Workshop 1: **Introduction to UNIX command-line**

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Swiss Army knife" set of tools

Day 1

pwd - report your current directory

cd *<to where>* - change your current directory

ls *<directory>* -list contents of directory

cp *<old file> <new file>* - copy file

cp –r *<old dir> <new dir>* - copy a directory and its contents

mv *<old file/dir> <new file/dir>* - move (or rename)

rm *<file>* -delete a file

rm –r <dir> - remove a directory and its contents

mkdir *<new directory name>* -make a directory

Using hoffman2

- Log on to hoffman2:
  - `ssh myname@hoffman2.idre.ucla.edu`

- Request an interactive shell:
  - `qrsh -l i,time=3:00:00,h_data=2g`

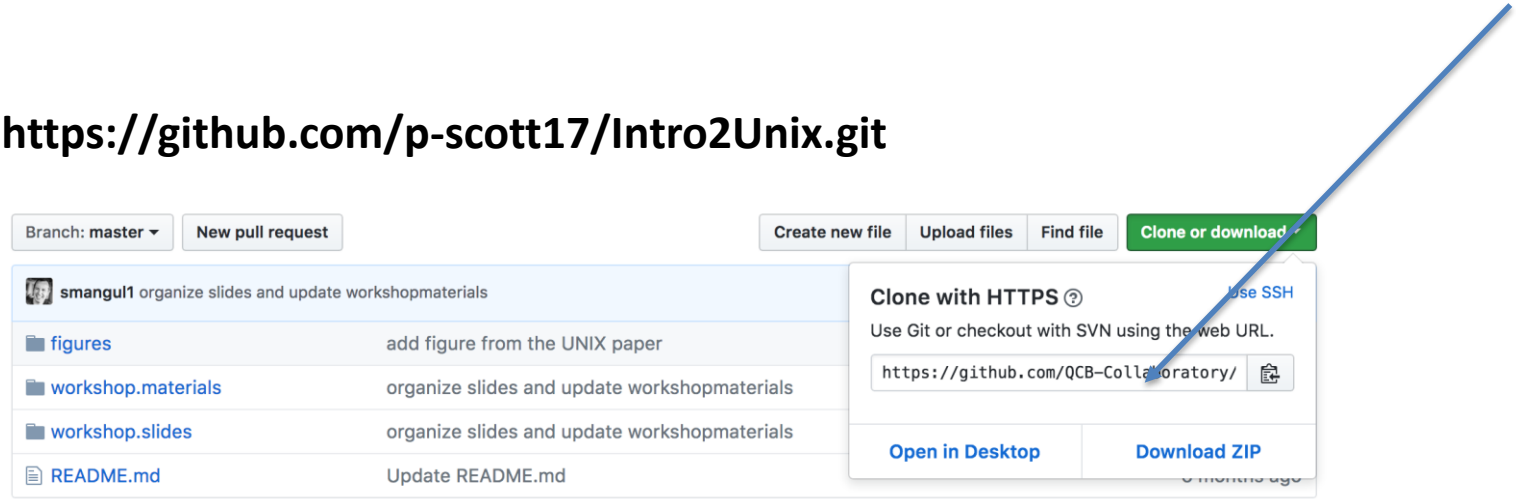
  `You can make a “program” with the interactive shell script`

Copy the working materials


```
[pscott17@login2 ~]$ git clone
https://github.com/p-scott17/Intro2Unix.git

Initialized empty Git repository in
/u/home/b/brigitta/code/W1.UNIX.command.line/.git/
remote: Counting objects: 88, done.
remote: Compressing objects: 100% (5/5), done.
remote: Total 88 (delta 0), reused 7 (delta 0), pack-reused 79
Unpacking objects: 100% (88/88), done.
```

https://github.com/p-scott17/Intro2Unix.git



https://qcb.ucla.edu/collaboratory/workshops/introtounix/

Working materials

- `cd Intro2Unix`
- `ls`

```
bwa_loop_pipe.sh   bwa_loop.sh  bwa.sh
day1_Unix_PAS_winter2020.pdf day2_Unix_PAS_winter2020.pdf
day3_Unix_PAS_winter2020.pdfemp.txt       hg19.gtf
file_sed.txt   f.txt numbers.txt   regex2.txt regex_sort.txt
regex.txt  sales.txt  tobe.txt   toy3.reads.fastq
toy2.reads.fastq toy.reads.fastq   toy.ref.fasta
    toy.ref.fasta.amb  toy.ref.fasta.ann   toy.ref.fasta.bwt
    toy.ref.fasta.pac  toy.ref.fasta.sa
```

Relative vs. absolute path

- A file or a directory can be referred to by
  - Relative path
    - **if you are at** `/u/home/p/pscott17/test/new/`
    - and you want `text.txt`
    - `../test.txt`
  - Absolute path
    - `/u/home/p/pscott17/test/test.txt`

Relative

Absolute

245 Highland Ave, Manhattan Beach, California 90266

File permissions

- Each file in Unix has an associated permission level
- This allows the user to prevent others from reading/writing/executing their files or directories
- Use "ls -l *filename*" to find the permission level of that file
- There are 3 kinds of people in the world: you (user), your friends (group) and

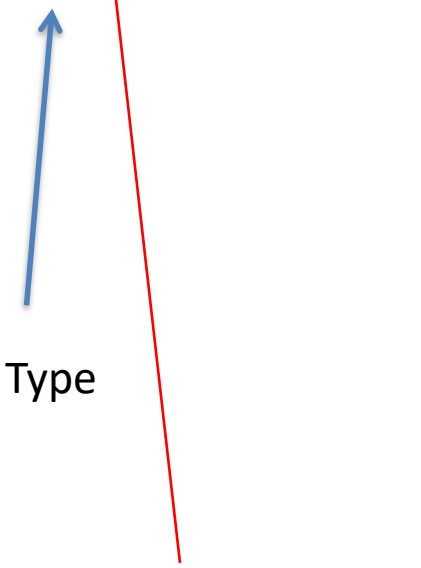
  the world (others).

Permission levels

- “**r**” means “read only” permission
- “**w**” means “write” permission
- “**x**” means “execute” permission
  - In case of directory, “**x**” grants permission to list directory contents

File Permissions

```
-rw-r--r-- 1 pscott17 hbshaffe  72 Mar 11 14:22 large.txt
-rw-r--r-- 1 pscott17 hbshaffe 263 Mar 11 15:18 new.tar
-rw-r--r-- 1 pscott17 hbshaffe  13 Mar 11 15:27 test.txt
drwxr-xr-x 2 pscott17 hbshaffe4096 Mar 11 15:36 dfgdf
```



File Permissions

```
-rw-r--r-- 1 pscott17 hbshaffe  72 Mar 11 14:22 large.txt
-rw-r--r-- 1 pscott17 hbshaffe 263 Mar 11 15:18 new.tar
-rw-r--r-- 1 pscott17 hbshaffe  13 Mar 11 15:27 test.txt
drwxr-xr-x 2 pscott17 hbshaffe4096 Mar 11 15:36 dfgdf
```

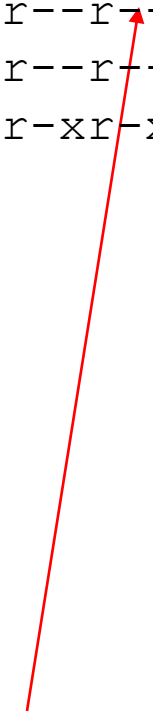
Type

Group

File Permissions

```
-rw-r--r-- 1 pscott17 hbshaffe  72 Mar 11 14:22 large.txt
-rw-r--r-- 1 pscott17 hbshaffe 263 Mar 11 15:18 new.tar
-rw-r--r-- 1 pscott17 hbshaffe  13 Mar 11 15:27 test.txt
drwxr-xr-x 2 pscott17 hbshaffe4096 Mar 11 15:36 dfgdf
```

Type



“The World”

Command: chmod

- If you own the file, you can change it's permissions with "chmod"
  - Syntax:

    `chmod [**u**ser/**g**roup/**o**thers/**a**ll]**+-**[permission] [file(s)]`

```
[pscott17@login2 test]$ ls -l
drwxr-xr-x 3 pscott17 hbshaffe4096 Mar 11 15:23 archive
-rw-r--r-- 1 pscott17 hbshaffe  72 Mar 11 14:22 large.txt
-rw-r--r-- 1 pscott17 hbshaffe 263 Mar 11 15:18 new.tar
-rw-r--r-- 1 pscott17 hbshaffe  13 Mar 11 15:27 test.txt
[pscott17@login2 test]$ chmod g+w large.txt
[pscott17@login2 test]$ ls -l
drwxr-xr-x 3 pscott17 hbshaffe4096 Mar 11 15:23 archive
-rw-rw-r-- 1 pscott17 hbshaffe  72 Mar 11 14:22 large.txt
-rw-r--r-- 1 pscott17 hbshaffe 263 Mar 11 15:18 new.tar
-rw-r--r-- 1 pscott17 hbshaffe  13 Mar 11 15:27 test.txt
```

Redirection

- `program_a`
  - display program_a's output at the terminal
- `program_a > file.txt`
  - program_a's output is written to file.txt
  - "`>`" will **overwrite** any existing data in file.txt
- `program_a < input.txt`
  - program_a gets its input from a file called "input.txt"
- `program_a >> file.txt`
  - program_a's output is **appended** to the end of file.txt

Let's practice!

```
[pscott17@login4 test]$ wc -l large.txt
300 large.txt
[pscott17@login4 test]$ wc -l large.txt > f_ls.txt
[pscott17@login4 test]$ head f_ls.txt
[pscott17@login4 test]$ ls > f_ls.txt
[pscott17@login4 test]$ head f_ls.txt
[pscott17@login4 test]$ head large.txt  >> f_ls.txt
[pscott17@login4 test]$ head f_ls.txt
```

Pipeline

pipe character

- `program_a | program_b`
  - program_a's output becomes program_b's input
  - Analogous to

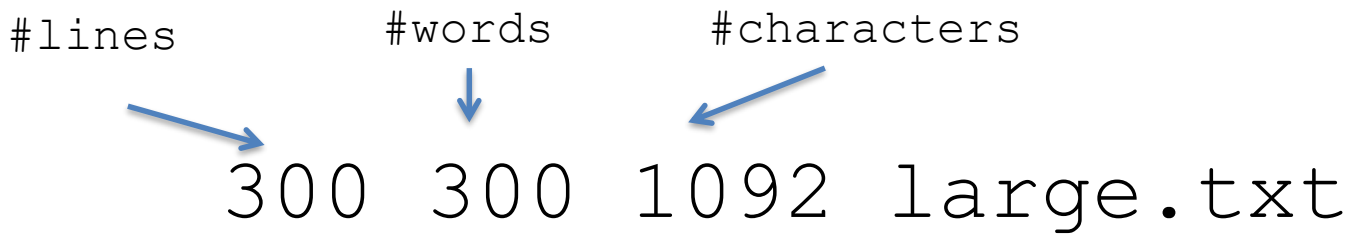
```
program_a > temp.txt
program_b < temp.txt
```

Command: **wc**

- To count the characters, words, and lines in a file use **wc**

```
wc <filename>
```

  - The first column in the output is lines, the second is words, and the last is characters
  - **-l** to count the lines



Let’s practice!

```
[pscott17@login2 test]$ wc test.txt
300 300 1092 large.txt
[pscott17@login2 test]$ wc -l test.txt
300 large.txt
[pscott17@login2 test]$ ls | wc -l
5
```

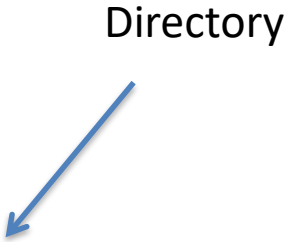
Command : **cat**

- Concatenate files together and displayed in the terminal.

```
cat <file1> <file2> …
```

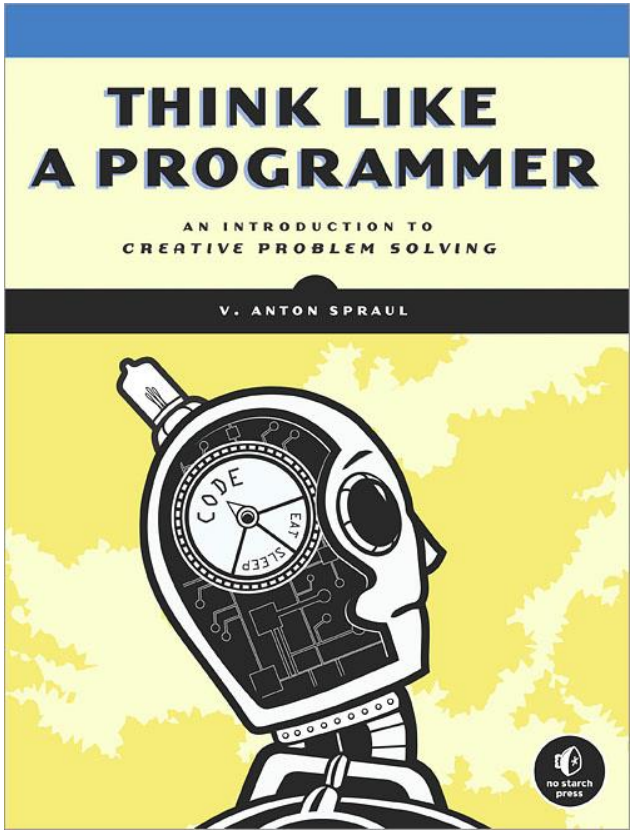
```
[pscott17@login2 test]$ cat large.txt f_ls.txt | wc -l
301
[pscott17@login2 test]$ cat large.txt test.txt > all.txt
[pscott17@login2 test]$ tail -n 3 all.txt
299
300
300 large.txt
```

Find



- find new -name test.txt -type f

Tools for processing text files



Command : **grep**

- allows to search one file or multiple files for lines that contain a certain string
- g/re/p (globally search a regular expression and print)
- **grep** options
  - lines not containing the selected string (-v)
  - line numbers where the string occurs (-n)
  - number of lines containing the string (-c)
  - filenames where the string occurs (-l)
  - makes the match case-insensitive (-i)

Grep syntax treats the first argument as the pattern and the rest as filenames

Let's practice!

```
[pscott17@login4 test]$ grep "1" large.txt
1
10
…
19
[pscott17@login4 test]$ grep -n "1" large.txt
1:1
10:10
…
19:19
[pscott17@login4 test]$ grep -c "1" large.txt
138
[pscott17@login4 test]$ grep -l "1" large.txt f_ls.txt
large.txt
[pscott17@login4 test]$ grep "1" large.txt f_ls.txt
large.txt:1
large.txt:10
…
```

Alternative?

Grep syntax treats the first argument as the pattern and the rest as filenames

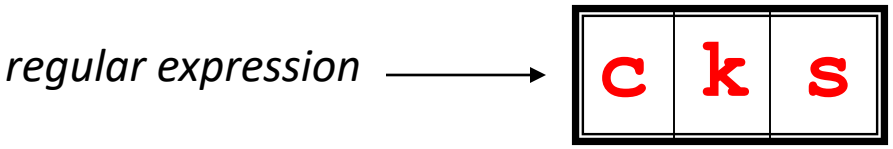
Lines corresponding to chr2

```
[pscott17@login4 test]$ cd ~/
[pscott17@login4 test]$ grep "chr2" hg19.gtf > chr2.txt
[pscott17@login4 test]$ tail -n 1 chr2.txt
chr21  hg19_knownGene   CDS 33066517  33066602  0.000000
   gene_id "uc002ypd.2"; transcript_id "uc002ypd.2";
```

`Gtf file:` The Gene transfer **format** (**GTF**) is a **file format** used to hold information about gene structure. It is a tab-delimited text **format** based on the general feature **format** (GFF), but contains some additional conventions specific to gene information. (https://en.wikipedia.org/wiki/Gene_transfer_format)

Regular Expression

- A **regular expression** is a string that can be used to describe several sequences of characters.




```
UNIX Tools rocks.
```

match

```
UNIX Tools sucks.
```

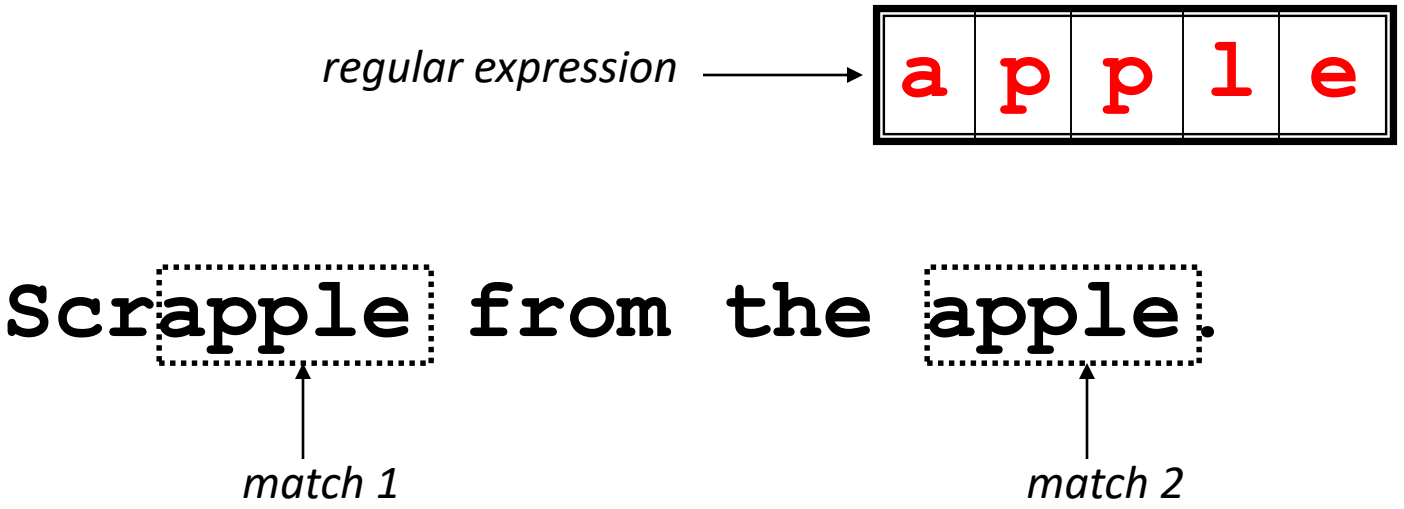
match

```
UNIX Tools are okay.
```

no match

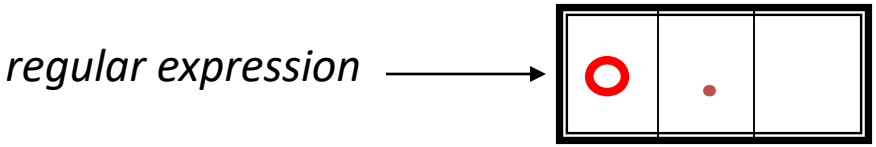
Regular Expressions

- A regular expression can match a string in more than one place.



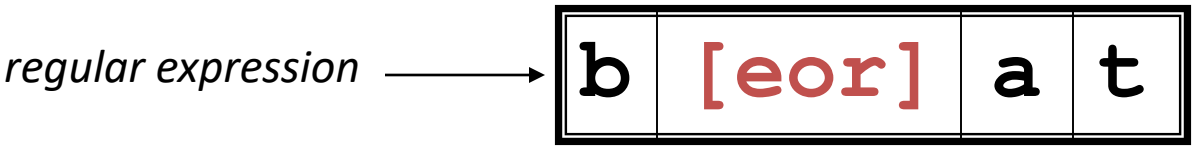
Regular Expressions

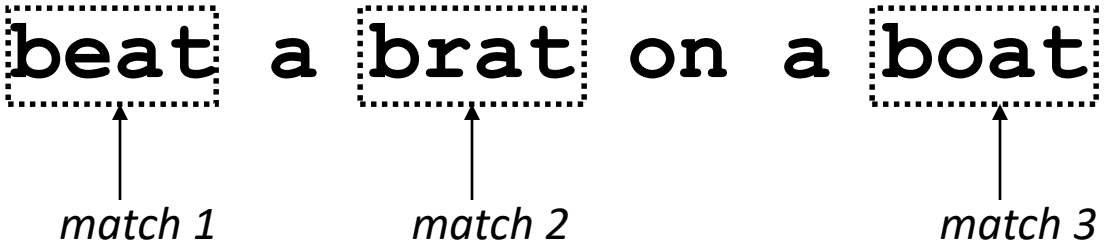
- The . regular expression can be used to match any character.



Character Classes

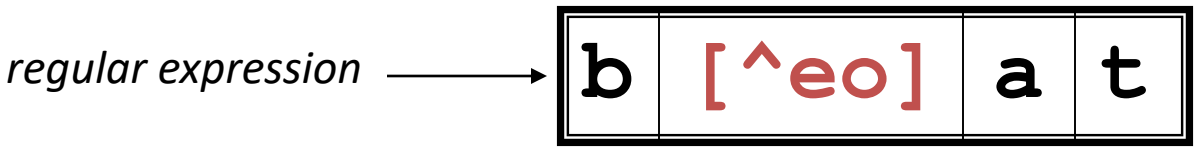
- Character classes [] can be used to match any specific set of characters.

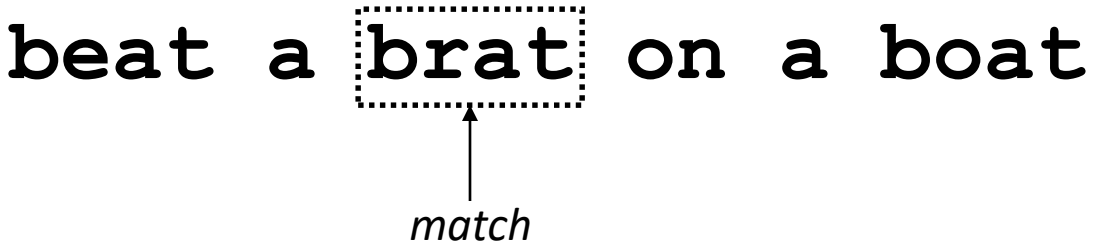




Negated Character Classes

- Character classes can be negated with the [^] syntax.





Let’s practice!

```
[pscott17@login4 intro2unix]$ grep "boat" regex.txt
[pscott17@login4 intro2unix]$ grep "b[eor]at" regex.txt
[pscott17@login4 intro2unix]$ grep "b.at” regex.txt
[pscott17@login4 intro2unix]$ grep "b[^eor]at" regex.txt
[pscott17@login4 intro2unix]$ grep "b[^eor]" regex.txt
```

More About Character Classes

- **[aeiou]** will match any of the characters **a**, **e**, **i**, **o**, or **u**
- **[kK]orn** will match **korn** or **Korn**

- Ranges can also be specified in character classes
  - **[1-9]** is the same as **[123456789]**
  - **[abcde]** is equivalent to **[a-e]**
  - You can also combine multiple ranges
    - **[abcde123456789]** is equivalent to **[a-e1-9]**
  - Note that the **-** character has a special meaning in a character class ***but only*** if it is used within a range, **[-123]** would match the characters **-**, **1**, **2**, or **3**

Alphanumeric characters

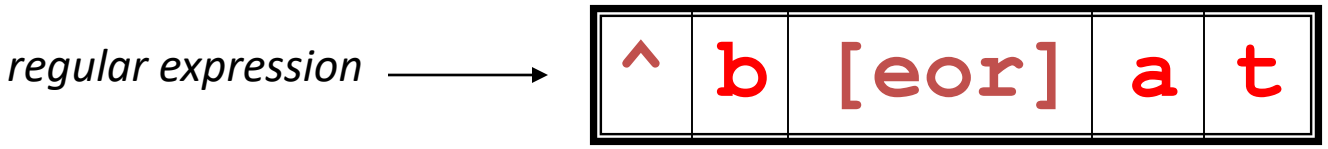
- Alphabetic characters
  - [a-zA-Z]
  - **[[:alpha:]]**
- Digits
  - **[0-9]**
  - [[:digit:]]
- Alphanumeric characters
  - [a-zA-Z0-9]
  - **[[:alnum:]]**

Anchors

- Anchors are used to match at the beginning or end of a line (or both).

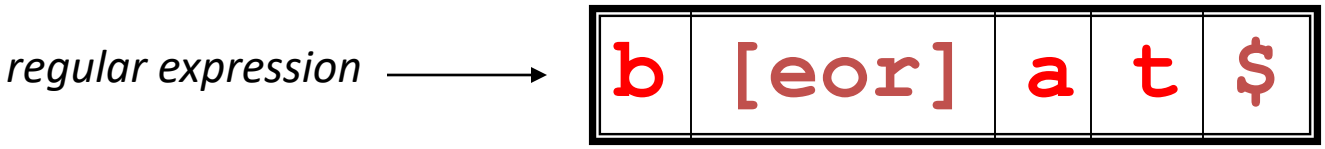
^ means beginning of the line

$ means end of the line



beat a brat on a boat

match



beat a brat on a boat

match

---

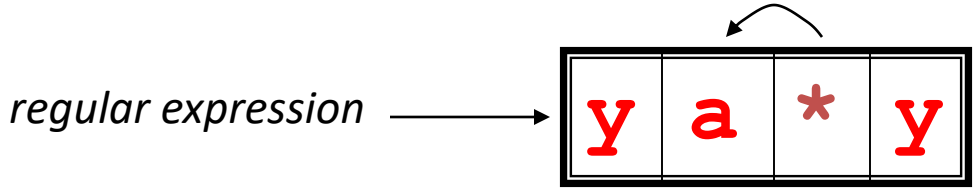
^word$ ^$

Let’s practice!

```
grep "[Aa]1" regex2.txt
grep "^[Aa]1" regex2.txt
grep "[Aa][0-9]$” regex2.txt
grep  "[0-9]" regex2.txt
grep "[[:alnum:]]" regex2.txt
grep  "[[:alpha:]]" regex2.txt
```

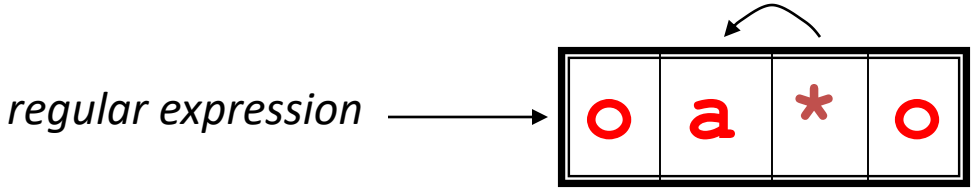
Repetition operators

- The * (asterisk) matches the zero or more occurrences of the **preceding** character



I got mail, yaaaaaaaaaay!

match



For me to fool with.

match

.*

Special characters

- **\s** space
- **\t** tab
- **\s+** many spaces
- **\t\t** two adjacent tabs

Lines corresponding to chr2

```
[pscott17@login4 test]$ grep "chr2" hg19.gtf > chr2.txt
[pscott17@login4 test]$ tail –n 1 chr2.txt
chr21  hg19_knownGene   CDS 33066517  33066602  0.000000
   gene_id "uc002ypd.2"; transcript_id "uc002ypd.2";
```

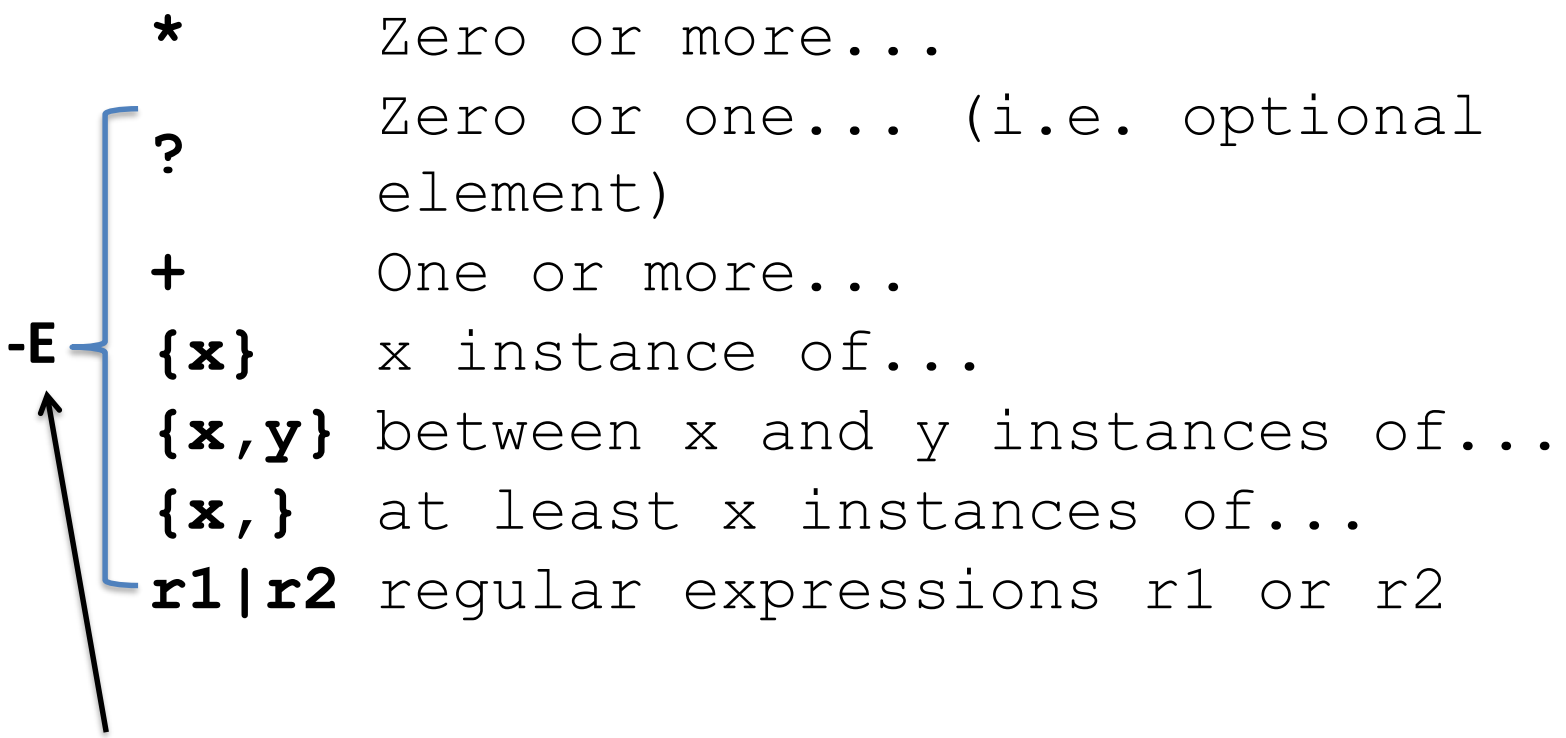
Lines corresponding to chr2

```
grep "chr2\s" hg19.gtf > chr2.gtf
```

Or more specific:

```
grep “^chr2\s" hg19.gtf > chr2.gtf
```

Repetition operators



Let’s practice!

```
grep -E "a1|b1" regex2.txt
```

Alternative

Let’s practice!

```
grep -E "a1|b1" regex2.txt
grep  "[ab]1" regex2.txt
```

Alternative

Repetition operators

- If you want to group part of an expression so that * or { } applies to more than just the previous character, use ( ) notation
- Subexpresssions are treated like a single character
  - **a*** matches 0 or more occurrences of **a**
  - **abc*** matches **ab**, **abc**, **abcc**, **abccc**, …
  - **(abc)*** matches **abc**, **abcabc**, **abcabcabc**, …
  - **(abc){2,3}** matches **abcabc** or **abcabcabc**

Let's practice!

```
grep -E "a+" regex2.txt
grep -E "a{3}" regex2.txt
grep -E "a{2,3}" regex2.txt
grep -E "a{2}" regex2.txt
grep -E "(abc)*" regex2.txt
grep -E "(abc)+" regex2.txt
grep -E "(abc){2}" regex2.txt
grep -E "[[:alpha:]]{3}" regex2.txt
grep -E "[[:alpha:]][0-9]{2}" regex2.txt
grep -E "([[:alpha:]][0-9]){2}" regex2.txt
grep -E "[[:alpha:]][0-9]\sa" regex2.txt
```

?

- `grep -E "[0-9]{3}[-]{0,1}[0-9]{3}[-]{0,1}[0-9]{4}" f.txt`

sed : a “**s**tream **ed**itor”

- A non-interactive text editor
- Routine editing tasks
  - find, replace, delete, append, insert
- Input text flows through the program, is modified, and is directed to standard output.

```
sed [options] commands [file-to-edit]
```

Why use **sed**?

- Sed is designed to be especially useful in three cases:
  - files are too large for interactive editing
  - editing is too complicated for regular text editors
  - multiple editing in one pass

sed : Substitute command **s**

```
sed 's/old_word/new_word/’ [file-to-edit]
```

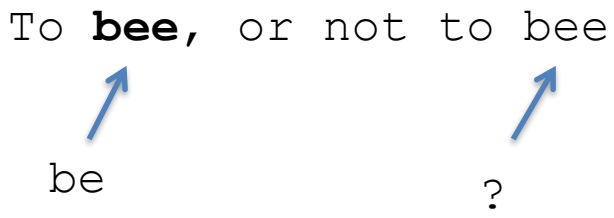
```
To bee, or not to bee
```

```
sed 's/bee/be/‘  tobe.txt
```

```
To be, or not to bee
```

sed : **g** - Global replacement

- Normally, substitutions apply to only the first match in the string.



- To apply the substitution to **all** matches in the string use "**g**" options

```
sed 's/bee/be/g'  tobe.txt
```

Edit matched text

- Put parentheses around the matched text:

```
sed -E 's/<pattern>/(&)/' annoying.txt
```

Let's practice!

To bee, or not to bee

```
less tobe.txt
sed 's/bee/be/' tobe.txt
To be, or not to bee
sed 's/bee/be/g' tobe.txt
To be, or not to be
```

```
sed  's/seven/nine/g' file_sed.txt | sed 's/nine/two/g'
sed 's/a/o/g' file_sed.txt
sed 's/^and/or/' file_sed.txt
sed 's/s..../xxxxx/g' file_sed.txt
sed 's/ago$/ago!/' file_sed.txt

sed 's/[12]/3/g' regex2.txt
sed 's/[[:alpha:]]/B/g' regex2.txt
sed -E 's/[[:alnum:]]{2}/(&)/g' regex2.txt
```

Don’t read and write the same file!

- sed 's/seven/nine/g' **sed_file.txt** >**sed_file.txt**

Redirections are done by the shell, before the command runs. This means that the shell is told to truncate the file before **sed** gets a chance to read it. There is no way around this if you are using shell redirection.

Delete lines with sed

- Remove the 3rd line:
  - `sed '3d' fileName.txt`
- Remove the line containing the string "awk":
  - `sed '/awk/d' filename.txt`
- Remove the last line:
  - `sed '$d' filename.txt`

Let’s practice!

```
sed '3d’ regex2.txt
sed '/a/d' regex2.txt
sed '/[0-9]/d' regex2.txt
sed '$d' regex2.txt
```

Summary

file permissions
cat
wc
>, >>, <
pipeline
ln –s
grep
regex

Set up the alias for Mac OS/linux

- Go to home directory ON YOUR COMPUTER: `cd ~`
- Open file .bash_profile: `nano .bash_profile`
- Add in the end of the file:

- `alias hoffman2='ssh pscott17@hoffman2.idre.ucla.edu'`

- Restart the session

Run from the local session of the terminal. To open a local session : **Control-T**

Set up the alias for Cygwin

- Go to home directory :
  - `This PC / Windows (C:) / Cygwin64 / etc`
- Open file **ssh_config** in text editor
- Add in the end of the file:
- ```
  Host hoffman
   HostName hoffman2.idre.ucla.edu
   Port 22
   User username
  ```
- Restart the session

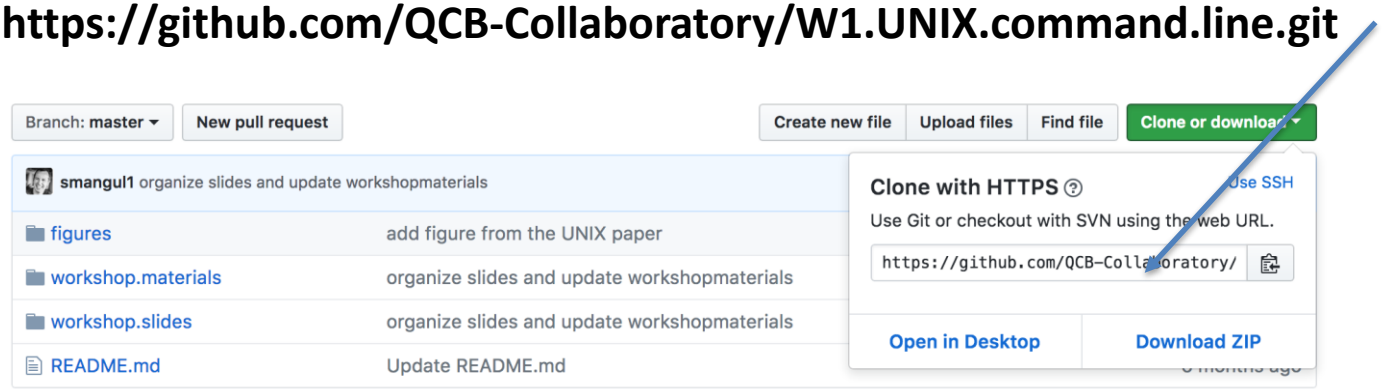
Run from the local session of the terminal. To open a local session : **Control-T**
  ```

Copy the working materials

```
[pscott17@login2 code]$ git clone
https://github.com/QCB-
Collaboratory/W1.UNIX.command.line.git
```

```
Initialized empty Git repository in
/u/home/b/brigitta/code/Intro2Unix/.git/
remote: Counting objects: 88, done.
remote: Compressing objects: 100% (5/5), done.
remote: Total 88 (delta 0), reused 7 (delta 0), pack-reused 79
Unpacking objects: 100% (88/88), done.
```

https://github.com/QCB-Collaboratory/W1.UNIX.command.line.git



https://qcb.ucla.edu/collaboratory/workshops/introtounix/