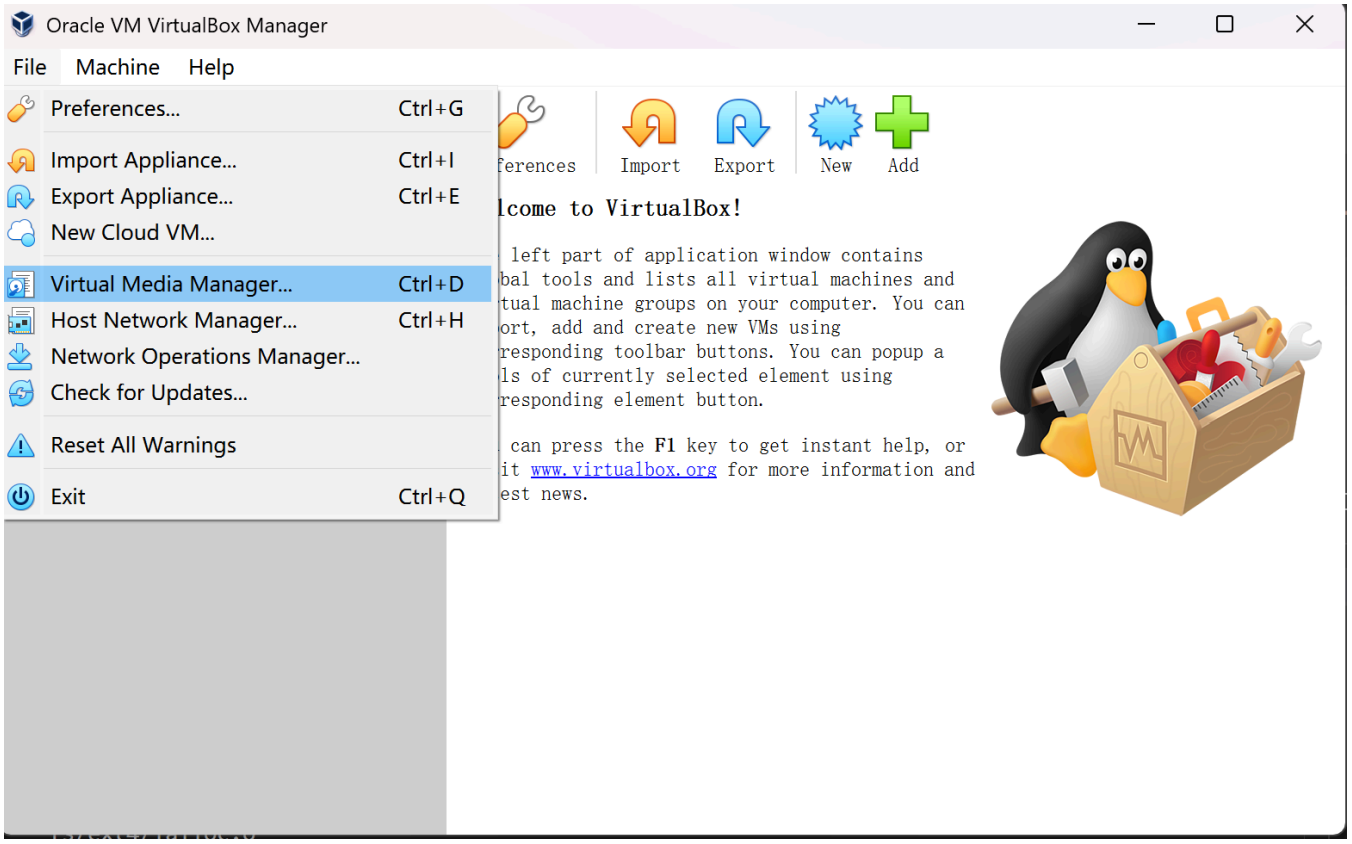
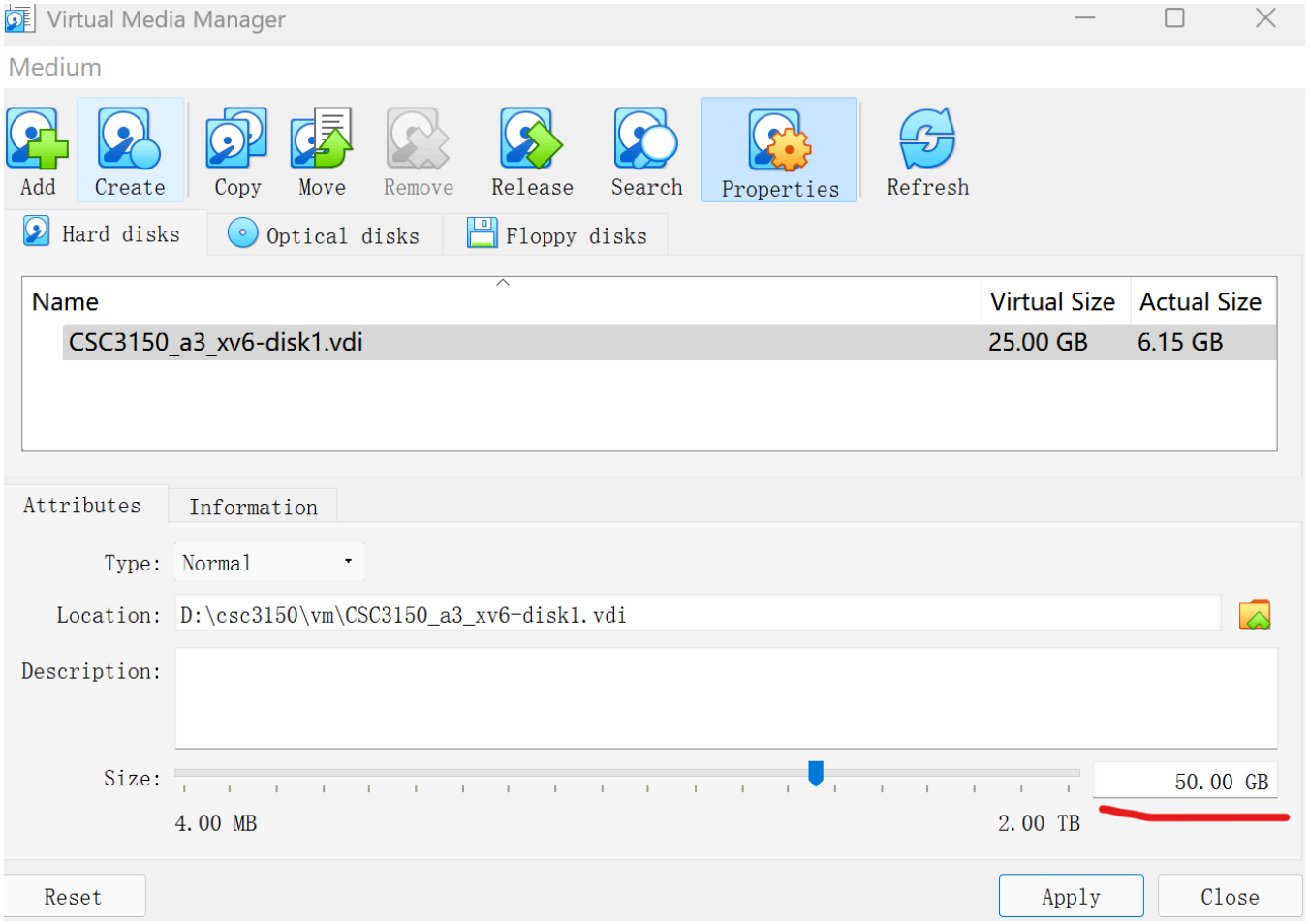
How to Extend virtual Disk

For students using the Ubuntu 20.04 image provided by us, since the first experiment involves compiling the kernel and requires 40-50G of space, and the current image does not have enough space, an expansion is necessary. The specific method is as follows:

Select virtual Media Manager.



Change the size of `csc3150_a3_xv6_disk1.vdi` to **50GB or above**



Open VM and change to superuser by command `sudo su`.

Use `df -h` to check the disk capacity information.

```
csc3150@csc3150:~$ sudo su
[sudo] password for csc3150:
root@csc3150:/home/csc3150# df -h
Filesystem                         Size  Used Avail Use% Mounted on
udev                               1.9G     0  1.9G   0% /dev
tmpfs                              392M  1.0M  391M   1% /run
/dev/mapper/ubuntu--vg-ubuntu--lv   12G  6.5G  4.2G  61% /
tmpfs                              2.0G     0  2.0G   0% /dev/shm
tmpfs                              5.0M     0  5.0M   0% /run/lock
tmpfs                              2.0G     0  2.0G   0% /sys/fs/cgroup
/dev/loop0                          50M   50M     0 100% /snap/snapd/18357
/dev/sda2                          2.0G  209M  1.6G  12% /boot
/dev/loop1                          41M   41M     0 100% /snap/snapd/20290
/dev/loop2                          64M   64M     0 100% /snap/core20/1828
/dev/loop3                          92M   92M     0 100% /snap/lxd/24061
tmpfs                              392M     0  392M   0% /run/user/1000
```

We can see "/dev/mapper/ubuntu--vg-ubuntu--lv" is mounted on '/' path and only have 12G.

The other disk space has not been allocated.

Next, we can use `lsblk` to see the block information.

```
root@csc3150:/home/csc3150# lsblk
NAME                      MAJ:MIN RM  SIZE RO TYPE MOUNTPOINT
loop0                       7:0    0 49.9M  1 loop /snap/snapd/18357
loop1                       7:1    0 40.9M  1 loop /snap/snapd/20290
loop2                       7:2    0 63.3M  1 loop /snap/core20/1828
loop3                       7:3    0 91.9M  1 loop /snap/lxd/24061
sda                         8:0    0   50G  0 disk
├─sda1                      8:1    0    1M  0 part
├─sda2                      8:2    0    2G  0 part /boot
└─sda3                      8:3    0   23G  0 part
  └─ubuntu--vg-ubuntu--lv 253:0    0 11.5G  0 lvm  /
```

We use `fdisk` to manage the partitions.

We deleted and recreated sda3, so all the remaining space was allocated to sda3.

```
root@csc3150:/home/csc3150# fdisk /dev/sda

Welcome to fdisk (util-linux 2.34).
Changes will remain in memory only, until you decide to write them.
Be careful before using the write command.


Command (m for help): d
Partition number (1-3, default 3): 3

Partition 3 has been deleted.

Command (m for help): n
Partition number (3-128, default 3): 3
First sector (4198400-104857566, default 4198400):
Last sector, +/-sectors or +/-size{K,M,G,T,P} (4198400-104857566, default 104857566):

Created a new partition 3 of type 'Linux filesystem' and of size 48 GiB.
Partition #3 contains a LVM2_member signature.

Do you want to remove the signature? [Y]es/[N]o: n
```

Change the type of sda3 to 'lvm' and then write back.

```
Command (m for help): t
Partition number (1-3, default 3): 3
Partition type (type L to list all types): L
  1 EFI System                     C12A7328-F81F-11D2-BA4B-00A0C93EC93B
  2 MBR partition scheme           024DEE41-33E7-11D3-9D69-0008C781F39F
  3 Intel Fast Flash               D3BFE2DE-3DAF-11DF-BA40-E3A556D89593
  4 BIOS boot                      21686148-6449-6E6F-744E-656564454649
  5 Sony boot partition            F4019732-066E-4E12-8273-346C5641494F
  6 Lenovo boot partition          BFBFAFE7-A34F-448A-9A5B-6213EB736C22
  7 PowerPC PReP boot              9E1A2D38-C612-4316-AA26-8B49521E5A8B
  8 ONIE boot                      7412F7D5-A156-4B13-81DC-867174929325
  9 ONIE config                    D4E6E2CD-4469-46F3-B5CB-1BFF57AFC149
 10 Microsoft reserved             E3C9E316-0B5C-4DB8-817D-F92DF00215AE
 11 Microsoft basic data           EBD0A0A2-B9E5-4433-87C0-68B6B72699C7
 12 Microsoft LDM metadata         5808C8AA-7E8F-42E0-85D2-E1E90434CFB3
 13 Microsoft LDM data             AF9B60A0-1431-4F62-BC68-3311714A69AD
 14 Windows recovery environment   DE94BBA4-06D1-4D40-A16A-BFD50179D6AC
 15 IBM General Parallel Fs        37AFFC90-EF7D-4E96-91C3-2D7AE055B174
 16 Microsoft Storage Spaces       E75CAF8F-F680-4CEE-AFA3-B001E56EFC2D
 17 HP-UX data                     75894C1E-3AEB-11D3-B7C1-7B03A0000000
 18 HP-UX service                  E2A1E728-32E3-11D6-A682-7B03A0000000
 19 Linux swap                     0657FD6D-A4AB-43C4-84E5-0933C84B4F4F
 20 Linux filesystem               0FC63DAF-8483-4772-8E79-3D69D8477DE4
 21 Linux server data              3B8F8425-20E0-4F3B-907F-1A25A76F98E8
 22 Linux root (x86)               44479540-F297-41B2-9AF7-D131D5F0458A
 23 Linux root (ARM)               69DAD710-2CE4-4E3C-B16C-21A1D49ABED3
 24 Linux root (x86-64)            4F68BCE3-E8CD-4DB1-96E7-FBCAF984B709
 25 Linux root (ARM-64)            B921B045-1DF0-41C3-AF44-4C6F280D3FAE
 26 Linux root  (IA-64)             993D8D3D-F80E-4225-855A-9DAF8ED7EA97
 27 Linux reserved                 8DA63339-0007-60C0-C436-083AC8230908
 28 Linux home                     933AC7E1-2EB4-4F13-B844-0E14E2AEF915
 29 Linux RAID                     A19D880F-05FC-4D3B-A006-743F0F84911E
 30 Linux extended boot            BC13C2FF-59E6-4262-A352-B275FD6F7172
 31 Linux LVM                      E6D6D379-F507-44C2-A23C-238F2A3DF928
 32 FreeBSD data                   516E7CB4-6ECF-11D6-8FF8-00022D09712B
 33 FreeBSD boot                   83BD6B9D-7F41-11DC-BE0B-001560B84F0F
 34 FreeBSD swap                   516E7CB5-6ECF-11D6-8FF8-00022D09712B
 35 FreeBSD UFS                    516E7CB6-6ECF-11D6-8FF8-00022D09712B
 36 FreeBSD ZFS                    516E7CBA-6ECF-11D6-8FF8-00022D09712B
 37 FreeBSD Vinum                  516E7CB8-6ECF-11D6-8FF8-00022D09712B
 38 Apple HFS/HFS+                 48465300-0000-11AA-AA11-00306543ECAC
 39 Apple UFS                      55465300-0000-11AA-AA11-00306543ECAC
```

```
Partition type (type L to list all types): 31

Changed type of partition 'Linux filesystem' to 'Linux LVM'.

Command (m for help): w
The partition table has been altered.
Syncing disks.
```

Resize the physical volume "/dev/sda3".

```
root@csc3150:/home/csc3150# pvresize /dev/sda3
  Physical volume "/dev/sda3" changed
  1 physical volume(s) resized or updated / 0 physical volume(s) not resized
root@csc3150:/home/csc3150# pvdisplay
  --- Physical volume ---
  PV Name               /dev/sda3
  VG Name               ubuntu-vg
  PV Size               <48.00 GiB / not usable 16.50 KiB
  Allocatable           yes
  PE Size               4.00 MiB
  Total PE              12287
  Free PE               9344
  Allocated PE          2943
  PV UUID               KCLmK3-8ndO-YRGU-xjIf-i93n-desP-6I7M1d
```

Extend logical volume "/dev/mapper/ubuntu--vg-ubuntu--lv".

`lvextend -l +100%FREE /dev/mapper/ubuntu--vg-ubuntu--lv` allocate all free space to "/dev/mapper/ubuntu--vg-ubuntu--lv".

```
root@csc3150:/home/csc3150# vgdisplay
  --- Volume group ---
  VG Name               ubuntu-vg
  System ID
  Format                lvm2
  Metadata Areas        1
  Metadata Sequence No  3
  VG Access             read/write
  VG Status             resizable
  MAX LV                0
  Cur LV                1
  Open LV               1
  Max PV                0
  Cur PV                1
  Act PV                1
  VG Size               <48.00 GiB
  PE Size               4.00 MiB
  Total PE              12287
  Alloc PE / Size       2943 / <11.50 GiB
  Free  PE / Size       9344 / 36.50 GiB
  VG UUID               xVekZB-3lml-kHco-bJro-XJdS-1aCK-Xctti6
root@csc3150:/home/csc3150# lvextend -l +100%FREE /dev/mapper/ubuntu--vg-ubuntu--lv
  Size of logical volume ubuntu-vg/ubuntu-lv changed from <11.50 GiB (2943 extents) to
<48.00 GiB (12287 extents).
  Logical volume ubuntu-vg/ubuntu-lv successfully resized.
```

Resize the file system.

Use `df -h` to check the change, we can see the size of "/dev/mapper/ubuntu--vg-ubuntu--lv" change to 48G. This indicates that we have successfully expanded the disk space.

```
root@csc3150:/home/csc3150# resize2fs /dev/mapper/ubuntu--vg-ubuntu--lv
resize2fs 1.45.5 (07-Jan-2020)
Filesystem at /dev/mapper/ubuntu--vg-ubuntu--lv is mounted on /; on-line resizing required
old_desc_blocks = 2, new_desc_blocks = 6
The filesystem on /dev/mapper/ubuntu--vg-ubuntu--lv is now 12581888 (4k) blocks long.

root@csc3150:/home/csc3150# df -h
Filesystem                         Size  Used Avail Use% Mounted on
udev                               1.9G     0  1.9G   0% /dev
tmpfs                              392M  1.1M  391M   1% /run
/dev/mapper/ubuntu--vg-ubuntu--lv   48G  6.6G   39G  15% /
tmpfs                              2.0G     0  2.0G   0% /dev/shm
tmpfs                              5.0M     0  5.0M   0% /run/lock
tmpfs                              2.0G     0  2.0G   0% /sys/fs/cgroup
/dev/sda2                          2.0G  209M  1.6G  12% /boot
/dev/loop1                          41M   41M     0 100% /snap/snapd/20290
/dev/loop2                          64M   64M     0 100% /snap/core20/1828
/dev/loop3                          92M   92M     0 100% /snap/lxd/24061
tmpfs                              392M     0  392M   0% /run/user/1000
/dev/loop4                          51M   51M     0 100% /snap/snapd/25202
```