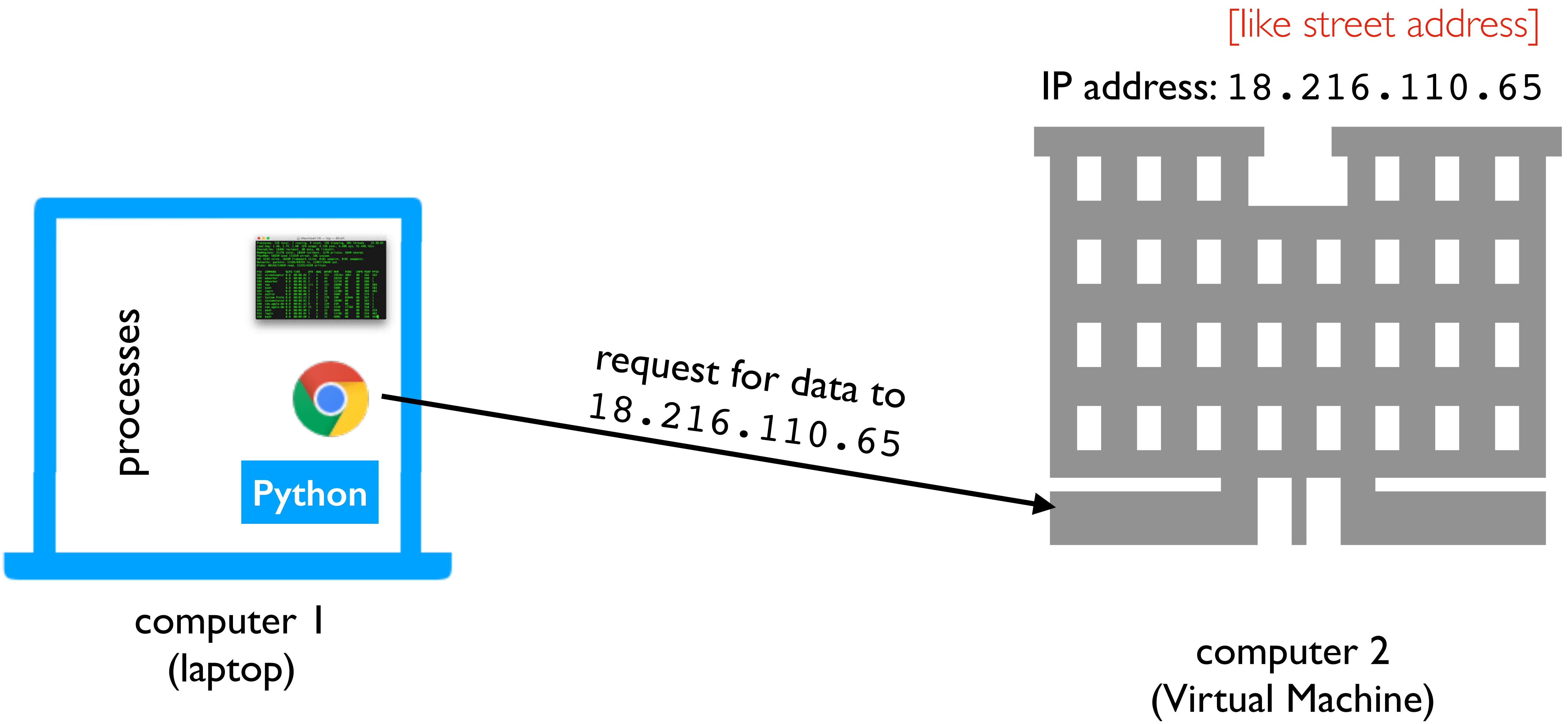
[320] Web 3: Flask

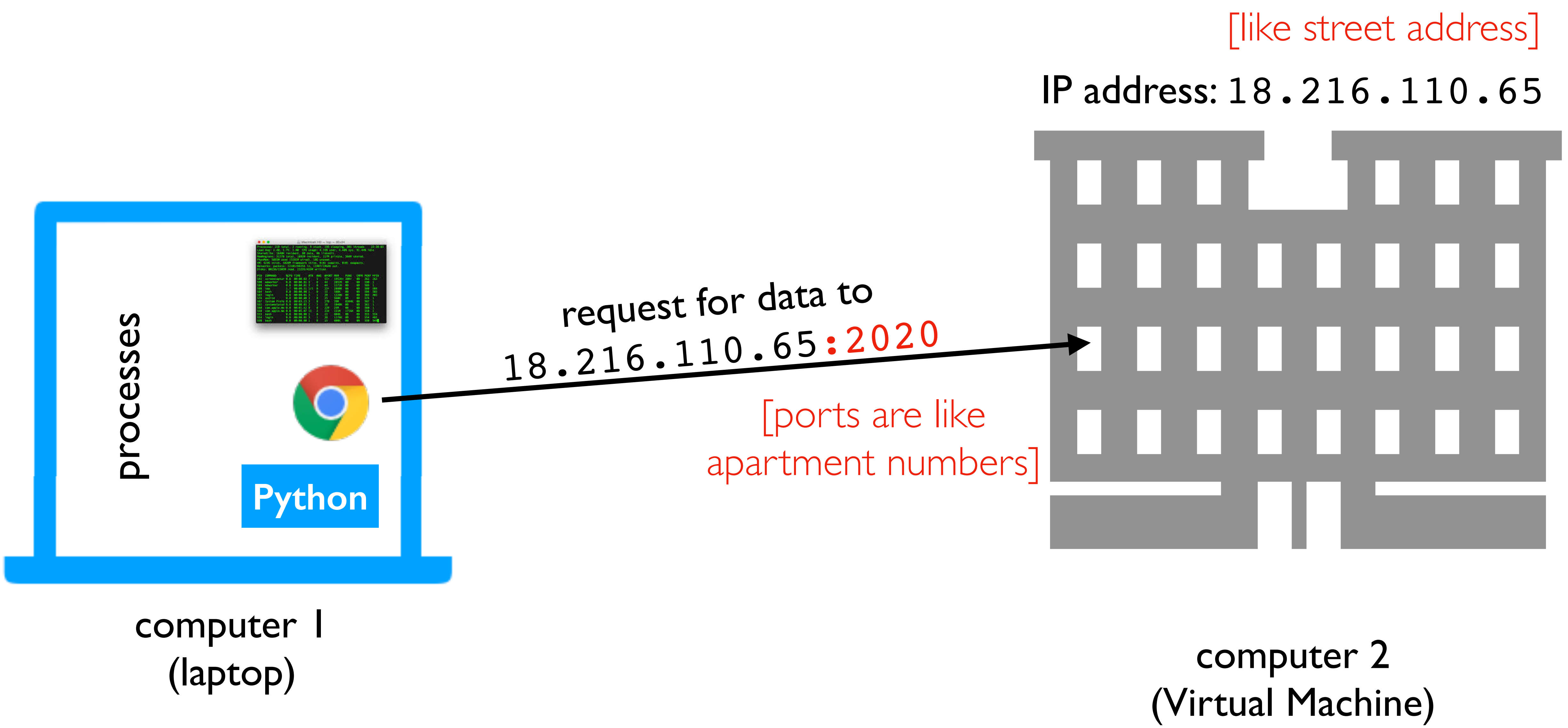
Tyler Caraza-Harter

Getting Requests Through



Scenario: we want to access Jupyter on our virtual machine from our laptop

Getting Requests Through



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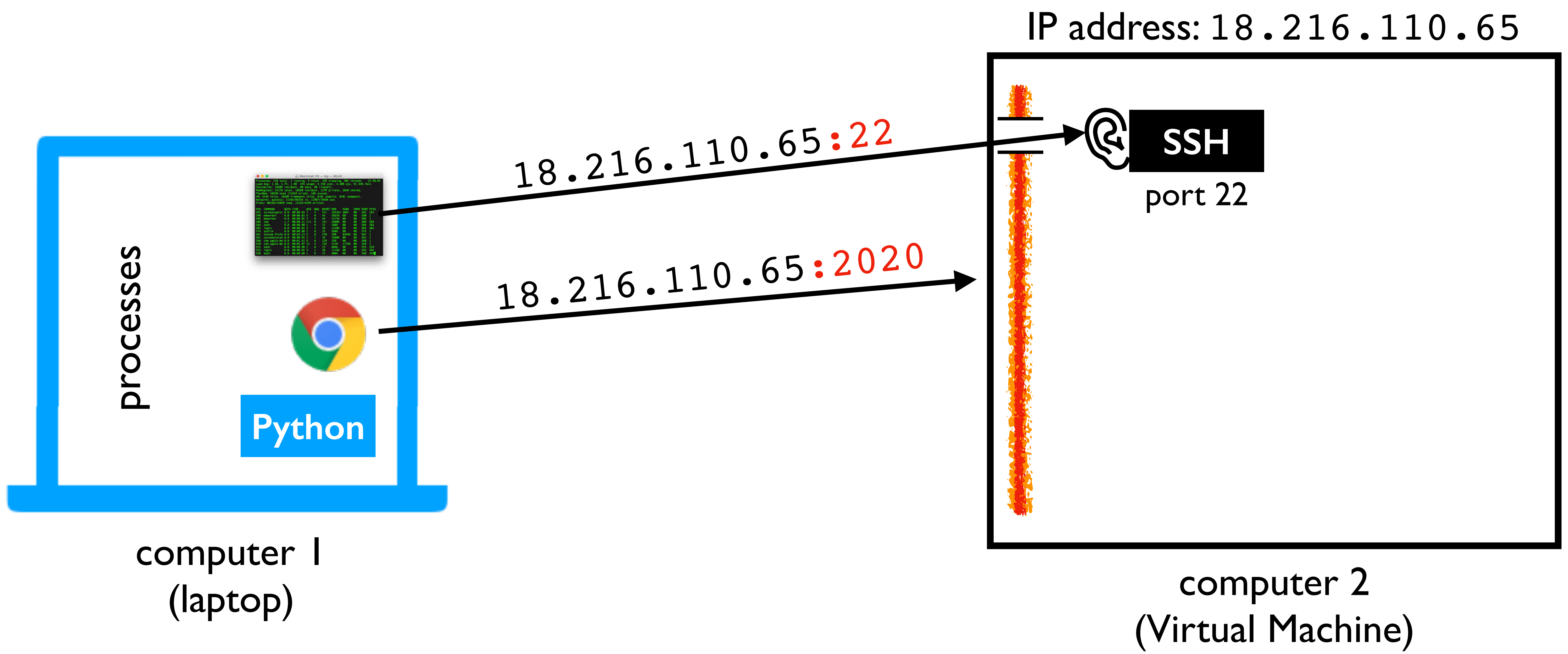
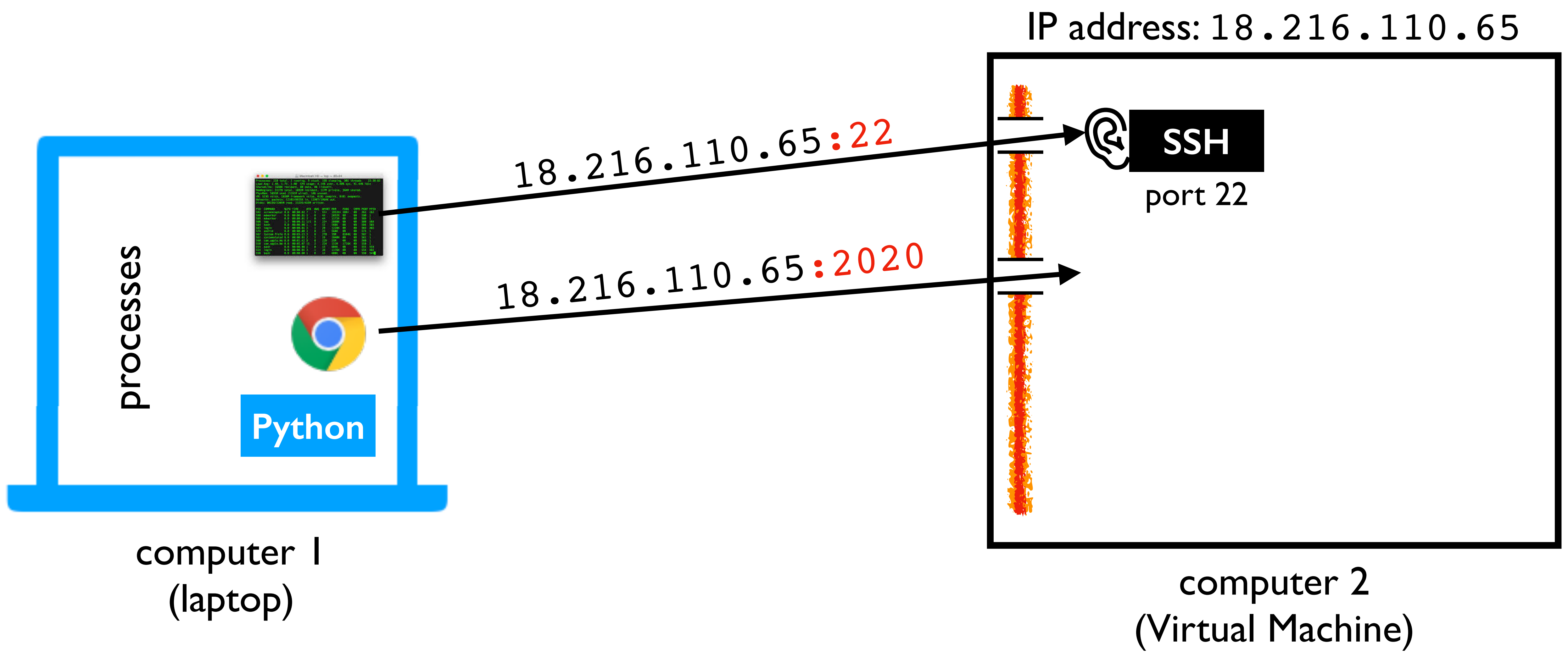


Issue 1: firewall may be blocking some ports (we disabled this in lab)

Getting Requests Through

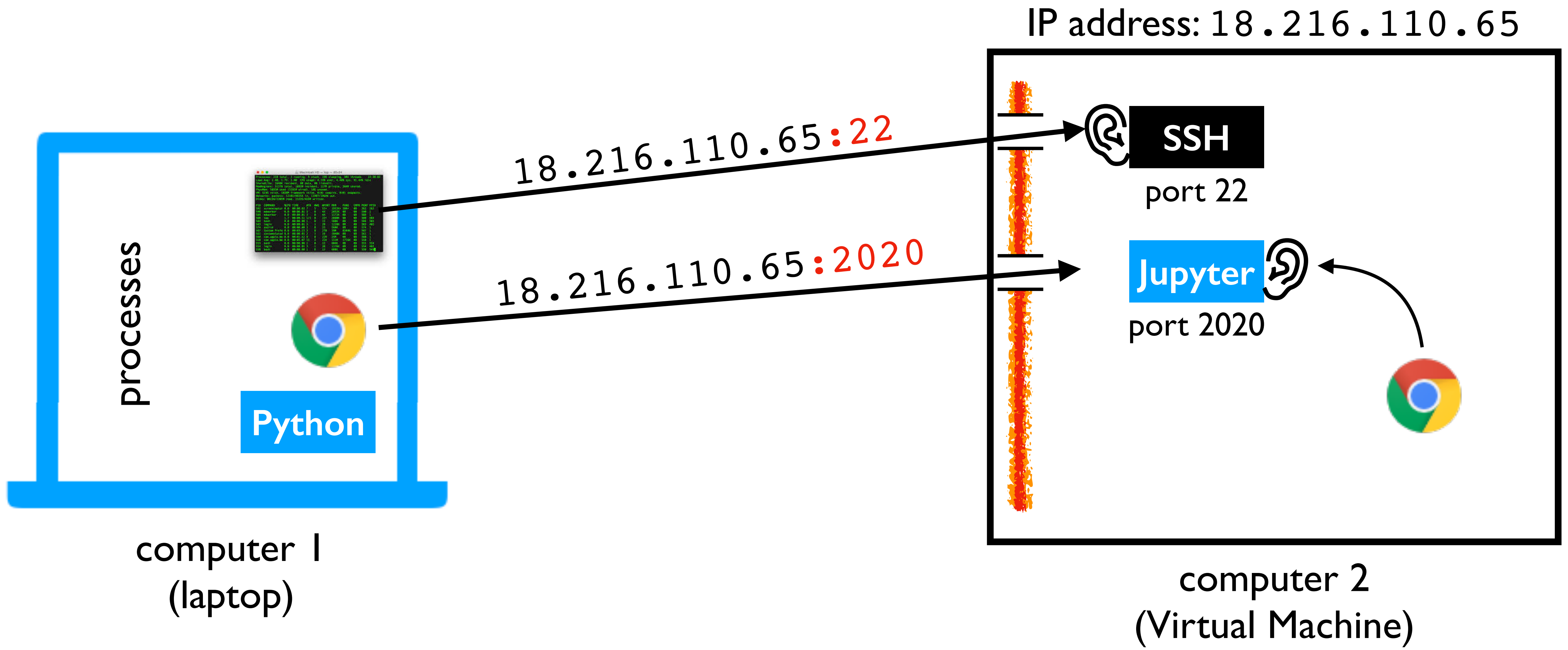


Issue 2: there might not be any process listening on port 2020

Getting Requests Through

[127.0.0.1 means "localhost", the default]

Start command: python3 -m notebook --no-browser **--ip=127.0.0.1** --port=2020

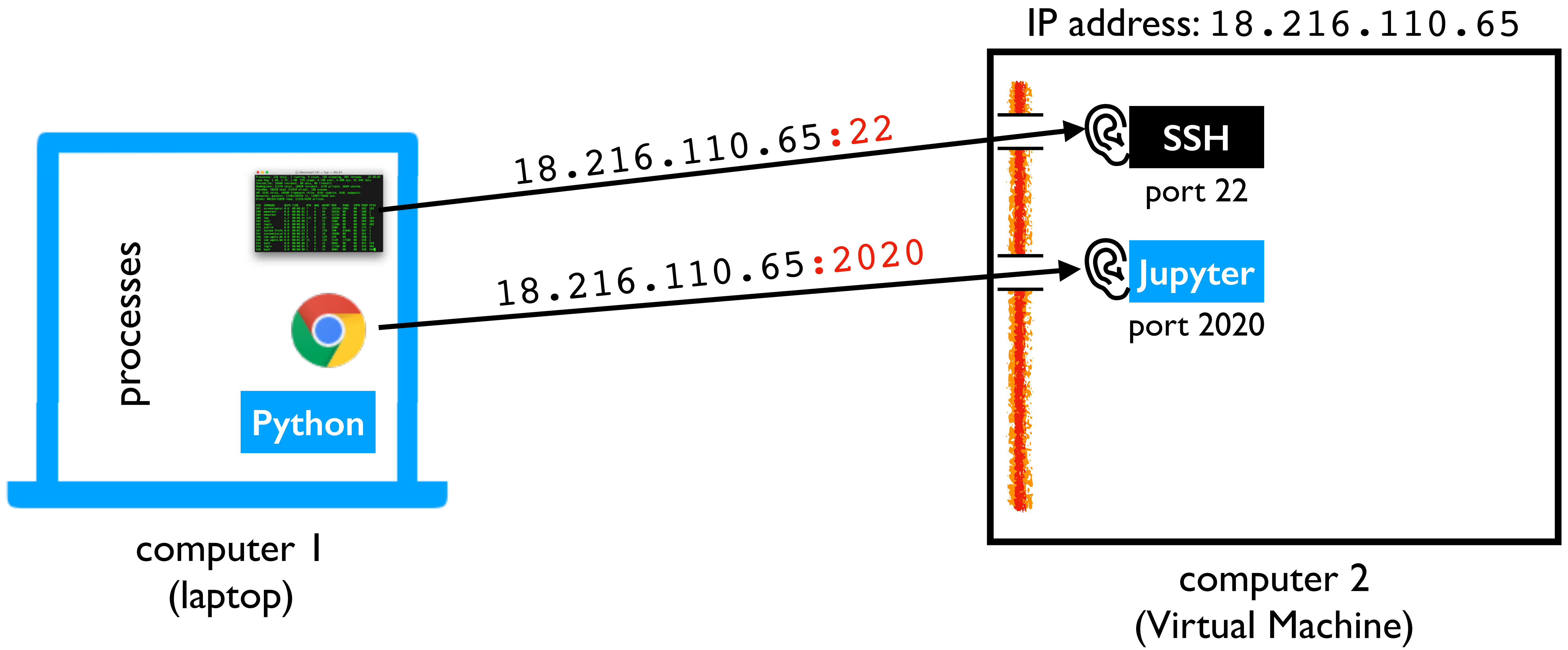


Issue 3: the process may only be listening for local (not external) requests

Getting Requests Through

[0.0.0.0 means all IP addresses]

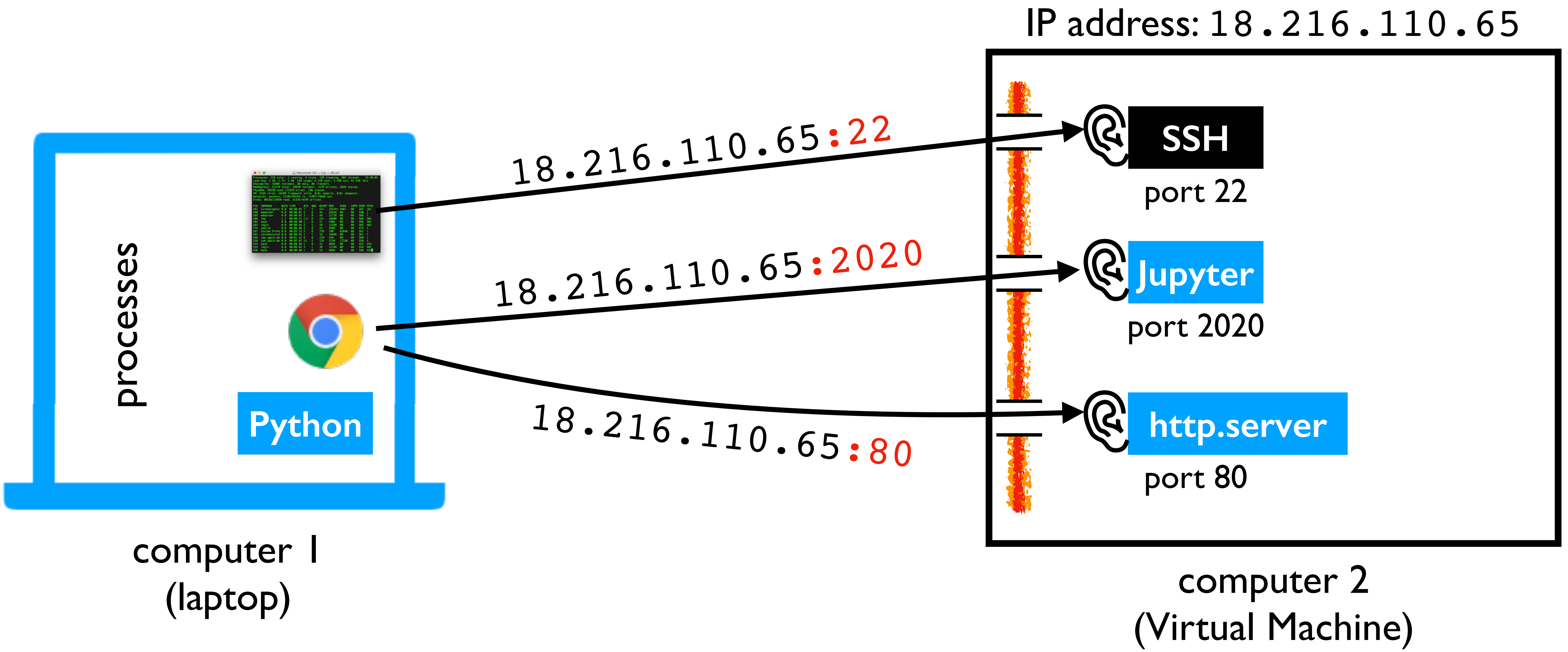
Start command: python3 -m notebook --no-browser **--ip=0.0.0.0** --port=2020



Success: Jupyter is listening for all 2020 requests, and the firewall isn't blocking them!

Getting Requests Through

Start command: python3 -m notebook --no-browser **--ip=0.0.0.0** --port=2020

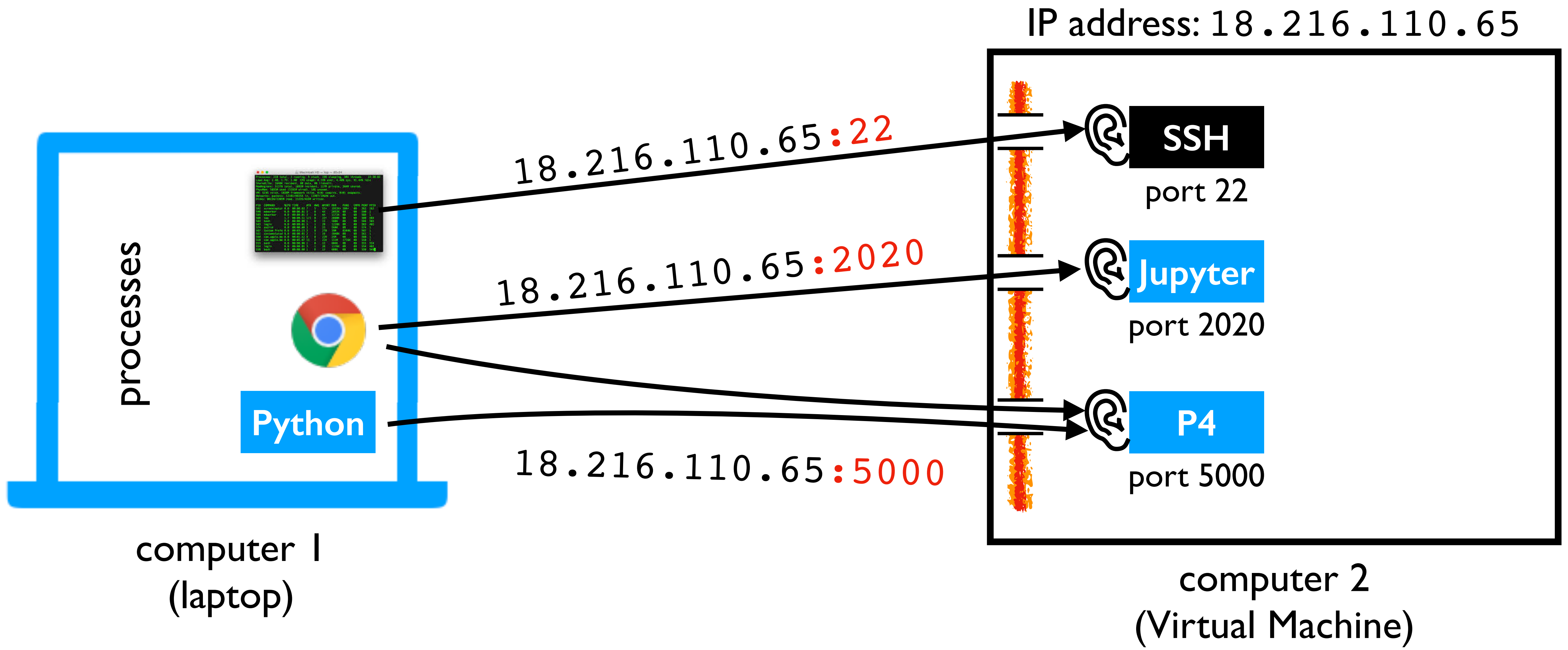


Demo: start web server with http.server

```
mkdir -p demo
cd demo
echo "<b>Hello</b> world!" > index.html
sudo python3 -m http.server --bind=0.0.0.0 80
```

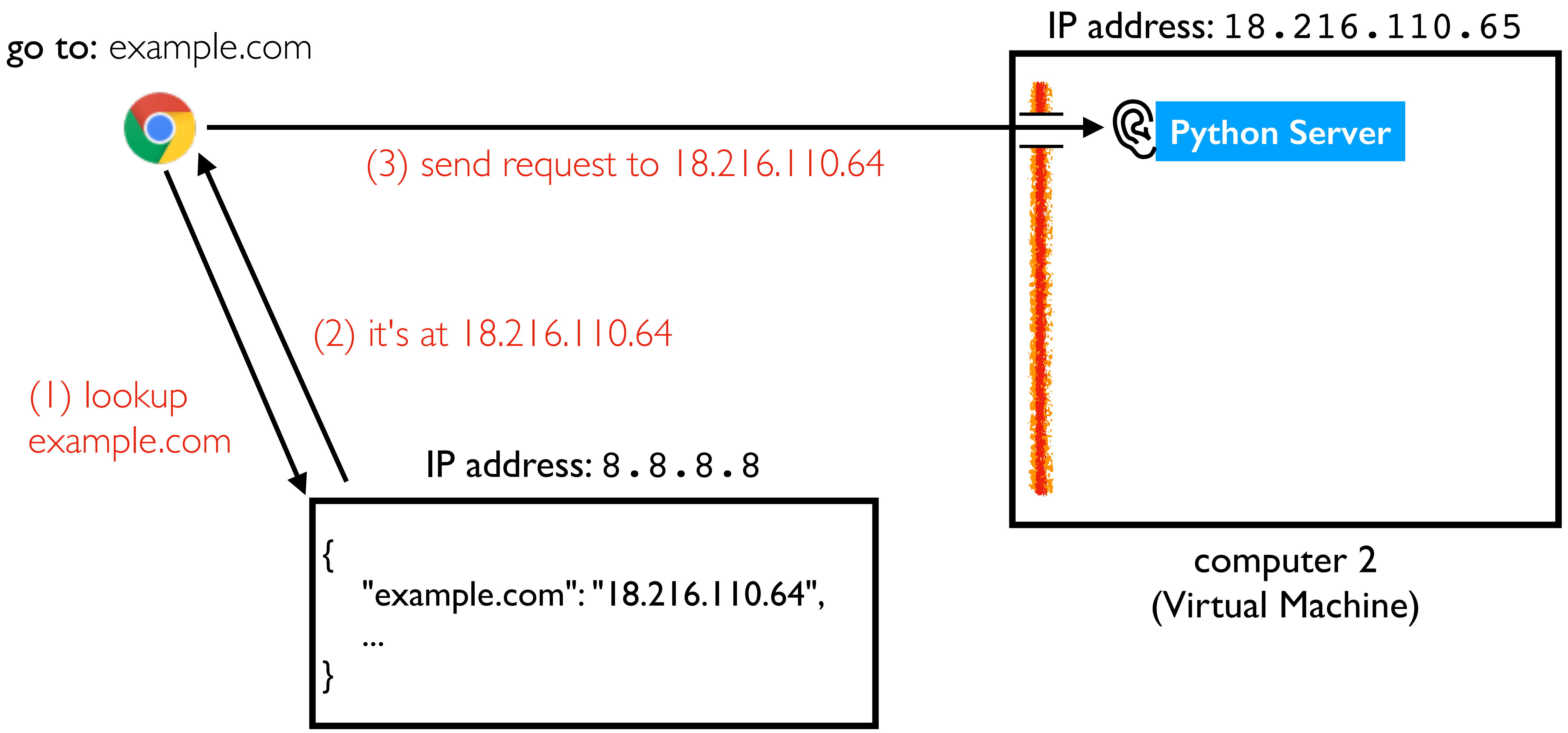
Getting Requests Through

Start command: python3 -m notebook --no-browser **--ip=0.0.0.0** --port=2020



Your Goal: build a web application for P4

DNS (Domain Name Service)

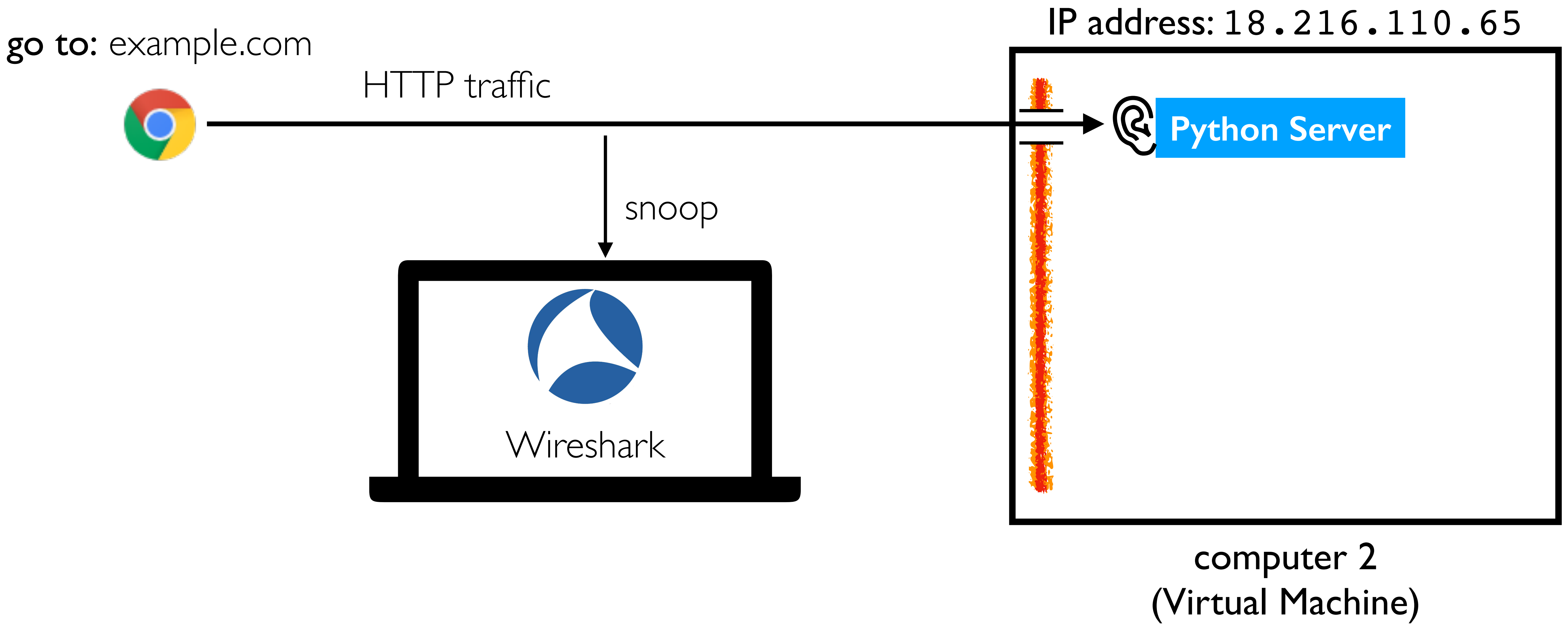


go to: example.com
(3) send request to 18.216.110.64
(2) it's at 18.216.110.64
(1) lookup example.com
IP address: 8.8.8.8
IP address: 18.216.110.65
Python Server
computer 2 (Virtual Machine)

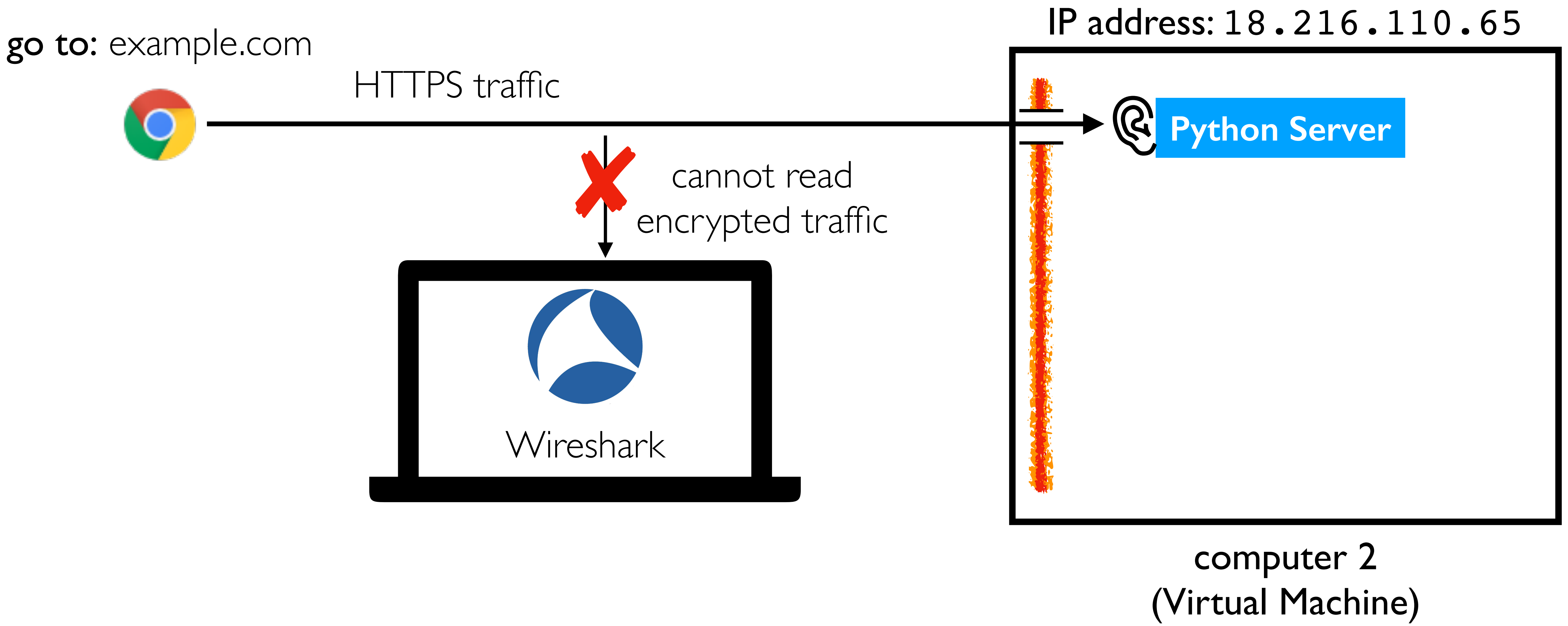
```
{
    "example.com": "18.216.110.64",
    ...
}
```

paying to register domain name is ~$10-15 / year

HTTPS: Hypertext Transfer Protocol Secure



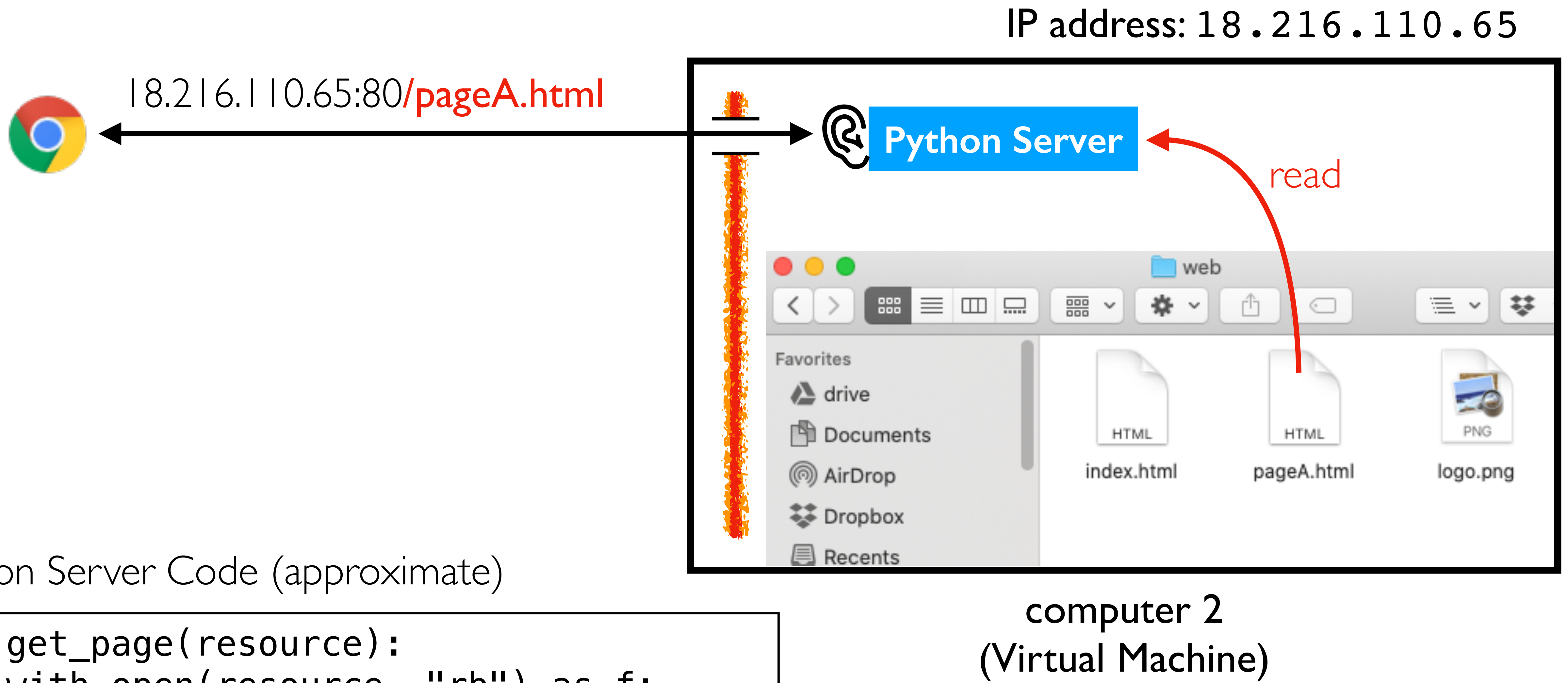
HTTPS: Hypertext Transfer Protocol Secure



paying to register SSL certificate for encryption name is ~$5-10 / year
(or free: https://letsencrypt.org/)

Pages vs. Files

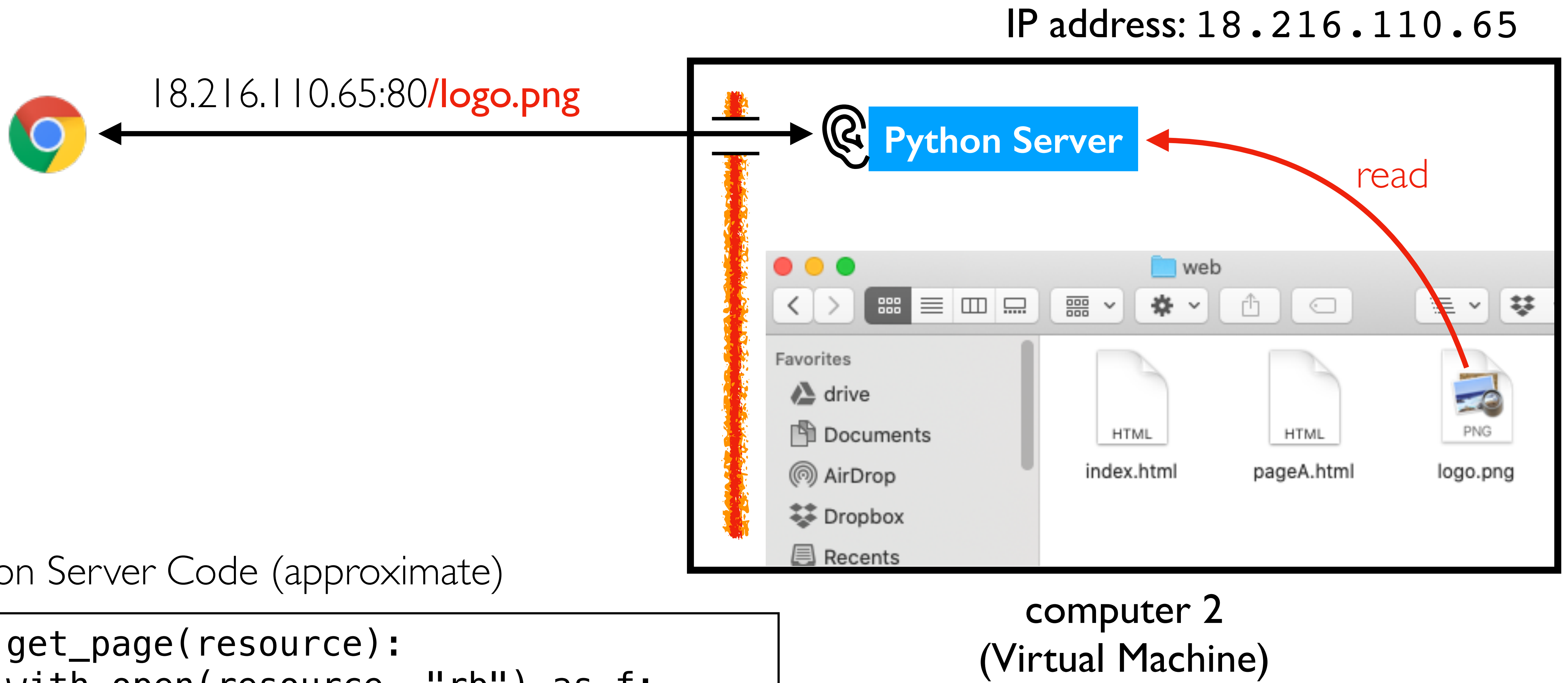
Static Pages Correspond to Files



Python Server Code (approximate)

```
def get_page(resource):
    with open(resource, "rb") as f:
        return f.read()
```

Static Pages Correspond to Files



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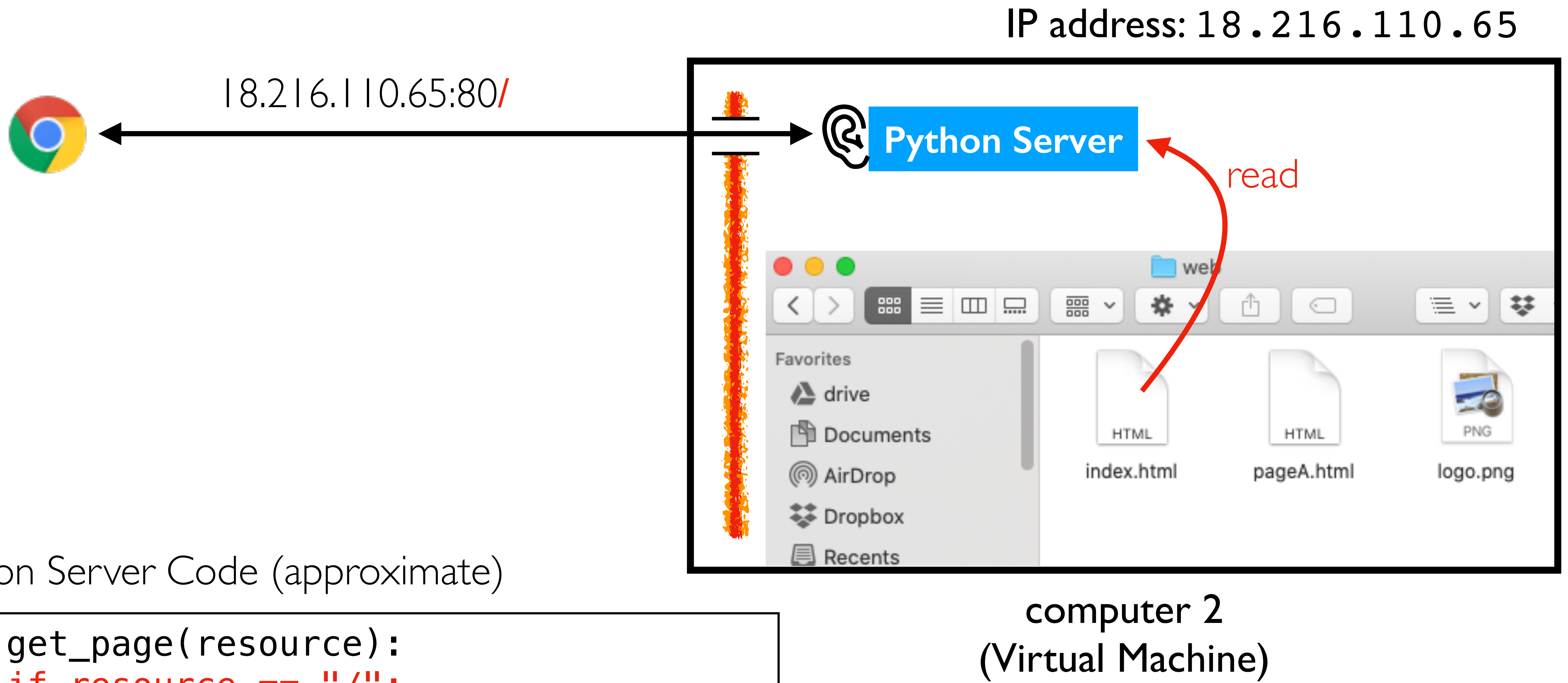
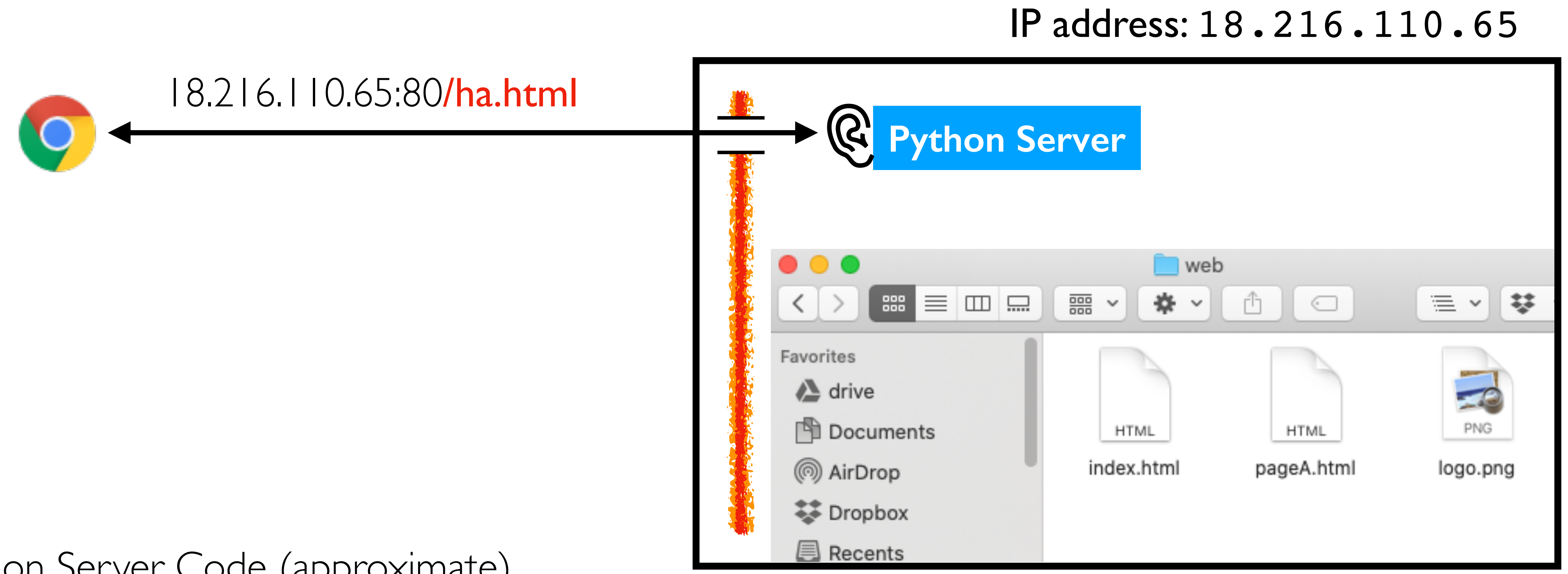


Python Server Code (approximate)

```
def get_page(resource):
    if resource == "/":
        resource = "index.html"

    with open(resource, "rb") as f:
        return f.read()
```

Dynamic Pages Generated by Code



Python Server Code (approximate)

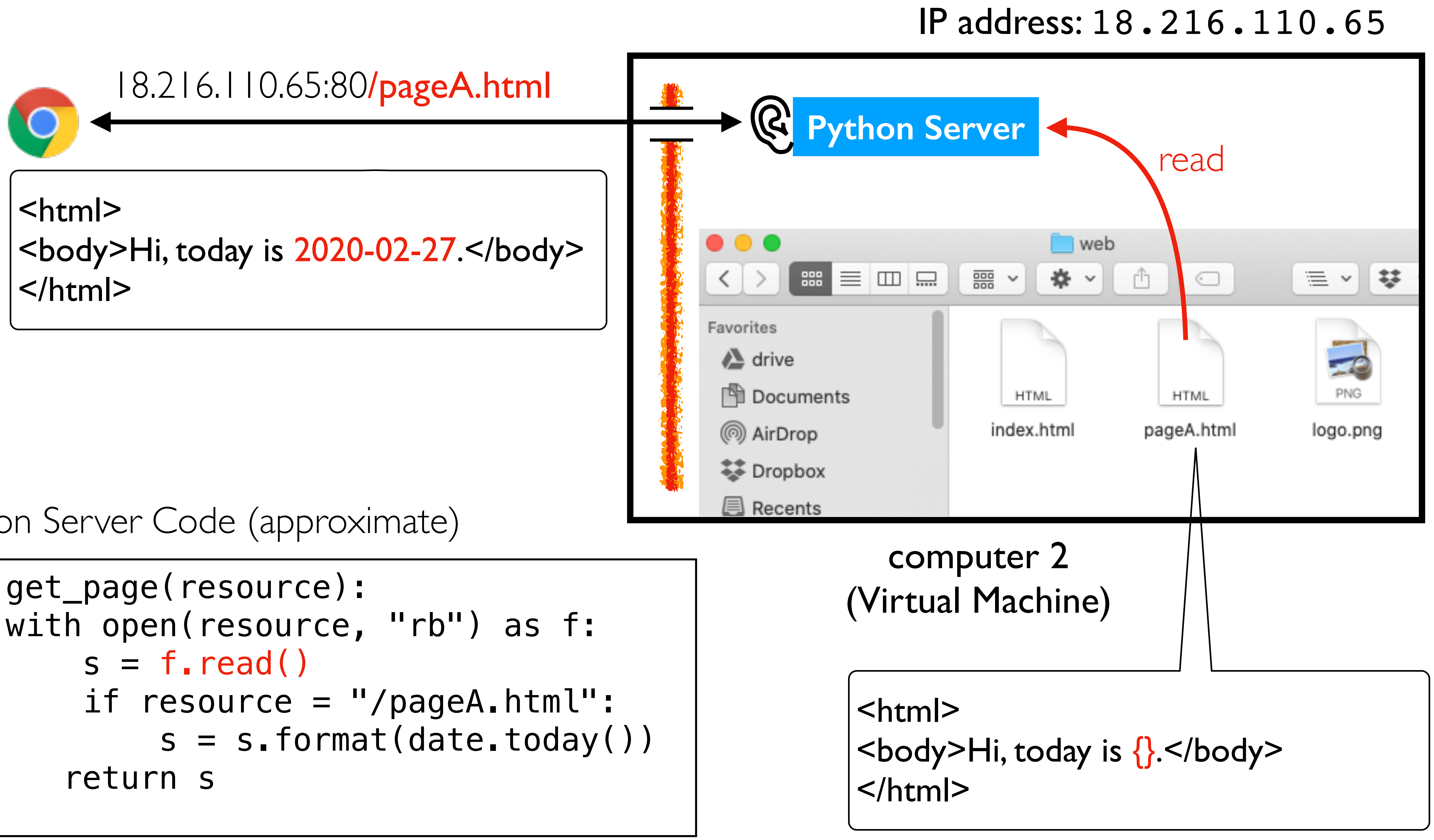
```
def get_page(resource):
    if resource == "/ha.html":
        return "<b>Ha!</b>" * 100

    with open(resource, "rb") as f:
        return f.read()
```

ha.html is dynamic

others are static

Templating: Add Dynamic Content to File



```
<html>
<body>Hi, today is 2020-02-27.</body>
</html>
```

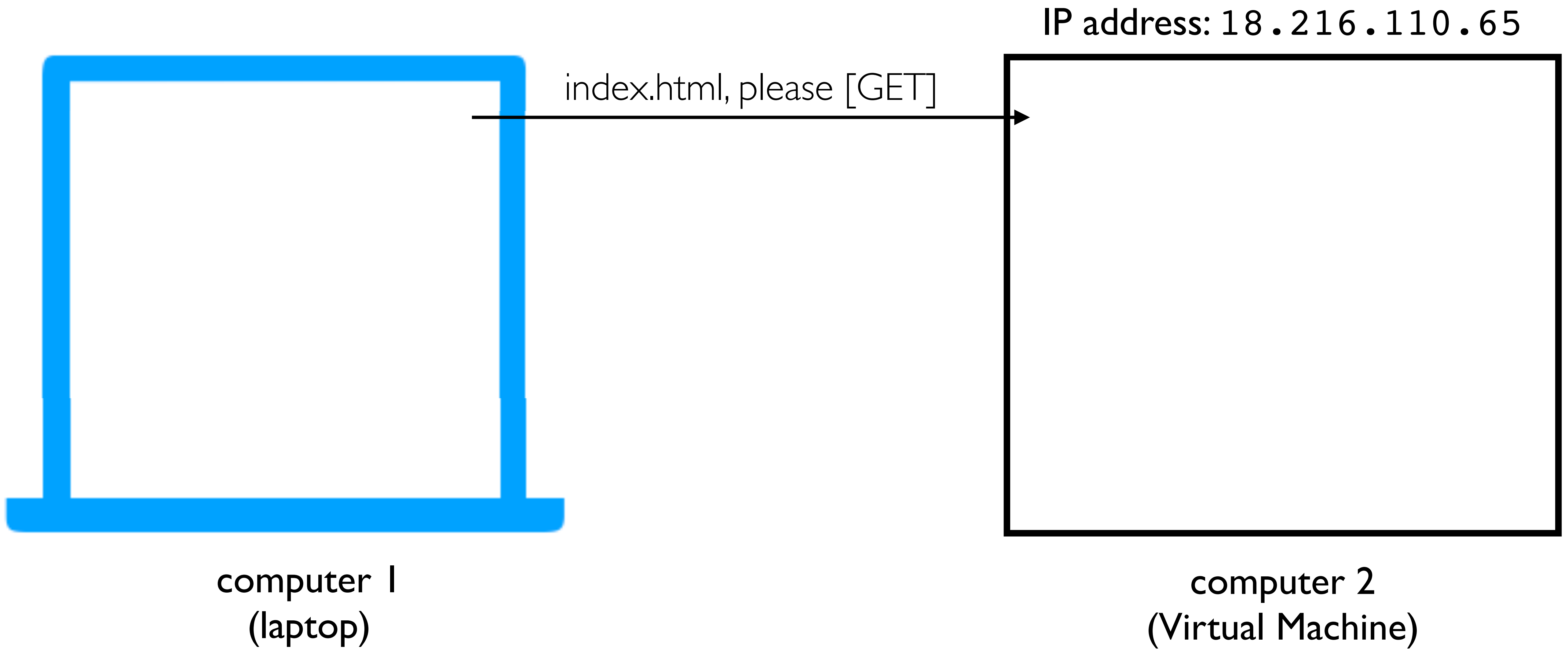
```
<html>
<body>Hi, today is {}.</body>
</html>
```

Python Server Code (approximate)

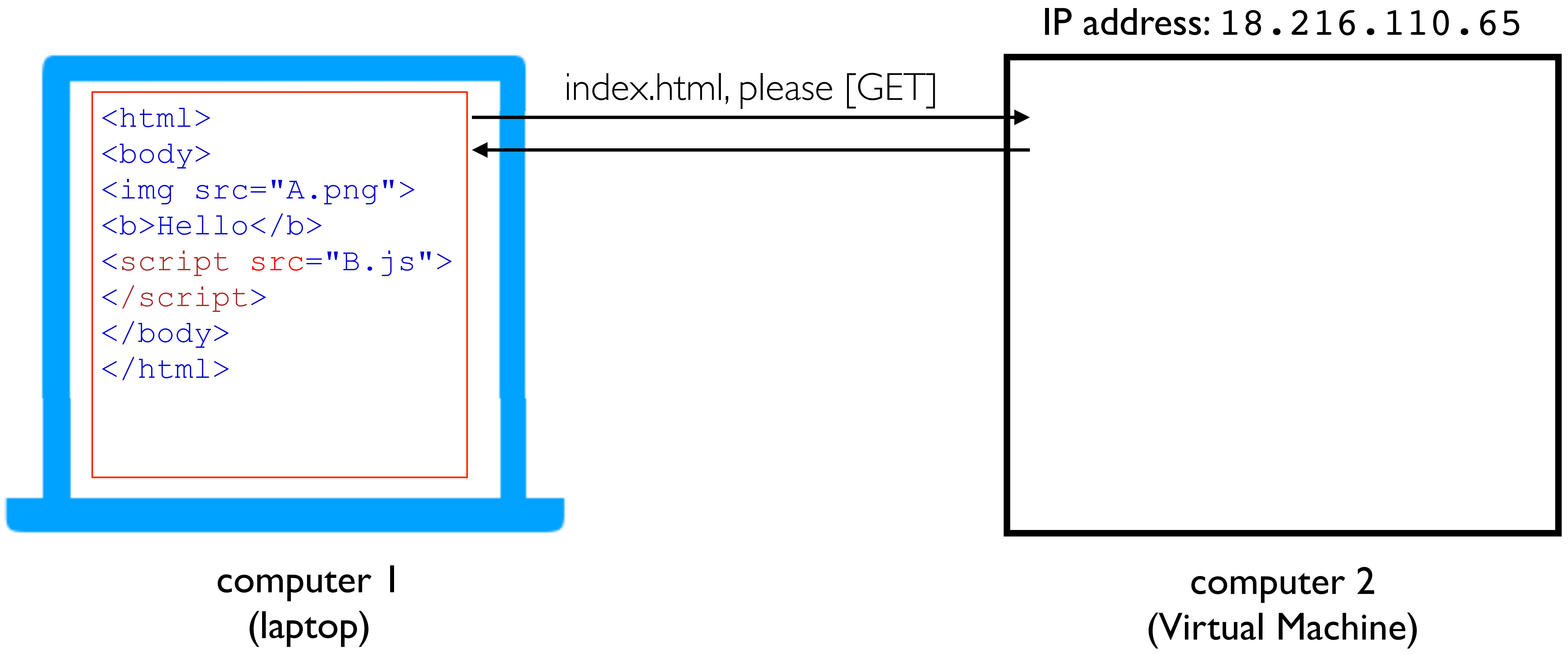
```
def get_page(resource):
    with open(resource, "rb") as f:
        s = f.read()
        if resource = "/pageA.html":
            s = s.format(date.today())
       return s
```

Multi-File Pages

Page Load, the Big Picture

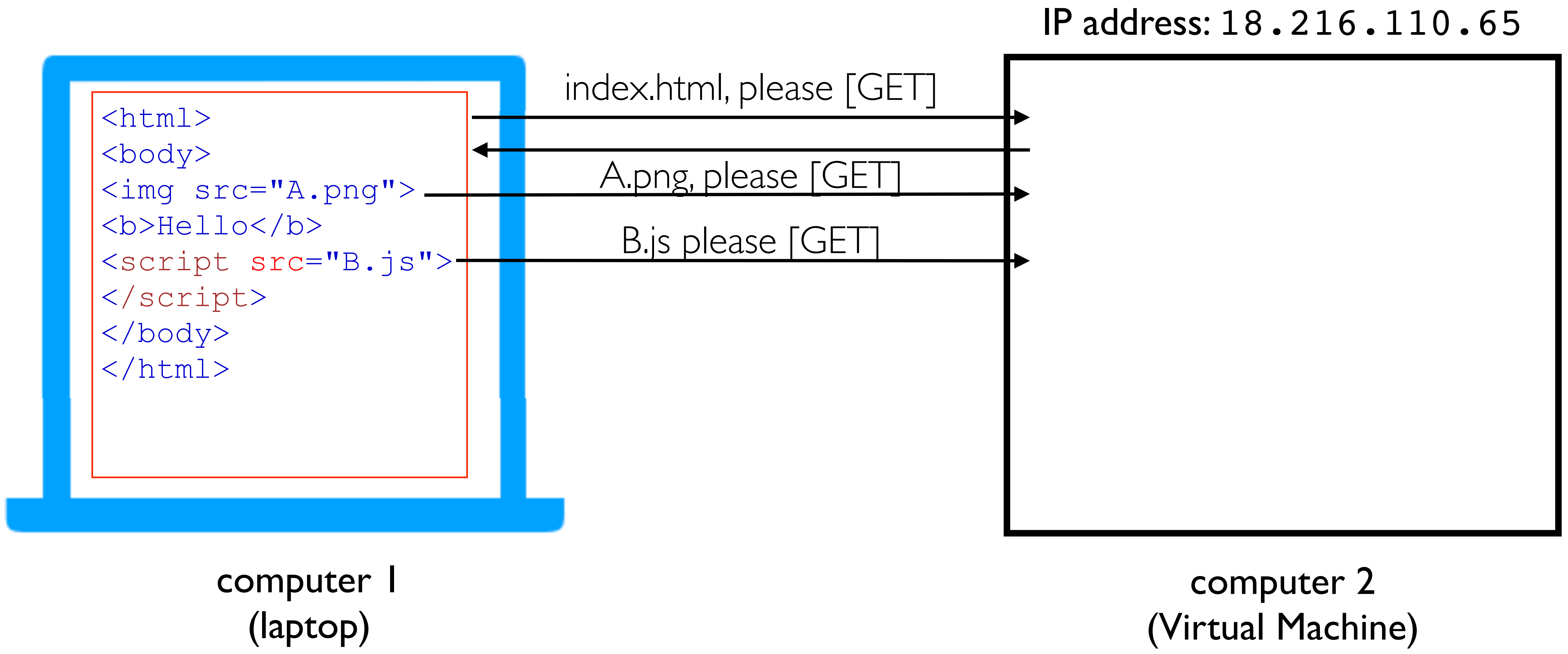


Page Load, the Big Picture



```
<html>
<body>
<img src="A.png">
<b>Hello</b>
<script src="B.js">
</script>
</body>
</html>
```

Page Load, the Big Picture



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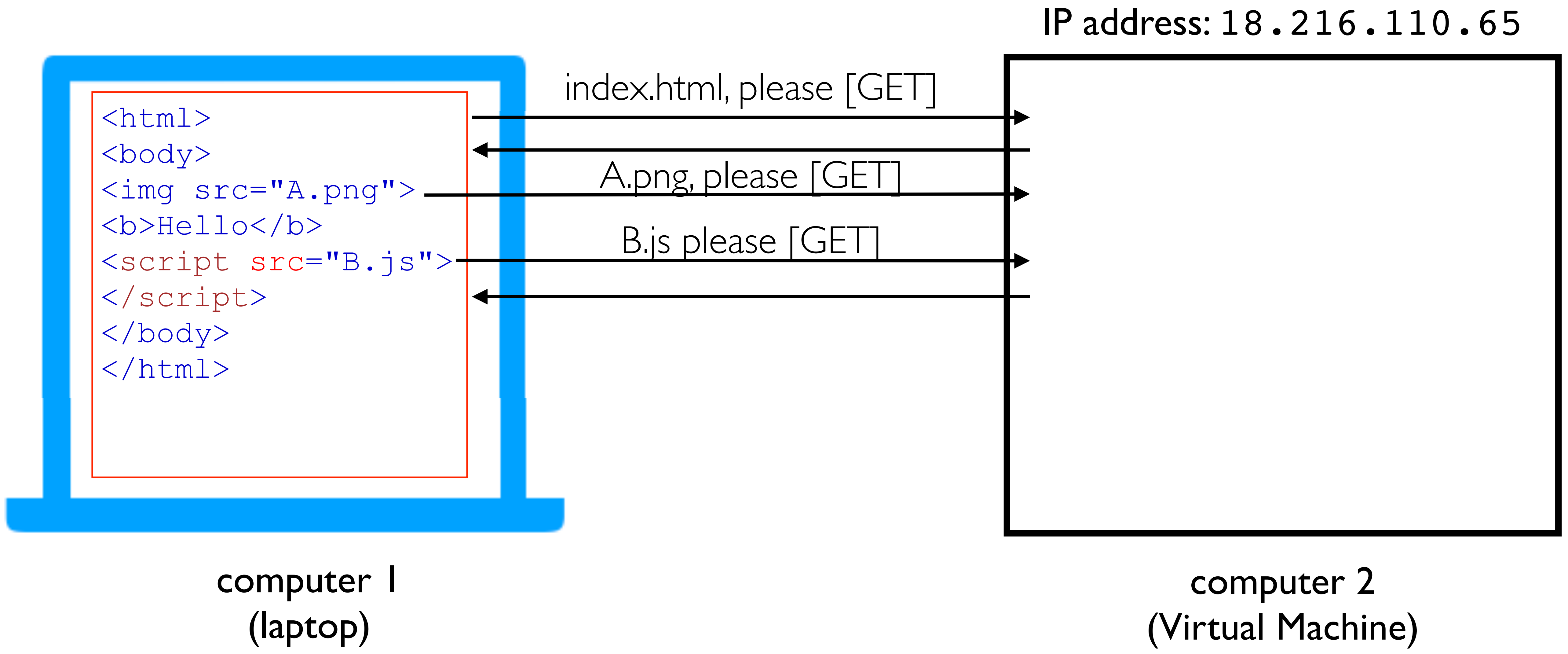
Page Load, the Big Picture



```
<html>
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```
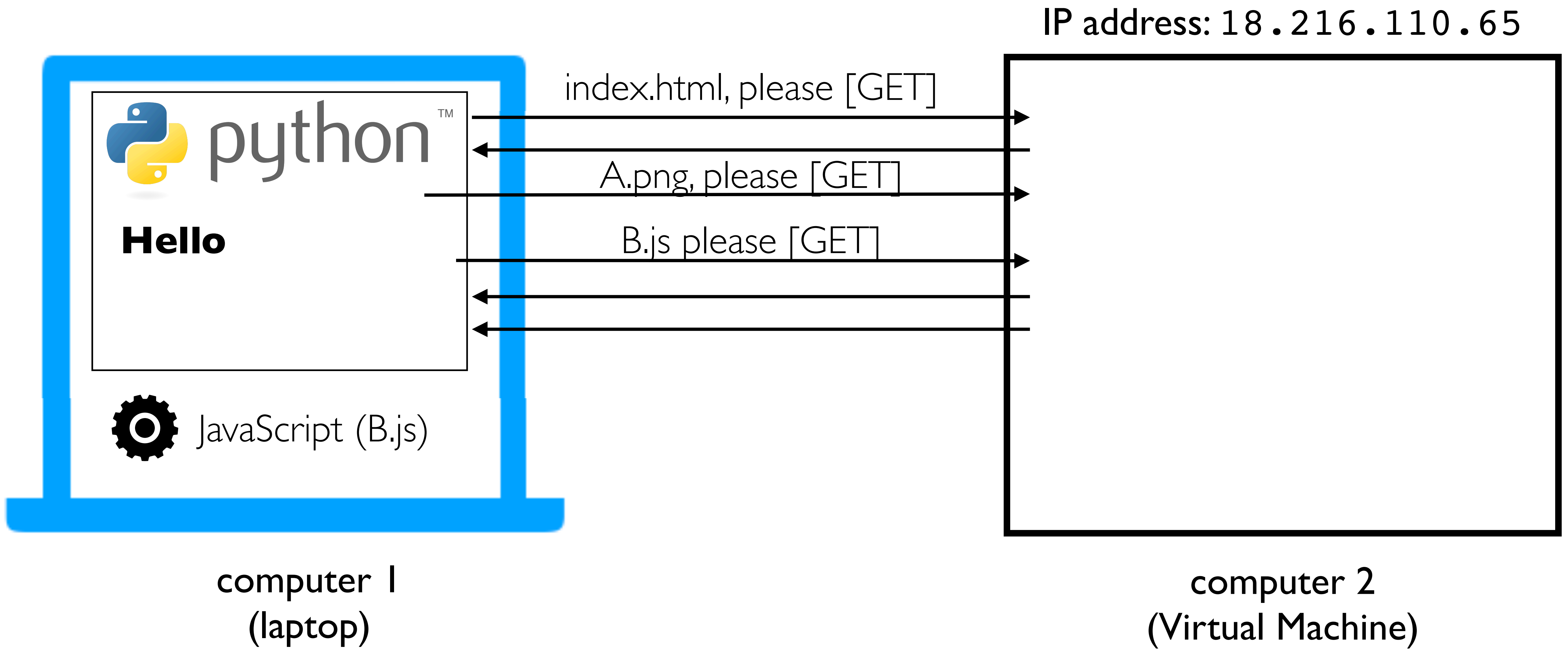
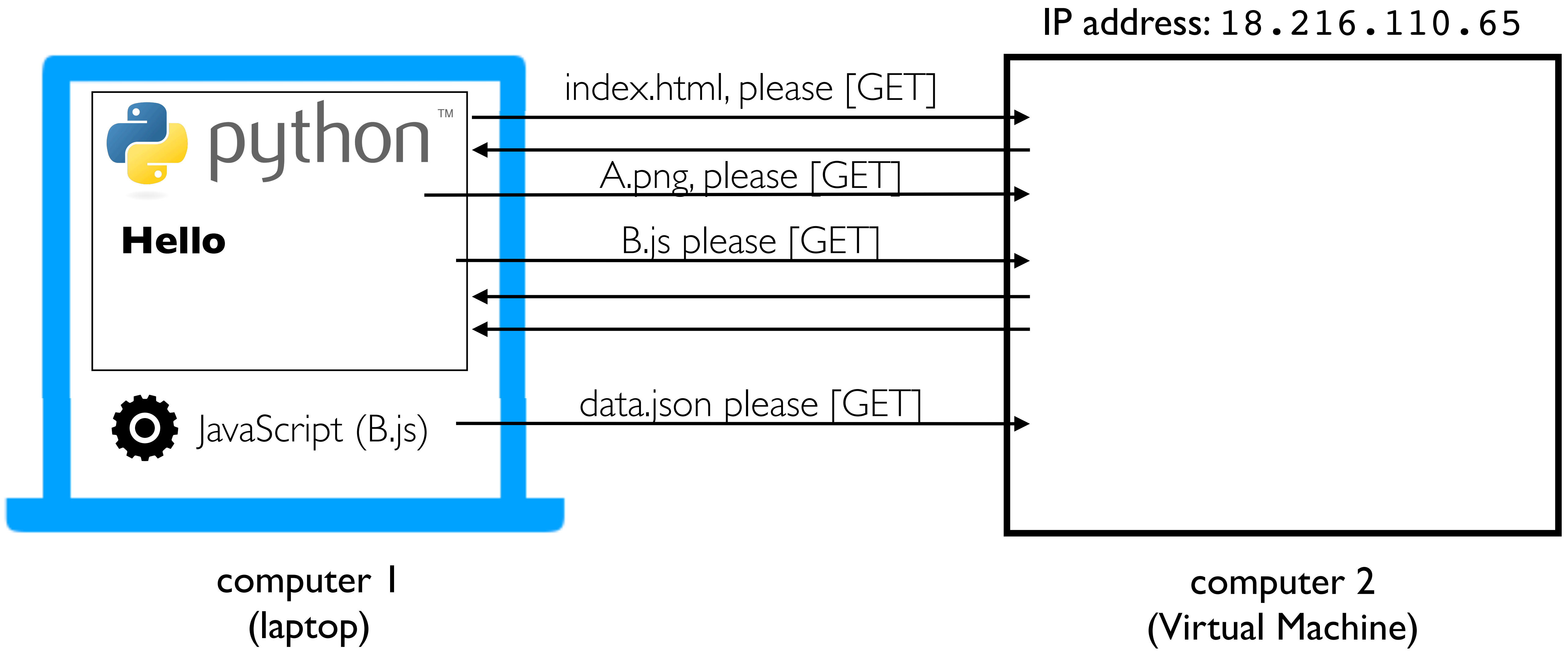
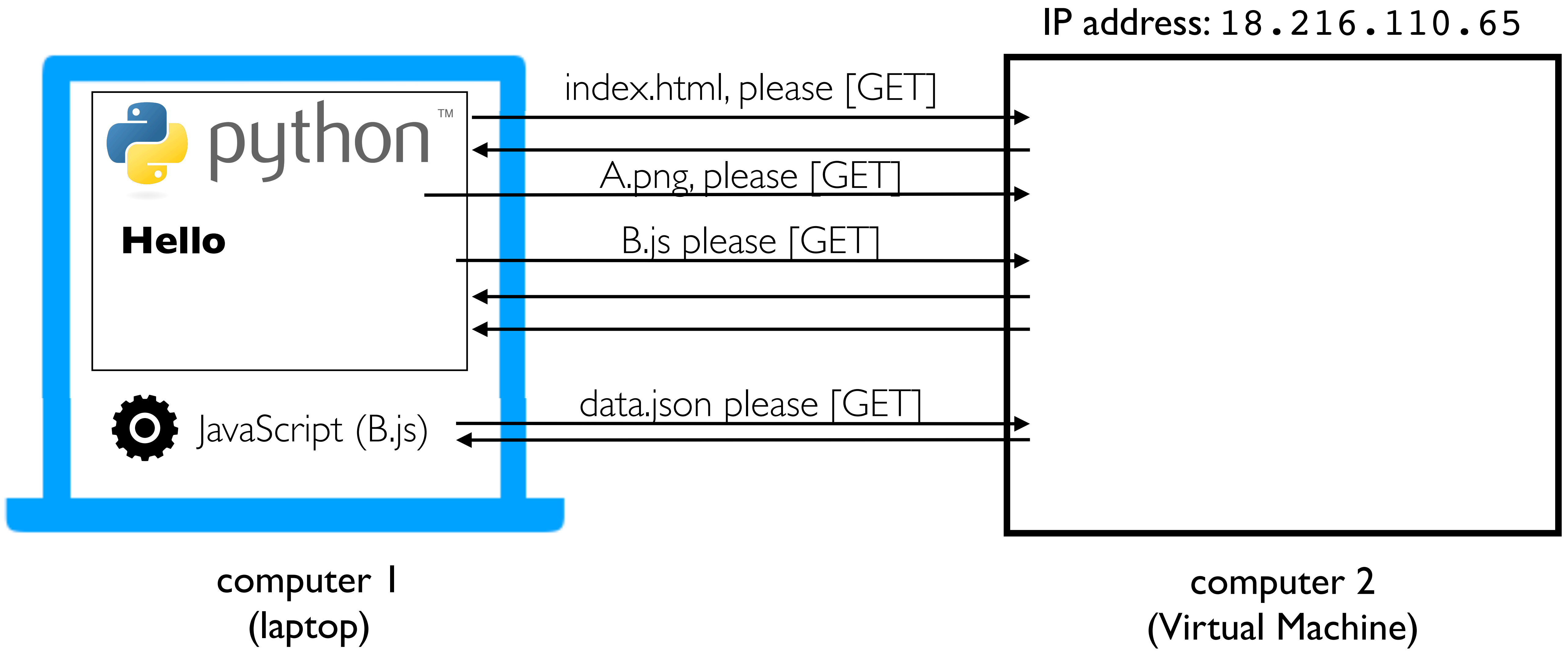

Page Load, the Big Picture



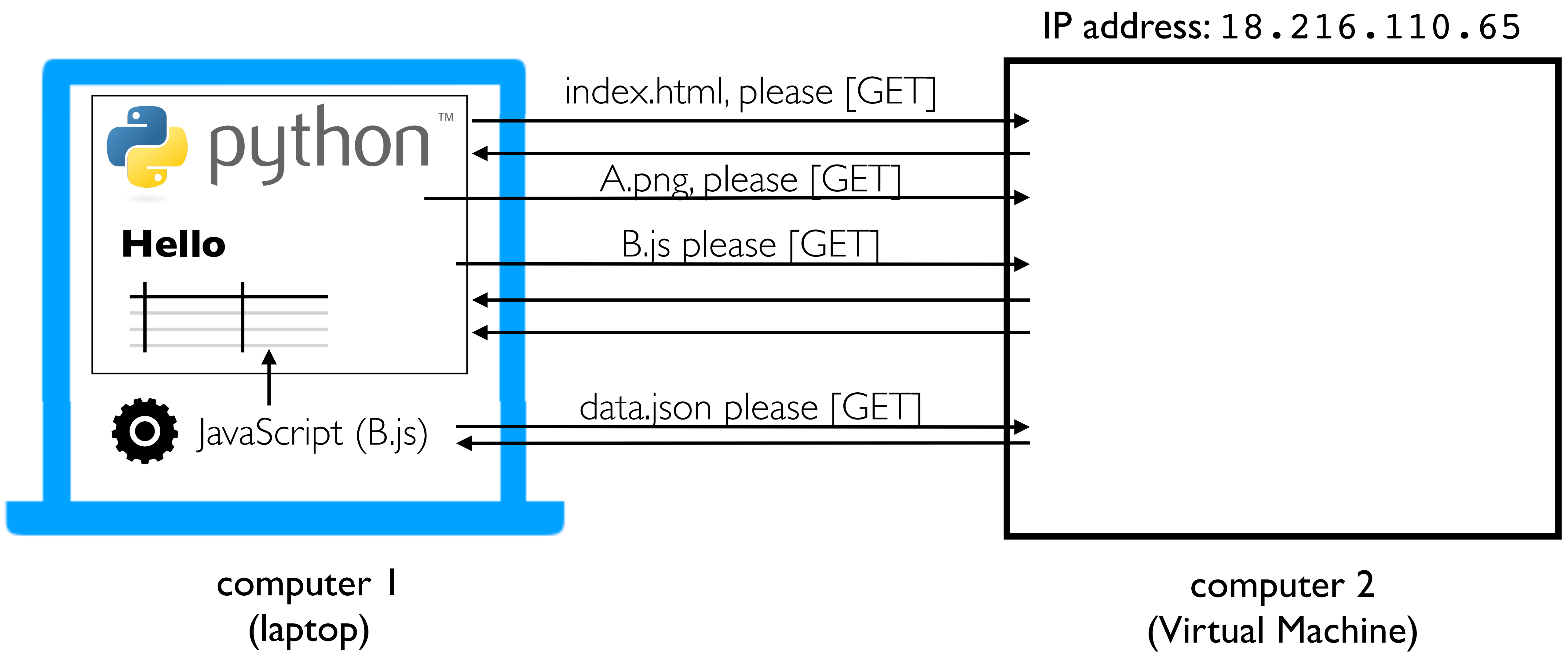
Page Load, the Big Picture



Page Load, the Big Picture

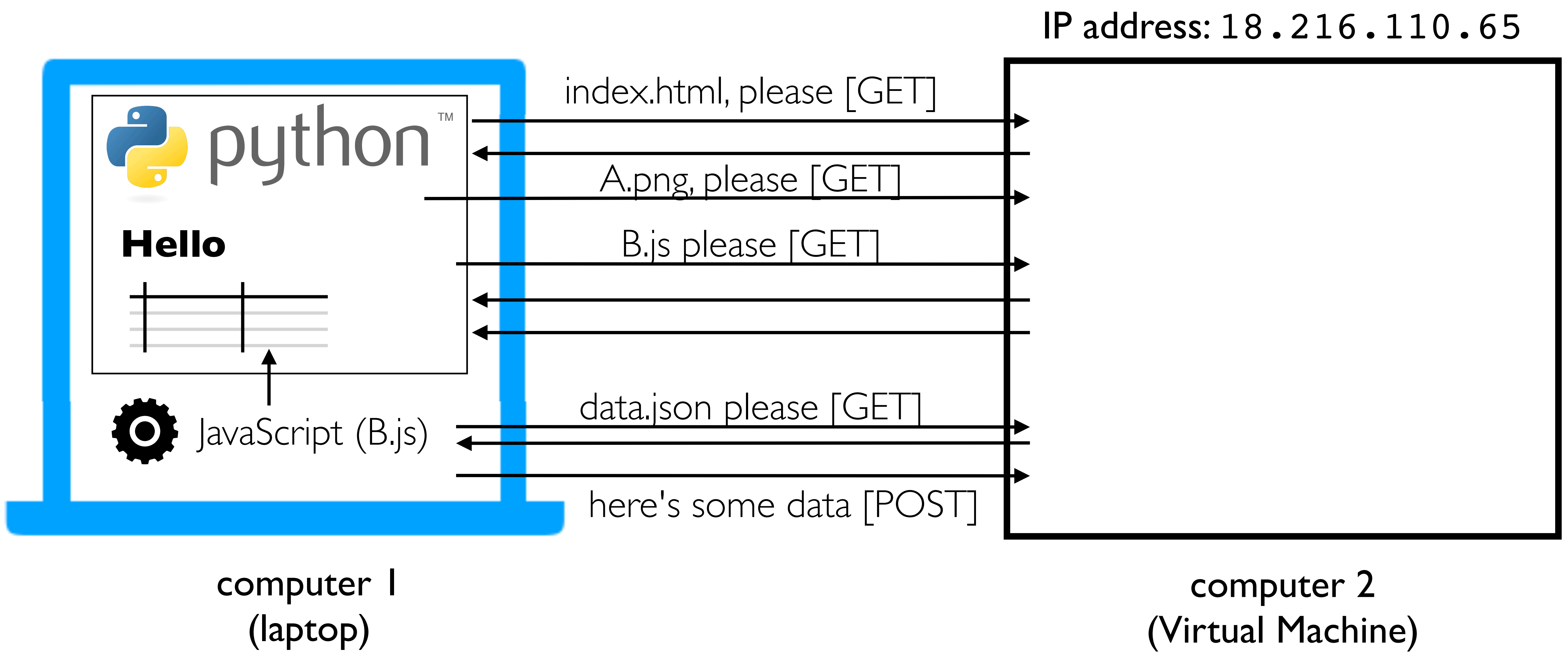


Page Load, the Big Picture



It's hard to scrape this kind of table: requests.get("index.html") wouldn't work...

Page Load, the Big Picture



It's hard to scrape this kind of table: requests.get("index.html") wouldn't work...

Summary: Key Web Concepts

IP address: identifier for a computer (or network card on computer)

port number: identifier used to route to specific process on computer

firewall: software to block certain requests, often for certain ports

listening: process is ready to receive requests from an IP/port

DNS: service for converting domains to IP addresses

HTTPS: encrypted HTTP traffic so others can't watch traffic on WIFI, etc

static pages: pages that correspond to files on the server

dynamic pages: pages generated on-the-fly by some Python code

templating: insert dynamic content into certain places in a file

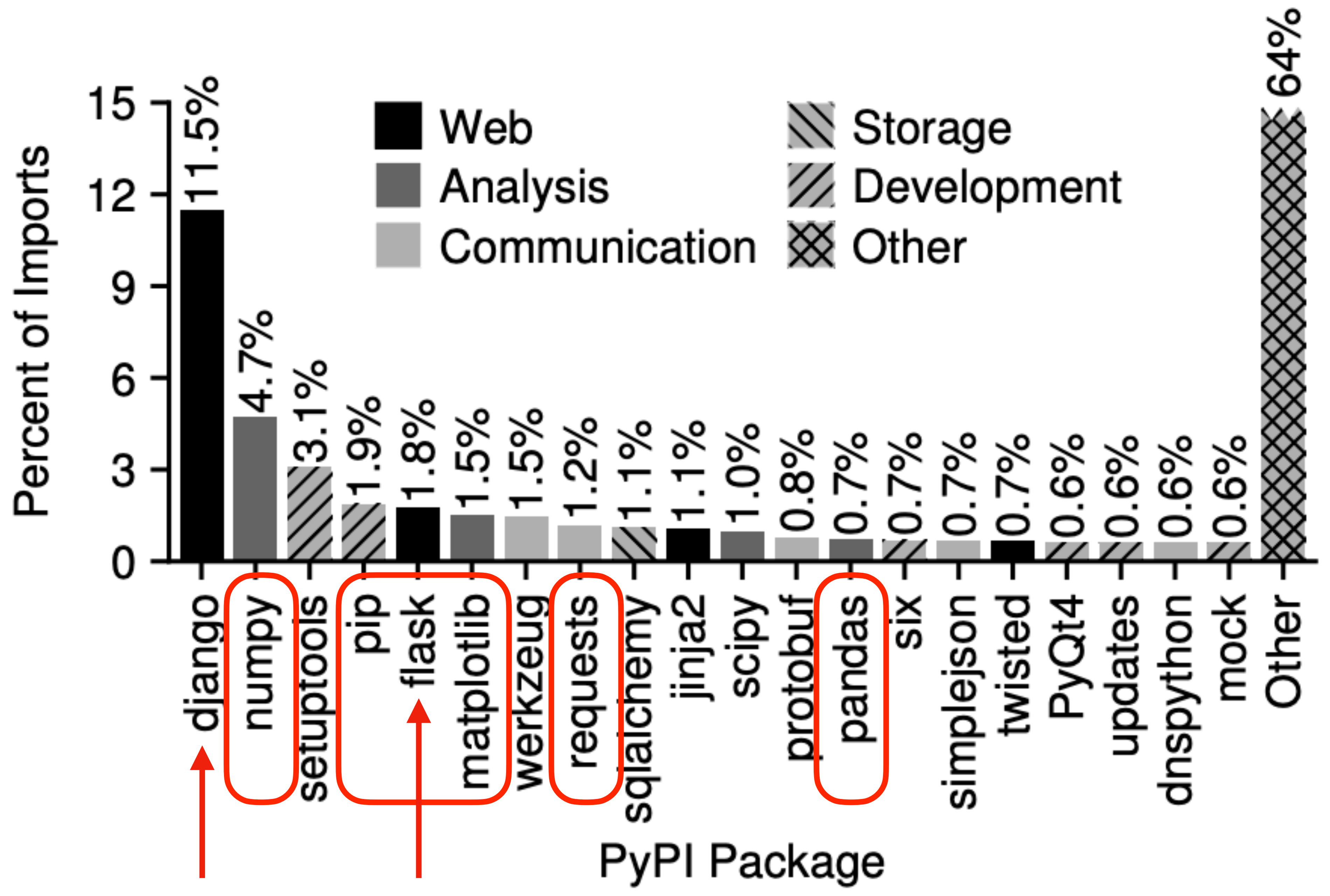
HTTP GET: request to download data

HTTP POST: request to upload data

Web Frameworks

Python Web Frameworks (and other packages)

Python web frameworks like Flask and Django make it easy to write functions for each webpage that can return a string with the contents.

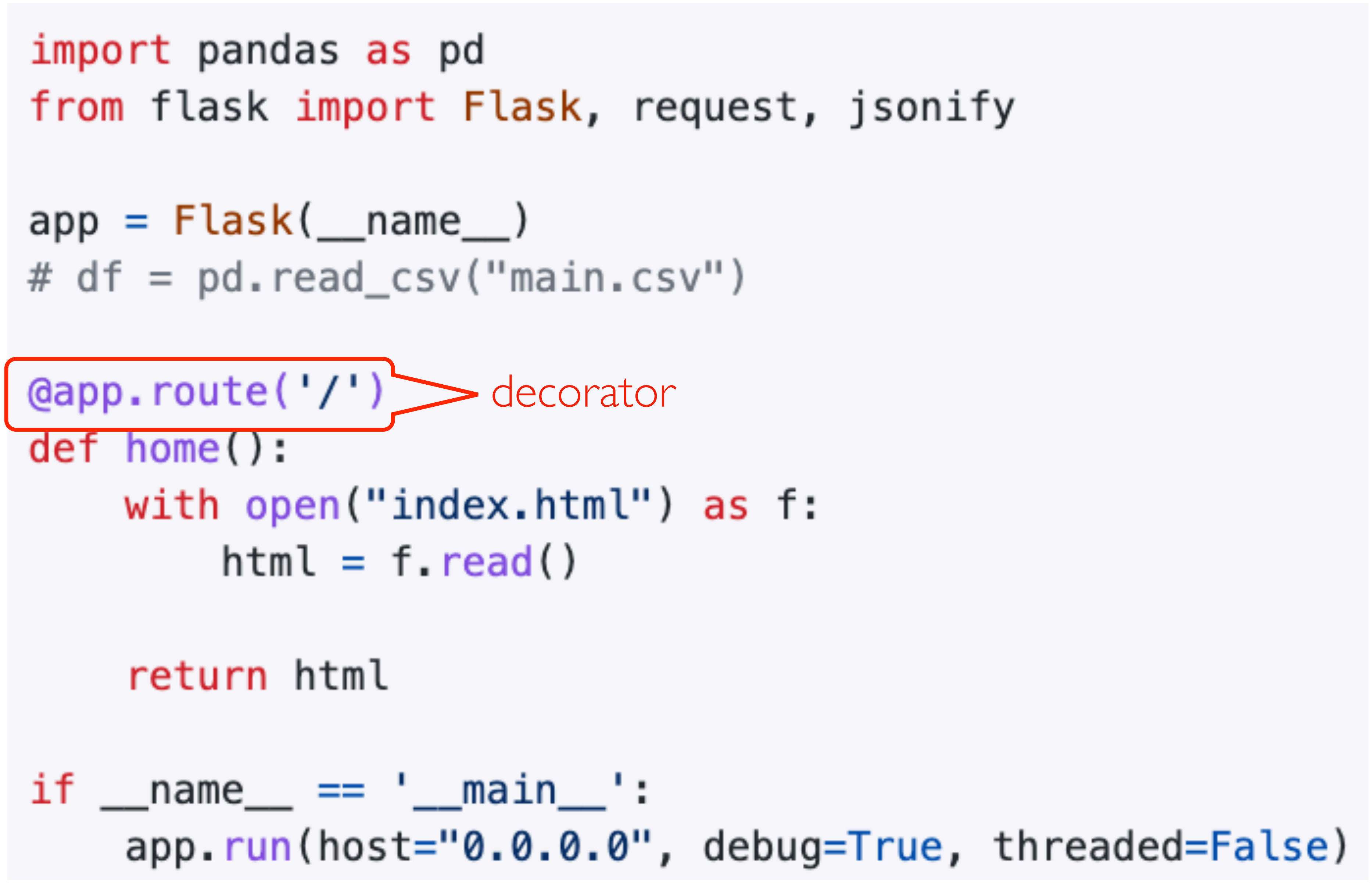


we'll use **Flask**
for CS 320 because
it is simpler than **Django**

https://www.usenix.org/system/files/conference/atc18/atc18-oakes.pdf

Flask Example

Example Flask application (P4 approximate starter code)
https://github.com/cs320-wisc/f21/tree/main/p4



```python
import pandas as pd
from flask import Flask, request, jsonify

app = Flask(__name__)
# df = pd.read_csv("main.csv")

@app.route('/')
def home():
    with open("index.html") as f:
        html = f.read()

    return html

if __name__ == '__main__':
    app.run(host="0.0.0.0", debug=True, threaded=False)
```

decorator

demo!

Decorators

Decorators: take a function, return a function

@name before a function "decorates" a function

```python
def test(fn):
    print("test")
    return fn

def f():
    print("running f")

f = test(f)
f()
```

$\Rightarrow$

```python
def test(fn):
    print("test")
    return fn

@test
def f():
    print("running f")

f()
```

Useful for (a) making lists of certain types of functions, or (b) modifying functions

Example from Course Website

```python
# decorator: user must authenticate to the admin user
def admin(fn):
    EXTRA_AUTH[fn.__name__].append(admin_check)
    return fn

# decorator: user must authenticate and have a valid email
def user(fn):
    EXTRA_AUTH[fn.__name__].append(user_check)
    return fn

# decorator: user must authenticate and be a grader
def grader(fn):
    EXTRA_AUTH[fn.__name__].append(grader_check)
    return fn
```

```python
@route
@admin
def put_roster(user, event):
    s3().write_cached_json("roster.json", json.loads(event['roster']))
    return (200, 'roster uploaded')


@route
@user
def roster_entry(user, event):
    email = user['email'].lower()
    parts = email.split("@")
    if parts[1] != "wisc.edu":
        return (500, 'not a wisc.edu email')
```

Example: Test Caller

```
# if @test(...) decorator is before a function, add that function to test_funcs
def test(points):
    def add_test(fn):
        tests.append(TestFunc(fn, points))
    return add_test
```

```
@test(points=8)
def has_classes():
    points = 0
    for name in ["BusDay", "Location", "Stop", "Trip"]:
        if hasattr(bus, name) and type(getattr(bus, name)) == type:
            points += 2
        else:
            print("no class named "+name)
    return points

@test(points=20)
def service_ids():
    points = 0
    for i, day in enumerate([datetime(2020, 2, 21), datetime(2020, 2, 22)]):
        bd = get_day(day)
        service_ids = sorted(bd.service_ids)

        err = is_expected(actual=service_ids, name="service_ids:%d"%i)
        if err != None:
            print("unexpected service_ids for {}: {}".format(day, err))
            continue

        points += 10
    return points
```

Example: Invocation Counter

```
counts = {}

def count(fn):
    counts[fn.__name__] = 0
    def wrapper():
        counts[fn.__name__] += 1
        fn()
    return wrapper

@count
def f():
    print("running f")

@count
def g():
    print("running g")

f()
g()
g()
print(counts)
```