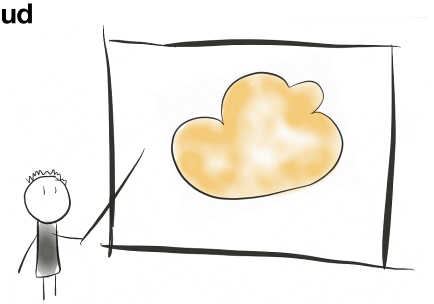
# CSC 346 - Cloud Computing

01: What is the Cloud?   An introduction to Docker

## The Cloud



## The Cloud

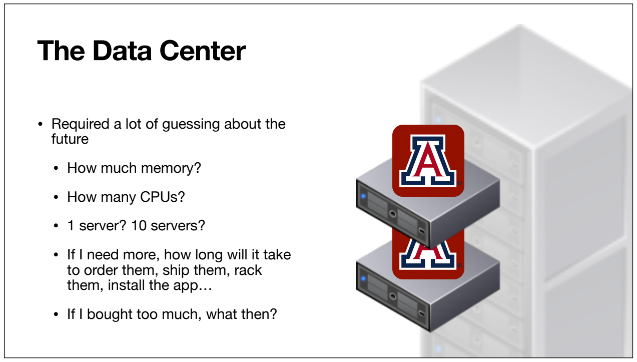
- Using someone else’s computers is actually pretty useful

## The Data Center

- Not too long ago, pretty much all big applications ran on physical servers in data centers that the Company or University controlled.

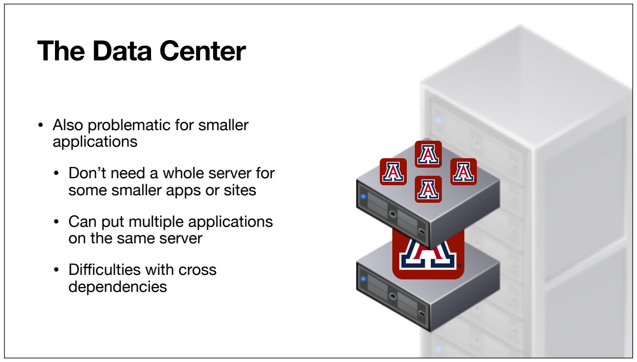
## The Data Center

- Our Apps pretty much used to be installed on specific physical servers.
- If it was a big app, maybe it was distributed across several physical servers.



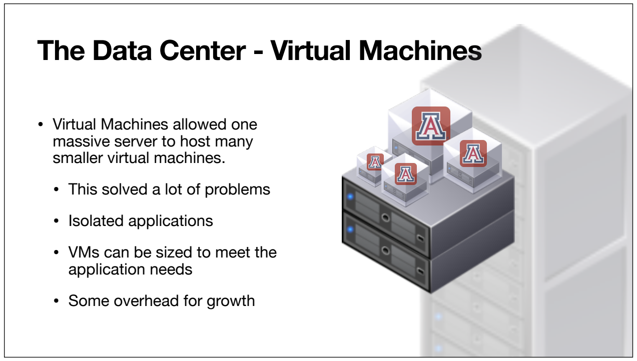
## The Data Center

- Required a lot of guessing about the future
  - How much memory?
  - How many CPUs?
  - 1 server? 10 servers?
  - If I need more, how long will it take to order them, ship them, rack them, install the app…
  - If I bought too much, what then?



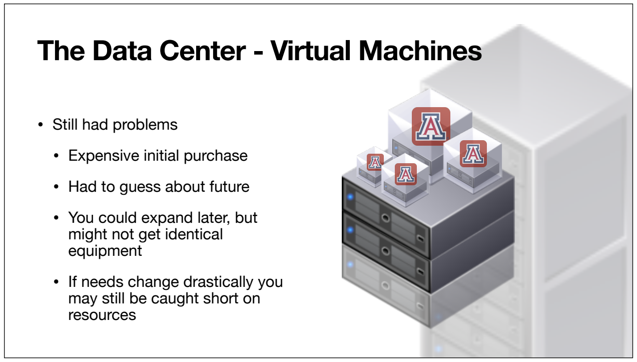
## The Data Center

- Also problematic for smaller applications
  - Don't need a whole server for some smaller apps or sites
  - Can put multiple applications on the same server
  - Difficulties with cross dependencies



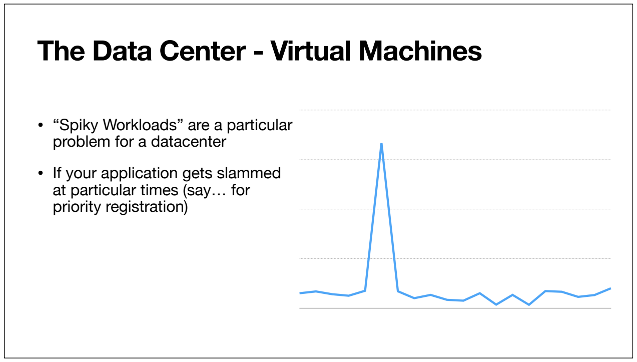
## The Data Center - Virtual Machines

- Virtual Machines allowed one massive server to host many smaller virtual machines.
  - This solved a lot of problems
  - Isolated applications
  - VMs can be sized to meet the application needs
  - Some overhead for growth



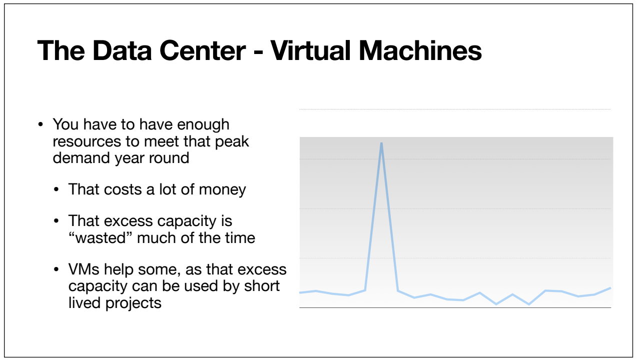
## The Data Center - Virtual Machines

- Still had problems
  - Expensive initial purchase
  - Had to guess about future
  - You could expand later, but might not get identical equipment
  - If needs change drastically you may still be caught short on resources



## The Data Center - Virtual Machines

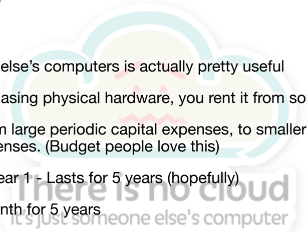
- “Spiky Workloads” are a particular problem for a datacenter
- If your application gets slammed at particular times (say… for priority registration)



## The Data Center - Virtual Machines

- You have to have enough resources to meet that peak demand year round
  - That costs a lot of money
  - That excess capacity is “wasted” much of the time
  - VMs help some, as that excess capacity can be used by short lived projects

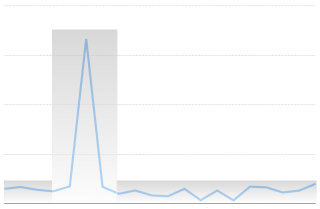
## The Cloud



- Using someone else's computers is actually pretty useful
- Instead of purchasing physical hardware, you rent it from someone else
- Costs move from large periodic capital expenses, to smaller monthly operational expenses. (Budget people love this)
  - $100,000 in year 1 - Lasts for 5 years (hopefully)
  - $2000 per month for 5 years
    - A bit more expensive over the long term possibly, but you don't need $100,000 up front

## The Cloud

- The biggest advantage of the Cloud is flexibility
  - Instead of paying for peak capacity year round, you can only pay for the 2 week spike
  - So maybe instead of $2000 a month its only $500 most months, and $2,000 that one peak month
    ($27,500 + $10,000 = $37,500)



## The Cloud

**Flexibility enables many different use cases**

- Autoscaling - detect when your backend hosts are getting stressed and automatically deploy more backend resources. Get rid of them as the load subsides
- Experiments - deploy additional development environments in parallel to your production environments. Maybe each developer or feature gets dedicated resources
- Try new things faster - you don't have to wait for new CPUs to be delivered to your datacenter. You can try new resources quickly and relatively cheaply.

# The Cloud

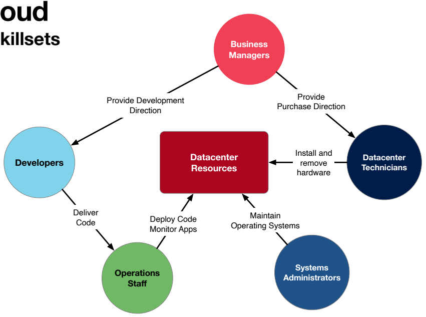
## Pay Per Hour vs Pay Per Request

- Cloud vendors offer many higher level services that shift the compute calculation
  - Virtual Servers are pay per hour.  You pick a configuration, and it costs that much as long as you have the server "on".
  - Other services are pay per request. You configure the service, and then you pay a small fraction for each request the service handles. This can offer tremendous savings for smaller services, but could also benefit large ones.
  - Become, hire, or befriend a cloud economist.

# The Cloud

## Shifting Skillsets

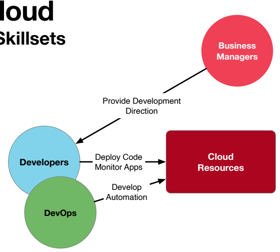
Datacenter Application Model



# The Cloud

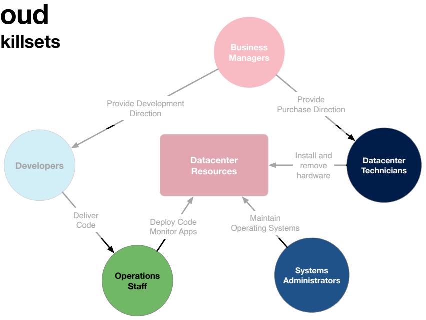
## Shifting Skillsets

Cloud Application Model

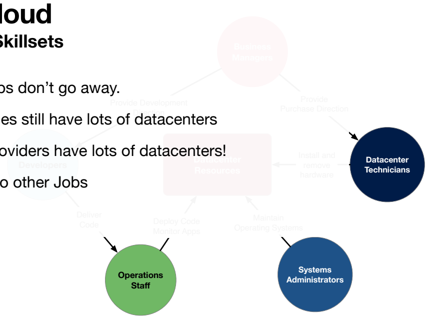


## The Cloud
### Shifting Skillsets

What about these folks?



## The Cloud
### Shifting Skillsets

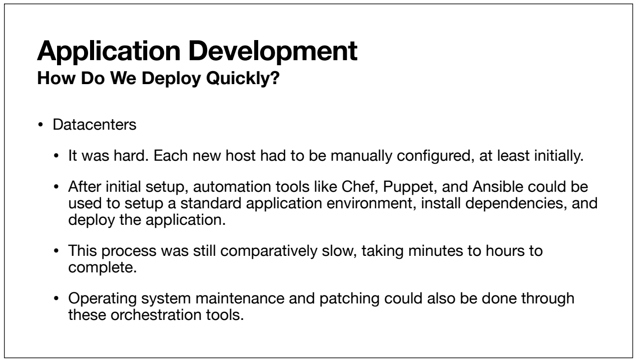


- These jobs don’t go away.
- Companies still have lots of datacenters
- Cloud Providers have lots of datacenters!
- Migrate to other Jobs

## Application Development
### It’s All About Speed of Deployment

- Research shows one of the best indicators of high performing development teams is how often they deploy new code to production, and how fast they can do this*
- Requires automation at all levels
- Cloud providers are easier to automate
  - API First mentality

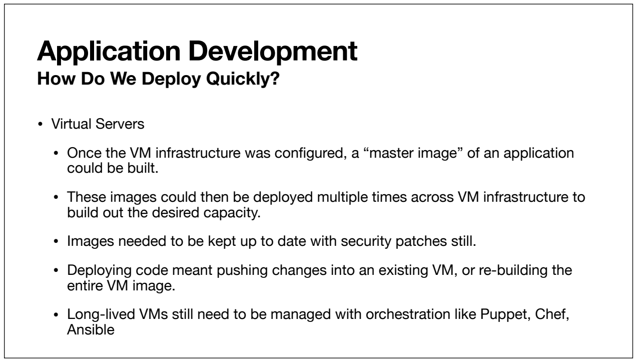
*Accelerate: The Science of Lean Software and DevOps: Building and Scaling High Performing Technology Organizations
Forsgren, Nicole ; Humble, Jez ; Kim, Gene ; 2018
Full text available at: O'Reilly Safari Learning Platform Academic
https://arizona-primo.hosted.exlibrisgroup.com/primo-explore/fulldisplay?docid=01UA_ALMA21382514420003843&context=L&vid=01UA



## Application Development

### How Do We Deploy Quickly?

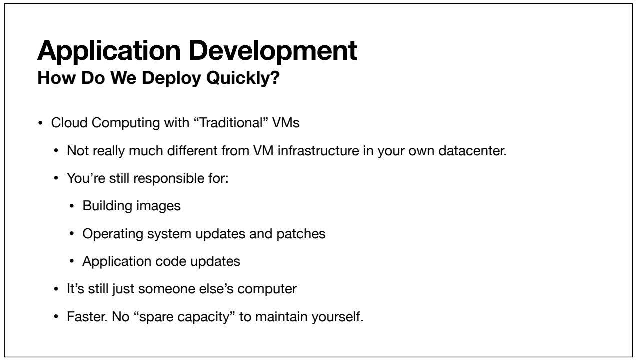
- Datacenters
  - It was hard. Each new host had to be manually configured, at least initially.
  - After initial setup, automation tools like Chef, Puppet, and Ansible could be used to setup a standard application environment, install dependencies, and deploy the application.
  - This process was still comparatively slow, taking minutes to hours to complete.
  - Operating system maintenance and patching could also be done through these orchestration tools.



## Application Development

### How Do We Deploy Quickly?

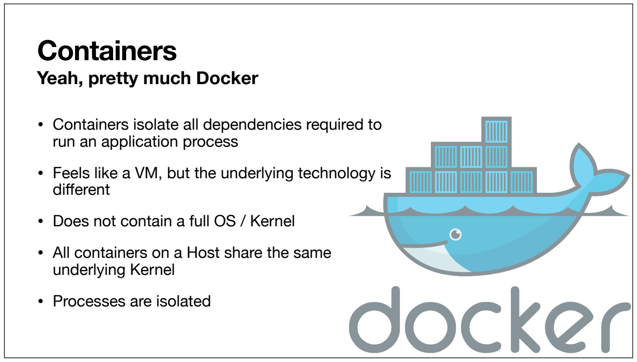
- Virtual Servers
  - Once the VM infrastructure was configured, a “master image” of an application could be built.
  - These images could then be deployed multiple times across VM infrastructure to build out the desired capacity.
  - Images needed to be kept up to date with security patches still.
  - Deploying code meant pushing changes into an existing VM, or re-building the entire VM image.
  - Long-lived VMs still need to be managed with orchestration like Puppet, Chef, Ansible



## Application Development

### How Do We Deploy Quickly?

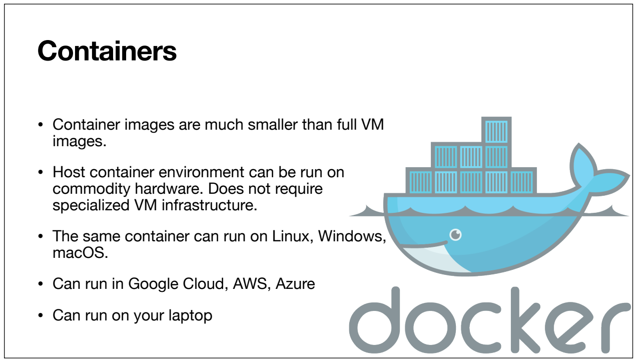
- Cloud Computing with “Traditional” VMs
  - Not really much different from VM infrastructure in your own datacenter.
  - You’re still responsible for:
    - Building images
    - Operating system updates and patches
    - Application code updates
  - It’s still just someone else’s computer
  - Faster. No “spare capacity” to maintain yourself.



## Containers

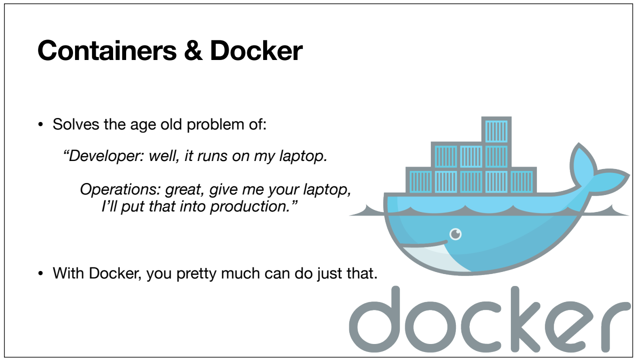
**Yeah, pretty much Docker**

- Containers isolate all dependencies required to run an application process
- Feels like a VM, but the underlying technology is different
- Does not contain a full OS / Kernel
- All containers on a Host share the same underlying Kernel
- Processes are isolated



## Containers

- Container images are much smaller than full VM images.
- Host container environment can be run on commodity hardware. Does not require specialized VM infrastructure.
- The same container can run on Linux, Windows, macOS.
- Can run in Google Cloud, AWS, Azure
- Can run on your laptop



## Containers & Docker

- Solves the age old problem of:

  *"Developer: well, it runs on my laptop.*

  *Operations: great, give me your laptop, I'll put that into production."*

- With Docker, you pretty much can do just that.

## Containers & Docker

### Key Concepts

- Containers isolate processes
- Containers encapsulate dependencies
- Running containers are ephemeral
- Images are immutable
- Images are composable

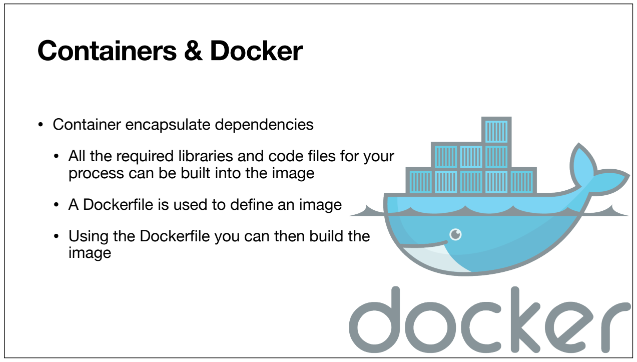
"that looks suspiciously like something that would show up on an exam"

## Containers & Docker

- Container isolate processes
  - A container is meant to run one process
  - You don't run Apache, Django, and MySQL all in one container
  - Instead have three separate containers
  - Allows each piece to be updated separately

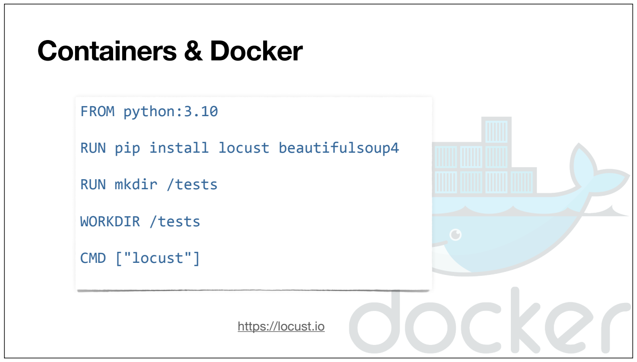
## Containers & Docker

- Container images are composable
  - You can start from a "base" image, and build your changes on top of this
  - Allows other teams/companies to be responsible for base configuration
  - You just have to worry about your specific dependencies
  - No limit to how many layers you want to go



## Containers & Docker

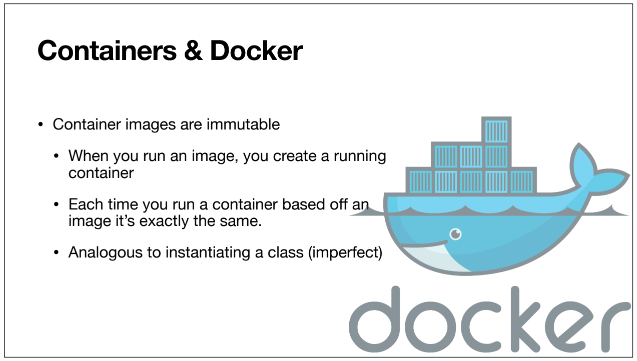
- Container encapsulate dependencies
  - All the required libraries and code files for your process can be built into the image
  - A Dockerfile is used to define an image
  - Using the Dockerfile you can then build the image



## Containers & Docker

```
FROM python:3.10

RUN pip install locust beautifulsoup4

RUN mkdir /tests

WORKDIR /tests

CMD ["locust"]
```

https://locust.io



## Containers & Docker

- Container images are immutable
  - When you run an image, you create a running container
  - Each time you run a container based off an image it's exactly the same.
  - Analogous to instantiating a class (imperfect)

## Containers & Docker

- Running containers are ephemeral
  - You don't "shut down" a container (at least in production)
  - When a container terminates, all changes to the container filesystem are lost
  - Any data the needs to be persisted must happen outside the container

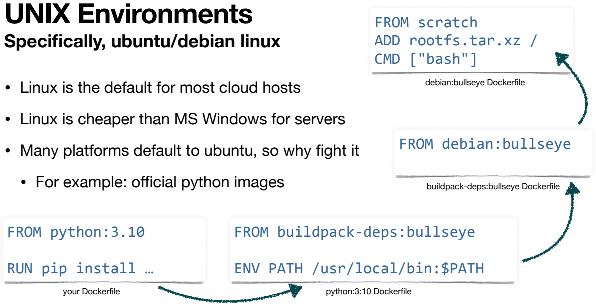
## Why Use Docker for CSC 346?

- You all have different laptops
- Docker gives us a way to have a standard development and evaluation environment across widely varying hosts
- You can turn in Dockerfiles and code files for us to run and test, without having to maintain a full Virtual Machine
- Remember that containers do not save their filesystem! Don't lose your work!

## UNIX Environments

**Specifically, ubuntu/debian linux**

- Linux is the default for most cloud hosts
- Linux is cheaper than MS Windows for servers
- Many platforms default to ubuntu, so why fight it
  - For example: official python images



```
FROM python:3.10

RUN pip install …
```

your Dockerfile

```
FROM buildpack-deps:bullseye

ENV PATH /usr/local/bin:$PATH
```

python:3:10 Dockerfile

```
FROM debian:bullseye
```

buildpack-deps:bullseye Dockerfile

```
FROM scratch
ADD rootfs.tar.xz /
CMD ["bash"]
```

debian:bullseye Dockerfile

# What is UNIX?

- Bell Labs in the early 1970s
- Spawned many Open Source derivatives
    - BSD → Darwin → macOS
    - Linux → Debian → Ubuntu
    - Linux → Android
- Nearly unchallenged in the server / cloud space
    - Great process model
    - Developer friendly
    - Great command line interface

# Linux Basics

## Files and Directories

- Linux organizes a filesystem based mainly on files and directories
    - Directories = Folders - We will not be pedantic about this 🙂
- A filesystem is organized into a **directory tree**
    - Directories = branches        Files = leaves
- A filesystem has a single root directory
- Linux uses the “forward slash”, or just “slash” as the directory delimiter

```
/Users/mark/Documents/csc246/01-cloud-docker.key
```

# Linux Basics

## Users and Groups

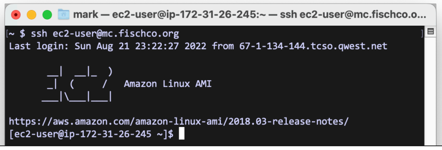
- Files are owned by users
- A ‘root’ user has access to everything
- Users can belong to groups
- File and Directories can have permissions that grant various access to users and groups
- Docker containers run everything inside them as a local root user, this is different from the host’s root user.

# Linux Basics

## Connecting

- A remote host is usually accessed through a Secure Shell - ssh

```
$ ssh username@hostname
```



mark — ec2-user@ip-172-31-26-245:~ — ssh ec2-user@mc.fischco.o...

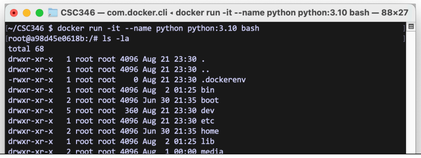
```
~ $ ssh ec2-user@mc.fischco.org
Last login: Sun Aug 21 23:22:27 2022 from 67-1-134-144.tcso.qwest.net

       __|  __|_  )
       _|  (     /   Amazon Linux AMI
      ___|\___|___|

https://aws.amazon.com/amazon-linux-ami/2018.03-release-notes/
[ec2-user@ip-172-31-26-245 ~]$ 
```

# Linux Basics

## Connecting

- A local docker container can be accessed either through the initial run command, or by an exec command.

```
$ docker run -it --name python python:3.10 bash
```



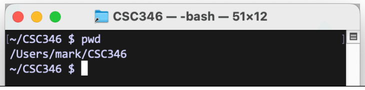
CSC346 — com.docker.cli ◂ docker run -it --name python python:3.10 bash — 88×27

```
~/CSC346 $ docker run -it --name python python:3.10 bash
root@a98d45e0618b:/# ls -la
total 68
drwxr-xr-x   1 root root 4096 Aug 21 23:30 .
drwxr-xr-x   1 root root 4096 Aug 21 23:30 ..
-rwxr-xr-x   1 root root    0 Aug 21 23:30 .dockerenv
drwxr-xr-x   1 root root 4096 Aug  2 01:25 bin
drwxr-xr-x   2 root root 4096 Jun 30 21:35 boot
drwxr-xr-x   5 root root  360 Aug 21 23:30 dev
drwxr-xr-x   1 root root 4096 Aug 21 23:30 etc
drwxr-xr-x   2 root root 4096 Jun 30 21:35 home
drwxr-xr-x   1 root root 4096 Aug  2 01:25 lib
drwxr-xr-x   2 root root 4096 Aug  1 00:00 media
```

# Linux Basics

## Where Am I?

- When you first connect to a linux host, your CLI session will usually start in the user's home directory
- Docker containers usually start at the WORKDIR defined in that Image's Dockerfile
  - If WORKDIR is not defined, you'll start at the filesystem root: /
- Use **`pwd`** to see your filesystem location (Present Working Directory)

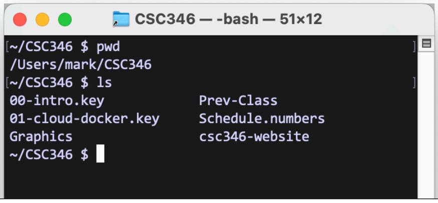


```
~/CSC346 $ pwd
/Users/mark/CSC346
~/CSC346 $ 
```

## Linux Basics

### What Stuff Is Here?

- To see the contents of the directory you're in, use the `ls` command (list)

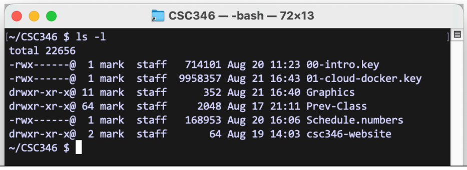


```
~/CSC346 $ pwd
/Users/mark/CSC346
~/CSC346 $ ls
00-intro.key            Prev-Class
01-cloud-docker.key     Schedule.numbers
Graphics                csc346-website
~/CSC346 $ 
```

## Linux Basics

### CLI Arguments

- Most CLI commands support arguments and options. Tells the command to do different things.
- The `ls` command accepts the `-l` option to list files in the long format.

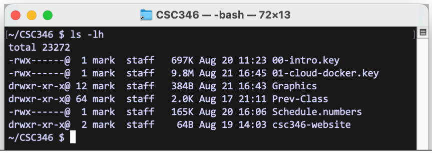


```
~/CSC346 $ ls -l
total 22656
-rwx------@  1 mark  staff   714101 Aug 20 11:23 00-intro.key
-rwx------@  1 mark  staff  9958357 Aug 21 16:43 01-cloud-docker.key
drwxr-xr-x@ 11 mark  staff      352 Aug 21 16:40 Graphics
drwxr-xr-x@ 64 mark  staff     2048 Aug 17 21:11 Prev-Class
-rwx------@  1 mark  staff   168953 Aug 20 16:06 Schedule.numbers
drwxr-xr-x@  2 mark  staff       64 Aug 19 14:03 csc346-website
~/CSC346 $ 
```

## Linux Basics

### CLI Arguments

- By default the `-l` long format shows file sizes in bytes.
- Use the `-h` option to show sizes in human readable format.
- Multiple options can be combined with the same dash: `-lh`

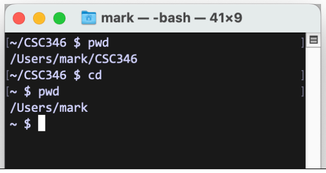


```
~/CSC346 $ ls -lh
total 23272
-rwx------@  1 mark  staff   697K Aug 20 11:23 00-intro.key
-rwx------@  1 mark  staff   9.8M Aug 21 16:45 01-cloud-docker.key
drwxr-xr-x@ 12 mark  staff   384B Aug 21 16:43 Graphics
drwxr-xr-x@ 64 mark  staff   2.0K Aug 17 21:11 Prev-Class
-rwx------@  1 mark  staff   165K Aug 20 16:06 Schedule.numbers
drwxr-xr-x@  2 mark  staff    64B Aug 19 14:03 csc346-website
~/CSC346 $ 
```

# Linux Basics

## Moving Yourself Around

- To move to a different directory, use the `cd` command (Change Directory)
- If used without an argument, `cd` will take you to your home directory.

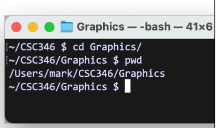


```
~/CSC346 $ pwd
/Users/mark/CSC346
~/CSC346 $ cd
~ $ pwd
/Users/mark
~ $ 
```

# Linux Basics

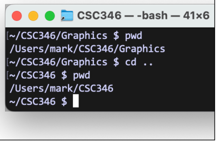
## Moving Yourself Around

- To move into another directory contained in the current one, use `cd dirname`



```
~/CSC346 $ cd Graphics/
~/CSC346/Graphics $ pwd
/Users/mark/CSC346/Graphics
~/CSC346/Graphics $ 
```

- To move up a directory, use the special "`..`" directory



```
~/CSC346/Graphics $ pwd
/Users/mark/CSC346/Graphics
~/CSC346/Graphics $ cd ..
~/CSC346 $ pwd
/Users/mark/CSC346
~/CSC346 $ 
```

# Linux Basics

## Core CLI Commands

| | |
|---|---|
| `pwd` | Prints your present working directory |
| `ls` | Lists the files in your current directory |
| `ls -lh` | Lists the files in your current directory in long form, with human readable file sizes |
| `cd [dir]` | Change your current working directory to `[dir]` |
| `mkdir [dir]` | Create a new directory named `dir` inside your current working directory |
| `mv [from] [to]` | Move a file from one location to another. If `to` is not within another directory, it renames the file in your current directory |
| `cp [from] [to]` | Copy a file `from` one location `to` another |
| `rm [file]` | Delete a `file` (remove it) |

# Linux Basics
## Core CLI Commands

| | |
|---|---|
| `cat [file]` | Prints the full contents of **`file`** to the screen |
| `grep [string] [file]` | Search **`file`** for the specified **`string`** |
| `head -n[count] [file]` | Print the first **`n`** lines of a **`file`** to the screen. |
| `tail -n[count] [file]` | Print the last **`n`** lines of a **`file`** to the screen. |
| `tail -f [file]` | Print the last few lines of a **`file`** to the screen, and continue to follow it as new lines are added. |
| `less [file]` | Prints out the contents of the first page of a file to your screen, and gives you keyboard commands for navigating through the file. Read-only. |

# Linux Basics
## CLI Text Editors

- Popular editors: **`vi, vim, emacs, nano`**
  - All keyboard and text based. No mouse.
- I mostly try and avoid CLI text editors. I like my GUI!
  - We'll see many strategies for avoiding the CLI editors
- When I need to, I mostly use **`vim`** or **`vi`** depending on what is available

# Linux Basics
## STDOUT, Redirection, and Pipes

- UNIX has a concept of Standard Out (STDOUT) and Standard Error (STDERR)
- By default STDOUT is directed to your terminal screen
- STDOUT can be redirected to other places though

| | |
|---|---|
| `ls -l > output.txt` | Sends the **`STDOUT`** of the **`ls`** command to a file named **`output.txt`**. If that file exists, it will be overwritten. If the file does not exist, it will be created. |
| `ls -l >> output.txt` | Appends the **`STDOUT`** of the **`ls`** command to a file named **`output.txt`**. If that file exists, it will add new output to the end of the file. If the file does not exist, it will be created. |
| `python3 ./prog.py \| less` | Pipe the **`STDOUT`** of the python program to **`less`**. This lets you scroll through the output of **`prog.py`** while still letting new text come in at the bottom. |

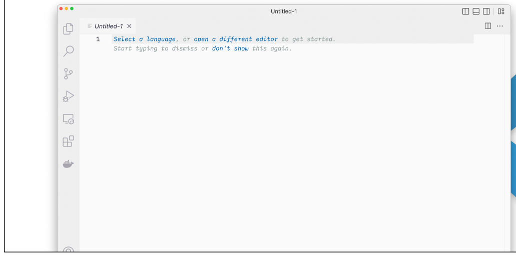
# Development Environments

## Microsoft VS Code

- Not required, but it's really great
- Free
- GUI Text editor and terminal all in one
- Can open a local folder and use it as a project
- Customizable
- Plugins for just about everything

# Development Environments

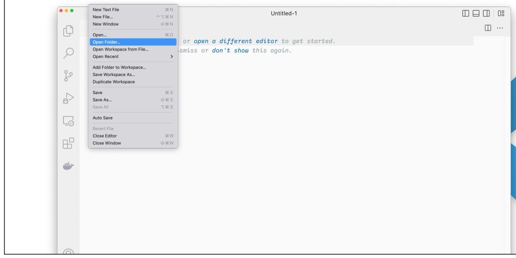
## Microsoft VS Code



Select a language, or open a different editor to get started.
Start typing to dismiss or don't show this again.

# Development Environments

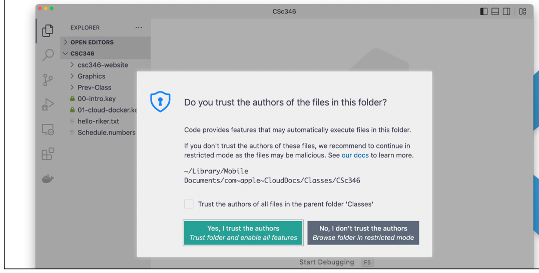
## Microsoft VS Code



... or open a different editor to get started.
...smiss or don't show this again.

## Development Environments

### Microsoft VS Code



Do you trust the authors of the files in this folder?

Code provides features that may automatically execute files in this folder.

If you don't trust the authors of these files, we recommend to continue in restricted mode as the files may be malicious. See our docs to learn more.

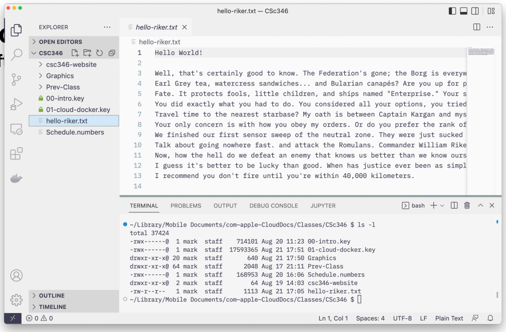
```
~/Library/Mobile
Documents/com~apple~CloudDocs/Classes/CSc346
```

□ Trust the authors of all files in the parent folder 'Classes'

Yes, I trust the authors
Trust folder and enable all features
No, I don't trust the authors
Browse folder in restricted mode

## Devel

### Microsof



```
Hello World!

Well, that's certainly good to know. The Federation's gone; the Borg is everyw
Earl Grey tea, watercress sandwiches... and Bularian canapés? Are you up for p
Fate. It protects fools, little children, and ships named "Enterprise." Your s
You did exactly what you had to do. You considered all your options, you tried
Travel time to the nearest starbase? My oath is between Captain Kargan and mys
Your only concern is with how you obey my orders. Or do you prefer the rank of
We finished our first sensor sweep of the neutral zone. They were just sucked
Talk about going nowhere fast. and attack the Romulans. Commander William Rike
Now, how the hell do we defeat an enemy that knows us better than we know ours
I guess it's better to be lucky than good. When has justice ever been as simpl
I recommend you don't fire until you're within 40,000 kilometers.
```

```
~/Library/Mobile Documents/com~apple~CloudDocs/Classes/CSc346 $ ls -l
total 37424
-rwx------@  1 mark  staff    714101 Aug 20 11:23 00-intro.key
-rwx------@  1 mark  staff  17593365 Aug 21 17:51 01-cloud-docker.key
drwxr-xr-x@ 20 mark  staff       640 Aug 21 17:50 Graphics
drwxr-xr-x@ 64 mark  staff      2048 Aug 17 21:11 Prev-Class
-rwx------@  1 mark  staff    168953 Aug 20 16:06 Schedule.numbers
drwxr-xr-x@  2 mark  staff        64 Aug 19 14:03 csc346-website
-rw-r--r--   1 mark  staff      1113 Aug 21 17:05 hello-riker.txt
~/Library/Mobile Documents/com~apple~CloudDocs/Classes/CSc346 $ 
```

## Docker

### Installation

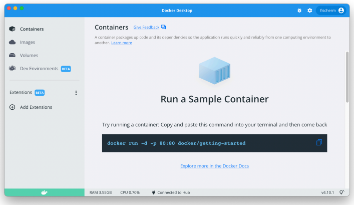
- For this class you will need access to Docker Desktop on a computer
  - Free for individual and educational uses
- Installers for Windows, Mac, and Linux

https://www.docker.com/products/docker-desktop/

# Docker

## Our First Container

- Once you have Docker Desktop installed and running, you should see a window like this.



Containers

A container packages up code and its dependencies so the application runs quickly and reliably from one computing environment to another.

Run a Sample Container

Try running a container: Copy and paste this command into your terminal and then come back

```
docker run -d -p 80:80 docker/getting-started
```

# Docker

## docker run

- Starting a new container from an image is done with the docker run command

```
$ docker run [OPTIONS] IMAGE [COMMAND] [ARG...]
```

```
$ docker run -it python:3.10 bash
```

# Docker

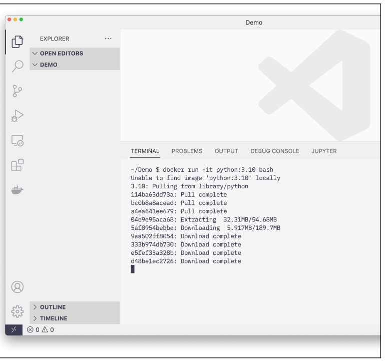
## docker run

```
$ docker run -it python:3.10 bash
```

- The `-it` options are for interactive `(i)` and connect tty terminal `(t)`
- The image is **`python`** and the tag for the image is `3.10`, this specifies which version of the image to run
- Once the container is running, we execute the **`bash`** command inside it. Since we connected our terminal to this, we should get a command prompt ‘inside’ the container

## Docker
### Our First Container

- We can run this command in our terminal
- Because we have never used the **`python:3.10`** image before, it must be downloaded from hub.docker.com



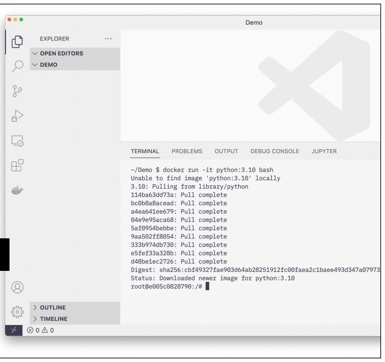
```
~/Demo $ docker run -it python:3.10 bash
Unable to find image 'python:3.10' locally
3.10: Pulling from library/python
114ba63dd73a: Pull complete
bc0b8a8acead: Pull complete
a4ea641ee679: Pull complete
04e9e95aca68: Extracting  32.31MB/54.68MB
5af0954bebbe: Downloading  5.917MB/189.7MB
9aa502ff8054: Download complete
333b974db730: Download complete
e5fef33a328b: Download complete
d48be1ec2726: Download complete
```

## Docker
### Our First Container

- Once the image has downloaded, our bash command is executed inside.
- You can see our terminal prompt has changed

```
root@e005c0828798:/#
```

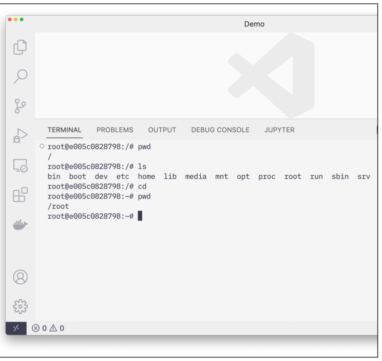
- We're root inside the container



```
~/Demo $ docker run -it python:3.10 bash
Unable to find image 'python:3.10' locally
3.10: Pulling from library/python
114ba63dd73a: Pull complete
bc0b8a8acead: Pull complete
a4ea641ee679: Pull complete
04e9e95aca68: Pull complete
5af0954bebbe: Pull complete
9aa502ff8054: Pull complete
333b974db730: Pull complete
e5fef33a328b: Pull complete
d48be1ec2726: Pull complete
Digest: sha256:cbf49327fae903d64ab28251912fc00faea2c1baee493d347a07973
Status: Downloaded newer image for python:3.10
root@e005c0828798:/#
```

## Docker
### Our First Container

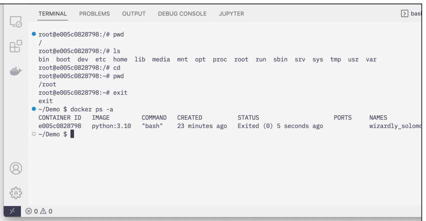
- We can use our linux commands here
- The **`pwd`** command shows we're currently at the filesystem root
- The **`ls`** command lists all the fils and directories at the root of the filesystem
- The **`cd`** command will take us to root's home directory



```
root@e005c0828798:/# pwd
/
root@e005c0828798:/# ls
bin  boot  dev  etc  home  lib  media  mnt  opt  proc  root  run  sbin  srv
root@e005c0828798:/# cd
root@e005c0828798:~# pwd
/root
root@e005c0828798:~#
```

# Docker

## Our First Container

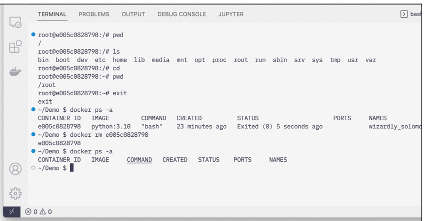


```
root@e005c0828798:/# pwd
/
root@e005c0828798:/# ls
bin  boot  dev  etc  home  lib  media  mnt  opt  proc  root  run  sbin  srv  sys  tmp  usr  var
root@e005c0828798:/# cd
root@e005c0828798:~# pwd
/root
root@e005c0828798:~# exit
exit
~/Demo $ docker ps -a
CONTAINER ID   IMAGE         COMMAND   CREATED          STATUS                     PORTS     NAMES
e005c0828798   python:3.10   "bash"    23 minutes ago   Exited (0) 5 seconds ago             wizardly_solomo
~/Demo $ 
```

- We can exit our container by typing the **`exit`** command
- This returns us to our host
- We can list all the running or stopped containers with the **`docker ps -a`** command

# Docker

## Our First Container



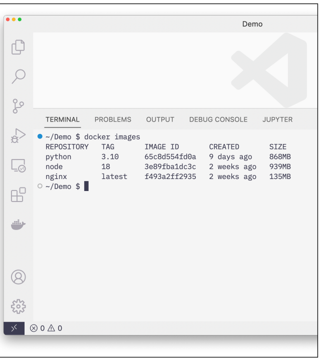
```
root@e005c0828798:/# pwd
/
root@e005c0828798:/# ls
bin  boot  dev  etc  home  lib  media  mnt  opt  proc  root  run  sbin  srv  sys  tmp  usr  var
root@e005c0828798:/# cd
root@e005c0828798:~# pwd
/root
root@e005c0828798:~# exit
exit
~/Demo $ docker ps -a
CONTAINER ID   IMAGE         COMMAND   CREATED          STATUS                     PORTS     NAMES
e005c0828798   python:3.10   "bash"    23 minutes ago   Exited (0) 5 seconds ago             wizardly_solomo
~/Demo $ docker rm e005c0828798
e005c0828798
~/Demo $ docker ps -a
CONTAINER ID   IMAGE     COMMAND   CREATED   STATUS    PORTS     NAMES
~/Demo $ 
```

- Docker containers are not removed by default
- Remove an exited container with **`docker rm [container id]`**
- Can also remove containers by name with **`docker rm [container name]`**

# Docker

## Our First Container

- You can list images you currently have locally with the **`docker images`** command

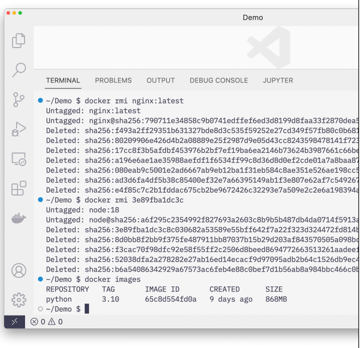


```
~/Demo $ docker images
REPOSITORY   TAG       IMAGE ID       CREATED       SIZE
python       3.10      65c8d554fd0a   9 days ago    868MB
node         18        3e89fba1dc3c   2 weeks ago   939MB
nginx        latest    f493a2ff2935   2 weeks ago   135MB
~/Demo $ 
```

# Docker

## Our First Container

- While still smaller than full Virtual Machine images, docker images can still clutter up your local storage
- Use **`docker rmi [image id]`** or **`docker rmi [image:tag]`** to remove them

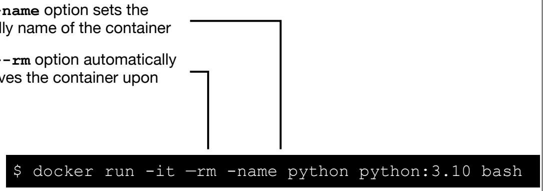


```
● ~/Demo $ docker rmi nginx:latest
  Untagged: nginx:latest
  Untagged: nginx@sha256:790711e34858c9b0741edffef6ed3d8199d8faa33f2870dea5
  Deleted: sha256:f493a2ff29351b631327bde8d3c535f59252e27cd349f57fb80c0b681
  Deleted: sha256:80209906e426d4b2a08889e25f2987d9e05d43cc8243598478141f723
  Deleted: sha256:17cc8f3b5afdbf453976b2bf7ef19ba6ea2146b73624b3987661c66be
  Deleted: sha256:a196e6ae1ae35988aefdf1f6534ff99c8d36d8d0ef2cde01a7a8baa87
  Deleted: sha256:080eab9c5001e2ad6667ab9eb12ba1f31eb584c8ae351e526ae198cc5
  Deleted: sha256:ad3d6fa4df5b38c85400ef32e7a66395149ab1f3e807e62af7c549267
  Deleted: sha256:e4f85c7c2b1fddac675cb2be9672426c32293e7a509e2c2e6a198394a
● ~/Demo $ docker rmi 3e89fba1dc3c
  Untagged: node:18
  Untagged: node@sha256:a6f295c2354992f827693a2603c8b9b5b487db4da0714f5913a
  Deleted: sha256:3e89fba1dc3c8c030682a53589e55bff642f7a22f323d324472fd814b
  Deleted: sha256:8d0bb8f2bb9f375fe487911bb87037b15b29d203af843570505a098bc
  Deleted: sha256:f3cac70f98dfc92e58f55ff2c2506d8beed8694772663513261aadee1
  Deleted: sha256:52038dfa2a278282e27ab16ed14ecacf9d97095adb2b64c1526db9ec4
  Deleted: sha256:b6a54086342929a67573ac6feb4e88c0bef7d1b56ab8a984bbc466c0b
● ~/Demo $ docker images
  REPOSITORY   TAG       IMAGE ID       CREATED       SIZE
  python       3.10      65c8d554fd0a   9 days ago    868MB
○ ~/Demo $ 
```

# Docker

## Our First Container

- Some additional run options
- The **`-name`** option sets the friendly name of the container
- The **`--rm`** option automatically removes the container upon exit

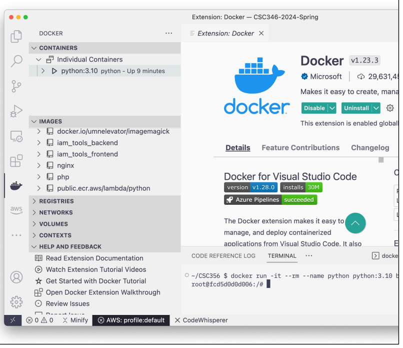


```
$ docker run -it —rm -name python python:3.10 bash
```

# Docker

## Our First Container

- Official Docker extension for VS Code is pretty useful



Makes it easy to create, mana

This extension is enabled global

Docker for Visual Studio Code

The Docker extension makes it easy to manage, and deploy containerized applications from Visual Studio Code. It also

```
○ ~/CSC356 $ docker run -it --rm --name python python:3.10 b
  root@fcd5d0d0d006:/# 
```

# Automation

## First Steps

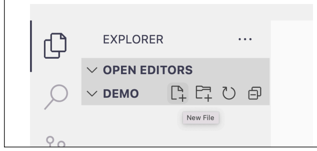
- Our CLI commands are already getting longer and harder to remember.
- Linux offers us a way to wrap up a set of commands into a script file that can be executed
    - This works by default for macOS and Linux based laptops
    - Windows uses PowerShell by default and can do similar things

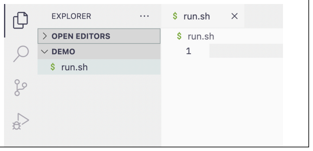
```
$ docker run -it —rm -name python python:3.10 bash
```

# Automation

## First Steps

- With a folder opened in VS Code, click on the new file icon next to the folder name in the Explorer tab
- Type in the name of the new file. For example **`run.sh`**
- The new file will open in a new tab in the Editor pane

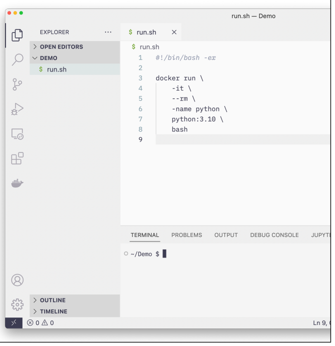




# Automation

## Bash Shell Script

- Instead of having everything on one line, it is often easier to break a command across multiple lines.
- Shell commands can be continued to a new line by having a backslash character as the final character on a line



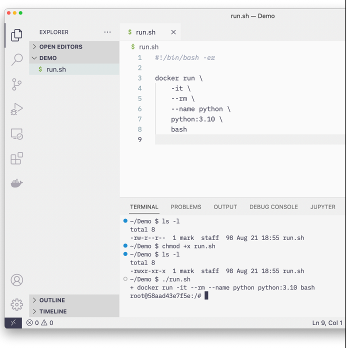
```
#!/bin/bash -ex

docker run \
    -it \
    --rm \
    -name python \
    python:3.10 \
    bash

```

```
~/Demo $ 
```

# Automation

## Bash Shell Script

- Before you can execute a shell script, you must flag it as executable
- The **`chmod`** command lets you change modes on a file
- The **`+x`** option adds the execute mode to the file
- Run the command with **`./[filename]`**



```
#!/bin/bash -ex

docker run \
    -it \
    --rm \
    --name python \
    python:3.10 \
    bash
```

```
~/Demo $ ls -l
total 8
-rw-r--r--  1 mark  staff  98 Aug 21 18:55 run.sh
~/Demo $ chmod +x run.sh
~/Demo $ ls -l
total 8
-rwxr-xr-x  1 mark  staff  98 Aug 21 18:55 run.sh
~/Demo $ ./run.sh
+ docker run -it --rm --name python python:3.10 bash
root@58aad43e7f5e:/#
```

next up: docker images in depth