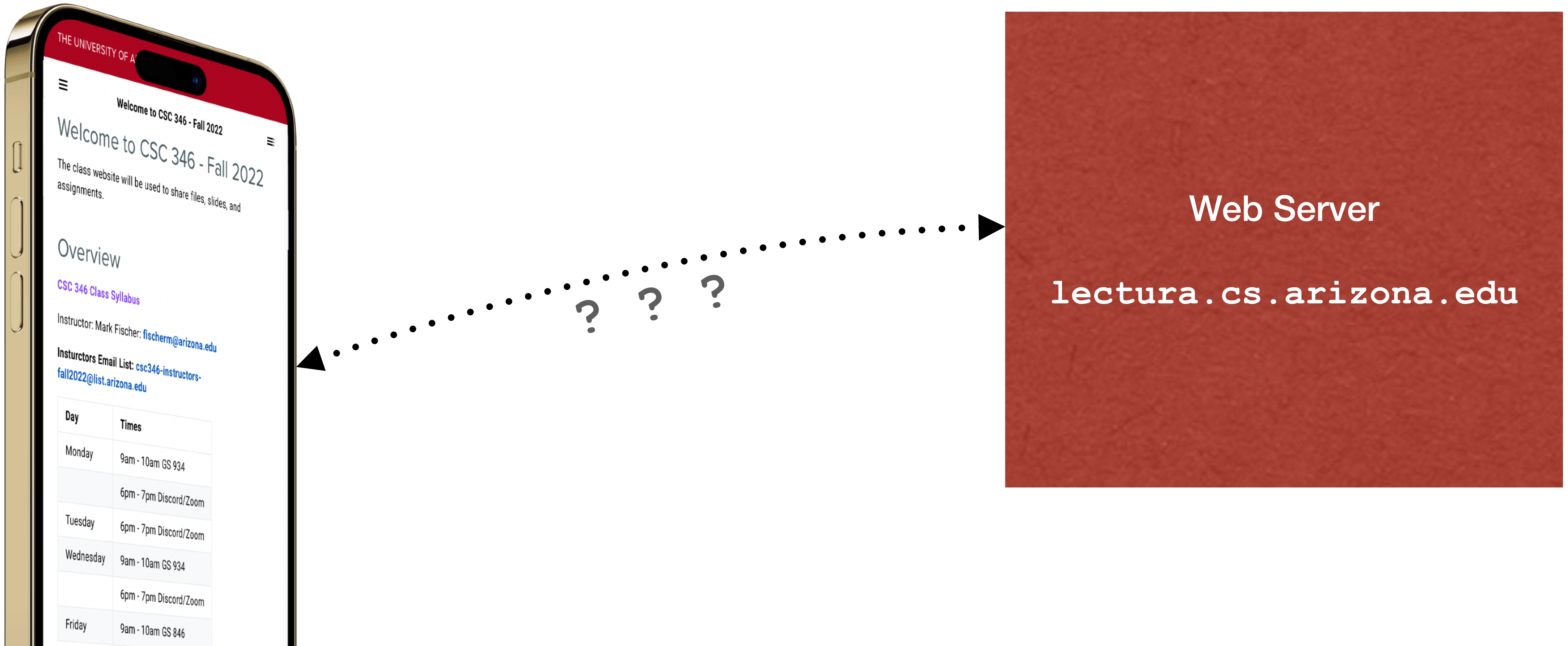
CSC 346 - Cloud Computing

04 - Web Servers, Ports & Sockets

Networking

Sockets

- How do things communicate over the internet? (the simple version)
- This is not a networking class 🤪



Welcome to CSC 346 - Fall 2022

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Overview

CSC 346 Class Syllabus

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	6pm - 7pm Discord/Zoom
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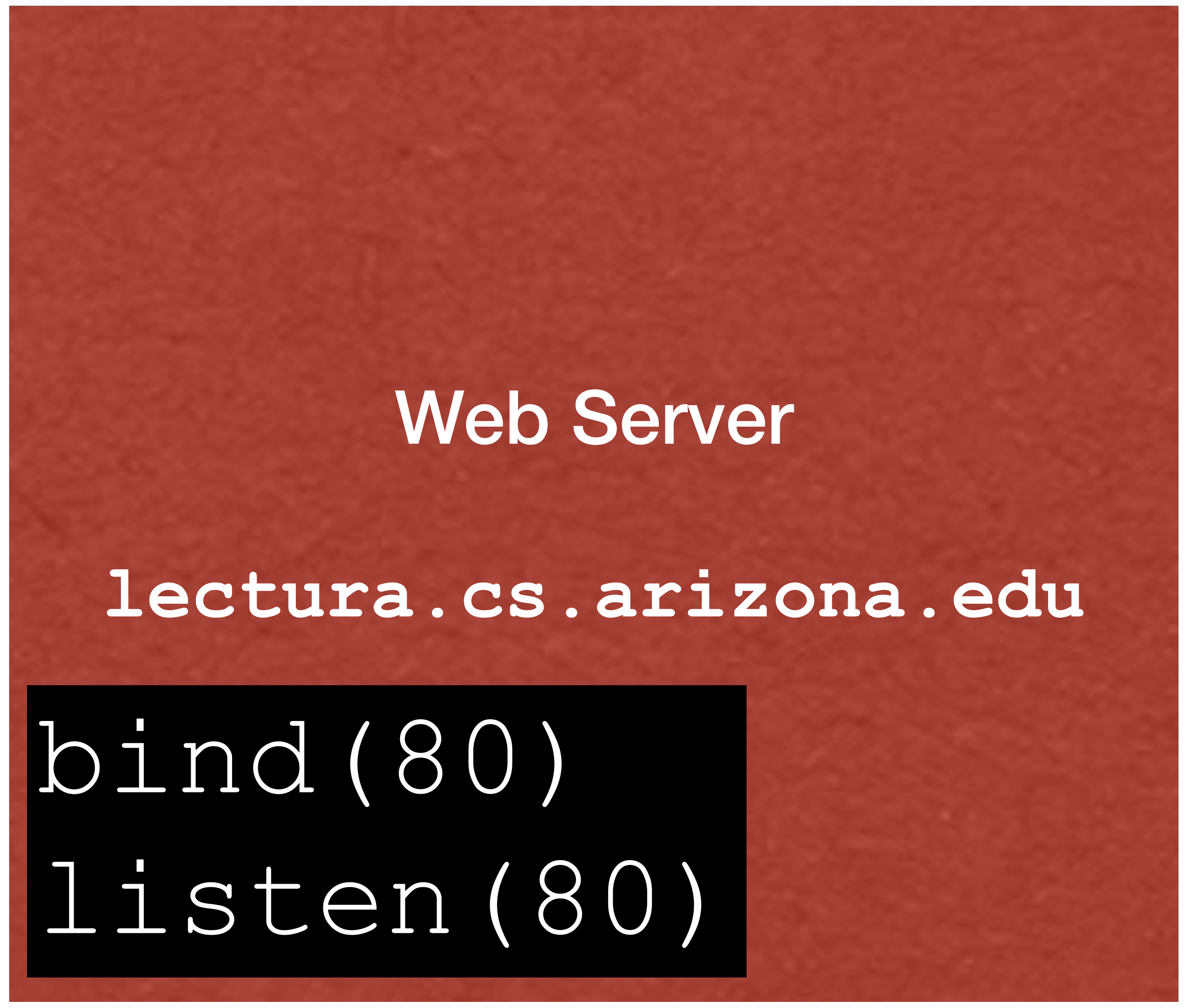
Networking

Sockets

- Some computing resource must ***bind*** to a specific ***port*** on its host, and then ***listen*** for incoming connections
- Listens on a specific ***port***
- For a HTTP, this software is our web server
- Since a bind must always precede a listen, we will typically omit the bind in our descriptions
- Most socket libraries will take care of this for you

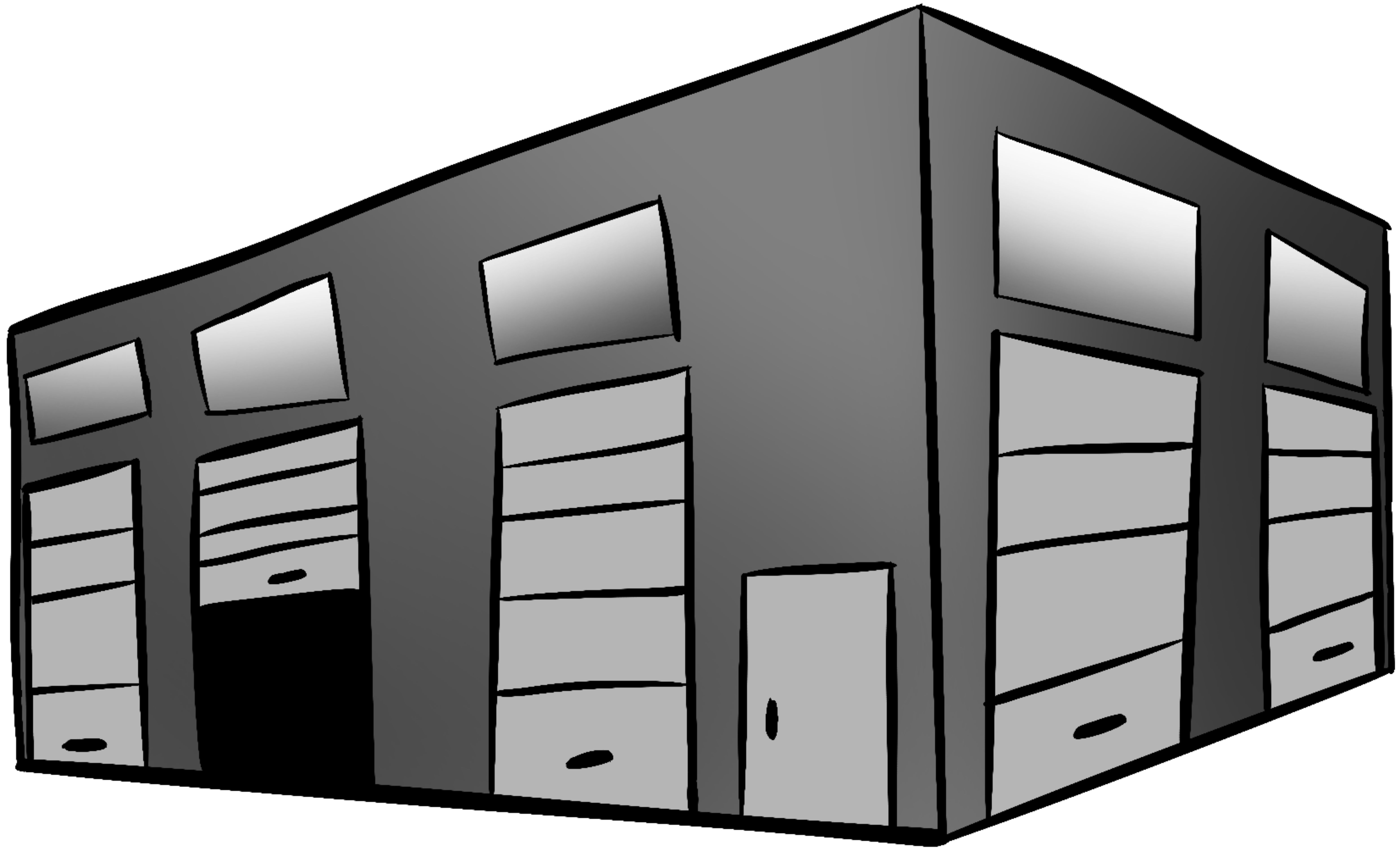


```
bind(80)
listen(80)
```

Networking Ports

What's a Port?

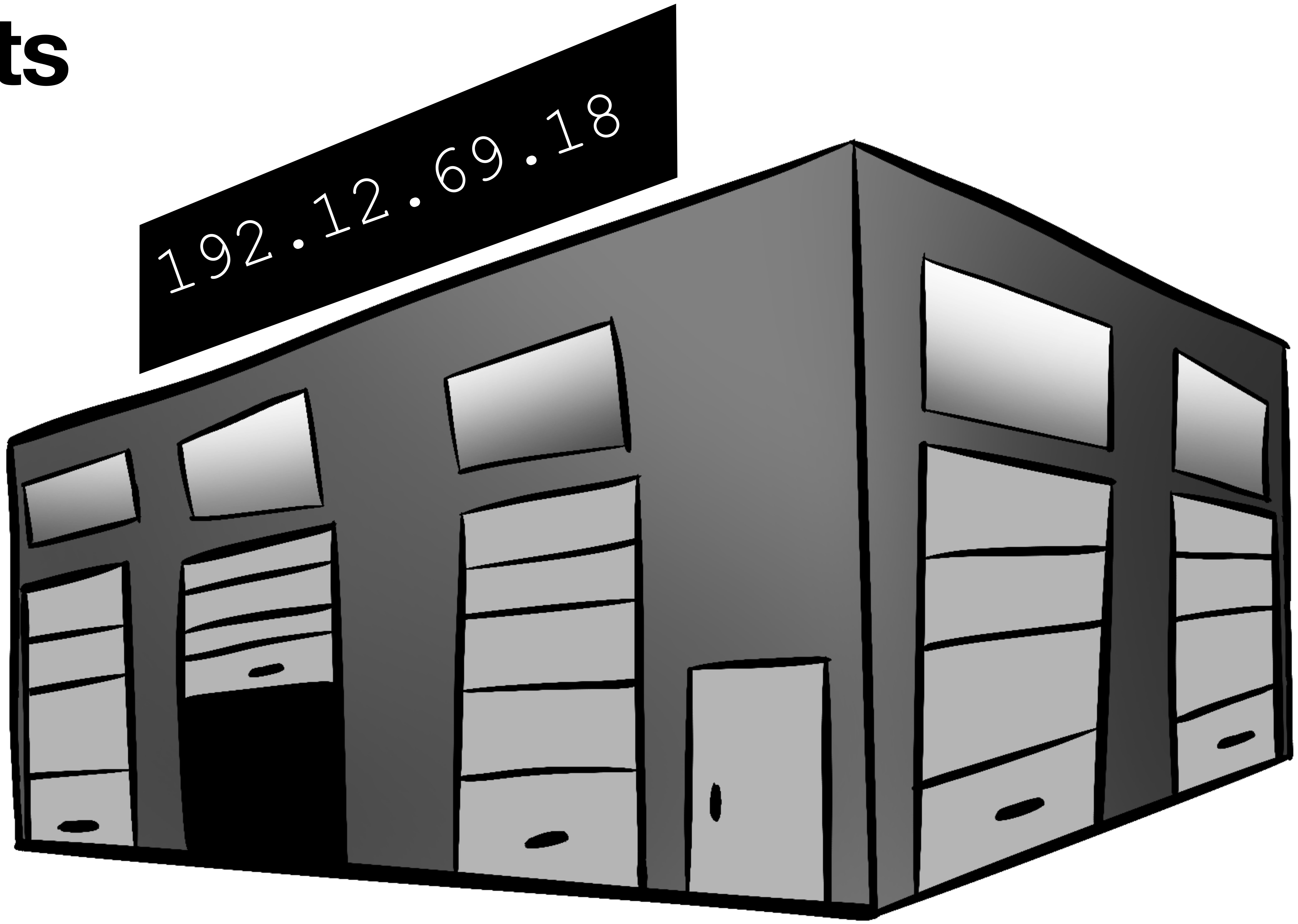
- It's basically a door
  - Italian: *Porta*
  - French: *Porte*
  - Spanish: *Puerta*
- I like to think of a port as a door to a building.



Networking Ports

What's a Port?

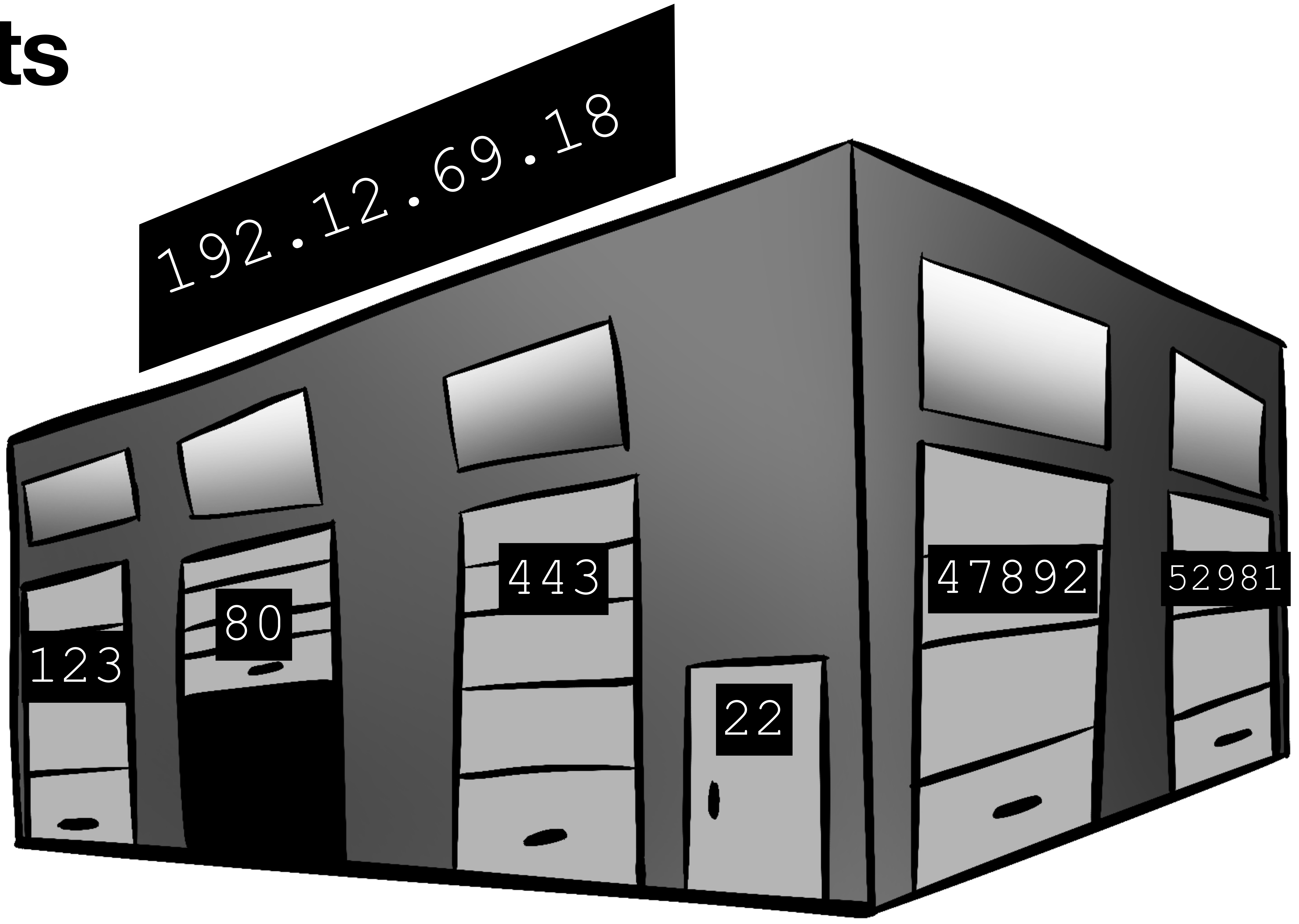
- If we have some device on the internet with an IP address assigned to it, we can think of that as a building.
- A port then can be thought of as a door to the building.
- Doors can let stuff in or out.



Networking Ports

What's a Port?

- Each port has a number
  - 16 bit unsigned integers
  - 0 - 65535
- Internet Assigned Numbers Authority (IANA) has designated different port ranges for different thing, but there's nothing stopping you from using them for whatever



Networking Ports

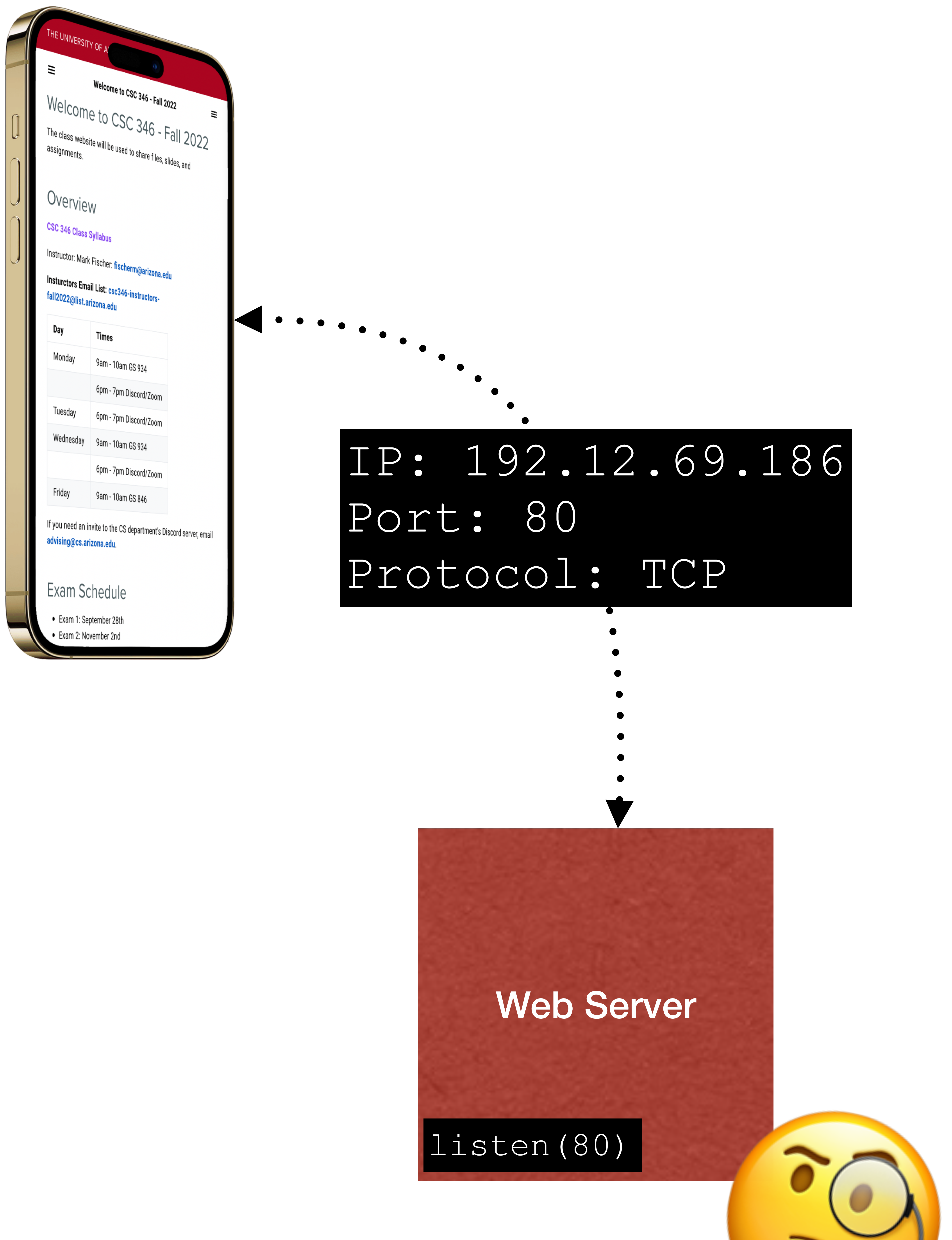
Common Ports

Port Number	Application
`22`	ssh - Secure Shell
`23`	Telnet (unsecure)
`25`	SMTP - Simple Mail Transport Protocol (unsecure)
`80`	HTTP - HyperText Transport Protocol (unsecure)
`123`	NTP - Network Time Protocol
`443`	HTTPS - HTTP Secure
`587`	SMTP Secure
`3306`	MySQL
`25565`	Minecraft

Networking

Sockets

- A client then opens a socket to the server
- A socket data stream that sits on top of the network layer provided by the operating system.
- A socket is described by an ***IP address***, a ***port***, and a ***transport protocol***
- For our class, we'll use TCP for our protocol
    - Transmission Control Protocol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Exam Schedule

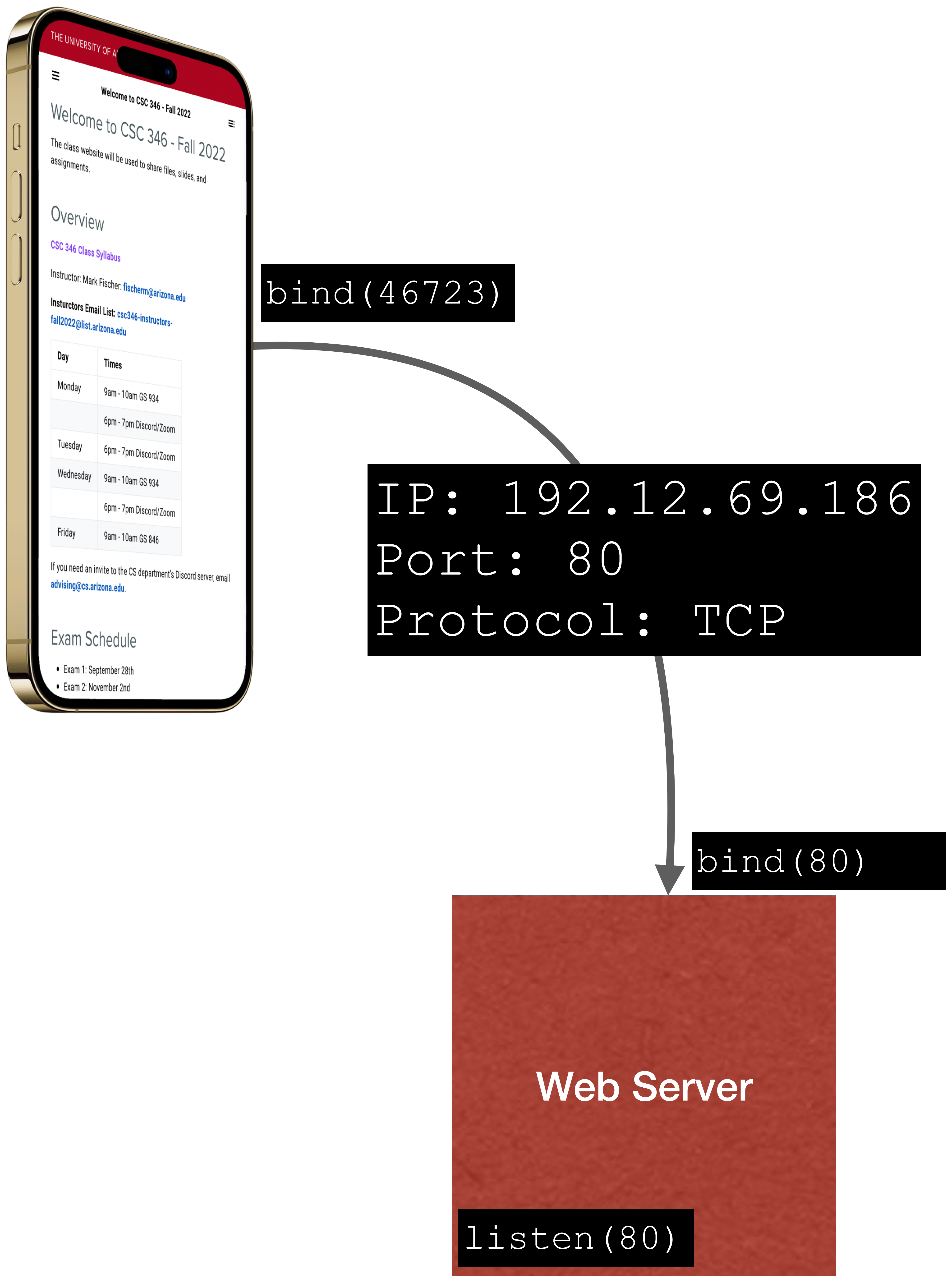
- Exam 1: September 28th
- Exam 2: November 2nd

```
IP: 192.12.69.186
Port: 80
Protocol: TCP
```

Networking

Sockets

- Both sides must ***bind*** to a port
- The server binds to the well known port 80, since the clients need to know this
- The client typically uses a random high number available port
- As part of the socket connection, the client tells the server what port it is using



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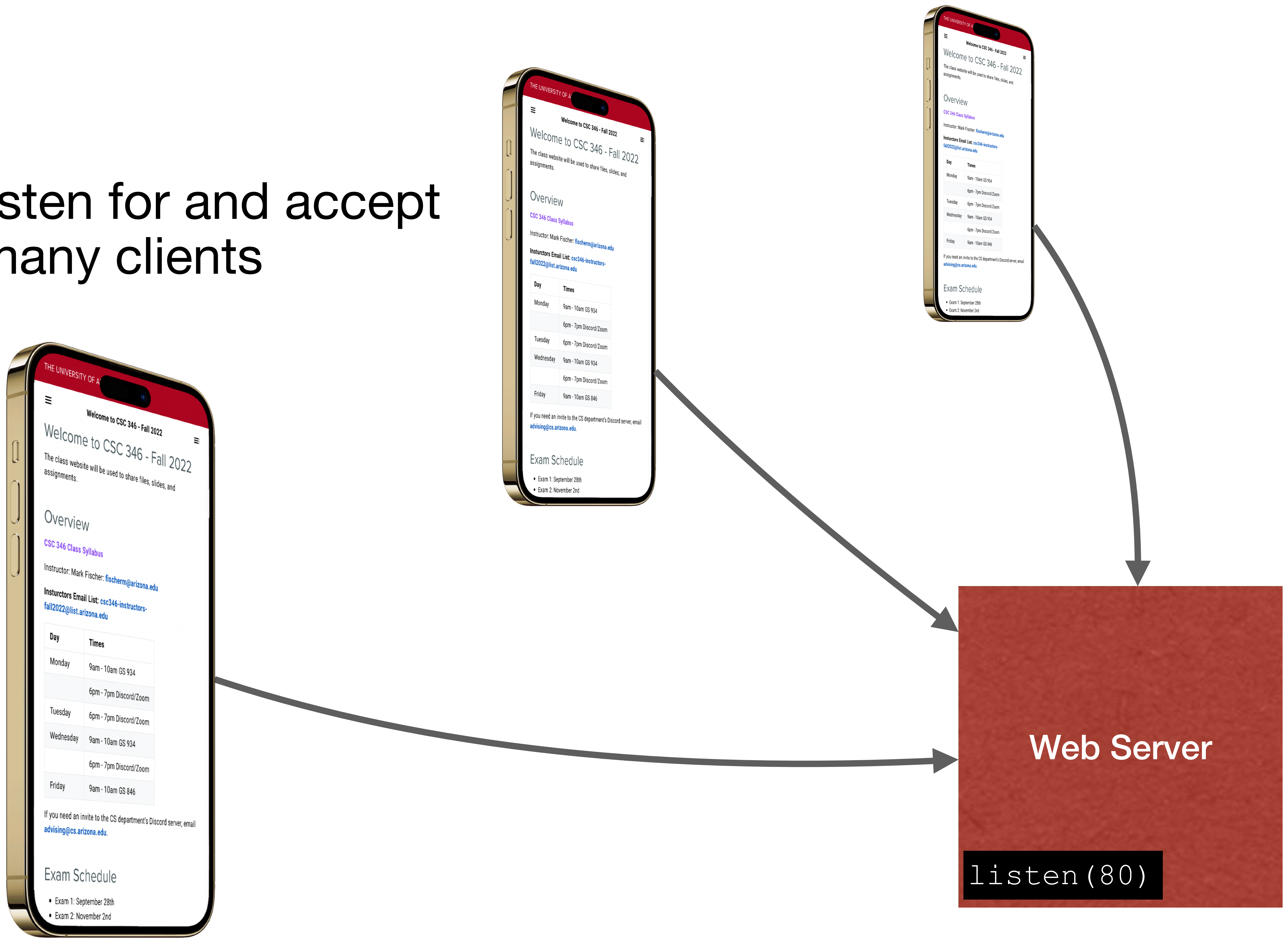
Networking

Sockets

- A web server can listen for and accept connections from many clients

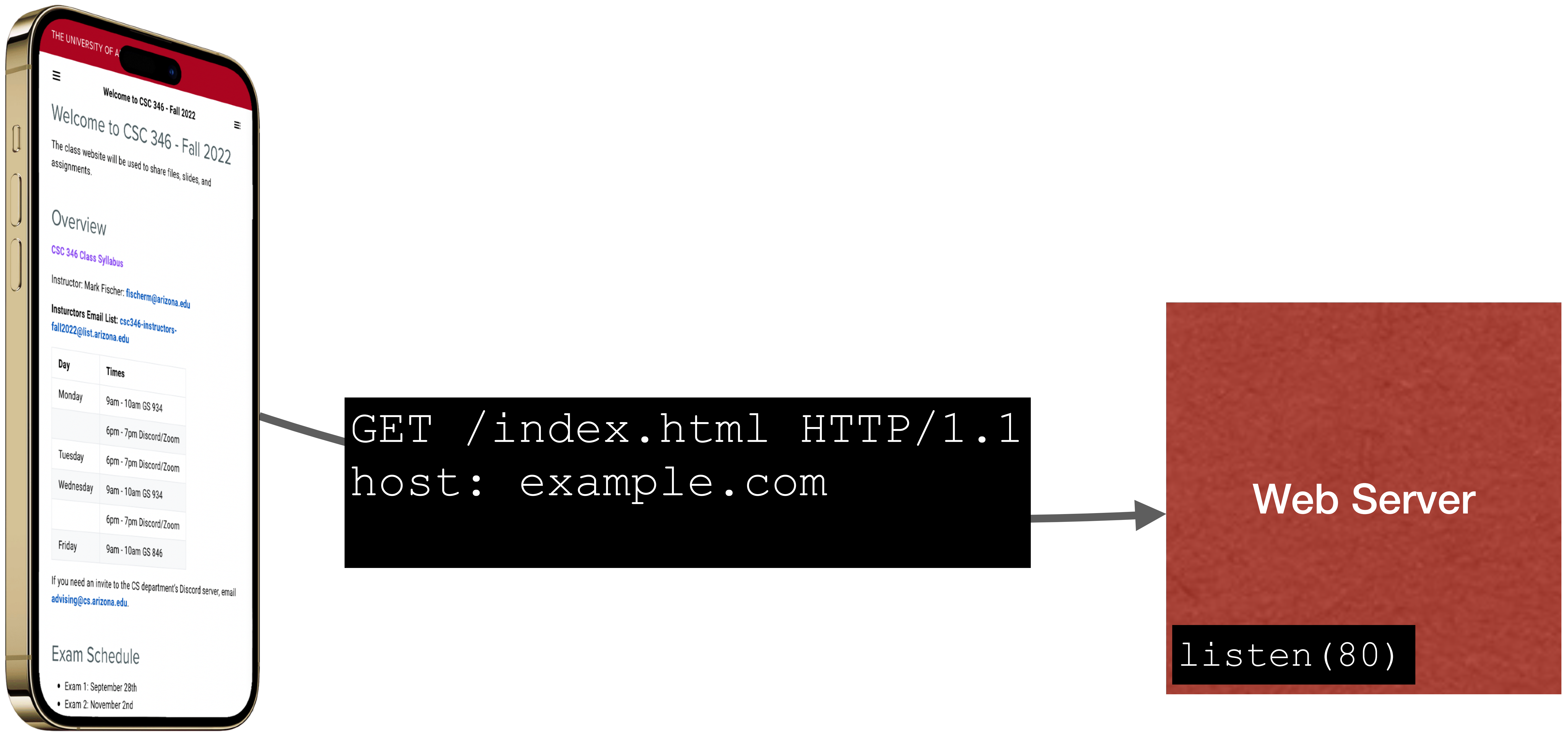


Networking

Sockets

- Once a socket is connected, the client and server can exchange data according to whatever protocol the server supports.

- For web servers,
  this is HTTP



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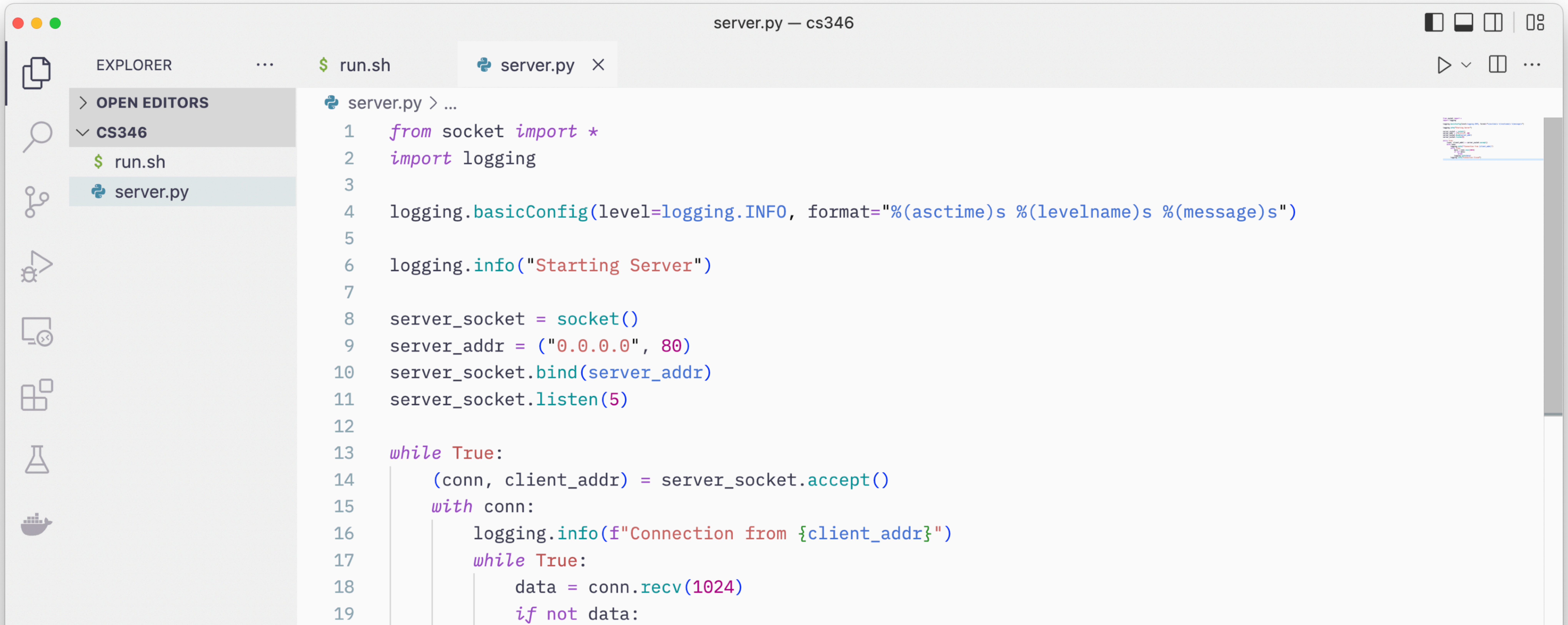
```
GET /index.html HTTP/1.1
host: example.com
```

```
listen(80)
```

Echo Server

The world’s worst web server



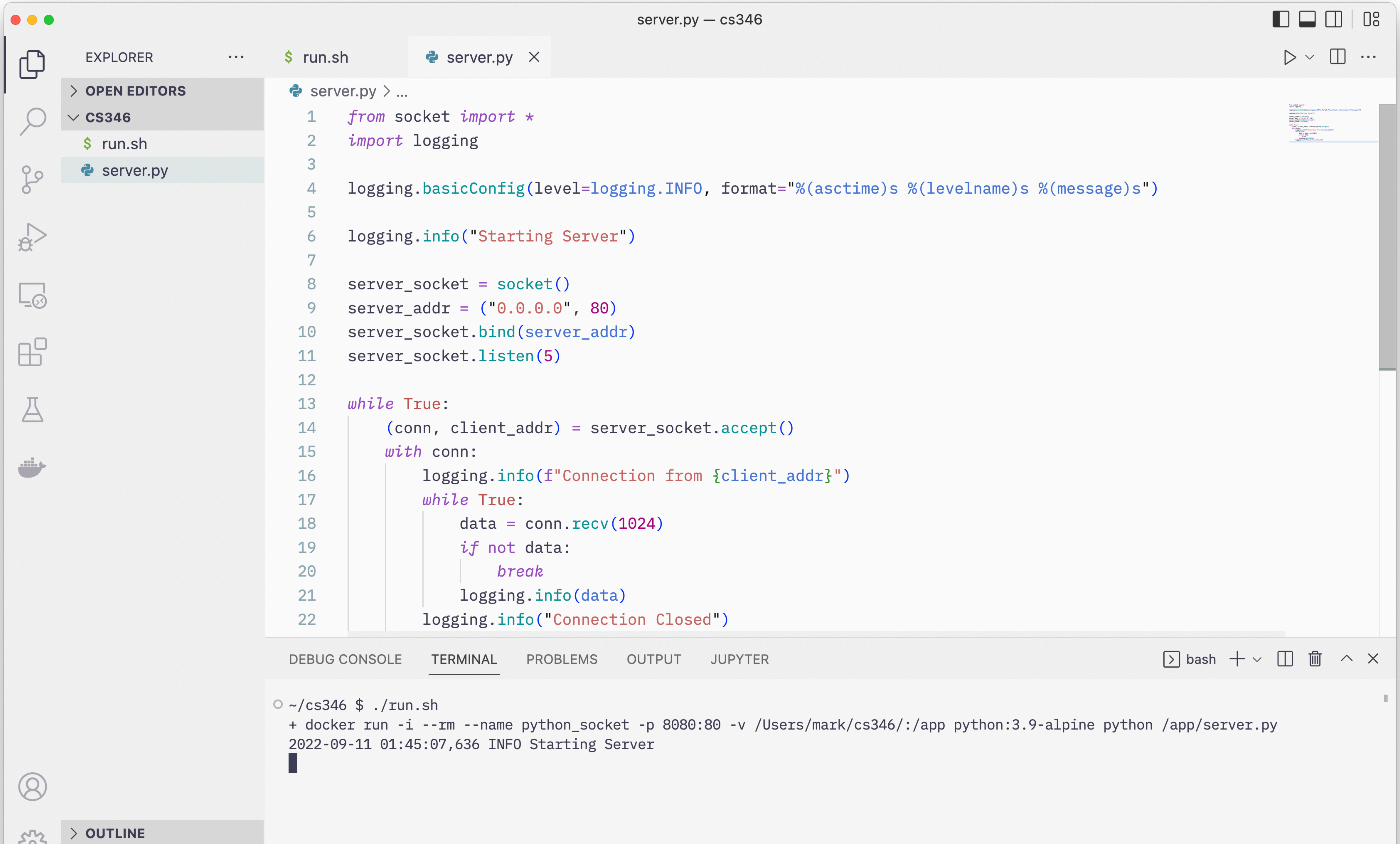
```python
from socket import *
import logging

logging.basicConfig(level=logging.INFO, format="%(asctime)s %(levelname)s %(message)s")

logging.info("Starting Server")

server_socket = socket()
server_addr = ("0.0.0.0", 80)
server_socket.bind(server_addr)
server_socket.listen(5)

while True:
    (conn, client_addr) = server_socket.accept()
    with conn:
        logging.info(f"Connection from {client_addr}")
        while True:
            data = conn.recv(1024)
            if not data:
```



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~/cs346 $ ./run.sh
+ docker run -i --rm --name python_socket -p 8080:80 -v /Users/mark/cs346/:/app python:3.9-alpine python /app/server.py
2022-09-11 01:45:07,636 INFO Starting Server
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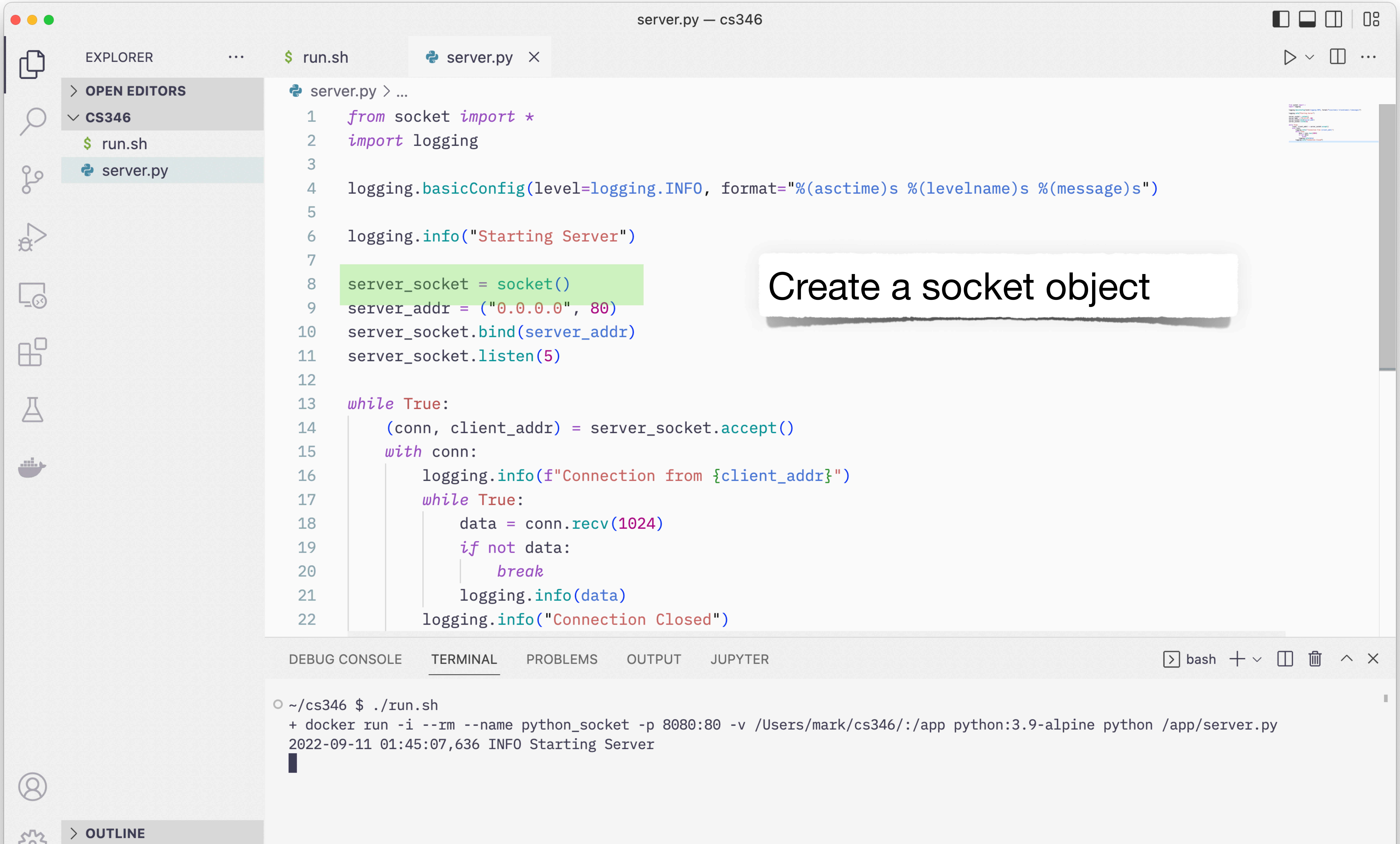

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```

Create a socket object

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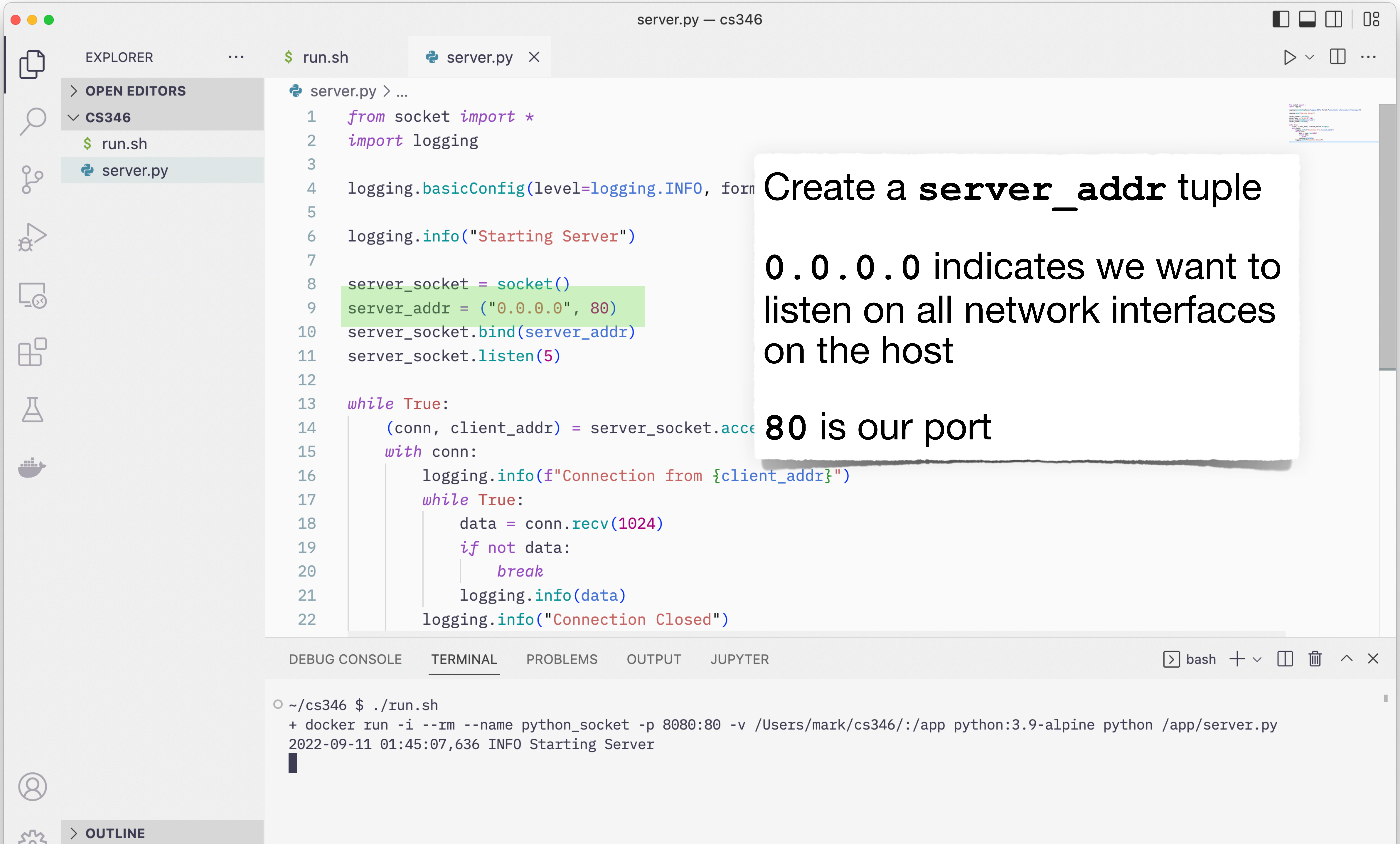

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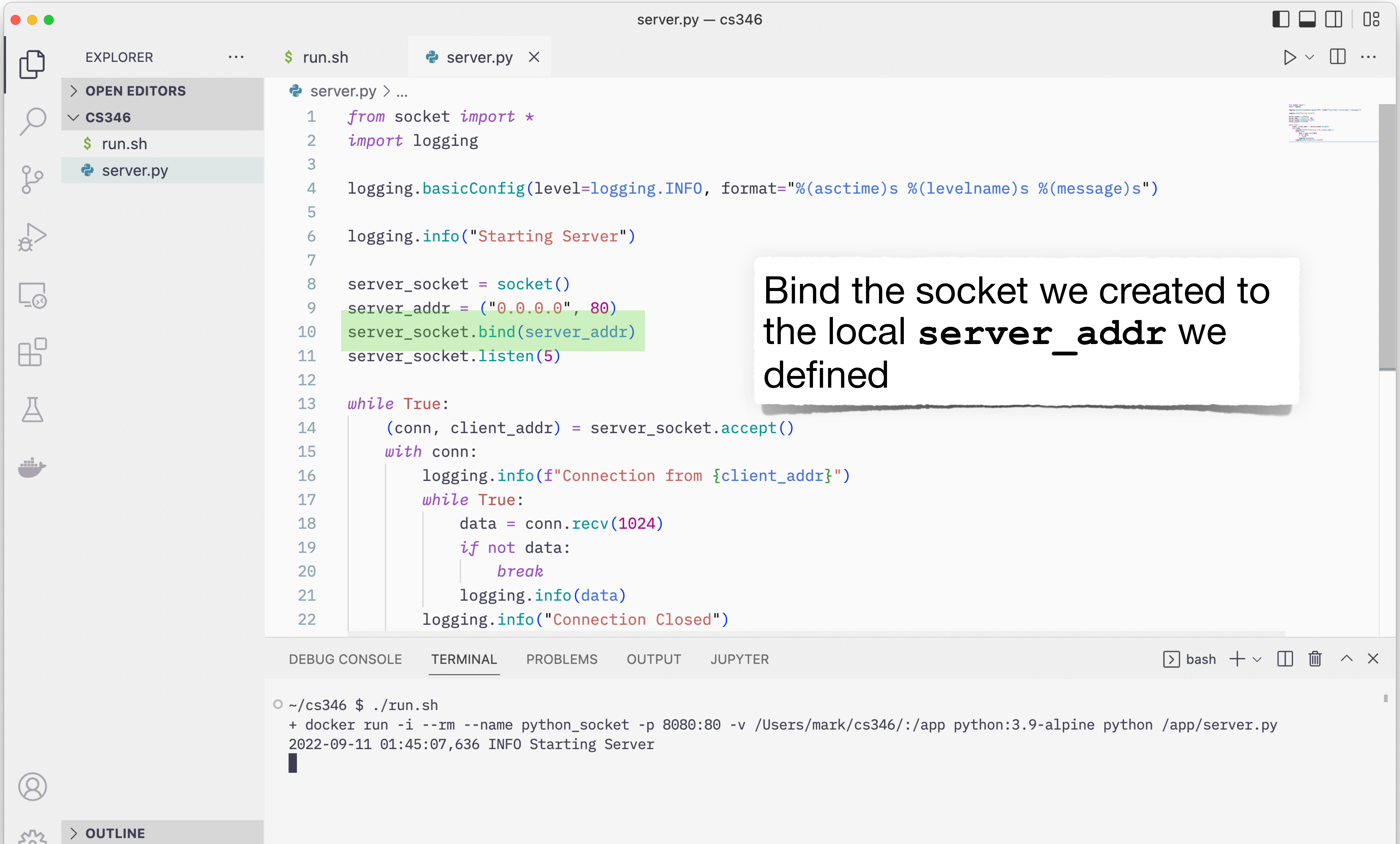
Create a **`server_addr`** tuple

`0.0.0.0` indicates we want to listen on all network interfaces on the host

`80` is our port



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```

Bind the socket we created to the local **`server_addr`** we defined

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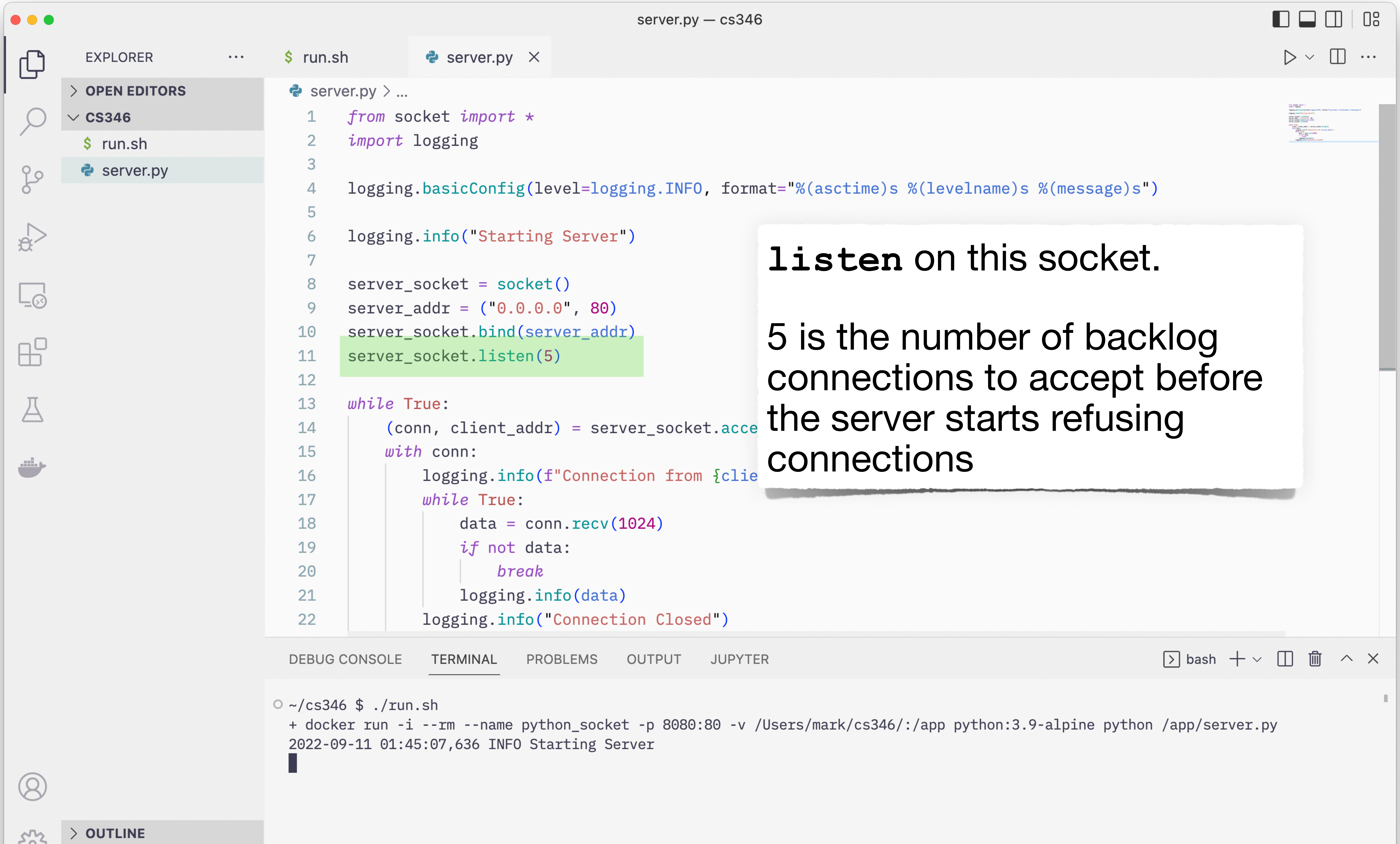

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```

`listen` on this socket.

5 is the number of backlog connections to accept before the server starts refusing connections

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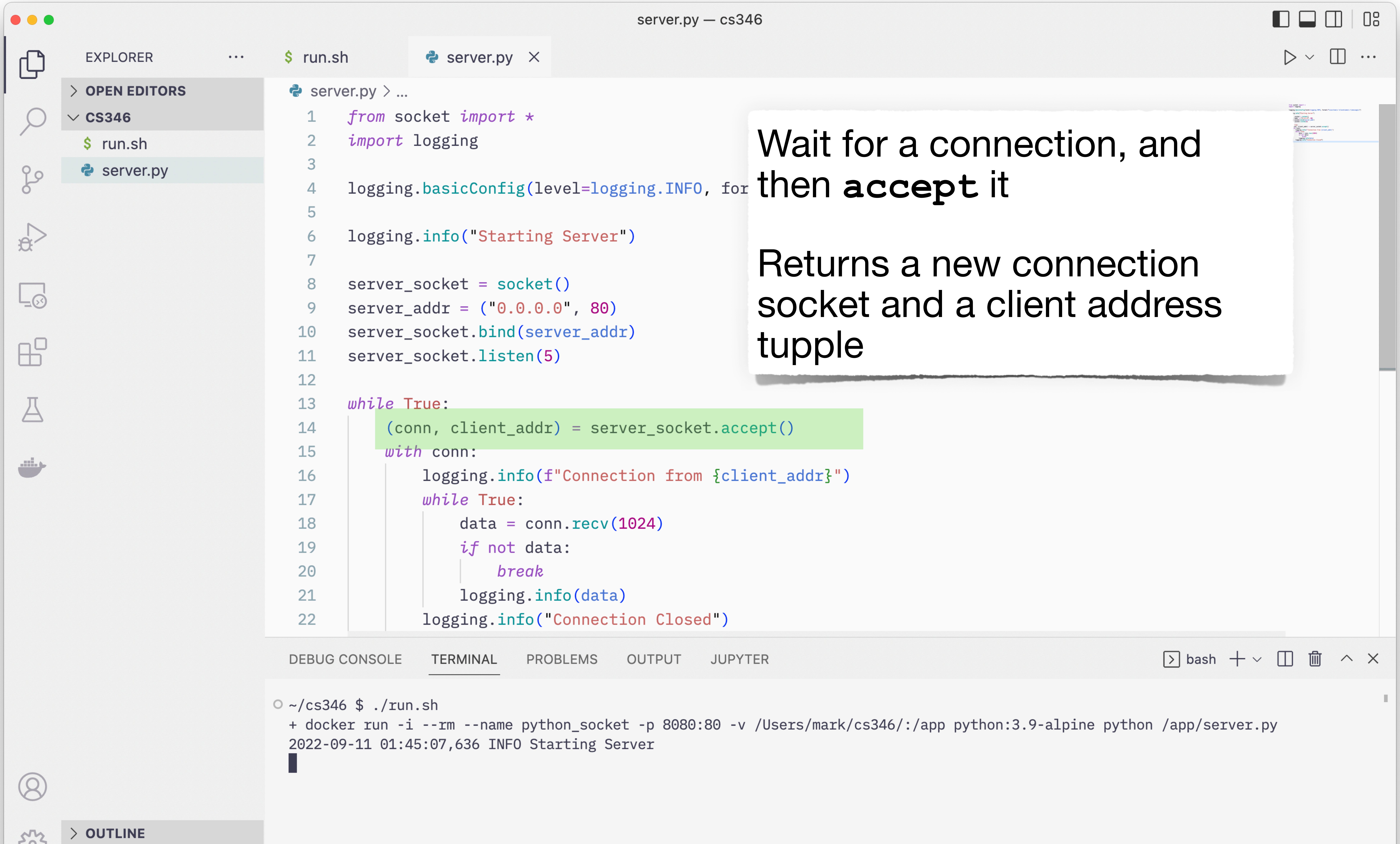

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            data = conn.recv(1024)
            if not data:
                break
            logging.info(data)
        logging.info("Connection Closed")
```

Wait for a connection, and then **`accept`** it

Returns a new connection socket and a client address tupple

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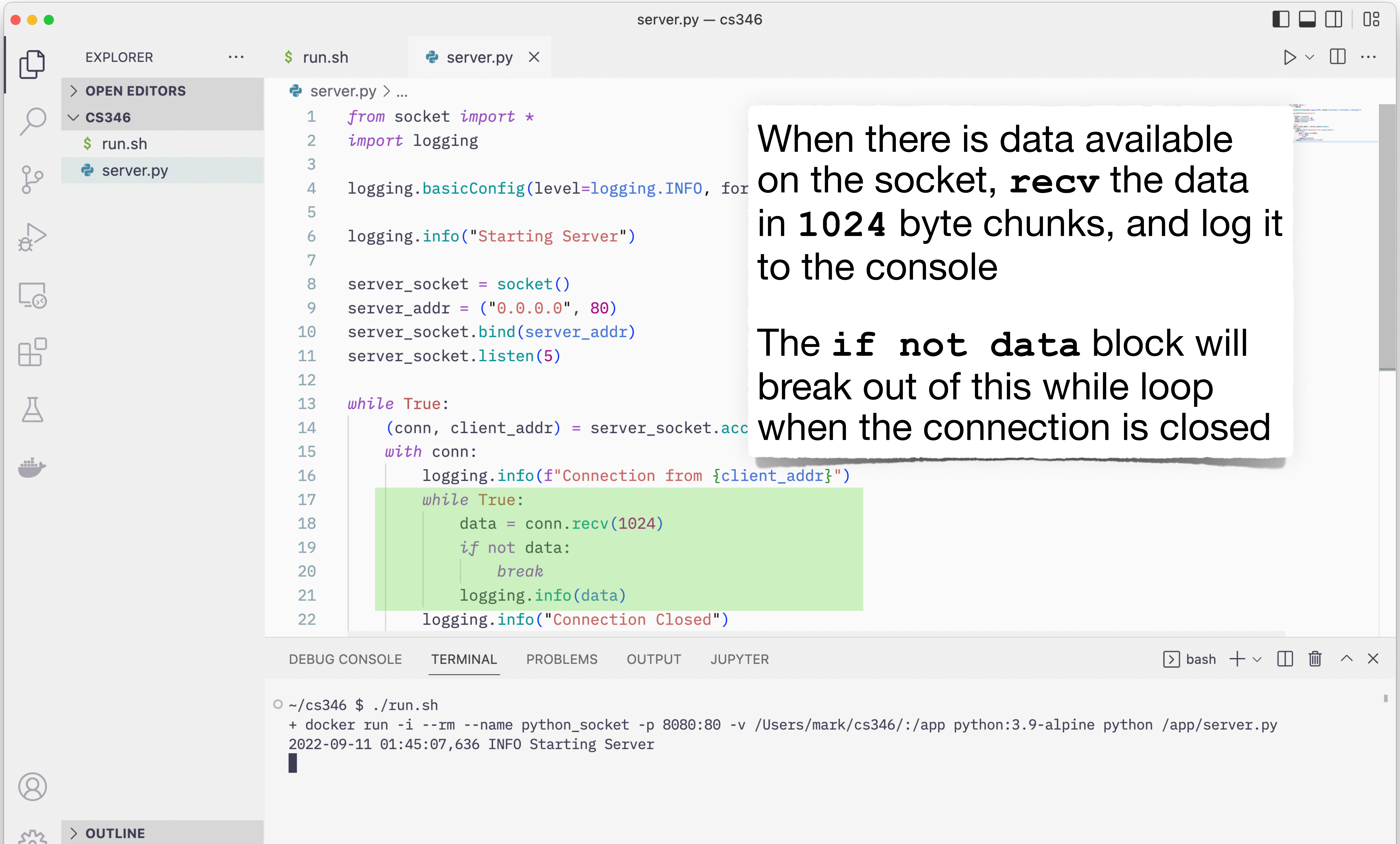

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            if not data:
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            logging.info(data)
        logging.info("Connection Closed")
```

When there is data available on the socket, **`recv`** the data in **`1024`** byte chunks, and log it to the console

The **`if not data`** block will break out of this while loop when the connection is closed

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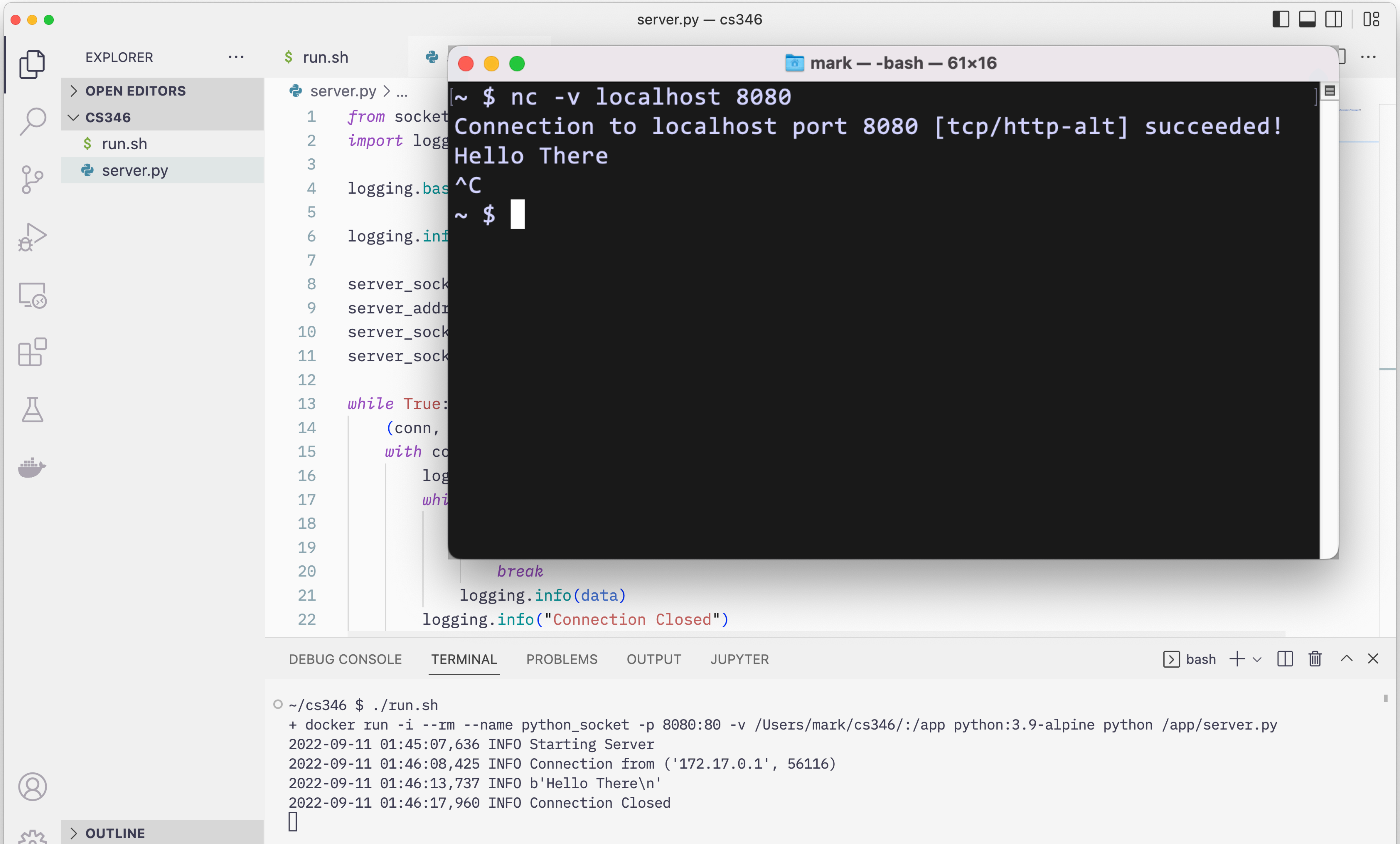


```
from socket
import logg

logging.bas

logging.inf

server_sock
server_addr
server_sock
server_sock

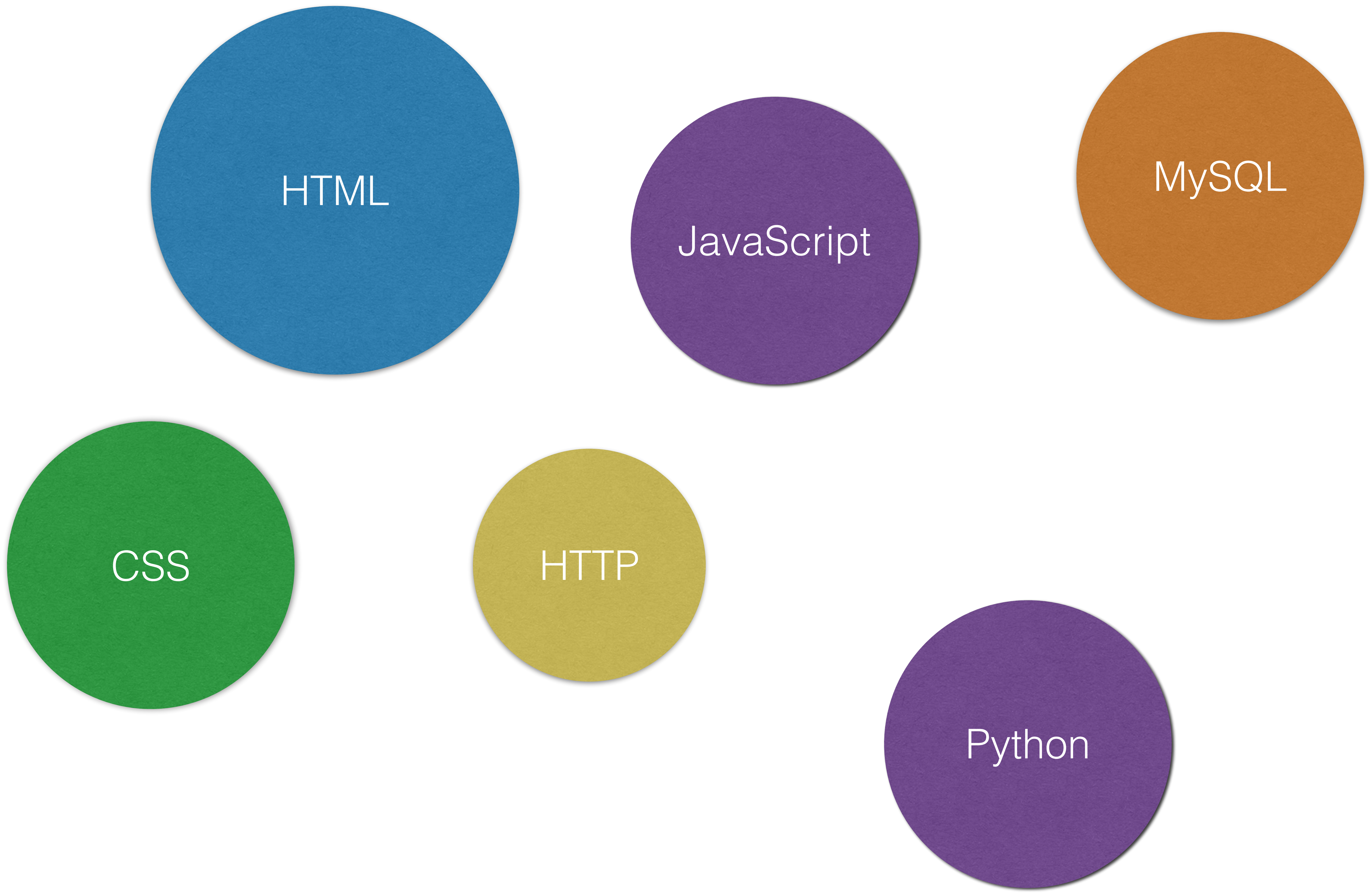
while True:
    (conn,
    with co
        log
        whi

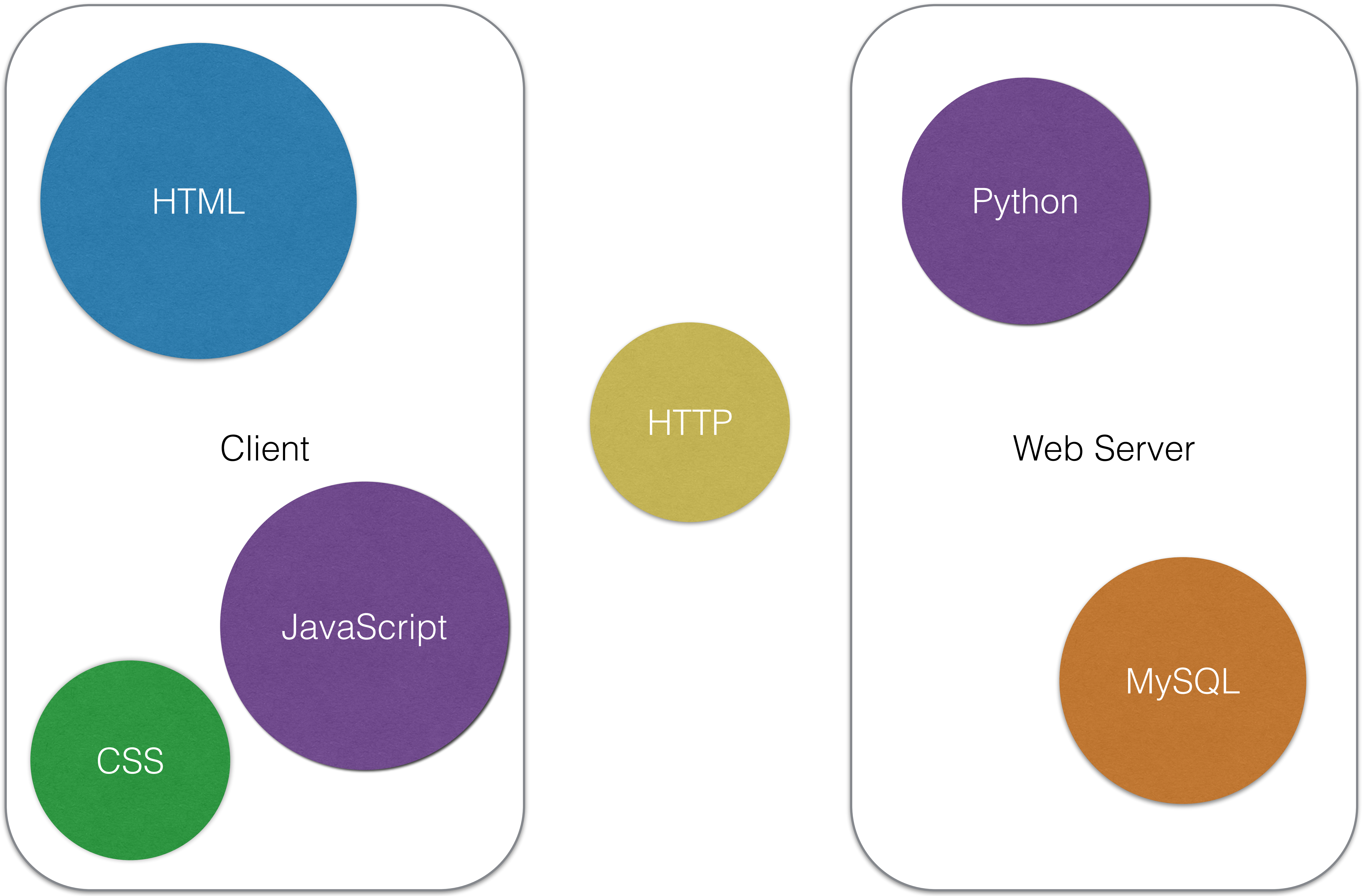

                break
            logging.info(data)
        logging.info("Connection Closed")
```

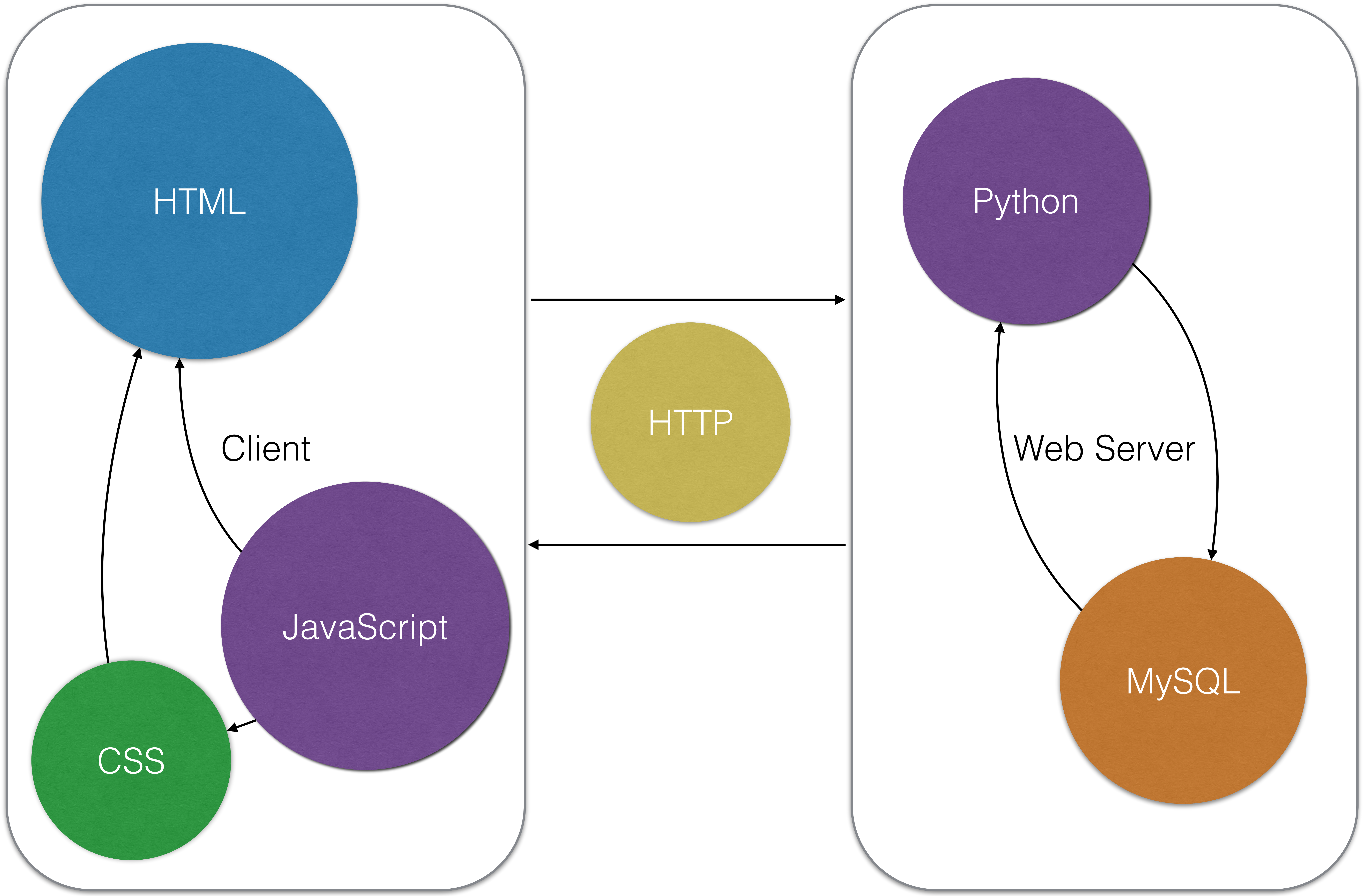
```
~ $ nc -v localhost 8080
Connection to localhost port 8080 [tcp/http-alt] succeeded!
Hello There
^C
~ $
```

```
~/cs346 $ ./run.sh
+ docker run -i --rm --name python_socket -p 8080:80 -v /Users/mark/cs346/:/app python:3.9-alpine python /app/server.py
2022-09-11 01:45:07,636 INFO Starting Server
2022-09-11 01:46:08,425 INFO Connection from ('172.17.0.1', 56116)
2022-09-11 01:46:13,737 INFO b'Hello There\n'
2022-09-11 01:46:17,960 INFO Connection Closed
```

The Big Picture




HTML
Client
JavaScript
CSS
HTTP
Python
Web Server
MySQL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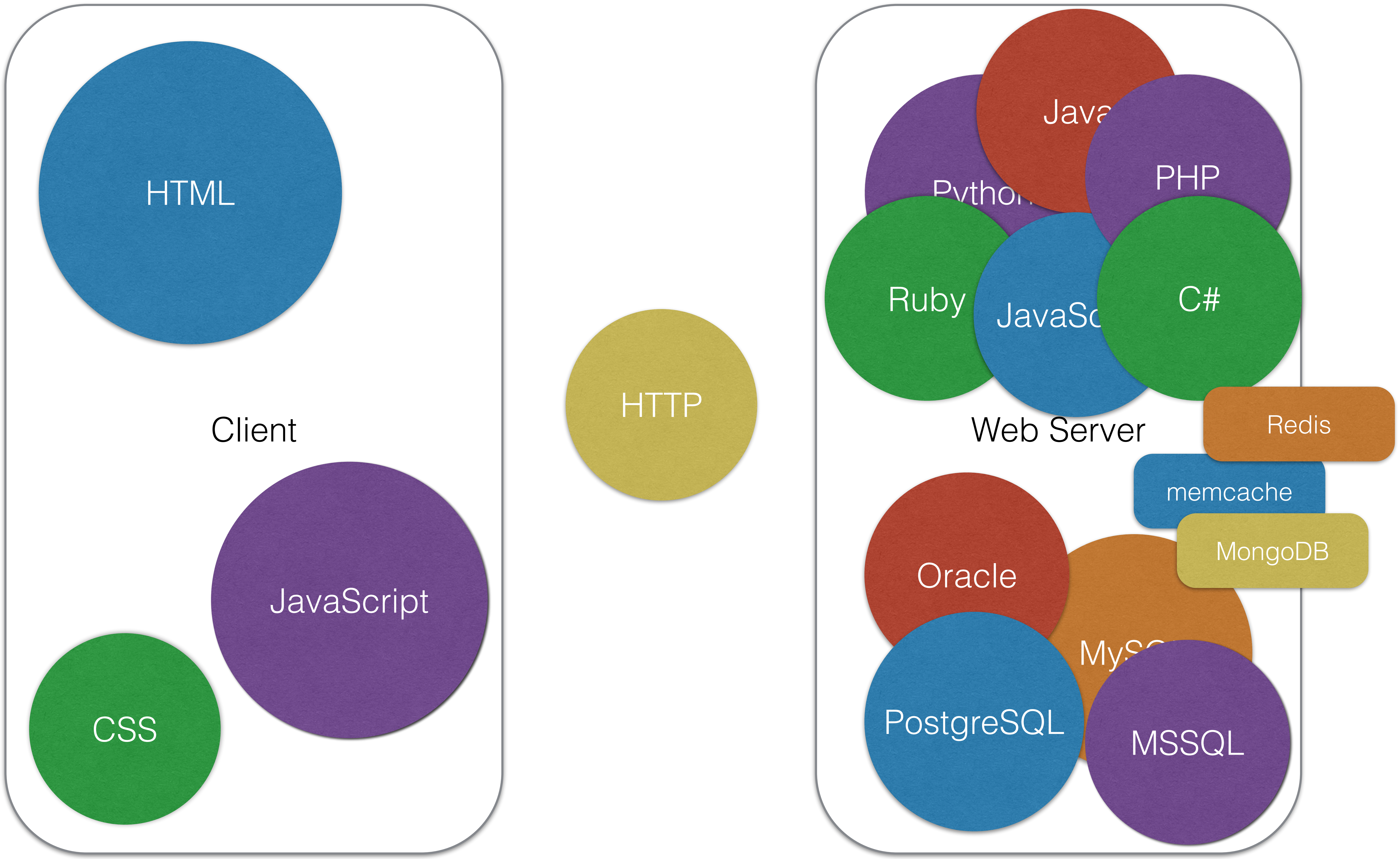
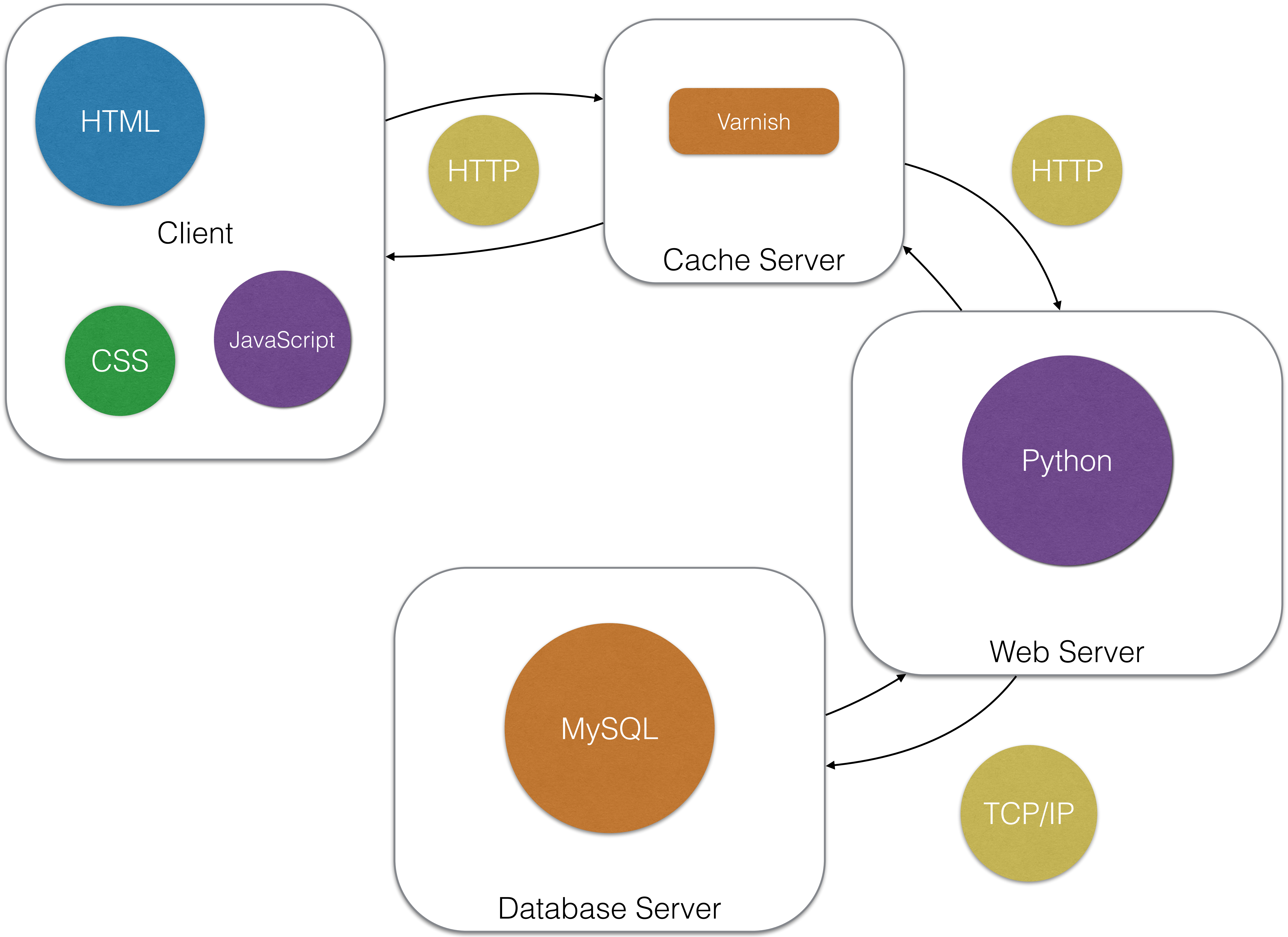
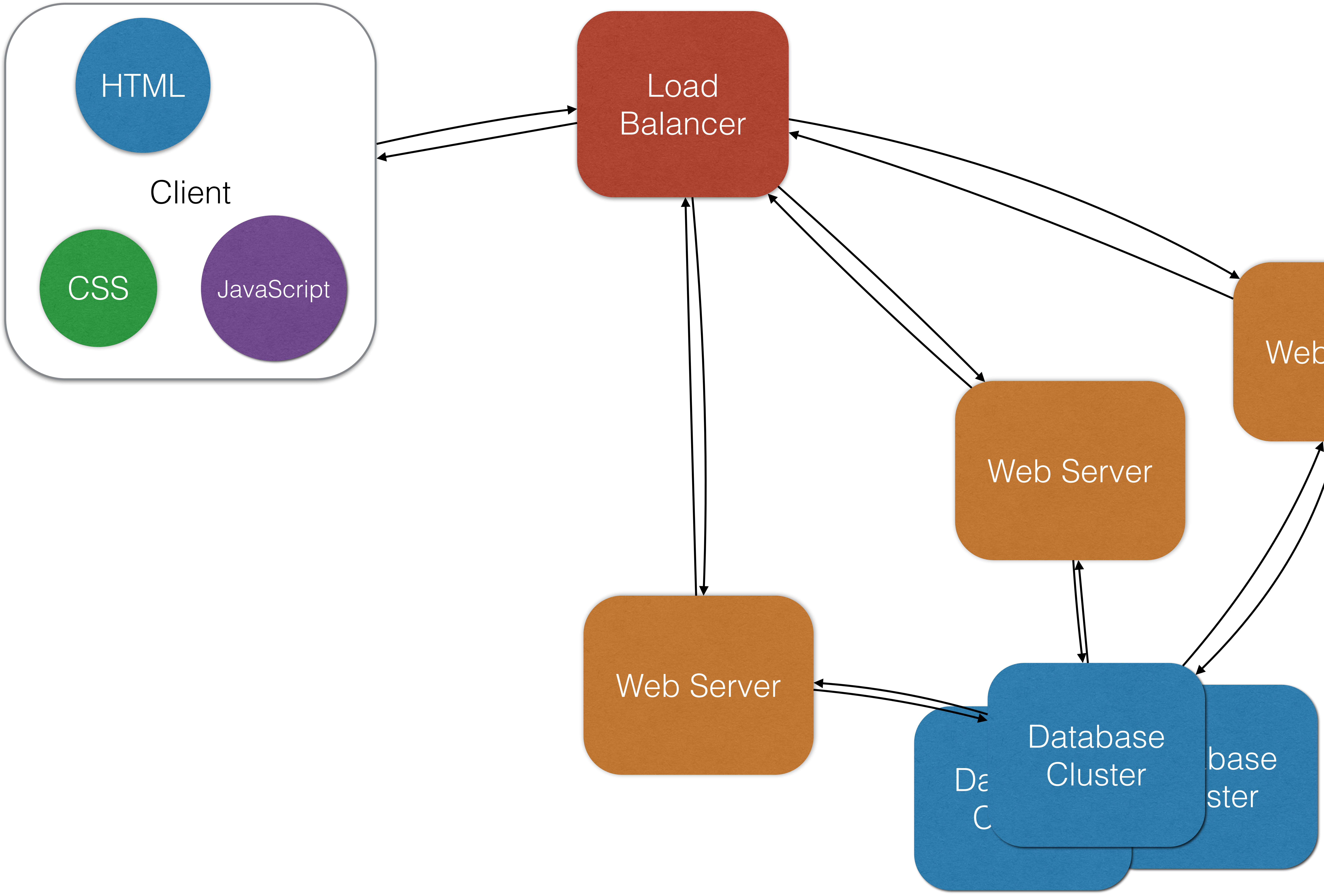
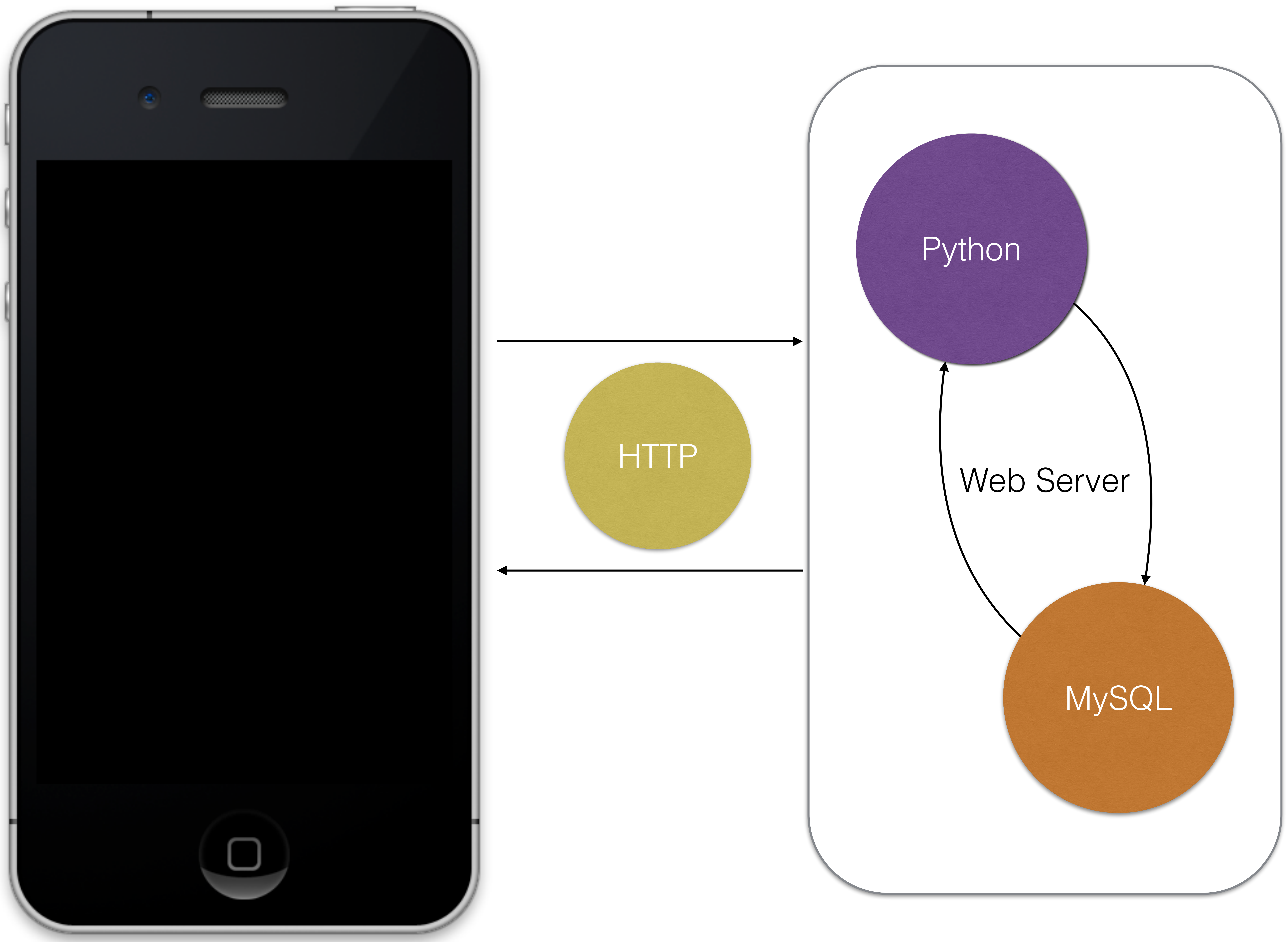
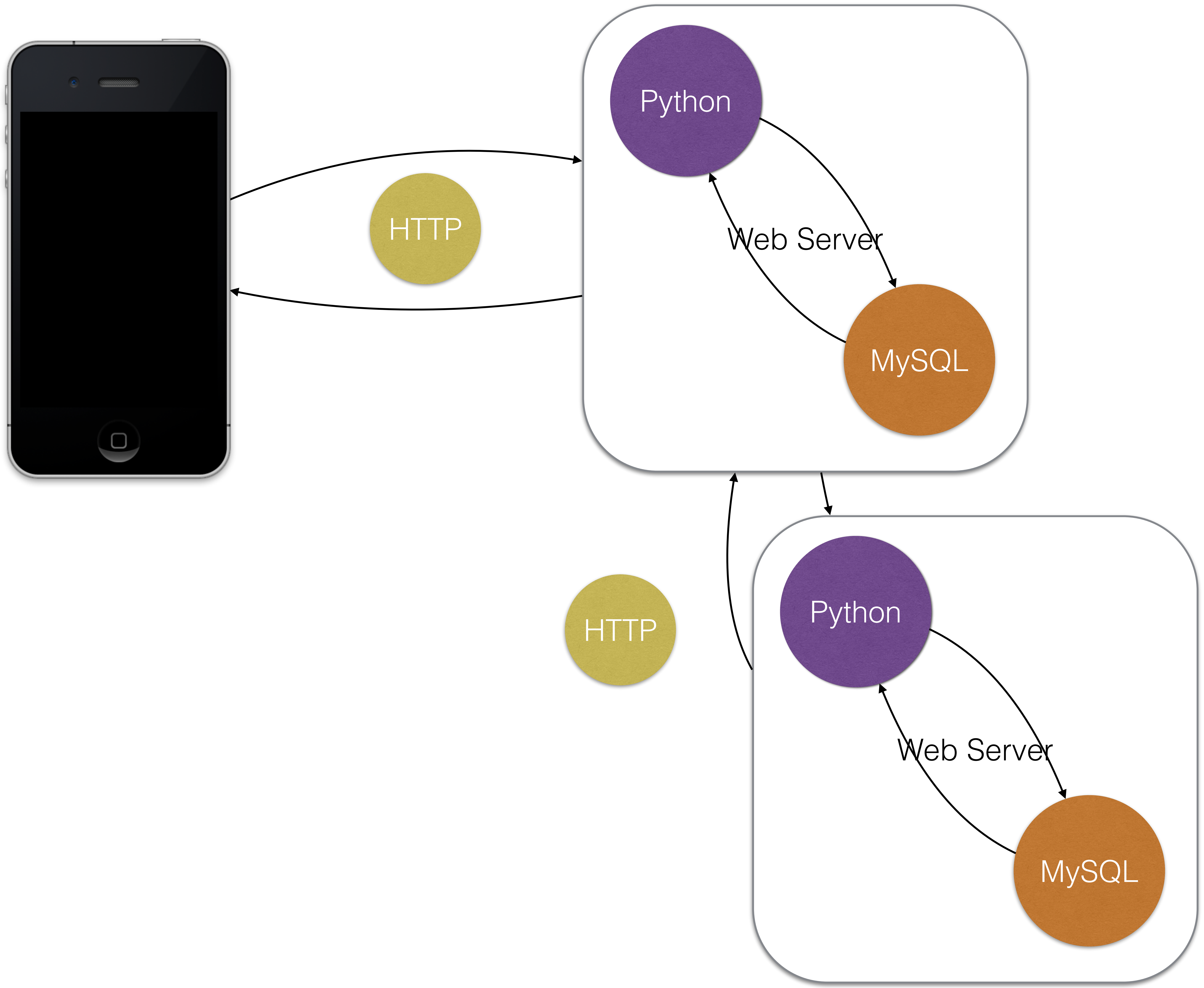

HTML
Client
JavaScript
CSS
HTTP
Java
Python
PHP
Ruby
JavaSc
C#
Web Server
Redis
memcache
MongoDB
Oracle
MyS
PostgreSQL
MSSQL


HTML
Client
CSS
JavaScript
HTTP
Varnish
Cache Server
HTTP
Python
Web Server
MySQL
Database Server
TCP/IP


HTML
Client
CSS
JavaScript
Load Balancer
Web Server
Web Server
Web Server
Database Cluster
Da C
base ster


Python
HTTP
Web Server
MySQL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Python
Web Server
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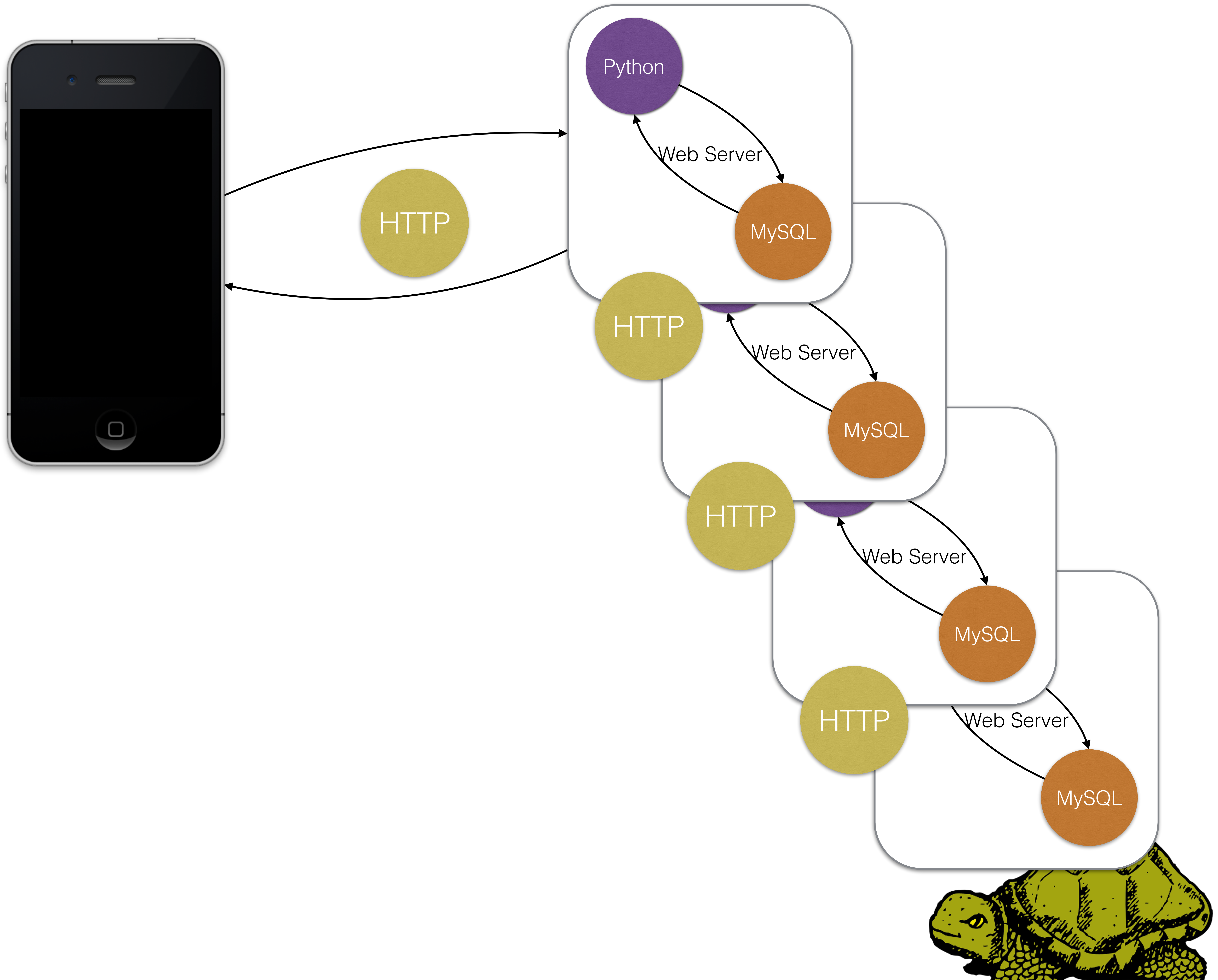
HTTP
Python
Web Server
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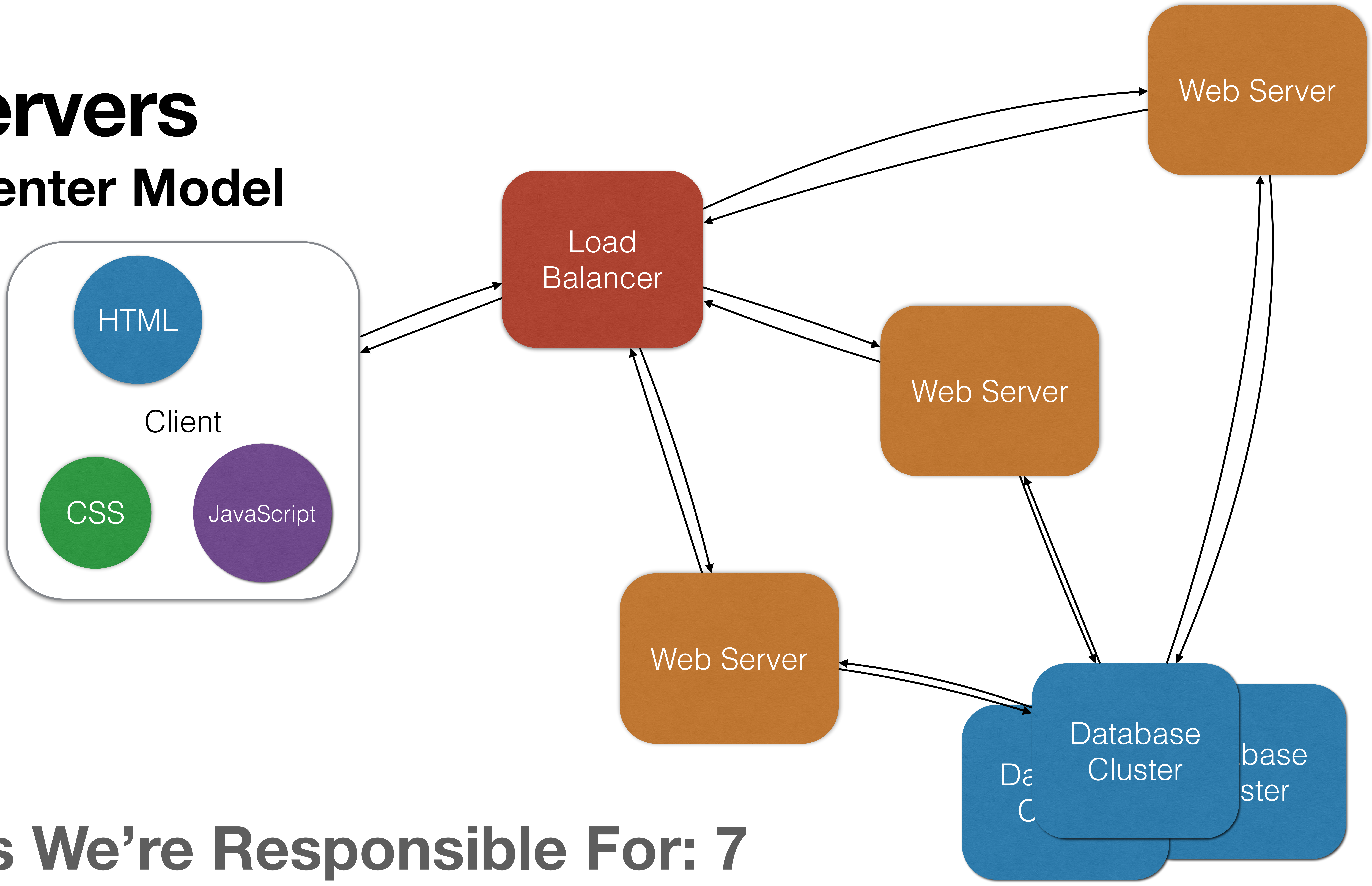
Web Servers

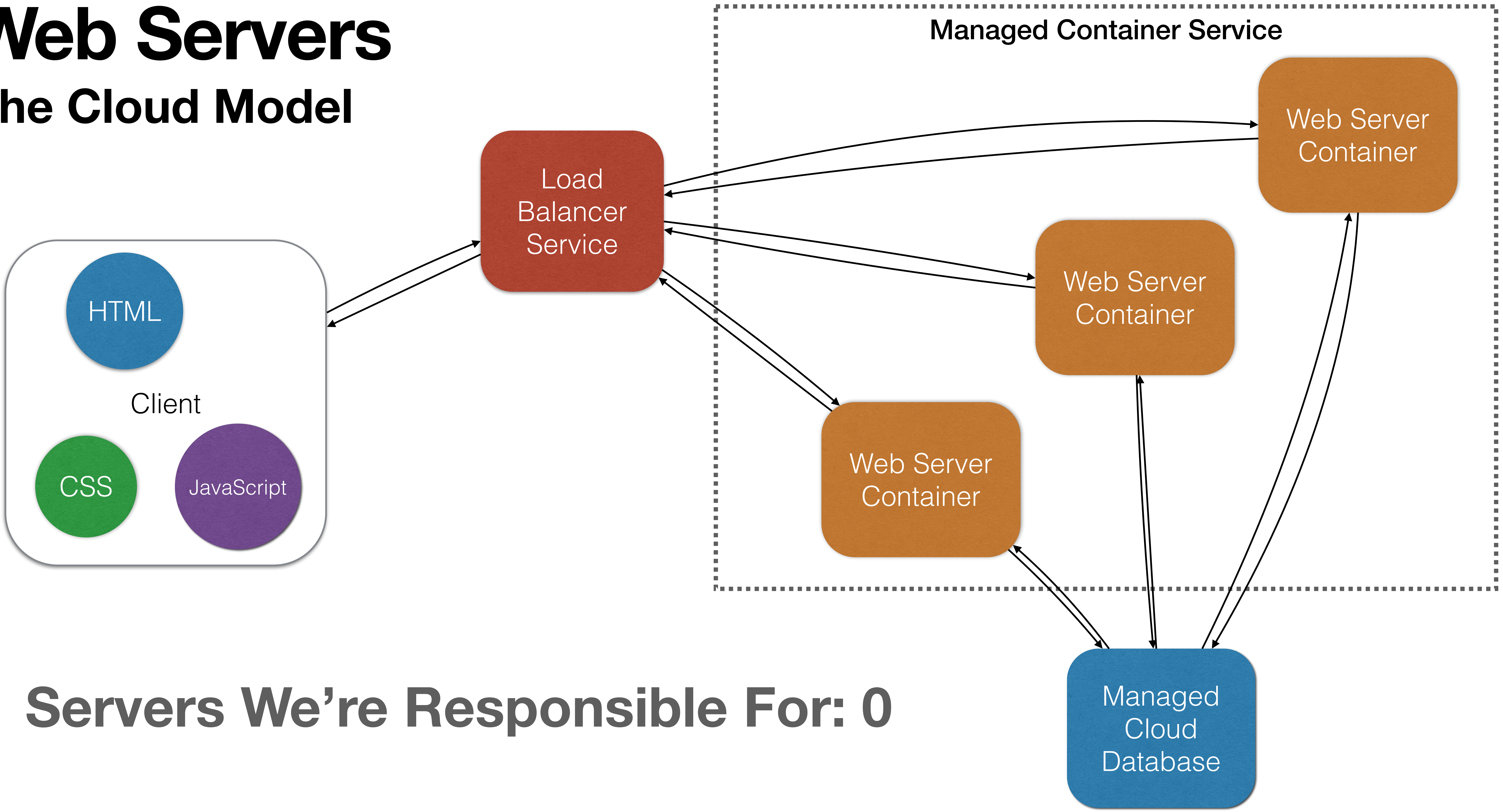
The Datacenter Model



Servers We're Responsible For: 7

Web Servers

The Cloud Model



Servers We're Responsible For: 0

Web Servers

Many Different Types

- Apache 2 - httpd
- nginx (pronounced “Engine X”)
- IIS
- Tomcat
- Jetty
- Gunicorn

Web Servers

Many Different Types

- Apache 2 - httpd
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General Purpose
HTTP Servers

Web Servers

Many Different Types

- Apache 2 - httpd
- nginx (pronounced “Engine X”)
- IIS
- Tomcat
- Jetty
- Gunicorn

Language Specific
HTTP Servers

Web Servers

Revisiting Containers

- We’ve already used containers to run a web server in Homework 2

```
docker run -it --rm -p 8080:80 hw02:latest
```

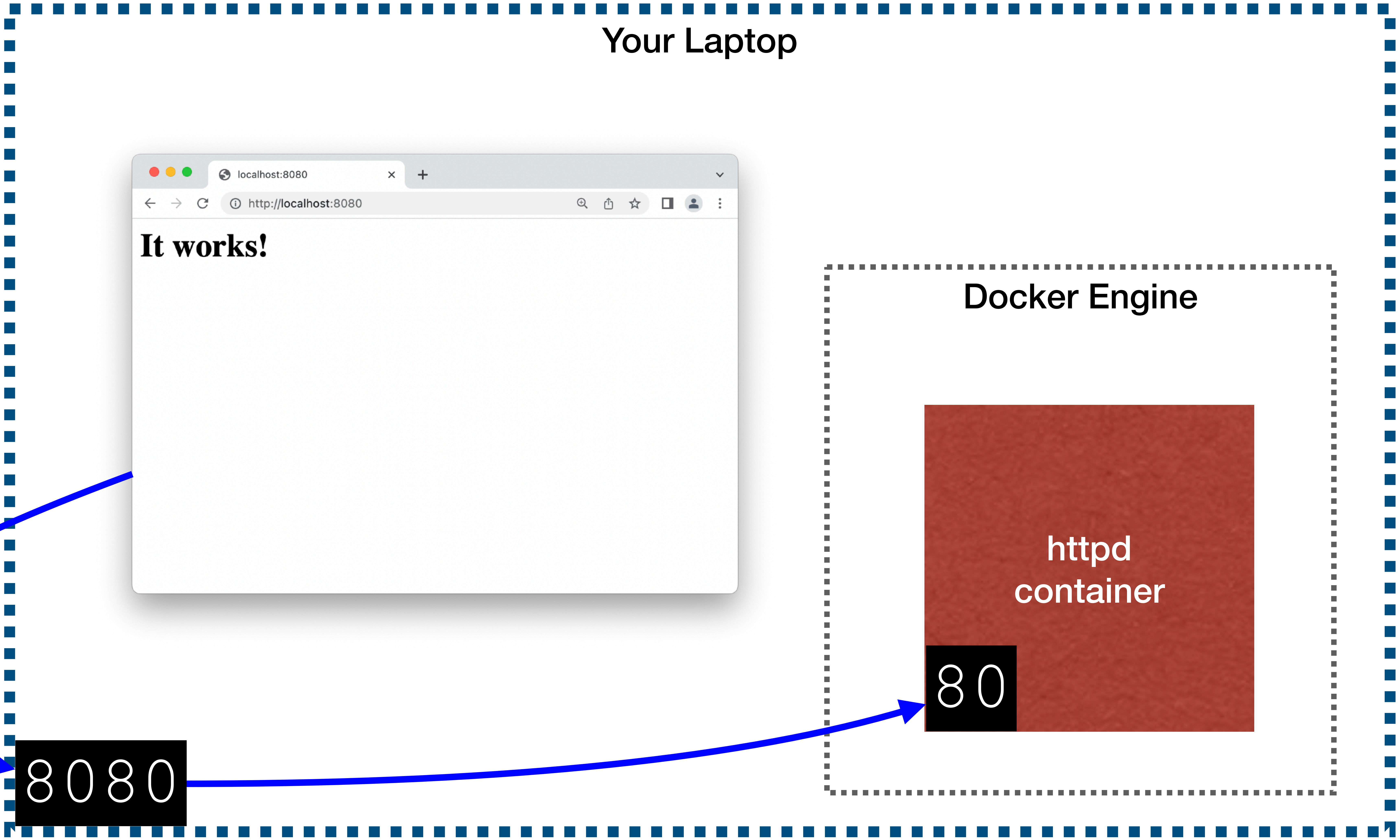
- Let’s look closer at what those port mappings mean

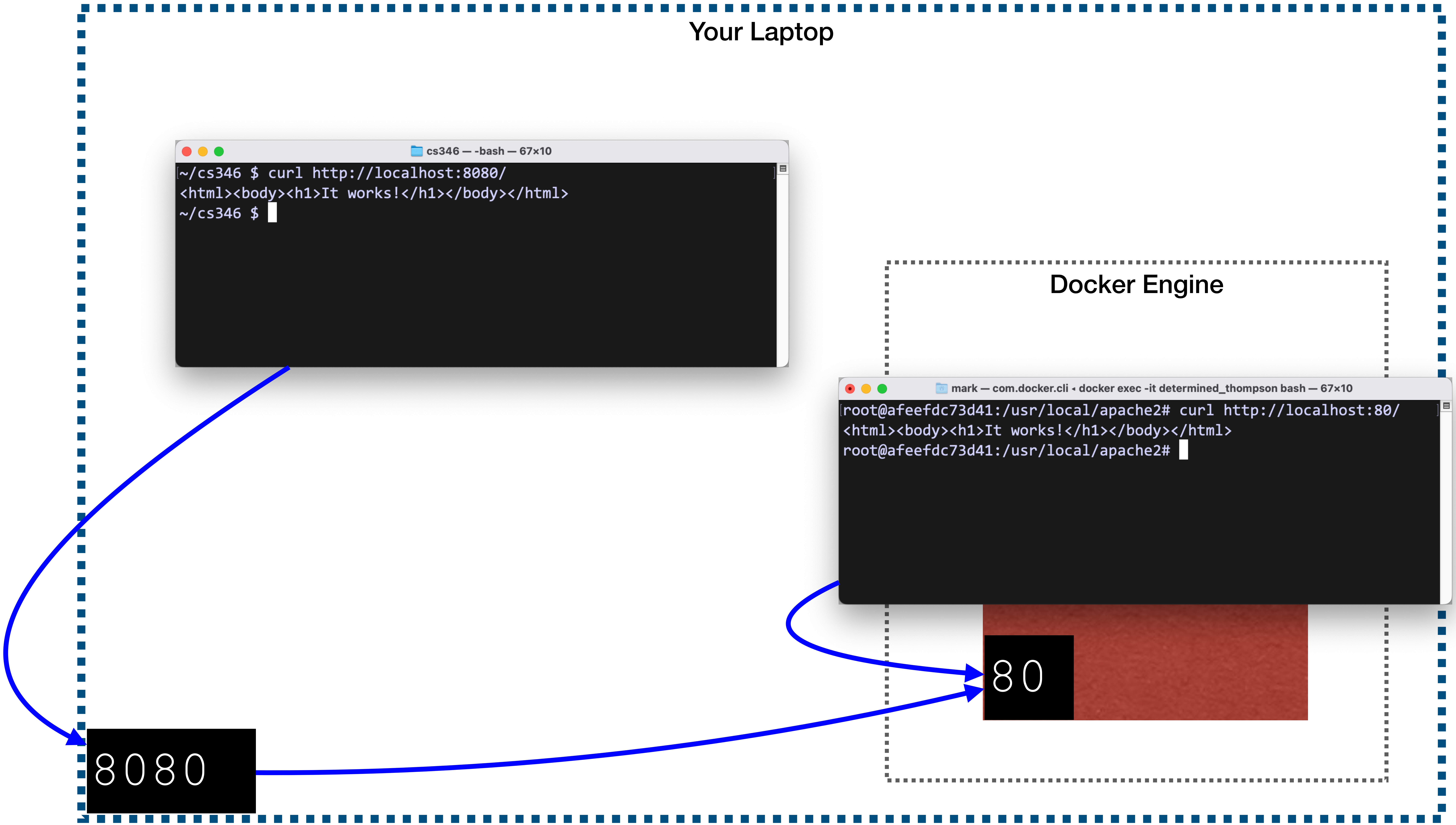
Web Servers

Revisiting Containers

```
-p 8080:80
```

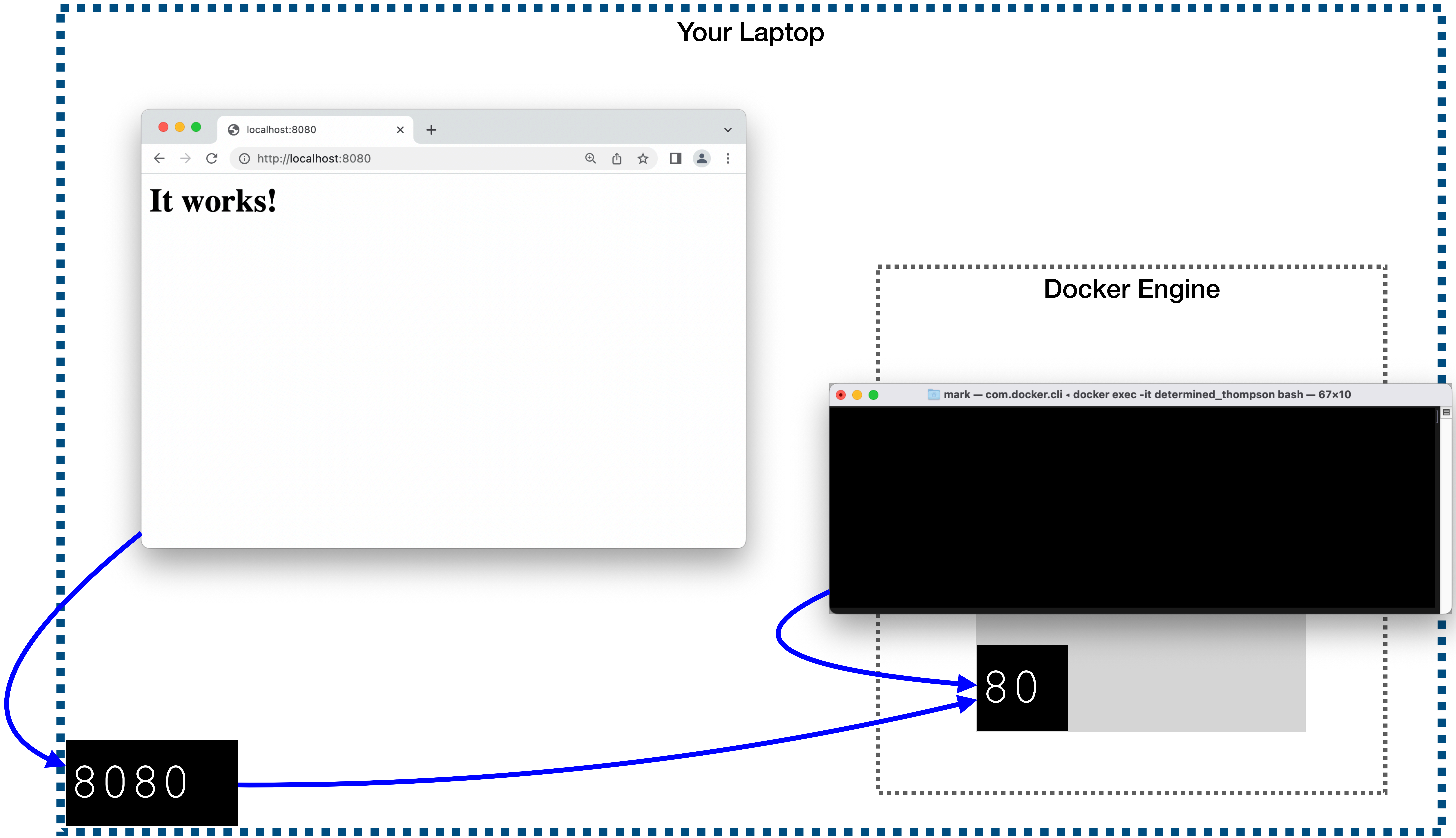
- Maps port **`8080`** on your host to the container's port **`80`**.



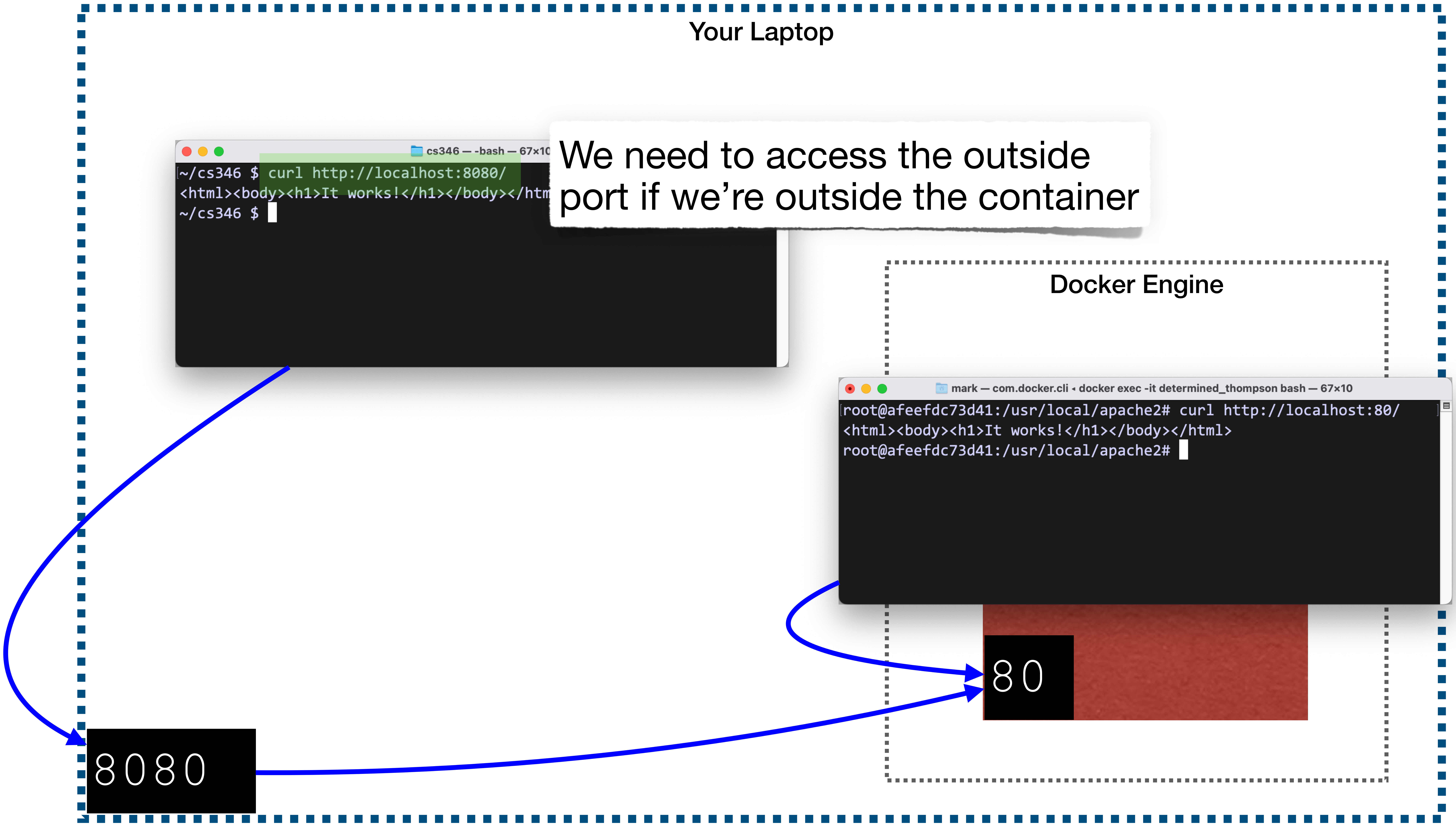

Your Laptop
Docker Engine
cs346 — -bash — 67×10
mark — com.docker.cli ◂ docker exec -it determined_thompson bash — 67×10
8080
80

```
~/cs346 $ curl http://localhost:8080/
<html><body><h1>It works!</h1></body></html>
~/cs346 $
```

```
root@afeefdc73d41:/usr/local/apache2# curl http://localhost:80/
<html><body><h1>It works!</h1></body></html>
root@afeefdc73d41:/usr/local/apache2#
```

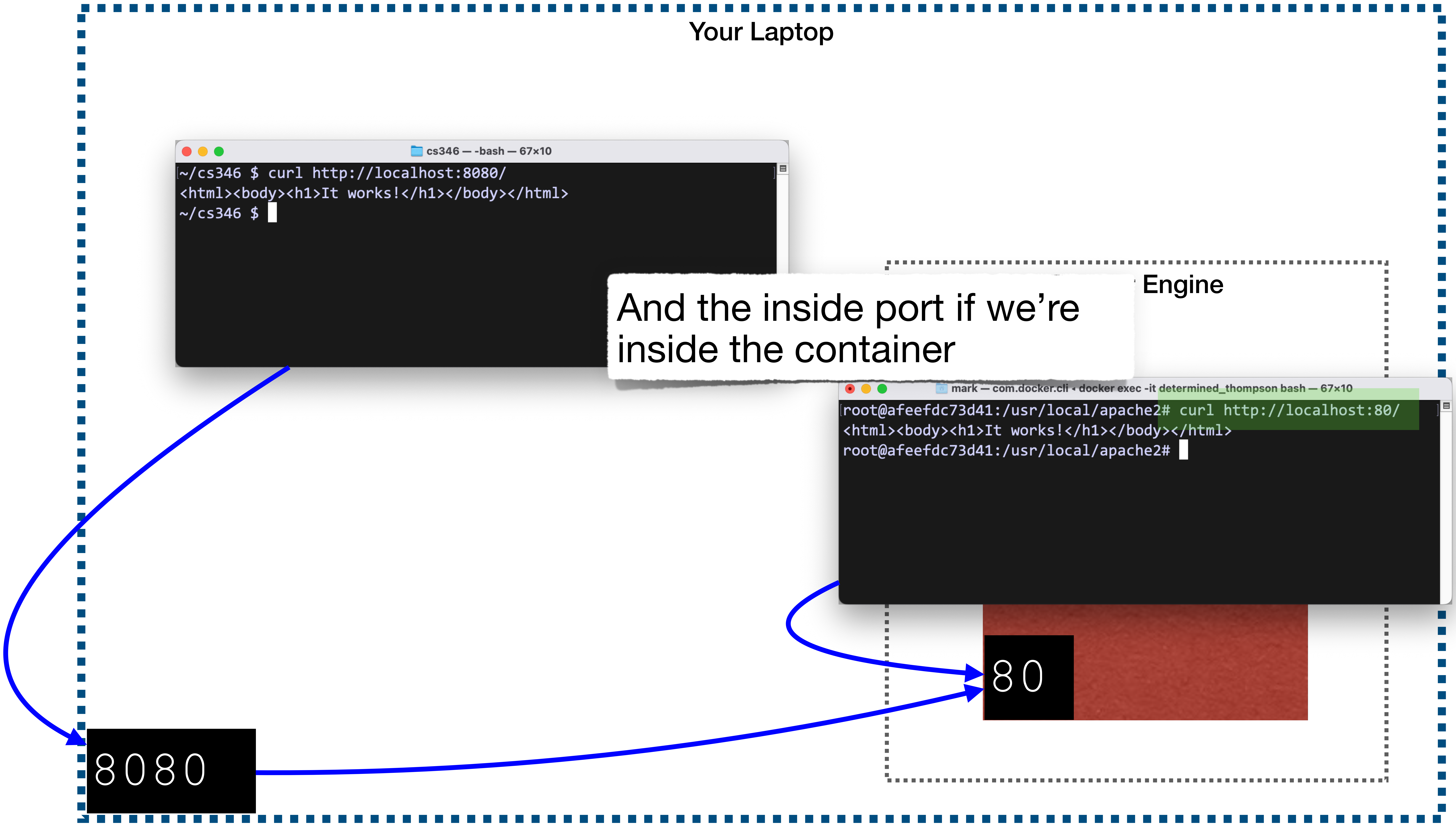

Your Laptop
localhost:8080
http://localhost:8080
It works!
Docker Engine
mark — com.docker.cli ◂ docker exec -it determined_thompson bash — 67×10
80
8080

We need to access the outside port if we're outside the container


Your Laptop
Docker Engine
cs346 — -bash — 67×10
mark — com.docker.cli ‹ docker exec -it determined_thompson bash — 67×10
8080
80

```
~/cs346 $ curl http://localhost:8080/
<html><body><h1>It works!</h1></body></htm
~/cs346 $
```

```
root@afeefdc73d41:/usr/local/apache2# curl http://localhost:80/
<html><body><h1>It works!</h1></body></html>
root@afeefdc73d41:/usr/local/apache2#
```


Your Laptop
cs346 — -bash — 67×10
Engine
mark — com.docker.cli ‹ docker exec -it determined_thompson bash — 67×10
8080
80

```
~/cs346 $ curl http://localhost:8080/
<html><body><h1>It works!</h1></body></html>
~/cs346 $
```

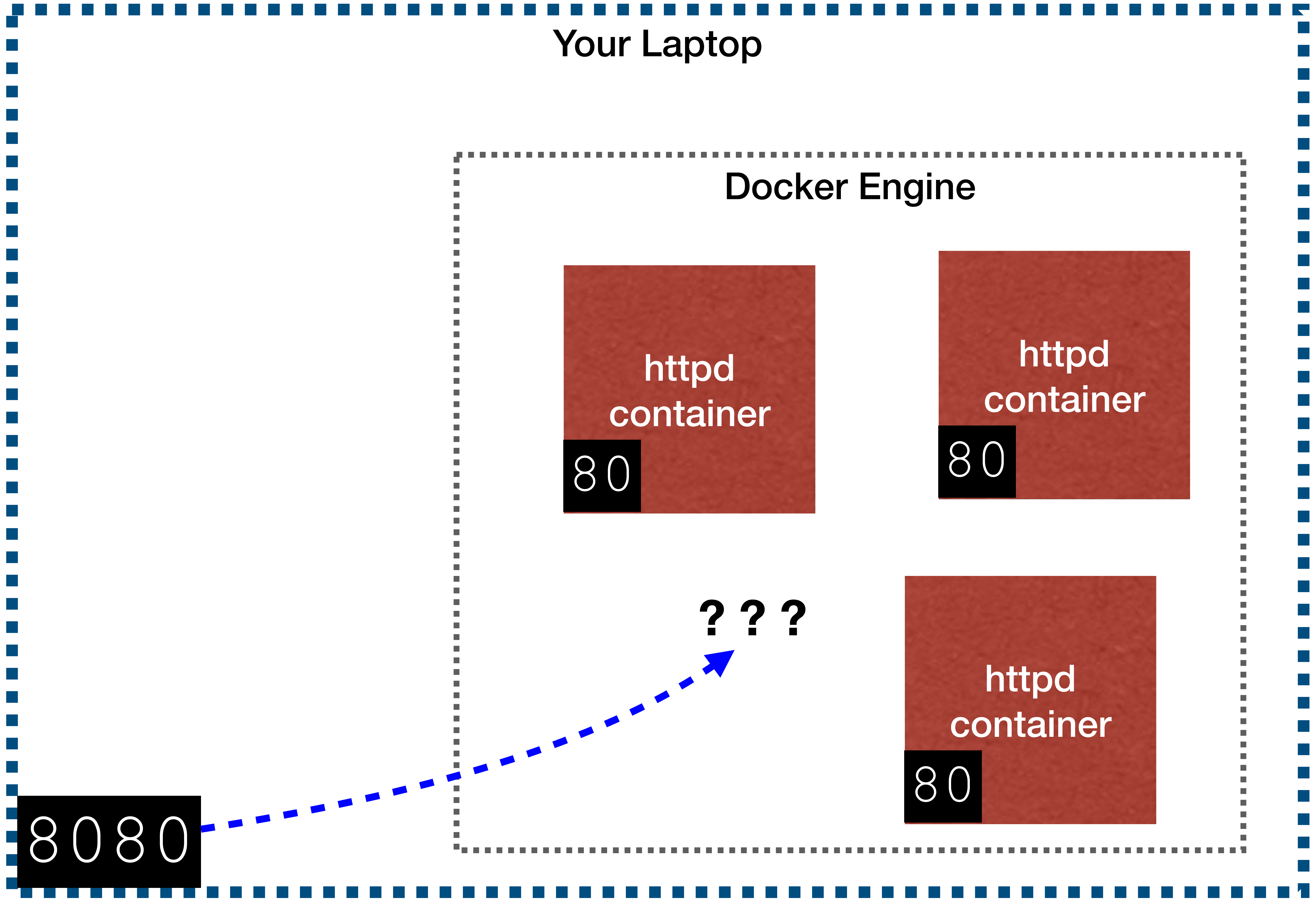
And the inside port if we're inside the container

```
root@afeefdc73d41:/usr/local/apache2# curl http://localhost:80/
<html><body><h1>It works!</h1></body></html>
root@afeefdc73d41:/usr/local/apache2#
```

Web Servers

Revisiting Containers

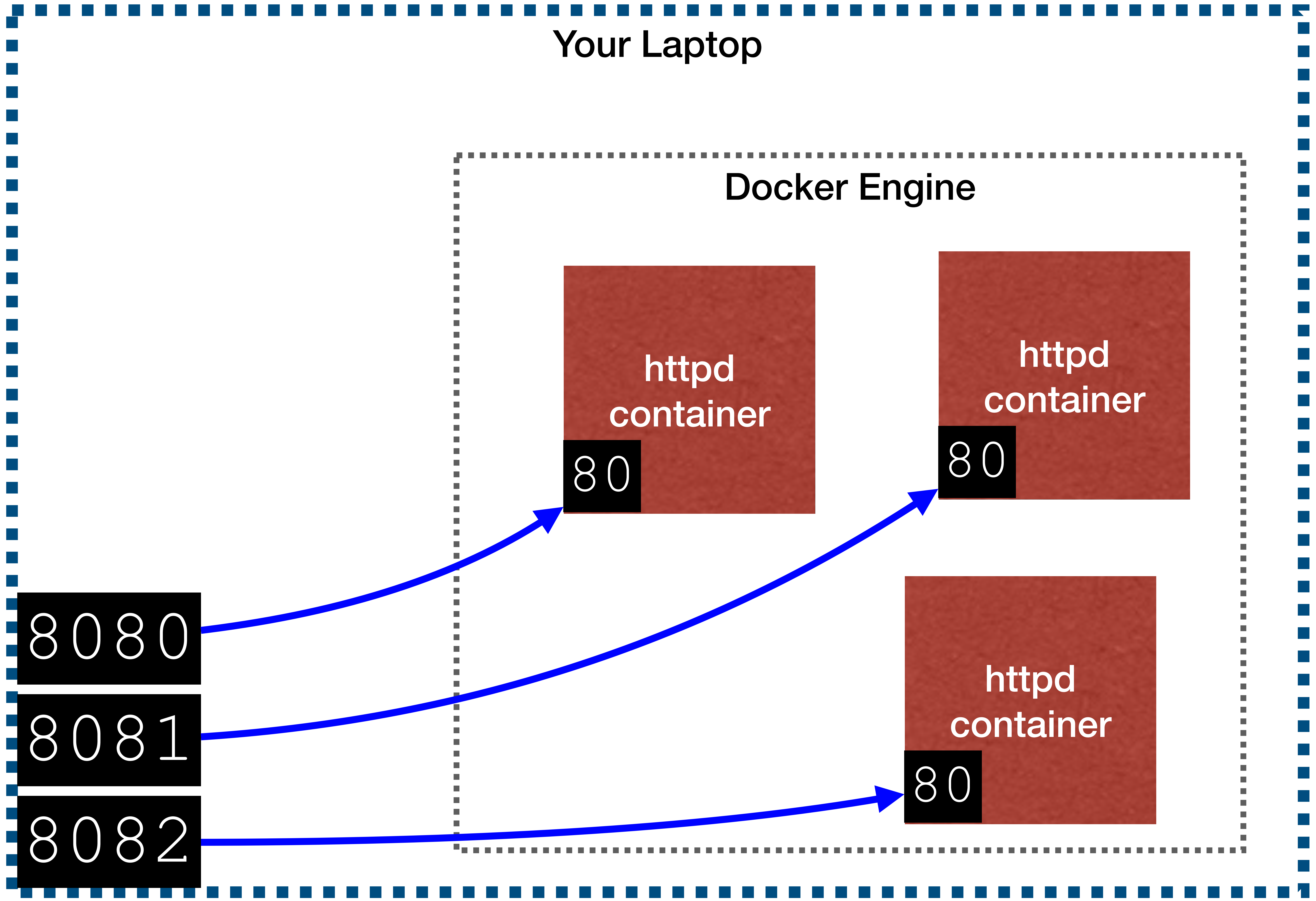
- We can run multiple containers, all with the same internal port.
- We can't map the same port on the host to multiple containers!



Web Servers

Revisiting Containers

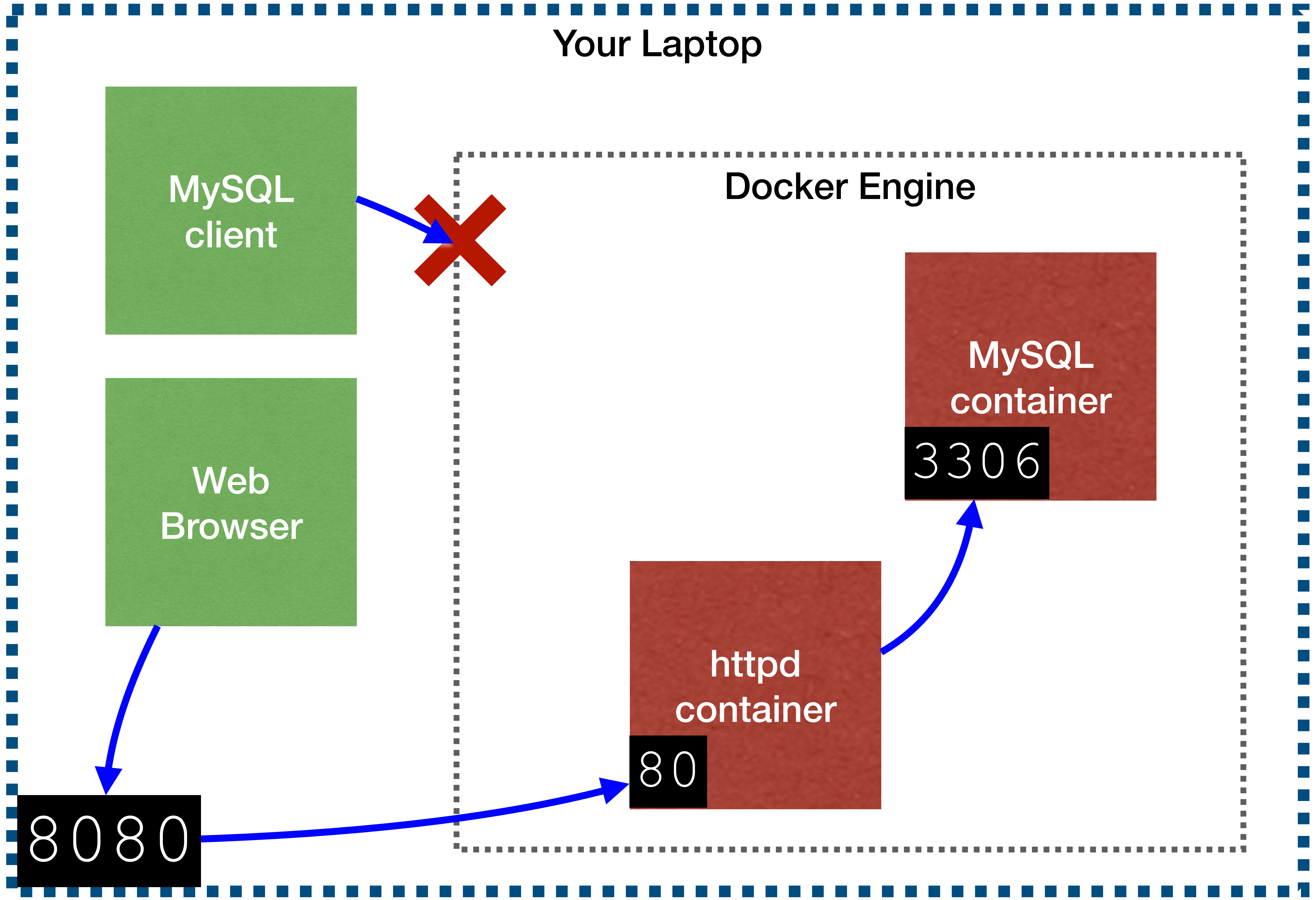
- We need separate ports on the host for each container we want to forward traffic to



Web Servers

Revisiting Containers

- Not all containers need their ports mapped to the host
- Containers can also talk to each other directly, without having to leave the internal docker network



Up Next: Javascript!