

Operating System Basics for Mac

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An operating system is a large, complex collection of software that manages the computer. All communication between the central processor and the keyboard, mouse, screen, computer disk and network is controlled by the operating system. It is the operating system that detects the click of a button or the movement of the mouse. Other programs cannot communicate with these peripheral devices directly. They have to ask the operating system to carry out these tasks.

The operating system on newer Mac computers is called macOS. This is based on the much older Unix operating system, first developed in 1969 at Bell Labs in New Jersey.

This document introduces you to the basics such as managing your files and shortcuts that can improve efficiency when using macOS. To start, these shortcuts may seem uncomfortable but it is worthwhile spending some time practising, as it will allow you to perform tasks faster. It covers:

- Useful Applications (e.g. Free access to Office365) Page 2
- Managing Applications (e.g. Split Screen and Virtual Desktops) Page 6
- Managing your Files (e.g. Organising files/folders and backups) Page 10
- Using a Terminal (e.g. Text-based commands to create folders) Page 15

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Icons throughout sourced from FlatIcon.com, made by [Freepik](https://www.freepik.com), Eucalyp, smashicons, wanicon, icongeek26 and tHose icons.



Useful Applications

Your operating system will come bundled with some applications. Departmental computers will already have all the software you need, however if you are working on a personal computer there may be some software you need to install.

Office 365

Students and staff at the University can access Office 365, which contains many useful applications for University work. The University of Oxford Office 365 system includes a cloud based working environment (called Nexus365). Follow the instructions here to get started: <https://help.it.ox.ac.uk/nexus365/getting-started>

Here you will find :-



Outlook: The Microsoft email client to view your University emails.



One Drive: A cloud based filing system. You can use this to backup your files and share files with other people.



Word: The Microsoft word processor. You can save files as a Word document(.docx) to **One Drive** or your own computer.



Excel: The Microsoft spreadsheet. You can save files as an Excel spreadsheet(.xlsx) to **One Drive** or your own computer.



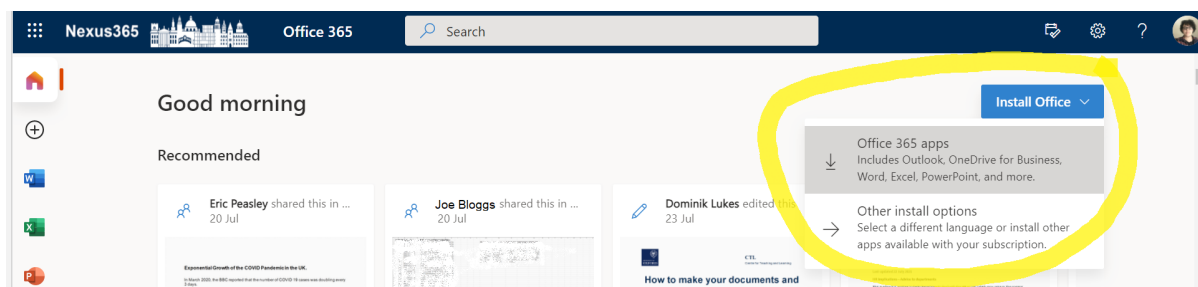
One Note: A digital notebook, you can use this for [taking notes](#).



Powerpoint: Used for creating presentations.

Each of these can be used online, in your browser. Some browsers work better than others so it may be worth having multiple installed (e.g. [Chrome](#) or [Firefox](#) as well as Safari).

You can only get full functionality by installing the software directly onto your machine, which we recommend. Once you have logged into Nexus365, you will see the **Install Office** button on the right.



Teams App

Another part of Nexus365 is the Application **Teams**. It is an online chat/conferencing tool. Teams lets you message, talk to and see other members of the University. It will be used for the online laboratories. There is a web based version, but it does not work in Safari.

Installing the Teams App

Go to the web site: <https://products.office.com/en-gb/microsoft-teams/download-app>

And select **Download for Desktop**. The installation is very straightforward. You just keep pressing the button in the bottom right hand corner.

Logging into the Teams App

Once Teams has launched:

Sign in using **abc123@OX.AC.UK**

Replacing **abc123** with your own Single Sign On (SSO) username.

Then log in using your Oxford University SSO and password. Sometimes it capitalizes the first letter of the SSO. If it does this, change it back to lower case.

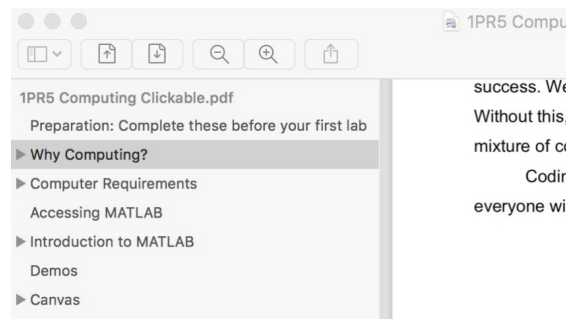
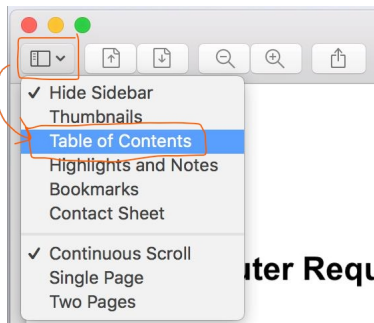


PDF Reader

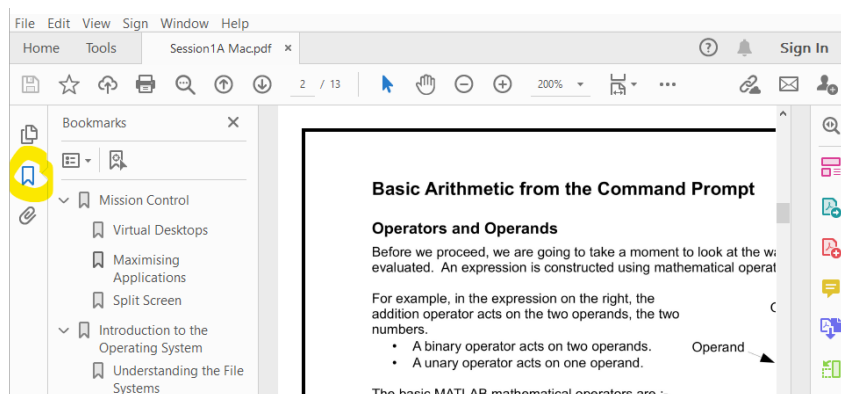
You will likely need to read many PDFs. MacOS can open PDFs in [Mac Previewer](#). This allows you to read PDFs as well as highlight and make notes. Other free options are available, e.g. [Adobe Acrobat](#). Whichever you use make sure you can:

- **Search within PDFs:** You will often work with many documents, searching for key terms using the Search bar is much faster than scrolling.
- **Viewing Headings for Navigation:** You can save a lot of time by enabling the navigation pane to click through Headings

In Previewer, view headings by opening **Table of Contents**:



In Adobe, open Headings via the button circled in yellow:



Other Applications

Other applications are available to everyone at the University, for free/a discounted rate, through the Central IT: <https://www.it.ox.ac.uk/get-software> They are not needed for the Engineering course, but Adobe Creative Cloud Subscription for Photoshop etc or Parallels to run Windows on your Mac may be of interest.



Creating Text Files

You will not always want files where the text is formatted. In some cases you will want something very simple: just words as a .txt file. This could be because of:

- personal preference (some people prefer the minimalist environment)
- the wider range of compatibility (all OS will be able to read a .txt even if Word is not installed).

Example

Follow these instructions to make a .txt file and see what you think:

- Click on the **Launchpad** to see the apps on your Mac.
- Click on **Others**.
- Open **TextEdit**



This opens the Apple Text Editor. This works with two different types of files.

The **Format** menu allows you to select :

- **Plain Text** format just contains ASCII character codes. You can't change the font. These save to **.txt** files.
- **Rich Text** format contains extra formatting codes for changing the font and size of the text and other formatting commands. These save to **.rtf** files.

Try the following :-

Select **New Document**

In the **Format** menu select **Make Plain Text**

Enter the following text into the document :-

This is an example text file.

Save as **ReadMe.txt**. You can move this file later.



Security

Keeping your computer, files and identity safe is hugely important. Sophos Anti-Virus is available for free from the Central IT pages, using the above link. You should also consider creating strong passwords and using a password manager. Many comprehensive guides can be found online, for example [here](#).



Managing Applications

Often you will need to work with multiple applications (apps) open. For example, if you are coding you may need a PDF of instructions open as well as MATLAB. Or if you are writing a report you may need an internet browser and a Word document.

This section introduces you to different ways to work with multiple apps. It covers Split screen, Mission Control and Virtual Desktops. These are shortcuts that can improve efficiency moving between different applications. To start, these shortcuts may seem uncomfortable but it is worthwhile spending some time practising, as it will allow you to perform tasks faster.

Minimising, Closing and Quitting

To get the best from your computer, it is important to only have the applications open that you need for your current task. Having too many applications open at once will cause your machine to be slow. You might think you are quitting applications by minimising and closing:

- You can **minimise** an application, by pressing the yellow minimise button  in the top-left corner of the window.
- You can **close** windows of an application, by pressing the red close button  in the top-left corner of the window. The shortcut **Option-Command-W** closes **all windows** open from a single application.

However, **minimising or closing windows does not close or quit the app.**

The app will still be using memory, which will slow down your computer. Instead of you should quit applications by using the shortcut Command-Q, or click the app's name in the menu bar, then choose Quit.



Quit rather than close/minimise any applications you are not using.

This will free up RAM (a type of computer memory).



Split Screen View

To work with two applications at once, a simple option is to split the screen between two applications. To do this:

- Open two applications on a Desktop.
- Select and hold the green button in the top-left corner of one of the apps.
- The Desktop splits in two. Drag the application to one half and release.
- Then Click on the other application.

You can drag the divide between the two applications to the left and right.

As an example, the image below shows a Desktop that has been split between some notes on the left and MATLAB on the right.

Basic Arithmetic from the Command Prompt

Operators and Operands

Before we proceed, we are going to take a moment to look at the way an expression is evaluated. An expression is constructed using mathematical operators.

For example, in the expression on the right, the addition operator acts on the two operands, the two numbers.

• A binary operator acts on two operands.
• A unary operator acts on one operand.

The basic MATLAB mathematical operators are :-

Operator	Symbol	Example	Mathematical Equivalent
Addition	+	1 + 2	1 + 2
Subtraction	-	4 - 3	4 - 3
Multiplication	*	2 * 5	2 × 5
Division	/	4 / 7	$\frac{4}{7}$
Raise to a power	^	3^2	3 ²
Unary plus	+	+ 2	+2
Unary minus	-	- 2	-2

A limitation of computers is that you are entering mathematical expressions on a keyboard designed for a typewriter. There is no key for multiply, so we use an * instead. Division and fractions are also a problem. So we use the forward slash key / to signify division. Also, the command input is limited to a single line of text, so you cannot enter 3² and have to use 3^2 instead.

This is far from being a complete list of MATLAB operators. There are many more that we will encounter later.


```
>> 1+2
ans =
     3
>> 4-3
ans =
     1
>> 2*5
ans =
    10
>> 4/7
ans =
    0.5714
>> 3^2
ans =
     9
fx >> |
```

For more information, see [the macOS User Guide](#).



Maximising Applications

The approach of splitting the screen is not always the best option – particularly if you have a small monitor. Sometimes we need to work with an application which has been maximised to fill the screen.

Maximise an application by clicking the green maximise button  in the top-left corner of an app window.


You can also double-click an app's title bar to maximise the window (as long as the option to do so is set to “zoom” in [Dock & Menu Bar preferences](#)).

When an application is maximised, you can view the banner and the menu bar by moving the pointer to the very top of the screen.



Mission Control

Mission Control offers a quick way to switch between multiple screens. There are many ways to start Mission Control:

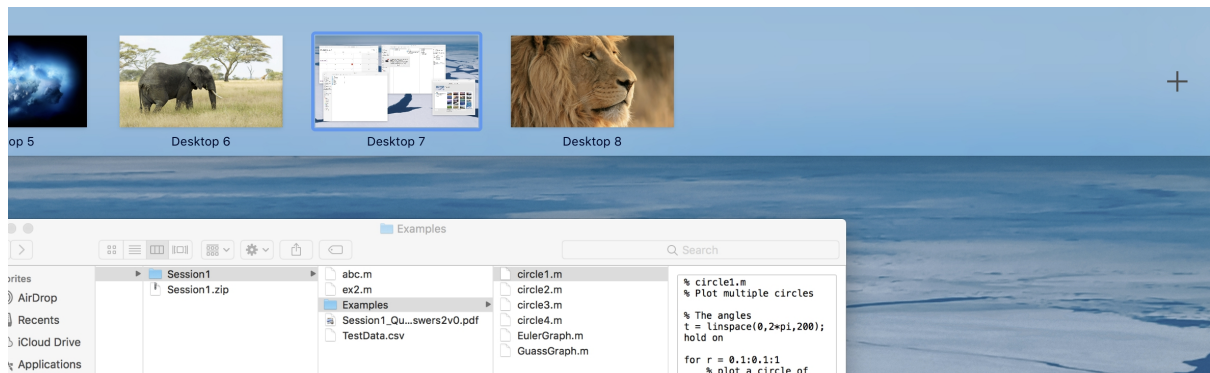
- Press the Mission Control Key, as shown on the right. 
- Hold down the **control** key and press the up arrow key, ▲.
- On a **trackpad**, swipe up with three fingers.
Swipe down to leave.

If you have windows hidden behind other windows, Mission Control spaces out all the windows so that you can select which window you want in front.



Virtual Desktops

Across the top of the screen, in Mission Control, is the **Spaces Bar**.



Hit the plus sign, + on the far right of the Spaces Bar.

This creates a **new Desktop**. You can have many different Desktops.

Desktops are shown on the Spaces Bar (see Desktop 6,7,8 in the image above).

You can easily move between desktops. Once you have created a new Desktop, you don't have to use Mission Control to switch Desktops. It is much quicker to holding down the Control key and pressing the left arrow key, ◀ or the right arrow key, ▶.

So, for example, you can have some notes open in one Desktop and MATLAB open in another Desktop and use control ◀ and control ▶ to quickly switch from the notes to MATLAB.

Note: If you maximise an application, it automatically opens in a new space with the rest of the Desktops. You can move to and from the space in the same way that you move from Desktop to Desktop.

Managing your Files

Files and Folders



A **file** is just a lot of ones and zeros stored in a permanent location on the computer. Each file is used to store a particular type of object.

It could contain a picture, a document, a program or many other types of object.

Each file has a name, which may also include a suffix (ending • something) which helps to show what the file contains. For example:

File name with suffix	Type of File
Lecturenotes.pdf	A document
ReadMe.txt	Plain Text
photo.jpg	A Picture
MyScript.m	A MATLAB Program

There are thousands of files on a typical computer. A **file system** is used to keep track of all the files. The file system is divided into folders.



A **folder**, also known as a **directory**, is a location where all the files related to a particular topic are stored. Folders help keep related files together, so they do not get mixed up with other files on the system.

Files and folders may seem basic, but keeping them organised can be a difficult habit to develop. It is always worth taking a few moments to correctly store your files.



When you download a file, it is usually stored automatically in your **Downloads** folder. If you want to store it long term, **move this file** so it is **stored in a sensible folder elsewhere** in your file system.



As well as storing files on your computer **locally**, it is sensible to **store a copy of your files online too**. e.g. [using OneDrive](#)

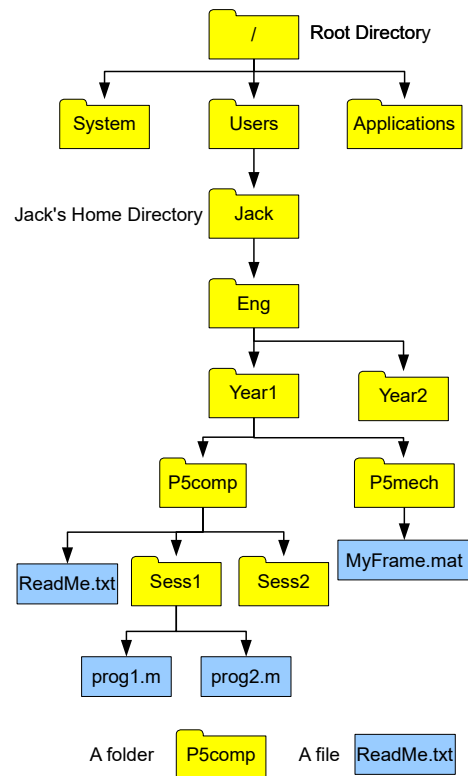


A File System

The whole file system is organised in a hierarchy of folders within folders. The diagram on the right represents a very small portion of a Mac file system. Another name for a folder is a **directory**.

At the top of the file system is the folder known as the **root directory**. It is specified with a simple forward slash "/". The root directory contains many other directories, more than the three shown here.

The diagram looks a bit like a family tree. The words **parent** and **child** are used in computing to describe the relationship between directories.



In the diagram:

- The directory **P5comp** is the **parent** of Sess1 and Sess2.
- Sess1 and Sess2 are the **children** of P5comp.



Home Directory

When using a computer, you don't want to mix up your files with those used by the operating system and other users. Therefore, each user on a system is allocated a **Home Directory**, where they can store their personal files. On a Mac, these are all kept in the **Users** folder. An example of **creating folders** is given on the next page.



Make sure that your **Home Directory** is always organised. This will make it easier to find files, and lead to efficient working.

If you already have some folders, you may want to move them around: [This video shows you 10 different ways](#). It includes **drag-and-drop**, **copy/paste**, setting **Favourites** and custom **Quick Actions**. These are very useful shortcuts!

Example: Creating Folders in your Home Folder

On the Dock along the bottom of the screen, Click on the **Finder** icon.



Click your **Home indicated by a house**, on the left hand sidebar.
Your contents will be shown on the right hand side.



If you do not see a house, from the Menu bar at the top of the screen:

- Select **Finder►Preferences**.
- Select the **SideBar** icon.
- Tick next to the house under **Favourites**.

Hold down the **control** key and click Home, on the right hand side.

*There are many different ways of doing this. From the **File** menu, click on the gear wheel icon or a right click, if right clicking is enabled on your mouse.*

Select **New Folder**

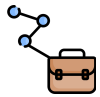
A new folder will appear in your Home. The name of the folder is highlighted so that you can type in the name of the folder.

To create the structure shown in the diagram on the previous page:

- Call the Folder **Eng** (stores files for your studies in Engineering Science)
- Double Click on the new folder, to view the contents.
- Inside the new folder, create another new folder called **Year1**.
- Inside **Year1**, create a folder called **P5computing** (storage for computing lab).

Previewing Files

Aim to build a structure of folders, so you can easily find files. e.g. If you create files for the mechanics laboratory, you put them into a **P5mechanics** folder in **Year1**. The **Finder** has [great preview capabilities](#) too, to help navigating your files.



File Paths

The **file path** is a way to describe the location of a file or folder, based on a fixed starting point. Every file/folder will have a unique **absolute path**.



The **Absolute Path of a file/folder** (e.g. fileA) is the path you would have to take from the **top of the system** (root directory) to reach **that file/folder**.

Example: Absolute Path of ReadMe.txt

Consider the file **ReadMe.txt** in the above diagram. Starting at the root directory, you would first have to go into the **Users** directory, then the users home directory (Jack), then **Eng**, **Year1**, **P5comp** until you arrive at **ReadMe.txt**. The Absolute path is

/Users/Jack/Eng/Year1/P5comp/ReadMe.txt



It is recommended that you [enable the Finder Path Bar](#).
With this, when you navigate your file system using Finder, you will **see the file paths** of the folder you currently have open.

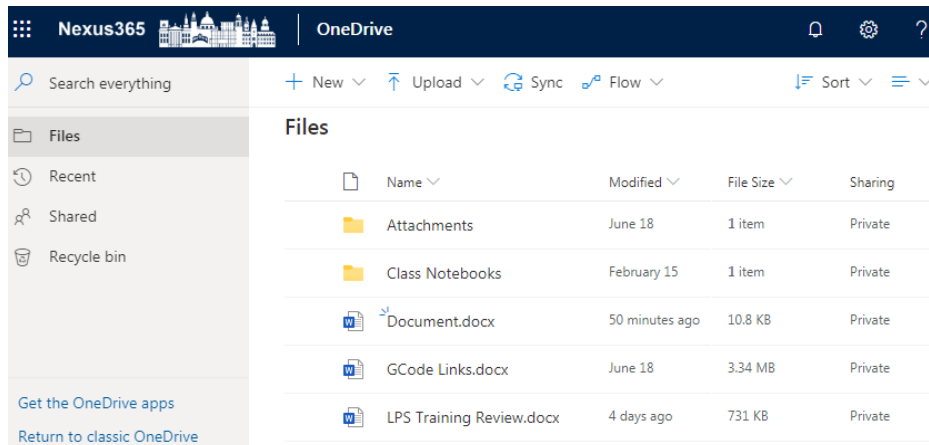
Backup using OneDrive

It is always a good idea to take a copy of your files, just in case anything happens to your computer. As part of your University Single Sign On (SSO) account, you have access to **One Drive**. This is a file storage area linked to the Microsoft Office Suite available online.

- Visit [Office.com](https://office.com) and click **Sign In**.
- Use your SSO username with ending **@ox.ac.uk**
- At the **Shibboleth SSO Sign In** page, use your SSO username and password.

Microsoft
Sign in
abc0123@ox.ac.uk
No account? [Create one!](#)
[Can't access your account?](#)
[Sign-in options](#)
Next

Once you logged in, select **OneDrive** on your **dashboard** to open your file storage:



- Use the **Upload** button to add files or folders to your storage area. You can also drag and drop. Try uploading a Folder.
- In OneDrive, Right Click any file and select **Download** to download a file.



If you want to avoid manually **uploading a back up to OneDrive**, you can set up a folder on your computer to [sync using OneDrive](#).



Using Zip Folders

An easy way to transfer **multiple files** or folders between computers is to use a **zip file**. This stores all the data into a single file. It also uses compression software to reduce the size of the data.

Zipping Items into a File

- Open the file or folder in Finder
- Control-click it or tap it using two fingers
- Select Compress from the menu.

You will now see a .zip file is created.

Extracting a Zip File

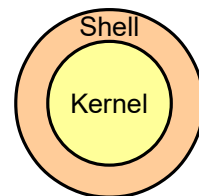
Double clicking on a zip file will extract the contents.

Using a Terminal

So far we have shown the the easiest way of interacting with the operating system: using a **Graphical User Interface** or **GUI**. This is where you interact with the computer using a mouse pointer and click to interact with applications.

Operating systems (OS) are designed like a nut:

- The main part of the OS is called the **Kernel**. This contains all the **programs to manage the computer** and hardware.
- Surrounding the kernel is the **Shell**. The shell contains the **software** that allows you to interact with the kernel.



The GUI that you use to interact with your computer is a part of the Shell. However, this is not the only way of interacting with the Kernel. There are also text based commands that allow you to control the OS without a mouse. This is known as using the **Command Line**.



To use the command line, we use a **Terminal** environment.
It is a simple window where we can type text.

Why use the Terminal?

Imagine Errol the Engineer has just returned from a six-month survey of materials in different off-shore structures. The 1430 samples have been run through a testing machine, resulting in 1430 data files. The research group has worked with files from this machine before, and know before they can graph the results the files need to be put through a program called **reformatData.sh**. In the past, they only had 20 files, so this script was run 20 times by hand. If Errol has to run **reformatData.sh** by hand using a GUI, they will have to **select and open a file 1430 times!** If it takes even 30 seconds to run each file, the whole process will take more than 12 hours. With the shell, Errol can instead assign the computer this mundane task!

You are not expected to become a terminal expert this year, but it is important to **know it exists and what it can do**. If you start practicing now, it is a good skill to be able to put on your CV. The next few pages give a brief introduction of how to navigate files. For a full introduction to shell, see this [self-paced online course](#).

Navigating Files using the Terminal

You cannot do anything in a terminal without knowing some commands. Different terminals will expect different commands. On a Mac, when you open the Terminal it expects **bash** (for Bourne Again Shell) commands. This section will introduce some key commands for looking at your files in the Terminal, like you would using **Finder**. The basic tasks covered will be: Launching the Terminal, Checking the starting location, moving to a subfolder, listing the folders contents and then creating a folder.



1. Launch Terminal

- Click on **Launchpad**, then **Others**.
- Open the **Terminal** app.



2. Check Starting Location

When using the terminal, you have a **Current Working Directory**. That is your current location within the file system. This is like when you open Finder and have a particular Folder open. You can also think of it as looking at one folder.

In the terminal, enter the command :

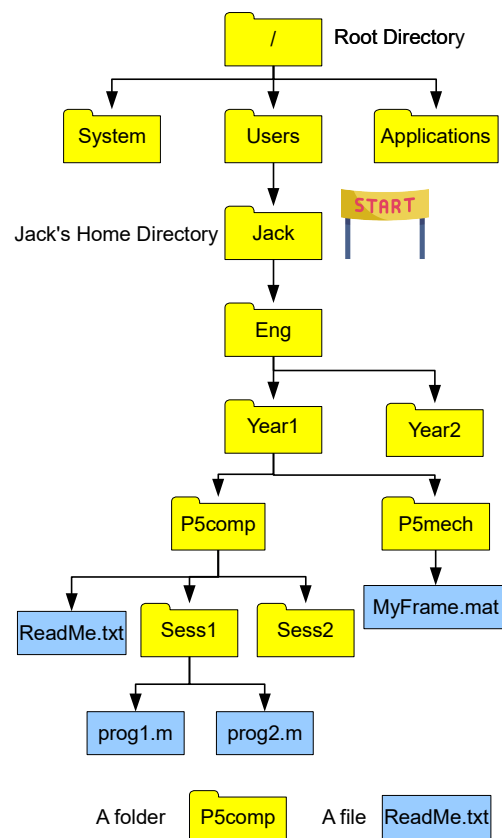
```
pwd
```

This **P**rints your **C**urrent **W**orking **D**irectory, your current location in the file system. To start with, the Current Working Directory is set to your Home directory.

Notice that when you press Enter, you will see a path returned.

In our example it would be:

/Users/Jack





3. List items in Current Folder

To list the content of the Current Working Directory enter

```
ls This is a lower case L followed by a lower case s
```

You should see a **list** of all the files and folders in your Home directory.

In our example, it would simply list one folder **Eng**.



4. Move into a Subfolder

To **move around** to look at other files/folders, use the command **cd**. It changes the current working **directory**. Here we move to **subfolder** called **Eng** then list contents.

```
cd Eng
```

```
pwd
```

```
ls
```

In our example, we would see the current path printed (due to the pwd command):

```
/Users/Jack/Eng
```

Then a list of folders Year1 and Year2.



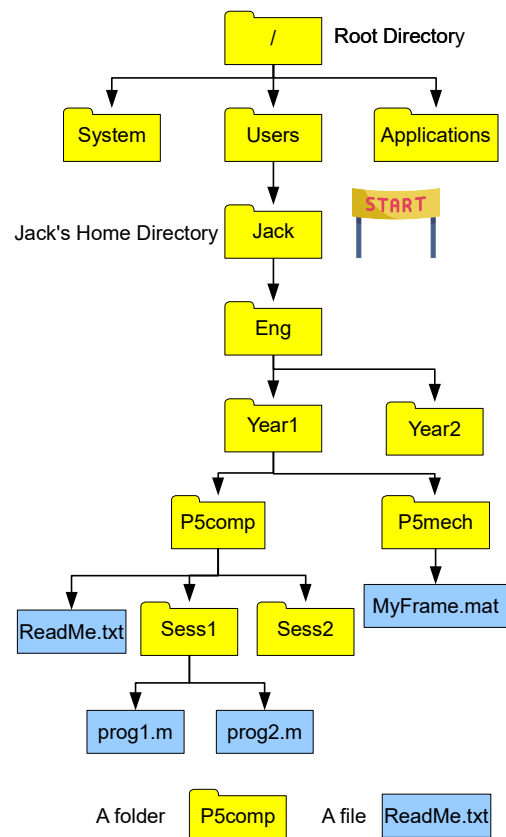
5. Create a new folder

To **create a new folder**, use the command **mkdir**. This stands for **make directory**.

```
mkdir Year3
```

```
ls
```

You should then see the new folder listed after the list command.





Relative Path

Earlier we introduced the **absolute path** (page 13). The absolute path of a file can be very long. Typing in the whole of the absolute path every time you need to use a file, would get very tedious. A quicker way to specify the path from the **Current Working Directory** to the file or folder you are interested in. This is called the **relative path** to a file. This describes a files location **relative** to the **Current Working Directory**.



The **Relative Path of a file/folder** is the path you would have to take from **the Current Working Directory** to the **original file/folder**.

Example: Relative Path moving Down

Considering the diagram on the previous page, if the Current Working Directory is **/Users/jack/Eng/Year1/P5comp**

- The Relative Path to **ReadMe.txt** is just **ReadMe.txt**
- The Relative Path to **Prog1.m** is **Sess1/Prog1.m**

A relative path does NOT start with a forward slash.

Example: Relative Path moving Up

You can also have a relative path that goes up the tree as well as down. Two full stops in a path indicates the parent directory from wherever you are in the path.

If the Current Working Directory is **/Users/Jack/Eng/Year1/P5comp/Sess2**

- The Relative Path to **Prog1.m** is **../Sess1/Prog1.m**
- The Relative Path to **MyFrame.mat** is **../../P5mech/ MyFrame.mat**

Relative paths take some getting used to, but can be a powerful tool when managing many files.

Examples with Relative Path

We can use the **ls** command to list the contents of any folder on the file system.

We can specify the folder we want by using the folder's **absolute path** :

```
ls /  
ls /Applications  
ls /Users
```

or **the relative path** of the folder:

```
ls Year1  
ls Year1/P5computing
```

You can use the tilde **~** as a shorthand to indicate your Home directory:

```
ls ~  
ls ~/Eng
```

Two full stops **..** indicates the parent folder. The folder one level above :

```
ls ..  
ls ../..
```

You can also use the two dots notation with the **cd** command:

```
cd Year1/P5computing  
pwd  
cd ..
```

The **cd** command on its own take you back to your home:

```
cd  
pwd
```

Now make another new directory inside **P5Computing** using the command **mkdir**.

```
cd ~/Year1/P5computing  
mkdir NewFolder
```

There are many more commands that you can use.

For a list of macOS commands, see <http://ss64.com/osx>

For a comprehensive introduction to shell, see this [self-paced online course](#).