Lab Manual

CSC322-Operating Systems

CUI

Department of Computer Science
Islamabad Campus

Lab Contents:

Installating Linux Distrubutions on Virtaul Machnes; Linux Command-line Interface: Basic Syntax, Navigation Commands, File & Directory Handling Commands, I/O Redirection, Controlling Access to Files, Package Management, Text-processing, Pipelining, Process Management; Writing & Compiling C++ on Linux; Process Management: Creating Child Processes, IPC with Shared-Memory & Message-Passing, Multithreading, Synchronization; Shell Scripting: Fundamentals, I/O, Variables, Operators, Conditional Statements, Looping Statements, Arrays, and Functions.

Student Outcomes (SO)

S.#	Description
1	Apply knowledge of computing fundamentals, knowledge of a computing specialization, and mathematics, science, and domain knowledge appropriate for the computing specialization to the abstraction and conceptualization of computing models from defined problems and requirements
2	Identify, formulate, research literature, and solve complex computing problems reaching substantiated conclusions using fundamental principles of mathematics, computing sciences, and relevant domain disciplines
4	Create, select, adapt and apply appropriate techniques, resources, and modern computing tools to complex computing activities, with an understanding of the limitations

Intended Learning Outcomes

Sr.#	Description	Blooms Taxonomy Learning Level	SO
CLO -5	Operate basic services and functionality of operating systems.	*Applying*	1
CLO -6	Compose Linux commands using Shell scripting.	*Applying*	1,4
CLO -7	Implement the concepts of process management.	*Applying*	2,4

Lab Assessment Policy

The lab work done by the student is evaluated using rubrics defined by the course instructor, viva-voce, project work/performance. Marks distribution is as follows:

Assignments	Lab Mid Term Exam	Lab Terminal Exam	Total
25	25	50	100

Note: Midterm and Final term exams must be computer based.

List of Labs

Lab No. 01

Installing Linux Distribution on Virtual Machine, Command-line Interface

Objective:

This lab will introduce the Linux Operating System to you. You will learn the how to createVM using Virtual-Box, Installing Ubuntu on VM and the basic syntax of Linux Commands.

Activity Outcomes:

On completion of this lab students will be able to:

- Introduction of Linux OS, Linux Distros and Virtual Machines
- Creating VM in Virtual-Box
- Installing Ubuntu on VM
- Writing basic commands in CLI

Instructor Note:

As pre-lab activity, read Chapter 1 to 6 from the book “The Linux Command Line”, William E.Shotts, Jr.

1) Useful Concepts

Operating System

An operating system (OS) is a program that interacts as interface between a user and ans a computer system software. It manages computer hardware, software resources, and provides common services for computer programs. Primary Goals of an Operating System include: To provide ease of use, convineance and throughput. The main functions perform by operating system can be categorized as: Process management, Resource Management, Stroge Management, Memory Management and Security Management.

Why Linux

Linux is among the most popular operating systems. The main reasons for this popularity are: Free and open source, Stable and Reliable, Secure, and Flexible.

Linux History

Linux was originally developed for ***personal computers*** based on the ***Intel x86*** architecture, but has since been ***ported*** to more ***platforms*** than any other operating system. In the early 1990s, Finnish computer science student Linus Torvalds began hacking on Minix, a small, Unix−like operating system for personal computers then used in college operating systems courses. He decided to improve the main software component underlying Minix, called the kernel, by writing his own. (The kernel is the central

component of any Unix−like operating system.) OnSeptember 1991, Torvalds published the first version of this kernel on the Internet, calling it "Linux" (a play on both Minix and his own name).(7) When Torvalds published Linux, he used the copyleft software license published by the GNU Project, the GNU General Public License. Doing so made his software free to use, copy, and modify by anyone−−provided any copies or variations were kept equally free. Torvalds also invited contributions by other

programmers, and these contributions came; slowly at first but, as the Internet grew, thousands of hackers and programmers from around the globe contributed to his free software project. The Linux software was immensely extended and improved so that the Linux−based system of today is a complete, modern operating system, which can be used by programmers and non−programmers .

Popularity:

Because of the dominance of the Linux-based Android on smartphones, Linux also has the largest installed base of all general-purpose operating systems. Although Linux is used by only around 2.3 percent of desktop computers, the Chromebook, which runs the Linux kernel-based Chrome OS, dominates the US K–12 education market and represents nearly 20 percent of sub $300 notebook sales in the US. Linux is the leading operating system on servers (over 96.4% of the top 1 million web servers' operating systems are Linux), leads other big iron systems such as mainframe computers, and is the only OS used on TOP500 supercomputers (since November 2017, having gradually eliminated all competitors).

Linux also runs on embedded systems, i.e. devices whose operating system is typically built into the firmware and is highly tailored to the system. This includes routers, automation controls, smart home technology, televisions (Samsung and LG Smart TVs use Tizen and WebOS, respectively) , automobiles (for example, Tesla, Audi, Mercedes-Benz, Hyundai, and Toyota all rely on Linux), digital video recorders, video game consoles, and smartwatches. The Falcon 9's and the Dragon 2's avionics use a customized version of Linux.

Linux Distribution

Linux is open-source, free to use kernel. It is used by programmers, rganizations, profit and non-profit companies around the world to create Operating systems to suit their individual requirements.To prevent hacking attempts, many organizations keep their Linux operating systems private. Many others make their variations of Linux available publicly so the whole world can benefit at large. These versions/ types /kinds of Linux operating system are called Distributions. A list of most popular Linux distributions is given below:

Deepin	**Deepin** is a Linux desktop-oriented operating system derived from *Debian*, supporting laptops, desktops, and all-in-ones. It aims to provide a beautiful, easy-to-use, safe, and reliable operating system to global users.
MX Linux	It is one of the most popular Desktop Distributions available out there. It launched in 2006 and is now considered to be the fourth most used Operating system in the computing world.
archlinux	This Linux Distro is popular amongst Developers. It is an independently developed system. It is designed for users who go for a do-it-yourself approach.
slackware linux	Slackware aims for design stability and simplicity
redhat	Another popular enterprise based Linux Distribution is Red Hat Enterprise.It has evolved from Red Hat Linux which was discontinued in 2004. It is a commercial Distro and very popular among its clientele.

nubuntu	This is the third most popular desktop operating system after Microsoft Windows and Apple Mac OS. It is based on the Debian Linux Distribution, and it is known as its desktop environment.
	Another Linux kernel based Distro, Fedora is supported by the Fedora project, an endeavor by Red Hat. It is popular among desktop users. Its versions are known for their short life cycle.

In this course, we will use the Ubuntu distro. Ubuntu is a popular and to use graphical Linux distro. It was developed and released by Canonical Ltd. in 2004. It is freely available and can be downloaded from ***http://www.ubuntu.com/download/desktop***.

Installing Ubuntu

Before discussing the options available to install Ubuntu, we discuss the basic system requirement. It is recommended to Ubuntu should be installed on a system that has a 2 GHz dual core processor with 2GB RAM and 25GB of free hard disk space. There are many ways to use Ubuntu. It can be installed on a system as a stand-alone OS. Similarly, it can be installed as multi-boot system where it is installed on a system that already has any other OS like windows. Further, it can also be used without installing from a bootable USB. However, in this course we will run the Ubuntu on virtual machine. To create virtual machine we will use Oracle VM Virtual-box. In the following, first we give an overview of Virtual-Box and then discuss the installation process of Ubuntu on VM.

Installing Linux using Virtual Machine

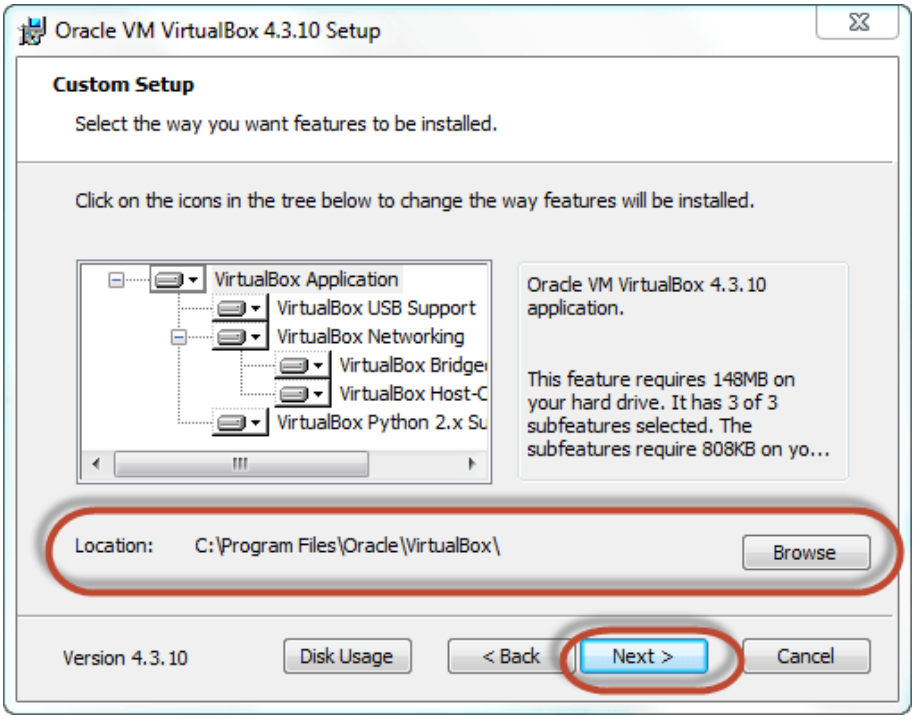
This is a popular method to install a Linux operating system. The virtual installation offers you the freedom of running on an existing OS already installed on your computer. This means if you have Windows running, then you can just run Linux with a click of a button.***Virtual machine software*** like Oracle VM can install Linux on Windows in easy steps. Let us look at them.
The following diagram shows the steps required to install Ubuntu on VM

Download and Install Virtual Box: Download Virtual box using this ***link*** Depending on your processor and OS, select the appropriate package. In our case, we have selectedwindows with AMD.

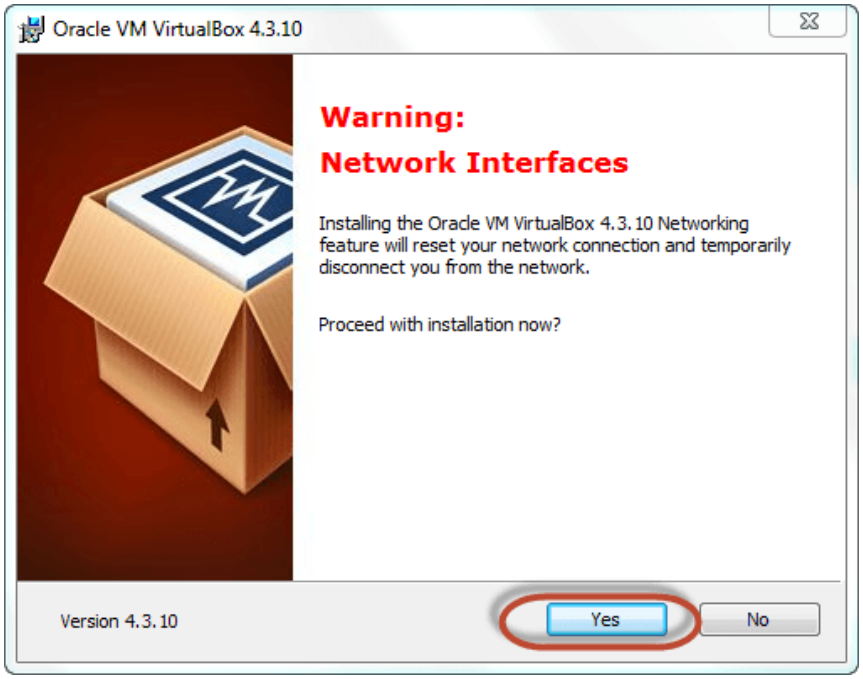
Once the download is complete, Open setup file and follow the steps below:

Click On next

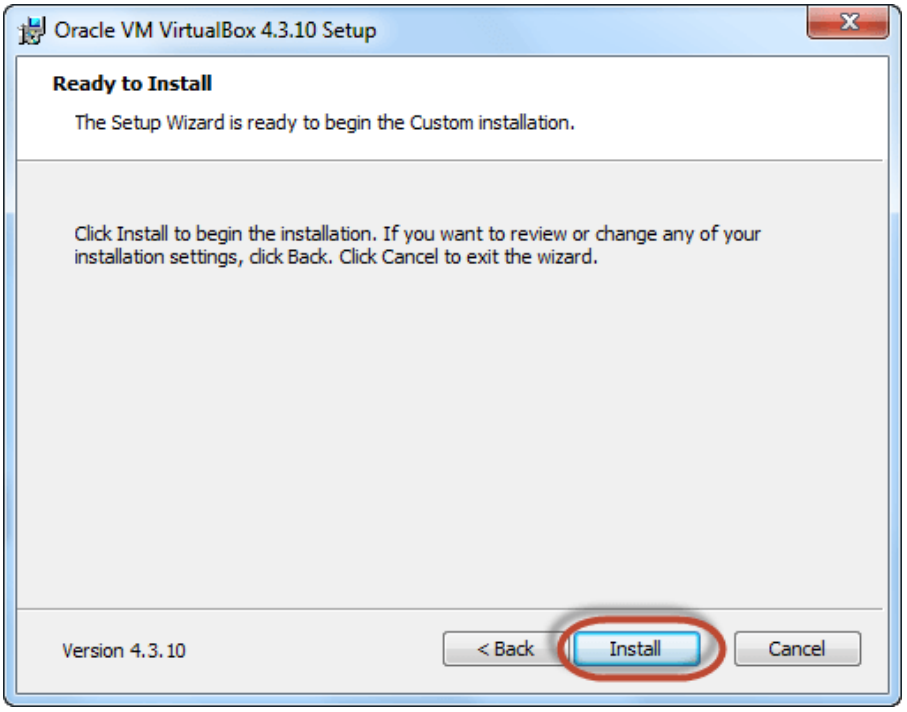
Select you're the directory to install VirtualBox and click on next



Select Desktop icon and click on next, now click on yes

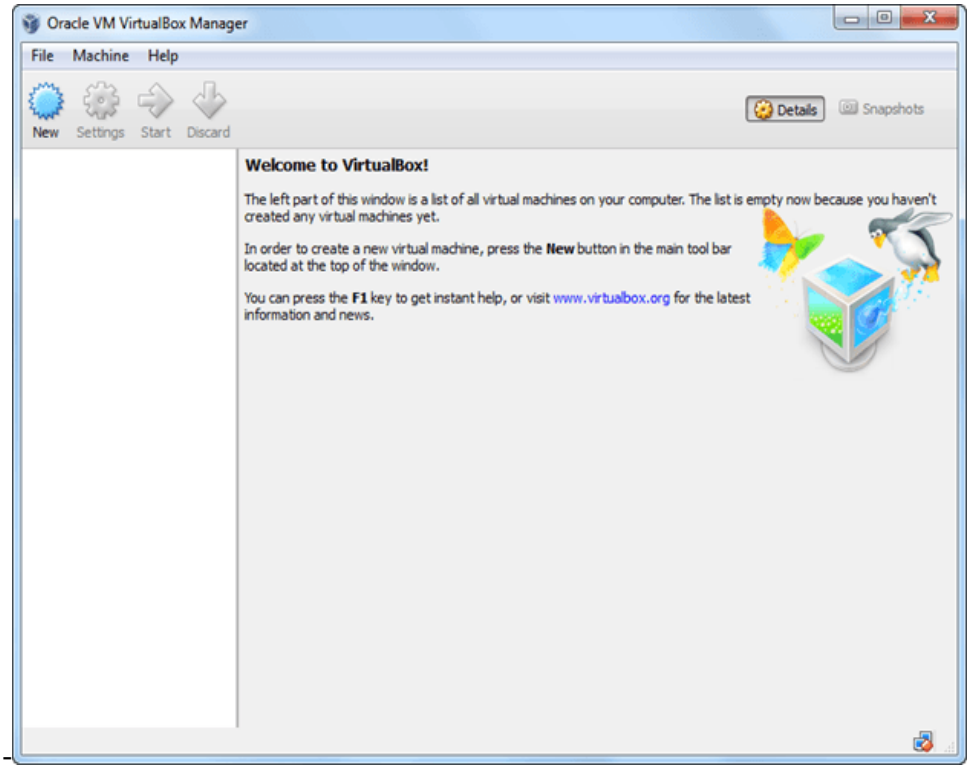


Click On install-to-install Linux on Windows.



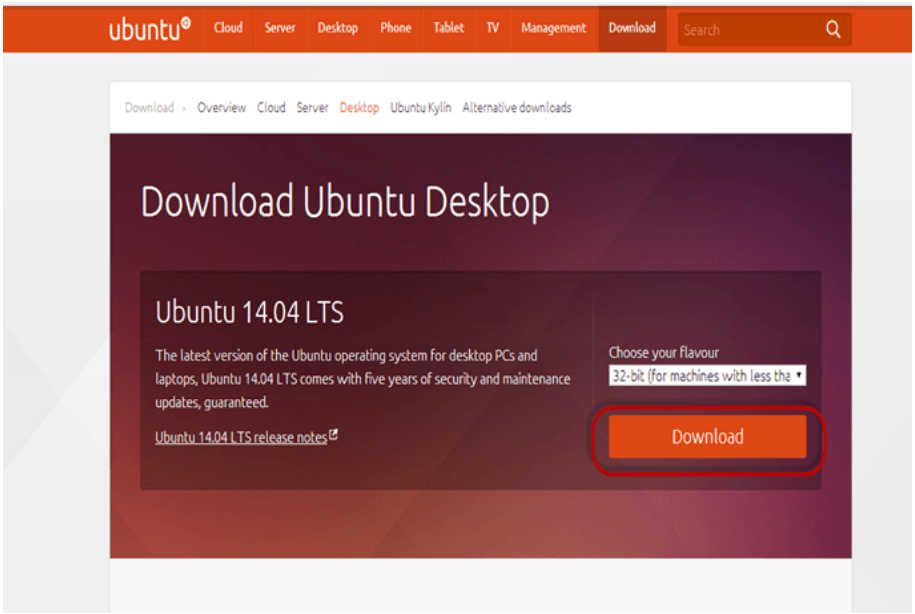
Now installation of the virtual box will start. Once complete, click on Finish Button to start Virtual Box

The virtual box dashboard looks like this



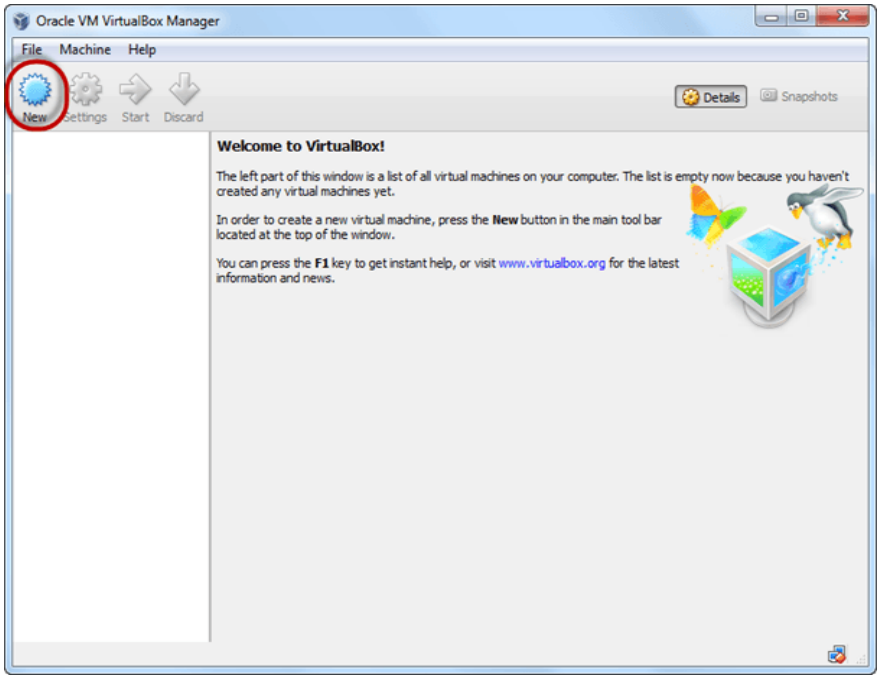
Download Ubuntu:

Visit this link to ***download*** Ubuntu.

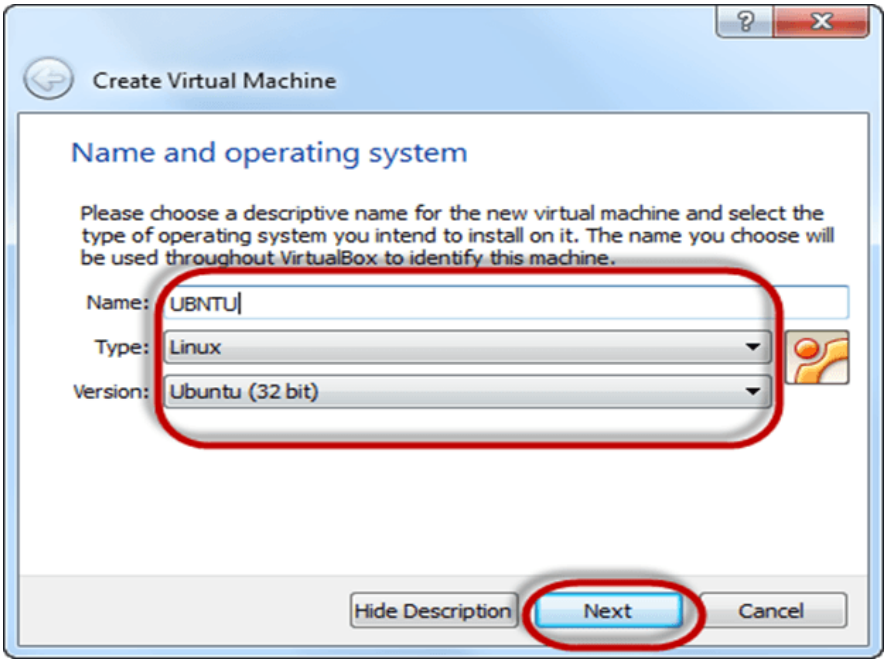


You can select 32/64-bit versions as per your choice.

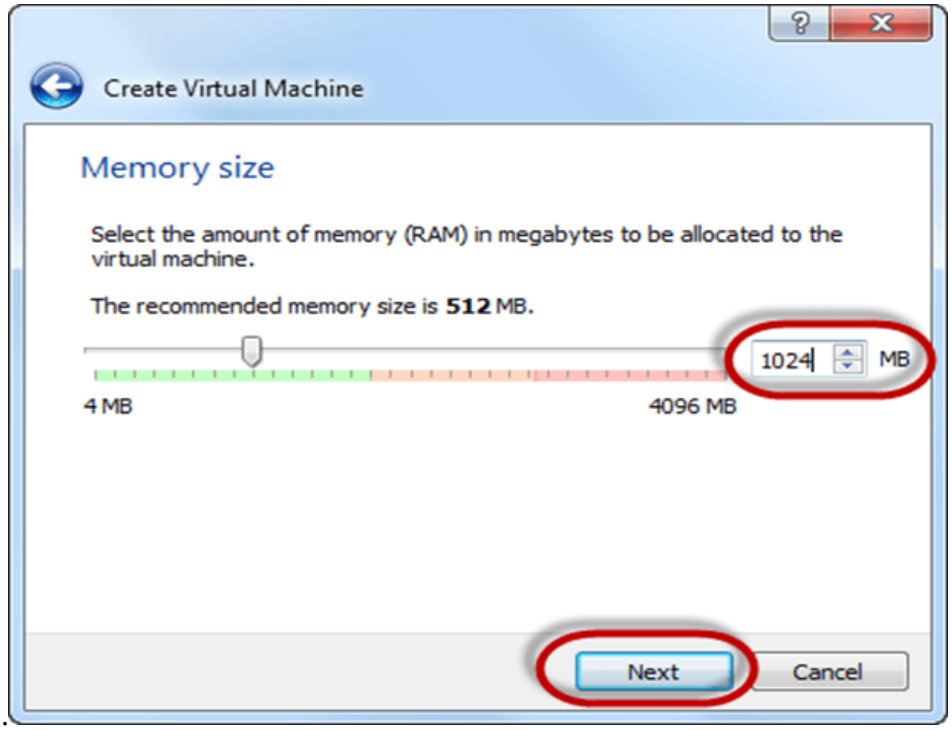
Create a Machine in Virtual Box: Open Virtual box and click on new button



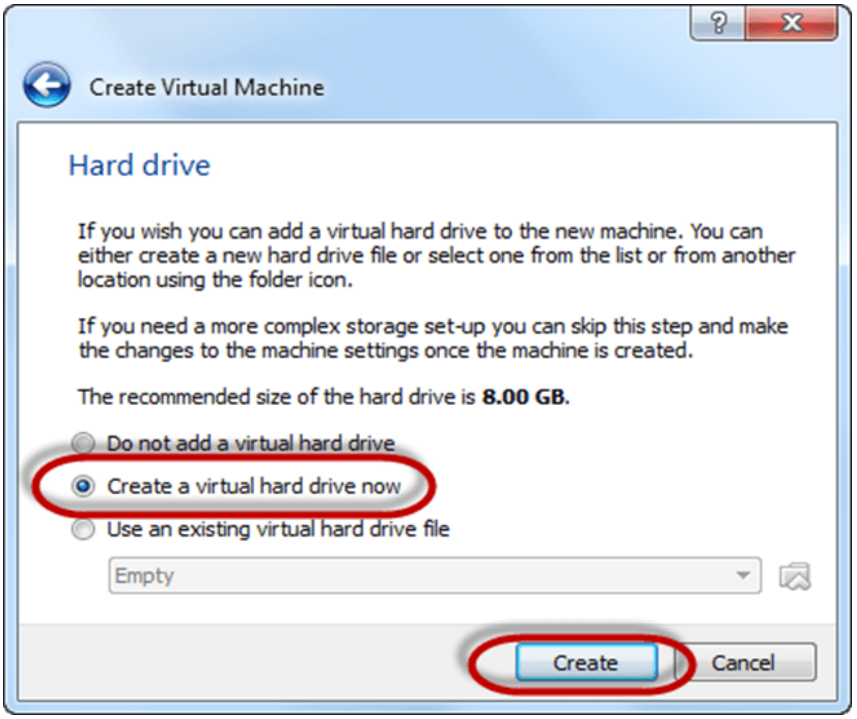
In next window, give the name of your OS which you are installing in virtual box. And select OS like ***Linux*** and version as Ubuntu 32 bit. And click on next



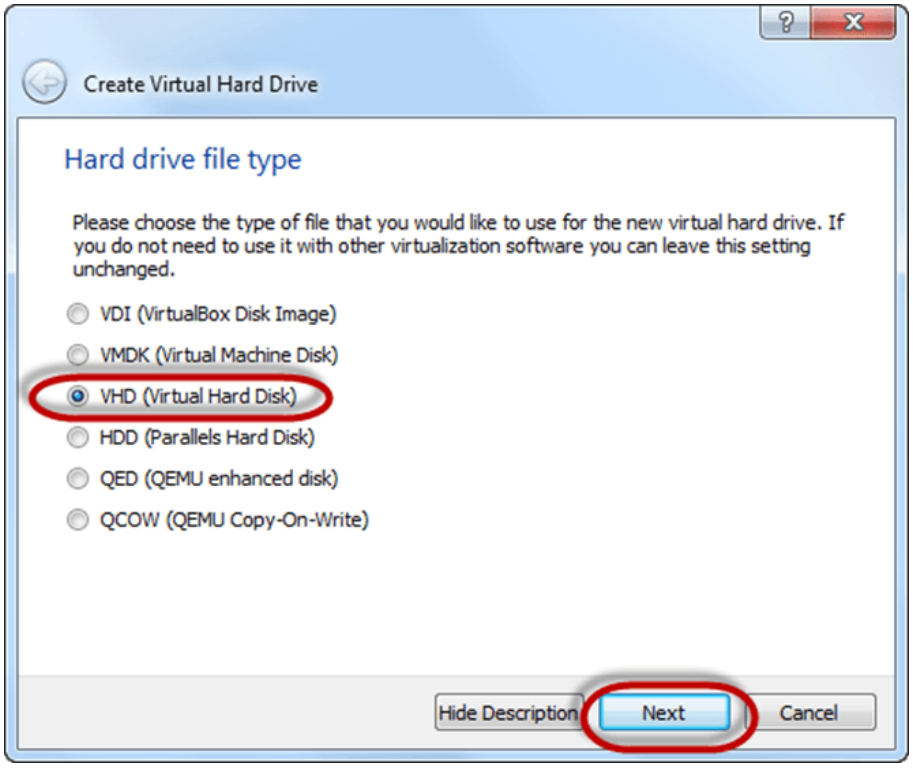
Now Allocate Ram Size To your Virtual OS. I recommended keeping 1024mb (1 GB) ram to run Ubuntu better. And click on next



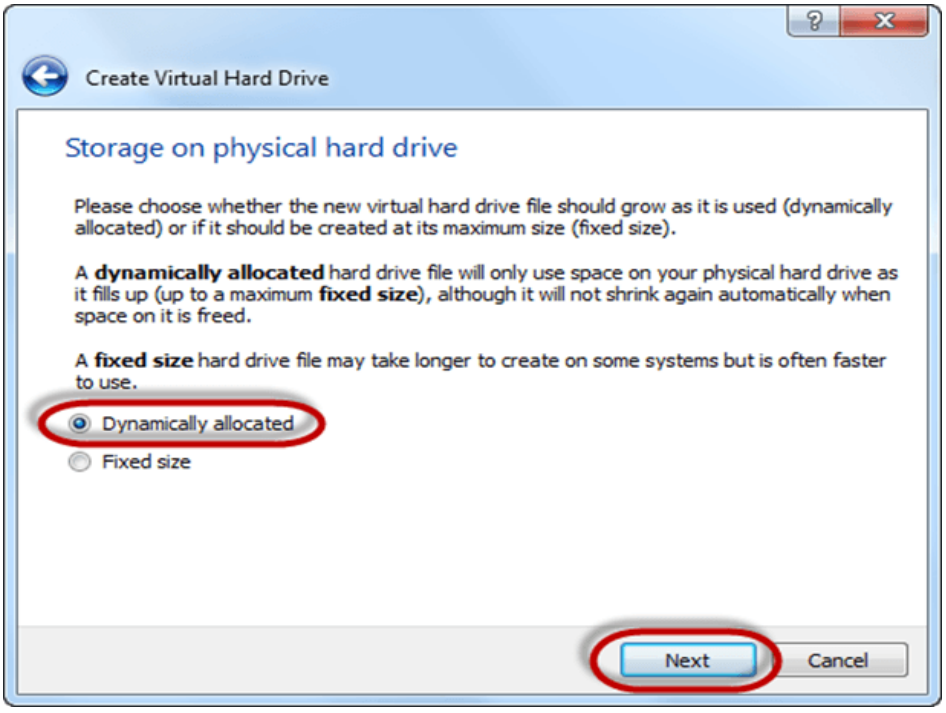
Now To run OS in virtual box we have to create virtual hard disk, click on create a virtual hard drive now and click on create button. The virtual hard disk is where the OS installation files and data/applications you create/install in this Ubuntu machine will reside



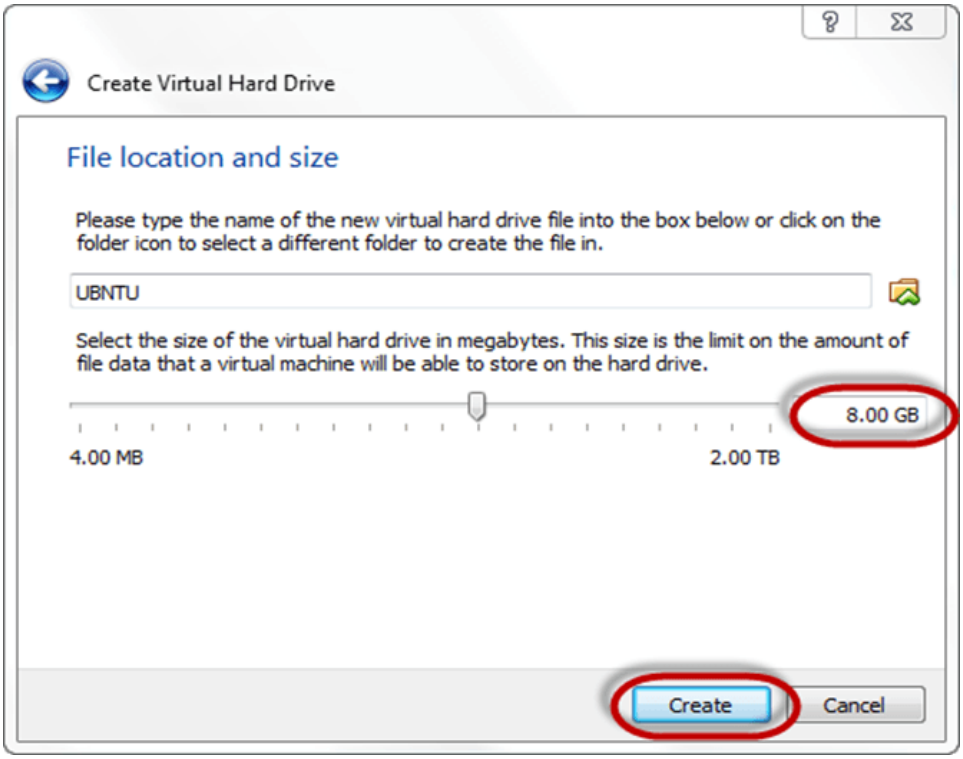
select VHD (virtual hard disk) option and click on next.



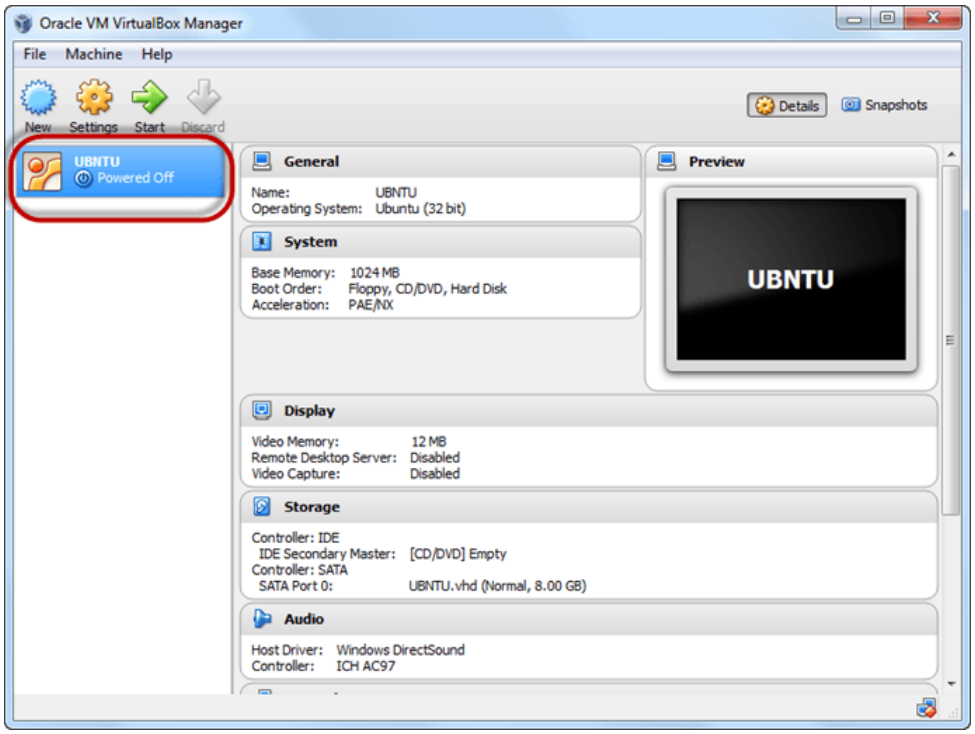
Click on dynamic allocated and click on next. This means that the size of the disk will increase dynamically as per requirement.



Allocate memory to your virtual hard drive .8GB recommended. Click on create button.



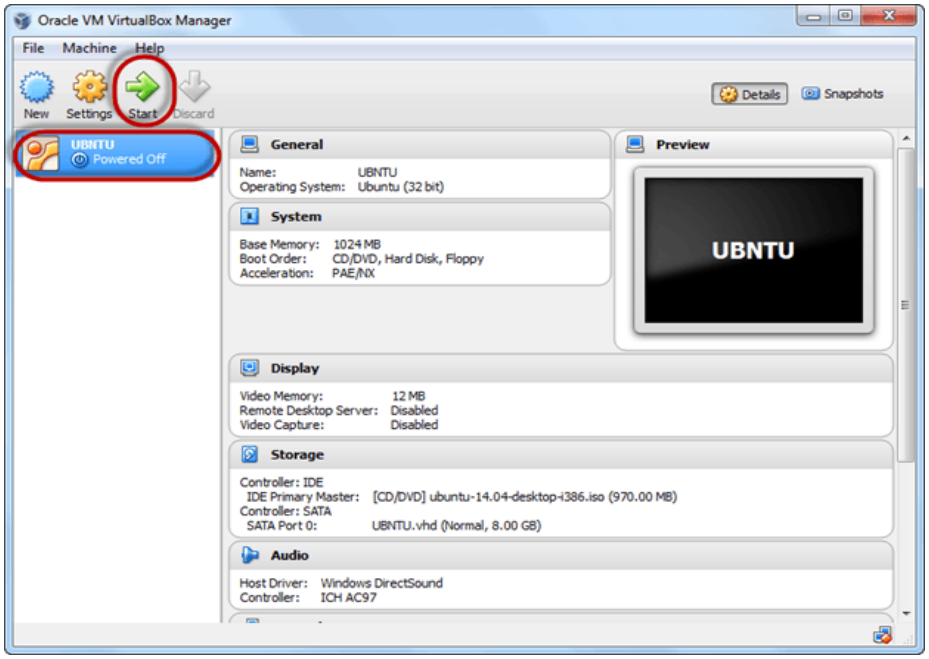
Now you can see the machine name in left panel



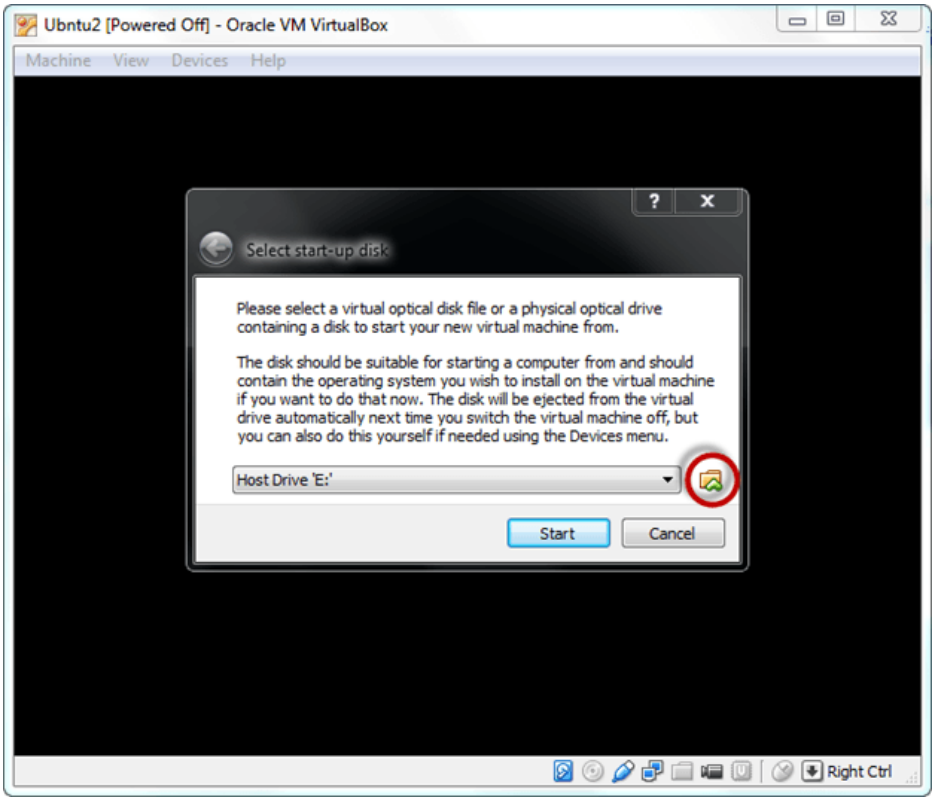
So a Machine (PC) with 8GB Hardisk, 1GB RAM is ready.

How to Install Ubuntu

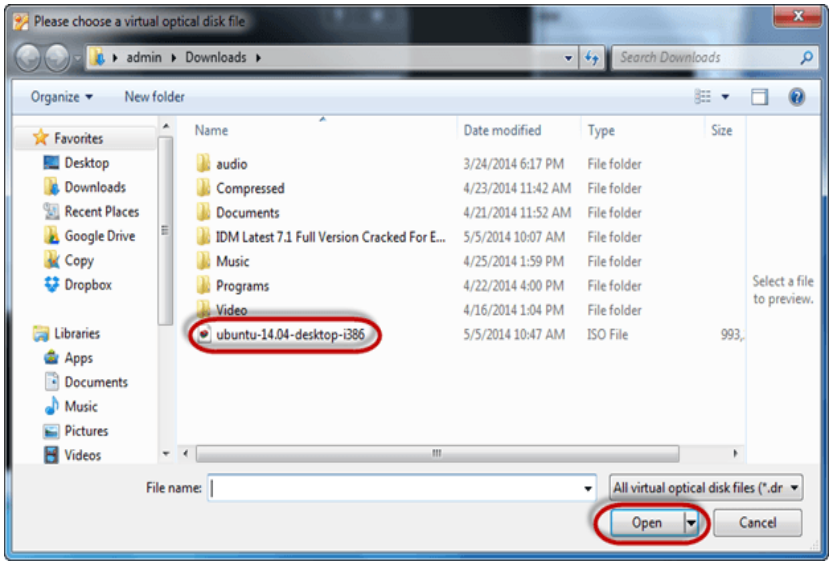
Select the Machine and Click on Start



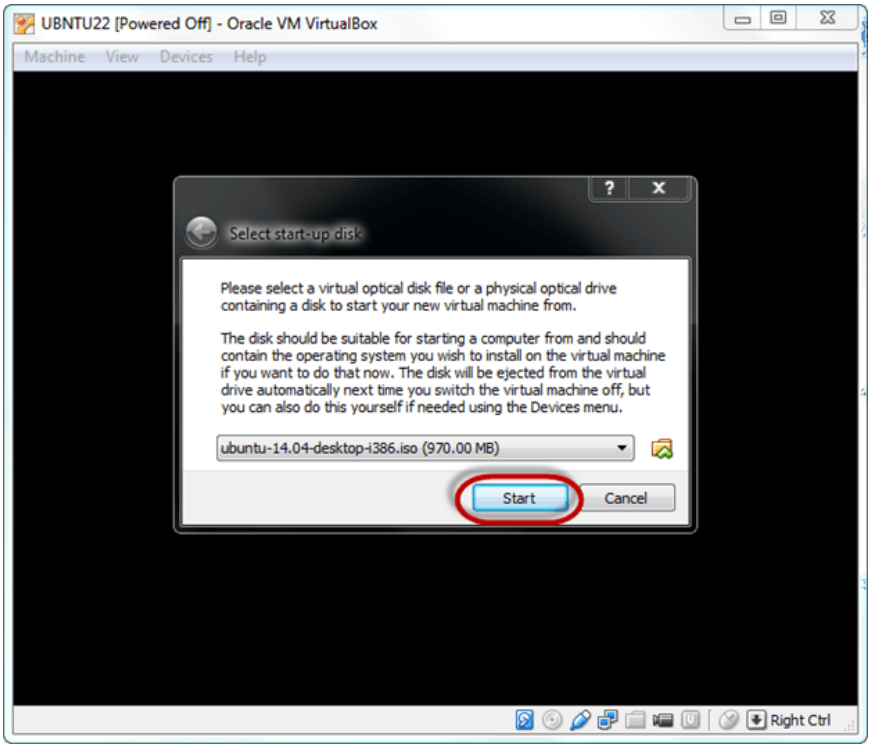
Select the Folder Option



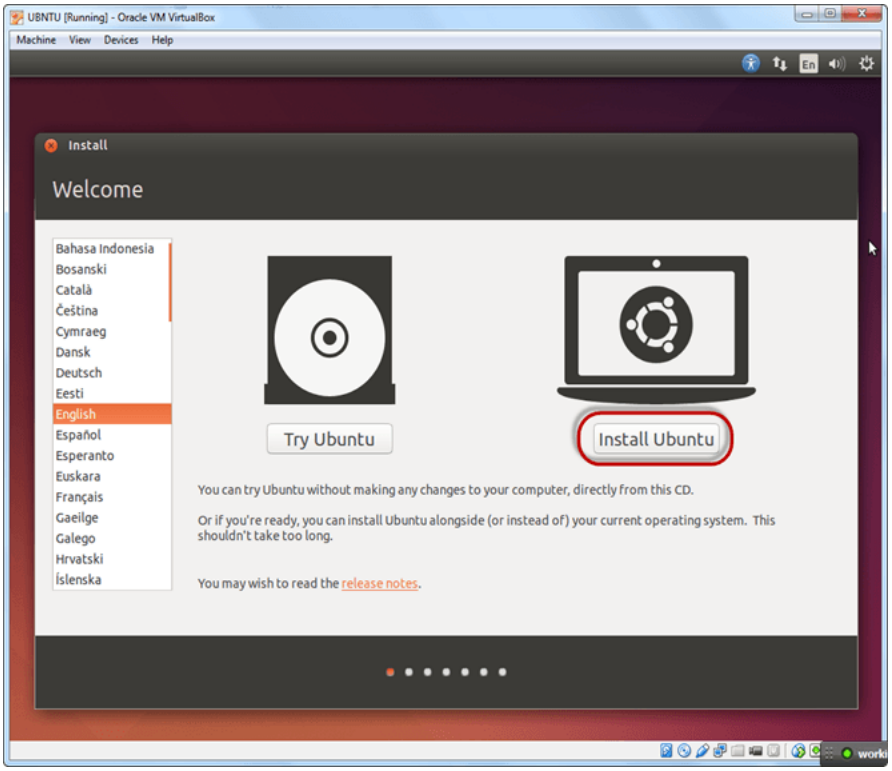
Select the Ubuntu iso file



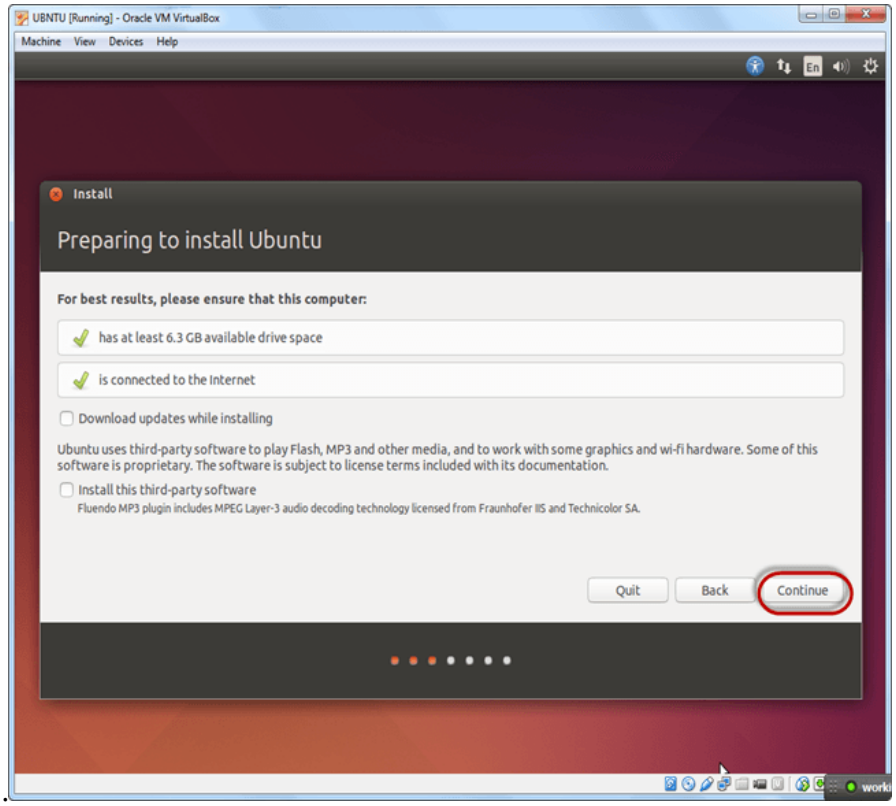
Click Startup



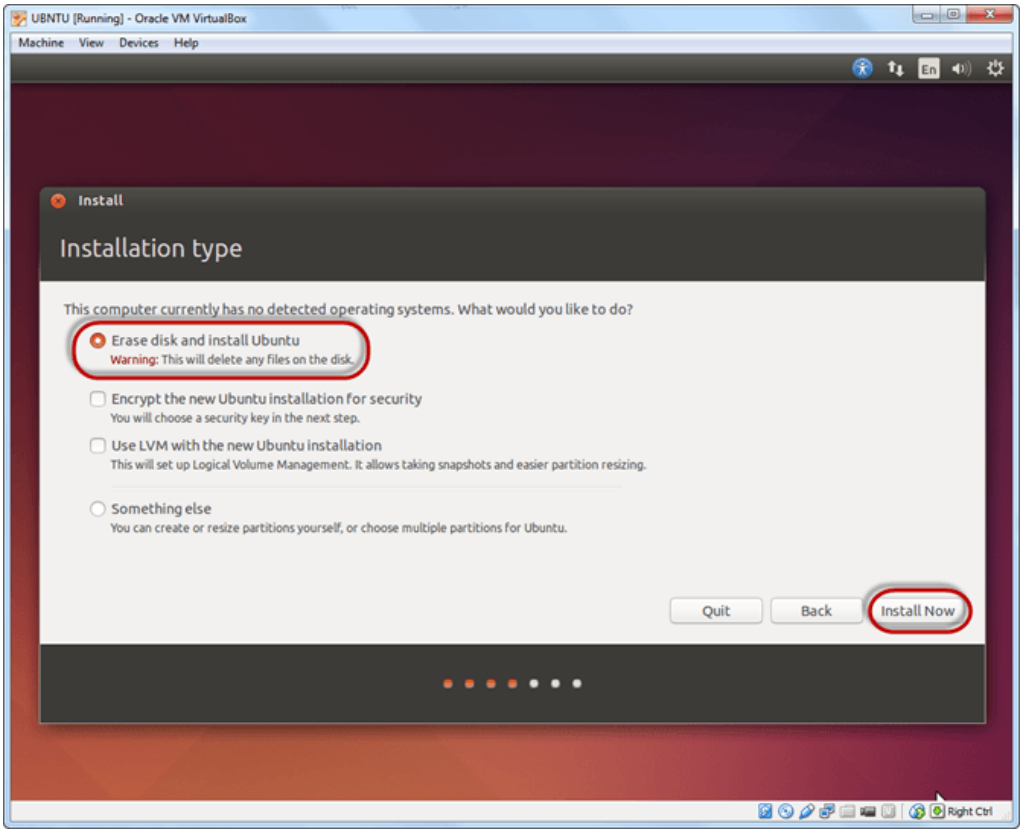
You have an option to Run Ubuntu WITHOUT installing. In this tutorial will install Ubuntu



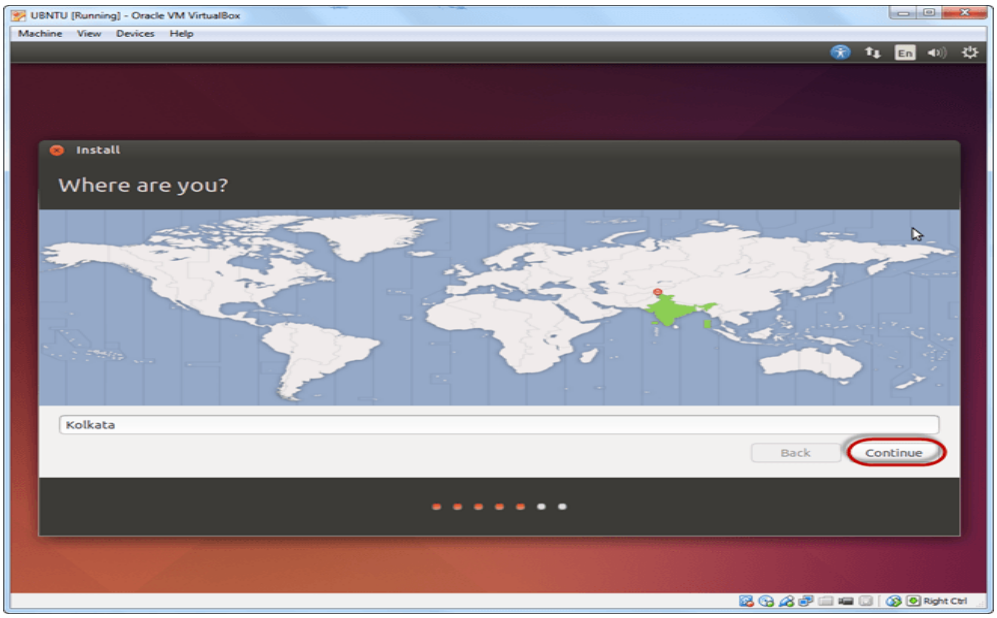
Click continue



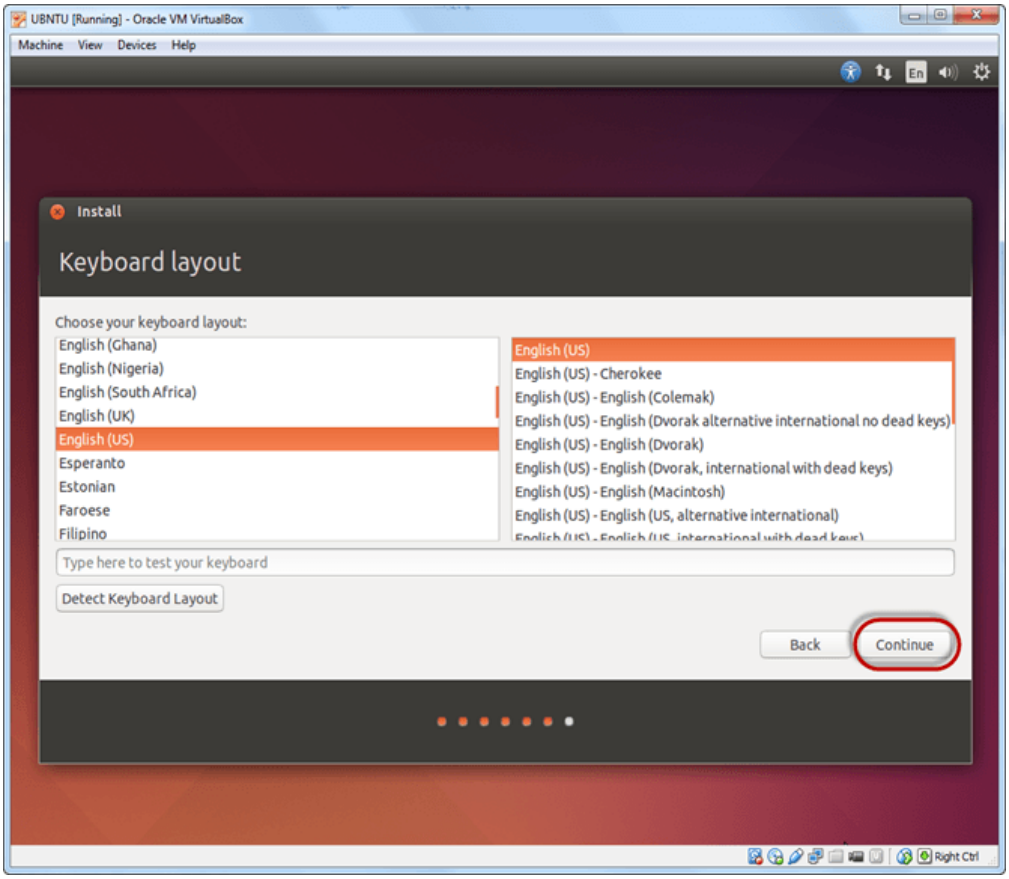
Select option to erase the disk and install Ubuntu and click on install now. This option installs Ubuntu into our virtual hard drive which is we made earlier. It will not harm your PC or Windows installation



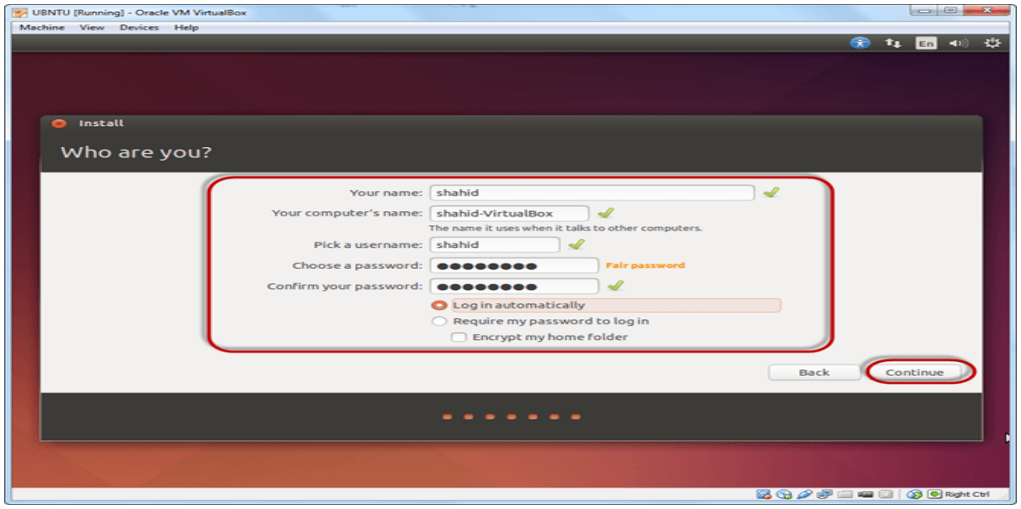
Select your location for setting up time zone, and click on continue



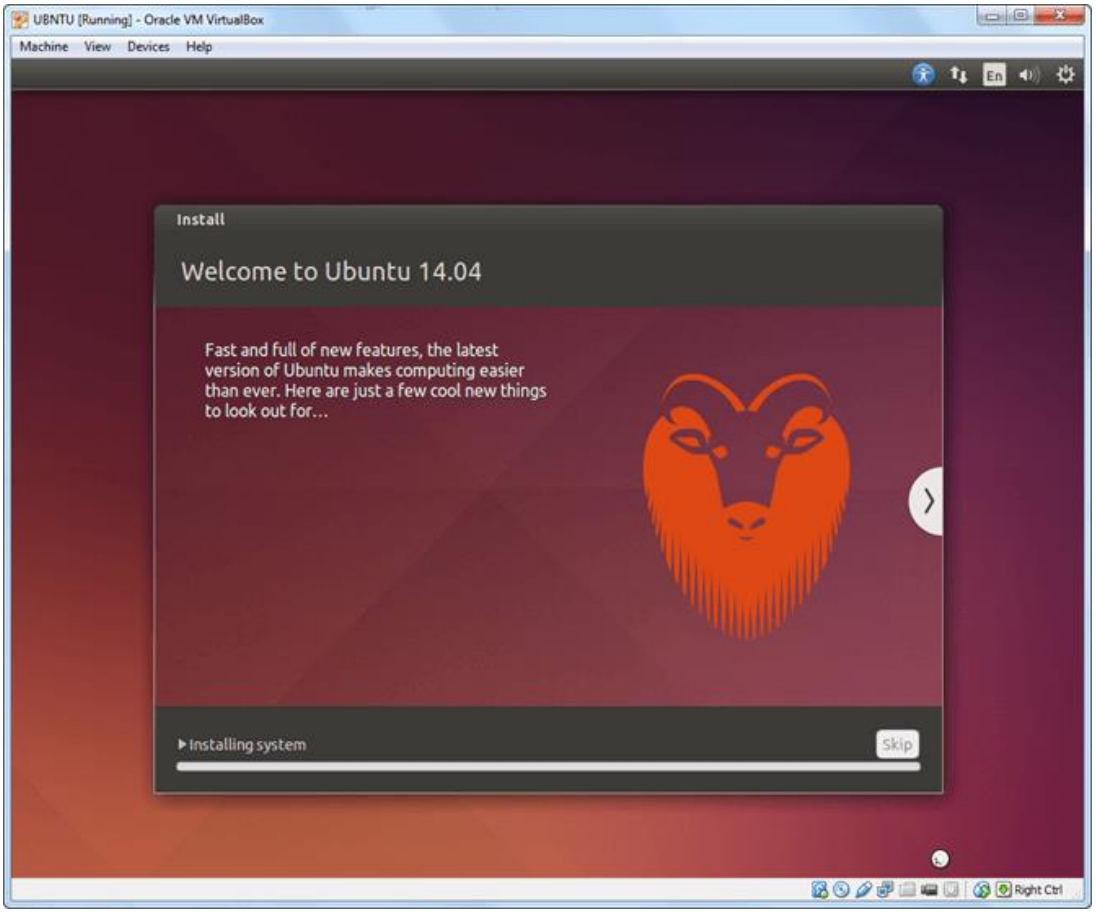
Select your keyboard layout, by default English (US) is selected but if you want to change then, you can select in the list. And click on continue



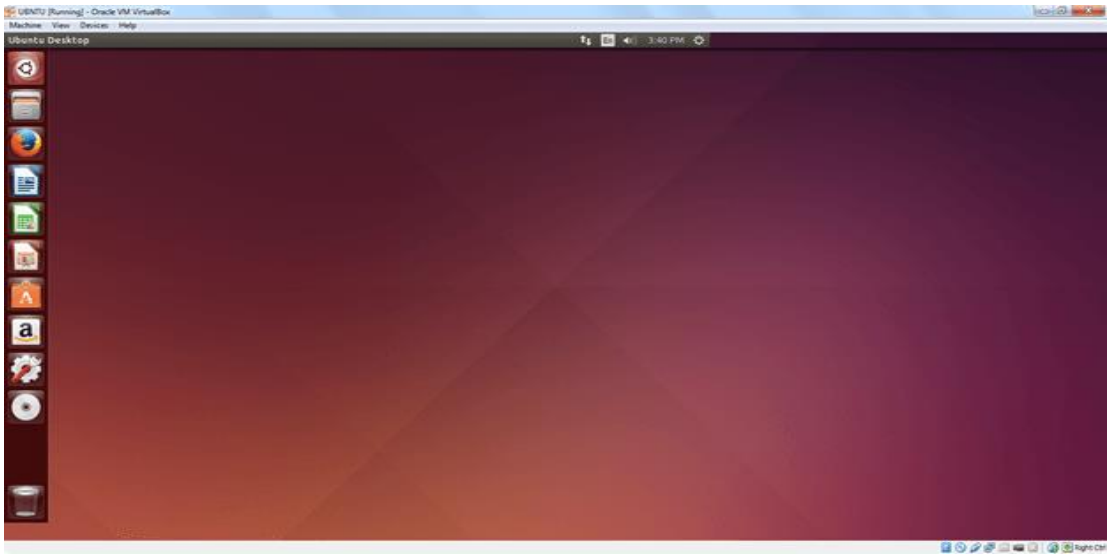
Select your username and password for your Ubuntu admin account. This information has been needed for installing any software package into Ubuntu and also for login to your OS. Fill up your details and tick on login automatically to ignore login attempt and click on continue



Installation process starts. May take up to 30 minutes. Please wait until installation process completes.



After finishing the installation, you will see Ubuntu Desktop.



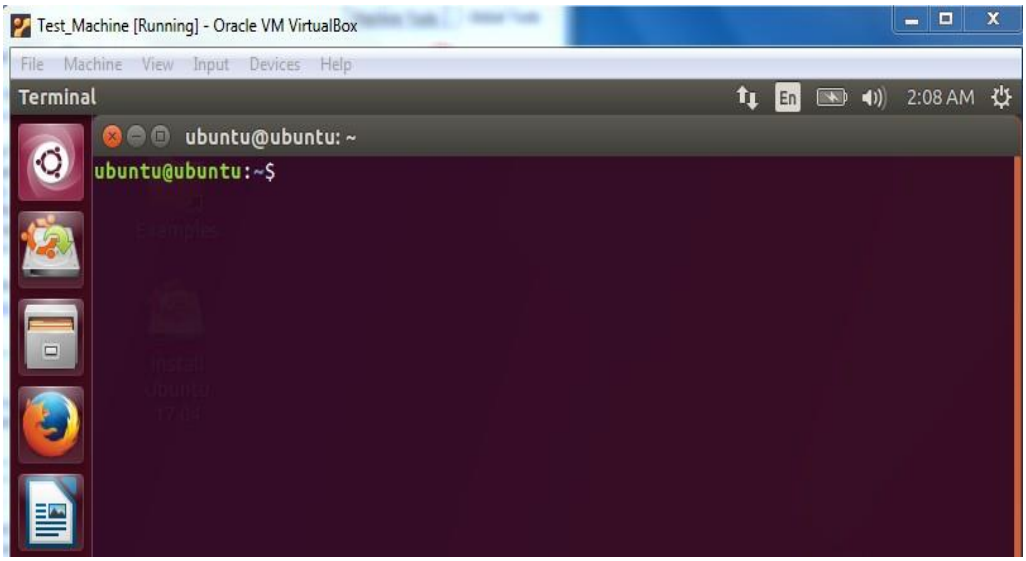
Writing Linux Commands

Command Line Interface

The Command Line Interface (CLI), is a non-graphical, text-based interface to the computer system, where the user types in a command and the computer then successfully executes it. The Terminal is the platform or the IDE that provides the command line interface (CLI) environment to the user. The CLI terminal accepts the commands that the user types and passes to a shell. The shell then receives and

interprets what the user has typed into the instructions that can be executed by the OS (Operating System). If the output is produced by the specific command, then this text is displayed in the terminal. If any of the problems with the commands are found, then some error message is displayed.

We can open the terminal by typing Ctrl + Alt + T short-key or by right-clicking the mouse and selecting the Open New Terminal option. The terminal window looks like given below.



Basic syntax of Linux Commands

A command is an instruction given by a user telling a computer to do something, such a run a single program or a group of linked programs. Commands are generally issued by typing them in at the c command line (i.e., the all-text display mode) and then pressing the ENTER key, which passes themto the shell. A shell is a program that reads commands that are typed on a keyboard and then executes (i.e., runs) them. Shells are the most basic method for a user to interact with the system.

Options and Arguments: This brings us to a very important point about how most commands work. Commands are often followed by one or more *options* that modify their behavior, and further, by one or more *arguments*,the items upon which the command acts. So most commands look kind of like this:

```
$command -optioins  arguments
```

Most commands use options consisting of a single character preceded by a dash, for example, "-l", but many commands, including those from the GNU Project, also support long options, consistingof a word preceded by two dashes. Also, many commands allow multiple short options to be strung together.
Command History: Most Linux distributions remember the last 500 commands by default. Press the down-arrow keyand the previous command disappears.

Some Basic Linux Commands

1) Date Command: This command is used to display the current data and time.

```
$date or $date +%ch
```

Common Options:

a = Abbreviated weekday. A = Full weekday.

b = Abbreviated month.

B = Full month.

c = Current day and time.

C = Display the century as a decimal number. d = Day of the month.

D = Day in „mm/dd/yy‟ format

h = Abbrevated month day.

2) cal Command: This command is used to display the calendar of the year or the particularmonth of calendar year.

```
$cal <year> or $cal <month> <year>
```

3) who Command: It is used to display who are the users connected to our computer currently.

```
$who –option‟s
```

Common Options:

H–Display the output with headers

b–Display the last booting date or time or when the system was lastly rebooted

4) whoami Command: Display the details of the current working directory.

```
$whoami
```

5) clear Command: It is used to clear the screen.

```
$clear
```

6) man Command: It help us to know about the particular command and its options & working. It is like„help‟ command in windows .

```
$man <command name>
```

7) df Command: is used to see the current amount of free space on your disk drives

```
$df
```

8) free Command: Likewise, to display the amount of free memory, enter the **free** command.

```
$free
```

9) exit Command: We can end a terminal session by either closing the terminal emulator window, or by enteringthe **exit** command at the shell prompt

```
$exit
```

2) Solved Lab Activities

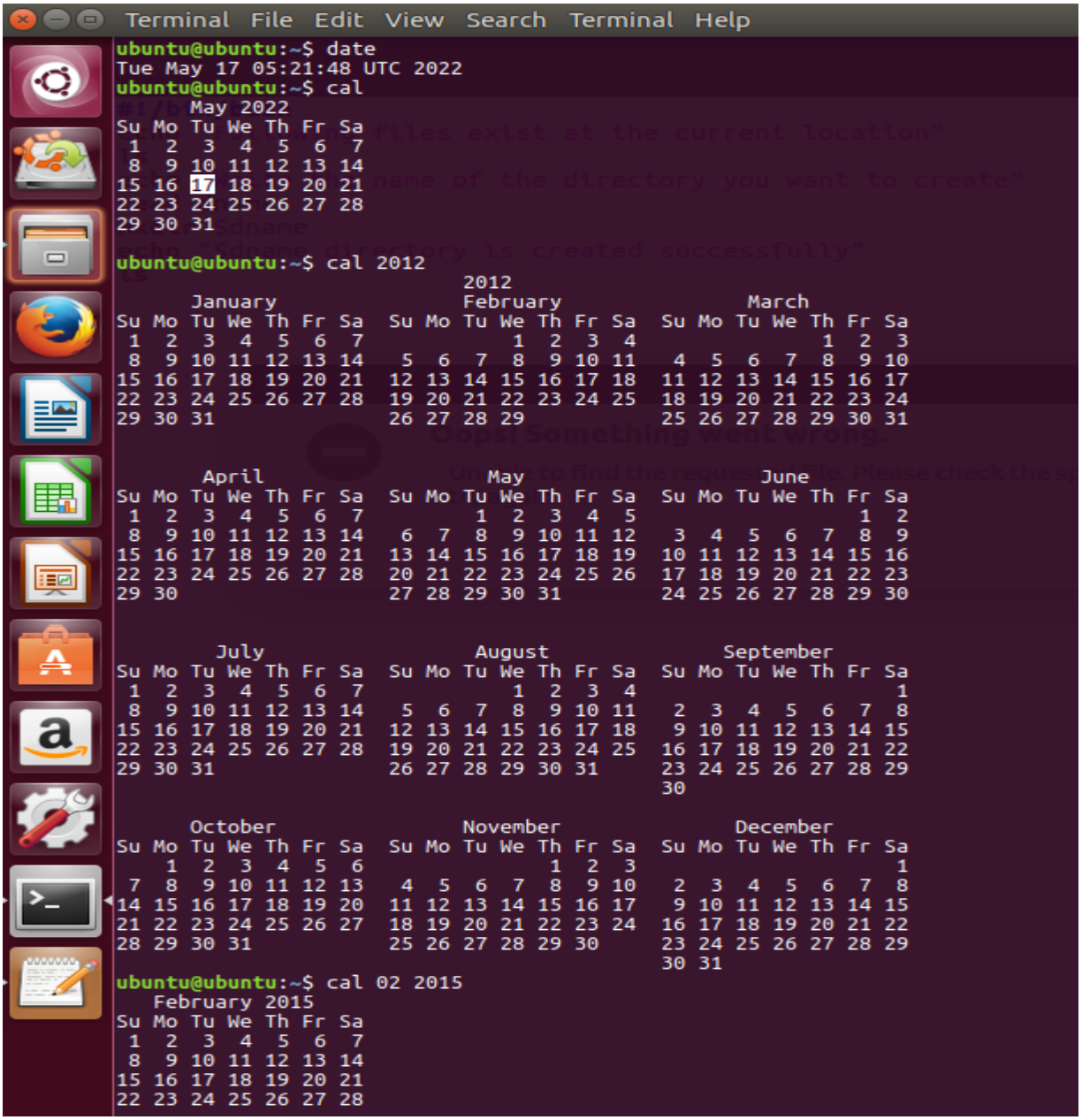
Sr.No	*Allocated Time*	*Level of Complexity*	*CLO Mapping*
1	10	Medium	CLO-5
2	10	Medium	CLO-5

Activity 1:

In this activity, you are required to perform tasks given below:

- Display the current date
- Display the calendar for the current month
- Display the calendar of 2012
- Display the calendar of Feb 2015

Solution:

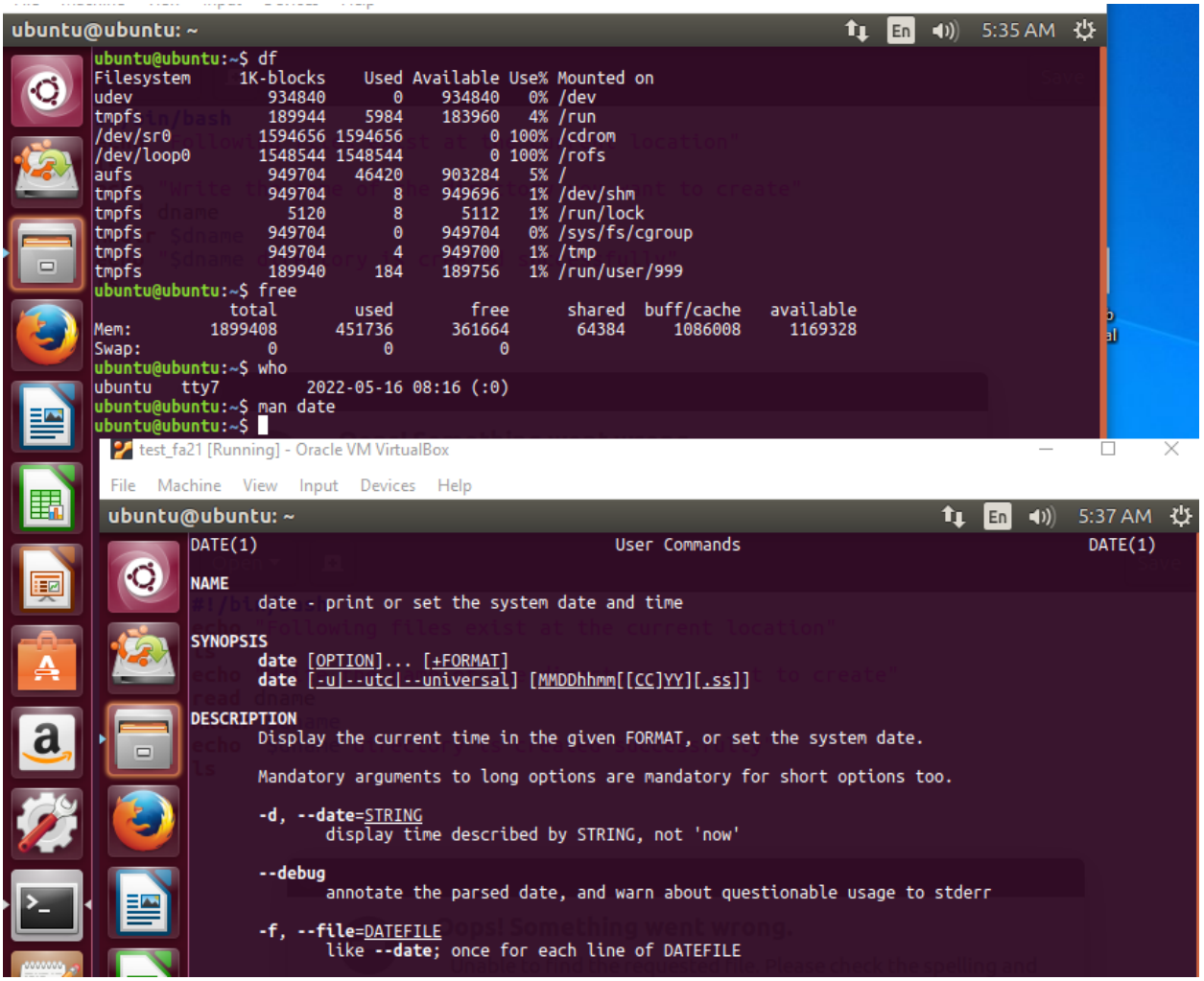


Activity 2:

In this activity, you are required to perform tasks given below:

- Display the amount of free storage on your machine
- Display the amount of free memory on your machine
- Display the user name of the current user
- Open the man of date free command

Solution:



3) Graded Lab Tasks

Note: The instructor can design graded lab activities according to the level of difficult and complexity of the solved lab activities. The lab tasks assigned by the instructor should be evaluated in the same lab.

Lab Task 1:

In GUI open the Libre Office writer tool create a document that contains information about your favorite place. Try the following short- keys while formatting the document.

Keyboard Shortcuts	Functions
Ctrl + C	Copy the Selected text or Object
Ctrl + X	Cut the selected text or object
Ctrl + V	Paste the Copied text or Object
Ctrl + A	Select all text or All files and folder in a Parent folder
Ctrl + B	Make the Selected text as **BOLD**
Ctrl + I	Mark the selected text as *italic*
Ctrl + U	Mark the Selected text Underline
Ctrl + N	Open a New document or Window
Ctrl + S	Save the Current Document
Ctrl + O	Open another Document
Ctrl + P	Print the Document (Print option)
Ctrl + Z	Undo the Last Change you made
Ctrl + Shift + Z	Redo a change that you just undeed

Lab No. 02

Working with Navigation, and File & Directory Handing Commands

Objective:

This lab will introduce the Directory and File related commands to you. We will start with the some basic but important commands used to navigate through the Linux file system. Then we will discuss Directory and File related commands. Finally, we will introduce the I/O redirection in Linux

Activity Outcomes:

On completion of this lab students will be able to:

- Navigation through Linux file system using CLI
- Working with directories in Linux using CLI
- Handling Files in Linux using CLI
- Using I/O redirection in Linux.

Instructor Notes

As pre-lab activity, read Chapter 1 to 6 from the book "The Linux Command Line", William E. Shotts, Jr.

1) Useful Concepts

Linux organizes its files in a hierarchical directory structure. The first directory in the file system is called the root directory. The root directory contains files and subdirectories, which contain more files and subdirectories and so on and so on. If we map out the files and directories in Linux, it would look like an upside-down tree. At the top is the root directory, which is represented by a single slash (/). Below that is a set of common directories in the Linux system, such as bin, dev, home, lib , and tmp , to name a few. Each of those directories, as well as directories added to the root, can contain subdirectories.

Navigation

The first thing we need to learn is how to navigate the file system on our Linux system. In this section we will introduce the commands used for navigation in Linux system.

Print Working Directory

The directory we are standing in is called the current working directory. To display the current working directory, we use the pwd (print working directory) command. When we first log in to our system our current working directory is set to our home directory. Suppose, a user is created with name ***me*** on machine Ubuntu; we display its current working directory as given below:

```
[me@ubuntu ~] $ pwd
/home/me
```

Listing The Contents Of A Directory

To list the files and directories in the current working directory, we use the **ls** command. Suppose, a user ***me*** is in its home directory; to display the contents of current working directory can be displayed as follows:

```
[me@ubuntu ~] $ ls
Desktop Documents Music Pictures Pulic Templates Videso
```

Besides the current working directory, we can specify the directory to list, like so:

```
[me@ubuntu ~] $ ls /usr
bin  games  kerberos libexec  sbin   src
etc  include lib      local    share  tmp
```

Or even specify multiple directories. In this example we will list both the user's home directory (symbolized by the "~" character) and the /usr directory:

```
[me@ubuntu ~] $ ls ~ /usr

/home/me:
Desktop Documents Music Pictures Pulic Templates Videso
/usr:
bin  games  kerberos libexec  sbin   src
etc  include lib      local    share  tmp
```

The following options can also be used with ls command

Options	Long-options	Description
-a	- - all	List all files, even those with names
-d	- - directory	Ordinarily, if a directory is specified, ls will list the contents of the directory, not the directory itself. Use this option in conjunction with the -l option to see details about the directory rather than its contents.
-h	- - human-readable	In long format listings, display file sizes in human readable format rather than in bytes.
-r	- - reeverse	Display the results in reverse order. Normally,ls displays its results in ascending alphabetical order.
-S	-	Sort results by file size.
-t		Sort by modification time
-l		Display results in long format.

Changing the Current Working Directory

To change your working directory, we use the **cd** command. To do this, type cd followed by the pathname of the desired working directory. A pathname is the route we take along the branches of the tree to get to the directory we want. Pathnames can be specified in one of two different ways; as **absolute pathnames** or as **relative pathnames**. An absolute pathname begins with the root directory and follows the tree branch by branch until the path to the desired directory or file is completed. On the other hand a relative pathname starts from the working directory.