Unix104

BIOL647
Digital Biology

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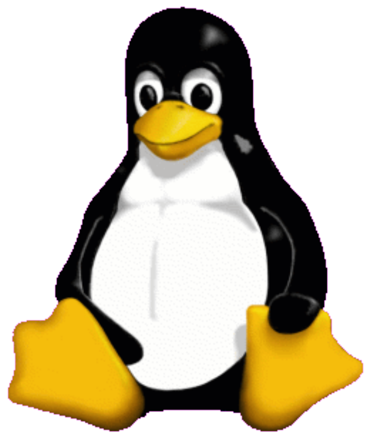

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Fundamentals of Scripting

Understanding Bash script syntax

```
## Check $GENOME
if [[ ! -d $GENOME ]]; then
        echo "Could not find reference genome: $GENOME, exiting. Please make sure
        exit 1
else
        GENOME_GTF="$GENOME/Annotation/Genes/genes.gtf"
        GENOME_FA="$GENOME/Sequence/WholeGenomeFasta/genome.fa"
        if [[ ! -f $GENOME_GTF ]]; then
                echo "$GENOME_GTF not found, exiting"
                exit 1
        fi
        if [[ ! -f $GENOME_FA ]]; then
                echo "$GENOME_FA not found, exiting"
                exit 1
        fi
        STAR_INDEX="$GENOME/star/STAR_2.4.1c/"
fi
```

- ***Variables***
- ***Arguments***
- ***Flow-control logic***

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Fundamentals of Scripting
Building Bash Scripts

To Shebang or not to Shebang

- ***What is The Shebang?***
    - ***In computing, a shebang is the character sequence consisting of the characters number sign and exclamation mark (#!) at the beginning of a script. It is also called sha-bang***

```
# Hashbang or Shebang, tells the shell that this is a BASH script \
# and that it should be run as such



# BASH
#!              <—Hash—bang
/usr/bin/bash   <—PATH to Bash executable

#!/usr/bin/bash
...
...
...
...
Exit 0
```

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Fundamentals of Scripting
Building Bash Scripts

To Shebang or not to Shebang

```
# Hashbang or Shebang, tells the shell that this is a PYTHON script \
# and that it should be run as such


# PYTHON
#!                  <—Hash—bang
/usr/bin/python3    <—PATH to Python3 executable

#!/usr/bin/python3
...
...
...
...
```

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Fundamentals of Scripting
Building Bash Scripts

To Shebang or not to Shebang

```
# Hashbang or Shebang, tells the shell that this is a PERL script \
# and that it should be run as such


# PERL
#!               <-Hash-bang
/usr/bin/perl   <-PATH to PERL executable

#!/usr/bin/perl
...
...
...
...
```

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Fundamentals of Scripting

Introducing for loops

- The for loop is used to execute commands a finite number of times on a list of items.
- The for command is followed by a user-defined variable, the keyword in, and then a list of words.
- The variable assumes the value of an element from the list of words, in order from left to right, before each iteration of the loop.
- At the end of each iteration, the current value gets shifted off from the beginning of the list and the next word becomes the head of the list.
- The loop finishes when there are no more words left in the word list.

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Fundamentals of Scripting

Introducing for loops

```
# Loop 01
for i in 1 2 3;do
 echo $i;
done


# Loop 02
for i in {1..10};do
 echo $i;
done


# Loop 03
for i in {1..100..2};do
 echo $i;
Done
```

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Fundamentals of Scripting

Introducing for loops

- ***01script.sh***

```
for i in {1..50};do
 echo "echo "$i"";
done
# Note how we are escaping special characters

for i in {1..50};do
 echo "echo \"$i\"";
done

# Execute file as follows:
./01script.sh and bash ./01script.sh

# Now add as a header to the file:
#!/path/to/bash

# And make file 01script.sh executable:
chmod 744 01script.sh

# And execute file as follows:
./01script.sh and bash ./01script.sh
```

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Fundamentals of Scripting

Working with variables

- ***02script.sh***

```
#!/usr/bin/bash
# 02script.sh

a=hello              # Note No Spaces
b="Good Morning"  # Note the quotes
c=42
# To use these variables we call them with the '$' sign
echo $a
echo $b
echo $c

exit 0
```

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Fundamentals of Scripting

Working with variables

- ***03script.sh***

```
#!/usr/bin/bash
# 03script.sh

a=hello            # Note No Spaces
b="Good Morning"   # Note the quotes
c=44
# To use these variables we call them with the '$' sign
echo $a
echo $b
echo $c

echo "$b! I have $c apples" <—NOTE The presence of spaces

exit 0
```

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Fundamentals of Scripting

Adding attributes to variables

- ***04script.sh***

```
#!/usr/bin/bash
# 04script.sh

declare -i d=var1     # -I = The variable is to be treated as an integer
                      # d must be an integer

echo "d=$d"           # Prints '0' because it is empty

declare -i d=12
echo "d=$d"           # Prints '12' because variable 'd' was declared to be '12'

d=hello               # Variable redefined as a 'non-integer'
echo "d=$d"           # Prints '0' because variable 'd' can only be an integer

echo "------------"   # Print a spacer

declare -r e=var2     # -r Make names readonly
                      # e must be read-only

echo "e=$e"           # Prints 'var2' because it is read-only

declare -r e
e=13
echo "e=$e"           # Fails to assign a new value to the variable 'e' because it is read-only

exit 0
```

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Fundamentals of Scripting

Built-in variables

- ***05script.sh***

```
#!/usr/bin/bash
# 05script.sh

# Returns Home directory
echo $HOME

# Returns current directory
echo $PWD

# Returns machine type
echo $MACHTYPE

# Returns system name
echo $HOSTNAME

# Returns Bash version
echo $BASH_VERSION

# Returns the number of seconds the Bash session has run
# Inside a script it counts the seconds since the script started (timing)
echo $SECONDS

# Returns the name of the script
echo $0

exit 0
```

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Fundamentals of Scripting

Command substitution

- ***06script.sh***

```
#!/usr/bin/bash
# 06script.sh

a=$HOME
echo $a

b=$(pwd)
echo $b

exit 0
```

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Fundamentals of Scripting

Command substitution

- *07script.sh*

```
#!/usr/bin/bash
# 07script.sh

a=$(ping -c 1 google.com | grep 'bytes from' | cut -d = -f 4)

echo "The ping was $a"

exit 0
```

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Fundamentals of Scripting

Arithmetic operations

```
      (( expression ))
val=$(( expression )) # Note the '$' sign
|----------------|----------|
| Operation      | Operator |
|----------------|--------- |
| Exponentiation | $a ** $b |
| Multiplication | $a * $b  |
| Division       | $a / $b  |
| Modulo         | $a % $b  |
| Addition       | $a + $b  |
| Subtraction    | $a - $b  |
|----------------|----------|
```

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Fundamentals of Scripting

Arithmetic operations

- ***08script.sh***

```
#!/usr/bin/bash
# 08script.sh

d=2

e=$((d+2))

echo "The value of e is $e"

exit 0
```

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Fundamentals of Scripting

Arithmetic operations

- ***09script.sh***

```
#!/usr/bin/bash
# 09script.sh

d=2
e=$((d+2))
echo "The value of e is $e"
((e++))
echo "The value of e is $e"
((e--))
echo "The value of e is $e"
((e+=5))
echo "The value of e is $e"
((e*=3))
echo "The value of e is $e"
((e/=3))
echo "The value of e is $e"
((e-=5))
echo "The value of e is $e"

exit 0
```

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Fundamentals of Scripting

Arithmetic operations

- ***10script.sh***

```
#!/usr/bin/bash
# 10script.sh

f=(1/3)

echo "The value of e is $f"

exit 0
```

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Fundamentals of Scripting

Arithmetic operations

- ***11script.sh***

```
#!/usr/bin/bash
# 11script.sh

f="1/3"
echo "The value of e is $f"

g=$(echo "1/3" | bc -l)
echo "The value of g is $g"

exit 0
```

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Fundamentals of Scripting

Comparing values

- ***Why 0 is true but false is 1 in the shell?***

```
[[ expression ]]
     0 = True
    1 = False
```

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Fundamentals of Scripting

Logical Arithmetic operators

Operation	Operator
Less than	`[[ $a -lt $b ]]`
Greater than	`[[ $a -gt $b ]]`
Less than or equal to	`[[ $a -le $b ]]`
Greater than or equal to	`[[ $a -ge $b ]]`
Equal	`[[ $a -eq $b ]]`
Not equal	`[[ $a -ne $b ]]`

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Fundamentals of Scripting

Logical Comparison operators

- ***12script.sh***

```
#!/usr/bin/bash
# 12script.sh

[[ "20" -gt "100" ]]
echo $?

[[ "20" -lt "100" ]]
echo $?

[[ "200" -gt "100" ]]
echo $?

[[ "200" -lt "100" ]]
echo $?

[[ "200" -eq "200" ]]
echo $?

exit 0
```

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Fundamentals of Scripting

Logical Comparison operators

Operation	Operator
Logical AND	`[[ $a && $b ]]`
Logical OR	`[[ $a || $b ]]`
Logical NOT	`[[ ! $a ]]`
Is Null?	`[[ -z $a ]]`
Is Not Null?	`[[ -n $A ]]`

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Fundamentals of Scripting

Logical Comparison operators

- ***13script.sh***

```
#!/usr/bin/bash
# 13script.sh

a=""

b="cat"

[[ -z $a && -n $b ]]

echo $?

exit 0
```

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Fundamentals of Scripting

Working with strings

- ***Using the command-line:***

```
> a="Hello" && b="World" && c=$a$b

> echo $c

> echo ${c}
# To Find out how long the string is:
> echo ${#c}
# To request a substring:
> d=${c:3}

> echo $d

# To request a specific number of characters after that position asking at character 3 and asking for 4 characters after that
> e=${c:3:4}
> echo $e
> echo ${c}
> echo ${#c}
# To request the last 10 letters
> echo ${c: -10}
# To request the last 8 letters
> echo ${c: -8}

# To request the last 2 letters of the last 8 letters
> echo ${c: -8:2}
```

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Fundamentals of Scripting

Working with strings

- ***To replace text in a string with some other text:***

```
fruit="apple banana banana cherry"

# To replace text in a string with some other text in this case banana with durian or the first instance of the search
> echo ${fruit/banana/durian}

# To replace all instances of banana with durian
> echo ${fruit//banana/durian}

# To replace the term only of the term is the very beginning of the string
> echo ${fruit/#apple/durian}

# and it only works if the term is at the beginning of the string
> echo ${fruit/#banana/durian}

# To replace the term only of the term is the very end of the string
> echo ${fruit/%cherry/durian}

# and it only works if the term is at the end of the string
> echo ${fruit/%banana/durian}

# Using matching terms
> echo ${fruit/c*/durian}
```

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Fundamentals of Scripting

Working with strings

• ***Using basename and dirname:***

```
> "$(basename $File .fq)"

> a="/root/dir01/dir02/SRA12345.fastq"
> echo $a
> echo $a $(basename $a)
> echo $a $(dirname $a)

# To delete fastq
> echo $a $(basename $a fastq)

# To add a new name
> echo $a $(basename $a fastq)fq
```

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Fundamentals of Scripting

Working with strings

- ***Using Parameter Expansion:***

```
> param="racecar"

# Extraction: offset = 3, length = 2
# ${param:offset:length}

> echo ${param}

> echo ${param:3}

> echo ${param:3:2}
```

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Fundamentals of Scripting

Working with strings

- ***Using Parameter Expansion:***

```
> param="racecar"

# Removal from left edge: pattern = “*c”
# ${param#pattern}

> echo ${param#*c}

> echo ${param##*c}

# Removal from right edge: pattern = “c*”
# ${param%pattern}

> echo ${param%c*}

> echo ${param%%c*}
```

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Fundamentals of Scripting

Coloring and styling text

- ***Colored text (using ANSI codes)***

Color	Foreground	Background
Black	30	40
Red	31	41
Green	32	42
Yellow	33	43
Blue	34	44
Magenta	35	45
Cyan	36	46
White	37	47

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Fundamentals of Scripting

Coloring and styling text

- ***White on Black***

```
# -e                <-Allows escaping characters
# \033[37;40m       <-Escaped sequence
# Color Text        <-String to print out
# \033[0m           <-Reset the colors


> echo -e '\033[37;40mColor Text\033[0m'
```

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Fundamentals of Scripting

Coloring and styling text

• ***Black on Red:***

```
# -e                <-Allows escaping characters
# \033[30;41m       <-Escaped sequence
# Color Text        <-String to print out
# \033[0m           <-Reset the colors



> echo -e '\033[30;41mColor Text\033[0m'
```

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Fundamentals of Scripting

Coloring and styling text

- ***Green on Black:***

```
# -e                <-Allows escaping characters
# \033[32;40m       <-Escaped sequence
# Color Text        <-String to print out
# \033[0m           <-Reset the colors


> echo -e '\033[32;40mColor Text\033[0m'
```

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Fundamentals of Scripting

Coloring and styling text

- ***Red on White:***

```
# -e                <-Allows escaping characters
# \033[31;47m       <-Escaped sequence
# Color Text        <-String to print out
# \033[0m           <-Reset the colors


> echo -e '\033[31;47mColor Text\033[0m'
```

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Fundamentals of Scripting

Coloring and styling text

- ***Blue on Yellow:***

```
# -e                <-Allows escaping characters
# \033[34;43m       <-Escaped sequence
# Color Text        <-String to print out
# \033[0m           <-Reset the colors


> echo -e '\033[34;43mColor Text\033[0m'
```

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Fundamentals of Scripting

Coloring and styling text

- ***Styled text (ANSI)***

Style	Value
No Style	0
Bold	1
Low Intensity	2
Underline	4
Blinking	5
Reverse	7
Invisible	8

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Fundamentals of Scripting

Coloring and styling text

- ***Error Message:***

```
> echo -e '\033[5;31;42mERROR: \033[0m'

> echo -e '\033[5;31;42mERROR: \033[0m\033[31;40mSomething went wrong\033[0m'
```

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Fundamentals of Scripting

Working with arrays

• ***Simple arrays (Using the command-line):***

```
# Empty array
> a=()

# Array with 3 elements
> b=("apple" "banana" "cherry")

> echo ${b[2]}
> b[5]="kiwi"
> b+=("mango")

# To print all elements on the array
echo ${b[@]}

# To request the first element of the array
echo ${b[0]}

# To request the last element of the array
echo ${b[@]: -1}
```

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Fundamentals of Scripting

Working with arrays

- ***Associative arrays (Using the command-line):***

```
> declare -A myarray

> myarray[color]=Blue

> myarray["office" "building"]="TAMU Biology"

> echo ${myarray["office" "building"]} is ${myarray[color]}
```

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Fundamentals of Scripting

Reading and writing text files

- ***14script.sh***

```
# Using the command line:
> echo -e "Command01\nCommand02\nCommand03\nCommand04\nCommand05" > 14script.txt

# Script
#!/usr/bin/bash
# 14script.sh

while read i; do
   echo "$i";
done < 14script.txt

exit 0
```

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Fundamentals of Scripting

Using *here* documents

- ***15script.sh***

```
# Used a lot for entering documentation
# Avoids multiple ‘echo’ commands

#!/usr/bin/bash
# 15script.sh
# EndofText Must be unique

cat <<EOF
Line01
Line02
Line03
EOF

cat <<EOF
Text01
Text02
Text03
EOF

exit 0
```

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Fundamentals of Scripting

Control Structures

- ***Testing truth conditions with the if keyword***

```
'if' statatement
if [[ expression ]] or if (( expression )) or if statement
if [[ expression ]]; then echo "True"; else echo "False"; fi
```

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Fundamentals of Scripting

Control Structures

- ***Testing truth conditions with the if keyword***

```
> if [[ 2 -gt 3 ]]; then echo "True"; else echo "False"; fi


> if [[ 2 -gt 1 ]]; then echo "True"; else echo "False"; fi
```

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Fundamentals of Scripting

Control Structures

- ***Testing files existence***

```
> if [[ ! -f test ]]; then echo "The file test does not exist";fi

> if [[ ! -f test ]]; then echo "The file test does not exist";else echo "The file test does exist";fi

> touch test

> if [[ ! -f test ]]; then echo "The file test does not exist";else echo "The file test does exist";fi
```

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Fundamentals of Scripting

Control Structures

- ***Testing files content***

```
> if [[ ! -s test ]]; then echo "The file test is empty";else echo "The file test is not empty";fi

> echo "bla bla" > test

> if [[ ! -s test ]]; then echo "The file test is empty";else echo "The file test is not empty";fi
```

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Fundamentals of Scripting

Working with while and until loops

- ***16script.sh***

```
#!/usr/bin/bash
# 16script.sh

i=0

while [[ $i -le 10 ]];do
   echo i:$i
   ((i+=1));
done

exit 0
```

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Fundamentals of Scripting

Working with while and until loops

- ***17script.sh***

```
#!/usr/bin/bash
# 17script.sh

i=0

while [[ $i -le 10 ]];do
   echo i:$i
   ((i+=1));
done

j=0

until [[ $j -ge 10 ]];do
   echo j:$j
   ((j+=1));
done

exit 0
```

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Fundamentals of Scripting

Advanced for loops

- ***"C" Style***

```
# Simple Loops:

for (( i=1; i<=10; i++));do

   echo $i;

done

# With Arrays Loops:

arr=("Line01" "Line02" "Line03")

> for i in ${arr[@]};do echo $i;done

> for i in ${arr[0]};do echo $i;done

> for i in ${arr[2]};do echo $i;done
```

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Fundamentals of Scripting

Selecting behavior using case

- ***18script.sh***

```
#!/usr/bin/bash
# 18script.sh

a="dog"

case $a in
   cat)       echo "Feline";;
   dog|puppy) echo "Canine";;
   *)         echo "No Match";;
esac

exit 0
```

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Fundamentals of Scripting

Using Functions
To avoid repeating code blocks use functions

- ***19script.sh***

```
#!/usr/bin/bash
# 19script.sh

function test {
   echo "Robert"
   }

echo "And now I am greeting!"

test

exit 0
```

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Fundamentals of Scripting

Interacting with the user
Arguments

- ***20script.sh***

```
#!/usr/bin/bash
# 20script.sh

echo $0 # Name of the script
echo $1
echo $2
echo $@ # All variables
echo $# # Number of variables

exit 0
```

- ***Save 20script.sh and Run***
    - ***bash ./20script.sh***
    - ***bash ./20script.sh file01 file02 file03***

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Fundamentals of Scripting

Interacting with the user
Flags

- ***21script.sh***

```
#!/usr/bin/bash
# 21script.sh
args=("$@");
FILENAME00=${args[0]}
FILENAME01=${args[1]}
FILENAME02=${args[2]}

echo $FILENAME00
echo $FILENAME01
echo $FILENAME02

exit 0
```

- ***Save 21script.sh and Run***
  - ***bash ./21script.sh file01 file02 file03***
  - ***bash ./21script.sh file03 file02 file01***
  - ***bash ./21script.sh file03 file03 file03***

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Fundamentals of Scripting

Interacting with the user
Flags

- ***22script.sh***

```
#!/usr/bin/bash
# 22script.sh

while getopts u:p: option;do
   case $option in
      u) user=$OPTARG;;
      p) pass=$OPTARG;;
   esac
done
echo "User: $user / Passwd: $pass"
exit 0
```

- ***Save 22script.sh and Run***
    - ***bash ./22script.sh***
    - ***bash ./22script.sh -p secret -u rod***

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Fundamentals of Scripting

Interacting with the user
Flags

- ***23script.sh***

```
#!/usr/bin/bash
# 23script.sh
while getopts u:p:a:b: option;do
   case $option in
      u) user=$OPTARG;;
      p) pass=$OPTARG;;
      a) echo "Got the A Flag";;
      b) echo "Got the B Flag";;
   esac
done
echo "User: $user / Passwd: $pass"
exit 0
```

- ***Save 23script.sh and Run***
    - ***bash ./23script.sh -u rod -p secret***
    - ***bash ./23script.sh -p secret -u rod -a test***
    - ***bash ./23script.sh -p secret -u rod -b test***

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Fundamentals of Scripting

Interacting with the user
Flags

- ***24script.sh***

```
#!/usr/bin/bash
# 24script.sh
while getopts u:p:ab: option;do
   case $option in
      u) user=$OPTARG;;
      p) pass=$OPTARG;;
      a) echo "Got the A Flag";;
      b) echo "Got the B Flag";;
      ?) echo "I do not know what $OPTARG is!";;
   esac
done
echo "User: $user / Passwd: $pass"
exit 0
```

- ***Save 24script.sh and Run***
  - ***bash ./24script.sh -u rod -p secret***
  - ***bash ./24script.sh -p secret -u rod -a test***
  - ***bash ./24script.sh -p secret -u rod -b test***
  - ***bash ./24script.sh -p secret -u rod -a test -b test***

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Fundamentals of Scripting
Building Bash Scripts

- ***25script.sh***

```
#!/usr/bin/bash
# 25script.sh

function numberthings {
   i=1

   for f in $@;do
      echo $i: $f
      ((i+=1));
   done
}

numberthings $(ls)

exit 0
```

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