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title: The Unix Shell  
subtitle: Loops  
minutes: 20

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# The Unix Shell: Variables, Loops and Repeating Things

## Learning Objectives

- Write a loop that applies one or more commands separately to each file in a set of files.
- Trace the values taken on by a loop variable during execution of the loop.
- Explain the difference between a variable's name and its value.
- Explain why spaces and some punctuation characters shouldn't be used in files' names.
- Demonstrate how to see what commands have recently been executed.
- Re-run recently executed commands without retyping them.

Wildcards and tab completion are two ways to reduce typing (and typing mistakes). Another is to tell the shell to do something over and over again.

Let's go back to our programming-fundamentals-master/data/new-york-times directory.

Before merging, let's say we'd like to make a backup directory called 'backup' and copy our articles in there, renaming each one original-human-rights-2000.TXT and original-human-rights-2001.TXT.

First we can make a directory and copy our files:

```
$ cd ~/programming-fundamentals-master/data/new-york-times
$ mkdir backup
$ cp *.txt backup
$ ls backup
```

So far so good. But when we try to rename the files, we can't use:

```
$ cd backup
$ mv *.TXT original-*.TXT
```

because that would expand to:

```
$ mv human-rights-2000.TXT human-rights-2001.TXT ... human-rights-2009.TXT
original-*.TXT
```

This wouldn't back up our files, instead we get an error

```
mv: target `original-*.TXT' is not a directory
```

This is because there are no files matching the wildcard `original-*.TXT`.  
In this case, Bash passes the unexpanded wildcard as a parameter to the `mv` command.

## Variables

In this case, we want to repeat the command on multiple files, but we don't want to write a new line of code with each different filename. Instead, we can create a **variable**, which we assign a value (e.g. a name), then use as a placeholder for that value in the operations we run. We can change the value assigned to the variable, in order to use the same lines of code to run the operations on different items or values.

First, we create a variable and assign it a value.

```
$ filename=human-rights-2000.TXT
```

Then we can run a command, using the variable as a placeholder for the value we stored in it. We retrieve the variable's value by putting `$` in front of it.

```
$ wc -w $filename
```

```
63661 human-rights-2000.TXT
```

Notice what happens if we don't include the `$`: the computer tries to interpret `filename` as an actual file or folder, rather than a variable containing a real filename.

```
$ wc -w filename
```

```
wc: filename: open: No such file or directory
```

## Loops

Now that we can refer to a specific thing using a variable as a placeholder, we can repeat the same operation on multiple things, using a **loop** to do the operation once for each thing in a list. Here's a simple example that displays the word counts of each file in turn:

```
$ for filename in human-rights-2000.TXT human-rights-2001.TXT
> do
>     wc -w $filename
> done
```

```
63661 human-rights-2000.TXT
```

```
56035 human-rights-2001.TXT
```

When the shell sees the keyword `for`, it knows it is supposed to repeat a command (or group of commands) once for each thing in a list. In this case, the list is the two filenames.

Each time through the loop, the name of the thing currently being operated on is assigned to the variable we created in the `for` line, called `filename`. Inside the loop, we get the variable's value by putting `$` in front of it as before: `$filename` is `human-rights-2000.TXT` the first time through the loop, `human-rights-2001.TXT` the second, and so on.

The command that's actually being run is our old friend `wc` again, so this loop prints out the word count of each data file in turn.

### Follow the Prompt

The shell prompt changes from \$ to > and back again as we were typing in our loop. The second prompt, >, is different to remind us that we haven't finished typing a complete command yet.

We have called the variable in this loop filename in order to make its purpose clearer to human readers. The shell itself doesn't care what the variable is called; if we wrote this loop as:

```
$ for x in human-rights-2000.TXT human-rights-2001.TXT
> do
>     wc -w $x
> done
```

or:

```
$ for temperature in human-rights-2000.TXT human-rights-2001.TXT
> do
>     wc -w $temperature
> done
```

it would work exactly the same way. *Don't do this.* Programs are only useful if people can understand them, so meaningless names (like x) or misleading names (like temperature) increase the odds that the program won't do what its readers think it does.

## Spaces in Names

Filename expansion in loops is another reason you should not use spaces in filenames. Suppose our data files are named:

```
basilisk.dat  
red dragon.dat  
unicorn.dat
```

If we try to process them using:

```
for filename in *.dat  
do  
    head -100 $filename | tail -20  
done
```

then the shell will expand \*.dat to create:

```
basilisk.dat red dragon.dat unicorn.dat
```

With older versions of Bash, or most other shells, filename will then be assigned the following values in turn:

```
basilisk.dat  
red  
dragon.dat  
unicorn.dat
```

That's a problem: head can't read files called red and dragon.dat because they don't exist, and won't be asked to read the file red dragon.dat.

We can make our script a little bit more robust by **quoting** our use of the variable:

```
for filename in *.dat  
do  
    head -100 "$filename" | tail -20  
done
```

but it's simpler just to avoid using spaces (or other special characters) in filenames.

## A Loopy Solution

Going back to our original file renaming problem, we can solve it using this loop:

```
$ for filename in *.TXT  
> do  
>     mv $filename original-$filename  
> done
```

This loop runs the `mv` command once for each filename. The first time, when `$filename` expands to `human-rights-2000.TXT`, the shell executes:

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

The second time, the command is:

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

### Measure Twice, Run Once

A loop is a way to do many things at once --- or to make many mistakes at once if it does the wrong thing. One way to check what a loop *would* do is to echo the commands it would run instead of actually running them. For example, we could write our file renaming loop like this:

```
for filename in *.TXT
do
    echo mv $filename original-$filename
done
```

Instead of running `mv`, this loop runs `echo`, which prints out:

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

*without* actually running those commands. We can then use up-arrow to redisplay the loop, back-arrow to get to the word `echo`, delete it, and then press "enter" to run the loop with the actual `mv` commands. This isn't foolproof, but it's a handy way to see what's going to happen when you're still learning how loops work..

## History

Another way to repeat previous work is to use the `history` command to get a list of the last few hundred commands that have been executed, and then to use `!123` (where "123" is replaced by the command number) to repeat one of those commands. For example, if Rochelle types this:

```
$ history | tail -5
474  for filename in *.txt; do sed -i".bak" '1d' $filename; done
475  cat africa1.txt
476  rm *.bak
477  history | tail -5
```

then she can re-run `cat africa1` simply by typing `!475`.

## Exercises

### Challenge 1

The command `expr` does simple arithmetic using command-line parameters:

```
$ expr 3 + 5
8
$ expr 30 / 5 - 2
4
```

Try to create an arithmetic expression that uses variables. First, create a variable called `x1` assigned the value 1. Then create a variable called `x2` with value 2. (In other words, instead of creating a filename variable with the name of a text file, we're creating a variable that just stores a number.)

Then use those two variables and the `expr` command to calculate the sum of `1 + 2`. Redirect the output to `programming-fundamentals-master/my_files/challenge_1.txt`.

## Challenge 2

Now create a for loop that iterates through a list of numbers from 1 through 5, and calculates the first five even numbers. (You can add each number to itself, or use the multiplication symbol `\*`.)

Redirect the output to `programming-fundamentals-master/my_files/challenge_2.txt`. (You can redirect output line-by-line and append it to the end of an existing file using `>>`, or redirect all output from the entire for loop by using `>` right after done.)

## Challenge 3

What is the output of:

```
for left in 2 3
do
    for right in $left
    do
        expr $left + $right
    done
done
```

Now test your theory and redirect your answer to `programming-fundamentals/my_files/challenge_3.txt`!

`cd` into test, and type `. 1-4_test.sh` once you've completed the challenges.

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Adapted from: [Software Carpentry \(http://software-carpentry.org/v5/novice/shell/04-loop.html\)](http://software-carpentry.org/v5/novice/shell/04-loop.html)