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Sed - An Introduction and Tutorial by Bruce Barnett

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Introduction to Sed

How to use sed, a special editor for modifying files automatically. If you want to write a program to make changes in a file, sed is the tool to use.

There are a few programs that are the real workhorse in the UNIX toolbox. These programs are simple to use for simple applications, yet have a rich set of commands for performing complex actions. Don't let the complex potential of a program keep you from making use of the simpler aspects. I'll start with the simple concepts and introduce the advanced topics later on.

When I first wrote this (in 1994), most versions of sed did not allow you to place comments inside the script. Lines starting with the '#' characters are comments. Newer versions of sed may support comments at the end of the line as well.

One way to think of this is that the old, "classic" version was the basis of GNU, FreeBSD and Solaris versions of sed. And to help you understand what I had to work with, here is the [sed\(1\) manual page from Sun/Oracle](#) .

The Awful Truth about sed

Sed is the ultimate **s**tream **e**ditor. If that sounds strange, picture a stream flowing through a pipe. Okay, you can't see a stream if it's inside a pipe. That's what I get for attempting a flowing analogy. You want literature, read James Joyce.

Anyhow, *sed* is a marvelous utility. Unfortunately, most people never learn its real power. The language is very simple, but the documentation is terrible. The Solaris on-line manual pages for *sed* are five pages long, and two of those pages describe the 34 different errors you can get. A program that spends as much space documenting the errors as it does documenting the language has a serious learning curve.

Do not fret! It is not your fault you don't understand *sed*. I will cover *sed* completely. But I will describe the features in the order that I learned them. I didn't learn everything at once. You don't need to either.

The essential command: s for substitution

Sed has several commands, but most people only learn the substitute command: *s*. The substitute command changes all occurrences of the regular expression into a new value. A simple example is changing "day" in the "old" file to "night" in the "new" file:

```
sed s/day/night/ <old >new
```

Or another way (for UNIX beginners),

```
sed s/day/night/ old >new
```

and for those who want to test this:

```
echo day | sed s/day/night/
```

This will output "night".

I didn't put quotes around the argument because this example didn't need them. If you read my earlier tutorial [on quotes](#) , you would understand why it doesn't need quotes. However, I recommend you do use quotes. If you have meta-characters in the command, quotes are necessary. And if you aren't sure, it's a

good habit, and I will henceforth quote future examples to emphasize the "best practice." Using the strong (single quote) character, that would be:

```
sed 's/day/night/' <old >new
```

I must emphasize that the sed editor changes exactly what you tell it to. So if you executed

```
echo Sunday | sed 's/day/night/'
```

This would output the word "Sunnight" because sed found the string "day" in the input.

Another important concept is that sed is line oriented. Suppose you have the input file:

```
one two three, one two three
four three two one
one hundred
```

and you used the command

```
sed 's/one/ONE/' <file
```

The output would be

```
ONE two three, one two three
four three two ONE
ONE hundred
```

Note that this changed "one" to "ONE" once on each line. The first line had "one" twice, but only the first occurrence was changed. That is the default behavior. If you want something different, you will have to use some of the options that are available. I'll explain them later.

So let's continue.

There are four parts to this substitute command:

s	Substitute command
/.../	Delimiter
one	Regular Expression Pattern Search Pattern
ONE	Replacement string

The search pattern is on the left hand side and the replacement string is on the right hand side.

We've covered **quoting** and **regular expressions**. That's 90% of the effort needed to learn the substitute command. To put it another way, you already know how to handle 90% of the most frequent uses of *sed*. There are a ... few fine points that any future sed expert should know about. (You just finished section 1. There are only 63 more sections to cover. :-) Oh. And you may want to bookmark this page, just in case you don't finish.

The slash as a delimiter

The character after the *s* is the delimiter. It is conventionally a slash, because this is what *ed*, *more*, and *vi* use. It can be anything you want, however. If you want to change a pathname that contains a slash - say `/usr/local/bin` to `/common/bin` - you could use the backslash to quote the slash:

```
sed 's\/usr\/local\/bin\/common\/bin/' <old >new
```

Gulp. Some call this a 'Picket Fence' and it's ugly. It is easier to read if you use an underline instead of a slash as a delimiter:

```
sed 's_/usr/local/bin_/common/bin_' <old >new
```

Some people use colons:

```
sed 's:/usr/local/bin:/common/bin:' <old >new
```

Others use the "|" character.

```
sed 's|/usr/local/bin|/common/bin|' <old >new
```

Pick one you like. As long as it's not in the string you are looking for, anything goes. And remember that you need three delimiters. If you get a "Unterminated `s' command" it's because you are missing one of them.

Using & as the matched string

Sometimes you want to search for a pattern and add some characters, like parenthesis, around or near the pattern you found. It is easy to do this if you are looking for a particular string:

```
sed 's/abc/(abc)/' <old >new
```

This won't work if you don't know exactly what you will find. How can you put the string you found in the replacement string if you don't know what it is?

The solution requires the special character "&." It corresponds to the pattern found.

```
sed 's/[a-z]*/&/' <old >new
```

You can have any number of "&" in the replacement string. You could also double a pattern, e.g. the first number of a line:

```
% echo "123 abc" | sed 's/[0-9]*/& &/'
123 123 abc
```

Let me slightly amend this example. Sed will match the first string, and make it as greedy as possible. I'll cover that later. If you don't want it to be so greedy (i.e. limit the matching), you need to put restrictions on the match.

The first match for '[0-9]*' is the first character on the line, as this matches zero or more numbers. So if the input was "abc 123" the output would be unchanged (well, except for a space before the letters). A better way to duplicate the number is to make sure it matches a number:

```
% echo "123 abc" | sed 's/[0-9][0-9]*/& &/'
123 123 abc
```

The string "abc" is unchanged, because it was not matched by the regular expression. If you wanted to eliminate "abc" from the output, you must expand the regular expression to match the rest of the line and explicitly exclude part of the expression using "(" , ")" and "\1", which is the next topic.

Extended Regular Expressions

Let me add a quick comment here because there is another way to write the above script. "[0-9]*" matches zero or more numbers. "[0-9][0-9]*" matches one or more numbers. Another way to do this is to use the "+" meta-character and use the pattern "[0-9]+" as the "+" is a special character when using "extended regular expressions." Extended regular expressions have more power, but sed scripts that treated "+" as a normal character would break. Therefore you must explicitly enable this extension with a command line option.

GNU sed turns this feature on if you use the "-r" command line option. So the above could also be written using

```
% echo "123 abc" | sed -r 's/[0-9]+/& &/'
123 123 abc
```

Mac OS X and FreeBSD uses **-E** instead of **-r**. For more information on extended regular expressions, see [Regular Expressions](#) and the [description of the -r command line argument](#)

Using \1 to keep part of the pattern

I have already described the use of "(" ")" and "1" in my tutorial on [regular expressions](#). To review, the escaped parentheses (that is, parentheses with backslashes before them) remember a substring of the characters matched by the regular expression. You can use this to exclude part of the characters matched by the regular expression. The "\1" is the first remembered pattern, and the "\2" is the second remembered pattern. Sed has up to nine remembered patterns.

If you wanted to keep the first word of a line, and delete the rest of the line, mark the important part with the parenthesis:

```
sed 's/\([a-z]*\).*\/\1/'
```

I should elaborate on this. Regular expressions are greedy, and try to match as much as possible. "[a-z]*" matches zero or more lower case letters, and tries to match as many characters as possible. The "." matches zero or more characters after the first match. Since the first one grabs all of the contiguous lower case letters, the second matches anything else. Therefore if you type

```
echo abcd123 | sed 's/\([a-z]*\).*\/\1/'
```

This will output "abcd" and delete the numbers.

If you want to switch two words around, you can remember two patterns and change the order around:

```
sed 's/\([a-z]*\) \([a-z]*\)/\2 \1/'
```

Note the space between the two remembered patterns. This is used to make sure two words are found. However, this will do nothing if a single word is found, or any lines with no letters. You may want to insist that words have at least one letter by using

```
sed 's/\([a-z][a-z]*\) \([a-z][a-z]*\)/\2 \1/'
```

or by using extended regular expressions (note that '(' and ')' no longer need to have a backslash):

```
sed -r 's/([a-z]+) ([a-z]+)/\2 \1/' # Using GNU sed
sed -E 's/([a-z]+) ([a-z]+)/\2 \1/' # Using Apple Mac OS X
```

The "\1" doesn't have to be in the replacement string (in the right hand side). It can be in the pattern you are searching for (in the left hand side). If you want to eliminate duplicated words, you can try:

```
sed 's/\([a-z]*\) \1\1/'
```

If you want to detect duplicated words, you can use

```
sed -n '/\([a-z][a-z]*\) \1/p'
```

or with extended regular expressions

```
sed -rn '/([a-z]+) \1/p' # GNU sed
```

```
sed -En '/([a-z]+) \1/p' # Mac OS X
```

This, when used as a filter, will print lines with duplicated words.

The numeric value can have up to nine values: "\1" thru "\9." If you wanted to reverse the first three characters on a line, you can use

```
sed 's/^(.)(.)(.)/\3\2\1/'
```

Sed Pattern Flags

You can add additional flags after the last delimiter. You might have noticed I used a 'p' at the end of the previous substitute command. I also added the '-n' option. Let me first cover the 'p' and other pattern flags. These flags can specify what happens when a match is found. Let me describe them.

/g - Global replacement

Most UNIX utilities work on files, reading a line at a time. *Sed*, by default, is the same way. If you tell it to change a word, it will only change the first occurrence of the word on a line. You may want to make the change on every word on the line instead of the first. For an example, let's place parentheses around words on a line. Instead of using a pattern like "[A-Za-z]*" which won't match words like "won't," we will use a pattern, "[^]*," that matches everything except a space. Well, this will also match anything because "*" means **zero or more**. The current version of Solaris's *sed* (as I wrote this) can get unhappy with patterns like this, and generate errors like "Output line too long" or even run forever. I consider this a bug, and have reported this to Sun. As a work-around, you must avoid matching the null string when using the "g" flag to *sed*. A work-around example is: "[^][^]*." The following will put parenthesis around the first word:

```
sed 's/[^ ]*/(&)/' <old >new
```

If you want it to make changes for every word, add a "g" after the last delimiter and use the work-around:

```
sed 's/[^ ][^ ]*/(&)/g' <old >new
```

Is sed recursive?

Sed only operates on patterns found in the in-coming data. That is, the input line is read, and when a pattern is matched, the modified output is generated, and the **rest** of the input line is scanned. The "s" command will not scan the newly created output. That is, you don't have to worry about expressions like:

```
sed 's/loop/loop the loop/g' <old >new
```

This will not cause an infinite loop. If a second "s" command is executed, it could modify the results of a previous command. I will show you how to execute multiple commands later.

/1, /2, etc. Specifying which occurrence

With no flags, the first matched substitution is changed. With the "g" option, all matches are changed. If you want to modify a particular pattern that is not the first one on the line, you could use "\(" and "\)" to mark each pattern, and use "\1" to put the first pattern back unchanged. This next example keeps the first word on the line but deletes the second:


```
sed 's/\([a-zA-Z]*\) \([a-zA-Z]*\) /\1 /' <old >new
```

Yuck. There is an easier way to do this. You can add a number after the substitution command to indicate you only want to match that particular pattern. Example:

```
sed 's/[a-zA-Z]* //2' <old >new
```

You can combine a number with the g (global) flag. For instance, if you want to leave the first word alone, but change the second, third, etc. to be DELETED instead, use /2g:

```
sed 's/[a-zA-Z]* /DELETED /2g' <old >new
```

I've heard that combining the number with the g command does not work on The MacOS, and perhaps the FreeBSD version of sed as well.

Don't get /2 and \2 confused. The /2 is used at the end. \2 is used in inside the replacement field.

Note the space after the "*" character. Without the space, *sed* will run a long, long time. (Note: this bug is probably fixed by now.) This is because the number flag and the "g" flag have the same bug. You should also be able to use the pattern

```
sed 's/[^ ]*//2' <old >new
```

but this also eats CPU. If this works on your computer, and it does on some UNIX systems, you could remove the encrypted password from the password file:

```
sed 's/[^:]*//2' </etc/passwd >/etc/password.new
```

But this didn't work for me the time I wrote this. Using "[^:][^:]*" as a work-around doesn't help because it won't match an non-existent password, and instead delete the third field, which is the user ID! Instead you have to use the ugly parenthesis:

```
sed 's/^\([^:]*\) :[^:]* :/\1 :/' </etc/passwd >/etc/password.new
```

You could also add a character to the first pattern so that it no longer matches the null pattern:

```
sed 's/[^:]*:/:/2' </etc/passwd >/etc/password.new
```

The number flag is not restricted to a single digit. It can be any number from 1 to 512. If you wanted to add a colon after the 80th character in each line, you could type:

```
sed 's/.&:/80' <file >new
```

You can also do it the hard way by using 80 dots:

```
sed 's/^...../&:/
```

/p - print

By default, *sed* prints every line. If it makes a substitution, the new text is printed instead of the old one. If you use an optional argument to sed, "sed -n," it will not, by default, print any new lines. I'll cover this and other options later. When the "-n" option is used, the "p" flag will cause the modified line to be printed. Here is one way to duplicate the function of *grep* with *sed*:

```
sed -n 's/pattern/&/p' <file
```

But a simpler version is described **later**

Write to a file with /w filename

There is one more flag that can follow the third delimiter. With it, you can specify a file that will receive the modified data. An example is the following, which will write all lines that start with an even number, followed by a space, to the file *even*:

```
sed -n 's/^[0-9]*[02468] /&/w even' <file
```

In this example, the output file isn't needed, as the input was not modified. You must have exactly one space between the *w* and the filename. You can also have ten files open with one instance of *sed*. This allows you to split up a stream of data into separate files. Using the previous example combined with multiple substitution commands described later, you could split a file into ten pieces depending on the last digit of the first number. You could also use this method to log error or debugging information to a special file.

/I - Ignore Case

GNU has added another pattern flags - /I

This flag makes the pattern match case insensitive. This will match *abc*, *aBc*, *ABC*, *AbC*, etc.:

```
sed -n '/abc/I p' <old >new
```

Note that a space after the /I' and the 'p' (print) command emphasizes that the 'p' is not a modifier of the pattern matching process, , but a command to execute **after** the pattern matching.

Combining substitution flags

You can combine flags when it makes sense. Please note that the "w" has to be the last flag. For example the following command works:

```
sed -n 's/a/A/2pw /tmp/file' <old >new
```

Next I will discuss the options to *sed*, and different ways to invoke *sed*.

Arguments and invocation of sed

previously, I have only used one substitute command. If you need to make two changes, and you didn't want to read the manual, you could pipe together multiple *sed* commands:

```
sed 's/BEGIN/begin/' <old | sed 's/END/end/' >new
```

This used two processes instead of one. A *sed* guru never uses two processes when one can do.

Multiple commands with -e command

One method of combining multiple commands is to use a -e before each command:

```
sed -e 's/a/A/' -e 's/b/B/' <old >new
```

A "-e" isn't needed in the earlier examples because *sed* knows that there must always be one command. If you give *sed* one argument, it must be a command,

and *sed* will edit the data read from standard input.

The long argument version is

```
sed --expression='s/a/A/' --expression='s/b/B/' <old >new
```

Also see [Quoting multiple sed lines in the Bourne shell](#)

Filename on the command line

You can specify files on the command line if you wish. If there is more than one argument to *sed* that does not start with an option, it must be a filename. This next example will count the number of lines in three files that don't begin with a "#:"

```
sed 's/^#.*//' f1 f2 f3 | grep -v '^$' | wc -l
```

Let's break this down into pieces. The *sed* substitute command changes every line that starts with a "#" into a blank line. *Grep* was used to filter out (delete) empty lines. *Wc* counts the number of lines left. *Sed* has more commands that make *grep* unnecessary. And *grep -c* can replace *wc -l*. I'll discuss how you can duplicate some of *grep*'s functionality later.

Of course you could write the last example using the "-e" option:

```
sed -e 's/^#.*//' f1 f2 f3 | grep -v '^$' | wc -l
```

There are two other options to *sed*.

sed -n: no printing

The "-n" option will not print anything unless an explicit request to print is found. I mentioned the "/p" flag to the substitute command as one way to turn printing back on. Let me clarify this. The command

```
sed 's/PATTERN/&/p' file
```

acts like the *cat* program if *PATTERN* is not in the file: e.g. nothing is changed. If *PATTERN* is in the file, then each line that has this is printed twice. Add the "-n" option and the example acts like *grep*:

```
sed -n 's/PATTERN/&/p' file
```

Nothing is printed, except those lines with *PATTERN* included.

The long argument of the -n command is either

```
sed --quiet 's/PATTERN/&/p' file
```

or

```
sed --silent 's/PATTERN/&/p' file
```

Using 'sed /pattern/'

Sed has the ability to specify which lines are to be examined and/or modified, by specifying **addresses** before the command. I will just describe the simplest version for now - the */PATTERN/* address. When used, only lines that match the pattern are given the command after the address. Briefly, when used with the /p flag, matching lines are printed twice:

```
sed '/PATTERN/p' file
```

And of course PATTERN is any regular expression.

Please note that if you do not include a command, such as the "p" for print, you will get an error. When I type

```
echo abc | sed '/a/'
```

I get the error

```
sed: -e expression #1, char 3: missing command
```

Also, you don't need to, but I recommend that you place a space after the pattern and the command. This will help you distinguish between flags that modify the pattern matching, and commands to execute after the pattern is matched. Therefore I recommend this style:

```
sed '/PATTERN/ p' file
```

Using 'sed -n /pattern/p' to duplicate the functionality of grep

If you want to duplicate the functionality of grep, combine the -n (noprnt) option with the /p print flag:

```
sed -n '/PATTERN/p' file
```

sed -f scriptname

If you have a large number of *sed* commands, you can put them into a file and use

```
sed -f sedscript <old >new
```

where *sedscript* could look like this:

```
# sed comment - This script changes lower case vowels to upper case
s/a/A/g
s/e/E/g
s/i/I/g
s/o/O/g
s/u/U/g
```

When there are several commands in one file, each command must be on a separate line.

The long argument version is

```
sed --file=sedscript <old >new
```

Also see [**here on writing a script that executes sed directly**](#)

sed in shell scripts

If you have many commands and they won't fit neatly on one line, you can break up the line using a backslash:

```
sed -e 's/a/A/g' \
    -e 's/e/E/g' \
    -e 's/i/I/g' \
    -e 's/o/O/g' \
    -e 's/u/U/g' <old >new
```

Quoting multiple sed lines in the C shell

You can have a large, multi-line *sed* script in the C shell, but you must tell the C shell that the quote is continued across several lines. This is done by placing a backslash at the end of each line:

```
#!/bin/csh -f
sed 's/a/A/g \
s/e/E/g \
s/i/I/g \
s/o/O/g \
s/u/U/g' <old >new
```

Quoting multiple sed lines in the Bourne shell

The Bourne shell makes this easier as a quote can cover several lines:

```
#!/bin/sh
sed '
s/a/A/g
s/e/E/g
s/i/I/g
s/o/O/g
s/u/U/g' <old >new
```

sed -V

The -V option will print the version of sed you are using. The long argument of the command is

```
sed --version
```

sed -h

The -h option will print a summary of the sed commands. The long argument of the command is

```
sed --help
```

A sed interpreter script

Another way of executing *sed* is to use an interpreter script. Create a file that contains:

```
#!/bin/sed -f
s/a/A/g
s/e/E/g
s/i/I/g
s/o/O/g
s/u/U/g
```

Click here to get file: **CapVowel.sed**

If this script was stored in a file with the name "CapVowel" and was executable, you could use it with the simple command:

```
CapVowel <old >new
```

Comments

Sed comments are lines where the first non-white character is a "#." On many systems, *sed* can have only one comment, and it must be the first line of the script. On the Sun (1988 when I wrote this), you can have several comment lines anywhere in the script. Modern versions of *Sed* support this. If the first line contains exactly "#n" then this does the same thing as the "-n" option: turning off printing by default. This could not be done with a *sed* interpreter script, because the first line must start with "#!/bin/sed -f" as I think "#!/bin/sed -nf" generated an error. It worked when I first wrote this (2008). Note that "#!/bin/sed -fn" does not work because *sed* thinks the filename of the script is "n". However,

```
"#!/bin/sed -nf"
```

does work.

Passing arguments into a sed script

Passing a word into a shell script that calls *sed* is easy if you remembered [my tutorial on the UNIX quoting mechanism](#). To review, you use the single quotes to turn quoting on and off. A simple shell script that uses *sed* to emulate *grep* is:

```
#!/bin/sh
sed -n 's/'$1'/&/p'
```

However - there is a problem with this script. If you have a space as an argument, the script would cause a syntax error. A better version would protect from this happening:

```
#!/bin/sh
sed -n 's/'"$1"'/&/p'
```

Click here to get file: [sedgrep.sed](#)

If this was stored in a file called *sedgrep*, you could type

```
sedgrep '[A-Z][A-Z]' <file
```

This would allow *sed* to act as the *grep* command.

Using sed in a shell here-is document

You can use *sed* to prompt the user for some parameters and then create a file with those parameters filled in. You could create a file with dummy values placed inside it, and use *sed* to change those dummy values. A simpler way is to use the "here is" document, which uses part of the shell script as if it were standard input:

```
#!/bin/sh
echo -n 'what is the value? '
read value
sed 's/XYZ/'$value'/' <<EOF
The value is XYZ
EOF
```

When executed, the script says:

```
what is the value?
```

If you type in "123," the next line will be:

The value is 123

I admit this is a contrived example. "Here is" documents can have values evaluated without the use of *sed*. This example does the same thing:

```
#!/bin/sh
echo -n 'what is the value? '
read value
cat <<EOF
The value is $value
EOF
```

However, combining "here is" documents with *sed* can be useful for some complex cases.

Note that

```
sed 's/XYZ/'$value'/' <<EOF
```

will give a syntax error if the user types an answer that contains a space, like "a b c". Better form would be to put double quotes around the evaluation of the value:

```
#!/bin/sh
echo -n 'what is the value? '
read value
sed 's/XYZ/'"$value"'/ ' <<EOF
The value is XYZ
EOF
```

I covered this in my [tutorial on quotation marks](#) .
Click here to get file: [sed_hereis.sed](#)

Multiple commands and order of execution

As we explore more of the commands of *sed*, the commands will become complex, and the actual sequence can be confusing. It's really quite simple. Each line is read in. Each command, in order specified by the user, has a chance to operate on the input line. After the substitutions are made, the next command has a chance to operate on the same line, which may have been modified by earlier commands. If you ever have a question, the best way to learn what will happen is to create a small example. If a complex command doesn't work, make it simpler. If you are having problems getting a complex script working, break it up into two smaller scripts and pipe the two scripts together.

Addresses and Ranges of Text

You have only learned one command, and you can see how powerful *sed* is. However, all it is doing is a *grep* and substitute. That is, the substitute command is treating each line by itself, without caring about nearby lines. What would be useful is the ability to restrict the operation to certain lines. Some useful restrictions might be:

- Specifying a line by its number.
- Specifying a range of lines by number.
- All lines containing a pattern.
- All lines from the beginning of a file to a regular expression
- All lines from a regular expression to the end of the file.
- All lines between two regular expressions.

Sed can do all that and more. Every command in *sed* can be preceded by an address, range or restriction like the above examples. The restriction or address

immediately precedes the command:

restriction command

Restricting to a line number

The simplest restriction is a line number. If you wanted to delete the first number on line 3, just add a "3" before the command:

```
sed '3 s/[0-9][0-9]*//' <file >new
```

Patterns

Many UNIX utilities like *vi* and *more* use a slash to search for a regular expression. *Sed* uses the same convention, provided you terminate the expression with a slash. To delete the first number on all lines that start with a "#," use:

```
sed '/^#/ s/[0-9][0-9]*//'
```

I placed a space after the *"expression"* so it is easier to read. It isn't necessary, but without it the command is harder to fathom. *Sed* does provide a few extra options when specifying regular expressions. But I'll discuss those later. If the expression starts with a backslash, the next character is the delimiter. To use a comma instead of a slash, use:

```
sed '\,^#, s/[0-9][0-9]*//'
```

The main advantage of this feature is searching for slashes. Suppose you wanted to search for the string *"/usr/local/bin"* and you wanted to change it for *"/common/all/bin."* You could use the backslash to escape the slash:

```
sed '\\/usr\\local\\bin/ s\\/usr\\local\\/\\common\\all/'
```

It would be easier to follow if you used an underline instead of a slash as a search. This example uses the underline in both the search command and the substitute command:

```
sed '\\_usr/local/bin_ s_/usr/local_/common/all_'
```

This illustrates why *sed* scripts get the reputation for obscurity. I could be perverse and show you the example that will search for all lines that start with a "g," and change each "g" on that line to an "s:"

```
sed '/^g/s/g/s/g'
```

Adding a space and using an underscore after the substitute command makes this **much** easier to read:

```
sed '/^g/ s_g_s_g'
```

Er, I take that back. It's hopeless. There is a lesson here: Use comments liberally in a *sed* script. You may have to remove the comments to run the script under a different (older) operating system, but you now know how to write a *sed* script to do that very easily! Comments are a Good Thing. You may have understood the script perfectly when you wrote it. But six months from now it could look like modem noise. And if you don't understand that reference, imagine an 8-month-old child typing on a computer.

Ranges by line number

You can specify a range on line numbers by inserting a comma between the

numbers. To restrict a substitution to the first 100 lines, you can use:

```
sed '1,100 s/A/a/'
```

If you know exactly how many lines are in a file, you can explicitly state that number to perform the substitution on the rest of the file. In this case, assume you used `wc` to find out there are 532 lines in the file:

```
sed '101,532 s/A/a/'
```

An easier way is to use the special character "\$," which means the last line in the file.

```
sed '101,$ s/A/a/'
```

The "\$" is one of those conventions that mean "last" in utilities like `cat -e`, `vi`, and `ed`. "cat -e" Line numbers are cumulative if several files are edited. That is,

```
sed '200,300 s/A/a/' f1 f2 f3 >new
```

is the same as

```
cat f1 f2 f3 | sed '200,300 s/A/a/' >new
```

Ranges by patterns

You can specify two regular expressions as the range. Assuming a "#" starts a comment, you can search for a keyword, remove all comments until you see the second keyword. In this case the two keywords are "start" and "stop:"

```
sed '/start/,/stop/ s/#.*//'
```

The first pattern turns on a flag that tells `sed` to perform the substitute command on every line. The second pattern turns off the flag. If the "start" and "stop" pattern occurs twice, the substitution is done both times. If the "stop" pattern is missing, the flag is never turned off, and the substitution will be performed on every line until the end of the file.

You should know that if the "start" pattern is found, the substitution occurs on the same line that contains "start." This turns on a switch, which is line oriented. That is, the next line is read and the substitute command is checked. If it contains "stop" the switch is turned off. Switches are line oriented, and not word oriented.

You can combine line numbers and regular expressions. This example will remove comments from the beginning of the file until it finds the keyword "start:"

```
sed -e '1,/start/ s/#.*//'
```

This example will remove comments everywhere except the lines **between** the two keywords:

```
sed -e '1,/start/ s/#.*//' -e '/stop,$ s/#.*//'
```

The last example has a range that overlaps the "/start/,/stop/" range, as both ranges operate on the lines that contain the keywords. I will show you later how to restrict a command up to, **but not including** the line containing the specified pattern. It is in **Operating in a pattern range except for the patterns** But I have to cover some more basic principles.

Before I start discussing the various commands, I should explain that some commands cannot operate on a range of lines. I will let you know when I mention the commands. In this next section I will describe three commands, one of which cannot operate on a range.

Delete with d

Using ranges can be confusing, so you should expect to do some experimentation when you are trying out a new script. A useful command deletes every line that matches the restriction: "d." If you want to look at the first 10 lines of a file, you can use:

```
sed '11,$ d' <file
```

which is similar in function to the *head* command. If you want to chop off the header of a mail message, which is everything up to the first blank line, use:

```
sed '1,/^\$/ d' <file
```

You can duplicate the function of the *tail* command, assuming you know the length of a file. *Wc* can count the lines, and *expr* can subtract 10 from the number of lines. A Bourne shell script to look at the last 10 lines of a file might look like this:

```
#!/bin/sh
# print last 10 lines of file
# First argument is the filename
lines=`wc -l $1 | awk '{print $1}'`
start=`expr $lines - 10`
sed "1,$start d" $1
```

Click here to get file: [**sed_tail.sh**](#)

The range for deletions can be regular expressions pairs to mark the begin and end of the operation. Or it can be a single regular expression. Deleting all lines that start with a "#" is easy:

```
sed '/^#/ d'
```

Removing comments and blank lines takes two commands. The first removes every character from the "#" to the end of the line, and the second deletes all blank lines:

```
sed -e 's/#.*//' -e '/^\$/ d'
```

A third one should be added to remove all blanks and tabs immediately before the end of line:

```
sed -e 's/#.*//' -e 's/[ ^I]*$//' -e '/^\$/ d'
```

The character "^I" is a *CTRL-I* or tab character. You would have to explicitly type in the tab. Note the order of operations above, which is in that order for a very good reason. Comments might start in the middle of a line, with white space characters before them. Therefore comments are first removed from a line, potentially leaving white space characters that were before the comment. The second command removes all trailing blanks, so that lines that are now blank are converted to empty lines. The last command deletes empty lines. Together, the three commands remove all lines containing only comments, tabs or spaces.

This demonstrates the pattern space *sed* uses to operate on a line. The actual operation *sed* uses is:

```
Copy the input line into the pattern space.
Apply the first
sed command on the pattern space, if the address restriction is true.
Repeat with the next sed expression, again
operating on the pattern space.
```

When the last operation is performed, write out the pattern space and read in the next line from the input file.

Printing with p

Another useful command is the print command: "p." If *sed* wasn't started with an "-n" option, the "p" command will duplicate the input. The command

```
sed 'p'
```

will duplicate every line. If you wanted to double every empty line, use:

```
sed '/^$/ p'
```

Adding the "-n" option turns off printing unless you request it. Another way of duplicating *head*'s functionality is to print only the lines you want. This example prints the first 10 lines:

```
sed -n '1,10 p' <file
```

Sed can act like *grep* by combining the print operator to function on all lines that match a regular expression:

```
sed -n '/match/ p'
```

which is the same as:

```
grep match
```

Reversing the restriction with !

Sometimes you need to perform an action on every line except those that match a regular expression, or those outside of a range of addresses. The "!" character, which often means *not* in UNIX utilities, inverts the address restriction. You remember that

```
sed -n '/match/ p'
```

acts like the *grep* command. The "-v" option to *grep* prints all lines that don't contain the pattern. *Sed* can do this with

```
sed -n '/match/ !p' </tmp/b
```

Relationships between d, p, and !

As you may have noticed, there are often several ways to solve the same problem with *sed*. This is because *print* and *delete* are opposite functions, and it appears that "!p" is similar to "d," while "!d" is similar to "p." I wanted to test this, so I created a 20 line file, and tried every different combination. The following table, which shows the results, demonstrates the difference:

Relations between d, p, and !			
Sed	Range	Command	Results
sed -n	1,10	p	Print first 10 lines
sed -n	11,\$!p	Print first 10 lines
sed	1,10	!d	Print first 10 lines
sed	11,\$	d	Print first 10 lines
sed -n	1,10	!p	Print last 10 lines
sed -n	11,\$	p	Print last 10 lines

sed	1,10	d	Print last 10 lines
sed	11,\$!d	Print last 10 lines
sed -n	1,10	d	Nothing printed
sed -n	1,10	!d	Nothing printed
sed -n	11,\$	d	Nothing printed
sed -n	11,\$!d	Nothing printed
sed	1,10	p	Print first 10 lines twice, then next 10 lines once
sed	11,\$!p	Print first 10 lines twice, then last 10 lines once
sed	1,10	!p	Print first 10 lines once, then last 10 lines twice
sed	11,\$	p	Print first 10 lines once, then last 10 lines twice

This table shows that the following commands are identical:

```
sed -n '1,10 p'
sed -n '11,$ !p'
sed '1,10 !d'
sed '11,$ d'
```

It also shows that the "!" command "inverts" the address range, operating on the other lines.

The q or quit command

There is one more simple command that can restrict the changes to a set of lines. It is the "q" command: quit. the third way to duplicate the head command is:

```
sed '11 q'
```

which quits when the eleventh line is reached. This command is most useful when you wish to abort the editing after some condition is reached.

The "q" command is the one command that does not take a range of addresses. Obviously the command

```
sed '1,10 q'
```

cannot quit 10 times. Instead

```
sed '1 q'
```

or

```
sed '10 q'
```

is correct.

Grouping with { and }

The curly braces, "{" and "}," are used to group the commands.

Hardly worth the buildup. All that prose and the solution is just matching squiggles. Well, there is one complication. Since each *sed* command must start on its own line, the curly braces and the nested *sed* commands must be on separate lines.

Previously, I showed you how to remove comments starting with a "#." If you wanted to restrict the removal to lines between special "begin" and "end" key words, you could use:

```
#!/bin/sh
```

```
# This is a Bourne shell script that removes #-type comments
# between 'begin' and 'end' words.
sed -n '
    /begin/,/end/ {
        s/#.*//
        s/[ ^I]*$//
        /^$/ d
    }
    p
'
```

Click here to get file: [sed_begin_end.sh](#)

These braces can be nested, which allow you to combine address ranges. You could perform the same action as before, but limit the change to the first 100 lines:

```
#!/bin/sh
# This is a Bourne shell script that removes #-type comments
# between 'begin' and 'end' words.
sed -n '
    1,100 {
        /begin/,/end/ {
            s/#.*//
            s/[ ^I]*$//
            /^$/ d
        }
    }
    p
'
```

Click here to get file: [sed_begin_end1.sh](#)

You can place a "!" before a set of curly braces. This inverts the address, which removes comments from all lines **except** those between the two reserved words:

```
#!/bin/sh
sed '
    /begin/,/end/ !{
        s/#.*//
        s/[ ^I]*$//
        /^$/ d
    }
    p
'
```

Click here to get file: [sed_begin_end2.sh](#)

Operating in a pattern range except for the patt

You may remember that I mentioned you can do a substitute on a pattern range, like changing "old" to "new" between a begin/end pattern:

```
#!/bin/sh
sed '
    /begin/,/end/ s/old/new/
'
```

Another way to write this is to use the curly braces for grouping:

```
#!/bin/sh
sed '
    /begin/,/end/ {
        s/old/new/
    }
'
```

```

    }
,

```

I think this makes the code clearer to understand, and easier to modify, as you will see below.

If you did not want to make any changes where the word "begin" occurred, you could simply add a new condition to skip over that line:

```

#!/bin/sh
sed '
    /begin/,/end/ {
        /begin/n # skip over the line that has "begin" on it
        s/old/new/
    }
,

```

However, skipping over the line that has "end" is trickier. If you use the same method you used for "begin" then the sed engine will not see the "end" to stop the range - it skips over that as well. The solution is to do a substitute on all lines that don't have the "end" by using

```

#!/bin/sh
sed '
    /begin/,/end/ {
        /begin/n # skip over the line that has "begin" on it
        /end/ !{
            s/old/new/
        }
    }
,

```

Writing a file with the 'w' command

You may remember that the substitute command can write to a file. Here again is the example that will only write lines that start with an even number (and followed by a space):

```
sed -n 's/^[0-9]*[02468] /&/w even' <file
```

I used the "&" in the replacement part of the substitution command so that the line would not be changed. A simpler example is to use the "w" command, which has the same syntax as the "w" flag in the substitute command:

```
sed -n '/^[0-9]*[02468]/ w even' <file
```

Remember - only one space must follow the command. Anything else will be considered part of the file name. The "w" command also has the same limitation as the "w" flag: only 10 files can be opened in *sed*.

Reading in a file with the 'r' command

There is also a command for reading files. The command

```
sed '$r end' <in>out
```

will append the file "end" at the end of the file (address "\$"). The following will insert a file after the line with the word "INCLUDE:"

```
sed '/INCLUDE/ r file' <in >out
```

You can use the curly braces to delete the line having the "INCLUDE" command on it:

```
#!/bin/sh
sed '/INCLUDE/ {
    r file
    d
}'
```

Click here to get file: [sed_include.sh](#)

The order of the delete command "d" and the read file command "r" is important. Change the order and it will not work. There are two subtle actions that prevent this from working. The first is the "r" command writes the file to the output stream. The file is not inserted into the pattern space, and therefore cannot be modified by any command. Therefore the delete command does not affect the data read from the file.

The other subtlety is the "d" command deletes the current data in the pattern space. Once all of the data is deleted, it does make sense that no other action will be attempted. Therefore a "d" command executed in a curly brace also aborts all further actions. As an example, the substitute command below is never executed:

```
#!/bin/sh
# this example is WRONG
sed -e '1 {
    d
    s/.*/ /
}'
```

Click here to get file: [sed_bad_example.sh](#)

The earlier example is a crude version of the C preprocessor program. The file that is included has a predetermined name. It would be nice if *sed* allowed a variable (e.g. "\1") instead of a fixed file name. Alas, *sed* doesn't have this ability. You could work around this limitation by creating *sed* commands on the fly, or by using shell quotes to pass variables into the *sed* script. Suppose you wanted to create a command that would include a file like *cxx*, but the filename is an argument to the script. An example of this script is:

```
% include 'sys/param.h' <file.c >file.c.new
```

A shell script to do this would be:

```
#!/bin/sh
# watch out for a '/' in the parameter
# use alternate search delimiter
sed -e '\#INCLUDE <"$1">_{
    r "$1"
    d
}'
```

Let me elaborate. If you had a file that contains

```
Test first file
#INCLUDE <file1>
Test second file
#INCLUDE <file2>
```

you could use the command

```
sed_include1.sh file1<input|sed_include1.sh file2
```

to include the specified files.

Click here to get file: [sed_include1.sh](#)

SunOS and the # Comment Command

As we dig deeper into *sed*, comments will make the commands easier to follow. The older versions of *sed* only allow one line as a comment, and it must be the first line. SunOS (and GNU's *sed*) allows more than one comment, and these comments don't have to be first. The last example could be:

```
#!/bin/sh
# watch out for a '/' in the parameter
# use alternate search delimiter
sed -e '\_#INCLUDE <"$1">_{

    # read the file
    r "$1"

    # delete any characters in the pattern space
    # and read the next line in
    d
}'
```

Click here to get file: [sed_include2.sh](#)

Adding, Changing, Inserting new lines

Sed has three commands used to add new lines to the output stream. Because an entire line is added, the new line is on a line by itself to emphasize this. There is no option, an entire line is used, and it must be on its own line. If you are familiar with many UNIX utilities, you would expect *sed* to use a similar convention: lines are continued by ending the previous line with a "\". The syntax to these commands is finicky, like the "r" and "w" commands.

Append a line with 'a'

The "a" command appends a line after the range or pattern. This example will add a line after every line with "WORD:"

```
#!/bin/sh
sed '
/WORD/ a\
Add this line after every line with WORD
'
```

Click here to get file: [sed_add_line_after_word.sh](#)

You could eliminate two lines in the shell script if you wish:

```
#!/bin/sh
sed '/WORD/ a\
Add this line after every line with WORD'
```

Click here to get file: [sed_add_line_after_word1.sh](#)

I prefer the first form because it's easier to add a new command by adding a new line and because the intent is clearer. There must not be a space after the "\".

Insert a line with 'i'

You can insert a new line before the pattern with the "i" command:

```
#!/bin/sh
sed '
/WORD/ i\
Add this line before every line with WORD
'
```

Click here to get file: [sed_add_line_before_word.sh](#)

Change a line with 'c'

You can change the current line with a new line.

```
#!/bin/sh
sed '
/WORD/ c\
Replace the current line with the line
'
```

Click here to get file: [sed_change_line.sh](#)

A "d" command followed by a "a" command won't work, as I discussed earlier. The "d" command would terminate the current actions. You can combine all three actions using curly braces:

```
#!/bin/sh
sed '
/WORD/ {
i\
Add this line before
a\
Add this line after
c\
Change the line to this one
}'
```

Click here to get file: [sed_insert_append_change.sh](#)

Leading tabs and spaces in a sed script

Sed ignores leading tabs and spaces in all commands. However these white space characters may or may not be ignored if they start the text following a "a," "c" or "i" command. In SunOS, both "features" are available. The Berkeley (and Linux) style *sed* is in /usr/bin, and the AT&T version (System V) is in /usr/5bin/.

To elaborate, the **/usr/bin/sed** command retains white space, while the **/usr/5bin/sed** strips off leading spaces. If you want to keep leading spaces, and not care about which version of *sed* you are using, put a "\" as the first character of the line:

```
#!/bin/sh
sed '
    a\
\    This line starts with a tab
'
```

Adding more than one line

All three commands will allow you to add more than one line. Just end each line with a "\:"

```
#!/bin/sh
sed '
/WORD/ a\
Add this line\
This line\
And this line
'
```

Adding lines and the pattern space

I have mentioned the pattern space before. Most commands operate on the pattern space, and subsequent commands may act on the results of the last modification. The three previous commands, like the read file command, add the new lines to the output stream, bypassing the pattern space.

Address ranges and the above commands

You may remember that earlier I warned you that some commands can take a range of lines, and others cannot. To be precise, the commands "a," "i," "r," and "q" will not take a range like "1,100" or "/begin/,/end/." The documentation states that the read command can take a range, but I got an error when I tried this. The "c" or change command allows this, and it will let you change several lines into one:

```
#!/bin/sh
sed '
/begin/,/end/ c\
***DELETED***
'
```

If you need to do this, you can use the curly braces, as that will let you perform the operation on every line:

```
#!/bin/sh
# add a blank line after every line
sed '1,$ {
    a\

}'
```

Multi-Line Patterns

Most UNIX utilities are line oriented. Regular expressions are line oriented. Searching for patterns that covers more than one line is not an easy task. (Hint: It will be very shortly.)

Sed reads in a line of text, performs commands which may modify the line, and outputs modification if desired. The main loop of a *sed* script looks like this:

The next line is read from the input file and places it in the pattern space. If the end of file is found, and there are additional files to read, the current file is closed, the next file is opened, and the first line of the file is placed into the pattern space.

The line count is incremented by one. Opening a new file does not reset this number. Each *sed* command is examined. If there is a restriction placed on the command, and the current line in pattern space meets that restriction, the command is executed. Some commands, like "n" or "d" cause go to the top of the loop. The "q" command causes *sed* to stop. Otherwise the next command is examined. After all of the commands are examined, the pattern space is output unless *sed* has the optional "-n" argument.

The restriction before the command determines if the command is executed. If the restriction is a pattern, and the operation is the delete command, then the following will delete all lines that have the pattern:

```
/PATTERN/ d
```

If the restriction is a pair of numbers, then the deletion will happen if the line number is equal to the first number or greater than the first number and less than or equal to the last number:

```
10,20 d
```

If the restriction is a pair of patterns, there is a variable that is kept for each of these pairs. If the variable is false and the first pattern is found, the variable is made true. If the variable is true, the command is executed. If the variable is true, and the last pattern is on the line, after the command is executed the variable is turned off:

```
/begin/,/end/ d
```

Whew! That was a mouthful. If you have read carefully up to here, you should have breezed through this. You may want to refer back, because I covered several subtle points. My choice of words was deliberate. It covers some unusual cases, like:

```
# what happens if the second number
# is less than the first number?
sed -n '20,1 p' file
```

and

```
# generate a 10 line file with line numbers
# and see what happens when two patterns overlap
yes | head -10 | cat -n | \
sed -n -e '/1/,/7/ p' -e '/5/,/9/ p'
```

Enough mental punishment. Here is another review, this time in a table format. Assume the input file contains the following lines:

```
AB
CD
EF
GH
IJ
```

When *sed* starts up, the first line is placed in the pattern space. The next line is "CD." The operations of the "n," "d," and "p" commands can be summarized as:

Pattern Space	Next Input	Command	Output	New Pattern Space	New Text Input
AB	CD	n	<default>	CD	EF
AB	CD	d	-	CD	EF
AB	CD	p	AB	CD	EF

The "n" command may or may not generate output depending upon the existence of the "-n" flag.

That review is a little easier to follow, isn't it? Before I jump into multi-line

patterns, I wanted to cover three more commands:

Print line number with =

The "=" command prints the current line number to standard output. One way to find out the line numbers that contain a pattern is to use:

```
# add line numbers first,
# then use grep,
# then just print the number
cat -n file | grep 'PATTERN' | awk '{print $1}'
```

The *sed* solution is:

```
sed -n '/PATTERN/ =' file
```

Earlier I used the following to find the number of lines in a file

```
#!/bin/sh
lines=`wc -l file | awk '{print $1}'`
```

Using the "=" command can simplify this:

```
#!/bin/sh
lines=`sed -n '$=' file`
```

The "=" command only accepts one address, so if you want to print the number for a range of lines, you must use the curly braces:

```
#!/bin/sh
# Just print the line numbers
sed -n '/begin/,/end/ {
=
d
}' file
```

Since the "=" command only prints to standard output, you cannot print the line number on the same line as the pattern. You need to edit multi-line patterns to do this.

Transform with y

If you wanted to change a word from lower case to upper case, you could write 26 character substitutions, converting "a" to "A," etc. *Sed* has a command that operates like the *tr* program. It is called the "y" command. For instance, to change the letters "a" through "f" into their upper case form, use:

```
sed 'y/abcdef/ABCDEF/' file
```

Here's a *sed* example that converts all uppercase letters to lowercase letters, like the *tr* command:

```
sed 'y/ABCDEFGHIJKLMNOPQRSTUVWXYZ/abcdefghijklmnopqrstuvwxyz/' <uppercase >lowercase
```

If you wanted to convert a line that contained a hexadecimal number (e.g. 0x1aff) to upper case (0x1AFF), you could use:

```
sed '/0x[0-9a-zA-Z]*/ y/abcdef/ABCDEF' file
```

This works fine if there are only numbers in the file. If you wanted to change the second word in a line to upper case, and you are using classic *sed*, you are out of luck - unless you use multi-line editing. (Hey - I think there is some sort of theme here!)

However, GNU sed has an uppercase and lowercase extension.

Displaying control characters with a l

The "l" command prints the current pattern space. It is therefore useful in debugging *sed* scripts. It also converts unprintable characters into printing characters by outputting the value in octal preceded by a "\" character. I found it useful to print out the current pattern space, while probing the subtleties of *sed*.

Working with Multiple Lines

There are three new commands used in multiple-line patterns: "N," "D," and "P." I will explain their relation to the matching "n," "d," and "p" single-line commands.

The "n" command will print out the current pattern space (unless the "-n" flag is used), empty the current pattern space, and read in the next line of input. The "N" command does **not** print out the current pattern space and does **not** empty the pattern space. It reads in the next line, but appends a new line character along with the input line itself to the pattern space.

The "d" command deletes the current pattern space, reads in the next line, puts the new line into the pattern space, and aborts the current command, and starts execution at the first *sed* command. This is called starting a new "cycle." The "D" command deletes the first portion of the pattern space, up to the new line character, leaving the rest of the pattern alone. Like "d," it stops the current command and starts the command cycle over again. However, it will not print the current pattern space. You must print it yourself, a step earlier. If the "D" command is executed with a group of other commands in a curly brace, commands after the "D" command are ignored. The next group of *sed* commands is executed, unless the pattern space is emptied. If this happens, the cycle is started from the top and a new line is read.

The "p" command prints the entire pattern space. The "P" command only prints the first part of the pattern space, up to the NEWLINE character. Neither the "p" nor the "P" command changes the patterns space.

Some examples might demonstrate "N" by itself isn't very useful. the filter

```
sed -e 'N'
```

doesn't modify the input stream. Instead, it combines the first and second line, then prints them, combines the third and fourth line, and prints them, etc. It does allow you to use a new "anchor" character: "\n." This matches the new line character that separates multiple lines in the pattern space. If you wanted to search for a line that ended with the character "#," and append the next line to it, you could use

```
#!/bin/sh
sed '
# look for a "#" at the end of the line
/#$/ {
# Found one - now read in the next line
N
# delete the "#" and the new line character,
s/#\n//
}' file
```

You could search for two lines containing "ONE" and "TWO" and only print out the two consecutive lines:

```
#!/bin/sh
sed -n '
ONE
TWO
p'
```

```

/ONE/ {
# found "ONE" - read in next line
    N
# look for "TWO" on the second line
# and print if there.
    /\n.*TWO/ p
}' file

```

The next example would delete everything between "ONE" and "TWO:"

```

#!/bin/sh
sed '
/ONE/ {
# append a line
    N
# search for TWO on the second line
    /\n.*TWO/ {
# found it - now edit making one line
        s/ONE.*\n.*TWO/ONE TWO/
    }
}' file

```

Matching three lines with sed

You can match multiple lines in searches.

Here is a way to look for the string "skip3", and if found, delete that line and the next two lines.

```

#!/bin/sh
sed '/skip3/ {
    N
    N
    s/skip3\n.*\n.*\n.*# 3 lines deleted/
}'

```

Note that it doesn't matter what the next two lines are. If you wanted to match 3 particular lines, it's a little more work.

This script looks for three lines, where the first line contains "one", the second contained "two" and the third contains "three", and if found, replace them with the string "1+2+3":

```

#!/bin/sh
sed '
/one/ {
    N
    /two/ {
        N
        /three/ {
            N
            s/one\ntwo\nthree/1+2+3/
        }
    }
}'

```

Matching patterns that span multiple lines

You can either search for a particular pattern on two consecutive lines, or you can search for two consecutive words that may be split on a line boundary. The next example will look for two words which are either on the same line or one is on the end of a line and the second is on the beginning of the next line. If found, the first word is deleted:

```

#!/bin/sh

```

```
sed '
/ONE/ {
# append a line
    N
# "ONE TWO" on same line
    s/ONE TWO/TWO/
# "ONE
# TWO" on two consecutive lines
    s/ONE\nTWO/TWO/
}' file
```

Let's use the "D" command, and if we find a line containing "TWO" immediately after a line containing "ONE," then delete the first line:

```
#!/bin/sh
sed '
/ONE/ {
# append a line
    N
# if TWO found, delete the first line
    /\n.*TWO/ D
}' file
```

Click here to get file: [sed_delete_line_after_word.sh](#)

If we wanted to print the first line instead of deleting it, and not print every other line, change the "D" to a "P" and add a "-n" as an argument to *sed*:

```
#!/bin/sh
sed -n '
# by default - do not print anything
/ONE/ {
# append a line
    N
# if TWO found, print the first line
    /\n.*TWO/ P
}' file
```

Click here to get file: [sed_print_line_after_word.sh](#)

It is very common to combine all three multi-line commands. The typical order is "N," "P" and lastly "D." This one will delete everything between "ONE" and "TWO" if they are on one or two consecutive lines:

```
#!/bin/sh
sed '
/ONE/ {
# append the next line
    N
# look for "ONE" followed by "TWO"
    /\n.*TWO/ {
#     delete everything between
        s/ONE.*TWO/ONE TWO/
#     print
        P
#     then delete the first line
        D
    }
}' file
```

Click here to get file: [sed_delete_between_two_words.sh](#)

Earlier I talked about the "=" command, and using it to add line numbers to a file. You can use two invocations of *sed* to do this (although it is possible to do it with one, but that must wait until next section). The first *sed* command will output a line number on one line, and then print the line on the next line. The second invocation of *sed* will merge the two lines together:

```
#!/bin/sh
sed '=' file | \
sed '{
    N
    s/\n/ /
}'
```

Click here to get file: [sed_merge_two_lines.sh](#)

If you find it necessary, you can break one line into two lines, edit them, and merge them together again. As an example, if you had a file that had a hexadecimal number followed by a word, and you wanted to convert the first word to all upper case, you can use the "y" command, but you must first split the line into two lines, change one of the two, and merge them together. That is, a line containing

```
0x1fff table2
```

will be changed into two lines:

```
0x1fff
table2
```

and the first line will be converted into upper case. I will use *tr* to convert the space into a new line, and then use *sed* to do the rest. The command would be

```
./sed_split <file
```

and *sed_split* would be:

```
#!/bin/sh
tr ' ' '\012' |
sed '{
    y/abcdef/ABCDEF/
    N
    s/\n/ /
}'
```

Click here to get file: [sed_split.sh](#)

It isn't obvious, but *sed* could be used instead of *tr*. You can embed a new line in a substitute command, but you must escape it with a backslash. It is unfortunate that you must use "\n" in the left side of a substitute command, and an embedded new line in the right hand side. Heavy sigh. Here is the example:

```
#!/bin/sh
sed '
s/ /\n
/' | \
sed '{
    y/abcdef/ABCDEF/
    N
    s/\n/ /
}'
```


Click here to get file: [sed_split_merge.sh](#)

Sometimes I add a special character as a marker, and look for that character in the input stream. When found, it indicates the place a blank used to be. A backslash is a good character, except it must be escaped with a backslash, and makes the *sed* script obscure. Save it for that guy who keeps asking dumb questions. The *sed* script to change a blank into a "\ " following by a new line would be:

```
#!/bin/sh
sed 's/ /\\"
/' file
```

Click here to get file: [sed_addslash_before_blank.sh](#)

Yeah. That's the ticket. Or use the C shell and really confuse him!

```
#!/bin/csh -f
sed \"
s/ /\\"
/' file
```

Click here to get file: [sed_addslash_before_blank.csh](#)

A few more examples of that, and he'll never ask you a question again! I think I'm getting carried away. I'll summarize with a chart that covers the features we've talked about:

Pattern Space	Next Input	Command	Output	New Pattern Space	New Text Input
AB	CD	n	<default>	CD	EF
AB	CD	N	-	AB\nCD	EF
AB	CD	d	-	-	EF
AB	CD	D	-	-	EF
AB	CD	p	AB	AB	CD
AB	CD	P	AB	AB	CD
AB\nCD	EF	n	<default>	EF	GH
AB\nCD	EF	N	-	AB\nCD\nEF	GH
AB\nCD	EF	d	-	EF	GH
AB\nCD	EF	D	-	CD	EF
AB\nCD	EF	p	AB\nCD	AB\nCD	EF
AB\nCD	EF	P	AB	AB\nCD	EF

Using newlines in sed scripts

Occasionally one wishes to use a new line character in a *sed* script. Well, this has some subtle issues here. If one wants to search for a new line, one has to use "\n." Here is an example where you search for a phrase, and delete the new line character after that phrase - joining two lines together.

```
(echo a;echo x;echo y) | sed '/x$/ {
N
s:x\n:x:
}'
```

which generates

```
a
xy
```

However, if you are inserting a new line, don't use "\n" - instead insert a literal new line character:

```
(echo a;echo x;echo y) | sed 's:x:X\n:'
```

generates

```
a
X
```

```
y
```

The Hold Buffer

So far we have talked about three concepts of *sed*: (1) The input stream or data before it is modified, (2) the output stream or data after it has been modified, and (3) the pattern space, or buffer containing characters that can be modified and send to the output stream.

There is one more "location" to be covered: the *hold buffer* or *hold space*. Think of it as a spare pattern buffer. It can be used to "copy" or "remember" the data in the pattern space for later. There are five commands that use the hold buffer.

Exchange with x

The "x" command eXchanges the pattern space with the hold buffer. By itself, the command isn't useful. Executing the *sed* command

```
sed 'x'
```

as a filter adds a blank line in the front, and deletes the last line. It looks like it didn't change the input stream significantly, but the *sed* command is modifying every line.

The hold buffer starts out containing a blank line. When the "x" command modifies the first line, line 1 is saved in the hold buffer, and the blank line takes the place of the first line. The second "x" command exchanges the second line with the hold buffer, which contains the first line. Each subsequent line is exchanged with the preceding line. The last line is placed in the hold buffer, and is not exchanged a second time, so it remains in the hold buffer when the program terminates, and never gets printed. This illustrates that care must be taken when storing data in the hold buffer, because it won't be output unless you explicitly request it.

Example of Context Grep

One use of the hold buffer is to remember previous lines. An example of this is a utility that acts like *grep* as it shows you the lines that match a pattern. In addition, it shows you the line before and after the pattern. That is, if line 8 contains the pattern, this utility would print lines 7, 8 and 9.

One way to do this is to see if the line has the pattern. If it does not have the pattern, put the current line in the hold buffer. If it does, print the line in the hold buffer, then the current line, and then the next line. After each set, three dashes are printed. The script checks for the existence of an argument, and if missing, prints an error. Passing the argument into the *sed* script is done by turning off the single quote mechanism, inserting the "\$1" into the script, and starting up the single quote again:

```
#!/bin/sh
# grep3 - prints out three lines around pattern
# if there is only one argument, exit

case $# in
    1);;
    *) echo "Usage: $0 pattern";exit;;
esac;
# I hope the argument doesn't contain a /
# if it does, sed will complain

# use sed -n to disable printing
# unless we ask for it
sed -n '
'/$1/' !{
    #no match - put the current line in the hold buffer
    x
    # delete the old one, which is
    # now in the pattern buffer
    d
}
'/$1/' {
    # a match - get last line
    x
    # print it
    p
    # get the original line back
    x
    # print it
    p
    # get the next line
    n
    # print it
    p
    # now add three dashes as a marker
    a\
---
    # now put this line into the hold buffer
    x
}'
```

Click here to get file: [grep3.sh](#)

You could use this to show the three lines around a keyword, i.e.:

```
grep3 vt100 </etc/termcap
```

Hold with h or H

The "x" command exchanges the hold buffer and the pattern buffer. Both are changed. The "h" command copies the pattern buffer into the hold buffer. The pattern buffer is unchanged. An identical script to the above uses the hold commands:

```
#!/bin/sh
# grep3 version b - another version using the hold commands
# if there is only one argument, exit

case $# in
    1);;
    *) echo "Usage: $0 pattern";exit;;
esac;

# again - I hope the argument doesn't contain a /
```

```
# use sed -n to disable printing

sed -n '
'/ $1/' !{
    # put the non-matching line in the hold buffer
    h
}
'/ $1/' {
    # found a line that matches
    # append it to the hold buffer
    H
    # the hold buffer contains 2 lines
    # get the next line
    n
    # and add it to the hold buffer
    H
    # now print it back to the pattern space
    x
    # and print it.
    p
    # add the three hyphens as a marker
    a\
---
}'
```

Click here to get file: [grep3a.sh](#)

Keeping more than one line in the hold buffer

The "H" command allows you to combine several lines in the hold buffer. It acts like the "N" command as lines are appended to the buffer, with a "\n" between the lines. You can save several lines in the hold buffer, and print them only if a particular pattern is found later.

As an example, take a file that uses spaces as the first character of a line as a continuation character. The files */etc/termcap*, */etc/printcap*, *makefile* and mail messages use spaces or tabs to indicate a continuing of an entry. If you wanted to print the entry before a word, you could use this script. I use a "^I" to indicate an actual tab character:

```
#!/bin/sh
# print previous entry
sed -n '
/^[ ^I]/!{
    # line does not start with a space or tab,
    # does it have the pattern we are interested in?
    '/ $1/' {
        # yes it does. print three dashes
        i\
---
        # get hold buffer, save current line
        x
        # now print what was in the hold buffer
        p
        # get the original line back
        x
    }
    # store it in the hold buffer
    h
}
# what about lines that start
# with a space or tab?
/^[ ^I]/ {
```

```

        # append it to the hold buffer
        H
    }'

```

Click here to get file: [grep_previous.sh](#)

You can also use the "H" to extend the context grep. In this example, the program prints out the two lines before the pattern, instead of a single line. The method to limit this to two lines is to use the "s" command to keep one new line, and deleting extra lines. I call it *grep4*:

```

#!/bin/sh

# grep4: prints out 4 lines around pattern
# if there is only one argument, exit

case $# in
    1);;
    *) echo "Usage: $0 pattern";exit;;
esac;

sed -n '
'/$1/' !{
    # does not match - add this line to the hold space
    H
    # bring it back into the pattern space
    x
    # Two lines would look like .*\n.*
    # Three lines look like .*\n.*\n.*
    # Delete extra lines - keep two
    s/^\.*\n\(.*\n.*\)$/\1/
    # now put the two lines (at most) into
    # the hold buffer again
    x
}
'/$1/' {
    # matches - append the current line
    H
    # get the next line
    n
    # append that one also
    H
    # bring it back, but keep the current line in
    # the hold buffer. This is the line after the pattern,
    # and we want to place it in hold in case the next line
    # has the desired pattern
    x
    # print the 4 lines
    p
    # add the mark
    a\
---
}'

```

Click here to get file: [grep4.sh](#)

You can modify this to print any number of lines around a pattern. As you can see, you must remember what is in the hold space, and what is in the pattern space. There are other ways to write the same routine.

Get with g or G

Instead of exchanging the hold space with the pattern space, you can copy the

hold space to the pattern space with the "g" command. This deletes the pattern space. If you want to append to the pattern space, use the "G" command. This adds a new line to the pattern space, and copies the hold space after the new line.

Here is another version of the "grep3" command. It works just like the previous one, but is implemented differently. This illustrates that *sed* has more than one way to solve many problems. What is important is you understand your problem, and document your solution:

```
#!/bin/sh
# grep3 version c: use 'G' instead of H

# if there is only one argument, exit

case $# in
    1);;
    *) echo "Usage: $0 pattern";exit;;
esac;

# again - I hope the argument doesn't contain a /

sed -n '
'/$1/' !{
    # put the non-matching line in the hold buffer
    h
}
'/$1/' {
    # found a line that matches
    # add the next line to the pattern space
    N
    # exchange the previous line with the
    # 2 in pattern space
    x
    # now add the two lines back
    G
    # and print it.
    p
    # add the three hyphens as a marker
    a\
---
    # remove first 2 lines
    s/.*\n.*\n\(.*)$/\1/
    # and place in the hold buffer for next time
    h
}'
```

Click here to get file: [grep3c.sh](#)

The "G" command makes it easy to have two copies of a line. Suppose you wanted to convert the first hexadecimal number to uppercase, and don't want to use the script I described in an earlier column

```
#!/bin/sh
# change the first hex number to upper case format
# uses sed twice
# used as a filter
# convert2uc <in >out
sed '
s/ /\
/' | \
sed ' {
    y/abcdef/ABCDEF/
    N
```

```
s/\n/ /
}'
```

Click here to get file: [convert2uc.sh](#)

Here is a solution that does not require two invocations of *sed*:

```
#!/bin/sh
# convert2uc version b
# change the first hex number to upper case format
# uses sed once
# used as a filter
# convert2uc <in >out
sed '
{
    # remember the line
    h
    #change the current line to upper case
    y/abcdef/ABCDEF/
    # add the old line back
    G
    # Keep the first word of the first line,
    # and second word of the second line
    # with one humongous regular expression
    s/^\([^ ]*\) .* \([^ ]*\) \1 \2/
}'
```

Click here to get file: [convert2uc1.sh](#)

Carl Henrik Lunde suggested a way to make this simpler. I was working too hard.

```
#!/bin/sh
# convert2uc version b
# change the first hex number to upper case format
# uses sed once
# used as a filter
# convert2uc <in >out
sed '
{
    # remember the line
    h
    #change the current line to upper case
    y/abcdef/ABCDEF/
    # add the old line back
    G
    # Keep the first word of the first line,
    # and second word of the second line
    # with one humongous regular expression
    s/ .* // # delete all but the first and last word
}'
```

Click here to get file: [convert2uc2.sh](#)

This example only converts the letters "a" through "f" to upper case. This was chosen to make the script easier to print in these narrow columns. You can easily modify the script to convert all letters to uppercase, or to change the first letter, second word, etc.

Flow Control

As you learn about *sed* you realize that it has its own programming language. It is true that it's a very specialized and simple language. What language would be complete without a method of changing the flow control? There are three commands *sed* uses for this. You can specify a label with a text string preceded

by a colon. The "b" command branches to the label. The label follows the command. If no label is there, branch to the end of the script. The "t" command is used to test conditions. Before I discuss the "t" command, I will show you an example using the "b" command.

This example remembers paragraphs, and if it contains the pattern (specified by an argument), the script prints out the entire paragraph.

```
#!/bin/sh
sed -n '
# if an empty line, check the paragraph
/^$/ b para
# else add it to the hold buffer
H
# at end of file, check paragraph
$ b para
# now branch to end of script
b
# this is where a paragraph is checked for the pattern
:para
# return the entire paragraph
# into the pattern space
x
# look for the pattern, if there - print
/'$1'/ p
'
```

Click here to get file: [grep_paragraph.sh](#)

Testing with t

You can execute a branch if a pattern is found. You may want to execute a branch only if a substitution is made. The command "t label" will branch to the label if the last substitute command modified the pattern space.

One use for this is recursive patterns. Suppose you wanted to remove white space inside parenthesis. These parentheses might be nested. That is, you would want to delete a string that looked like "((())))." The *sed* expressions

```
sed 's/([ ^I]*)/g'
```

would only remove the innermost set. You would have to pipe the data through the script four times to remove each set or parenthesis. You could use the regular expression

```
sed 's/([ ^I()]*)/g'
```

but that would delete non-matching sets of parenthesis. The "t" command would solve this:

```
#!/bin/sh
sed '
:again
    s/([ ^I]*)//
    t again
'
```

An earlier version had a 'g' after the 's' expression. This is not needed.

Click here to get file: [delete_nested_parens.sh](#)

Debugging with l

The 'l' command will print the pattern space in an unambiguous form. Non-printing characters are printed in a C-style escaped format.

This can be useful when debugging a complex multi-line sed script.

An alternate way of adding comments

There is one way to add comments in a *sed* script if you don't have a version that supports it. Use the "a" command with the line number of zero:

```
#!/bin/sh
sed '
/begin/ {
0i\
    This is a comment\
    It can cover several lines\
    It will work with any version of sed
}'
```

Click here to get file: [sed_add_comments.sh](#)

The poorly documented ;

There is one more *sed* command that isn't well documented. It is the ";" command. This can be used to combined several *sed* commands on one line. Here is the *grep4* script I described earlier, but without the comments or error checking and with semicolons between commands:

```
#!/bin/sh
sed -n '
'$1/' !{;H;x;s/^.*\n\(.*\n.*\)$/\1/;x;}
'$1/' {;H;n;H;x;p;a\
---
}'
```

Click here to get file: [grep4a.sh](#)

Yessireebob! Definitely character building. I think I have made my point. As far as I am concerned, the only time the semicolon is useful is when you want to type the *sed* script on the command line. If you are going to place it in a script, format it so it is readable. I have mentioned earlier that many versions of *sed* do not support comments except on the first line. You may want to write your scripts with comments in them, and install them in "binary" form without comments. This should not be difficult. After all, you have become a *sed* guru by now. I won't even tell you how to write a script to strip out comments. That would be insulting your intelligence. Also - some operating systems do NOT let you use semicolons. So if you see a script with semicolons, and it does not work on a non-Linux system, replace the semicolon with a new line character. (As long as you are not using csh/tcsh, but that's another topic.

Passing regular expressions as arguments

In the earlier scripts, I mentioned that you would have problems if you passed an argument to the script that had a slash in it. In fact, regular expression might

cause you problems. A script like the following is asking to be broken some day:

```
#!/bin/sh
sed 's/'"$1"'//g'
```

If the argument contains any of these characters in it, you may get a broken script: `"/\.*[]^$"` For instance, if someone types a `"/` then the substitute command will see four delimiters instead of three. You will also get syntax errors if you provide a `"]` without a `"]`. One solution is to have the user put a backslash before any of these characters when they pass it as an argument. However, the user has to know which characters are special. Another solution is to add a backslash before each of those characters in the script

```
#!/bin/sh
arg=`echo "$1" | sed 's:[]\[\^\$\.\\*\|/]:\\\\&:g'`
sed 's/'"$arg"'//g'
```

Click here to get file: [**sed_with_regular_expressions1.sh**](#)

If you were searching for the pattern `"^./,"` the script would convert this into `"\^.\.\/"` before passing it to `sed`.

Inserting binary characters

Dealing with binary characters can be trick, especially when writing scripts for people to read. I can insert a binary character using an editor like EMACS but if I show the binary character, the terminal may change it to show it to you.

The easiest way I have found to do this in a script in a portable fashion is to use the `tr(1)` command. It understands octal notations, and it can be output into a variable which can be used.

Here's a script that will replace the string "ding" with the ASCII bell character:

```
#!/bin/sh
BELL=`echo x | tr 'x' '\007'`
sed "s/ding/$BELL/"
```

Please note that I used double quotes. Since special characters are interpreted, you have to be careful when you use this mechanism.

GNU sed Command Line arguments

One of the conventions UNIX systems have is to use single letters as command line arguments. This makes typing faster, and shorter, which is an advantage if you are in a contest. Normal people often find `sed`'s terseness cryptic. You can improve the readability of `sed` scripts by using the long word equivalent options. That is, instead of typing

```
sed -n 20p
```

You can type the long word version of the `-n` argument

```
sed --quiet 20p
```

Or

```
sed --silent 20p
```

The long form of `sed`'s command line arguments always have 2 hyphens before their names. GNU `sed` has the following long-form command line arguments:

GNU Command Line

Arguments	
Short Form	Long Form
-n	--quiet --silent
-e script	--expression=SCRIPT
-f SCRIPTFILE	--file=SCRIPTFILE
-i[SUFFIX]	--in-place[=SUFFIX]
-l N	--line-length=N
	--posix
-b	--binary
	--follow-symlinks
-r	--regular-extended
-s	--separate
-u	--unbuffered
	--help
	--version

Let's define each of these.

The -posix argument

The GNU version of sed has many features that are not available in other versions. When portability is important, test your script with the -posix option. If you had an example that used a feature of GNU sed, such as the 'v' command to test the version number, such as

```
#this is a sed command file
```

```
v 4.0.1
# print the number of lines
$=
```

And you executed it with the command

```
sed -nf sedfile --posix <file
```

then the GNU version of sed program would give you a warning that your sed script is not compatible. It would

```
sed: -e expression #1, char 2: unknown command: `v'
```

The --version argument

You can determine which version of sed you are using with the GNU sed --version command. This is what it outputs on my computer

```
# sed --version
GNU sed version 4.2.1
Copyright (C) 2009 Free Software Foundation, Inc.
This is free software; see the source for copying conditions. There is NO
warranty; not even for MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE,
to the extent permitted by law.
```

```
GNU sed home page: <http://www.gnu.org/software/sed/>.
General help using GNU software: <http://www.gnu.org/gethelp/>.
E-mail bug reports to: <bug-gnu-utils@gnu.org>.
Be sure to include the word ``sed'' somewhere in the ``Subject:'' field.
```

The -h Help argument

The -h option will print a summary of the sed commands. The long argument of the command is

```
sed --help
```

It provides a nice summary of the command line arguments.

The -l Line Length Argument

I've already described the 'l' command. The default line width for the 'l' command is 70 characters. This default value can be changed by adding the '-l N' option and specifying the maximum line length as the number after the '-l'.

```
sed -n -l 80 'l' <file
```

The long form version of the command line is

```
sed -n --line-length=80 'l' <file
```

The -s Separate argument

Normally, when you specify several files on the command line, sed concatenates the files into one stream, and then operates on that single stream. If you had three files, each with 100 lines, then the command

```
sed -n '1,10 p' file1 file2 file3
```

would only print the first 10 lines of file file1. The '-s' command tells GNU sed to treat the files as independent to print out the first 10 lines of each file, which is similar to the head command. Here's another example: If you print the number of lines of each file, you could use 'wc -l' which prints the number of lines, and the filename, and at the end print the total number of lines. Here is a simple shell script that does something similar, just use

```
#!/bin/sh
```

```
FILES=$*
sed -s -n '$=' $FILES # print the number of lines for each file
sed -n '$=' $FILES # print the total number of lines.
```

The 'wc -l' command does print out the filenames, unlike the above script. A better emulation of the 'wc -l' command is to execute the command in a loop, and print the filenames. Here is a more advanced script that does this, but it uses the '-s' command:

```
#!/bin/sh
for F in "$@"
do
    NL=`sed -n '$=' < "$F"` && printf " %d %s\n" $NL "$F"
done
TOTAL=`sed -n '$=' "$@"`
printf " %d total\n" $TOTAL
```

The -i in-place argument

I've already described in Editing multiple files the way I like to do this. For those who want a simpler method, GNU Sed allows you to do this with a command line option - "-i". Let's assume that we are going to make the same simple change - adding a tab before each line. This is a way to do this for all files in a directory with the ".txt" extension in the current directory:

```
sed -i 's/^/\t/' *.txt
```

The long argument name version is

```
sed --in-place 's/^/\t/' *.txt
```

This version deletes the original file. If you are as cautious as I am, you may prefer to specify an extension, with the "-i" option, to keep a copy of the original:

```
sed -i.tmp 's/^/\t/' *.txt
```

And the long argument name version is

```
sed --in-place=.tmp 's/^/\t/' *.txt
```

In the last two versions, the original version of the "a.txt" file would have the name "a.txt.tmp". You can then rename the original files after you make sure all worked as you expected. Please consider the backup option, and heed my advice. You can easily delete the backed-up original file, as long as the extension is unique.

The GNU version of sed allows you to use "-i" without an argument. The FreeBSD/Mac OS X does not. You **must** provide an extension for the FreeBSD/Mac OS X version. If you want to do in-place editing without creating a backup, you can use

```
sed -i '' 's/^/\t/' *.txt
```

The --follow-symlinks argument

The in-place editing feature is handy to have. But what happens if the file you are editing is a symbolic link to another file? Let's assume you have a file named "b" in a directory called "tmp", with a symbolic link to this file:

```
$ ls -l b
lrwxrwxrwx 1 barnett adm 6 Mar 16 16:03 b.txt -> tmp/b.txt
```

If you executed the above command to do in place editing, there will be a new file called "b.txt" in the current directory and "tmp/b.txt" will be unchanged. Now you have two versions of the file, one is changed (in the current directory) and one is not (in the "tmp" directory). And where you had a symbolic link, it has been replaced with a modified version of the original file. If you want to edit the real file, and keep the symbolic link in place, use the "--follow-symlinks" option:

```
sed -i --follow-symlinks 's/^/\t/' *.txt
```

This follows the symlink to the original location, and modifies the file in the "tmp" directory. If you specify an option that does not follow symlinks, the file in the current directory is modified.

the original file will be found with that extension in the same directory as the real source. Without the `--follow` command line option, the "backup" file "b.tmp" will be in the same directory that held the symbolic link, and the symbolic link - just renamed to give it a new extension.

The -b Binary argument

Unix and Linux systems consider the new line character "\n" to be the end of the line. However, MS-DOS, Windows, and Cygwin systems end each line with "\r\n" - Carriage return and line-feed. If you are using any of these operating systems, the "-b" or "--binary" command line option will treat the carriage return/new line combination as the end of the line. Otherwise the carriage return is treated as an unprintable character immediately before the end-of-line. I think. (Note to self - verify this).

The -r Extended Regular Expression argument

When I mention patterns, such as "s/pattern/", the pattern is a regular expression. There are two common classes of regular expressions, the original "basic" expressions, and the "extended" regular expressions. For more on the differences see [My tutorial on regular expressions](#) and the [the section on extended regular expressions](#). Because the meaning of certain characters are different between the regular and extended expressions, you need a command line argument to enable `sed` to use the extension. To enable this extension, use the "-r" command, as mentioned in [the example on finding duplicated words on a line](#)

```
sed -r -n '/\[a-z]+\)/ \1/p'
```

or

```
sed --regular-extended -quiet '/\[a-z]+\)/ \1/p'
```

I already mentioned that Mac OS X and FreeBSD uses `-E` instead of `-r`.

The -u Unbuffered argument

Normally - Unix and Linux systems apply some intelligence to handling standard output. It's assumed that if you are sending results to a terminal, you want the output as soon as it becomes available. However, if you are sending the output to a file, then it's assumed you want better performance, so it buffers the output until the buffer is full, and then the contents of the buffer is written to the file. Let me elaborate on this. Let's assume for this example you have a very large file, and you are using `sed` to search for a string, and to print it when it is found:

```
sed -n '/MATCH/p' <file
```

Since the output is the terminal, as soon as a match is found, it is printed. However, if `sed` pipes its output to a program, it will buffer the results. But there are times when you want immediate results. This is especially true if you are dealing with large files, or files that occasionally generate data. To summarize, you have lots of input data that you want `sed` to process it, and then send this to another program that processes the results, but you want the results to be immediate, and not delayed. Let me make up a simple example. It's contrived, but it does explain how this world works. A program called `SlowText` that prints numbers from 1 to 60, once a second:

```
#!/bin/sh
for i in `seq 1 60`
do
    echo $i
    sleep 1
done
```

Let's use `sed` to search for lines that have the character '1', and have it send results to `awk`, which will calculate the sum of that number. This would be the admittedly contrived script:

```
SlowText | sed -n '/1/p' | awk '{print $1*$1}'
```

This works, but because sed is buffering the results, we have to wait until the buffer fills up, or until the SlowText exists, before we see the results. You can eliminate the buffering, and see the results as soon as SlowText outputs using the "-u" option. With this option, you will see the squares printed as soon as possible:

```
SlowText | sed -un '/1/p' | awk '{print $1*$1}'
```

The long form of the argument is "--unbuffered".

Mac OS X and FreeBSD use the argument "-l".

GNU Sed 4.2.2 and later will also be unbuffered while reading files, not just writing them.

The -z Null Data argument

Normally, sed reads a line by reading a string of characters up to the end-of-line character (new line or carriage return). See **the -b Binary command line argument**. The GNU version of sed added a feature in version 4.2.2 to use the "NULL" character instead. This can be useful if you have files that use the NULL as a record separator. Some GNU utilities can generate output that uses a NULL instead of a new line, such as "find . -print0" or "grep -lZ". This feature is useful if you are operating on filenames that might contain spaces or binary characters.

For instance, if you wanted to use "find" to search for files and you used the "-print0" option to print a NULL at the end of each filename, you could use sed to delete the directory pathname:

```
find . -type f -print0 | sed -z 's:^\./::' | xargs -0 echo
```

The above example is not terribly useful as the "xargs" use of echo does not retain the ability to retain spaces as part of the filename. But it does show how to use the sed "-z" command.

GNU grep also has a -Z option to search for strings in files, placing a "NULL" at the end of each filename instead of a new line. And with the -l command, grep will print the filename that contains the string, retaining non-printing and binary characters:

```
grep -lZ STRING */** | sed -z 's:^\./::' | xargs -0 echo
```

This feature is very useful when users have the ability to create their own filenames.

FreeBSD Extensions

Apple uses the FreeBSD version of sed for Mac OS X instead of the GNU sed. However, the FreeBSD version has a couple of additions.

The -a or delayed open Argument

Normally, as soon as sed starts up, it opens all files that are referred to by the **"w"** command. The FreeBSD version of sed has an option to delay this action until the "w" command is executed.

The -I in-place argument

FreeBSD added a "-I" option that is similar to the **-i** option. The "-i" option treats the editing of each file as a separate instance of sed. If the "-I" option is used, then

line numbers do not get reset at the beginning of each line, and ranges of addresses continue from one file to the next. That is, if you used the range '/BEGIN/,/END/' and you used the "-I" option, you can have the "BEGIN" in the first file, and "END" in the second file, and the commands executed within the range would span both files. If you used "-i", then the commands would not.

And like the **-i** option, the extension used to store the backup file must be specified.

-E or Extended Regular Expressions

I mentioned extended regular expressions **earlier**. FreeBSD (and Mac OS X) uses "-E" to enable this. However, FreeBSD later added the **-r** command to be compatible with GNU sed.

Using word boundaries

Someone once asked me to help them solve a tricky sed problem involving word boundaries. Let's suppose you have the following input

```
/usr/bin /usr/local/bin /usr/local /usr/local/project/bin
```

and you wanted to delete '/usr/local' but leave the other 3 paths alone. You could use the simple (and incorrect) command:

```
sed 's@/usr/local@@'
```

which would output

```
/usr/bin /bin /usr/local /usr/local/project/bin
```

That is, it would mistakenly change '/usr/local/bin' to '/bin' and not delete '/usr/local' which was the intention of the programmer. The better method is to include spaces around the search:

```
sed 's@ /usr/local @ @'
```

However, this won't work if '/usr/local' is at the beginning, or at the end of the line. It also won't work if '/usr/local' is the only path on the line. To handle these edge cases, you can simply describe all of these conditions as separate cases:

```
#!/bin/sh
sed '
s@ /usr/local @ @g
s@^/usr/local @@
s@ /usr/local$@@
s@^/usr/local$@@
'
```

This works fine if the string you are searching for is surrounded by a space. But what happens if the string is surrounded by other characters, which may be one of several possible characters? You can always make up your own class of characters that define the 'end of a word'; For instance, if your string consists of alphanumeric characters and the slash, the class of characters can be defined by '[a-zA-Z0-9/]' or the more flexible '[:alnum:]/'. We can define the class for characters to be all but these, by using the caret, i.e. '[^[:alnum:]/]'. And unlike the space before, if you are going to use character classes, you may have to remember what these characters are and not delete them. So we can replace the space with '[^[:alnum:]/]' and then change the command to be

```
#!/bin/sh
sed '
s@\([^[:alnum:]/]\)/usr/local\([^[:alnum:]/]\)@\1\2@g
'
```



```
s@~/usr/local\([^[:alnum:]]/\)\@1@
s@\([^[:alnum:]]/\)\@usr/local$@1@
s@~/usr/local$@@
'
```

The first version would replace ' /usr/local ' with a single space. This method would replace ' :usr/local: ' with ' :: ' - because the redundant delimiters are not deleted. Be sure to fix this if you need to.

This method always works, but it is inelegant and error prone. There are other methods, but they **may not be portable**. Solaris's version of sed used the special characters '\<' and '\>' as anchors that indicated a word boundary. So you could use

```
s@\</usr/local\>@@
```

However, the GNU version of sed says the usage of these special characters are undefined. According to the manual page:

Regex syntax clashes (problems with backslashes)

'sed' uses the POSIX basic regular expression syntax. According to the standard, the meaning of some escape sequences is undefined in this syntax; notable in the case of 'sed' are '\|', '\+', '\?', '\'', '\'', '\<', '\>', '\b', '\B', '\w', and '\W'.

As in all GNU programs that use POSIX basic regular expressions, 'sed' interprets these escape sequences as special characters. So, 'x\+' matches one or more occurrences of 'x'. 'abc\|def' matches either 'abc' or 'def'.

When in doubt, experiment.

Command Summary

As I promised earlier, here is a table that summarizes the different commands. The second column specifies if the command can have a range or pair of addresses or a single address or pattern. The next four columns specifies which of the four buffers or streams are modified by the command. Some commands only affect the output stream, others only affect the hold buffer. If you remember that the pattern space is output (unless a "-n" was given to sed), this table should help you keep track of the various commands.

Command	Address or Range	Modification to Input Stream	Modification to Output Stream	Modification to Pattern Space	Modification to Hold Buffer
=	-	-	Y	-	-
a	Address	-	Y	-	-
b	Range	-	-	-	-
c	Range	-	Y	-	-
d	Range	Y	-	Y	-
D	Range	Y	-	Y	-
g	Range	-	-	Y	-
G	Range	-	-	Y	-
h	Range	-	-	-	Y
H	Range	-	-	-	Y
i	Address	-	Y	-	-
I	Address	-	Y	-	-
n	Range	Y	*	-	-
N	Range	Y	-	Y	-
p	Range	-	Y	-	-
P	Range	-	Y	-	-
q	Address	-	-	-	-

r	Address	-	Y	-	-
s	Range	-	-	Y	-
t	Range	-	-	-	-
w	Range	-	Y	-	-
x	Range	-	-	Y	Y
y	Range	-	-	Y	-

The "n" command may or may not generate output, depending on the "-n" option. The "r" command can only have one address, despite the documentation.

Check out my new [Sed Reference Chart](#)

In Conclusion

This concludes my tutorial on *sed*. It is possible to find shorter forms of some of my scripts. However, I chose these examples to illustrate some basic constructs. I wanted clarity, not obscurity. I hope you enjoyed it.

More References

This concludes my tutorial on *sed*. Other of my UNIX shell tutorials can be found [here](#). Other shell tutorials and references can be found at

[FreeBSD Sed Man Page](#)
[Apple/Mac OS X Sed Man Page](#)
[GNU Sed Manual](#)
[GNU Sed 4.2.2 Release Notes](#)
[sed\(1\) Seventh Edition Unix](#)
[sed\(1\) manual page from Sun/Oracle](#)
[Heiner's SHELLdorado](#)
[Chris F. A. Johnson's UNIX Shell Page](#)
[The Wikipedia Entry on SED](#)
[SED one-liners](#)

And don't forget [The SED FAQ](#)

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Corey Richardson
Eric Mathison
Ildar Mulyukov
Tom Zhu
Abhijeet Rastogi@shadyabhi
Steve LeBlanc @slevo
dontforget yourtowel@whatissixbynine
Yiming
Fei Wang
Kenneth R. Beesley
Duncan Sung W. Kim@DuncanSungWKim
Juan Eugenio Abadie
Zander Hill@_ZPH
Rob Smith
Peter Moore

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