learnbyexample

CLI text processing with GNU Coreutils

- ✓ 200+ examples
- ✓ 100+ exercises

Sundeep Agarwal

Table of contents

Preface

You might be already aware of popular coreutils commands like `head` , `tail` , `tr` , `sort` and so on. This book will teach you more than twenty of such specialized text processing tools provided by the `GNU coreutils` package.

My Command Line Text Processing repo includes chapters on some of these coreutils commands. Those chapters have been significantly edited for this book and new chapters have been added to cover more commands.

Prerequisites

You should be familiar with command line usage in a Unix-like environment. You should be comfortable with concepts like file redirection and command pipelines.

If you are new to the world of command line, check out my Computing from the Command Line ebook and curated resources on Linux CLI and Shell scripting before starting this book.

Conventions

- The examples presented here have been tested on the `GNU bash` shell and **version 9.1** of the `GNU coreutils` package.
- Code snippets shown are copy pasted from the `bash` shell and modified for presentation purposes. Some commands are preceded by comments to provide context and explanations. Blank lines have been added to improve readability, only `real` time is shown for speed comparisons and so on.
- Unless otherwise noted, all examples and explanations are meant for **ASCII** characters.
- External links are provided throughout the book for you to explore certain topics in more depth.
- The cli_text_processing_coreutils repo has all the code snippets and files used in examples, exercises and other details related to the book. If you are not familiar with the `git` command, click the **Code** button on the webpage to get the files.

Acknowledgements

- GNU coreutils documentation — manual and examples
- /r/commandline/, /r/linux4noobs/ and /r/linux/ — helpful forums
- stackoverflow and unix.stackexchange — for getting answers to pertinent questions on coreutils and related commands
- tex.stackexchange — for help on pandoc and `tex` related questions
- canva — cover image
- Warning and Info icons by Amada44 under public domain
- oxipng, pngquant and svgcleaner — optimizing images
- SpikePy — for spotting an ambiguous explanation

Feedback and Errata

I would highly appreciate it if you'd let me know how you felt about this book. It could be anything from a simple thank you, pointing out a typo, mistakes in code snippets, which aspects of the book worked for you (or didn't!) and so on. Reader feedback is essential and especially so for self-published authors.

You can reach me via:

- Issue Manager: https://github.com/learnbyexample/cli_text_processing_coreutils/issues
- E-mail: learnbyexample.net@gmail.com
- Twitter: https://twitter.com/learn_byexample

Author info

Sundeep Agarwal is a lazy being who prefers to work just enough to support his modest lifestyle. He accumulated vast wealth working as a Design Engineer at Analog Devices and retired from the corporate world at the ripe age of twenty-eight. Unfortunately, he squandered his savings within a few years and had to scramble trying to earn a living. Against all odds, selling programming ebooks saved his lazy self from having to look for a job again. He can now afford all the fantasy ebooks he wants to read and spends unhealthy amount of time browsing the internet.

When the creative muse strikes, he can be found working on yet another programming ebook (which invariably ends up having at least one example with regular expressions). Researching materials for his ebooks and everyday social media usage drowned his bookmarks, so he maintains curated resource lists for sanity sake. He is thankful for free learning resources and open source tools. His own contributions can be found at https://github.com/learnbyexample.

List of books: https://learnbyexample.github.io/books/

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Book version

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See Version_changes.md to track changes across book versions.

Introduction

I've been using Linux since 2007, but it took me ten more years to *really* explore coreutils when I wrote tutorials for the Command Line Text Processing repository.

Any beginner learning Linux command line tools would come across the `cat` command within the first week. Sooner or later, they'll come to know popular text processing tools like `grep` , `head` , `tail` , `tr` , `sort` , etc. If you were like me, you'd come across `sed` and `awk` , shudder at their complexity and prefer to use a scripting language like Perl and text editors like Vim instead (don't worry, I've already corrected that mistake).

Knowing power tools like `grep` , `sed` and `awk` can help solve most of your text processing needs. So, why would you want to learn text processing tools from the coreutils package? The biggest motivation would be faster execution since these tools are optimized for the use cases they solve. And there's always the advantage of not having to write code (and test that solution) if there's an existing tool to solve the problem.

This book will teach you more than twenty of such specialized text processing tools provided by the `GNU coreutils` package. Plenty of examples and exercise are provided to make it easier to understand a particular tool and its various features.

Writing a book always has a few pleasant surprises for me. For this one, it was discovering a `sort` option for calendar months, regular expressions in the `tac` and `nl` commands, etc.

Installation

On a GNU/Linux based OS, you are most likely to already have GNU coreutils installed. This book covers the **version 9.1** of the coreutils package. To install a newer/particular version, see the coreutils download section for details.

If you are not using a Linux distribution, you may be able to access coreutils using these options:

- Windows Subsystem for Linux — compatibility layer for running Linux binary executables natively on Windows
- brew — Package Manager for macOS (or Linux)

Documentation

It is always a good idea to know where to find the documentation. From the command line, you can use the `man` and `info` commands for brief manuals and full documentation respectively. I prefer using the online GNU coreutils manual which feels much easier to use and navigate.

See also:

- Release notes — overview of changes and bug fixes between versions
- Bug list
- Common options
- FAQ
- Gotchas

cat and tac

`cat` derives its name from con**cat**enation and provides other nifty options too.

`tac` helps you to reverse the input line wise, usually used for further text processing.

Creating text files

Yeah, `cat` can be used to write contents to a file by typing them from the terminal itself. If you invoke `cat` without providing file arguments or `stdin` data from a pipe, it will wait for you to type the content. After you are done typing all the text you want to save, press Enter and then the `Ctrl+d` key combinations. If you don't want the last line to have a newline character, press `Ctrl+d` twice instead of Enter and `Ctrl+d`. See also unix.stackexchange: difference between Ctrl+c and Ctrl+d.

```
# press Enter and Ctrl+d after typing all the required characters
$ cat > greeting.txt
Hi there
Have a nice day
```

In the above example, the output of `cat` is redirected to a file named `greeting.txt`. If you don't redirect the `stdout` data, each line will be echoed as you type. You can check the contents of the file you just created by using `cat` again.

```
$ cat greeting.txt
Hi there
Have a nice day
```

Here Documents is another popular way to create such files. In this case, the termination condition is a line matching a predefined string which is specified after the `<<` redirection operator. This is especially helpful for automation, since pressing `Ctrl+d` interactively isn't desirable. Here's an example:

```
# > and a space at the start of lines represents the secondary prompt PS2
# don't type them in a shell script
# EOF is typically used as the identifier
$ cat << 'EOF' > fruits.txt
> banana
> papaya
> mango
> EOF

$ cat fruits.txt
banana
papaya
mango
```

The termination string is enclosed in single quotes to prevent parameter expansion, command substitution, etc. You can also use `\string` for this purpose. If you use `<<-` instead of `<<`, you can use leading tab characters for indentation purposes. See bash manual: Here Documents and stackoverflow: here-documents for more examples and details.

Note that creating files as shown above isn't restricted to `cat`, it can be applied to any command waiting for `stdin`.

```
# 'tr' converts lowercase alphabets to uppercase in this example
$ tr 'a-z' 'A-Z' << 'end' > op.txt
> hi there
> have a nice day
> end

$ cat op.txt
HI THERE
HAVE A NICE DAY
```

Concatenate files

Here are some examples to showcase `cat`'s main utility. One or more files can be passed as arguments.

```
$ cat greeting.txt fruits.txt nums.txt
Hi there
Have a nice day
banana
papaya
mango
3.14
42
1000
```

Visit the cli_text_processing_coreutils repo to get all the example files used in this book.

To save the output of concatenation, use the shell's redirection features.

```
$ cat greeting.txt fruits.txt nums.txt > op.txt

$ cat op.txt
Hi there
Have a nice day
banana
papaya
mango
3.14
42
1000
```

Accepting stdin data

You can represent the `stdin` data using `-` as a file argument. If the file arguments are not present, `cat` will read the `stdin` data if present or wait for interactive input as seen earlier.

```
# only stdin (- is optional in this case)
$ echo 'apple banana cherry' | cat
apple banana cherry

# both stdin and file arguments
$ echo 'apple banana cherry' | cat greeting.txt -
Hi there
Have a nice day
apple banana cherry

# here's an example without a newline character at the end of the first input
$ printf 'Some\nNumbers' | cat - nums.txt
Some
Numbers3.14
42
1000
```

Squeeze consecutive empty lines

As mentioned before, `cat` provides many features beyond concatenation. Consider this sample `stdin` data:

```
$ printf 'hello\n\n\nworld\n\nhave a nice day\n\n\n\n\n\napple\n'
hello


world

have a nice day





apple
```

You can use the `-s` option to squeeze consecutive empty lines to a single empty line. If present, leading and trailing empty lines will also be squeezed (won't be completely removed). You can modify the below example to test it out.

```
$ printf 'hello\n\n\nworld\n\nhave a nice day\n\n\n\n\n\napple\n' | cat -s
hello

world

have a nice day

apple
```

Prefix line numbers

The `-n` option will prefix line numbers and a tab character to each input line. The line numbers are right justified to occupy a minimum of `6` characters, with space as the filler.

```
$ cat -n greeting.txt fruits.txt nums.txt
     1	Hi there
     2	Have a nice day
     3	banana
     4	papaya
     5	mango
     6	3.14
     7	42
     8	1000
```

Use the `-b` option instead of `-n` if you don't want empty lines to be numbered.

```
# -n option numbers all the input lines
$ printf 'apple\n\nbanana\n\ncherry\n' | cat -n
     1	apple
     2	
     3	banana
     4	
     5	cherry

# -b option numbers only the non-empty lines
$ printf 'apple\n\nbanana\n\ncherry\n' | cat -b
     1	apple

     2	banana

     3	cherry
```

ℹ Use the `nl` command if you want more customization options like number formatting, separator string, regular expression based filtering and so on.

Viewing special characters

Characters like backspace and carriage return will mangle the contents if viewed naively on the terminal. Characters like NUL won't even be visible. You can use the `-v` option to show such characters using the caret notation (see wikipedia: Control code chart for details). See this unix.stackexchange thread for non-ASCII examples.

```
# example for backspace and carriage return characters
$ printf 'mar\bt\nbike\rp\n'
mat
pike
$ printf 'mar\bt\nbike\rp\n' | cat -v
mar^Ht
bike^Mp
```

```
# NUL character
$ printf 'car\0jeep\0bus\0' | cat -v
car^@jeep^@bus^@

# form-feed and vertical-tab
$ printf '1 2\t3\f4\v5\n' | cat -v
1 2     3^L4^K5
```

The `-v` option doesn't cover the newline and tab characters. You can use the `-T` option to spot tab characters.

```
$ printf 'good food\tnice dice\napple\tbanana\tcherry\n' | cat -T
good food^Inice dice
apple^Ibanana^Icherry
```

The `-E` option adds a `$` marker at the end of input lines. This is useful to spot trailing whitespace characters.

```
$ printf 'ice   \nwater\n cool  \n chill\n' | cat -E
ice   $
water$
 cool  $
 chill$
```

The following options combine two or more of the above options:

- `-e` option is equivalent to `-vE`
- `-t` option is equivalent to `-vT`
- `-A` option is equivalent to `-vET`

```
$ printf 'mar\bt\nbike\rp\n' | cat -e
mar^Ht$
bike^Mp$

$ printf '1 2\t3\f4\v5\n' | cat -t
1 2^I3^L4^K5

$ printf '1 2\t3\f4\v5\n' | cat -A
1 2^I3^L4^K5$
```

Useless use of cat

Using `cat` to view the contents of a file, to concatenate them, etc are well and good. But, using `cat` when it is not needed is a bad habit that you should avoid. See wikipedia: UUOC and Useless Use of Cat Award for more details.

Most commands that you'll see in this book can directly work with file arguments, so you shouldn't use `cat` to pipe the contents for such cases. Here's a single file example:

```
# useless use of cat
$ cat greeting.txt | sed -E 's/\w+/\L\u&/g'
Hi There
Have A Nice Day

```

```
# sed can handle file arguments
$ sed -E 's/\w+/\L\u&/g' greeting.txt
Hi There
Have A Nice Day
```

If you prefer having the file argument before the command, you can use the shell's redirection feature to supply input data instead of `cat`. This also applies to commands like `tr` that do not accept file arguments.

```
# useless use of cat
$ cat greeting.txt | tr 'a-z' 'A-Z'
HI THERE
HAVE A NICE DAY

# use shell redirection instead
$ <greeting.txt tr 'a-z' 'A-Z'
HI THERE
HAVE A NICE DAY
```

Such useless use of `cat` might not have a noticeable negative impact for most cases. But it becomes important if you are dealing with large input files. Especially for commands like `tac` and `tail` which will have to wait for all the data to be read instead of directly processing from the end of the file if they had been passed as arguments (or using shell redirection).

If you are dealing with multiple files, then the use of `cat` will depend upon the desired result. Here are some examples:

```
# match lines containing 'o' or '0'
# -n option adds line number prefix
$ cat greeting.txt fruits.txt nums.txt | grep -n '[o0]'
5:mango
8:1000
$ grep -n '[o0]' greeting.txt fruits.txt nums.txt
fruits.txt:3:mango
nums.txt:3:1000

# count the number of lines containing 'o' or '0'
$ grep -c '[o0]' greeting.txt fruits.txt nums.txt
greeting.txt:0
fruits.txt:1
nums.txt:1
$ cat greeting.txt fruits.txt nums.txt | grep -c '[o0]'
2
```

For some use cases like in-place editing with `sed`, you can't use `cat` or shell redirection at all. The files have to be passed as arguments only. To conclude, don't use `cat` just to pass the input as `stdin` to another command, unless necessary.

tac

`tac` will reverse the order of the input lines. If you pass multiple input files, each file content will be reversed separately. Here are some examples:

```
# won't be the same as: cat greeting.txt fruits.txt | tac
$ tac greeting.txt fruits.txt
Have a nice day
Hi there
mango
papaya
banana

$ printf 'apple\nbanana\ncherry\n' | tac
cherry
banana
apple
```

⚠ If the last input line doesn't end with a newline, the output will also not have that newline character.

```
$ printf 'apple\nbanana\ncherry' | tac
cherrybanana
apple
```

Reversing input lines makes some of the text processing tasks easier. For example, if there are multiple matches but you want only the last one. See my ebooks on GNU sed and GNU awk for more such use cases.

```
$ cat log.txt
--> warning 1
a,b,c,d
42
--> warning 2
x,y,z
--> warning 3
4,3,1

$ tac log.txt | grep -m1 'warning'
--> warning 3

$ tac log.txt | sed '/warning/q' | tac
--> warning 3
4,3,1
```

In the above example, `log.txt` has multiple lines containing `warning`. The task is to fetch lines based on the last match, which isn't usually supported by CLI tools. Matching the first occurrence is easy with tools like `grep` and `sed`. Hence, `tac` is helpful to reverse the condition from the last match to the first match. After processing with tools like `sed`, the result is then reversed again to get back the original order of input lines. Another benefit is that the first `tac` command will stop reading the input contents after the match is found.

ℹ Use the `rev` command if you want each input line to be reversed character wise.

Customize line separator for tac

By default, the newline character is used to split the input content into *lines*. You can use the `-s` option to specify a different string to be used as the separator.

```
# use NUL as the line separator
# -s $'\0' can also be used instead of -s '' if ANSI-C quoting is supported
$ printf 'car\0jeep\0bus\0' | tac -s '' | cat -v
bus^@jeep^@car^@

# as seen before, the last entry should also have the separator
# otherwise it won't be present in the output
$ printf 'apple banana cherry' | tac -s ' ' | cat -e
cherrybanana apple $
$ printf 'apple banana cherry ' | tac -s ' ' | cat -e
cherry banana apple $
```

When the custom separator occurs before the content of interest, use the `-b` option to print those separators before the content in the output as well.

```
$ cat body_sep.txt
%=%=
apple
banana
%=%=
teal
green

$ tac -b -s '%=%=' body_sep.txt
%=%=
teal
green
%=%=
apple
banana
```

The separator will be treated as a regular expression if you use the `-r` option as well.

```
$ cat shopping.txt
apple   50
toys    5
Pizza   2
mango   25
Banana  10

# separator character is 'a' or 'm' at the start of a line
$ tac -b -rs '^[am]' shopping.txt
mango   25
Banana  10
apple   50
toys    5
Pizza   2
```

```
# alternate solution for: tac log.txt | sed '/warning/q' | tac
# separator is zero or more characters from the start of a line till 'warning'
$ tac -b -rs '^.*warning' log.txt | awk '/warning/ && ++c==2{exit} 1'
--> warning 3
4,3,1
```

ℹ See Regular Expressions chapter from my **GNU grep** ebook if you want to learn about regexp syntax and features.

Exercises

ℹ All the exercises are also collated together in one place at Exercises.md. For solutions, see Exercise_solutions.md.

ℹ The exercises directory has all the files used in this section.

1) The given sample data has empty lines at the start and end of the input. Also, there are multiple empty lines between the paragraphs. How would you get the output shown below?

```
# note that there's an empty line at the end of the output
$ printf '\n\n\ndragon\n\n\n\nunicorn\nbee\n\n\n' | ##### add your solution here

     1  dragon

     2  unicorn
     3  bee

```

2) Pass appropriate arguments to the `cat` command to get the output shown below.

```
$ cat greeting.txt
Hi there
Have a nice day

$ echo '42 apples and 100 bananas' | cat ##### add your solution here
42 apples and 100 bananas
Hi there
Have a nice day
```

3) What does the `-v` option of the `cat` command do?

4) Which options of the `cat` command do the following stand in for?

- `-e` option is equivalent to
- `-t` option is equivalent to
- `-A` option is equivalent to

5) Will the two commands shown below produce the same output? If not, why not?

```
$ cat fruits.txt ip.txt | tac

$ tac fruits.txt ip.txt
```

6) Reverse the contents of `blocks.txt` file as shown below, considering `----` as the separator.

```
$ cat blocks.txt
----
apple--banana
mango---fig
----
3.14
-42
1000
----
sky blue
dark green
----
hi hello

##### add your solution here
----
hi hello
----
sky blue
dark green
----
3.14
-42
1000
----
apple--banana
mango---fig
```

7) For the `blocks.txt` file, write solutions to display only the last such group and last two groups.

```
##### add your solution here
----
hi hello

##### add your solution here
----
sky blue
dark green
----
hi hello
```

8) Reverse the contents of `items.txt` as shown below. Consider digits at the start of lines as the separator.

```
$ cat items.txt
1) fruits
apple 5
banana 10
2) colors
green
sky blue
3) magical beasts
dragon 3
unicorn 42

##### add your solution here
3) magical beasts
dragon 3
unicorn 42
2) colors
green
sky blue
1) fruits
apple 5
banana 10
```

head and tail

`cat` is useful to view entire contents of files. Pagers like `less` can be used if you are working with large files (`man` pages for example). Sometimes though, you just want a peek at the starting or ending lines of input files. Or, you know the line numbers for the information you are looking for. In such cases, you can use `head` or `tail` or a combination of both these commands to extract the content you want.

Leading and trailing lines

Consider this sample file, with line numbers prefixed for convenience.

```
$ cat sample.txt
 1) Hello World
 2)
 3) Hi there
 4) How are you
 5)
 6) Just do-it
 7) Believe it
 8)
 9) banana
10) papaya
11) mango
12)
13) Much ado about nothing
14) He he he
15) Adios amigo
```

By default, `head` and `tail` will display the first and last 10 lines respectively.

```
$ head sample.txt
 1) Hello World
 2)
 3) Hi there
 4) How are you
 5)
 6) Just do-it
 7) Believe it
 8)
 9) banana
10) papaya

$ tail sample.txt
 6) Just do-it
 7) Believe it
 8)
 9) banana
10) papaya
11) mango
12)
13) Much ado about nothing
```

```
14) He he he
15) Adios amigo
```

If there are less than 10 lines in the input, only those lines will be displayed.

```
# seq command will be discussed in detail later, generates 1 to 3 here
# same as: seq 3 | tail
$ seq 3 | head
1
2
3
```

You can use the `-nN` option to customize the number of lines (`N`) needed.

```
# first three lines
# space between -n and N is optional
$ head -n3 sample.txt
 1) Hello World
 2) 
 3) Hi there

# last two lines
$ tail -n2 sample.txt
14) He he he
15) Adios amigo
```

Excluding the last N lines

By using `head -n -N` , you can get all the input lines except the ones you'll get when you use the `tail -nN` command.

```
# except the last 11 lines
# space between -n and -N is optional
$ head -n -11 sample.txt
 1) Hello World
 2) 
 3) Hi there
 4) How are you
```

Starting from the Nth line

By using `tail -n +N` , you can get all the input lines except the ones you'll get when you use the `head -n(N-1)` command.

```
# all lines starting from the 11th line
# space between -n and +N is optional
$ tail -n +11 sample.txt
11) mango
12) 
13) Much ado about nothing
14) He he he
15) Adios amigo
```

Multiple input files

If you pass multiple input files to the `head` and `tail` commands, each file will be processed separately. By default, the output is nicely formatted with filename headers and empty line separators.

```
$ seq 2 | head -n1 greeting.txt -
==> greeting.txt <==
Hi there

==> standard input <==
1
```

You can use the `-q` option to avoid filename headers and empty line separators.

```
$ tail -q -n2 sample.txt nums.txt
14) He he he
15) Adios amigo
42
1000
```

Byte selection

The `-c` option works similar to the `-n` option, but with bytes instead of lines. In the below examples, the shell prompt at the end of the output aren't shown for illustration purposes.

```
# first three characters
$ printf 'apple pie' | head -c3
app

# last three characters
$ printf 'apple pie' | tail -c3
pie

# excluding the last four characters
$ printf 'car\njeep\nbus\n' | head -c -4
car
jeep

# all characters starting from the fifth character
$ printf 'car\njeep\nbus\n' | tail -c +5
jeep
bus
```

Since `-c` works byte wise, it may not be suitable for multibyte characters:

```
# all input characters in this example occupy two bytes each
$ printf 'αλεπού' | head -c2
α

# ğ requires three bytes
$ printf 'cağe' | tail -c4
ğe
```

Range of lines

You can select a range of lines by combining both the `head` and `tail` commands.

```
# 9th to 11th lines
# same as: head -n11 sample.txt | tail -n +9
$ tail -n +9 sample.txt | head -n3
 9) banana
10) papaya
11) mango

# 6th to 7th lines
# same as: tail -n +6 sample.txt | head -n2
$ head -n7 sample.txt | tail -n +6
 6) Just do-it
 7) Believe it
```

> See unix.stackexchange: line X to line Y on a huge file for performance comparison with other commands like `sed` , `awk` , etc.

NUL separator

The `-z` option sets the NUL character as the line separator instead of the newline character.

```
$ printf 'car\0jeep\0bus\0' | head -z -n2 | cat -v
car^@jeep^@

$ printf 'car\0jeep\0bus\0' | tail -z -n2 | cat -v
jeep^@bus^@
```

Further Reading

- wikipedia: File monitoring with tail -f and -F options
    - toolong — terminal application to view, tail, merge, and search log files
- unix.stackexchange: How does the tail -f option work?
- How to deal with output buffering?

Exercises

> The exercises directory has all the files used in this section.

1) Use appropriate commands and shell features to get the output shown below.

```
$ printf 'carpet\njeep\nbus\n'
carpet
jeep
bus

# use the above 'printf' command for input data
```

```
$ c=##### add your solution here
$ echo "$c"
car
```

2) How would you display all the input lines except the first one?

```
$ printf 'apple\nfig\ncarpet\njeep\nbus\n' | ##### add your solution here
fig
carpet
jeep
bus
```

3) Which command would you use to get the output shown below?

```
$ cat fruits.txt
banana
papaya
mango
$ cat blocks.txt
----
apple--banana
mango---fig
----
3.14
-42
1000
----
sky blue
dark green
----
hi hello

##### add your solution here
==> fruits.txt <==
banana
papaya

==> blocks.txt <==
----
apple--banana
```

4) Use a combination of `head` and `tail` commands to get the 11th to 14th characters from the given input.

```
$ printf 'apple\nfig\ncarpet\njeep\nbus\n' | ##### add your solution here
carp
```

5) Extract the starting six bytes from the input files `ip.txt` and `fruits.txt` .

```
##### add your solution here
it is banana
```

6) Extract the last six bytes from the input files `fruits.txt` and `ip.txt` .

```
##### add your solution here
mango
erish
```

7) For the input file `ip.txt`, display except the last 5 lines.

```
##### add your solution here
it is a warm and cozy day
listen to what I say
go play in the park
come back before the sky turns dark
```

8) Display the third line from the given `stdin` data. Consider the NUL character as the line separator.

```
$ printf 'apple\0fig\0carpet\0jeep\0bus\0' | ##### add your solution here
carpet
```

tr

`tr` helps you to map one set of characters to another set of characters. Features like range, repeats, character sets, squeeze, complement, etc makes it a must know text processing tool.

To be precise, `tr` can handle only bytes. Multibyte character processing isn't supported yet.

Transliteration

Here are some examples that map one set of characters to another. As a good practice, always enclose the sets in single quotes to avoid issues due to shell metacharacters.

```
# 'l' maps to '1', 'e' to '3', 't' to '7' and 's' to '5'
$ echo 'leet speak' | tr 'lets' '1375'
1337 5p3ak

# example with shell metacharacters
$ echo 'apple;banana;cherry' | tr ; :
tr: missing operand
Try 'tr --help' for more information.
$ echo 'apple;banana;cherry' | tr ';' ':'
apple:banana:cherry
```

You can use `-` between two characters to construct a range (ascending order only).

```
# uppercase to lowercase
$ echo 'HELLO WORLD' | tr 'A-Z' 'a-z'
hello world

# swap case
$ echo 'Hello World' | tr 'a-zA-Z' 'A-Za-z'
hELLO wORLD

# rot13
$ echo 'Hello World' | tr 'a-zA-Z' 'n-za-mN-ZA-M'
Uryyb Jbeyq
$ echo 'Uryyb Jbeyq' | tr 'a-zA-Z' 'n-za-mN-ZA-M'
Hello World
```

`tr` works only on `stdin` data, so use shell input redirection for file inputs.

```
$ tr 'a-z' 'A-Z' <greeting.txt
HI THERE
HAVE A NICE DAY
```

Different length sets

If the second set is longer, the extra characters are simply ignored. If the first set is longer, the last character of the second set is reused for the missing mappings.

```
# only abc gets converted to uppercase
$ echo 'apple banana cherry' | tr 'abc' 'A-Z'
Apple BAnAnA Cherry

```

```
# c-z will be converted to C
$ echo 'apple banana cherry' | tr 'a-z' 'ABC'
ACCCC BACACA CCCCCC
```

You can use the `-t` option to truncate the first set so that it matches the length of the second set.

```
# d-z won't be converted
$ echo 'apple banana cherry' | tr -t 'a-z' 'ABC'
Apple BAnAnA Cherry
```

You can also use `[c*n]` notation to repeat a character `c` by `n` times. You can specify `n` in decimal format or octal format (starts with `0`). If `n` is omitted, the character `c` is repeated as many times as needed to equalize the length of the sets.

```
# a-e will be translated to A
# f-z will be uppercased
$ echo 'apple banana cherry' | tr 'a-z' '[A*5]F-Z'
APPLA AANANA AHARRY

# a-c and x-z will be uppercased
# rest of the characters will be translated to -
$ echo 'apple banana cherry' | tr 'a-z' 'ABC[-*]XYZ'
A---- BA-A-A C----Y
```

Escape sequences and character sets

Certain characters like newline, tab, etc can be represented using escape sequences. You can also specify characters using the `\NNN` octal representation.

```
# same as: tr '\011' '\072'
$ printf 'apple\tbanana\tcherry\n' | tr '\t' ':'
apple:banana:cherry

$ echo 'apple:banana:cherry' | tr ':' '\n'
apple
banana
cherry
```

Certain commonly useful groups of characters like alphabets, digits, punctuation, etc have named character sets that you can use instead of manually creating the sets. Only `[:lower:]` and `[:upper:]` can be used by default, others will require `-d` or `-s` options.

```
# same as: tr 'a-z' 'A-Z' <greeting.txt
$ tr '[:lower:]' '[:upper:]' <greeting.txt
HI THERE
HAVE A NICE DAY
```

To override the special meaning for `-` and `\` characters, you can escape them using the `\` character. You can also place the `-` character at the end of a set to represent it literally. Can you reason out why placing the `-` character at the start of a set can cause issues?

```
$ echo '/python-projects/programs' | tr '/-' '\\_'
\python_projects\programs
```

See the tr manual for more details and a list of all the escape sequences and character sets.

Deleting characters

Use the `-d` option to specify a set of characters to be deleted.

```
$ echo '2024-08-12' | tr -d '-'
20240812

# delete all punctuation characters
$ s='"Hi", there! How *are* you? All fine here.'
$ echo "$s" | tr -d '[:punct:]'
Hi there How are you All fine here
```

Complement

The `-c` option will invert the first set of characters. This is often used in combination with the `-d` option.

```
$ s='"Hi", there! How *are* you? All fine here.'

# retain alphabets, whitespaces, period, exclamation and question mark
$ echo "$s" | tr -cd 'a-zA-Z.!?[:space:]'
Hi there! How are you? All fine here.
```

If you use `-c` for transliteration, you can only provide a single character for the second set. In other words, all the characters except those provided by the first set will be mapped to the character specified by the second set.

```
$ s='"Hi", there! How *are* you? All fine here.'

$ echo "$s" | tr -c 'a-zA-Z.!?[:space:]' '1%'
tr: when translating with complemented character classes,
string2 must map all characters in the domain to one

$ echo "$s" | tr -c 'a-zA-Z.!?[:space:]' '%'
%Hi%% there! How %are% you? All fine here.
```

Squeeze

The `-s` option changes consecutive repeated characters to a single copy of that character.

```
# squeeze lowercase alphabets
$ echo 'HELLO... hhoowwww aaaaaareeeeee yyouuuu!!' | tr -s 'a-z'
HELLO... how are you!!

# translate and squeeze
$ echo 'hhoowwww aaaaaareeeeee yyouuuu!!' | tr -s 'a-z' 'A-Z'
HOW ARE YOU!!
```

```
# delete and squeeze
$ echo 'hhoowwww aaaaaareeeeee yyouuuu!!' | tr -sd '!' 'a-z'
how are you

# squeeze other than lowercase alphabets
$ echo 'apple    noon     banana!!!!!' | tr -cs 'a-z'
apple noon banana!
```

Exercises

The exercises directory has all the files used in this section.

1) What's wrong with the following command?

```
$ echo 'apple#banana#cherry' | tr # :
```

2) Retain only alphabets, digits and whitespace characters.

```
$ printf 'Apple_42  cool,blue\tDragon:army\n' | ##### add your solution here
Apple42  coolblue       Dragonarmy
```

3) Similar to rot13, figure out a way to shift digits such that the same logic can be used both ways.

```
$ echo '4780 89073' | ##### add your solution here
9235 34528

$ echo '9235 34528' | ##### add your solution here
4780 89073
```

4) Figure out the logic based on the given input and output data. Hint: use two ranges for the first set and only 6 characters in the second set.

```
$ echo 'apple banana cherry damson etrog' | ##### add your solution here
1XXl5 21n1n1 3h5XXX 41mXon 5XXog
```

5) Which option would you use to truncate the first set so that it matches the length of the second set?

6) What does the `*` notation do in the second set?

7) Change `:` to `-` and `;` to the newline character.

```
$ echo 'tea:coffee;brown:teal;dragon:unicorn' | ##### add your solution here
tea-coffee
brown-teal
dragon-unicorn
```

8) Convert all characters to `*` except digit and newline characters.

```
$ echo 'ajsd45_sdg2Khnf4v_54as' | ##### add your solution here
****45****2****4**54**
```

9) Change consecutive repeated punctuation characters to a single punctuation character.

```
$ echo '""hi...""', good morning!!!!' | ##### add your solution here
"hi.", good morning!
```

10) Figure out the logic based on the given input and output data.

```
$ echo 'Aapple    noon     banana!!!!!' | ##### add your solution here
:apple:noon:banana:
```

11) The `books.txt` file has items separated by one or more `:` characters. Change this separator to a single newline character as shown below.

```
$ cat books.txt
Cradle:::Mage Errant::The Weirkey Chronicles
Mother of Learning::Eight:::::Dear Spellbook:Ascendant
Mark of the Fool:Super Powereds:::Ends of Magic

##### add your solution here
Cradle
Mage Errant
The Weirkey Chronicles
Mother of Learning
Eight
Dear Spellbook
Ascendant
Mark of the Fool
Super Powereds
Ends of Magic
```

cut

`cut` is a handy tool for many field processing use cases. The features are limited compared to `awk` and `perl` commands, but the reduced scope also leads to faster processing.

Individual field selections

By default, `cut` splits the input content into fields based on the tab character. You can use the `-f` option to select a desired field from each input line. To extract multiple fields, specify the selections separated by the comma character.

```
# only the second field
$ printf 'apple\tbanana\tcherry\n' | cut -f2
banana

# first and third fields
$ printf 'apple\tbanana\tcherry\n' | cut -f1,3
apple   cherry
```

`cut` will always display the selected fields in ascending order. And you cannot display a field more than once.

```
# same as: cut -f1,3
$ printf 'apple\tbanana\tcherry\n' | cut -f3,1
apple   cherry

# same as: cut -f1,2
$ printf 'apple\tbanana\tcherry\n' | cut -f1,1,2,1,2,1,1,2
apple   banana
```

By default, `cut` uses the newline character as the line separator. `cut` will add a newline character to the output even if the last input line doesn't end with a newline.

```
$ printf 'good\tfood\ntip\ttap' | cut -f2
food
tap
```

Field ranges

You can use the `-` character to specify field ranges. You can skip the starting or ending range, but not both.

```
# 2nd, 3rd and 4th fields
$ printf 'apple\tbanana\tcherry\tfig\tmango\n' | cut -f2-4
banana  cherry  fig

# all fields from the start till the 3rd field
$ printf 'apple\tbanana\tcherry\tfig\tmango\n' | cut -f-3
apple   banana  cherry

# all fields from the 3rd one till the end
$ printf 'apple\tbanana\tcherry\tfig\tmango\n' | cut -f3-
cherry  fig     mango
```

Input field delimiter

Use the `-d` option to change the input delimiter. Only a single byte character is allowed. By default, the output delimiter will be same as the input delimiter.

```
$ cat scores.csv
Name,Maths,Physics,Chemistry
Ith,100,100,100
Cy,97,98,95
Lin,78,83,80

$ cut -d, -f2,4 scores.csv
Maths,Chemistry
100,100
97,95
78,80

# use quotes if the delimiter is a shell metacharacter
$ echo 'one;two;three;four' | cut -d; -f3
cut: option requires an argument -- 'd'
Try 'cut --help' for more information.
-f3: command not found
$ echo 'one;two;three;four' | cut -d';' -f3
three
```

Output field delimiter

Use the `--output-delimiter` option to customize the output separator to any string of your choice. The string is treated literally. Depending on your shell you can use ANSI-C quoting to allow escape sequences.

```
# same as: tr '\t' ','
$ printf 'apple\tbanana\tcherry\n' | cut --output-delimiter=, -f1-
apple,banana,cherry

# example for multicharacter output separator
$ echo 'one;two;three;four' | cut -d';' --output-delimiter=' : ' -f1,3-
one : three : four

# ANSI-C quoting example
# depending on your environment, you can also press Ctrl+v and then the Tab key
$ echo 'one;two;three;four' | cut -d';' --output-delimiter=$'\t' -f1,3-
one     three   four

# newline as the output field separator
$ echo 'one;two;three;four' | cut -d';' --output-delimiter=$'\n' -f2,4
two
four
```

Complement

The `--complement` option allows you to invert the field selections.

```
# except the second field
$ printf 'apple ball cat\n1 2 3 4 5' | cut --complement -d' ' -f2
apple cat
1 3 4 5

# except the first and third fields
$ printf 'apple ball cat\n1 2 3 4 5' | cut --complement -d' ' -f1,3
ball
2 4 5
```

Suppress lines without delimiters

By default, lines not containing the input delimiter will still be part of the output. You can use the `-s` option to suppress such lines.

```
$ cat mixed_fields.csv
1,2,3,4
hello
a,b,c

# second line doesn't have the comma separator
# by default, such lines will be part of the output
$ cut -d, -f2 mixed_fields.csv
2
hello
b

# use the -s option to suppress such lines
$ cut -sd, -f2 mixed_fields.csv
2
b

$ cut --complement -sd, -f2 mixed_fields.csv
1,3,4
a,c
```

If a line contains the specified delimiter but doesn't have the field number requested, you'll get a blank line. The `-s` option has no effect on such lines.

```
$ printf 'apple ball cat\n1 2 3 4 5' | cut -d' ' -f4

4
```

Character selections

You can use the `-b` or `-c` options to select specific bytes from each input line. The syntax is same as the `-f` option. The `-c` option is intended for multibyte character selection, but for now it works exactly as the `-b` option. Character selection is useful for working with fixed-width fields.

```
$ printf 'apple\tbanana\tcherry\n' | cut -c2,8,11
pan

$ printf 'apple\tbanana\tcherry\n' | cut -c2,8,11 --output-delimiter=-
p-a-n

$ printf 'apple\tbanana\tcherry\n' | cut -c-5
apple

$ printf 'apple\tbanana\tcherry\n' | cut --complement -c13-
apple   banana

$ printf 'cat-bat\ndog:fog\nget;pet' | cut -c5-
bat
fog
pet
```

NUL separator

Use the `-z` option if you want to use NUL character as the line separator. In this scenario, `cut` will ensure to add a final NUL character even if not present in the input.

```
$ printf 'good-food\0tip-tap\0' | cut -zd- -f2 | cat -v
food^@tap^@
```

Alternatives

Here are some alternate commands you can explore if `cut` isn't enough to solve your task.

- hck — supports regexp delimiters, field reordering, header based selection, etc
- choose — negative indexing, regexp based delimiters, etc
- xsv — fast CSV command line toolkit
- rcut — my `bash+awk` script, supports regexp delimiters, field reordering, negative indexing, etc
- awk — my ebook on `GNU awk` one-liners
- perl — my ebook on Perl one-liners

Exercises

The exercises directory has all the files used in this section.

1) Display only the third field.

```
$ printf 'tea\tcoffee\tchocolate\tfruit\n' | ##### add your solution here
chocolate
```

2) Display the second and fifth fields. Consider `,` as the field separator.

```
$ echo 'tea,coffee,chocolate,ice cream,fruit' | ##### add your solution here
coffee,fruit
```

3) Why does the below command not work as expected? What other tools can you use in such cases?

```
# not working as expected
$ echo 'apple,banana,cherry,fig' | cut -d, -f3,1,3
apple,cherry

# expected output
$ echo 'apple,banana,cherry,fig' | ##### add your solution here
cherry,apple,cherry
```

4) Display except the second field in the format shown below. Can you construct two different solutions?

```
# solution 1
$ echo 'apple,banana,cherry,fig' | ##### add your solution here
apple cherry fig

# solution 2
$ echo '2,3,4,5,6,7,8' | ##### add your solution here
2 4 5 6 7 8
```

5) Extract the first three characters from the input lines as shown below. Can you also use the `head` command for this purpose? If not, why not?

```
$ printf 'apple\nbanana\ncherry\nfig\n' | ##### add your solution here
app
ban
che
fig
```

6) Display only the first and third fields of the `scores.csv` input file, with tab as the output field separator.

```
$ cat scores.csv
Name,Maths,Physics,Chemistry
Ith,100,100,100
Cy,97,98,95
Lin,78,83,80

##### add your solution here
Name    Physics
Ith     100
Cy      98
Lin     83
```

7) The given input data uses one or more `:` characters as the field separator. Assume that no field content will have the `:` character. Display except the second field, with `:` as the output field separator.

```
$ cat books.txt
Cradle:::Mage Errant::The Weirkey Chronicles
Mother of Learning::Eight:::::Dear Spellbook:Ascendant
Mark of the Fool:Super Powereds:::Ends of Magic
```

```
##### add your solution here
Cradle : The Weirkey Chronicles
Mother of Learning : Dear Spellbook : Ascendant
Mark of the Fool : Ends of Magic
```

8) Which option would you use to not display lines that do not contain the input delimiter character?

9) Modify the command to get the expected output shown below.

```
$ printf 'apple\nbanana\ncherry\n' | cut -c-3 --output-delimiter=:
app
ban
che

$ printf 'apple\nbanana\ncherry\n' | ##### add your solution here
a:p:p
b:a:n
c:h:e
```

10) Figure out the logic based on the given input and output data.

```
$ printf 'apple\0fig\0carpet\0jeep\0' | ##### add your solution here | cat -v
ple^@g^@rpet^@ep^@
```

seq

The `seq` command is a handy tool to generate a sequence of numbers in ascending or descending order. Both integer and floating-point numbers are supported. You can also customize the formatting for numbers and the separator between them.

Integer sequences

You need three numbers to generate an arithmetic progression — **start**, **step** and **stop**. When you pass only a single number as the stop value, the default start and step values are assumed to be `1` .

```
# start=1, step=1 and stop=3
$ seq 3
1
2
3
```

Passing two numbers are considered as start and stop values (in that order).

```
# start=25434, step=1 and stop=25437
$ seq 25434 25437
25434
25435
25436
25437

# start=-5, step=1 and stop=-3
$ seq -5 -3
-5
-4
-3
```

When you want to specify all the three numbers, the order is start, step and stop.

```
# start=1000, step=5 and stop=1010
$ seq 1000 5 1010
1000
1005
1010
```

By using a negative step value, you can generate sequences in descending order.

```
# no output
$ seq 3 1

# need to explicitly use a negative step value
$ seq 3 -1 1
3
2
1

$ seq 5 -5 -10
5
```

```
0
-5
-10
```

Floating-point sequences

Since `1` is the default start and step values, you need to change at least one of them to get floating-point sequences.

```
$ seq 0.5 3
0.5
1.5
2.5

$ seq 0.25 0.33 1.12
0.25
0.58
0.91
```

E-scientific notation is also supported.

```
$ seq 1.2e2 1.22e2
120
121
122

$ seq 1.2e2 0.752 1.22e2
120.000
120.752
121.504
```

Customizing separator

You can use the `-s` option to change the separator between the numbers of a sequence. Multiple characters are allowed. Depending on your shell you can use ANSI-C quoting to use escapes like `\t` instead of a literal tab character. A newline is always added at the end of the output.

```
$ seq -s' ' 4
1 2 3 4

$ seq -s: -2 0.75 3
-2.00:-1.25:-0.50:0.25:1.00:1.75:2.50

$ seq -s' - ' 4
1 - 2 - 3 - 4

$ seq -s$'\n\n' 3
1

2

3
```

Leading zeros

By default, the output will not have leading zeros, even if they are part of the numbers passed to the command.

```
$ seq 008 010
8
9
10
```

The `-w` option will equalize the width of the output numbers using leading zeros. The largest width between the start and stop values will be used.

```
$ seq -w 8 10
08
09
10

$ seq -w 0002
0001
0002
```

printf style formatting

You can use the `-f` option for `printf` style floating-point number formatting. See bash manual: printf for more details on formatting options.

```
$ seq -f'%g' -s: 1 0.75 3
1:1.75:2.5

$ seq -f'%.4f' -s: 1 0.75 3
1.0000:1.7500:2.5000

$ seq -f'%.3e' 1.2e2 0.752 1.22e2
1.200e+02
1.208e+02
1.215e+02
```

Limitations

As per the manual:

> On most systems, `seq` can produce whole-number output for values up to at least `2^53` . Larger integers are approximated. The details differ depending on your floating-point implementation.

```
# example with approximate values
$ seq 100000000000000000000 3333 100000000000000010000
100000000000000000000
100000000000000003336
100000000000000006664
100000000000000010000
```

However, when limited to non-negative whole numbers, an increment of less than `200` , and no format-specifying option, `seq` can print arbitrarily large numbers.

```
# no approximation for smaller step values
$ seq 100000000000000000000000000000 100000000000000000000000000005
100000000000000000000000000000
100000000000000000000000000001
100000000000000000000000000002
100000000000000000000000000003
100000000000000000000000000004
100000000000000000000000000005
```

Exercises

The exercises directory has all the files used in this section.

1) Generate numbers from `42` to `45` in ascending order.

```
##### add your solution here
42
43
44
45
```

2) Why does the command shown below produce no output?

```
# no output
$ seq 45 42

# expected output
##### add your solution here
45
44
43
42
```

3) Generate numbers from `25` to `10` in descending order, with a step value of `5` .

```
##### add your solution here
25
20
15
10
```

4) Is the sequence shown below possible to generate with `seq` ? If so, how?

```
##### add your solution here
01.5,02.5,03.5,04.5,05.5
```

5) Modify the command shown below to customize the output numbering format.

```
$ seq 30.14 3.36 40.72
30.14
33.50
36.86
40.22

##### add your solution here
3.014e+01
3.350e+01
3.686e+01
4.022e+01
```

shuf

The `shuf` command helps you randomize the input lines. And there are features to limit the number of output lines, repeat lines and even generate random positive integers.

Randomize input lines

By default, `shuf` will randomize the order of input lines. Here's an example:

```
$ cat purchases.txt
coffee
tea
washing powder
coffee
toothpaste
tea
soap
tea

$ shuf purchases.txt
tea
coffee
tea
toothpaste
soap
coffee
washing powder
tea
```

> ℹ You can use the `--random-source=FILE` option to provide your own source for randomness. With this option, the output will be the same across multiple runs. See Sources of random data for more details.

> ⚠ `shuf` doesn't accept multiple input files. Use `cat` for such cases.

Limit output lines

Use the `-n` option to limit the number of lines you want in the output. If the value is greater than the number of lines in the input, it would be similar to not using the `-n` option.

```
$ printf 'apple\nbanana\ncherry\nfig\nmango' | shuf -n2
mango
cherry
```

> ℹ As seen in the example above, `shuf` will add a newline character even if it is not present for the last input line.

Repeated lines

The `-r` option helps if you want to allow input lines to be repeated. This option is usually paired with `-n` to limit the number of lines in the output.

```
$ cat fruits.txt
banana
papaya
mango

$ shuf -n3 -r fruits.txt
banana
mango
banana

$ shuf -n5 -r fruits.txt
papaya
banana
mango
papaya
papaya
```

If a limit using `-n` is not specified, `shuf -r` will produce output lines indefinitely.

Specify input lines as arguments

You can use the `-e` option to specify multiple input lines as arguments to the command.

```
# quote the arguments as necessary
$ shuf -e hi there 'hello world' good
hello world
good
hi
there

$ shuf -n1 -e brown green blue
blue

$ shuf -n4 -r -e brown green blue
blue
green
brown
blue
```

The shell will autocomplete unquoted glob patterns (provided there are files that match the given expression). You can thus easily construct a solution to get a random selection of files matching the given glob pattern.

```
$ echo *.csv
marks.csv mixed_fields.csv report_1.csv report_2.csv scores.csv

```

```
$ shuf -n2 -e *.csv
scores.csv
marks.csv
```

Generate random numbers

The `-i` option will help generate random positive integers. The argument has to be a range, with `-` as the separator between the two numbers.

```
$ shuf -i 5-8
5
8
7
6

$ shuf -n3 -i 100-200
170
112
148

$ shuf -n5 -r -i 0-1
1
0
0
1
1
```

`2^64 - 1` is the maximum allowed integer when I tested it on my machine.

```
$ shuf -i 18446744073709551612-18446744073709551615
18446744073709551615
18446744073709551614
18446744073709551612
18446744073709551613

$ shuf -i 18446744073709551612-18446744073709551616
shuf: invalid input range: ‘18446744073709551616’:
Value too large for defined data type

# seq can help in such cases
# but remember that shuf needs to read the entire input
$ seq 100000000000000000000000000000 100000000000000000000000000105 | shuf -n2
100000000000000000000000000039
100000000000000000000000000018
```

`seq` can also help when you need negative and floating-point numbers.

```
$ seq -10 -8 | shuf
-9
-10
-8
```

```
$ seq -f'%.4f' 100 0.25 3000 | shuf -n3
1627.7500
1303.5000
2466.2500
```

> See unix.stackexchange: generate random strings if numbers aren’t enough for you.

Specifying output file

The `-o` option can be used to specify the output file to be used for saving the results. This is more useful for in-place editing, since you can simply use shell redirection to save the output in a different file.

```
$ cat book_list.txt
Cradle
Mage Errant
Mother of Learning
Super Powereds
The Umbral Storm
The Weirkey Chronicles

$ shuf book_list.txt -o book_list.txt
$ cat book_list.txt
Super Powereds
Cradle
Mage Errant
The Weirkey Chronicles
Mother of Learning
The Umbral Storm
```

NUL separator

Use the `-z` option if you want to use NUL character as the line separator. In this scenario, `shuf` will ensure to add a final NUL character even if not present in the input.

```
$ printf 'apple\0banana\0cherry\0fig\0mango' | shuf -z -n3 | cat -v
banana^@mango^@cherry^@
```

Exercises

> The exercises directory has all the files used in this section.

1) What’s wrong with the given command?

```
$ shuf --random-source=greeting.txt fruits.txt books.txt
shuf: extra operand ‘books.txt’
Try 'shuf --help' for more information.

```

```
# expected output
##### add your solution here
banana
Cradle:::Mage Errant::The Weirkey Chronicles
Mother of Learning::Eight:::::Dear Spellbook:Ascendant
papaya
Mark of the Fool:Super Powereds:::Ends of Magic
mango
```

2) What do the `-r` and `-n` options do? Why are they often used together?

3) What does the following command do?

```
$ shuf -e apple banana cherry fig mango
```

4) Which option would you use to generate random numbers? Given an example.

5) How would you generate 5 random numbers between `0.125` and `0.789` with a step value of `0.023` ?

```
# output shown below is a sample, might differ for you
##### add your solution here
0.378
0.631
0.447
0.746
0.723
```