CS 290B

Scalable Internet Services

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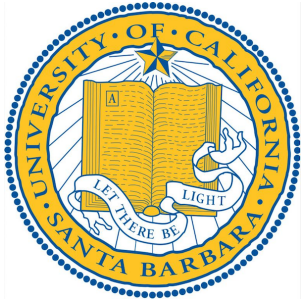
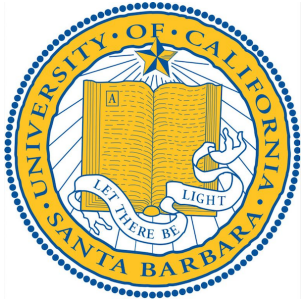
October 7, 2014



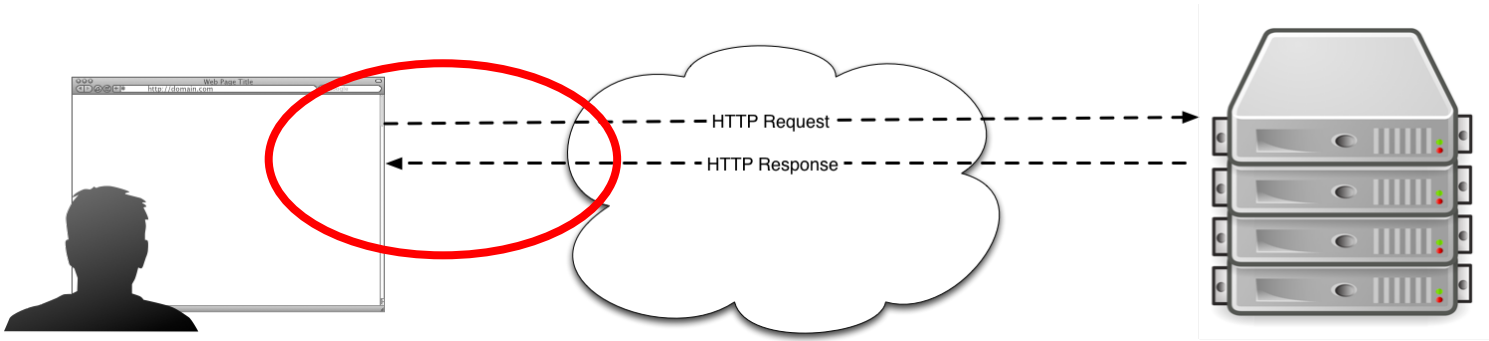
Today's Agenda

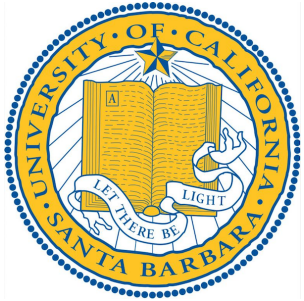
- Understand the browser's technology stack
  - HTTP
  - HTML
  - CSS
  - Bring it all together

- For next time...



Today's Agenda

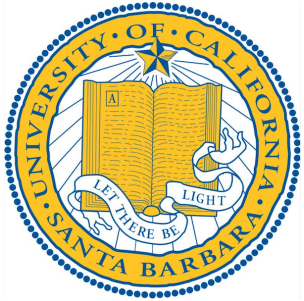




Today's Agenda

CSS?? I thought this was Scalable Internet Services!

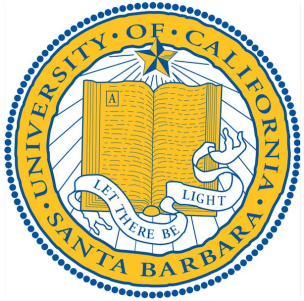
- It's important to know what browsers are capable of in order to design scalable web services
  - Example: If you don't know what assets are, you can't appreciate the importance of a CDN
- We will only be discussing the basics
- It will be useful for your projects



Today's Agenda

- The year is 1990. The internet has existed for ~20 years, email has existed for ~8 years.
- Tim Berners-Lee is at CERN, and believes that two already-existing technologies could be combined to good effect: the internet and HyperText
  - HyperText is the idea of linking documents together with HyperLinks.
  - Engelbart, Hypercard, Xanadu
  - Berners-Lee creates the first versions of HTTP and HTML

- In 1993, Mosaic is created at the NCSA center at UIUC
- In 1994, Marc Andreessen leaves UIUC and founds Netscape with Jim Clark.



HTTP


PROPRIETE CERN
PROPRIETE CERN
Information Management: A Proposal


UNIVERSITY OF CALIFORNIA
SANTA BARBARA
LET THERE BE LIGHT

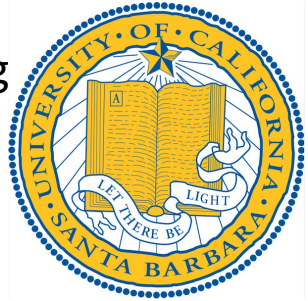
HTTP Explained

- Simple, ASCII protocol

- In its original, simplest version
  - Open a TCP socket (standard is port 80)
  - Send over a request
  - Response comes back
  - Close the TCP socket

- Originally designed to exchange HTML, extended to send anything

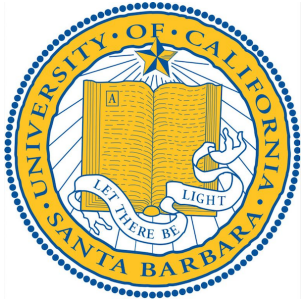
- Originally designed for web browser to server interaction, today very widely used for server to server APIs



HTTP Explained

- Request:
  - **Verb**: What do you want to do? GET something?
  - **Resource**: What is logical path of the resource you want?
  - **HTTP version**: specify version to aid in compatibility
  - **Headers**: Standard ways to request optional behavior
  - **Body**: A data payload

- Response comes back:
  - **HTTP Version:** specify version to aid in compatibility
  - **Status code:** Success? Failure? Other?
  - **Headers**: Standard ways to convey metadata
  - **Body**: A data payload



HTTP Explained

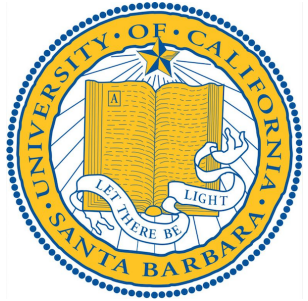
Verb
Resource
Version
Headers
Status
Body

Request:

```
GET /about/ HTTP/1.1
Accept: text/html
```

Response:

```
HTTP/1.1 200 OK
Content-Type: text/html

<!DOCTYPE html>
<html class="example" lang="en">
...
```



HTTP Verbs

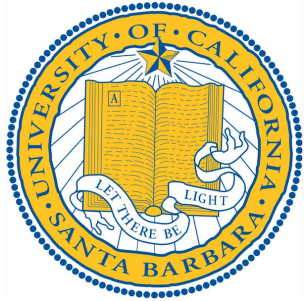
- **`GET`**
  - Get a copy of the resource
  - Should have no side-effects
  - Example: **`GET /users/sign_out`** shouldn't be done.

- **`POST`**
  - Sends data to the server. Generally creates a new resource
  - Commonly used for form submissions.
  - Should be assumed to have side-effects.
  - Not idempotent.
    - "Do you want to post your form submission again?"

HTTP Verbs

- **`PUT`**
  - Sends data to the server. Generally updates an existing resource.
  - Has side effects, but is idempotent.
    - Does this make sense?
  - The difference between **`PUT`** and **`POST`** is subtle. We will cover it more later in the course while discussing REST.

- **`DELETE`**
  - Destroys a resource.
  - Has side effects, is idempotent.
  - This is the right way to do a user signout:
    - **`DELETE /session/<id>`**



HTTP Verbs

- **`HEAD`**
  - Just like **`GET`**, but only returns the headers.
  - What would this be useful for?
    - (Hint: we will be discussing this topic in greater length later)

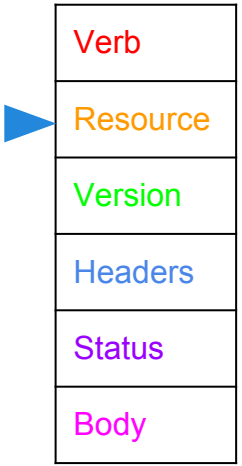
- These are how the verbs should be used, not everyone understands them or uses them correctly.
  - Example: **`GET /blog_postings/5?action=hide`**

- What problems can you think of happening through the misuse of HTTP verbs?

HTTP Verbs

- Less commonly used verbs:
  - **`TRACE`**
  - **`OPTIONS`**
  - **`CONNECT`**

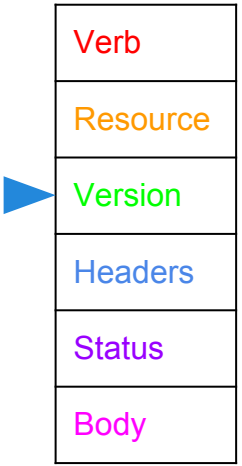
HTTP Resource



- The resource specifies the thing you are referring to via a logical hierarchy.
  - This is not the file path location.
  - Good: `http://www.amazon.com/gp/product/1565925092/`
  - Bad: `http://www.cocacola.com/index.jsp?page_id=4251`

- Anything past the question mark is called a query string
  - Query strings are intended to assist in locating the resource
  - Parameters are assigned using equals, concatenated using ampersand
  - Example:
    - `http://www.amazon.com/search?term=dogs&new=1`

HTTP Version



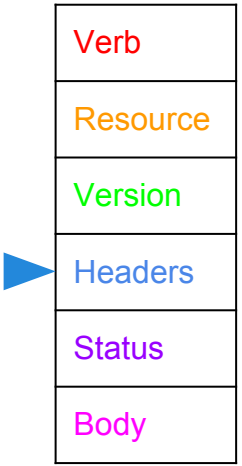
The HTTP version is included with each request/response for ease of protocol development.

Everyone today uses HTTP 1.1, with some support for SPDY/HTTP 2.0

Timeline:

- 1991, HTTP 0.9: Single line protocol. No headers.
- 1996, HTTP 1.0: Headers added, more than just HyperText.
- 1999, HTTP 1.1: Connection keep-alive, more caching mechanisms, everything else we enjoy today

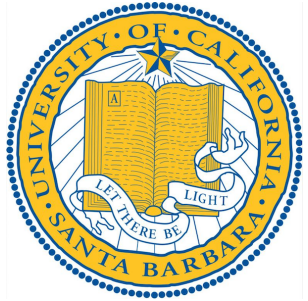
HTTP Headers



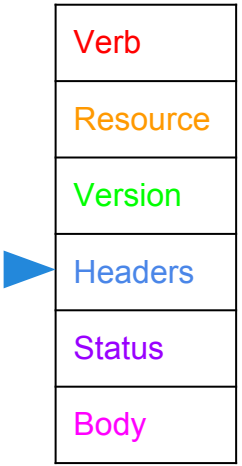
HTTP headers are where a lot of the power lies.

- `Accept:` indicates the preferred format of the resource
  - `Accept: text/html`
    - Give me the resource as a web page
  - `Accept: application/json:`
    - Give me the resource as a JSON document
  - `Accept: application/json,application/xml :`
    - Give me the resource as a JSON document, but if you can't do that then I will accept XML.

- `Accept-Encoding:` indicates the content should be compressed
  - `Accept-Encoding: bzip2,gzip`
    - Compress the data using bzip2, and if you don't support that, then use gzip



HTTP Headers

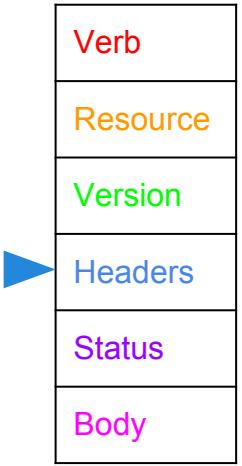


- `Host:` indicates the DNS host the requestor is trying to reach
  - Why is this important? Why isn't the host implied?

- `Accept-Language:` indicates the preferred languages (in order)
  - `Accept-Language: es,en-US`
    - I prefer spanish, but will accept US english.
    - Without this header, every website intended for an international audience would need a massive "choose your language" list on its homepage.

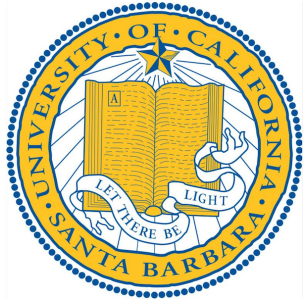
- `User-Agent`: indicates what type of browser or device is connecting.
  - Too often, web applications make decisions based on this.
  - Ridiculousness ensues. Current Chrome User-Agent:
    - `Mozilla/5.0 (Macintosh; Intel Mac OS X 10_9_5) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/37.0.2062.124 Safari/537.36`

HTTP Headers

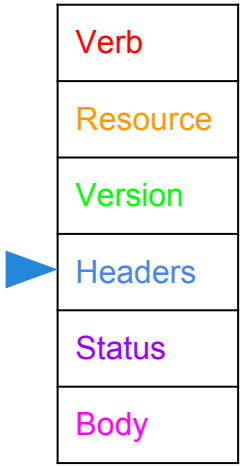


- `Set-Cookie & Cookie`
  - Server includes the `Set-Cookie` header in a response, and data is stored in the browser.
  - That data will later be provided on all subsequent requests in the `Cookie` header.
  - What are some examples of application of Cookies?

- `Connection: keep-alive`
  - Continuously opening and closing TCP connections to the same server is slow and wasteful
  - Why not keep a single TCP connection open and reuse it?
  - In HTTP/1.1, a client can send multiple requests on a single TCP connection
    - The client can send additional requests before receiving responses, but responses must come in order.
      - What problems can happen?

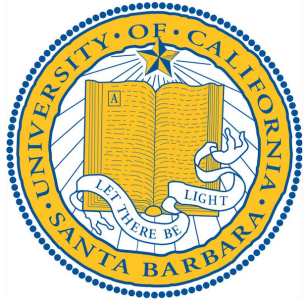


HTTP Headers

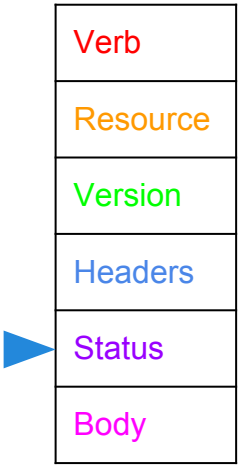


There are many more headers than we can cover here.

- Some useful headers that we will discuss later in the course regarding caching:
  - `ETag, Date, Last-Modified, Cache-Control, Age`
- Some useful headers we will later discuss later in the course regarding security:
  - `Strict-Transport-Security, X-Frame-Options, X-Forwarded-Proto`
- Chunked Encoding will be discussed later in the course regarding application servers
- Headers that begin with `X-` are not part of the specification, but may be commonly used and “standardized”

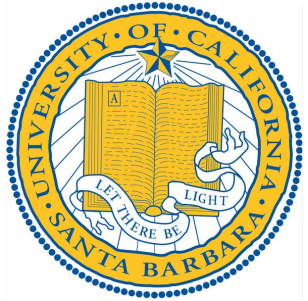


HTTP Headers

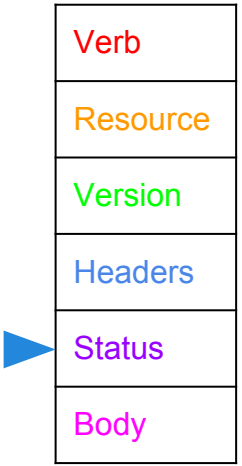


HTTP Status is provided in the response to indicate the outcome of the request.

- The first digit of a status code classifies it:
  - 1XX - Informational
  - 2XX - Successful
  - 3XX - Redirecting
  - 4XX - Client Error
  - 5XX - Server Error



HTTP Headers



A few of the most common response codes:

- `200 OK`: The go-right case.
- `301 Moved Permanently`: The client should use the provided new URL moving forward.
  - The new URL will be provided in the `Location` header.
- `302 Found`: You should go to a different URL to get this resource, but it hasn't permanently moved there.
- `403 Forbidden`: The request is not authorized
- `404 Not Found`: The specified resource could not be found.
- `500 Internal Server Error`: Something crashed.
- `503 Service Unavailable`: Temporary failure.

HTTP Body

The HTTP body is where content is delivered.

When used in a request, the HTTP body can have key-value pairs for a `POST` or a `PUT`.

Example:

```
POST /comments HTTP/1.1
Content-Type: application/x-www-form-urlencoded
Content-Length: 32

username=andrew&comment=Hello%20World
```

HTTP Body

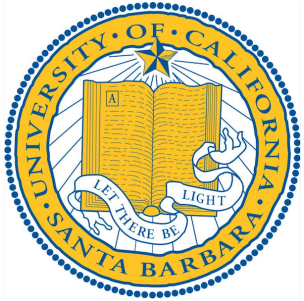
When used in a response, the body most commonly has the data of the resource.

```
GET /about/ HTTP/1.1
Accept: text/html

HTTP/1.1 200 OK
Content-Type: text/html

<!DOCTYPE html>
<html>
  <head>...
```

HTML Explained

Overview of HTML

- Syntax
- Essential tags
- Relationship to CSS



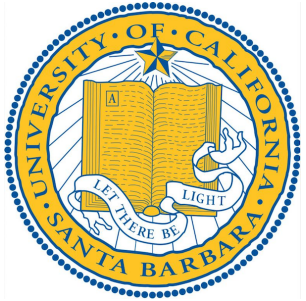
HTML Explained: Syntax

- HyperText Markup Language
  - A markup language takes flat text and annotates it to add structure.
  - HTML uses SGML syntax:

```
<h1>Endangered Species</h1>

<p class="intro">Why we <i>need</i> to act.</p>
```

- Areas of text are marked up using tags enclosed in <tag>...</tag>
- Tags are nestable
- Tags have key-value attributes

(Markup languages aren't really "languages", rather they are structured data.)

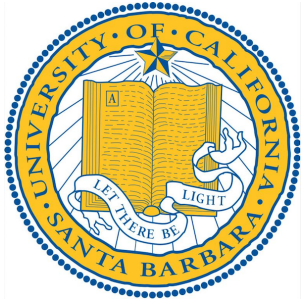


HTML Explained: Essential Tags

HTML documents consist of an all-encompassing `<html>` tag. The logical tree of tags found inside this is referred to as the Document Object Model (DOM)

Within this, the document is divided into the `<head>` and the `<body>`:

```
<html>
    <head>
        <title>My HTML Page</title>
    </head>
    <body> Hello World </body>
</html>
```

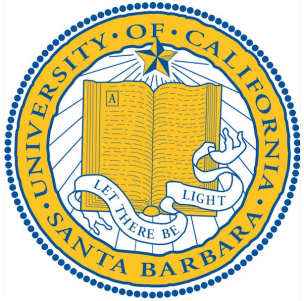


HTML Explained: Essential Tags

The HTML header generally contains information about the page that isn't directly rendered:

- CSS
- JavaScript
- Metadata (`title`, `refresh`, etc.)

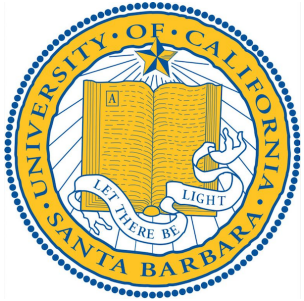
We will cover CSS in greater detail later this lecture.



HTML Explained: Essential Tags

The body includes most of the content that is seen by the user of the web browser. Tags can be used for formatting and styling, but this is increasingly the role of CSS.

- `h1` - Header
- `p` - Paragraph
- `ul, ol, li` - Unordered and ordered lists
- `table, tr, td` - Tabular information
- `span` - An inline grouping mechanism
- `div` - A block-level grouping mechanism

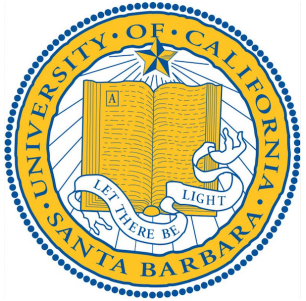


HTML Explained: Essential Tags

The body will also include Anchor tags. The anchor tag is one of the original, central innovations of the world wide web.

```
You can search <a href="http://www.google.com">here</a>.
```

The links that are created by anchor tags make HyperText.



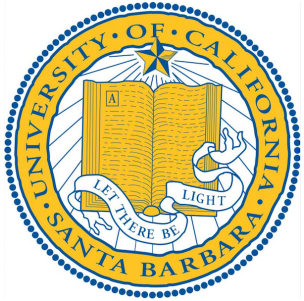
HTML Explained

HTML elements have some important attributes:

- `id` - A unique identifier can be assigned to a DOM element.
- `class` - Multiple classes can be assigned to DOM elements. There is a many-to-many relationship between classes and DOM elements.

```
<span class=”alert,loud” id=”flash_message”>Error.</span>
```

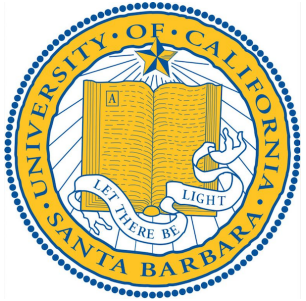
Classes and IDs can be used to refer to DOM elements by CSS and JavaScript.



Intro to CSS

- Inside the HTML head, we can define styles using the `<style>` tag.
  - (As we will later see, we generally don't style with style tags)

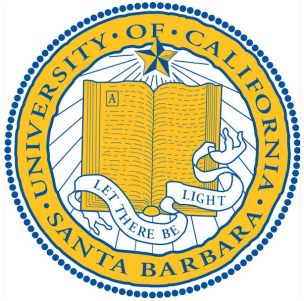
```
<html>
    <head>
        <style>
            h1 {color: blue;}
        </style>
    </head>
    <body>
        <h1> Hello World </h1>
    </body>
</html>
```



Intro to CSS

- We can style DOM elements in a variety of ways

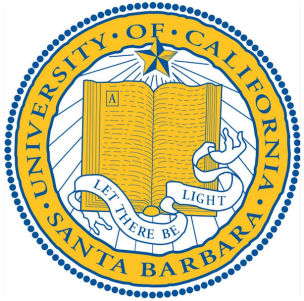
```
<html>
    <head>
        <style>
            #header {color: blue;}
        </style>
    </head>
    <body>
        <span id="header"> Hello World </span>
    </body>
</html>
```



Intro to CSS

- We can style DOM elements in a variety of ways

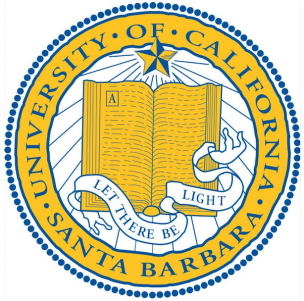
```
<html>
    <head>
        <style>
            .alerting {color: red;}
        </style>
    </head>
    <body>
        <span class="alerting"> Hello World </span>
    </body>
</html>
```



Intro to CSS

- We can style DOM elements in a variety of ways

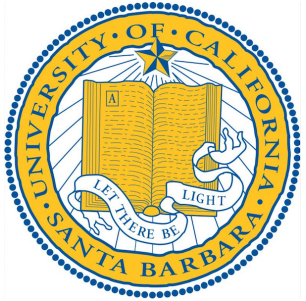
```
<html>
    <head>
        <style>
        </style>
    </head>
    <body>
        <span style="color: red;"> Hello World </span>
    </body>
</html>
```



Intro to CSS

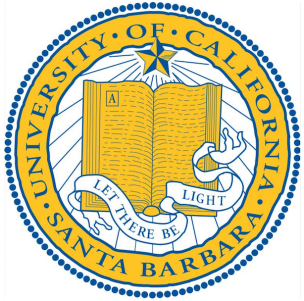
- If we can style in many ways, we can style in contradictory ways
  - What color will the text be rendered below?

```
<html>
    <head>
        <style>
            span {color: blue;}
            .a {color: yellow;}
            #b {color: green;}
        </style>
    </head>
    <body>
        <span class="a" id="b" style="color: red;"> Hello World </span>
    </body>
</html>
```



Intro to CSS

- The precedence order is somewhat complex, but in general…
  - More specific has higher precedence than less specific
    - Example: A style applied to an id-specified `img` tag takes precedence over one applied to all `img` tags
  - Styles specified in the markup itself via the style attribute are higher than those specified in separate CSS files
  - The `!important` annotation can be used to increase the precedence of a CSS rule.



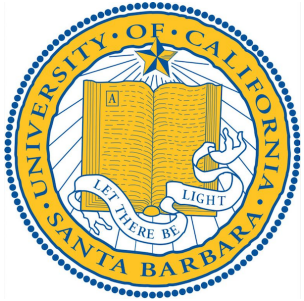
Intro to CSS

Styling is not generally done in-line, either on an element or elsewhere in the markup using the <style> tag

Instead, we serve these styles as separate resources and indicate their location to the browser with a link tag:

- `<link rel="stylesheet" href=”styling.css” type="text/css" >`

Why is this better?

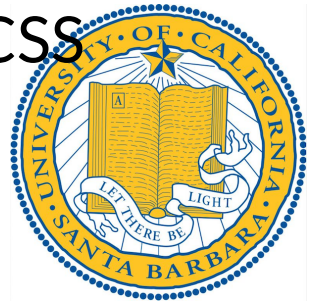


Intro to CSS

CSS styling can give you limitless control over the appearance of a web application.

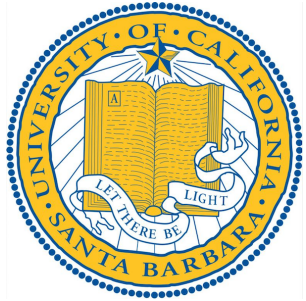
This is not the focus of this class, but if you want to learn more, see

- https://developer.mozilla.org/en-US/docs/Web/CSS



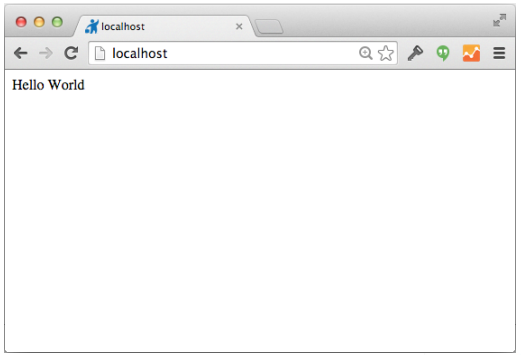
Bringing it all Together

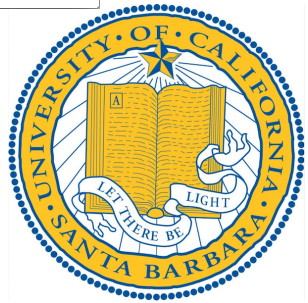
```
%sudo nc -l localhost 80 #after this, tell chrome to go to localhost


GET / HTTP/1.1
Host: localhost
Connection: keep-alive
Accept: text/html,application/xhtml+xml,application/xml;q=0.9,image/webp,*/*;q=0.8
User-Agent: Mozilla/5.0 (Macintosh; Intel Mac OS X 10_9_5) AppleWebKit/537.36 (KHTML,
like Gecko) Chrome/37.0.2062.124 Safari/537.36
Accept-Encoding: gzip,deflate,sdch
Accept-Language: en-US,en;q=0.8
```



Bringing it all Together

```
%echo "HTTP/1.1 200 OK\nContent-Type:
text/html\n\n<html><body>Hello
World</body></html>" | sudo nc -l 80
```

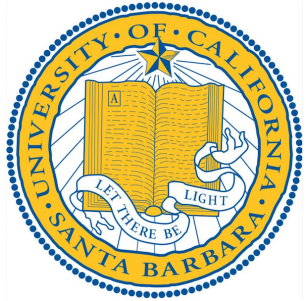




Bringing it all Together

```
%echo "GET /about/ HTTP/1.1\nAccept: text/html
\n\n" | nc www.google.com 80
```

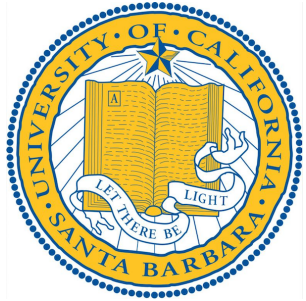
```
HTTP/1.1 200 OK
Vary: Accept-Encoding
Content-Type: text/html
Last-Modified: Tue, 26 Aug 2014 10:35:15 GMT
Date: Tue, 07 Oct 2014 02:42:23 GMT
Expires: Tue, 07 Oct 2014 02:42:23 GMT
Cache-Control: private, max-age=0
X-Content-Type-Options: nosniff
Server: sffe
X-XSS-Protection: 1; mode=block
Alternate-Protocol: 80:quic,p=0.01
Transfer-Encoding: chunked

3aae
<!DOCTYPE html>
<html class="google" lang="en">
```



Bringing it all Together

```
%echo "GET /about/ HTTP/1.1\nAccept-Language:
es\nAccept: text/html \n\n" | nc www.google.com
80
```

```
HTTP/1.1 200 OK
Vary: Accept-Encoding
Content-Type: text/html
Last-Modified: Tue, 26 Aug 2014 10:35:15 GMT
Date: Tue, 07 Oct 2014 02:38:47 GMT
Expires: Tue, 07 Oct 2014 02:38:47 GMT
Cache-Control: private, max-age=0
X-Content-Type-Options: nosniff
Server: sffe
X-XSS-Protection: 1; mode=block
Alternate-Protocol: 80:quic,p=0.01
Transfer-Encoding: chunked

3954
<!DOCTYPE html>
<html class="google" lang="es">
```



For Next Time...

- **We have a special guest speaker for Thursday:**

  Ross Hale, Director of Engineer at Pivotal Labs

- Read Chapter 9 from HPBN.
- Bring laptop to tomorrow's lab
  - Lab is at 6pm, here.
  - We will be covering Rails setup.
  - Please follow Chapters 1 and 2 from AWDR, try to set up Rails