Introduction to Terminal

Qingyu Song

XMU

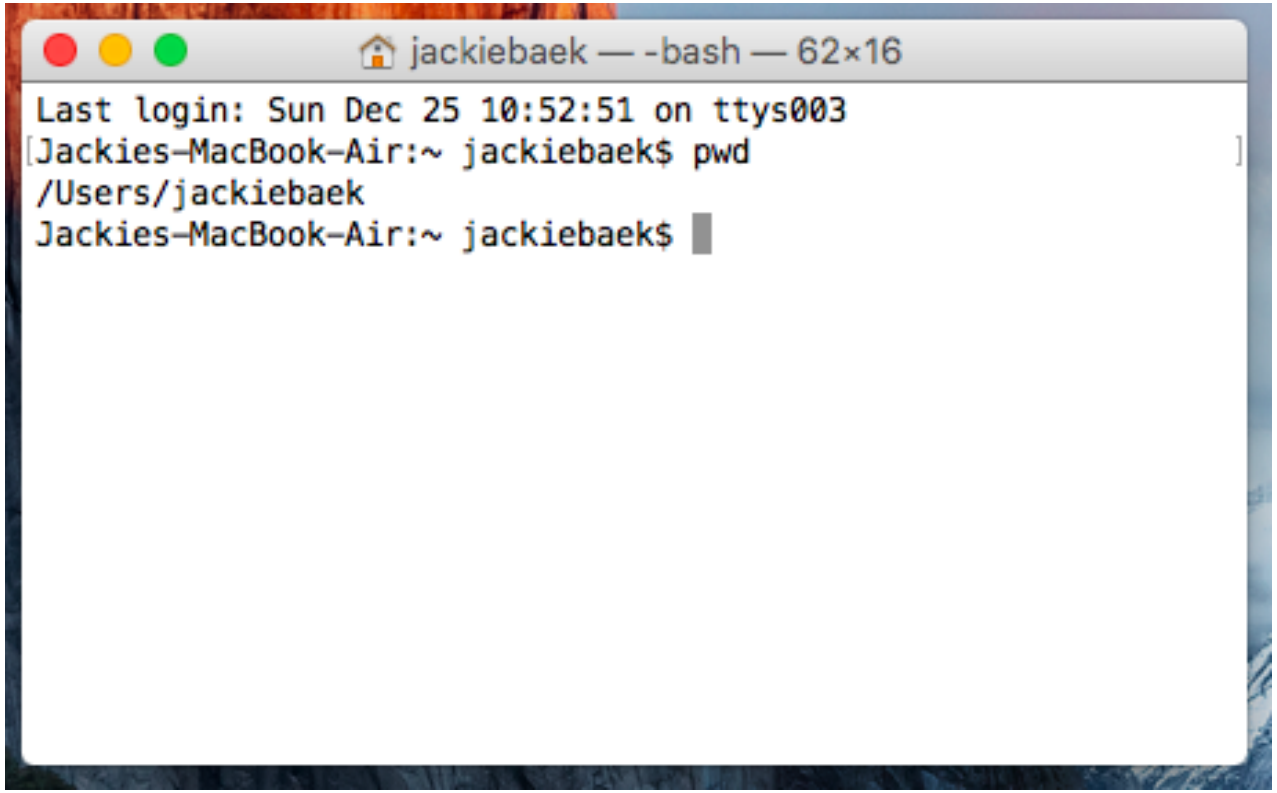
November 10, 2025

Credit to Jackie Baek, Computing in Optimization and Statistics 2017, MIT

Overview

What is the terminal?

What is the terminal?



- The terminal is a text-based interface to interact with the computer.
- Alternate names: console, shell, command line, command prompt

Example

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

```
$ rm *.pyc
```

- 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.
- It is sometimes the only option (e.g. accessing a client's server using SSH).
- It is universal.

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/jackiebaek
```

Basic navigation commands

pwd: prints working directory.

```
$ pwd
/Users/jackiebaek
```

ls: lists directory contents.

```
$ ls
Applications                    Movies
Desktop                         Music
Documents                       Pictures
```

Basic navigation commands

pwd: prints working directory.

```
$ pwd
/Users/jackiebaek
```

ls: lists directory contents.

```
$ ls
Applications                    Movies
Desktop                         Music
Documents                       Pictures
```

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

```
$ cd Documents
$ pwd
/Users/jackiebaek/Documents
```

Tab and arrow keys are your friends

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

What is a file?

A file is a container of data (0's and 1's).

What is a file?

A file is a container of data (0's and 1's).

A file name usually has an **extension** (e.g. .pdf, .doc, .csv), but these are just conventions.

What is a file?

A file is a container of data (0's and 1's).

A file name usually has an **extension** (e.g. .pdf, .doc, .csv), but these are just conventions.

A file is contained in a **directory** (folder). Files within the same directory have unique names.

What is a file?

A file is a container of data (0's and 1's).

A file name usually has an **extension** (e.g. .pdf, .doc, .csv), but these are just conventions.

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/jackiebaek/Dropbox/Documents/hello.txt*
- **Relative path** (if my current working directory is /Users/jackiebaek/Dropbox): *Documents/hello.txt*

Working with files

Working with files

mkdir *directory_name*: create a new directory.

```
$ mkdir new_directory
```

Working with files

mkdir *directory_name*: create a new directory.

```
$ mkdir new_directory
```

touch *file*: create an empty file.
rm *file*: delete a file (Careful! Can't be undone!)

```
$ touch brand_new_file.txt
$ rm brand_new_file.txt
```

Working with files

mkdir *directory_name*: create a new directory.

```
$ mkdir new_directory
```

touch *file*: create an empty file.
rm *file*: delete a file (Careful! Can't be undone!)

```
$ touch brand_new_file.txt
$ rm brand_new_file.txt
```

nano *file*: edit contents of a file (many other editors exist).

```
$ nano helloworld.txt
```

Working with files

mkdir *directory_name*: create a new directory.

```
$ mkdir new_directory
```

touch *file*: create an empty file.
rm *file*: delete a file (Careful! Can't be undone!)

```
$ touch brand_new_file.txt
$ rm brand_new_file.txt
```

nano *file*: edit contents of a file (many other editors exist).

```
$ nano helloworld.txt
```

cat *file*: prints contents of a file.

```
$ cat helloworld.txt
Hello, World!
```

Working with files

mkdir *directory_name*: create a new directory.

```
$ mkdir new_directory
```

touch *file*: create an empty file.
rm *file*: delete a file (Careful! Can't be undone!)

```
$ touch brand_new_file.txt
$ rm brand_new_file.txt
```

nano *file*: edit contents of a file (many other editors exist).

```
$ nano helloworld.txt
```

cat *file*: prints contents of a file.

```
$ cat helloworld.txt
Hello, World!
```

cp *source target*: copy.
mv *source target*: move/rename.

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

File path shortcuts

. is current directory.

.. is parent directory.

- *../file.txt* references a file named file.txt in the parent directory.

File path shortcuts

. is current directory.

.. is parent directory.

- *../file.txt* references a file named file.txt in the parent directory.

$\sim$ is home.

- expands to */Users/<username>* (or wherever *home* is on that machine).
- $\sim$*/Documents* $\rightarrow$ */Users/jackiebaek/Documents*
- The command **cd** (without any arguments) takes you to $\sim$.

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
```

.bashrc / .bash_profile

- There is a hidden file in $\sim$ directory called .bashrc or .bash_profile.
- This file is a bash script that runs at the beginning of each session (i.e. when you open the terminal).

.bashrc / .bash_profile

- There is a hidden file in $\sim$ directory called .bashrc or .bash_profile.
- This file is a bash script that runs at the beginning of each session (i.e. when you open the terminal).
- This file can be used to set variables or to declare **aliases**.
- **alias** *new_command=command*

```
$ alias athena="ssh baek@athena.dialup.mit.edu"
```

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
```

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
```

$<$ 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.
- Can use SSH to securely access the terminal for the remote machine.

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.
- Can use SSH to securely access the terminal for the remote machine.

```
$ ssh baek@athena.dialup.mit.edu
```

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.
- Can use SSH to securely access the terminal for the remote machine.

```
$ ssh baek@athena.dialup.mit.edu

Password:
```

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.
- Can use SSH to securely access the terminal for the remote machine.

```
$ ssh baek@athena.dialup.mit.edu

Password:


Welcome to Ubuntu 14.04.5 LTS
...
Last login: Tue Aug 30 10:11:49 2016 from howe-and-ser-...

baek@howe-and-ser-moving:~$
```

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 baek@athena.dialup.mit.edu:~
```

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

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

Simple Pattern Matching (Globbing)

- Match [multiple] filenames with wildcard characters.
- Similar to *regular expressions*, but slightly different syntax.

Simple Pattern Matching (Globbing)

- Match [multiple] filenames with wildcard characters.
- Similar to *regular expressions*, but slightly different syntax.

Example:

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

Simple Pattern Matching (Globbing)

- Match [multiple] filenames with wildcard characters.
- Similar to *regular expressions*, but slightly different syntax.

Example:

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


$ echo a*
a1.txt    a2.pdf    apple.txt
```

Simple Pattern Matching (Globbing)

- Match [multiple] filenames with wildcard characters.
- Similar to *regular expressions*, but slightly different syntax.

Example:

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


$ echo a*
a1.txt    a2.pdf    apple.txt


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

Simple Pattern Matching (Globbing)

- Match [multiple] filenames with wildcard characters.
- Similar to *regular expressions*, but slightly different syntax.

Example:

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


$ echo a*
a1.txt    a2.pdf    apple.txt


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


$ echo *.pdf
a2.pdf    bar.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`
`[a-z]`	matches one character from the range given in the bracket	`Letter[0-9]`	`Letter0`, `Letter1`, `Letter2` up to `Letter9`

Figure: *Source: Wikipedia*

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`
`[a-z]`	matches one character from the range given in the bracket	`Letter[0-9]`	`Letter0`, `Letter1`, `Letter2` up to `Letter9`

Figure: *Source: Wikipedia*

Remove all files that end with .pyc

```
$ rm *.pyc
```

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`
`[a-z]`	matches one character from the range given in the bracket	`Letter[0-9]`	`Letter0`, `Letter1`, `Letter2` up to `Letter9`

Figure: *Source: Wikipedia*

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

How bash works

- Bash is a programming language.
  - Can set variables, use for loops, if statements, comments, etc.

How bash works

- 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.

How bash works con't

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

How bash works con't

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

- Bash runs the program called *pwd*.
- Where is this program?
  - Usually under a directory called *bin*, which stands for *binary*.

How bash works con't

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

- Bash runs the program called *pwd*.
- 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.

How bash works con't

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

- Bash runs the program called *pwd*.
- 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

/Users/jackiebaek/.local/bin:/Users/jackiebaek/.cabal/bin:/
Applications/ghc-7.10.3.app/Contents/bin:/usr/local/bin:
/usr/bin:/bin:/usr/sbin:/sbin:/usr/texbin
```

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

Documentation

- To look up documentation for a particular command, use '**man** *command*'. (man = manual)

```
$ man mkdir

NAME
     mkdir -- make directories

SYNOPSIS
     mkdir [-pv] [-m mode] directory_name ...

DESCRIPTION
     The mkdir utility creates the directories named as operands
     ...
```

- *d* for down, *u* for up, *q* to quit.
- Commands can have required and/or optional arguments.
- Optional arguments usually come first, and are indicated by a hyphen (-). These are called **flags**.

Key Takeaways

Key Takeaways

- Basic commands: ls, cd, pwd, cat, cp, mv, rm, mkdir

Key Takeaways

- Basic commands: ls, cd, pwd, cat, cp, mv, rm, mkdir
- Google is your friend.

Key Takeaways

- Basic commands: ls, cd, pwd, cat, cp, mv, rm, mkdir
- Google is your friend.
- So is *tab* for autocomplete, *arrow keys* for history.

Key Takeaways

- Basic commands: ls, cd, pwd, cat, cp, mv, rm, mkdir
- Google is your friend.
- So is *tab* for autocomplete, *arrow keys* for history.
- Be careful with *rm*.

Key Takeaways

- Basic commands: ls, cd, pwd, cat, cp, mv, rm, mkdir
- Google is your friend.
- 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!