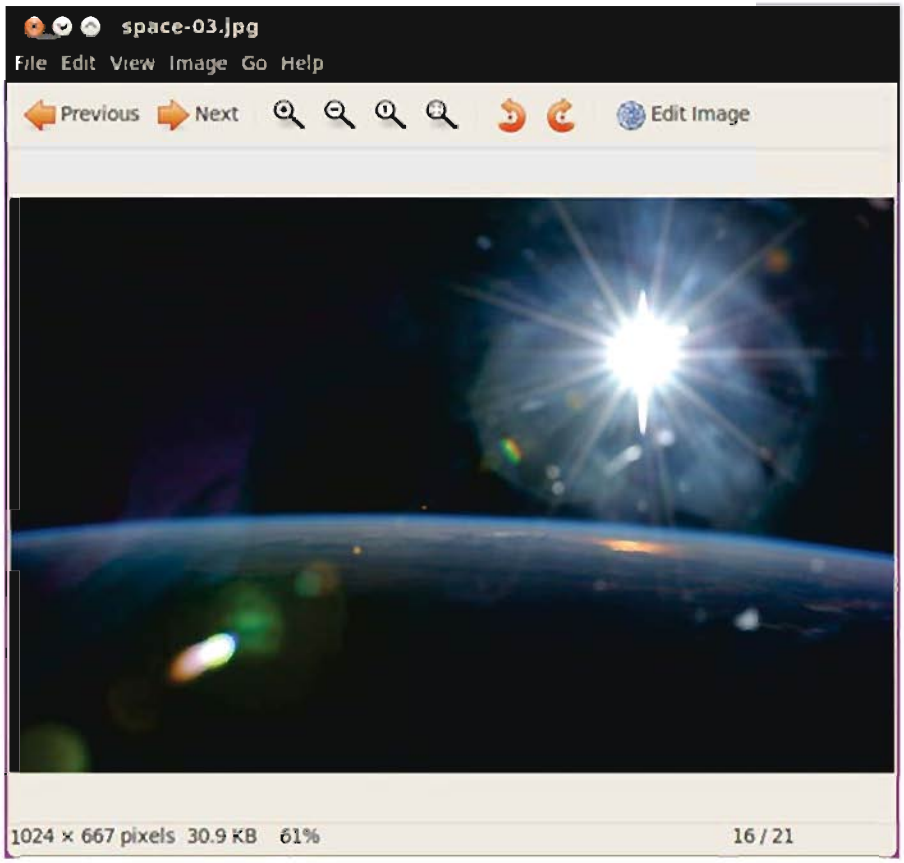


Figure 8.17 : The Eye of Gnome Image Editor

The software provides all the common operations in the toolbar itself. If you have opened the image from a folder that contains other images as well, you may use the Previous and Next tools to view the previous and next images in the folder respectively. The Zoom In and Zoom Out tools can be used to enlarge and shrink the display of the image (not the original image itself) respectively. The Rotate Left and Rotate Right tools rotate the image counterclockwise and clockwise respectively, by 90^0. This is especially useful for viewing photographs taken using a digital camera or mobile phone where we tend to take photographs in portrait mode or landscape mode depending on the scene/object. Again, the change is made to a copy of the image in main memory and is only temporary, but we get to save the changed image for permanent storage on the disk using the File → Save menu option. If we modify some image(s), and then try to close the Image Viewer without saving them, then the software asks us whether we would like to save the changes. Figure 8.18 shows an image in its original form and after each step when the operations Rotate Left, Rotate Left, Rotate Right and Rotate Right are applied in that sequence.

Figure 8.18 : Rotation of an Image

There is also a tool Edit that opens the image in an image editor program, F-Spot by default. However, we shall not discuss it here because we are going to cover the more powerful and better known GIMP image editor in a later section. Also, this tool is not visible by default in later versions of Ubuntu. Some of the more commonly used functionality provided in the menu and not covered by the default toolbar are as mentioned in table 8.1:

Functionality	Description
File → Print	To print the image.
View → Image Collection	Enables the display of a scrollable bar of thumbnails (small preview images) of the images in the current folder, we may click on a thumbnail to see its full view (see figure 8.19)
View → Slideshow	Starts showing images in the current folder one by one, changing images at a fixed interval (shortcut key: F5)
Edit → Undo	To undo the changes made by us (one by one)
Edit → Move to Trash	Delete the image and move it to trash, very useful when you have a large number of images and you want to decide which ones are to be deleted after looking at them.

Edit → Toolbar	Displays several tools, we may add or remove tools to the toolbar by drag and drop.
Edit → Preferences	Allows us to modify some options
Image → Flip Horizontal	Replaces the two halves of the image formed by an imaginary vertical line passing through the center of the image to their mirror images as seen in an imaginary mirror at the said line (see figure 8.20)
Image → Flip Vertical	Replaces the two halves of the image formed by an imaginary horizontal line passing through the center of the image to their mirror images as seen in an imaginary mirror at the said line (see figure 8.21)
Image → Set as Desktop Background	Sets the current image as the desktop background

Table 8.1 : Functionalities of Eye of GNOME

Figure 8.19 : Image Collection in Image Editor

Figure 8.20 shows a series of images in which the first image is in its original form while subsequent images are obtained by flipping the previous image horizontally.

a. b. c.

Figure 8.20 : Horizontal Flipping of Images

Figure 8.21 shows a series of images in which the first image is in its original form while subsequent images are obtained by flipping the previous image vertically.

a. b. c.

Figure 8.21 : Vertical Flipping of Images

Flipping can also be interpreted as if the image were painted on one side of transparent glass. Such an image is visible from both sides. The horizontal flipping would rotate the image 180^0 around a vertical axis passing through the center of the image while vertical flipping would rotate the image 180^0 around a horizontal axis passing through the center of the image (both axes are shown in respective figures for reference). Please note that the images shown in this section are readily available in Ubuntu 10.04 and may be copied from the directories /usr/share/backgrounds and /usr/share/icons/hicolor/scalable/apps into the Pictures directory of your home directory for practice.

The Rhythmbox Music Player

Rhythmbox is the default music player in Ubuntu. It can be used to play music or audio files from the computer, podcasts (digital media, especially audio containing human voice(s) broadcast over the Internet), Internet radio, etc. Rhythmbox can be started from the Applications menu or by double-clicking any audio file. When started, Rhythmbox does not display any window – it simply adds a small music-player-like indicator to the indicator applet on the right hand side of the top panel. It almost seems like it didn't start (if we start it by double-clicking on a file, the file starts playing). However, on clicking on the said indicator we get the options to start

and pause the playback, changing to the next or previous track as well as a "Show Rhythmbox" option to show the actual Rhythmbox window as shown in figure 8.22.

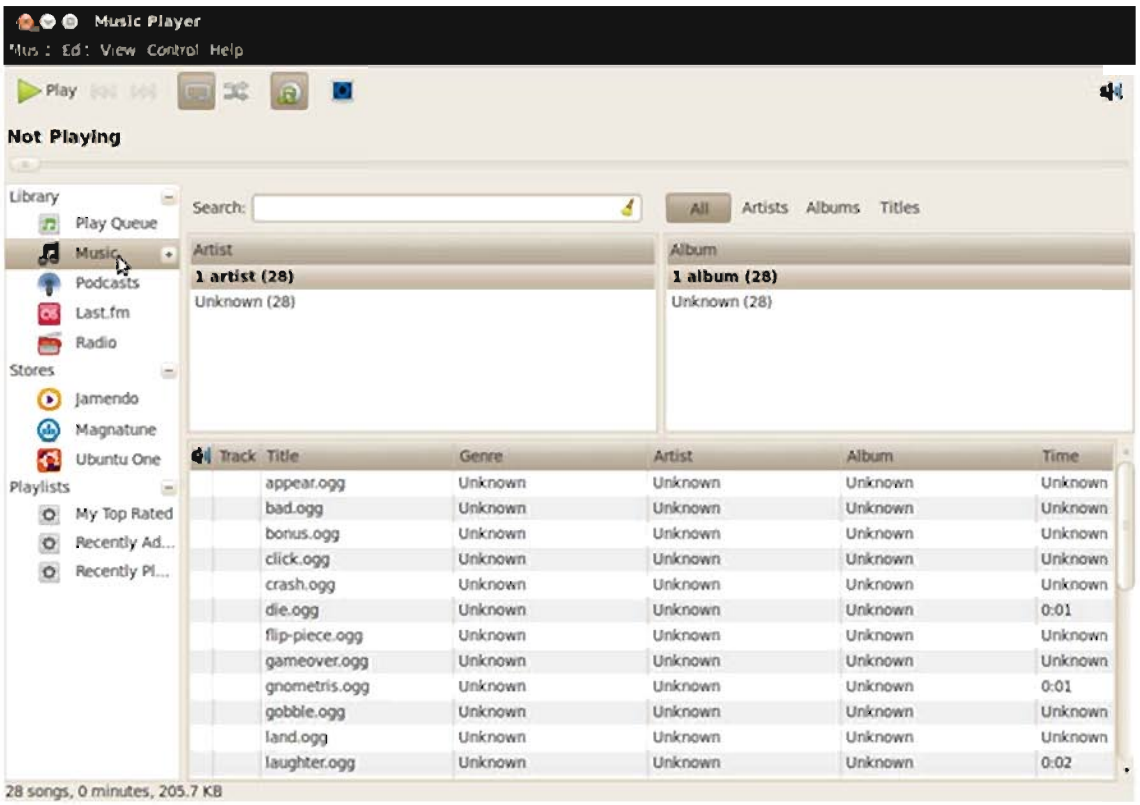


Figure 8.22 : Rhythmbox Music Player

Selecting Quit from the same menu terminates Rhythmbox, while closing the window by clicking on the window close button merely hides it in the indicator applet and the playback of song, if running, continues.

Rhythmbox works just like so many other music player applications. It scans the entire computer or some directories on it as well as connected removable media for audio files and generates a "library" (catalog) of music. For each audio file, called "track", it also stores common information like the album name, artist (singer), genre (type of music), year of publication, etc. wherever available. It also allows the user to sort (arrange) and filter the music based on these attributes. At different times, the user may play music from different albums, by different artists or belonging to a particular genre, according to the mood. It allows the user to create different sets of songs, called playlists, to reflect their choices. Later, the user may instruct Rhythmbox to "play the playlist", Rhythmbox will automatically play songs from the playlist one after another, either in sequence or in random order if the user chooses the "shuffle" option.

Rhythmbox also has some "smart" playlists like "My Top Rated", "Recently Added" and "Recently Played" that are created and automatically updated by Rhythmbox. The user may also use recommendations from the popular Last.fm website, which provides automated or user created music recommendations to users based on the preferences they show or the kind of music they play more. Rhythmbox provides the usual controls like "Play", "Previous Track", "Next Track", "Loop" (start

the first song again after the last song in the playlist) and "Shuffle" (play songs in random order). The "Play" button transforms into "Pause" Once the music starts playing and again becomes "Play" when the music is paused. Even though Rhythmbox is the default music player that comes with Ubuntu, we also have the choice to install other free music player software. Rhythmbox does not support the popular MP3 format out of box because MP3 is a proprietary format covered by patents and creators of hardware or software MP3 players are often asked to pay royalty to the owners of the patents. Ubuntu, as a policy, includes only 100% free and open source software on the CD. But it does allow users to install plug-in software (additional part) that add support for MP3 to Rhythmbox. It also permits installation of other media players (including those supporting MP3). For example, VLC is a free multimedia player that supports several audio and video formats and is widely used.

The Totem Movie Player

Ubuntu bundles the Totem Movie Player for playing video (see figure 8.23). It is a simple video player with an easy to understand interface. You may run a video in it by double-clicking a video file. Alternately, you may click Applications → Sound & Video → Movie Player to open it. The Movie → Open option may then be used to open a video file. The left-central part of the window is used to display the movie. Below the movie display, a slider marked "Time" has a small button on it. Dragging this button back and forth, allows us to watch the movie from a particular time point and to skip or repeat some parts.

Below the time slider are the buttons to move to the previous and next videos and a Play button that transforms into a Pause button when a video starts playing. A small icon besides that allows us to watch the movie in full screen mode.

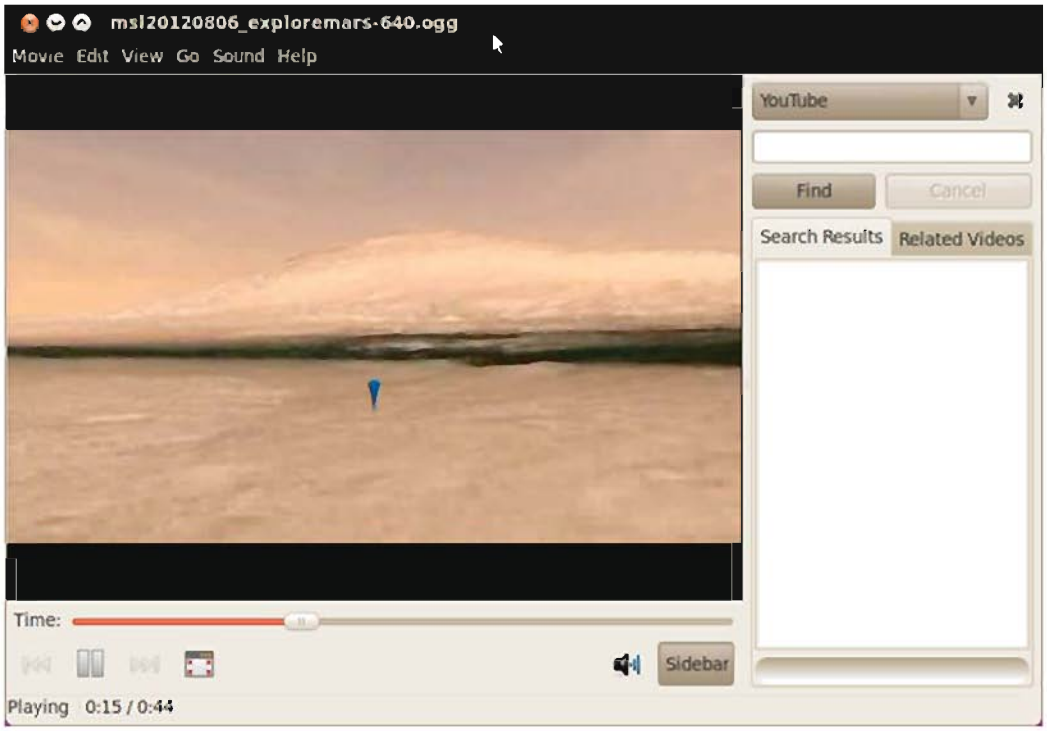


Figure 8.23 : Totem Movie Player

In full screen mode, the video is played over the whole screen, leaving only a small bar at the bottom for essential controls and a button at the top to close the full screen mode and return to normal mode. A speaker button to the right allows us to adjust the volume. The side bar has options to search the popular video-sharing site YouTube, to display the current playlist or to display the properties of the current video.

The Edit menu has the options Repeat (to play again the current movie or playlist when its end is reached, also known as "loop") and shuffle. It also allows us to capture screenshots (still pictures) from the movie currently playing.

Totem movie player comes with support for open video formats. Support for other free, but not open, formats needs to be downloaded in the form of plug-ins.

The GIMP Image Editor

GIMP (GNU Image Manipulation Program) is a powerful image editor. Even though it is free software, its image processing capabilities have started competing with costly professional image processing tools. It has so many features and capabilities that entire books have been written on it, still most not managing to cover everything that GIMP has to offer. As such, the explanation in this section has been highly simplified to mask the complexity and provide a quick overview of some basic concepts and features of this powerful program.

A computer image consists of a rectangular grid of dots called pixels (picture elements). Image processing generally comes down to manipulation of an image (picture) by performing a series of operations on it. Even creation of a new image is done by creating an empty image and then manipulating it. Dozens of image file formats have been developed over a period of decades with different characteristics and applications. Some of the very common image file formats are JPEG (JPG), GIF, BMP, PNG, SVG. While there are dedicated conversion tools, image processing software can also often be used as a format converter. GIMP's native file format is XCF, but it has input filters for importing images in most other common formats and output filters for exporting to a wide range of image formats. Hence a file in one format may be opened in GIMP and saved in another format to achieve conversion.

Since different image file formats have different characteristics, you may be warned that some features may be lost if you save the image in the new format. GIMP's own XCF format supports saving in the image file all the features that GIMP itself supports. You may also be prompted to specify various options for conversion. You may change the options, or accept the default values for them.

GIMP is not included on the Ubuntu CDs by default. Hence we need to install it first by going to Ubuntu Software Center. Once installed, we may start it by clicking Applications → Graphics → GIMP Image Editor or by right-clicking an image file and selecting Open With → GIMP Image Editor. GIMP has a interface that consists of three independently positioned and sized windows by default (See figure 8.24).

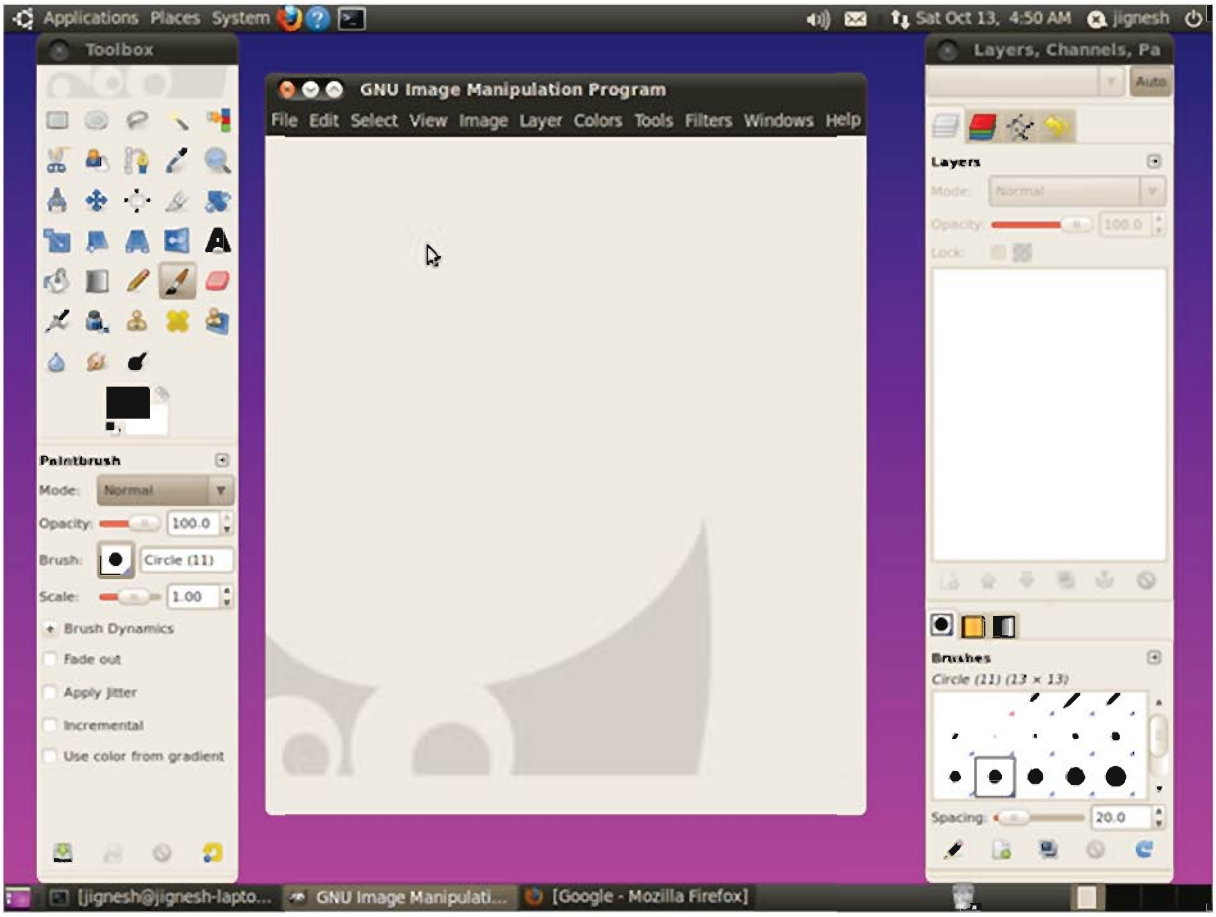


Figure 8.24 : GIMP Image Editor

Later versions also provide the option of a simpler single window interface. We start working with GIMP by either opening an existing file or creating a new one from the File menu. There are three windows – the main window holds the image we are manipulating, the Toolbox and a window holding several additional tools. The Toolbox contains a large number of tools in the upper part. Hovering over a tool displays a tooltip identifying the tool. The lower part displays various options available for the currently selected tool. The general way of working is to select a tool from the upper part, change the options in the lower part if needed and then apply the tool using the mouse in some part of the image in the main window. The menu system also contains a large number of operations to choose from.

An image may also have some transparent areas. By default GIMP displays the transparent areas using a checkered pattern. However, we may change this behavior from the Edit → Preferences menu item. The Display section has a Transparency subsection that allows us to set the check size as well as check colour. We may set the check style to "white only", if we wish. If an image having transparent areas is overlaid over another image, in the transparent portions we can see the image behind it. (See figure 8.25).

Figure 8.25 : Transparency and Overlaying

Did you wonder how the first image was overlaid over the second ? GIMP, like other sophisticated image editors, supports layers. Figure 8.24 shows the "Layers" tab in the right-hand side window. It allows us to create and manipulate layers. Each layer can hold one image, parts of which may be transparent. Each layer can be manipulated individually. The order of layers can also be changed. You may think of an image with multiple layers as consisting of multiple transparent sheets of glass stacked on top of one another, with images painted on them, leaving some parts transparent. When viewed from the top, we see the image on the top sheet, but through its transparent parts we can see the image on the second sheet, third sheet, and so on. Figure 8.26, taken straight from the GIMP manual, explains this concept.

Quite often, you may want to select a portion of the image and perform some operation(s) only on the selected area. GIMP provides various selection tools for this purpose. For example, the Rectangle Select tool allows us to select rectangular (including square) areas. By default, making a new selection removes the previous selection (though this behavior can be changed).

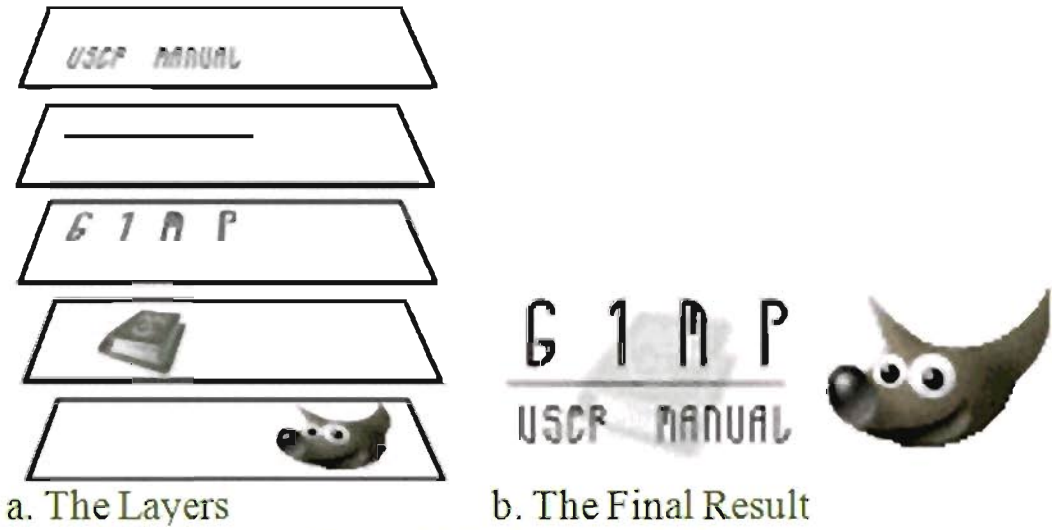


Figure 8.26 : Concept of Layers

GIMP has a notion of the current foreground colour and the current background colour. These colours are used in various tools for drawing and filling. Hence, before using those tools, we should set

the foreground and background tools the way we want. The bottom-most tool in the upper part of the toolbox (one rectangle covering a major part of another rectangle) is used to set these options. In fact, the colour of the partially covered rectangle is the current background colour and the colour of the rectangle covering it is the current foreground colour. By default, these are white and black respectively. To change the foreground or background colour, click on the appropriate rectangle in the tool, which will open the colour selection dialog as shown in figure 8.27.

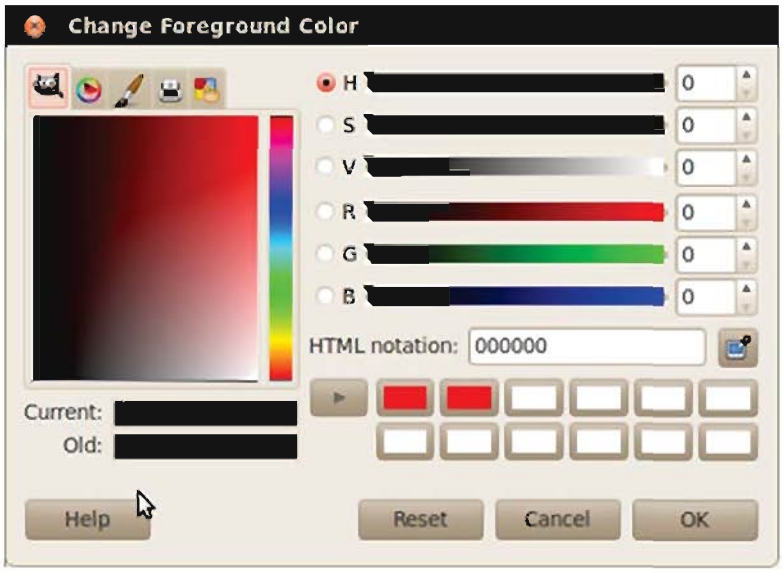


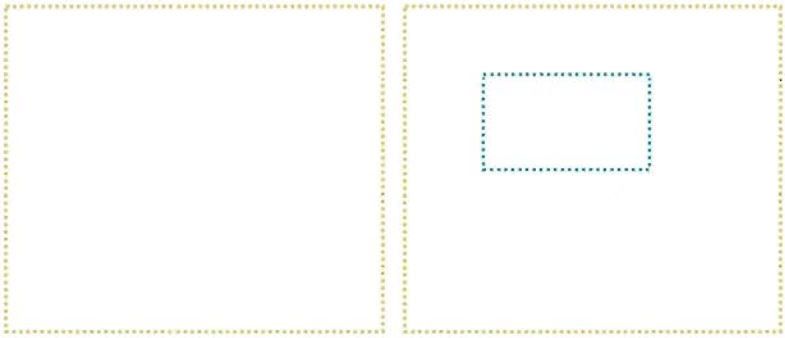
Figure 8.27 : Changing Foreground Colour

The dialog box displays the old (original) colour and the current (new) colour. Initially both are same. While there are so many ways of selecting the colour we want, we shall use one of the two simple methods. First, if you know the exact English name for the colour (this should not be difficult for simple colours like red or orange), you may type the first letter of the colour name in the HTML notation field, which will open up a list of all colours starting with that letter along with previews. You may select the colour you want by clicking on the colour name. The other simple way is to select the colour you want from the vertical rainbow strip besides the large shaded rectangle (try to be as precise as possible). This will fill the large rectangle with shades of that colour. Now click at a point in the rectangle that has the exact shade you want. The current colour field will change to reflect your choice. If you like it, click OK to set the colour, otherwise continue to experiment.

Creating New Image

Now, we shall start by creating a blank image and perform a series of operations in sequence. Each stage of the operations is shown in figure 8.28. Continue to refer to it as each operation is described. First, create a new image by selecting File → New option from the menu. You need to specify the size of the image, which may be in terms of pixels, inches, millimeters, etc. The image is initially blank (see figure 8.28 a). Now, select a rectangular area in the image. First click on the Rectangle Select tool, move the mouse pointer to one corner of the rectangle you want to draw on the image, press the left mouse button and drag to the other corner. Finally, click inside the

rectangle to finalize the selection. (See figure 8.28 b). At this point, we have only selected an area in the image, but we have not changed anything in the image.

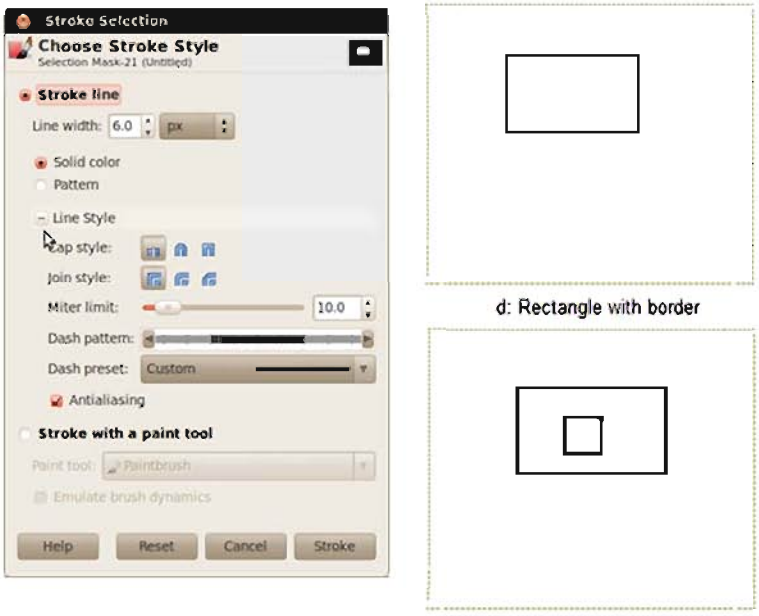


a : Blank Image b : Rectangle drawn

Figure 8.28 : Processing Image in GIMP

Selections are transient in nature and a new selection removes the previous one by default. Now, let us draw a line along the border of the selection. Click the menu option Edit → Stroke Selection, which opens a dialog box (see figure 8.28 c). We may select the thickness of the line and the dash pattern (whether to use a solid line or a dashed line) among a host of options. The line will be drawn using the current foreground colour (see figure 8.28 d).

While a square selection can be done in the same way, to get an exact square follow these steps. First select the same Rectangle Select tool and start dragging from one corner of the square you want to select. Without releasing the mouse button, press the SHIFT key, which will force the rectangle to be a square. When you get the right size, release the mouse button first, and then the SHIFT key. As GIMP is very powerful software with so many options, different combinations of mouse and keyboard actions and even the order in which these actions are taken result in different operation taking place. Figure 8.28 e shows a perfect rectangle drawn in this way.



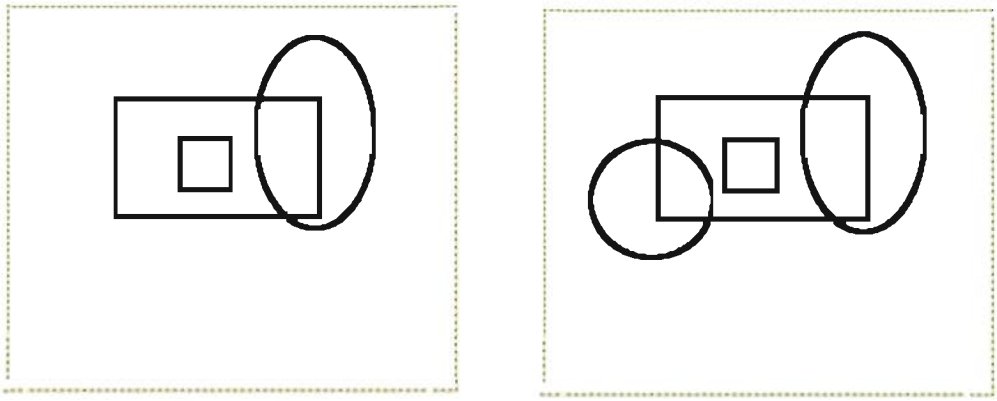
c: Stroke selection

d: Rectangle with border

e: Rectangle and square

Figure 8.28 : Processing Image in GIMP

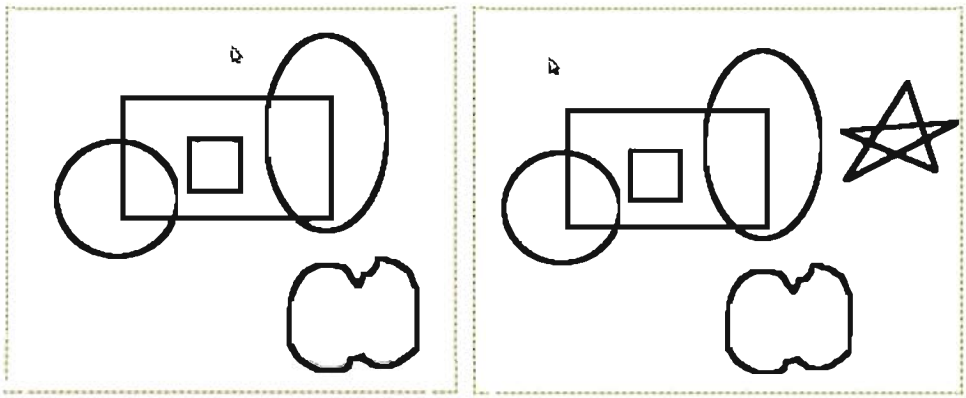
We may use the Ellipse Select tool to select ellipses and, with SHIFT, perfect circles in the same way (figure 8.28 f and figure 8.28 g respectively).



f: Ellipse tool g: Ellispe and circle

Figure 8.28 : Processing Image in GIMP

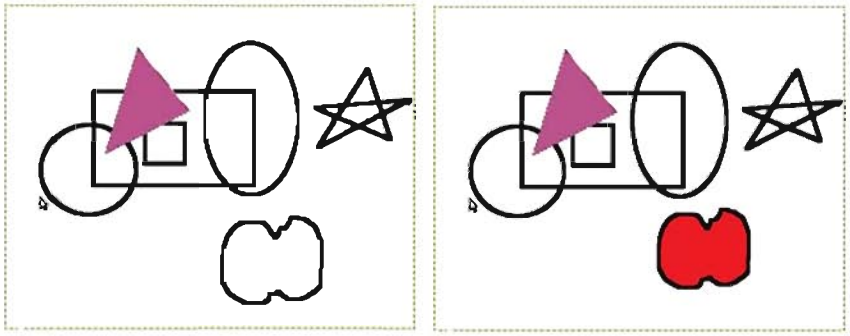
The Free Selection tool allows us to select an area of arbitrary shape. Start at any one point of the shape you want to select and, holding down the mouse button, move the mouse cursor as if you were drawing with a pencil. If a part of the shape is a straight line, release the mouse button when drawing that part, which will draw a perfect straight line. You must close the shape by ultimately reaching back to your starting point before releasing the mouse button because all selections must be closed shapes (see figure 8.28 h). A polygon consisting of arbitrary shapes can be drawn using the Free Selection tool. To draw a polygon, just go on clicking on the points of the polygon in sequence (do not hold down the mouse button), clicking on the first point again at the end (See figure 8.28 i).



h: Arbitrary shape i: Polygon

Figure 8.28 : Processing Image in GIMP

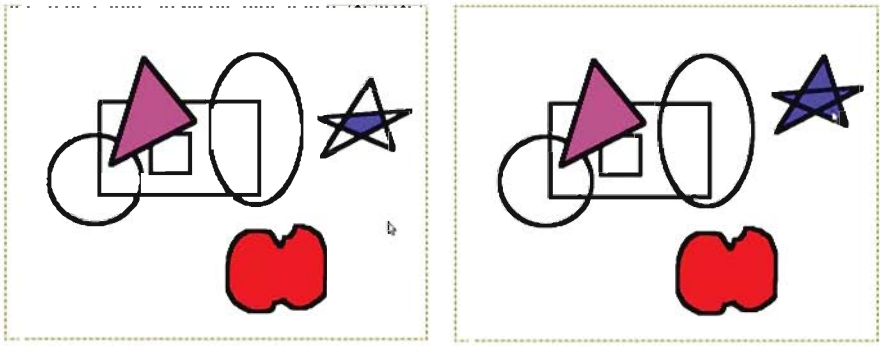
If you want to fill a shape with some colour, there are two options. Immediately after selecting the shape; select Edit → Fill with FG Color menu option, which will fill the selection with the current foreground colour as shown in figure 8.28 j. After this, you may change the background colour and stroke the figure to get a border, if you want. The other alternative is to select the Bucket Fill tool and click on any point inside the shape we want to fill (See figure 8.28 k).



j : Filling foreground colour k : Using bucket fill

Figure 8.28 : Processing Image in GIMP

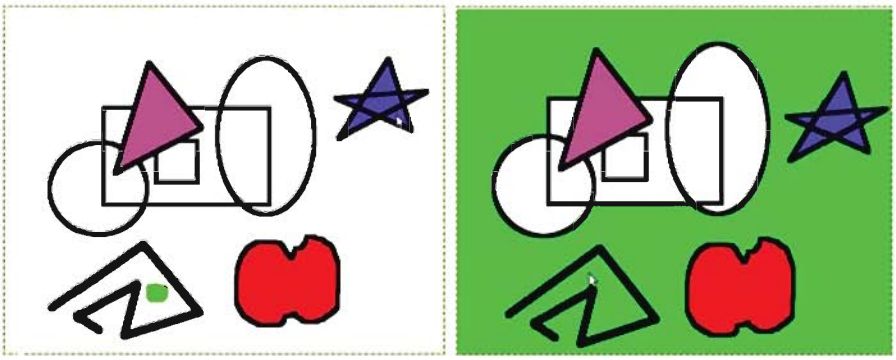
It will only fill the innermost immediately enclosing shape (see figure 8.28 l). You may have to click repeatedly to fill different parts of a shape as shown in figure 8.28 m). This gives you an opportunity to fill different parts of a shape with different colours (by changing the foreground colour in between), if required. If you click in an open area or a shape that is not closed by solid colour from all sides, the fill colour will "spill over outside" and fill all open areas of the image.



l: Filling inner area m: Filling inner area

Figure 8.28 : Processing Image in GIMP

For example, clicking on the point marked with green in figure 8.28 n, the colour will flow out and fill all open areas as shown in figure 8.28 o because the shape in question is open. Fortunately, if you commit any mistake and want to correct it, you can always undo your last actions in reverse order by selection Edit → Undo option or the shortcut key CTRL+Z. We undo the last fill before continuing.

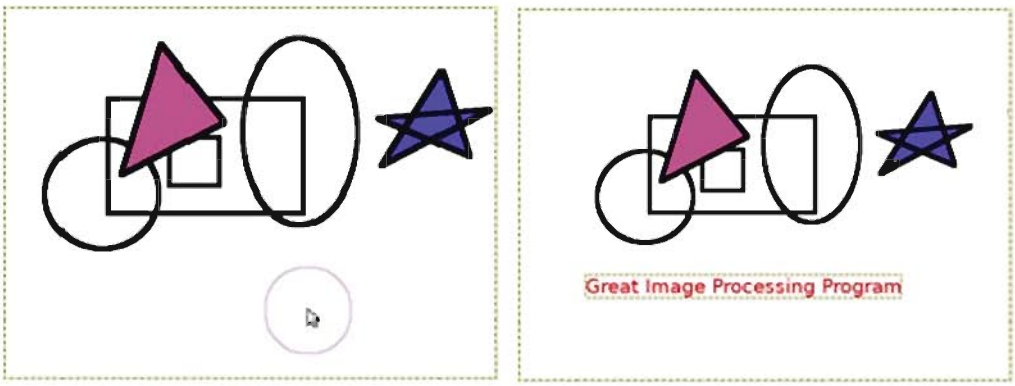


n: Selection of green point o: Outside fill

Figure 8.28: Processing Image in GIMP

But wait! Did you not read that all selections must be closed ? Then how did we land with an open shape in the first place ? Another question: how do you put a dot in the figure or draw a line ? Well, the answer to these questions is – using the pencil tool. When you select the pencil tool and click anywhere in the image, a tiny circle (its size can be set) is drawn and filled with the foreground colour. You may go on clicking like this to create more circles at different locations in the image. If you hold down the shift key when clicking, a straight line is drawn in place of a circle, connecting the previous point to the current one. One may draw such lines anywhere one wishes and shapes created using such lines need not be closed.

What do you do if you are making a pencil drawing and want to correct something ? You use an eraser. Indeed, GIMP also provides an eraser tool that can be used to erase parts of the drawing. Unlike a real world eraser, GIMP's eraser can change both the size and the shape as per your wish. Figure 8.28 p shows the image after we erase some portion with a large circular eraser. Using the Text tool one may write text in the image (see figure 8.28 q). One gets to choose the font, font size, colour, etc. Clicking anywhere in the image brings up a dialog in which you may type the text. The text appears at the location where you typed. It can be corrected or moved immediately after creation by clicking inside. You correct the text in the dialog that opens and move the text by dragging it (ignoring the dialog).

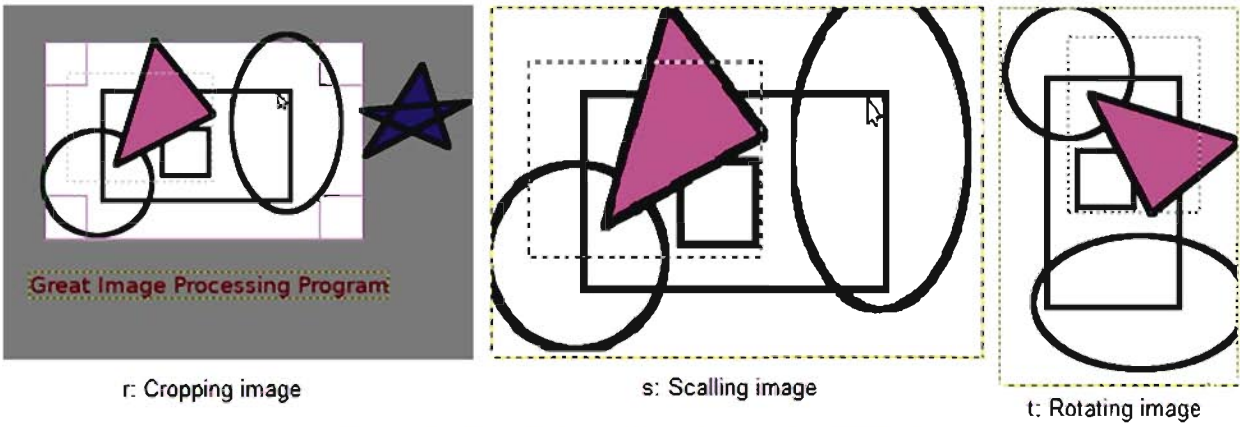


p: Erasing shapes q: Writing Text

Figure 8.28 : Processing Image in GIMP

The act of cutting certain parts of the image out is called cropping. The Crop tool is used to crop the image. After selecting it, we use drag and drop to draw a rectangle on the image (see figure 8.28 r). The rest of the image is darkened to highlight the rectangle. If we click inside the rectangle we have drawn, the image is cropped to that rectangle, i.e. everything outside that rectangle is "cut out " (removed) from the image (see figure 8.28 s). An image can be "scaled", i.e. its size changed (enlarged or reduced) by selecting the menu item Image → Scale Image. In the dialog that appears, we change either the height or width and the other will automatically change correspondingly to maintain the "aspect ratio" (ratio of width to height). If we click on the little chain symbol between these two, it breaks the link and allows us to change both arbitrarily, not caring to maintain aspect ratio.

If you do this on a person's photograph, the person may look fatter or thinner in the scaled image. And yes, if you remember the facilities provided by the Eye of GNOME viewer, what that simple program can do, GIMP can do too. An image can be rotated or flipped by selecting the appropriate options from the Image → Transform menu item. Figure 8.28 t shows the image after rotation by 90^0 clockwise.



r: Cropping image s: Scalling image t: Rotating image

Figure 8.28 : Processing Image in GIMP

Even though we have covered only basic features of GIMP in this text, it has probably become clear to you that GIMP is a very powerful and feature-rich image editor.

Summary

In this chapter we discussed some of the utility programs that are available under Ubuntu. The Nautilus file manager program allows us to manipulate files and directories with ease using a GUI. The calculator program lets us perform arithmetic and scientific calculations quickly, easily and accurately. The gedit Text Editor can be used to create and manipulate text files. There are built-in applications for viewing multimedia content like pictures, audio and video. GIMP is an extremely powerful image editor program that can be used for various types of image processing tasks.

EXERCISE

1. Write down the benefits of the GNOME Terminal over ordinary text terminal.
2. What are the preferences in Terminal ?
3. Explain how the CLI works.
4. What are the components of the Nautilus window ? What is the function of each ?
5. Explain different views in Nautilus and how to switch between them.
6. Explain the cut, copy and paste operations.
7. Explain the checking of spelling in gedit.

8. Describe the image viewing features of Eye of GNOME.
9. Describe the image editing features of Eye of GNOME.
10. Explain horizontal flipping of an image with the help of a figure.
11. Explain vertical flipping of an image with the help of a figure.
12. Write down the process of selecting a colour in GIMP.
13. How do you draw a line along the border of a selection ? What options do you have in performing this operation ?
14. Write the process of drawing a perfect square in GIMP.
15. Write the process of drawing a perfect circle in GIMP.
16. Describe the working of the Free Selection tool.
17. What is cropping ? How is it done ?
18. **Choose the most appropriate option from those given below :**

(1) What is the shortcut key to start a GNOME Terminal ?

(a) SHIFT+ALT+G (b) CTRL+SHIFT+T

(c) CTRL+ALT+T (d) CTRL+SHIFT+G

(2) How many lines of output are stored in the memory by default by the GNOME Terminal ?

(a) 251 (b) 512

(c) 521 (d) 215

(3) What is the shortcut key to switch to the 3rd tab in the GNOME Terminal ?

(a) ALT+3 (b) CTRL+ALT+3

(c) SHIFT+CTRL+3 (d) CTRL+SHIFT+3

(4) What is the shortcut key to paste text in the GNOME Terminal ?

(a) SHIFT+ALT+P (b) SHIFT+CTRL+P

(c) SHIFT+CTRL+P (d) SHIFT+CTRL+V

(5) Which command is used to come out of the CLI session ?

(a) finish (b) terminate

(c) quit (d) exit

(6) What is the name of the default file browser in Ubuntu ?

(a) Notorious (b) Nautilus

(c) Notirus (d) Nautirus

(7) Which program is used to open text files by default ?

(a) vi (b) gedit

(c) Plain Text Editor (d) Nautilus

(8) Which program is used to open image files by default ?

(a) gedit (b) GIMP

(c) GNOME (d) Eye of GNOME

(9) Which program is used to open video files by default ?

(a) Totem Movie Player (b) Tutom Video Player

(c) VLC Player (d) Eye of GNOME

(10) Which of the following is not a view in Nautilus ?

(a) Icon View (b) List View

(c) Files View (d) Compact View

(11) Which of the following view in Nautilus allows sorting files by clicking the column heading ?

(a) Icon View (b) List View

(c) Files View (d) Compact View

(12) Which of the following view in Nautilus displays + or – against folders ?

(a) Icon View (b) Files View

(c) Compact View (d) List View

(13) An object that is copied is stored on -

(a) the whiteboard (b) the blackboard

(c) the chopboard (d) the clipboard

(14) Which operation creates a new copy of the object ?

(a) copy followed by paste (b) cut followed by paste

(c) paste followed by copy (d) paste followed by cut

(15) Which operation moves the object ?

(a) copy followed by paste (b) cut followed by paste

(c) paste followed by copy (d) paste followed by cut

(16) Which of the following is not a type of calculator available in Ubuntu ?

(a) Advanced (b) Binary

(c) Scientific (d) Programming

(17) What is the shortcut key for undoing the last action in gedit ?

(a) CTRL+U (b) ALT+U

(c) CTRL+Z (d) ALT+Z

(18) The default image viewer in Ubuntu is known as -

(a) See of GNOME (b) View of GNOME

(c) Eye of GNOME (d) (D) Sea of GNOME

(19) What is the name of the default music player in Ubuntu ?

(a) Rhythmbox (b) Banshee

(c) VLC (d) Media Player

(20) What is the full form of GIMP ?

(a) Great Image modification Program

(b) General Image Modification Program

(c) GNU Image Modification Program

(d) GNU Image Manipulation Program

(21) Which is GIMP's native file format ?

(a) XPG (b) XCF

(c) JPG (d) PNG

(22) Which tool is used to fill a shape with colour in GIMP ?

(a) Bucket Tool (b) Fill Tool

(c) Bucket Fill Tool (d) Shape Fill Tool

(23) Which tool can be used to draw open shapes ?

(a) Line Tool (b) Pen Tool

(c) Bucket Fill Tool (d) Pencil Tool

(24) The act of cutting certain parts of the image out is called -

(a) deleting (b) cropping

(c) scaling (d) erasing

(25) The act of enlarging or shrinking an image is called -

(a) deleting (b) cropping

(c) scaling (d) erasing

LABORATORY EXERCISE

1. Start the Terminal. Close it using the appropriate command. Again start it and close it using a key combination.
2. Type the command *ls* in the Terminal and copy-paste its output into a file opened using gedit. Note down your observation.
3. Create a directory structure as shown in the following figure in your home directory (directories are marked in green colour, while files are marked in blue).