COMP 175

System Administration and Security

Bash Continued

A web server in a shell script

- A minimalist web server implemented in bash
- Step 1: A typical beginning

```
#!/bin/bash
base=/var/www
```

A web server in a shell script

- Step 2: The inetd feeds the script with data received from the remote host, the first row being the standard HTTP request, followed by zero or more header lines.

```
read request
while /bin/true; do
  read header
  [ "$header" == $'\r' ] && break;
done
```

- Note: /bin/true -do nothing, successfully

A web server in a shell script

- Step 3: extract the URL from the request string and locate the document on the local file system

```
url="${request#GET }"
url="${url% HTTP/*}"
filename="$base$url"
```

- Step 4: send the file (if it exists) with a leading standard header:

A web server in a shell script

```
if [ -f "$filename" ]; then
  echo -e "HTTP/1.1 200 OK\r"
  echo -e "Content-Type: `/usr/bin/file -bi
  \"$filename\"`\r"
  echo -e "\r"
  cat "$filename"
  echo -e "\r"
else
  echo -e "HTTP/1.1 404 Not Found\r"
  echo -e "Content-Type: text/html\r"
  echo -e "\r"
  echo -e "404 Not Found\r"
  echo -e "Not Found
           The requested resource was not found\r"
  echo -e "\r"
fi
```

A web server in a shell script

- Add this to /etc/inetd.conf (on a server)

```
www stream tcp nowait nobody /usr/local/bin/webd webd
```

- where webd is the name you gave to the script
- Restart the internet daemon

```
/etc/init.d/inetd restart
```

- Make the directory /var/www,
- place some HTML files in it
- load a web browser and try the URL:

```
http://localhost/filename.html
```

The usual disclaimers and caveats apply.

Disclaimer

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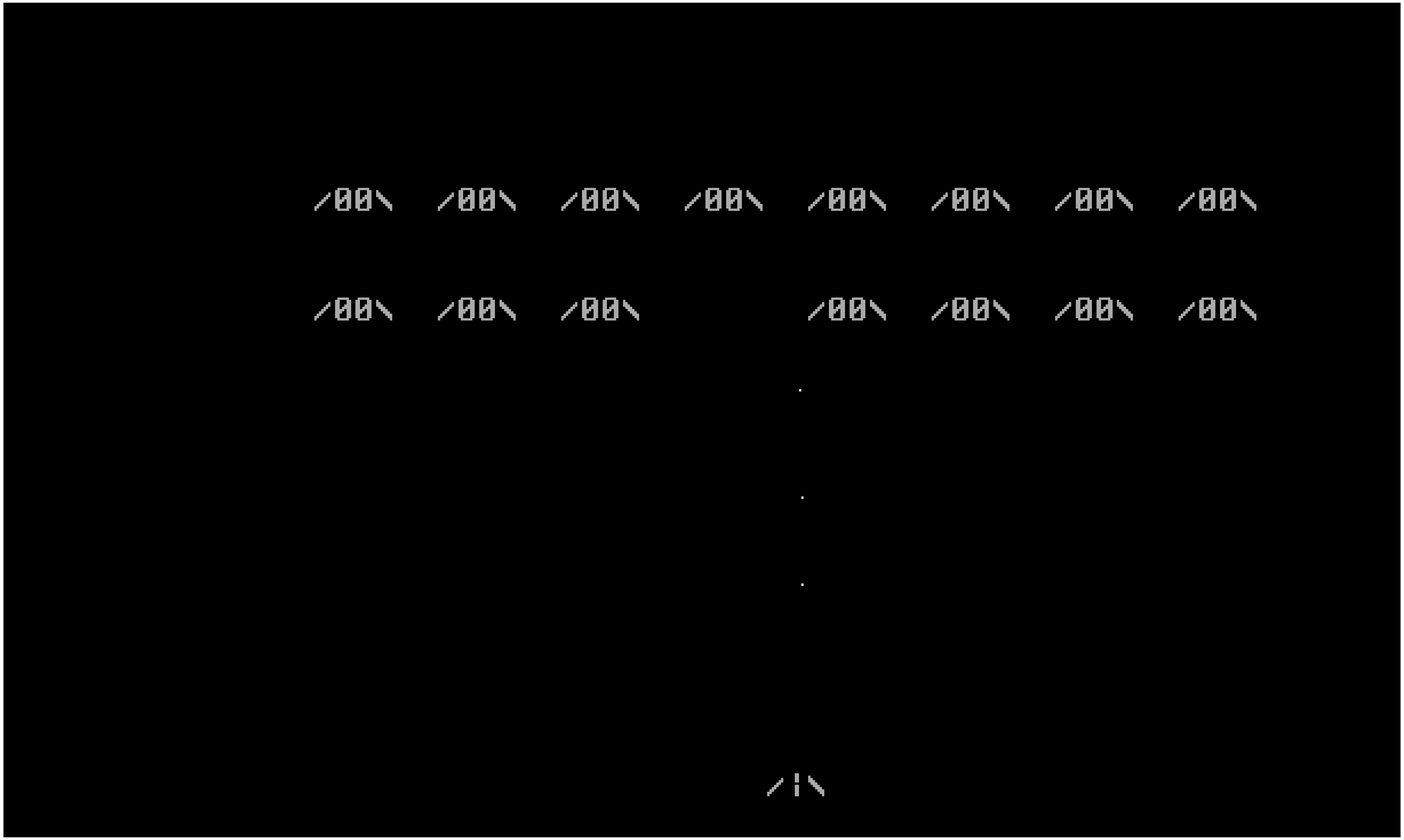
bash

- Scripts are good for repetitive tasks
- Shell code good for ad-hoc queries, tasks
- unique feature in bash is built in help system
- `help` - returns list of bash commands & options
- `help command` returns description of command

- Bash can even be used for games

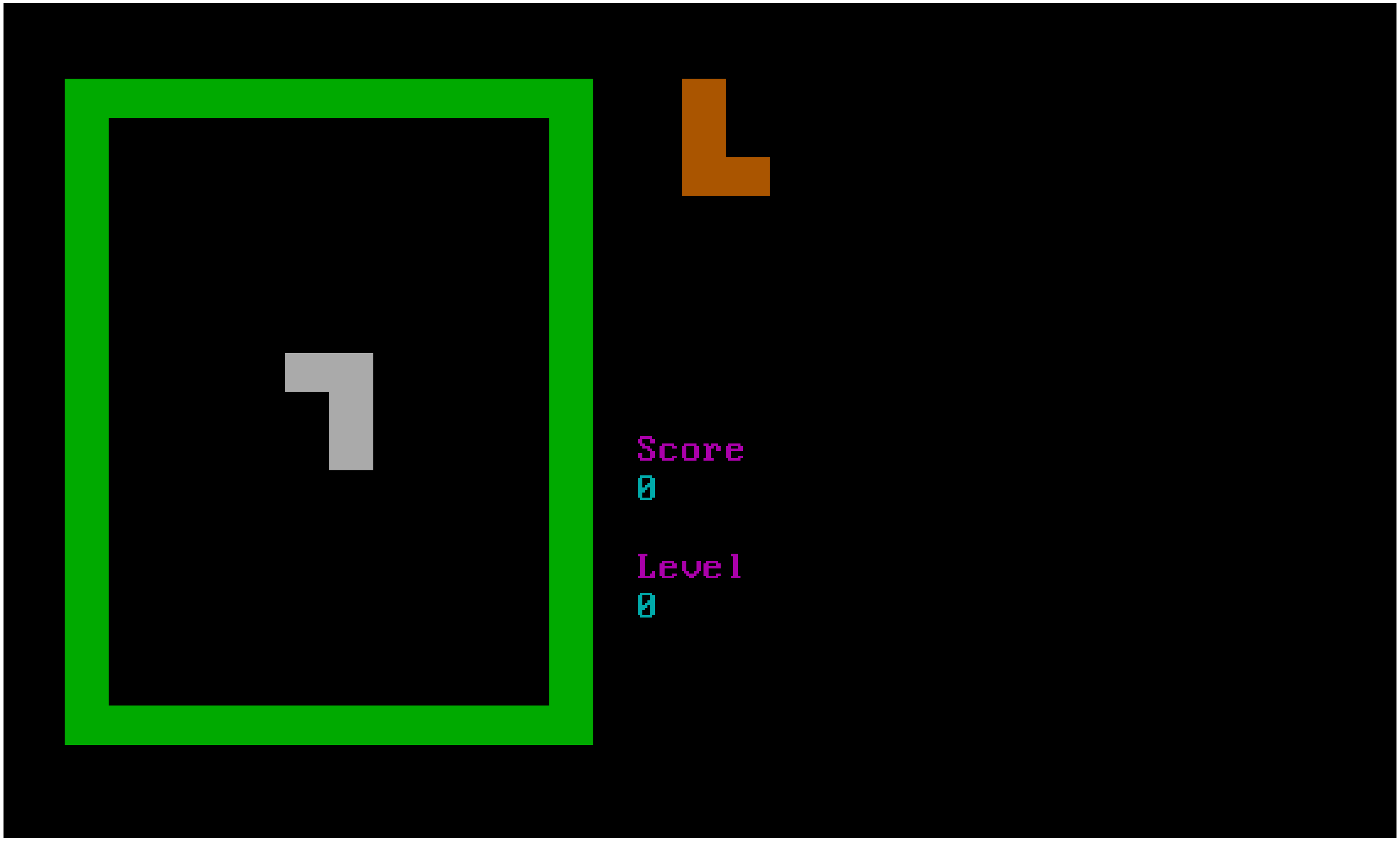
bash invaders



```
/00\  /00\  /00\  /00\  /00\  /00\  /00\  /00\


/00\  /00\  /00\        /00\  /00\  /00\  /00\

                        .


                        .


                        .




                      /¡\
```

(Google for source)

bash tetris



```
Score
0

Level
0
```

A CLOSER LOOK

WHEN I STARTED PROGRAMMING, WE DIDN'T HAVE ANY OF THESE SISSY "ICONS" AND "WINDOWS."
ALL WE HAD WERE ZEROS AND ONES -- AND SOMETIMES WE DIDN'T EVEN HAVE ONES.
I WROTE AN ENTIRE DATABASE PROGRAM USING ONLY ZEROS.
YOU HAD ZEROS? WE HAD TO USE THE LETTER "O."
S.Adams
© 1992 United Feature Syndicate, Inc.

Finding the Program

- #!/bin/bash
- echo ‘Hello, world’

- $ echo $PATH

  /usr/local/bin:/usr/bin:/bin .....
- $ which echo

  /usr/bin/echo

Bash Startup Files

1. /etc/profile – Executed automatically at login
2. Execute at login first file found in this list:
   a) ~/.bash_profile
   b) ~/.bash_login
   c) ~/.profile (same as in Korn shell)
3. ~/.bashrc – Executed by every shell at login
4. ~/.bash_logout – Executed at logout

Use bash for both programming and interactive use

executable scripts

- The first line in your script must be
  - hashbang and absolute path to the shell
  - no shebang? default shell

```
#!/bin/bash
```

- Convention has script filenames end with .sh
- Make the script executable

```
$chmod u+x mfile.sh


$ ls –lg filename.sh
-rwxr--r–- users 104 Oct 5 22:12 mfile.sh
```

Execution

- To execute the program

```
$ mfile.sh
bash: mfile.sh: command not found
```

- $PATH environment variable holds the location where all commands are stored

- Specify path of mfile.sh - absolute or relative

```
$./mfile.sh
```

Continuing Lines

```
echo This \
Is \
  A \
Very \
Long \
 Command Line
```

- This Is A Very Long Command Line

List of Commands

`cmd1; cmd2;` execute sequentially

`cmd1 &` execute asynchronously[ⓘ]

`cmd1 && cmd2` execute cmd2 if cmd1 has exit(0)

`cmd1 || cmd2` execute cmd2 only if cmd1 has non-zero exit status

[ⓘ] Background or non-blocking I/O - permits other processing to continue

Quoting

- Quoting allows you to distinguish between the literal value of symbol and symbols used as code
- A way to distinguish between the literal symbol and the symbol's use as a metacharacter or wild card characters
- To do this you must use of the following symbols:
  - Backslash (\)
  - Single quote (')
  - Double quote (")

Backslash

- A backslash is also called the escape character
- It preserves only the character immediately following it

- Example:
  - to create a file named "tools>", enter:
  - `% touch tools\>`

Single Quote

- A single quote is used to protect the literal meaning of metacharacters.
- It protects all characters within the single quotes
- The only character it cannot protect is itself
- A single quote cannot occur with other single quotes even if preceded by a backslash
- Examples:

```
% echo 'Joe said 'Have fun''
Joe said Have fun
% echo 'Joe said "Have fun"'
Joe said "Have fun"
```

Double Quotes

- Double quotes protect all symbols and characters within the double quotes.
- Double quotes will not protect literal symbols: $ (dollar sign), ! (history event), and \ (backslash).
- Example:

```
% echo "I've been studying"
I've been studying
```

Quoting and Comments

'something': preserve literally

"something": allow $ variable expansion

$’C-escaped’: e.g., $’\a’

# comment

- Redirecting output

1>	redirect standard output (stdout)
2>	redirect standard error (stderr)
2>&1	redirect stderr into stdout

Variables

- Variables - just like any programming language
- Values are always stored as strings
- Mathematical operators in the shell language that will convert variables to numbers for calculations
- No need to declare a variable, just assigning a value to its reference will create it
- Local variables
  - Set by user within script or on the shell
- Environmental variables
  - Set by OS for use in current shell

Shell Variables

- ${N} = shell Nth parameter
- $$ = process ID
- $? = exit status

- Standard environment variables include:
  - HOME = home directory
  - PATH = list of directories to search
  - TERM = type of terminal (vt100, ...)
  - TZ = timezone (e.g., US/Eastern)
  - LOGNAME = user name

Variables and Expressions

- Variables are placeholders for the value
- shell does variable substitution
- $var or ${var} is value of variable
- assignment with var=value
- no space before or after!
  - Also, let “x = 17” or let “b = b + 10”
- uninitialized variables have no value
- variables are untyped
  - interpreted based on context

Export Command

- Export command puts variable into environment and accessible to child processes.

```
$ x=hello
$ bash          # Run a child shell
$ echo $x       # Nothing in x
$ exit          # Return to parent
$ export x
$ bash
$ echo $x
hello           # It's there
```

- Child can't modify parents original value

Expansion

Biggest difference to traditional languages

- shell substitutes and executes
- mix variables and code
- run-time code generation

For bash:

- brace expansion
- tilde expansion
- parameter and variable expansion
- command substitution
- arithmetic expansion
- word splitting
- filename expansion

Brace Expansion

- Expand comma-separated list of strings into separate words:

```
bash$ echo a{d,c,b}e
ade ace abe
```

- Useful for generating list of filenames:

```
mkdir /usr/local/{old,new,dist,bugs}
```

Tilde Expansion

- ~ expands to $HOME
- e.g.,
- ~/foo   /usr/home/foo
- ~hgs/src   /home/hgs/src

Filename Expansion

- Any word containing *?[is considered a pattern
- * matches any string
- ? matches any single character
- […] matches any of the enclosed characters

Quotes

- When assigning character data containing spaces or special characters, the data must be enclosed in either single or double quotes.
- Using double quotes to show a string of characters will allow any variables in the quotes to be resolved
- Using single quotes to show a string of characters will not allow variable resolution

Quoting

```
echo '$USER'
$USER
echo "$USER"
mmaxwell
echo "\""
"
echo '\"'
\"
```

Exit Status

- 0 is True

```
ls non-existant_file
echo $?
1
echo $?
0
```

Exit Status: exit

```
cat > test.sh                 <<_TEST_
exit 3
% chmod +x test.sh
% ./test.sh
% echo $?
3
```

File Attribute Operators

-d file	file exists and is a directory
-e file	file exists
-f file	file exists and is not a directory
-r file	you have read permissions on file
-s file	file exists and is not empty

file1 –nt file2	file1 is newer than file2
file1 –ot file2	file1 is older than file2

File Testing Example

```
#!/bin/bash
echo "Enter a filename: "
read filename
if [ ! –r "$filename" ]
 then
   echo "File is not read-able"
 exit 1
fi
```

Expressions

- An expression can be: String comparison, Numeric comparison, File operators and Logical operators and it is represented by [expression]:
- String Comparisons:

=	compare if two strings are equal
!=	compare if two strings are not equal
-n	evaluate if string length is greater than zero
-z	evaluate if string length is equal to zero

- Examples:

[s1 = s2]	(true if s1 same as s2, else false)
[s1 != s2]	(true if s1 not same as s2, else false)
[s1]	(true if s1 is not empty, else false)
[-n s1]	(true if s1 has a length greater then 0, else false)
[-z s2]	(true if s2 has a length of 0, otherwise false)

Expressions

- Number Comparisons:

-eq	compare if two numbers are equal
-ge	compare if one number is greater than or equal to a number
-le	compare if one number is less than or equal to a number
-ne	compare if two numbers are not equal
-gt	compare if one number is greater than another number
-lt	compare if one number is less than another number

- Examples:

[n1 -eq n2]	(true if n1 same as n2, else false)
[n1 -ge n2]	(true if n1greater then or equal to n2, else false)
[n1 -le n2]	(true if n1 less then or equal to n2, else false)
[n1 -ne n2]	(true if n1 is not same as n2, else false)
[n1 -gt n2]	(true if n1 greater then n2, else false)
[n1 -lt n2]	(true if n1 less then n2, else false)

Expressions

- Compound Logical Expressions

!	not	
&&	and	must be enclosed within [[ ]]
||	or	must be enclosed within [[ ]]

Examples:

```
if [ ! "$Years" -lt 20 ]; then
if [[ "$Status" = "H" && "$Shift" = 3 ]]
```

Flow Control

- if/else
- for
- case
- select
- while and until

Logic: test

```
% test 1 -lt 10
% echo $?
0

% test 1 = 10
% echo $?
1
```

Conditional Tests

- [] condition test
- -f file exists and is not a dir

```
[ -f /etc/passwd ]
echo $?
0

[ ! –f /etc/passwd ]
echo $?
1
```

Logic: if

```
if [ $USER –eq "mmaxwell" ]
then
   :
# "elif" a contraction of "else if":
elif something-else
then
   :
else
then
   :
fi
```

Logic: if

```
# see if a file exists
if [ -e /etc/passwd ]
then
  echo "/etc/passwd exists"
else
  echo "/etc/passwd not found!"
fi
```

Logic: for

```
$ for i in 1 2 3
> do
> echo $i
> done
1
2
3
```

Logic: for

```
$ for i in /*
> do
> echo "Listing $i:"
> ls -l $i
> read
> done
```

Logic: C-style for

```
LIMIT=10
for (( a=1       ;
       a<=LIMIT ;
       a++      ))
do
  echo -n “$a ”
done
```

Logic: while

```
a=0; LIMIT=10
while [ "$a" -lt "$LIMIT" ]
do
  echo -n "$a"
  a=$(( a + 1 ))
done
```

```
0 1 2 3 4 5 6 7 8 9
```

Break and Continue

Interrupt for, while or until loop

- The break statement
  - transfer control to the statement AFTER the done statement
  - terminate execution of the loop
- The continue statement
  - resumes iteration of an enclosing
    - for
    - while
    - until
    - select

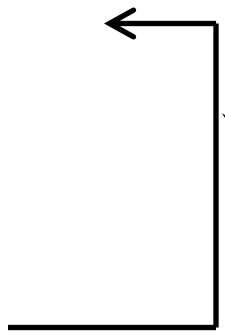
Break Command

```
while [ condition ]
do
    cmd-1
    break
    cmd-n
done
echo "done"
```

This iteration is over and there are no more iterations

Continue Command

```
while [ condition ]
do
    cmd-1
    continue
    cmd-n
done
echo "done"
```



This iteration is over; do the next iteration

Reading

- read inputs everything up to the newline

```
echo -n "Type: "
read ln
echo "You entered: $ln"
```

...a more useful example – next slide

Cursor keys

```
#!/bin/bash
ESC=$(echo -en "\033")              # define ESC
while :;do                          # infinite loop
# read quietly three characters of served input
read -s -n3 key 2>/dev/null >&2
  # if A is the result, print up
  if [ "$key" = "$ESC[A" ];then echo up;fi
  #  B dn
  if [ "$key" = "$ESC[B" ];then echo dn;fi
  #  C ri
  if [ "$key" = "$ESC[C" ];then echo ri;fi
  #  D  le
  if [ "$key" = "$ESC[D" ];then echo le;fi
done
```

Functions

- Bash has functions
  - Somewhat limited implementation
- Functions make scripts easier to maintain
- Function is a subroutine, code block, etc.
- Called by name
- Must be defined prior to being called
- May not be empty
- Can have strange names _ :
  - Obfuscation

cards.sh

```
#!/bin/bash
# Count how many elements.
Suites="Clubs Diamonds Hearts Spades"
Denominations="2 3 4 5 6 7 8 9 10 Jack Queen King Ace"
# Read into array variable.
suite=($Suites)
denomination=($Denominations)
# Count how many elements.
num_suites=${#suite[*]}
num_denominations=${#denomination[*]}
echo -n "${denomination[$((RANDOM%num_denominations))]} of "
echo ${suite[$((RANDOM%num_suites))]}
exit 0
```

```
Queen of Clubs
```

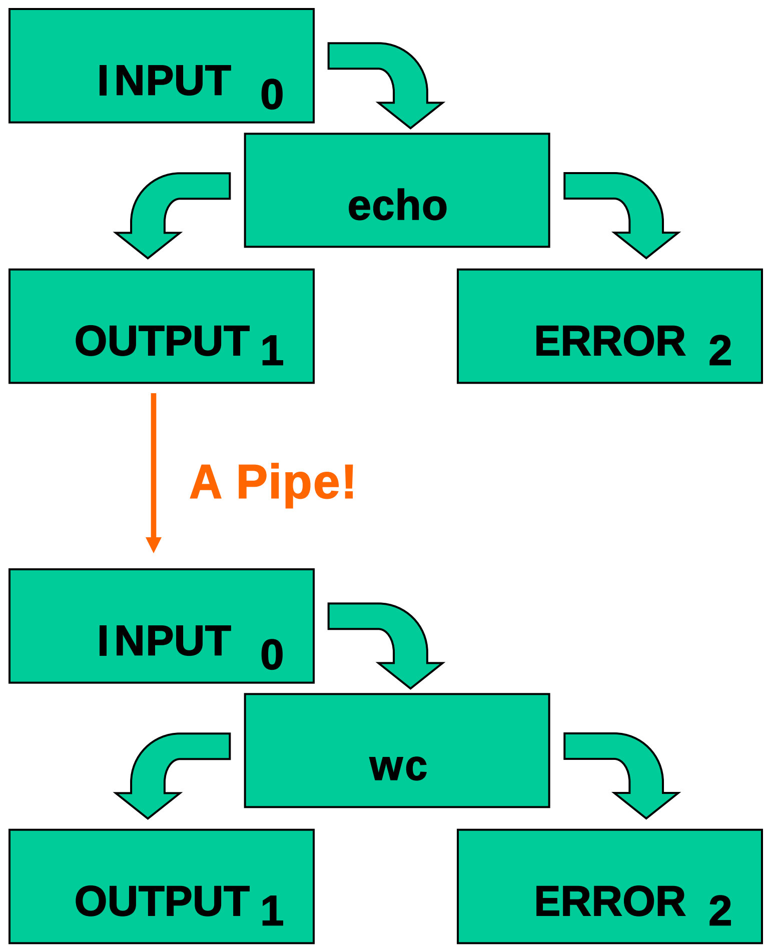
Change all filenames to lowercase

```
#!/bin/bash
# Traverse all files in directory
for filename in *
do
  fname='basename $filename'       # strip path
   n='echo $fname | tr A-Z a-z'    # to lower
  if [ "$fname" != "$n" ]
  then
    mv $fname $n
  fi
done
exit 0
```

Connecting Tools Together

Lots of Little Tools

```
echo “Hello” | \
  wc -c
```



Additional Resources

- Advanced Bash-Scripting Guide

  http://tldp.org/LDP/abs/html/

- GNU Bash

  http://www.gnu.org/s/bash/