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Survival guide for Unix newbies

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As a professor, I worry that the upcoming generation of programmers is missing out on the Unix experience, and with it, the power it grants.

Modern computing environments tend to favor form over function: the primary objective in their design is ease of use for non-experts.

Unix is a naked celebration of function over form. The premium is on control, efficiency and flexibility. Its audience is the power user.

The origin of Unix's power is an organic design philosophy that emphasizes linguistic abstraction and composition.

In Unix, a word is worth a thousand mouse clicks.

I've written the short guide below as an introduction for those just getting started with Unix or Linux. (I'll write follow-up articles covering intermediate and advanced Unix.)

Please feel free to forward this series to a student, friend, partner or spouse that needs a little help getting started.

Update: After this, see the companion post on settling into Unix.

What is computing with Unix?

Unix is a family of operating systems and environments that exploits the power of linguistic abstraction and composition to orchestrate tasks.

Unix users spend a lot of time at the command line.

The command line (often called the console, the shell or the terminal) looks something like this:

```
$ _
```

When you type in a command like `ls`, it will give you feedback:

```
$ ls
Documents README.txt

$ _
```

In this case, the `ls` command listed the files in the current directory.

Getting access to Unix

It was once a daunting task to get access to or install Unix. Fortunately, it's no longer a hassle.

These days, the two most accessible flavors of Unix are Apple's OS X (based on the BSD family of Unix) and Ubuntu Linux.

The easy option: OS X

OS X is a good way for many users to tip-toe into Unix.

What you're buying is a Unix machine that "just works."

To turn it into a complete Unix system, you'll need to install Apple's free Xcode development suite (available from the Mac App Store) and the (free) X11 server.

Xcode includes the compilers and interpreters you'll need to compile and run many open source applications.

You'll need the X11 server to run traditional graphical applications for Unix.

The DIY option: Linux

When I was in high school, before CD burning was widely available and when internet connections were slow, the best way to get Linux was to buy a book with an installation CD.

(Given that there wasn't much in the way of online resources for Linux back then, it was good to have a book that walked through the installation process and explained all the features, too.)

A quick search of amazon shows no shortages of such books today.

These days, there are plenty of free options:

- If you're a CS major, you should have access to a Unix shell account at your school that you can acces with `ssh`. (See details on ssh below.)
- You can set up your computer to dual boot into either your preferred OS or Linux. Macs come with Boot Camp to make this easy. If you take the dual boot route with a Windows PC, FIRST BACK UP YOUR DATA. There is a chance you'll wipe out your files by accident. I recommend adding a second internal hard drive if you want to set up a dual boot with Linux for the first time.
- You can burn a CD that lets you boot into or install Linux. I recommend Ubuntu Linux for this.
- You can also create a USB thumb drive that boots into Linux. I recommend Ubuntu Linux for this as well.
- You can run Linux inside your existing OS as a virtual machine. VirtualBox is a freely available virtualization tool. (I personally use VMware Fusion to run Windows on my Mac for those rare instances where I need to see what a page looks like in an old version of IE.)
- You can run cygwin on Windows to get a "Unix-like" environment. (This isn't quite the real deal.)
- You can buy a virtualized Linux server with remote access from a service like linode.com. (might.net runs on a linode.)

Getting to the command line

Once you're into Unix, you'll want to get to the command line.

On Linux, you can press CTRL+ALT+F1 to get to a raw terminal, and CTRL+ALT+F7 to get back to the window system. (In fact, CTRL+ALT+F1-F6 will get you different terminal on most systems, and of course, you can configure this.)

In most popular flavors of Linux, there is a way to open a graphical terminal in a window.

On a Mac, it's Applications > Utilities > Terminal.

The filesystem: `ls` and `cd`

If you find yourself at a command prompt, run `ls` to list the files in the current directory.

You might see something like this:

```
$ ls
Documents README.txt

$ _
```

With `ls /`, you can list the contents of the root directory.

You'll notice several directories that are common to almost all Unices:

- `/bin`, standard executables.
- `/sbin`, important system executables.
- `/etc`, system configuration files.
- `/var`, frequently updated files like logs.
- `/root`, home directory of the administrator account.
- `/home`, a user account home directories. (`/Users` on a Mac.)
- `/opt`, package-manager installed files.
- `/tmp`, temporary files; usually wiped between boots.
- `/usr`, user applications and utilities.

To change to a different directory, use the command `cd`.

For example:

- `cd Documents` to change to the `Documents` sub-folder.
- `cd ..` to change to the parent directory.
- `cd` to change to your home directory.

Paths

To print the path of the current working directory, use `pwd`:

```
$ pwd
/home/matt
$ _
```

On Unix, a path is a description of a file's location.

For example, `/home/matt/README` is a path to a file called `README` contained within the home directory for the user `matt`.

Notice that forward slashes (`/`) separate components of a path.

For example:

```
$ pwd
/home/matt
$ cd ..
$ pwd
/home
$ cd matt
$ pwd
/home/matt
$ _
```

Symbolic links

Unix filesystems make use of aliases for files known as symbolic links (symlinks).

(There are also *hard* links, in which there are two true, indistingushible references to the same file, but these are less commonly used.)

A symbolic link to a file is ordinarily treated identically to that file.

The command `ln -s` creates sym links.

The command `ls -l` can reveal where a symlink points.

For example:

```
$ ls
bar foo

$ ln -s bar baz

$ ls -l
total 8
-rw-r--r--  1 matt  staff  0 Jan  8 09:57 bar
lrwxr-xr-x  1 matt  staff  3 Jan  8 09:58 baz -> bar
-rw-r--r--  1 matt  staff  0 Jan  8 09:57 foo

$ _
```

Working with text: `cat`, `less`, `emacs` and `vi`

Suppose you want to look at a text file within the current directory.

A common way to take a glance at a text file is with the `cat` command:

```
$ cat README.txt
* A README file for my home directory.

  Documents contains my files.

$ _
```

(The command `cat` is actually meant to do more powerful things than just look at files, but that's what it's most commonly used for.)

If the file is too long to fit on a screen, use `less` instead of `cat`. (To quit `less`, press `q`.)

You're going to spend a lot of time editing text, so you'll want to learn one (or both) of the powerful Unix text editors: `emacs` and `vim`.

Both have a tutorial mode for teaching the essentials.

Help yourself: `man` up

If you don't know what a command does, use the command `man` *`command`*.

This will bring up the man(ual) page for *command*, which will document how the command operates; it frequently provides examples of usage.

Press `q` to quit the man page viewer.

The `apropos` can help you find the command you're looking for if you don't know it's name. It will search a database of command *descriptions*.

Some tools use an alternate documentation system called `info`

To look up documentation using `info`, try `info` *`topic`*.

For more info on `info`, run `info info`.

Search for it: `grep` and `find`

If you're looking for text within a file or a set of files, `grep` is the right tool.

The command `grep` *`pattern file ...`* will search the specified files for the

pattern.

The pattern language used throughout Unix is called *regular expressions*, and there are many good introductions to these, including the man page for grep.

To list all files under the working directory (and its subdirectories), try the command `find`.

Pipes and redirection

Nearly every command in Unix makes use of a convention to have a "standard input" (also called stdin or STDIN) and standard output (also called stdout or STDOUT).

There is also a "standard error" (stderr or STDERR) output that is, by convention, reserved for error messages.

Many techniques in Unix rely on redirecting these channels.

If you want to dump the standard output into a file, use *`command > file`*.

For example:

```
$ pwd > pwd.txt
$ ls
pwd.txt
$ cat pwd.txt
/home/matt
$ _
```

One of the most useful capabilities of Unix is the ability to redirect the STDOUT of one command into the STDIN of another.

To do this, you'll want to use a "pipe"; for example:

```
$ find . | grep READ
./Desktop/READINGLIST.txt
./README.txt
$ _
```

This command found a file named `READINGLIST.txt` in the `Desktop` subdirectory, and a file named `README` in the current one.

It's customary for Unix programs to read from STDIN when no input file is specified, which is what `grep` is doing here.

It is also possible to send the contents of a file into the STDIN of a command

using *`command < file`*.

Permissions: `chmod`, `chown` and `chgrp`

In Unix, every file and directory has an owner and a group.

Every user on a Unix machine can belong to one or more groups.

Every file also has three sets of permissions: what the owner can do, what the group can do and what anyone can do.

To see the owner, group and permissions associated with a file run `ls -l`. You'll see something like:

```
$ ls -l
drwxr-xr-x    4 matt  staff      136 Jun 23  2010 Documents
drwxr-xr-x  143 matt  staff     4862 Dec 30  2009 Desktop
-rw-r--r--    1 matt  staff        4 Feb  7 11:16 README.txt
$ _
```

The first column tells you about the permissions on the file.

The third and fourth tell you the owner and group respectively.

The very first character in the permissions column tells you what kind of file it is. A `-` means it's a regular file. A `d` means it's a directory.

The next nine characters come in three classes of three characters each. The three classes are owner permissions, group permissions and world permissions.

Inside a permission class, `r` means that class can read the file; `w` means that class can write the file; `x` means that class can execute the file.

If a file is a directory, `x` grants the permission to access inside the directory, while `r` grants permission to list its contents.

Package managers

Modern Unixes have package managers to that download install (free) software for you.

On a Mac, MacPorts is a popular package-management system, and Homebrew is gaining in popularity.

On Ubuntu, `apt` is the standard package manager, with both a command-line and graphical interface available.

It's a good idea to familiarize yourself with your package manager.

Remote access: `ssh`

If you have more than one machine, or you need remote access to another machine, `ssh` is a powerful "secure shell" utility.

`ssh` can grant you console access on a remote machine, while safely encrypting the session.

It is worth setting up passwordless key-based authentication using `ssh-keygen`.

Using `~/.ssh/config`, many options, including aliases and per-host private keys, are available. (Try `man ssh_config`).

To ssh into another computer, use `ssh` *`user@address`* where *user* is the user name of your account on the other machine, and *address* is host name or IP address of the other computer.

Windows users can use PuTTY to connect to another computer over ssh.

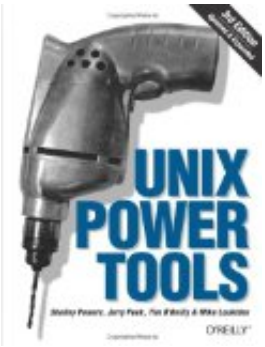
What's next?

Wikipedia has a list of Unix utilities to peruse.

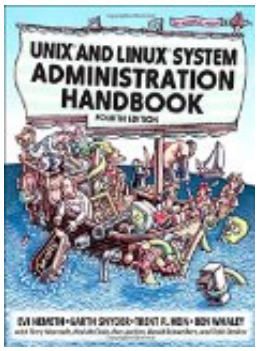
You can also move onto my guide to settling into Unix.

Good books

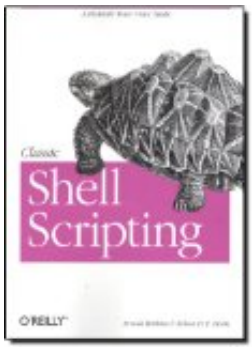
- Unix Power Tools:



- The UNIX and Linux System Administration Handbook:



- Classic Shell Scripting:



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