

Linux Primer – Answers to Exercises

Exercise 1:

Search the `ls` man page for the option that outputs object names in every directory beneath the current directory. What is that option?

In a terminal window run the command ‘`man ls`’. Search for ‘recursive’ by typing the ‘/’ character followed by ‘recursive’ and the Return or Enter key. The **option is ‘-R’** as shown in the desktop terminal window on the right in Figure 1. Trying this in the home directory results in what is seen in the left desktop terminal window of Figure 1: the command is ‘`ls -R`’; the first line shows directories in the home directory; the next lines explore those directories but since each directory is empty, no files appear in any of the sections corresponding to those directories.

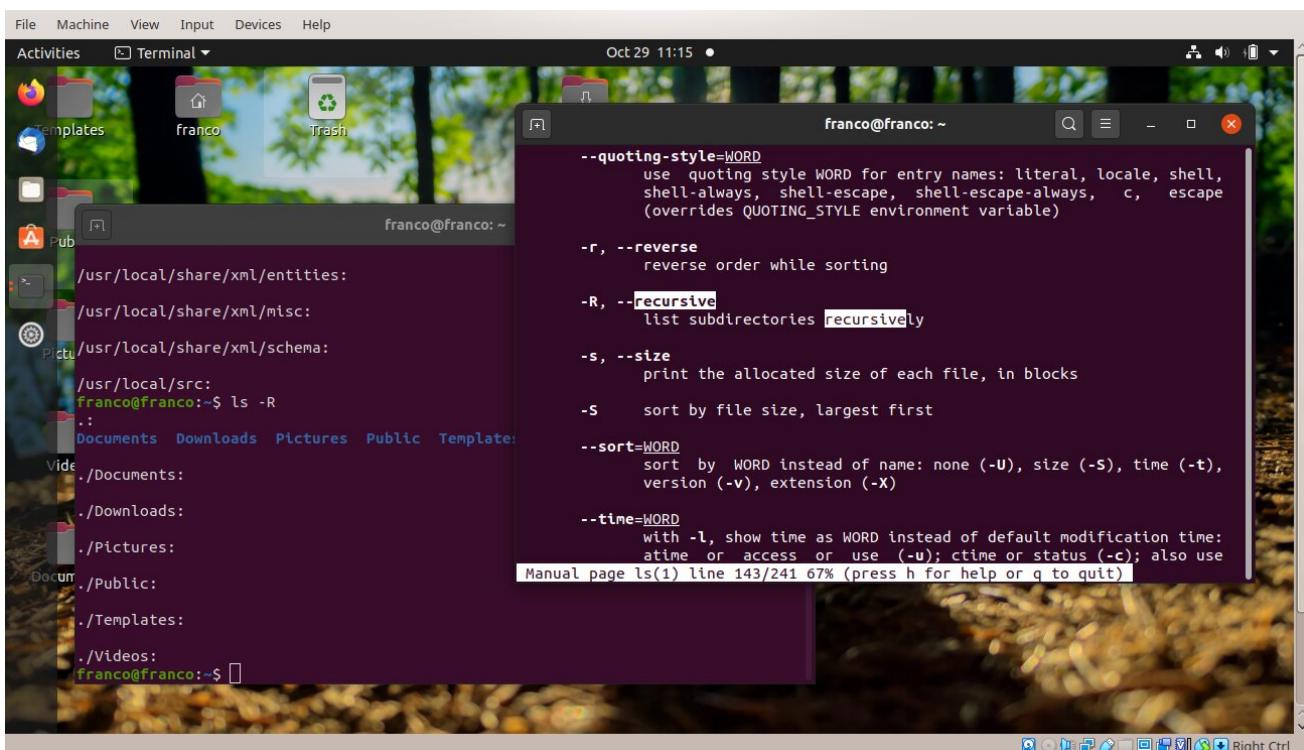


Figure 1: Run command ‘`man ls`’ to find the recursive option and try that option in the home directory

Exercise 2:

Search the `ls` man page for the option that orders object names by size. What is that option?

-S, see Figure 2 and Exercise 3: below.

Exercise 3:

Use that option to list files in directory `/etc` in long listing format. What was the result and write a few of the lines that you saw?

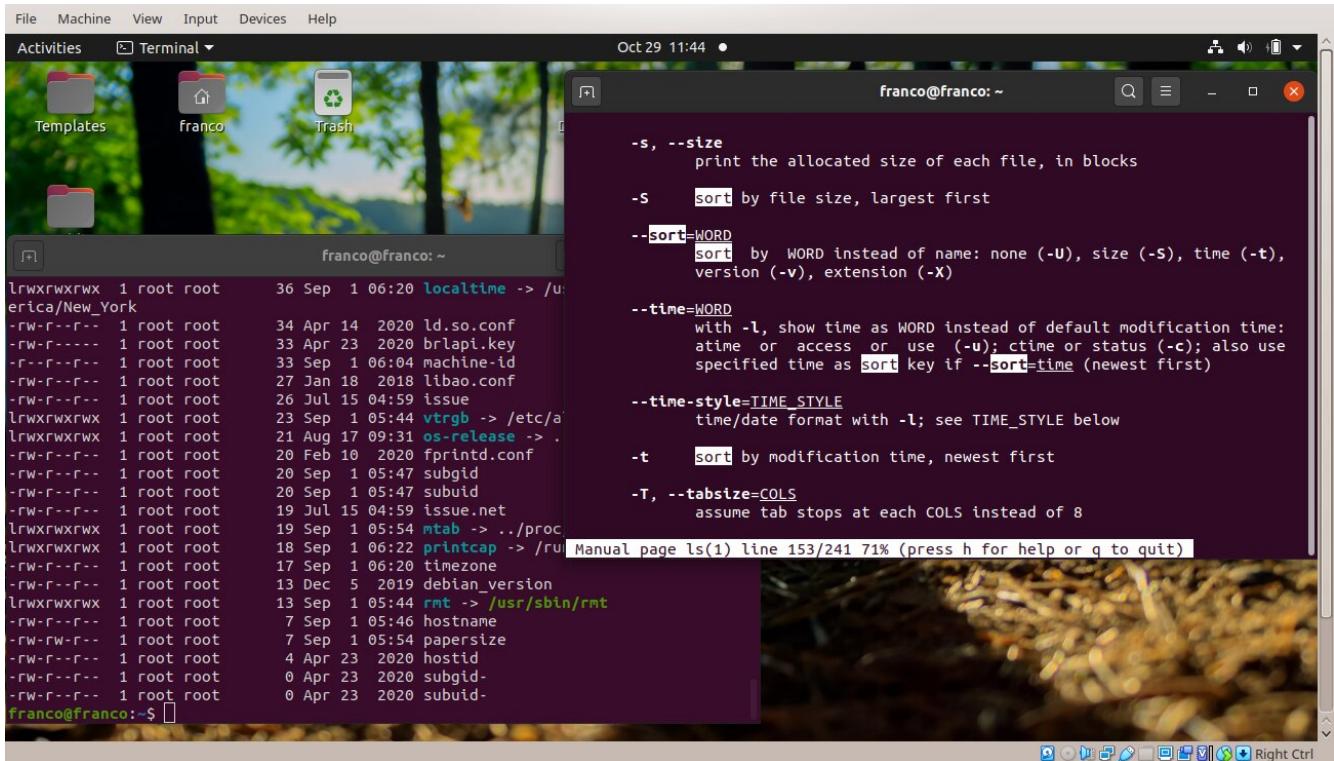


Figure 2: Run command 'man ls' and search for 'sort' (by file size) then run ls -ls /etc

In a terminal window run the command 'man ls'. Search for 'sort' by typing the '/' character followed by 'sort' and the Return or Enter key. The first match is not suitable so '/' followed by the Return or Enter key is typed again. This match is not suitable either. Continue typing '/' followed by Return or Enter until finding 'sort by file size, largest first' as shown in Figure 2. The option is '-S' as shown in the desktop terminal window on the right in Figure 2. Trying this on directory /etc results in what is seen in the left desktop terminal window of Figure 2: the command is 'ls -ls /etc'. The -l option is added to show the sizes which appear in long listing format. The command itself is not seen in the left terminal window because the /etc directory contains many objects, but the last 22 items in the listing are in order of decreasing size from localtime at the top (36 bytes) to subuid- at the bottom with 0 bytes.

Exercise 4:

What is the full path to your current working directory?

In a terminal window run the command pwd. The result is similar to that of Figure 3.

Exercise 5:

Find the type of file for the following objects:

```
/usr/share/pixmaps/faces/yellow-rose.jpg
/usr/share/mime/application/vnd.adobe.flash.movie.xml
/swapfile
/var/lib/colord/mapping.db
/bin
/usr/bin
/usr/share/doc/util-linux/cal.txt
```

/usr/share/doc/util-linux/howto-pull-request.txt.gz

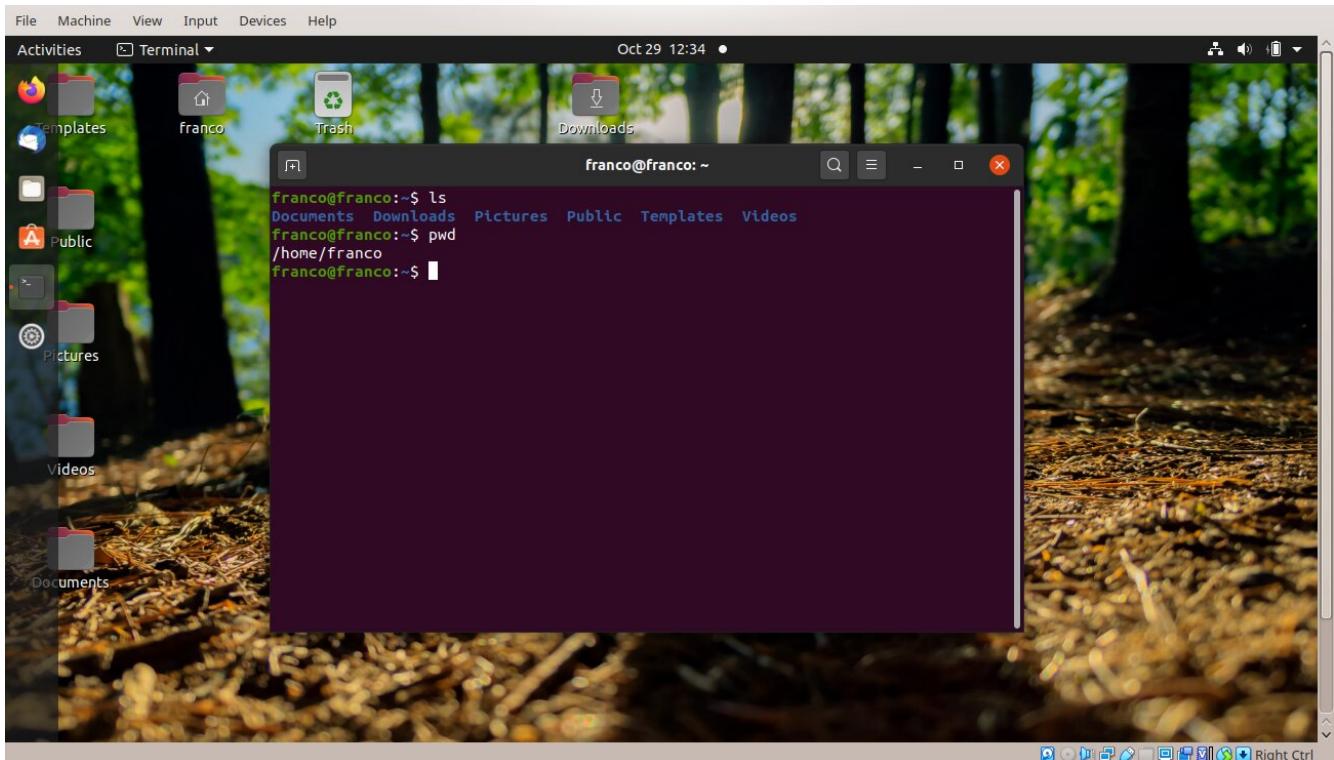


Figure 3: Run `pwd` to see the full path to the current working directory

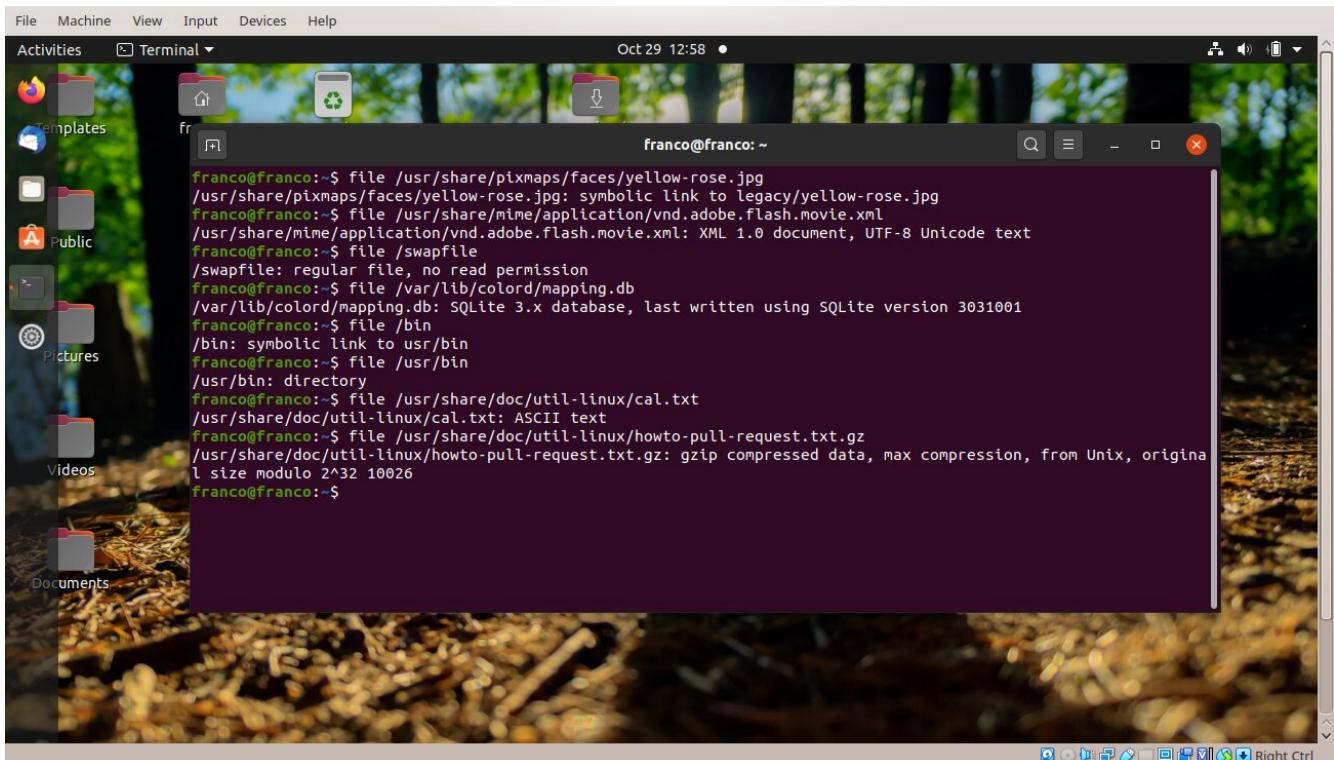


Figure 4: Run the `file` command on objects to see their types

The result of applying the command file to all the listed objects of the exercise is shown in Figure 4. Types include symbolic links (symlink), XML document with UTF-8 encoding, regular file, SQLite database file, directory, ASCII text, gzip compressed data.

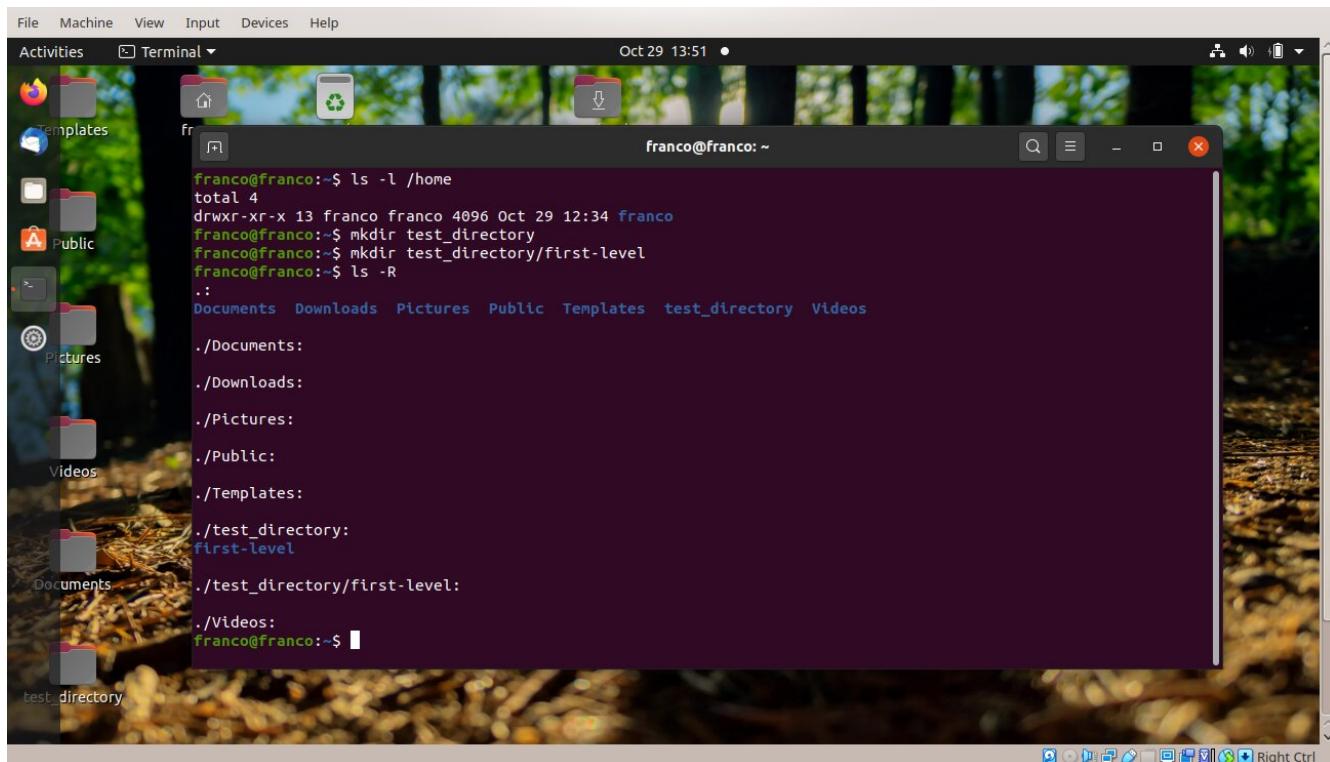
Exercise 6:

Determine that a directory can be created in your home directory. The home directory does not have to be the current working directory to do this. Then create a directory called test_directory in your home directory. Then create a directory called first-level in test_directory.

To answer the first question run ‘ls -l /home’. The result is similar to this:

```
drwxr-xr-x 13 franco franco 4096 Oct 29 12:34 franco
```

The home directory is /home/franco (labeled on the right). The owner of that directory is franco, (from franco franco) and franco, as owner, has permission rwx so franco can create a directory in its home directory. To create directory test_directory franco runs mkdir test_directory. To create directory first-level under test_directory franco runs mkdir test_directory/first-level. See Figure 5 for the results.

A screenshot of a Linux desktop environment. On the left is a dock with icons for a browser, terminal, file manager, and system tools. The main area shows a desktop background of a forest floor. A terminal window titled 'Terminal' is open in the center. It displays the following command-line session:

```
franco@franco:~$ ls -l /home
total 4
drwxr-xr-x 13 franco franco 4096 Oct 29 12:34 franco
franco@franco:~$ mkdir test_directory
franco@franco:~$ mkdir test_directory/first-level
franco@franco:~$ ls -R
.:
Documents Downloads Pictures Public Templates test_directory Videos
./Documents:
./Downloads:
./Pictures:
./Public:
./Templates:
./test_directory:
first-level
./test_directory/first-level:
./Videos:
franco@franco:~$
```

Figure 5: Make directories in the home directory

Exercise 7:

Make the current working directory /etc. Determine whether you can create a directory in /etc. Make the current working directory /etc/init.d. List the files in the current working directory.

To find permissions of /etc run ‘ls -l /’ and look for the line with etc at the right end:

```
drwxr-xr-x 130 root root 12288 Oct 29 11:03 etc
```

See the right side terminal window of Figure 6 for this line. The owner of the directory is root but the user is franco (for me) so the permissions are r-x. Since write permission is not granted, a directory cannot be created in /etc by franco. To make the current directory /etc run cd /etc. This directory can be entered due to the x permission and can be read due to the r permission being granted to 'other' which includes franco. The same is true for /etc/init.d which is determined by running ls -l /etc. After running 'cd init.d' run 'ls' to find files in /etc/init.d as shown in the left side terminal window in Figure 6.

```

File Machine View Input Devices Help
Templates franco Trash
Public

franco@franco:~$ cd /etc/
franco@franco:/etc$ ls -l /
total 140568
lrwxrwxrwx 1 root root
drwxr-xr-x 4 root root
drwxrwxr-x 2 root root
drwxr-xr-x 18 root root
drwxr-xr-x 130 root root
drwxr-xr-x 3 root root

franco@franco:~$ cd /etc/init.d/
franco@franco:/etc/init.d$ ls
acpid      grub-common      pulseaudio-enable-autospawn
alsa-utils  hwclock.sh      rsync
anacron    irqbalance      rsyslog
apparmor   kerneloops      saned
apport     keyboard-setup.sh speech-dispatcher
avahi-daemon knod          spice-vdagent
bluetooth   network-manager udev
console-setup.sh open-vm-tools ufw
cron       openvpn          unattended-upgrades
cups        plymouth         whoopsie
cups-browsed plymouth-log    x11-common
dbus       pppd-dns
gdm3       procps

franco@franco:/etc/init.d$


franco@franco:~$ ls -l /
total 140568
lrwxrwxrwx 1 root root
drwxr-xr-x 4096 Oct 29 11:03 boot
drwxr-xr-x 4096 Sep 1 05:46 cdrom
drwxr-xr-x 4120 Oct 29 10:59 dev
drwxr-xr-x 12288 Oct 29 11:03 etc
drwxr-xr-x 4096 Sep 1 05:47 home
drwxr-xr-x 7 Sep 1 05:44 lib -> usr/lib
drwxr-xr-x 9 Sep 1 05:44 lib32 -> usr/lib32
drwxr-xr-x 9 Sep 1 05:44 lib64 -> usr/lib64
drwxr-xr-x 10 Sep 1 05:44 libx32 -> usr/libx32
drwxr-xr-x 16384 Sep 1 05:44 lost+found
drwxr-xr-x 4096 Apr 23 2020 media
drwxr-xr-x 4096 Apr 23 2020 mnt
drwxr-xr-x 4096 Apr 23 2020 opt
drwxr-xr-x 0 Oct 29 10:59 proc
drwxr-xr-x 4096 Sep 8 01:10 root
drwxr-xr-x 900 Oct 29 12:27 run
drwxr-xr-x 8 Sep 1 05:44 sbin -> usr/sbin
drwxr-xr-x 4096 Sep 1 06:06 snap
drwxr-xr-x 4096 Apr 23 2020 srv
drwxr-xr-x 38704640 Sep 1 05:44 swapfile
drwxr-xr-x 0 Oct 29 10:59 sys
drwxr-xr-x 4096 Oct 29 14:03 tmp
drwxr-xr-x 4096 Apr 23 2020 usr
drwxr-xr-x 4096 Apr 23 2020 var

```

Figure 6: List files in /etc/init.d

Exercise 8:

Change directory to test_directory/first-level. If that directory does not exist create it. In that directory create a new file called new-file.txt with touch. Use ls to find out how many bytes new-file.txt contains.

The directories test_directory and test_directory/first-level have been created in Exercise 6:. Run cd to be in the home directory then run

```
cd test_directory/first-level
```

Then run

```
touch new-file.txt
```

To find out how many bytes 'new-file.txt' contains run

```
ls -l new-file.txt
```

The result, for user franco, is this:

```
-rw-rw-r-- 1 franco franco 0 Oct 29 17:24 new-file.txt
```

See Figure 7 for the result.

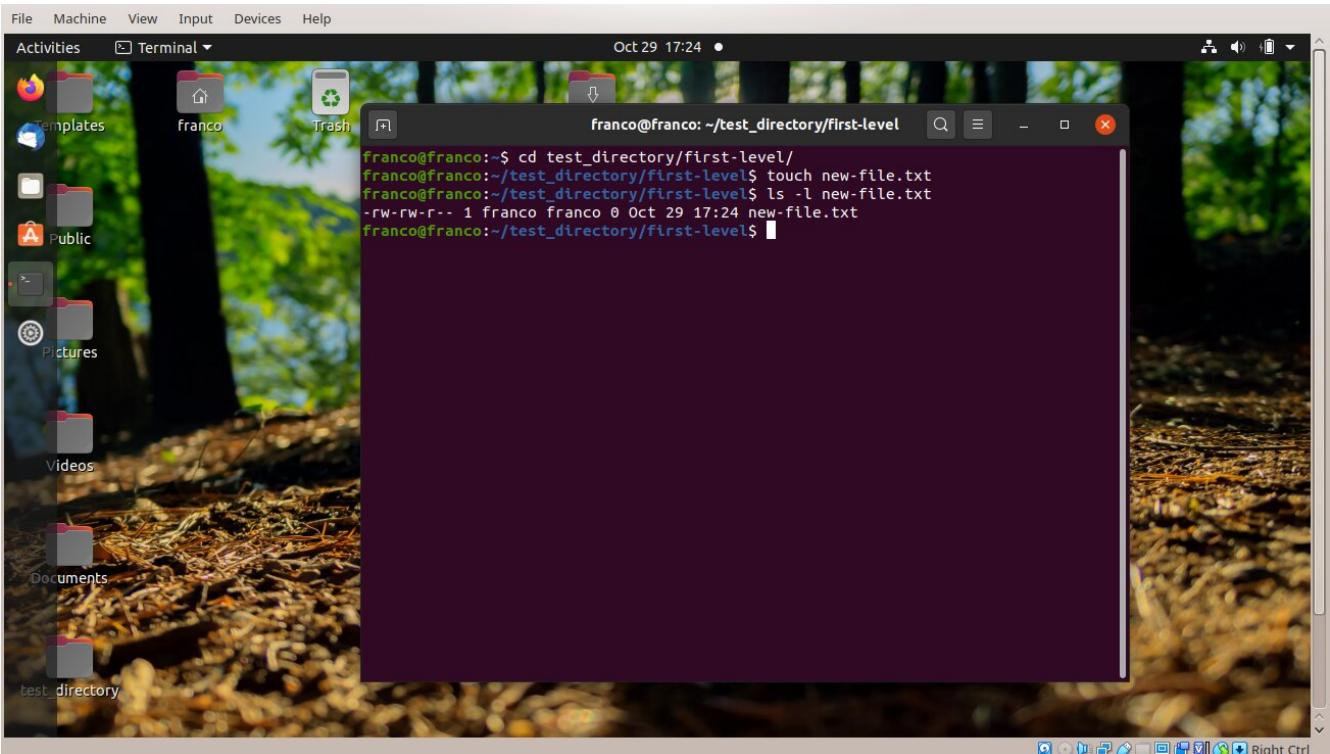


Figure 7: Use touch to create a file with no content

Exercise 9:

Add the following content to test_directory/first-level/new-file.txt:

We should forget about small efficiencies, say about 97% of the time: premature optimization is the root of all evil

Then add "Just Kidding" to that file.

From the home directory run this:

```
echo "We should forget about small efficiencies, say about 97% of the
time: premature optimization is the root of all evil" >
test_directory/first-level/new-file.txt
```

The above should be on a single line and line wrap is expected. Next run the following:

```
echo "Just Kidding" >> test_directory/first-level/new-file.txt
```

The result of these commands is shown in Figure 8.

Exercise 10:

Display the contents of test_directory/first-level/new-file.txt

Run the following command:

```
cat test_directory/first-level/new-file.txt
```

The result is shown in Figure 9.

Exercise 11:

Copy all of directory test_directory to a new directory named first. Then display the contents of new-file.txt which is somewhere in the hierarchy of directory first.

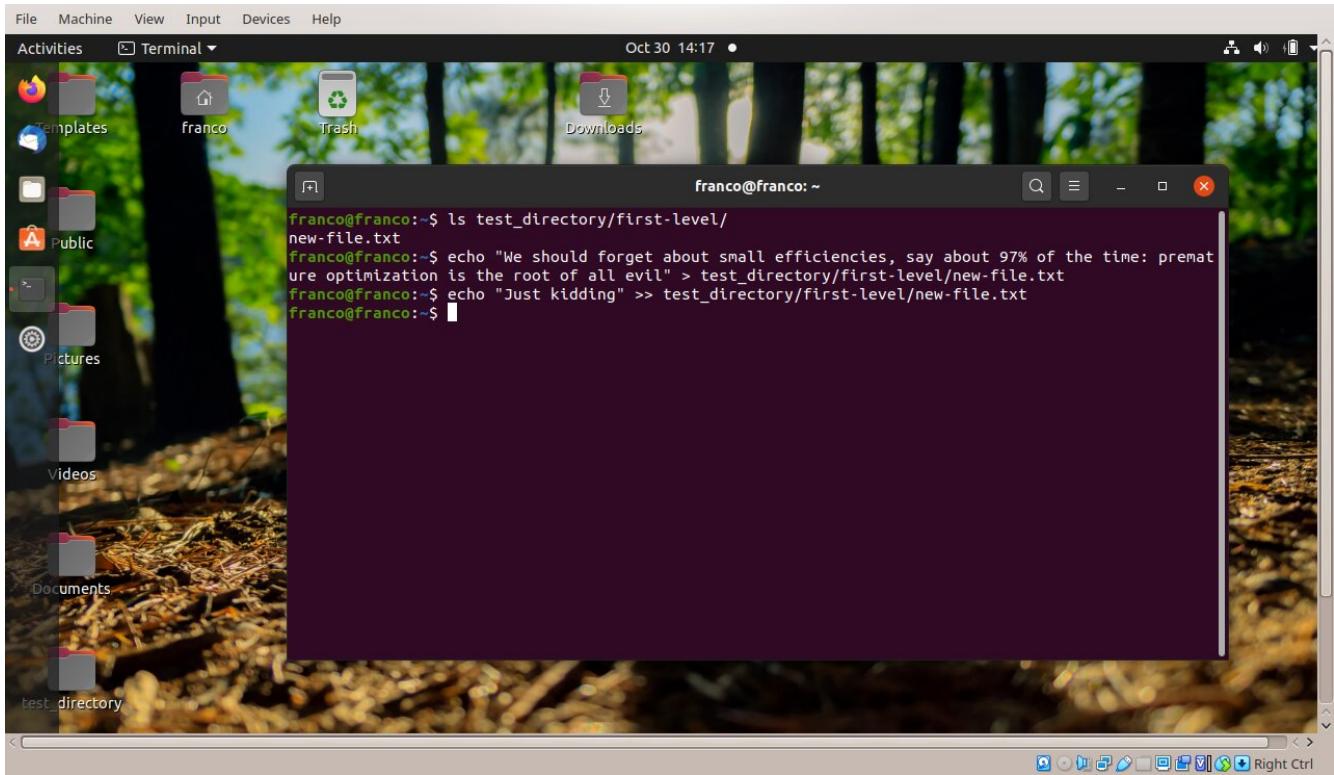


Figure 8: Use echo to give content and append content to a file

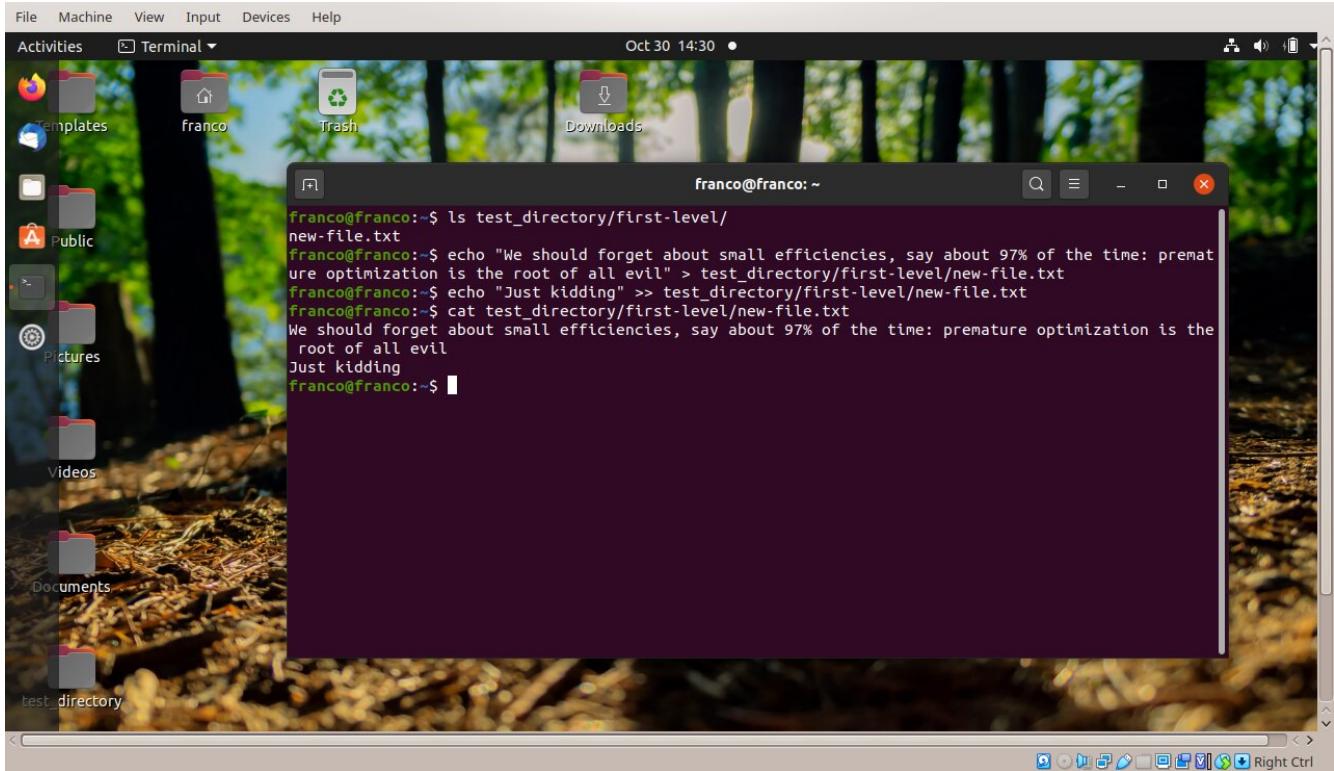


Figure 9: Display the contents of test_directory/first-level/new-file.txt

The first part is achieved with the following:

```
cp -r test_directory first
```

The second part is achieved with the following:

```
cat first/first-level/new-file.txt
```

The result is shown in Figure 10.

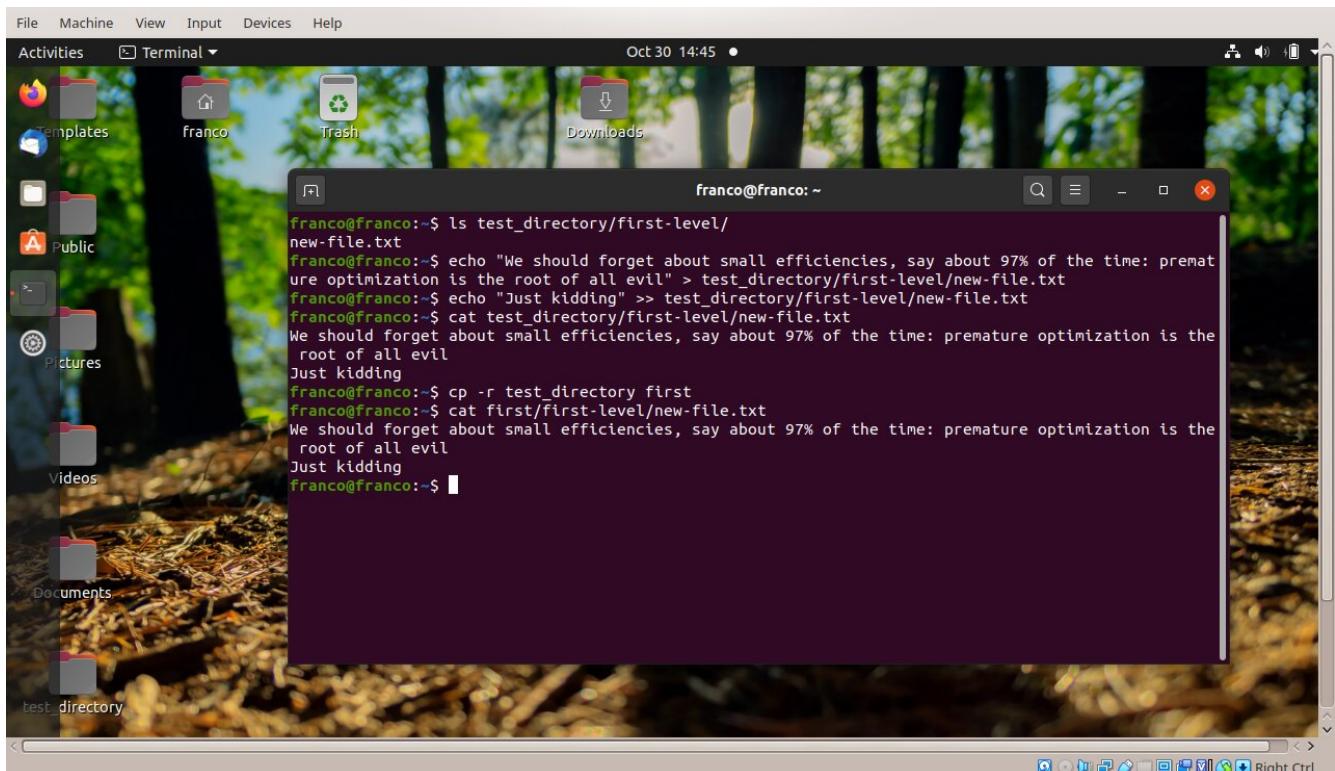


Figure 10: Copy the contents of test_directory to first and display contents of new-file.txt

Exercise 12:

From the home directory, rename directory first/first-level to first/second-level. Then display the contents of first/second-level/new-file.txt.

Run cd to arrive in the home directory. Run

```
mv first/first-level first/second-level
```

Run

```
cat first/second-level/new-file.txt
```

The result is shown in Figure 11.

Exercise 13:

Find a network interface over which traffic flows. This can be done with /sbin/ifconfig. Consult the man page of ifconfig for help in using it. Use the man page for tcpdump to find out how to list packets that pass through that interface. Now apply tcpdump to that interface. What happened? Now correct the problem with sudo.

According to the man page for `ifconfig` the `-s` switch will provide a short listing of network interfaces. So, do this:

```
/sbin/ifconfig -s
```

The output is shown in Figure 12. The interface to work with in this case is `enp0s3`. According to the man page for `tcpdump` the `-i` switch sets the interface. So run this:

```
/usr/sbin/tcpdump -i enp0s3
```

The output in Figure 12 shows an error message which states we do not have permission. So now do this:

```
sudo /usr/bin/tcpdump -i enp0s3
```

This works – we jumped out with control-C after seeing a few packets.

Exercise 14

File `/usr/bin/dumpcap` must be a ‘set user id’ program in order to be used by `wireshark`. But the default permissions for that file are `rwxr-xr-x`. Consult the man page for `chmod` to figure out how to change permission to `rwsr-xr-x` with `chmod` and attempt to make the change without using `sudo`. What happened? Now use `sudo` then `ls -l /usr/bin/dumpcap` to make sure the permissions are as needed. If you feel lucky, attempt to use `wireshark`.

Check the permissions of `/usr/bin/dumpcap` like this as in Figure 13:

```
ls -l /usr/bin/dumpcap
```

There is likely an error message saying that the file does not exist. Run `/usr/bin/dumpcap` and get a message saying install `wireshark-common`. Use `sudo` to install it like this:

```
sudo apt install wireshark-common
```

Choose ‘yes’ when prompted. Now run the `ls` command again and look at the permissions. To change the permissions as needed do this as shown in Figure 13:

```
sudo chmod u+s /usr/bin/dumpcap
```

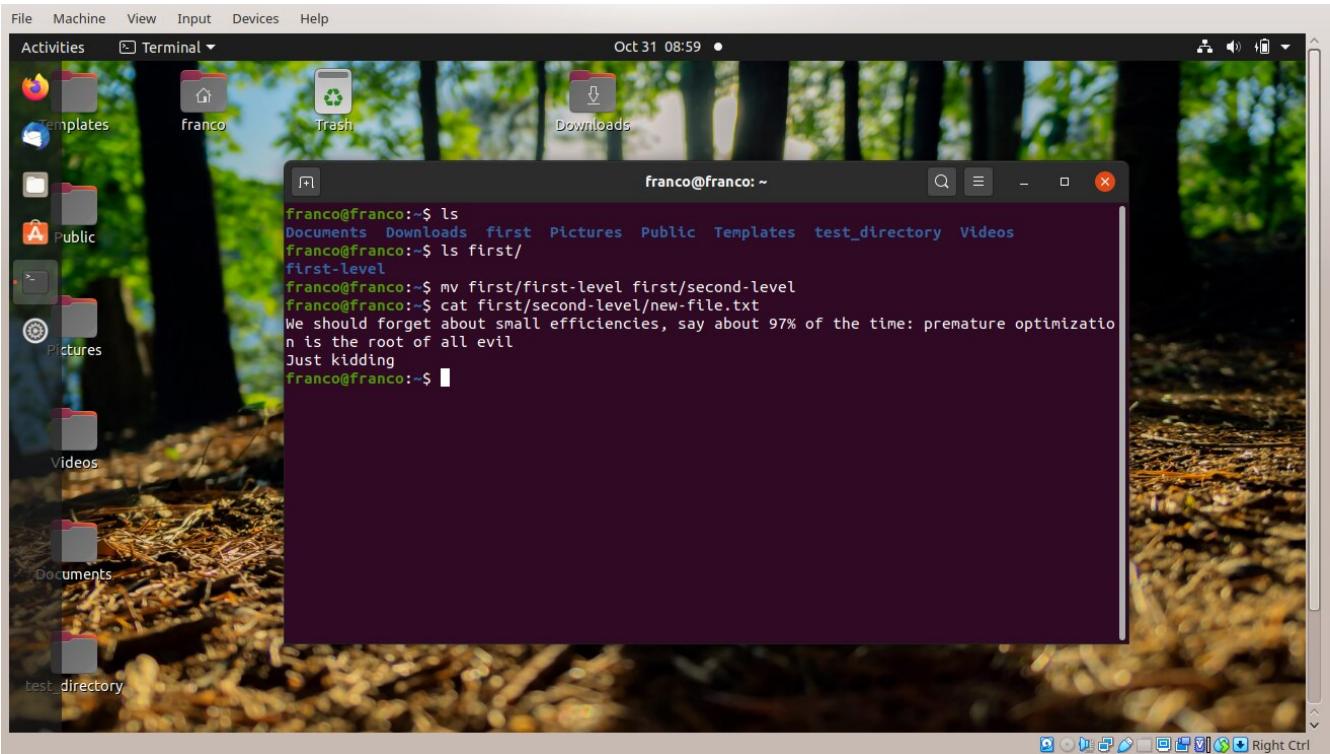


Figure 11: Rename directory first/first-level to first/second-level

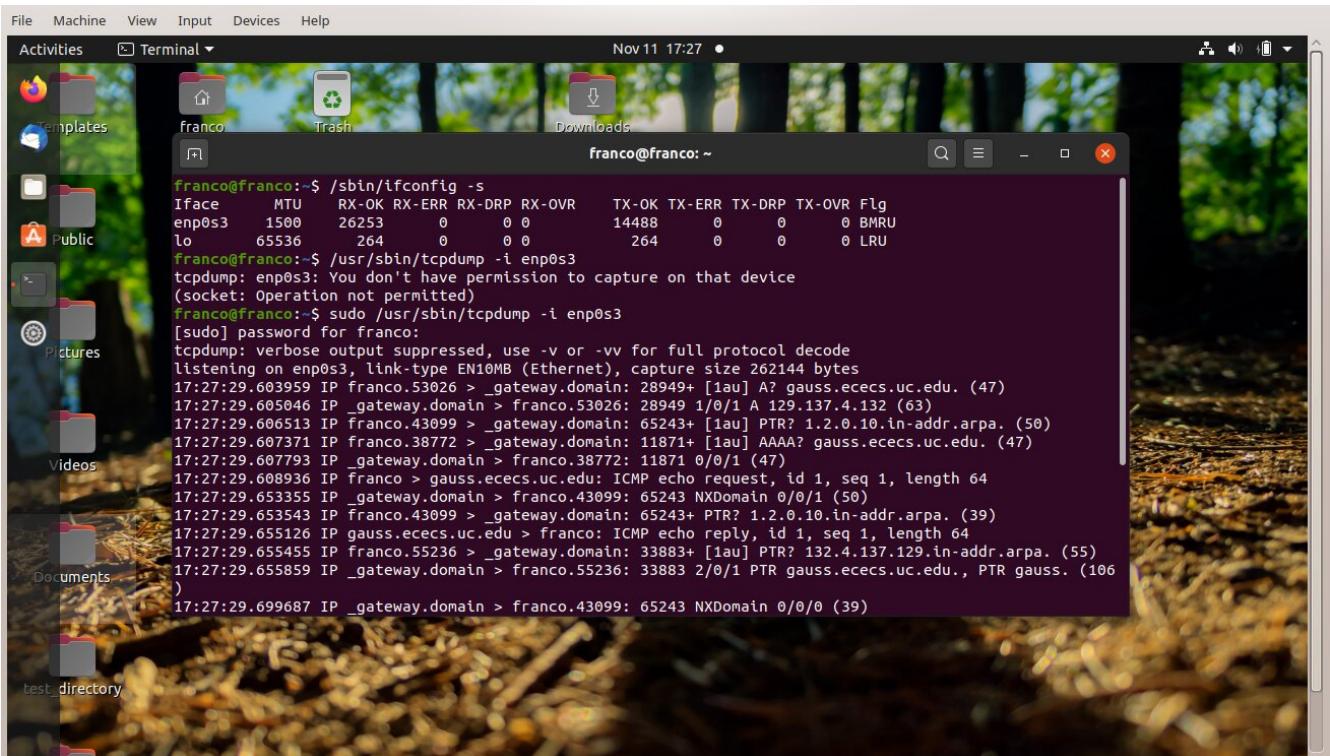


Figure 12: Use sudo to run tcpdump

```

franco@franco:~$ /sbin/ifconfig -s
Iface      MTU   RX-OK RX-ERR RX-DRP RX-OVR   TX-OK TX-ERR TX-DRP TX-OVR Flg
enp0s3    1500     3044      0      0      1895      0      0      0      0 BMRU
lo       65536     222      0      0      222      0      0      0      0 LRU

franco@franco:~$ /usr/sbin/tcpdump -i enp0s3
tcpdump: enp0s3: You don't have permission to capture on that device
(socket: Operation not permitted)
franco@franco:~$ sudo /usr/sbin/tcpdump -i enp0s3
[sudo] password for franco:
tcpdump: verbose output suppressed, use -v or -vv for full protocol decode
listening on enp0s3, link-type EN10MB (Ethernet), capture size 262144 bytes
^C
0 packets captured
0 packets received by filter
0 packets dropped by kernel
franco@franco:~$ ls -l /usr/bin/dumpcap
ls: cannot access '/usr/bin/dumpcap': No such file or directory
franco@franco:~$ sudo apt install wireshark-common
[sudo] password for franco:
franco@franco:~$ ls -l /usr/bin/dumpcap
-rwxr-xr-- 1 root wireshark 113112 Apr 19 2020 /usr/bin/dumpcap
franco@franco:~$ sudo chmod u+s /usr/bin/dumpcap
[sudo] password for franco:
franco@franco:~$ ls -l /usr/bin/dumpcap
-rwsr-xr-- 1 root wireshark 113112 Apr 19 2020 /usr/bin/dumpcap
franco@franco:~$ 

```

Figure 13: Use sudo to install wireshark-common and change permissions of dumpcap

Exercise 15:

What does this command do?

```
find [A-Z,0-9,a-z]* -maxdepth 3 -type d \(! -name "*second*" \) -exec ls {} \;
```

Let DIR represent all directories of the current directory with names beginning with an alphabetic character or numerical digit. Then the find command lists the contents (files, symlinks, directories, etc) of subdirectories of DIR directories that are at depth at most 3 from the current directory, excluding any directory with name containing 'second'.

Exercise 16:

Use find to find broken symlinks in subdirectories of the current directory.

Run

```
find . -xtype l
```

Exercise 17:

What does the following do?

```
locate .txt | grep -v /var | grep -v /etc | grep -v /usr
```

Finds the location of all files ending in the extension txt which are not in paths containing /var, /etc, or /usr.