Computer Programming II

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Course Information

- Teaching Assistants (TAs)
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  - Office Hours:
    - **Wed. 1600-1700**
    - **Fri. 13:00-14:00**
    - **Place: 大仁 402**

加簽順序

- 本課程為**資訊系大一基礎必修課**，加簽順序為:
  - 1.本系本班、轉系
  - 2.重修
  - 3.雙修
  - 4.輔系
  - 5.其他（依加簽序號遞補）
- **待選課加退選開始後，請於下週三（03/01）將正課加簽單列印出來帶至課堂上手動加簽，依上述順序進行加簽至雙輔生結束為止！（如沒有加簽到，歡迎旁聽）**

Unix Introduction

Install Ubuntu on Your Computer

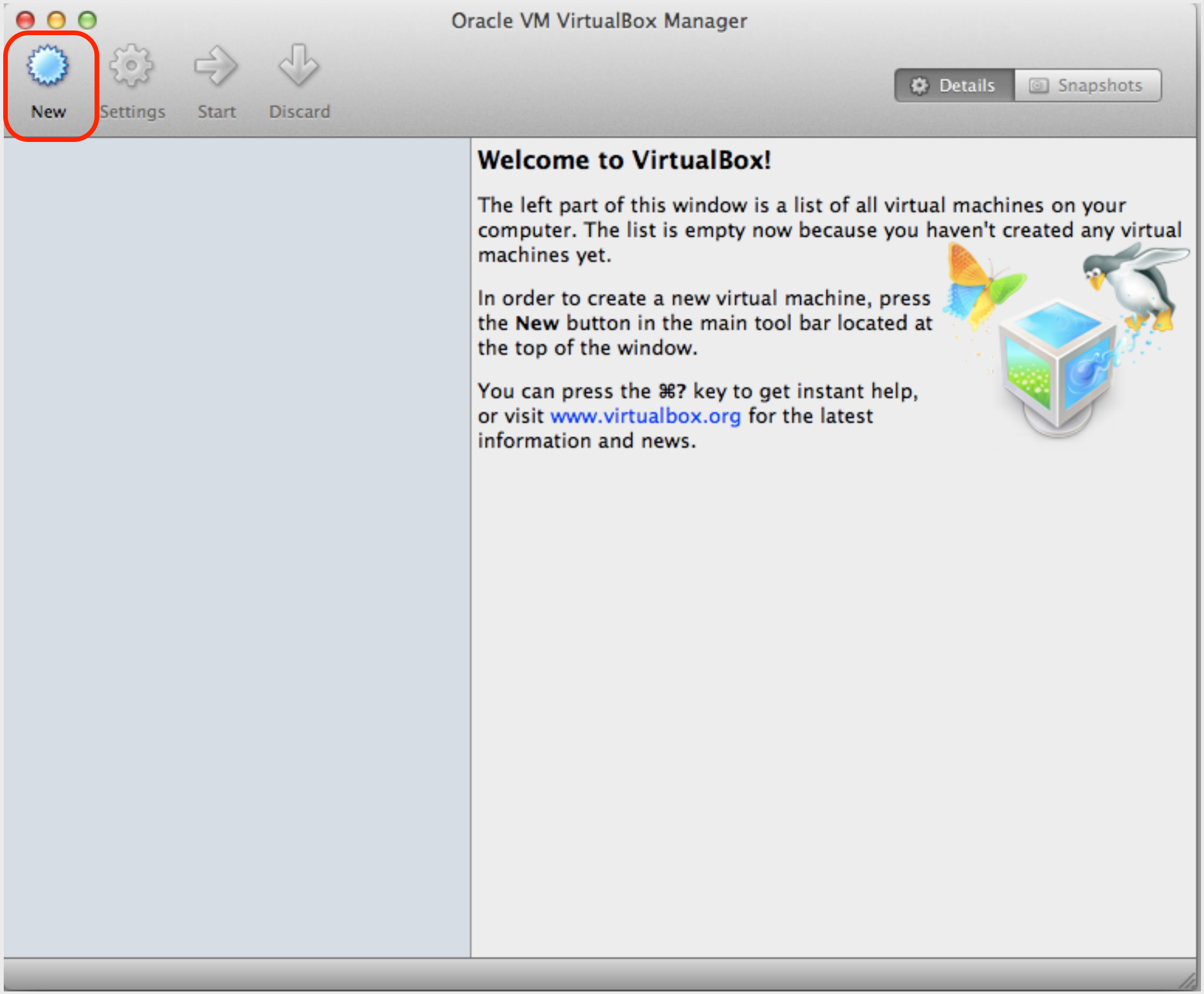
1. Download and install VirtualBox
   - https://www.virtualbox.org/wiki/Downloads/
2. Download Ubuntu
   - http://www.ubuntu.com/download/desktop/

Install Ubuntu on Your Computer

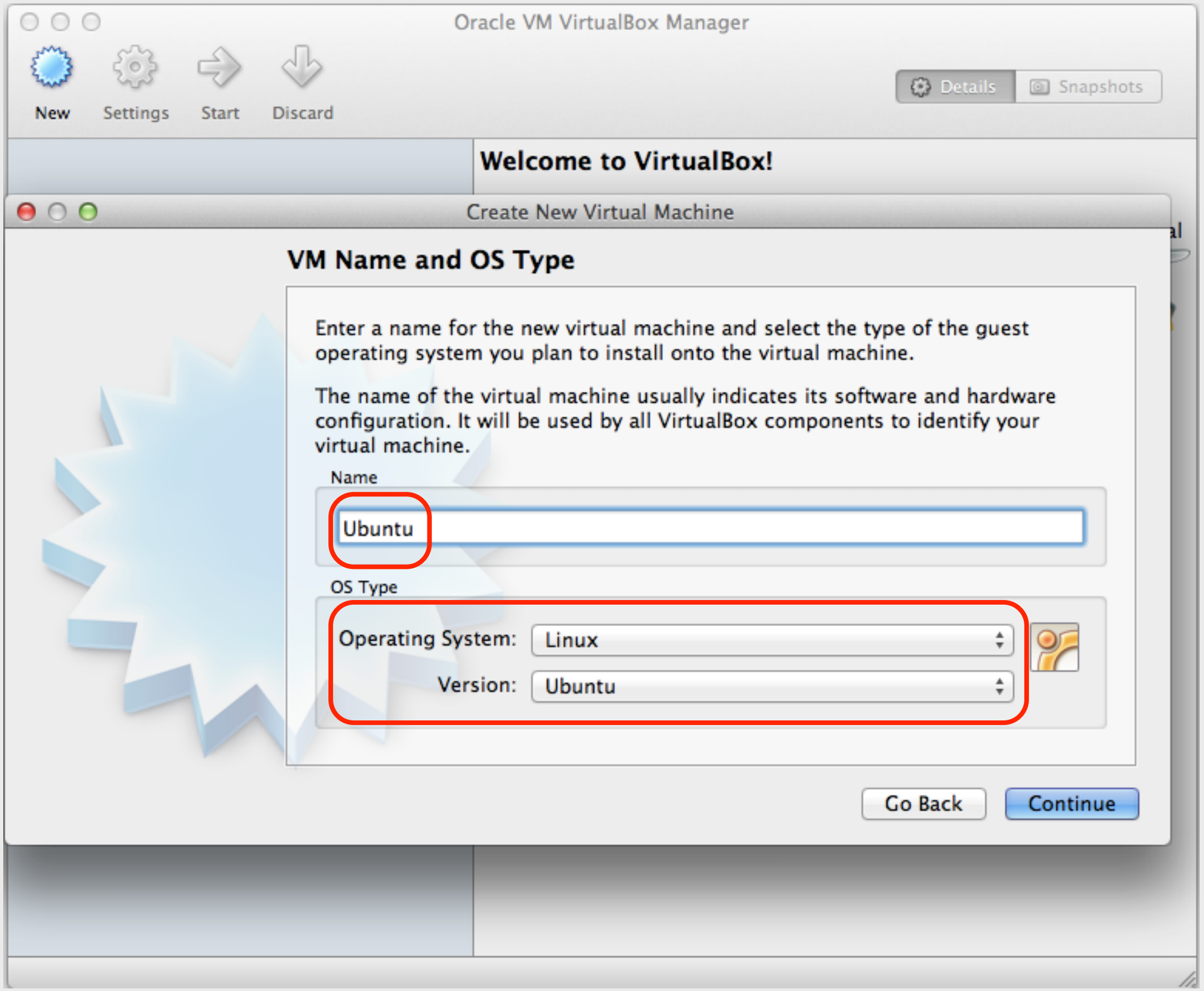
3. Installing Ubuntu inside Windows using VirtualBox
   - http://www.psychocats.net/ubuntu/virtualbox
   - https://ubuntu.com/tutorials/how-to-run-ubuntu-desktop-on-a-virtual-machine-using-virtualbox

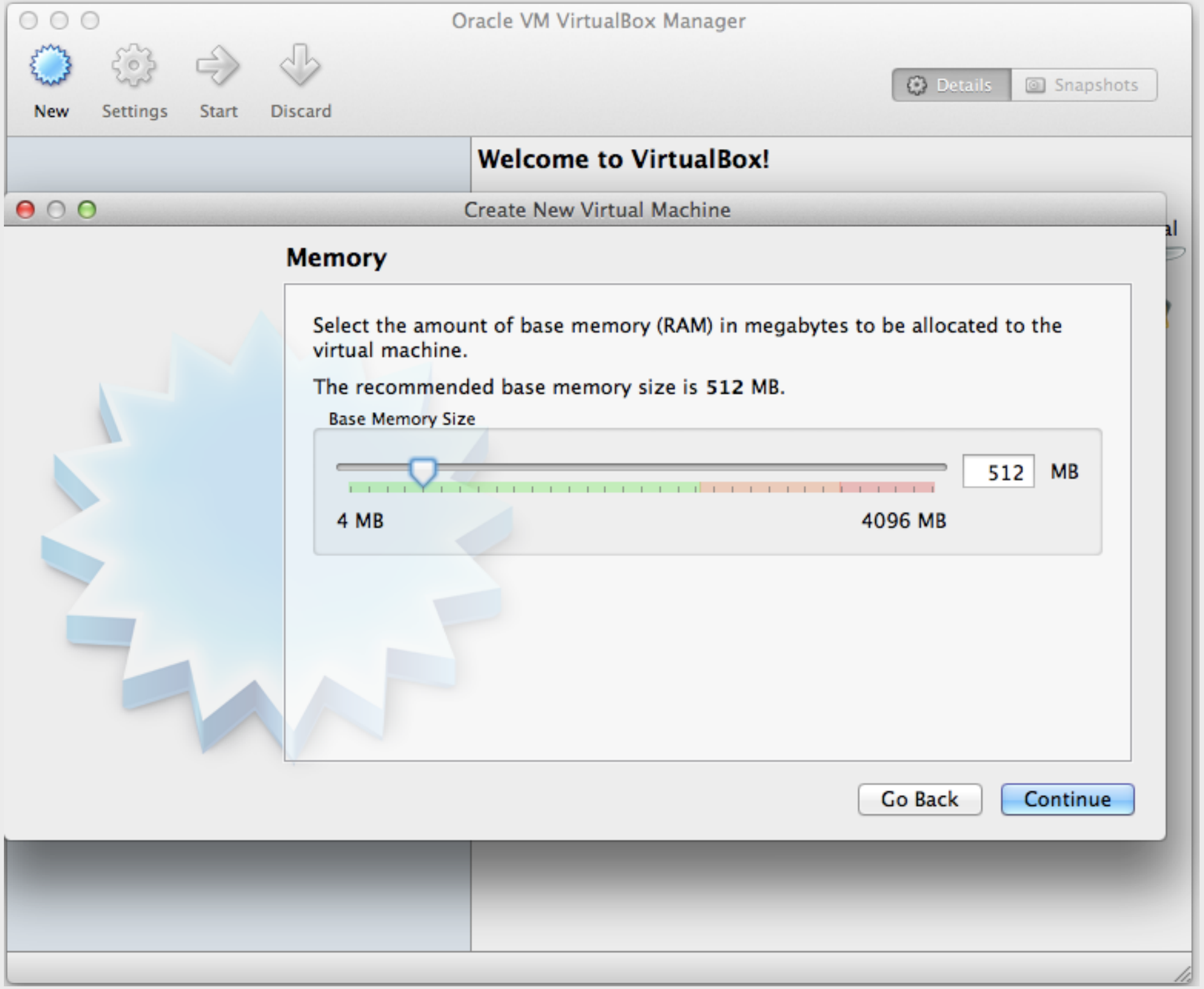
   !! Before installation, choose **bridge** to attach your network.

4. Install Guest Additions
   - Devices -> **Install Guest Addition**

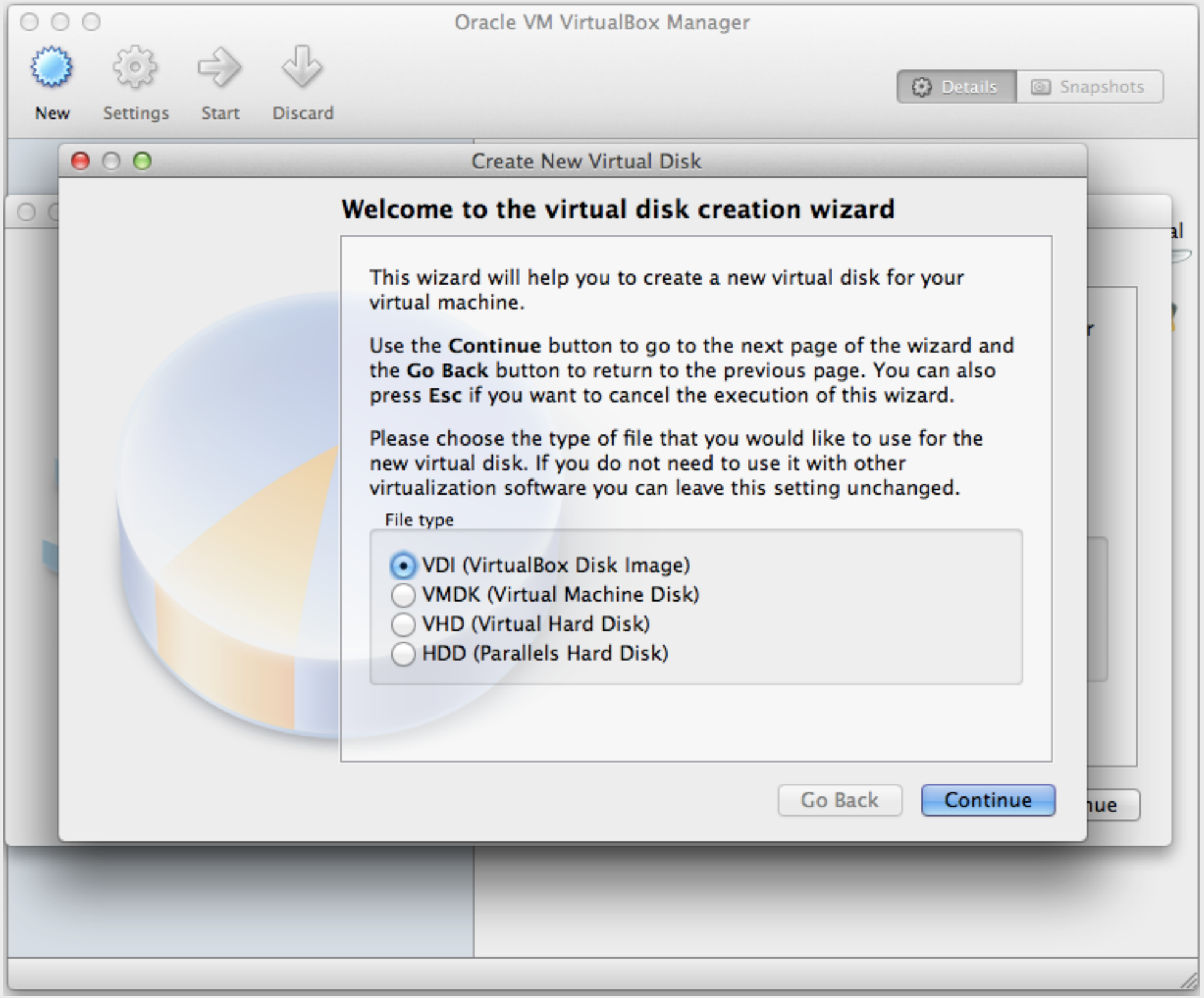

Oracle VM VirtualBox Manager
New
Settings
Start
Discard
Details
Snapshots
Welcome to VirtualBox!
The left part of this window is a list of all virtual machines on your computer. The list is empty now because you haven't created any virtual machines yet.
In order to create a new virtual machine, press the New button in the main tool bar located at the top of the window.
You can press the ⌘? key to get instant help, or visit www.virtualbox.org for the latest information and news.


Oracle VM VirtualBox Manager
New
Settings
Start
Discard
Details
Snapshots
Welcome to VirtualBox!
Create New Virtual Machine
Welcome to the New Virtual Machine Wizard!
This wizard will guide you through the steps that are necessary to create a new virtual machine for VirtualBox.
Use the Continue button to go to the next page of the wizard and the Go Back button to return to the previous page. You can also press Esc if you want to cancel the execution of this wizard.
Go Back
Continue

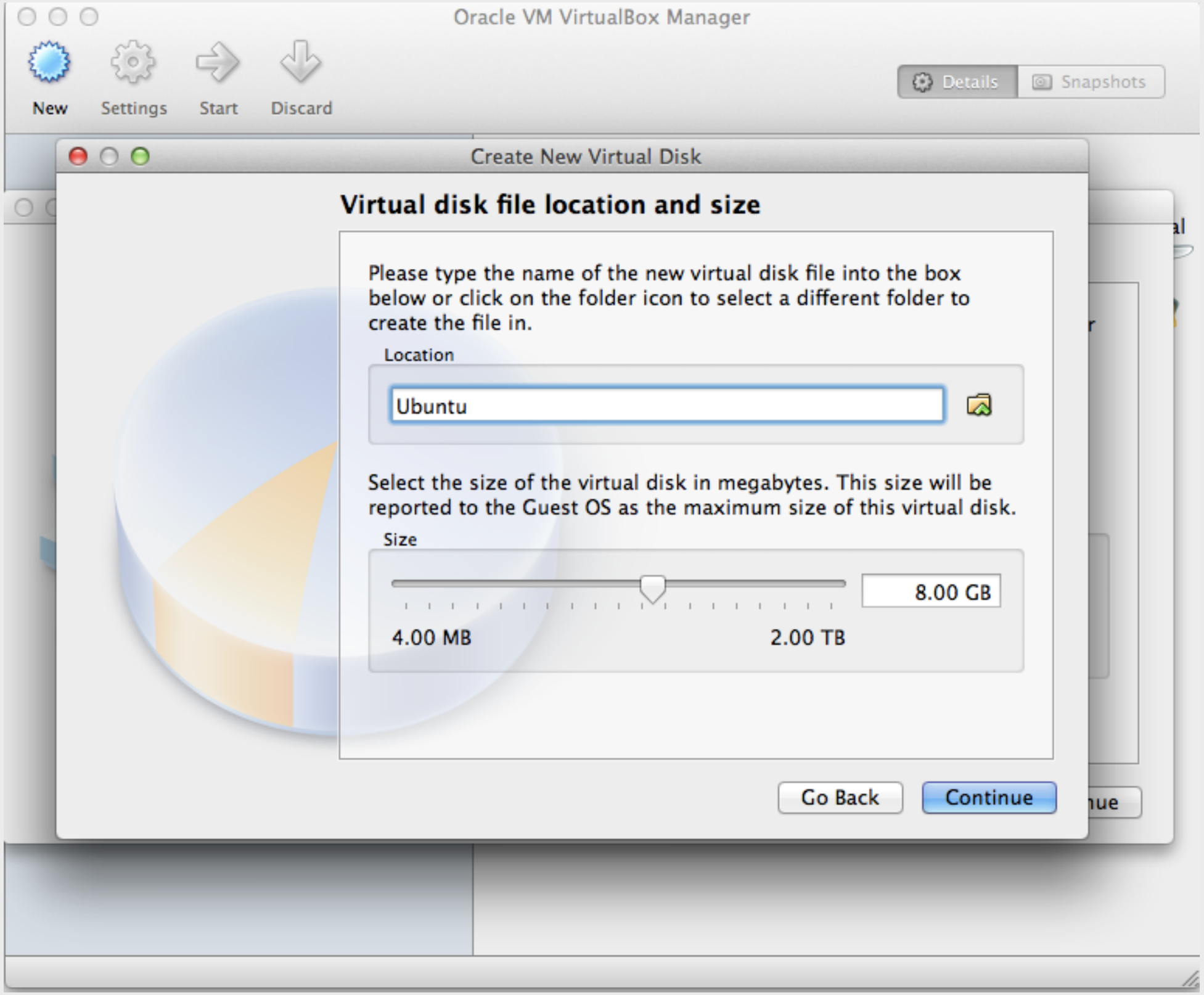

Oracle VM VirtualBox Manager
New
Settings
Start
Discard
Details
Snapshots
Welcome to VirtualBox!
Create New Virtual Machine
VM Name and OS Type
Enter a name for the new virtual machine and select the type of the guest operating system you plan to install onto the virtual machine.
The name of the virtual machine usually indicates its software and hardware configuration. It will be used by all VirtualBox components to identify your virtual machine.
Name
Ubuntu
OS Type
Operating System:
Linux
Version:
Ubuntu
Go Back
Continue

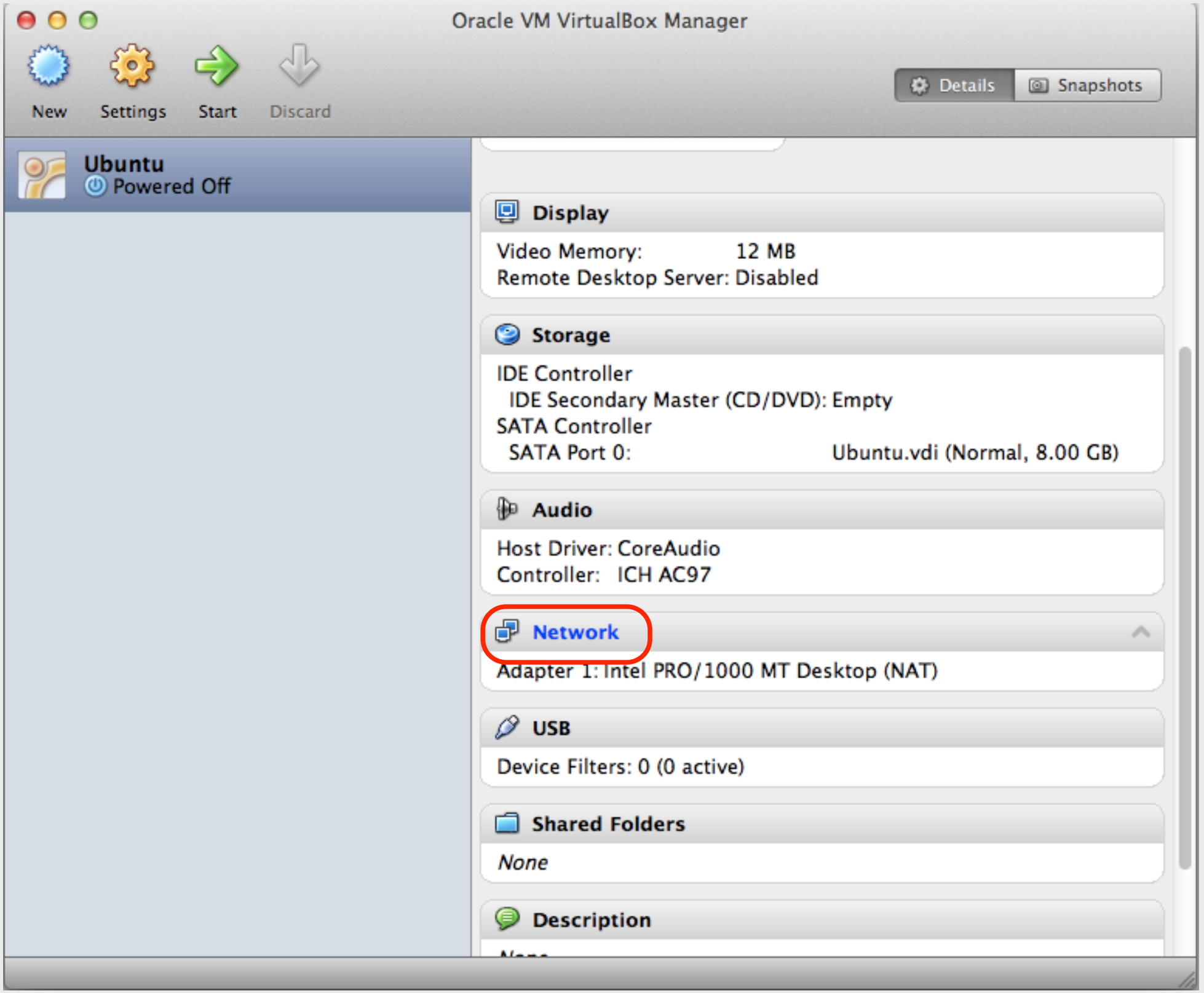

Oracle VM VirtualBox Manager
New
Settings
Start
Discard
Details
Snapshots
Welcome to VirtualBox!
Create New Virtual Machine
Memory
Select the amount of base memory (RAM) in megabytes to be allocated to the virtual machine.
The recommended base memory size is 512 MB.
Base Memory Size
512
MB
4 MB
4096 MB
Go Back
Continue

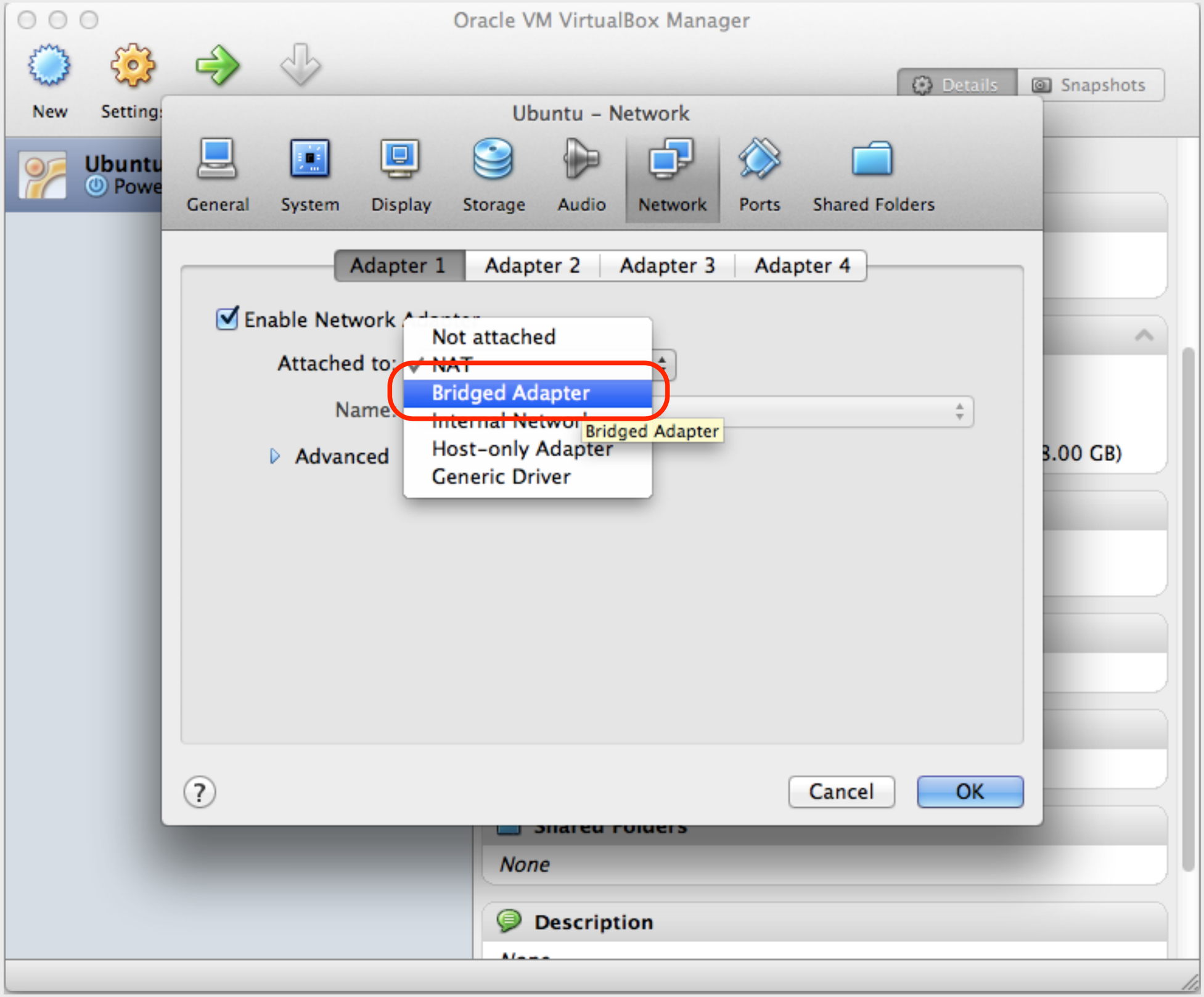

Oracle VM VirtualBox Manager
New
Settings
Start
Discard
Details
Snapshots
Welcome to VirtualBox!
Create New Virtual Machine
Virtual Hard Disk
If you wish you can now add a start-up disk to the new machine. You can either create a new virtual disk or select one from the list or from another location using the folder icon.
If you need a more complex virtual disk setup you can skip this step and make the changes to the machine settings once the machine is created.
The recommended size of the start-up disk is 8.00 GB.
Start-up Disk
Create new hard disk
Use existing hard disk
Empty
Go Back
Continue

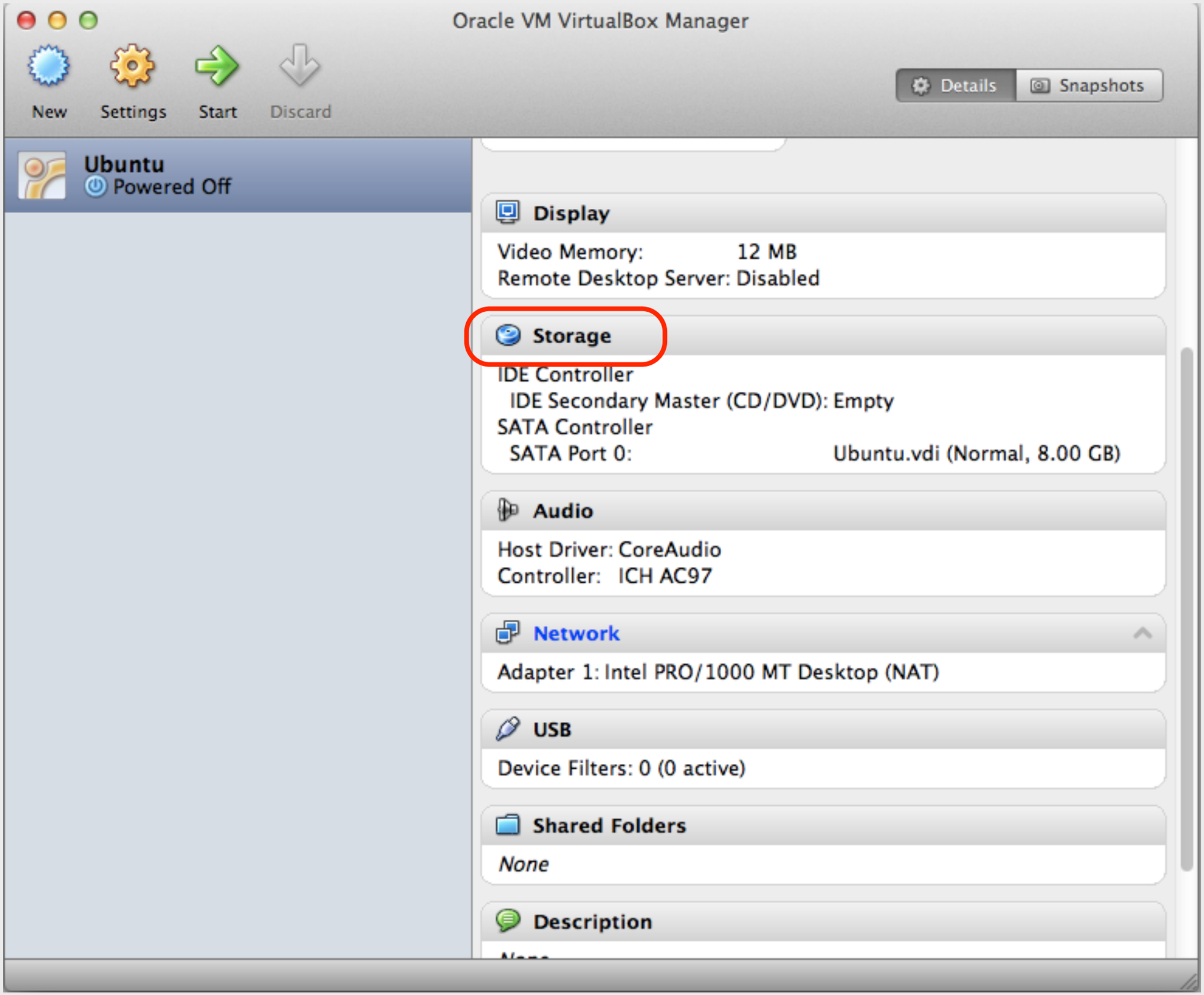

Oracle VM VirtualBox Manager
New
Settings
Start
Discard
Details
Snapshots
Create New Virtual Disk
Welcome to the virtual disk creation wizard
This wizard will help you to create a new virtual disk for your virtual machine.
Use the Continue button to go to the next page of the wizard and the Go Back button to return to the previous page. You can also press Esc if you want to cancel the execution of this wizard.
Please choose the type of file that you would like to use for the new virtual disk. If you do not need to use it with other virtualization software you can leave this setting unchanged.
File type
VDI (VirtualBox Disk Image)
VMDK (Virtual Machine Disk)
VHD (Virtual Hard Disk)
HDD (Parallels Hard Disk)
Go Back
Continue

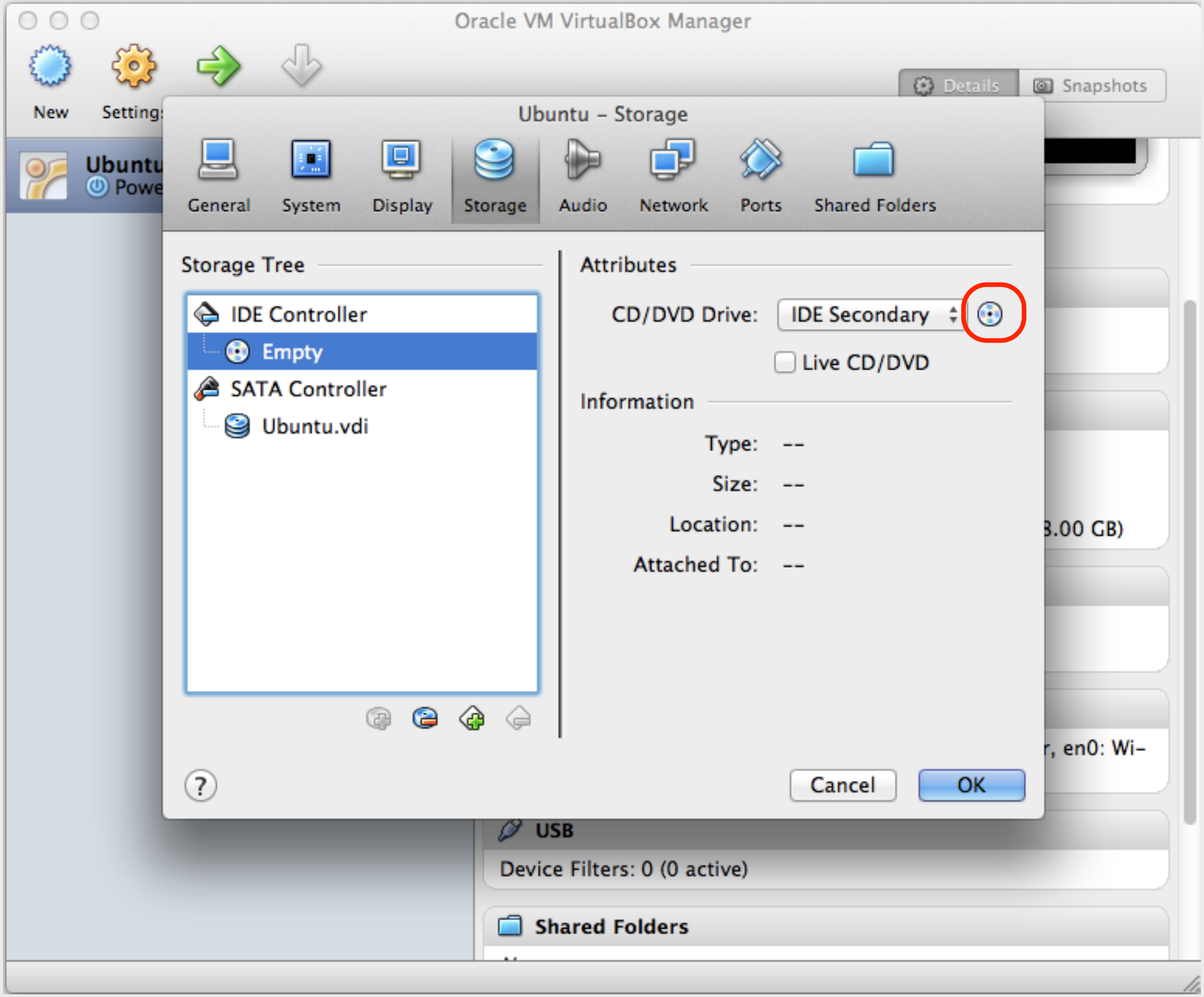

Oracle VM VirtualBox Manager
New
Settings
Start
Discard
Details
Snapshots
Create New Virtual Disk
Virtual disk storage details
Please choose whether the new virtual disk file should be allocated as it is used or if it should be created fully allocated.
A dynamically allocated virtual disk file will only use space on your physical hard disk as it fills up, although it will not shrink again automatically when space on it is freed.
A fixed size virtual disk file may take longer to create on some systems but is often faster to use.
Storage details
Dynamically allocated
Fixed size
Go Back
Continue

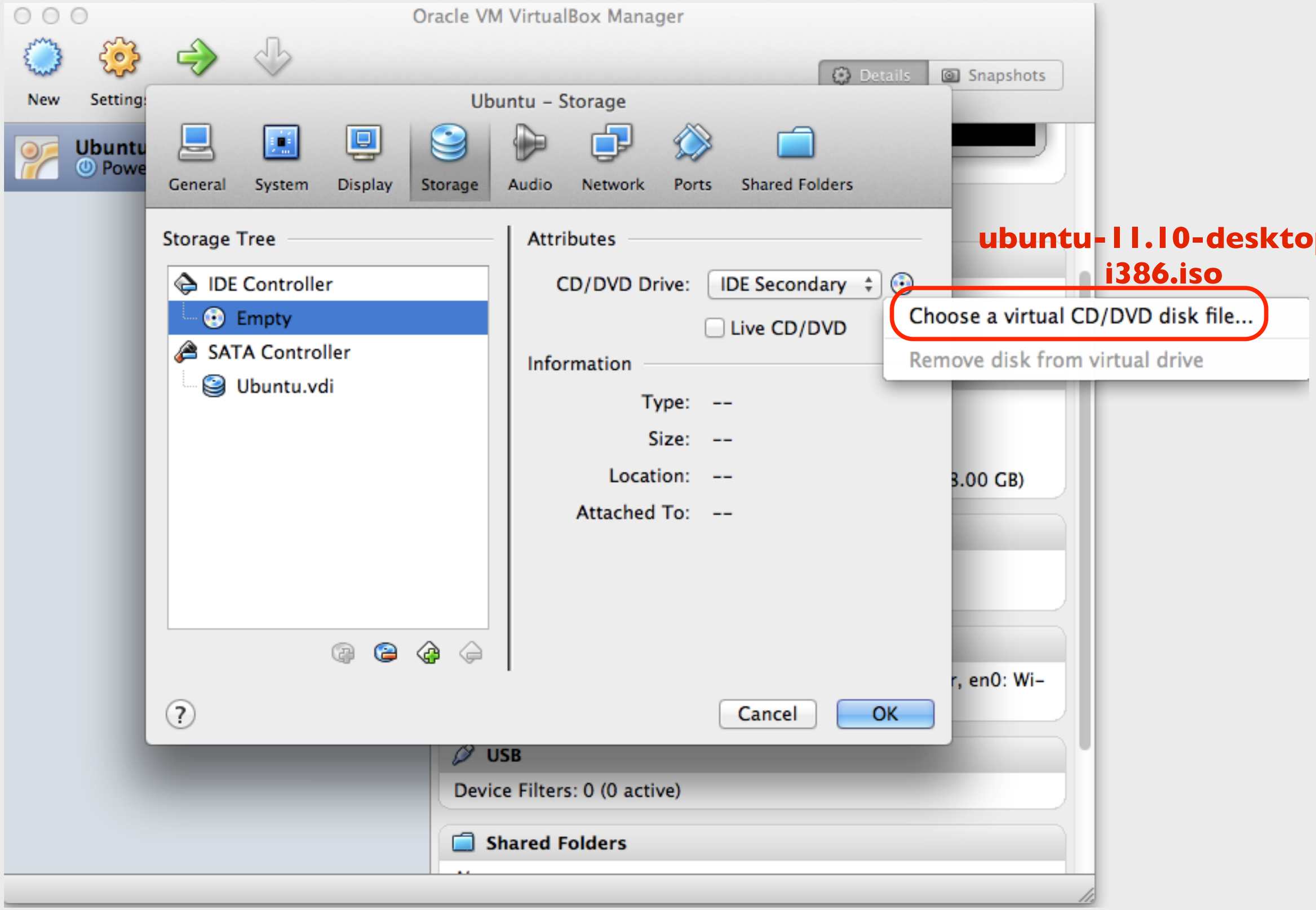

Oracle VM VirtualBox Manager
New
Settings
Start
Discard
Details
Snapshots
Create New Virtual Disk
Virtual disk file location and size
Please type the name of the new virtual disk file into the box below or click on the folder icon to select a different folder to create the file in.
Location
Ubuntu
Select the size of the virtual disk in megabytes. This size will be reported to the Guest OS as the maximum size of this virtual disk.
Size
8.00 GB
4.00 MB
2.00 TB
Go Back
Continue

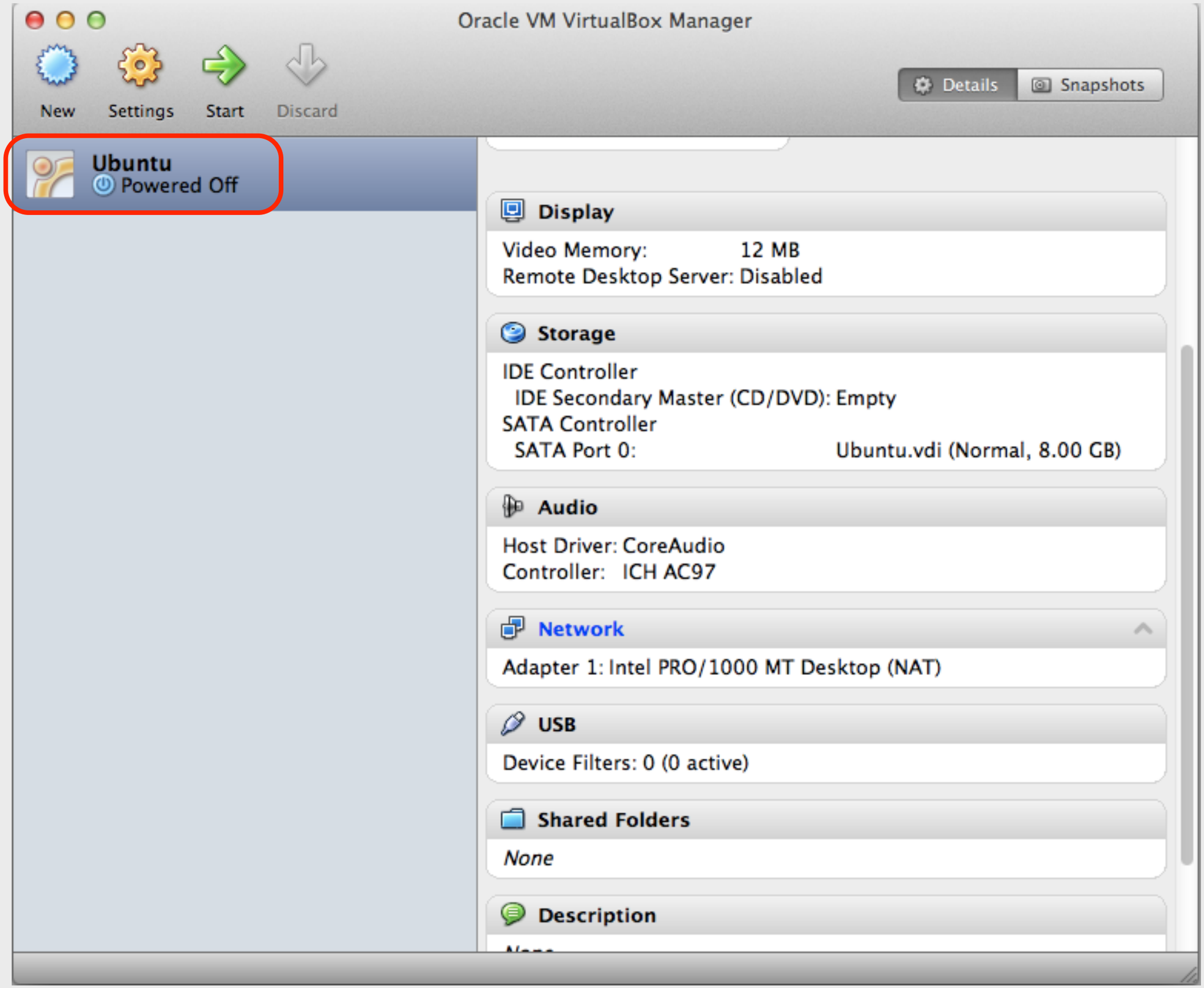

Oracle VM VirtualBox Manager
New
Settings
Start
Discard
Details
Snapshots
Ubuntu
Powered Off
Display
Video Memory: 12 MB
Remote Desktop Server: Disabled
Storage
IDE Controller
IDE Secondary Master (CD/DVD): Empty
SATA Controller
SATA Port 0: Ubuntu.vdi (Normal, 8.00 GB)
Audio
Host Driver: CoreAudio
Controller: ICH AC97
Network
Adapter 1: Intel PRO/1000 MT Desktop (NAT)
USB
Device Filters: 0 (0 active)
Shared Folders
None
Description


Oracle VM VirtualBox Manager
New
Setting
Details
Snapshots
Ubuntu
Powe
Ubuntu - Network
General
System
Display
Storage
Audio
Network
Ports
Shared Folders
Adapter 1
Adapter 2
Adapter 3
Adapter 4
Enable Network Adapter
Attached to:
Name:
Advanced
Not attached
NAT
Bridged Adapter
Internal Network
Host-only Adapter
Generic Driver
Bridged Adapter
Cancel
OK
None
Description


Oracle VM VirtualBox Manager
New
Settings
Start
Discard
Details
Snapshots
Ubuntu
Powered Off
Display
Video Memory: 12 MB
Remote Desktop Server: Disabled
Storage
IDE Controller
IDE Secondary Master (CD/DVD): Empty
SATA Controller
SATA Port 0: Ubuntu.vdi (Normal, 8.00 GB)
Audio
Host Driver: CoreAudio
Controller: ICH AC97
Network
Adapter 1: Intel PRO/1000 MT Desktop (NAT)
USB
Device Filters: 0 (0 active)
Shared Folders
None
Description


Oracle VM VirtualBox Manager
New
Setting
Details
Snapshots
Ubuntu – Storage
General
System
Display
Storage
Audio
Network
Ports
Shared Folders
Storage Tree
IDE Controller
Empty
SATA Controller
Ubuntu.vdi
Attributes
CD/DVD Drive:
IDE Secondary
Live CD/DVD
Information
Type: --
Size: --
Location: --
Attached To: --
Cancel
OK
USB
Device Filters: 0 (0 active)
Shared Folders


Oracle VM VirtualBox Manager
New
Setting
Details
Snapshots
Ubuntu – Storage
General
System
Display
Storage
Audio
Network
Ports
Shared Folders
Storage Tree
IDE Controller
Empty
SATA Controller
Ubuntu.vdi
Attributes
CD/DVD Drive:
IDE Secondary
Live CD/DVD
Information
Type: --
Size: --
Location: --
Attached To: --
Choose a virtual CD/DVD disk file...
Remove disk from virtual drive
ubuntu-11.10-desktop-i386.iso
Cancel
OK
USB
Device Filters: 0 (0 active)
Shared Folders

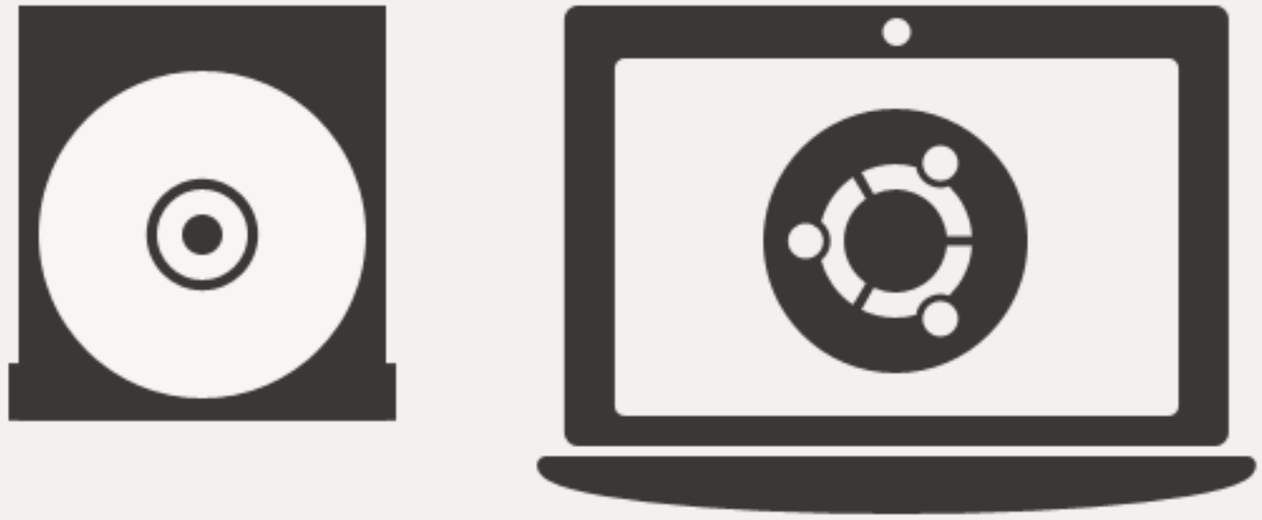

Oracle VM VirtualBox Manager
New
Settings
Start
Discard
Details
Snapshots
Ubuntu
Powered Off
Display
Video Memory: 12 MB
Remote Desktop Server: Disabled
Storage
IDE Controller
IDE Secondary Master (CD/DVD): Empty
SATA Controller
SATA Port 0: Ubuntu.vdi (Normal, 8.00 GB)
Audio
Host Driver: CoreAudio
Controller: ICH AC97
Network
Adapter 1: Intel PRO/1000 MT Desktop (NAT)
USB
Device Filters: 0 (0 active)
Shared Folders
None
Description

Ubuntu (Snapshot 1) [Running]

Install

Welcome

Asturianu
Bahasa Indonesia
Bosanski
Català
Čeština
Dansk
Deutsch
Eesti
English
Español
Esperanto
Euskara
Français
Gaeilge
Galego
Hrvatski
Íslenska
Italiano
Kurdî



Try Ubuntu

Install Ubuntu

You can try Ubuntu without making any changes to your computer, directly from this CD.

Or if you're ready, you can install Ubuntu alongside (or instead of) your current operating system. This shouldn't take too long.

You may wish to read the release notes.

Ubuntu (Snapshot 1) [Running]

Install

Preparing to install Ubuntu

For best results, please ensure that this computer:

- ✓ has at least 4.4 GB available drive space
- ✗ is plugged in to a power source
- ✓ is connected to the Internet

☐ Download updates while installing

Ubuntu uses third-party software to display Flash, MP3 and other media, and to work with some wireless hardware. Some of this software is closed-source. The software is subject to the license terms included with the software's documentation.

☐ Install this third-party software
Fluendo MP3 plugin includes MPEG Layer-3 audio decoding technology licensed from Fraunhofer IIS and Thomson.

Quit | Back | Continue

Left ⌘

Ubuntu (Snapshot 1) [Running]

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 any files on the disk.

Something else
You can create or resize partitions yourself, or choose multiple partitions for Ubuntu.

Quit | Back | Continue

Ubuntu (Snapshot 1) [Running]

Install

Erase disk and install Ubuntu

Select drive: SCSI3 (0,0,0) (sda) - 8.6 GB ATA VBOX HARDDISK

The entire disk will be used:

Ubuntu
/dev/sda (ext4)
8.6 GB

Quit | Back | Install Now

Left ⌘

Ubuntu (Snapshot 1) [Running]

Install

Erase disk and install Ubuntu

Select drive: SCSI3 (0,0,0) (sda) - 8.6 GB ATA VBOX HARDDISK

The entire disk will be used:

Ubuntu
/dev/sda (ext4)
8.6 GB

Back | Install Now

Copying files...

Left ⌘

Ubuntu (Snapshot 1) [Running]

Install

Who are you?

Your name: Place your ID

Your computer's name:

The name it uses when it talks to other computers.

Pick a username: Username

Choose a password: Password

Confirm your password: Confirm password

Log in automatically

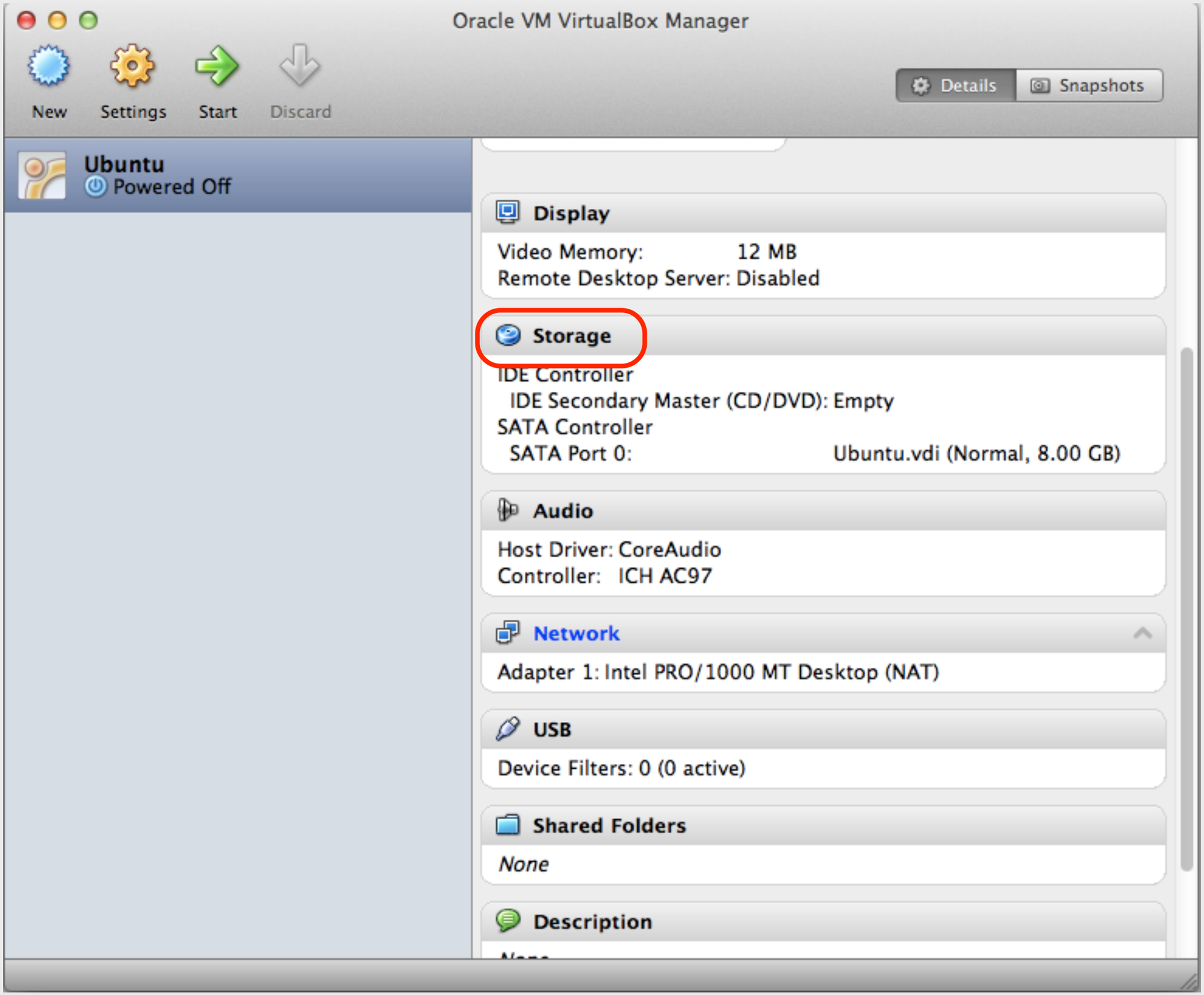
Require my password to log in

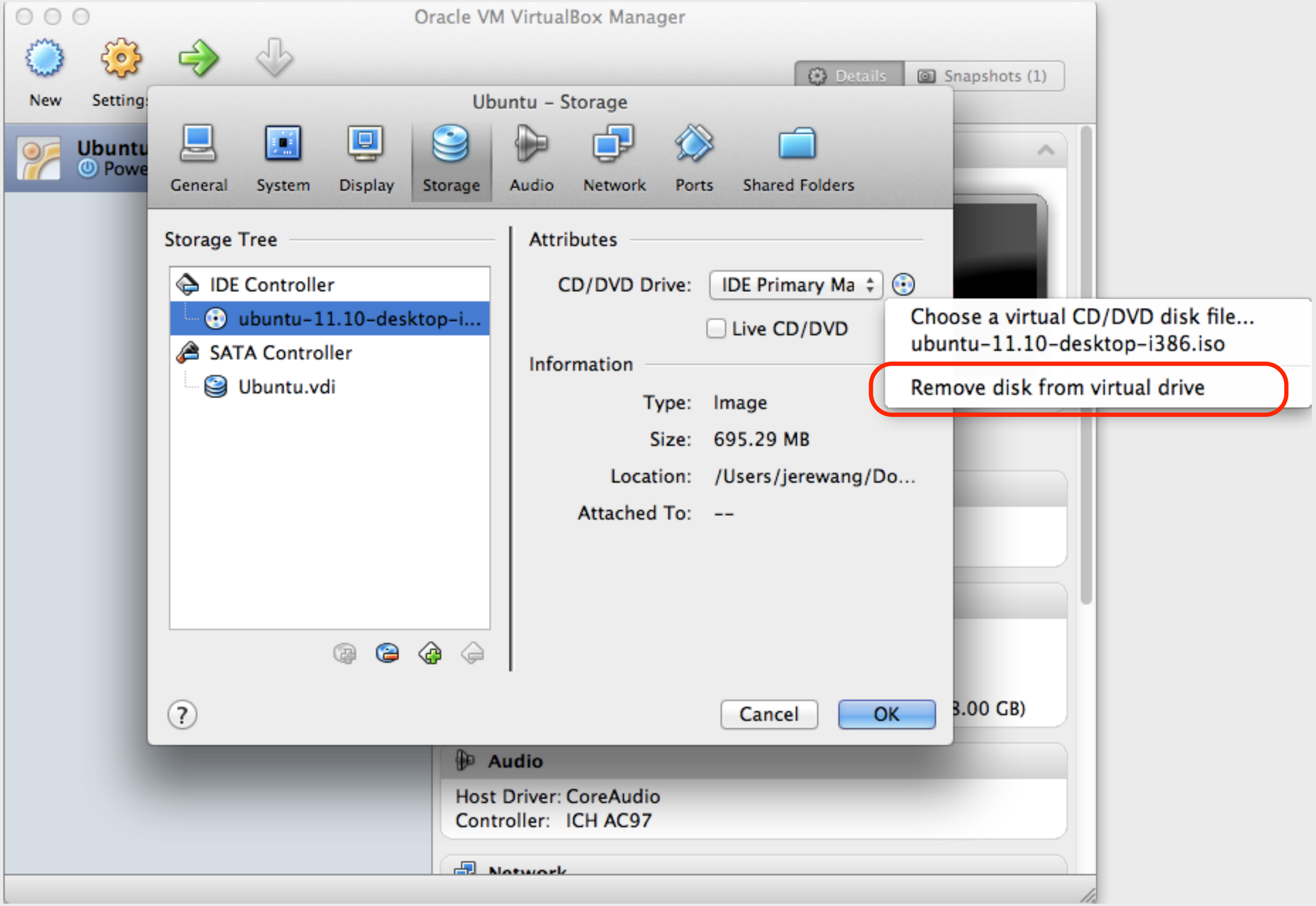
Encrypt my home folder

Back Continue

Ready when you are...

Left ⌘


Oracle VM VirtualBox Manager
New
Settings
Start
Discard
Details
Snapshots
Ubuntu
Powered Off
Display
Video Memory: 12 MB
Remote Desktop Server: Disabled
Storage
IDE Controller
IDE Secondary Master (CD/DVD): Empty
SATA Controller
SATA Port 0: Ubuntu.vdi (Normal, 8.00 GB)
Audio
Host Driver: CoreAudio
Controller: ICH AC97
Network
Adapter 1: Intel PRO/1000 MT Desktop (NAT)
USB
Device Filters: 0 (0 active)
Shared Folders
None
Description


Oracle VM VirtualBox Manager
New
Setting
Details
Snapshots (1)
Ubuntu
Powe
Ubuntu - Storage
General
System
Display
Storage
Audio
Network
Ports
Shared Folders
Storage Tree
IDE Controller
ubuntu-11.10-desktop-i...
SATA Controller
Ubuntu.vdi
Attributes
CD/DVD Drive:
IDE Primary Ma
Live CD/DVD
Information
Type: Image
Size: 695.29 MB
Location: /Users/jerewang/Do...
Attached To: --
Choose a virtual CD/DVD disk file...
ubuntu-11.10-desktop-i386.iso
Remove disk from virtual drive
Cancel
OK
3.00 GB)
Audio
Host Driver: CoreAudio
Controller: ICH AC97
Network

Ubuntu (Snapshot 1) [Running]

jere-VirtualBox 10:14 PM

Other...

jere
Password:

Guest Session

Left ⌘

VirtualBox VM Machine View Devices Help

CD/DVD Devices
USB Devices
Network Adapters...
Shared Folders...
Enable Remote Display

Install Guest Additions... (Host+D)

unning]

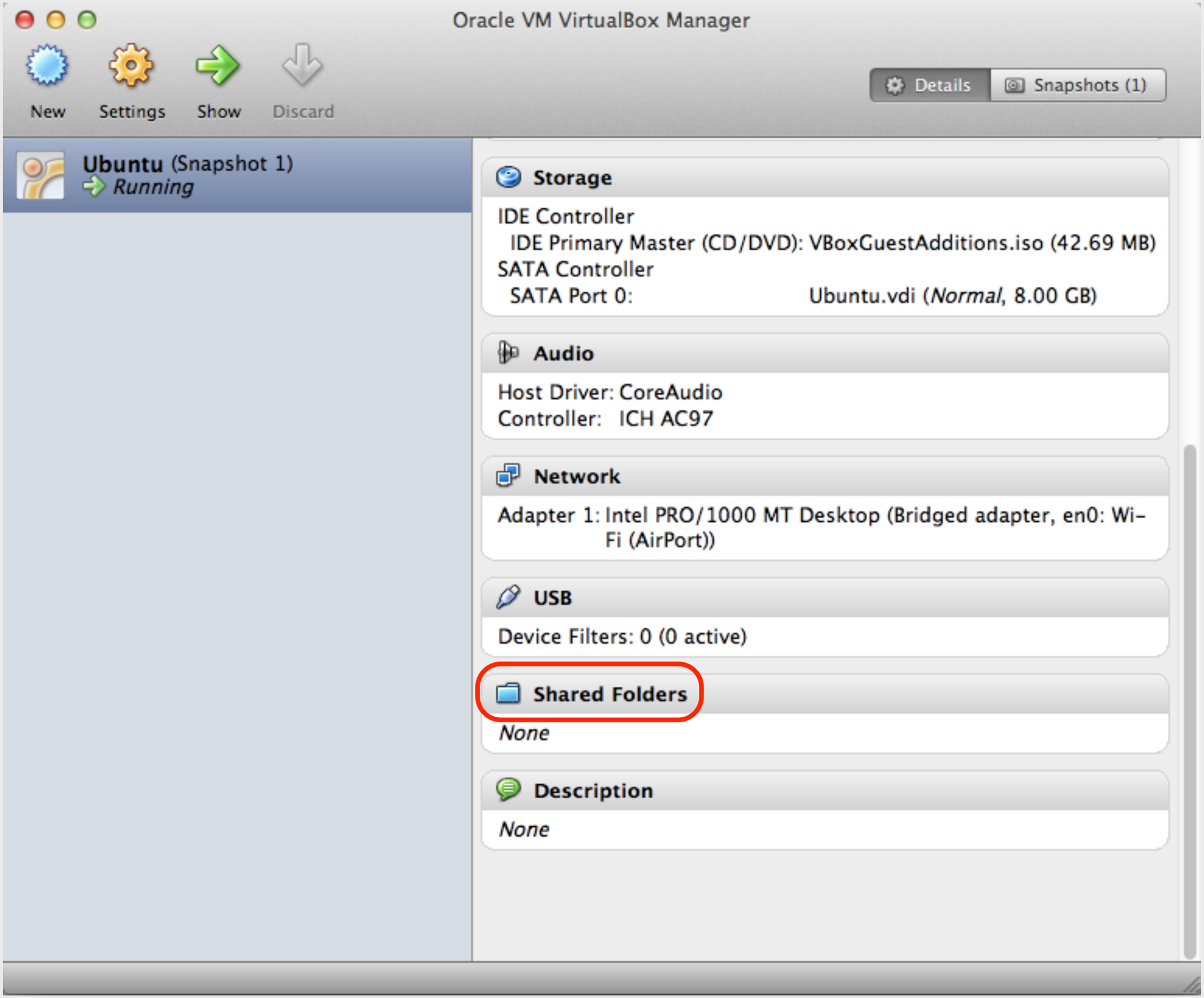
10:27 PM jere

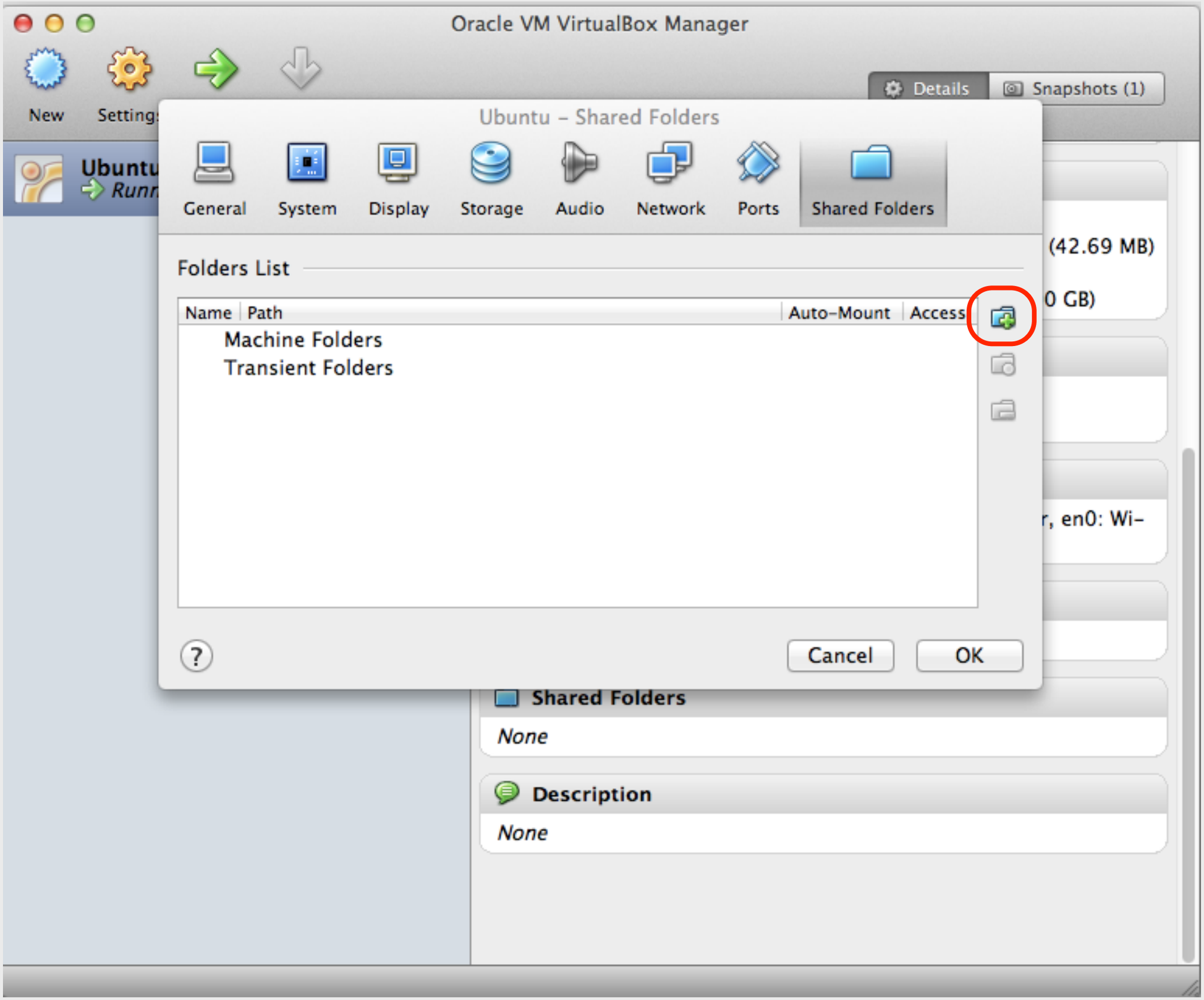
277

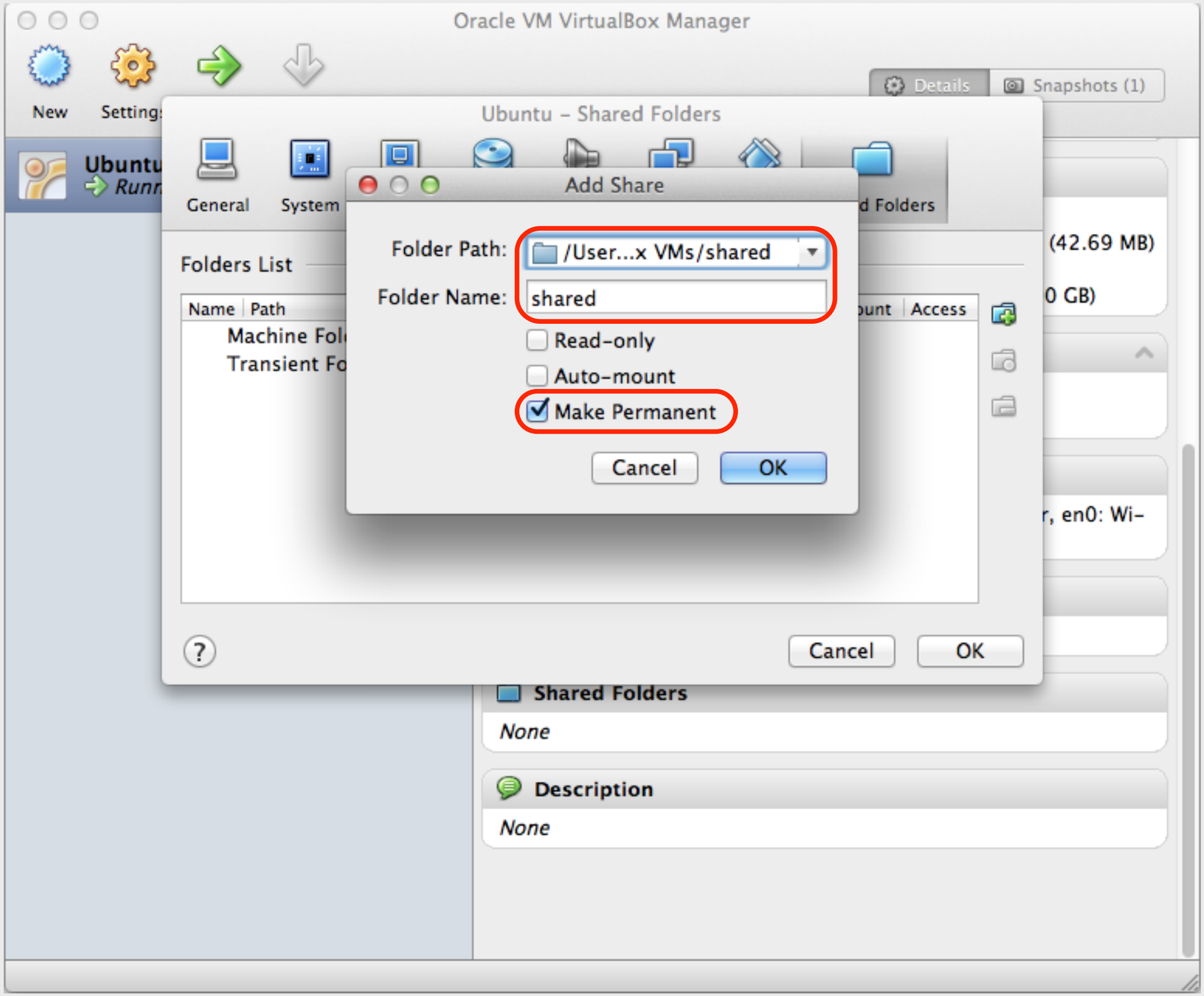
Left ⌘

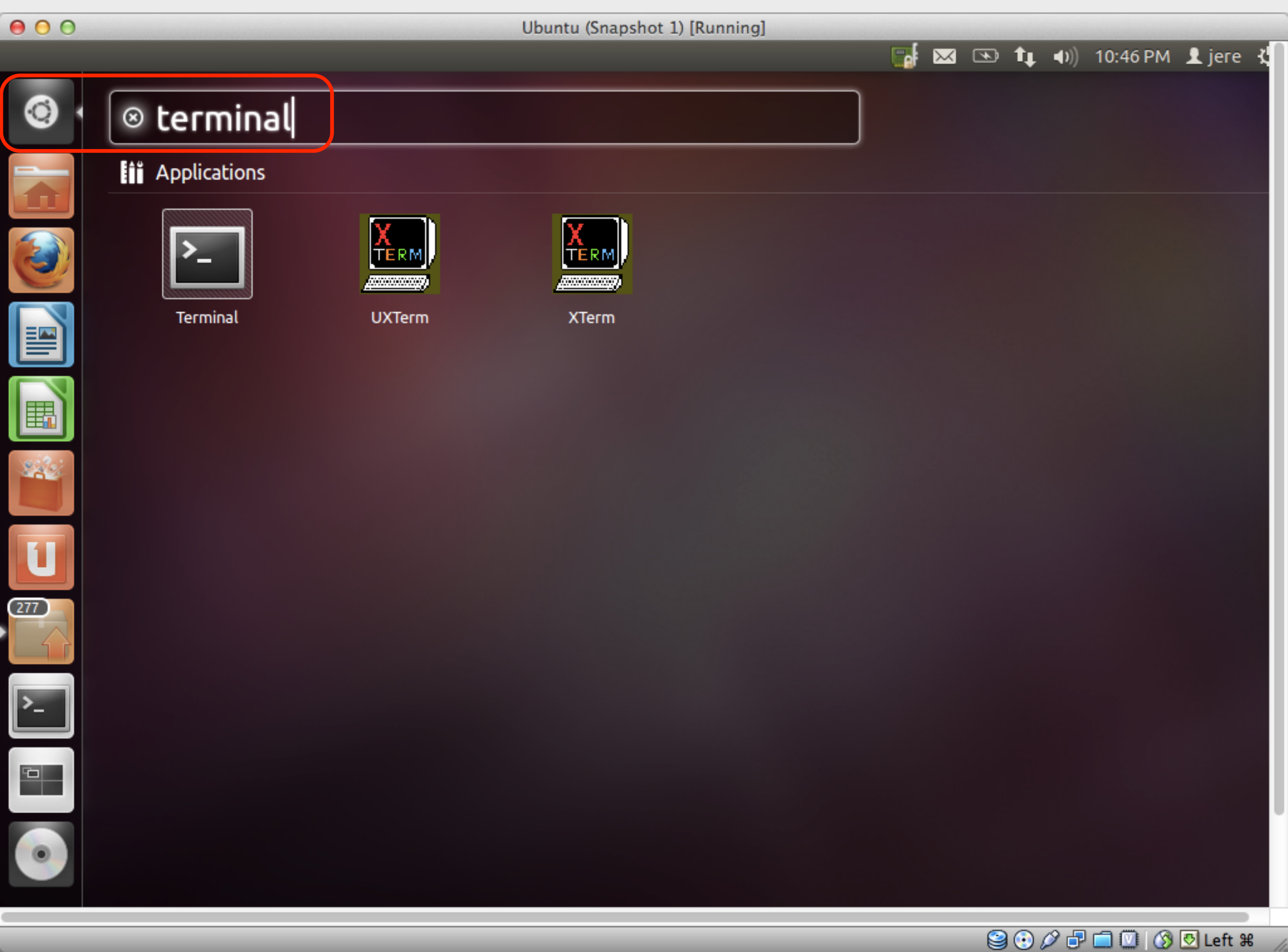
Make a folder shared

- Make a folder shared
  - http://briian.com/?p=6241
    - Use `mount` command
    - !! Do not choose auto-mount!


Oracle VM VirtualBox Manager
New
Settings
Show
Discard
Details
Snapshots (1)
Ubuntu (Snapshot 1)
Running
Storage
IDE Controller
IDE Primary Master (CD/DVD): VBoxGuestAdditions.iso (42.69 MB)
SATA Controller
SATA Port 0: Ubuntu.vdi (Normal, 8.00 GB)
Audio
Host Driver: CoreAudio
Controller: ICH AC97
Network
Adapter 1: Intel PRO/1000 MT Desktop (Bridged adapter, en0: Wi-Fi (AirPort))
USB
Device Filters: 0 (0 active)
Shared Folders
None
Description
None


Oracle VM VirtualBox Manager
New
Setting
Details
Snapshots (1)
Ubuntu
Ubuntu – Shared Folders
General
System
Display
Storage
Audio
Network
Ports
Shared Folders
Folders List
Name
Path
Auto-Mount
Access
Machine Folders
Transient Folders
Cancel
OK
(42.69 MB)
0 GB)
, en0: Wi-
Shared Folders
None
Description
None


Oracle VM VirtualBox Manager
New
Setting
Details
Snapshots (1)
Ubuntu
Ubuntu - Shared Folders
General
System
d Folders
Folders List
Name
Path
Machine Fol
Transient Fo
unt
Access
Add Share
Folder Path:
/User...x VMs/shared
Folder Name:
shared
Read-only
Auto-mount
Make Permanent
Cancel
OK
(42.69 MB)
0 GB)
r, en0: Wi-
Cancel
OK
Shared Folders
None
Description
None


Ubuntu (Snapshot 1) [Running]
10:46 PM
jere
terminal
Applications
Terminal
UXTerm
XTerm
277
Left ⌘

Ubuntu (Snapshot 1) [Running]

Terminal

10:45 PM jere

jere@jere-VirtualBox: ~/shared

```
jere@jere-VirtualBox:~$ ls
Desktop    Downloads         Music     Public     Videos
Documents  examples.desktop  Pictures  Templates
jere@jere-VirtualBox:~$ mkdir shared
jere@jere-VirtualBox:~$ ls
Desktop    Downloads         Music     Public  Templates
Documents  examples.desktop  Pictures  shared  Videos
jere@jere-VirtualBox:~$ mount -t vboxsf shared ~/shared
mount: only root can do that
jere@jere-VirtualBox:~$ sudo mount -t vboxsf shared ~/shared
[sudo] password for jere:
jere@jere-VirtualBox:~$ cd shared/
jere@jere-VirtualBox:~/shared$ ls
100-Calendar.pdf
jere@jere-VirtualBox:~/shared$
```

Left ⌘

Install Ubuntu on Your Computer

- Another installation
  - Using “wubi” installer of Ubuntu
  - For more details, please refer to

    http://www.ubuntu.com/download/help/install-ubuntu-with-windows

Install Development Tools on Ubuntu

- Use the following commands to install the development tools package on your Ubuntu

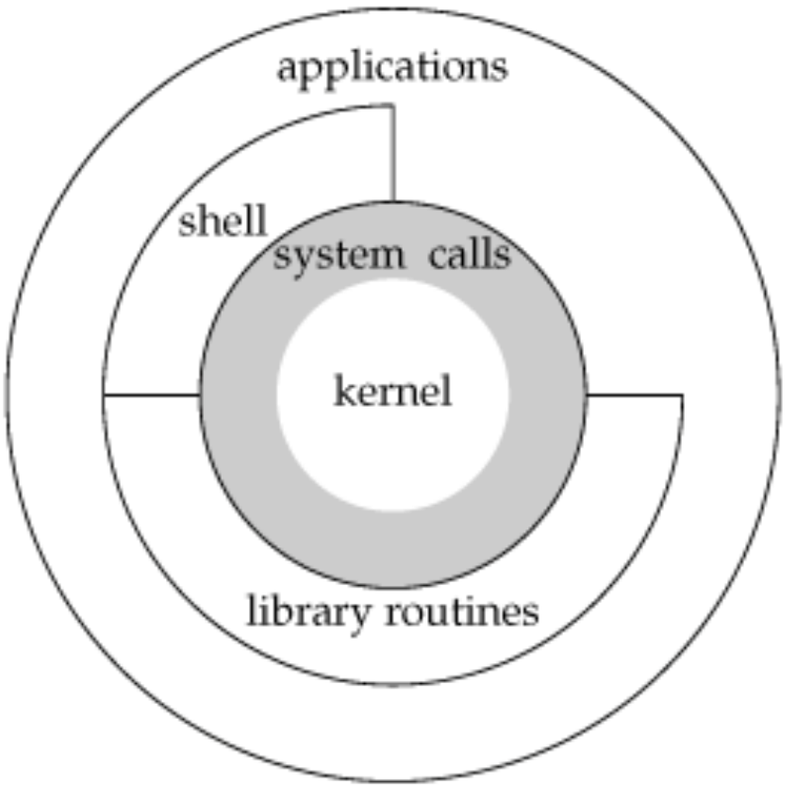
sudo apt update

sudo apt install build-essential

https://tecadmin.net/install-development-tools-on-ubuntu/

UNIX Architecture

Figure 1.1. Architecture of the UNIX operating system



Kernel: the software that controls the hardware resources of the computer and provides an environment under which programs can run

System call: the interface to the kernel is a layer of software

Libraries of common functions are built on top of the system call interface

Shell: A special application that provides an interface for running other applications

Logging In

- **`/etc/passwd`**
  - the login name, encrypted password, numeric user ID (205), numeric group ID (105), a comment field, home directory (/home/sar), and shell program (/bin/ksh).

```
sar:x:205:105:Stephen Rago:/home/sar:/bin/ksh
```

Shell

- The shell is the program that runs when you log in.
  - It prints the prompt and reads what you type, invokes programs, etc.
  - Your window to the Unix world

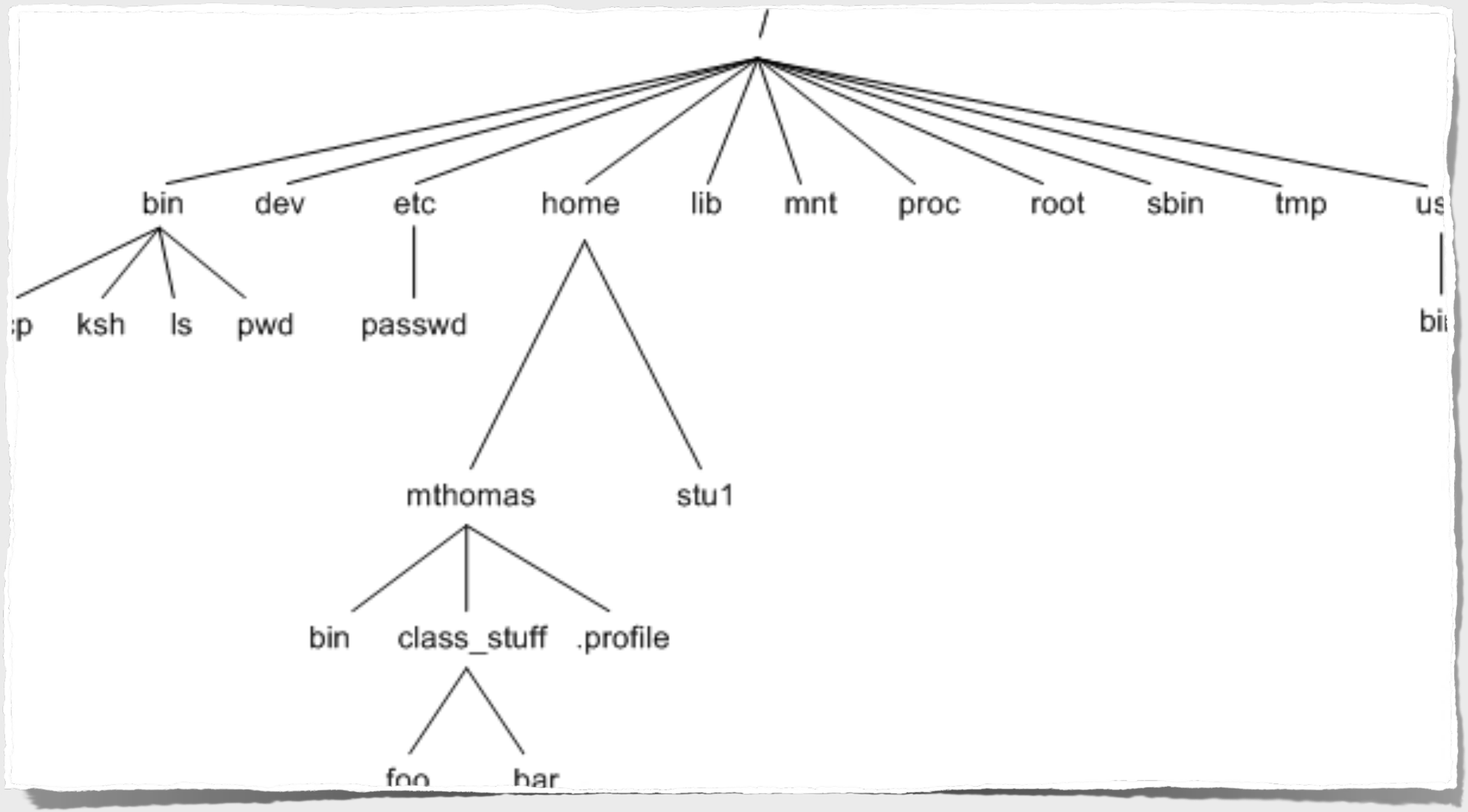
Figure 1.2. Common shells used on UNIX systems

Name	Path	FreeBSD 5.2.1	Linux 2.4.22	Mac OS X 10.3	Solaris 9
Bourne shell	/bin/sh	•	link to bash	link to bash	•
Bourne-again shell	/bin/bash	optional	•	•	•
C shell	/bin/csh	link to tcsh	link to tcsh	link to tcsh	•
Korn shell	/bin/ksh				•
TENEX C shell	/bin/tcsh	•	•	•	•

Files and Directories

- Filesystem
  - A hierarchical arrangement of directories and files – starting in root /
- File
  - No / or null char in filenames
  - Relative path: . and ..
  - BSD: 255-char filenames (14 in the past)

Files and Directories



Files and Directories

- Path name
  - Absolute path name
    - Start at the root / of the file system
      - /user/john/fileA
  - Relative path name
    - Start at the “current directory” which is an attribute of the process accessing the path name.
      - ./dirA/fileB

Basic Commands

- `ls`, `cd`, `mv`, `cp`, `mkdir`, `tar`, etc.
  - https://linux.vbird.org/linux_basic/redhat6.1/linux_06command.php

https://udn.com/news/story/7326/5622404

Basic Commands

Basic Commands

Basic Commands

Connections and users	

Basic Commands

Connections and users	
`whoami`	prints the ID of the current logged-in user

Basic Commands

Connections and users	
`whoami`	prints the ID of the current logged-in user
`who`	prints a list of other users who are logged

Basic Commands

Connections and users	
`whoami`	prints the ID of the current logged-in user
`who`	prints a list of other users who are logged
Directories	

Basic Commands

Connections and users	
`whoami`	prints the ID of the current logged-in user
`who`	prints a list of other users who are logged
Directories	
`pwd`	prints the full path of the current directory

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`rmdir filePath`	delete specified directory (or directories)

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`cmp filePath1 FilePath2`	like diff, but for binary files
`od filePath`	displays specified binary file in octal or hex

Basic Commands

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On-line Manual Pages	
`man cmd`	displays the on-line manual pages

Basic Commands

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Make a file compressed or uncompressed	

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`tar jcvf eilenamr.tar.bz2 targetfile`	compress file by bzip2

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Basic Commands

- A man page (short for manual page) is the software documentation for a computer program in a Unix, orUnix-like operating systems.
- To read a manual page for a Unix command, one can use
  - `man <command_name>`

Basic Commands

- Use man to check the information of C library
  - `man 3 printf`

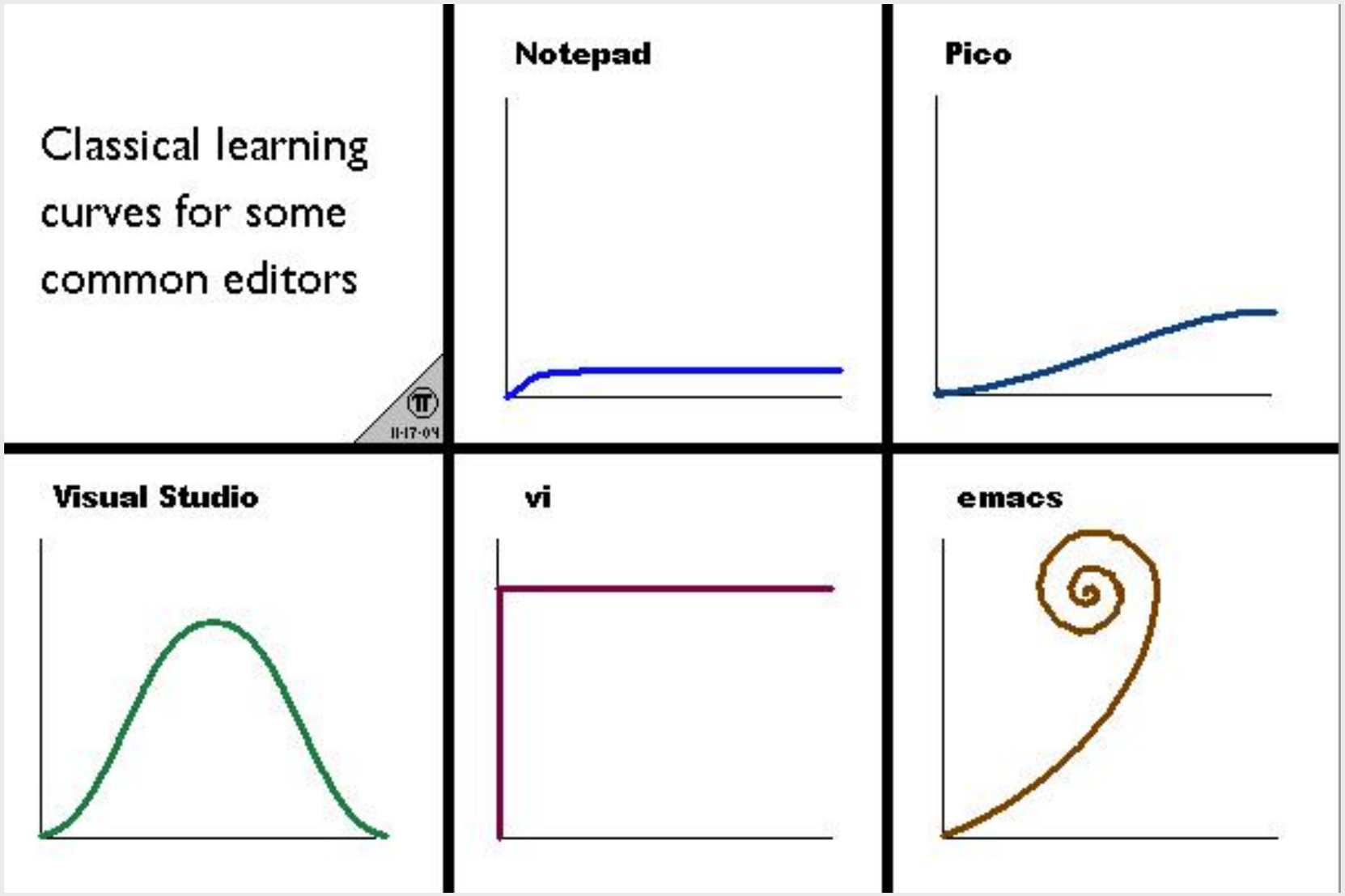
```
DESCRIPTION
       man is the system's manual pager. Each page argument given to man is normally the nam
       manual  page  associated with each of these arguments is then found and displayed. A
       only in that section of the manual.  The default action is to search in all of the av
       order and to show only the first page found, even if page exists in several sections.

       The table below shows the section numbers of the manual followed by the types of page

       1   Executable programs or shell commands
       2   System calls (functions provided by the kernel)
       3   Library calls (functions within program libraries)
       4   Special files (usually found in /dev)
       5   File formats and conventions eg /etc/passwd
       6   Games
       7   Miscellaneous (including macro packages and conventions), e.g. man(7), groff(7)
       8   System administration commands (usually only for root)
       9   Kernel routines [Non standard]
```

* Make you man page colorful: http://unstableme.blogspot.com/2009/01/colorful-man-pages-in-linux-ubuntu-tips.html

Utilities for Development

Editor: Vim

- Learning curves



Editor: Vim

- Two vivid introduction slides in course web site
  - Vim_Hacks.pdf
  - Vim_Hack_Your_Editor.pdf
- Resources
  - 追求神乎其技的程式設計之道
  - Vim As Your Editor on YouTuber
    - https://www.youtube.com/watch?v=X6AR2RMB5tE
  - Vim Tips Wiki
    - http://vim.wikia.com/wiki/Vim_Tips_Wiki
  - Best of Vim Tips
    - http://www.rayninfo.co.uk/vimtips.html

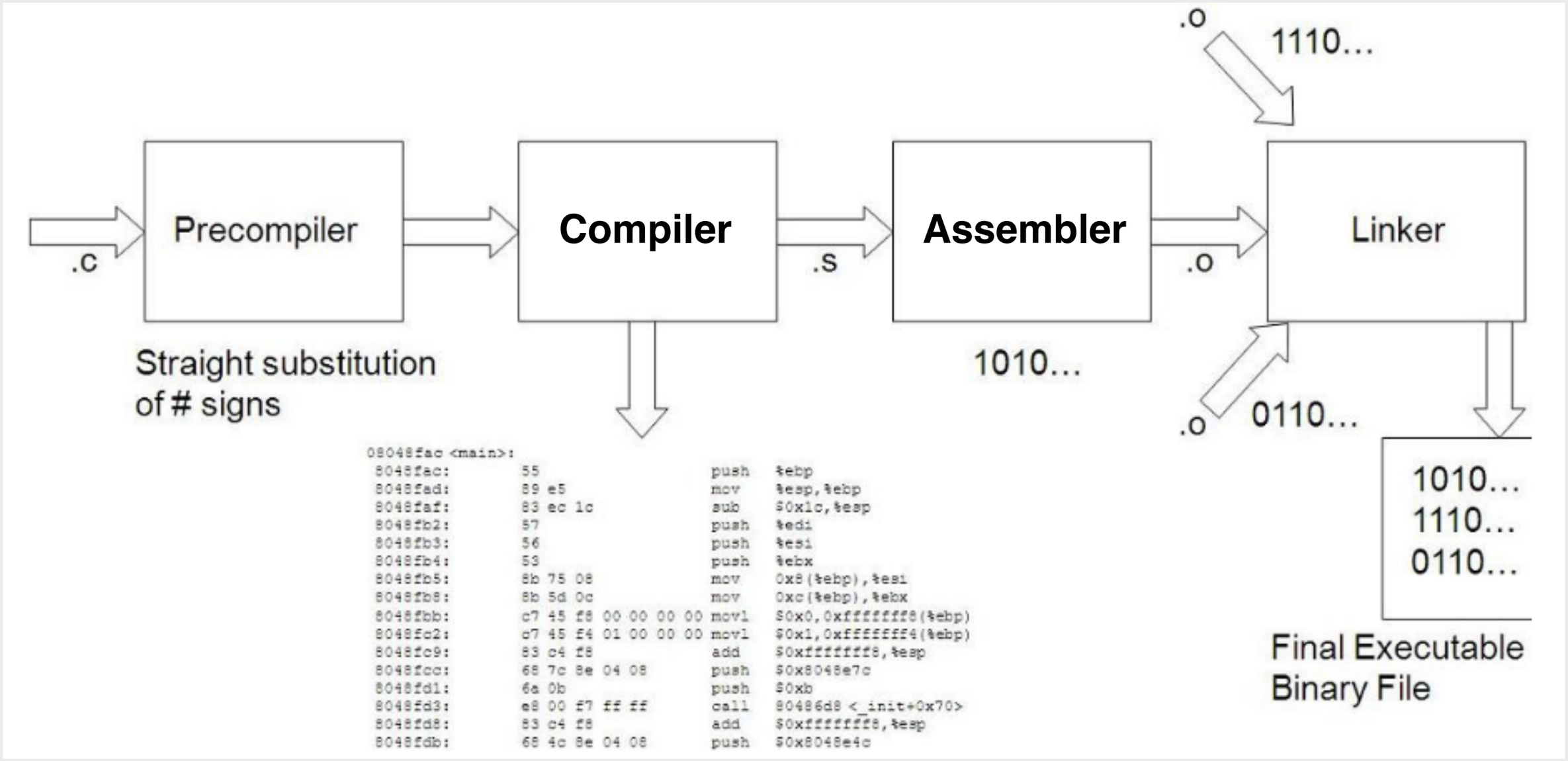
Compiler: gcc

- Command to compile a C program
  - **gcc -ansi -pedantic -Wall -Wextra -O2 -o main main.c**
- Options
  - **-ansi**: in C mode, support all ISO C90 programs
  - **-pedantic**: issue all the warnings demanded by strict ISO C
  - **-Wall**: enable all the warnings about constructions
  - **-Wextra:** print extra warning messages for several specific events
  - **-O2:** enable nearly all supported optimizations that do not involve a space-speed tradeoff (without loop unrolling or function inlining)
  - **-o**: outfile

Compiler: gcc

- Four stages to convert C code into an executable
  - **Pre-compiler:** processes .c files looking for #include, #define and other such macros and does text substitution etc.
  - **Assembler:** converts each .c file into an assembly language file with a .s extension
  - **Compiler:** coverts .s files into object (.o) files
  - **Linker:** combines the .o files and pulls in other compiled code from libraries (stdio, stdlib, string) that your program uses. It combines them to form a single binary executable file such as a.out or whatever you named it with the **-o** switch when you compiled.

Compiler: gcc




```
08048fac <main>:
 8048fac:       55                      push   %ebp
 8048fad:       89 e5                   mov    %esp,%ebp
 8048faf:       83 ec 1c                sub    $0x1c,%esp
 8048fb2:       57                      push   %edi
 8048fb3:       56                      push   %esi
 8048fb4:       53                      push   %ebx
 8048fb5:       8b 75 08                mov    0x8(%ebp),%esi
 8048fb8:       8b 5d 0c                mov    0xc(%ebp),%ebx
 8048fbb:       c7 45 f8 00 00 00 00    movl   $0x0,0xfffffff8(%ebp)
 8048fc2:       c7 45 f4 01 00 00 00    movl   $0x1,0xfffffff4(%ebp)
 8048fc9:       83 c4 f8                add    $0xfffffff8,%esp
 8048fcc:       68 7c 8e 04 08          push   $0x8048e7c
 8048fd1:       6a 0b                   push   $0xb
 8048fd3:       e8 00 f7 ff ff          call   80486d8 <_init+0x70>
 8048fd8:       83 c4 f8                add    $0xfffffff8,%esp
 8048fdb:       68 4c 8e 04 08          push   $0x8048e4c
```

Compiler: gcc

- Intermediate stage
  - **Assembler:** Compiling a .c file into a .s (assembly language) file by using the -S switch
  - **Object Files**
    - Produced by compilation but are typically deleted by the linker
    - The automatic destruction of the object file can be suppressed by suppressing the linker with the **-c** switch.

Compiler: gcc

- Example: **gccDemo/hello-1.c**
  - gcc **-S** -ansi -pedantic -W -Wall hello-1.c

```
LC2:
        .ascii "\12You entered %d for x and %d for y\12\0"
        .text
.globl _main
_main:
LFB14:
        pushq   %rbp
LCFI0:
        movq    %rsp, %rbp
LCFI1:
        subq    $16, %rsp
LCFI2:
        leaq    LC0(%rip), %rdi
        movl    $0, %eax
        call    _printf
        movq    ___stdoutp@GOTPCREL(%rip), %rax
        movq    (%rax), %rdi
        call    _fflush
        leaq    -8(%rbp), %rdx
        leaq    -4(%rbp), %rsi
        leaq    LC1(%rip), %rdi
        movl    $0, %eax
```

Compiler: gcc

- Example: **gccDemo/hello-1.c**
  - gcc **-c** -ansi -pedantic -W -Wall hello-1.c

```
^_^ mftsai@MBP [~/Classes/CPII_2011/02/codes] gcc -c -ansi -pedantic -W -Wall hello-1.c
^_^ mftsai@MBP [~/Classes/CPII_2011/02/codes] ls *.o
hello-1.o
^_^ mftsai@MBP [~/Classes/CPII_2011/02/codes]
```

Compiler: gcc

- For further information, please use
  - **man gcc**

Debugger: gdb

- gdb's common commands
  - **run**
  - **breakpoint** line_number
  - **print** variable
  - **set** variable
  - **next**
  - **step**
  - **whatis** variable

Debugger: gdb

- gdbDemo1: bugging.c

```c
#include <stdio.h>


int main() {
    char* string;
    /*char string [256];*/

    printf("Please input a string:");
    gets(string); /*use set variable string = "c" in cgdb to fix it!!*/
    printf("\nYour string is: %s\n", string);
}

```

Debugger: gdb

- How to de the bug
  - compile: **gcc -g -o bugging bugging.c**
  - load your program into gdb: **gdb bugging**
  - run the program: **run**
    - use “**list**” to lookup the nearby codes
    - use “**breakpoint**” to set breakpoints
    - use “**print**” to check the value of the variable of string
    - use “**r**” to rerun your program

Builder: Makefile

- Makefile
  - Specify how to derive the target program
  - Becomes a necessity when working with larger programs consisting of many source files and thousands of lines of code

Builder: Makefile (2)

- Variable Definitions

```
CFLAGS = -pedantic -Wall
SRCS = main.c file1.c file2.c
CC = gcc
```

- Dependency Rules

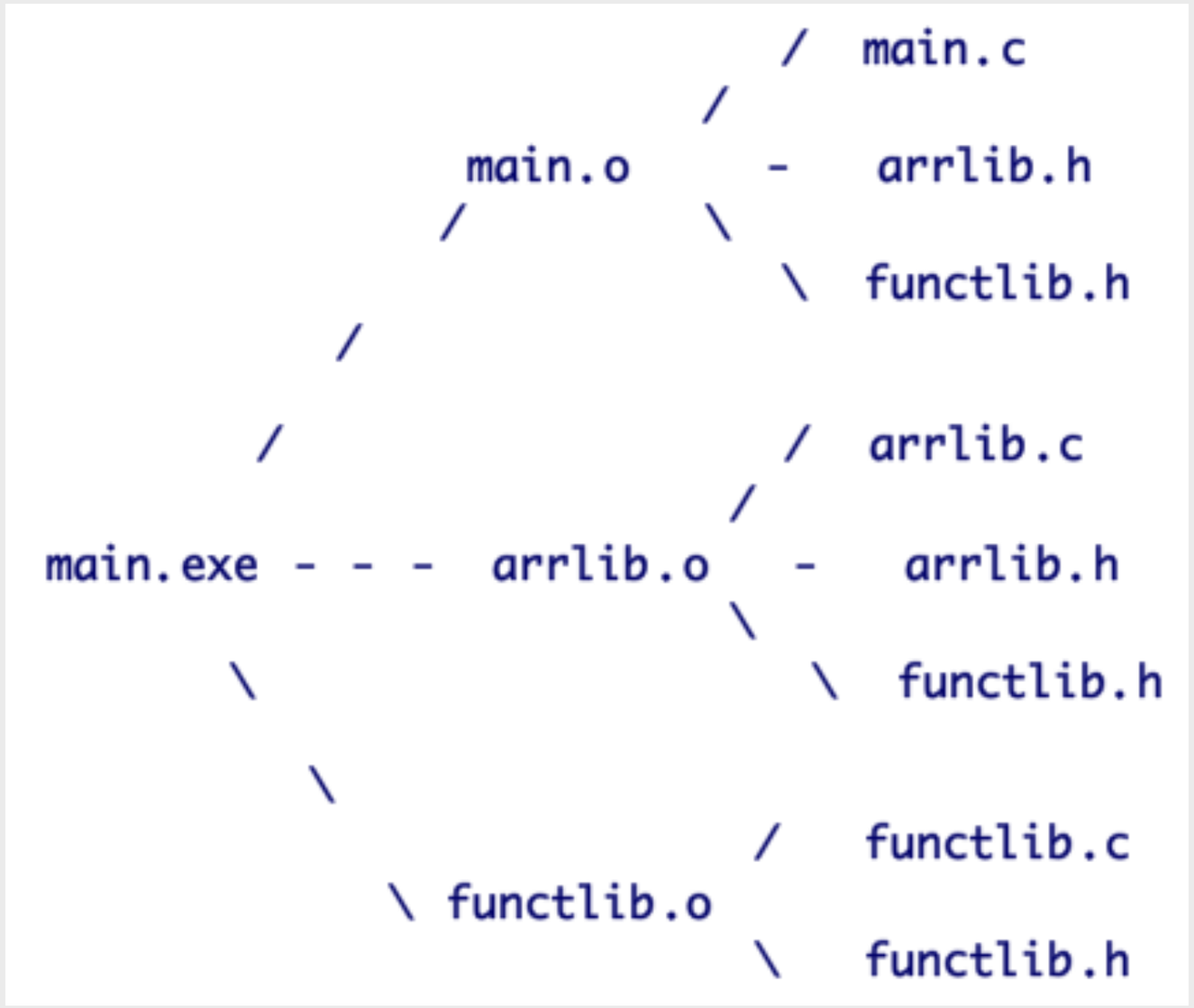
```
target: [dependencies]
    <command>
    <command 2>
    ...
```

```
main.o: main.c
    $(CC) $(CFLAGS) -c main.c
clean:
    rm *.o
```

  - Comments: Any line beginning with a "#" sign, or any line that contains only white-space.

Builder: Makefile (3)

- Example: makeDemo



Builder: Makefile (4)

```
$
$ ls
Demo.c    Makefile~   arrlib.c  functlib.c  functlib.h~
Makefile  Makefile~~  arrlib.h  functlib.h
$ make
gcc -ansi -pedantic -W -Wall   -c main.c
gcc -ansi -pedantic -W -Wall   -c arrlib.c
gcc -ansi -pedantic -W -Wall   -c functlib.c
gcc -ansi -pedantic -W -Wall   -o main.exe main.o arrlib.o functlib.o
```

```
$ emacs functlib.h
$ make
gcc -ansi -pedantic -W -Wall  -c main.c
gcc -ansi -pedantic -W -Wall  -c arrlib.c
gcc -ansi -pedantic -W -Wall  -c functlib.c
gcc -ansi -pedantic -W -Wall  -o main.exe main.o arrlib.o functlib.o
```

```
$ emacs arrlib.h
$ make
gcc -ansi -pedantic -W -Wall   -c main.c
gcc -ansi -pedantic -W -Wall   -c arrlib.c
gcc -ansi -pedantic -W -Wall   -o main.exe main.o arrlib.o functlib.o
$
```

Builder: Makefile (4)

- Resources
  - Makefiles
    - http://www.cprogramming.com/tutorial/makefiles.html
  - Learn Makefiles with the tastiest examples
    - https://makefiletutorial.com

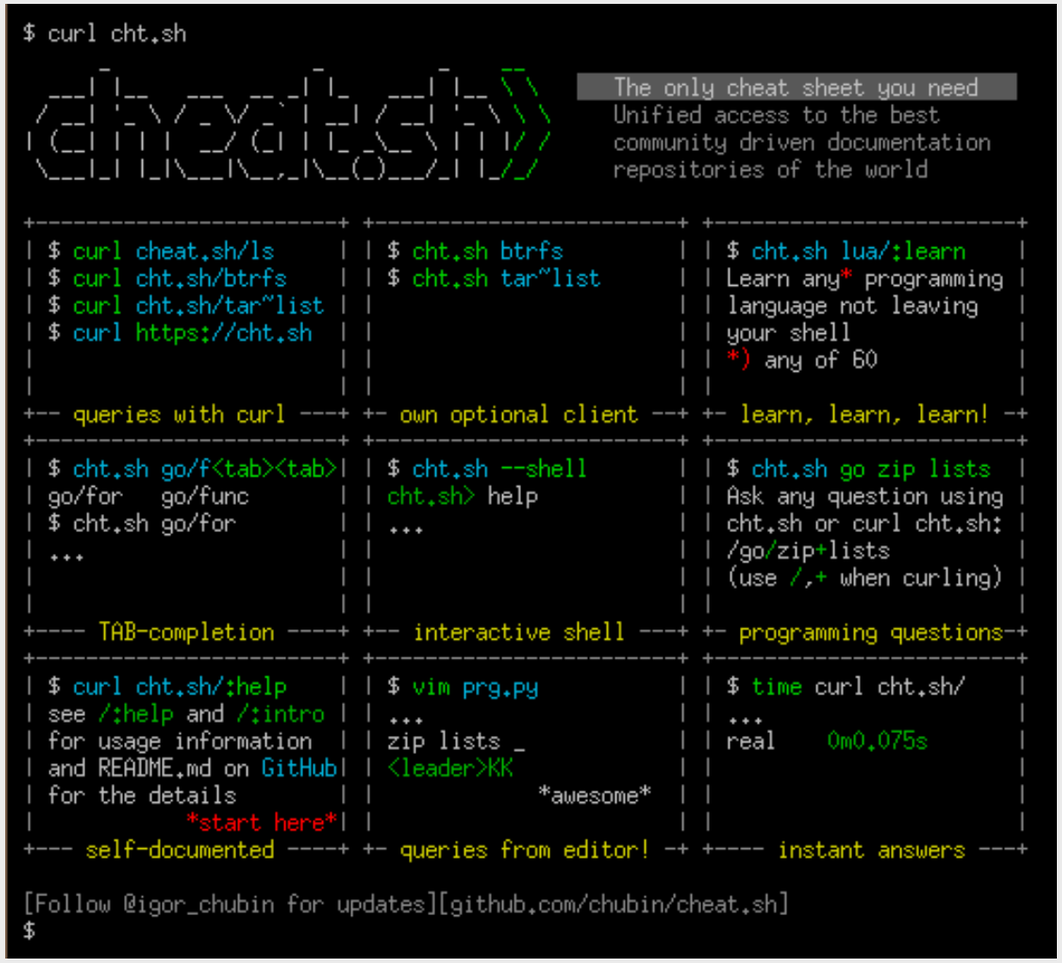
Git - Version Control

- Git (https://git-scm.com)
  - A widely used source code management system for software development.
  - It was initially designed and developed in 2005 by Linux kernel developers (including Linus Torvalds) for Linux kernel development.
- GitHub (http://github.com/)
  - A web-based Git repository hosting service.
- Vivid Tutorials
  - https://try.github.io/
  - https://www.atlassian.com/git/tutorials/

Unix Tips

- too long; didn't read (tldr)
  - Simplified and community-driven man pages
  - https://tldr.sh/
  - https://github.com/tldr-pages/tldr

Unix Tips



- cheat.sh
  - The only cheat sheet you need
  - https://github.com/chubin/cheat.sh