The Environment

What is Environment?

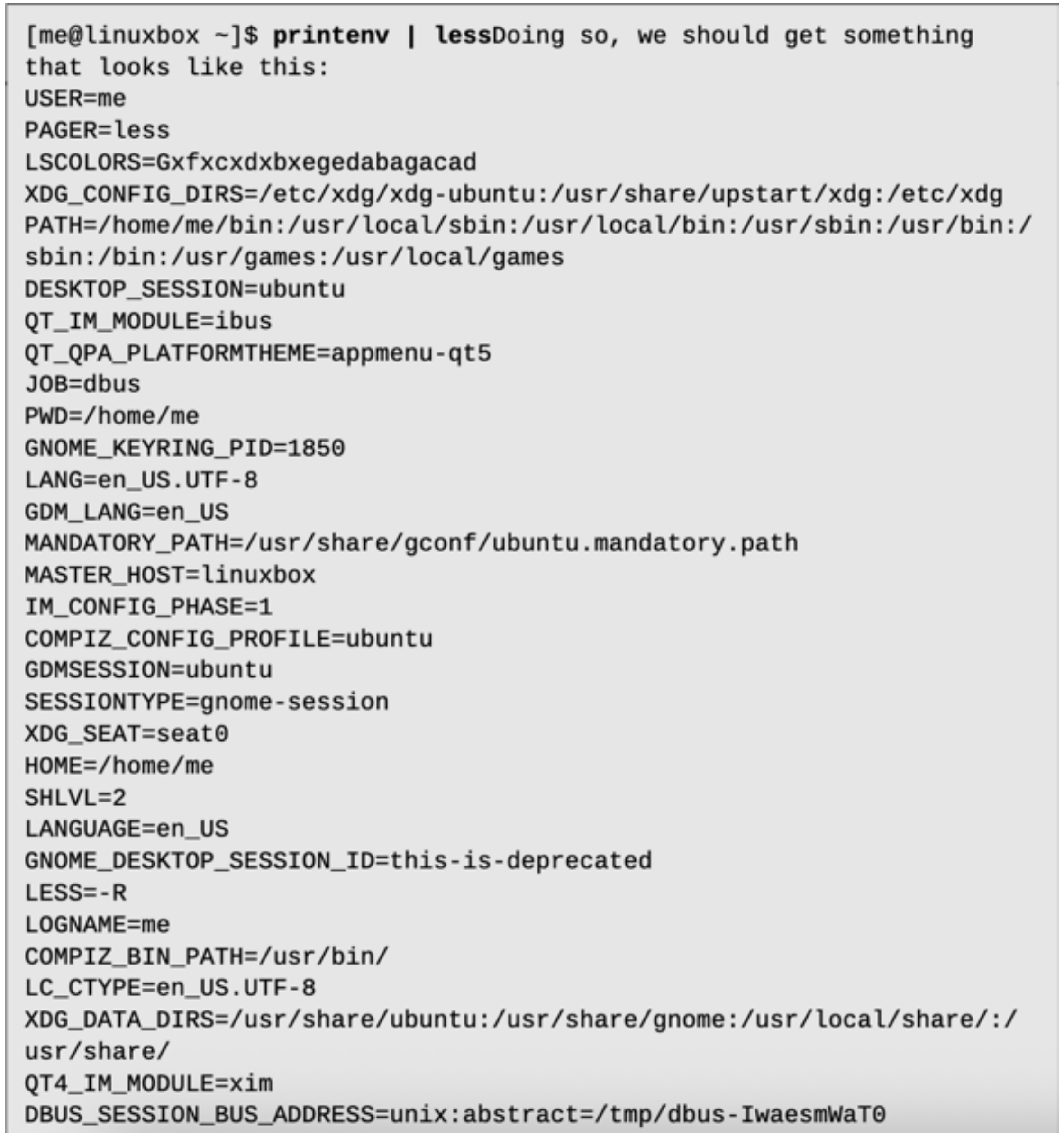
- The shell maintains a body of information during our shell session called the environment. Programs use data stored in the environment to determine facts about the system's configuration.
- While most programs use configuration files to store program settings, some programs also look for values stored in the environment to adjust their behavior.
- Knowing this, we can use the environment to customize our shell experience.
- We will work with the following commands:
    - printenv – Print part or all of the environment
    - set – Set shell options
    - export – Export environment to subsequently executed programs
    - alias – Create an alias for a command
    - source – Execute commands from a file in the current shell

What is Stored in the Environment?

- The shell stores two basic types of data in the environment; environment variables and shell variables.
  - Shell variables are bits of data placed there by current instance of bash, and environment variables are everything else.
  - In addition to variables, the shell stores some programmatic data, namely aliases and shell functions

Examining The Environment

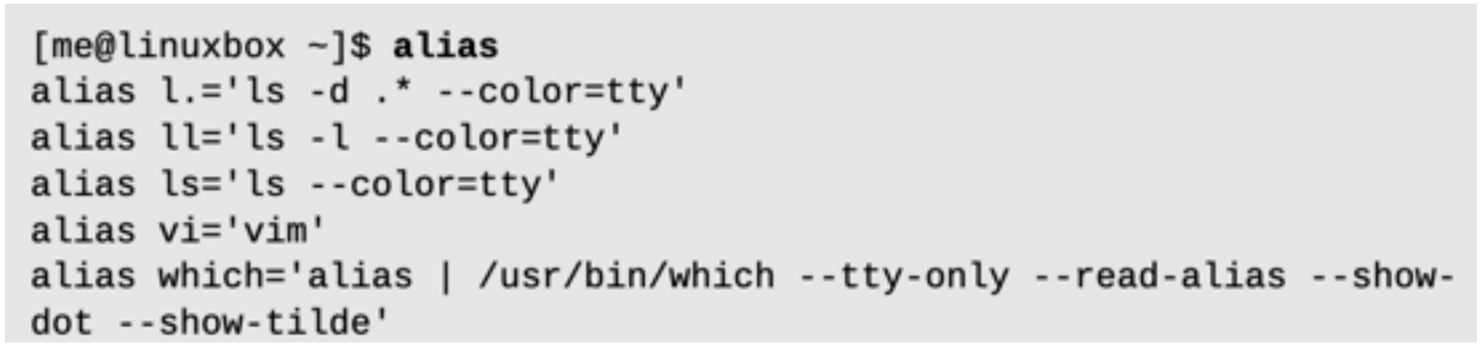
- To see what is stored in the environment, we can use either the `set` builtin in bash or the `printenv` program.
- The `set` command will show both the shell and environment variables, while `printenv` will only display the latter.
- Since the list of environment contents will be fairly long, it is best to pipe the output of either command into `less`.
- What we see is a list of environment variables and their values. For example, we see a variable called USER, which contains the value me.



```
[me@linuxbox ~]$ printenv | lessDoing so, we should get something
that looks like this:
USER=me
PAGER=less
LSCOLORS=Gxfxcxdxbxegedabagacad
XDG_CONFIG_DIRS=/etc/xdg/xdg-ubuntu:/usr/share/upstart/xdg:/etc/xdg
PATH=/home/me/bin:/usr/local/sbin:/usr/local/bin:/usr/sbin:/usr/bin:/
sbin:/bin:/usr/games:/usr/local/games
DESKTOP_SESSION=ubuntu
QT_IM_MODULE=ibus
QT_QPA_PLATFORMTHEME=appmenu-qt5
JOB=dbus
PWD=/home/me
GNOME_KEYRING_PID=1850
LANG=en_US.UTF-8
GDM_LANG=en_US
MANDATORY_PATH=/usr/share/gconf/ubuntu.mandatory.path
MASTER_HOST=linuxbox
IM_CONFIG_PHASE=1
COMPIZ_CONFIG_PROFILE=ubuntu
GDMSESSION=ubuntu
SESSIONTYPE=gnome-session
XDG_SEAT=seat0
HOME=/home/me
SHLVL=2
LANGUAGE=en_US
GNOME_DESKTOP_SESSION_ID=this-is-deprecated
LESS=-R
LOGNAME=me
COMPIZ_BIN_PATH=/usr/bin/
LC_CTYPE=en_US.UTF-8
XDG_DATA_DIRS=/usr/share/ubuntu:/usr/share/gnome:/usr/local/share/:/
usr/share/
QT4_IM_MODULE=xim
DBUS_SESSION_BUS_ADDRESS=unix:abstract=/tmp/dbus-IwaesmWaT0
```

- The `printenv` command can also list the value of a specific variable.
    - `$ printenv USER`
- The `set` command, when used without options or arguments, will display both the shell and environment variables, as well as any defined shell functions. Unlike `printenv`, its output is courteously sorted in alphabetical order.
    - `$ set | less`
- It is also possible to view the contents of a variable using the echo command,
    - `$ echo $HOME`

    /home/me
- One element of the environment that neither `set` nor `printenv` displays is aliases. To see them, enter the alias command without arguments.



```
[me@linuxbox ~]$ alias
alias l.='ls -d .* --color=tty'
alias ll='ls -l --color=tty'
alias ls='ls --color=tty'
alias vi='vim'
alias which='alias | /usr/bin/which --tty-only --read-alias --show-
dot --show-tilde'
```

Some Interesting Variables

- The environment contains quite a few variables, and though the environment will differ from the one presented here, we will likely see the variables listed in Table 11-1 in our environment.

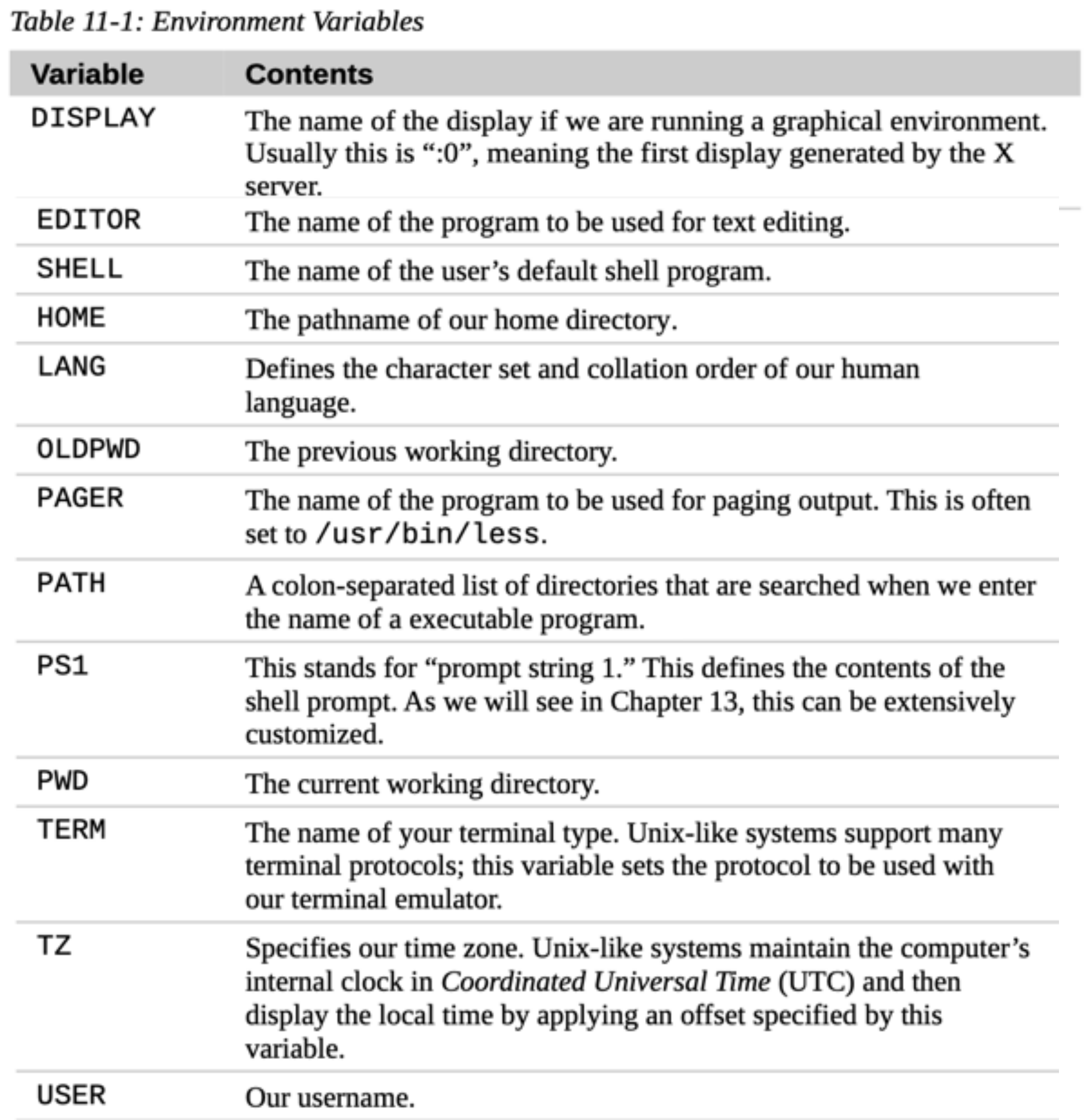


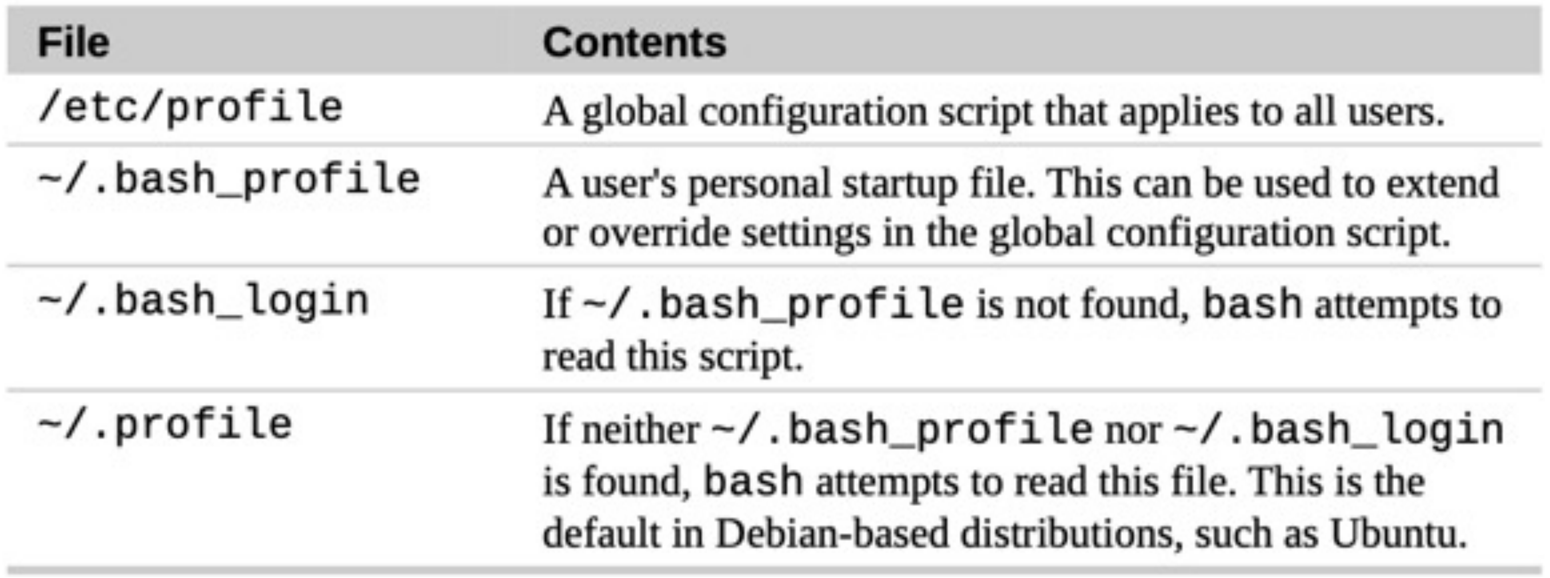
Table 11-1: Environment Variables

Variable	Contents
`DISPLAY`	The name of the display if we are running a graphical environment. Usually this is ":0", meaning the first display generated by the X server.
`EDITOR`	The name of the program to be used for text editing.
`SHELL`	The name of the user's default shell program.
`HOME`	The pathname of our home directory.
`LANG`	Defines the character set and collation order of our human language.
`OLDPWD`	The previous working directory.
`PAGER`	The name of the program to be used for paging output. This is often set to `/usr/bin/less`.
`PATH`	A colon-separated list of directories that are searched when we enter the name of a executable program.
`PS1`	This stands for "prompt string 1." This defines the contents of the shell prompt. As we will see in Chapter 13, this can be extensively customized.
`PWD`	The current working directory.
`TERM`	The name of your terminal type. Unix-like systems support many terminal protocols; this variable sets the protocol to be used with our terminal emulator.
`TZ`	Specifies our time zone. Unix-like systems maintain the computer's internal clock in *Coordinated Universal Time* (UTC) and then display the local time by applying an offset specified by this variable.
`USER`	Our username.

How Is The Environment Established?

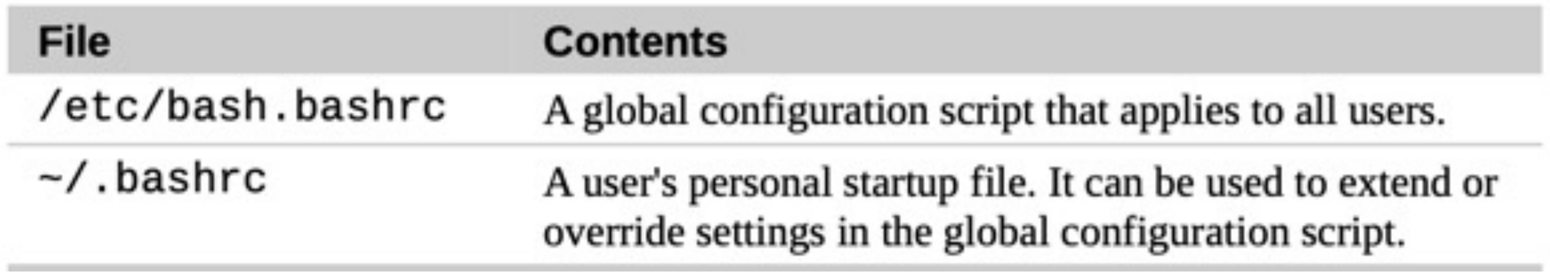
- When we log on to the system, the bash program starts, and reads a series of configuration scripts called startup files, which define the default environment shared by all users.
- This is followed by more startup files in our home directory that define our personal environment. The exact sequence depends on the type of shell session being started.
- There are two kinds:
- A **login shell session:** A login shell session is one in which we are prompted for our username and password. This happens when we when we log into a graphical environment, for example. It is also done when we start a virtual console session.
- A **non-login shell session:** A non-login shell session typically occurs when we launch a terminal session in the GUI with our terminal emulator.

Table 11-2: Startup Files for Login Shell Sessions



File	Contents
`/etc/profile`	A global configuration script that applies to all users.
`~/.bash_profile`	A user's personal startup file. This can be used to extend or override settings in the global configuration script.
`~/.bash_login`	If `~/.bash_profile` is not found, `bash` attempts to read this script.
`~/.profile`	If neither `~/.bash_profile` nor `~/.bash_login` is found, `bash` attempts to read this file. This is the default in Debian-based distributions, such as Ubuntu.

Table 11-3: Startup Files for Non-Login Shell Sessions

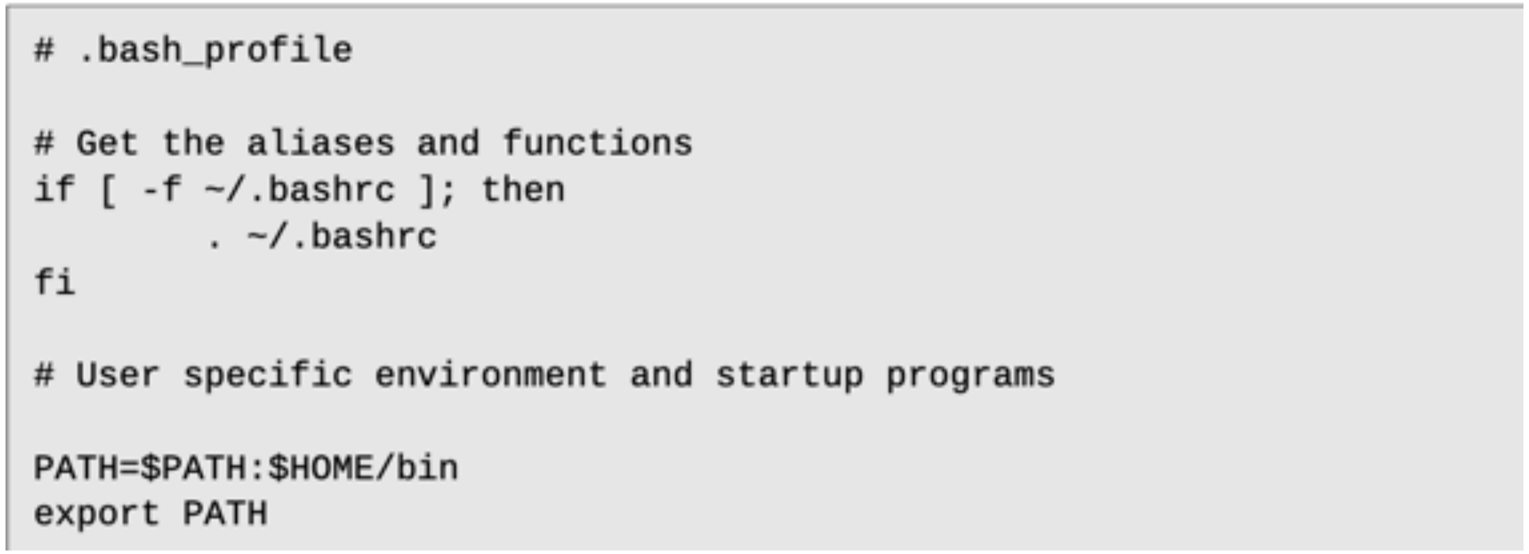


File	Contents
`/etc/bash.bashrc`	A global configuration script that applies to all users.
`~/.bashrc`	A user's personal startup file. It can be used to extend or override settings in the global configuration script.

- In addition to reading the startup files in Table 11-3, non-login shells inherit the environment variables from their parent process, usually a login shell.
- Take a look and see which of these startup files are installed. Remember — since most of the filenames listed above start with a period (meaning that they are hidden), we will need to use the "-a" option when using ls.
- The `~/.bashrc` file is probably the most important startup file from the ordinary user's point of view, since it is almost always read.
- Non-login shells read it by default and most startup files for login shells are written in such a way as to read the ~/.bashrc file as well.

What's in a Startup File?

- If we take a look inside a typical .bash_profile (taken from a CentOS 6 system), it looks something like this,



```
# .bash_profile

# Get the aliases and functions
if [ -f ~/.bashrc ]; then
        . ~/.bashrc
fi

# User specific environment and startup programs

PATH=$PATH:$HOME/bin
export PATH
```

- Lines that begin with a “#” are comments and are not read by the shell. These are there for human readability.

- The first interesting thing occurs on the fourth line, with the following code:

```
if [ -f ~/.bashrc ]; then
        . ~/.bashrc
fi
```

- This is called an if compound command, here is a translation:

```
If the file "~/.bashrc" exists, then
    read the "~/.bashrc" file.
```

- We can see that this bit of code is how a login shell gets the contents of .bashrc. The next thing in our startup file has to do with the PATH variable.

- Ever wonder how the shell knows where to find commands when we enter them on the command line?
- For example, when we enter ls, the shell does not search the entire computer to find `/bin/ls` (the full pathname of the ls command); rather, it searches a list of directories that are contained in the PATH variable.
- The PATH variable is often (but not always, depending on the distribution) set by the `/etc/profile` startup file with this code:

```
PATH=$PATH:$HOME/bin
```

- PATH is modified to add the directory `$HOME/bin` to the end of the list. This is an example of parameter expansion.
- To demonstrate how this works, try the following:

```
[me@linuxbox ~]$ foo="This is some "
[me@linuxbox ~]$ echo $foo
This is some
[me@linuxbox ~]$ foo=$foo"text."
[me@linuxbox ~]$ echo $foo
This is some text.
```

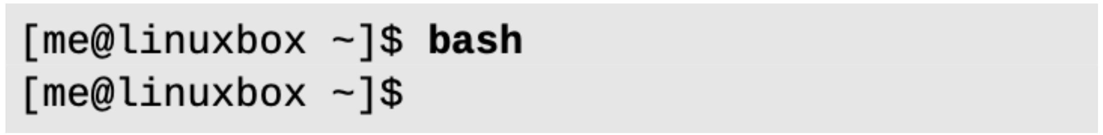
- Using this technique, we can append text to the end of a variable's contents.
- By adding the string `$HOME/bin` to the end of the PATH variable's contents, the directory `$HOME/bin` is added to the list of directories searched when a command is entered.
- This means that when we want to create a directory within our home directory for storing our own private programs, the shell is ready to accommodate us.
- All we have to do is call it bin, and we’re ready to go.

- The export command tells the shell to make the contents of PATH available to child processes of this shell. In a sense, it converts a shell variable into an environment variable.

```
export PATH
```

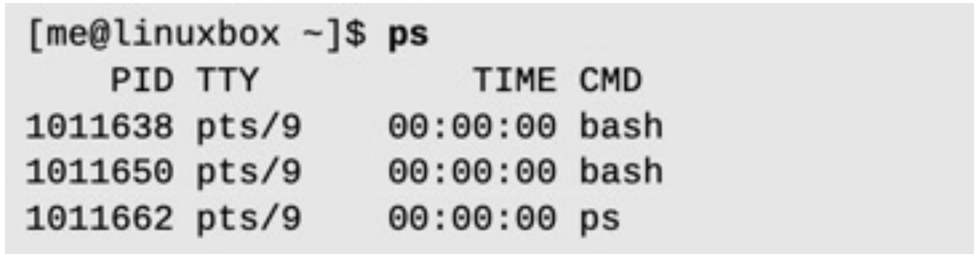
Exploring How Child Processes Inherit Their Environments

- Shell variables are local to the current instance of the shell and are not copied to any children the shell launches.
- Let’s demonstrate that. First, we’ll set a shell variable in our current shell:
  - `$ foo="bar”`
- Next, we’ll launch another copy of the shell:



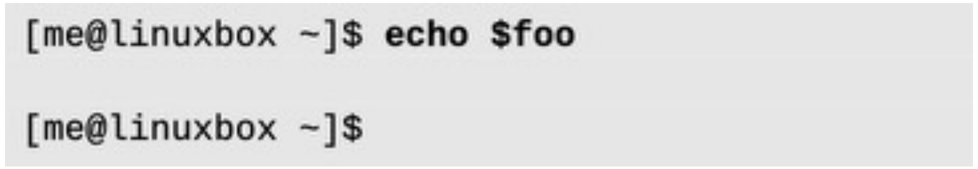
```
[me@linuxbox ~]$ bash
[me@linuxbox ~]$
```

- Now it looks like nothing happened, but we are in fact running another instance of the shell. We can show this by looking at the results of the ps command:



```
[me@linuxbox ~]$ ps
    PID TTY          TIME CMD
1011638 pts/9    00:00:00 bash
1011650 pts/9    00:00:00 bash
1011662 pts/9    00:00:00 ps
```

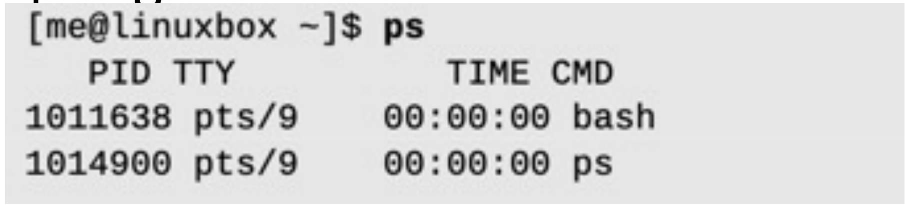
- Here we see that we are running two copies of bash. Since we didn’t put the new instance into the background when we launched it, it is now the foreground task and the original instance is waiting for this new shell to finish.
- Now let’s try and view the value of the variable foo that we set a moment ago:



```
[me@linuxbox ~]$ echo $foo

[me@linuxbox ~]$
```

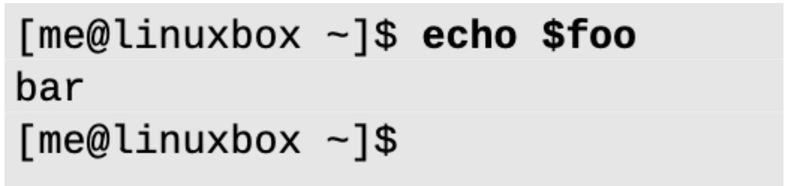
- No result indicates the foo variable is empty. The reason for this is we didn’t give it a value in this instance of the shell.
- Shell variables are not copied and given to a child process when the child process is created. Environment variables, on the other hand, are copied to become the environment of the child process.

- let’s define `foo` in this instance of the shell:
  - `$ foo="barbar”`
- Next, we’ll exit this bash instance and return to the parent instance which has been patiently waiting for the child process to terminate before proceeding as it does with any other program we didn’t put in the background.
  - `$ exit`
- We’ll run `ps` again to see that we have returned to the first instance.



```
[me@linuxbox ~]$ ps
   PID TTY          TIME CMD
1011638 pts/9    00:00:00 bash
1014900 pts/9    00:00:00 ps
```

- Now let’s look at the value of foo in this instance.
- We see that it still contains the value we gave it, not the new value we set in the child instance.
- This shows an important rule regarding child processes: a child process cannot alter the environment of its parent.
- When a child process terminates, it takes its environment with it. This fact will become important when we start writing shell scripts.



```
[me@linuxbox ~]$ echo $foo
bar
[me@linuxbox ~]$
```

Launching a Program with a Temporary Environment

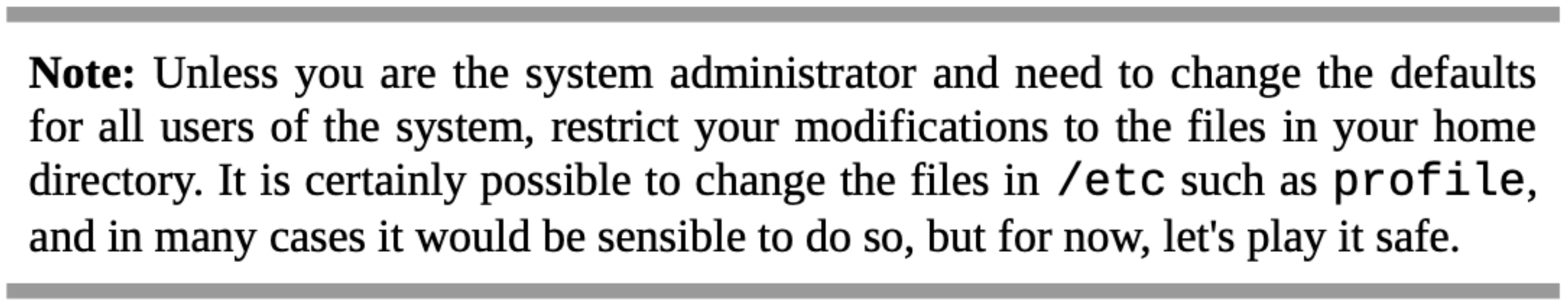
- The shell provides is the ability to execute a command and give it a temporary environment variable. Sometimes we want to run a program and give it a special environment value.
- A good example is the man command which looks for an environment variable named MANWIDTH that tells man how wide to format its output.
- For example, to have man format its output a maximum of 75 characters wide (a handy setting for easy reading) we can do this:
  - `$ MANWIDTH=75 man ls`
- This outputs the man page for the ls command nicely formatted to a comfortable width.
- By the way, this is good thing to alias: `$ alias man=’MANWIDTH=75 man’`
- Now whenever we use the `man` command it will always limit line length to 75 characters.

Modifying the Environment

- Since we know where the startup files are and what they contain, we can modify them to customize our environment.

Which Files Should We Modify?

- As a general rule, to add directories to your PATH or define additional environment variables, place those changes in `.bash_profile` (or the equivalent, according to your distribution; for example, Ubuntu uses `.profile`). For everything else, place the changes in `.bashrc`.



Note: Unless you are the system administrator and need to change the defaults for all users of the system, restrict your modifications to the files in your home directory. It is certainly possible to change the files in `/etc` such as `profile`, and in many cases it would be sensible to do so, but for now, let's play it safe.

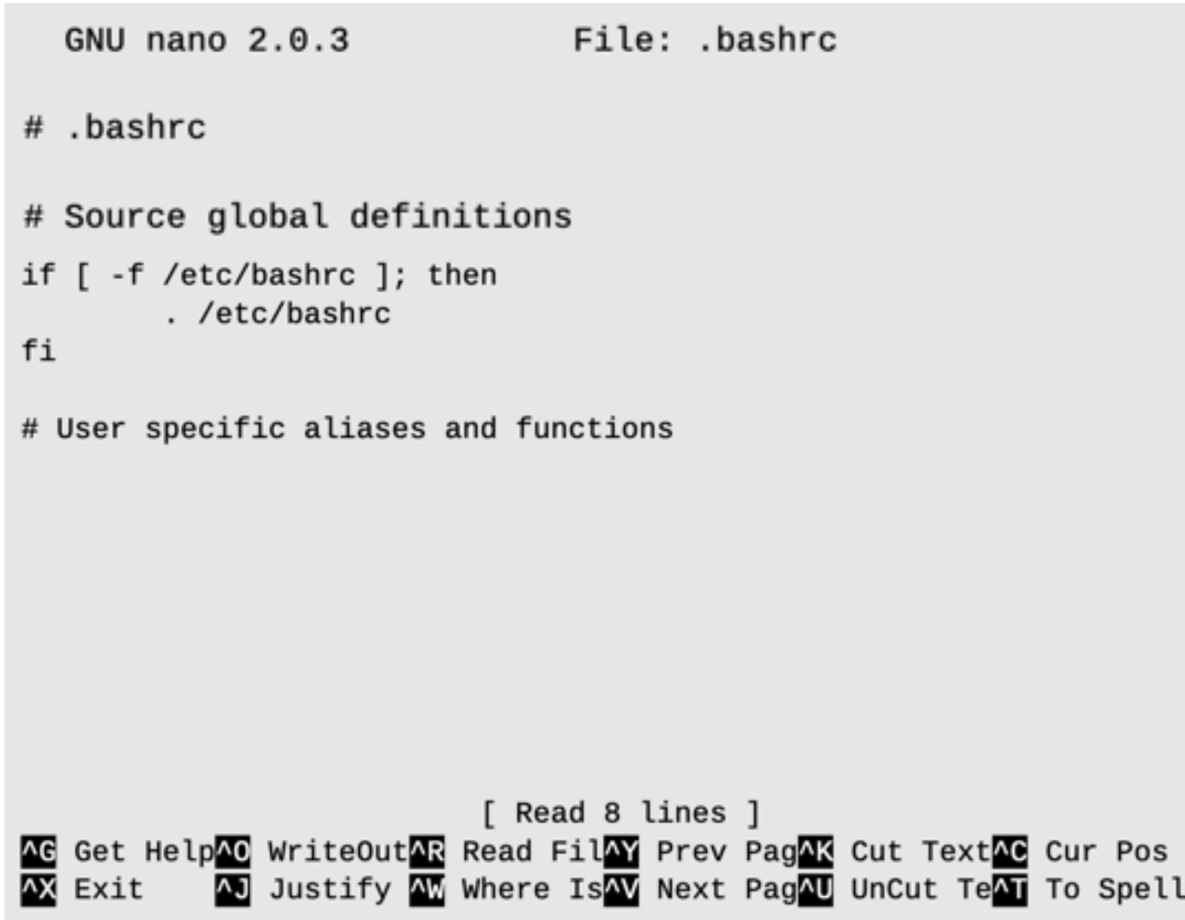
Text Editors

- To edit (i.e., modify) the shell's startup files, as well as most of the other configuration files on the system, we use a program called a text editor.
- A text editor is a program that is, in some ways, like a word processor in that it allows us to edit the words on the screen with a moving cursor.
- It differs from a word processor by only supporting pure text and often contains features designed for writing programs.
- Text editors are the central tool used by software developers to write code and by system administrators to manage the configuration files that control the system.
- A lot of different text editors are available for Linux; most systems have several installed.
- Text editors fall into two basic categories: graphical and text-based. GNOME and KDE both include some popular graphical editors. GNOME ships with an editor called `gedit`, which is usually called "Text Editor" in the GNOME menu. KDE usually ships with three, which are (in order of increasing complexity) `kedit, kwrite`, and `kate`.
- There are many text-based editors. The popular ones we'll often encounter are `nano, vi,` and `emacs`. The nano editor is a simple, easy-to-use editor designed as a replacement for the `pico` editor supplied with the PINE email suite. The `vi` editor (which on most
- Linux systems is replaced by a program called `vim`, which is short for "vi improved") is the traditional editor for Unix-like systems.

Using a Text Editor

- Text editors are invoked from the command line by typing the name of the editor followed by the name of the file we want to edit. If the file does not already exist, the editor will assume that we want to create a new file. Here is an example using `gedit`:
  - `$ gedit some_file`
- This command will start the `gedit` text editor and load the file named "some_file", if it exists.
- Now, Let's fire up `nano` and edit the .bashrc file. But before we do that, let's practice some "safe computing." Whenever we edit an important configuration file, it is always a good idea to create a backup copy of the file first. This protects us in case we mess up the file while editing. To create a backup of the `.bashrc` file, do this:
  - `$ cp .bashrc .bashrc.bak`
- It doesn't matter what we call the backup file; just pick an understandable name. The ex-tensions ".bak", ".sav", ".old", and ".orig" are all popular ways of indicating a backup file. And remember that cp will overwrite existing files silently.

- Now that we have a backup file, we'll start the editor.
  - `$ nano .bashrc`
- Once nano starts, we’ll get a screen like this:



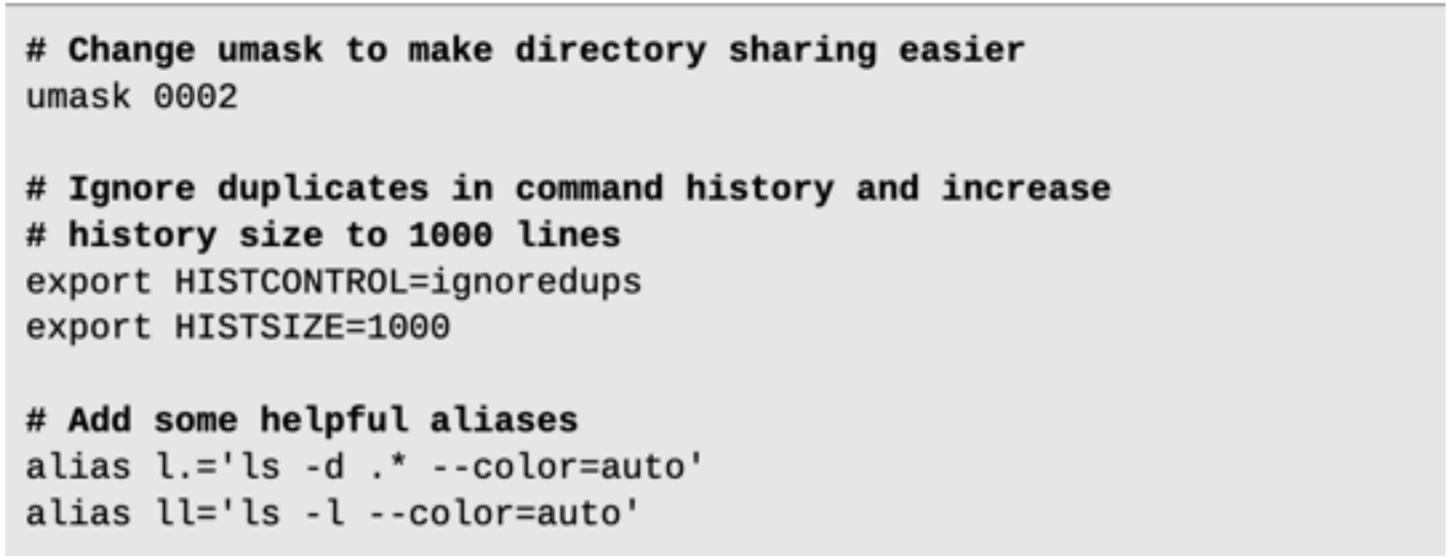
```
  GNU nano 2.0.3           File: .bashrc

# .bashrc

# Source global definitions
if [ -f /etc/bashrc ]; then
        . /etc/bashrc
fi

# User specific aliases and functions









                         [ Read 8 lines ]
^G Get Help^O WriteOut^R Read Fil^Y Prev Pag^K Cut Text^C Cur Pos
^X Exit    ^J Justify ^W Where Is^V Next Pag^U UnCut Te^T To Spell
```

- The screen consists of a header at the top, the text of the file being edited in the middle, and a menu of commands at the bottom. Since nano was designed to replace the text editor supplied with an email client, it is rather short on editing features.
- The first command we should learn in any text editor is how to exit the program. In the case of `nano`, we press `Ctrl-x` to exit. This is indicated in the menu at the bottom of the screen.
- The notation `^X` means `Ctrl-x`. This is a common notation for control characters used by many programs.
- The second command we need to know is how to save our work. With nano it's `Ctrl-o`. With this knowledge, we're ready to do some editing. Using the down arrow key and/or the `PageDown` key, move the cursor to the end of the file, and then add the following lines to the `.bashrc` file:

```
umask 0002
export HISTCONTROL=ignoredups
export HISTSIZE=1000
alias l.='ls -d .* --color=auto'
alias ll='ls -l --color=auto'
```

Table 11-4: Additions to Our `.bashrc`

Line	Meaning
`umask 0002`	Sets the `umask` to solve the problem with the shared directories we discussed in Chapter 9, "Permissions."
`export HISTCONTROL=ignoredups`	Causes the shell's history recording feature to ignore a command if the same command was just recorded.
`export HISTSIZE=1000`	Increases the size of the command history from the usual default of 500 lines to 1,000 lines.
`alias l.='ls -d .* --color=auto'`	Creates a new command called `l.`, which displays all directory entries that begin with a dot.
`alias ll='ls -l --color=auto'`	Creates a new command called `ll`, which displays a long-format directory listing.



```
# Change umask to make directory sharing easier
umask 0002

# Ignore duplicates in command history and increase
# history size to 1000 lines
export HISTCONTROL=ignoredups
export HISTSIZE=1000

# Add some helpful aliases
alias l.='ls -d .* --color=auto'
alias ll='ls -l --color=auto'
```

With the changes complete, press Ctrl-o to save our modified `.bashrc` file, and press `Ctrl-x` to exit nano.

Why Comments Are Important

- Whenever you modify configuration files it's a good idea to add some comments to document your changes.
- While you're at it, it’s not a bad idea to keep a log of what changes you make.
- Shell scripts and bash startup files use a “#” symbol to begin a comment. Other configuration files may use other symbols.
- Most configuration files will have comments. Use them as a guide.
- You will often see lines in configuration files that are commented out to prevent them from being used by the affected program. This is done to give the reader suggestions for possible configuration choices or examples of correct configuration syntax. For example, the .bashrc file of Ubuntu 18.04 contains these lines:

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

- The last three lines are valid alias definitions that have been commented out. If you remove the leading “#” symbols from these three lines, a technique called uncommenting, you will activate the aliases

Activating Our Changes

- The changes we have made to our `.bashrc` will not take effect until we close our terminal session and start a new one because the .bashrc file is only read at the beginning of a session.
- However, we can force bash to reread the modified `.bashrc` file with the following command:
- `$ source ~/.bashrc`
- After doing this, we should be able to see the effect of our changes. Try one of the new aliases.
- `$ ll`