

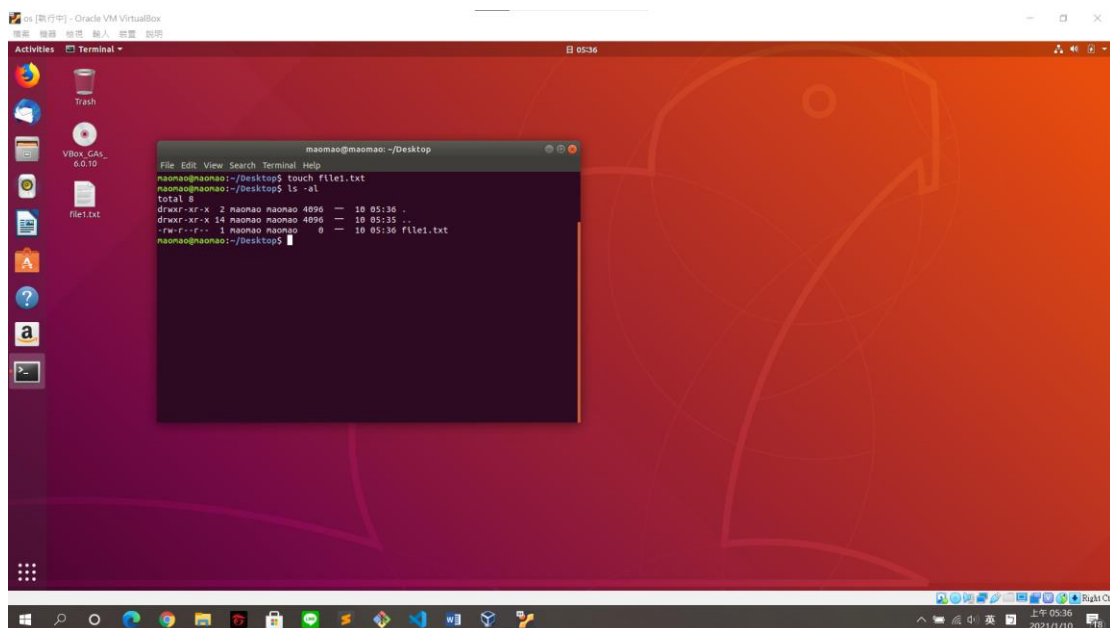
HW3 File system

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Task1 - Soft Link and Hard Link

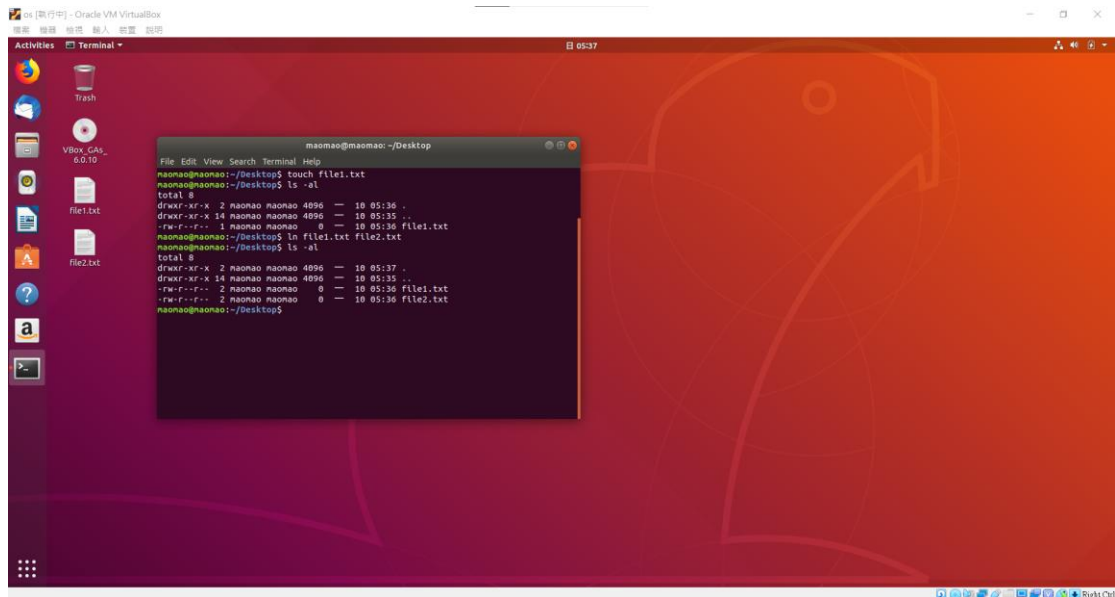
1. Create a text file as file1.txt

```
$ touch file1.txt
```



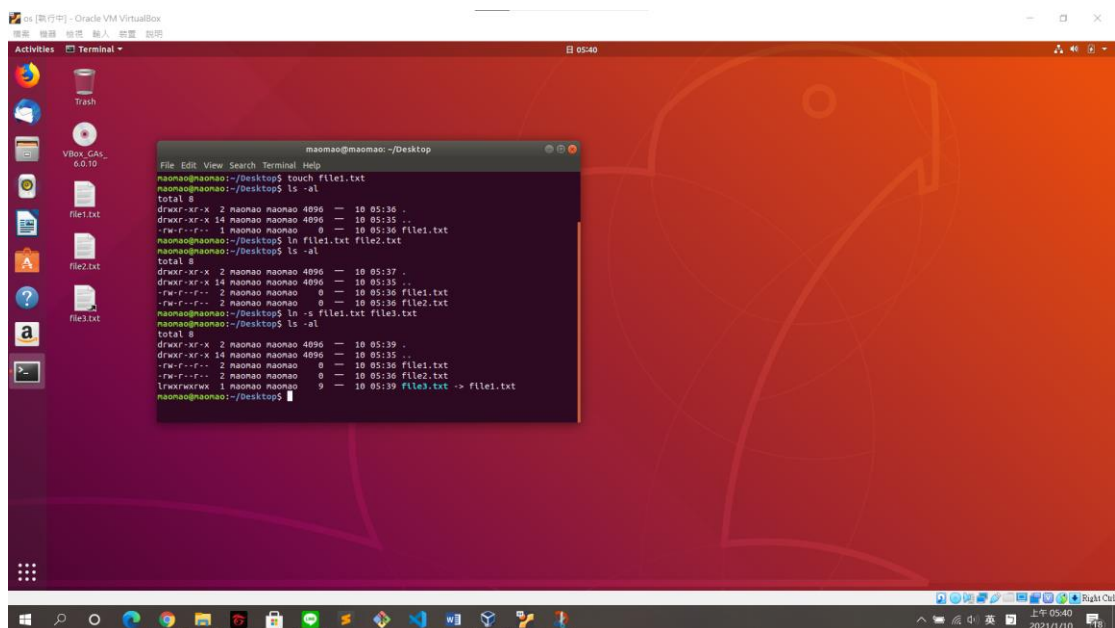
2. Create a hard link from file1.txt to file2.txt

```
$ ln file1.txt file2.txt
```



3. Create a soft link from file1.txt to file3.txt

\$ ln -s file1.txt file3.txt



What are the inode values of each file?

\$ ls -li file1.txt file2.txt file3.txt

```
maomao@maomao:~/Desktop
maomao@maomao:~/Desktop$ cd Desktop/
maomao@maomao:~/Desktop$ clear
maomao@maomao:~/Desktop$ touch file1.txt
maomao@maomao:~/Desktop$ ls -al
total 8
drwxr-xr-x 2 maomao maomao 4096 10 05:36 .
drwxr-xr-x 14 maomao maomao 4096 10 05:35 ..
-rw-r--r-- 1 maomao maomao 0 10 05:36 file1.txt
maomao@maomao:~/Desktop$ ln file1.txt file2.txt
maomao@maomao:~/Desktop$ ls -al
total 8
drwxr-xr-x 2 maomao maomao 4096 10 05:37 .
drwxr-xr-x 14 maomao maomao 4096 10 05:35 ..
-rw-r--r-- 2 maomao maomao 0 10 05:36 file1.txt
-rw-r--r-- 2 maomao maomao 0 10 05:36 file2.txt
maomao@maomao:~/Desktop$ ln -s file1.txt file3.txt
maomao@maomao:~/Desktop$ ls -al
total 8
drwxr-xr-x 2 maomao maomao 4096 10 05:39 .
drwxr-xr-x 14 maomao maomao 4096 10 05:35 ..
-rw-r--r-- 2 maomao maomao 0 10 05:36 file1.txt
-rw-r--r-- 2 maomao maomao 0 10 05:36 file2.txt
lrwxrwxrwx 1 maomao maomao 9 10 05:39 file3.txt -> file1.txt
maomao@maomao:~/Desktop$ ls -li file1.txt file2.txt file3.txt
268833 -rw-r--r-- 2 maomao maomao 0 10 05:36 file1.txt
268833 -rw-r--r-- 2 maomao maomao 0 10 05:36 file2.txt
278108 lrwxrwxrwx 1 maomao maomao 9 10 05:39 file3.txt -> file1.txt
maomao@maomao:~/Desktop$ vim file1.txt
maomao@maomao:~/Desktop$ cat file1.txt
os hw3 0610098
maomao@maomao:~/Desktop$ cat file2.txt
os hw3 0610098
maomao@maomao:~/Desktop$ cat file3.txt
os hw3 0610098
maomao@maomao:~/Desktop$
```

The inode of **hard link** (file2.txt) is 268833, which is same as the file(file1.txt).

The inode of **soft link** (file3.txt) is 278108, which is different from the file(file1.txt).

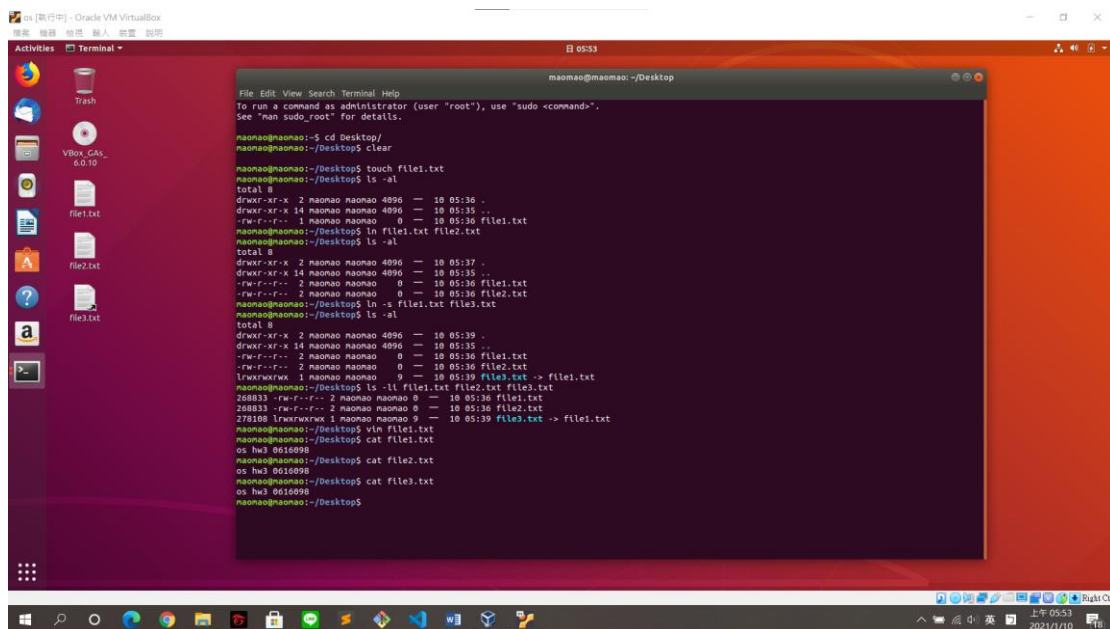
Do they have the same content?

```
maomao@maomao:~/Desktop
maomao@maomao:~/Desktop$ cd Desktop/
maomao@maomao:~/Desktop$ clear
maomao@maomao:~/Desktop$ touch file1.txt
maomao@maomao:~/Desktop$ ls -al
total 8
drwxr-xr-x 2 maomao maomao 4096 10 05:36 .
drwxr-xr-x 14 maomao maomao 4096 10 05:35 ..
-rw-r--r-- 1 maomao maomao 0 10 05:36 file1.txt
maomao@maomao:~/Desktop$ ln file1.txt file2.txt
maomao@maomao:~/Desktop$ ls -al
total 8
drwxr-xr-x 2 maomao maomao 4096 10 05:37 .
drwxr-xr-x 14 maomao maomao 4096 10 05:35 ..
-rw-r--r-- 2 maomao maomao 0 10 05:36 file1.txt
-rw-r--r-- 2 maomao maomao 0 10 05:36 file2.txt
maomao@maomao:~/Desktop$ ln -s file1.txt file3.txt
maomao@maomao:~/Desktop$ ls -al
total 8
drwxr-xr-x 2 maomao maomao 4096 10 05:39 .
drwxr-xr-x 14 maomao maomao 4096 10 05:35 ..
-rw-r--r-- 2 maomao maomao 0 10 05:36 file1.txt
-rw-r--r-- 2 maomao maomao 0 10 05:36 file2.txt
lrwxrwxrwx 1 maomao maomao 9 10 05:39 file3.txt -> file1.txt
maomao@maomao:~/Desktop$ ls -li file1.txt file2.txt file3.txt
268833 -rw-r--r-- 2 maomao maomao 0 10 05:36 file1.txt
268833 -rw-r--r-- 2 maomao maomao 0 10 05:36 file2.txt
278108 lrwxrwxrwx 1 maomao maomao 9 10 05:39 file3.txt -> file1.txt
maomao@maomao:~/Desktop$ vim file1.txt
maomao@maomao:~/Desktop$ cat file1.txt
os hw3 0610098
maomao@maomao:~/Desktop$ cat file2.txt
os hw3 0610098
maomao@maomao:~/Desktop$ cat file3.txt
os hw3 0610098
maomao@maomao:~/Desktop$
```

inode
permission
links
size

The attribute of **hard link** (file2.txt) is same as the file(file1.txt), e.g., Inode, permission, # links, size. And it is a file not a link.

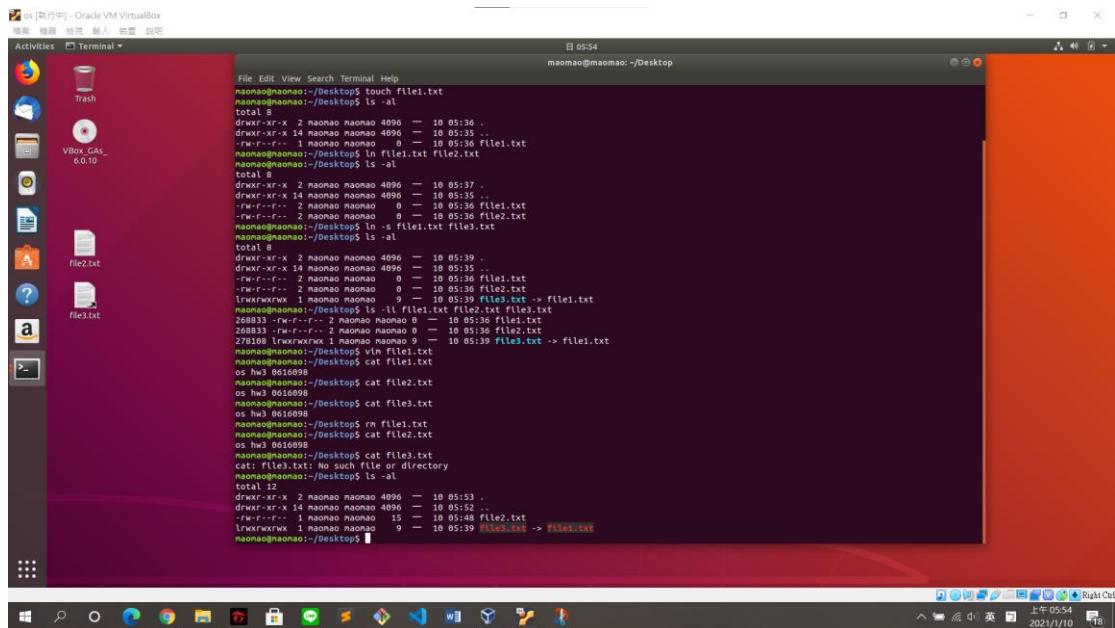
The attribute of **soft link** (file3.txt) is different from the file(file1.txt), e.g., Inode, permission, # links, size. And it is a link not a file.



```
maomao@maomao:~/Desktop$ cd Desktop/
maomao@maomao:~/Desktop$ clear
maomao@maomao:~/Desktop$ touch file1.txt
maomao@maomao:~/Desktop$ ls -al
total 0
drwxr-xr-x 2 maomao maomao 4096 -- 10 05:36 .
drwxr-xr-x 14 maomao maomao 4096 -- 10 05:35 ..
-rw-r--r-- 1 maomao maomao 0 -- 10 05:36 file1.txt
maomao@maomao:~/Desktop$ ln file1.txt file2.txt
maomao@maomao:~/Desktop$ ls -al
total 0
drwxr-xr-x 2 maomao maomao 4096 -- 10 05:37 .
drwxr-xr-x 14 maomao maomao 4096 -- 10 05:35 ..
-rw-r--r-- 2 maomao maomao 0 -- 10 05:36 file1.txt
-rw-r--r-- 2 maomao maomao 0 -- 10 05:36 file2.txt
maomao@maomao:~/Desktop$ ln -s file1.txt file3.txt
maomao@maomao:~/Desktop$ ls -al
total 0
drwxr-xr-x 2 maomao maomao 4096 -- 10 05:39 .
drwxr-xr-x 14 maomao maomao 4096 -- 10 05:35 ..
-rw-r--r-- 2 maomao maomao 0 -- 10 05:36 file1.txt
-rw-r--r-- 2 maomao maomao 0 -- 10 05:36 file2.txt
lrwxrwxrwx 1 maomao maomao 9 -- 10 05:39 file3.txt -> file1.txt
maomao@maomao:~/Desktop$ ls -all file1.txt file2.txt file3.txt
-rw-r--r-- 2 maomao maomao 0 -- 10 05:36 file1.txt
-rw-r--r-- 2 maomao maomao 0 -- 10 05:36 file2.txt
-rw-r--r-- 2 maomao maomao 0 -- 10 05:36 file3.txt
maomao@maomao:~/Desktop$ vim file1.txt
maomao@maomao:~/Desktop$ cat file1.txt
os hw3 0610098
maomao@maomao:~/Desktop$ cat file2.txt
os hw3 0610098
maomao@maomao:~/Desktop$ cat file3.txt
os hw3 0610098
maomao@maomao:~/Desktop$
```

The content of **hard link** (file2.txt) is same as the file(file1.txt).

The content of **soft link** (file3.txt) is same as the file(file1.txt).



```
maomao@maomao: ~/Desktop
File Edit View Search Terminal Help
maomao@maomao:~/Desktop$ touch file1.txt
maomao@maomao:~/Desktop$ ls -al
total 8
drwxr-xr-x 2 maomao maomao 4096 -- 10 05:30 .
drwxr-xr-x 14 maomao maomao 4096 -- 10 05:35 ..
-rw-r--r-- 1 maomao maomao 0 -- 10 05:36 file1.txt
maomao@maomao:~/Desktop$ ln file1.txt file2.txt
maomao@maomao:~/Desktop$ ls -al
total 8
drwxr-xr-x 2 maomao maomao 4096 -- 10 05:37 .
drwxr-xr-x 14 maomao maomao 4096 -- 10 05:35 ..
-rw-r--r-- 2 maomao maomao 0 -- 10 05:36 file1.txt
-rw-r--r-- 2 maomao maomao 0 -- 10 05:36 file2.txt
maomao@maomao:~/Desktop$ ln -s file1.txt file3.txt
maomao@maomao:~/Desktop$ ls -al
total 8
drwxr-xr-x 2 maomao maomao 4096 -- 10 05:39 .
drwxr-xr-x 14 maomao maomao 4096 -- 10 05:35 ..
-rw-r--r-- 2 maomao maomao 0 -- 10 05:36 file1.txt
-rw-r--r-- 2 maomao maomao 0 -- 10 05:36 file2.txt
lrwxrwxrwx 1 maomao maomao 9 -- 10 05:39 file3.txt -> file1.txt
maomao@maomao:~/Desktop$ ls -ll file1.txt file2.txt file3.txt
-rw-r--r-- 2 maomao maomao 0 -- 10 05:36 file1.txt
-rw-r--r-- 2 maomao maomao 0 -- 10 05:36 file2.txt
-rw-r--r-- 2 maomao maomao 0 -- 10 05:36 file3.txt
maomao@maomao:~/Desktop$ rm file1.txt
maomao@maomao:~/Desktop$ cat file2.txt
cat: file2.txt: No such file or directory
maomao@maomao:~/Desktop$ cat file3.txt
cat: file3.txt: No such file or directory
maomao@maomao:~/Desktop$ ls -al
total 12
drwxr-xr-x 2 maomao maomao 4096 -- 10 05:53 .
drwxr-xr-x 14 maomao maomao 4096 -- 10 05:52 ..
-rw-r--r-- 1 maomao maomao 15 -- 10 05:48 file2.txt
lrwxrwxrwx 1 maomao maomao 9 -- 10 05:39 file3.txt -> file1.txt
maomao@maomao:~/Desktop$
```

When removing the file (file1.txt):

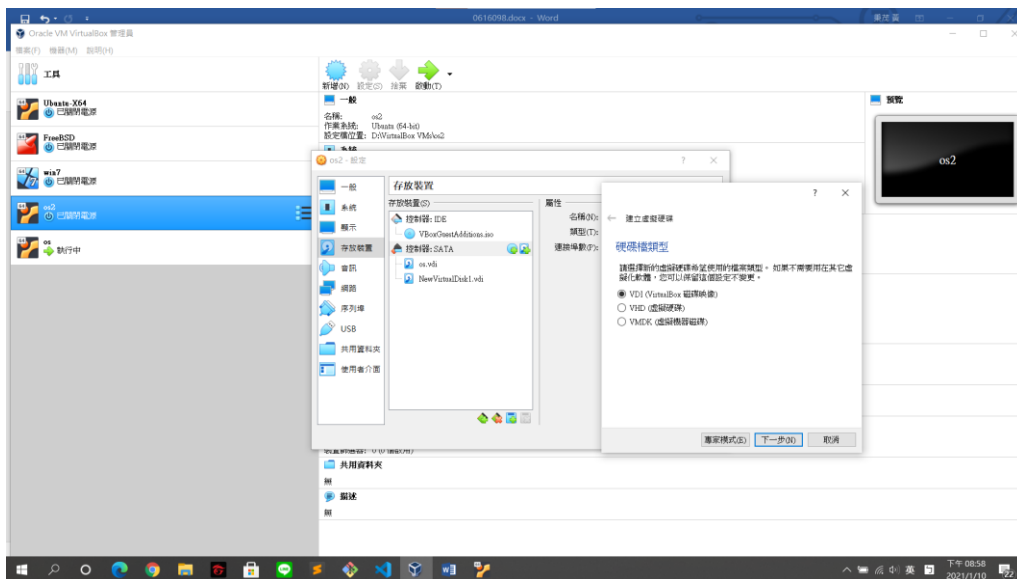
hard link (file2.txt) still exists, and the content doesn't changed.

soft link (file3.txt) is also removed.

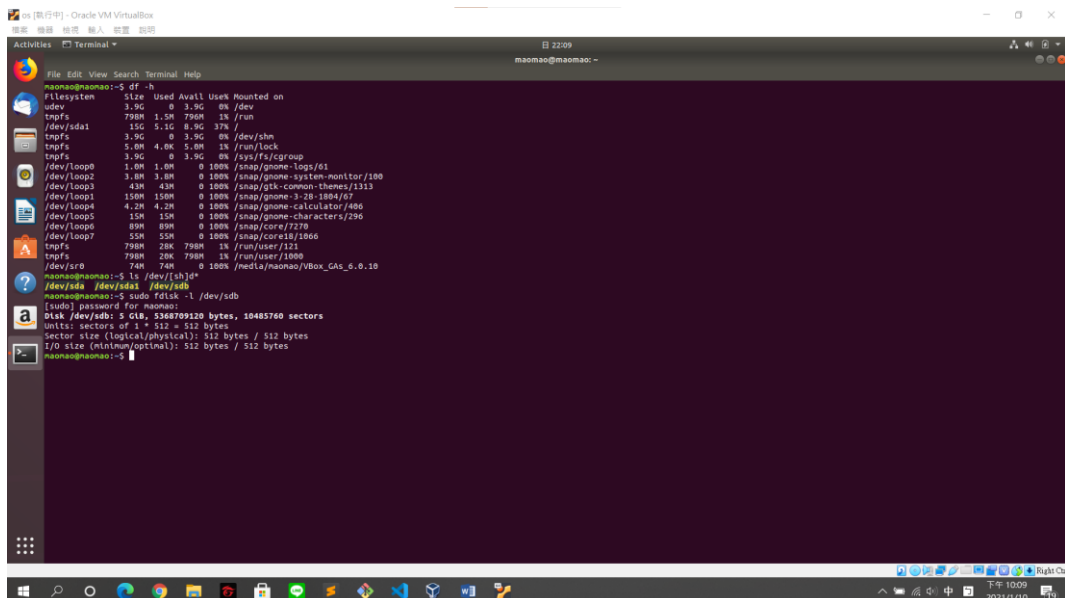
Task2 - Creating and mounting file system

1. Use the fdisk command to add a new 500MB logical partition to your hard drive.

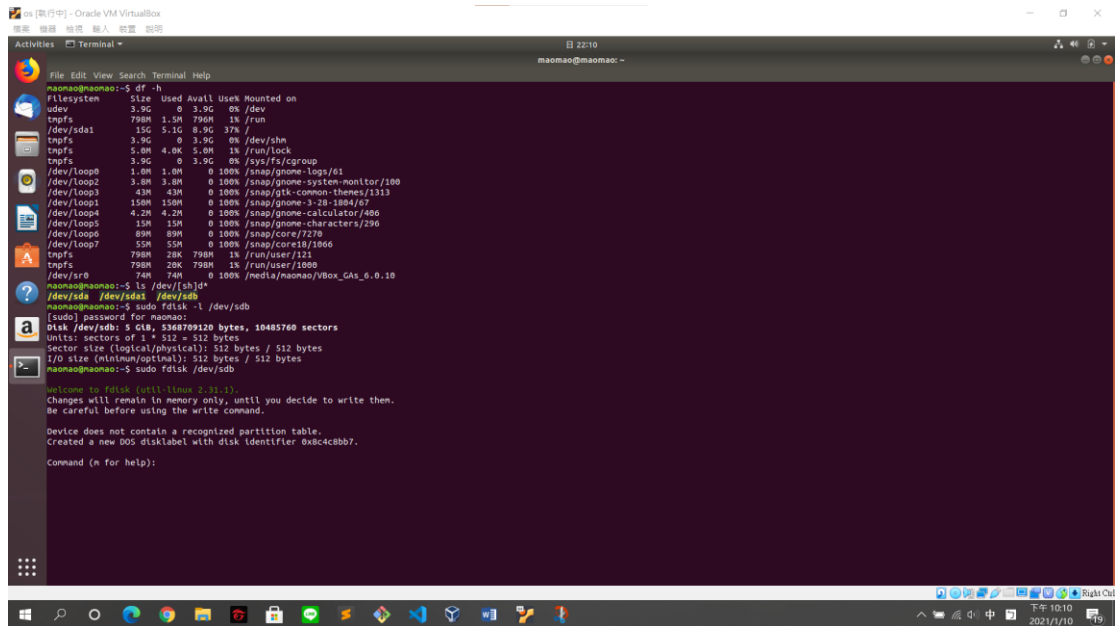
先新增虛擬硬碟以做實驗



preceding operation



\$ sudo fdisk /dev/sdb



```
maomao@maomao:~$ df -h
Filesystem      Size  Used Avail Use% Mounted on
udev            3.9G     0  3.9G   0% /dev
tmpfs           790M   1.5M  790M   1% /run
/dev/sda1       15G   5.1G   9.9G  37% /
tmpfs           3.9G     0  3.9G   0% /dev/shm
tmpfs           5.0M   4.0K   5.0M   1% /run/lock
tmpfs           3.9G     0  3.9G   0% /sys/fs/cgroup
/dev/loop0      1.0M   1.0M   0 100% /snap/gnome-logs/61
/dev/loop2     3.8M   3.8M   0 100% /snap/gnome-system-monitor/100
/dev/loop3     43M   43M   0 100% /snap/gtk-common-themes/1313
/dev/loop1     150M  150M   0 100% /snap/gnome-3-28-1804/67
/dev/loop4     4.2M   4.2M   0 100% /snap/gnome-calculator/486
/dev/loop5     15M   15M   0 100% /snap/gnome-characters/296
/dev/loop6     89M   89M   0 100% /snap/core/7270
/dev/loop7     55M   55M   0 100% /snap/core18/1866
tmpfs          790M   28K  790M   1% /run/user/121
tmpfs          790M   28K  790M   1% /run/user/1000
/dev/sr0        74M   74M   0 100% /media/maomao/VBox_CAs_6.0.18

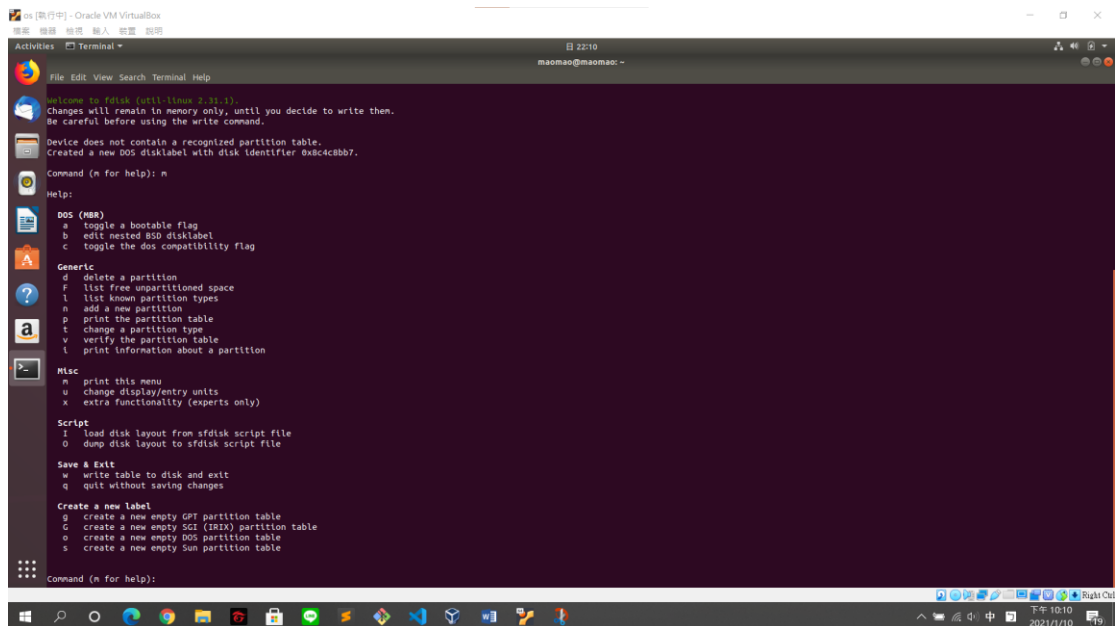
maomao@maomao:~$ ls /dev/shd*
/dev/sda /dev/sda1 /dev/sdb

maomao@maomao:~$ sudo fdisk -l /dev/sdb
[sudo] password for maomao:
Disk /dev/sdb: 5 GiB, 5368709120 bytes, 10485760 sectors
Units: sectors of 1 * 512 = 512 bytes
Sector size (logical/physical): 512 bytes / 512 bytes
I/O size (minimum/optimal): 512 bytes / 512 bytes
maomao@maomao:~$ sudo fdisk /dev/sdb

Welcome to fdisk (util-linux 2.41.1).
Changes will remain in memory only, until you decide to write them.
Be careful before using the write command.

Device does not contain a recognized partition table.
Created a new DOS disklabel with disk identifier 0x8c4cbb7.

Command (m for help):
```



```
Help:
DOS (MBR)
a toggle a bootable flag
b edit nested BIOS disklabel
c toggle the dos compatibility flag

Generic
d delete a partition
f list free unpartitioned space
l list known partition types
n add a new partition
p print the partition table
t change a partition type
v verify the partition table
l print information about a partition

Misc
m print this menu
u change display/entry units
x extra functionality (experts only)

Script
i load disk layout from sfdisk script file
o dump disk layout to sfdisk script file

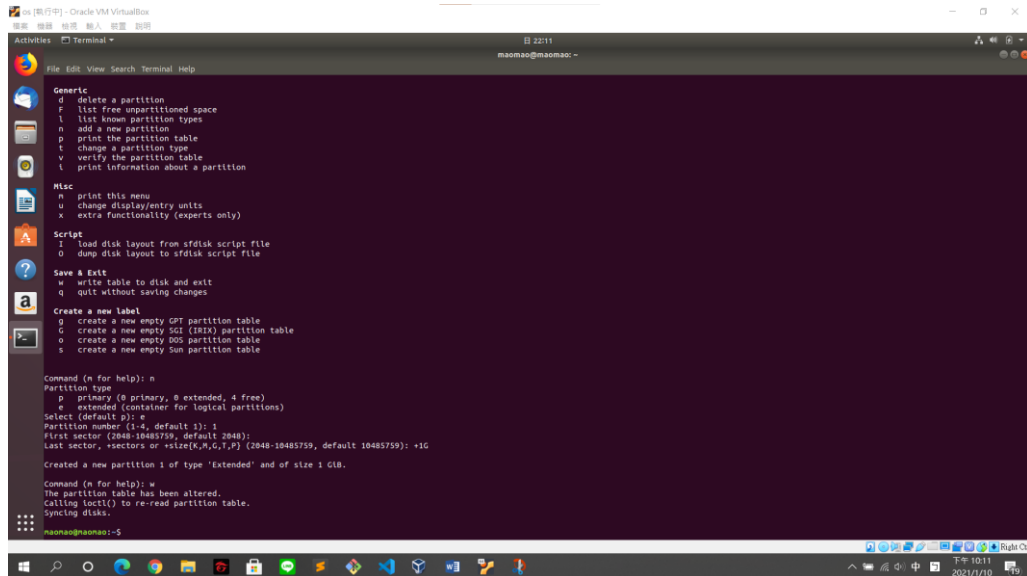
Save & Exit
w write table to disk and exit
q quit without saving changes

Create a new label
g create a new empty GPT partition table
G create a new empty GPT (MBR) partition table
o create a new empty DOS partition table
s create a new empty Sun partition table

Command (m for help):
```

Create extended partition first, which is the container for logical partitions

n -> e -> 1 -> "enter" -> +1G (must more than 500MB) -> w



```
Generic
d delete a partition
l list free unpartitioned space
l list known partition types
n add a new partition
p print the partition table
t change a partition type
v verify the partition table
l print information about a partition

Misc
m print this menu
u change display/entry units
x extra functionality (experts only)

Script
i load disk layout from sfdisk script file
o dump disk layout to sfdisk script file

Save & Exit
w write table to disk and exit
q quit without saving changes

Create a new label
o create a new empty GPT partition table
G create a new empty SGI (IBIX) partition table
o create a new empty DOS partition table
s create a new empty Sun partition table

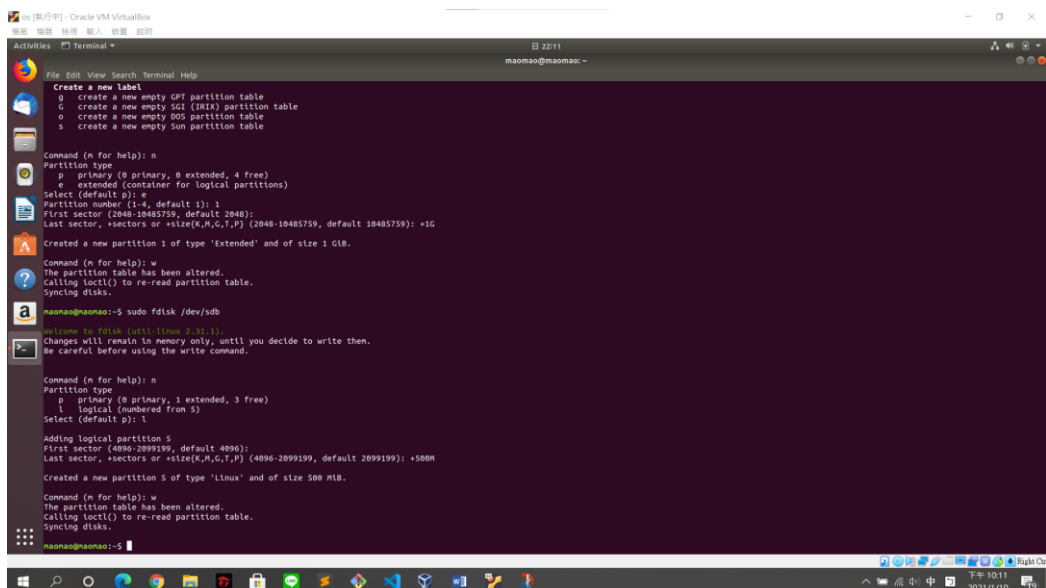
Command (n for help): n
Partition type
  p primary (0 primary, 0 extended, 4 free)
  e extended (container for logical partitions)
Select (default p): e
Partition number (1-4, default 1): 1
First sector (2048-10485759, default 2048):
Last sector, +sectors or +size(K,M,G,T,P) (2048-10485759, default 10485759): +1G
Created a new partition 1 of type 'Extended' and of size 1 GiB.

Command (n for help): w
The partition table has been altered.
Calling ioctl() to re-read partition table.
Syncing disks.
maomao@maomao:~$
```

\$ sudo fdisk /dev/sdb

Create logical partition

n -> l -> "enter" -> +500M -> w



```
Create a new label
o create a new empty GPT partition table
G create a new empty SGI (IBIX) partition table
o create a new empty DOS partition table
s create a new empty Sun partition table

Command (n for help): n
Partition type
  p primary (0 primary, 0 extended, 4 free)
  e extended (container for logical partitions)
Select (default p): e
Partition number (1-4, default 1): 1
First sector (2048-10485759, default 2048):
Last sector, +sectors or +size(K,M,G,T,P) (2048-10485759, default 10485759): +1G
Created a new partition 1 of type 'Extended' and of size 1 GiB.

Command (n for help): w
The partition table has been altered.
Calling ioctl() to re-read partition table.
Syncing disks.
maomao@maomao:~$ sudo fdisk /dev/sdb

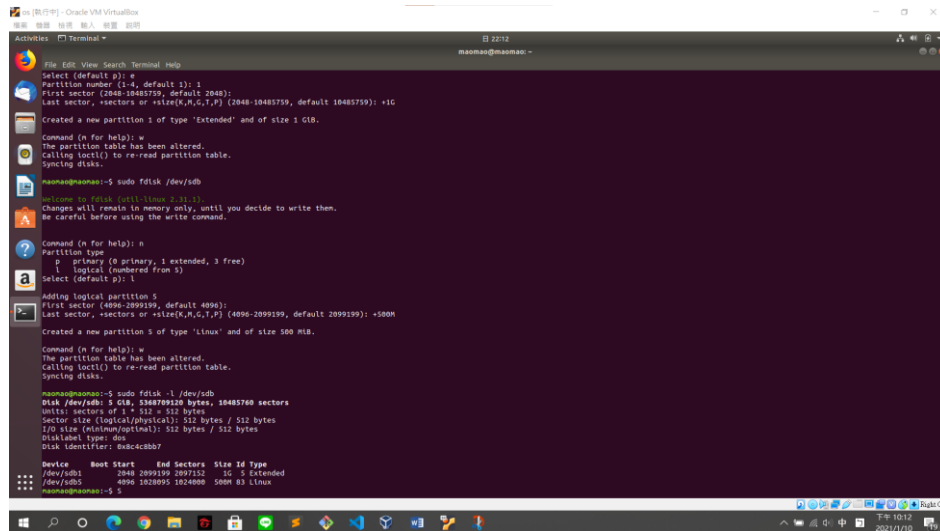
Welcome to fdisk (util-linux 2.31.1).
Changes will remain in memory only, until you decide to write them.
Be careful before using the write command.

Command (n for help): n
Partition type
  p primary (0 primary, 1 extended, 3 free)
  l logical (numbered from 5)
Select (default p): l
Adding logical partition 5
First sector (4096-2099199, default 4096):
Last sector, +sectors or +size(K,M,G,T,P) (4096-2099199, default 2099199): +500M
Created a new partition 5 of type 'Linux' and of size 500 MiB.

Command (n for help): w
The partition table has been altered.
Calling ioctl() to re-read partition table.
Syncing disks.
maomao@maomao:~$
```


2. Use the `fdisk -l` command to verify that the new partition has been created.

```
$ sudo fdisk -l /dev/sdb
```



```
maomao@maomao:~$ sudo fdisk -l /dev/sdb
Welcome to fdisk (util-linux 2.31.1).
Changes will remain in memory only, until you decide to write them.
Be careful before using the write command.

Command (n for help): n
Partition type:
  p primary (0 primary, 1 extended, 3 free)
  l logical (numbered from 5)
Select (default p): l
Adding logical partition 5
First sector (4096-2099199, default 4096):
Last sector, +sectors or +size(K,M,G,T,P) (4096-2099199, default 2099199): +500M
Created a new partition 5 of type 'Linux' and of size 500 MiB.

Command (n for help): w
The partition table has been altered.
Calling ioctl() to re-read partition table.
Syncing disks.

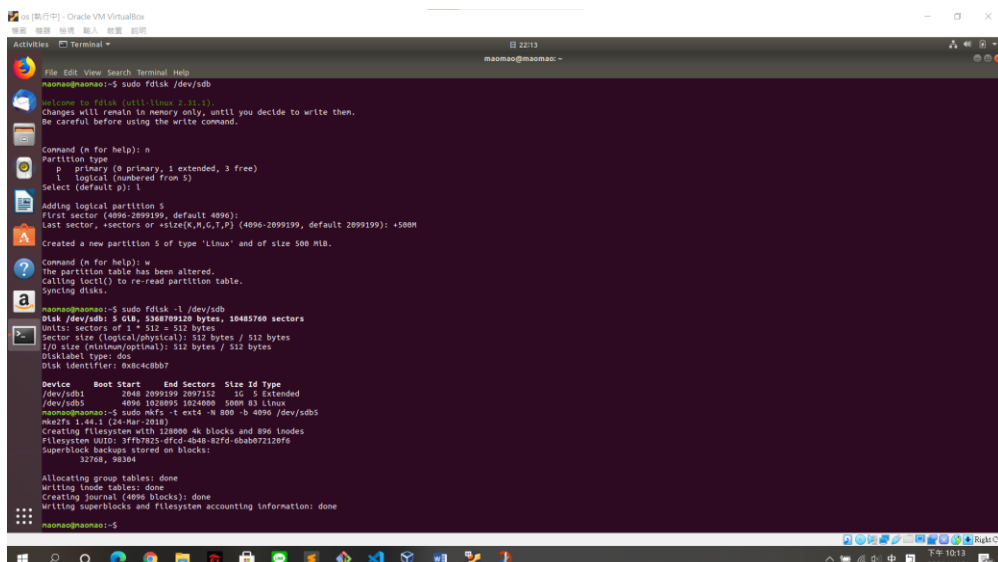
maomao@maomao:~$ sudo fdisk -l /dev/sdb
Disk /dev/sdb: 5 GiB, 5368709120 bytes, 10485760 sectors
Units: sectors of 1 * 512 = 512 bytes
Sector size (logical/physical): 512 bytes / 512 bytes
I/O size (minimum/optimal): 512 bytes / 512 bytes
Disklabel type: dos
Disk identifier: 0x8c4c8b07

Device      Boot Start      End Sectors Size Id Type
/dev/sdb1   2048 2099199 2097152 1G  1  Extended
/dev/sdb5   4096 1028095 1024000 500M  83  Linux

maomao@maomao:~$
```

3. Format this partition with an ext4 file system that contains 800 inodes and block size is 4096 bytes.

```
$ sudo mkfs -t ext4 -N 800 -b 4096 /dev/sdb5
```

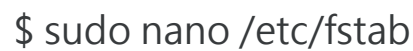


```
maomao@maomao:~$ sudo mkfs -t ext4 -N 800 -b 4096 /dev/sdb5
Creating filesystem with 128000 4k blocks and 800 inodes
filesystem UUID: 3f87822c-efcd-4b48-82f6-d8ab67213d96
Superblock backups stored on blocks:
    32768, 92384

Allocating group tables: done
Writing inode tables: done
Creating journal (4096 blocks): done
Writing superblocks and filesystem accounting information: done

maomao@maomao:~$
```

```
$ sudo blkid (check UUID)
```



```
os [运行中] - Oracle VM VirtualBox
maomao@maomao: ~
File Edit View Search Terminal Help
Disk /dev/sdb: 5 GB, 5368709120 bytes, 10485760 sectors
Units: sectors of 1 * 512 = 512 bytes
Sector size (logical/physical): 512 bytes / 512 bytes
I/O size (minimum/optimal): 512 bytes / 512 bytes
Disklabel type: dos
Disk identifier: 0x8c4c8bb7

Device      Boot Start      End Sectors Size Id Type
/dev/sdb1   2048 2099199 2097152 1G 5 Extended
/dev/sdb5   4096 1028095 1024000 500M 83 Linux
maomao@maomao:~$ sudo mkfs -t ext4 -N 800 -b 4096 /dev/sdb5
mkfs 1.44.1 (24-Mar-2018)
Creating filesystem with 128000 4k blocks and 896 inodes
Filesystem UUID: 3ffb7825-dfcd-4b48-82fd-6bab072128f6
Superblock backups stored on blocks:
    32768, 98304

Allocating group tables: done
Writing inode tables: done
Creating journal (4096 blocks): done
Writing superblocks and filesystem accounting information: done

maomao@maomao:~$ sudo blkid
/dev/loop0: TYPE="squashfs"
/dev/loop1: TYPE="squashfs"
/dev/loop2: TYPE="squashfs"
/dev/loop3: TYPE="squashfs"
/dev/loop4: TYPE="squashfs"
/dev/loop5: TYPE="squashfs"
/dev/loop6: TYPE="squashfs"
/dev/loop7: TYPE="squashfs"
/dev/sr0: UUID="2019-07-12-09-13-14-35" LABEL="VBox_GAs_6.0.10" TYPE="iso9660"
/dev/sda1: UUID="781a78c9-6a57-4ace-8c88-519ccba4c4e" TYPE="ext4" PARTUUID="adc7b47d-01"
/dev/sdb1: UUID="3ffb7825-dfcd-4b48-82fd-6bab072128f6" TYPE="ext4" PARTUUID="8c4c8bb7-05"
maomao@maomao:~$ sudo nano /etc/fstab
maomao@maomao:~$ cat /etc/fstab
#
# /etc/fstab: static file system information.
#
# Use 'blkid' to print the universally unique identifier for a
# device; this may be used with UUID= as a more robust way to name devices
# that works even if disks are added and removed. See fstab(5).
#
# <file system> <mount point> <type> <options> <dump> <pass>
# / was on /dev/sda1 during installation
UUID=781a78c9-6a57-4ace-8c88-519ccba4c4e / ext4 errors=remount-ro 0 1
# /dev/sdb1 during installation
UUID=3ffb7825-dfcd-4b48-82fd-6bab072128f6 /mnt/os_hws ext4 defaults 0 0
/swapfile none swap sw 0 0
maomao@maomao:~$
```

And then, reboot

```
os [运行中] - Oracle VM VirtualBox
maomao@maomao: ~
File Edit View Search Terminal Help
Disk /dev/sdb: 5 GB, 5368709120 bytes, 10485760 sectors
Units: sectors of 1 * 512 = 512 bytes
Sector size (logical/physical): 512 bytes / 512 bytes
I/O size (minimum/optimal): 512 bytes / 512 bytes
Disklabel type: dos
Disk identifier: 0x8c4c8bb7

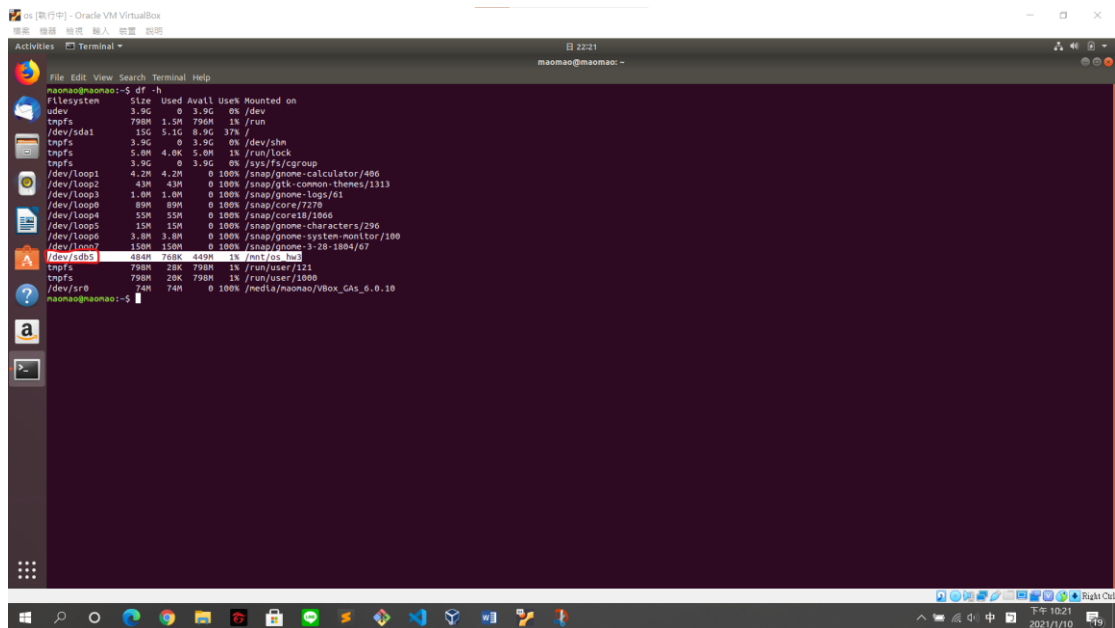
Device      Boot Start      End Sectors Size Id Type
/dev/sdb1   2048 2099199 2097152 1G 5 Extended
/dev/sdb5   4096 1028095 1024000 500M 83 Linux
maomao@maomao:~$ sudo mkfs -t ext4 -N 800 -b 4096 /dev/sdb5
mkfs 1.44.1 (24-Mar-2018)
Creating filesystem with 128000 4k blocks and 896 inodes
Filesystem UUID: 3ffb7825-dfcd-4b48-82fd-6bab072128f6
Superblock backups stored on blocks:
    32768, 98304

Allocating group tables: done
Writing inode tables: done
Creating journal (4096 blocks): done
Writing superblocks and filesystem accounting information: done

maomao@maomao:~$ sudo blkid
/dev/loop0: TYPE="squashfs"
/dev/loop1: TYPE="squashfs"
/dev/loop2: TYPE="squashfs"
/dev/loop3: TYPE="squashfs"
/dev/loop4: TYPE="squashfs"
/dev/loop5: TYPE="squashfs"
/dev/loop6: TYPE="squashfs"
/dev/loop7: TYPE="squashfs"
/dev/sr0: UUID="2019-07-12-09-13-14-35" LABEL="VBox_GAs_6.0.10" TYPE="iso9660"
/dev/sda1: UUID="781a78c9-6a57-4ace-8c88-519ccba4c4e" TYPE="ext4" PARTUUID="adc7b47d-01"
/dev/sdb1: UUID="3ffb7825-dfcd-4b48-82fd-6bab072128f6" TYPE="ext4" PARTUUID="8c4c8bb7-05"
maomao@maomao:~$ sudo nano /etc/fstab
maomao@maomao:~$ cat /etc/fstab
#
# /etc/fstab: static file system information.
#
# Use 'blkid' to print the universally unique identifier for a
# device; this may be used with UUID= as a more robust way to name devices
# that works even if disks are added and removed. See fstab(5).
#
# <file system> <mount point> <type> <options> <dump> <pass>
# / was on /dev/sda1 during installation
UUID=781a78c9-6a57-4ace-8c88-519ccba4c4e / ext4 errors=remount-ro 0 1
# /dev/sdb1 during installation
UUID=3ffb7825-dfcd-4b48-82fd-6bab072128f6 /mnt/os_hws ext4 defaults 0 0
/swapfile none swap sw 0 0
maomao@maomao:~$ reboot
```

5. Use the df command to confirm whether the mount is success

```
$ df -h
```



```
maomao@maomao:~$ df -h
```

Filesystem	Size	Used	Avail	Use%	Mounted on
udev	3.9G	0	3.9G	0%	/dev
tmpfs	798M	1.5M	796M	1%	/run
/dev/sda1	15G	5.1G	8.9G	37%	/
tmpfs	3.9G	0	3.9G	0%	/dev/shm
tmpfs	5.0M	4.0K	5.0M	1%	/run/lock
tmpfs	3.9G	0	3.9G	0%	/sys/fs/cgroup
/dev/loop1	4.2M	4.2M	0	100%	/snap/gnome-calculator/446
/dev/loop2	43M	43M	0	100%	/snap/gtk-common-themes/1313
/dev/loop3	1.0M	1.0M	0	100%	/snap/gnome-logs/61
/dev/loop4	89M	89M	0	100%	/snap/core/7278
/dev/loop4	55M	55M	0	100%	/snap/core18/1066
/dev/loop5	15M	15M	0	100%	/snap/gnome-characters/756
/dev/loop6	3.8M	3.8M	0	100%	/snap/gnome-system-monitor/100
/dev/loop7	158M	158M	0	100%	/snap/gnome-3-28-1004/67
/dev/sdb5	4.0M	4.0M	0	100%	/run/lock/mao
tmpfs	798M	28K	798M	1%	/run/user/1211
tmpfs	798M	20K	798M	1%	/run/user/1000
/dev/sr0	74M	0	74M	0%	/media/maomao/VBox_GAs_6.0.10

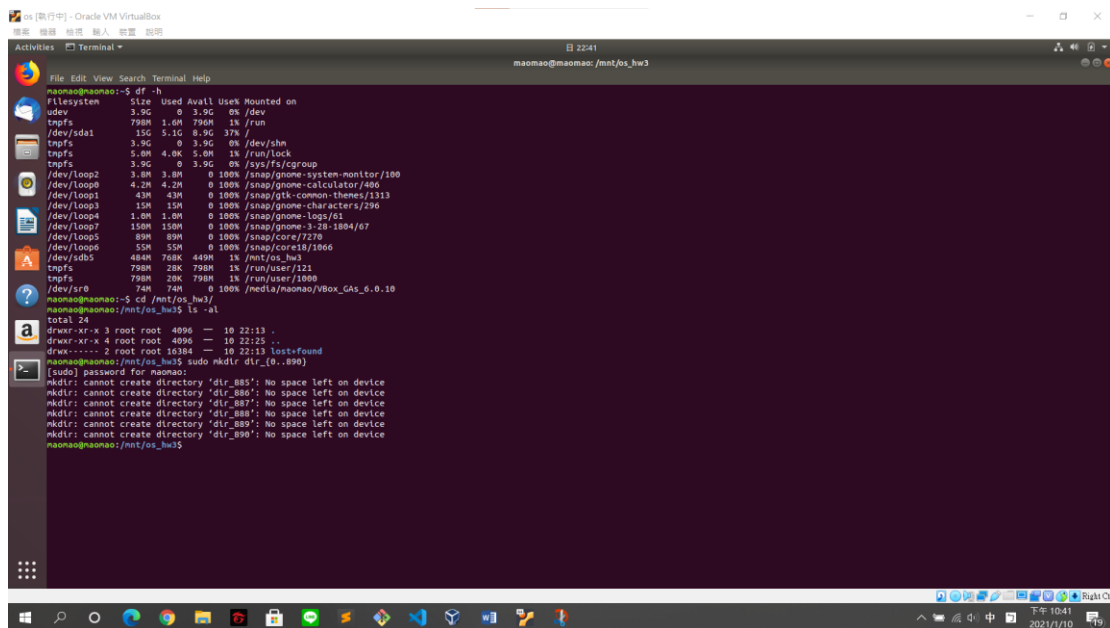
```
maomao@maomao:~$
```

Task3 – Inode and block

1. Try to create directories in this file system as many as you can. How many directories can be created in this file system? Why? (Hint: inode)

```
$ sudo mkdir dir_{0..890}
```

(create 891 directories)

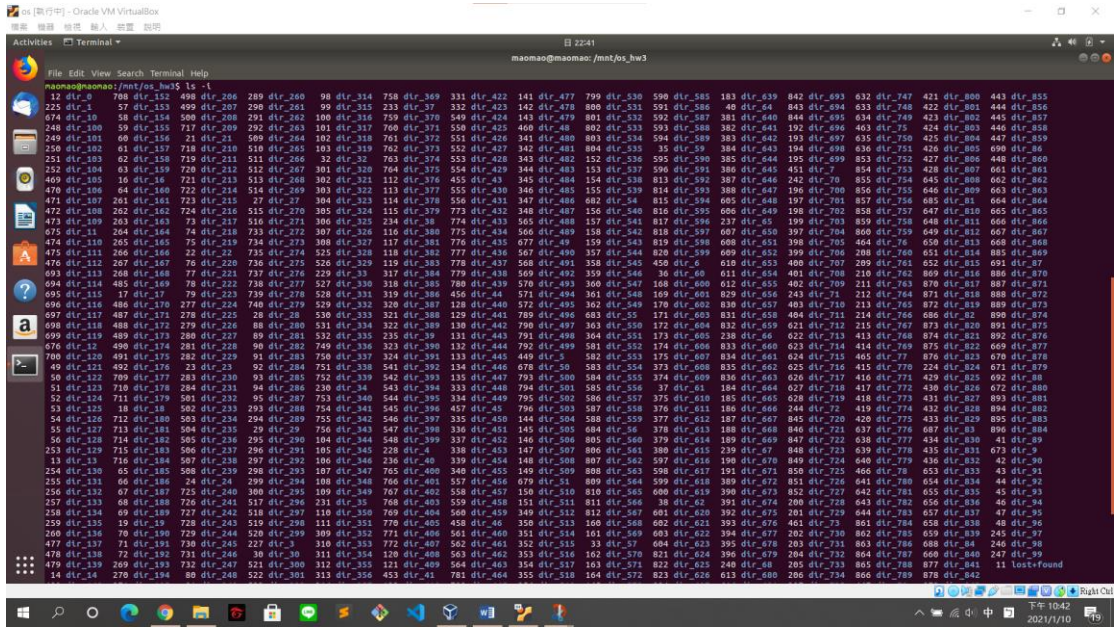


```
maomao@maomao:~$ df -h
Filesystem      Size  Used Avail Use% Mounted on
udev            3.9G     0  3.9G   0% /dev
tmpfs           798M  1.0M  796M   1% /run
/dev/sda1       15G   5.1G  9.9G  37% /
tmpfs           3.9G     0  3.9G   0% /dev/shm
tmpfs           5.0M  4.0K  5.0M   1% /run/lock
tmpfs           3.9G     0  3.9G   0% /sys/fs/cgroup
/dev/loop2      3.8M  3.8M   0 100% /snap/gnome-system-monitor/100
/dev/loop0      4.2M  4.2M   0 100% /snap/gnome-calculator/400
/dev/loop1      43M  43M   0 100% /snap/gtk-common-themes/1333
/dev/loop3      15M  15M   0 100% /snap/gnome-characters/296
/dev/loop4      1.0M  1.0M   0 100% /snap/gnome-logs/61
/dev/loop7     150M  150M   0 100% /snap/gnome-3-20-1004/67
/dev/loop5      89M  89M   0 100% /snap/core/7270
/dev/loop6      55M  55M   0 100% /snap/core18/1066
/dev/sdb5      484M  708K  484M   1% /mnt/os_hw3
tmpfs           798M  28K  798M   1% /run/user/1211
tmpfs          798M  20K  798M   1% /run/user/1000
/dev/sr0        74M  74M   0 100% /media/maomao/VBox_GAs_6.0.10

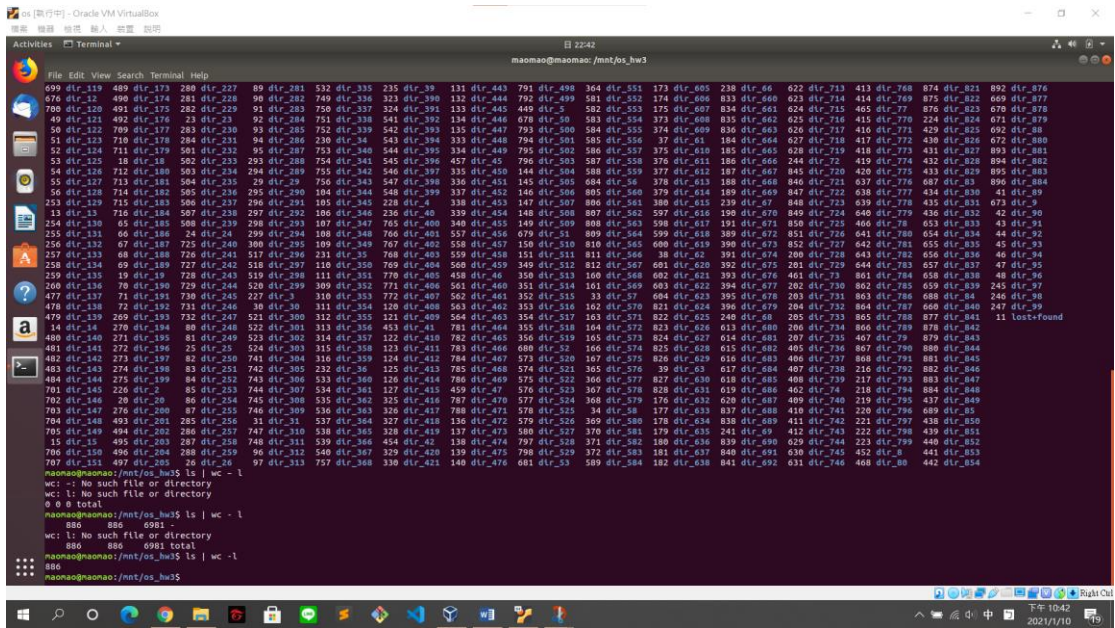
maomao@maomao:~$ cd /mnt/os_hw3/
maomao@maomao:/mnt/os_hw3$ ls -al
total 24
drwxr-xr-x 3 root root 4096 -- 10 22:13 .
drwxr-xr-x 4 root root 4096 -- 10 22:25 ..
drwx----- 2 root root 16384 -- 10 22:13 lost+found
maomao@maomao:/mnt/os_hw3$ sudo mkdir dir_{0..890}
[sudo] password for maomao:
mkdir: cannot create directory 'dir_885': No space left on device
mkdir: cannot create directory 'dir_886': No space left on device
mkdir: cannot create directory 'dir_887': No space left on device
mkdir: cannot create directory 'dir_888': No space left on device
mkdir: cannot create directory 'dir_889': No space left on device
mkdir: cannot create directory 'dir_890': No space left on device
maomao@maomao:/mnt/os_hw3$
```

(6 directories cannot be created)

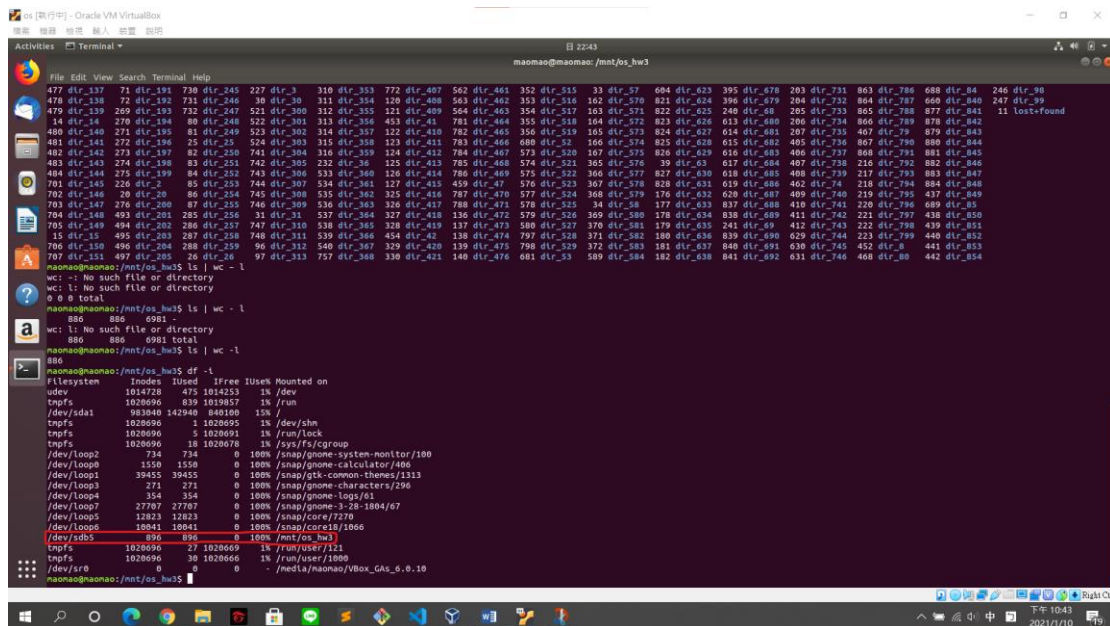
\$ ls -li (show inodes)



```
$ ls | wc -l (count the numbers of directories)
```



885 directories can be created in this file system.



```
maomao@maomao: /mnt/os_hw3
477 dir_137 71 dir_191 730 dir_245 227 dir_3 310 dir_353 772 dir_407 502 dir_461 352 dir_515 33 dir_57 804 dir_623 395 dir_678 263 dir_731 863 dir_788 688 dir_84 246 dir_90
478 dir_138 72 dir_192 731 dir_246 30 dir_30 311 dir_354 120 dir_408 563 dir_462 353 dir_516 102 dir_570 821 dir_624 396 dir_679 264 dir_732 864 dir_789 689 dir_840 247 dir_91
479 dir_139 269 dir_193 732 dir_247 521 dir_300 312 dir_355 121 dir_409 564 dir_463 354 dir_517 163 dir_571 822 dir_625 240 dir_680 265 dir_733 865 dir_788 677 dir_841 11 lost-found
480 dir_140 270 dir_194 80 dir_248 522 dir_301 313 dir_356 453 dir_41 781 dir_464 355 dir_518 164 dir_572 823 dir_626 266 dir_681 266 dir_734 866 dir_789 678 dir_842
481 dir_141 271 dir_195 81 dir_249 523 dir_302 314 dir_357 122 dir_410 782 dir_465 356 dir_519 165 dir_573 824 dir_627 614 dir_681 267 dir_735 467 dir_79 879 dir_843
482 dir_142 272 dir_196 25 dir_25 524 dir_303 315 dir_358 123 dir_411 783 dir_466 680 dir_52 166 dir_574 825 dir_628 615 dir_682 465 dir_736 867 dir_790 880 dir_844
483 dir_143 273 dir_197 82 dir_250 741 dir_304 316 dir_359 124 dir_412 784 dir_467 573 dir_520 167 dir_575 826 dir_629 616 dir_683 466 dir_737 868 dir_791 881 dir_845
484 dir_144 274 dir_198 83 dir_251 742 dir_305 232 dir_36 125 dir_413 785 dir_468 574 dir_521 365 dir_576 39 dir_63 617 dir_684 467 dir_738 216 dir_792 882 dir_846
485 dir_145 275 dir_199 84 dir_252 743 dir_306 533 dir_360 126 dir_414 786 dir_469 575 dir_522 366 dir_577 827 dir_630 618 dir_685 468 dir_739 217 dir_793 883 dir_847
486 dir_146 276 dir_200 85 dir_253 744 dir_307 534 dir_361 127 dir_415 459 dir_47 576 dir_523 367 dir_578 828 dir_631 619 dir_686 469 dir_740 218 dir_794 884 dir_848
487 dir_147 277 dir_201 86 dir_254 745 dir_308 535 dir_362 325 dir_416 787 dir_470 577 dir_524 368 dir_579 176 dir_632 620 dir_687 469 dir_740 219 dir_795 437 dir_849
488 dir_148 278 dir_202 87 dir_255 746 dir_309 536 dir_363 326 dir_417 788 dir_471 578 dir_525 34 dir_58 177 dir_633 837 dir_688 410 dir_741 220 dir_796 689 dir_85
489 dir_149 493 dir_203 285 dir_256 31 dir_31 537 dir_364 327 dir_418 136 dir_472 579 dir_526 369 dir_580 178 dir_634 838 dir_689 411 dir_742 221 dir_797 438 dir_850
490 dir_150 494 dir_204 286 dir_257 747 dir_310 538 dir_365 328 dir_419 137 dir_473 580 dir_527 370 dir_581 179 dir_635 241 dir_69 412 dir_743 222 dir_798 439 dir_851
491 dir_151 495 dir_205 287 dir_258 748 dir_311 539 dir_366 454 dir_42 138 dir_474 797 dir_528 371 dir_582 180 dir_636 839 dir_690 629 dir_744 223 dir_799 440 dir_852
492 dir_152 496 dir_206 288 dir_259 96 dir_312 540 dir_367 329 dir_420 139 dir_475 798 dir_529 372 dir_583 181 dir_637 840 dir_691 630 dir_745 452 dir_8 441 dir_853
493 dir_153 497 dir_207 289 dir_26 97 dir_313 757 dir_368 330 dir_421 140 dir_476 681 dir_53 589 dir_584 182 dir_638 841 dir_692 631 dir_746 468 dir_80 442 dir_854
maomao@maomao: /mnt/os_hw3$ wc -l
wc: -: No such file or directory
0 0 total
maomao@maomao: /mnt/os_hw3$ ls | wc -l
886 886 896l
maomao@maomao: /mnt/os_hw3$ ls | wc -l
886 886 896l total
maomao@maomao: /mnt/os_hw3$ ls | wc -l
886
maomao@maomao: /mnt/os_hw3$ df -l
Filesystem          Inodes      Used      Ifree  IUsed  Mounted on
udev                1014720      472 1014253    1% /dev
tmpfs               1020696      839 1019857    1% /run
/dev/sda1           983840 142940 840900    15% /dev/sda1
tmpfs               1020696      1 1020695    1% /dev/shm
tmpfs               1020696      5 1020691    1% /run/lock
tmpfs               1020696      18 1020678    1% /sys/fs/cgroup
/dev/loop2          734 734 0 100% /snap/gnome-system-monitor/180
/dev/loop1          1550 1550 0 100% /snap/gnome-calculator/406
/dev/loop3           39455 39455 0 100% /snap/gtk-common-themes/1313
/dev/loop4           771 771 0 100% /snap/gnome-characters/706
/dev/loop5           354 354 0 100% /snap/gnome-logs/61
/dev/loop7           27707 27707 0 100% /snap/gnome-3-20-1004/67
/dev/loop8           12823 12823 0 100% /snap/core/7270
/dev/loop9           10841 10841 0 100% /snap/core18/1066
/dev/sdb5            896 896 0 100% /mnt/os_hw3
tmpfs               1020696      27 1020669    1% /run/user/121
tmpfs               1020696      30 1020666    1% /run/user/1000
/dev/sr0             0 0 0 /media/maomao/VBox_GAs_6.0.10
maomao@maomao: /mnt/os_hw3$
```

Only 885 directories can be created in this file system because inodes run out.

雖然 mkfs 是指定 800 inodes，但 inodes 的數量有一定的規則，所以會自動增加成 896 inodes，因為是離散的所以無法真的是 800 inodes。因為結構跟設計的關係所以只能用到快接近滿而非用掉 896

2. Try to create 1-byte files in this file system as many as you can. How many 1-byte files can be created in this file system? Can it completely use all space in this file system? (Hint: block size is 4096 bytes)

\$ sudo truncate -s 1 file_{1..890}

(create 890 files)

```
maomao@maomao: /mnt/os_hw3
704 dlr_348 493 dlr_201 285 dlr_256 31 dlr_31 537 dlr_364 327 dlr_418 136 dlr_472 579 dlr_526 369 dlr_580 178 dlr_634 838 dlr_689 411 dlr_742 221 dlr_797 438 dlr_850
705 dlr_149 494 dlr_202 286 dlr_257 747 dlr_310 538 dlr_365 328 dlr_419 137 dlr_473 580 dlr_527 370 dlr_581 179 dlr_635 241 dlr_69 412 dlr_743 222 dlr_798 439 dlr_851
15 dlr_15 495 dlr_203 287 dlr_258 748 dlr_311 539 dlr_366 454 dlr_42 138 dlr_474 797 dlr_528 371 dlr_582 180 dlr_636 839 dlr_690 629 dlr_744 223 dlr_799 440 dlr_852
706 dlr_150 496 dlr_204 288 dlr_259 96 dlr_312 540 dlr_367 329 dlr_420 139 dlr_475 798 dlr_529 372 dlr_583 181 dlr_637 840 dlr_691 630 dlr_745 452 dlr_8 441 dlr_853
707 dlr_151 497 dlr_205 26 dlr_26 97 dlr_313 757 dlr_368 330 dlr_421 140 dlr_476 681 dlr_53 589 dlr_584 182 dlr_638 841 dlr_692 631 dlr_746 468 dlr_80 442 dlr_854

maomao@maomao: /mnt/os_hw3$ ls | wc -l
0 0 0 total
wc: -: No such file or directory
wc: l: No such file or directory
maomao@maomao: /mnt/os_hw3$ ls | wc -l
886 886 6981 total
wc: l: No such file or directory
maomao@maomao: /mnt/os_hw3$ ls | wc -l
886
maomao@maomao: /mnt/os_hw3$ df -l
Filesystem            Inodes    IUsed    IFree IUse% Mounted on
udev                  1014728    475 1014253    1% /dev
tmpfs                 1020696    839 1019857    1% /run
/dev/sda1             983040   142940  840100   15% /
tmpfs                 1020696    1 1020695    1% /dev/shm
tmpfs                 1020696    5 1020691    1% /run/lock
tmpfs                 1020696   18 1020678    1% /sys/fs/cgroup
/dev/loop2            734      734    0 100% /snap/gnome-system-monitor/180
/dev/loop0            1550     1550    0 100% /snap/gnome-calculator/406
/dev/loop1            39455    39455    0 100% /snap/gtk-common-themes/1313
/dev/loop3            271      271    0 100% /snap/gnome-characters/296
/dev/loop4            354      354    0 100% /snap/gnome-logs/61
/dev/loop7            27707   27707    0 100% /snap/gnome-3-28-1804/67
/dev/loop5           12823   12823    0 100% /snap/core/7270
/dev/loop6           10041   10041    0 100% /snap/core18/1066
/dev/sdb5              896      896    0 100% /mnt/os_hw3
tmpfs                 1020696   27 1020669    1% /run/user/121
tmpfs                 1020696   30 1020666    1% /run/user/1000
/dev/sr0                0        0    0 - /media/maomao/VBox_GAs_6.0.10

maomao@maomao: /mnt/os_hw3$ sudo rm -r dir*
maomao@maomao: /mnt/os_hw3$ ls -al
total 48
drwxr-xr-x 3 root root 24576 -- 10 22:43 .
drwxr-xr-x 4 root root 4096 -- 10 22:25 ..
drwx----- 2 root root 16384 -- 10 22:13 lost+found
maomao@maomao: /mnt/os_hw3$ sudo truncate -s 1 file_{1..890}.txt
truncate: cannot open 'file887.txt' for writing: No space left on device
truncate: cannot open 'file887.txt' for writing: No space left on device
truncate: cannot open 'file888.txt' for writing: No space left on device
truncate: cannot open 'file888.txt' for writing: No space left on device
truncate: cannot open 'file889.txt' for writing: No space left on device
truncate: cannot open 'file889.txt' for writing: No space left on device
maomao@maomao: /mnt/os_hw3$
```

(5 files cannot be created)

\$ ls file* | wc -l (count the numbers of files)

```
maomao@maomao: /mnt/os_hw3
15 dlr_15 495 dlr_203 287 dlr_258 748 dlr_311 539 dlr_366 454 dlr_42 138 dlr_474 797 dlr_528 371 dlr_582 180 dlr_636 839 dlr_690 629 dlr_744 223 dlr_799 440 dlr_852
706 dlr_150 496 dlr_204 288 dlr_259 96 dlr_312 540 dlr_367 329 dlr_420 139 dlr_475 798 dlr_529 372 dlr_583 181 dlr_637 840 dlr_691 630 dlr_745 452 dlr_8 441 dlr_853
707 dlr_151 497 dlr_205 26 dlr_26 97 dlr_313 757 dlr_368 330 dlr_421 140 dlr_476 681 dlr_53 589 dlr_584 182 dlr_638 841 dlr_692 631 dlr_746 468 dlr_80 442 dlr_854

maomao@maomao: /mnt/os_hw3$ ls | wc -l
0 0 0 total
wc: -: No such file or directory
wc: l: No such file or directory
maomao@maomao: /mnt/os_hw3$ ls | wc -l
886
maomao@maomao: /mnt/os_hw3$ df -l
Filesystem            Inodes    IUsed    IFree IUse% Mounted on
udev                  1014728    475 1014253    1% /dev
tmpfs                 1020696    839 1019857    1% /run
/dev/sda1             983040   142940  840100   15% /
tmpfs                 1020696    1 1020695    1% /dev/shm
tmpfs                 1020696    5 1020691    1% /run/lock
tmpfs                 1020696   18 1020678    1% /sys/fs/cgroup
/dev/loop2            734      734    0 100% /snap/gnome-system-monitor/180
/dev/loop0            1550     1550    0 100% /snap/gnome-calculator/406
/dev/loop1            39455    39455    0 100% /snap/gtk-common-themes/1313
/dev/loop3            271      271    0 100% /snap/gnome-characters/296
/dev/loop4            354      354    0 100% /snap/gnome-logs/61
/dev/loop7            27707   27707    0 100% /snap/gnome-3-28-1804/67
/dev/loop5           12823   12823    0 100% /snap/core/7270
/dev/loop6           10041   10041    0 100% /snap/core18/1066
/dev/sdb5              896      896    0 100% /mnt/os_hw3
tmpfs                 1020696   27 1020669    1% /run/user/121
tmpfs                 1020696   30 1020666    1% /run/user/1000
/dev/sr0                0        0    0 - /media/maomao/VBox_GAs_6.0.10

maomao@maomao: /mnt/os_hw3$ sudo rm -r dir*
maomao@maomao: /mnt/os_hw3$ ls -al
total 48
drwxr-xr-x 3 root root 24576 -- 10 22:43 .
drwxr-xr-x 4 root root 4096 -- 10 22:25 ..
drwx----- 2 root root 16384 -- 10 22:13 lost+found
maomao@maomao: /mnt/os_hw3$ sudo truncate -s 1 file_{1..890}.txt
truncate: cannot open 'file886.txt' for writing: No space left on device
truncate: cannot open 'file887.txt' for writing: No space left on device
truncate: cannot open 'file888.txt' for writing: No space left on device
truncate: cannot open 'file888.txt' for writing: No space left on device
truncate: cannot open 'file889.txt' for writing: No space left on device
truncate: cannot open 'file889.txt' for writing: No space left on device
maomao@maomao: /mnt/os_hw3$ ls file* | wc -l
885
maomao@maomao: /mnt/os_hw3$
```


885 files can be created in this file system.

```
maomao@maomao: /mnt/os_hw3
total 48
drwxr-xr-x 3 root root 24576 -- 10 22:43 ..
drwxr-xr-x 4 root root 4096 -- 10 22:25 .
maomao@maomao: /mnt/os_hw3$ sudo truncate -s 1 file{1..890}.txt
truncate: cannot open 'file886.txt' for writing: No space left on device
truncate: cannot open 'file887.txt' for writing: No space left on device
truncate: cannot open 'file888.txt' for writing: No space left on device
truncate: cannot open 'file889.txt' for writing: No space left on device
truncate: cannot open 'file890.txt' for writing: No space left on device
maomao@maomao: /mnt/os_hw3$ ls -la | wc -l
885
maomao@maomao: /mnt/os_hw3$ df -l
Filesystem          Inodes  Used    IFree IUse% Mounted on
udev                1014728  475 1014253    1% /dev
tmpfs               1020696   639 1019857    1% /run
/dev/sda1           983040 142940  840100   15% /
tmpfs               1020696    1 1020695    1% /dev/shm
tmpfs               1020696    5 1020691    1% /run/lock
tmpfs               1020696  18 1020678    1% /sys/fs/cgroup
/dev/loop2          734      734    0 100% /snap/gnome-system-monitor/100
/dev/loop3          1550     1550    0 100% /snap/gnome-calculator/406
/dev/loop1          39455    39455    0 100% /snap/gtk-common-themes/1313
/dev/loop3          271      271    0 100% /snap/gnome-characters/290
/dev/loop4          354      354    0 100% /snap/gnome-logs/61
/dev/loop7          27707    27707    0 100% /snap/gnome-3-28-1804/67
/dev/loop5          12823    12823    0 100% /snap/core/7270
/dev/loop6          10041    10041    0 100% /snap/core16/1066
/dev/sdb5           896      896    0 100% /mnt/os_hw3
tmpfs               1020696  27 1020669    1% /run/user/1211
tmpfs               1020696  30 1020666    1% /run/user/1000
/dev/sr0            0         0      0  - /media/maomao/VBox_GAs_6.0.10
maomao@maomao: /mnt/os_hw3$
```

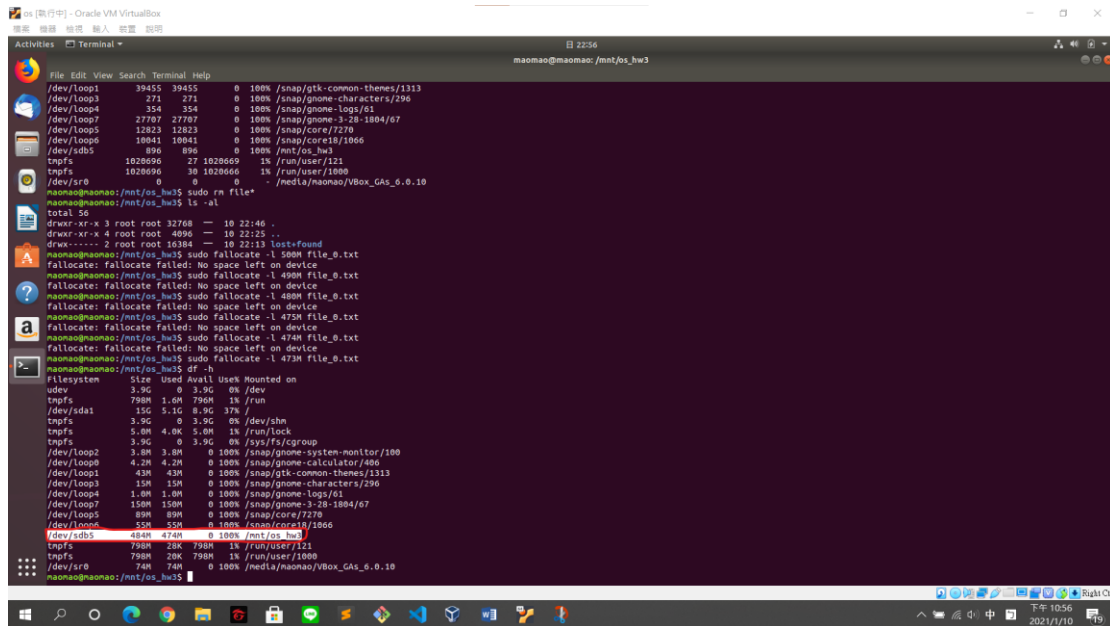
It cannot completely use all space in this file system because inodes run out.

雖然 mkfs 是指定 800 inodes，但 inodes 的數量有一定的規則，所以會自動增加成 896 inodes，因為是離散的所以無法真的是 800 inodes。因為結構跟設計的關係所以只能用到快接近滿而非用掉 896

3. Try to create a file which size as large as you can.

What is the maximum file size? Can it completely use all space in this file system?

```
$ sudo fallocate -l 473M file_0.txt
```



```
maomao@maomao: /mnt/os_hw3
maomao@maomao: /mnt/os_hw3$ sudo rm file*
maomao@maomao: /mnt/os_hw3$ ls -al
total 56
drwxr-xr-x 3 root root 32768 -- 10 22:46 .
drwxr-xr-x 4 root root 4096 -- 10 22:25 ..
drwx----- 2 root root 16384 -- 10 22:13 lost+found
maomao@maomao: /mnt/os_hw3$ sudo fallocate -l 500M file_0.txt
fallocate: fallocate failed: No space left on device
maomao@maomao: /mnt/os_hw3$ sudo fallocate -l 490M file_0.txt
fallocate: fallocate failed: No space left on device
maomao@maomao: /mnt/os_hw3$ sudo fallocate -l 475M file_0.txt
fallocate: fallocate failed: No space left on device
maomao@maomao: /mnt/os_hw3$ sudo fallocate -l 473M file_0.txt
fallocate: fallocate failed: No space left on device
maomao@maomao: /mnt/os_hw3$ df -h
Filesystem      Size  Used Avail Use% Mounted on
udev            3.9G   0 3.9G   0% /dev
tmpfs           790M  1.6M 790M   1% /run
/dev/sda1       15G   5.1G  8.9G  37% /
tmpfs           3.9G   0 3.9G   0% /dev/shm
tmpfs           5.0M  4.0K 5.0M   1% /run/lock
tmpfs           3.9G   0 3.9G   0% /sys/fs/cgroup
/dev/loop1      3.9M  3.8M  0 100% /snap/gnome-system-monitor/100
/dev/loop6      4.2M  4.2M  0 100% /snap/gnome-calculator/466
/dev/loop1      43M   43M  0 100% /snap/gtk-common-themes/1313
/dev/loop3      15M   15M  0 100% /snap/gnome-characters/290
/dev/loop4      1.9M   1.9M  0 100% /snap/gnome-logs/61
/dev/loop7      150M  150M  0 100% /snap/gnome-3-28-1804/67
/dev/loop5      89M   89M  0 100% /snap/core/7270
/dev/loop6      55M   55M  0 100% /snap/core16/1066
/dev/sdb5       484M  474M  0 100% /mnt/os_hw3
tmpfs           790M  23K 790M   1% /run/user/1000
tmpfs           74M   74M  0 100% /media/maomao/VBox_GAs_6.0.10
maomao@maomao: /mnt/os_hw3$
```

The maximum file size is 473 MB.

It cannot completely use all space in this file system.

Some space for system not for data and the usage runs out.

By default, 5% of the filesystem blocks will be reserved for the super-user, to avoid fragmentation and "allow root-owned daemons to continue to function correctly after non-privileged processes are prevented from writing to the filesystem.