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title: The Unix Shell  
subtitle: Shell Scripts  
minutes: 20

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# The Unix Shell: Scripts

## Learning Objectives

- Write a shell script that runs a command or series of commands for a fixed set of files.
- Run a shell script from the command line.
- Write a shell script from shell's history.
- Explain the importance of comments in scripts.

We are finally ready to see what makes the shell such a powerful programming environment. We are going to take the commands we repeat frequently and save them in files so that we can re-run all those operations again later by typing a single command.

## Writing a script

For historical reasons, a bunch of commands saved in a file is usually called a **shell script**, but make no mistake: these are actually small programs.

Let's create a script to backup our files, the way we did in the last segment. To start, let's go back to new-york-times, delete the backup we made last time:

```
$ cd ~/programming-fundamentals-master/data/new-york-times
$ rm backup/*.TXT
$ rmdir backup
```

Then let's create a file called `backup.sh` so we can do this in a script instead:

```
$ touch backup.sh
$ nano backup.sh
```

Put the following commands, which we used last time directly in the shell, into this script file:

```
mkdir backup
for filename in *.TXT
do
    cp $filename backup/original-$filename
done
```

Then save and quit.

Remember, we are *not* running these commands just yet: we are putting the commands in a file.

## Running a script

Once we have saved the file, we can ask the shell to execute the commands it contains.

First we have to tell the shell what program the script is in. If we want to run a Python script, we would enter in python first. If R, then R and so on.

Our shell is called bash, so we run the following command:

```
$ bash backup.sh
$ ls backup
```

```
original-human-rights-2000.TXT  original-human-rights-2005.TXT
original-human-rights-2001.TXT  original-human-rights-2006.TXT
original-human-rights-2002.TXT  original-human-rights-2007.TXT
original-human-rights-2003.TXT  original-human-rights-2008.TXT
original-human-rights-2004.TXT  original-human-rights-2009.TXT
```

Sure enough, our script has created a directory backup with copies of the files in our current directory, with the prefix original- added to the filenames.

## Text vs. Whatever

We usually call programs like Microsoft Word or LibreOffice Writer "text editors", but we need to be a bit more careful when it comes to programming. By default, Microsoft Word uses .docx files to store not only text, but also formatting information about fonts, headings, and so on. This extra information isn't stored as characters, and doesn't mean anything to tools like head: they expect input files to contain nothing but the letters, digits, and punctuation on a standard computer keyboard. When editing programs, therefore, you must either use a plain text editor, or be careful to save files as plain text.

## Variables in Scripts

What if we want to backup an arbitrary list of files? We could edit backup.sh each time to change the filename, but that would probably take longer than just retyping the command.

Instead, let's edit backup.sh and replace \*.TXT with a special variable called "\$@":

```
$ nano backup.sh
```

```
mkdir backup
for filename in "$@"
do
    cp $filename backup/original-$filename
done
```

Inside a shell script, \$1 means "the first filename (or other parameter) on the command line". \$2 means the second and so on. But in this case, we can't use \$1, \$2, and so on because we don't know how many files there are.

Instead, we use the special variable \$@, which means, "All of the command-line parameters to the shell script." So ("\$@" is equivalent to "\$1" "\$2" ...)

We put `$@` inside double-quotes to handle the case of parameters containing spaces.

Let's delete the last backup directory we made, which had more files than we want to backup, then run the script on just a couple files:

```
$ rm backup/*.TXT
$ rmdir backup
$ bash backup.sh human-rights-2000.TXT human-rights-2001.TXT
$ ls backup
```

```
original-human-rights-2000.TXT  original-human-rights-2001.TXT
```

## Commenting

This works, but it may take the next person who reads `backup.sh` a moment to figure out what it does. We can improve our script by adding some **comments** at the top:

```
$ cat backup.sh
```

```
# Copy select files in the current directory to a new backup directory
# Usage: backup.sh files
mkdir backup
for filename in "$@"
do
    cp $filename backup/original-$filename
done
```

A comment starts with a `#` character and runs to the end of the line.

The computer ignores comments, but they're invaluable for helping people understand and use scripts.

Each time you modify the script, you should check that the comment is still accurate: an explanation that sends the reader in the wrong direction is worse than none at all.

### Why Isn't It Doing Anything? {.callout}

What happens if a script is supposed to process a bunch of files, but we don't give it any filenames? For example, what if we type:

```
$ bash backup.sh
```

but don't say `*.dat` (or anything else)? In this case, `$@` expands to nothing at all, so the `for` loop inside the script is effectively:

```
for filename in
do
    cp $filename backup/original-$filename
done
```

Since it doesn't have any filenames, the loop repeats zero times.

## Scripts from History

Now, suppose we have just run a series of commands that did something useful --- for example, that created a graph we'd like to use in a paper.

We'd like to be able to re-create the graph later if we need to, so we want to save the commands in a file. Instead of typing them in again (and potentially getting them wrong) we can do this:

```
$ history | tail -4 > redo-figure-3.sh
```

The file redo-figure-3.sh now contains:

```
297 goostats -r NENE01729B.txt stats-NENE01729B.txt
298 goodiff stats-NENE01729B.txt /data/validated/01729.txt > 01729-
differences.txt
299 cut -d ',' -f 2-3 01729-differences.txt > 01729-time-series.txt
300 ygraph --format scatter --color bw --borders none 01729-time-series.txt
figure-3.png
```

After a moment's work in an editor to remove the serial numbers on the commands, we have a completely accurate record of how we created that figure.

## Unnumbering {.callout}

Rochelle could also use `colrm` (short for "column removal") to remove the serial numbers on her previous commands.

Its parameters are the range of characters to strip from its input:

```
$ history | tail -5
173 cd /tmp
174 ls
175 mkdir bakup
176 mv bakup backup
177 history | tail -5
$ history | tail -5 | colrm 1 7
bash group.sh
bash group.sh asia*.txt > all-asia.txt
ls all-asia.txt
cat all-asia.txt
history | tail -5 | colrm 1 7
```

In order to get a range in your history, simply combine `head` and `tail` arguments, e.g.:

```
$ history | tail -15 | head -5 | colrm 1 7 > new_script.sh
```

would place the five commands from 15 commands before into a new\_script.sh file without the serial numbers.

In practice, most people develop shell scripts by running commands at the shell prompt a few times to make sure they're doing the right thing, then saving them in a file for re-use.

This style of work allows people to recycle what they discover about their data and their workflow with one call to `history` and a bit of editing to clean up the output and save it as a shell script.

## Practical scripts

So what is a good example of a shell script for practical use? Look at `regen_pdfs.sh`:

```
cd programming-fundamentals
nano regen_pdfs.sh
```

This script is used for the materials you're reading now! While you may not have the program `markdown-pdf` installed, you can see how it's called in a bash script to batch convert a number of files. One of the true powers of bash is gluing together other programs, maybe written in different languages, to perform a sequence of events, especially events dealing with files.

## Exercises

### Challenge 1

Write a shell script called `longest.sh` in `my_files/` that takes the name of a directory and a filename extension as its parameters, and prints out the number of lines and name of the file with the most lines in that directory with that extension. For example:

```
> bash my_files/longest.sh /tmp/data pdb
```

would print the name of the `.pdb` file in `/tmp/data` that has the most lines.

### Challenge 2

Joel's data directory contains three files: `fructose.dat`, `glucose.dat`, and `sucrose.dat`. Each of the `.dat` files contains only the word `sugar`. Explain what a script called `example.sh` (also in the directory!) would do when run as `bash example.sh *.dat` if it contained the following lines:

```
# Script a
echo *.*
```

```
# Script b
for filename in $1 $2 $3
do
    cat $filename
done
```

```
# Script c
echo $@.dat
```

Now test your theory and redirect the output to `my_files/challenge_2a.txt`, `my_files/challenge_2b.txt`, and `my_files/challenge_2c.txt` respectively.

### Challenge 3

What happens if you rename `example.sh` to `example.R`?

When you feel you have met these challenges successfully, cd into test/ and type

```
. 1-5_test.sh
```

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Adapted from: [Software Carpentry \(http://software-carpentry.org/v5/novice/shell/05-script.html\)](http://software-carpentry.org/v5/novice/shell/05-script.html)