

Week 02 Tutorial Sample Answers

1. Imagine that we have just typed a shell script into the file `my_first_shell_script.sh` in the current directory. We then attempt to execute the script and observe the following:

```
$ my_first_shell_script.sh
my_first_shell_script.sh: command not found
```

Explain the possible causes for this, and describe how to rectify them.

Answer:

- Problem:** you might not have the current directory in your `$PATH`.
Solution: either add `.` to the end of your `$PATH` (via `PATH=$PATH:.`), or type the command name as `./my_first_shell_script.sh`
- Problem:** the `my_first_shell_script.sh` file may not be executable.
Solution: either make the file executable, by running (e.g.,) `chmod +x my_first_shell_script.sh`, or execute it via the command `sh my_first_shell_script.sh` (also fixes the first problem)
- Problem:** you might have gotten the `#!/bin/sh` line wrong.
Solution: check the first line of the script, to make sure there are no spurious spaces or spelling mistakes, and then check that the shell is called `/bin/sh` on your system
- Problem:** the `my_first_shell_script.sh` file has been transferred from a Windows-based computer in binary mode, and there is a carriage-return character, which is often rendered as `^M` (or `'\r'` in C) after `/bin/sh`.
Solution: Run the command `dos2unix my_first_shell_script.sh`, which will remove the pesky `^M`s.

Note that some of these problems might result in a message like:
`my_first_shell_script.sh: Permission denied`, depending on which shell you're using.

2. Implement a shell script called `seq.sh` for writing sequences of integers onto its standard output, with one integer per line. The script can take up to three arguments, and behaves as follows:

- `seq.sh LAST` writes all numbers from 1 up to *LAST*, inclusive. For example:

```
$ ./seq.sh 5
1
2
3
4
5
```

- `seq.sh FIRST LAST` writes all numbers from *FIRST* up to *LAST*, inclusive. For example:

```
$ ./seq.sh 2 6
2
3
4
5
6
```

- `seq.sh FIRST INCREMENT LAST` writes all numbers from *FIRST* to *LAST* in steps of *INCREMENT*, inclusive; that is, it writes the sequence *FIRST*, *FIRST* + *INCREMENT*, *FIRST* + 2**INCREMENT*, ..., up to the largest integer in this sequence less than or equal to *LAST*. For example:

```
$ ./seq.sh 3 5 24
3
8
13
18
23
```

Answer:

A sample solution for `seq.sh`:

```
#!/bin/sh
# Write the sequence of integers specified by command-line arguments
# /usr/bin/seq provides similar functionality on Linux

if test $# = 1
then
    first=1
    increment=1
    last=$1
elif test $# = 2
then
    first=$1
    increment=1
    last=$2
elif test $# = 3
then
    first=$1
    increment=$2
    last=$3
else
    cat <<E0I
Usage:
    $0 last           ... prints numbers in range 1..last
    $0 first last     ... prints numbers in range first..last
    $0 first 2nd last ... prints numbers first,2nd,..last
                      (using difference between first and
                      2nd as the increment)

E0I
    exit 1
fi

if test $increment -lt 1
then
    echo "$0: invalid increment value: $increment"
    exit 1
fi

i=$first
while test $i -le $last
do
    echo $i
    i=`expr $i + $increment`
done
```

Another sample solution for seq.sh:

```
#!/bin/bash
# Write the sequence of integers specified by command-line arguments
# /usr/bin/seq provides similar functionality on Linux

# The bash-specific syntax ((..)) is used for arithmetic
# This increases the readability but reduces the portability

if (( $# == 1 ))
then
    first=1
    increment=1
    last=$1
elif (( $# == 2 ))
then
    first=$1
    increment=1
    last=$2
elif (( $# == 3 ))
then
    first=$1
    increment=$2
    last=$3
else
    cat <<EOI
Usage:
$0 last          ... prints numbers in range 1..last
$0 first last    ... prints numbers in range first..last
$0 first 2nd last ... prints numbers first,2nd,..last
                  (using difference between first and
                  2nd as the increment)

EOI
    exit 1
fi

if (( increment < 1 ))
then
    echo "$0: invalid increment value: $increment"
    exit 1
fi

i=$first
while (( i <= last ))
do
    echo $i
    (( i = i + increment ))
done
```

Another sample solution for seq.sh:

```
#!/bin/bash
# Write the sequence of integers specified by command-line arguments
# /usr/bin/seq provides similar functionality on Linux

# Uses a C-style for loop in bash.

if (( $# == 1 ))
then
    first=1
    increment=1
    last=$1
elif (( $# == 2 ))
then
    first=$1
    increment=1
    last=$2
elif (( $# == 3 ))
then
    first=$1
    increment=$2
    last=$3
else
    cat <<EOI
Usage:
    $0 last           ... prints numbers in range 1..last
    $0 first last     ... prints numbers in range first..last
    $0 first 2nd last ... prints numbers first,2nd,..last
                      (using difference between first and
                      2nd as the increment)

EOI
    exit 1
fi

if (( increment < 1 ))
then
    echo "$0: invalid increment value: $increment"
    exit 1
fi

for (( i = first; i <= last; i += increment ))
do
    echo $i
done
```

Another sample solution for seq.sh:

```
#!/bin/bash
# Write the sequence of integers specified by command-line arguments
# /usr/bin/seq provides similar functionality on Linux

# The bash-specific syntax {n..m} is a sequence expression, similar to
# `seq`. `eval echo` is needed because the for loop is parsed before
# the variables are expanded

if (( $# == 1 ))
then
    first=1
    increment=1
    last=$1
elif (( $# == 2 ))
then
    first=$1
    increment=1
    last=$2
elif (( $# == 3 ))
then
    first=$1
    increment=$2
    last=$3
else
    cat <<EOI
Usage:
    $0 last           ... prints numbers in range 1..last
    $0 first last     ... prints numbers in range first..last
    $0 first 2nd last ... prints numbers first,2nd,..last
                        (using difference between first and
                        2nd as the increment)

EOI
    exit 1
fi

if (( increment < 1 ))
then
    echo "$0: invalid increment value: $increment"
    exit 1
fi

for i in $(eval echo ${first}..${last}..${increment})
do
    echo $i
done
```

3. Write a shell script, `no_blinking.sh`, which removes all HTML files in the current directory which use the [blink element](#):

```
$ no_blinking.sh
Removing old.html because it uses the <blink> tag
Removing evil.html because it uses the <blink> tag
Removing bad.html because it uses the <blink> tag
```

Answer:

```
#!/bin/sh
# Removes all HTML files in the current directory which use <blink>

for file in *.html
do
    # note use of -i to ignore case and -w to ignore white space
    # however tags containing newlines won't be detected
    if egrep -iw '</?blink>' $file >/dev/null
    then
        echo "Removing $file because it uses the <blink> tag"
        rm "$file"
    fi
done
```

4. Modify the `no_blinking.sh` shell script to instead take the HTML files to be checked as command line arguments and, instead of removing them, adding the suffix **.bad** to their name:

```
$ no_blinking.sh awful.html index.html terrible.html
Renaming awful.html to awful.html.bad because it uses the <blink> tag
Renaming terrible.html to terrible.html.bad because it uses the <blink> tag
```

Answer:

```
#!/bin/sh
# Removes all HTML files supplied as argument which use <blink>

for file in "$@"
do
    # note use of -i to ignore case and -w to ignore white space
    # however tags containing newlines won't be detected
    if egrep -iw '</?blink>' $file >/dev/null
    then
        echo "Rename $file to $file.bad because it uses the <blink> tag"
        mv "$file" "$file.bad"
    fi
done
```

5. Write a shell script, `list_include_files.sh`, which for all the C source files (`.c` files) in the current directory prints the names of the files they include (`.h` files), for example

```
$ list_include_files.sh
count_words.c includes:
    stdio.h
    stdlib.h
    ctype.h
    time.h
    get_word.h
    map.h
get_word.c includes:
    stdio.h
    stdlib.h
map.c includes:
    get_word.h
    stdio.h
    stdlib.h
    map.h
```

Answer:

```
#!/bin/sh
# list the files included by the C sources files included as arguments

for file in *.c
do
    echo "$file includes:"
    egrep '^#include' "$file" | # find '#include' lines
    sed 's/[>][^>]*$//' |      # remove the last '"' or '>' and anything after it
    sed 's/^\.*["<]/ /'      # remove the first '"' or '>' and anything before it
done
```

6. Consider the following columnar (space-delimited) data file containing (fictional) contact for various CSE academic staff:

G Heiser	Newtown	9381-1234
S Jha	Kingsford	9621-1234
C Sammut	Randwick	9663-1234
R Buckland	Randwick	9663-9876
J A Shepherd	Botany	9665-4321
A Taylor	Glebe	9692-1234
M Pagnucco	North Ryde	9868-6789

Note: This data is fictitious. Do not ring these phone numbers. I have no idea whether they are real or not, but they are certainly not the correct phone numbers for the academic staff mentioned.

The data is currently sorted in phone number order. Can we use the `Yr wAQ` filter to re-arrange the data into “telephone-book” order? If not, how would we need to change the file in order to achieve this?

Answer:

We need to sort based on the family name field, but this occurs in different positions on each line of the file, depending how many initials the person has.

To achieve this, we need to make sure that the family name occurs in the same "field" on each line. One possibility: make it the first field in each line:

Keller G	Newtown	9381-1234
Wilson W H	Kingsford	9621-1234
...		

Another possibility: make sure that the initials form a single field:

G. Keller	Newtown	9381-1234
W.H. Wilson	Kingsford	9621-1234
...		

7. Consider this Unix password file (usually found in `/etc/passwd`):

```
root:ZHolHAHZw8As2:0:0:root:/root:/bin/bash
jas:iaiSHX49Jvs8.:100:100:John Shepherd:/home/jas:/bin/bash
andrewt:rX9KwSSPqkLyA:101:101:Andrew Taylor:/home/andrewt:/bin/cat
postgres::997:997:PostgreSQL Admin:/usr/local/pgsql:/bin/bash
oracle::999:998:Oracle Admin:/home/oracle:/bin/bash
cs2041:rX9KwSSPqkLyA:2041:2041:COMP2041 Material:/home/cs2041:/bin/bash
cs3311:mLRiCIvmtI902:3311:3311:COMP3311 Material:/home/cs3311:/bin/bash
cs9311:fIVLdSXYoVFai:9311:9311:COMP9311 Material:/home/cs9311:/bin/bash
cs9314:nTn.JwDgZE1Hs:9314:9314:COMP9314 Material:/home/cs9314:/bin/bash
cs9315:sOMXwkqmFbKlA:9315:9315:COMP9315 Material:/home/cs9315:/bin/bash
```

Provide a command that would produce each of the following results:

- a. display the first three lines of the file
- b. display lines belonging to class accounts (assuming that their login name starts with either "cs", "se", "bi" or "en", followed by a digit)
- c. display the user name of everyone whose shell is `/bin/bash`
- d. create a tab-separated file `passwords.txt` containing only login name and password for all users

Answer:

a. `head -3 /etc/passwd`

b. `egrep '^(cs|se|bi|en)[0-9]' /etc/passwd`

c. `egrep '/bin/bash' /etc/passwd | cut -d':' -f1`

 a more accurate version that restricts the search to the right field:
 `cut -d':' -f1,7 /etc/passwd | egrep ':/bin/bash' | cut -d':' -f1`

d. `cut -d':' -f1,2 /etc/passwd | tr ':' '\t' > passwords.txt`

8. The following shell script emulates the `ul AQ` command using the built-in shell commands `G KQ` and `GID: AQ`.

```
#!/bin/sh
while read line
do
    echo "$line"
done
```

- a. What are the differences between the above script and the real `ul AQ` command?
- b. modify the script so that it can concatenate multiple files from the command line, like the real `ul AQ`.

(Hint: the shell's control structures — for example, `if`, `while`, `for` — are commands in their own right, and can form a component of a pipeline.)

Answer:

a. Some differences:

- the script doesn't concatenate files named on the command line, just standard input
- it doesn't implement all of the [tilde expansion](#) options
- the appearance of lines may be altered: space at start of line is removed, and runs of multiple spaces will be compressed to a single space.

b. A shell script to concatenate multiple files specified on command line:

```
#!/bin/sh
for f in "$@"
do
    if [ ! -r "$f" ]
    then
        echo "No such file: $f"
    else
        while read line
        do
            echo "$line"
        done < $f
    fi
done
```

9. The [bzip2](#) command compresses a text file, and renames it to `filename.gz`. The [unzip](#) command takes the name of a single compressed file as its argument and writes the original (non-compressed) text to its standard output.

Write a shell script called `zshow` that takes multiple `.gz` file names as its arguments, and displays the original text of each file, separated by the name of the file.

Consider the following example execution of `zshow`:

```
$ zshow a.gz b.gz bad.gz c.gz
===== a =====
... original contents of file "a" ...
===== b =====
... original contents of file "b" ...
===== bad =====
No such file: bad.gz
===== c =====
... original contents of file "c" ...
```

Answer:

A simple solution which aims to make things obvious:

```
#!/bin/sh
for f in "$@" # for each command line arg
do
    f1=`echo $f | sed -e 's/\.gz//`
    echo "===== $f1 ====="
    if test ! -r "$f" # is the arg readable?
    then
        echo "No such file: $f"
    else
        zcat "$f"
    fi
done
```

A solution that aims to be more robust


```
#!/bin/sh
for f in "$@" # iterates over command line args
do
    f1=`echo $f | sed 's/\.gz//`
    echo "===== $f1 ====="
    if test ! -r "$f" # is the arg readable?
    then
        echo "No such file: $f"
    else
        ftype=`file -b $f | sed 's/ .*//`
        if [ "$ftype" != "gzip" ]
        then
            echo "Incorrect file type: $f"
        else
            zcat "$f"
        fi
    fi
done
```

Notice that robustness typically adds a significant amount of code: the extra code is definitely worth it.

The `file` command tells you what kind of file its argument is; the call to `zcat` adjusts its output.

10. Consider the marks data file from last week's tutorial; assume it's stored in a file called Marks:

```
2111321 37 FL
2166258 67 CR
2168678 84 DN
2186565 77 DN
2190546 78 DN
2210109 50 PS
2223455 95 HD
2266365 55 PS
...
```

Assume also that we have a file called Students that contains the names and student ids of for all students in the class, e.g.

```
2166258 Chen, X
2186565 Davis, PA
2168678 Hussein, M
2223455 Jain, S
2190546 Phan, DN
2111321 Smith, JA
2266365 Smith, JD
2210109 Wong, QH
...
```

Write a shell script that produces a list of names and their associated marks, sorted by name:

```
67 Chen, X
77 Davis, PA
84 Hussein, M
95 Jain, S
78 Phan, DN
37 Smith, JA
55 Smith, JD
50 Wong, QH
```

Note: there are many ways to do this, generally involving combinations of filters such as `grep`, `sed`, `awk`, `sort`, `cat`, etc. Try to think of more than one solution, and discuss the merits of each.

Answer:

One obvious strategy: iterate over the Students file using the `read` builtin. We iterate over Students rather than Marks, as it is already in the order we want; we could iterate the other way, but then we would have to sort the output afterwards. For each student, we can use `grep` and `sed` (or `awk` or `perl`) to extract their information from the Marks file.

```
#!/bin/sh
while read sid name init
do
    mark=`egrep $sid Marks | cut -d' ' -f2`
    echo $mark $name $init
done < Students
```

For minimalists (and Haskell lovers), a one-line solution:

```
#!/bin/sh
sort Students | join Marks - | sort -k4 | cut -d' ' -f2,4,5
```

Note the use of `-` to make the second argument to `join` come from standard input: without this mechanism, we would need to create a temporary file containing a sorted copy of `Students`.

11. Implement a shell script, `grades.sh`, that reads a sequence of (studentID, mark) pairs from its standard input, and writes (studentID, grade) pairs to its standard output. The input pairs are written on a single line, separated by spaces, and the output should use a similar format. The script should also check whether the second value on each line looks like a valid mark, and output an appropriate message if it does not. The script can ignore any extra data occurring after the mark on each line.

Consider the following input and corresponding output to the program:

Input

```
2212345 65
2198765 74
2199999 48
2234567 50 ok
2265432 99
2121212 hello
2222111 120
2524232 -1
```

Output

```
2212345 CR
2198765 CR
2199999 FL
2234567 PS
2265432 HD
2121212 ?? (hello)
2222111 ?? (120)
2524232 ?? (-1)
```

To get you started, here is a framework for the script:

```
#!/bin/sh
while read id mark
do
    # ... insert mark/grade checking here ...
done
```

Note that the `read` shell builtin assumes that the components on each input line are separated by spaces. How could we use this script if the data was supplied in a file that used commas to separate the (studentID, mark) components, rather than spaces?

Answer:

Since “mapping a mark to a grade” is a standard problem in first year tutes, working out the algorithm should not pose any problems. Hopefully the only tricky thing is getting the shell syntax right. The main aim of the exercise is to write a multi-way selection statement.

We supply two solutions: one using `if`, the other using `case`. The `if` one is more natural for people who know how to program in languages like Java. The `case` version requires us to develop patterns to match all the possible inputs.

The `case` construct is a nice way for checking strings via patterns. The pattern used here catches both non-numbers and negative numbers: they start with a minus rather than a digit. Unfortunately, the `grep` command does not support pattern-matching.

Shell supports a C-style `continue` construct for loops, which is used here to prevent processing non-numeric “mark” fields.

All of the bracket-style (`[...]`) syntax for tests could be replaced by the more conventional syntax for the `test` command — e.g., `test $mark -lt 50`.

Note that the `read` statement has 2 arguments to ensure that the mark is bundled in with the optional comment on each data line.

```
#!/bin/sh
while read stid mark extras
do
    case "$mark" in
        [0-9]*) ;;
        *)      echo "$stid ?? ($mark)"
                continue
                ;;

    esac
    if test $mark -lt 50
    then
        echo $stid FL
    elif test $mark -lt 65
    then
        echo $stid PS
    elif test $mark -lt 75
    then
        echo $stid CR
    elif test $mark -lt 85
    then
        echo $stid DN
    elif test $mark -le 100
    then
        echo $stid HD
    else
        echo "$stid ?? ($mark)"
    fi
done
```

Another possibility would be to use case patterns to match the correct ranges of values, but this assumes that all marks are integer values. Floating point values could also be handled, but at the cost of making the patterns more complex. Also, this approach would not scale up to arbitrary ranges of integers; it would become too messy to specify patterns for all possible numbers.

```
#!/bin/sh
while read stid mark extras
do
    case "$mark" in
        [0-9] | [0-4][0-9])    echo $stid FL ;;
        5[0-9] | 6[0-4])      echo $stid PS ;;
        6[5-9] | 7[0-4])      echo $stid CR ;;
        7[5-9] | 8[0-4])      echo $stid DN ;;
        8[5-9] | 9[0-9] | 100) echo $stid HD ;;
        *)                    echo "$stid ?? ($mark)" ;;
    esac
done
```

If the input file used comma as a separator, the easiest thing would be to run the input through [tr](#) to convert the commas to spaces, and pipe the output into the grades program:

```
tr ',' ' ' <data | grades
```

Alternatively, you could alter the “input field separator” for the shell, by setting IFS=,.

Revision questions

The following questions are primarily intended for revision, either this week or later in session. Your tutor may still choose to cover some of these questions, time permitting.

19. Write a shell script, `time_date.sh`, that prints the time and date once an hour. It should do this until a new month is reached.

Reminder the [date](#) command produces output like this:

```
Friday 5 August 17:37:01 AEST 2016
```

Answer:

Sample solution for `time_date.sh`:

```
#!/bin/sh

start_month=`date | cut -d' ' -f3` # or use options to date, e.g. date +%m
while test $start_month = `date | cut -d' ' -f3`
do
    date
    sleep 3600 # i.e. one hour
done
```

Normally, we would double-quote like this:

```
while test "$start_month" = "`date | cut -d' ' -f3`"
```

but this is not needed, as the month does not contain spaces.

20. Consider a scenario where we have a directory containing two LaTeX files, `a.tex` and `b.tex`. The file `a.tex` is 20 lines long, and `b.tex` is 30 lines long. What is the effect of each of the commands below? How will their output differ?

```
$ wc -l *.tex
$ echo `wc -l *.tex`
```

Answer:

The first command counts the number of lines in each file and writes this data out, one file per line, followed by a total. The result:

```
$ wc -l *.tex
20 a.tex
30 b.tex
50 total
```

The second command starts out doing exactly the same thing as the first: counting lines in the two files. However, because of the backquotes, its output is written to a single string which is then taken by the shell and passed as arguments to the `echo` command. In the process of capturing the output, it is trimmed of trailing newlines. By the time the shell has processed it further and it is fed as arguments to the `echo` command, all newlines have been removed, and it becomes a sequence of words. The `echo` command separates its arguments with a single space.

```
$ echo `wc -l *.tex`
20 a.tex 30 b.tex 50 total
```

21. Write a shell script that displays the name and size of all files in the current directory that are bigger than, say, 100,000 bytes.

(Hint: use `wc -c` to do the counting, and capture its output using back-ticks. How do you get rid of the file name and/or line and word counts?)

Answer:

```
#!/bin/sh
LIMIT=100000
for f in *
do
    bytes=`wc -c <"$f"`
    if test $bytes -gt $LIMIT
    then
        echo "$f has $bytes bytes"
    fi
done
```

22. What is the output of each of the following pipelines if the text

```
this is big Big BIG
but this is not so big
```

is supplied as the initial input to the pipeline?

- `tr -d ' ' | wc -w`
- `tr -cs 'a-zA-Z0-9' '\n' | wc -l`
- `tr -cs 'a-zA-Z0-9' '\n' | tr 'a-z' 'A-Z' | sort | uniq -c`

Answer:

- a. This pipeline deletes (–d) all of the blanks between words, thus compressing each line into a single long word, which means the number of words is the same as the number of lines — i.e., 2.

b. This splits the input up so there is one word of input on each line of output; counting the number of output lines thus also counts the total number of words in the text — i.e., 11.

c. This splits the input into words, then normalises them (by mapping all words to all upper-case), then counts the number of occurrences of each distinct word. The output looks like:

```
4 BIG
1 BUT
2 IS
1 NOT
1 SO
2 THIS
```

23. Consider the fairly standard “split-into-words” technique from the previous question —

```
tr -c -s 'a-zA-Z0-9' '\n' < someFile
```

Explain how this command works. What does each argument do?

Answer:

- –c is complement: it replaces everything **Ör Ä**in string 1 with string 2
- –s is 'squeeze repeated characters': it replaces any duplicate newlines with just one.
- the string 'a–zA–Z0–9' is shorthand for the string of all alphanumeric characters —

```
abcdefghijklmnopqrstuvwxyzABCDEFGHIJKLMNOPQRSTUVWXYZ0123456789
```

24. Assume that we are in a shell where the following shell variable assignments have been performed, and **kyo** gives the following result:

```
$ x=2 y='Y Y' z=ls
$ ls
  a      b      c
```

What will be displayed as a result of the following **ÖD: Q** commands:

- a. \$ echo a b c

b. \$ echo "a b c"

c. \$ echo \$y

d. \$ echo x\$x

e. \$ echo \$xx

f. \$ echo "\$y"

g. \$ echo '\$y'

h. \$ echo ` \$y `

i. \$ echo ` \$z `

j. \$ echo `echo a b c`

Answer:

The aim of this question is to clarify notions about command line arguments and the various transformations the shell performs on the command line before executing it.

Recall that the shell performs command and variable substitution before splitting the command line into separate words to make up the arguments. Single-quotes and double-quotes perform a grouping function that overrides the normal word-splitting.

- a. \$ echo a b c
- a b c

Spaces between arguments are not preserved; echo puts one space between each argument.

- b. \$ echo "a b c"
- a b c

Spaces are preserved, because the quotes turn "a b c" into a single argument to echo.

c. `$ echo $y`
Y Y

`$y` expands into two separate arguments.

d. `$ echo x$x`
x2

`$x` expands to 2 and is appended after the letter x.

e. `$ echo $xx`

`$xx` is treated as a reference to the shell variable `xx`: since there is no such variable, it expands to the empty string.

f. `$ echo "$y"`
Y Y

`$y` expands into a single argument.

g. `$ echo '$y'`
\$y

Single quotes prevent variable expansion.

h. `$ echo ` $y ``
Y: command not found

`$y` expands to Y Y which is then executed as a command because of the backquotes; since there is no command Y, an error message follows.

i. `$ echo `ls``
a b c

`$z` expands to `ls`, which is then executed as a command, giving the names of the files in the current directory, which are treated as three separate arguments.

j. `$ echo `echo a b c``
a b c

The inner echo command is executed, giving a b c which are passed as arguments to the outer echo.

25. The following C program and its equivalent in Java both aim to give precise information about their command-line arguments.

```
// Display command line arguments, one per line, in C
#include <stdio.h>
int main (int argc, char *argv[])
{
    printf ("#args = %d\n", argc - 1);
    for (int i = 1; i < argc; i++)
        printf ("arg[%d] = \"%s\"\n", i, argv[i]);
    return 0;
}
```

```
// Display command line arguments, one per line, in Java
public class args {
    public static void main(String args[]) {
        System.out.println("#args = " + args.length);
        for (int i = 0; i < args.length; i++)
            System.out.println("arg[" + (i+1) + "] = \"" + args[i] + "\"");
    }
}
```

Assume that these programs are compiled in such a way that we may invoke them as `args`. Consider the following examples of how it operates:

```
$ args a b c
#args = 3
arg[1] = "a"
arg[2] = "b"
arg[3] = "c"
$ args "Hello there"
#args = 1
arg[1] = "Hello there"
```


As with the previous question, assume that we are in a shell where the following shell variable assignments have been performed, and `ls` gives the following result:

```
$ x=2 y='Y Y' z=ls
$ ls
  a      b      c
```

What will be the output of the following:

- a. `$ args x y z`
- b. `$ args `ls``
- c. `$ args $y`
- d. `$ args "$y"`
- e. `$ args `echo "$y"``
- f. `$ args xx$x`
- g. `$ args xy`
- h. `$ args $xy`

Answer:

This question has a similar aim to the previous one, but now we need to be more precise about what are the actual arguments that are being passed to the command. Note that we place double quotes around each argument so that we can see `echo $y` what is contained in the argument, including any embedded spaces.

a. `$ args x y z`
`#args = 3`
`arg[1] = "x"`
`arg[2] = "y"`
`arg[3] = "z"`

Each of the letters is a single argument (separated by spaces).

b. `$ args `ls``
`#args = 3`
`arg[1] = "a"`
`arg[2] = "b"`
`arg[3] = "c"`

The `ls` command is executed and its output is interpolated into the command line; the shell then splits the command-line into arguments.

c. `$ args $y`
`#args = 2`
`arg[1] = "Y"`
`arg[2] = "Y"`

`$y` expands to the string `Y Y`; when the shell splits the line into words, these two characters becomes separate arguments.

d. `$ args "$y"`
`#args = 1`
`arg[1] = "Y Y"`

`$y` expands to `Y Y` within the quotes, so it is treated as a single word when the shell breaks the line into arguments.

e. `$ args `echo $y``
`#args = 2`
`arg[1] = "Y"`
`arg[2] = "Y"`

The command within the backquotes expands to `Y Y`, but since backquotes don't have a grouping function, the two `Y`'s are treated as separate arguments

f. `$ args xx$x`
`#args = 1`
`arg[1] = "222"`

`$x` expands into `2`, which is concatenated with itself three times

g.

```
$ args $x$y
#args  = 2
arg[1] = "2Y"
arg[2] = "Y"
```

\$x expands to 2 and \$y expands to Y Y; these two strings are concatenated to give 2Y Y and, when the shell splits the line into words, the second Y becomes an argument in its own right.

h.

```
$ args $xy
#args  = 0
```

There is no variable called xy, so \$xy expands to the empty string, which vanishes when the shell splits the command line into words.

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