15. How the Web Works

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(Some slides borrowed from Ben Zhao)
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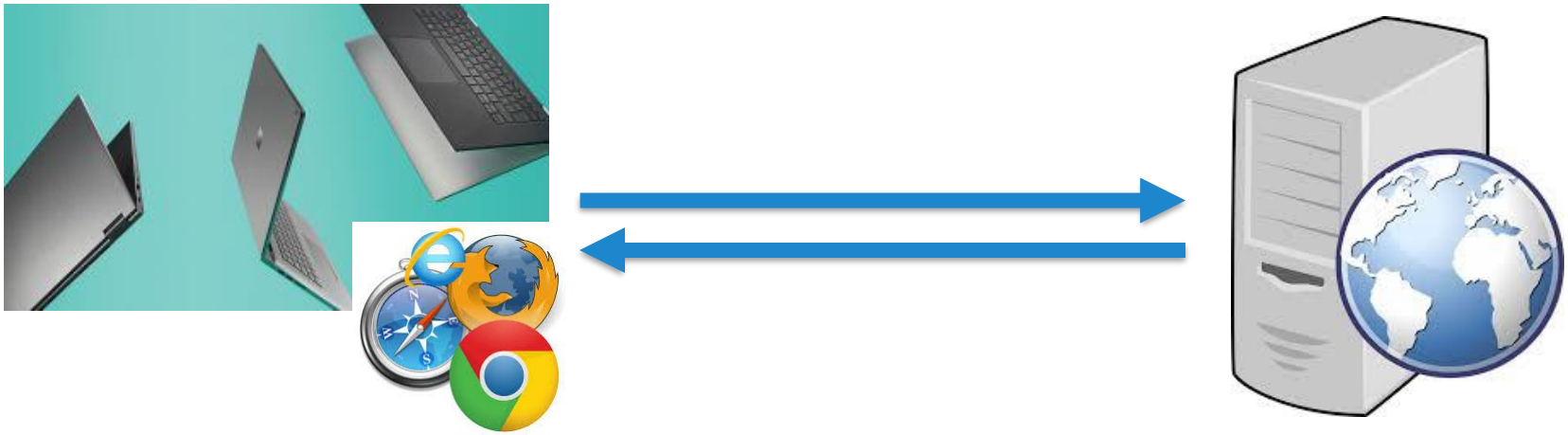
THE UNIVERSITY OF CHICAGO

Your interface to the web

- Your web browser contacts a web server



A 10,000 Foot View of Technologies

- Where things run:

HTTP(S)

HTML / CSS

JavaScript
(Angular/React)

Browser Extensions

Django (Python) / CGI (Perl) /
PHP / Node.js / Ruby on Rails

Databases (MySQL)

The Anatomy of a URL

- https://www.uchicago.edu/fun/funthings.htm?query=music&year=2022#topsection

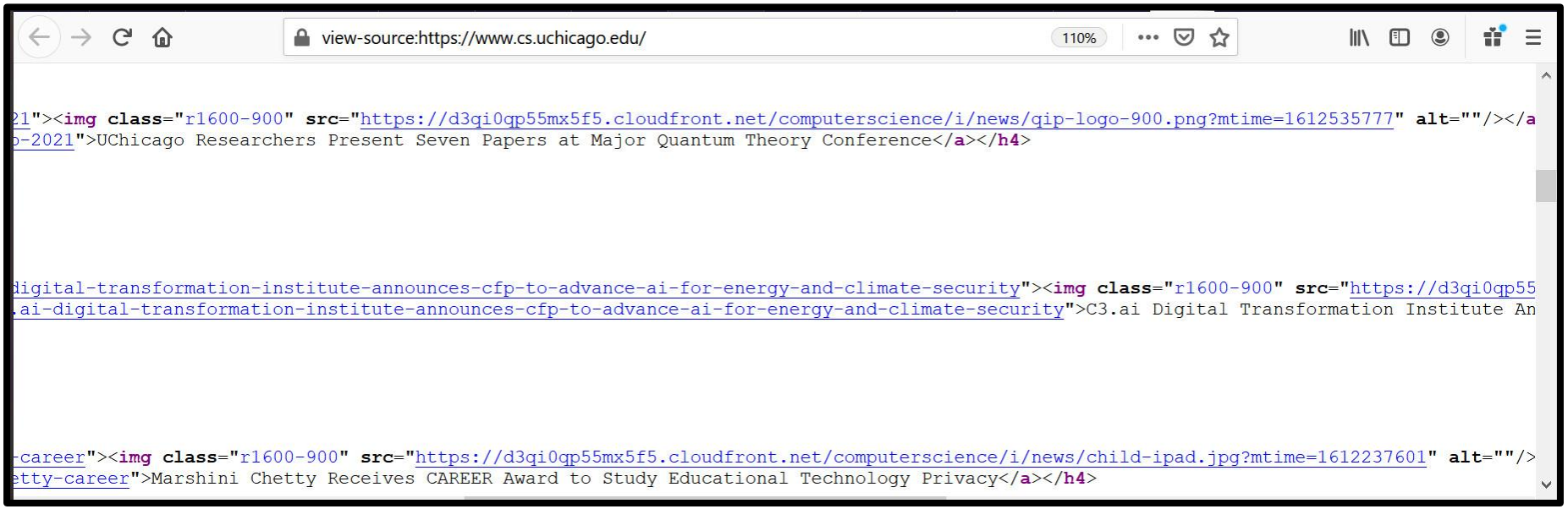
The Anatomy of a URL

- https://www.uchicago.edu/fun/funthings.htm?query=music&year=2022#topsection
  - Protocol: https
  - Hostname: www.uchicago.edu
    - .edu is the top level domain (TLD)
  - Path: /fun/funthings.html
  - Parameters: (key=value pairs, & delimited)
  - Named anchor: #topsection
- Some technologies (e.g., Django) parse the path differently (e.g., parameters in path)

The Anatomy of a Webpage

- view-source:https://www.cs.uchicago.edu/
- HTML (hypertext markup language)
  - Formatting of a page
  - All sorts of formatting: Hi
  - Links: Click here
  - Pictures:
  - Forms
  - Audio/video

The Anatomy of a Webpage

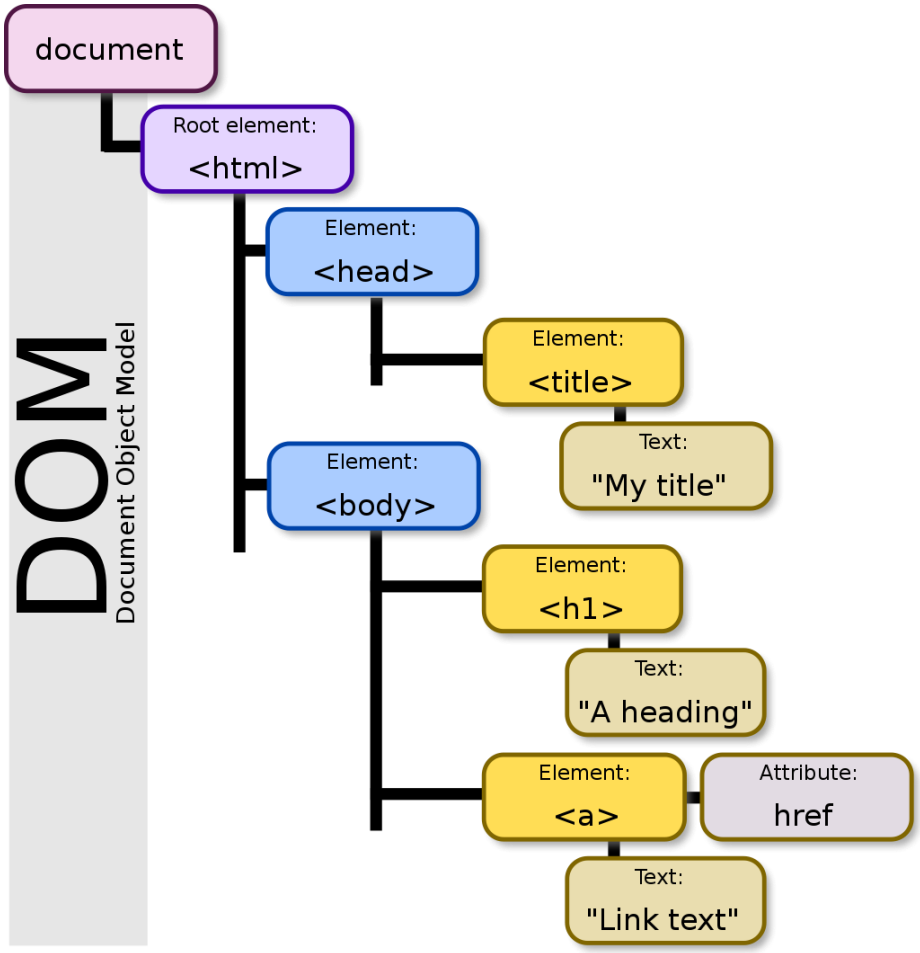


The Anatomy of a Webpage

- CSS (cascading style sheets)
- <link href="/css/main.css?updated=20181020002547" rel="stylesheet" media="all">
- view-source:https://www.cs.uchicago.edu/css/main.css?updated=20181020002547
- #id (*intended* to be unique)
- .class (not intended to be unique)

The Anatomy of a Webpage

- DOM (document object model)



Typing Something into a Browser:

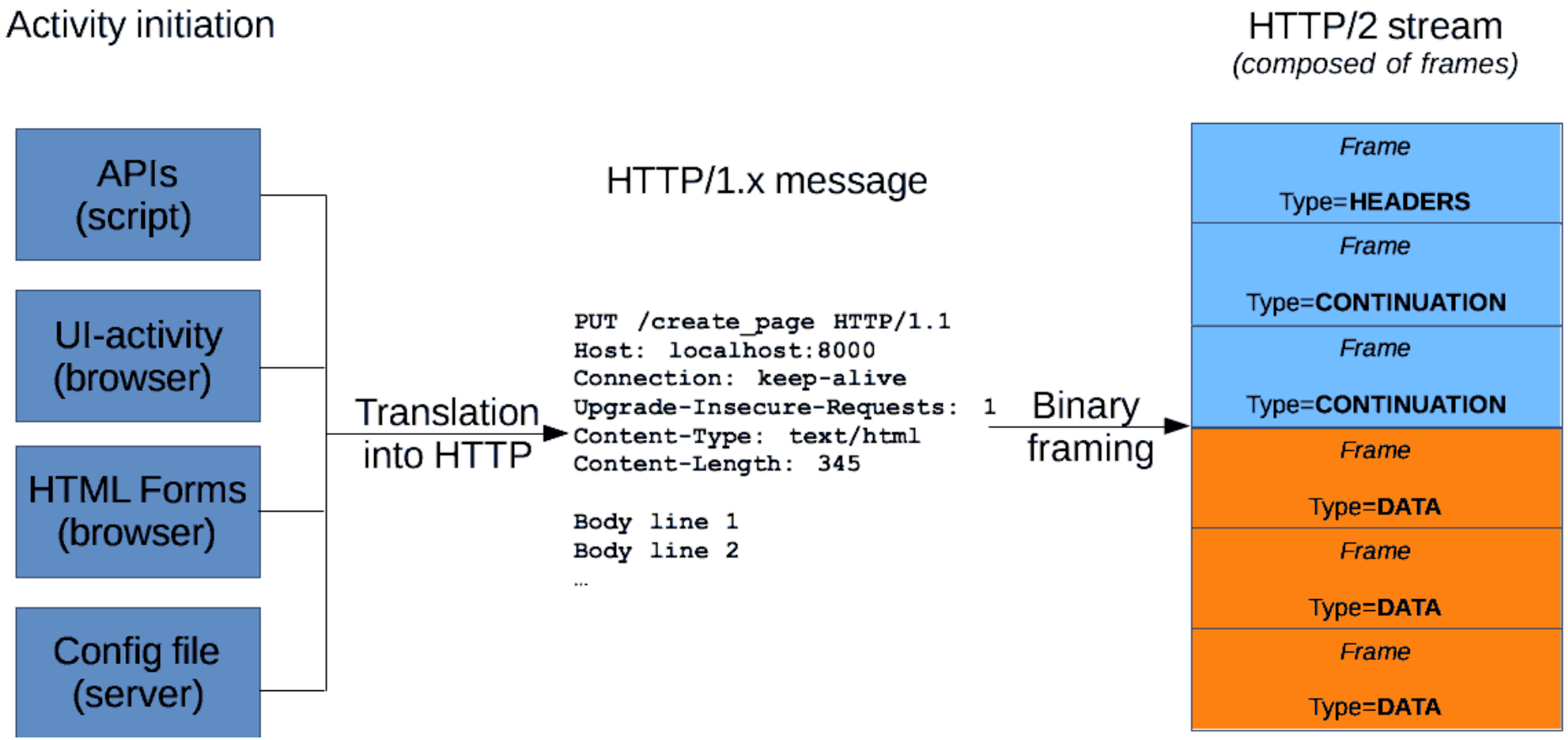
- DNS (domain name service)
  - www.cs.uchicago.edu resolves to IP address 128.135.164.125
- https://www.cs.uchicago.edu/
  - Protocol: https
  - Hostname: www.cs.uchicago.edu
  - Default file name (since none is listed): index.html (and similar)

HTTP Request

- HTTP = Hypertext Transfer Protocol
- Start line: method, target, protocol version
  - GET /index.html HTTP/1.1
  - Method: GET, PUT, POST, HEAD, OPTIONS
- HTTP Headers
  - Host, User-agent, Referer, many others
  - https://developer.mozilla.org/en-US/docs/Web/HTTP/Headers
- Body (not needed for GET, etc.)
- In Firefox: F12, “Network” to see HTTP requests

HTTP Request

- GET /index.html HTTP/1.1



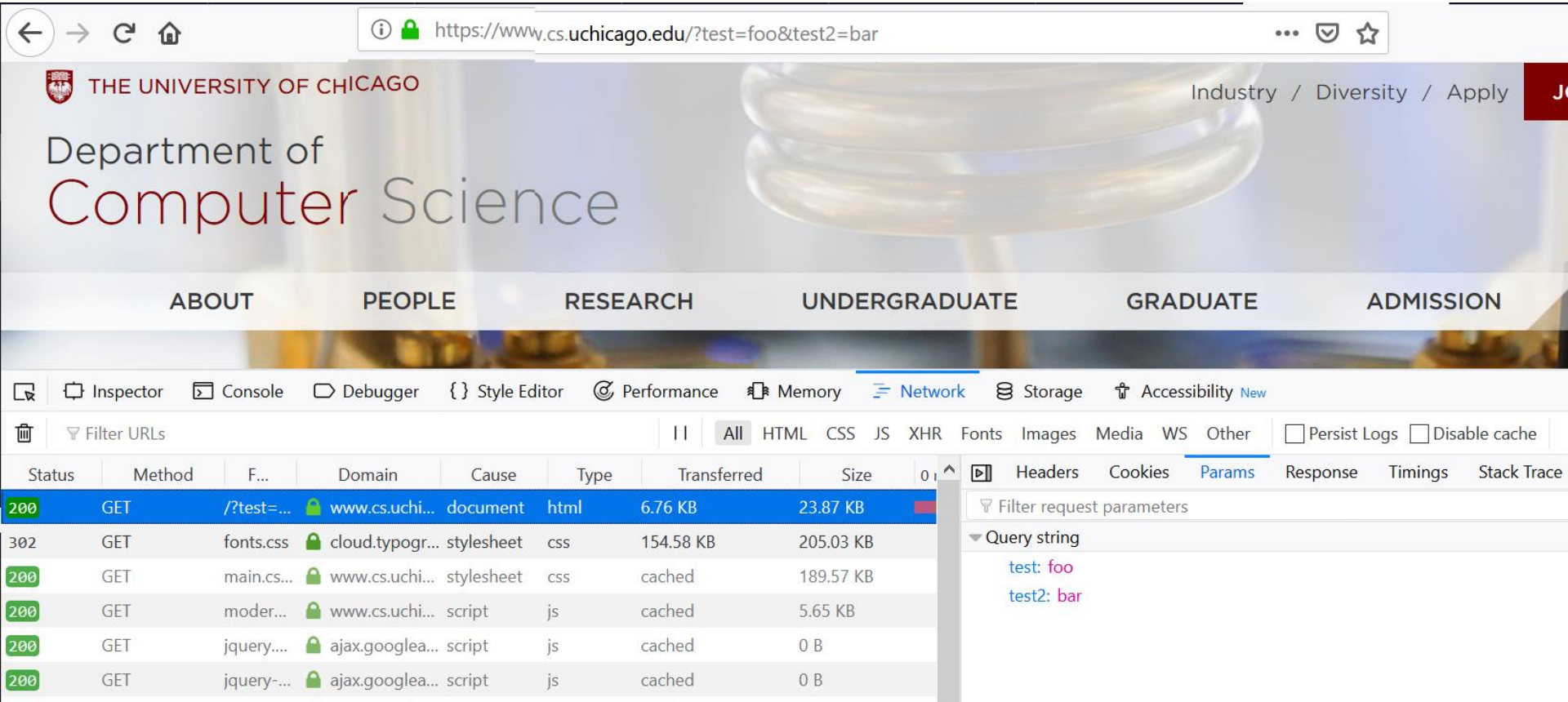
From https://developer.mozilla.org/en-US/docs/Web/HTTP/Messages

Sending Data to a Server

- GET request
  - Data at end of URL (following “?”)
- POST request
  - Typically used with forms
  - Data *not* in URL, but rather (in slightly encoded form) in the HTTP request body
- PUT request
  - Store an entity at a location

URL Parameters / Query String

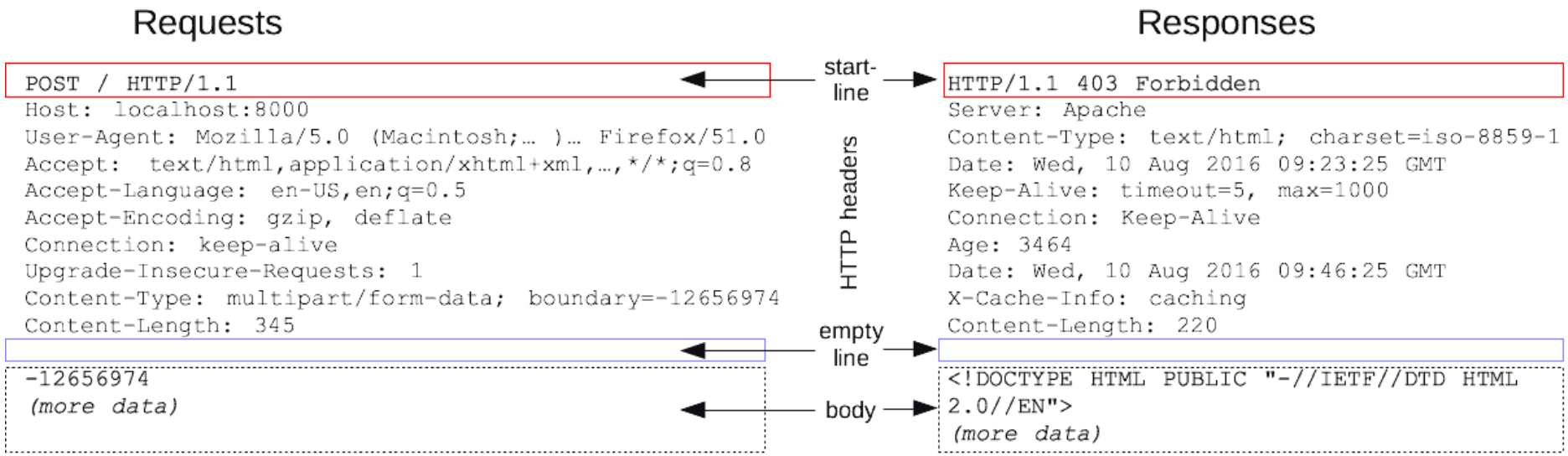
- End of URL (GET request)
  - https://www.cs.uchicago.edu/?test=foo&test2=bar



HTTP Response

- Status: https://developer.mozilla.org/en-US/docs/Web/HTTP/Status
  - 200 (OK)
  - 404 (not found)
  - 301 (moved permanently)
  - 302 (moved temporarily)
- HTTP Headers
- Body

HTTP



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HTTPS

- Simply an HTTP request sent over TLS!
  - That is, the request and response are encrypted
- An extension of HTTP over TLS (i.e., the request/response itself is encrypted)
- Which CAs (certificate authorities) does your browser trust?
  - Firefox: Options → Privacy & Security → (all the way at the bottom) View Certificates

Keeping State Using Cookies

- Cookies enable persistent state
- Set-Cookie HTTP header
- Cookie HTTP header
  - *Cookie: name=value; name2=value2; name3=value3*
- Cookies are **automatically sent** with all requests your browser makes
- Cookies are *bound to an origin* (only sent to the origin that set them)

Keeping State Using Cookies

- Session cookies (until you close your browser) vs. persistent cookies (until the expiration date)
- *Secure* cookies = only sent over HTTPS, not HTTP
- *HTTPonly* cookies are not accessible to JavaScript, etc.
- View cookies: “Application” tab in Chrome developer tools, “Storage” in Firefox

Authorization Tokens = Cookies

- You log into a website, and it presents you an authorization token (typically a hash of some secret)
- Subsequent HTTP requests automatically embed this authorization token

Other Ways to Keep State

- Local storage
- Flash cookies
- (Many more)

Interactive Pages?

- JavaScript!
  - The core idea: Let's run (somewhat) arbitrary code on the **client's** computer
- Math, variables, control structures
- Imperative, object-oriented, or functional
- Modify the DOM
- Request data (e.g., through AJAX)
- Can be multi-threaded (web workers)