

# Operating Systems, Virtual Machine and Cloud computing

Dumrong Mairiang, PhD

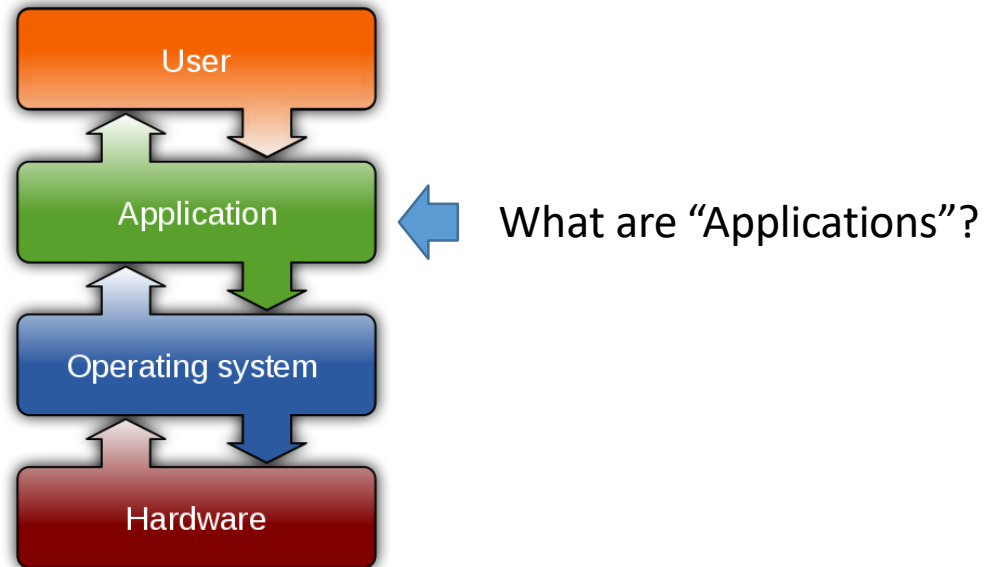
SIRE507: FUNDAMENTAL COMPUTER SCIENCE FOR BIOLOGIST

# Operating system (OS)

- What is it?
- Why is it important?

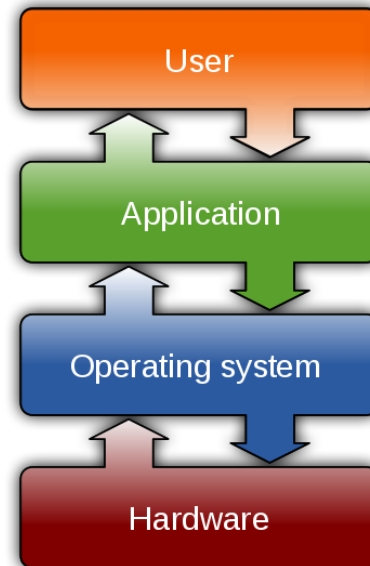
# Operating system (OS)

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



# 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**

**ubuntu** 

The Ubuntu logo, which is a red circle containing a white stylized gear or flower-like shape.

# Operating system (OS)

- Do you know any OS?



macOS

ubuntu 

The Ubuntu logo, which is a red circle containing a white stylized gear or flower-like shape.

Mobile OS

iOS



# Operating system (OS)

- Do you know any OS?

Microsoft Windows family



Other



Unix/Unix-like family



FreeBSD

ORACLE  
SOLARIS



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

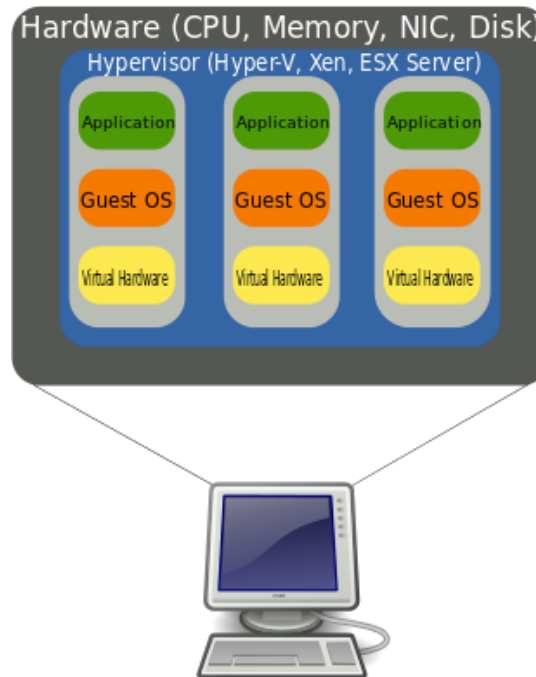
- Any other features?

# 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



# Virtual Machine (VM)

- What VM is not:
  - Virtual machine  $\neq$  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

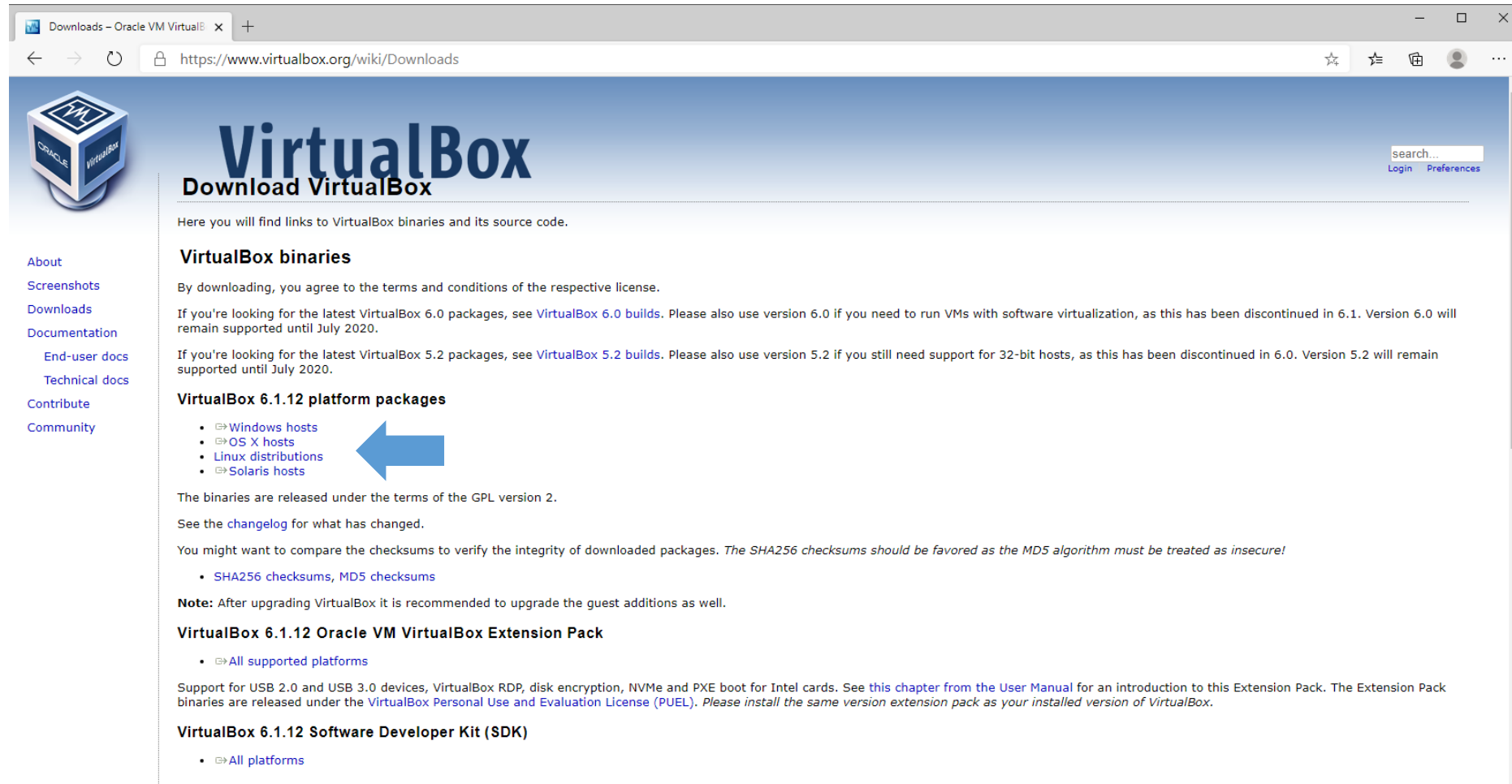
- Applications for virtualization:
  - VM ware (Commercial)
  - **Oracle VM VirtualBox (Free and open-source)**
  - Vagrant (Free and open-source, but no GUI)
  - Other...

# 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



The screenshot shows a web browser window with the address bar displaying `https://www.virtualbox.org/wiki/Downloads`. The page features the VirtualBox logo on the left and a search bar on the right. The main content area is titled "Download VirtualBox" and includes a sidebar with links to "About", "Screenshots", "Downloads", "Documentation", "End-user docs", "Technical docs", "Contribute", and "Community". The main text explains that the page provides links to VirtualBox binaries and source code. It lists "VirtualBox binaries" and "VirtualBox 6.1.12 platform packages" with links to Windows, OS X, Linux, and Solaris hosts. A large blue arrow points to the "Linux distributions" link. The page also mentions the "VirtualBox 6.1.12 Oracle VM VirtualBox Extension Pack" and the "VirtualBox 6.1.12 Software Developer Kit (SDK)".

Downloads – Oracle VM VirtualB x +

← → ↻ 🔒 `https://www.virtualbox.org/wiki/Downloads` ☆ ⚙️ 🏠 👤 ...

 **VirtualBox**  
Download VirtualBox

search...  
Login Preferences

About  
Screenshots  
Downloads  
Documentation  
End-user docs  
Technical docs  
Contribute  
Community

Here you will find links to VirtualBox binaries and its source code.

### VirtualBox binaries

By downloading, you agree to the terms and conditions of the respective license.

If you're looking for the latest VirtualBox 6.0 packages, see [VirtualBox 6.0 builds](#). Please also use version 6.0 if you need to run VMs with software virtualization, as this has been discontinued in 6.1. Version 6.0 will remain supported until July 2020.

If you're looking for the latest VirtualBox 5.2 packages, see [VirtualBox 5.2 builds](#). Please also use version 5.2 if you still need support for 32-bit hosts, as this has been discontinued in 6.0. Version 5.2 will remain supported until July 2020.

### VirtualBox 6.1.12 platform packages

- Windows hosts
- OS X hosts
- Linux distributions
- Solaris hosts

The binaries are released under the terms of the GPL version 2.

See the [changelog](#) for what has changed.

You might want to compare the checksums to verify the integrity of downloaded packages. *The SHA256 checksums should be favored as the MD5 algorithm must be treated as insecure!*

- SHA256 checksums, MD5 checksums

**Note:** After upgrading VirtualBox it is recommended to upgrade the guest additions as well.

### VirtualBox 6.1.12 Oracle VM VirtualBox Extension Pack

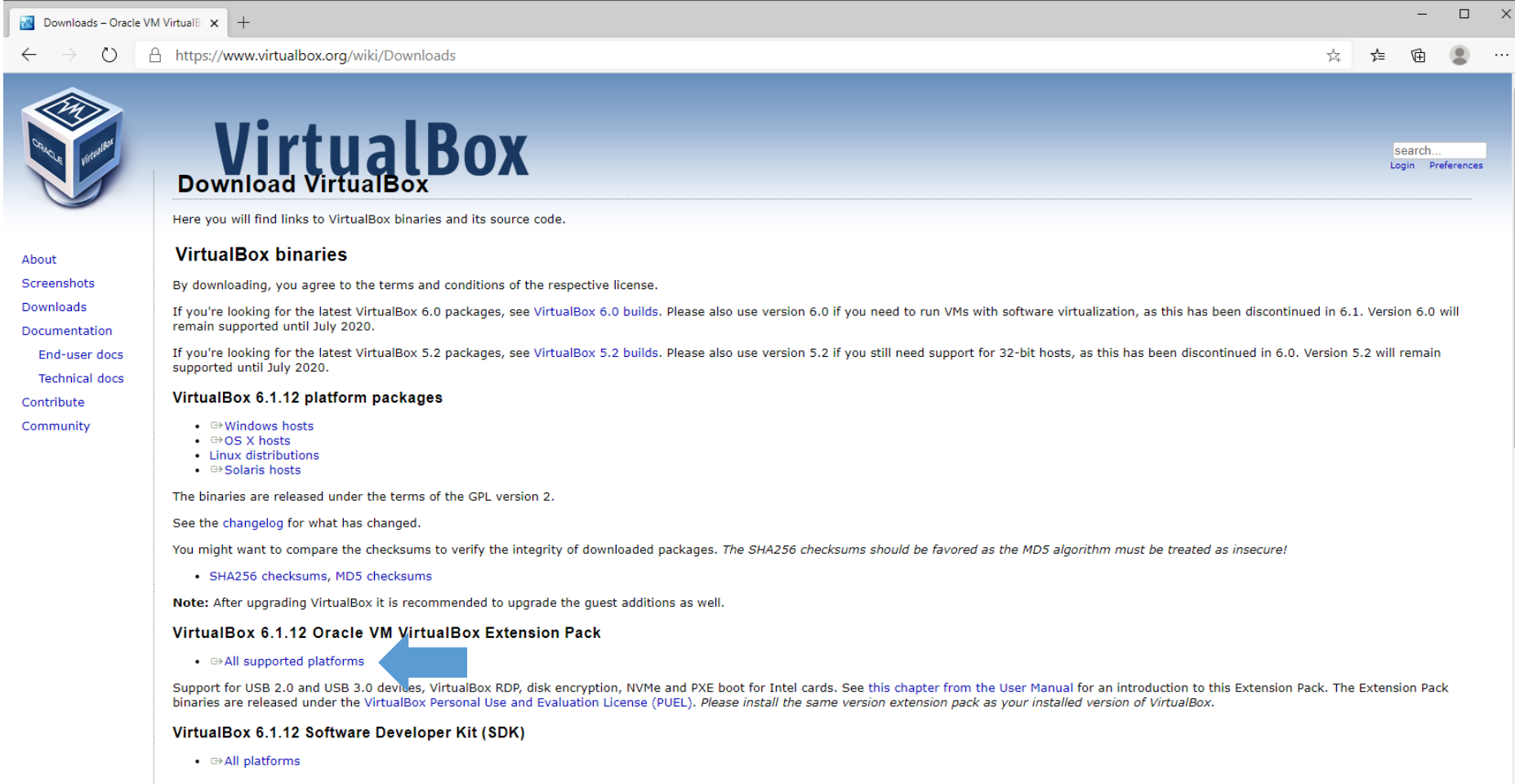
- All supported platforms

Support for USB 2.0 and USB 3.0 devices, VirtualBox RDP, disk encryption, NVMe and PXE boot for Intel cards. See [this chapter from the User Manual](#) for an introduction to this Extension Pack. The Extension Pack binaries are released under the [VirtualBox Personal Use and Evaluation License \(PUEL\)](#). Please install the same version extension pack as your installed version of VirtualBox.

### VirtualBox 6.1.12 Software Developer Kit (SDK)

- All platforms


# Let's create the first VM



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Downloads – Oracle VM VirtualB x +

← → ↻ <https://www.virtualbox.org/wiki/Downloads> ☆ ⚙️ 🔍 👤 ⋮

 **VirtualBox**  
Download VirtualBox

search...  
[Login](#) [Preferences](#)

About  
[Screenshots](#)  
[Downloads](#)  
[Documentation](#)  
    [End-user docs](#)  
    [Technical docs](#)  
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- [OS X hosts](#)
- [Linux distributions](#)
- [Solaris hosts](#)

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- [SHA256 checksums](#), [MD5 checksums](#)

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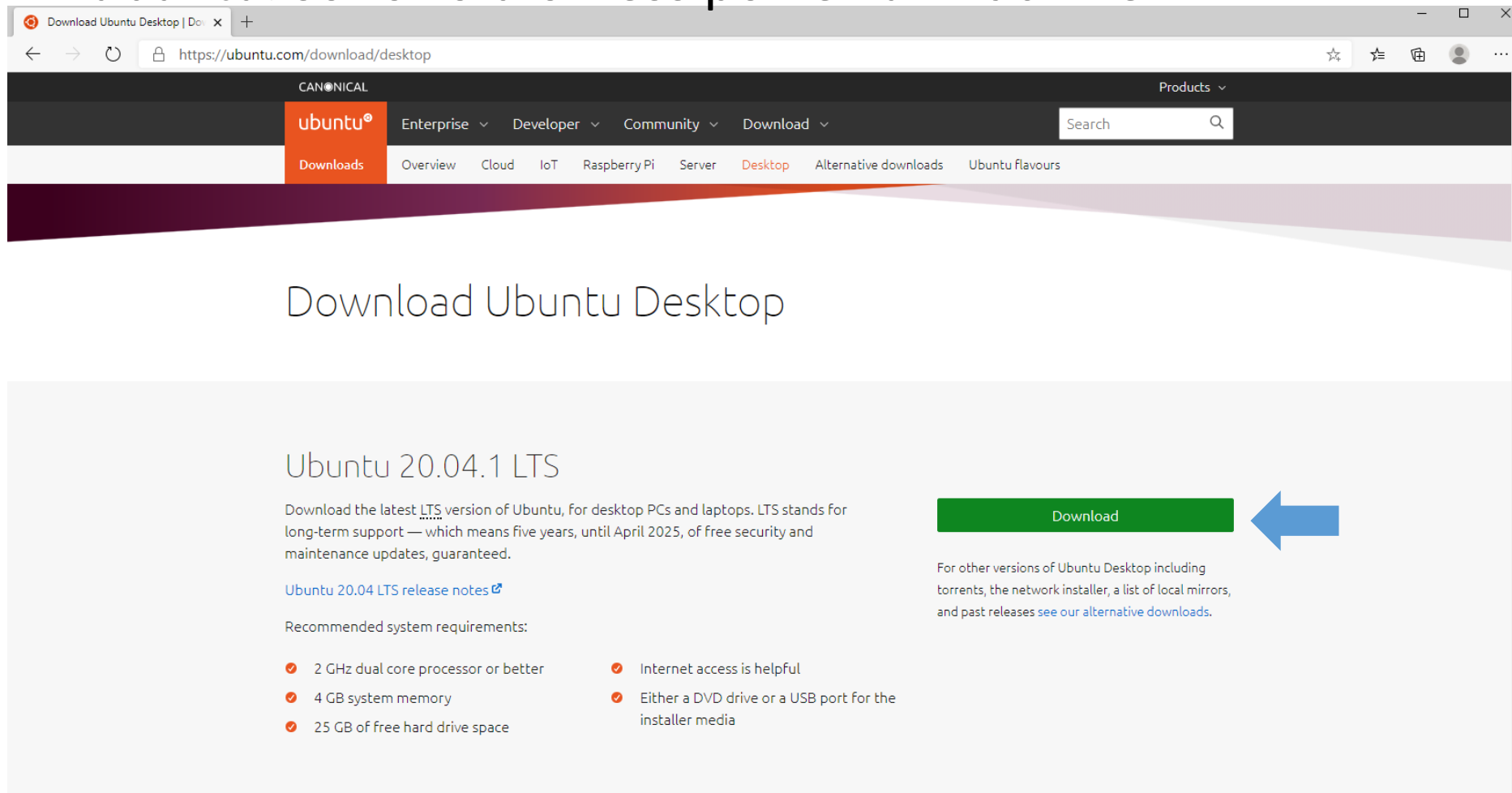
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### VirtualBox 6.1.12 Software Developer Kit (SDK)

- [All platforms](#)

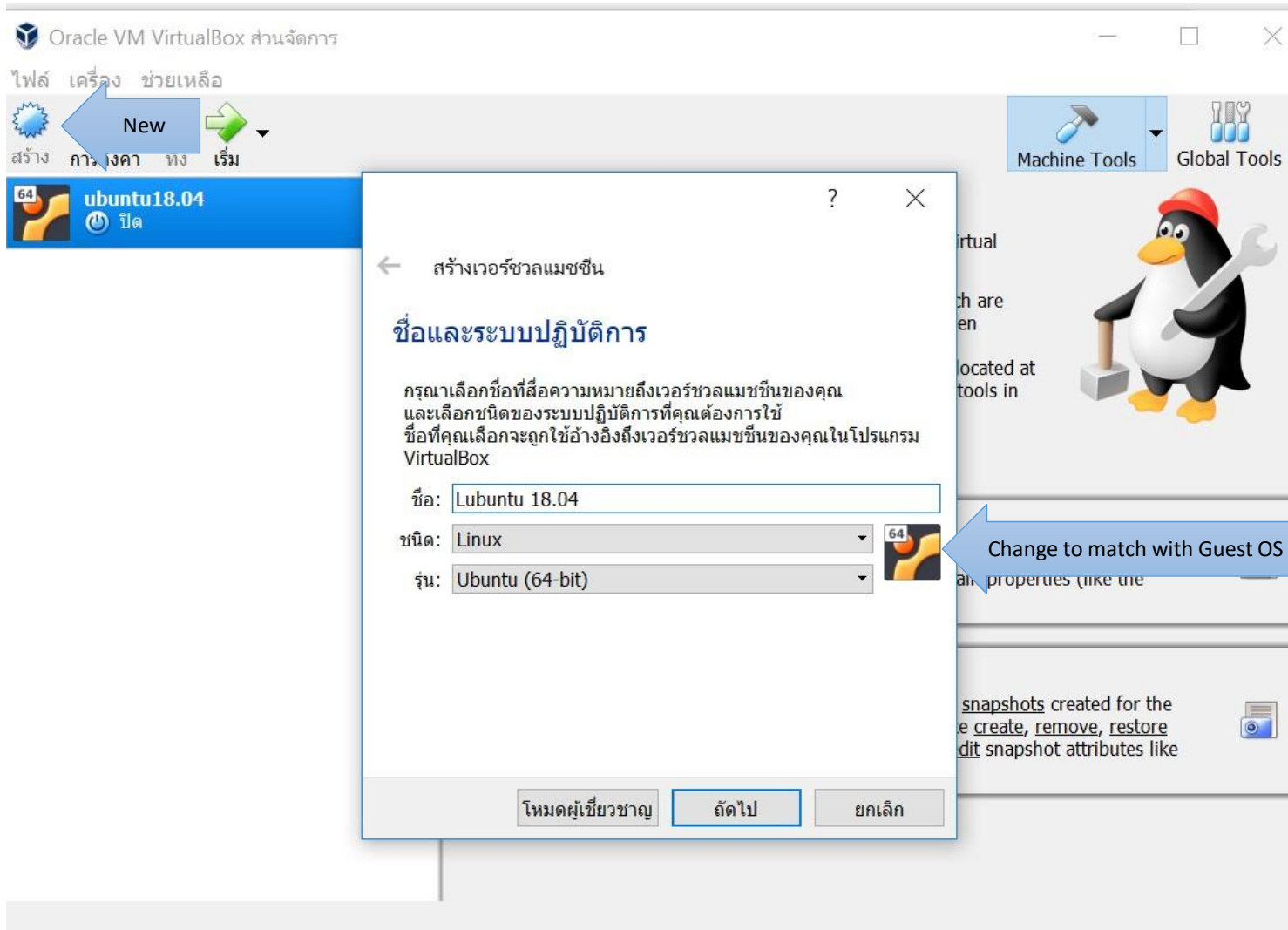
# Let's create the first VM

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

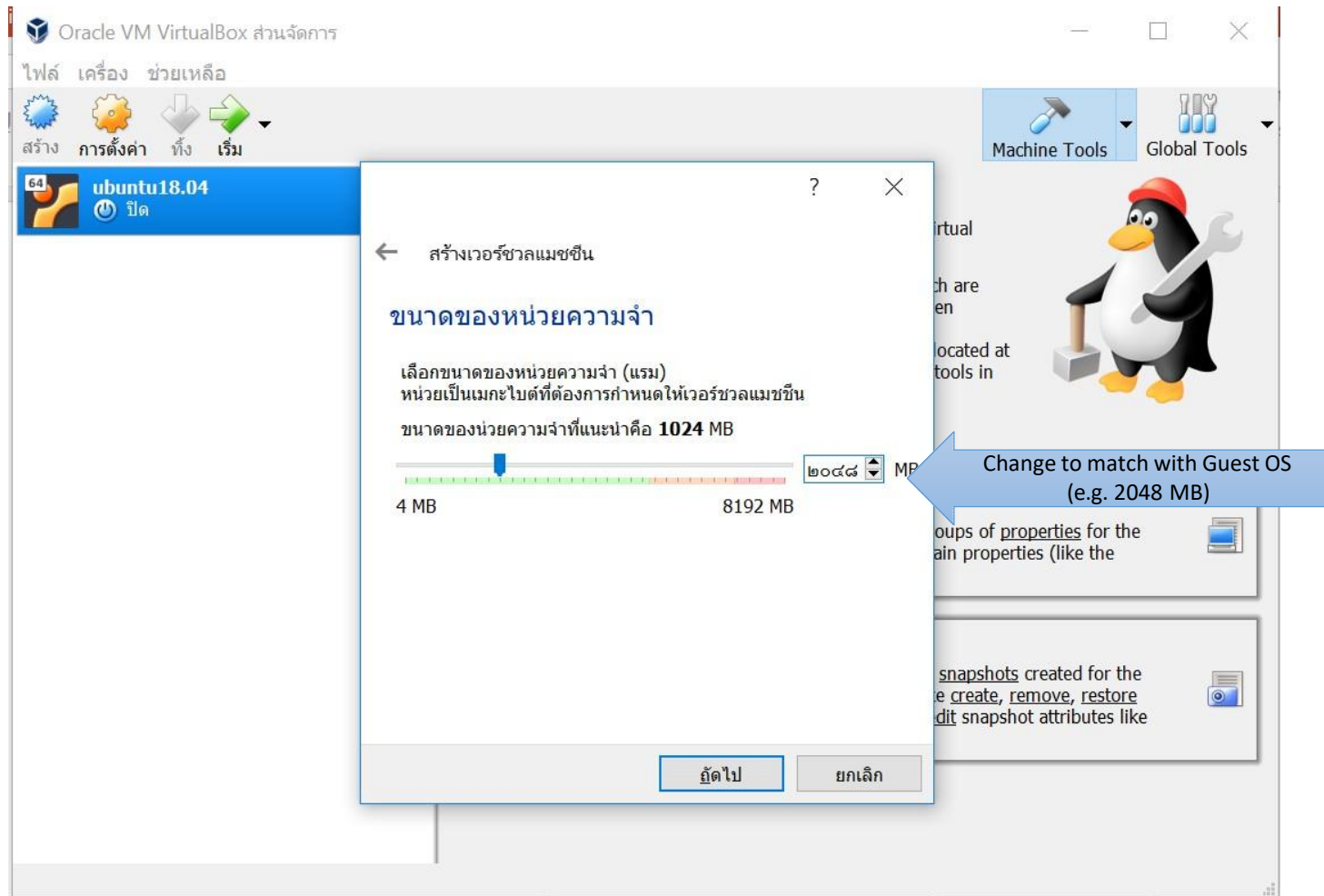




# Let's create the first VM



# Let's create the first VM



# Let's create the first VM

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← สร้างเวอร์ชวลแมชชีน

## ฮาร์ดดิสก์

หากต้องการ คุณสามารถเพิ่มฮาร์ดดิสก์เสมือนให้กับเวอร์ชวลแมชชีน  
คุณสามารถสร้างไฟล์ฮาร์ดดิสก์เสมือนขึ้นมาใหม่  
เลือกไฟล์จากรายการหรือจากที่อื่นได้โดยใช้ไอคอนรูปโฟลเดอร์

หากคุณต้องการกำหนดสื่อบันทึกที่มีความซับซ้อนกว่านี้  
คุณสามารถข้ามขั้นตอนนี้แล้วไปปรับแต่งที่การตั้งค่าของเครื่องหลังจาก  
เวอร์ชวลแมชชีนถูกสร้างขึ้นมาแล้ว

ขนาดของฮาร์ดดิสก์ที่แนะนำคือ **10.00 GB**

☐ ไม่ต้องเพิ่มฮาร์ดดิสก์เสมือน

☒ สร้างฮาร์ดดิสก์เสมือนขึ้นมาใหม่

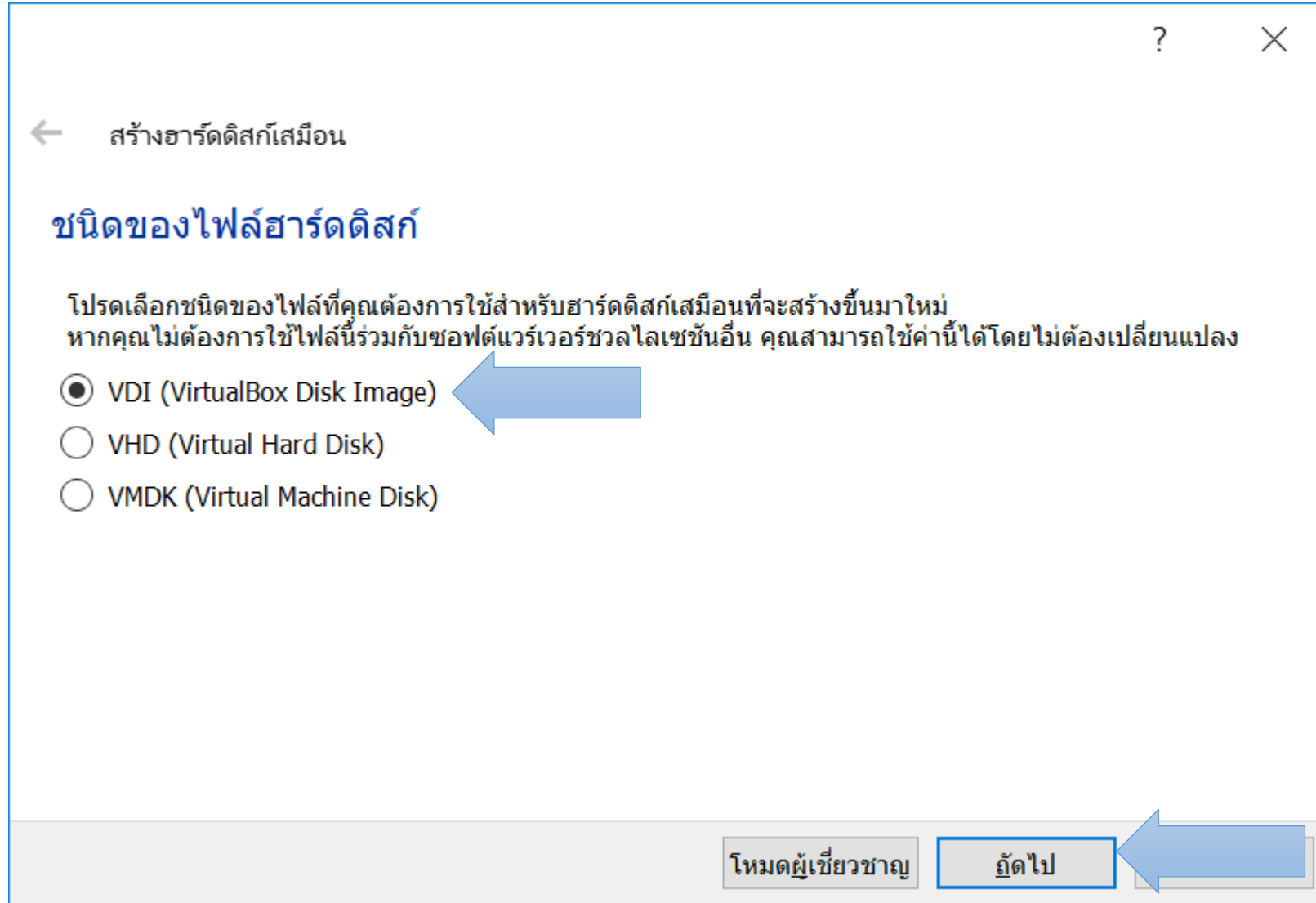
☐ ใช้ไฟล์ฮาร์ดดิสก์เสมือนที่มีอยู่แล้ว

ubuntu18.04.vdi (ปกติ, 10.00 GB) 📁

สร้าง

ยกเลิก

# Let's create the first VM



# Let's create the first VM

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สร้างฮาร์ดดิสก์เสมือน

สื่อบันทึกบนฮาร์ดดิสก์จริง

โปรดเลือกไฟล์ฮาร์ดดิสก์เวอร์ชวลบล็อกซ์ควรขยายขนาดตามการใช้งาน (จัดสรรแบบพลวัต)  
หรือควรสร้างโดยใช้ขนาดสูงสุด (ขนาดคงที่)

ฮาร์ดดิสก์ที่**จัดสรรแบบพลวัต** จะใช้พื้นที่บนฮาร์ดดิสก์กายภาพของคุณเพิ่มขึ้นตามการใช้งาน (จนถึง **ขนาดคงที่** ที่ระบุไว้) แต่มันจะไม่ลดขนาดลงโดยอัตโนมัติแม้พื้นที่ภายในจะว่างลง

ไฟล์ฮาร์ดดิสก์ **ขนาดคงที่** อาจใช้เวลานานในการสร้างบนบางระบบ แต่มักทำงานได้เร็วกว่า

☒ จัดสรรแบบพลวัต

☐ ขนาดคงที่

Dynamics

ถัดไป

←

# Let's create the first VM

← สร้างฮาร์ดดิสก์เสมือน

## ที่ตั้งและขนาดของไฟล์

โปรดป้อนชื่อไฟล์สำหรับฮาร์ดดิสก์เสมือนที่สร้างขึ้นใหม่ลงในกล่องด้านล่าง  
หรือคลิกไอคอนโฟลเดอร์เพื่อเลือกโฟลเดอร์อื่นสำหรับการสร้างไฟล์

D:\virtualbox\Lubuntu 18.04.vdi

เลือกขนาดไฟล์เวอร์ชวลฮาร์ดดิสก์มีหน่วยเป็นเมกะไบต์  
ขนาดนี้ถูกใช้เพื่อจำกัดขนาดของข้อมูลที่เวอร์ชวลแมชีนจะสามารถบันทึกลงในฮาร์ดดิสก์ได้

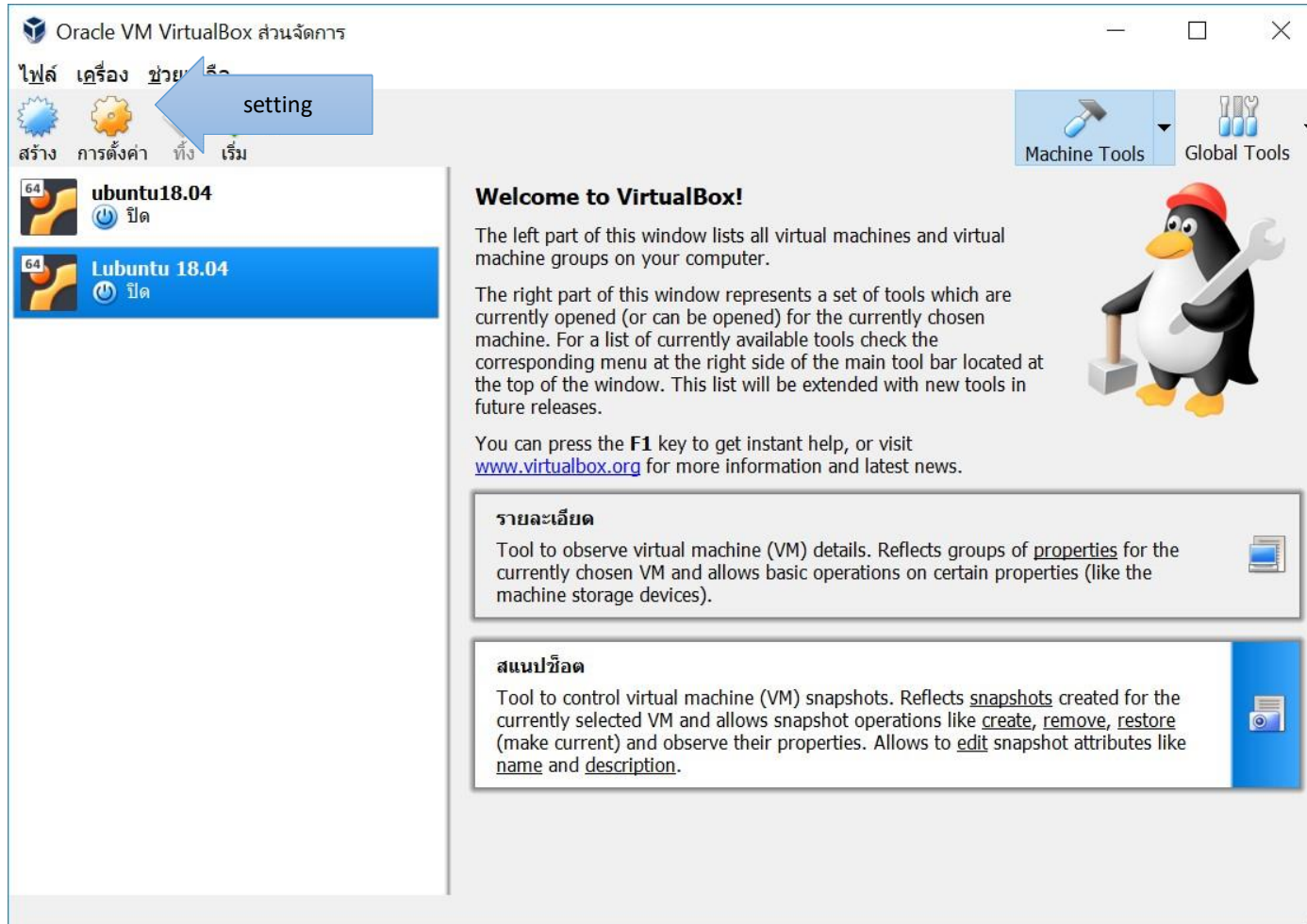
4.00 MB 2.00 TB 50 GB

สร้าง

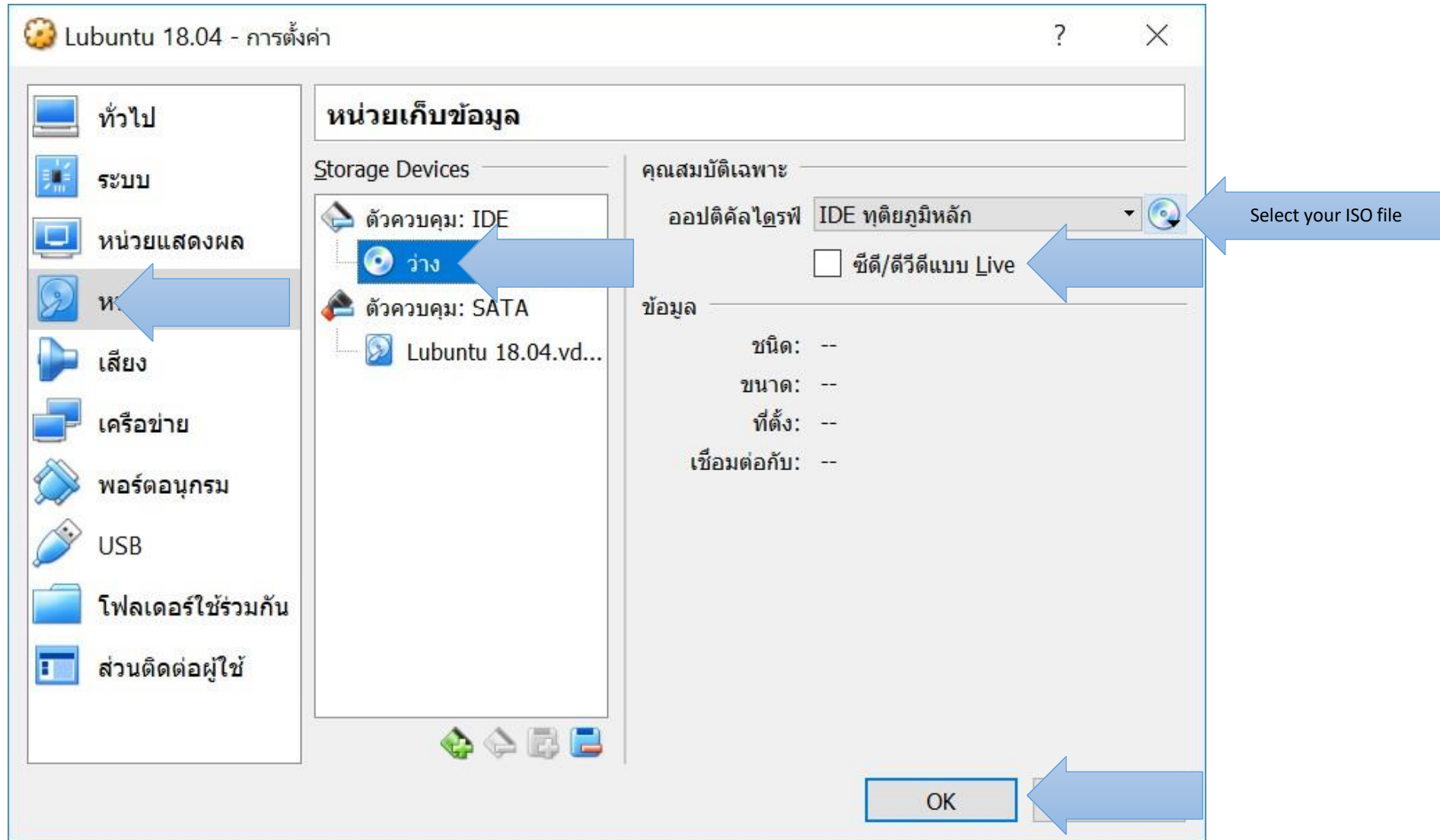
Change to appropriate path

Change to appropriate size

# Let's create the first VM

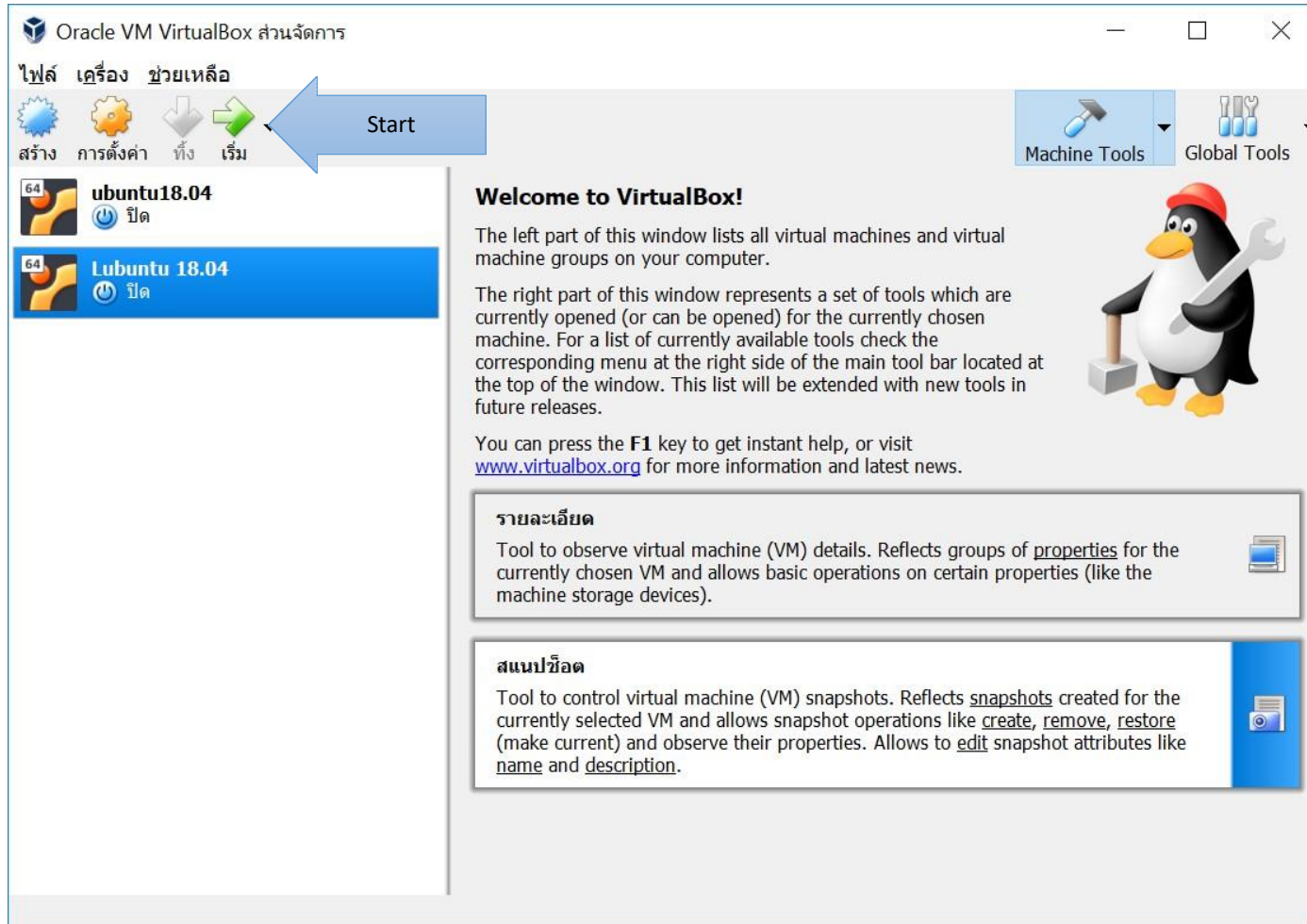


# Let's create the first VM



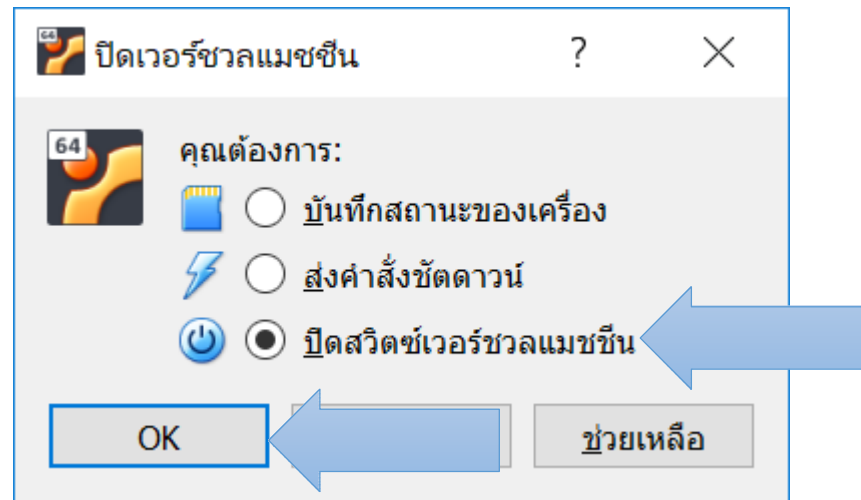


# Let's create the first VM

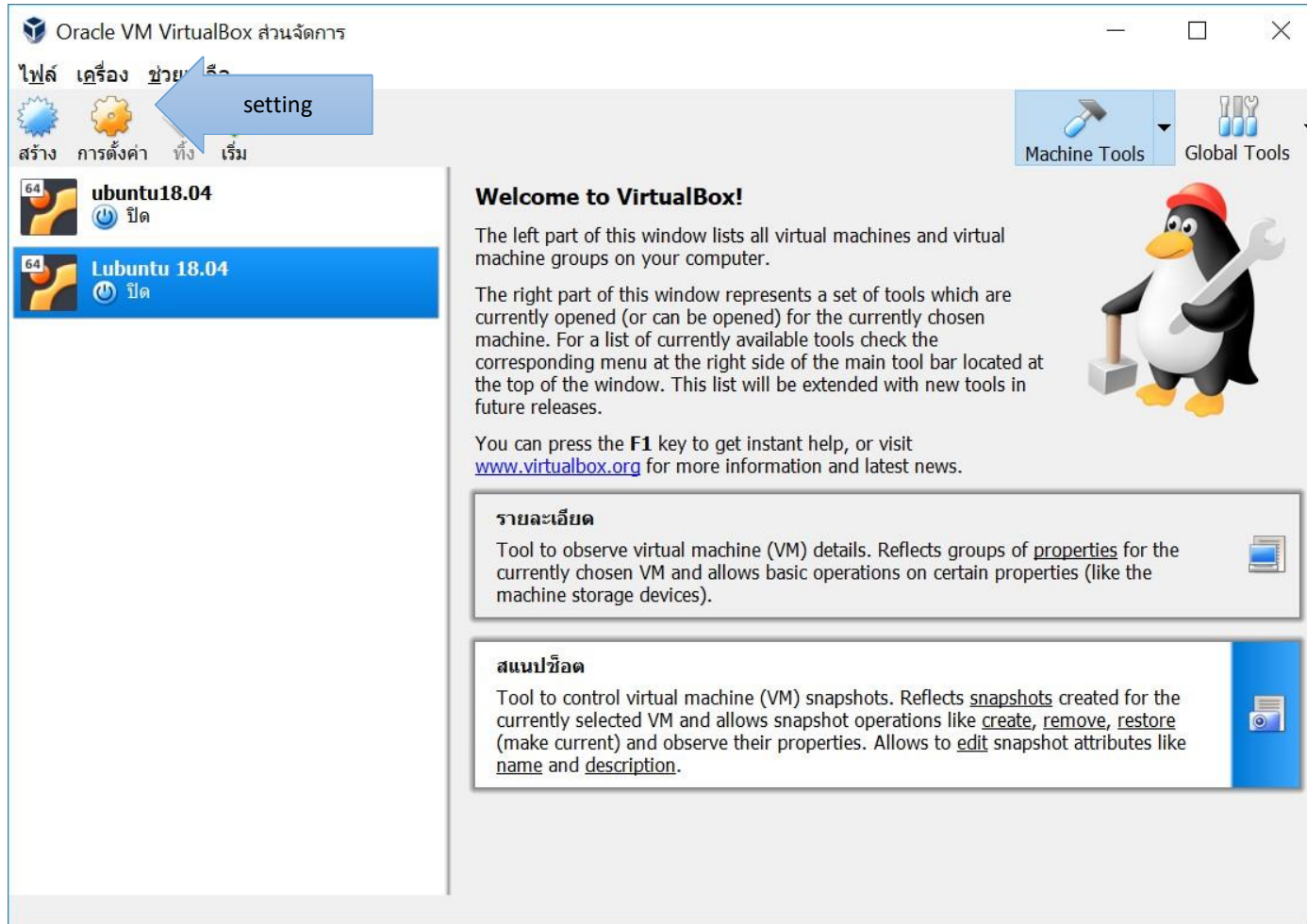


# Let's create the first VM

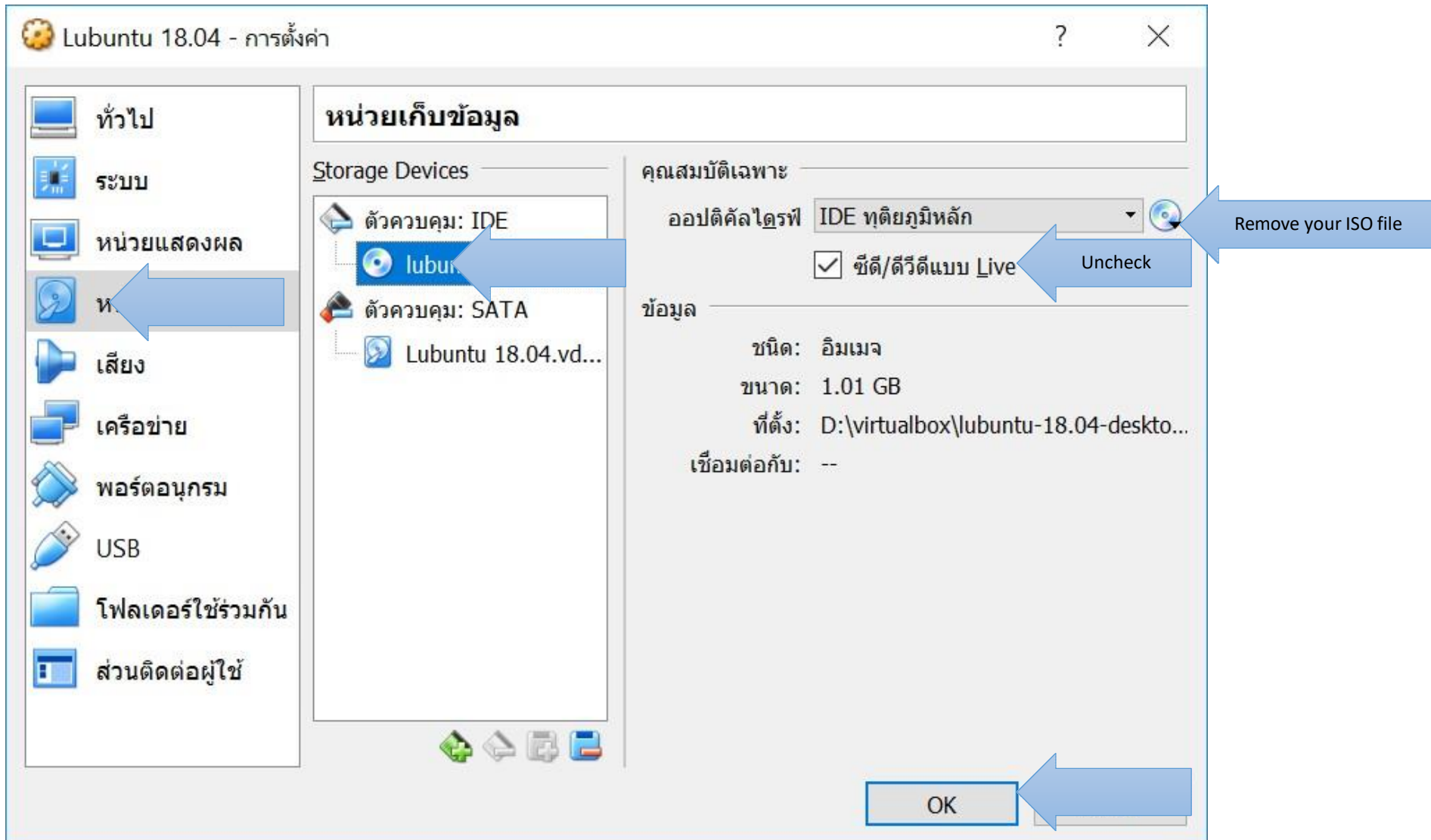
- Install Ubuntu according to instructions
- After installation is done, close the VM → Switch off



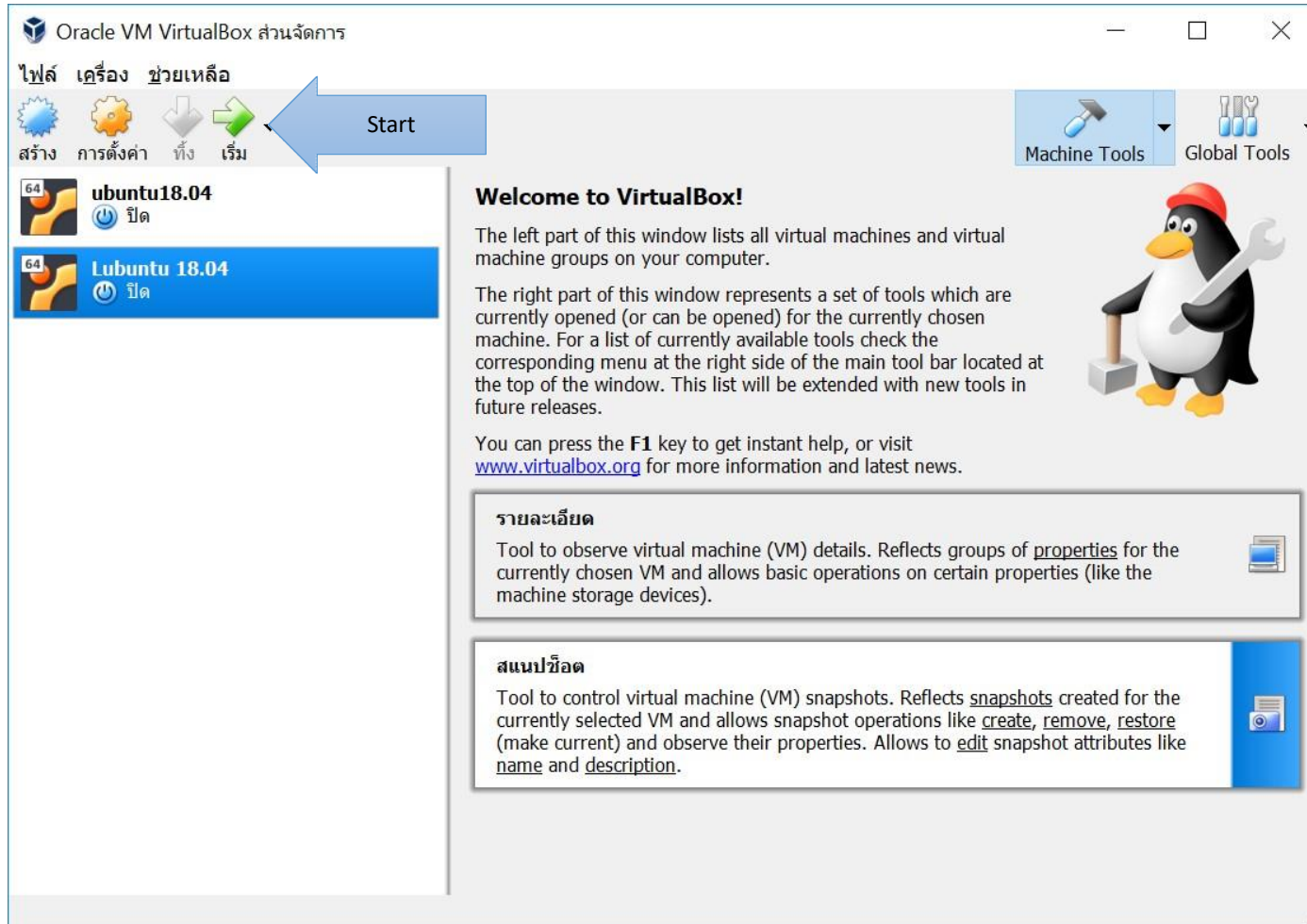
# Let's create the first VM



# Let's create the first VM



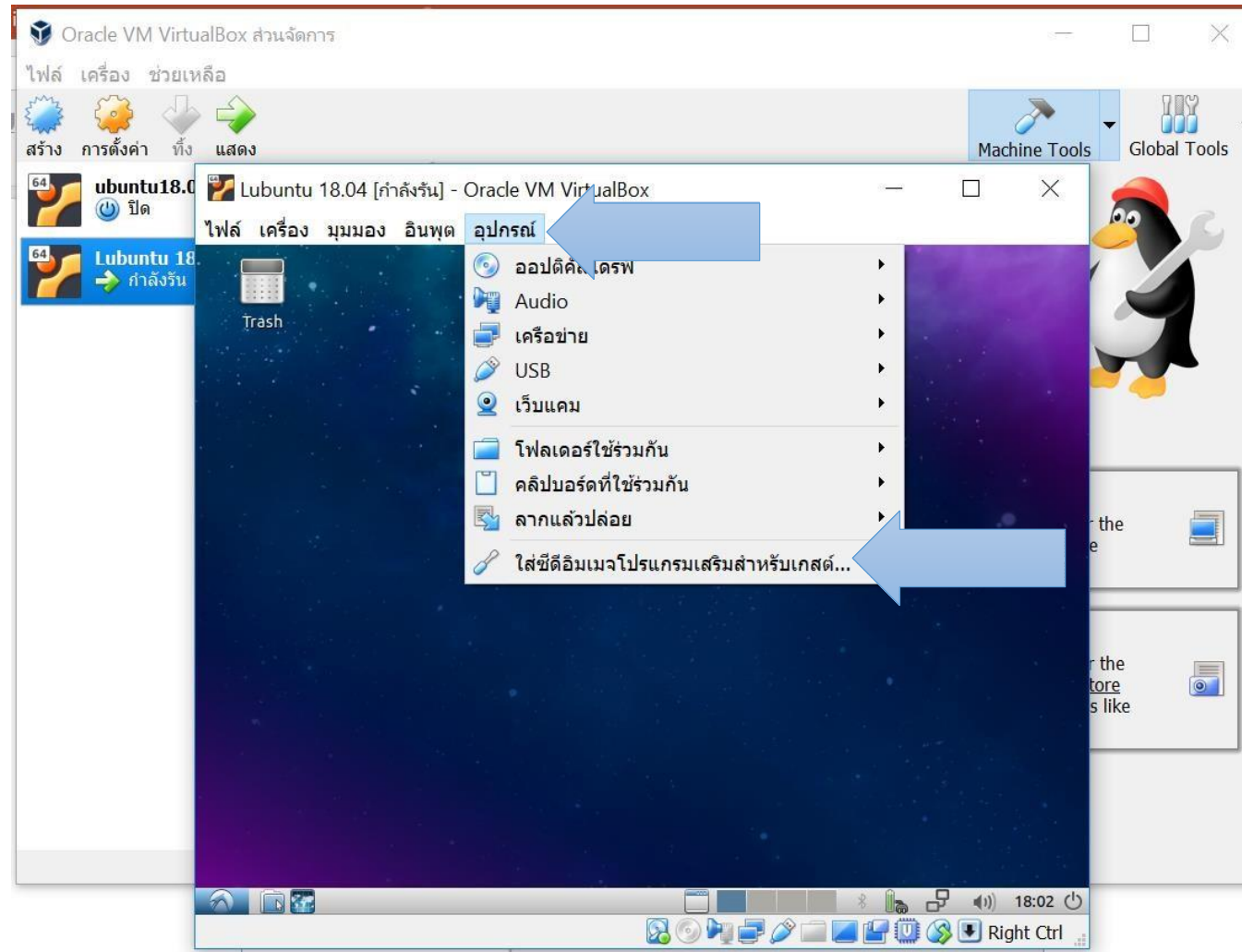
# Let's create the first VM



# 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



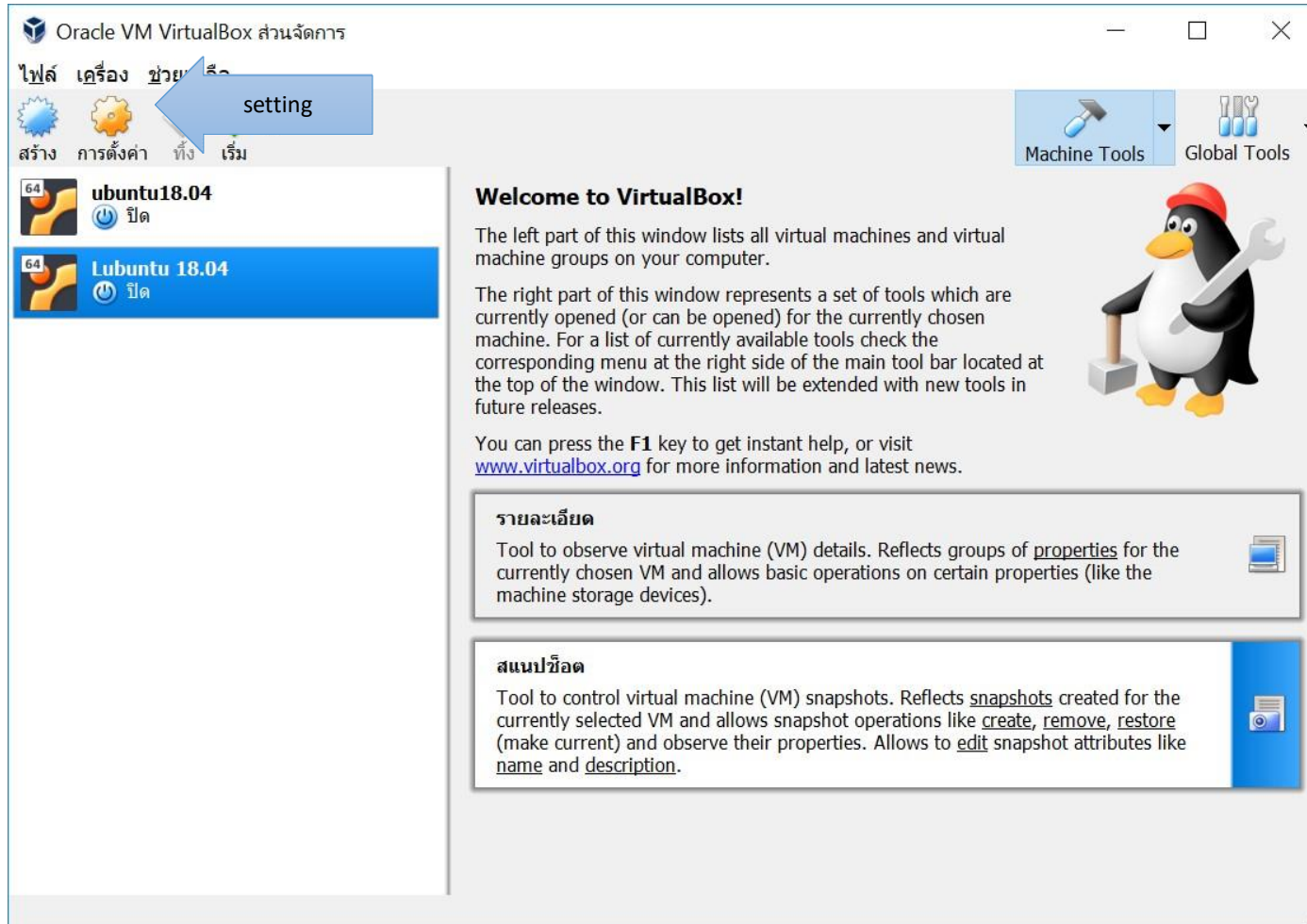
# Run guest additions (Lubuntu)

- Open the Terminal

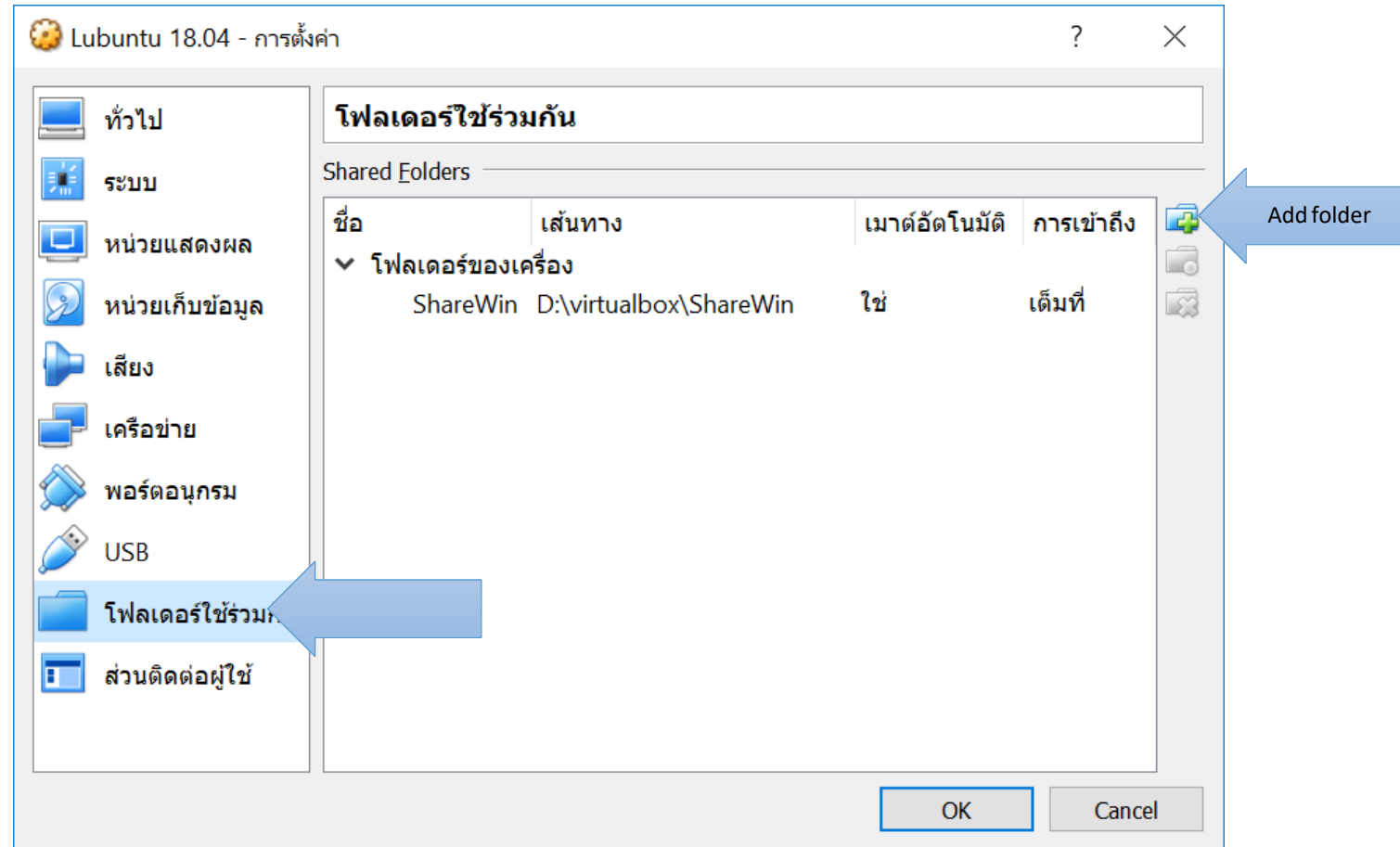
```
cd /media/YourName/VBox_GAs_5.x.x  
sudo sh ./VBoxLinuxAdditions.run
```

- Shutdown and restart

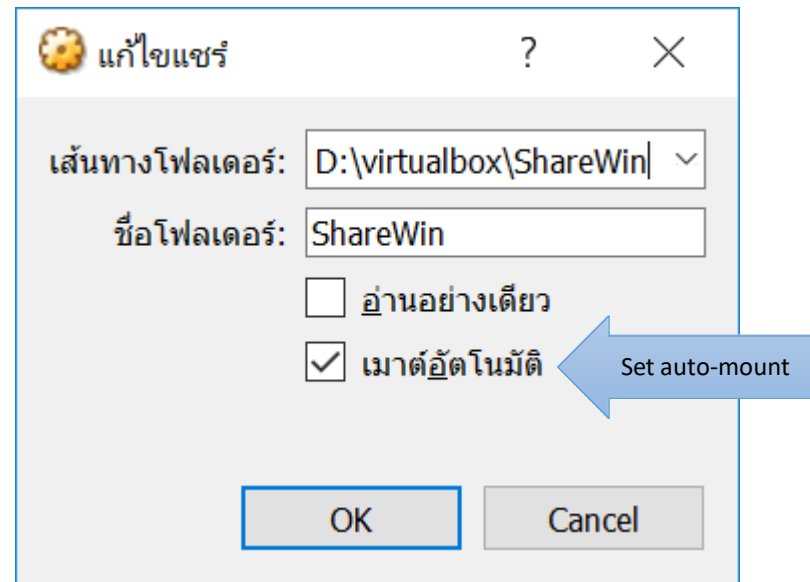
# Set a shared folder



# Set a shared folder



# Set a shared folder



# Set a shared folder

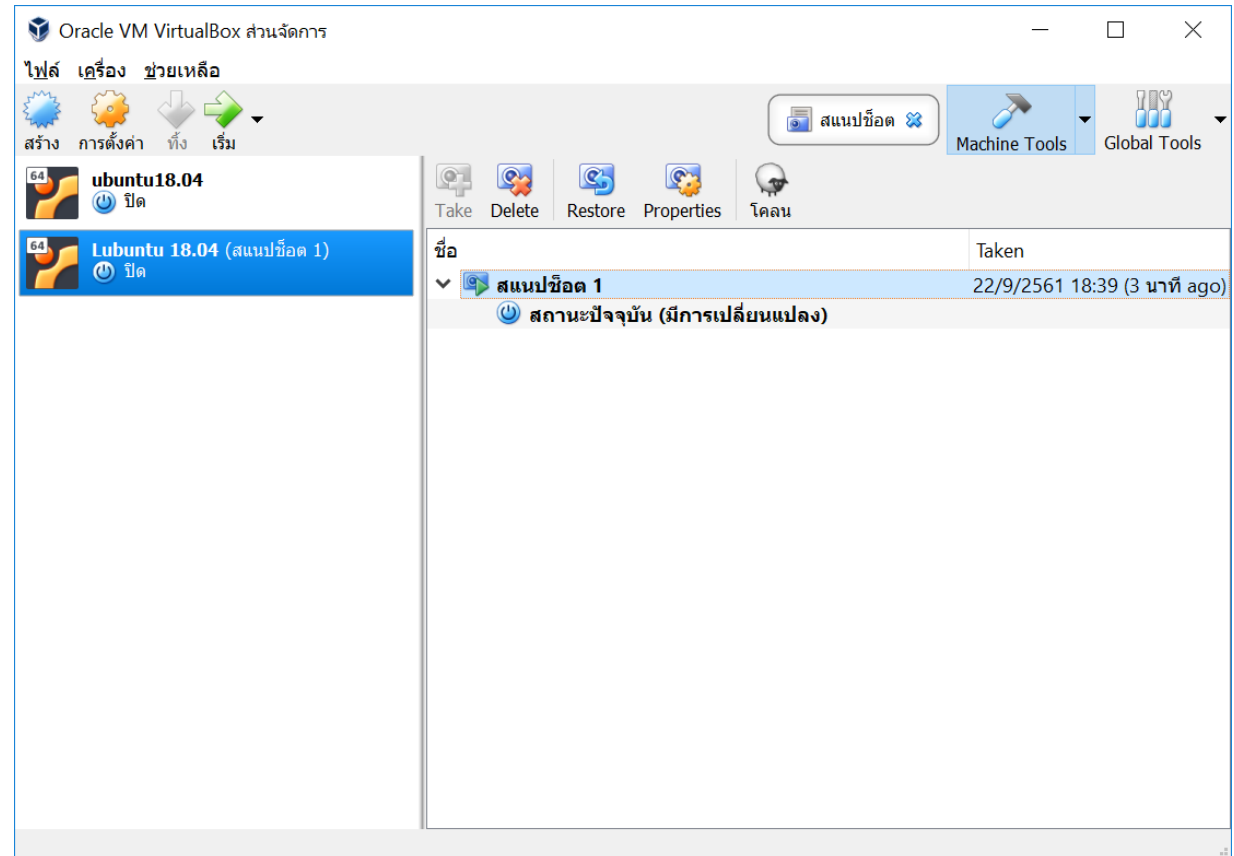
- Switch on the VM
- Open the Terminal

```
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








# 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 The AWS logo consists of the lowercase letters "aws" in a dark blue, sans-serif font, with a curved orange arrow underneath that points from the 'a' to the 's'.
- Google cloud platform Google Cloud Platform logo, featuring a colorful hexagonal icon with a white circle in the center, followed by the text "Google Cloud Platform" in a grey, sans-serif font.
- Microsoft Azure The Azure logo features a stylized blue triangle icon to the left of the word "Azure" in a blue, sans-serif font.
- IBM cloud The IBM Cloud logo features a blue cloud icon with three small blue lines above it, followed by the text "IBM Cloud" in a bold, black, sans-serif font.
- Digital Ocean The DigitalOcean logo features a blue circular icon with a white square and a blue square inside, followed by the text "DigitalOcean" in a blue, sans-serif font.

# Hands on: Cloud Computing

# Overview

- Demo for creating a cloud VM with  DigitalOcean
- 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

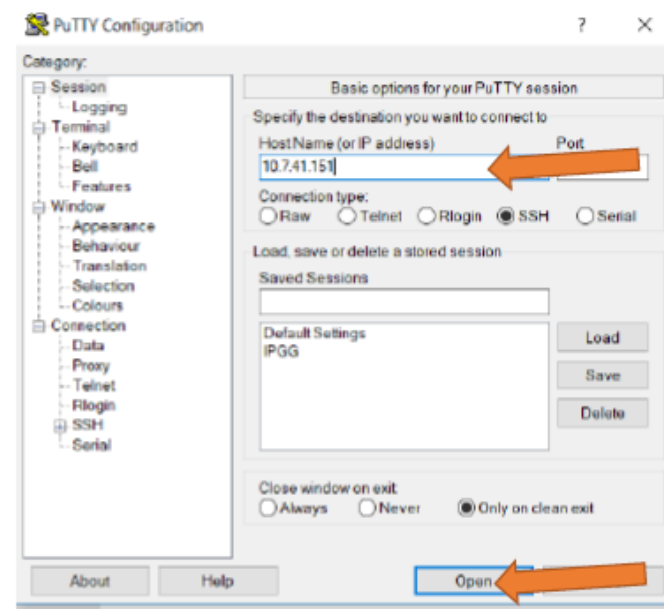


Creating a VM on



# 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)

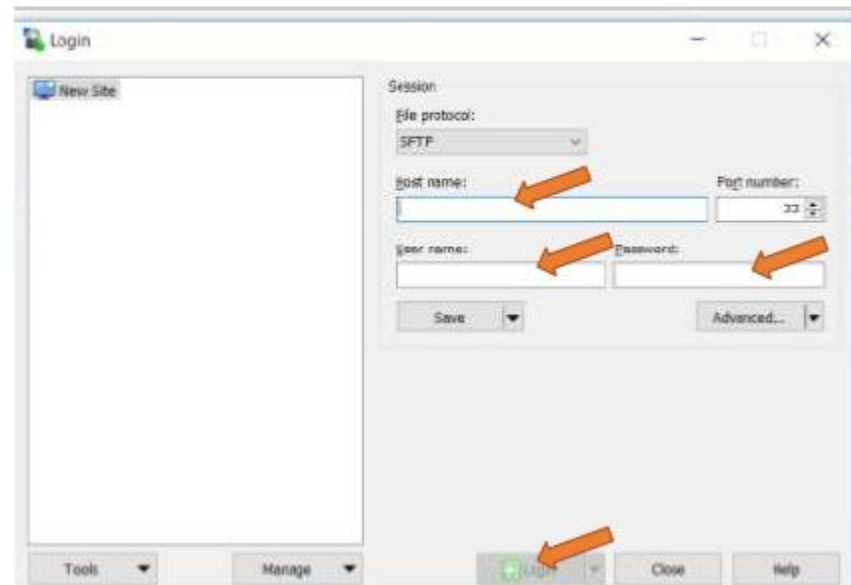
- Mac and Linux
  - Use your 'terminal'
  - `ssh root@<VM IP address>`

# Test basic Unix/Linux commands

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

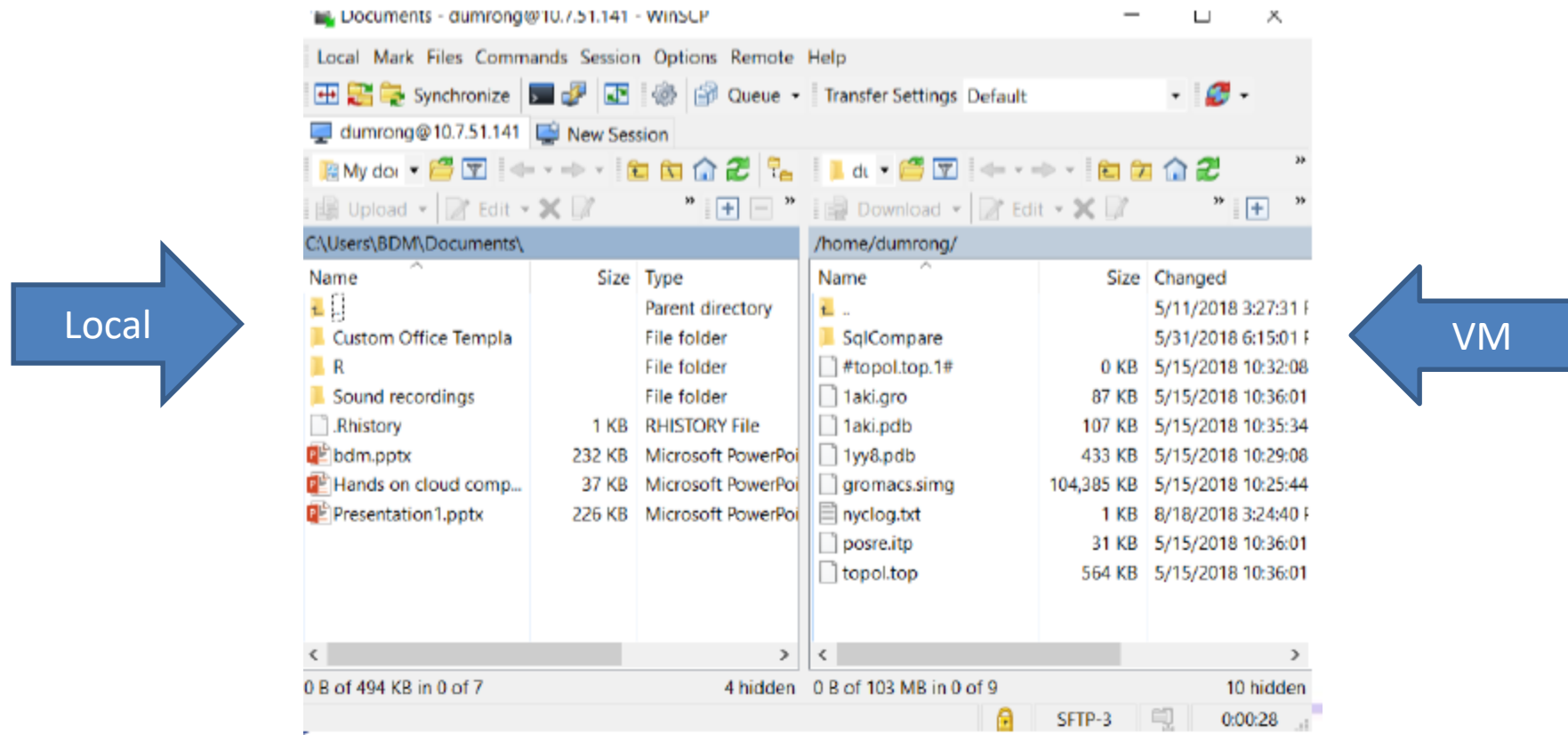
# Remotely transfer files from/to the VM

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



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# 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!