

# lab1-report

## Task1: Manipulating Environment Variables

In this task, we study the commands that can be used to set and unset environment variables  
Use printenv or env command to print out the environment variables.

```
[09/01/20]seed@M:~$ printenv
XDG_VTNR=7
XDG_SESSION_ID=c1
XDG_GREETER_DATA_DIR=/var/lib/lightdm-data/seed
CLUTTER_IM_MODULE=xim
SESSION=ubuntu
ANDROID_HOME=/home/seed/android/android-sdk-linux
GPG_AGENT_INFO=/home/seed/.gnupg/S.gpg-agent:0:1
TERM=xterm-256color
VTE_VERSION=4205
XDG_MENU_PREFIX=gnome-
SHELL=/bin/bash
DERBY_HOME=/usr/lib/jvm/java-8-oracle/db
QT_LINUX_ACCESSIBILITY_ALWAYS_ON=1
LD_PRELOAD=/home/seed/lib/boost/libboost_program_options.so.1.64.0:/home/seed/lib/boost/libboost_filesystem.so.1.64.0:/home/seed/lib/boost/libboost_system.so.1.64.0
WINDOWID=39845898
UPSTART_SESSION=unix:abstract=/com/ubuntu/upstart-session/1000/1201
GNOME_KEYRING_CONTROL=
GTK_MODULES=gail:atk:bridge:unity-gtk-module
USER=seed
LS_COLORS=rs=0:di=01;34:ln=01;36:mh=00:pi=40;33:so=01;35:do=01;33:bd=40;33:cd=40;33:ol=40;31:or=40;31:mi=00;34:st=01;31:ca=30;41:tw=30;42:ow=34;42:st=37;44:ex=01;32:tz=01;31:tar=01;31:arc=01;31:a
rj=01;31:arz=01;31:lha=01;31:lx4=01;31:lzH=01;31:lzma=01;31:tlz=01;31:txz=01;31:tz=01;31
:z=01;31:zst=01;31:bz=01;31:tbz=01;31:tbz2=01;31:xz=01;31:deb=01;31:debz=01;31:zoo=01;31:X
z=01;31:bz2=01;31:bsz=01;31:tbz2=01;31:tbz=01;31:xz=01;31:deb=01;31:debz=01;31:zoo=01;31:X
z=01;31:ear=01;31:tar=01;31:tarw=01;31:lz=01;31:lzma=01;31:ace=01;31:zoo=01;31:cpio=01;31:7z=01;31
:r=01;31:cab=01;31:Jpg=01;35:jpeg=01;35:gif=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:svg=01;35:svgz=01;35:m
ng=01;35:pcx=01;35:mov=01;35:mpg=01;35:mpeg=01;35:m2v=01;35:mkv=01;35:webm=01;35:ogg=01;3
5:m4v=01;35:m4v=01;35:mp4v=01;35:vob=01;35:qt=01;35:nuv=01;35:wmv=01;35:asf=01;35:r=01
;35:rmb=01;35:f1c=01;35:avi=01;35:fli=01;35:flv=01;35:gl=01;35:dl=01;35:xcf=01;35:xwd=
01;35:yuv=01;35:cgm=01;35:emf=01;35:ogv=01;35:ogx=01;35:aac=00;36:au=00;36:flac=00;36:m
4a=00;36:mid=00;36:midi=00;36:mka=00;36:mp3=00;36:mpc=00;36:ogg=00;36:ra=00;36:wav=00;36:
ogg=00;36:opus=00;36:spx=00;36:xspf=00;36:
```

```
QT_ACCESSIBILITY=1
LD_LIBRARY_PATH=/home/seed/source/boost_1_64_0/stage/lib:/home/seed/source/boost_1_64_0/stage/lib:
XDG_SESSION_PATH=/org/freedesktop/DisplayManager/Session0
XDG_SEAT_PATH=/org/freedesktop/DisplayManager/Seat0
SSH_AUTH_SOCK=/run/user/1000/keyring/ssh
DEFAULTS_PATH=/usr/share/gconf/ubuntu.default.path
SESSION_MANAGER=local:VM:/tmp/.ICE-unix/2489,unix/VM:/tmp/.ICE-unix/2489
XDG_CONFIG_DIRS=/etc/xdg:$xdg-ubuntu:/usr/share/upstart/xdg:/etc/xdg
DESKTOP_SESSION=ubuntu
PATH=/home/seed/bin:/usr/local/sbin:/usr/bin:/sbin:/usr/bin:/bin:/usr/games:/usr/local/ga
mes...:/snap/bin:/usr/lib/jvm/java-8-oracle/bin:/usr/lib/jvm/java-8-oracle/db/bin:/usr/lib/jvm/java-8-orac
le/jre/bin:/home/seed/android/android-sdk-linux/tools:/home/seed/android/android-sdk-linux/platform-tools
:/home/seed/android/android-ndk/android-ndk-r8d:/home/seed/.local/bin
QT_IM_MODULE=ibus
QT_QPA_PLATFORMTHEME=appmenu-qt5
XDG_SESSION_TYPE=x11
PnD=/home/seed
JOB=dibus
XMODIFIERS=@im=ibus
JAVA_HOME=/usr/lib/jvm/java-8-oracle
GNOME_KEYRING_PID=
LANG=en_US.UTF-8
GDM_LANG=en_US
MANDATORY_PATH=/usr/share/gconf/ubuntu.mandatory.path
COMPIZ_CONFIG_PROFILE=ubuntu
IN_CONFIG_PHASE=1
GDMSESSION=ubuntu
SESSIONTYPE=gnome-session
GTK2_MODULES=overlay-scrollbar
SHLVL=1
HOME=/home/seed
XDG_SEAT=seat0
LANGUAGE=en_US
GNOME_DESKTOP_SESSION_ID=this-is-deprecated
XDG_SESSION_DESKTOP=ubuntu
LOGNAME=seed
DBUS_SESSION_BUS_ADDRESS=unix:abstract=/tmp/dbus-YNhZsVBF0n
JSDOMDIR=/usr/lib/jvm/java-8-oracle
XDG_DATA_DIRS=/usr/share/ubuntu:/usr/share/gnome:/usr/local/share:/usr/share:/var/lib/snapd/desktop
QT4_IM_MODULE=xim
LESSOPEN=| /usr/bin/lesspipe %
INSTANCE=
XDG_RUNTIME_DIR=/run/user/1000
DISPLAY=:0
XDG_CURRENT_DESKTOP=Unity
GTK_IM_MODULE=ibus
```

```
JAVA_HOME=/usr/lib/jvm/java-8-oracle
GNOME_KEYRING_PID=
LANG=en_US.UTF-8
GDM_LANG=en_US
MANDATORY_PATH=/usr/share/gconf/ubuntu.mandatory.path
COMPIZ_CONFIG_PROFILE=ubuntu
IM_CONFIG_PHASE=1
GDMSESSION=ubuntu
SESSIONTYPE=gnome-session
GTK2_MODULES=overlay-scrollbar
SHLVL=1
HOME=/home/seed
XDG_SEAT=seat0
LANGUAGE=en_US
GNOME_DESKTOP_SESSION_ID=this-is-deprecated
XDG_SESSION_DESKTOP=ubuntu
LOGNAME=seed
DBUS_SESSION_BUS_ADDRESS=unix:abstract=/tmp/dbus-YNhZsVBf0n
J2SDKDIR=/usr/lib/jvm/java-8-oracle
XDG_DATA_DIRS=/usr/share/ubuntu:/usr/share/gnome:/usr/local/share/:/usr/share:/var/lib/snapd/desktop
QT4_IM_MODULE=xim
LESSOPEN=-l /usr/bin/lesspipe %
INSTANCE=
XDG_RUNTIME_DIR=/run/user/1000
DISPLAY=:0
XDG_CURRENT_DESKTOP=Unity
GTK_IM_MODULE=ibus
J2REDIR=/usr/lib/jvm/java-8-oracle/jre
LESSCLOSE=/usr/bin/lesspipe %s %
XAUTHORITY=/home/seed/.Xauthority
_=user/bin/printenv
```

```
[09/01/20]seed@VM:~$ env | grep jre
PATH=/home/seed/bin:/usr/local/sbin:/usr/local/bin:/usr/sbin:/usr/bin:/sbin:/bin:/usr/games:/usr/local/games
.:./snap/bin:/usr/lib/jvm/java-8-oracle/bin:/usr/lib/jvm/java-8-oracle/db/bin:/usr/lib/jvm/java-8-oracle/jre/bin:/home/seed/android/android-sdk-linux/tools:/home/seed/android/android-sdk-linux/platform-tools
:/home/seed/android/android-ndk/android-ndk-r8d:/home/seed/.local/bin
J2REDIR=/usr/lib/jvm/java-8-oracle/jre
[09/01/20]seed@VM:~$
```

```
[09/01/20]seed@VM:~$ printenv PWD
/home/seed
[09/01/20]seed@VM:~$ env | grep PWD
PWD=/home/seed
[09/01/20]seed@VM:~$
```

Use export and unset to set or unset environment variables.

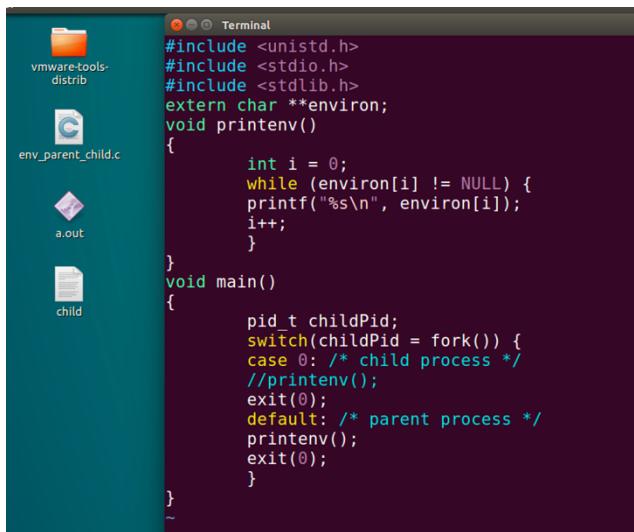
```
[09/01/20]seed@VM:~$ export SIXIAOKAI=123
[09/01/20]seed@VM:~$ printenv SIXIAOKAI
123
[09/01/20]seed@VM:~$ unset SIXIAOKAI
[09/01/20]seed@VM:~$ printenv SIXIAOKAI
[09/01/20]seed@VM:~$
```

## Task2: Passing Environment Variables from Parent Process to Child Process

In this task, we study how a child process gets its environment variables from its parent.

### Step 1

Compile and run the following program, and describe your observation. Because the output contains many strings, you should save the output into a file, such as using a.out > child



```
#include <unistd.h>
#include <stdio.h>
#include <stdlib.h>
extern char **environ;
void printenv()
{
    int i = 0;
    while (environ[i] != NULL) {
        printf("%s\n", environ[i]);
        i++;
    }
}
void main()
{
    pid_t childPid;
    switch(childPid = fork()) {
    case 0: /* child process */
        //printenv();
        exit(0);
    default: /* parent process */
        printenv();
        exit(0);
    }
}
```

Child 的文件内容为子进程的环境变量。

```
XDG_VTNR=7
XDG_SESSION_ID=c1
XDG_GREETER_DATA_DIR=/var/lib/lightdm-data/seed
CLUTTER_IM_MODULE=xim
SESSION=ubuntu
ANDROID_HOME=/home/seed/android/android-sdk-linux
GPG_AGENT_INFO=/home/seed/.gnupg/S.gpg-agent:0:1
TERM=xterm-256color
VTE_VERSION=4205
XDG_MENU_PREFIX=gnome-
SHELL=/bin/bash
DERBY_HOME=/usr/lib/jvm/java-8-oracle/db
QT_LINUX_ACCESSIBILITY_ALWAYS_ON=1
LD_PRELOAD=/home/seed/lib/boost/libboost_program_options.so.1.64.0:/home/seed/lib/b
oost/libboost_filesystem.so.1.64.0:/home/seed/lib/boost/libboost_system.so.1.64.0
WINDOWID=54525962
UPSTART_SESSION=unix:abstract=/com/ubuntu/upstart-session/1000/1172
GNOME_KEYRING_CONTROL=
GTK_MODULES=gail:atk-bridge:unity-gtk-module
USER=seed
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=30;41:tw=30;42:ow=34;42:st=37;44:ex=
01;32:*.tar=01;31:*.tgz=01;31:*.arc=01;31:*.arj=01;31:*.taz=01;31:*.lha=01;31:*.lz4=01;31:*.lz=
h=01;31:*.lzma=01;31:*.tlz=01;31:*.txz=01;31:*.tzo=01;31:*.t7z=01;31:*.zip=01;31:*.z=01;31:*
.Z=01;31:*.dz=01;31:*.gz=01;31:*.lrz=01;31:*.lz=01;31:*.lzo=01;31:*.xz=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=0
1;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:*.jpg=01;35:*.jpeg=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:\*.svg=01;35:\*.svgz=01;35:\*.mng=01;35:\*.pcx=01;35:\*.mov=01;35:\*.mpg=01;  
35:\*.mpeg=01;35:\*.m2v=01;35:\*.mkv=01;35:\*.webm=01;35:\*.ogm=01;35:\*.mp4=01;35:\*.m4v  
=01;35:\*.mp4v=01;35:\*.vob=01;35:\*.qt=01;35:\*.nuv=01;35:\*.wmv=01;35:\*.ASF=01;35:\*.rm=01  
;35:\*.rmvb=01;35:\*.flc=01;35:\*.avi=01;35:\*.fli=01;35:\*.flv=01;35:\*.gl=01;35:\*.dl=01;35:\*.xcf=01  
1;35:\*.xwd=01;35:\*.yuv=01;35:\*.cgm=01;35:\*.emf=01;35:\*.ogv=01;35:\*.ogx=01;35:\*.aac=00;  
36:\*.au=00;36:\*.flac=00;36:\*.m4a=00;36:\*.mid=00;36:\*.midi=00;36:\*.mka=00;36:\*.mp3=00;3  
6:\*.mpc=00;36:\*.ogg=00;36:\*.ra=00;36:\*.wav=00;36:\*.oga=00;36:\*.opus=00;36:\*.spx=00;36:  
.xspf=00;36:

QT\_ACCESSIBILITY=1

LD\_LIBRARY\_PATH=/home/seed/source/boost\_1\_64\_0/stage/lib:/home/seed/source/boost\_1\_64\_0/stage/lib:

XDG\_SESSION\_PATH=/org/freedesktop/DisplayManager/Session0

XDG\_SEAT\_PATH=/org/freedesktop/DisplayManager/Seat0

SSH\_AUTH\_SOCK=/run/user/1000/keyring/ssh

DEFAULTS\_PATH=/usr/share/gconf/ubuntu.default.path

SESSION\_MANAGER=local/VM:@/tmp/.ICE-unix/1667,unix/VM:/tmp/.ICE-unix/1667

XDG\_CONFIG\_DIRS=/etc/xdg/xdg-ubuntu:/usr/share/upstart/xdg:/etc/xdg

DESKTOP\_SESSION=ubuntu

PATH=/home/seed/bin:/usr/local/sbin:/usr/local/bin:/usr/sbin:/usr/bin:/sbin:/bin:/usr/games  
:/usr/local/games:::/snap/bin:/usr/lib/jvm/java-8-oracle/bin:/usr/lib/jvm/java-8-oracle/db/bin:/usr/lib/jvm/java-8-oracle/jre/bin:/home/seed/android/android-sdk-linux/tools:/home/seed/android/android-sdk-linux/platform-tools:/home/seed/android/android-ndk/android-ndk-r8d:/home/seed/.local/bin

QT\_IM\_MODULE=ibus

QT\_QPA\_PLATFORMTHEME=appmenu-qt5

XDG\_SESSION\_TYPE=x11

PWD=/home/seed/Desktop

JOB=dbus

XMODIFIERS=@im=ibus

JAVA\_HOME=/usr/lib/jvm/java-8-oracle

GNOME\_KEYRING\_PID=

LANG=en\_US.UTF-8

GDM\_LANG=en\_US

MANDATORY\_PATH=/usr/share/gconf/ubuntu.mandatory.path

COMPIZ\_CONFIG\_PROFILE=ubuntu

IM\_CONFIG\_PHASE=1

GDMSESSION=ubuntu

SESSIONTYPE=gnome-session

GTK2\_MODULES=overlay-scrollbar

SHLVL=1

HOME=/home/seed

XDG\_SEAT=seat0

LANGUAGE=en\_US

```
GNOME_DESKTOP_SESSION_ID=this-is-deprecated
XDG_SESSION_DESKTOP=ubuntu
LOGNAME=seed
DBUS_SESSION_BUS_ADDRESS=unix:abstract=/tmp/dbus-zXtw1QEMot
J2SDKDIR=/usr/lib/jvm/java-8-oracle
XDG_DATA_DIRS=/usr/share/ubuntu:/usr/share/gnome:/usr/local/share/:/usr/share/:/var/lib
/snapd/desktop
QT4_IM_MODULE=xim
LESSOPEN=| /usr/bin/lesspipe %s
INSTANCE=
XDG_RUNTIME_DIR=/run/user/1000
DISPLAY=:0
XDG_CURRENT_DESKTOP=Unity
GTK_IM_MODULE=ibus
J2REDIR=/usr/lib/jvm/java-8-oracle/jre
LESSCLOSE=/usr/bin/lesspipe %s %s
XAUTHORITY=/home/seed/.Xauthority
_=./a.out
OLDPWD=/home/seed
```

## Step 2

Now comment out the `printenv()` statement in the child process case (Line A), and uncomment the `printenv()` statement in the parent process case (Line A). Compile and run the code again, and describe observation. Save the output in another file called `parent`.

`Parent` 的文件内容为父进程的环境变量。

```
XDG_VTNR=7
XDG_SESSION_ID=c1
XDG_GREETER_DATA_DIR=/var/lib/lightdm-data/seed
CLUTTER_IM_MODULE=xim
SESSION=ubuntu
ANDROID_HOME=/home/seed/android/android-sdk-linux
GPG_AGENT_INFO=/home/seed/.gnupg/S.gpg-agent:0:1
TERM=xterm-256color
VTE_VERSION=4205
XDG_MENU_PREFIX=gnome-
SHELL=/bin/bash
DERBY_HOME=/usr/lib/jvm/java-8-oracle/db
QT_LINUX_ACCESSIBILITY_ALWAYS_ON=1
LD_PRELOAD=/home/seed/lib/boost/libboost_program_options.so.1.64.0:/home/seed/lib/bo
ost/libboost_filesystem.so.1.64.0:/home/seed/lib/boost/libboost_system.so.1.64.0
WINDOWID=54525962
```

UPSTART\_SESSION=unix:abstract=/com/ubuntu/upstart-session/1000/1172  
GNOME\_KEYRING\_CONTROL=  
GTK\_MODULES=gail:atk-bridge:unity-gtk-module  
USER=seed  
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=30;41:tw=30;42:ow=34;42:st=37;44:e  
x=01;32:\*.tar=01;31:\*.tgz=01;31:\*.arc=01;31:\*.arj=01;31:\*.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:\*.Z=01;31:\*.dz=01;31:\*.gz=01;31:\*.lrz=01;31:\*.lz=01;31:\*.lzo=01;31:\*.xz=01;31  
:\*.bz2=01;31:\*.bz=01;31:\*.tbz=01;31:\*.tbz2=01;31:\*.tz=01;31:\*.deb=01;31:\*.rpm=01;31:\*.j  
ar=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:\*.jpg=01;35:\*.jpeg=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:\*.svg=01;35:\*.svgz=01;35:\*.mng=01;35:\*.pcx=01;  
35:\*.mov=01;35:\*.mpg=01;35:\*.mpeg=01;35:\*.m2v=01;35:\*.mkv=01;35:\*.webm=01;35:\*.ogm=01;  
35:\*.mp4=01;35:\*.m4v=01;35:\*.mp4v=01;35:\*.vob=01;35:\*.qt=01;35:\*.nuv=01;35:\*.wmv=01;  
35:\*.ASF=01;35:\*.rm=01;35:\*.rmvb=01;35:\*.flc=01;35:\*.avi=01;35:\*.fli=01;35:\*.flv=01;  
35:\*.gl=01;35:\*.dl=01;35:\*.xcf=01;35:\*.xdw=01;35:\*.yuv=01;35:\*.cgm=01;35:\*.emf=01;  
35:\*.ovg=01;35:\*.ogx=01;35:\*.aac=00;36:\*.au=00;36:\*.flac=00;36:\*.m4a=00;36:\*.mid=00;  
36:\*.midi=00;36:\*.mka=00;36:\*.mp3=00;36:\*.mpc=00;36:\*.ogg=00;36:\*.ra=00;36:\*.wav=00;36:\*.oga=00;  
36:\*.opus=00;36:\*.spx=00;36:\*.xspf=00;36:  
QT\_ACCESSIBILITY=1  
LD\_LIBRARY\_PATH=/home/seed/source/boost\_1\_64\_0/stage/lib:/home/seed/source/boost\_1\_64\_0/stage/lib:  
XDG\_SESSION\_PATH=/org/freedesktop/DisplayManager/Session0  
XDG\_SEAT\_PATH=/org/freedesktop/DisplayManager/Seat0  
SSH\_AUTH\_SOCK=/run/user/1000/keyring/ssh  
DEFAULTS\_PATH=/usr/share/gconf/ubuntu.default.path  
SESSION\_MANAGER=local/VM:@/tmp/.ICE-unix/1667,unix/VM:/tmp/.ICE-unix/1667  
XDG\_CONFIG\_DIRS=/etc/xdg/xdg-ubuntu:/usr/share/upstart/xdg:/etc/xdg  
DESKTOP\_SESSION=ubuntu  
PATH=/home/seed/bin:/usr/local/sbin:/usr/local/bin:/usr/sbin:/usr/bin:/sbin:/bin:/usr/games:/u  
sr/local/games:::/snap/bin:/usr/lib/jvm/java-8-oracle/bin:/usr/lib/jvm/java-8-oracle/db/bin:/u  
r/lib/jvm/java-8-oracle/jre/bin:/home/seed/android/android-sdk-linux/tools:/home/seed/android/and  
roid-ndk/android-ndk-r8d:/home/seed/.local/bin  
QT\_IM\_MODULE=ibus  
QT\_QPA\_PLATFORMTHEME=appmenu-qt5  
XDG\_SESSION\_TYPE=x11  
PWD=/home/seed/Desktop  
JOB=dbus  
XMODIFIERS=@im=ibus  
JAVA\_HOME=/usr/lib/jvm/java-8-oracle  
GNOME\_KEYRING\_PID=

```
LANG=en_US.UTF-8
GDM_LANG=en_US
MANDATORY_PATH=/usr/share/gconf/ubuntu.mandatory.path
COMPIZ_CONFIG_PROFILE=ubuntu
IM_CONFIG_PHASE=1
GDMSESSION=ubuntu
SESSIONTYPE=gnome-session
GTK2_MODULES=overlay-scrollbar
SHLVL=1
HOME=/home/seed
XDG_SEAT=seat0
LANGUAGE=en_US
GNOME_DESKTOP_SESSION_ID=this-is-deprecated
XDG_SESSION_DESKTOP=ubuntu
LOGNAME=seed
DBUS_SESSION_BUS_ADDRESS=unix:abstract=/tmp/dbus-zXtw1QEMot
J2SDKDIR=/usr/lib/jvm/java-8-oracle
XDG_DATA_DIRS=/usr/share/ubuntu:/usr/share/gnome:/usr/local/share/:/usr/share/:/var/lib/
snapd/desktop
QT4_IM_MODULE=xim
LESSOPEN=| /usr/bin/lesspipe %s
INSTANCE=
XDG_RUNTIME_DIR=/run/user/1000
DISPLAY=:0
XDG_CURRENT_DESKTOP=Unity
GTK_IM_MODULE=ibus
J2REDIR=/usr/lib/jvm/java-8-oracle/jre
LESSCLOSE=/usr/bin/lesspipe %s %s
XAUTHORITY=/home/seed/.Xauthority
_=./a.out
OLDPWD=/home/seed
```

## Step 3

Compare the difference of these two files using the diff command. Please draw your conclusion.

```
seed@VM:~/Desktop$ diff parent child
seed@VM:~/Desktop$
```

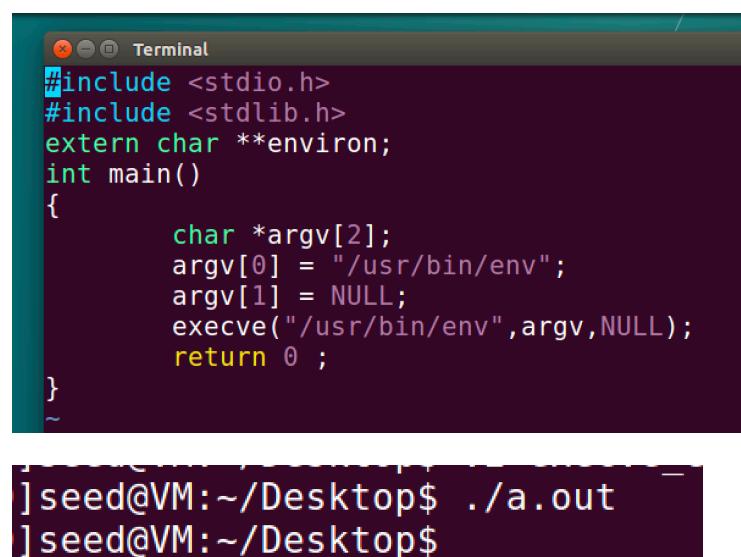
两个文件相同，子进程继承了父进程的环境变量。

## Task 3: Environment Variables and execve()

In this task, we study how environment variables are affected when a new program is executed via execve().

### Step 1

Compile and run the following program, and describe observation. This program simply executes a program called /usr/bin/env, which prints out the environment variables of the current process.



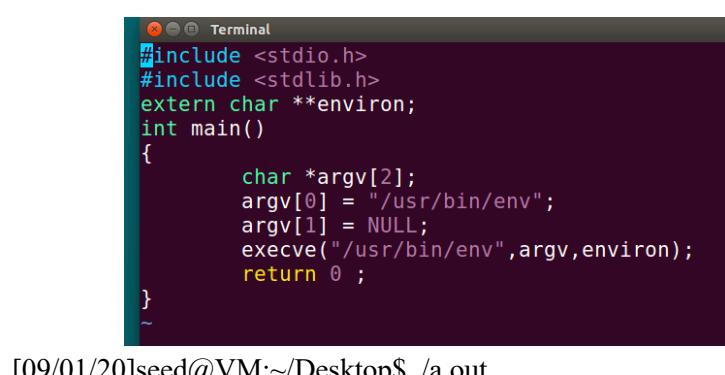
```
#include <stdio.h>
#include <stdlib.h>
extern char **environ;
int main()
{
    char *argv[2];
    argv[0] = "/usr/bin/env";
    argv[1] = NULL;
    execve("/usr/bin/env", argv, NULL);
    return 0 ;
}
```

```
[09/01/20]seed@VM:~/Desktop$ ./a.out
[09/01/20]seed@VM:~/Desktop$
```

### Step 2

Change the invocation of execve() in Line to the following; describe your observation.

```
execve("/usr/bin/env", argv, environ);
```



```
#include <stdio.h>
#include <stdlib.h>
extern char **environ;
int main()
{
    char *argv[2];
    argv[0] = "/usr/bin/env";
    argv[1] = NULL;
    execve("/usr/bin/env", argv, environ);
    return 0 ;
}
```

```
[09/01/20]seed@VM:~/Desktop$ ./a.out
XDG_VTNR=7
```

```

XDG_SESSION_ID=c1
XDG_GREETER_DATA_DIR=/var/lib/lightdm-data/seed
CLUTTER_IM_MODULE=xim
SESSION=ubuntu
ANDROID_HOME=/home/seed/android/android-sdk-linux
GPG_AGENT_INFO=/home/seed/.gnupg/S.gpg-agent:0:1
TERM=xterm-256color
VTE_VERSION=4205
XDG_MENU_PREFIX=gnome-
SHELL=/bin/bash
DERBY_HOME=/usr/lib/jvm/java-8-oracle/db
QT_LINUX_ACCESSIBILITY_ALWAYS_ON=1
LD_PRELOAD=/home/seed/lib/boost/libboost_program_options.so.1.64.0:/home/seed/lib/boost/libboost_filesystem.so.1.64.0:/home/seed/lib/boost/libboost_system.so.1.64.0
WINDOWID=54525962
UPSTART_SESSION=unix:abstract=/com/ubuntu/upstart-session/1000/1172
GNOME_KEYRING_CONTROL=
GTK_MODULES=gail:atk-bridge:unity-gtk-module
USER=seed
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=30;41:tw=30;42:ow=34;42:st=37;44:ex=01;32:*.tar=01;31:*.tgz=01;31:*.arc=01;31:*.arj=01;31:*.taz=01;31:*.lh=01;31:*.lz4=01;31:*.lzh=01;31:*.lzma=01;31:*.tlz=01;31:*.txz=01;31:*.tzo=01;31:*.tz=01;31:*.zip=01;31:*.z=01;31:*.Z=01;31:*.dz=01;31:*.gz=01;31:*.lrz=01;31:*.lz=01;31:*.lzo=01;31:*.xz=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:*.jpg=01;35:*.jpeg=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:*.svg=01;35:*.svgz=01;35:*.mng=01;35:*.pcx=01;35:*.mov=01;35:*.mpg=01;35:*.mpeg=01;35:*.m2v=01;35:*.mkv=01;35:*.webm=01;35:*.ogm=01;35:*.mp4=01;35:*.m4v=01;35:*.mp4v=01;35:*.vob=01;35:*.qt=01;35:*.nuv=01;35:*.wmv=01;35:*.ASF=01;35:*.rm=01;35:*.rmvb=01;35:*.flc=01;35:*.avi=01;35:*.fli=01;35:*.flv=01;35:*.gl=01;35:*.dl=01;35:*.xcf=01;35:*.xwd=01;35:*.yuv=01;35:*.cgm=01;35:*.emf=01;35:*.ogv=01;35:*.ogx=01;35:*.aac=00;36:*.au=00;36:*.flac=00;36:*.m4a=00;36:*.mid=00;36:*.midi=00;36:*.mka=00;36:*.mp3=00;36:*.mpc=00;36:*.ogg=00;36:.....

```

## Step 3

Draw conclusion regarding how the new program gets its environment variables.

通过传递参数来设置其环境变量。可以看到，使用execve函数时，新执行程序的环境变

量就是调用execve函数时传入的环境变量参数，与原本的程序无关。

## Task4:

In this task, we study how environment variables are affected when a new program is executed via the function. system()

```
[08/31/20]seed@VM:~/Lab/lab1$ task4.out
LESSOPEN=| /usr/bin/lesspipe %s
GNOME_KEYRING_PID=
USER=seed
LANGUAGE=en_US
J2SDKDIR=/usr/lib/jvm/java-8-oracle
XDG_SEAT=seat0
SESSION=ubuntu
XDG_SESSION_TYPE=x11
COMPIZ_CONFIG_PROFILE=ubuntu-lowgfx
LD_LIBRARY_PATH=/home/seed/source/boost_1_64_0/stage/lib:/home/seed/source/boost_1_64_0/stage/lib:
SHLVL=1
LIBGL_ALWAYS_SOFTWARE=1
J2REDIR=/usr/lib/jvm/java-8-oracle/jre
```

## Task5:

Step1 编译程序设置权限

```
[08/31/20]seed@VM:~/Lab/lab1$ gedit task5.c
[08/31/20]seed@VM:~/Lab/lab1$ gcc -o task5.out task5.c
[08/31/20]seed@VM:~/Lab/lab1$ sudo chown root task5.out
[08/31/20]seed@VM:~/Lab/lab1$ sudo chmod 4755 task5.out
```

Step2 设置环境变量：

```
[08/31/20]seed@VM:~/Lab/lab1$ export PATH="/bin"
[08/31/20]seed@VM:~/Lab/lab1$ export LD_LIBRARY_PATH="/bin"
[08/31/20]seed@VM:~/Lab/lab1$ export NVAR="TESTVAR"
```

Step3 运行结果：

```
[08/31/20]seed@VM:~/Lab/lab1$ ./task5.out | grep PATH  
XDG_SESSION_PATH=/org/freedesktop/DisplayManager/Session0  
XDG_SEAT_PATH=/org/freedesktop/DisplayManager/Seat0  
DEFAULTS_PATH=/usr/share/gconf/ubuntu.default.path  
PATH=/bin  
MANDATORY_PATH=/usr/share/gconf/ubuntu.mandatory.path
```

```
[08/31/20]seed@VM:~/Lab/lab1$ ./task5.out | grep LD_LIBRARY_PATH  
[08/31/20]seed@VM:~/Lab/lab1$ █
```

```
[08/31/20]seed@VM:~/Lab/lab1$ ./task5.out | grep NVAR  
NVAR=TESTVAR  
[08/31/20]seed@VM:~/Lab/lab1$ █
```

程序运行结果显示程序执行时 LD\_LIBRARY\_PATH 被忽略了，另两个变量则正常，显示了设定后的值。原因是操作系统会检查 EUID 和 RUID，不一致时，忽略 LD\_PRELOAD 和 LD\_LIBRARY\_PATH。

## Task6: The PATH Environment Variable and Set-UID Programs

```
[09/01/20]seed@VM:~$ /bin/sh  
$  
$  
$  
$ ls  
android Desktop examples.desktop lib Music source  
bin Documents get-pip.py ls Pictures Templates  
Customization Downloads Lab ls.c Public Videos  
$ export PATH=/home/seed:$PATH  
$ cd Lab/lab1  
$ task6.out  
VM# id  
uid=1000(seed) gid=1000(seed) euid=0(root) groups=1000(seed),4(adm),24(cdrom),27  
(sudo),30(dip),46(plugdev),113(lpadmin),128(sambashare)  
VM# strings task6.c  
#include <stdio.h>  
#include <stdlib.h>  
int main()  
system("ls");  
return 0 ;  
VM#  
VM# █
```

## Task7: The LD PRELOAD Environment Variable and Set-UID Programs

运行自定义的 sleep 函数

```
[09/01/20]seed@VM:~/Lab/lab1$ myprog.out  
I am not sleeping!  
[09/01/20]seed@VM:~/Lab/lab1$ █
```

运行系统的 sleep 函数

```
[09/01/20] seed@VM:~/Lab/lab1$ myprog.out
[09/01/20] seed@VM:~/Lab/lab1$ █
```

进入 root 用户模式，exportLD\_PRELOAD 后再运行，运行的是自定义 sleep 函数

```
root@VM:/home/seed/Lab/lab1# myprog.out
I am not sleeping!
root@VM:/home/seed/Lab/lab1# █
```

新建用户lab1user，更改程序权限，以seed用户运行，运行的是系统sleep函数。

```
[09/01/20] seed@VM:~/Lab/lab1$ export LD_PRELOAD=./libmylib.so.1.0.1
[09/01/20] seed@VM:~/Lab/lab1$ myprog.out
[09/01/20] seed@VM:~/Lab/lab1$ █
```

如果在seed用户下使用export命令更改LD\_PRELOAD，当使用su命令变为root用户后再查看环境变量，发现该值又转换为了原值（应该是环境变量文件中的值）。如果再切回seed用户（使用su命令切换），仍是原值。

```
[09/02/20] seed@VM:~/Lab/lab1$ export LD_PRELOAD=./libmylib.so.1.0.1
[09/02/20] seed@VM:~/Lab/lab1$ env | grep LD_PRELOAD
LD_PRELOAD=./libmylib.so.1.0.1
[09/02/20] seed@VM:~/Lab/lab1$ su root
Password:
root@VM:/home/seed/Lab/lab1# env | grep LD_PRELOAD
LD_PRELOAD=/home/seed/lib/boost/libboost_program_options.so.1.64.0:/home/seed/lib/boost/libboost_filesystem.so.1.64.0:/home/seed/lib/boost/libboost_system.so.1.64.0
root@VM:/home/seed/Lab/lab1# su seed
[09/02/20] seed@VM:~/Lab/lab1$ env | grep LD_PRELOAD
LD_PRELOAD=/home/seed/lib/boost/libboost_program_options.so.1.64.0:/home/seed/lib/boost/libboost_filesystem.so.1.64.0:/home/seed/lib/boost/libboost_system.so.1.64.0
[09/02/20] seed@VM:~/Lab/lab1$ █
```

不过在使用exit命令退出root命令进程后，回到原来seed用户进程，该变量还是修改后的值：

```
[09/02/20] seed@VM:~/Lab/lab1$ export LD_PRELOAD=./libmylib.so.1.0.1
[09/02/20] seed@VM:~/Lab/lab1$ env | grep LD_PRELOAD
LD_PRELOAD=./libmylib.so.1.0.1
[09/02/20] seed@VM:~/Lab/lab1$ su root
Password:
root@VM:/home/seed/Lab/lab1# exit
exit
[09/02/20] seed@VM:~/Lab/lab1$ env | grep LD_PRELOAD
LD_PRELOAD=./libmylib.so.1.0.1
[09/02/20] seed@VM:~/Lab/lab1$ █
```

系统发现程序运行时的RUID和EUID不同，会忽略LD\_PRELOAD和LD\_LIBRARY\_PATH的修改后的值，使用原来的默认值，但并没有改回去。

而su命令应该是因为产生了新进程，不继承父进程的环境变量，新进程的环境变量与父进程没什么关系了。

## Task8: Invoking External Programs Using system() versus execve()

```
[09/01/20]seed@VM:/home$ ls -l | grep t8
-rw-r--r-- 1 root      root     14 Sep  1 05:21 t82.txt
-rw-r--r-- 1 root      root     15 Sep  1 05:21 t8.txt
[09/01/20]seed@VM:/home$
```

```
[09/01/20]seed@VM:/home$ rm t8.txt
rm: remove write-protected regular file 't8.txt'? y
rm: cannot remove 't8.txt': Permission denied
[09/01/20]seed@VM:/home$
```

在 seed 用户下尝试删除创建的文件失败。

```
[09/01/20]seed@VM:~/Lab/lab1$ task8.out "aa;rm /home/t8.txt"
/bin/cat: aa: No such file or directory
[09/01/20]seed@VM:~/Lab/lab1$ cd ../..
[09/01/20]seed@VM:~$ cd ..
[09/01/20]seed@VM:/home$ ls
lab1user  seed  t82.txt
[09/01/20]seed@VM:/home$
```

调用 system 函数时运行程序成功删除。

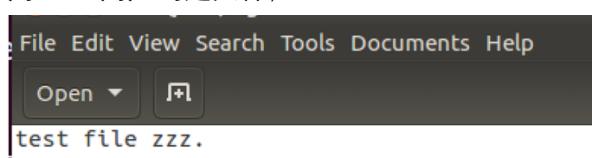
```
[09/01/20]seed@VM:~/Lab/lab1$ task8cve.out "aa;rm /home/t82.txt"
/bin/cat: 'aa;rm /home/t82.txt': No such file or directory
[09/01/20]seed@VM:~/Lab/lab1$ cd /home/
[09/01/20]seed@VM:/home$ ls
lab1user  seed  t82.txt
[09/01/20]seed@VM:/home$
```

将程序换为调用 execve, 删除操作没有成功。

execve 将用户的输入整体作为文件名, 不是和命令简单地拼接。使通过分号执行其他命令的尝试失败。

## Task9 : Capability Leaking

用 root 用户创建文件,



```
[09/01/20]seed@VM:~/Lab/lab1$ task9.out
[09/01/20]seed@VM:~/Lab/lab1$ cd /etc
[09/01/20]seed@VM:/etc$ cat zzz
test file zzz.
Malicious Data
[09/01/20]seed@VM:/etc$
```

文件被修改了。

在程序中，关闭文件描述符的语句在 fork 之后，并且只在父进程中执行。在未降权之前的产生的文件描述符被子进程继承了，子进程就可以利用该文件描述符写入数据。