Q: What is caching?

...have we talked about caching before?

Q: Why is caching important on a cloud-scale?

Caching can occur at multiple different places – and we have different strategies and techniques for each “layer” of the full caching strategy.

<table>
<thead>
<tr>
<th>[Users]</th>
<th>[Origin]</th>
</tr>
</thead>
<tbody>
<tr>
<td>[1]:</td>
<td></td>
</tr>
<tr>
<td>[2]:</td>
<td></td>
</tr>
<tr>
<td>[3]:</td>
<td></td>
</tr>
</tbody>
</table>

Caching Technique #1: Age-Based Caching

Idea + Purpose of Age-Based Caching:

Age-Based Caching Use Case:
- The CS 340 course websites the Bootstrap CSS library from stylizing the front-end content.
- When we load the page from a browser that has never visited the CS 340 website, we see the following requests:

```
GET https://stackpath.bootstrapcdn.com/bootstrap/4.2.1/js/bootstrap.min.js
GET /bootstrap/4.2.1/js/bootstrap.min.js HTTP/1.1
```

HTTP Response:

```
HTTP/1.1 200 OK
date: Wed, 02 Nov 2022 18:37:00 GMT
age: 6156514
cache-control: public, max-age=31919000
cdn-cache: HIT
cdn-cachedat: 2022-03-12 17:14:47
```

[Line 3]: The **age** header:

[Line 4]: The **cache-control["max-age"]** header:

Q: What happens when we request a page using this resource again before the content expires?

...how much traffic is saved?

...how much time is saved?

...what are disadvantages of age-based caching?
Caching Technique #2: Entity Tag Caching

Idea + Purpose of Entity Tag (ETag) Caching:

ETag-Based Caching Use Case:
- Some content is likely to be the same for a period of time, but change occasionally and at unpredictable times.
- Ex: My Institute for Interactive Visualization Systems site has data updates to the visualizations each day. Here’s a request for the snow data in Champaign, IL:

```
GET https://vis.cs.illinois.edu/data/weather-snow/USC00118740.csv
```

HTTP Response:
```
HTTP/1.1 200 OK
age: 82924
date: Wed, 02 Nov 2022 15:30:13 GMT
etag: "b3975be708f4c7a36dc55d466b991ac2"
x-cache: Hit from cloudfront
```

[Line 4]: The `etag` header:

Q: What happens when we request a page again?

```
GET https://vis.cs.illinois.edu/data/weather-snow/USC00118740.csv
1 2
GET /data/weather-snow/USC00118740.csv HTTP/1.1
[...]
```

HTTP Response:
```
HTTP/1.1 200 OK
age: 82924
date: Wed, 02 Nov 2022 15:30:13 GMT
etag: "b3975be708f4c7a36dc55d466b991ac2"
x-cache: Hit from cloudfront
```

Q: What are the disadvantages of Entity Tag caching?

One Additional, Modern Drawback:
In recent years, regulations have prohibited various tracking using a specific technology called HTTP Cookies. If a developer can’t use a cookie, what else can they use to track you?

Example:
```
GET /trackingImage.png
```

HTTP Response:
```
HTTP/1.1 200 OK
etag: "unique-identifier-just-for-you"
```

When you visit again:
```
GET /trackingImage.png
```

HTTP Response:
```
HTTP/1.1 304 Not Modified
If-None-Match: "unique-identifier-just-for-you"
```

Your Web Application
Your web application generates a complex response for every request. Your AWS server can handle **10 requests/second** when you must generate a new response and the cost of it is exactly $4/month. *(You can assume you can return 1,000+ cached responses/second.)*

Q1: You need to set up a cloud-scale system that handles 1,000 requests/second. How many EC2 instances do you need if you use no caching? What is the cost?

Q2: If you have a cache-hit rate of 70%, how does that change things?

...how does ETag and Age-based differ here?