Operating Systems, Virtual Machine and Cloud computing

Dumrong Mairiang, PhD

SIRE507: FUNDAMENTAL COMPUTER SCIENCE FOR BIOLOGIST

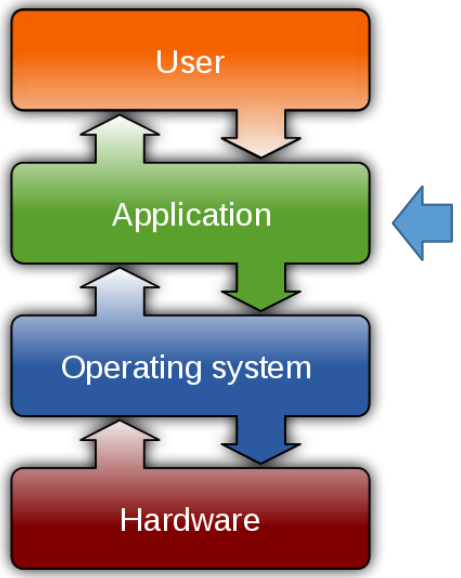
Operating system (OS)

- What is it?

- Why is it important?

Operating system (OS)

- What is it?
  - The basic software that manages a computer
- Why is it important?

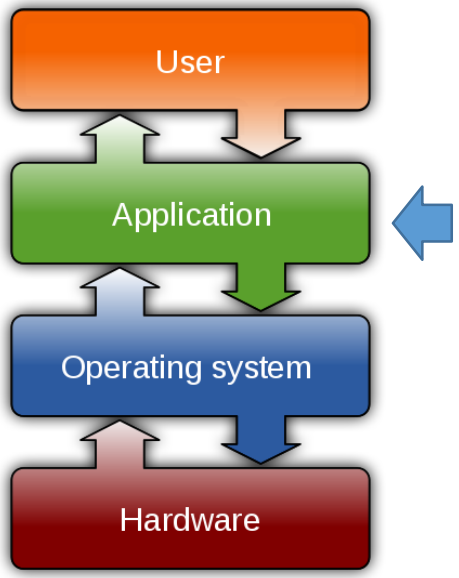


What are “Applications”?

Golftheman

Operating system (OS)

- What is it?
  - The basic software that manages a computer
- Why is it important?



Golftheman

What are “Applications”?

Self-contained programs that perform a specific function

Operating system (OS)

- Do you know any OS?

Operating system (OS)

- Do you know any OS?

macOS

Operating system (OS)

- Do you know any OS?

macOS

ubuntu

Mobile OS

iOS

Operating system (OS)

- Do you know any OS?

Microsoft Windows family

Windows 10

Microsoft Windows NT

Microsoft Windows 95

XBOX ONE

Windows 8

Other

MS-DOS

RISC OS

Unix/Unix-like family

FreeBSD

ORACLE SOLARIS

PS4

Macintosh/Darwin

iOS

macOS

Linux

CentOS

ubuntu

fedora

debian

Why do you need to know about OSes?

Why do you need to know about OSes?

- Many (if not majority) of bioinformatic applications were developed for Unix-like or Linux OS
- If you want to develop a web application, web servers usually run with Linux
- Many free and open-source applications must be run on Unix-like or Linux OS

Operating system (OS)

- Old machine, legacy application and IoT:
  - 32-bit vs 64-bit (32-bit apps on Windows?)
  - Lite version/distribution of OS (e.g. Alpine, Lubuntu)
- Users of your application
  - Windows
    - General users with probably no or little bioinformatic background
    - Graphical user interface is likely to be expected
  - Unix-like/Linux
    - Bioinformaticians
    - Command lines are acceptable

Distinct features of each OS

- OS-specific file extensions
  - Microsoft Windows
    - File.exe
    - File.msi
  - Mac OS
    - File.dmg
  - Linux (Debian)
    - File.deb

Distinct features of each OS

- File naming rules
  - Microsoft Windows
    - Reserved characters: \, /, :, ?, *, >, <, |, “
  - Linux and Mac OS
    - Reserved characters: /, >, <, |, &, (,), “, ‘
    - Reserved characters but will be “automatically escaped”: \ , *, :, space
  - As bioinformatician: Please AVOID using “space” in the file name
    - FileName.txt
    - File_Name.txt

Distinct features of each OS

- File paths to YourFile.txt in your “home” directory
  - Microsoft Windows
    - C:\Users\YourName\YourFile.txt
  - Mac OS
    - /Users/YourName/YourFile.txt
  - Linux
    - /home/YourName/YourFile.txt
- Linux (root access)
    - /root/YourFile.txt

Distinct features of each OS

- Application for accessing command line
  - Microsoft Windows
    - Command Prompt
  - Mac OS
    - Terminal
  - Linux
    - Terminal

Distinct features of each OS

- Application for Back-up
  - Microsoft Windows
    - System Restore and Restore Point
  - Mac OS
    - Time Machine
  - Linux
    - Ubuntu backups
    - Backups application

Distinct features of each OS

- Application for Hardware Management/List
  - Microsoft Windows
    - Device Manager
  - Mac OS
    - System Reports (“About this Mac”)
  - Linux (Ubuntu)
    - hardinfo, lspci, lsusb

Distinct features of each OS

- Checking or interrupting programs
  - Microsoft Windows
    - Task Manager
  - Mac OS
    - top (basic) and htop (to be installed)
  - Linux (Ubuntu)
    - top (basic) and htop (to be installed)

Distinct features of each OS

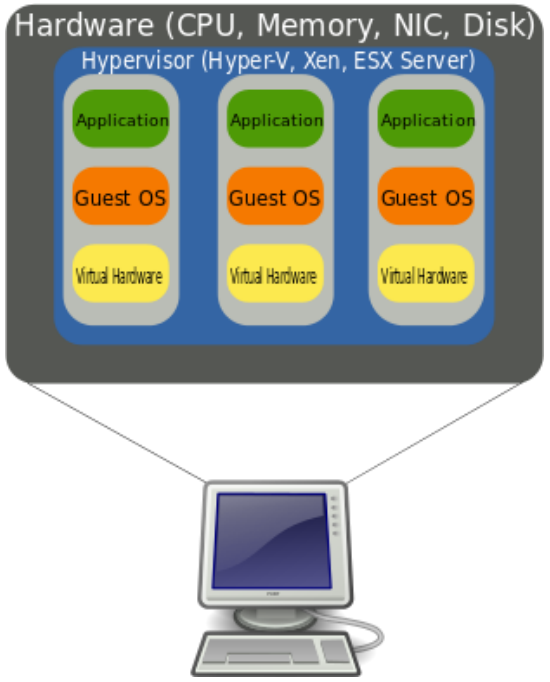
- Any other features?

Virtual Machine (VM)

- What is it?

Virtual Machine (VM)

- What is it?
  - A complete environment for a guest operating system to function as though that operating system were installed on its own computer



John Aplessed

Virtual Machine (VM)

- What VM is not:
  - Virtual machine ≠ Emulator
  - Emulator converts commands to and from a host machine to an entirely different platform
  - Emulator: DosBOX (CPU), PuTTY (Terminal), ZSNES (Gaming), PCSX2 (Gaming), N64 Emulator (Gaming)

Why do you need to know about VMs?

Why do you need to know about VMs?

- SENARIO 1 (Flexibility): The OS of your machine is not compatible with the application you need to run/test:
  - No spare machine for installing a new OS
  - No space or resources to create a dual boot

Why do you need to know about VMs?

- SENARIO 2 (Simulation): You want to simulate network connection to your web application in your own machine
  - No spare machine
  - Do not want to deploy in web server yet

Why do you need to know about VMs?

- SENARIO 3 (Security): Controlled/Quarantined environment for developing, testing or running applications
  - Potentially harmful applications
  - Secured VM

Why do you need to know about VMs?

- Any other scenario?

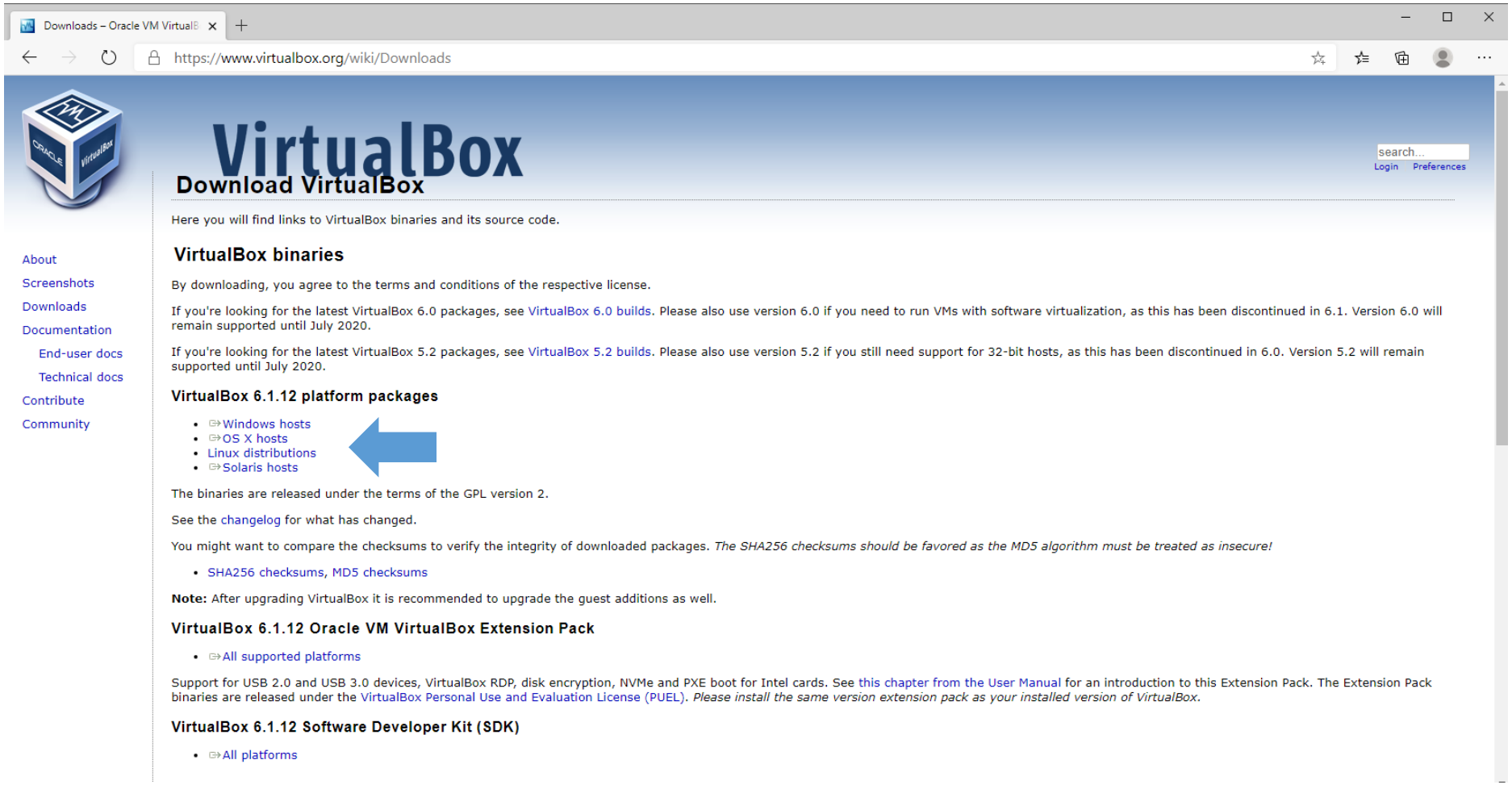
Let’s create the first VM

- Applications for virtualization:
  - VM ware (Commercial)
  - **Oracle VM VirtualBox (Free and open-source)**
  - Vagrant (Free and open-source, but no GUI)
  - Other…

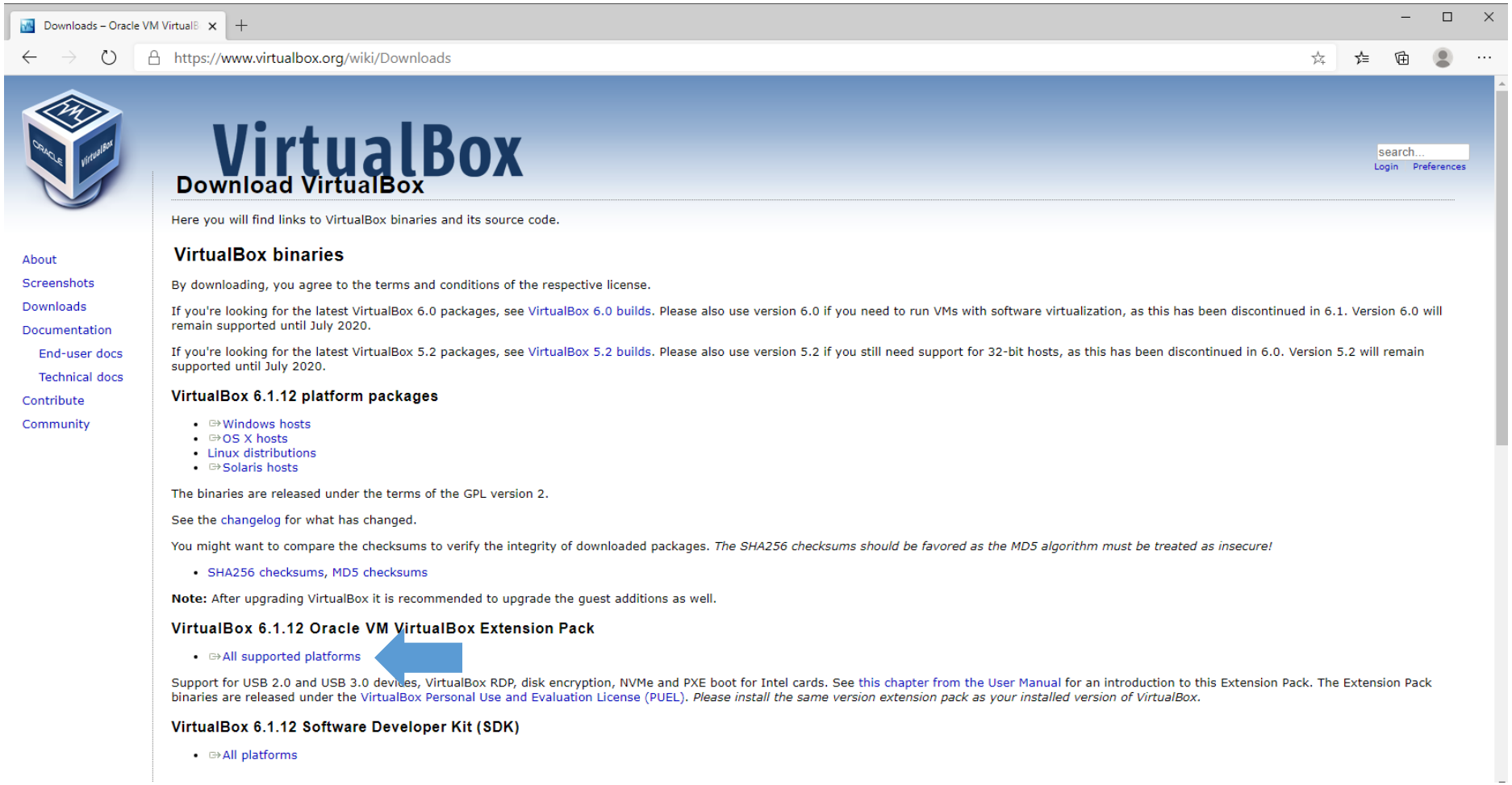
Let’s create the first VM

- Check your machine
  - CPU: at least 2 cores
  - RAM: Host OS minimal requirement + Guest OS minimal requirement
  - Hard disk: Guest OS minimal requirement or External HDD or USB Flash drive

Let’s create the first VM

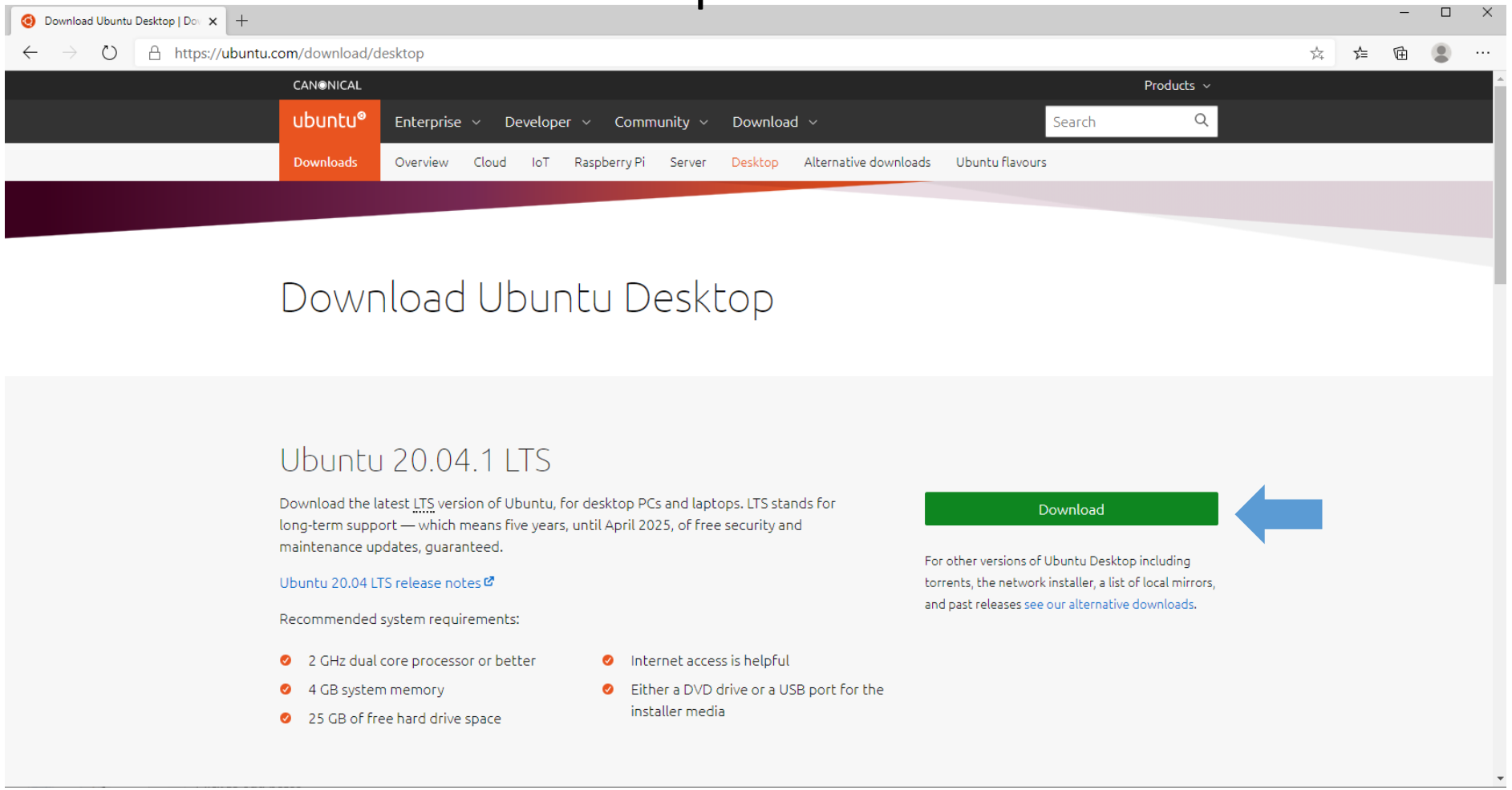


Let’s create the first VM

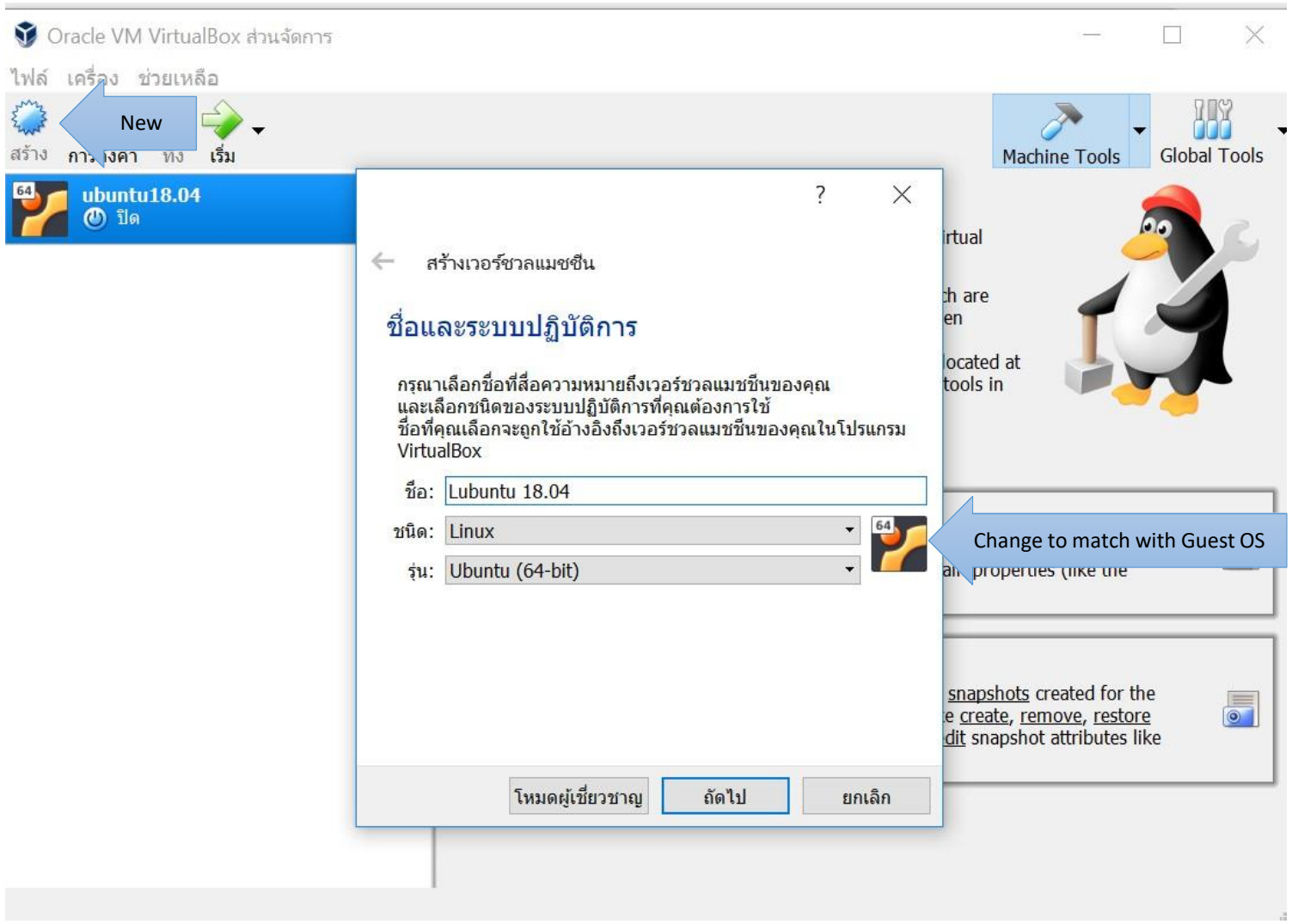


Let’s create the first VM

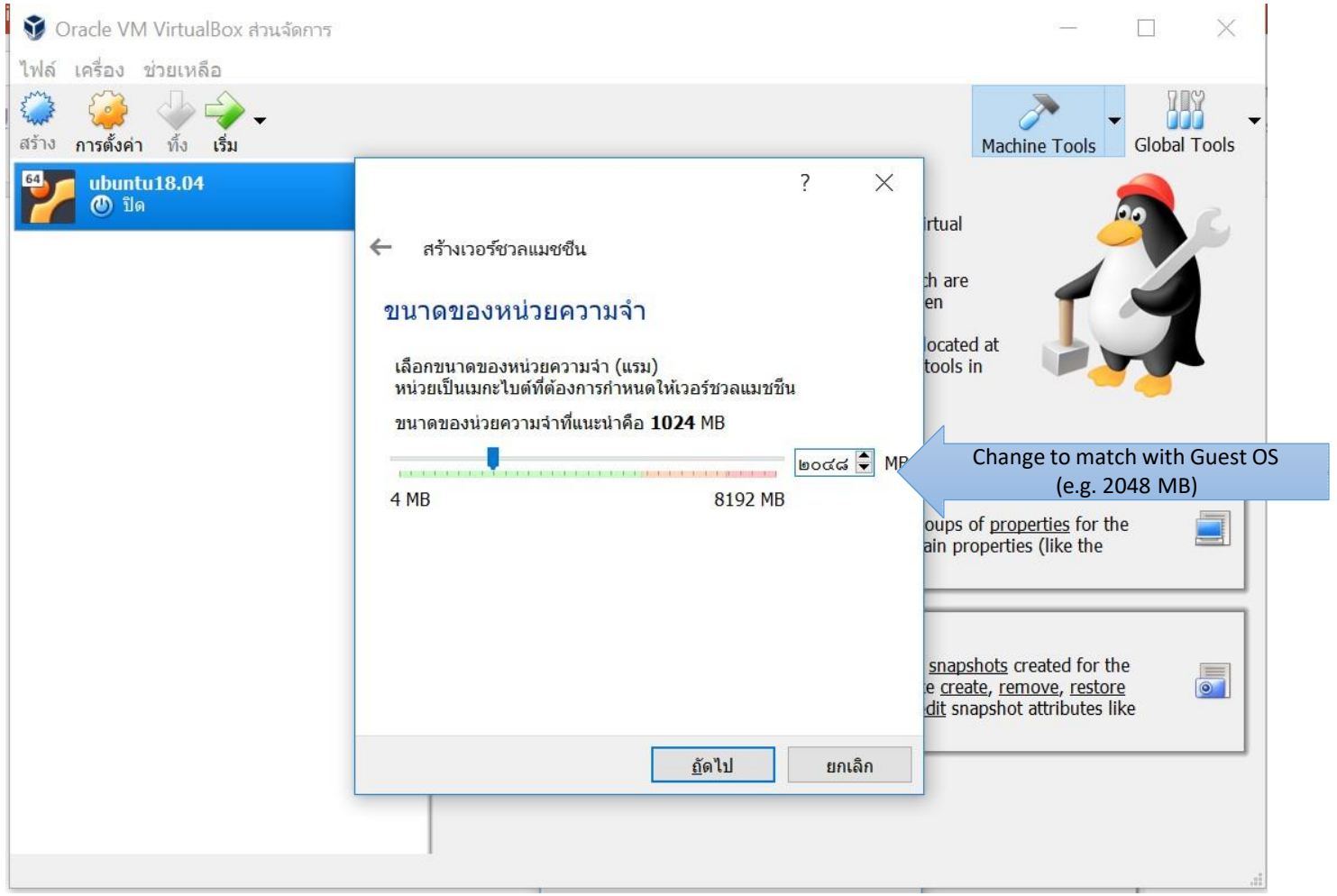
- Ubuntu.iso will be used for the demonstration
- Lubuntu.iso for old or less powerful machine



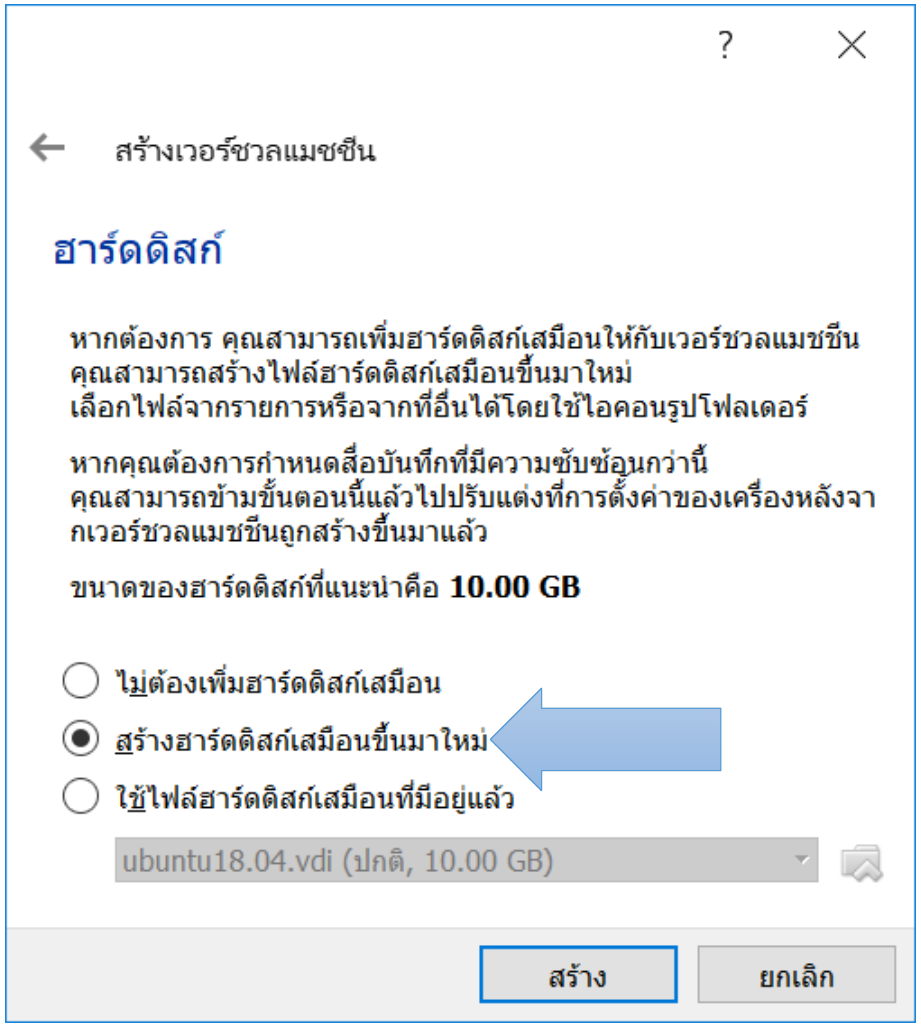
Let’s create the first VM



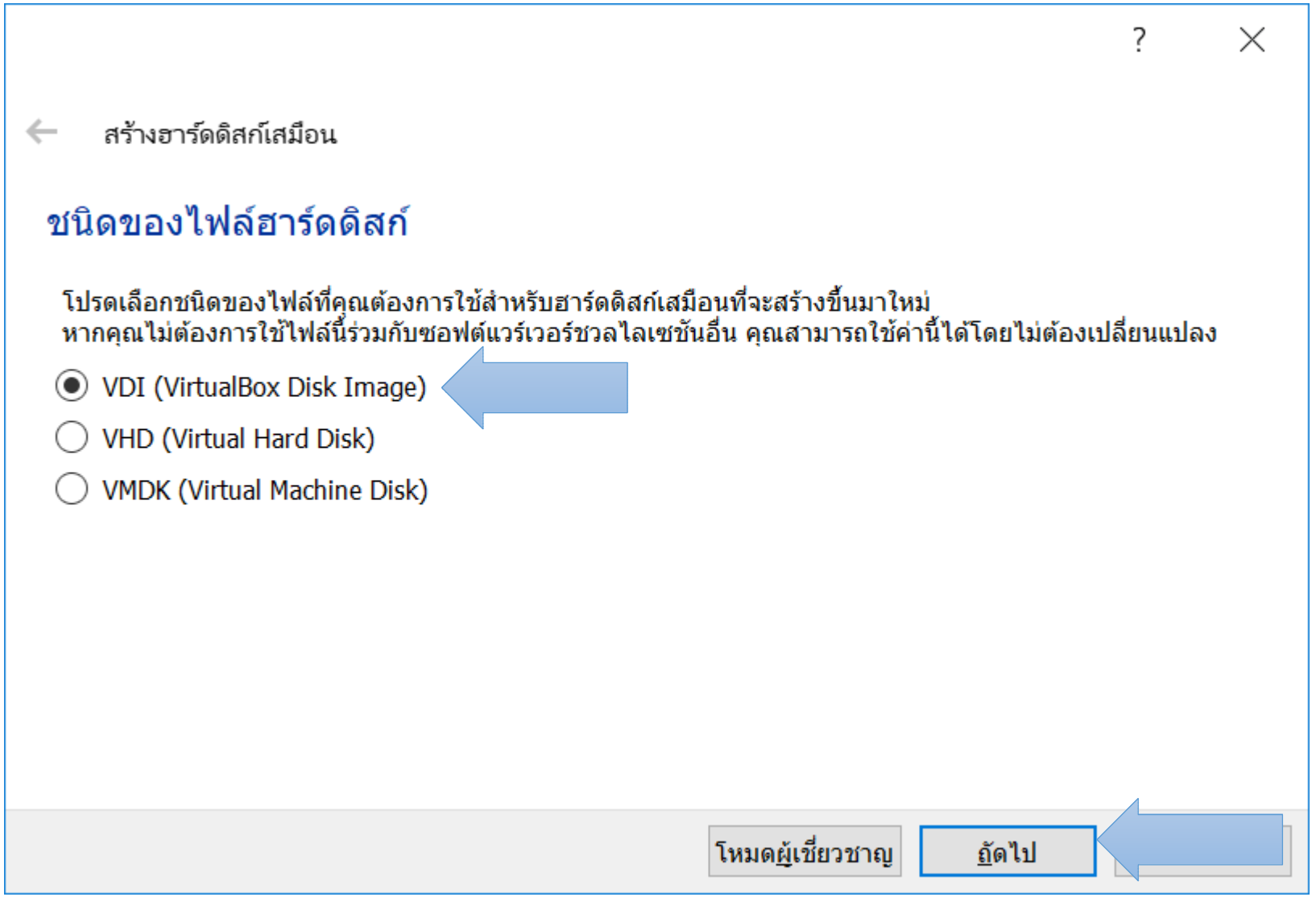
Let’s create the first VM



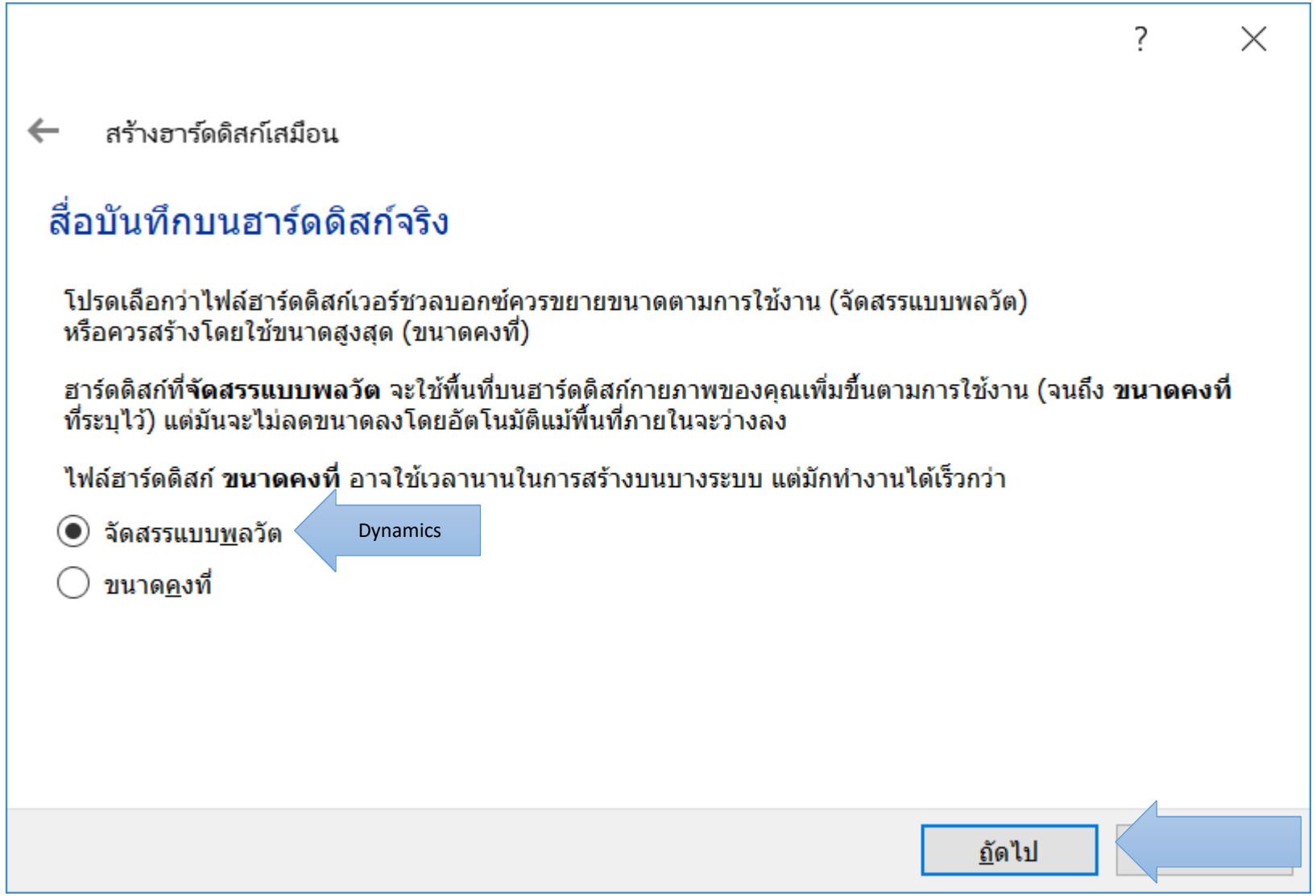
Let’s create the first VM



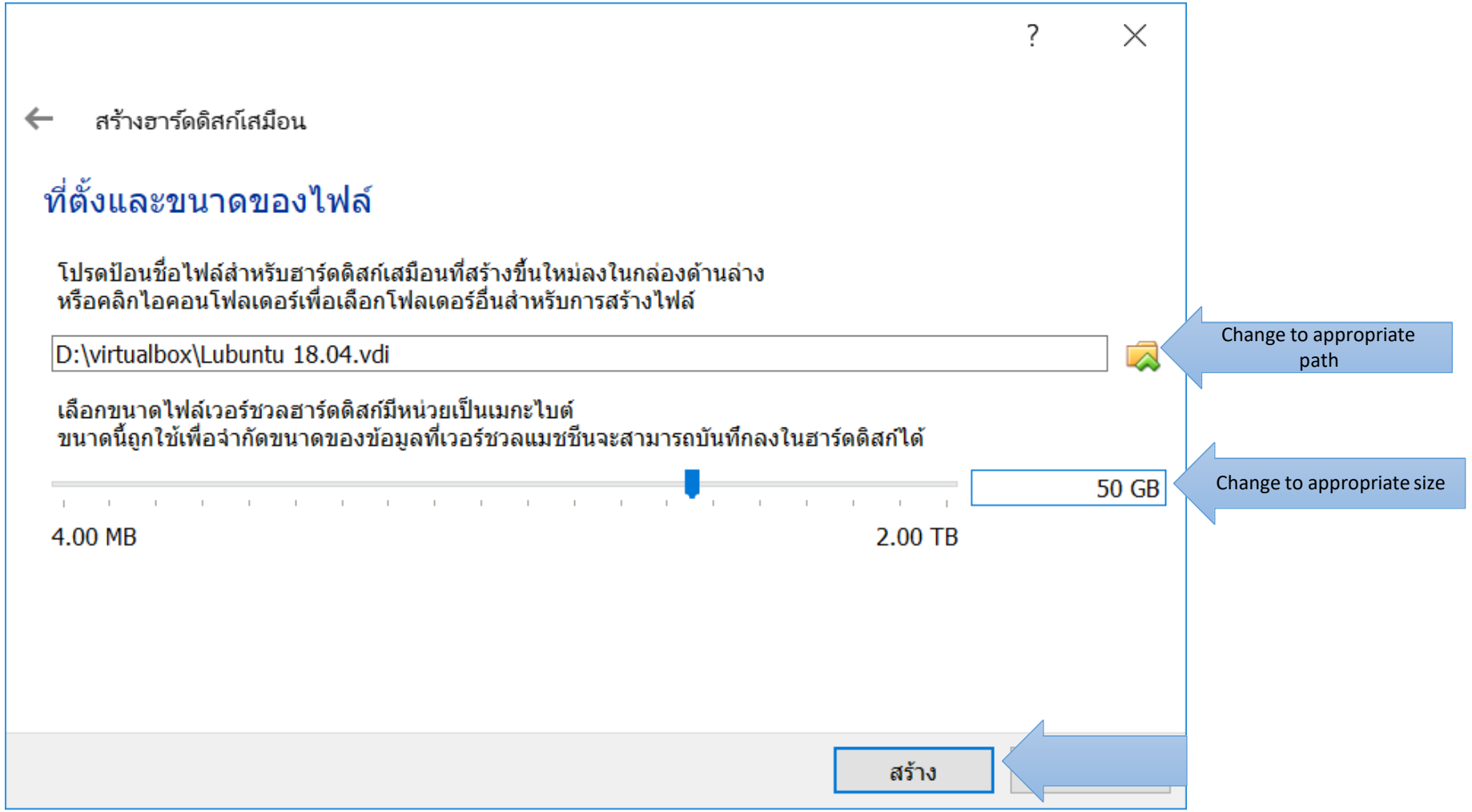
Let’s create the first VM



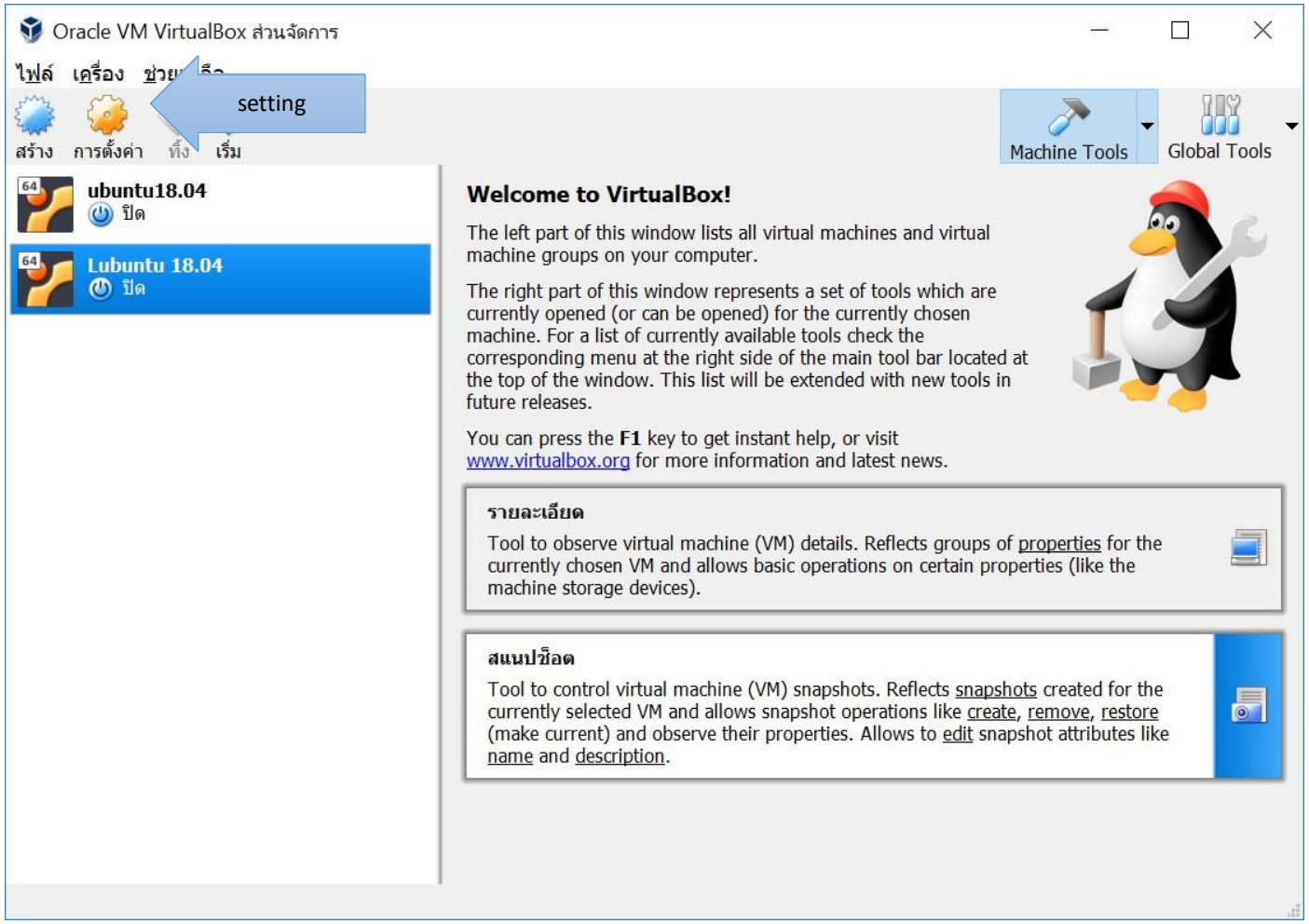
Let’s create the first VM



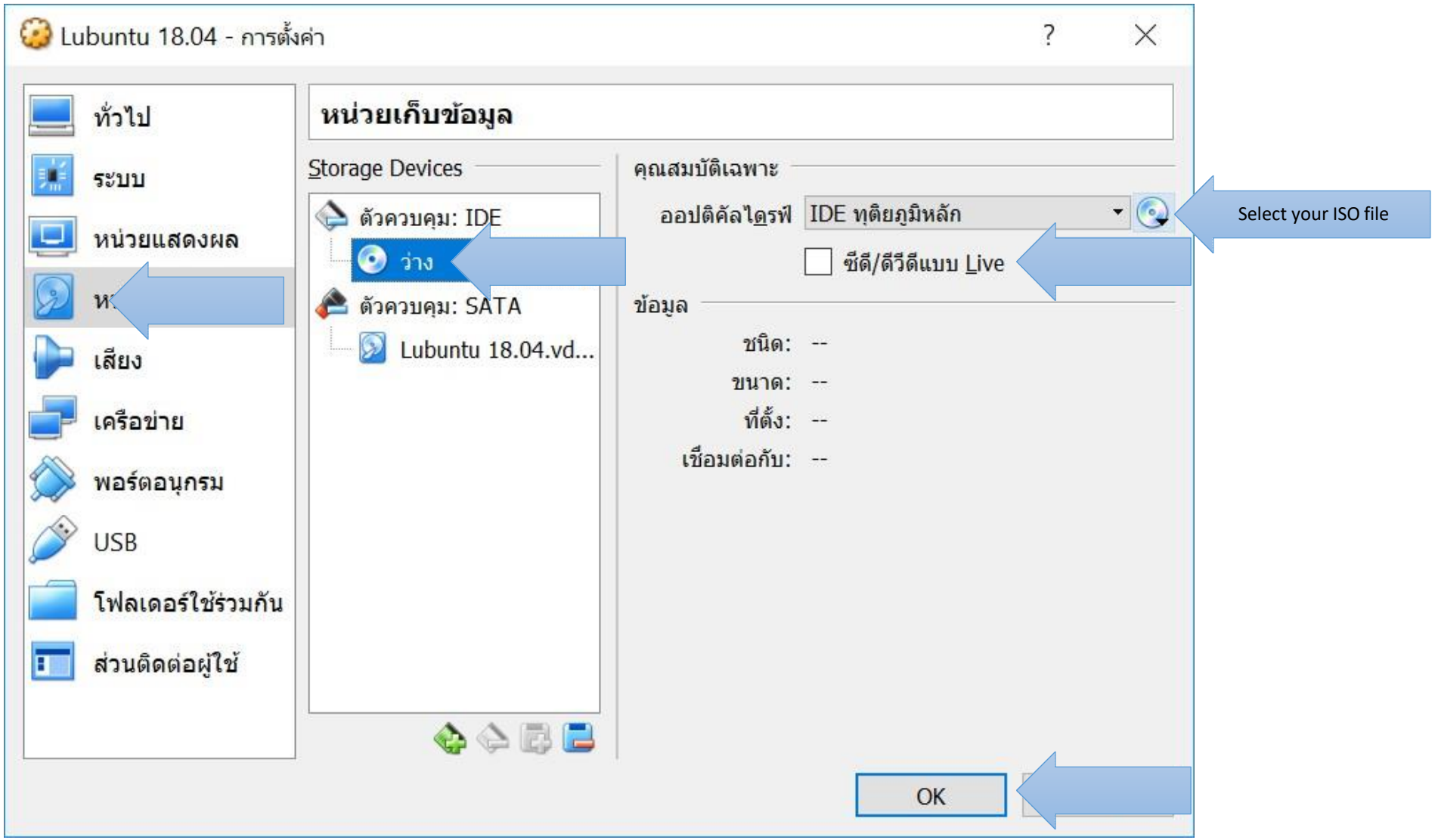
Let’s create the first VM



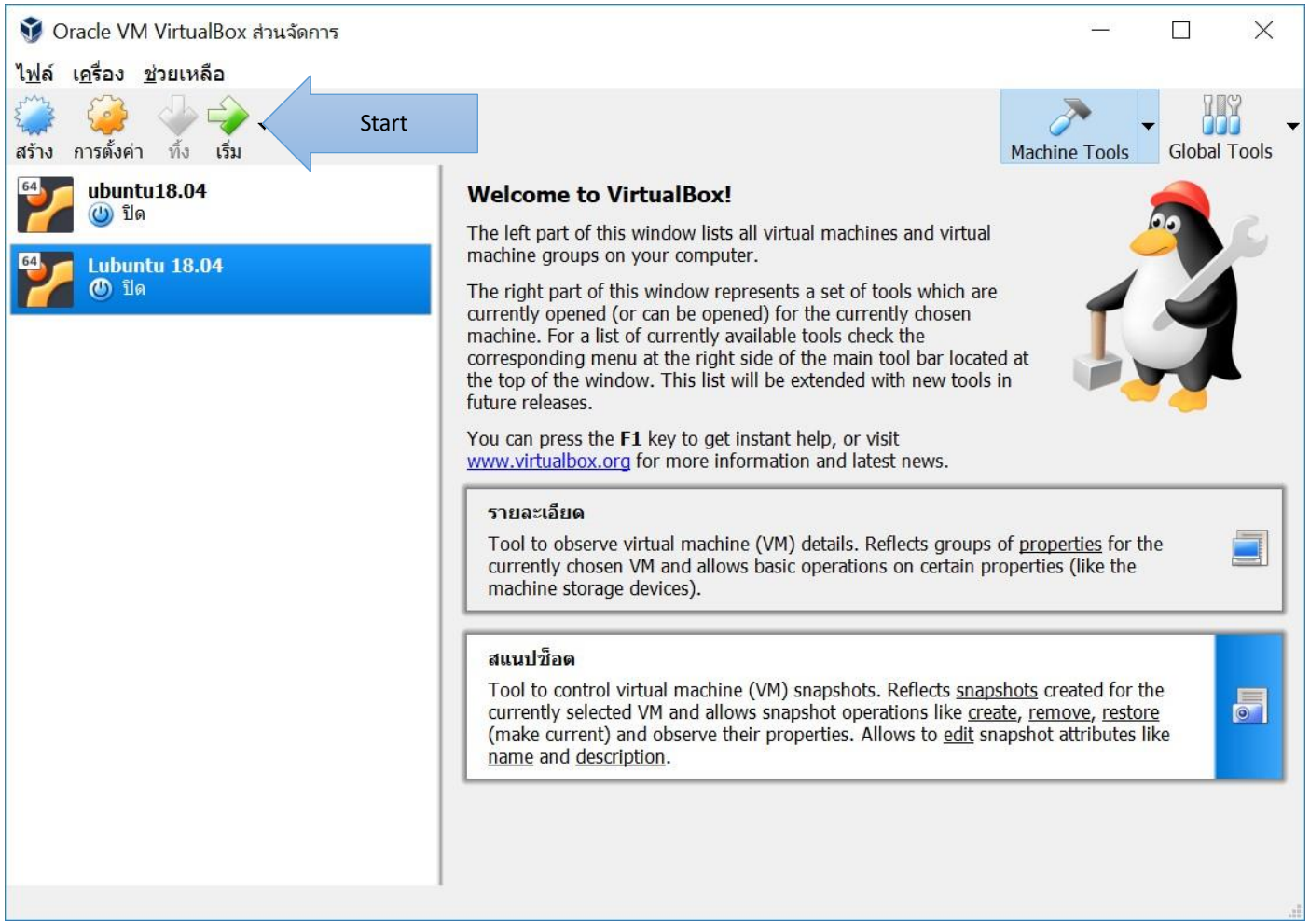
Let’s create the first VM



Let’s create the first VM

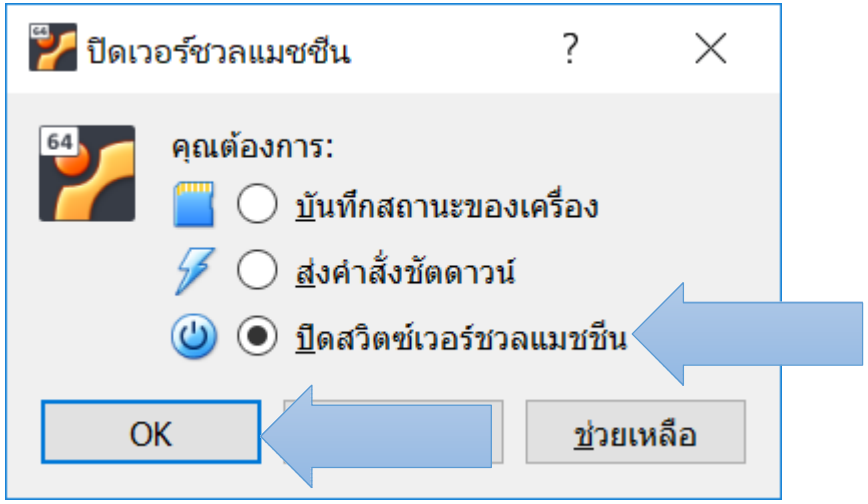


Let’s create the first VM

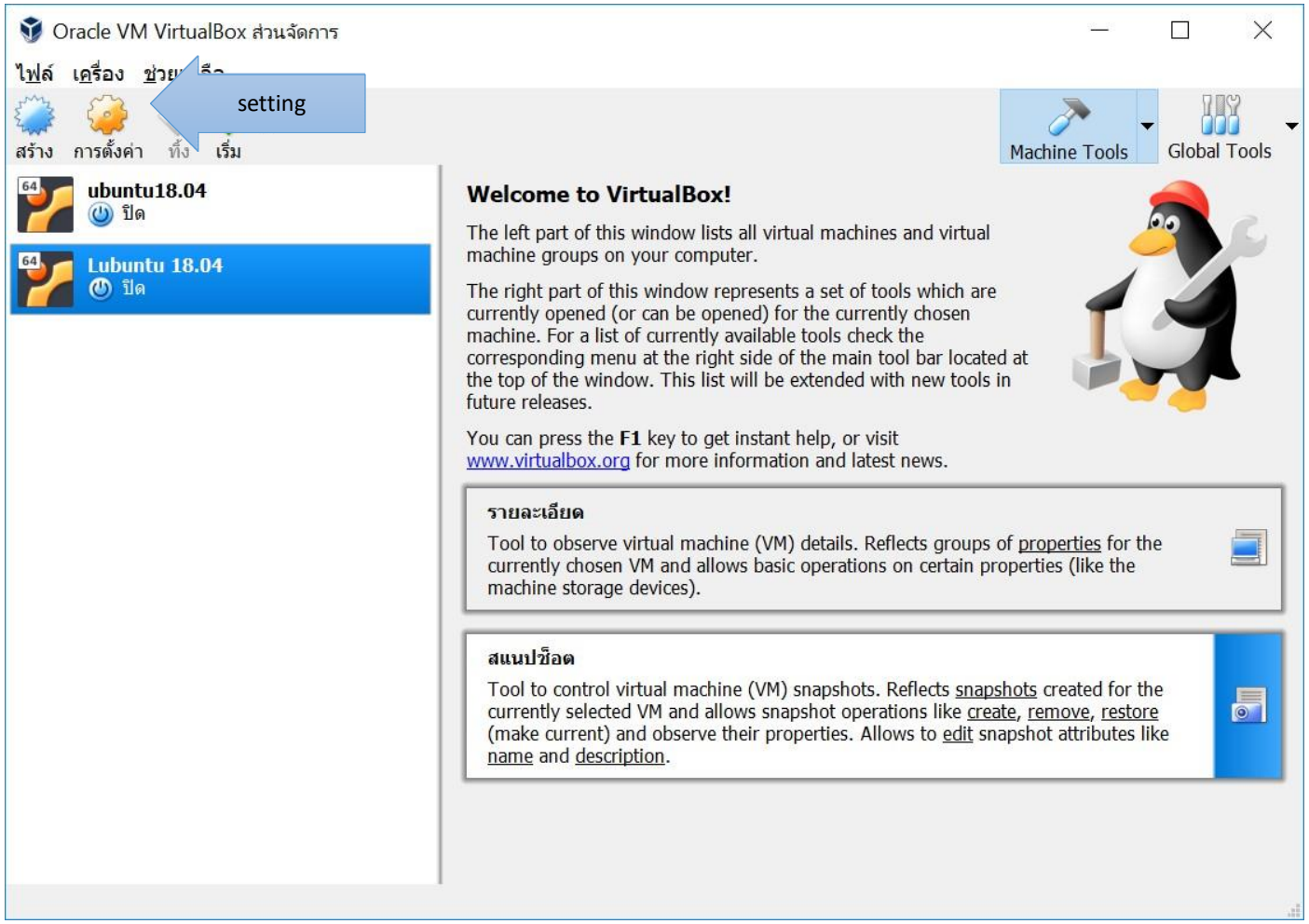


Let’s create the first VM

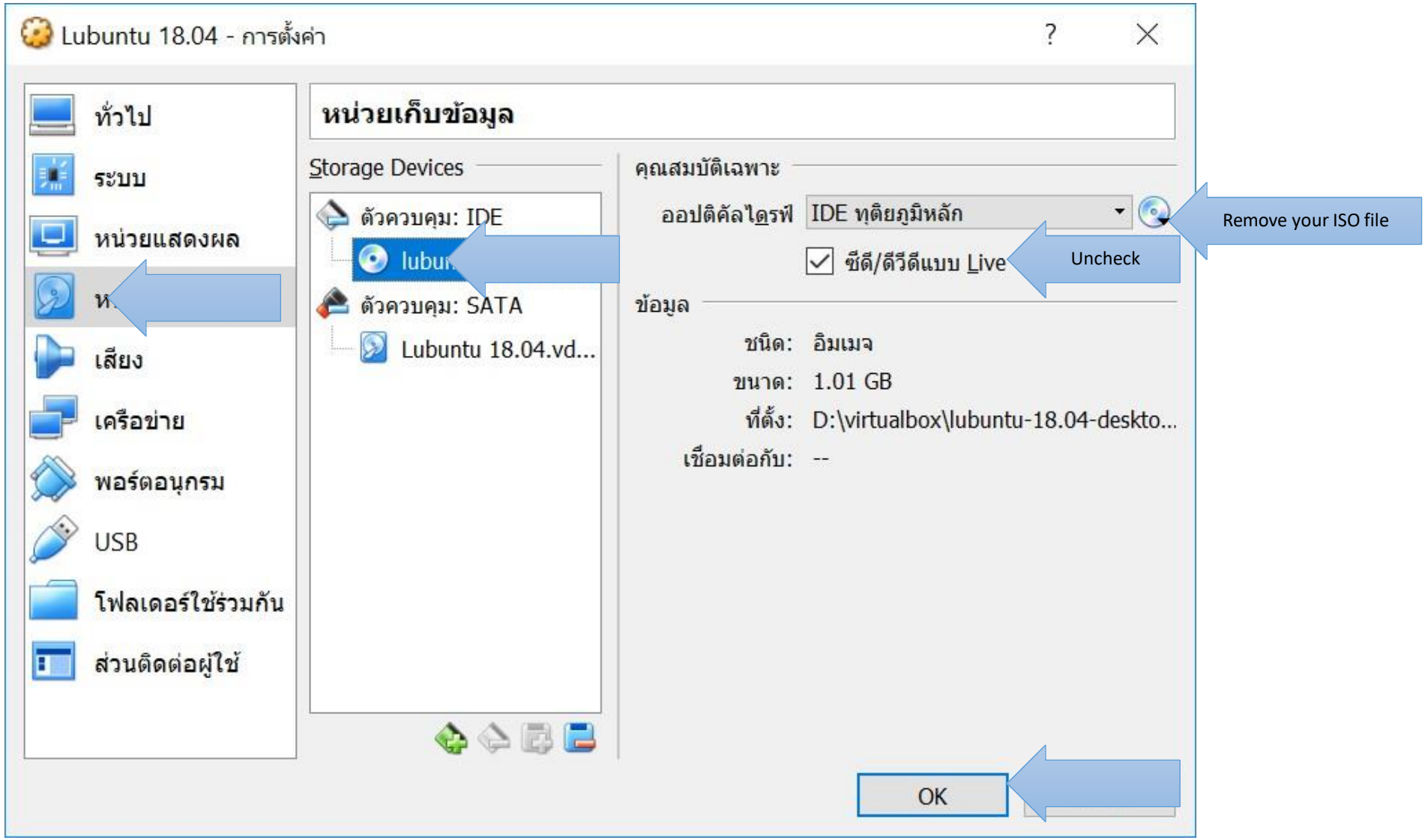
- Install Ubuntu according to instructions
- After installation is done, close the VM → Switch off



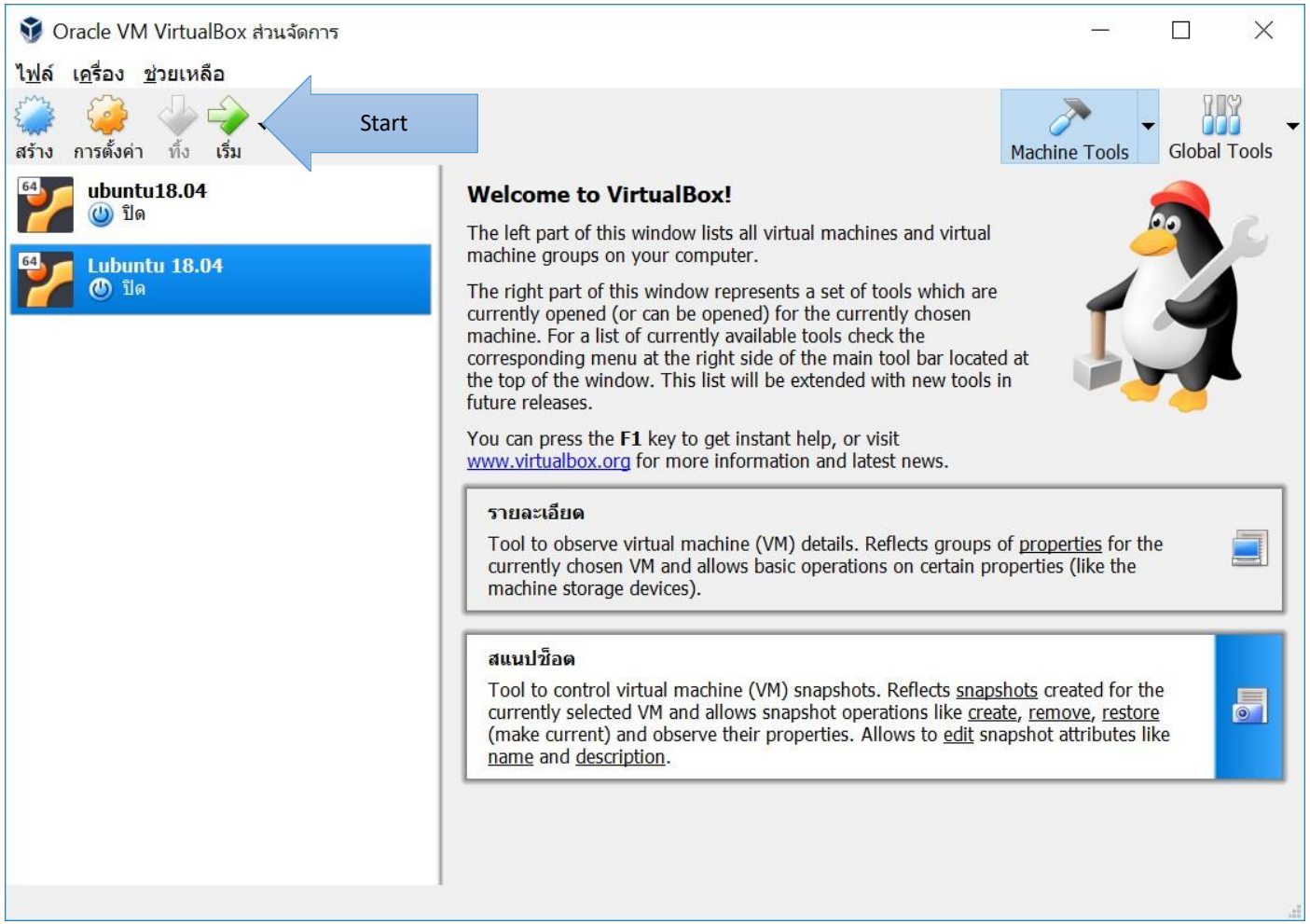
Let’s create the first VM



Let’s create the first VM



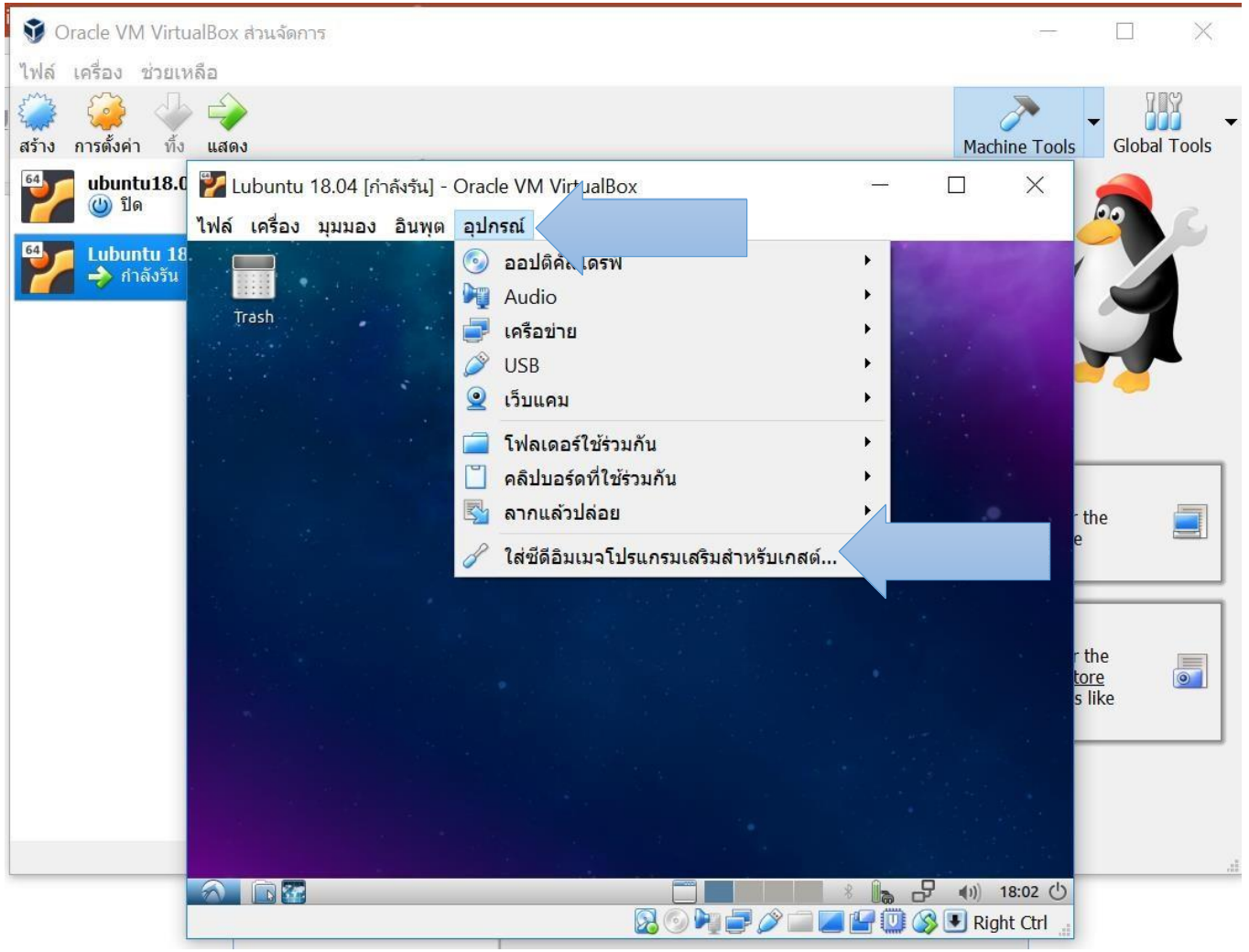
Let’s create the first VM



Let’s create the first VM

1. Run guest additions
2. Set a shared folder

Run guest additions



Run guest additions

- Update & Upgrade systems
- Install `'build-essential'`
- Run virtual CD as software
- Shutdown and restart

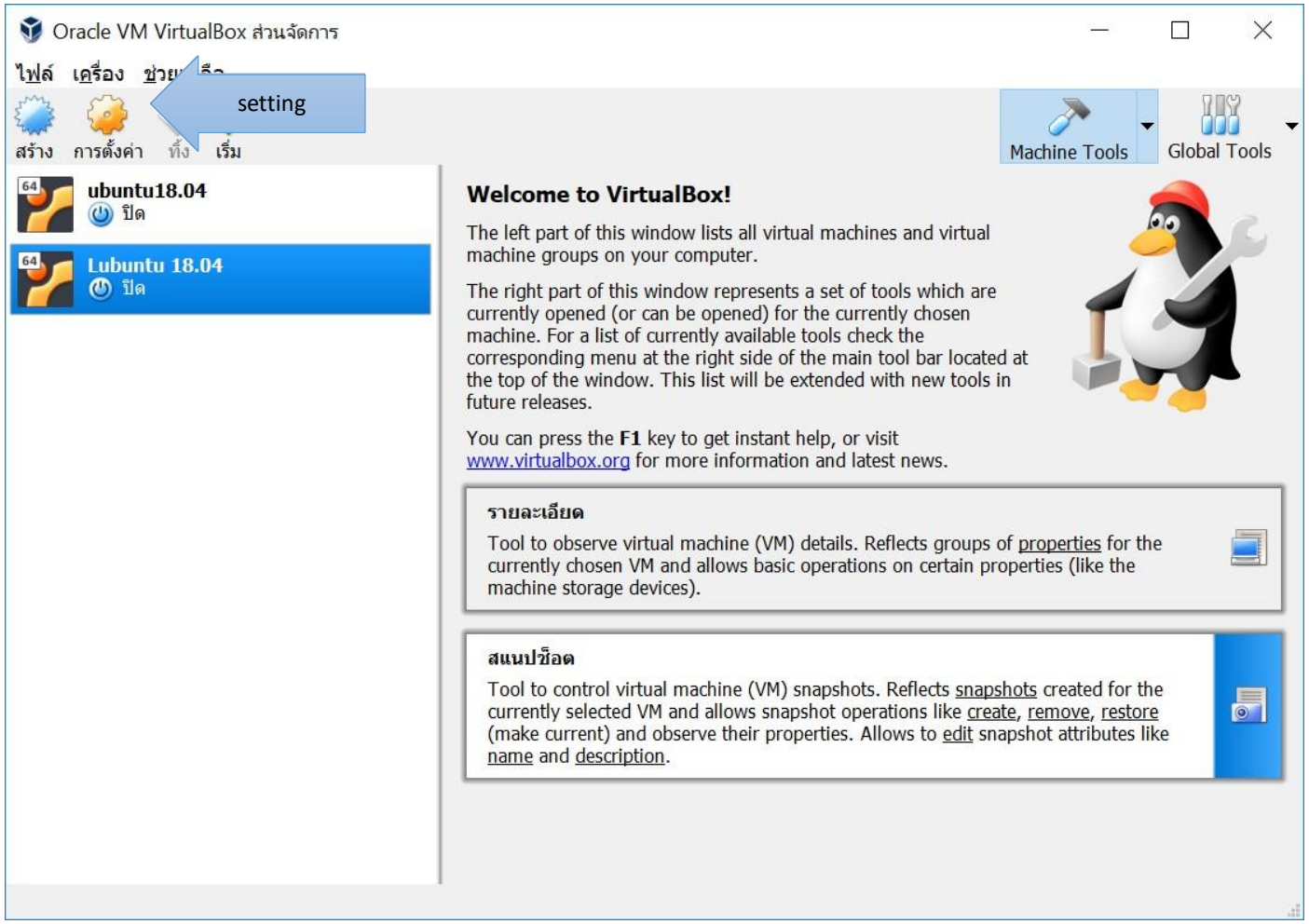
Run guest additions (Lubuntu)

- Open the Terminal

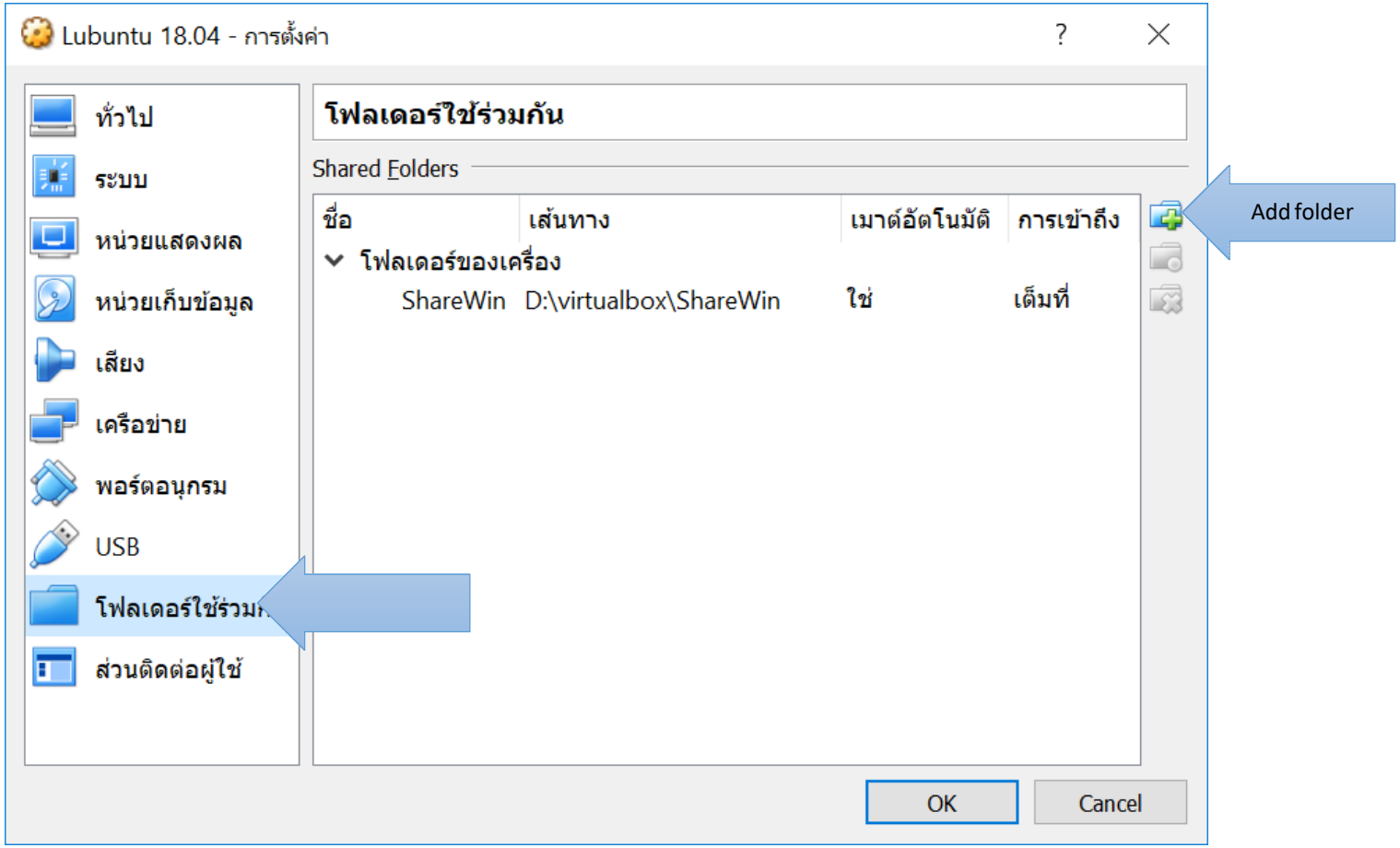
```
cd /media/YourName/VBox_GAs_5.x.x
sudo sh ./VBoxLinuxAdditions.run
```

- Shutdown and restart

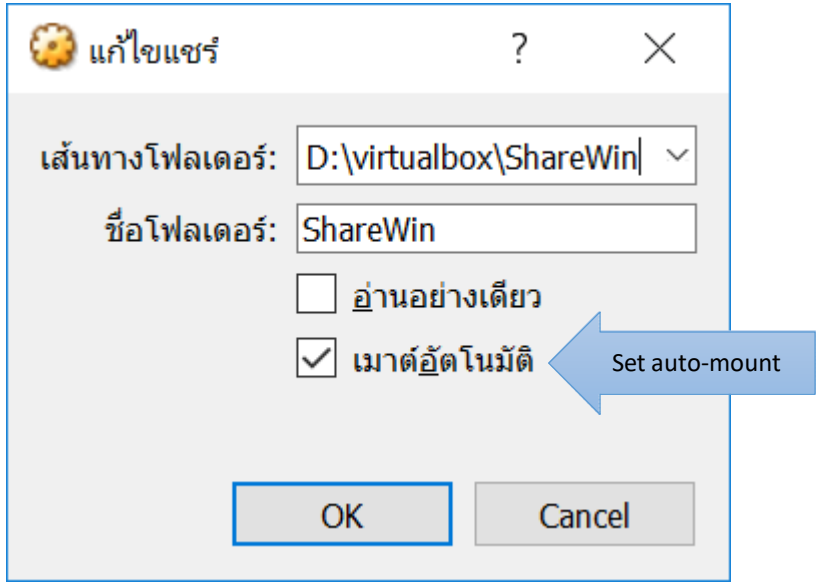
Set a shared folder



Set a shared folder



Set a shared folder



Set a shared folder

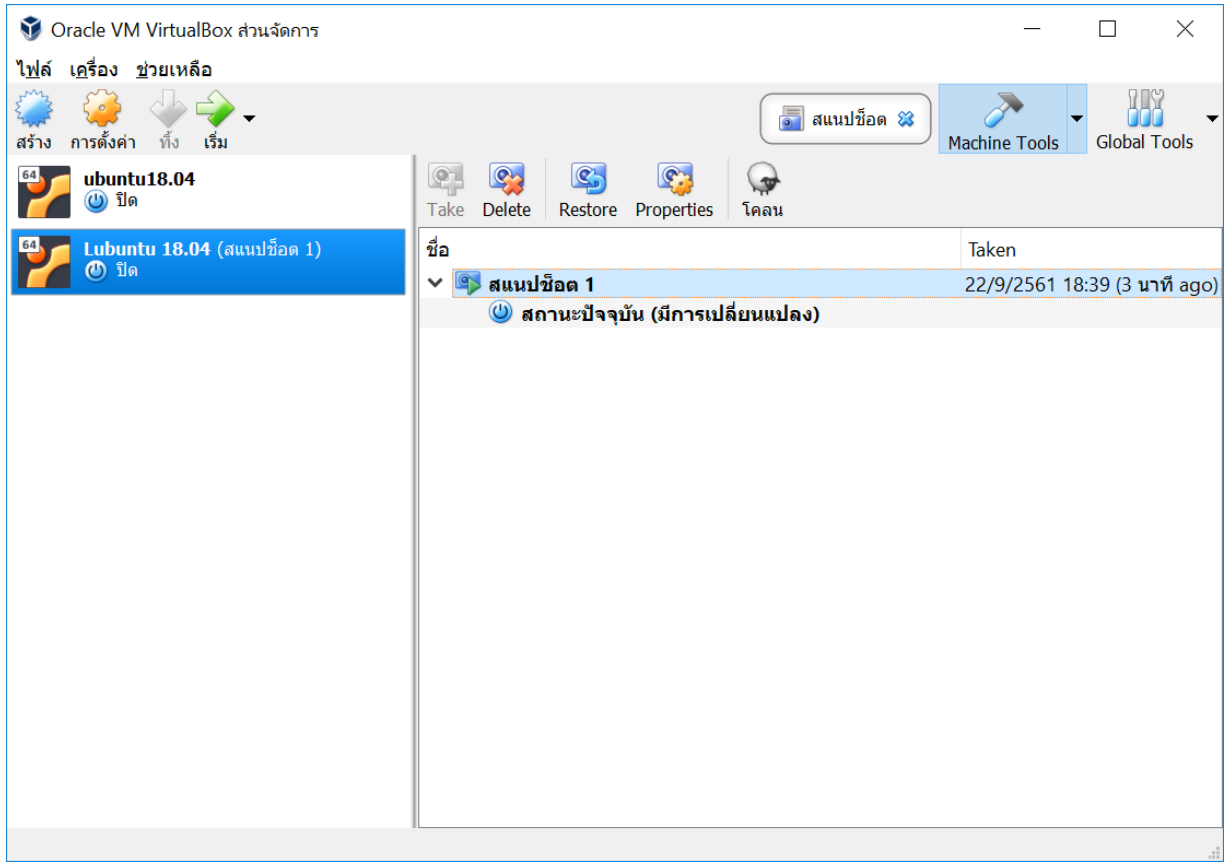
- Switch on the VM
- Open the Terminal

```
sudo usermod -aG vboxsf YourName
```

- Shutdown and restart

Backups by snapshot

- Backup = A copy of files from a computer's hard disk, usually made on some external medium such as CD-ROM or flash drive
- Save a snapshot (R Ctrl + T)



Portable VM

- You can save file.vdi to external HDD or USB flash drive
- Connect to any host machine with Virtualbox to quickly create a copy of VM in file.vdi
- **NOTE:**
  - USB flash drive must be formatted as NTFS
  - FAT32 format (default format in some USB flash drives) cannot accommodate a single file larger than 4GB

Cloud computing

- What is it?

Cloud computing

- What is it?
- Cloud computing, often referred to as simply “the cloud,” is the delivery of on-demand computing resources — everything from applications to data centers — over the internet on a pay-for-use basis.
  - Elastic resources — Scale up or down quickly and easily to meet demand
  - Metered service so you only pay for what you use
  - Self service — All the IT resources you need with self-service access

IBM **Cloud** https://www.ibm.com/cloud/learn/what-is-cloud-computing

Why do you need to know Cloud Computing?

Why do you need to know Cloud Computing?

- Web application deployment
- Requiring intensive but transient computing power
- Backup and archive
- Sharing and hosting (Public cloud)
- Anything else?

Cloud service providers

- Amazon web services 

- Google cloud platform 

- Microsoft Azure 

- IBM cloud 

- Digital Ocean 

Hands on: Cloud Computing

Overview

- Demo for creating a cloud VM with 

- Practice: remotely access the VM
- Practice: remotely transfer files from/to the VM
- Back-up and clean-up

Creating a VM

- Platform will be based on “your advisor”
  - Digital ocean (Simple Unix/Linux applications, web application)
  - Google Cloud Platform (Machine learning)
  - **IPGG server** (Intensive calculation with CPUs and RAM)

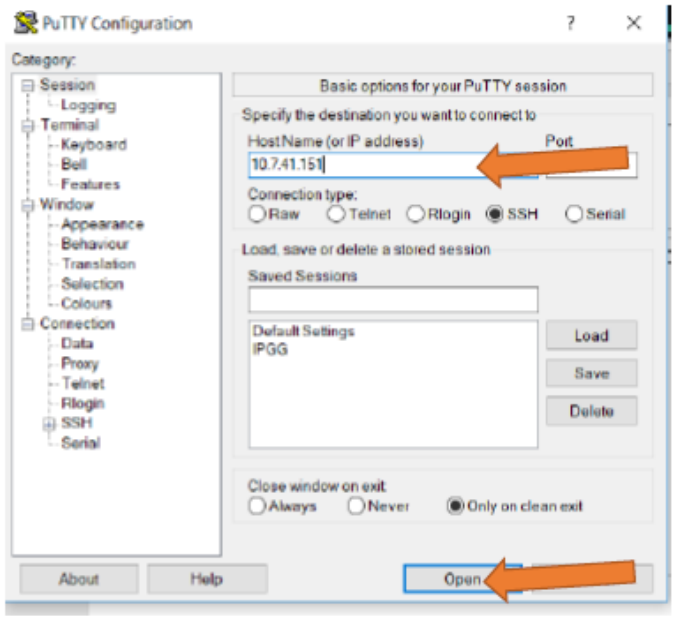
Creating a VM

- Calculate/Estimate your resource wisely
  - CPU/RAM/HDD
  - OS
  - Location of your data center
  - Safety features

Creating a VM on

Remotely access the VM (or server)

- Windows
  - Require a software
  - Install “putty”
  - Login as ‘root’
    - Windows user: Open PuTTY → enter droplet’s IP Address → click “Open”



Remotely access the VM (or server)

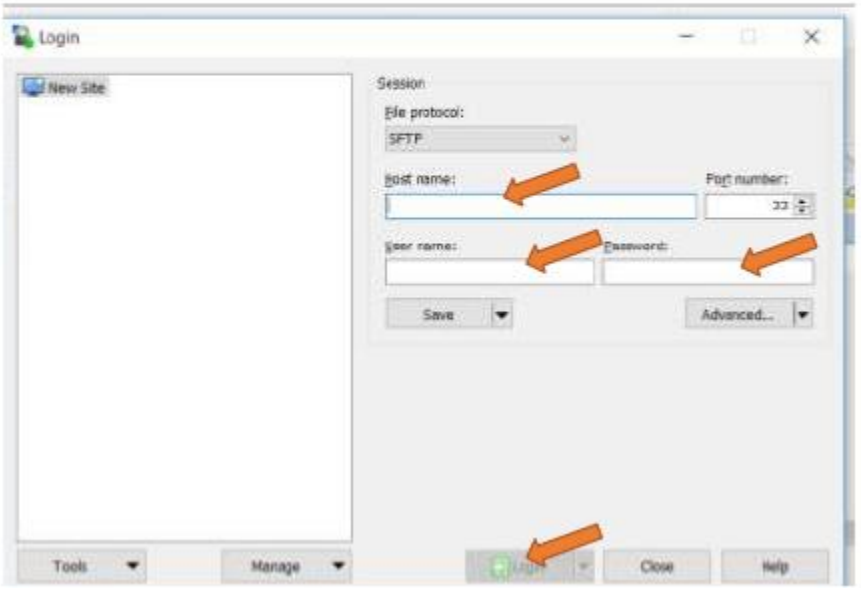
- Mac and Linux
  - Use your ‘terminal’
  - `ssh root@<VM IP address>`

Test basic Unix/Linux commands

- `ls`
- `pwd`
- `touch`
- `cp`
- `mv`
- `rm`
- `mkdir`
- `cd`
- `*nano*`

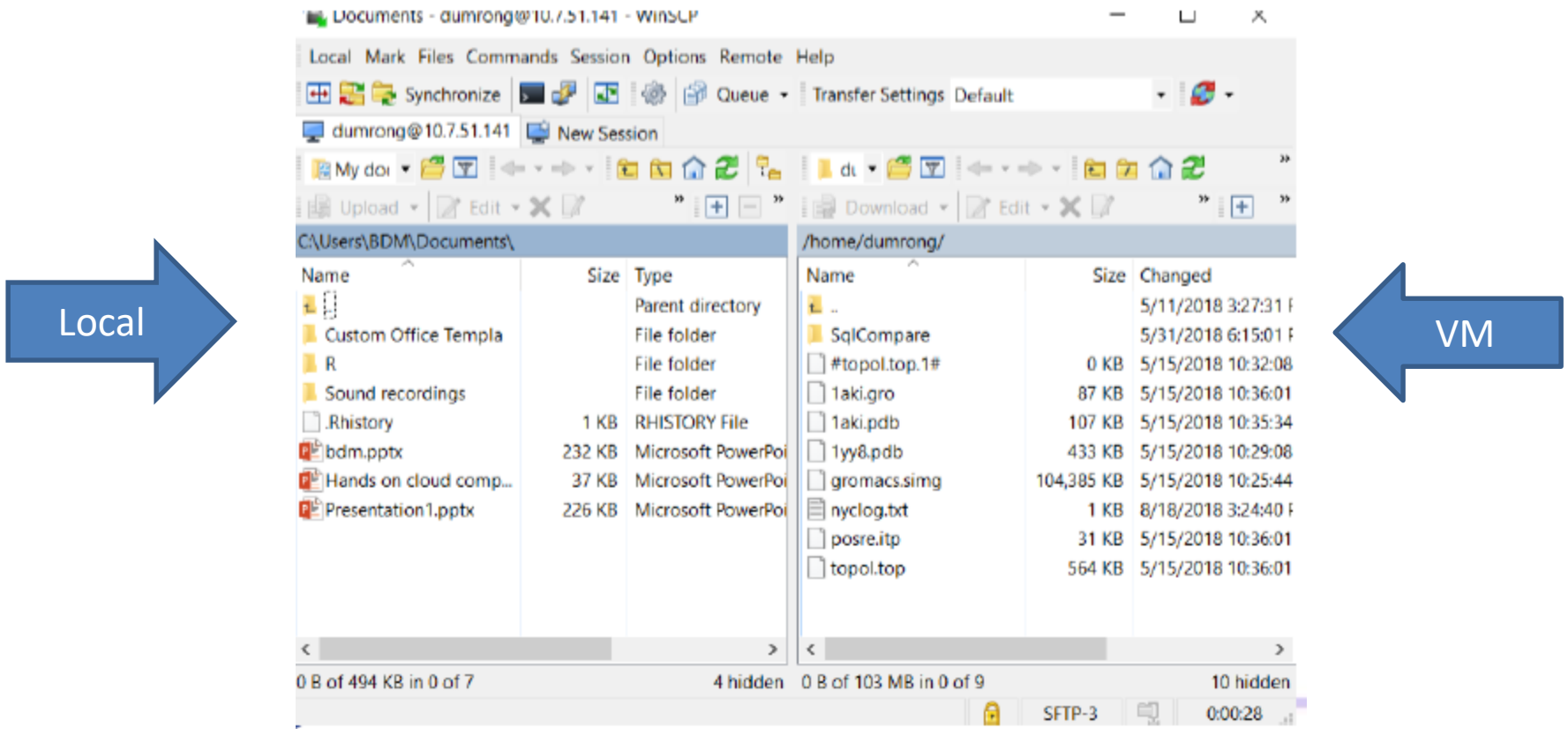
Remotely transfer files from/to the VM

- Windows
  - Require a software
  - Install “WinSCP”
    - Windows user: Open WinSCP → enter droplet’s IP Address → Enter username (‘root’) and password → click “Login”



Remotely transfer files from/to the VM

- Windows
  - Require a software
  - Install “WinSCP”



Remotely transfer files from/to the VM

- Mac and Linux
  - Use your ‘terminal’
  - Download:

```
scp root@<VM IP address>:/path/to/file /local/path
```

  - Upload:

```
scp /local/path/to/file root@<VM IP address>:/path/
```

Practice file transfer (to VM)

1. Open notepad/text editor in your computer
2. Write “Thank you.” in a new text file
3. Save the file as `thank.txt`
4. Upload this file to your VM (WinSCP or scp)
5. Access your VM (PuTTY or ssh)
6. Type `ls` see if you can find your file
7. Type `cat thank.txt` to read the content in the file

Practice file transfer (from VM)

1. Access your droplet (PuTTY or ssh)
2. Type `echo "you are welcome" > yaw.txt`
3. Connect to your VM with WinSCP (or use scp)
4. Download `yaw.txt` to you computer
5. Use notepad or word to read the file

Back-up and clean-up

- Back-up with ‘snapshot’:
  - Freeze everything in your VM at the time of the snapshot.
  - The snapshot is used to instantly restore the VM.
  - Use for:
    - Routine back-up
    - Temporary paused VM
  - Cheaper than let the VM run. (Snapshot is **NOT** free!)

Back-up and clean-up

- Clean-up:
  - Running and power-off VMs cost the same!
  - **Everything** must be destroyed to stop the cloud provider from charging you.
  - Snapshots and volumes cost money!
  - Clean-up after:
    - Finish the project
    - Results and scripts are downloaded to local machines
  - After a VM is destroyed, data in the VM are gone for good!