

Instructions:

This homework is done *individually*. You are allowed to use search engines, textbook/s, lecture notes, and any other non-human sources you wish. BUT you are *not* allowed to consult others, or help other students with their work, give hints or solutions to anyone in the class. The reason it is called a *Discovery* is because you will do some hands-on exercises and show what you have accomplished. Each exercise may have several sub-questions, so please read carefully. Do not copy questions, but do number your answers. Thoroughly explain what you have discovered. Save as pdf and submit. This is not the case when “less is more”. Avoid generic answers, as they will not earn you any points.

Screenshots

You may need to take a screenshots (with your keyboard, not the phone) to illustrate your work. Before you do this, please increase the font size of your terminal to 20. While taking a screenshot, make sure your command line prompt displaying your username and current date are clearly visible, or if screenshot content does not display the prompt, open another terminal in the background and make sure it displays the prompt. All screenshots should be clearly legible and illustrate without a doubt what you are doing. Each screenshot must have your new prompt visible in one of the terminal windows on your desktop. You can also open your screenshot in an image editor and trim off the parts you do not need, so that they take less space. Insert them into the file when answering the question, do NOT submit them separately as image files. You will not get credit for screenshots submitted separately. You can type in black or blue, please do not use red. Save your file as a .pdf file and submit to Canvas before the deadline.

Computer Science is attention to detail, so let's make your work look nice and professional, even though *it does not have to conform to MLA, APA, or ACM format*.

What and how to submit

Submit your .pdf file to canvas before the due date. All screenshots illustrating your work should be part of the document, not submitted separately.

Grading and Points

Every question indicates how many points it is worth.

Exercises

1. Explore Linux environment variables and shell variables. Explain the difference between them, and show how to list and create such variables. Select 3 environment variables of your choice and show how to change the value. (6)

Environment variables are available to the shell and to the child processes that it starts. Shell variables, on the other hand, are for the local and current shell instance. To list environment variables, the env command is used and set is used for shell variables.

```
gfhg123@numbat:~  
mcdonn7@numbat:~ Tue Sep 23 23:06:49$env  
SHELL=/bin/bash  
SESSION_MANAGER=local/numbat:@/tmp/.ICE-unix/2470,unix/numbat:/tmp/.ICE-unix/2470  
QT_ACCESSIBILITY=1  
COLORTERM=truecolor  
XDG_CONFIG_DIRS=/etc/xdg/xdg-ubuntu:/etc/xdg  
XDG_MENU_PREFIX=gnome-  
GNOME_DESKTOP_SESSION_ID=this-is-deprecated  
GNOME_SHELL_SESSION_MODE=ubuntu  
SSH_AUTH_SOCK=/run/user/1000/keyring/ssh  
MEMORY_PRESSURE_WRITE=c29tZSAyMDAwMDAgMjAwMDAwMAA=  
XMODIFIERS=@im=ibus  
DESKTOP_SESSION=ubuntu  
GTK_MODULES=gail:atk-bridge  
PWD=/home/gfhg123  
LOGNAME=gfhg123  
XDG_SESSION_DESKTOP=ubuntu  
XDG_SESSION_TYPE=wayland  
SYSTEMD_EXEC_PID=2514  
XAUTHORITY=/run/user/1000/.mutter-Xwaylandauth.T0SFD3  
HOME=/home/gfhg123  
USERNAME=gfhg123  
IM_CONFIG_PHASE=1  
LANG=en_US.UTF-8  
LS_COLORS=rs=0:di=01;34:ln=01;36:mh=00:pi=40;33:so=01;35:do=01;35:bd=40;33:01:cd=40;33:01:or=40;31:01:mi=00  
:su=37;41:sg=30;43:ca=00:tw=30;42:ow=34;42:st=37;44:ex=01;32:*.tar=01;31:*.tgz=01;31:*.arc=01;31:*.arj=01;3  
1:*.taz=01;31:*.lha=01;31:*.lz4=01;31:*.lzh=01;31:*.lzma=01;31:*.tlz=01;31:*.txz=01;31:*.tzo=01;31:*.t7z=01  
;31:*.zip=01;31:*.z=01;31:*.dz=01;31:*.gz=01;31:*.lrz=01;31:*.lz=01;31:*.lzo=01;31:*.xz=01;31:*.zst=01;31:*.  
.tzt=01;31:*.bz2=01;31:*.bz=01;31:*.tbz=01;31:*.tbz2=01;31:*.tz=01;31:*.deb=01;31:*.rpm=01;31:*.jar=01;31:  
*.war=01;31:*.ear=01;31:*.sar=01;31:*.rar=01;31:*.alz=01;31:*.ace=01;31:*.zoo=01;31:*.cpio=01;31:*.7z=01;31  
:*.rz=01;31:*.cab=01;31:*.wim=01;31:*.swm=01;31:*.dwm=01;31:*.esd=01;31:*.avif=01;35:*.jpg=01;35:*.jpeg=01;  
35:*.mjpg=01;35:*.mjpeg=01;35:*.gif=01;35:*.bmp=01;35:*.pbm=01;35:*.pgm=01;35:*.ppm=01;35:*.tga=01;35:*.xbm  
=01;35:*.xpm=01;35:*.tif=01;35:*.tiff=01;35:*.png=01;35:*.sva=01;35:*.svaz=01;35:*.mna=01;35:*.pcx=01;35:*.  
gfhg123@numbat:~  
mcdonn7@numbat:~ Tue Sep 23 23:07:19$set  
BASH=/usr/bin/bash  
BASHOPTS=checkwinsize:cmdhist:complete_fullquote:expand_aliases:extglob:extquote:force_ignores:globasciiran  
ges:globskipdots:histappend:interactive_comments:patsub_replacement:progcomp:promptvars:sourcepath  
BASH_ALIASES=()  
BASH_ARGC=([0]="0")  
BASH_ARGV=()  
BASH_CMDS=()  
BASH_COMPLETION_VERSION=([0]="2" [1]="11")  
BASH_LINENO=()  
BASH_LOADABLES_PATH=/usr/local/lib/bash:/usr/lib/bash:/opt/local/lib/bash:/usr/pkg/lib/bash:/opt/pkg/lib/ba  
sh:.  
BASH_SOURCE=()  
BASH_VERSION=([0]="5" [1]="2" [2]="21" [3]="1" [4]="release" [5]="aarch64-unknown-linux-gnu")  
BASH_VERSION='5.2.21(1)-release'  
CLUTTER_DISABLE_MIPMAPPED_TEXT=1  
COLORTERM=truecolor  
COLUMNS=107  
DBUS_SESSION_BUS_ADDRESS=unix:path=/run/user/1000/bus  
DEBUGINFOD_URLS='https://debuginfod.ubuntu.com'  
DESKTOP_SESSION=ubuntu  
DIRSTACK=()  
DISPLAY=:0  
EUID=1000  
GDMSESSION=ubuntu  
GNOME_DESKTOP_SESSION_ID=this-is-deprecated  
GNOME_SETUP_DISPLAY=:1  
GNOME_SHELL_SESSION_MODE=ubuntu  
GNOME_TERMINAL_SCREEN=/org/gnome/Terminal/screen/bbcb6dfe_cf0f_4cc4_a2b4_8542881bab56  
GNOME_TERMINAL_SERVICE=:1.108  
GROUPS=()  
GSM_SKIP_SSH_AGENT_WORKAROUND=true  
GTK_MODULES=gail:atk-bridge
```

The export command is used to make environment variables. Past that, the creation of the two variables is essentially the same: variable_name="variable value".

```
gfhg123@numbat: ~  
mcdonn7@numbat:~ Tue Sep 23 23:09:35$export my_env_var="Yippee"  
mcdonn7@numbat:~ Tue Sep 23 23:10:44$my_shell_var="Yippee Shell"  
mcdonn7@numbat:~ Tue Sep 23 23:10:57$echo $my_env_var  
Yippee  
mcdonn7@numbat:~ Tue Sep 23 23:11:04$echo $my_shell_var  
Yippee Shell  
mcdonn7@numbat:~ Tue Sep 23 23:11:12$
```

Changing value for \$USER:

```
gfhg123@numbat: ~  
mcdonn7@numbat:~ Tue Sep 23 23:15:58$echo $USER  
gfhg123  
mcdonn7@numbat:~ Tue Sep 23 23:16:01$export USER="mcdonn7"  
mcdonn7@numbat:~ Tue Sep 23 23:16:12$echo $USER  
mcdonn7  
mcdonn7@numbat:~ Tue Sep 23 23:16:16$
```

Changing value for \$PATH

```
Sep 23 23:18  
gfhg123@numbat: ~  
mcdonn7@numbat:~ Tue Sep 23 23:17:56$echo $PATH  
/usr/local/sbin:/usr/local/bin:/usr/sbin:/usr/bin:/sbin:/bin:/usr/games:/usr/local/games:/snap/bin:/snap/bin  
mcdonn7@numbat:~ Tue Sep 23 23:18:14$export PATH=$PATH:/home/mcdonn7/scripts  
mcdonn7@numbat:~ Tue Sep 23 23:18:41$echo $PATH  
/usr/local/sbin:/usr/local/bin:/usr/sbin:/usr/bin:/sbin:/bin:/usr/games:/usr/local/games:/snap/bin:/snap/bin:/home/mcdonn7/scripts  
mcdonn7@numbat:~ Tue Sep 23 23:18:45$
```

Changing value for \$EDITOR:

```
Sep 23 23:21
gfhg123@numbat: ~
mcdonn7@numbat:~ Tue Sep 23 23:21:06$echo $EDITOR
mcdonn7@numbat:~ Tue Sep 23 23:21:09$export EDITOR="code"
mcdonn7@numbat:~ Tue Sep 23 23:21:17$echo $EDITOR
code
mcdonn7@numbat:~ Tue Sep 23 23:21:22$
```

2. Investigate Linux process with pid = 0. What is the function of the process and why is it not listed when you list running processes with top or ps. (4)

The process with pid = 0 is known as the Kernel Idle Process. It is also known as the “swapper” process. It is utilized when there are no other processes running. The reason that it is not listed is because it is a kernel-mode process and not a user-mode process.

3. Investigate the difference between two command line programs – *more* and *less*. Explain what the differences in functionalities are. (4)

More and Less are both used to read the content of files. However, more is a more primitive file reader as it only allows you to read, transverse forward, and it must load the entire file before you can read it. Less, on the other hand, adds special features like being able to search, bidirectional reading, and it loads the file as you go, making much faster.

“Less is more, more or less”

4. Investigate files *.profile*, *.bashrc*, and *.bash_profile*. Answer the following questions.(8)

- a. Explain why their filenames start with a dot. Which command allows you to list these files.

These filenames start with a dot because they are hidden files. Adding -a or -A to ls lists all hidden files as well as normal files.

- b. Does Ubuntu distro have all of them, or which ones does it have? Please include screenshot/s showing if your system has these files.

My distro does has .profile and .bashrc but not .bash_profile.

```
mcdonn7@numbat:~ Tue Sep 23 23:40:19$ls -la
.          .bashrc      .lesshst    my_softlink .sudo_as_admin_successful
..         .cache        .local      Pictures     Templates
asciiquarium_1.1 .config      Music       .profile     Term-Animation-2.5
asciiquarium.tar.gz Desktop      my_hardlink Public        Term-Animation-2.5.tar.gz
.bash_history Documents   my_prog     snap         Videos
.bash_logout Downloads  my_prog.c   .ssh         .viminfo
mcdonn7@numbat:~ Tue Sep 23 23:40:21$
```

c. Describe in general terms what the contents of these files are, and what role they play in the system.

.profile – This is used when a user logs in via console or SSH. It is not specific to a certain shell like bash is, but is used to set up the environment. It is executed upon log in. It contains environment variables.

.bashrc – This is used to set up a specific bash shell environment and creates everything needed for that. It is executed upon creation of a Bash Shell. It contains aliases, functions for the shell, shell options, and custom prompts.

.bash_profile -This is used for log ins specific to a Bash Shell and is executed upon log in. Normally a user will only have this or .profile and not both. This contains environment variables and which apps should start at login.

d. When do they get executed?

.profile – log in

.bashrc – creation of a bash shell

.bash_profile – log in

5. Research aliases. Create aliases described below that persist across boots. To do this you will place these aliases into the appropriate file, so that they work every time you boot the system. (6)

- a. Alias *lsdirs* to list all files/subdirectories in the current directory (should work in any directory, so do not hard-code the path), even hidden files, in long format, in sorted by time with a slash indicating if an entry is a directory.
- b. Alias *hid* to lists only hidden files in your home directory, in long format.
- c. Which file did you change to add aliases? Open that file in an editor, take a screenshot with your changes and insert below.

The aliases go in the .bashrc file, meaning that is what was changed.

```
# colored GCC warnings and errors
#export GCC_COLORS='error=01;31:warning=01;35:success=01;32:stderr=01;35;'

# some more ls aliases
alias ll='ls -alF'
alias la='ls -A'
alias l='ls -CF'

alias lsdirs='ls -alF --sort=time'
alias hid='ls -ald ~/.*'

```

6. Figure out how to display GRUB menu on startup for a single-OS system. In multi-boot system it will be shown automatically, but there is also a way to display it in a single-boot system, like your VM. Research which grub variables you need to change to do this. Insert a screenshot that shows what changes you have made and in which file, and another screenshot that shows your grub menu displayed at boot time. (6)

I changed the GRUB_TIMEOUT_STYLE and GRUB_TIMEOUT to menu and 15 respectively.

```
gfhg123@numbat: /etc/default
# If you change this file, run 'update-grub' afterwards to update
# /boot/grub/grub.cfg.
# For full documentation of the options in this file, see:
#   info -f grub -n 'Simple configuration'

GRUB_DEFAULT=0
GRUB_TIMEOUT_STYLE=menu
GRUB_TIMEOUT=15
GRUB_DISTRIBUTOR=`( . /etc/os-release; echo ${NAME:-Ubuntu} ) 2>/dev/null || echo Ubuntu`
GRUB_CMDLINE_LINUX_DEFAULT="console=tty0"
GRUB_CMDLINE_LINUX=""

# If your computer has multiple operating systems installed, then you
# probably want to run os-prober. However, if your computer is a host
# for guest OSes installed via LVM or raw disk devices, running
# os-prober can cause damage to those guest OSes as it mounts
# filesystems to look for things.
#GRUB_DISABLE_OS_PROBER=false

# Uncomment to enable BadRAM filtering, modify to suit your needs

GNU GRUB  version 2.12

#Ubuntu
Advanced options for Ubuntu
UEFI Firmware Settings

Use the ↑ and ↓ keys to select which entry is highlighted.
Press enter to boot the selected OS, 'e' to edit the commands before booting or 'c'
for a command-line. ESC to return previous menu.
The highlighted entry will be executed automatically in 13s.
```

7. Change background image of GRUB menu to a tiger (find the one you like online). There is more than one way to do this. Insert a screenshot that clearly shows how/where you did this and another screenshot that shows that your background image is now a tiger.

(6)

```
mcdonn7@numbat:~ Wed Sep 24 01:10:09$ sudo vim /etc/default/grub
```



gfhg123@numbat: ~

```
# If you change this file, run 'update-grub' and
# /boot/grub/grub.cfg.
# For full documentation of the options in the
#   info -f grub -n 'Simple configuration'
```

```
GRUB_DEFAULT=0
GRUB_TIMEOUT_STYLE=menu
GRUB_TIMEOUT=15
GRUB_DISTRIBUTOR=`(. /etc/os-release; echo $-
| echo Ubuntu`
GRUB_CMDLINE_LINUX_DEFAULT="console=tty0"
GRUB_CMDLINE_LINUX=""
GRUB_BACKGROUND=/boot/grub/tiger.png
```

GNU GRUB version 2.12

*Ubuntu
Advanced options for Ubuntu
UEFI Firmware Settings

Use the ↑ and ↓ keys to select which entry is highlighted.
Press enter to boot the selected OS, 'e' to edit the commands before booting, or 'c' for a command-line. ESC to
return previous menu.
The highlighted entry will be executed automatically in 14s.

8. Investigate the sudo grace period. Change it to be 13 minutes. Screenshot your changes.(5)

```
Firefox gfhg123@numbat: ~
GNU nano 7.2 /etc/sudoers.tmp *
#
# This file MUST be edited with the 'visudo' command as root.
#
# Please consider adding local content in /etc/sudoers.d/ instead of
# directly modifying this file.
#
# See the man page for details on how to write a sudoers file.
#
Defaults      env_reset
Defaults      mail_badpass
Defaults      secure_path="/usr/local/sbin:/usr/local/bin:/usr/sbin:/usr>
Defaults      timestamp_timeout=13
```

9. In this exercise you will limit the number of processes that your user can create to a small number (20-30?) and test to verify that the change is effective by running a fork bomb. First run a fork bomb in your VM to see that the system crashed. Then you will limit the number and run again and screenshot the results and all the changes made. (5)

```
gfhg123@numbat: ~
#
# - msgqueue - max memory used by POSIX messa
#
# - nice - max nice priority allowed to raise
#
# - rtprio - max realtime priority
#
# - chroot - change root to directory (Debian
#
#<domain>      <type>  <item>          <value>
#
#*              soft    core            0
#root           hard    core            100000
#*              hard    rss             10000
#@student       hard    nproc           20
#@faculty       soft    nproc           20
#@faculty       hard    nproc           50
#ftp            hard    nproc           0
#ftp            -       chroot           /ftp
#@student       -       maxlogins        4
gfhg123         soft    nproc           20
gfhg123         hard    nproc           20
# End of file
```