- you should know the following shell concepts
  - hierarchical file system
    - directory tree
    - root directory
    - home directory
    - standard directory contents
      - /etc: configuration files
      - /dev: device files
      - /home: user home directories
      - /lib: shared library files used by core systems programs
      - /sbin: system binaries for vital system tasks
      - /usr: programs and support files for users
      - /var: system log files
    - absolute path: starts with root directory, that is "/", and specifies a complete path for a file or a directory, e.g. /usr/bin/firefox
    - relative path: specifies the path for a file relative to the current directory; e.g. if the current directory is /usr, then ./bin/firefox is a relative path for the firefox binary
  - types of shell commands
    - binary files: separate programs executed by shell
    - shell builtins: commands interpreted by shell, the functionality for these commands are implemented in the shell program itself
    - aliases: shortcuts defined by users to avoid typing of long commands or command sequences
  - shell variables: variables that a user can set to control shell's behavior
    - PATH: when a user types a command, shell looks for the binary in the list of directories present in the PATH variable.
  - input/output redirection
    - every program executed in shell has three streams associated with it
      - standard input: where the program reads the input from; attached to keyboard by default
      - standard output: where the program writes its output; attached to screen by default
      - standard error: where the program writes its errors; attached to screen by default
    - shell allows us to redirect these streams from their defaults
      - use > to redirect standard output to a file:
        - ls -l /usr/bin >ls-output.txt
      - use >> to append standard output to a file; using >> will append to a file whereas using > will wipe the output of the file first before writing to it; thus, after the following commands, the file ls-output.txt will have twice the contents of the /usr/bin directory:
        - ls -l /usr/bin >ls-output.txt
        - ls -l /usr/bin >>ls-output.txt
      - use 2> to redirect standard error to a file:
        - ls -l /nonexistentfile 2>ls-error.txt
      - use < to read input from a file instead of keyboard:
        - cat < /etc/passwd
    - shell allows us to send the output of one program to the input of another program using pipe (|). the following command sequence sends the output of "ls -l /usr/bin" command to the input of "less" command for easier viewing:

  - ls -l /usr/bin | less
  - shell allows us to form powerful pipelines to perform arbitrarily complex tasks. see the lecture for an example.

- you should know the following shell commands; use tldr command to find out the most frequently used forms of these commands:
  - man
  - pwd
  - ls
  - cd
  - cp
  - mv
  - rm
  - mkdir
  - rmdir
  - type
  - alias
  - file
  - echo
  - less
  - cat

- the following is an example shell session. you should be able to understand and explain what is going on:

```
neo@ubuntu:~$ pwd
/home/neo
neo@ubuntu:~$ ls
demo    Documents  Music   Templates   Videos
Desktop  Downloads  Public  typescript
neo@ubuntu:~$ cd /
neo@ubuntu:/$ ls
bin   dev  lib   libx32     mnt   root  snap     sys  var
boot  etc  lib32  lost+found  opt   run   srv      tmp
cdrom  home  lib64  media      proc  sbin  swapfile  usr
neo@ubuntu:/$ cd
neo@ubuntu:~$ ls -a
.              .config    .gitconfig  Public                    typescript
..             demo       .gnupg      .ssh                      Videos
.bash_history  Desktop    .local      .sudo_as_admin_successful
.bash_logout   Documents  .mozilla    Templates
.bashrc        Downloads  Music       .thunderbird
.cache         .emacs.d   .profile    .tldr
neo@ubuntu:~$ cd .
neo@ubuntu:~$ pwd
/home/neo
neo@ubuntu:~$ cd ..
neo@ubuntu:/home$ pwd
/home
neo@ubuntu:/home$ cd ..
neo@ubuntu:/$ pwd
/
```

```
neo@ubuntu:/$ cd
neo@ubuntu:~$ ls
demo    Documents  Music  Templates  Videos
Desktop  Downloads  Public  typescript
neo@ubuntu:~$ file demo
demo: directory
neo@ubuntu:~$ cd demo
neo@ubuntu:~/demo$ ls
demo.c
neo@ubuntu:~/demo$ file demo.c
demo.c: C source, ASCII text
neo@ubuntu:~/demo$ cat demo.c
#include <stdio.h>

int main() {
  printf("welcome to git demo!\n");
  printf("Nice to meet you!");
}
neo@ubuntu:~/demo$ cd
neo@ubuntu:~$ alias
alias alert='notify-send --urgency=low -i "$([ $? = 0 ] && echo terminal || echo error)" "$(history|tail
-n1|sed -e '\''s/^\s*[0-9]\+\s*//;s/[;&|]\s*alert$//'\'')"'
alias egrep='egrep --color=auto'
alias fgrep='fgrep --color=auto'
alias grep='grep --color=auto'
alias l='ls -CF'
alias la='ls -A'
alias ll='ls -alF'
alias ls='ls --color=auto'
neo@ubuntu:~$ alias deepdir='mkdir a; cd a; mkdir b; cd b; mkdir c; cd c'
neo@ubuntu:~$ alias
alias alert='notify-send --urgency=low -i "$([ $? = 0 ] && echo terminal || echo error)" "$(history|tail
-n1|sed -e '\''s/^\s*[0-9]\+\s*//;s/[;&|]\s*alert$//'\'')"'
alias deepdir='mkdir a; cd a; mkdir b; cd b; mkdir c; cd c'
alias egrep='egrep --color=auto'
alias fgrep='fgrep --color=auto'
alias grep='grep --color=auto'
alias l='ls -CF'
alias la='ls -A'
alias ll='ls -alF'
alias ls='ls --color=auto'
neo@ubuntu:~$ deepdir
neo@ubuntu:~/a/b/c$ cd
neo@ubuntu:~$ deepdir
mkdir: cannot create directory ‘a’: File exists
mkdir: cannot create directory ‘b’: File exists
mkdir: cannot create directory ‘c’: File exists
neo@ubuntu:~/a/b/c$ cd
neo@ubuntu:~$ rmdir a
rmdir: failed to remove 'a': Directory not empty
neo@ubuntu:~$ rm -rf a
neo@ubuntu:~$ type deepdir
```

```
deepdir is aliased to `mkdir a; cd a; mkdir b; cd b; mkdir c; cd c'
neo@ubuntu:~$ unalias deepdir
neo@ubuntu:~$ type deepdir
bash: type: deepdir: not found
neo@ubuntu:~$ ls
demo    Documents  Music  Templates  Videos
Desktop  Downloads  Public  typescript
neo@ubuntu:~$ rmdir Videos
neo@ubuntu:~$ mkdir Videos
neo@ubuntu:~$ ls
demo    Documents  Music  Templates  Videos
Desktop  Downloads  Public  typescript
neo@ubuntu:~$ cp /etc/passwd x
neo@ubuntu:~$ file x
x: ASCII text
neo@ubuntu:~$ cp /etc/passwd Documents/
neo@ubuntu:~$ ls Documents/
passwd
neo@ubuntu:~$ cp /etc/passwd Documents/mypasswd
neo@ubuntu:~$ ls -l Documents/
total 8
-rw-r--r-- 1 neo neo 2744 Feb  2 07:50 mypasswd
-rw-r--r-- 1 neo neo 2744 Feb  2 07:49 passwd
neo@ubuntu:~$ mv Documents Templates/
neo@ubuntu:~$ ls
demo  Desktop  Downloads  Music  Public  Templates  typescript  Videos  x
neo@ubuntu:~$ ls Templates/
Documents
neo@ubuntu:~$ ls Templates/Documents/
mypasswd  passwd
neo@ubuntu:~$ exit
```