Sed – super ed!?

Sed - stream editor

Sed is a Stream version of ed, so before attempting on the real file develop & check with ed interactively, then with sed on test file.

Although sed writes to standard output, and doesn't modify the original file, custom and good practice recommends keeping a backup copy to avoid oversight and accidental corruption of file with any other tool, even a typo and using 'ed'.

For modifying files and streams of text, whether lots of

- Code files
- Website files
- Any text
- Any data stream available as text
  - comms
  - Files, including lists of filenames as a stream
    - e.g. for changing all filenames
      - e.g. changing file extensions – irrelevant in 'nix
  - Formatting commands for a print formatting program

sed, The **S**tream **Ed**itor

- *sed* is descended from an extremely basic line-editor *ed*
  - Both operate on files one line at a time
  - Both use a similar command format
    - *[address] operation [argument]*
  - *ed* can use command scripts; files containing *ed* editing commands
    - *ed filename* <*script_file*
- *sed* is a special purpose editor that
  - will only take commands from a script or the command line,
  - it cannot be used interactively
- All editing
  - command input to sed comes from
    - Either standard input (indicated with an -e flag)
    - Or a file containing edit commands (indicate by an –f flag)
  - output goes to standard output,
    - which can be redirected,
    - And **must** be redirected for changes to be saved.

Sed - main points

- is a line editor, changing a line at a time
- Commands are given in a file or in command line
- All editing commands, in the command line or entire script, if applicable, are applied to each line in turn, before processing the next line – all commands to each line in turn
  - Beware unintended consequences of command sequence on line
- Cannot be used interactively - i.e. midstream
- Does not modify original file, but writes to output file when directed; convenient if used to insert formatting commands for a print pipleline, without changing the original text.
- And for those who are aware, editing commands resemble those in ex, ed, or last line (colon) mode in vi

- Therefore,
  - changes are not made to the edit file itself,
  - instead the input file, along with any changes, is written to standard output
- This is an important difference between *ed* and *sed* - *ed* changes the edit file, *sed* does not
- If you want to save the changes from sed, they must be redirected from standard output to a file
  - sed -f scriptfile editfile >outputfile

Stream vs Line Addressing

- A very important difference is the stream orientation aspect of sed's impact on line addressing, unlike ed
  - ed operates only on lines that are specifically addressed or the current line if no address is specified
  - If you enter the command "s/dog/cat/" it would change the first instance of "dog" on the current line to "cat"
- sed goes through the file a line at a time, so if no specific address is provided for a command, it operates on **all** lines, like AWK
- The same command in sed would change the first occurrence of "dog" on **every** line to "cat"

sed Syntax

sed [-n] [-e] ['command'] [file…]
sed [-n] [-f scriptfile] [file…]

-e command –

the next argument is an editing command rather than a filename, useful if multiple commands are specified

-f scriptfile

next argument is a filename containing editing commands

-n

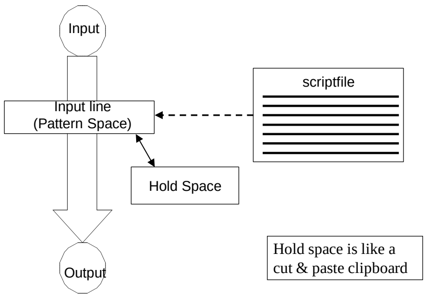
only print lines specified with the 'p' command or the 'p' flag of the substitute ('s') command

If the first line of a scriptfile is "#n", sed acts as though *-n* had been specified

Note that all forms of calling sed are really the same:-

sed [options] script file_argument(s)

How Does sed Treat Files?



Sed scripts

- A sed script is nothing more than a file of commands
- Each command consists of an address and an action, where the address can be a pattern (regular expression)
- As each line of the input file is read, *sed* reads the first command of the script and checks the address or pattern against the current input line
  - If there is a match, the command is executed
  - If there is no match, the command is ignored
  - *sed* then repeats this action for every command in the script file
- All commands in the script are read and applied - not just the first one that matches
- Beware of unintended effects of command sequences!

e.g. to switch a&b in bac to get abc:

switching a before b works	: bac→ s/a/b/→bbc; s/b/a/→abc
but switching b before a won't	: bac→ s/b/a/→aac; s/a/b/→bac

- When it has reached the end of the script, *sed* outputs the current line unless the *-n* option has been set, when it only prints those specified with *p*
- *sed* then reads the next line in the input file and restarts from the beginning of the script file
- All commands in the script file are compared to, and potentially act on, all lines in the input file*

Note again the difference from *ed*

- If no address is given, *ed* operates only on the current line
- If no address is given *sed* operates on all lines

Four Basic Script Types

- Multiple edits to the same file
  - Changing from one document formatter's codes to that of another
- Making changes across a set of files
  - Global changes:- e.g. due to mergers, acquisitions, rebranding or product name changes etc.
- Extracting the contents of a file
  - Flat-file database operations
- Making edits in a pipeline
  - Used when making changes prior to some other command that you don't want made permanently to the source file; e.g. formatting commands in a print pipeline

Three Basic Principles of sed

- All editing lines of a script
  - apply to all lines of the file being edited
  - unless line addressing restricts the lines affected by the command
- The original file is unchanged,
  - the editing commands modify a copy of the original line and the copy is sent to standard output
- All editing commands in a script
  - are applied in order to each line of input,
  - unless the command is d (delete) or c (change)
    - in which case a new line from the edit file (file being edited) is read after the d or c command executes

sed Commands

- sed commands have the general form
  - *[address[, address]][!]command [arguments]*
- *sed* copies each input line into a *pattern space*
  - If the address in the edit command matches the line in the *pattern space*, the edit command is applied to that line
  - If the command has no address, it is applied to each line as it enters *pattern space*
  - <u>If a command changes the line in *pattern space*, subsequent commands operate on the modified line</u>
    - E.g. try reversing the order of '**<u>words two'</u>** in a line..?
    - Identical to the 'bac' → 'abc' example a few slides back!
- When all editing commands have been applied, the line in *pattern space* is written to standard output and a new line is read into *pattern space*

Addressing

- An address can be either a line number or a pattern, enclosed in slashes (/pattern/)
- A pattern is described using *regular expressions*
- Additionally a NEWLINE can be specified using the "\n" character pair
  - This is only really useful when two lines have been joined in pattern space with the N command* so that patterns crossing line boundaries can be searched
- If no pattern is specified, the command will be applied to all lines of the input file

* From slide 20 below
N Append the next line of input to the pattern space with an embedded NEWLINE. (The current line number changes.)

- Most commands will accept two addresses
  - If only one address is given, the command operates only on that line
  - If two comma separated addresses are given, then the command operates on a range of lines between the first and second address, inclusively
- The ! operator can be used to negate an address, ie; *address!command* causes *command* to be applied to all lines that do not match *address*
- Braces { } can be used to apply multiple commands to an address

---

- Braces { } can be used to apply multiple commands to an address
- The opening brace must be the last character on a line and the closing brace must be on a line by itself
- Make sure there are no spaces following the braces

```
[/pattern/[,/pattern/]]{
command1
command2
command3
}
```

Address Examples

d	deletes the current line
6d	deletes line 6
/^$/d	deletes all blank lines
1,10d	deletes lines 1 through 10
1,/^$/d	deletes from line 1 through the first blank line
/^$/,/$/d	deletes from the first blank line through EOF
/^$/,10d	deletes from the first blank line through line 10
/^Co*t/,/[0-9]$/d	deletes from the first line that begin with Ct, Cot, Coot, etc. - - C(any no. of o' s) through the first line that ends with a digit

---

- Although sed contains many editing commands, we need only consider a small subset, most of which are common throughout Unix editors.

+ s	- substitute	+p	- print
+ a	- append	+!	- NOT
+ i	- insert	+ r	- read
+ c	- change	+ w	- write
+ d	- delete	+ y	- transform
+h,H	- put pattern space into hold space	+ q	- quit
+g,G	- Get hold space		

Hold space is like a clipboard for 'cut & paste'.

sed Command List

a\ text	Append. Place text on output before reading next input line.
b label	Branch to the : command bearing the label. If label is empty, branch to the end of the script.
c\ text	Change:- i.e. Delete pattern space. Place text on the output. Start the next cycle. (i.e. apply edit scriptfile to all following lines in pattern space)
D	Delete the pattern space. Start the next cycle.
D	Delete the initial segment of the pattern space through the first NEWLINE. Start the next cycle.
g	Replace contents of pattern space with those of hold space.
G	Append contents of hold space to that of pattern space.

h	Replace contents of hold space with those of pattern space.
H	Append the contents of hold space to those of pattern space.
i\	text Insert. Place text on standard output.
l	List the pattern space on standard output in an unambiguous form. Non-printable characters are displayed in octal notation and long lines are folded.
n	Copy the pattern space to standard output. Replace the pattern space with the next line of input.
N	Append the next line of input to the pattern space with an embedded NEWLINE. (The current line number changes.)
p	Print. Copy the pattern space to standard output.
P	Copy the initial segment of the pattern space up through the first NEWLINE to standard output.
q	Quit. Branch to the end of the script. Do not start a new cycle.

r rfile Read the contents of rfile.
Place them on standard output before reading the next input line.

s /regular expression/replacement/flags

Substitute the replacement string for instances of the regular expression in the pattern space.

Flag is zero or more of:

- n n=1-512. Substitute the nth occurrence of the regular expression
- g Global. Substitute all non-overlapping instances of the regular expression rather than just the first one.
- p Print the pattern space if a replacement was made.

w wfile Write. Append the pattern space to wfile if replacement was made.

t label Test.
Branch to the : command bearing the label if any substitutions have been made since the most recent reading of the input line or execution of a t. If label is empty, branch to end of script.

w wfile	Write. Append the pattern space to wfile. The first occurrence of a w will caused wfile to be cleared. Subsequent invocations of w will append. Each time the sed command is used, wfile is overwritten.
x	Exchange the contents of the pattern and the hold space.
y/string1/string2/	Transform. Replace all occurrences of the characters in string1 with the characters in string2. string1 and string2 must have the same number of characters.
!function	Don't apply the function (or group if function is {}) only to those lines not selected by the address(s).
: label	Just the target label for the b and t to branches.
=	Place the current line number on standard output as a line. {Execute the following commands through a matching } only when the pattern space is selected. An empty command is ignored.

# If an # appears as the first character on a line of script,

then that line is treated as a comment

unless
it is the first line of the file
and the character after the # is an n.
Then the default output is suppressed (just like sed -n).
The rest of the line after the n is also ignored.

A script file must contain at least one non-comment line.

Substitute

- Syntax:
  [address(es)]s/pattern/replacement/[flags]
  - *pattern* - search pattern
  - *replacement* - replacement string for pattern
  - *flags* - optionally any of the following
    - n a number from 1 to 512 indicating which occurrence of *pattern* should be replaced
    - g global, replace all occurrences of *pattern* in pattern space
    - p print contents of pattern space
    - w *file* write the contents of pattern space to *file*

Replacement Patterns

Substitute can use several special characters in the *replacement* string

- & - replaced by the entire string matched in the regular expression for pattern
- \n - replaced by the *n*th substring
  (or subexpression) previously specified using “\\(“ and “ \\)”
- \\ - used to escape the ampersand (&) and the backslash (\\)

Replacement Pattern Examples

As could be used to achieve insertions

```
“ the UNIX system□
s/.NI./wonderful &/
“ the wonderful UNIX system...”
```

& - means the entire string matched in the regexp, which is UNIX,
/.NI./ matches UNIX above, so UNIX is replaced with /wonderful UNIX/

As can be used to reverse matches; e.g. reversing firstname, surname etc.

```
cat test1
first:second
one:two
sed   ‘s/\(.*\):\(.*\)/\2:\1/□test1     # colours only for easy reading
second:first
two:one
```

Note : the colon ‘:’ is detected and not dismissed as any other character using ‘ .* ’, because the regex automata/state machine has a lookahead facility before definitively committing to the next state

Other Substitute Examples

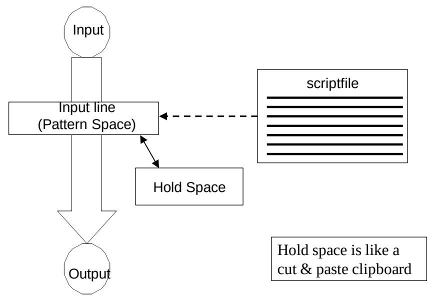
s/cat/dog/
Substitute dog for the first occurrence of cat in *pattern space*

s/Sky/Sea/2
Substitutes ***Sky*** for the second occurrence of ***Sea*** in the *pattern space*

s/wood/plastic/p
Substitutes plastic for the first occurrence of wood and outputs (prints) *pattern space*

s/Mr/Dr/g
Substitutes Dr for every occurrence of Mr in *pattern space*

How Does sed Treat Files?



Append, Insert, and Change

- Syntax for these commands is a little strange because they **must** be specified on multiple lines
- append *[address]a\*
  text
- insert *[address]i\*
  text
- change *[address(es)]c\*
  text
- Text is
  - Continued over multiple lines by escaping newline with a ‘\\’
    - i.e. to continue text to next line, have ‘\\’ as the last character on the line
  - And clearly terminated by omitting a ‘\\’ at the end of the last line

Append and Insert

- Append places *text* after the current line in pattern space
- Insert places *text* before the current line in pattern space
- Each of these commands requires a ‘ \\ ’ following it to “ escape” the NEWLINE that is entered when you press RETURN (or ENTER). *text* must begin on the next line.
- To use multiple lines, simply ESCAPE all but the last with a ‘ \\ ’
- If text begins with whitespace, sed will discard it unless you start the line with a ‘ \\ ’

Append and Insert can only be applied to a single line address, not a range of lines

Example:

```
    /<Insert Pattern Matching SearchText Here>/i\
            Line 1 of inserted text\
            \       Line 2 of inserted text
```

would leave the following in the pattern space:

```
            Line 1 of inserted text
                    Line 2 of inserted text
            <Insert Text Here>
```

Note

1 – '\' at end of line-1 in text above escapes newline for line continuation

2 – and no '\' at end of line-2, shows no line continuation, end of text

3 – '\' at start of line-2 is to ensure line beginning with spaces isn't ignored

Change

- Unlike Insert and Append,
  - Which can only be applied to a single line – local copies pointless!

  Change can be applied to
  - either a single line address : matching a regex
  - or a range of addresses : matching regexes separated by a comma
- When a single Change command is applied to a range,
  - the entire range is replaced by text specified with change,
  - not each line
- BUT, if the Change command is
  - one of a group of commands enclosed in { }
  - that act on a range of lines,
  - Then the Change command is applied to each line

    i.e. each line will be replaced with *text* (PTO--→)

Change Examples : Remove mail headers,

- the address specifies a range of lines – the ',' between regex /…/,/…/
  - beginning with a line that begins with From /^From /
  - until the first blank line. /^$/

1. The first example replaces all lines with a single occurrence of <Mail Header Removed>.

```
/^From /,/^$/c\
<Mail Header Removed>
```

1. The second example replaces each line beginning with /From / to <Mail Header Removed>

```
/^From /,/^$/{
    s/^From //p
    c\
    <Mail Header Removed>
    }
```

Swap /From / at the beginning of a line, /^
With nothing //, but print to pattern space, p
And change to <Mail Header Removed>

p is vital, as c\ only applies to pattern space

Side Effects

- Change clears the pattern space.
  - No command following the change command in the script is applied
- Insert and Append do not clear the pattern space
  - but none of the commands in the script will be applied to the text that is inserted or appended – assumption : raw text is correct!
- No matter what changes are made to pattern space,
  - the text from change, insert, or append will be output as supplied
- This is true even if default output is suppressed
  - using the -n or #n option,

    text will still be output for these commands

Delete

- Delete takes 0, 1 or 2 addresses and respectively deletes:-

  0 - either the current pattern space,

  1 - the pattern space when it matches the first address,

  2 - the range of lines contained within two addresses
- Once delete is executed,
  - no other commands are applied to pattern space.
  - Instead,
    - the next line from the edit file is read into pattern space
    - The edit script starts all over again with the first edit instruction
- Delete deletes the entire line,
  - not just the part that matches the address.
- To delete a portion of a line,
  - use substitute with a blank replacement string

NOT – Negation ! DON'T

If an address is followed by an exclamation point (!), the associated command is applied to all lines that don□t match the address or address range

Example:

1,5!d

would delete all lines except 1 through 5

/black/!s/cow/horse/

would substitute "horse" for "cow" on all lines, except those that contained "black"

"The brown cow"	-> "The brown horse"
"The black cow"	-> "The black cow"

Extract to & from other files with Read and Write

- These commands permit extraction to and from other files.
  - allow you to work directly with files
  - Both take a single argument, a file name
- The Read ([address]r filename)
  - The read command takes
    - an optional single address
  - and reads the specified file into *pattern space* after the addressed line.
  - It cannot operate on a range of lines
- Write ([address1[, address2]]w filename)
  - Write takes
    - an optional line address
    - or range of addresses
  - and writes the contents of *pattern space* to the specified file

---

- There must be a single space between the r or w command and the filename.
- There must not be any spaces after the filename or sed will include them as part of the file name
- Read will not complain if the file doesn't exist
- Write will
  - create it if it doesn't exist;
  - overwrite it if it already exists
    - unless created during the current invocation of sed
      - in which case write will append to it
- If there are multiple commands writing to the same file, each will append to it
- There are a maximum of ten files per script

Uses for Read and Write

- Read can be used for substitution in form letters

```
cat sedscr
/^<Company-list>/r company.list
/^Company-list>/d
```

```
cat company.list
CompUSA
MicroCenter
Lucky Computers
```

Clearly, editing the company.list changes the edit!

Example

```
cat formletter
☐
☐
To purchase your own copy of
    FrontPage, contact
 any of the following companies:
<Company-list>
Thank you
```

```
sed -f sedscr formletter
☐
☐
To purchase your own copy of
    FrontPage, contact
 any of the following companies:
CompUSA
MicroCenter
Lucky Computers
Thank you
```

Simple data extraction / selection to files!

- Write can be used to pull selected lines and segregate them into individual files
- Suppose I have a customer file (customers) containing the following (US states) data:
  - John Cleese WA
  - Jerry Smith CA
  - Tom Jones VA
  - Gene Autry CA
  - Ranger Bob VA
  - Annie Oakley CA

Now, suppose I want to segregate all of the customers from each state into a file of their own

```
cat sedscr
/CA$/w customers.CA
/VA$/w customers.VA
/WA$/w customers.WA
```

sed -f sedscr customers

will create files for each state that contain only the customers from that state

Transform

- The Transform command (y) operates like tr,
  doing a 1-to-1 or character-to-character replacement
- Transform accepts zero, one or two addresses
- [address[, address]]y/abc/xyz/
  - every a within the specified address(es) is transformed to an x. The same is true for b to y and c to z
  - y/abcdefghijklmnopqrstuvwxyz/ABCDEFGHIJKLMNOPQRSTUVWXYZ/ changes **all** lower case characters on the addressed line to upper case
  - If you only want to do specific characters, or a word, in the line, it is much more difficult and requires use of the *hold space*

Copy Pattern Space to Hold Space

- Like copy to clipboard as in copy & paste
- The h and H commands move the contents of *pattern space* to *hold space*
- h copies *pattern space* to *hold space*, replacing anything that was previously there
- H appends an embedded NEWLINE (“ \n”) to whatever is currently in *hold space* followed by the contents of *pattern space*
  - Even if the *hold space* is empty, the embedded NEWLINE is appended to *hold space* first

Get Contents of Hold Space

- Like paste from clipboard as in cut & paste
- g and G get the contents of *hold space* and place it in *pattern space*
- g copies the contents of *hold space* into *pattern space*, replacing whatever was there
- G appends an embedded NEWLINE character (“ \n”) followed by the contents of *hold space* to *pattern space*
  - Even if *pattern space* is empty, the NEWLINE is still appended to *pattern space* before the contents of the *hold space*

- Now, a specific word in a file should be capitalized, such as changing

  “ the abc statement” to “ the ABC statement”

- A script to do this looks like this:

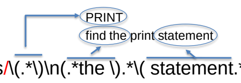
```
/the .* statement/{
h
s/.*the \(.*\) statement.*/\1/
y/abcdefghijklmnopqrstuvwxyz/ABCDEFGHIJKLMNOPQRSTUVWXYZ/
G
s/\(.*\)\n(.*the \).*\( statement.*\)/\2\1\3/
}
```

Explanation on following slides.

So How Does It Work?

- `/the .* statement/`
  - The address limits the procedure to lines that match
    “ the .* statement”
- h copies the current line into hold space, replacing whatever was there
  - After the h, pattern space and hold space are identical
    - pattern space - “ find the print statement”
    - hold space - “ find the print statement”
- s/.*the \(.*\) statement.* /\1/
  - extracts the name of the statement (\1)
  - and replaces the entire line with it
    - pattern space - “ print”
    - hold space - “ find the print statement”

- y/abc…/ABC…/ changes each lowercase to uppercase
  - pattern space - “ PRINT”
  - hold space - “ find the print statement”
- The G command appends a NEWLINE (“\n”) to pattern space followed by the line saved in hold space



- s/\(.*\)\n(.*the \).*\(statement.*\)/\2\1\3/
  - matches three different parts of the pattern space as shown
  - and rearranges them : -
    find the PRINT statement

(NB ‘find’ isn’t deleted, because all on line until ‘the’ is copied!)

Print

- The Print command (p)
  - can be used to force the pattern space to be output, even if the -n or #n option has been specified
- Syntax: [address1[, address2]]p
  - Note:

    if the -n or #n option has not been specified, p will cause the line to be output twice!
- Examples:

  1,5p will display lines 1 through 5

  /^$/,/$/p will display the lines

  from the first blank line through the last line of the file

Quit

- **Quit** causes **sed** to stop reading new input lines and stop sending them to standard output
- It takes at most a single line address
  - Once a line matching the address is reached, the script will be terminated
  - This can be used to save time when you only want to process some portion of the beginning of a file
- Example:
- To print the first 100 lines of a file (like *head*) use:
  - *Sed '100q' filename*
  - sed will, by default, send the first 100 lines of *filename* to standard output and then quit processing
  - Of course : *head -100 filename* will do same

Regex Metacharacters for sed

Character	Use …. i.e. matches
.	any single character except NEWLINE
*	zero or more occurrences of the single preceding char
[?]	any one of the class of characters contained
\	Escapes follow special character
\(\)	saves enclosed pattern for backreferencing
\n	matches the nth pattern saved via \(\)
\{n,m\}	a range of occurrences of the regex immediately preceding it
	\{n\} will match exactly n occurrences
	\{n,\} will match at least n occurrences (note the comma!)
	\{n,m\} will match any number of occurrences from n to m
^	beginning of line
$	end of line
&	prints all matched text when used in a replacement string

Info manual extract for 'sed' : Appendix A Extended regular expressions

The only difference between basic and extended regular expressions is in the behavior of a few characters:

`?', `+', parentheses, and braces (`{}').

Basic regular expressions require these to be escaped if you want them to behave as special characters.

Extended regular expressions require these to be escaped if you want them _to match a literal character_.

Examples : needs clarification… ignore for now..will update soon

`abc?' becomes `abc\?' when using extended regular expressions. It matches the literal string `abc?'.

`c\+' becomes `c+' when using extended regular expressions. It matches one or more `c's.

`a\{3,\}' becomes `a{3,}' when using extended regular expressions. It matches three or more `a's.

`\(abc\)\{2,3\}'
becomes `(abc){2,3}' when using extended regular expressions. It matches either `abcabc' or `abcabcabc'.

`\(abc*\)\1'
becomes `(abc*)\1' when using extended regular expressions. Backreferences must still be escaped for extended regex

Online repositories of example seds!

- Check, possibly in this order
- local system documentation : man, info, or GUI
  - As it should be specific to local implementation
- The original, for general information:
  - https://www.gnu.org/software/sed/manual/
- Search for 'sed examples' online, for specific needs

  these will change, and update, so best you search,

But 10/2016 here is a reasonable one:-
  - http://sed.sourceforge.net/sed1line.txt
  - With links to other resources (books, source) within.