Project #0 Tutorial: Linux Environment Setup and Kernel Compilation

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Setting Virtual Machine Environment

with VirtualBox

2024. 03. 19.

Contents

- Goal: Setting Linux Environment and Compiling Linux Kernel
- 1. VirtualBox Installation
- 2. Ubuntu 18.04.2 LTS Installation
- 3. Linux Kernel Compilation
- Live Demonstration

Preparation

- **VirtualBox**
  - http://www.virtualbox.org/wiki/Downloads
  - Note: The download site may not be accessible if you're on a campus network

- **Ubuntu 18.04.2 LTS**
  - http://old-releases.ubuntu.com/releases/18.04.2

  - Download in 64-bit (Questions about 32-bit will not be responded)
  - Download the ISO image and save it to the PC (where virtual machine is installed)

- **Linux Kernel Source (Ver. 4.20.11)**
  - https://www.kernel.org/pub/linux/kernel/v4.x/
    - Download **linux-4.20.11.tar.xz**
    - Download the kernel image after installing Ubuntu 18.04.02 in the virtual machine

1

VirtualBox Installation

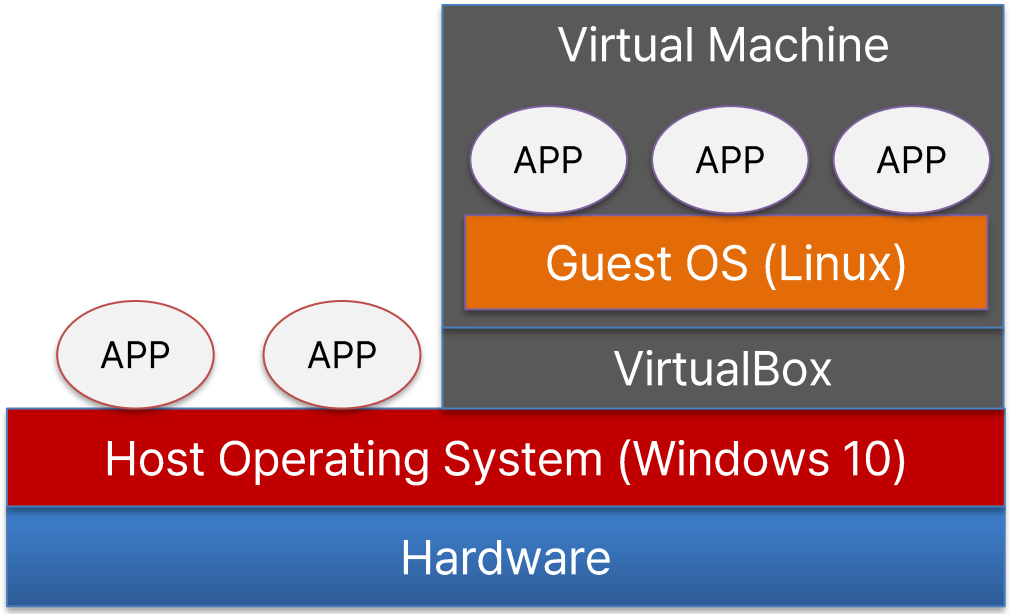
Virtual Machine

- **A 'virtual' computer, not physical one**
- **A software layer called a virtual machine monitor (VMM) or hypervisor provides virtualization**
- **Why?**
  - To run a program that is not supported by the currently installed operating system
  - To run a program that can affects a physical system
- **Host OS**
  - operating system that will be installed on top of the physical machine
  - operating system on which the virtual machine will be mounted
- **Guest OS**
  - operating system installed on top of the implemented virtual machine

What is Host OS, Guest OS in our project?

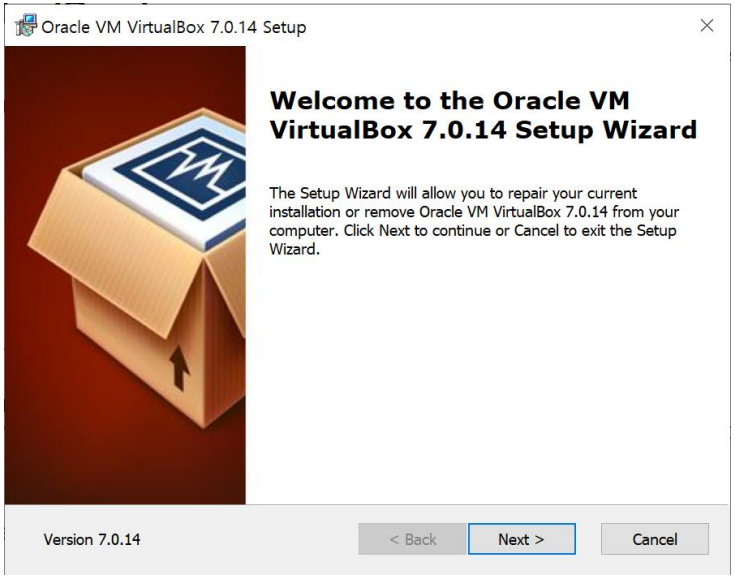
VirtualBox

- **Virtual machine software developed by InnoTek (now acquired by Oracle)**
- **Available on Windows, Linux, MacOS, OS/2, etc**
- **Easy-to-use, open-source free edition (OSE) released**
  - Available for personal, educational, and product evaluation at no cost
  - [Caution] Some features require a license (Charged)



VirtualBox Installation

- **Install latest version (Version 7.0.14 as of Mar. 2024)**
  - http://www.virtualbox.org/wiki/Downloads
    - Note: The download site may not be accessible if you're on a campus network
  - Press NEXT to install without any special steps



Caution

For Apple Silicon Mac (M1, M2, …) users, VirtualBox only provides developer preview versions.
You may encounter problems due to the Apple Silicon chips.

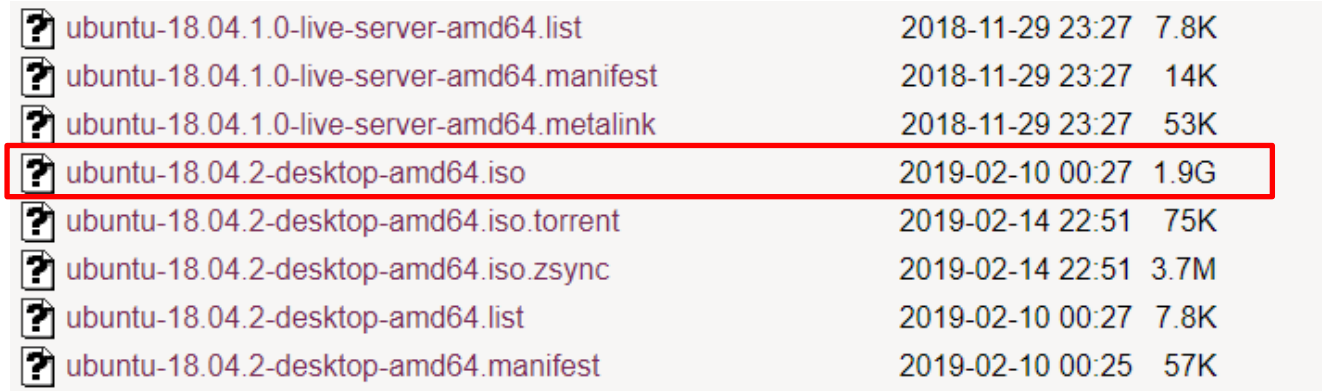
No technical support from TAs will be provided on the issues due to the **Apple Silicon Mac environment**.

No penalty for using Apple Silicon Macs

2
Ubuntu 18.04.2 Installation

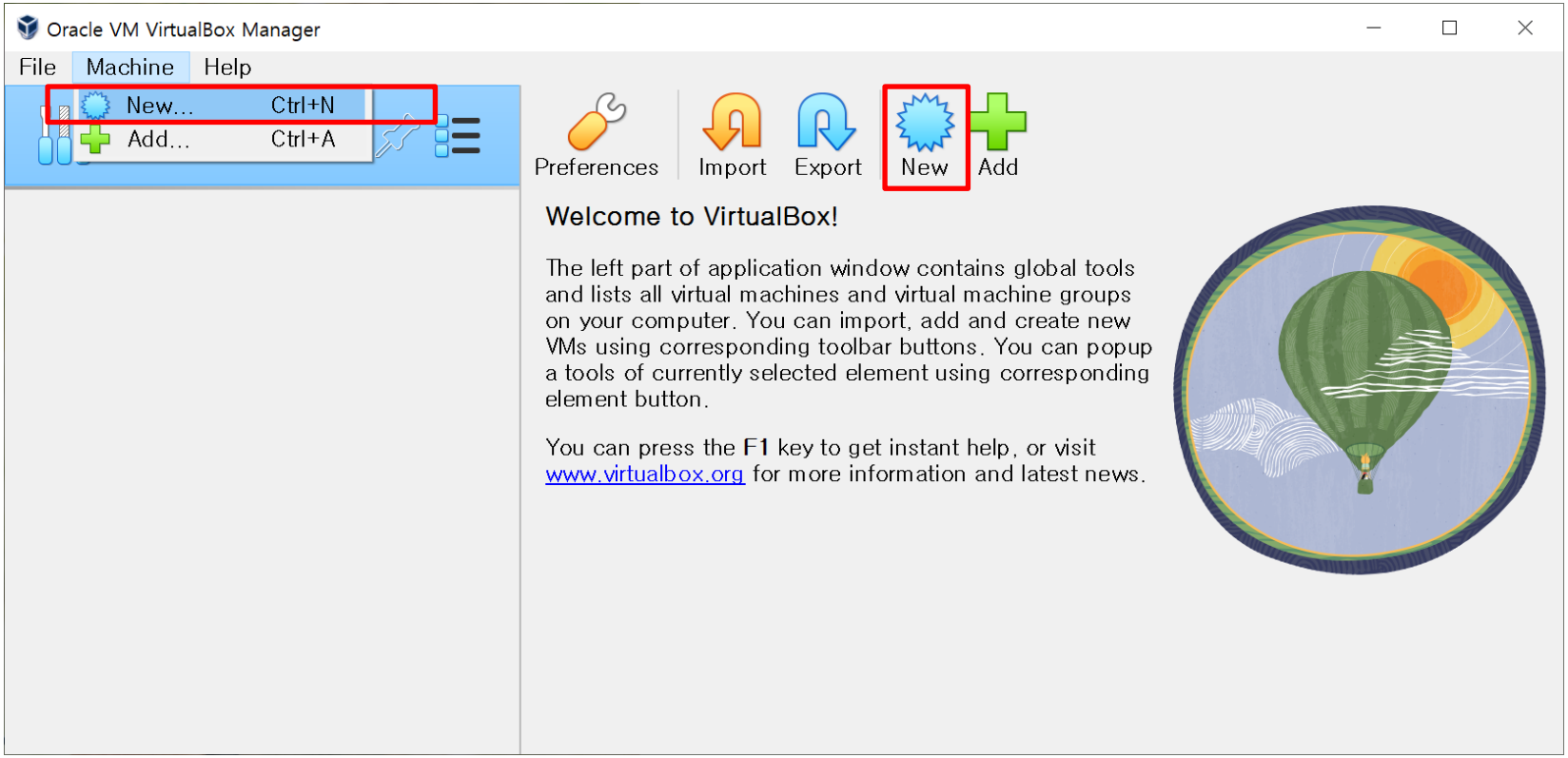
Ubuntu Installation

- **This course will use Ubuntu among various Linux distributions**
  - Linux distribution: includes the Linux kernel and various software
    - Ubuntu, Debian, Fedora, etc
    - Android is also a type of Linux distribution
  - Ubuntu is one of the most popular distributions on desktops and servers
- **Ubuntu 18.04.2 LTS image download**
  - http://old-releases.ubuntu.com/releases/18.04.2
  - 1.9G image file



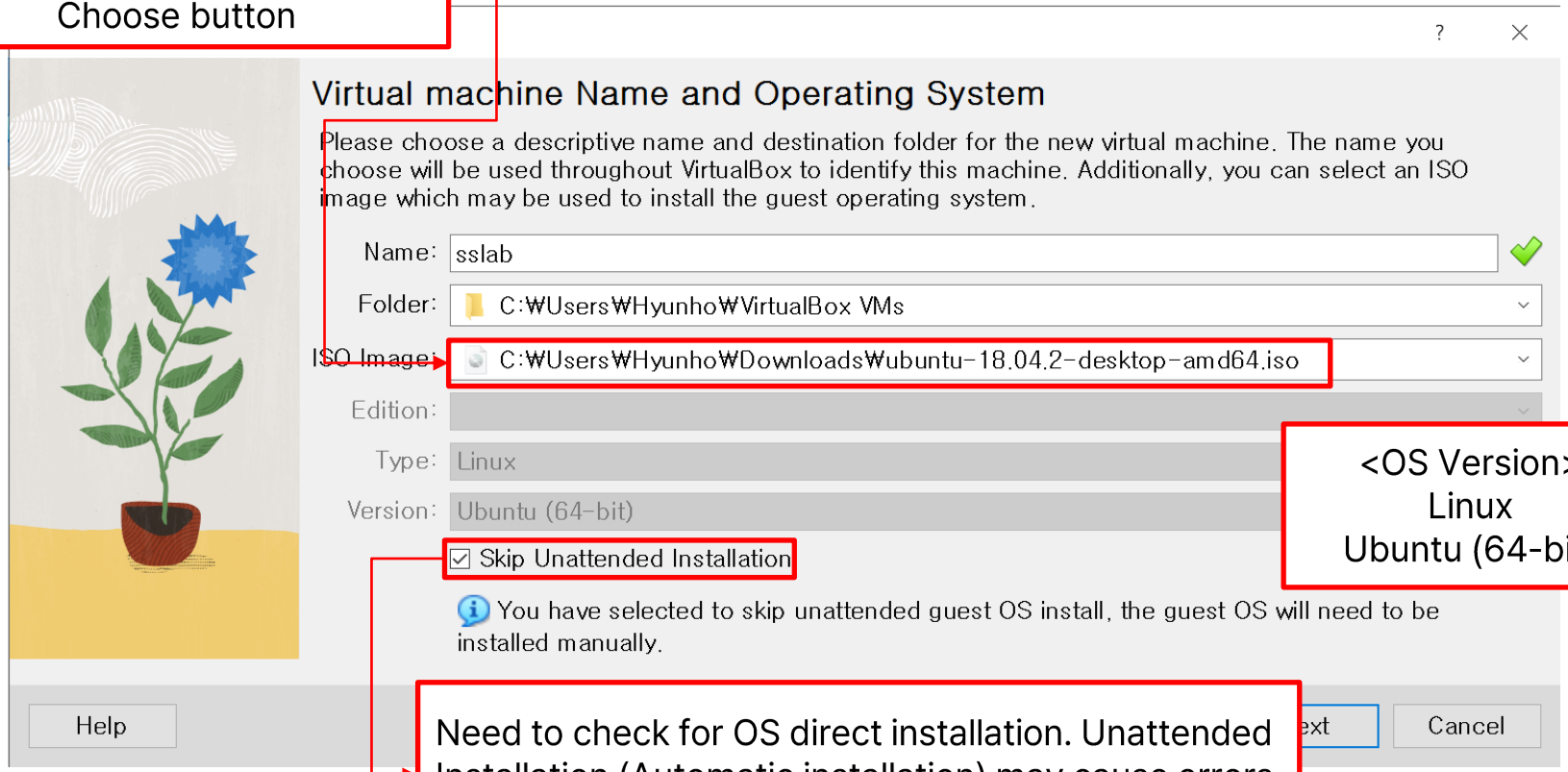
Ubuntu Installation

- **Install Ubuntu 18.04.2 LTS on VirtualBox**
  - Click [Machine] - [New]



1

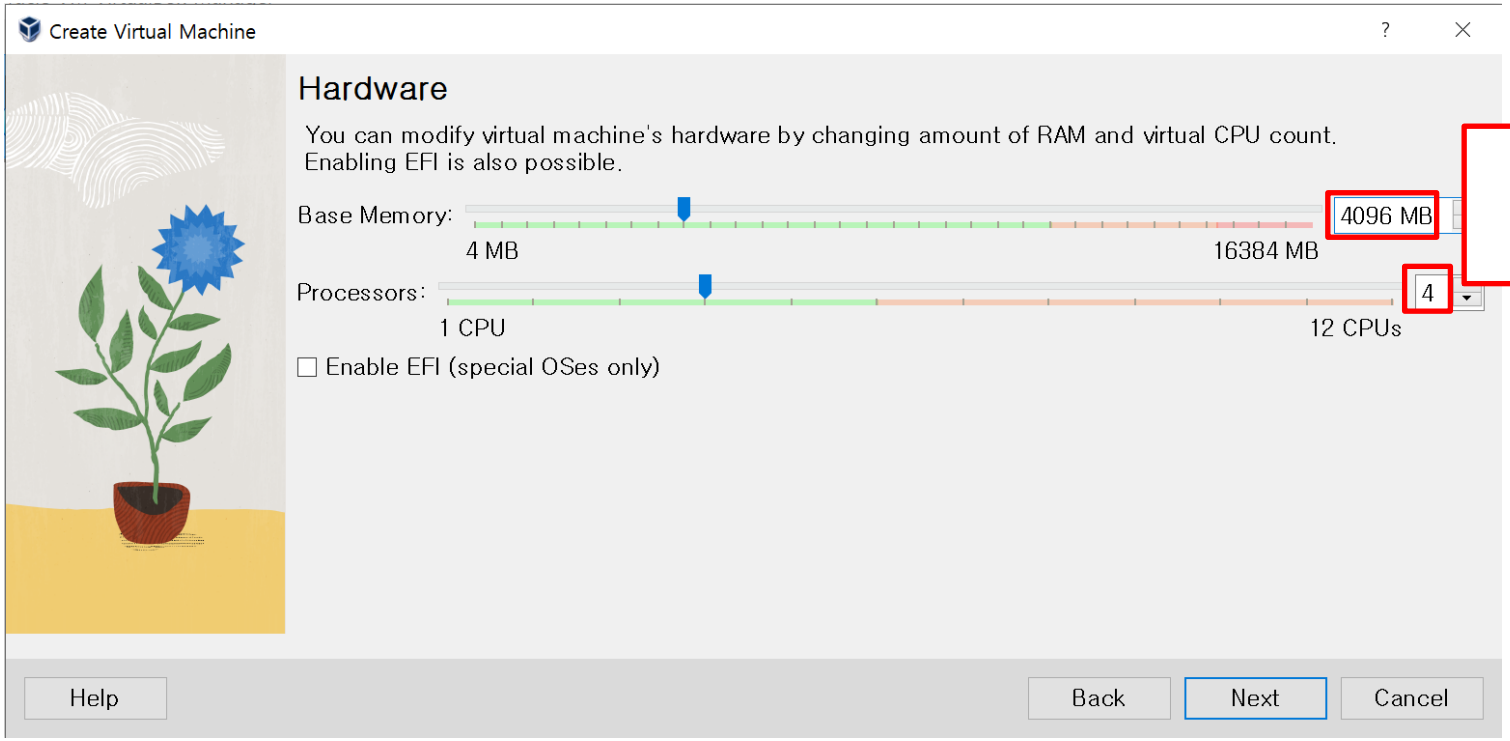
Add downloaded Ubuntu 18.04.2 image and click the Choose button



<OS Version>
Linux
Ubuntu (64-bit)

Need to check for OS direct installation. Unattended Installation (Automatic installation) may cause errors such as inability to run terminals

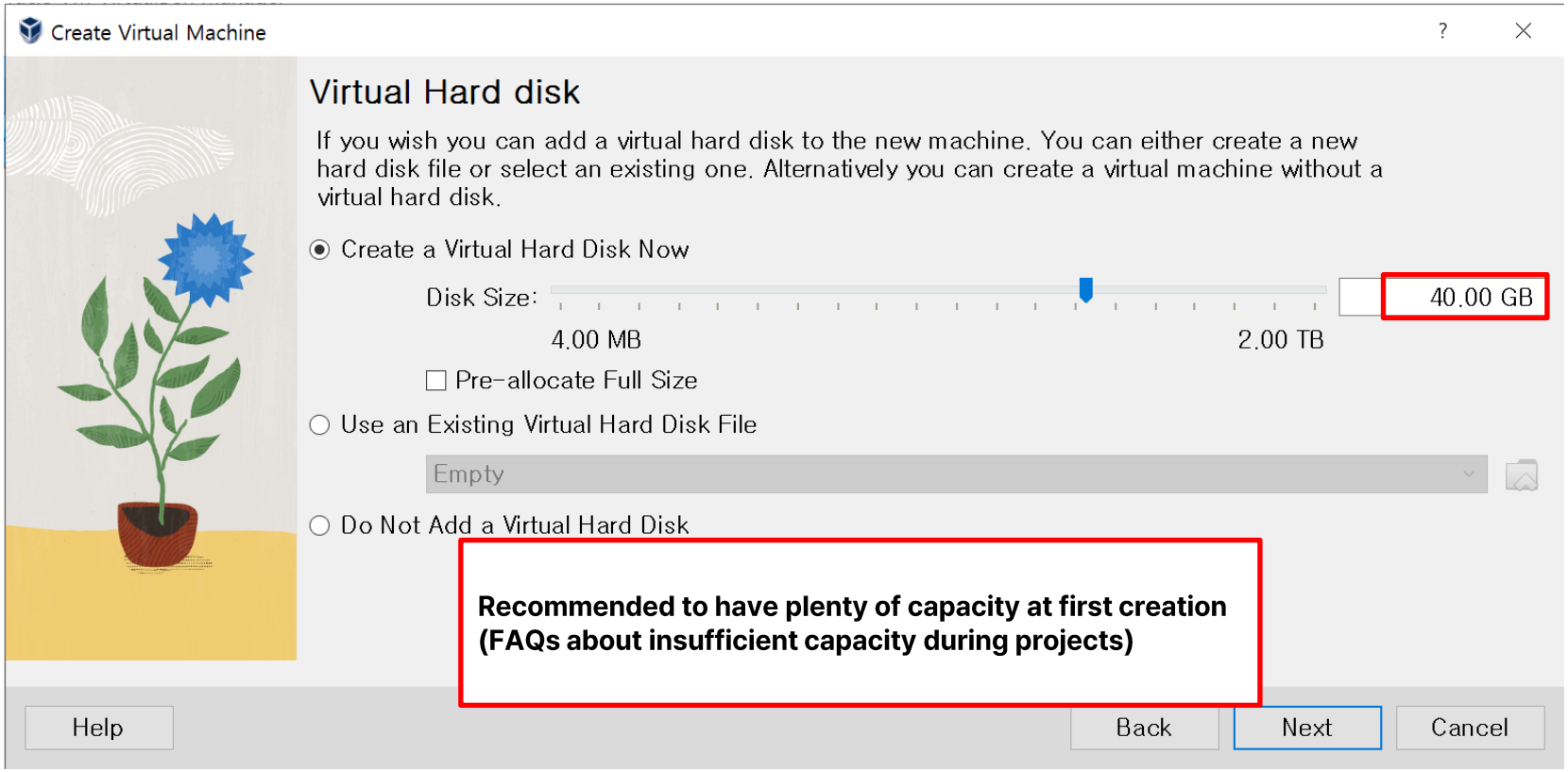
2



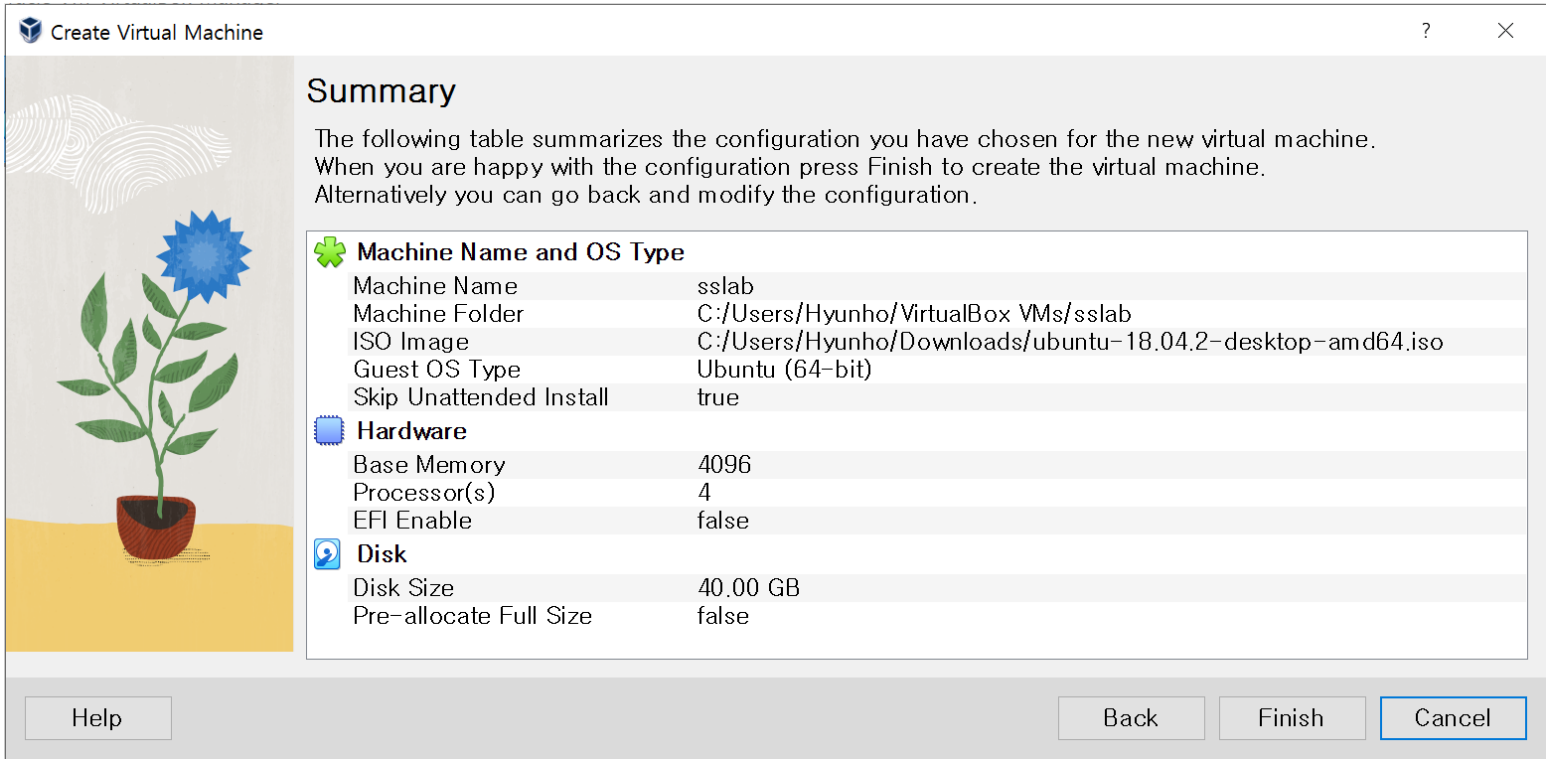
<Memory Size>
Select based on host PC

3

Select freely based on
Disk size of Host PC



4


Create Virtual Machine
Summary
The following table summarizes the configuration you have chosen for the new virtual machine.
When you are happy with the configuration press Finish to create the virtual machine.
Alternatively you can go back and modify the configuration.
Machine Name and OS Type
Machine Name sslab
Machine Folder C:/Users/Hyunho/VirtualBox VMs/sslab
ISO Image C:/Users/Hyunho/Downloads/ubuntu-18.04.2-desktop-amd64.iso
Guest OS Type Ubuntu (64-bit)
Skip Unattended Install true
Hardware
Base Memory 4096
Processor(s) 4
EFI Enable false
Disk
Disk Size 40.00 GB
Pre-allocate Full Size false
Help
Back
Finish
Cancel

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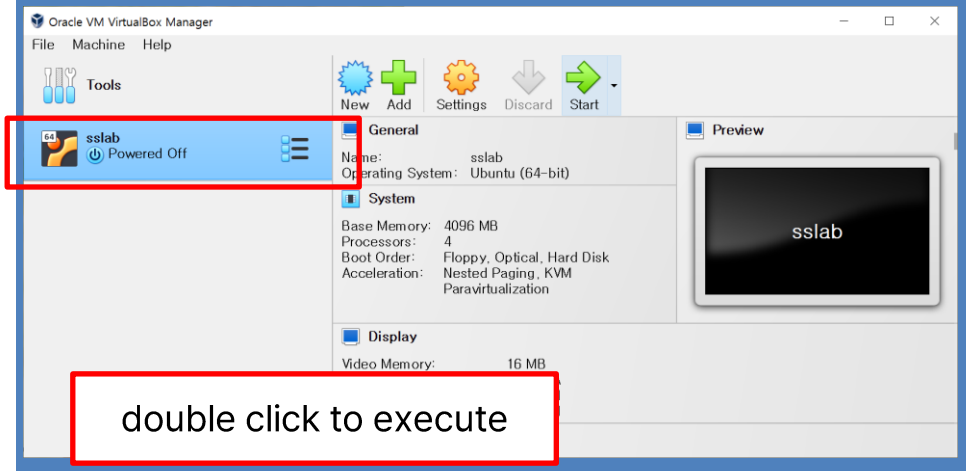

double click to execute

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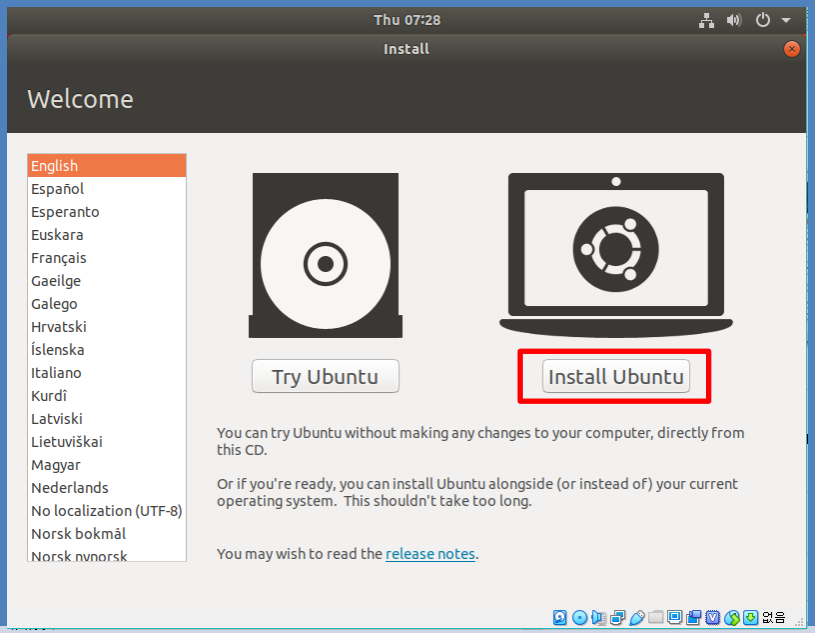
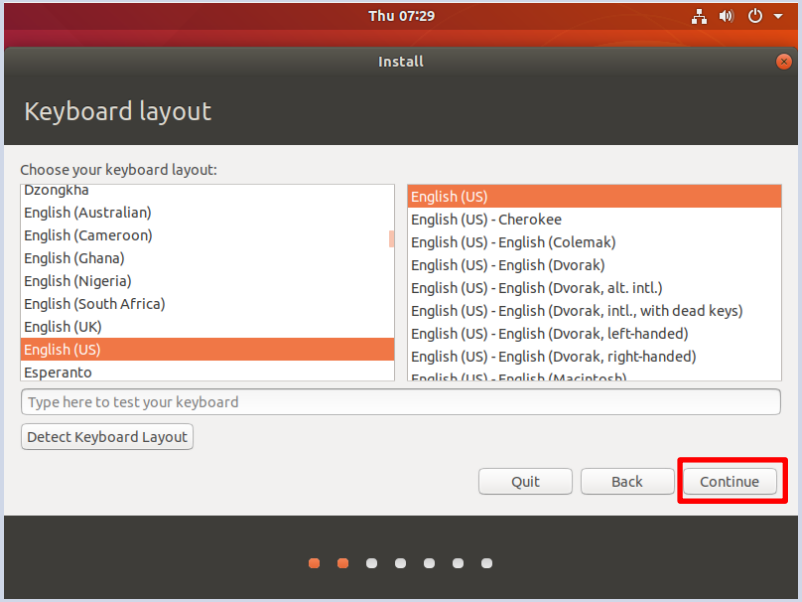
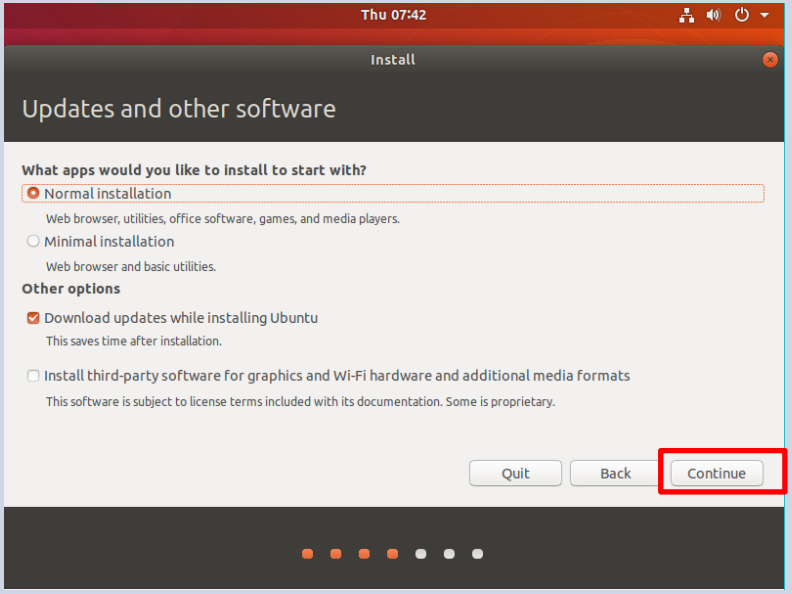


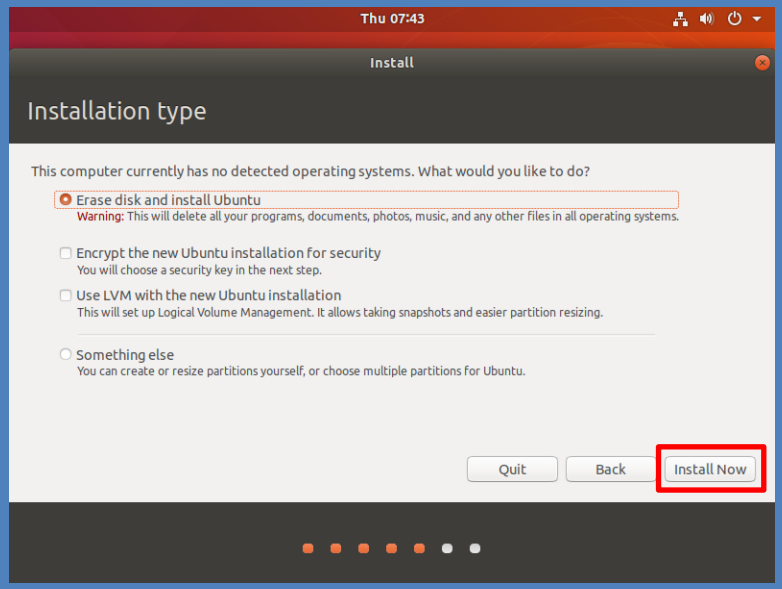
15



16



17


Thu 07:43
Install
Installation type
This computer currently has no detected operating systems. What would you like to do?
Erase disk and install Ubuntu
Warning: This will delete all your programs, documents, photos, music, and any other files in all operating systems.
Encrypt the new Ubuntu installation for security
You will choose a security key in the next step.
Use LVM with the new Ubuntu installation
This will set up Logical Volume Management. It allows taking snapshots and easier partition resizing.
Something else
You can create or resize partitions yourself, or choose multiple partitions for Ubuntu.
Quit
Back
Install Now

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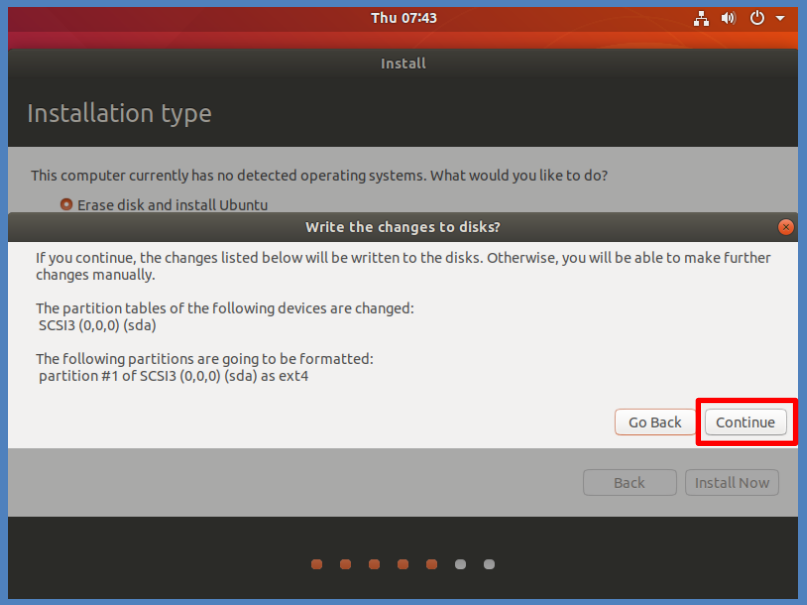
Thu 07:43
Install
Installation type
This computer currently has no detected operating systems. What would you like to do?
Erase disk and install Ubuntu
Write the changes to disks?
If you continue, the changes listed below will be written to the disks. Otherwise, you will be able to make further changes manually.
The partition tables of the following devices are changed:
SCSI3 (0,0,0) (sda)
The following partitions are going to be formatted:
partition #1 of SCSI3 (0,0,0) (sda) as ext4
Go Back
Continue
Back
Install Now

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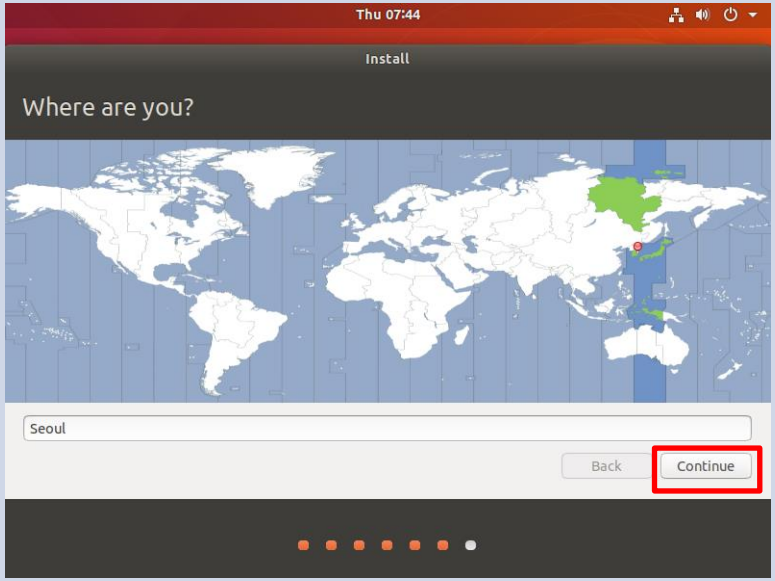
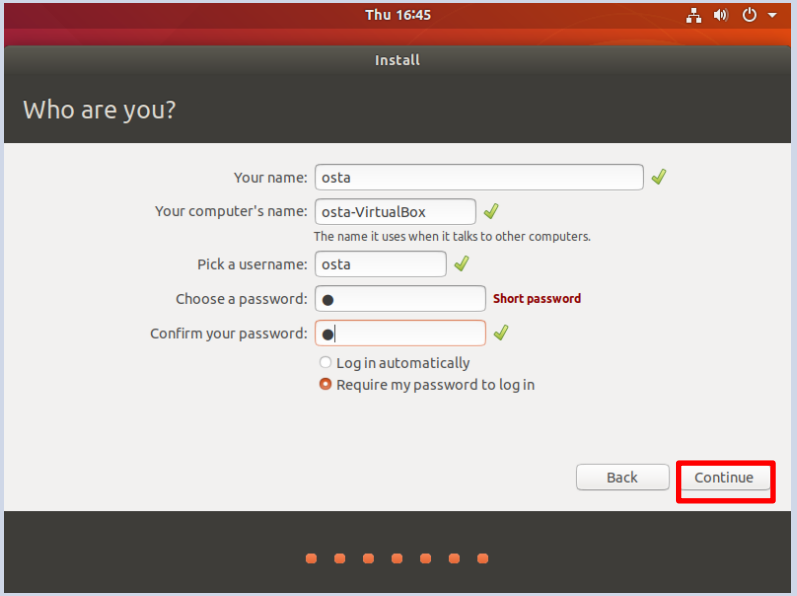

Thu 07:44
Install
Where are you?
Seoul
Back
Continue

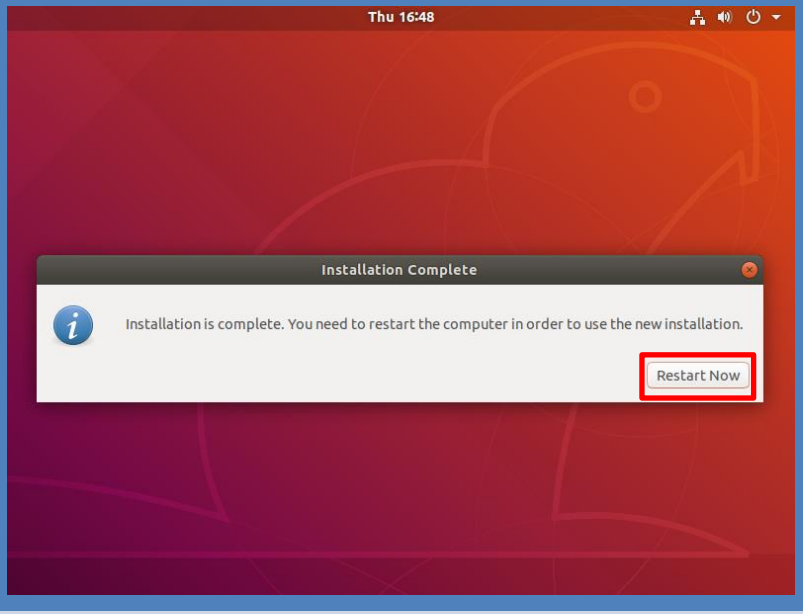
20


Thu 16:45
Install
Who are you?
Your name:
osta
Your computer's name:
osta-VirtualBox
The name it uses when it talks to other computers.
Pick a username:
osta
Choose a password:
Short password
Confirm your password:
Log in automatically
Require my password to log in
Back
Continue

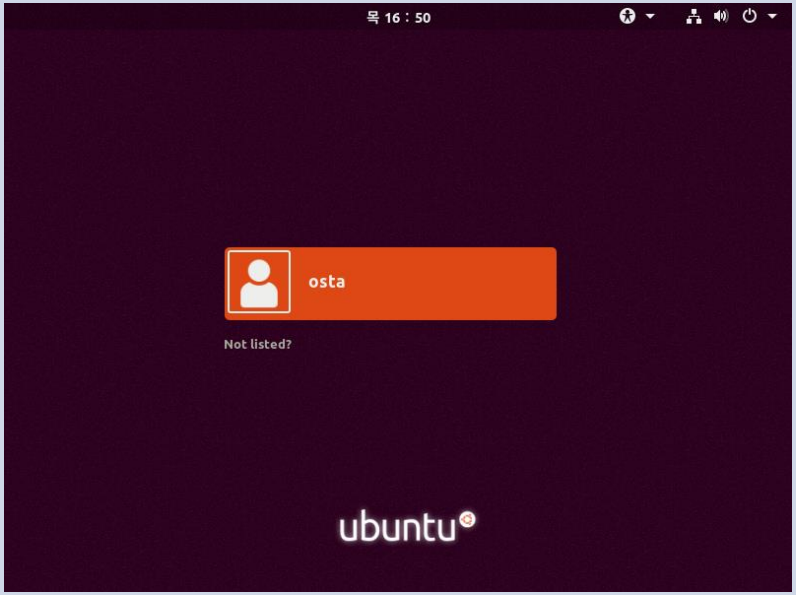
21


Thu 16:45
Install
Welcome to Ubuntu
Fast and full of new features, the latest version of Ubuntu makes computing easier than ever. Here are just a few cool new things to look out for…
Almost finished copying files...
Skip

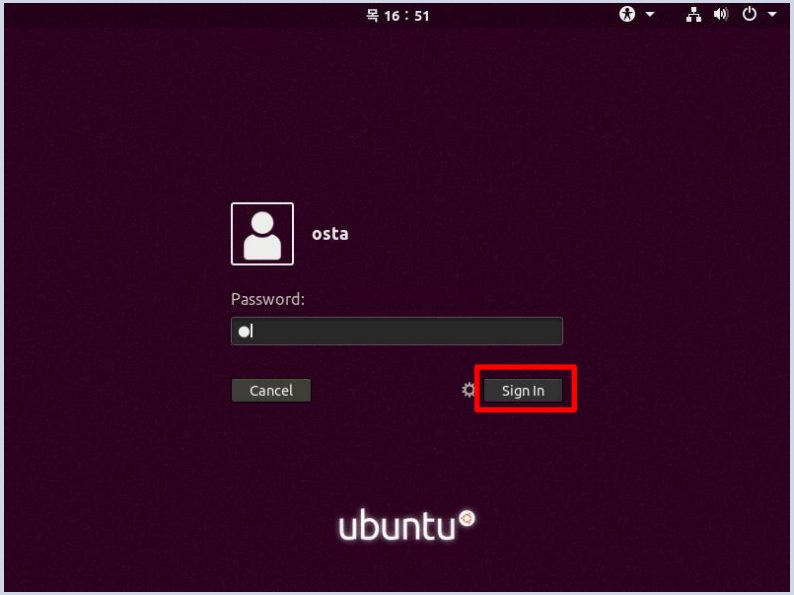
22


Thu 16:48
Installation Complete
Installation is complete. You need to restart the computer in order to use the new installation.
Restart Now

23


목 16 : 50
osta
Not listed?
ubuntu

24


목 16 : 51
osta
Password:
Cancel
Sign In
ubuntu

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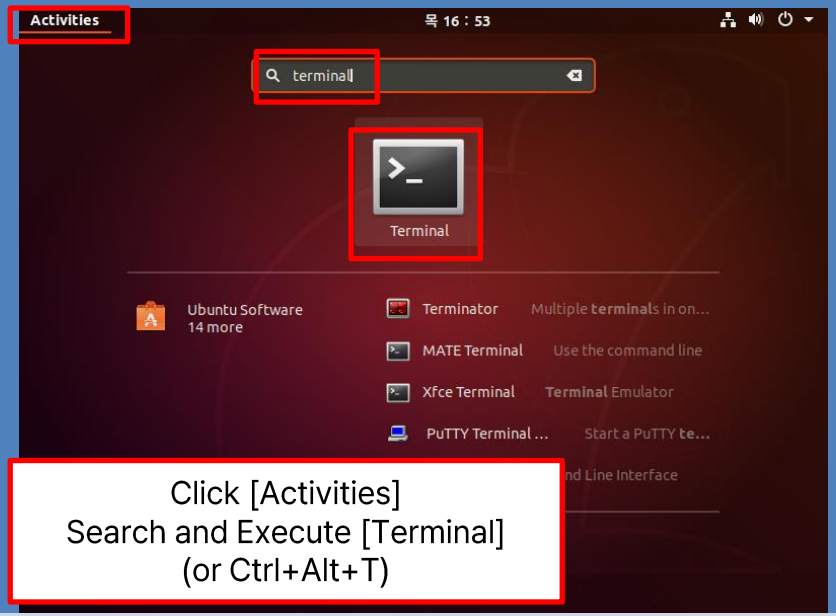

Click [Activities]
Search and Execute [Terminal]
(or Ctrl+Alt+T)

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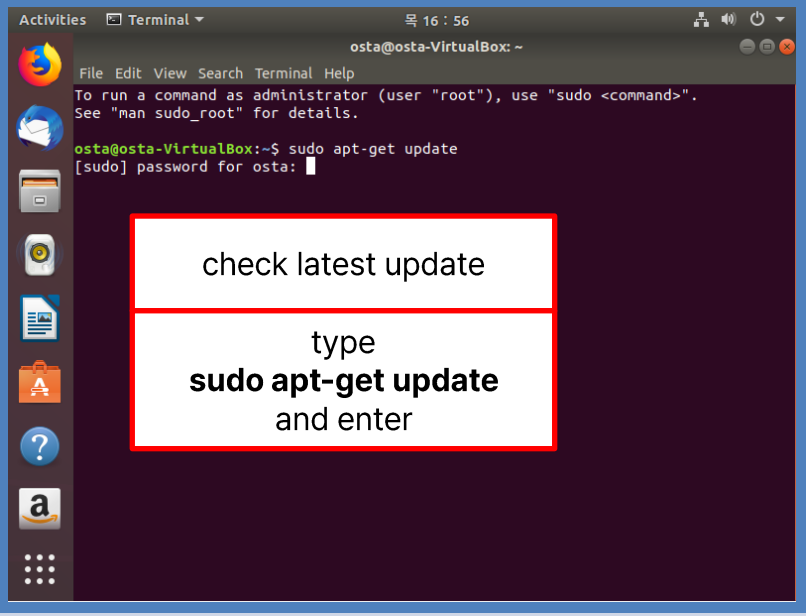
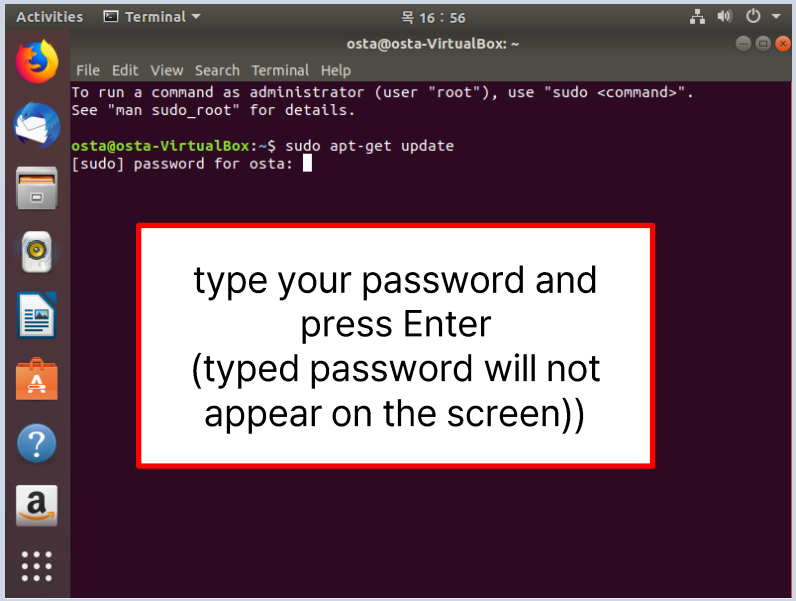


check latest update

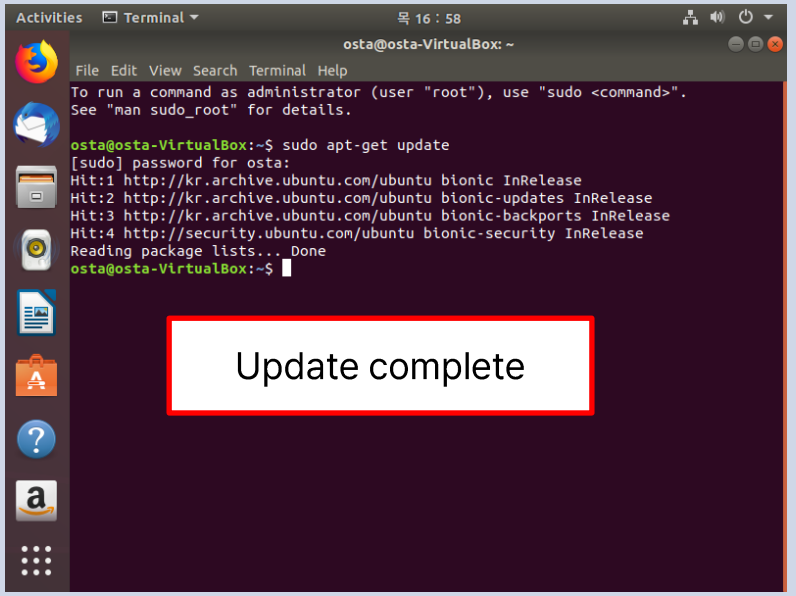
type
sudo apt-get update
and enter

27



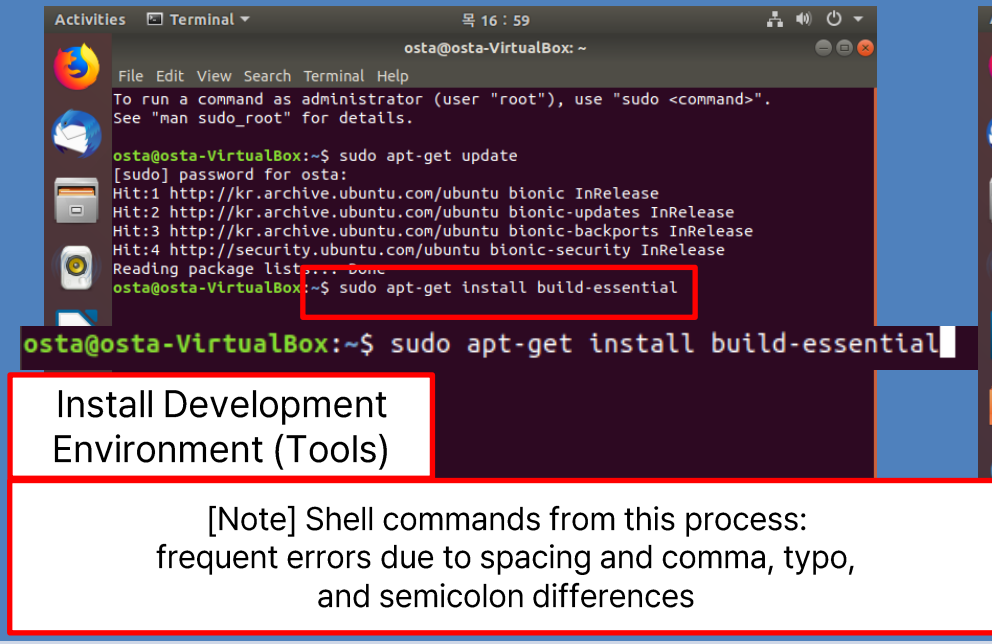
type your password and
press Enter
(typed password will not
appear on the screen))

28



Update complete

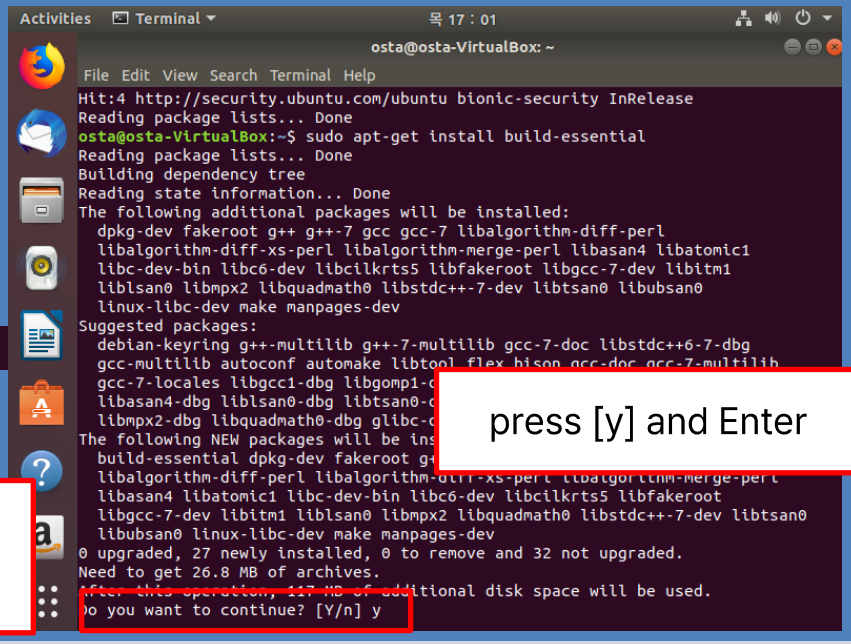
29



Install Development Environment (Tools)

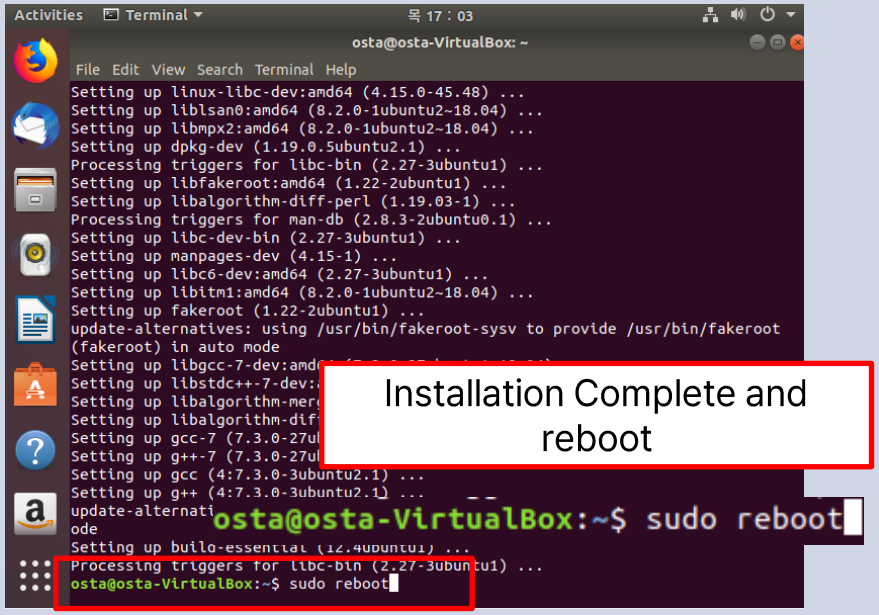
[Note] Shell commands from this process:
frequent errors due to spacing and comma, typo, and semicolon differences

30



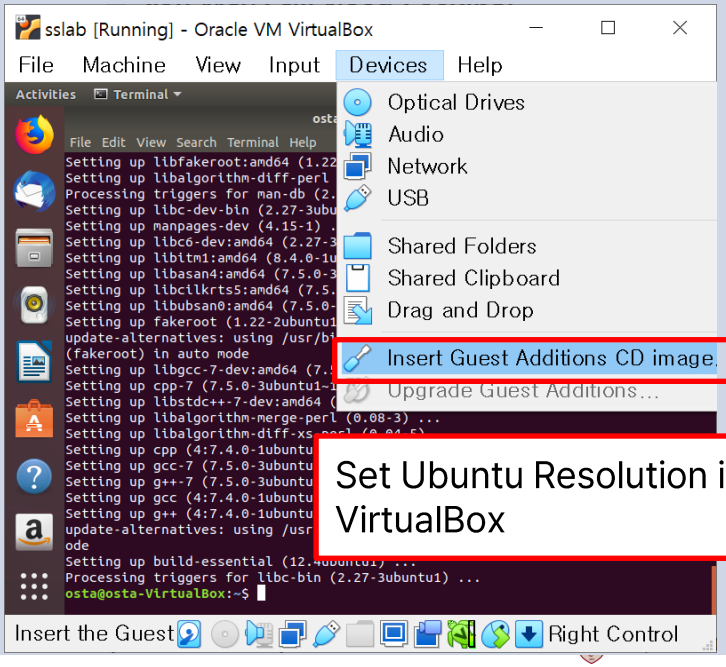
press [y] and Enter

31



Installation Complete and reboot

32



Set Ubuntu Resolution in VirtualBox

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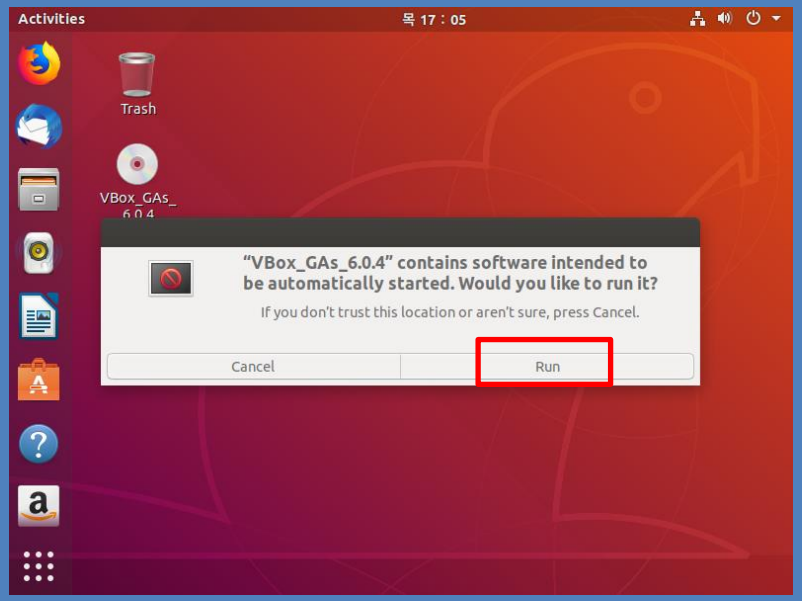
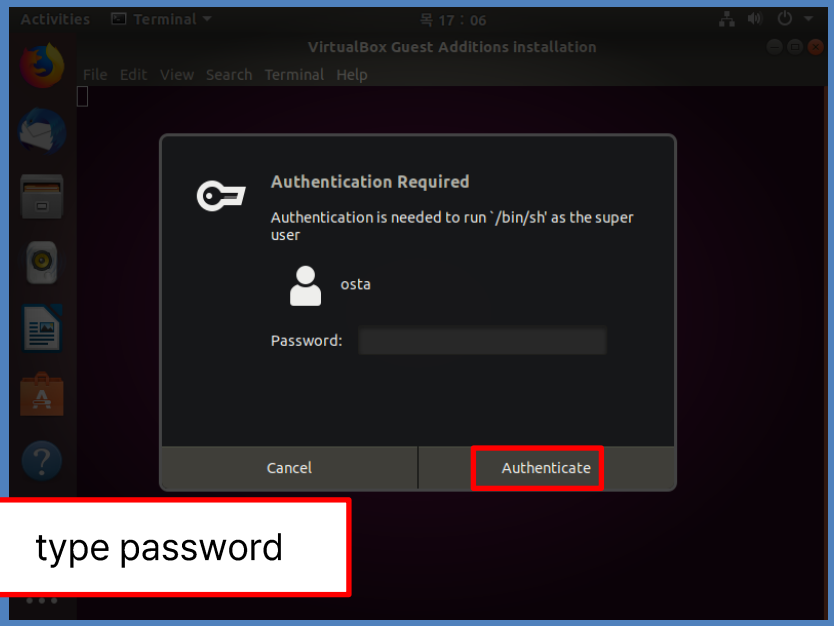
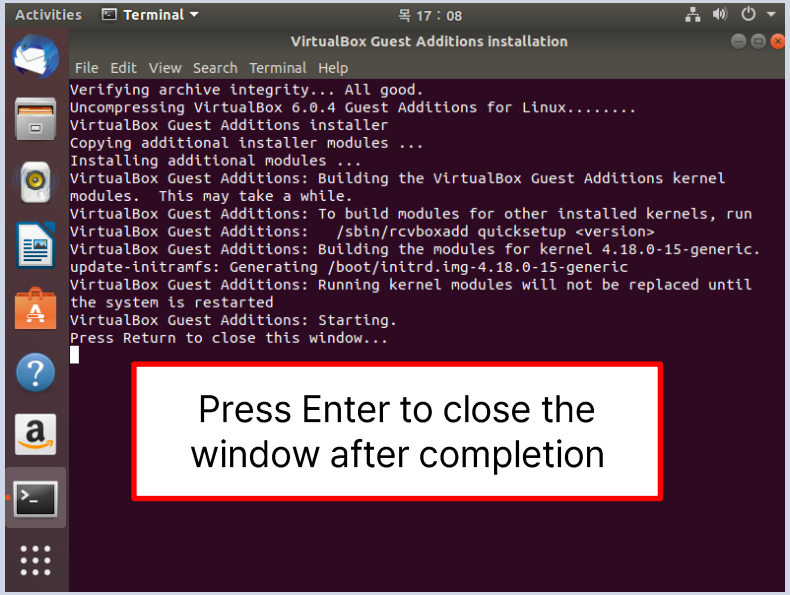


34



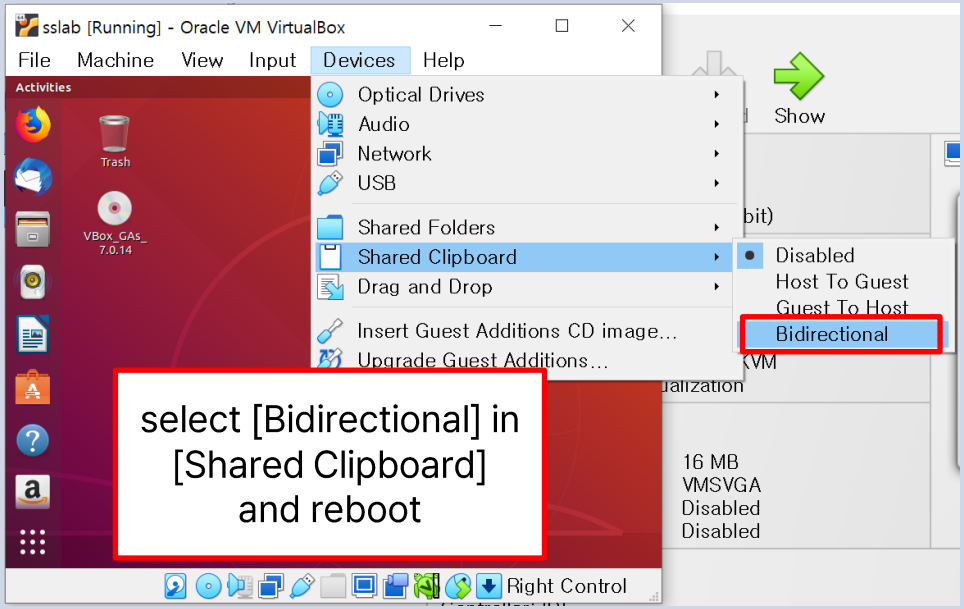
type password

35



Press Enter to close the window after completion

36



select [Bidirectional] in [Shared Clipboard] and reboot

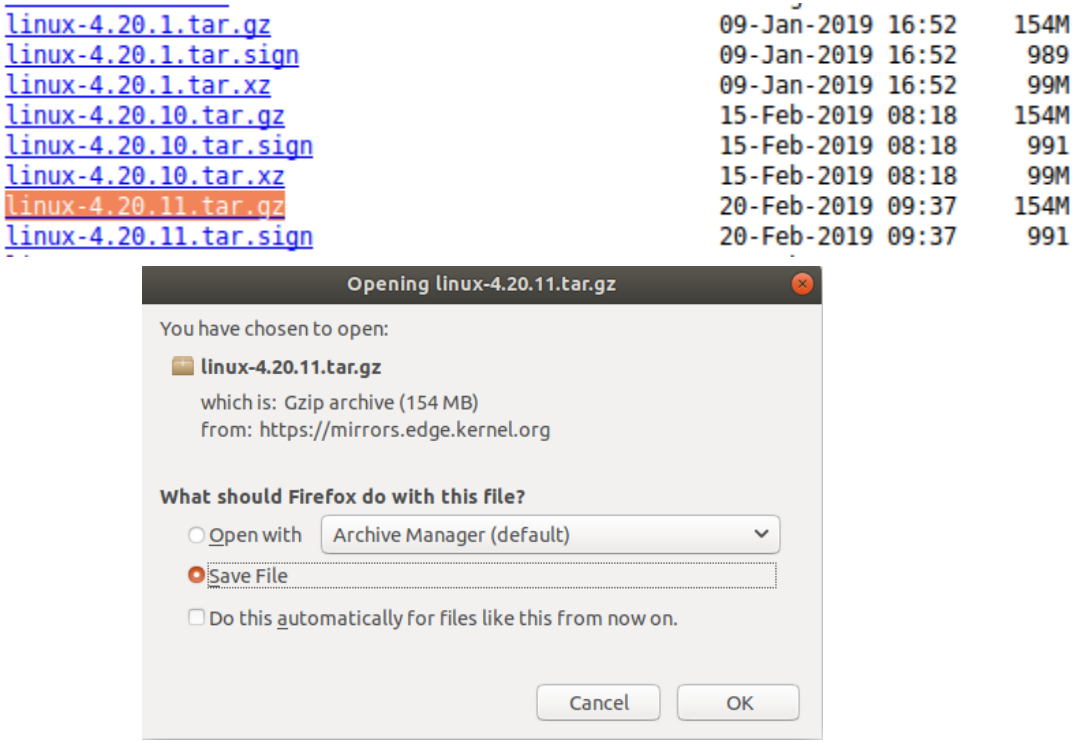
3
Linux Kernel Compilation

Preparation for Kernel Compilation

- **Learn basic Linux shell commands**
  - ls, cd, mv, cp, rm, sudo, … *(The More, The Better)* for your projects
- **Understand basic Linux concepts**
  - current directory, upper directory (. , ..)
  - User permission, root permission (su, sudo)
  - Compress (tar)
  - Compile (gcc, make)
  - Edit file (vi, gedit)
  - Change file permissions (chmod)
  - Run an executable file
- **Why compile the kernel?**
  - To add/modify/delete features of the Linux kernel

Download Kernel Source

- **Download Kernel source (v4.20.11) from kernel.org**
  - https://www.kernel.org/pub/linux/kernel/v4.x/
  - Download from Ubuntu
  - Latest stable kernel version as of 19.02



1
Moving and extracting files

- **pwd: check current directory**
- **cd: change directory**
- **ls: check directories and files of current directory**
- **mv: move file**
- **tar: decompressing (extract)**

```
File  Edit  View  Search  Terminal  Help
osta@osta-VirtualBox:~$ pwd
/home/osta
osta@osta-VirtualBox:~$ cd Downloads/
osta@osta-VirtualBox:~/Downloads$ ls
linux-4.20.11.tar.gz
```

```
osta@osta-VirtualBox:~/Downloads$ sudo mv linux-4.20.11.tar.gz /usr/src/
osta@osta-VirtualBox:~/Downloads$ cd /usr/src/
osta@osta-VirtualBox:/usr/src$ ls
linux-4.20.11.tar.gz  linux-headers-4.18.0-15  linux-headers-4.18.0-15-generic
osta@osta-VirtualBox:/usr/src$ sudo tar -xvzf linux-4.20.11.tar.gz
```

2
Moving and extracting files

New kernel source just decompressed

Kernel source installed by default in Ubuntu 18.04.2

```
osta@osta-VirtualBox:/usr/src$ ls
linux-4.20.11           linux-headers-4.18.0-15
linux-4.20.11.tar.gz    linux-headers-4.18.0-15-generic
```

3
copy **Config** file

- Copy the Config file from the default kernel source to the new kernel source
- for avoid setting it up one by one

```
osta@osta-VirtualBox:/usr/src$ sudo cp linux-headers-4.18.0-15-g
eneric/.config linux-4.20.11
```

4
modify kernel name

```
osta@osta-VirtualBox:/usr/src$ cd linux-4.20.11/
osta@osta-VirtualBox:/usr/src/linux-4.20.11$ sudo gedit Makefile
```

```
# SPDX-License-Identifier: GPL-2.0
VERSION = 4
PATCHLEVEL = 20
SUBLEVEL = 11
EXTRAVERSION = .sslab
NAME = Shy Crocodile
```

Kernel Compilation

- **Kernel must be configured (config) before compilation**

- **What is config?**
  - configuring the kernel
  - Select the feature you want to compile among the features of the various kernels

- **What to do for kernel config**
  - First, libncurses5-dev is required for menuconfig setup
  - run commands below:

$ sudo apt-get install libncurses5-dev
$ sudo apt-get install libssl-dev
$ sudo apt-get install libelf-dev
$ sudo apt-get install bison
$ sudo apt-get install flex

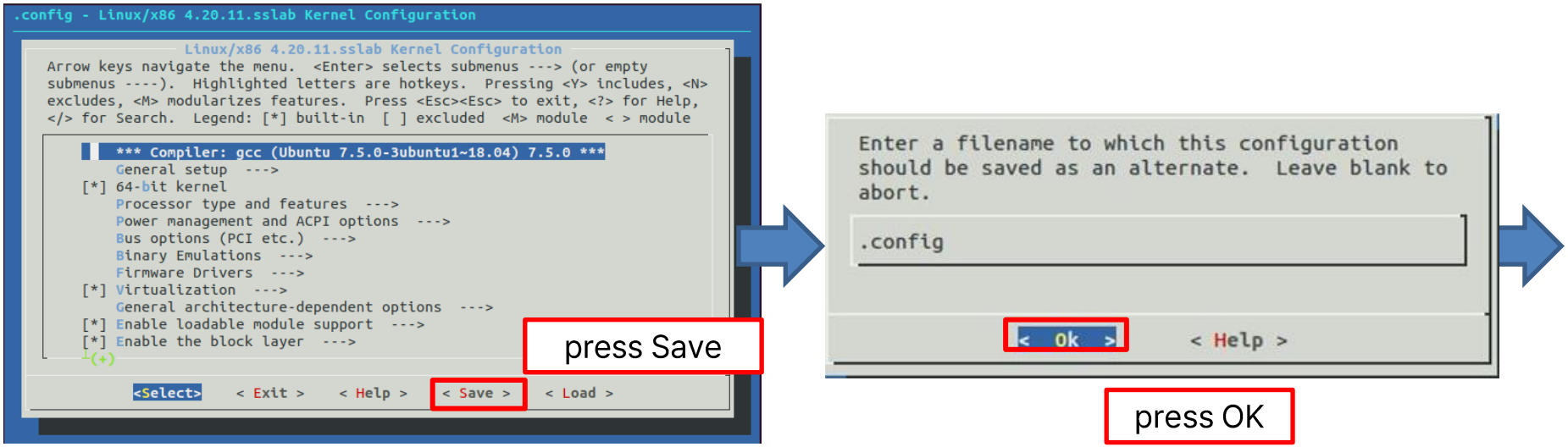
Kernel Compilation

- **Kernel config: Enter the followings from Linux terminal**
  - The path after the **cd** is the previously decompressed directory of Linux kernel code

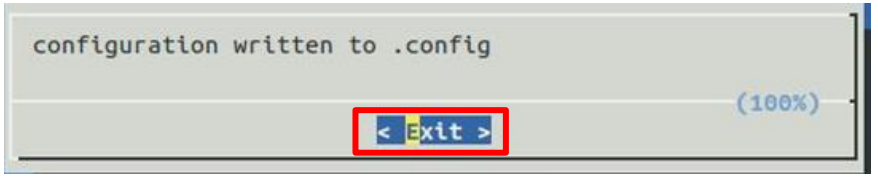
    $ **cd** /usr/src/linux-4.20.11/

    $ sudo make menuconfig

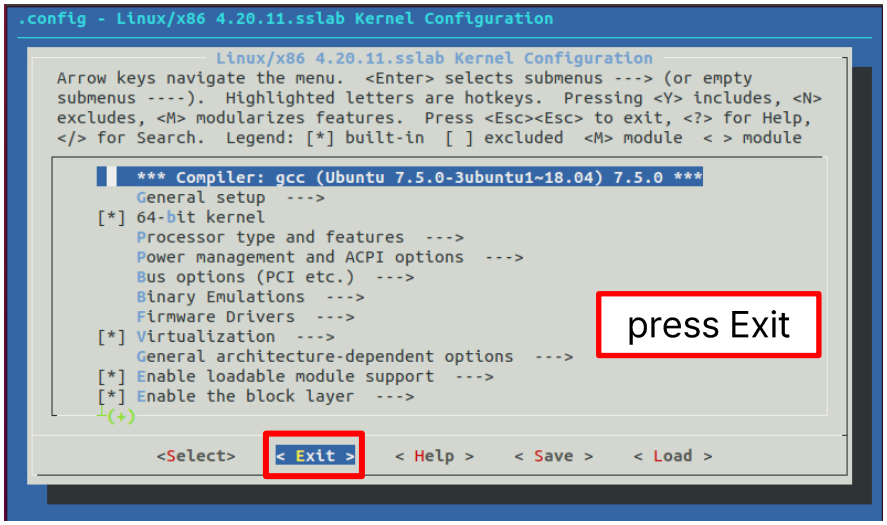
  - The following window appears on the screen



Kernel Compilation



press Exit



press Exit

- **Compiling and installing the kernel: type the following commands in order**

  $ sudo make –j 4

  -j option: Specify the number of cores to compile (for faster compilation)

  $ sudo make modules_install

  $ sudo make install

- **Kernel compilation takes a very, very long time. Please take your time and wait.**

Kernel Compilation

- **Check installed kernel: check kernel version after reboot**

  # sudo reboot

  # uname –r

```
osta@osta-VirtualBox:~$ uname -r
4.20.11.sslab
```

  - Successful installation if "uname –r" prints new kernel name
  - should be printed as [4.20.11.XXX] format

- **If you want to return to the old kernel (failed to boot new kernel)**
  - Press "left shift key" at boot time
  - select previous version from [Advanced options for Ubuntu]

- **After first kernel compilation**
  - Can compile and install only by "make", "make install"
  - if you erase all binaries with "make clean", the compile time will take as long as the first kernel build time

Live Demonstration (at BlackBoard)