Introduction to Terminal

Computing in Optimization and Statistics: Lecture 1

Galit Lukin
Based on Slides byJackie Baek

MIT

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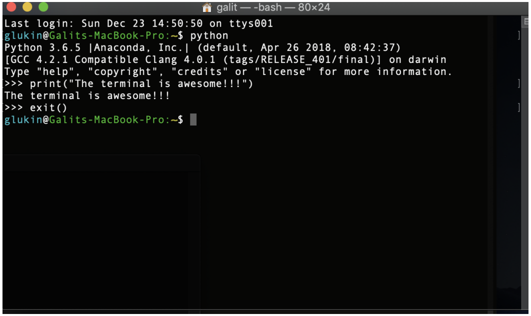
What is the terminal?

- Console, Shell, Command line, Command prompt

What is the terminal?



```
Last login: Sun Dec 23 14:50:50 on ttys001
glukin@Galits-MacBook-Pro:~$ python
Python 3.6.5 |Anaconda, Inc.| (default, Apr 26 2018, 08:42:37)
[GCC 4.2.1 Compatible Clang 4.0.1 (tags/RELEASE_401/final)] on darwin
Type "help", "copyright", "credits" or "license" for more information.
>>> print("The terminal is awesome!!!")
The terminal is awesome!!!
>>> exit()
glukin@Galits-MacBook-Pro:~$
```

- The terminal is a text-based interface to interact with the computer.
- For example, it can replace the use of the file system and the use of IDEs

Example

- Say you want to delete all files in a directory that end with .csv

```
$ rm *.csv
```

- Or change their location to a folder for outputs

```
$ mv *.csv ../OutputFolder
```

- This is possible to do without the terminal, but it requires much more effort.

Why should I learn it?

- You can do almost everything using just the terminal.
- It can do many tasks faster than using a graphic interface.
- You can simultaneously run different simulations with different parameters.
- Using the terminal is sometimes the only option (e.g. accessing a client's server using SSH).
- The terminal is universal.

Use case: running code

- Without the terminal, you need to install an IDE (Integrated development environment) for every programming language.
  - e.g. RStudio for R
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$ python process_stuff.py
$ R make_plots.R
```

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    ```
    $ python process_stuff.py
    $ R make_plots.R
    ```

  - You want to chain commands together.
    - The following command will execute the command on the right if and only if the command on the left succeeded.

      ```
      $ python process_stuff.py && R make_plots.R
      ```

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    $ python process_stuff.py
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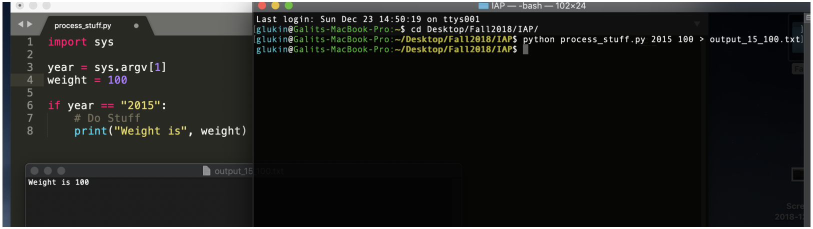
  - You want to chain commands together.
    - The following command will execute the command on the right if and only if the command on the left succeeded.

      ```
      $ python process_stuff.py && R make_plots.R
      ```

  - You want to run a script with different parameters and different output files.

    ```
    $ python process_stuff.py 2015 100 > output_15_100.txt
    ```

Use case: running a script with parameters and output files



```
import sys

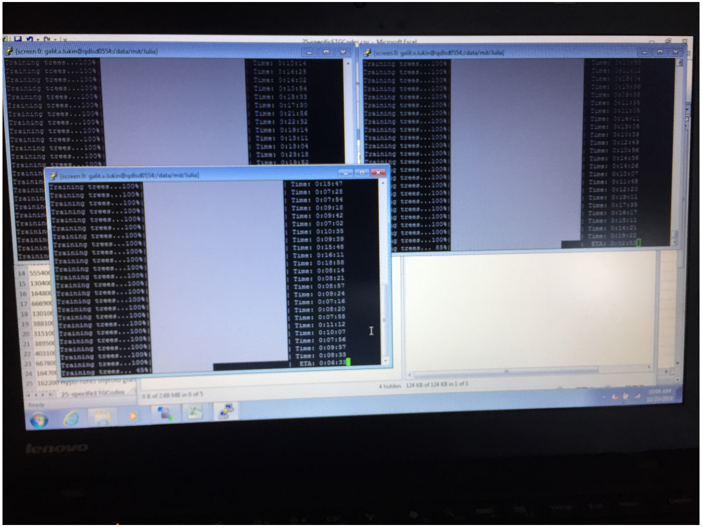
year = sys.argv[1]
weight = 100

if year == "2015":
    # Do Stuff
    print("Weight is", weight)
```

```
Last login: Sun Dec 23 14:50:19 on ttys001
glukin@Galits-MacBook-Pro:~$ cd Desktop/Fall2018/IAP/
glukin@Galits-MacBook-Pro:~/Desktop/Fall2018/IAP$ python process_stuff.py 2015 100 > output_15_100.txt
glukin@Galits-MacBook-Pro:~/Desktop/Fall2018/IAP$
```

```
Weight is 100
```

Use case: running optimal trees

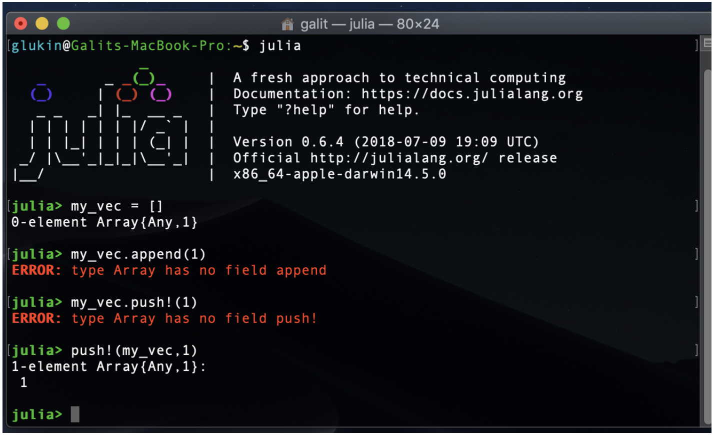


```
[screen 0: galit.x.lukin@qdlsd0554:/data/mit/Julia]
Time: 0:10:14
Time: 0:14:25
Time: 0:14:02
Time: 0:10:54
Time: 0:15:33
Time: 0:17:30
Time: 0:21:56
Time: 0:22:32
Time: 0:19:14
Time: 0:13:11
Time: 0:13:04
Time: 0:23:18
Time: 0:19:52
```

```
[screen 0: galit.x.lukin@qdlsd0554:/data/mit/Julia]
Training trees...100%|     Time: 0:15:47
Training trees...100%|     Time: 0:07:28
Training trees...100%|     Time: 0:07:54
Training trees...100%|     Time: 0:09:18
Training trees...100%|     Time: 0:09:42
Training trees...100%|     Time: 0:07:02
Training trees...100%|     Time: 0:10:35
Training trees...100%|     Time: 0:09:39
Training trees...100%|     Time: 0:15:48
Training trees...100%|     Time: 0:16:11
Training trees...100%|     Time: 0:18:58
Training trees...100%|     Time: 0:08:14
Training trees...100%|     Time: 0:08:21
Training trees...100%|     Time: 0:08:57
Training trees...100%|     Time: 0:09:24
Training trees...100%|     Time: 0:07:16
Training trees...100%|     Time: 0:08:20
Training trees...100%|     Time: 0:07:58
Training trees...100%|     Time: 0:11:12
Training trees...100%|     Time: 0:10:07
Training trees...100%|     Time: 0:07:56
Training trees...100%|     Time: 0:09:57
Training trees...100%|     Time: 0:08:33
Training trees... 45%|      ETA: 0:06:33
```

Use case: learning a language

- Instead of constantly Googling or running scripts that fail ....
- Have a separate terminal open to test your syntax!



```
glukin@Galits-MacBook-Pro:~$ julia
               _
   _       _ _(_)_     |  A fresh approach to technical computing
  (_)     | (_) (_)    |  Documentation: https://docs.julialang.org
   _ _   _| |_  __ _   |  Type "?help" for help.
  | | | | | | |/ _` |  |
  | | |_| | | | (_| |  |  Version 0.6.4 (2018-07-09 19:09 UTC)
 _/ |\__'_|_|_|\__'_|  |  Official http://julialang.org/ release
|__/                   |  x86_64-apple-darwin14.5.0

julia> my_vec = []
0-element Array{Any,1}

julia> my_vec.append(1)
ERROR: type Array has no field append

julia> my_vec.push!(1)
ERROR: type Array has no field push!

julia> push!(my_vec,1)
1-element Array{Any,1}:
 1

julia> 
```

Terminal Basics

- We will be using a **shell** called **bash**: a program that interprets and processes the commands you input into the terminal.
- The shell is always in a **working directory**.
- A typical command looks like:

```
$ command <argument1> <argument2> ...
```

Basic navigation commands

pwd: prints working directory.

```
$ pwd
/Users/galit
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ls: lists directory contents.

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$ ls
Applications                    Movies
Desktop                         Music
Documents                       Pictures
```

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cd <**directory**>: change working directory to new directory.

```
$ cd Desktop/Fall2018
$ pwd
/Users/galit/Desktop/Fall2018
```

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$ pwd
/Users/galit/Desktop/Fall2018
```

open <**filename**>: opens the file - analogous to double-clicking.

```
$ open FallRegistration.pdf
```

Use tab, arrow keys and file path shortcuts

- Use **tab** to autocomplete *commands* and *file paths*.
- Use $\uparrow$ and $\downarrow$ arrow keys to navigate through your command history.

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- . is current directory.

```
$ open  ./FallRegistration.pdf
```

- .. is parent directory.

```
$ cd IAP #Fall2018 is the parent directory of IAP
$ open  ../FallRegistration.pdf
```

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$ cd IAP #Fall2018 is the parent directory of IAP
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```

- ∼ is home.
  - expands to */Users/<username>* (or wherever *home* is on that machine).
  - *∼/Documents* → */Users/galit/Documents*
  - The command **cd** (without any arguments) takes you to ∼.

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- A file is contained in a **directory** (folder). Files within the same directory have unique names.
- Every file and directory has a unique location in the file system, called a **path**.
  - **Absolute path**: */Users/galit/Desktop/Fall2018/FallRegistration.pdf*
  - **Relative path** (if my current working directory is /Users/galit/Desktop): *Fall2018/FallRegistration.pdf*

Working with files

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touch *file*: create an empty file.
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$ touch brand_new_file.txt
$ rm brand_new_file.txt
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$ nano helloworld.txt
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cp *source target*: copy.
mv *source target*: move/rename.

```
$ cp helloworld.txt helloworld_copy.txt
$ mv helloworld.txt goodbyeworld.txt
```

Hidden Files

- Files that start with a dot (.) are called **hidden** files.
- Used for storing preferences, config, settings.
- Use *ls -a* to list all files.

```
$ ls
github_notes.md   presentation     scripts

$ ls -a
.                  .git             github_notes.md    scripts
..                 .gitignore       presentation
```

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  - What is the difference?
  - Variables can be used anywhere in a command line (e.g. as parts of program arguments)
  - Aliases can only be used as the names of programs to run (e.g. cd, ssh, mkdir)
- **alias** *new_command=command*

```
$ alias fall2018="cd ~/Desktop/Fall2018"
$ alias athena="ssh glukin@athena.dialup.mit.edu"
```

- **PATH**=*path:$PATH*

```
$ PATH="/Applications/anaconda3/bin:$PATH"
```

Redirection

> redirects output to a file, *overwriting* if file already exists.

```
$ ls > out.txt
```

>> redirects output to a file, *appending* if file already exists.

```
$ python fetch_data.py >> output.csv
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```

$<$ uses contents of file as STDIN (standard input) to the command.

```
$ python process_stuff.py < input.txt
```

Secure Shell (SSH)

- Sometimes we need to work on a remote machine.
  - We need more computing power than just our local machine.
  - We need to access data from a client's server.
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```
$ ssh glukin@athena.dialup.mit.edu
or
$ athena

Password:

Welcome to Ubuntu 14.04.5 LTS
...
Last login:  Sun Dec 23 10:56:22 2018 ....

glukin@buzzword-bingo:~$
```

Use *logout* to exit SSH session.

Secure Copy (scp)

Can transfer files between local and remote machines using the **scp** command on your local machine.

Move *my_file.txt* from local machine to remote home directory.

```
$ scp my_file.txt glukin@athena.dialup.mit.edu:~
```

Move *remote_file.txt* from remote to local machine.

```
$ scp glukin@athena.dialup.mit.edu:~/remote_file.txt .
```

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Example:

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$ ls
a1.txt    a2.pdf    apple.txt    bar.pdf
```

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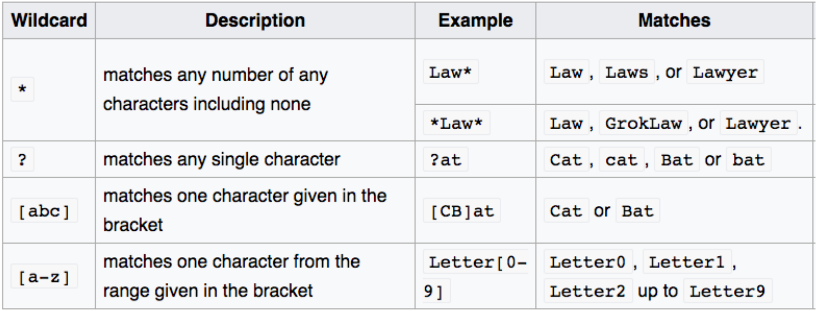
$ ls a[0-9]*
a1.txt    a2.pdf
```

Simple Pattern Matching (Globbing)



Wildcard	Description	Example	Matches
`*`	matches any number of any characters including none	`Law*`	`Law`, `Laws`, or `Lawyer`
		`*Law*`	`Law`, `GrokLaw`, or `Lawyer`.
`?`	matches any single character	`?at`	`Cat`, `cat`, `Bat` or `bat`
`[abc]`	matches one character given in the bracket	`[CB]at`	`Cat` or `Bat`
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Source: Wikipedia

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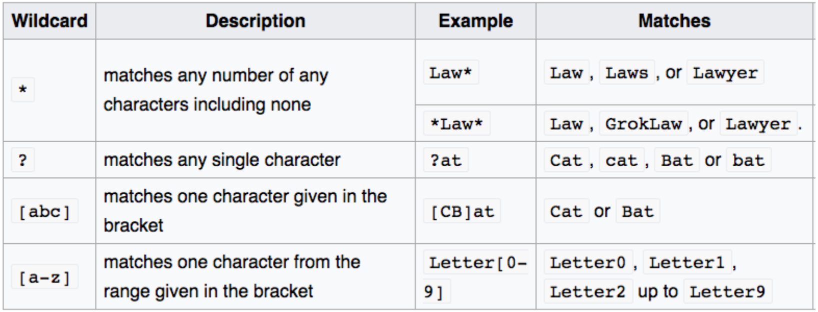

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Remove all files that end with .pyc

```
$ rm *.pyc
```

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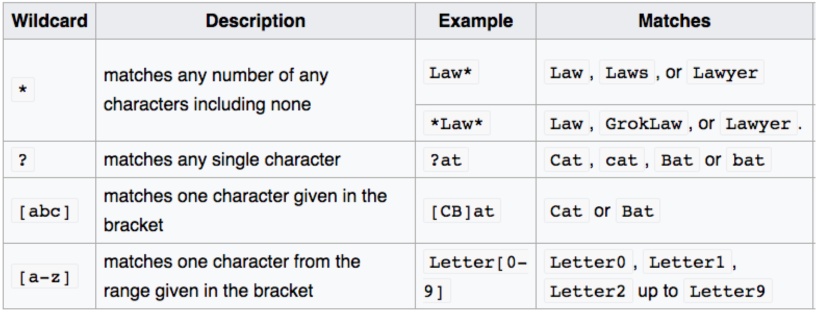

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Remove all files that end with .pyc

```
$ rm *.pyc
```

Copy all files that has "dog" in its name to the *animal/* directory.

```
$ cp *dog* animal/
```

How bash works

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- Bash is a programming language.
  - Can set variables, use for loops, if statements, comments, etc.
- There are several special ”environment” variables (i.e. $PATH, $HOME, $USER, etc.) that many programs rely on.

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  - Usually under a directory called *bin*, which stands for *binary*.

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What happens when you type in a command, say *pwd*?

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- Where is this program?
  - Usually under a directory called *bin*, which stands for *binary*.
- When you type in a command, bash looks for a program with that name under the directories listed in the *$PATH* environment variable.

```
$ echo $PATH

/Applications/anaconda3/bin:
/Library/Frameworks/Python.framework/Versions/3.6/bin:
/usr/local/bin:/usr/bin:/bin:/usr/sbin:/sbin:
/Library/TeX/texbin
```

- *$PATH* contains is liist of directories separated by :
- Bash looks into each of these directories to look for the program *pwd*.

Common Error: Command not found

You installed a new software (e.g. TeX), but as soon as you try to run it, you get this error:

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- **Solution:** Find where you installed TeX, find the directory with the binary files (usually a directory called *bin*), and add the directory to *$PATH*.

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- This means that bash cannot find the program ‘pdflatex‘ in the *$PATH* variable.
- **Solution:** Find where you installed TeX, find the directory with the binary files (usually a directory called *bin*), and add the directory to *$PATH*.
- Add the following to your ∼/*.bash_profile*:

  ```
  PATH="$PATH:/Library/TeX/Distributions/Programs/texbin"
  export PATH
  ```
- The export command allows a child process to inherit all marked variables

Key Takeaways

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- So is *tab* for autocomplete, *arrow keys* for history.
- Be careful with *rm*.
- Getting comfortable with the terminal can be daunting at first, but it has the potential to greatly boost your efficiency!

Thank you!