Big Data Analytics - Lab 1

Files, Shell, Bash, Scripting

On this first applied class we will start looking at files. The most basic unit to store information.

When dealing with very large amounts of data, visual tools like Excel or single host in-memory programming languages like python have a big performance degradation to the point of not working at all.

During the course of these lectures, we will learn how to work in environments capable of horizontally scale to datasets long above the 1M max rows of excel.

One of the original ways to use computers to process data was developed for the Unix Environment and followed its philosophy. Shortly summarized as:

- Write programs that do one thing and do it well.
- Write programs to work together.
- Write programs to handle text streams because that is a universal interface.

Why starts this way?

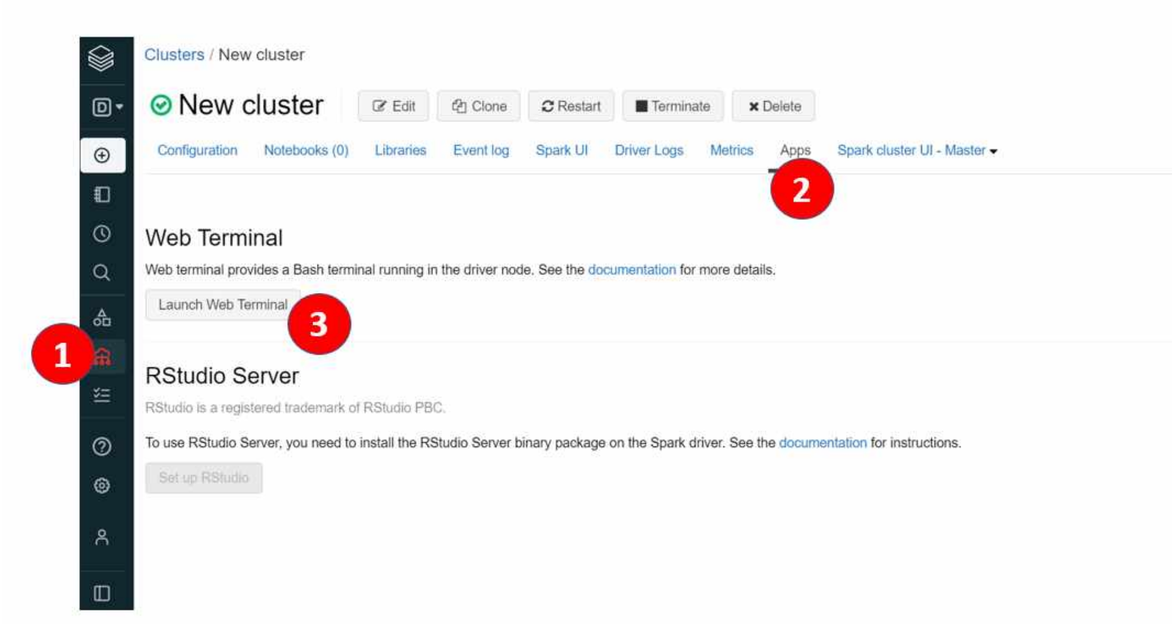
- Ease of execution of commands (no need to copy and paste every time)
- Powerful programming constructs

This mantra evolved extremely well, to the point that most of the commands developed within the Unix ecosystem, more than 30 years ago, are still relevant today. Not only that, but state of the art tools like Spark, which we will learn later in the course, follow a similar approach.

Today the course will be a brief introduction to Unix commands, often called Shell commands, and how they can be useful on modern day-to-day data processes.

Big Data Analytics - Lab 1

For the ones running MacOS or any Linux distribution you can run the class on your own computer. For windows users, Databricks runs on Linux, therefore all notebook exercises will work on Databricks.



Web Terminal

Web terminal provides a Bash terminal running in the driver node. See the documentation for more details.

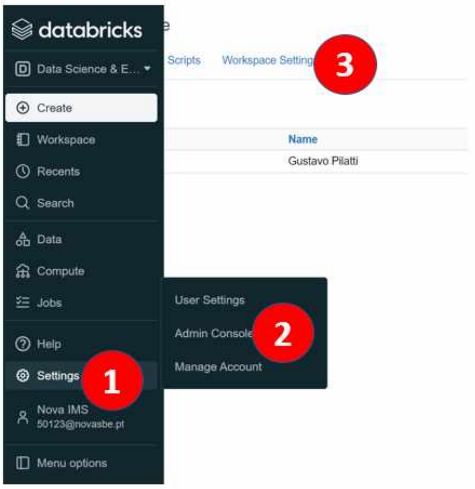
RStudio Server

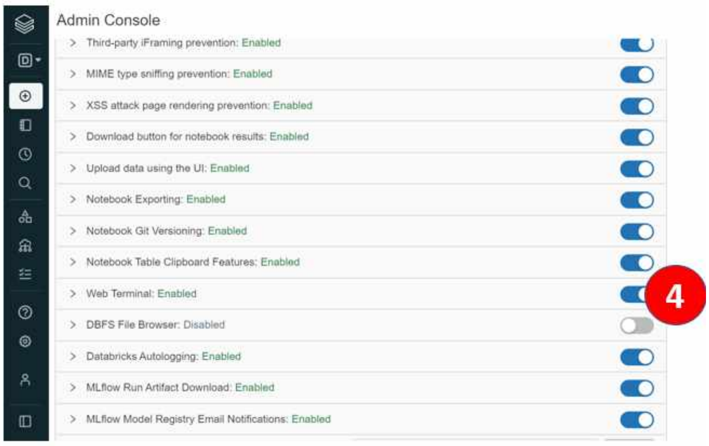
RStudio is a registered trademark of RStudio PBC.

To use RStudio Server, you need to install the RStudio Server binary package on the Spark driver. See the documentation for instructions.

If the Web Terminal is not enabled, follow these steps:

1. Go to the Settings
2. Click on Admin Console.
3. Click the Workspace Settings tab.
4. In the Advanced section, click the Web Terminal toggle.
5. Refresh the page.





Third-party iFraming prevention: Enabled
MIME type sniffing prevention: Enabled
XSS attack page rendering prevention: Enabled
Download button for notebook results: Enabled
Upload data using the UI: Enabled
Notebook Exporting: Enabled
Notebook Git Versioning: Enabled
Notebook Table Clipboard Features: Enabled
Web Terminal: Enabled
DBFS File Browser: Disabled
Databricks Autologging: Enabled
MLflow Run Artifact Download: Enabled
MLflow Model Registry Email Notifications: Enabled

Note: For the ones running windows it is also possible to run bash in it. Although the process is a bit more complicated but still possible. (https://docs.microsoft.com/en-us/windows/wsl/install-win10)

Shell commands:

A Shell provides you with an interface to the operating system. It gathers input from you and executes programs based on that input. When a program finishes executing, it displays that program's output.

Shell is an environment in which we can run our commands, programs, and shell scripts. There are different flavors of a shell, just as there are different flavors of operating systems. Each flavor of shell has its own set of recognized commands and functions.

In this course we will use **Bash** ("Bourne Again Shell") shell as the main shell interpreter.

This shell is currently running on your local filesystem. Here is a list of shell commands to get comfortable with:

ls	ls [*options*]	Show directory contents, lists names of files.
mkdir	mkdir [*options*] directory	Creates a new directory of the specified name.
cat	cat [*filename*]	Display file's contents
cd	cd */directorypath*	Change directory. Change to a certain directory name if provided.
pwd	pwd [-LP] By default, `pwd' behaves as if `-L' were specified.	Displays the name of the working directory.
touch	touch *filename*	Creates a blank file with a specified name.
less	less [*options*] [*filename*]	View contents of specified file, page by page.
head/tail	tail [*options*] [*filename*]	Displays the first/ last 10 lines of a file.
rm	rm [*options*] *directory*	Removes a specified file. There is no recycle bin
history	history [*options*]	Display a listing of the last commands you've run.
cp	cp [*options*] *source destination*	Copy specified file to a new named file. Use -r flag copy a directory.
mv	mv [*options*] *source destination*	Rename a specified file or directory.

find	find [-H] [-L] [-P] [-Olevel] [-D debugopts] [path...] [expression]	Search files and directories. Can use with wildcards (* ?[ ]).
curl	curl [*options*] url	Download a webpage
help	help [-dms]	Get help on a command eg. help ls
echo	echo [*options*]	Prints text to the terminal window
grep	grep [*options*] *pattern* [*filesname*]	Used to search text for patterns specified by the user.
uniq	uniq [*options*] [*unput [output]*]	report or filter out repeated lines in a file
sort	Sort [*options*] [*filesname*]	sort or merge records (lines) of text and binary files
wc	Wc [*options*] [*filesname*]	Word count
sed	sed [options]	Pattern-matched string replacement

TIP: You can press the up arrow to cycle through previous commands

TIP: When using windows, you can right-click to paste (instead of ctrl-v).

TIP:

- **[command] -h:** Display a file's help information.
- **[command] --help:** Display a file's help information.
- **whatis [command]:** Display a short blurb about the command.
- **Some commands do not have the --**help buit0in function, as echo, so you can enable it by typing: enable -n echo ; echo --help

IMPORTANT: CTRL-C (cmd-C) will cancel any command running, this will be useful if you accidentally try to open a large file.

Let us start:

We start by understanding where we are within the file system and the content of the current directory.

hostname – what machine you are on

whoami – who you are logged in as

pwd - Show the current directory. Folders are divided with slashes "/".

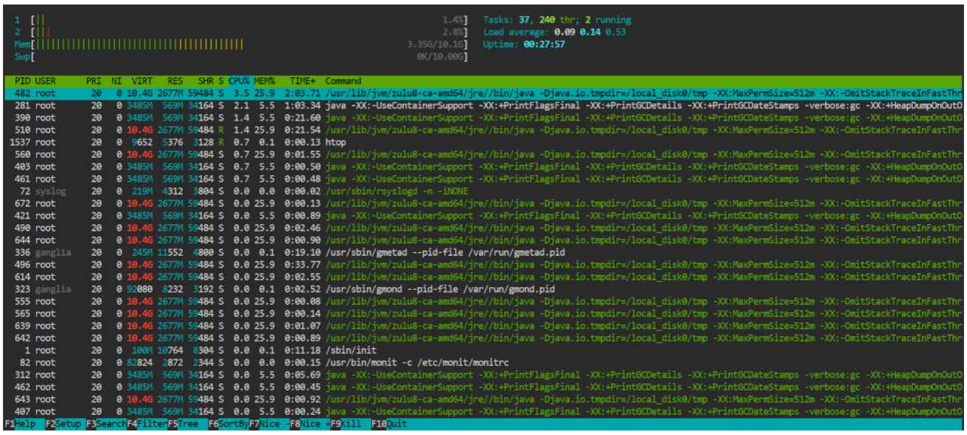
ls - List the contents of the current directory.

Let us try to open a file with cat:

cat /etc/lsb-release - In this case we are opening a file called "lsb-release" in the "etc" folder that contains information about the operating system.

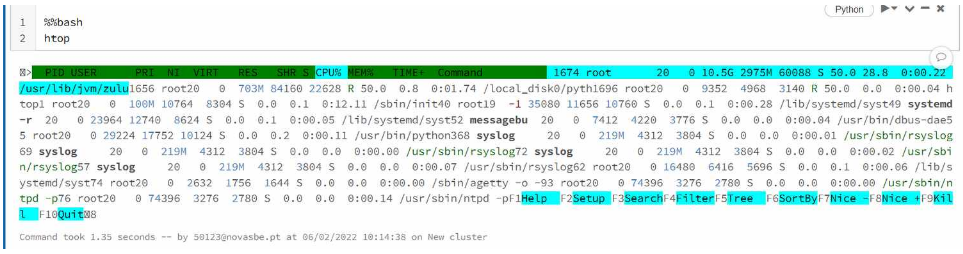
Now adding a bit of action, let us get a live stream of information.

htop - is an important command to check the status of the tasks running on the computer.



```
  1  [||                                    1.4%]   Tasks: 37, 240 thr; 2 running
  2  [|||                                   2.8%]   Load average: 0.09 0.14 0.53
  Mem[||||||||||||||||||||||||||||||| 3.35G/10.1G]   Uptime: 00:27:57
  Swp[                                 0K/10.00G]

  PID USER      PRI  NI  VIRT   RES   SHR S CPU% MEM%   TIME+  Command
  482 root       20   0 10.4G 2677M 59484 S  3.5 25.9  2:03.71 /usr/lib/jvm/zulu8-ca-amd64/jre//bin/java -Djava.io.tmpdir=/local_disk0/tmp -XX:MaxPermSize=512m -XX:-OmitStackTraceInFastThr
  281 root       20   0 3485M  569M 34164 S  2.1  5.5  1:03.34 java -XX:-UseContainerSupport -XX:+PrintFlagsFinal -XX:+PrintGCDetails -XX:+PrintGCDateStamps -verbose:gc -XX:+HeapDumpOnOutO
  390 root       20   0 3485M  569M 34164 S  1.4  5.5  0:21.60 java -XX:-UseContainerSupport -XX:+PrintFlagsFinal -XX:+PrintGCDetails -XX:+PrintGCDateStamps -verbose:gc -XX:+HeapDumpOnOutO
  510 root       20   0 10.4G 2677M 59484 R  1.4 25.9  0:21.54 /usr/lib/jvm/zulu8-ca-amd64/jre//bin/java -Djava.io.tmpdir=/local_disk0/tmp -XX:MaxPermSize=512m -XX:-OmitStackTraceInFastThr
 1537 root       20   0  9652  5376  3128 R  0.7  0.1  0:00.13 htop
  560 root       20   0 10.4G 2677M 59484 S  0.7 25.9  0:01.55 /usr/lib/jvm/zulu8-ca-amd64/jre//bin/java -Djava.io.tmpdir=/local_disk0/tmp -XX:MaxPermSize=512m -XX:-OmitStackTraceInFastThr
  403 root       20   0 3485M  569M 34164 S  0.7  5.5  0:00.50 java -XX:-UseContainerSupport -XX:+PrintFlagsFinal -XX:+PrintGCDetails -XX:+PrintGCDateStamps -verbose:gc -XX:+HeapDumpOnOutO
  461 root       20   0 3485M  569M 34164 S  0.7  5.5  0:00.48 java -XX:-UseContainerSupport -XX:+PrintFlagsFinal -XX:+PrintGCDetails -XX:+PrintGCDateStamps -verbose:gc -XX:+HeapDumpOnOutO
   72 syslog     20   0  219M  4312  3804 S  0.0  0.0  0:00.02 /usr/sbin/rsyslogd -n -iNONE
  672 root       20   0 10.4G 2677M 59484 S  0.0 25.9  0:00.13 /usr/lib/jvm/zulu8-ca-amd64/jre//bin/java -Djava.io.tmpdir=/local_disk0/tmp -XX:MaxPermSize=512m -XX:-OmitStackTraceInFastThr
  421 root       20   0 3485M  569M 34164 S  0.0  5.5  0:00.89 java -XX:-UseContainerSupport -XX:+PrintFlagsFinal -XX:+PrintGCDetails -XX:+PrintGCDateStamps -verbose:gc -XX:+HeapDumpOnOutO
  490 root       20   0 10.4G 2677M 59484 S  0.0 25.9  0:02.46 /usr/lib/jvm/zulu8-ca-amd64/jre//bin/java -Djava.io.tmpdir=/local_disk0/tmp -XX:MaxPermSize=512m -XX:-OmitStackTraceInFastThr
  644 root       20   0 10.4G 2677M 59484 S  0.0 25.9  0:00.90 /usr/lib/jvm/zulu8-ca-amd64/jre//bin/java -Djava.io.tmpdir=/local_disk0/tmp -XX:MaxPermSize=512m -XX:-OmitStackTraceInFastThr
  336 ganglia    20   0  245M 11552  4800 S  0.0  0.1  0:19.10 /usr/sbin/gmetad --pid-file /var/run/gmetad.pid
  496 root       20   0 10.4G 2677M 59484 S  0.0 25.9  0:33.77 /usr/lib/jvm/zulu8-ca-amd64/jre//bin/java -Djava.io.tmpdir=/local_disk0/tmp -XX:MaxPermSize=512m -XX:-OmitStackTraceInFastThr
  614 root       20   0 10.4G 2677M 59484 S  0.0 25.9  0:02.55 /usr/lib/jvm/zulu8-ca-amd64/jre//bin/java -Djava.io.tmpdir=/local_disk0/tmp -XX:MaxPermSize=512m -XX:-OmitStackTraceInFastThr
  323 ganglia    20   0 92080  8232  3192 S  0.0  0.1  0:02.52 /usr/sbin/gmond --pid-file /var/run/gmond.pid
  555 root       20   0 10.4G 2677M 59484 S  0.0 25.9  0:00.08 /usr/lib/jvm/zulu8-ca-amd64/jre//bin/java -Djava.io.tmpdir=/local_disk0/tmp -XX:MaxPermSize=512m -XX:-OmitStackTraceInFastThr
  565 root       20   0 10.4G 2677M 59484 S  0.0 25.9  0:00.14 /usr/lib/jvm/zulu8-ca-amd64/jre//bin/java -Djava.io.tmpdir=/local_disk0/tmp -XX:MaxPermSize=512m -XX:-OmitStackTraceInFastThr
  639 root       20   0 10.4G 2677M 59484 S  0.0 25.9  0:01.07 /usr/lib/jvm/zulu8-ca-amd64/jre//bin/java -Djava.io.tmpdir=/local_disk0/tmp -XX:MaxPermSize=512m -XX:-OmitStackTraceInFastThr
  642 root       20   0 10.4G 2677M 59484 S  0.0 25.9  0:00.89 /usr/lib/jvm/zulu8-ca-amd64/jre//bin/java -Djava.io.tmpdir=/local_disk0/tmp -XX:MaxPermSize=512m -XX:-OmitStackTraceInFastThr
    1 root       20   0  100M 10764  8304 S  0.0  0.1  0:11.18 /sbin/init
   82 root       20   0 82824  2872  2344 S  0.0  0.0  0:00.15 /usr/bin/monit -c /etc/monit/monitrc
  312 root       20   0 3485M  569M 34164 S  0.0  5.5  0:05.69 java -XX:-UseContainerSupport -XX:+PrintFlagsFinal -XX:+PrintGCDetails -XX:+PrintGCDateStamps -verbose:gc -XX:+HeapDumpOnOutO
  462 root       20   0 3485M  569M 34164 S  0.0  5.5  0:00.45 java -XX:-UseContainerSupport -XX:+PrintFlagsFinal -XX:+PrintGCDetails -XX:+PrintGCDateStamps -verbose:gc -XX:+HeapDumpOnOutO
  643 root       20   0 10.4G 2677M 59484 S  0.0 25.9  0:00.92 /usr/lib/jvm/zulu8-ca-amd64/jre//bin/java -Djava.io.tmpdir=/local_disk0/tmp -XX:MaxPermSize=512m -XX:-OmitStackTraceInFastThr
  407 root       20   0 3485M  569M 34164 S  0.0  5.5  0:00.24 java -XX:-UseContainerSupport -XX:+PrintFlagsFinal -XX:+PrintGCDetails -XX:+PrintGCDateStamps -verbose:gc -XX:+HeapDumpOnOutO
F1Help  F2Setup F3SearchF4FilterF5Tree  F6SortByF7Nice -F8Nice +F9Kill  F10Quit
```



```
%%bash
htop
```

```
⊠>  PID USER      PRI  NI  VIRT   RES   SHR S CPU% MEM%   TIME+  Command              1674 root       20   0 10.5G 2975M 60088 S 50.0 28.8  0:00.22
/usr/lib/jvm/zulu1656 root20    0  703M 84160 22628 R 50.0  0.8  0:01.74 /local_disk0/pyth1696 root20    0  9352  4968  3140 R 50.0  0.0  0:00.04 h
top1 root20    0  100M 10764  8304 S  0.0  0.1  0:12.11 /sbin/init40 root19  -1 35080 11656 10760 S  0.0  0.1  0:00.28 /lib/systemd/syst49 systemd
-r  20   0 23964 12740  8624 S  0.0  0.1  0:00.05 /lib/systemd/syst52 messagebu  20   0  7412  4220  3776 S  0.0  0.0  0:00.04 /usr/bin/dbus-dae5
5 root20   0 29224 17752 10124 S  0.0  0.2  0:00.11 /usr/bin/python368 syslog     20   0  219M  4312  3804 S  0.0  0.0  0:00.01 /usr/sbin/rsyslog
69 syslog     20   0  219M  4312  3804 S  0.0  0.0  0:00.00 /usr/sbin/rsyslog72 syslog     20   0  219M  4312  3804 S  0.0  0.0  0:00.02 /usr/sbi
n/rsyslog57 syslog     20   0  219M  4312  3804 S  0.0  0.0  0:00.07 /usr/sbin/rsyslog62 root20    0 16480  6416  5696 S  0.0  0.1  0:00.06 /lib/s
ystemd/syst74 root20    0  2632  1756  1644 S  0.0  0.0  0:00.00 /sbin/agetty -o -93 root20    0 74396  3276  2780 S  0.0  0.0  0:00.00 /usr/sbin/n
tpd -p76 root20    0 74396  3276  2780 S  0.0  0.0  0:00.14 /usr/sbin/ntpd -pF1Help  F2Setup F3SearchF4FilterF5Tree  F6SortByF7Nice -F8Nice +F9Kil
l  F10Quit⊠8
```

Command took 1.35 seconds -- by 50123@novasbe.pt at 06/02/2022 10:14:38 on New cluster

As a way to chain operations bash uses the concept operators. They are used to combine several operations together; this is where the power of bash comes from. By chaining the simple commands shown in the previous section it allows for more advanced and useful operations.

BASH operators:

List terminators

- “**;**”: Will run one command after another has finished, irrespective of the outcome of the first. E.g.: `command1 ; command2` First `command1` is run, in the foreground, and once it has finished, `command2` will be run.

Pipe operator

● “**|**”: The pipe operator, it passes the output of one command as input to another. A command built from the pipe operator is called a pipeline. E.g.: `command1 | command2` Any output printed by `command1` is passed as input to command2.

Redirection operators

These allow you to control the input and output of your commands. They can appear anywhere within a simple command or may follow a command. Redirections are processed in the order they appear, from left to right.

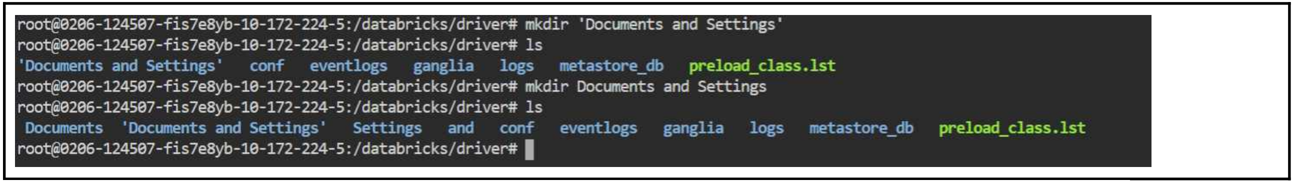
- “**<**“: Gives input to a command. `command < file.txt` will execute `command` on the contents of “file.txt”.
- “**>**“: Directs the output of a command into a file. `command > out.txt` will save the output of `command` as “out.txt”. If the file exists, its contents will be overwritten and if it does not exist it will be created.
- “**>>**“: Does the same as “>”, except that if the target file exists, the new data are appended. `command >> out.txt` If “out.txt” exists, the output of `command` will be appended to it, after whatever is already in it. If it does not exist it will be created.

Multi-line execution

Long commands can be separated into multiple lines by using a backlash after each line

```
January February March April \
May June July August September October November \
December
```

Quotes



```
root@0206-124507-fis7e8yb-10-172-224-5:/databricks/driver# mkdir 'Documents and Settings'
root@0206-124507-fis7e8yb-10-172-224-5:/databricks/driver# ls
'Documents and Settings'   conf   eventlogs   ganglia   logs   metastore_db   preload_class.lst
root@0206-124507-fis7e8yb-10-172-224-5:/databricks/driver# mkdir Documents and Settings
root@0206-124507-fis7e8yb-10-172-224-5:/databricks/driver# ls
 Documents  'Documents and Settings'   Settings   and   conf   eventlogs   ganglia   logs   metastore_db   preload_class.lst
root@0206-124507-fis7e8yb-10-172-224-5:/databricks/driver# 
```

Tip: attention to ‘rm -r -f *’. For more information, follow this link. **Never run it***

Example

Let’s create a file and deal with it!

1. Create a file with the name “myfile.txt” with the words “banana apple carrot” as the file content

   ```
   echo "banana apple carrot" > myfile.txt
   ```

2. Verify if your file was created

   ```
   ls
   ```

3. All entries are in the same line. Let’s delete this file

   ```
   rm myfile.txt
   ```

4. We need to create a file with one entry per line. Call this file ‘data.txt’

   ```
   echo "banana" > data.txt
   ```

5. Append more lines with new entries

   ```
   echo "apple" >> data.txt | echo "carrot" >> data.txt |echo "watermelon" >> data.txt
   ```

6. Search for words with ‘a’

   ```
   grep 'a' data.txt
   ```

7. Search for words with ‘p’ and ‘c’

   ```
   grep '[pc]' data.txt
   ```

Tip: square parentheses are a matching set.

High quality guide

http://www.compciv.org/bash-guide/