# CS168: Discussion 1

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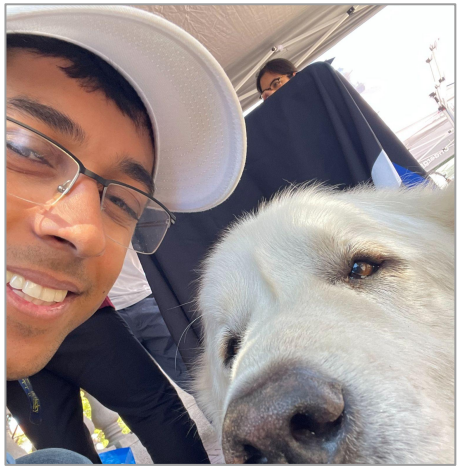
Intro to the Internet I
Fall 2024

# Agenda

- Introductions
- Terms
- Poking the Internet
- Intro to Project Traceroute

*Light discussion today*

# About Me - Arjun (He/Him)



I'm a 4th year undergrad student studying CS and Applied Mathematics
I'm from LA (lowkey actually from Simi Valley which is a lot less interesting), and like climbing, photography, sleeping, yapping, and walking doggs.

**Disclaimer**: I have NOT taken this class
My office hours (Soda 411), VERY subject to change:

- Fri: 2-4 PM
- Tu: 4-5 PM

My email: arjundamerla@berkeley.edu (Edstem is faster)

# About Me - Anita (She/Her)

I’m a 4th year undergrad student studying CS.

I’m from the East Bay. I like snowboarding, playing the guitar, and CTFs.

My office hours: Monday 2-5 pm @ Soda 411
My email: anitading556@berkeley.edu (Edstem is faster though)

# About Me - Ian

I’m a 4th year undergrad student studying CS and DS.

I’m from the East Bay. I like playing basketball, tennis, and exploring new restaurants

My office hours: Tuesday 2-5 pm @ Soda 411
My email: ihdong@berkeley.edu
(Edstem is faster though)

# About Me - Jaewon (He/Him)

I’m a 4th year undergrad student studying EECS and ORMS.

I’m from South Bay. I like playing tennis, hiking, and urban exploration!

My office hours (Soda 411):

- Mon, Wed, Fri: 2-3 PM
- Tu, Th: 1-3 PM

My email: jaewon.lee@berkeley.edu (please include “[CS 168]” in the header; Edstem is faster though)

# Deadlines

Project 1A: Basic Traceroute

- Deadline: Tuesday 09/10

Project 1B: Traceroute Error Handling (there are a few hard tests)

- Deadline: Friday 09/20

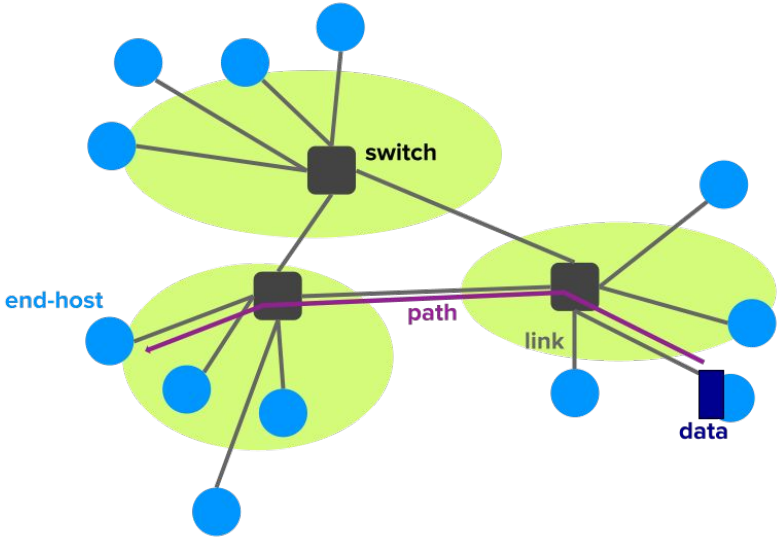
Additional Information

- File to modify: traceroute.py
- Grade: 15%
- One partner allowed

# Terms

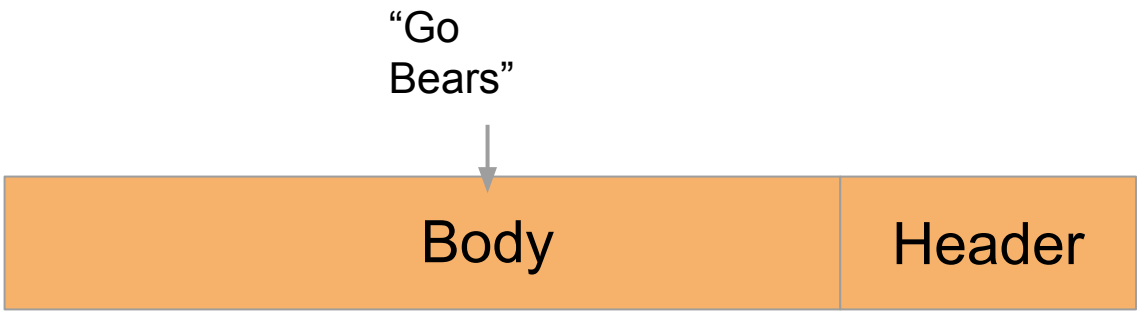
# Terms

- **Routers/Switches:** Devices that forward packets arriving on one link to another link. We make no distinction between routers/switches at this point
- **End-host:** a device attached to the network that sends or receives packets.
  - Examples: mobile phone, laptop, security camera, smart fridge



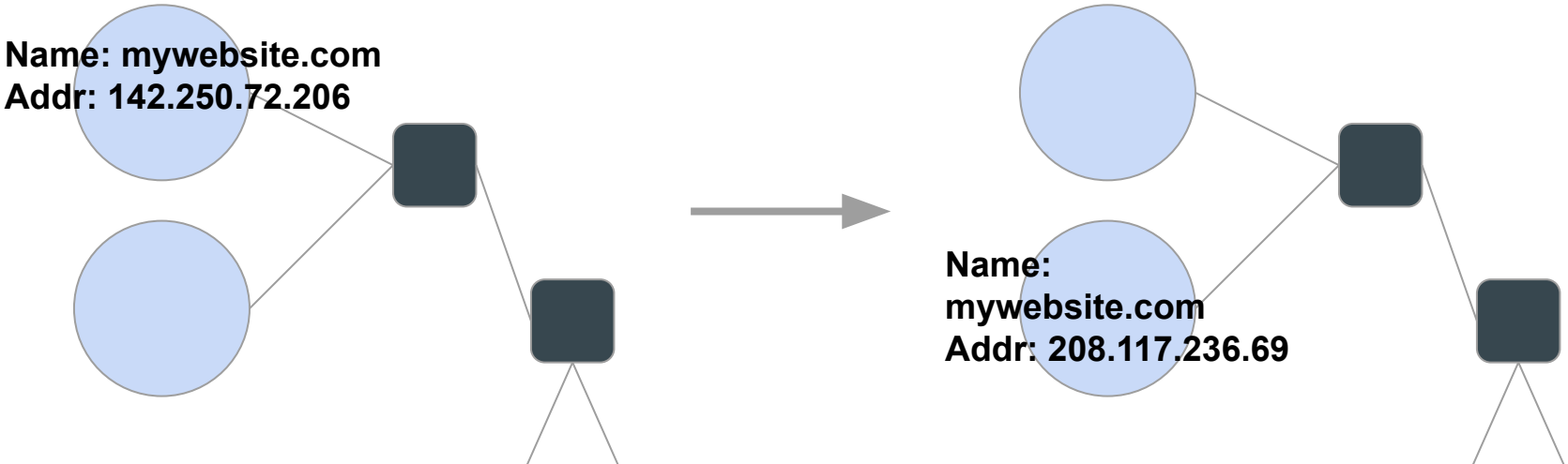
# Terms

- **Packets:** A Bags of bits with a
  - *Header*-- info for network and network stack to make decisions
  - *Body*-- contains a payload. Ex. A file, image, an application header
    - The network doesn't really care about what's in the payload.



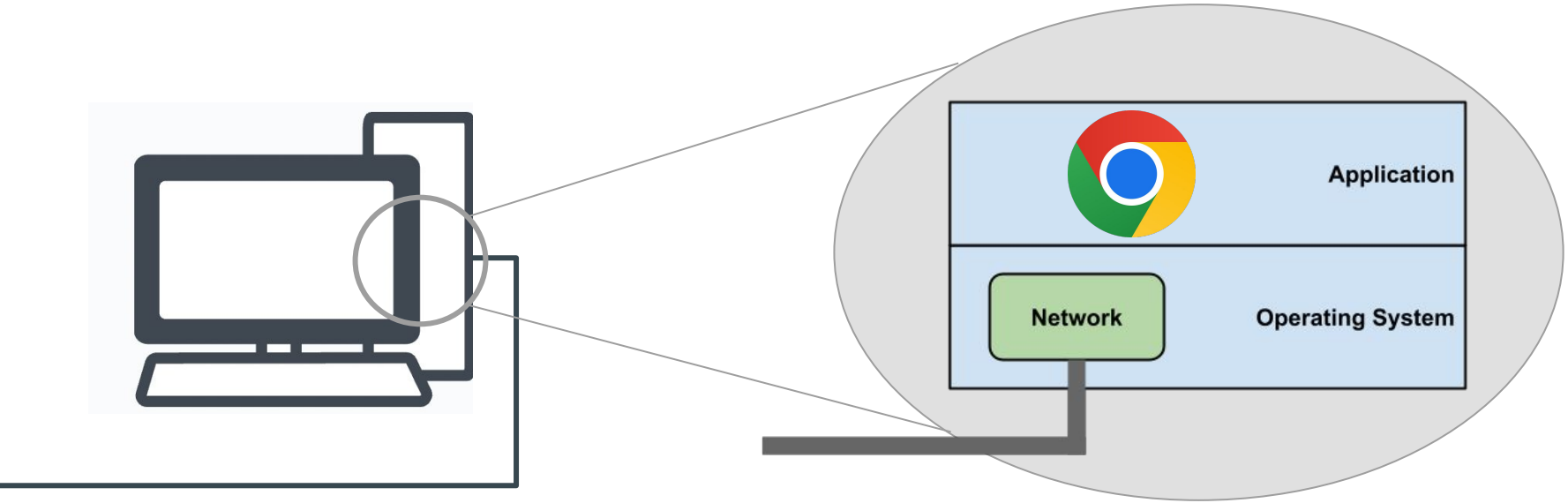
# Terms

- **Naming:**
  - Network name: which host it is
  - Network address: where host is located
  - When you move a server to a new building, its name does not change but its address does



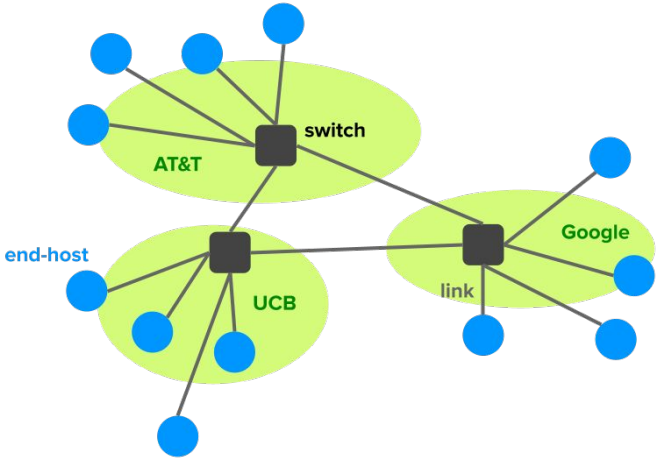
# Terms

- **Network “Stack”:** Networking Software on host.
  - Replicates some router/switch functionality and adds some additional functionality before passing the body of packets to the application



# Terms (cont'd)

- **ISP (Internet Service Provider):** A network of packet switches and links that provide network access (i.e. Comcast, ATT, Sonic)
- **ASes (Autonomous Systems):** Groups of routers under the same control
  - Usually each ISP has one AS, but may have multiple ASes
  - Routers within the same AS will have information about each other



# Poking the Internet

# Ping, Traceroute

- Internet is large and complex. Network engineers and researchers have built some handy tools to get some insight into what is going on inside and across the internet.
- We're going to play around with them a little bit

*Think of this as a "tinker discussion"* - you aren't expected to know any of these concepts yet. We'll learn about them throughout the semester.

# Ping, Traceroute

- Simple utility that lets you “poke” a website and see if it moves (spoiler: most do!)
- You say hi and see if the server says hi back
  - This by itself is not super interesting
- Ping also tells you how long the reply took to come back
  - This is more interesting!
- Let’s try out a few websites.

# Ping, Traceroute

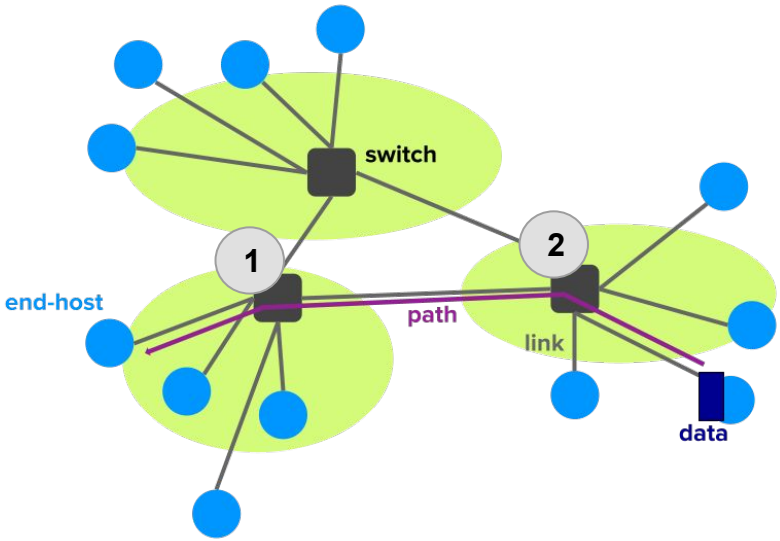
```
ping berkeley.edu -c 3
PING berkeley.edu (141.193.213.21): 56 data bytes
64 bytes from 141.193.213.21: icmp_seq=0 ttl=50 time=14.142 ms
64 bytes from 141.193.213.21: icmp_seq=1 ttl=50 time=20.024 ms
64 bytes from 141.193.213.21: icmp_seq=2 ttl=50 time=17.540 ms

--- berkeley.edu ping statistics ---
3 packets transmitted, 3 packets received, 0.0% packet loss
round-trip min/avg/max/stddev = 14.142/17.235/20.024/2.411 ms

ping csail.mit.edu -c 3
PING csail.mit.edu (128.52.132.19): 56 data bytes
64 bytes from 128.52.132.19: icmp_seq=0 ttl=32 time=108.253 ms
64 bytes from 128.52.132.19: icmp_seq=1 ttl=32 time=109.574 ms
64 bytes from 128.52.132.19: icmp_seq=2 ttl=32 time=98.613 ms

--- csail.mit.edu ping statistics ---
3 packets transmitted, 3 packets received, 0.0% packet loss
round-trip min/avg/max/stddev = 98.613/105.480/109.574/4.886 ms
```

# Ping: A prediction

- We've pinged a couple websites and seen pretty significant differences in *latency*.
  - **Latency** is the time between when a request is sent and when the response is heard.
- What about differences in latency for the same website, but in different regions?
- We've pinged google.com and seen its latency.
  - How many times longer will it take for a ping to google.co.uk to come back?

# Ping, Traceroute

- Tool to *trace* the *route* that packets take from your computer to the destination.
  - Specifically lets you see the routers/switches that are forwarding your packets.



```
traceroute berkeley.edu
traceroute: Warning: berkeley.edu has multiple addresses; using 141.193.213.20
traceroute to berkeley.edu (141.193.213.20), 64 hops max, 40 byte packets
 1  sut-mdc-sr9--ae0-558.net.berkeley.edu (10.40.232.2)  6.154 ms  10.428 ms  7.135 ms
 2  sut-mdc-cr1--xe-2-1-13.net.berkeley.edu (128.32.255.96)  16.284 ms  19.354 ms  7.312 ms
 3  reccev-cev-cr2--et-0-2-8.net.berkeley.edu (128.32.255.177)  5.652 ms
      sut-mdc-cr2--et-0-2-8.net.berkeley.edu (128.32.255.41)  10.454 ms *
 4  * * *
 5  * sut-mdc-fw9--xe-0-0-1-3.net.berkeley.edu (128.32.255.143)  6.366 ms  5.512 ms
 6  reccev-cev-sr1--xe-0-1-1-0-2.net.berkeley.edu (128.32.255.140)  5.309 ms  4.949 ms  5.388 ms
 7  reccev-cev-sr1--lt-0-1-0-0.net.berkeley.edu (128.32.255.166)  4.160 ms  5.037 ms  4.338 ms
 8  reccev-cev-cr2--et-0-0-0-3.net.berkeley.edu (128.32.255.74)  5.742 ms  9.072 ms  7.551 ms
 9  sut-mdc-cr1--et-0-1-0.net.berkeley.edu (128.32.255.40)  7.412 ms
      sut-mdc-cr1--et-0-1-5.net.berkeley.edu (128.32.255.176)  5.063 ms
      reccev-cev-cr1--et-0-1-0.net.berkeley.edu (128.32.255.174)  6.135 ms
10  reccev-cev-br1--et-1-1-1.net.berkeley.edu (128.32.0.38)  4.994 ms  5.771 ms
      reccev-cev-br1--et-1-1-0.net.berkeley.edu (128.32.0.36)  5.349 ms
11  emvl1-agg-01--ucb--100g.cenic.net (137.164.3.26)  9.055 ms  5.400 ms  5.872 ms
12  svl-agg10--emvl1-agg-01--400g--01.cenic.net (137.164.11.94)  9.312 ms  9.272 ms  8.780 ms
13  198.32.251.193 (198.32.251.193)  18.352 ms *  33.886 ms
14  172.68.188.80 (172.68.188.80)  10.743 ms
      172.68.188.94 (172.68.188.94)  10.407 ms
      172.68.188.80 (172.68.188.80)  26.217 ms
15  141.193.213.20 (141.193.213.20)  8.597 ms  9.852 ms  8.677 ms
```

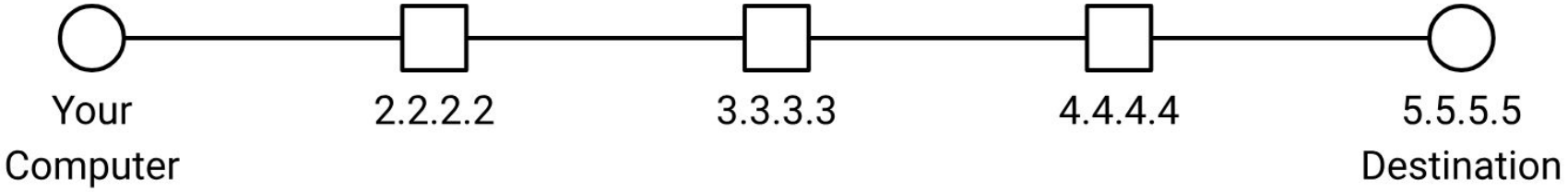
# Traceroute: Notice anything?

- Traceroute gives us a lot more interesting feedback than ping.
  - Latency to *every* step along the way.
    - Can see a breakdown of latencies!
  - Router names.
    - Often have locations in them (i.e. city name)
    - Can roughly trace packet path on a map!
  - Weird stars
    - Some routers just don’t respond ¯_(ツ)_/¯

# Traceroute

- Traceroute gives you the path of routers and switches your packets take.
- How?
  - Takes advantage of something called a **TTL** in the packet IP header.
  - TTL denotes how many times a packet should be forwarded before it is discarded.
    - Why does this exist?
      - To stop the internet from collapsing! (We'll cover this when we get to routing)
  - Sets the TTL to 1, 2, 3, etc
  - When packets are dropped because of TTL expiring, most routers send back a message telling us.
  - Use the source of this notification to identify the routers along the packet's path.

# Visualizing Traceroute




| | | | | |
|---|---|---|---|---|
| Time to Live: | TTL=1 | TTL=2 | TTL=3 | TTL=4 |
| Error: | Time Exceeded | Time Exceeded | Time Exceeded | Destination unreachable |

# Traceroute

How many bytes are the headers for IP, ICMP, and UDP packets?
What are the fields in each protocol header?
What ICMP error messages are relevant to traceroute?

Hint 1: What's included in the ICMP response packets?
Hint 2: Check out some of the professional traceroute implementations.
Hint 3: Implement logging in your code to track the receipt and handling of each packet.

# Questions?

**Feedback Form:**
**https://tinyurl.com/cs168-disc-fa24**