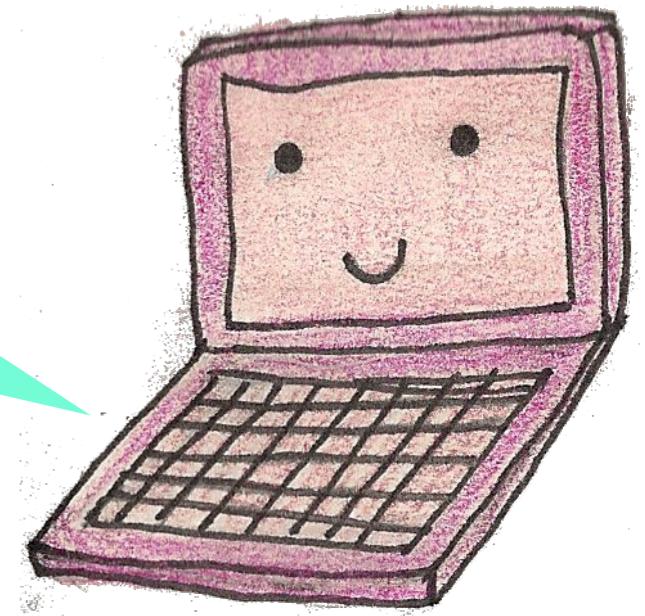


# Server Farm to Table

(or, how the Internet works)

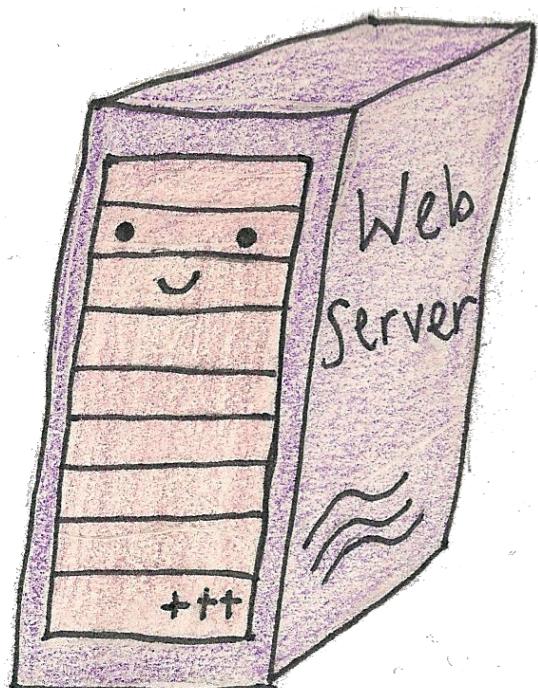
Jenna Zeigen  
@zeigenvector  
November 3, 2015



hey, sup?

# Server Farm to Table

(or, how the Internet works)



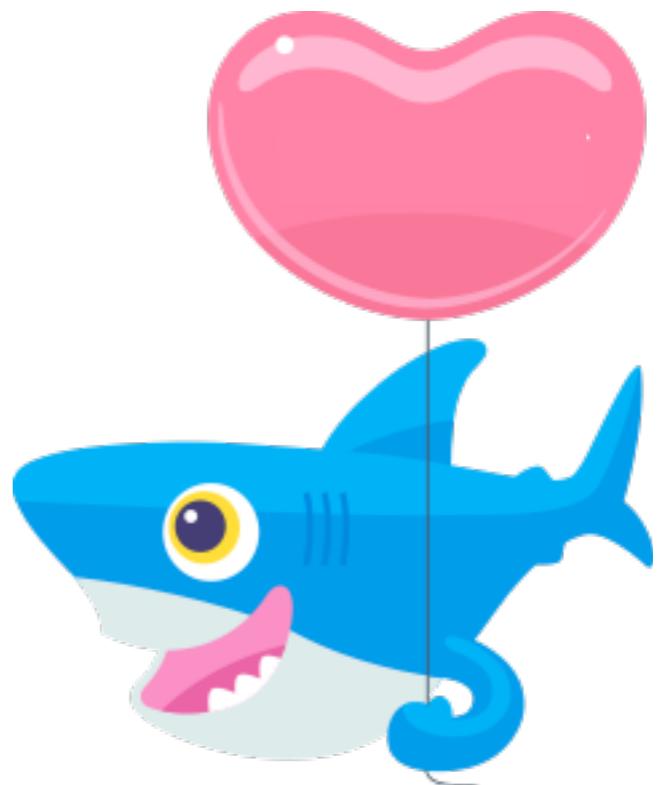
nm, u?

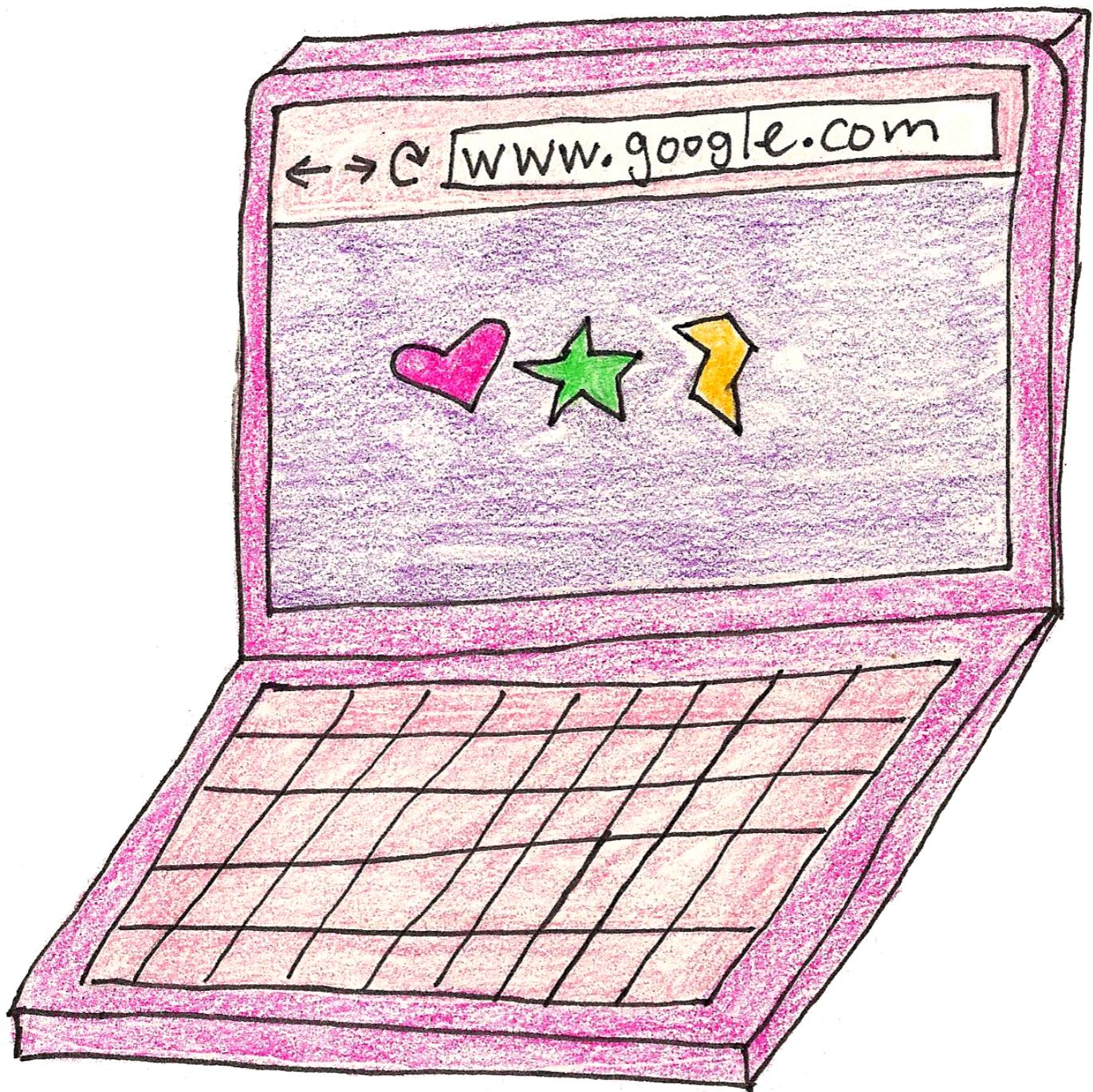
Jenna Zeigen  
@zeigenvector  
ManhattanJS  
January 13, 2015

Engineering Manager  
@ DigitalOcean



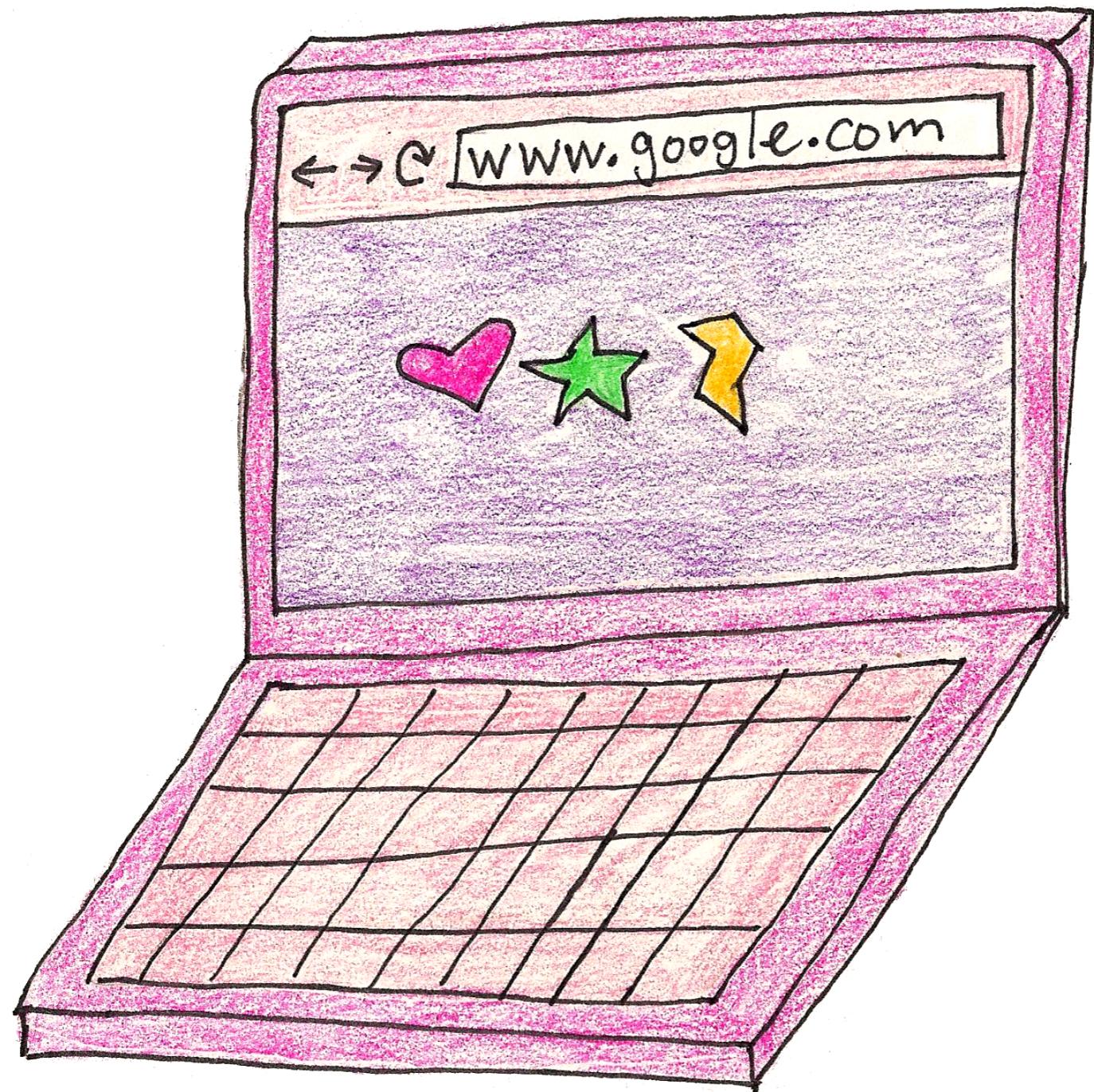
zeigenvector





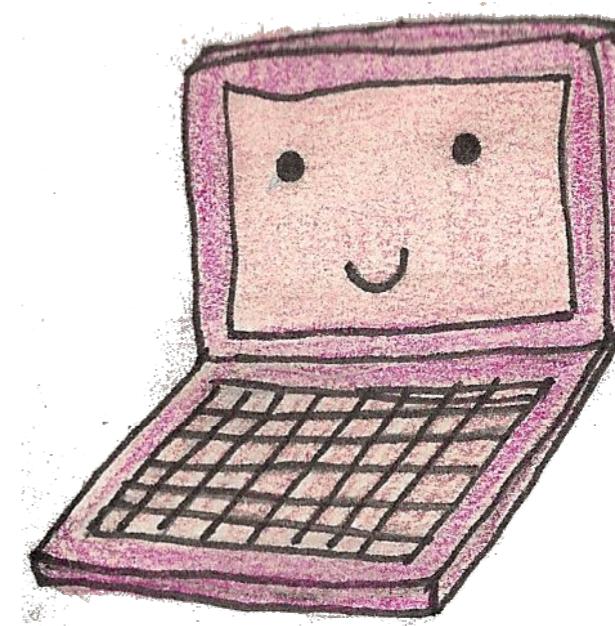
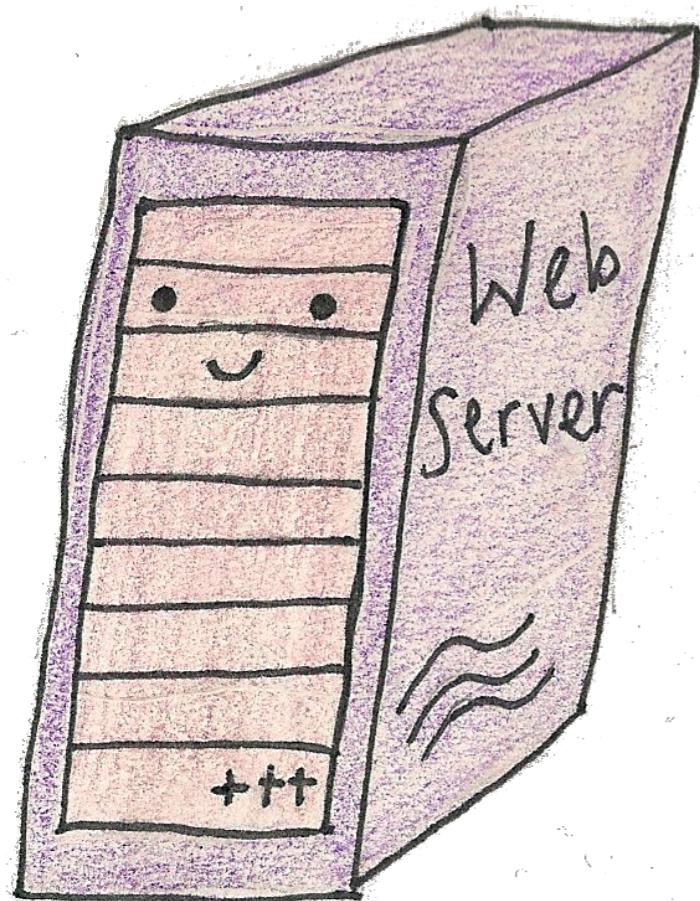
# Overview

1. IP Address Lookup
2. Opening a socket
3. Security Stuff
4. HTTP Request
5. Server Things
6. HTTP Response
7. Parsing
8. Rendering



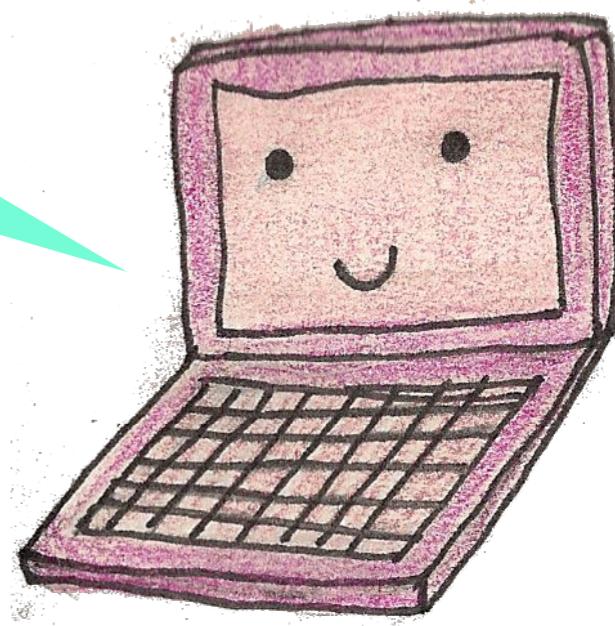
# IP Address Lookup

You know my name  
Look up the number



# IP Address Lookup

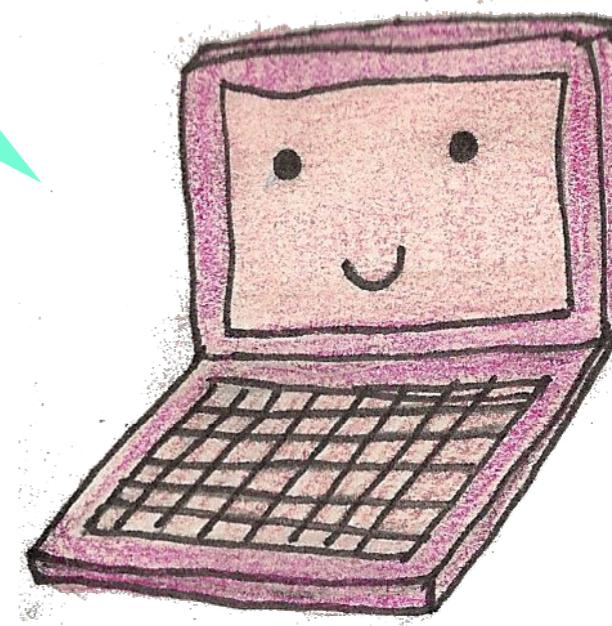
Hey, I just met you  
This is easy  
I still know your number  
Super breezy!



# IP Address Lookup

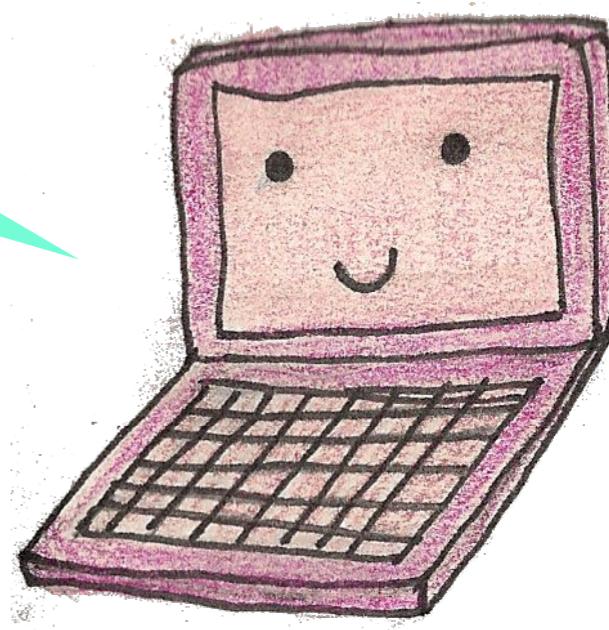
Is this name special?  
So very special?

♪ ♪ ♪



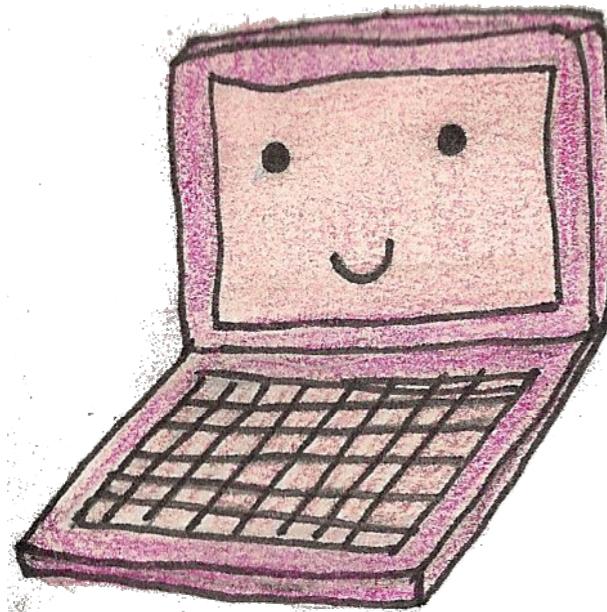
# IP Address Lookup

Nope!

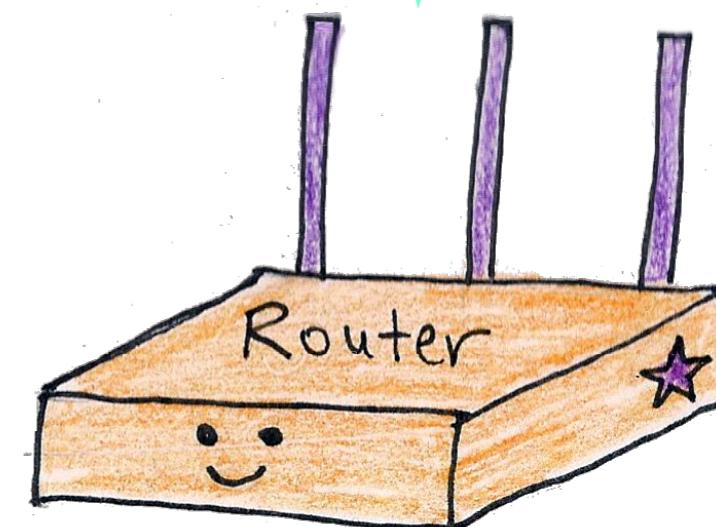


# IP Address Lookup

Do you have  
a www.google.com?

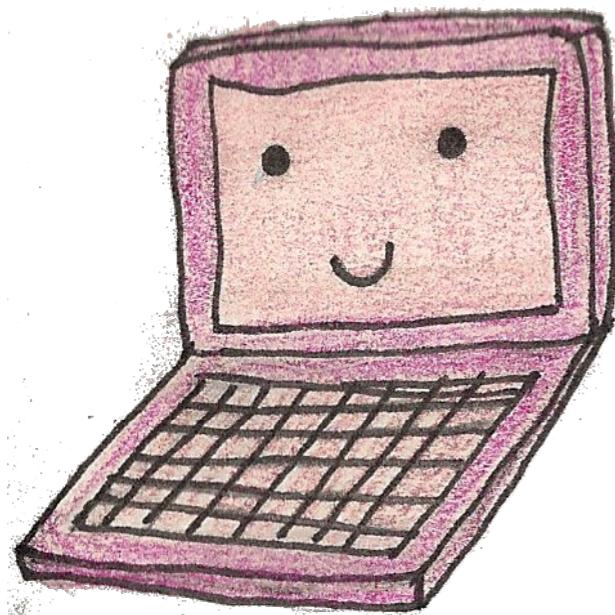


You weren't asking  
me, but I know  
where that is!  
173.194.46.84!

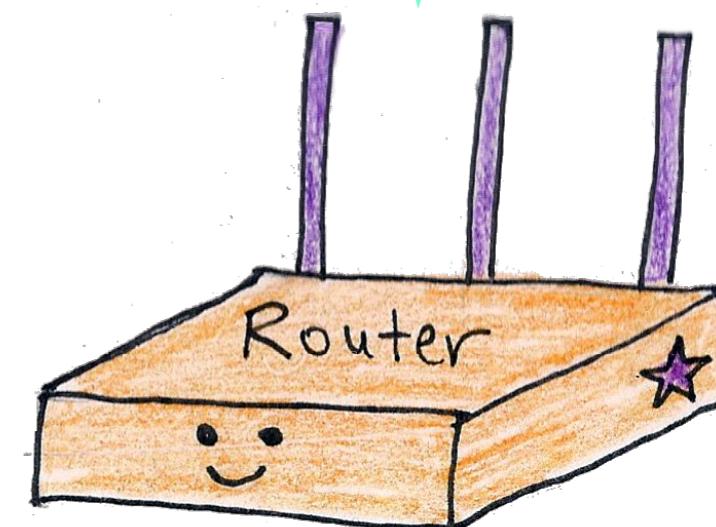


# IP Address Lookup

Do you have  
a www.google.com?

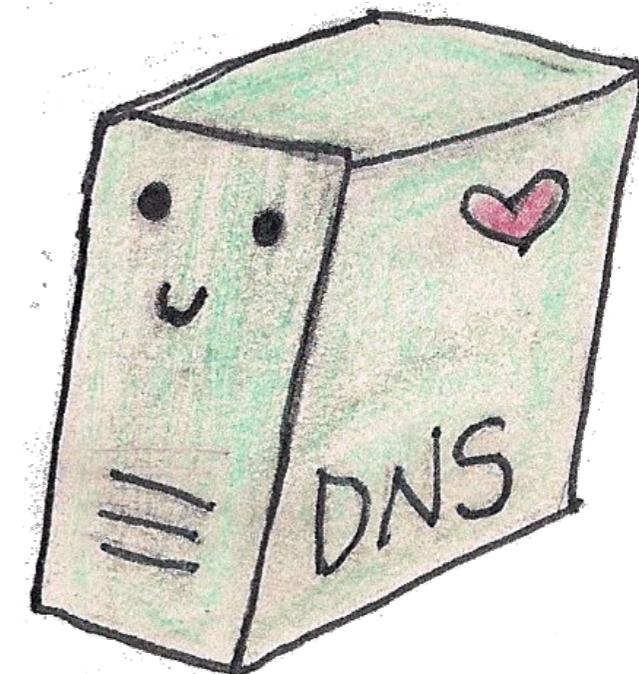
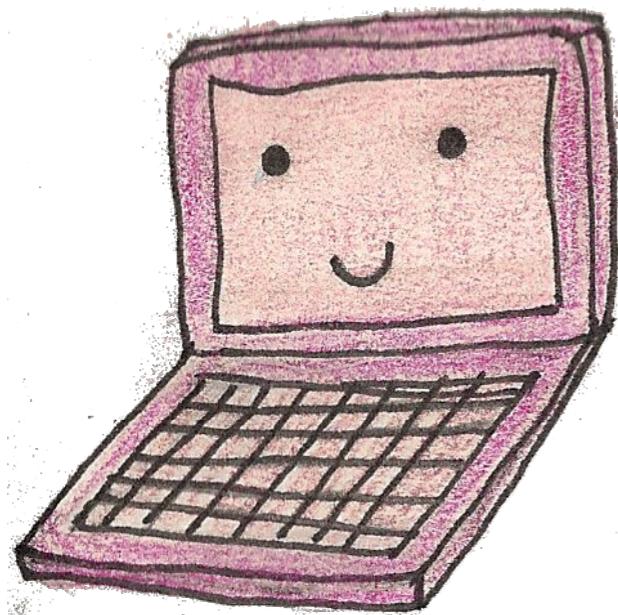


<lansplaining...>



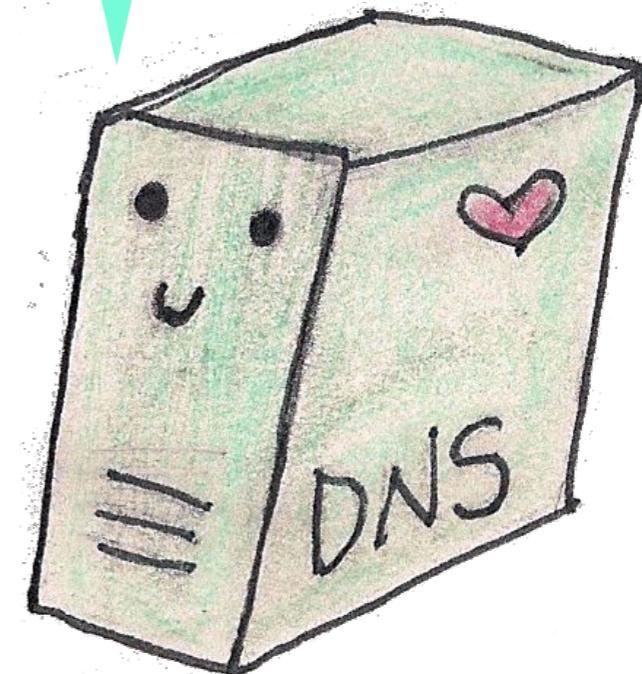
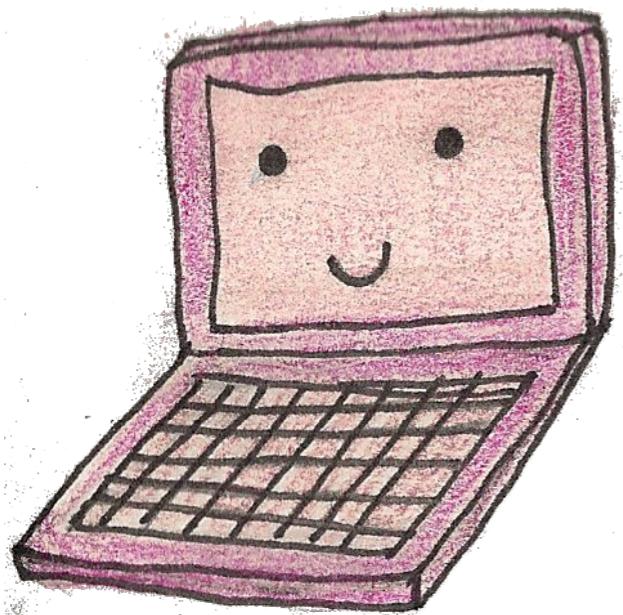
# IP Address Lookup

Do you have  
a www.google.com?



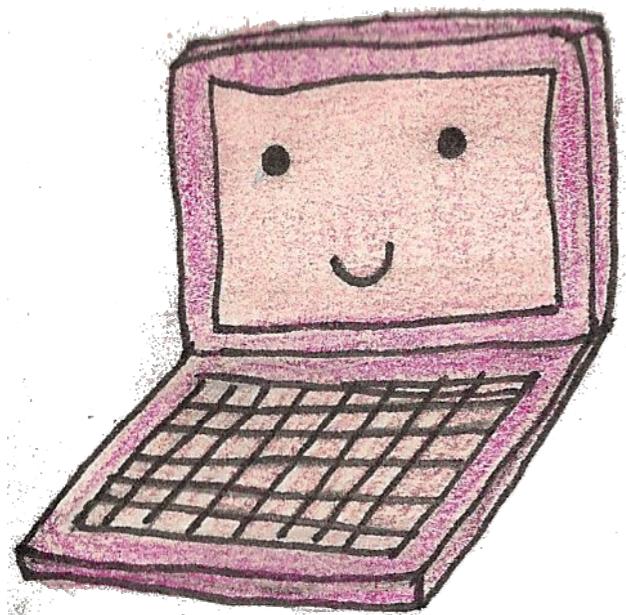
# IP Address Lookup

Got a long list of these numbers  
But if it's not in my "brain"  
I'll ask some servers  
And we'll find it by name

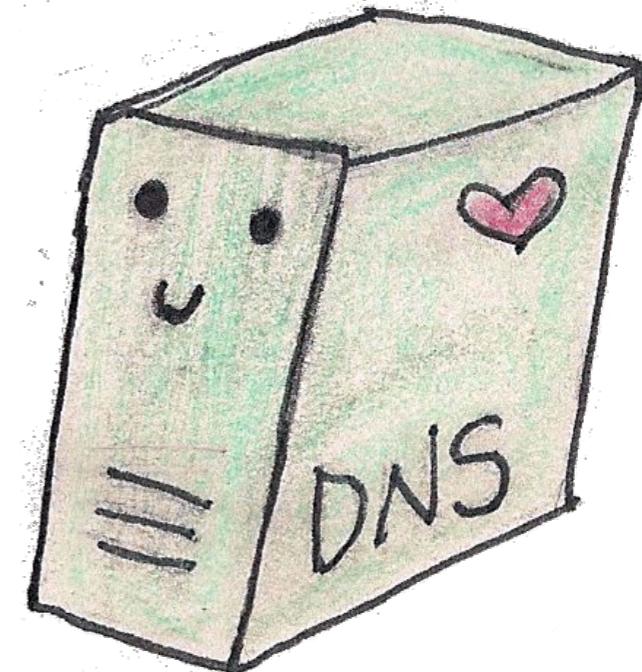


# IP Address Lookup

Do you have  
a www.google.com?

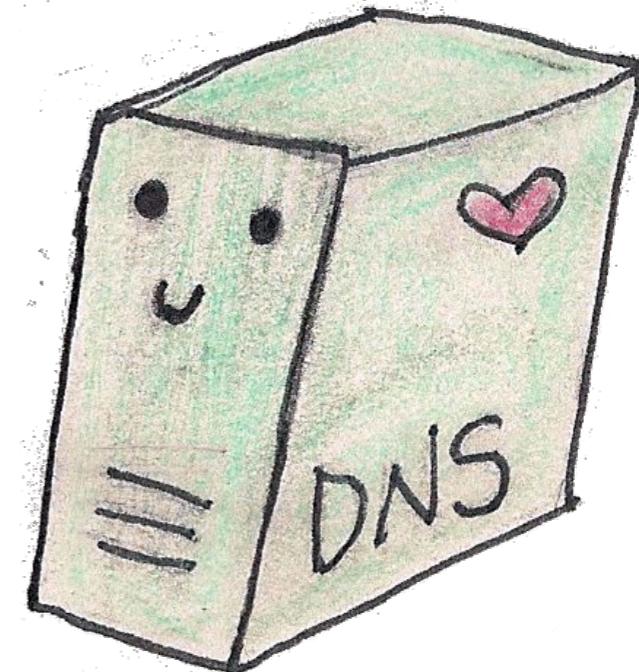
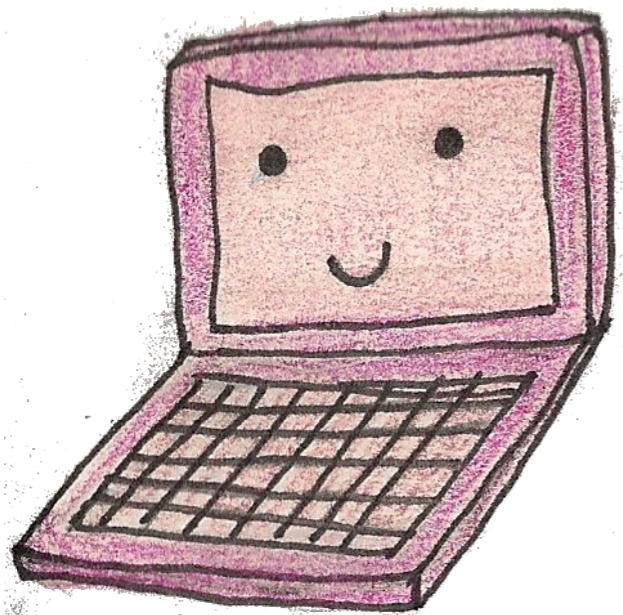


Hold on, lemme  
phone a friend...



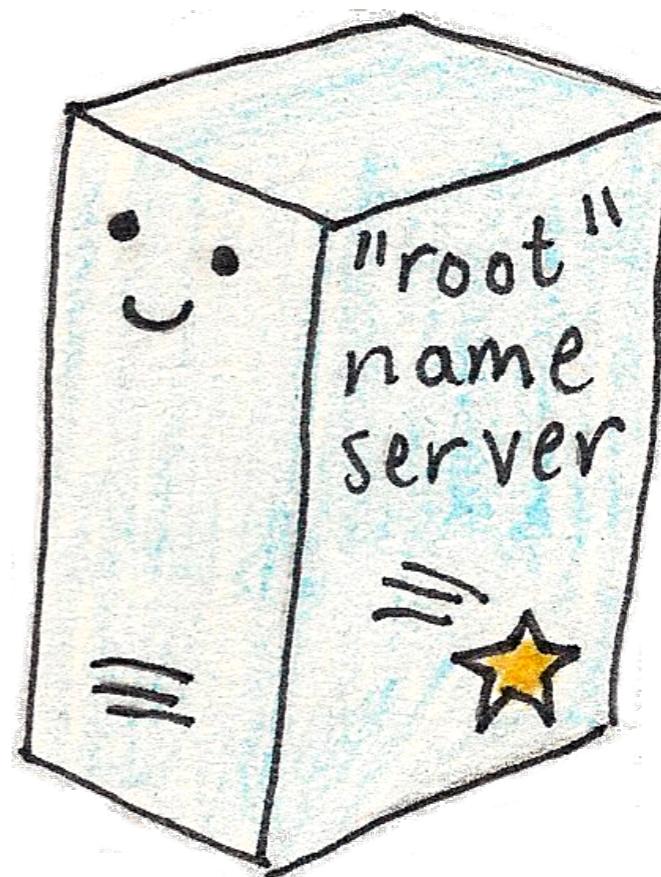
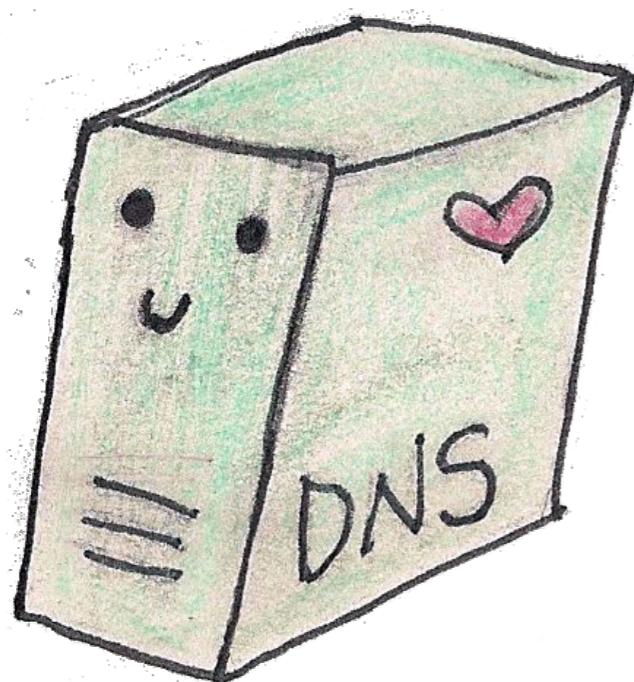
# IP Address Lookup

You go talk to your friends,  
talk to more friends,  
talk to me



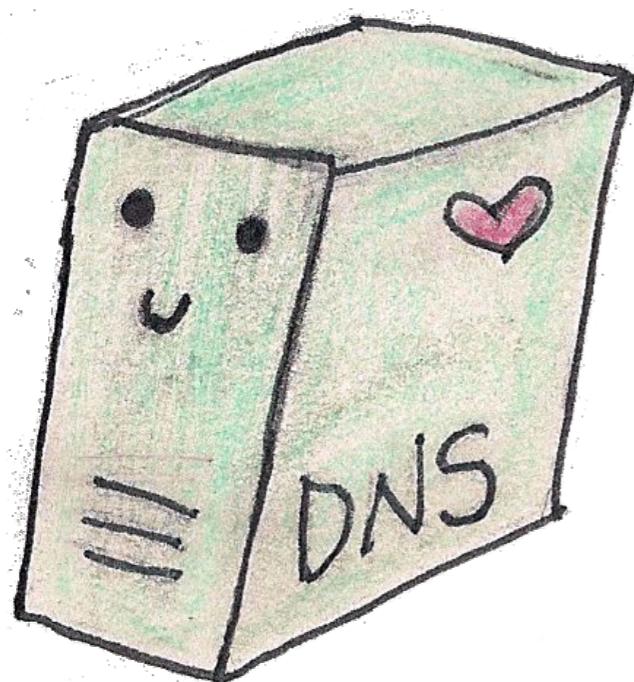
# IP Address Lookup

Do you know where  
www.google.com is?

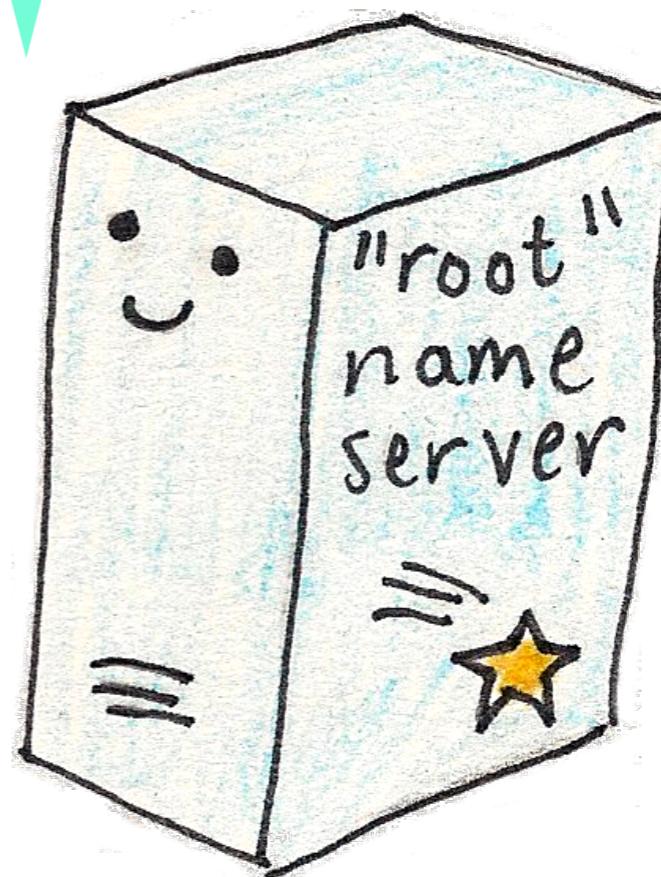


# IP Address Lookup

Do you know where  
www.google.com is?

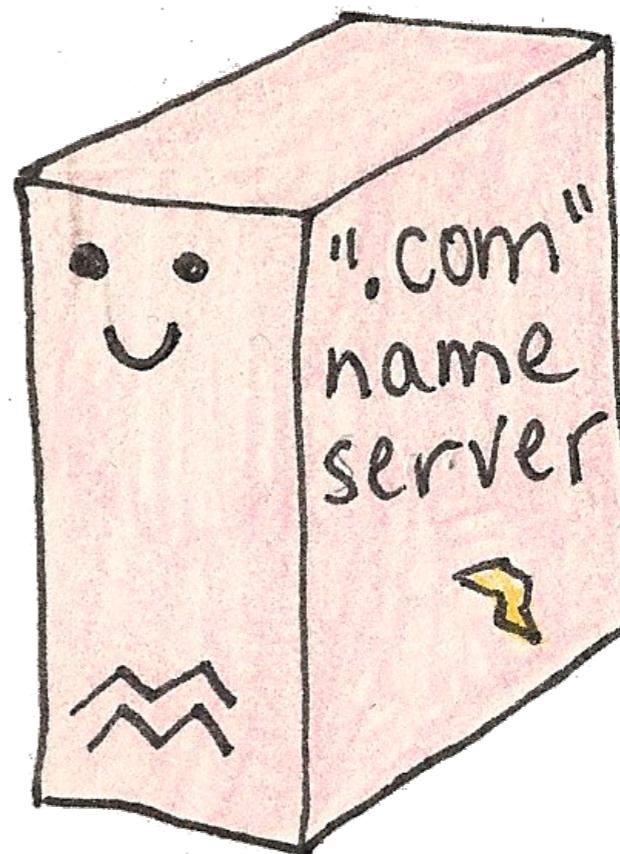
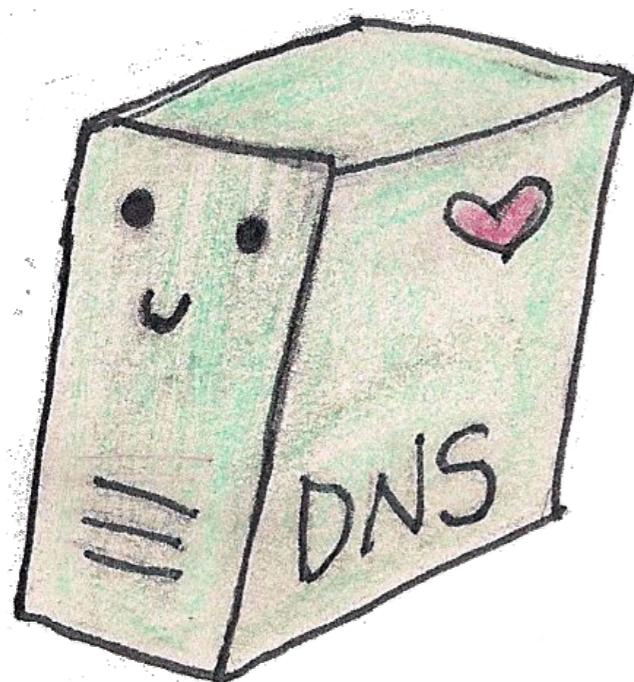


No, but maybe ask  
.com?



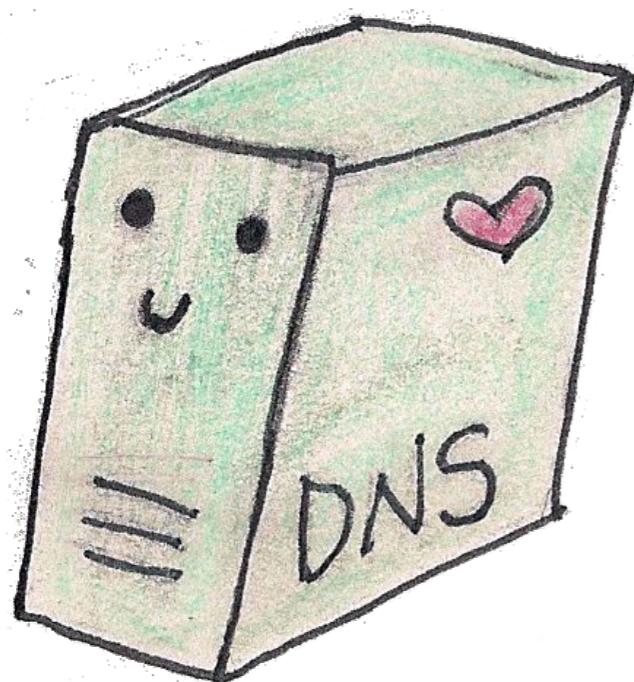
# IP Address Lookup

Do you know where  
www.google.com is?

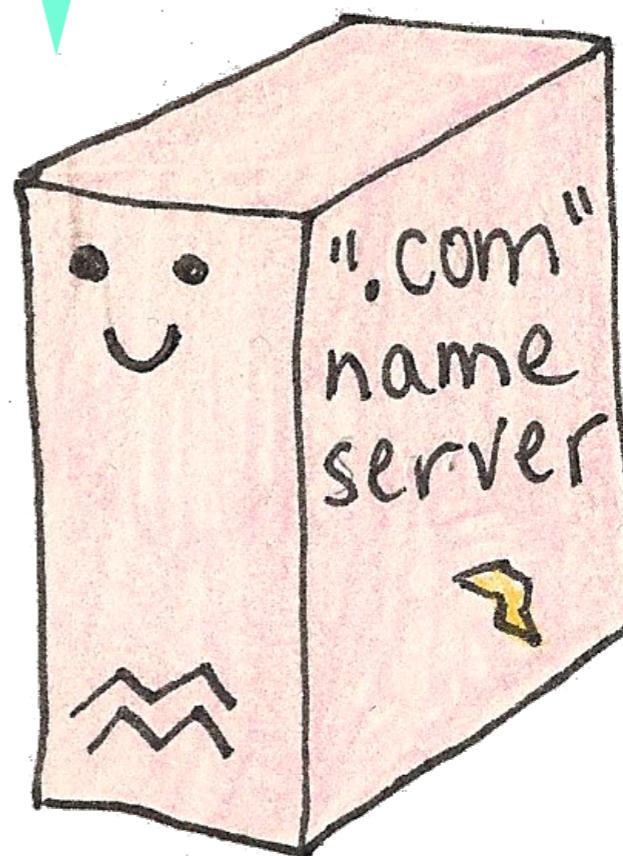


# IP Address Lookup

Do you know where  
www.google.com is?

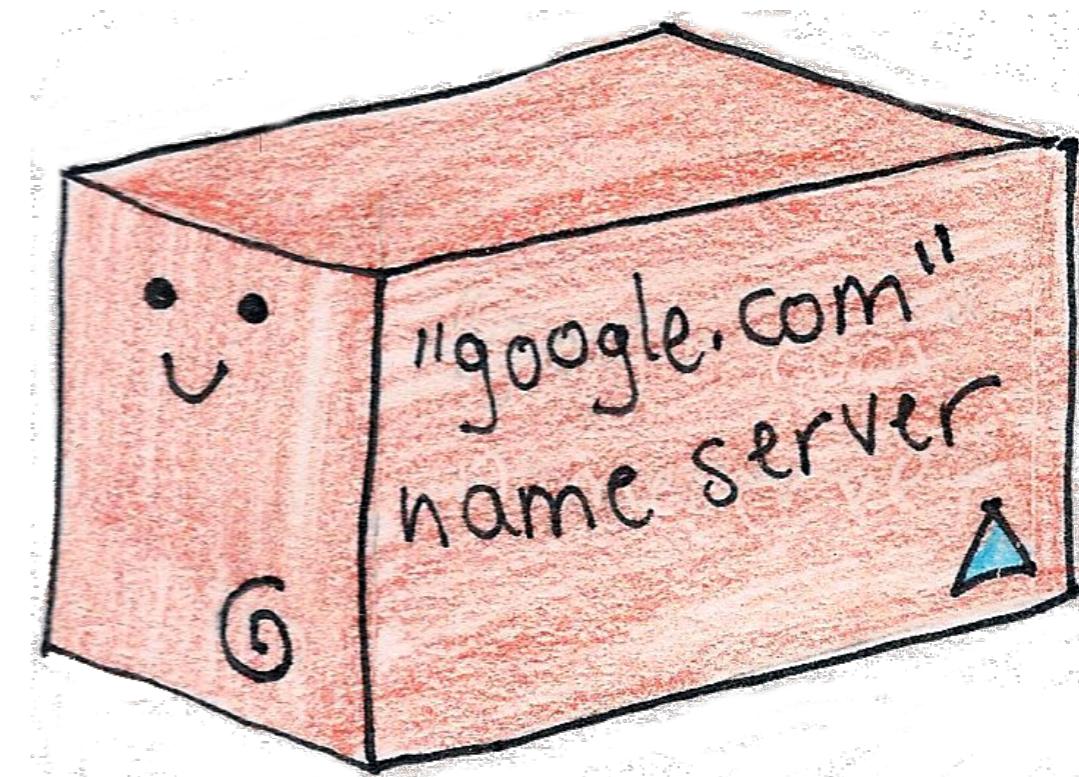
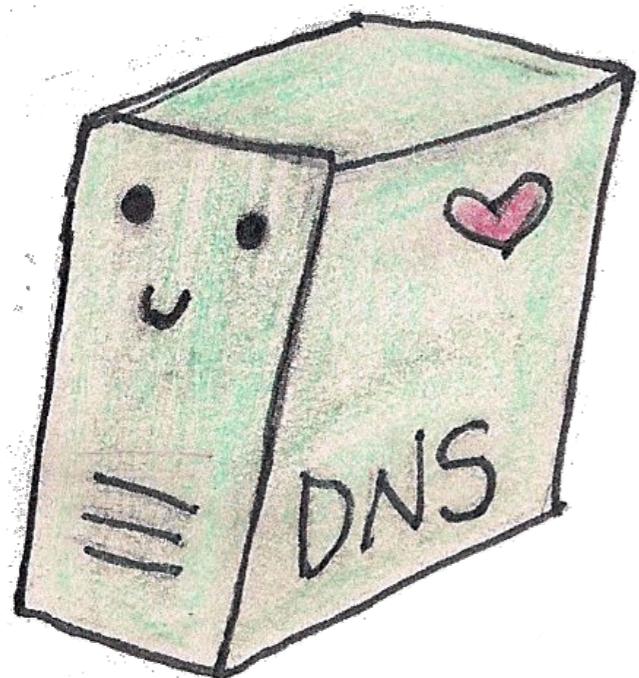


No, but maybe ask  
“google.com”?



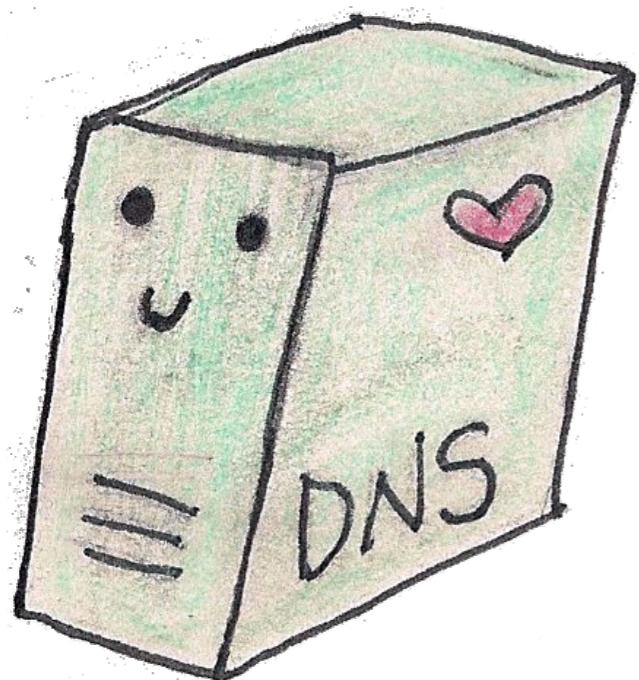
# IP Address Lookup

Do you know where  
www.google.com is?

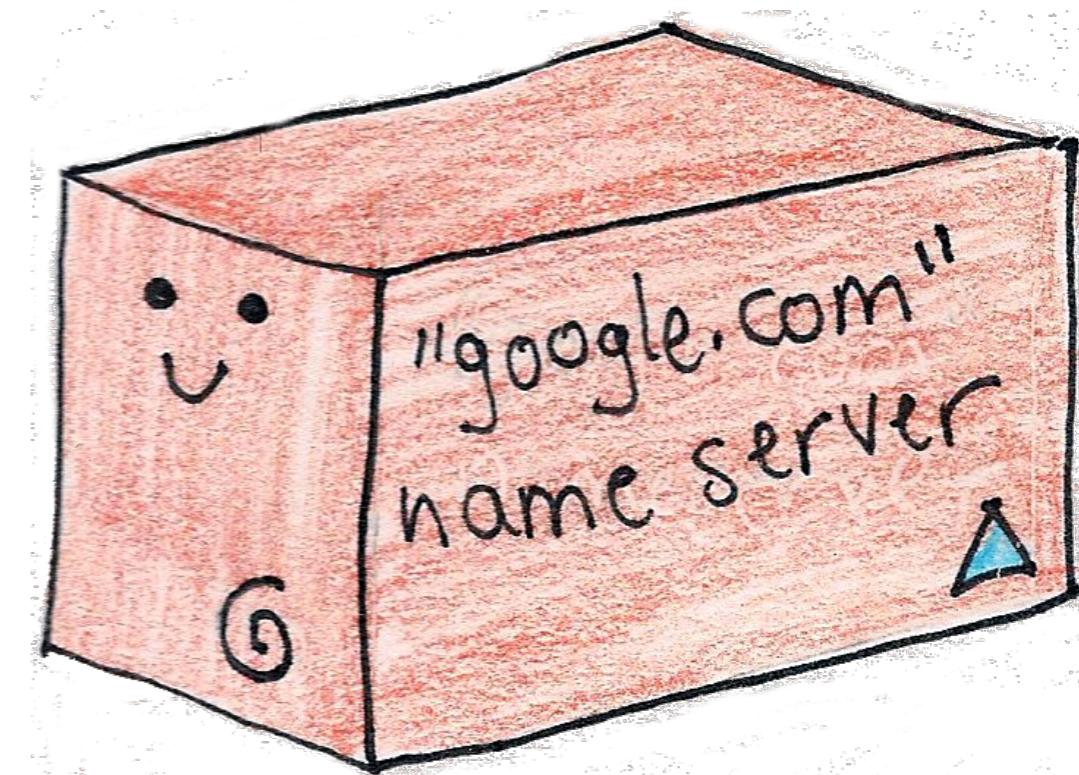


# IP Address Lookup

Do you know where  
www.google.com is?

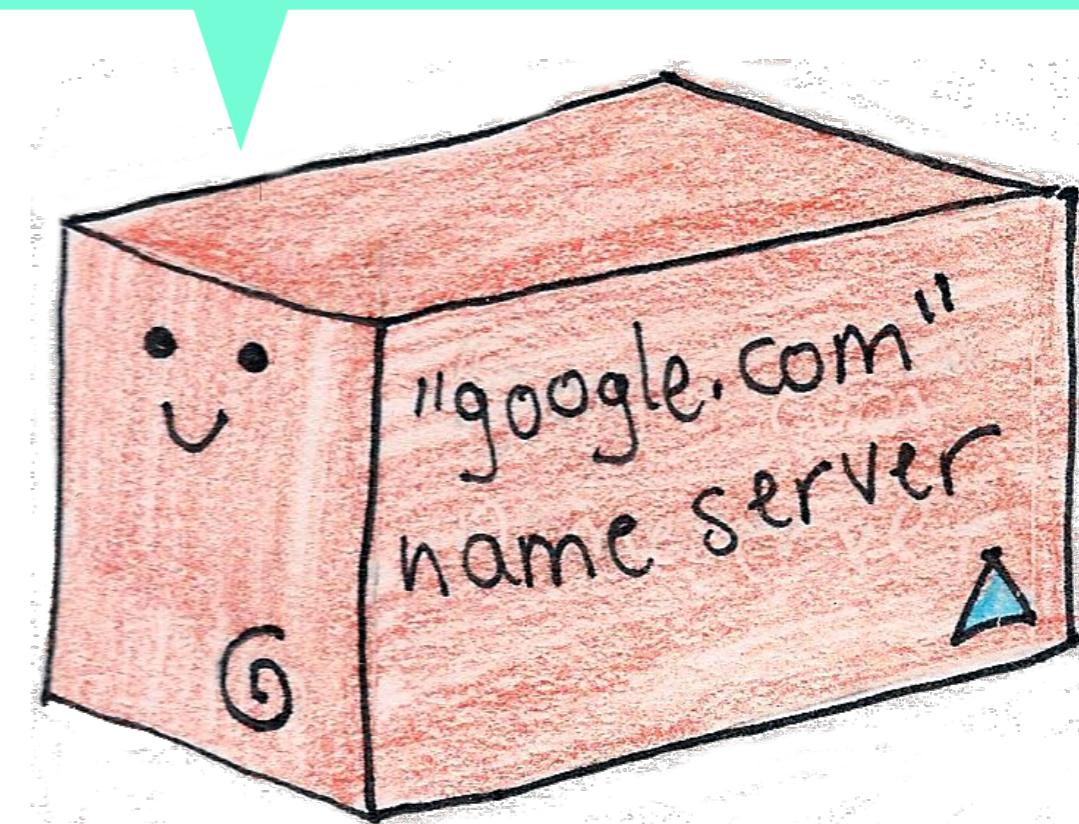
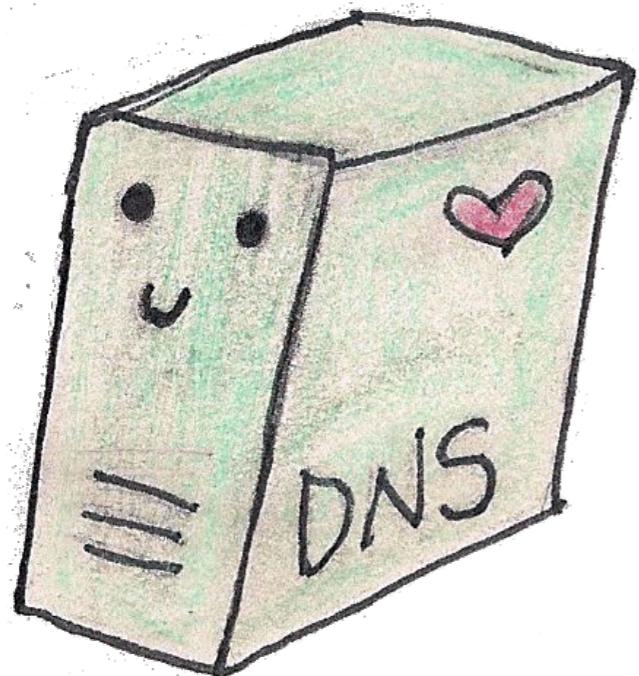


Yep!  
173.194.46.84!



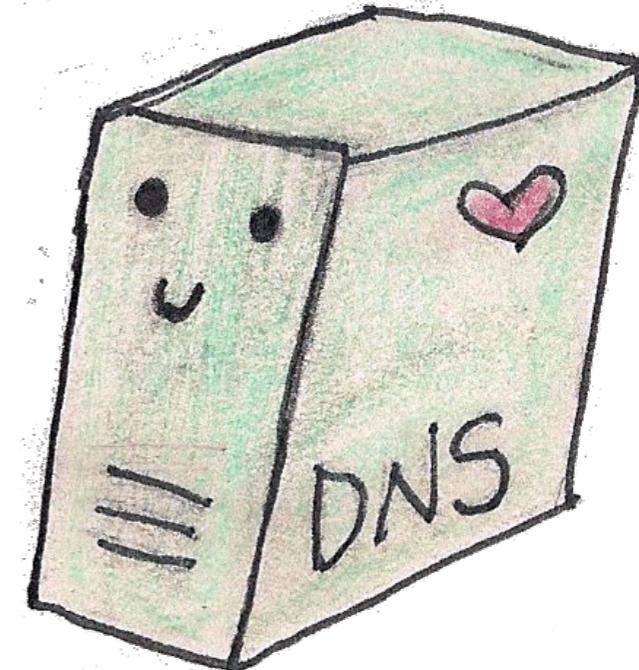
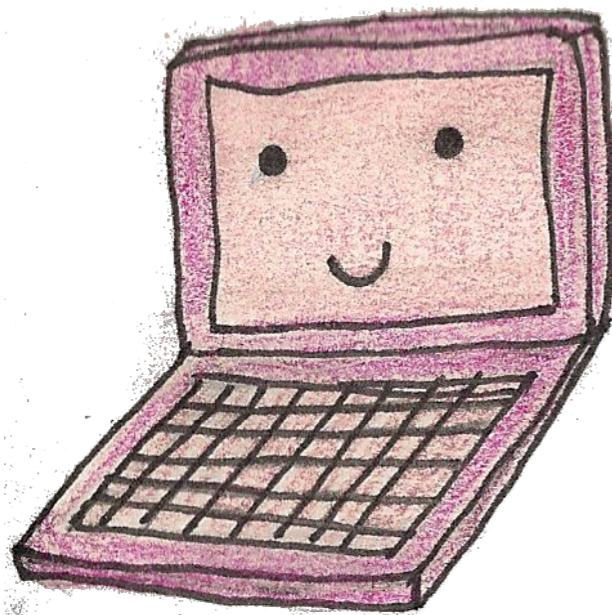
# IP Address Lookup

Say you'll remember me  
Or at least this IP address  
So we don't have to relive this mess



# IP Address Lookup

Yep!  
173.194.46.84!



# IP Address Lookup

```
zeigenspace:~ jenna$ dig www.google.com
```

```
; <>> DiG 9.8.3-P1 <>> www.google.com
;; global options: +cmd
;; Got answer:
;; ->>HEADER<<- opcode: QUERY, status: NOERROR, id: 45898
;; flags: qr rd ra; QUERY: 1, ANSWER: 5, AUTHORITY: 0, ADDITIONAL: 0
```

```
;; QUESTION SECTION:
```

```
;www.google.com. IN A
```

```
;; ANSWER SECTION:
```

|                 |     |    |   |               |
|-----------------|-----|----|---|---------------|
| www.google.com. | 251 | IN | A | 74.125.226.48 |
| www.google.com. | 251 | IN | A | 74.125.226.50 |
| www.google.com. | 251 | IN | A | 74.125.226.51 |
| www.google.com. | 251 | IN | A | 74.125.226.49 |
| www.google.com. | 251 | IN | A | 74.125.226.52 |

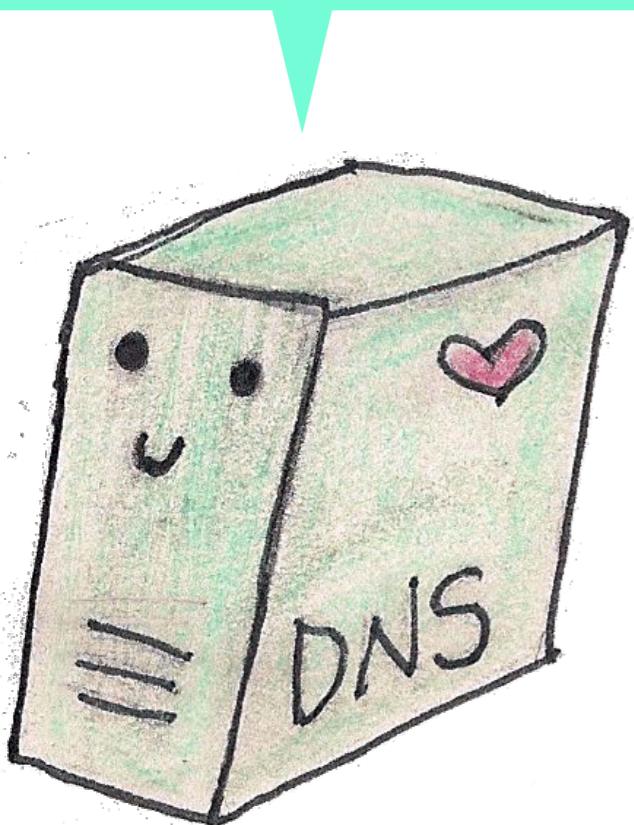
```
;; Query time: 16 msec
```

```
;; SERVER: 209.18.47.61#53(209.18.47.61)
```

```
;; WHEN: Sun Nov 1 17:10:36 2015
```

```
;; MSG SIZE rcvd: 112
```

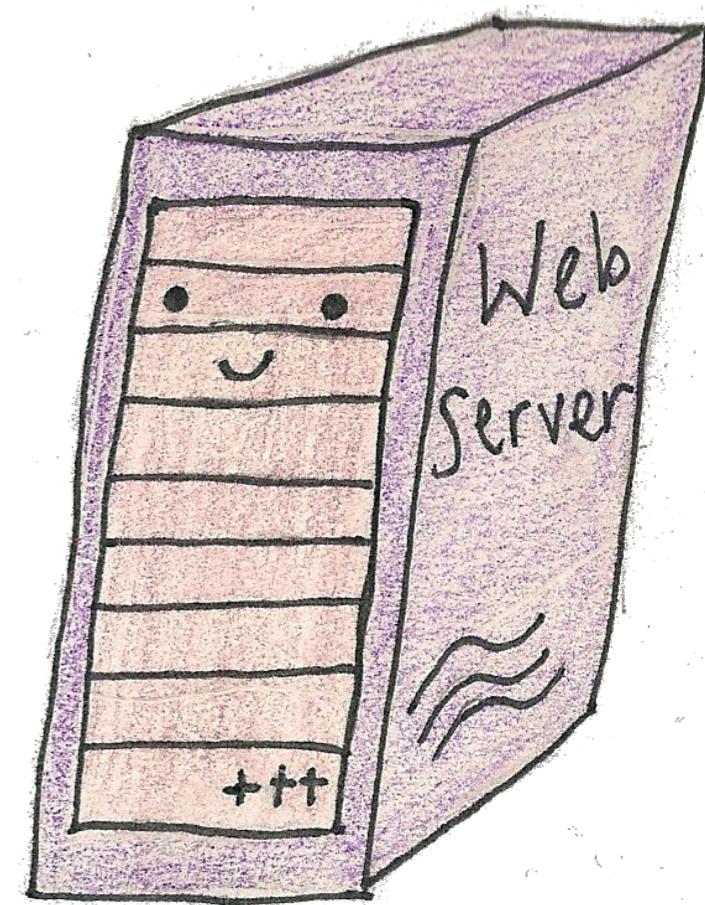
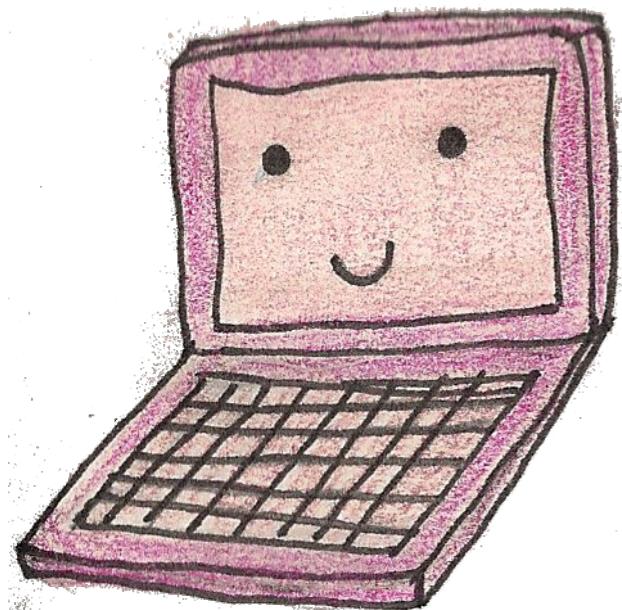
```
zeigenspace:~ jenna$ _
```



I dig it.

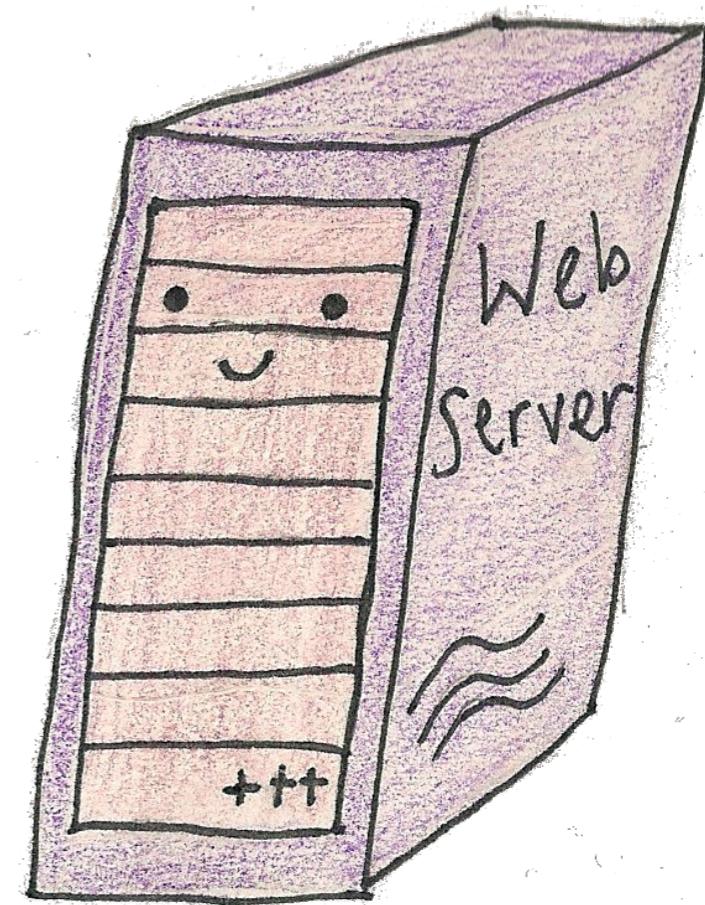
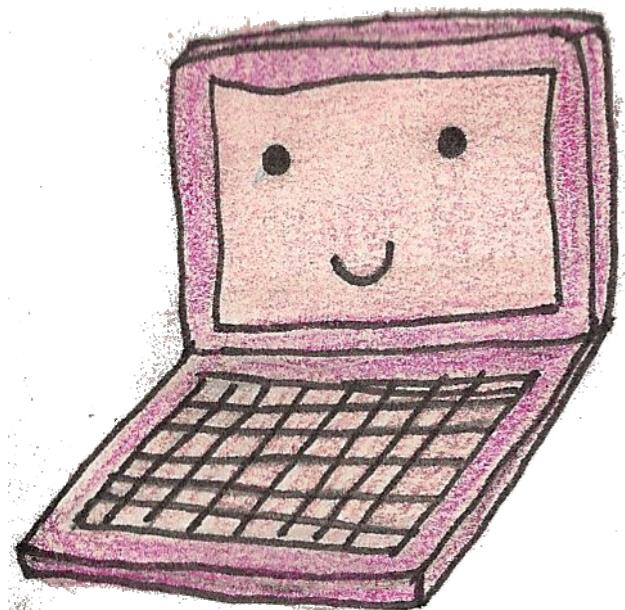
# Opening a socket

Socket to me.



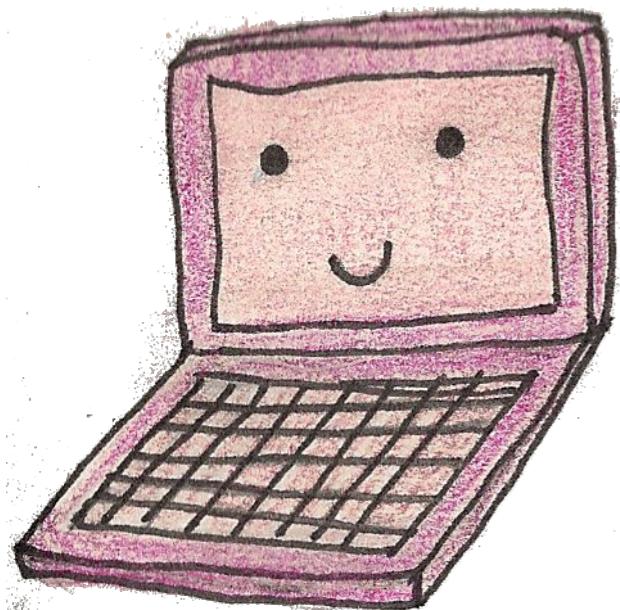
# Opening a socket

Hey! Will you  
talk to me?

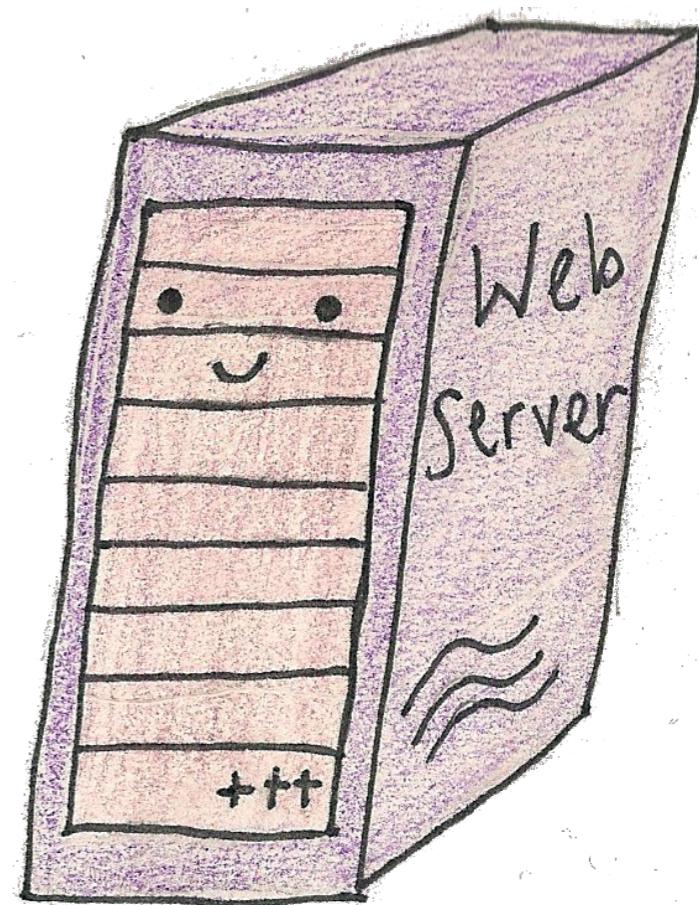


# Opening a socket

Hey! Will you  
talk to me?

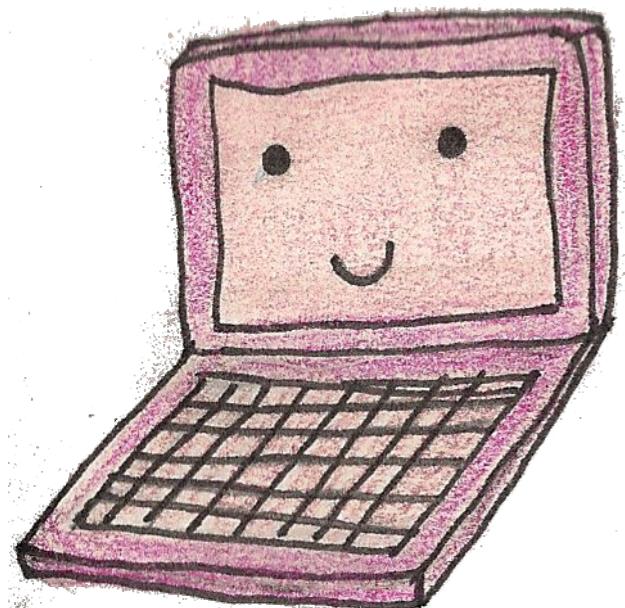


Sure!



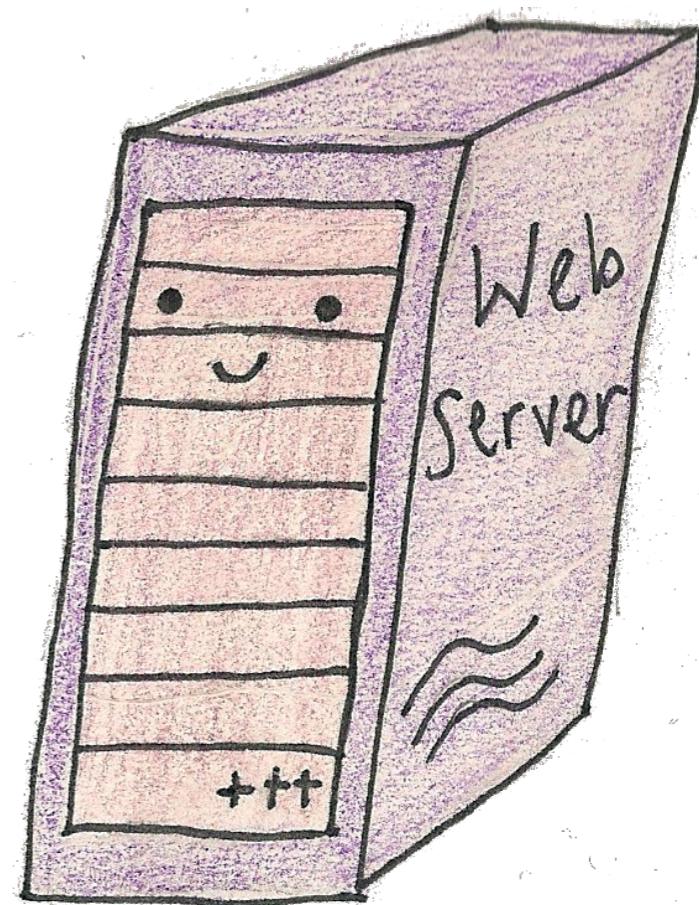
# Opening a socket

Hey! Will you  
talk to me?

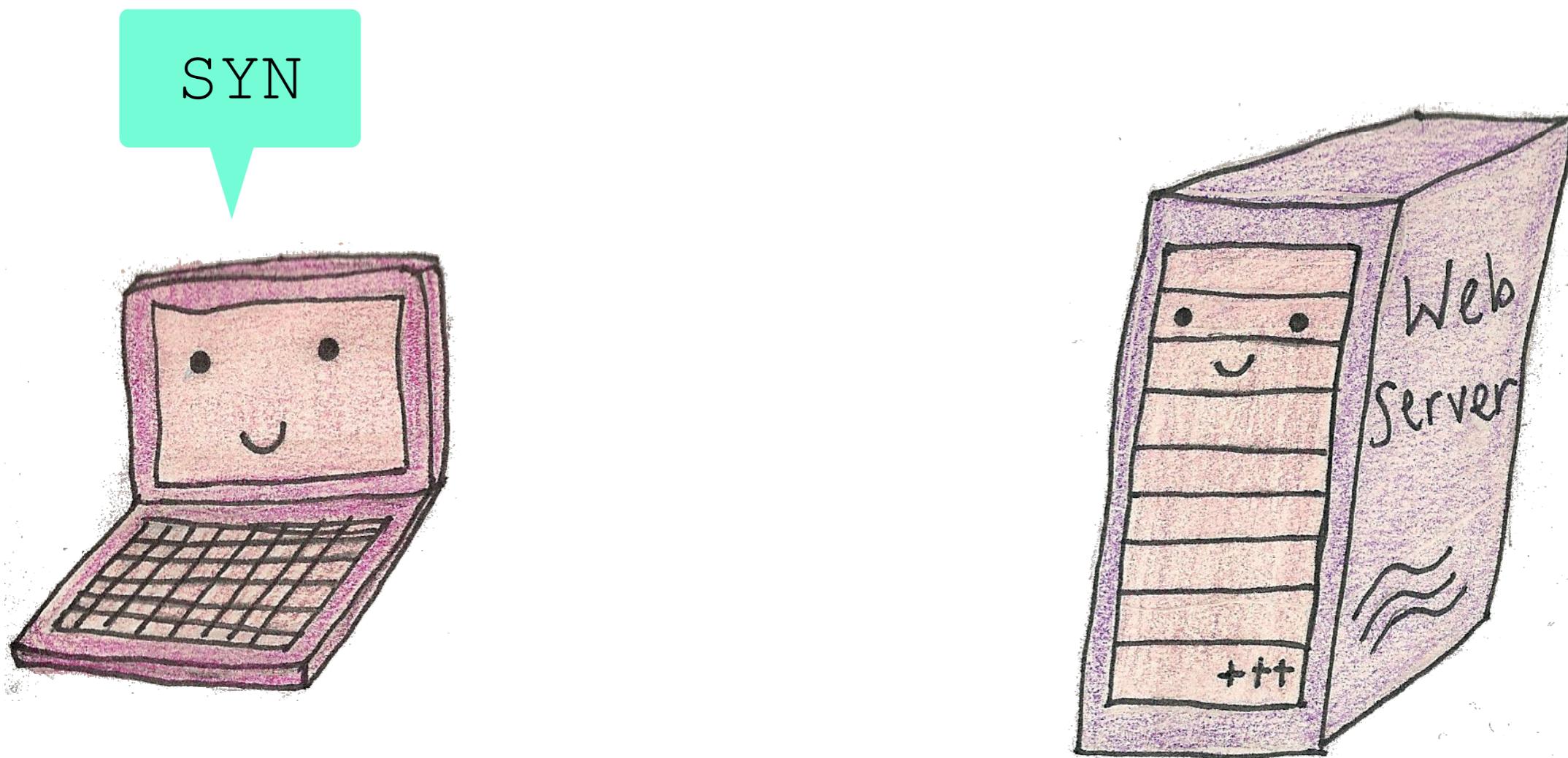


Sweet.

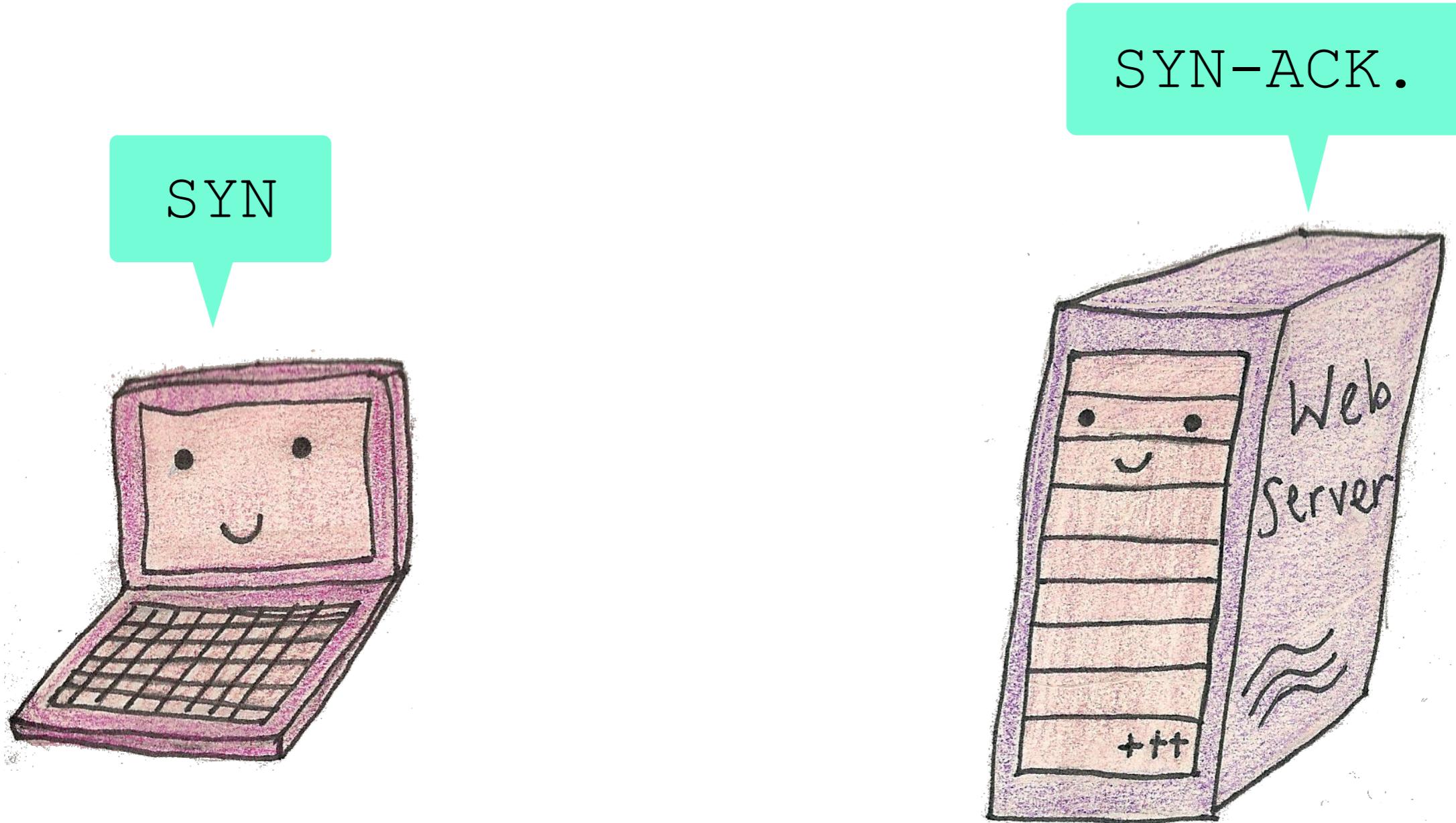
Sure!



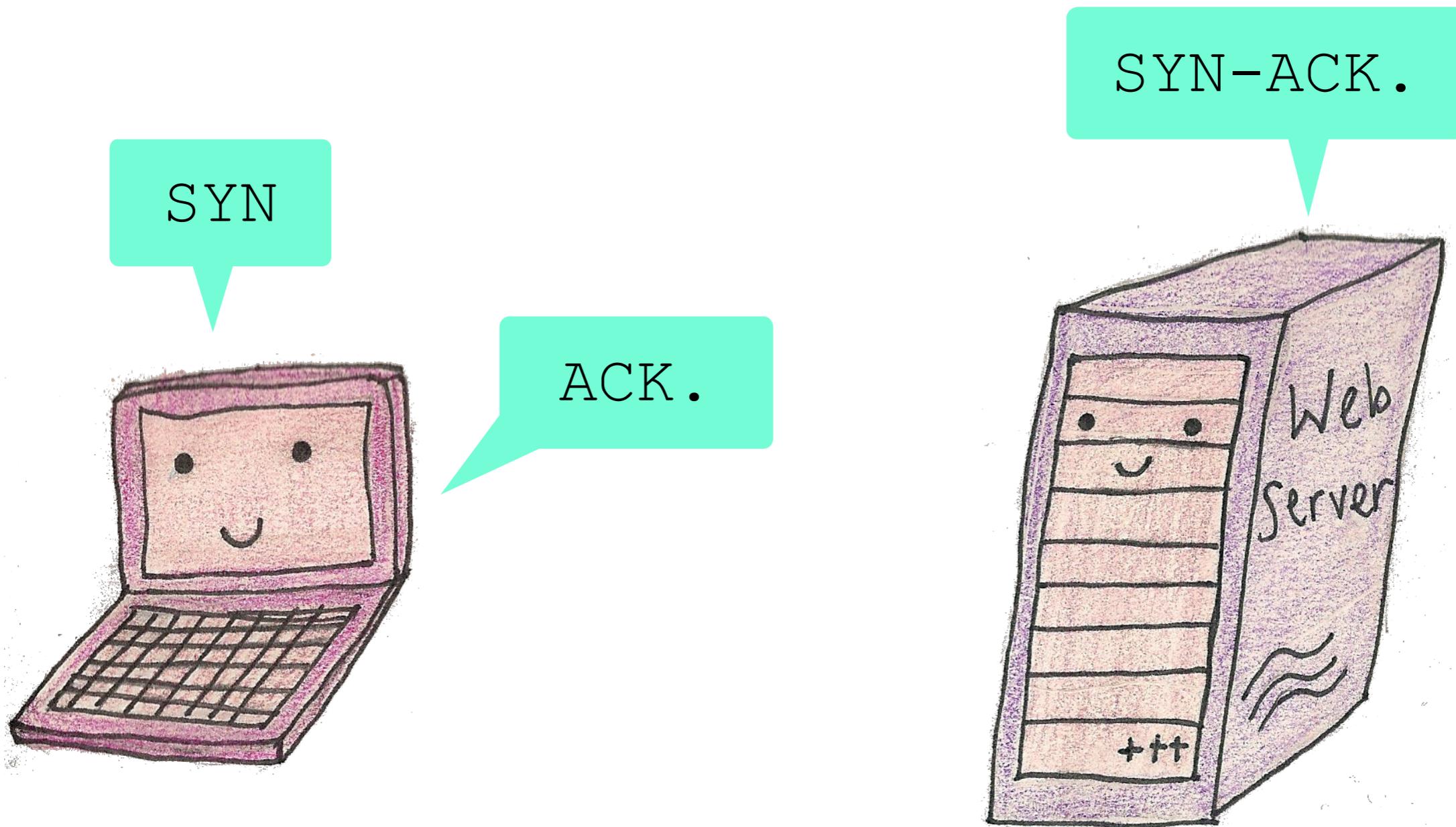
# Opening a socket



# Opening a socket



# Opening a socket

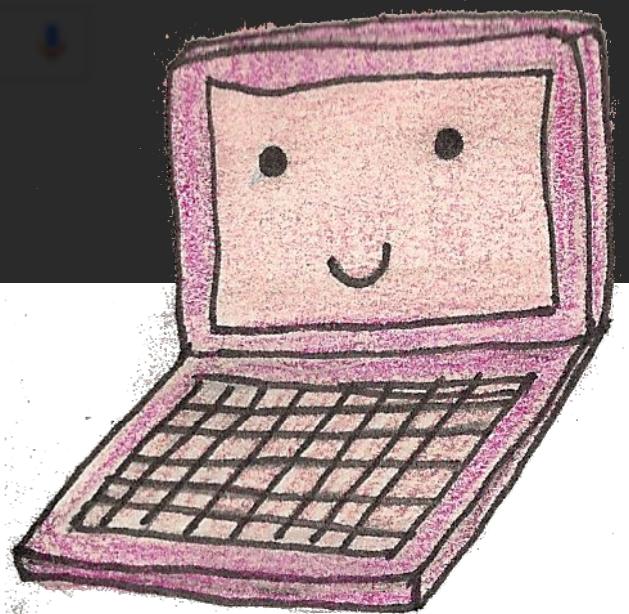


# Opening a socket

```
zeigenspace:~ jenna$ sudo tcpdump -c3 host www.google.com
```

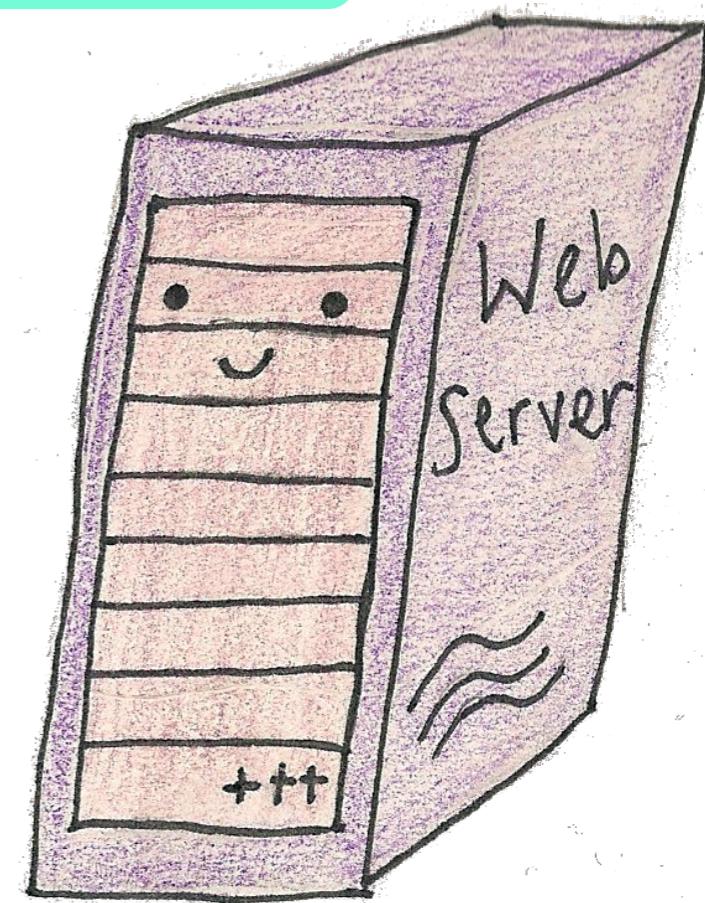
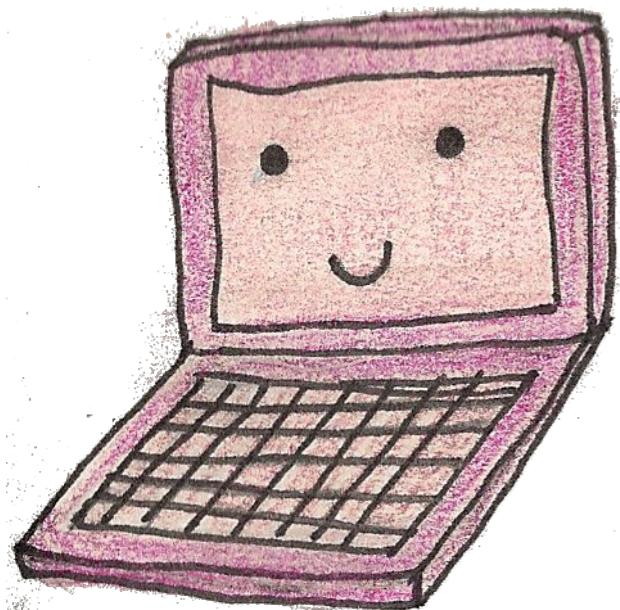
```
tcpdump: data link type PKTAP
tcpdump: verbose output suppressed, use -v or -vv for full protocol decode
listening on ptkap, link-type PKTAP (Packet Tap), capture size 65535 bytes
01:05:42.209216 IP 192.168.0.23.52293 > lga25s40-in-f196.1e100.net.https: UDP, length 190
01:05:42.249138 IP lga25s40-in-f196.1e100.net.https > 192.168.0.23.52293: UDP, length 35
01:05:42.259526 IP lga25s40-in-f196.1e100.net.https > 192.168.0.23.52293: UDP, length 221
```

```
3 packets captured
16 packets received by filter
0 packets dropped by kernel
zeigenspace:~ jenna$ _
```



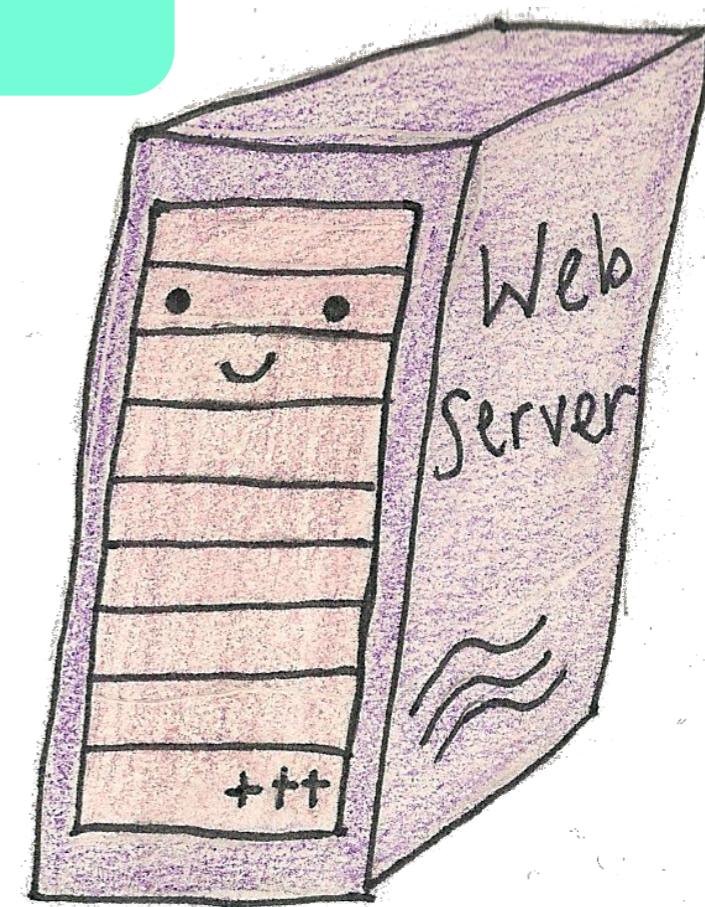
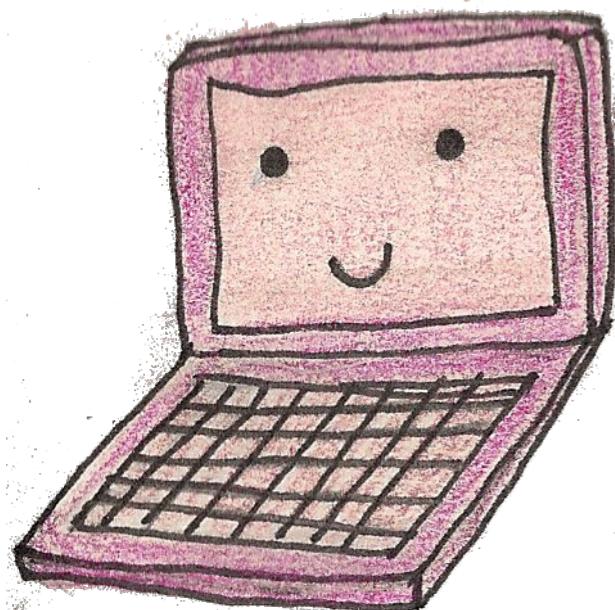
# Security Stuff

After all this goes down,  
I know that we'll be safe and sound  
♪ ♪ ♪



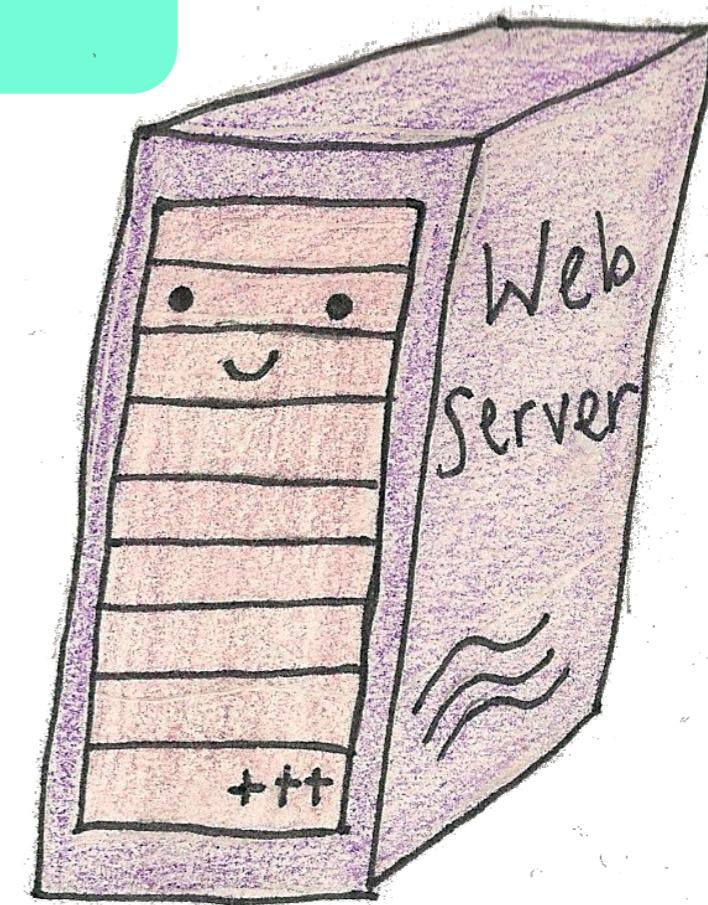
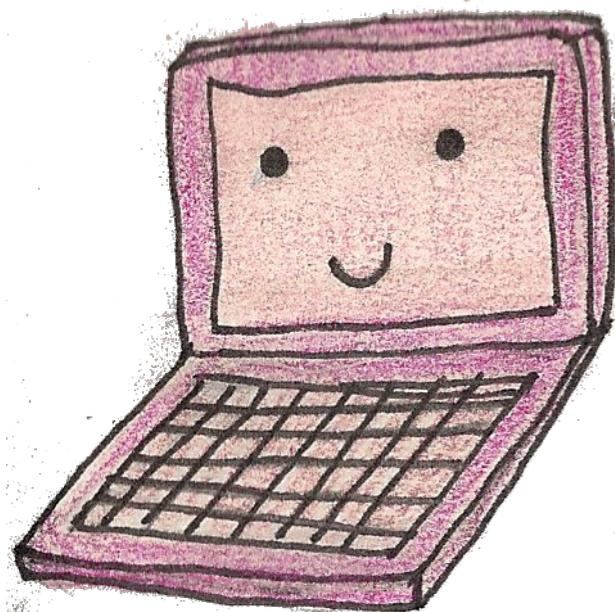
# HTTP Request

```
> GET / HTTP/1.1  
> Host: google.com  
> Connection: close  
> [other headers]
```



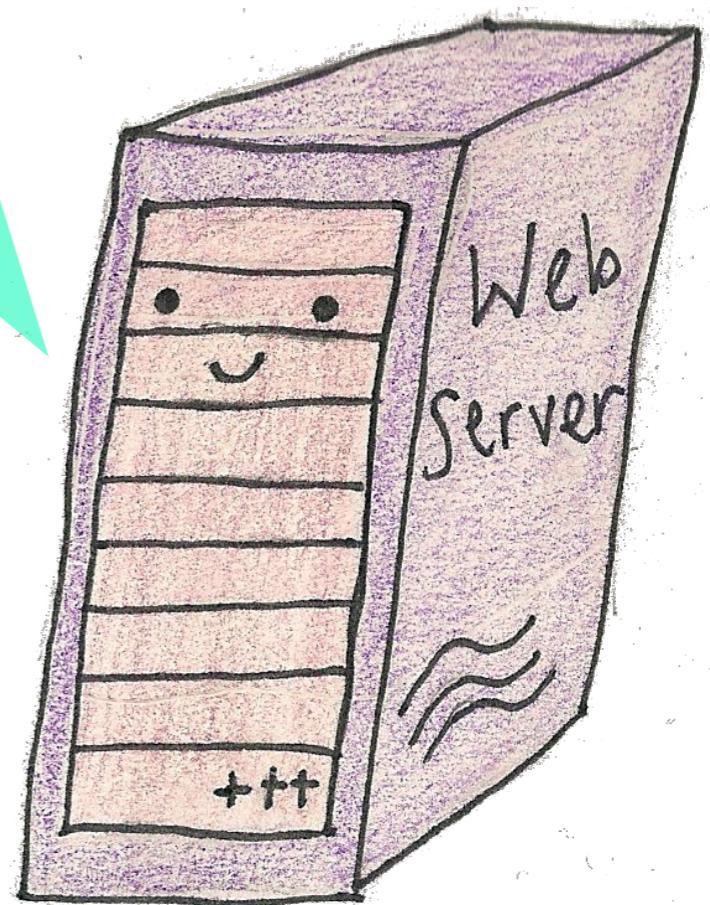
# HTTP Request

```
> GET / HTTP/1.1  
> Host: google.com  
> Connection: close  
> [other headers]
```



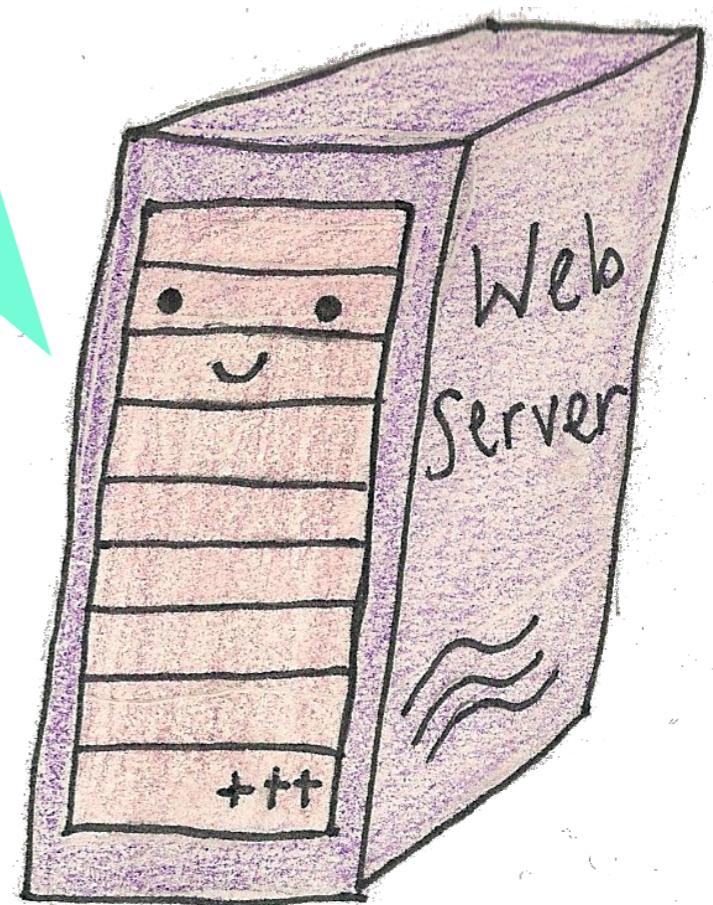
# Server Things...

Look inside  
It's where my daemon hides  
♪ ♪ ♪



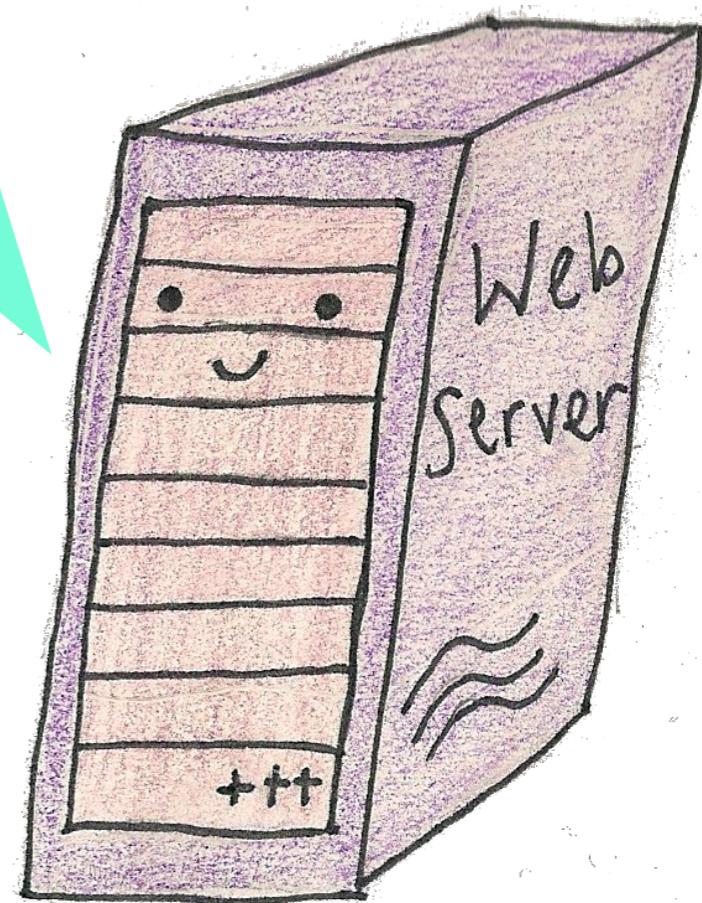
# Server Things...

I got racks on  
racks on racks  
♪ ♪ ♪



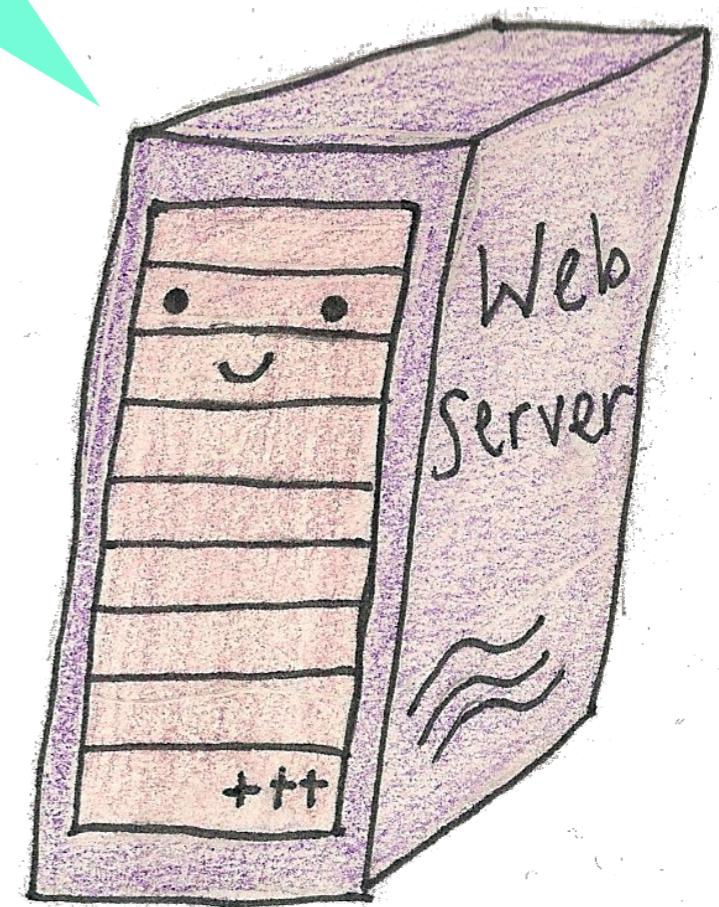
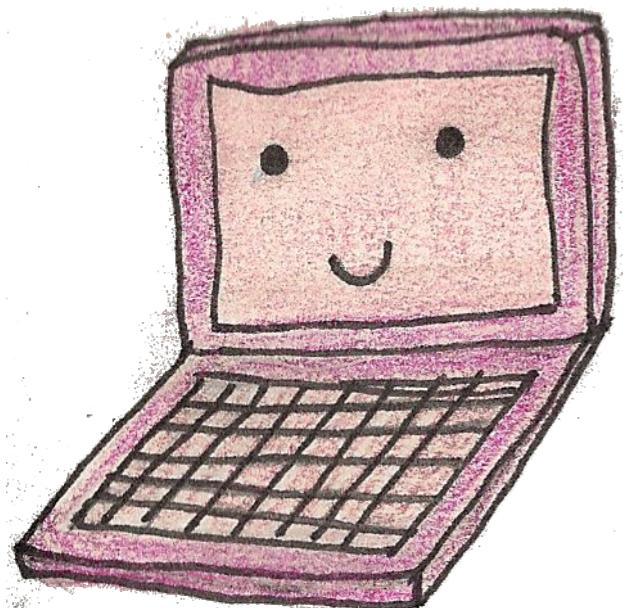
# Server Things...

Whatcha, whatcha,  
whatcha want?  
(Whatcha want?)



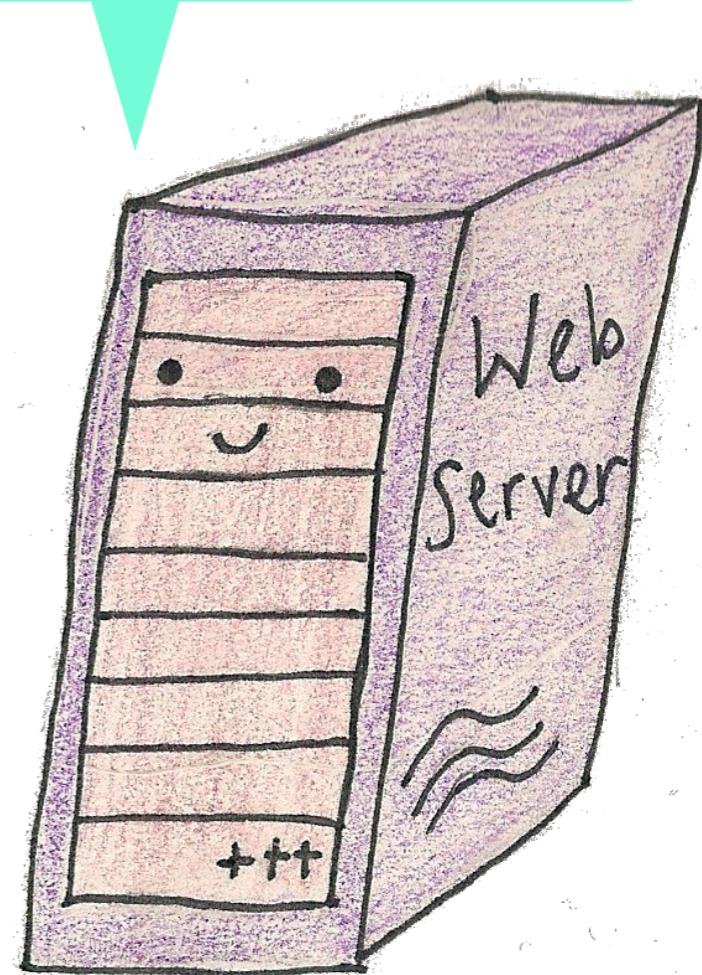
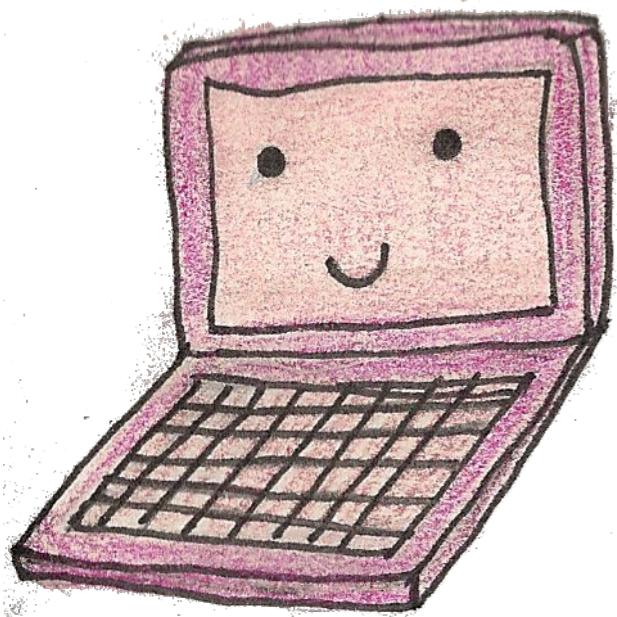
# HTTP Response

< HTTP/1.1 304 Not Modified  
[other headers]



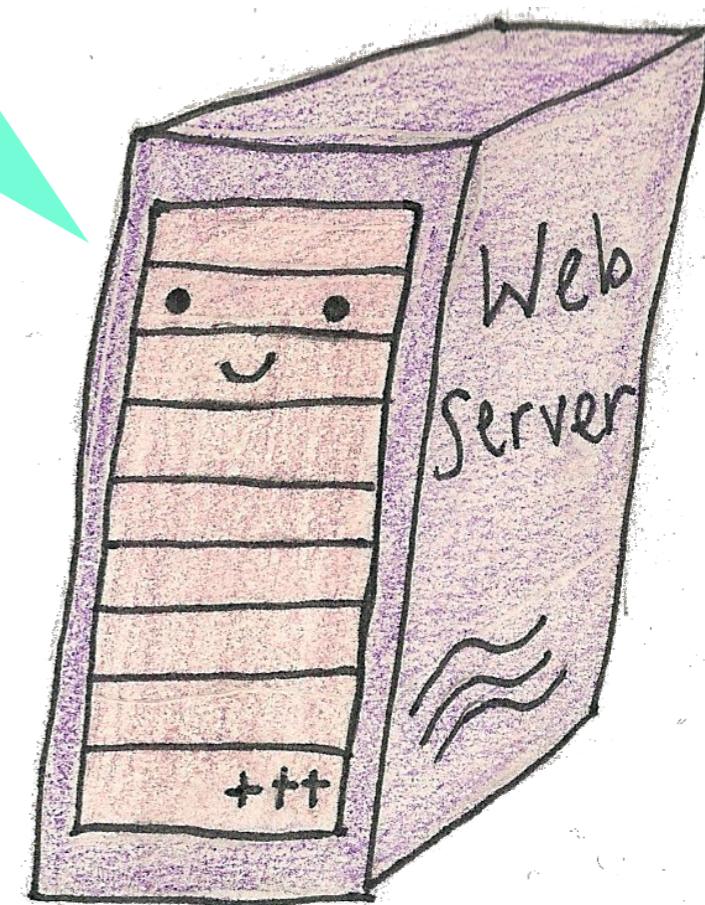
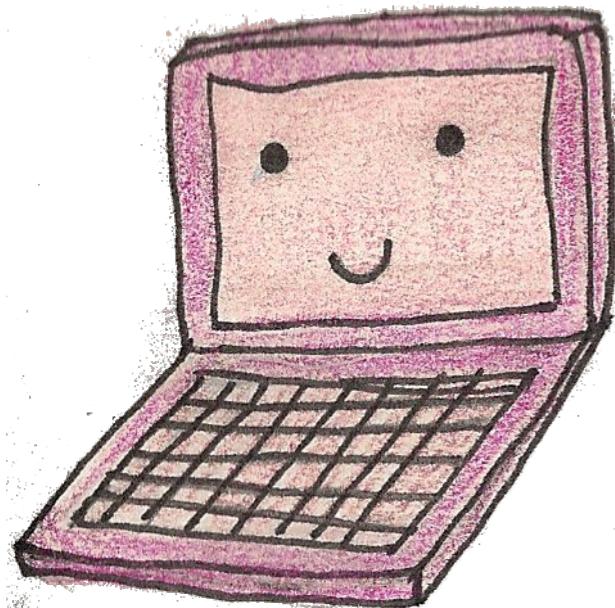
# HTTP Response

Sorry, we had to change to that code  
Updated that file and then changed its number  
I guess you need the new stuff though  
Now it's just some page that you used to know



# HTTP Response

```
< HTTP/1.1 200 OK  
[other headers]  
<  
<!DOCTYPE html><html>...</html>
```



# HTTP Response

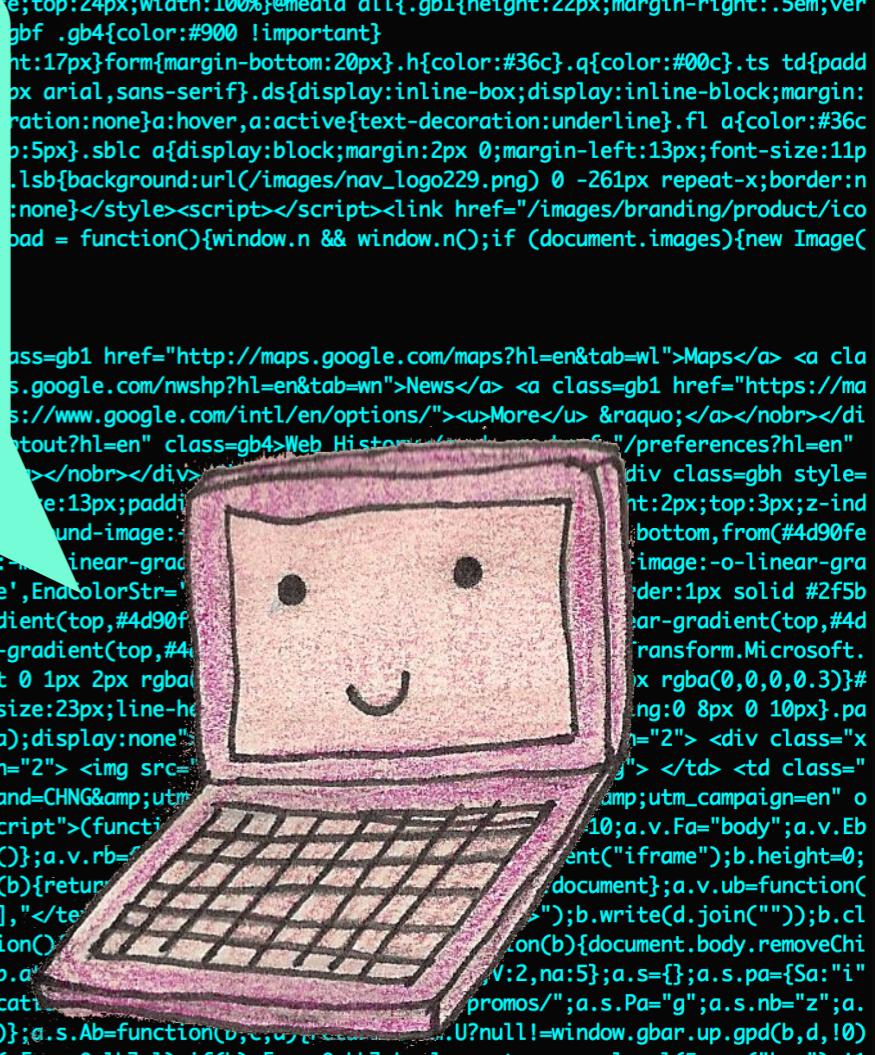
```
<!doctype html><html itemscope="" itemtype="http://schema.org/WebPage" lang="en"><head><meta content="Search the world's information, including webpages, images, videos and more. Google has many special features to help you find exactly what you're looking for." name="description"><meta content="nooodp" name="robots"><meta content="/images/branding/googleleg/1x/googleleg_standard_color_128dp.png" itemprop="image"><title>Google</title><script>(function(){window.google={kEI:'sey2VrLI04nUmAGIrpCYDg',kEXPI:'4029815,4031109,4032677,4033307,4033344,4036527,4037333,4037569,4038012,4041440,4041837,4041898,4042492,4043255,4043457,4043458,4043492,4044246,4044606,4045841,4046304,4046400,4047930,4048007,4048011,4048141,4048144,4048346,4048452,4048570,4048770,4048854,4048901,4048909,4048972,4049250,4049597,4050323,4050735,4050766,4050802,4050814,4050891,4050912,4050916,4050927,4051115,4051155,4051195,4051290,8300096,8300227,8300272,8502095,8502221,8502312,8502315,8502342,8502444,8502468,8502482,8502529,8502537,8502552,10200083',authuser:0,kscs:'c9c918f0_10'};google.kHL='en';})();(function(){google.lc=[];google.li=0;google.getEI=function(a){for(var b;a&&(!a.getAttribute||!(b=a.getAttribute("eid"))));}a=a.parentNode;return b||google.kEI};google.getLEI=function(a){for(var b=null;a&&(!a.getAttribute||!(b=a.getAttribute("leid"))));}a=a.parentNode;return b};google.https=function(){return"https":==window.location.protocol};google.ml=function(){return null};google.wl=function(a,b){try{google.ml(Error(a),!1,b)}catch(d){}};google.time=function(){return(new Date).getTime()};google.log=function(a,b,d,e,g){a=google.logUrl(a,b,d,e,g);if("!=a){b=new Image;var c=google.lc,f=google.li;c[f]=b;b.onerror=b.onload=function(){delete c[f]};window.google&&window.google.vel&&window.google.vel.lu&&window.google.vel.a;b.src=a;google.logUrl=function(a,b,d,e,g){var c="",f=google.ls||"";if(!d&&-1==b.search("&ei")){var h=google.getEI(e),c=&ei+"h;-1==b.search("&lei")&&(!e.google.getLEI(e))?c+="&lei="+e:h!=google.kEI&&(c+="&lei="+google.kEI)}a=d||"/"+(g||"gen_204")+"?atyp=i&ct="+a+"&cad="+b+c+f+"&zx="+google.time();/^http://i.test(a)&&google.https()&&(google.ml(Error("a"),!1,{src:a,glmm:1}),a="");return a};google.y={};google.x=function(a,b){google.y[a.id]=[a,b];return!1};google.load=function(a,b,d){google.x({id:a+k++},function(){google.load(a,b,d)});var k=0;});var _gjwl=location;function _gjuc(){var a=_gjwl.href.indexOf("#");if(0<=a&&a=_gjwl.href.substring(a),0<=a.indexOf("#q"))&&(a=a.substring(1),-1=a.indexOf("#")){for(var d=0;d<a.length;){var b=d;"#"-=a.charAt(b)&&+b;var c=a.indexOf("&",b);-1==c&&(c=a.length);b=a.substring(b,c);if(0==b.indexOf("fp"))a=a.substring(0,d)+a.substring(c,a.length),c=d;else if("cad=h"==b) return 0;d=c}_gjwl.href="/search?" +a+"&cad=h";return 1}return 0}function _gjh(){!_gjuc()&&window.google&&google.x&&google.x[{id:"GJH"}],function(){google.nav&&google.nav.gjh&&google.nav.gjh});window._gjh&&_gjh;</script><style>#gbar,#guser{font-size:13px;padding-top:1px !important;}#gbar{height:22px}#guser{padding-bottom:7px !important;text-align:right}.gbh,.gbd{border-top:1px solid #c9d7f1;font-size:1px}.gbh{height:0;position:absolute;top:24px;width:100%}@media all{.gb1{height:22px;margin-right:.5em;vertical-align:top}#gbar{float:left}}.gb1,a.gb4{text-decoration:underline !important}.gb1,a.gb4{color:#00c !important}.gb1 .gb4{color:#dd8e27 !important}.gbf .gb4{color:#900 !important}</style><style>body,td,a,p,.h{font-family:arial,sans-serif}body{margin:0;overflow-y:scroll}#gog{padding:3px 8px 0}td{line-height:.8em}.gac_m td{line-height:17px}form{margin-bottom:20px}.h{color:#36c}.q{color:#00c}.ts td{padding:0}.ts{border-collapse:collapse}em{font-weight:bold;font-style:normal}.lst{height:25px;width:496px}.gsfi,.lst{font:18px arial,sans-serif}.gsfs{font:17px arial,sans-serif}.ds{display:inline-block;display:inline-block;margin:3px 0 4px;margin-left:4px}input{font-family:inherit}a.gb1,a.gb2,a.gb3,a.gb4{color:#11c !important}body{background:#fff;color:black}a{color:#11c;text-decoration:none}a:hover,a:active{text-decoration:underline}.fl a{color:#36c}a:visited{color:#551a8b}a.gb1,a.gb4{text-decoration:underline}a.gb3:hover{text-decoration:none}#ghead a.gb2:hover{color:#fff !important}.sblc{padding-top:5px}.sblc a{display:block;margin:2px 0;margin-left:13px;font-size:11px}.lsbb{background:#eee;border:solid 1px;border-color:#ccc #999 #999 #ccc;height:30px}.lsbb{display:block}.ftl,#ftl a{display:inline-block;margin:0 12px}.lsb{background:url(/images/nav_logo229.png) 0 -261px repeat-x;border:none;color:#000;cursor:pointer;height:30px;margin:0;outline:0;font:15px arial,sans-serif;vertical-align:top}.lsb:active{background:#ccc}.lst:focus{outline:none}</style><script></script><link href="/images/branding/product/icon/gogleleg_lodp.ico" rel="shortcut icon"></head><body bgcolor="#fff"><script>(function(){var iesg=false;document.body.onload = function(){window.n && window.n();if (document.images){new Image().src=src;}if (!iesg){document.f&&document.f.q.focus();document.gbf&&document.gbf.q.focus();}}})();<div id="mngb"><div id="gbar"><nobr><b class="gb1">Search</b> <a class="gb1" href="http://www.google.com/imghp?hl=en&tab=wi">Images</a> <a class="gb1" href="http://maps.google.com/maps?hl=en&tab=wl">Maps</a> <a class="gb1" href="https://play.google.com/?hl=en&tab=w8">Play</a> <a class="gb1" href="http://www.youtube.com/?tab=w1">YouTube</a> <a class="gb1" href="http://news.google.com/nwshp?hl=en&tab=wn">News</a> <a class="gb1" href="https://mail.google.com/mail/?tab=wm">Gmail</a> <a class="gb1" href="https://drive.google.com/?tab=wo">Drive</a> <a class="gb1" style="text-decoration:none" href="https://www.google.com/intl/en/options/">&gt;More</a> &quo;</nobr></div><div id="guser" width=100%><nobr><span id="gbn" class="gb1"></span><span id="gbf" class="gbf"></span><span id="gbe"></span><a href="http://www.google.com/history/optout?hl=en" class="gb4">Web History</a> | <a href="/preferences?hl=en"
```

# HTTP Response

zeigenspace:~ jenna\$ curl www.google.com

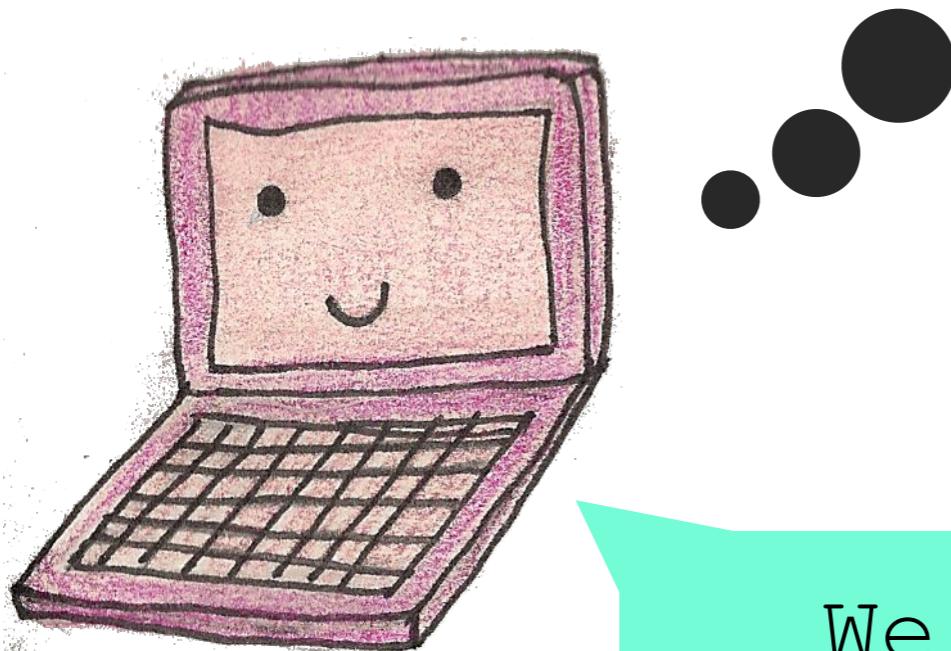
<!doctype html><html itemscope="" itemtype="http://schema.org/Article">

My curl, my curl, my curl  
Talkin' 'bout my curl.  
My curl!



# HTML Parsing

```
1 <!doctype html>
2 <html>
3   <head>
4     <script type="text/javascript" src="library.js"></script>
5     <link rel="stylesheet" type="text/css" href="styles.css">
6     <script type="text/javascript" src="website.js"></script>
7   </head>
8   <body>
9     <div>Let's pretend this is all of google</div>
10  </body>
11 </html>
```

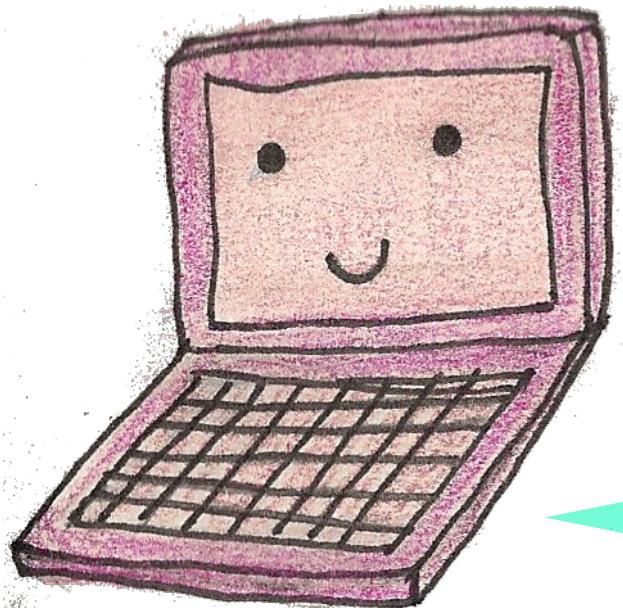


We did everything right,  
Bytes are on the client side



# HTML Parsing

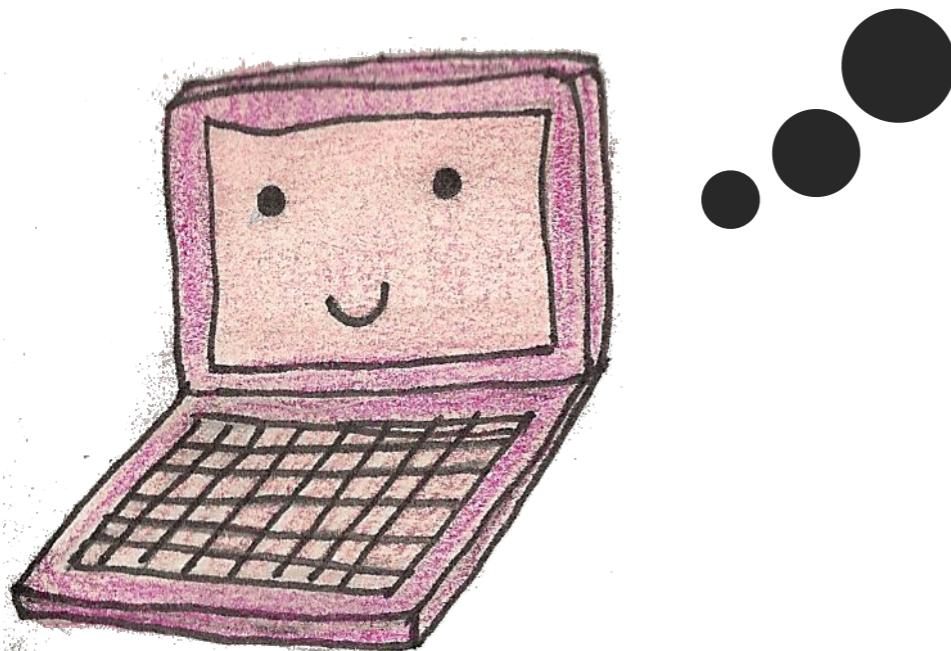
```
1 <!doctype html>
2 <html>
3   <head>
4     <script type="text/javascript" src="library.js"></script>
5     <link rel="stylesheet" type="text/css" href="styles.css">
6     <script type="text/javascript" src="website.js"></script>
7   </head>
8   <body>
9     <div>Let's pretend this is all of google</div>
10  </body>
11 </html>
```



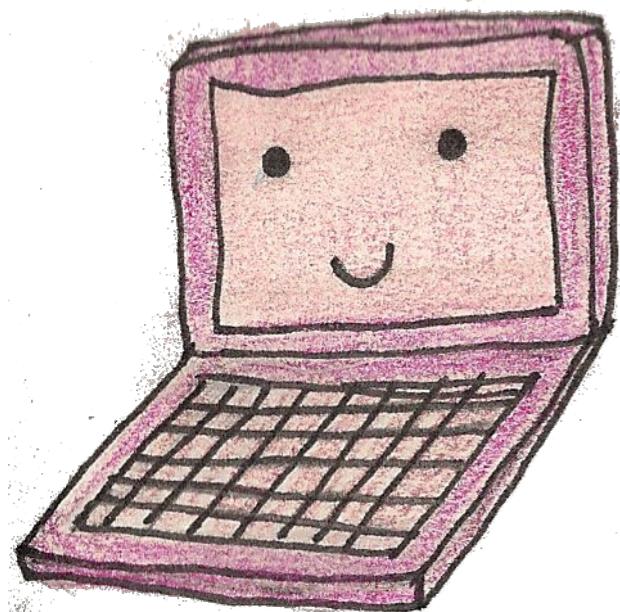
Are you listening? (Whoa-oh-oh)  
Please come back. (Whoa-oh-oh)  
I'll tell you what I need  
♪ ♪ ♪

# HTML Parsing

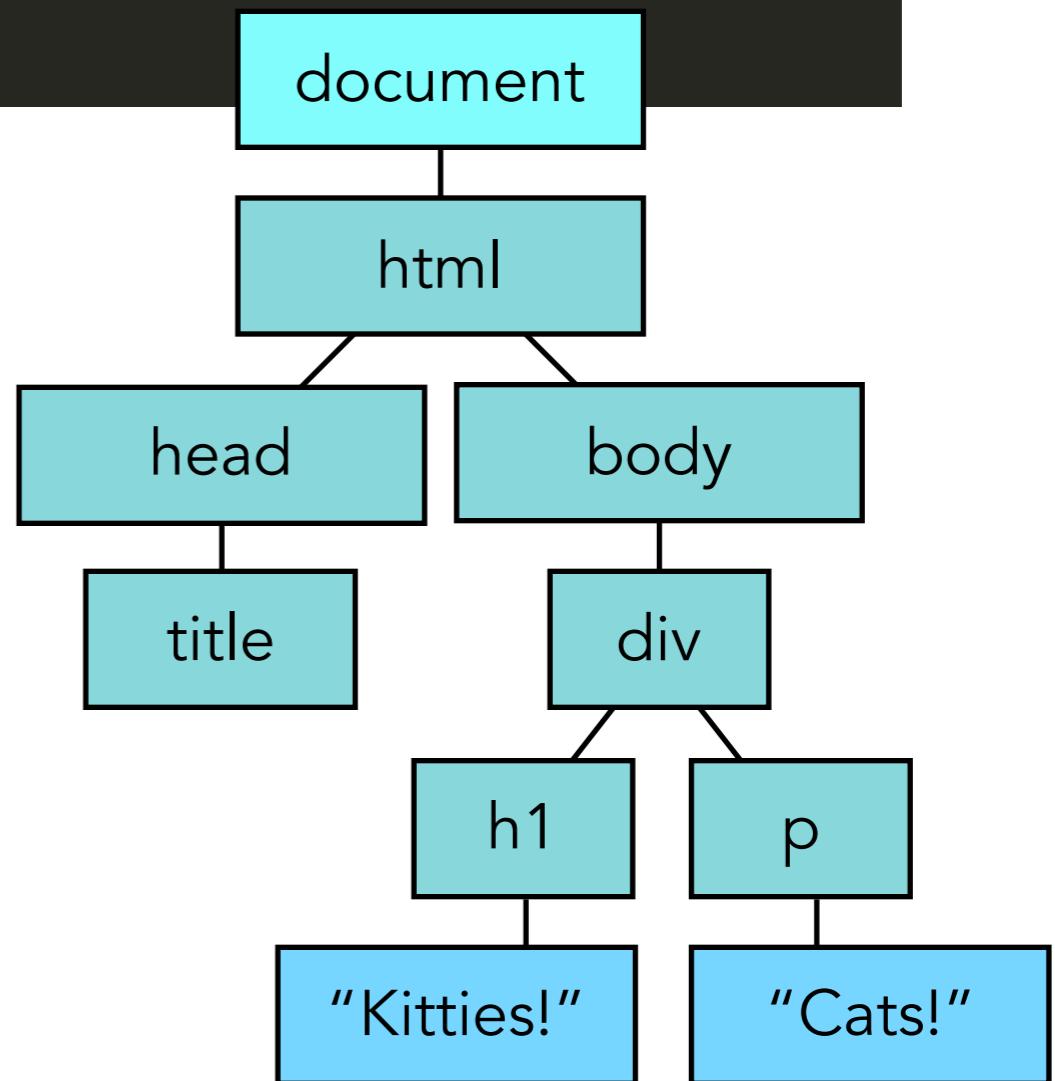
```
1 <!doctype html>
2 <html>
3   <head>
4     <script type="text/javascript" src="library.js"></script>
5     <link rel="stylesheet" type="text/css" href="styles.css">
6     <script type="text/javascript" src="website.js"></script>
7   </head>
8   <body>
9     <div>Let's pretend this is all of google</div>
10   </body>
11 </html>
```



# HTML Parsing

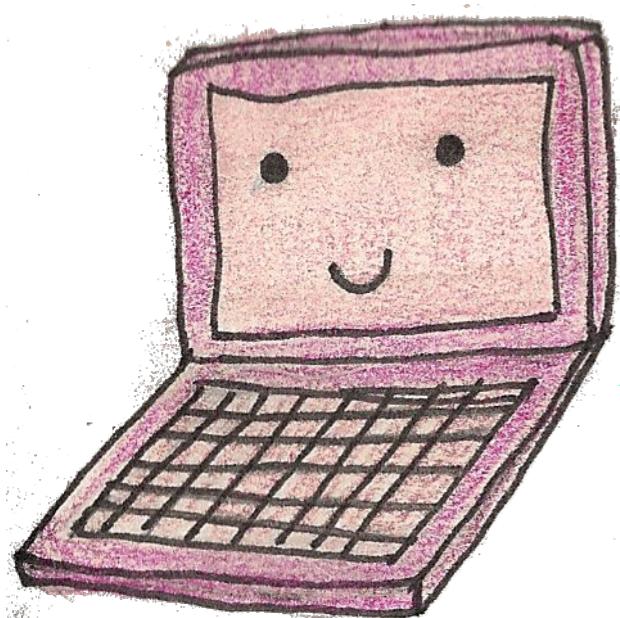


```
1 <!doctype html>
2 <html>
3   <head>
4     <script type="text/javascript" src="library.js"></script>
5     <link rel="stylesheet" type="text/css" href="styles.css">
6     <script type="text/javascript" src="website.js"></script>
7   </head>
8   <body>
9     <div>Let's pretend this is all of google</div>
10  </body>
11 </html>
```



# HTML Parsing

```
1 <!doctype html>
2 <html>
3   <head>
4     <script type="text/javascript" src="library.js"></script>
5     <link rel="stylesheet" type="text/css" href="styles.css">
6     <script type="text/javascript" src="website.js"></script>
7   </head>
8   <body>
9     <div>Let's pretend this is all of google</div>
10   </body>
11 </html>
```

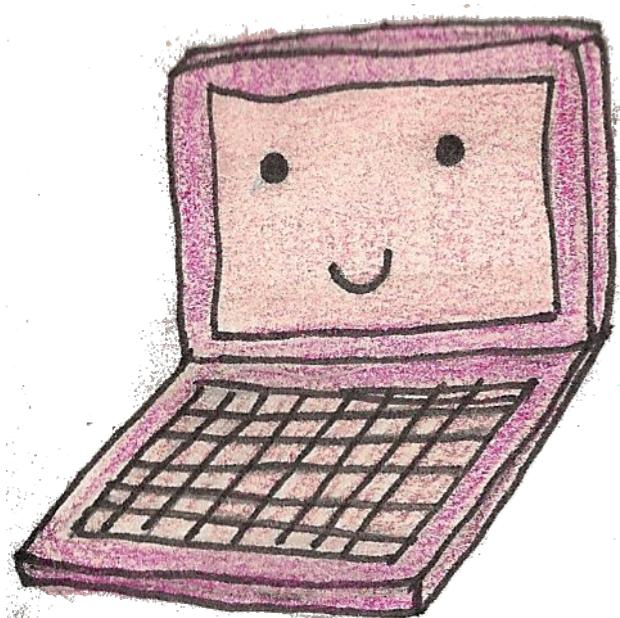


Whatever, wherever  
I'm gonna make it render!



# HTML Parsing

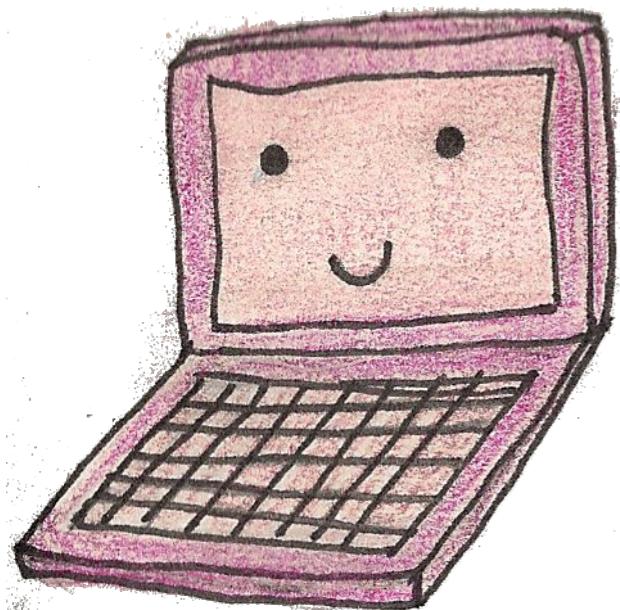
```
1 <!doctype html>
2 <html>
3   <head>
4     <script type="text/javascript" src="library.js"></script>
5     <link rel="stylesheet" type="text/css" href="styles.css">
6     <script type="text/javascript" src="website.js"></script>
7   </head>
8   <body>
9     <div>Let's pretend this is all of google</div>
10  </body>
11 </html>
```



Whatever, wherever  
I'm gonna make it render!



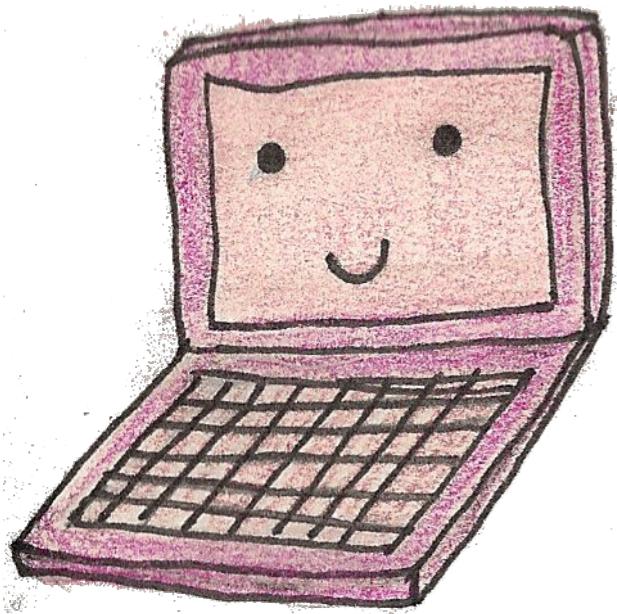
# HTML Parsing



Assets come quickly,  
The execution of all things

♪ ♪ ♪

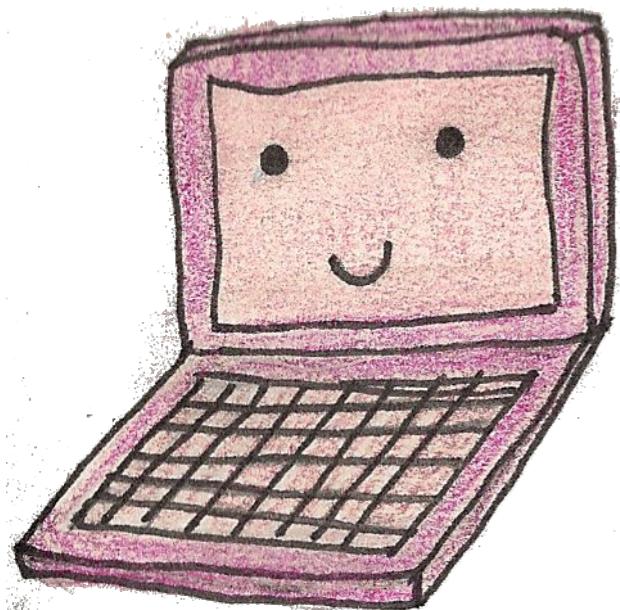
# HTML Parsing



Stop, JavaScript time!  
♪ ♪ ♪

```
<head>
  <script src="library.js"></script>
  <link href="styles.css">
  <script src="website.js"></script>
</head>
<body></body>
```

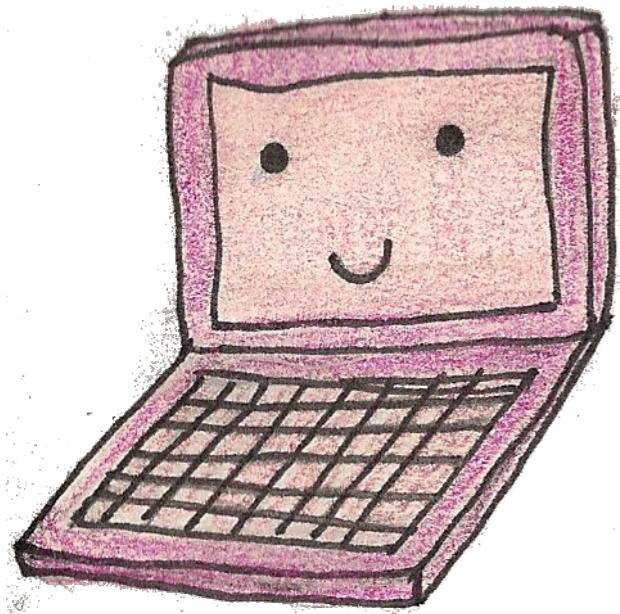
# HTML Parsing



I'm not going to  
wait for you...

```
<head>
  <script defer src="library.js"></script>
  <link href="styles.css">
  <script src="website.js"></script>
</head>
<body></body>
```

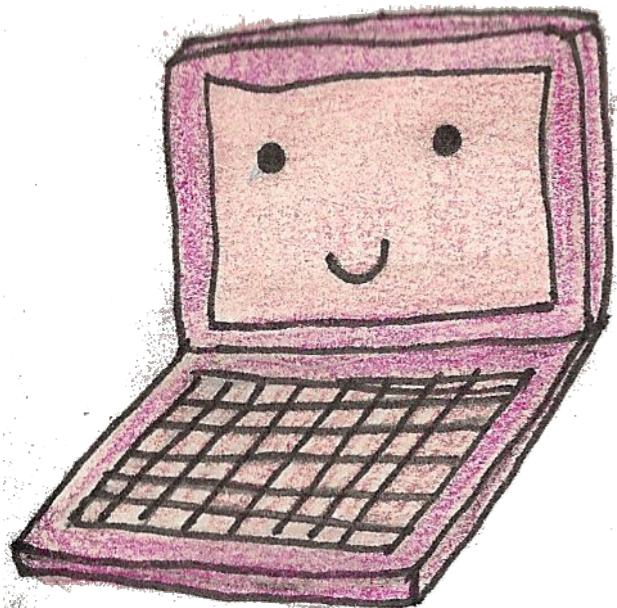
# HTML Parsing



Still not going to  
wait for you...

```
<head>
  <script async src="library.js"></script>
  <link href="styles.css">
  <script src="website.js"></script>
</head>
<body></body>
```

# HTML Parsing

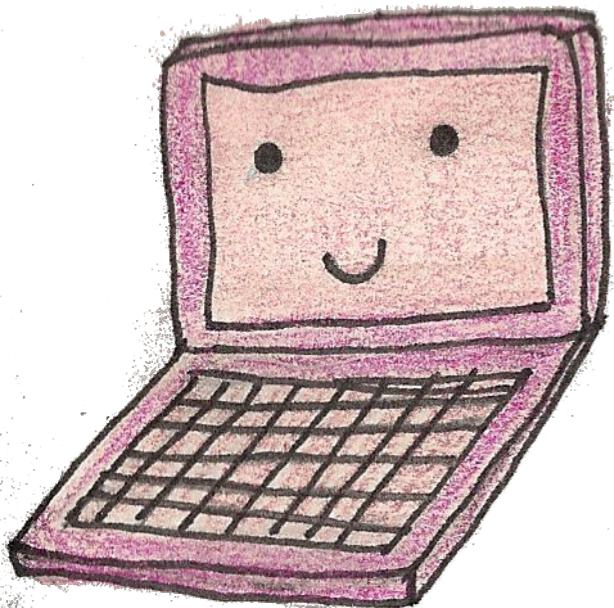


Just doing that  
browser thing...

```
<head>
  <script src="library.js"></script>
  <link href="styles.css">
  <script src="website.js"></script>
</head>
<body></body>
```

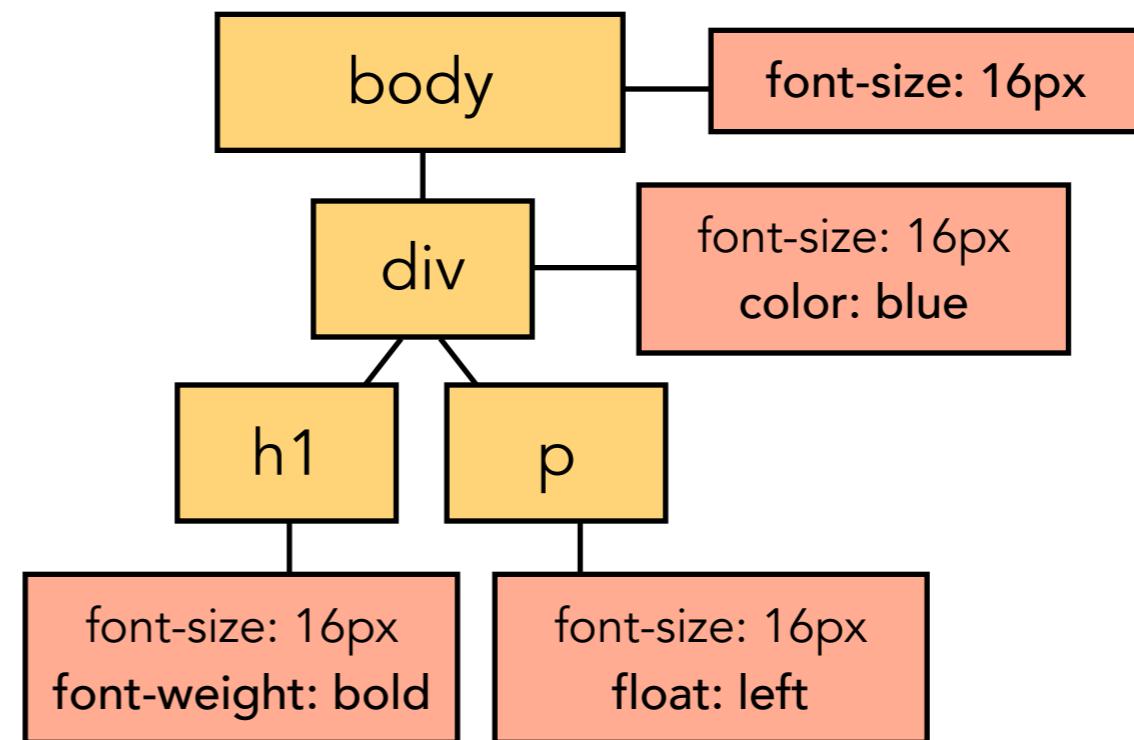
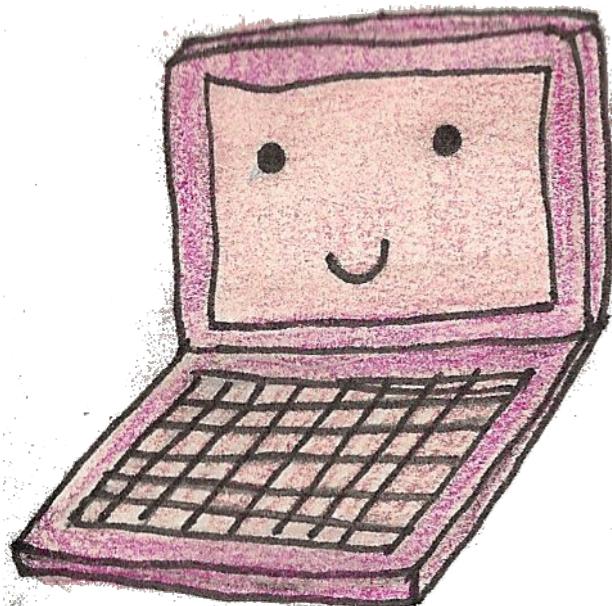
# CSS Parsing

Just doing that  
browser thing...

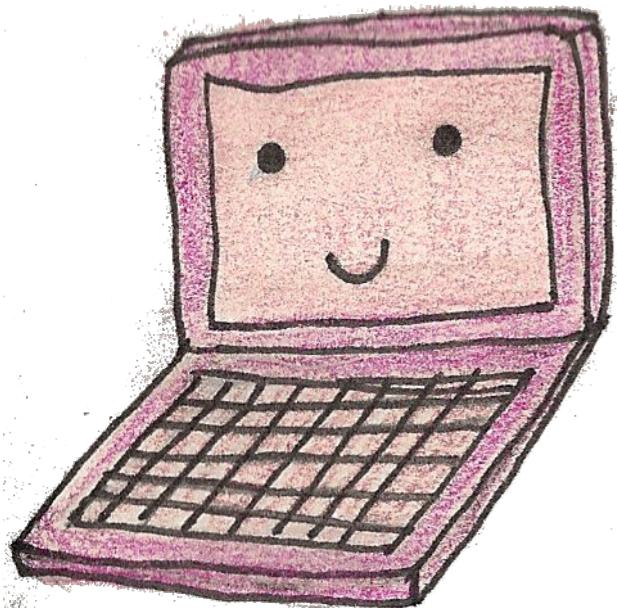


# CSS Parsing

'Cause we know how to style  
We know how to style  
♪ ♪ ♪



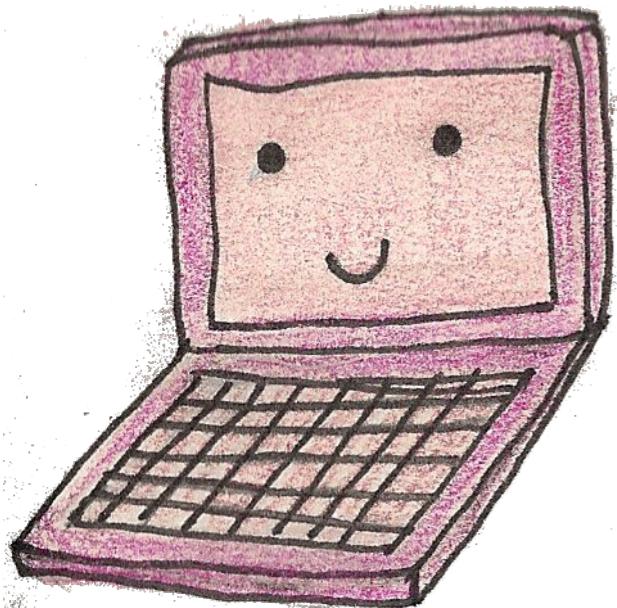
# HTML Parsing



Just doing that  
browser thing...

```
<head>
  <script src="library.js"></script>
  <link href="styles.css"> ✓
  <script src="website.js"></script>
</head>
<body></body>
```

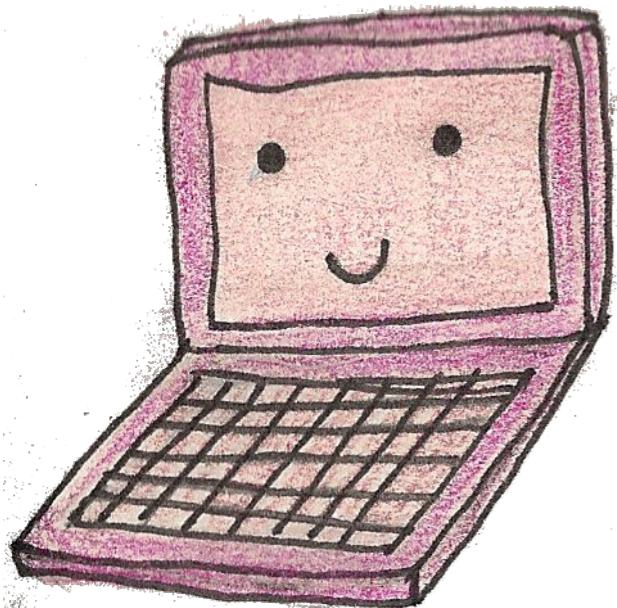
# HTML Parsing



Just doing that  
browser thing...

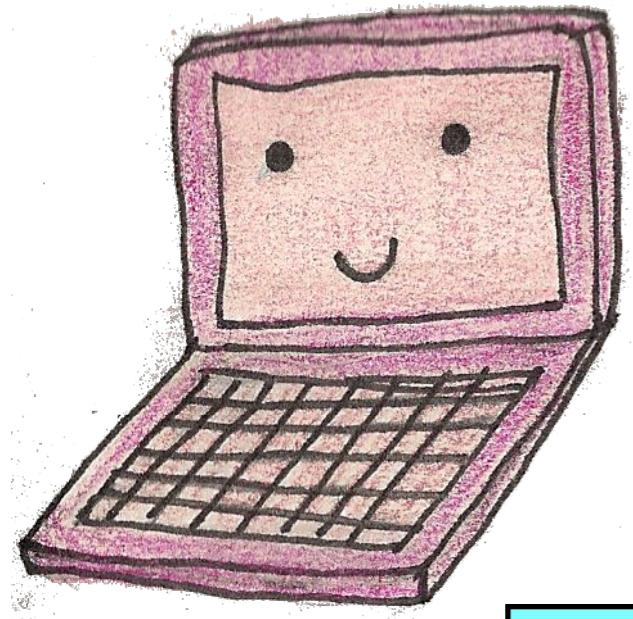
```
<head>
  <script src="library.js"></script> ✓
  <link href="styles.css"> ✓
  <script src="website.js"></script>
</head>
<body></body>
```

# HTML Parsing

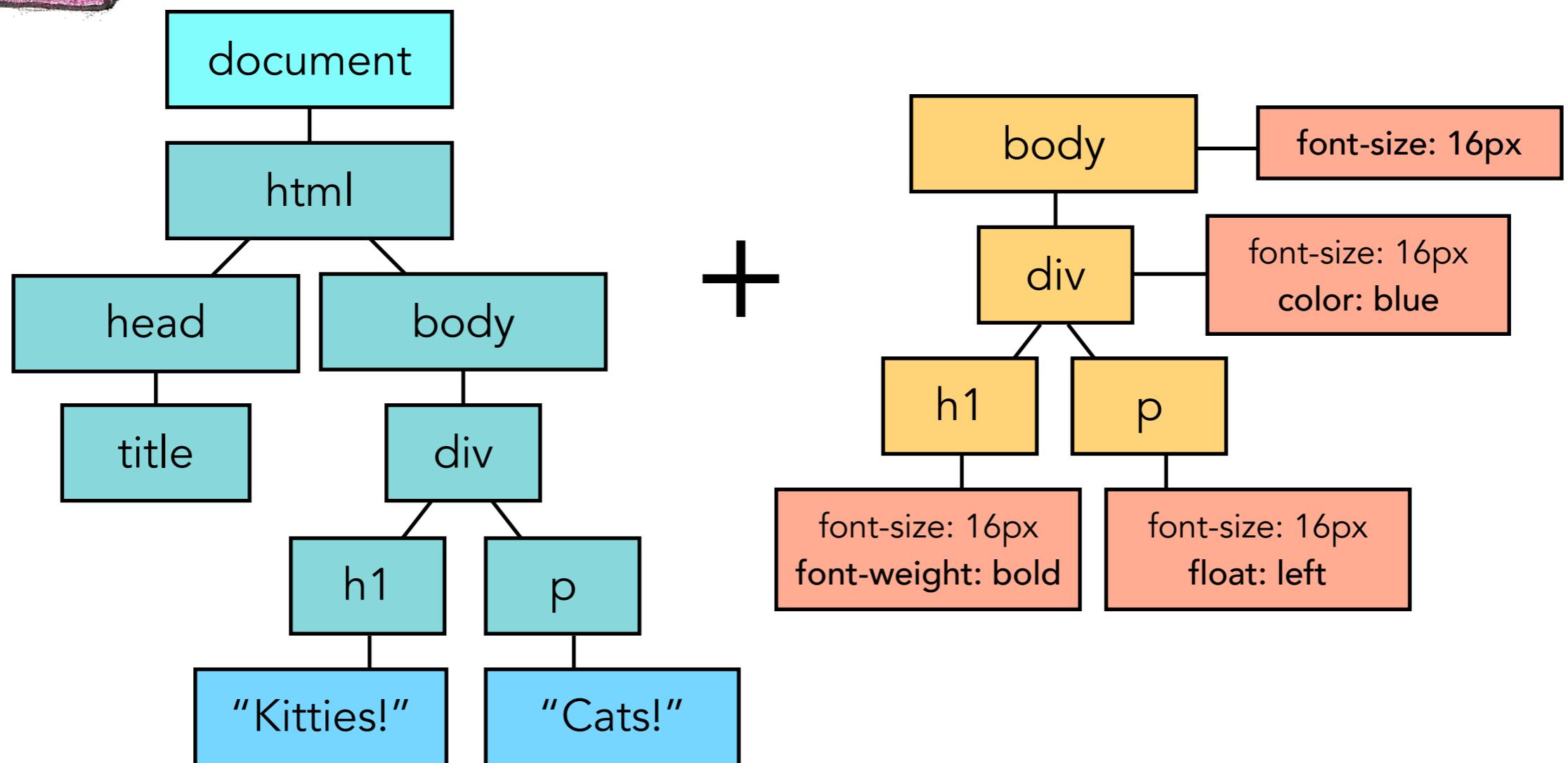


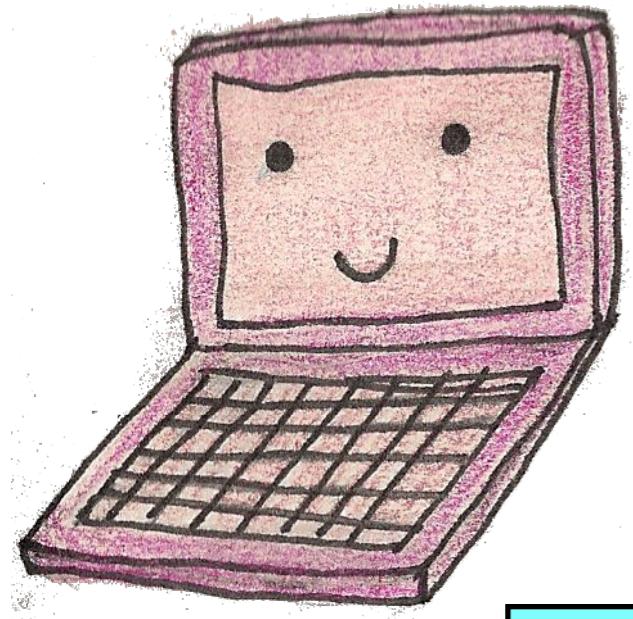
Just doing that  
browser thing...

```
<head>
  <script src="library.js"></script> ✓
  <link href="styles.css"> ✓
  <script src="website.js"></script> ✓
</head>
<body></body>
```

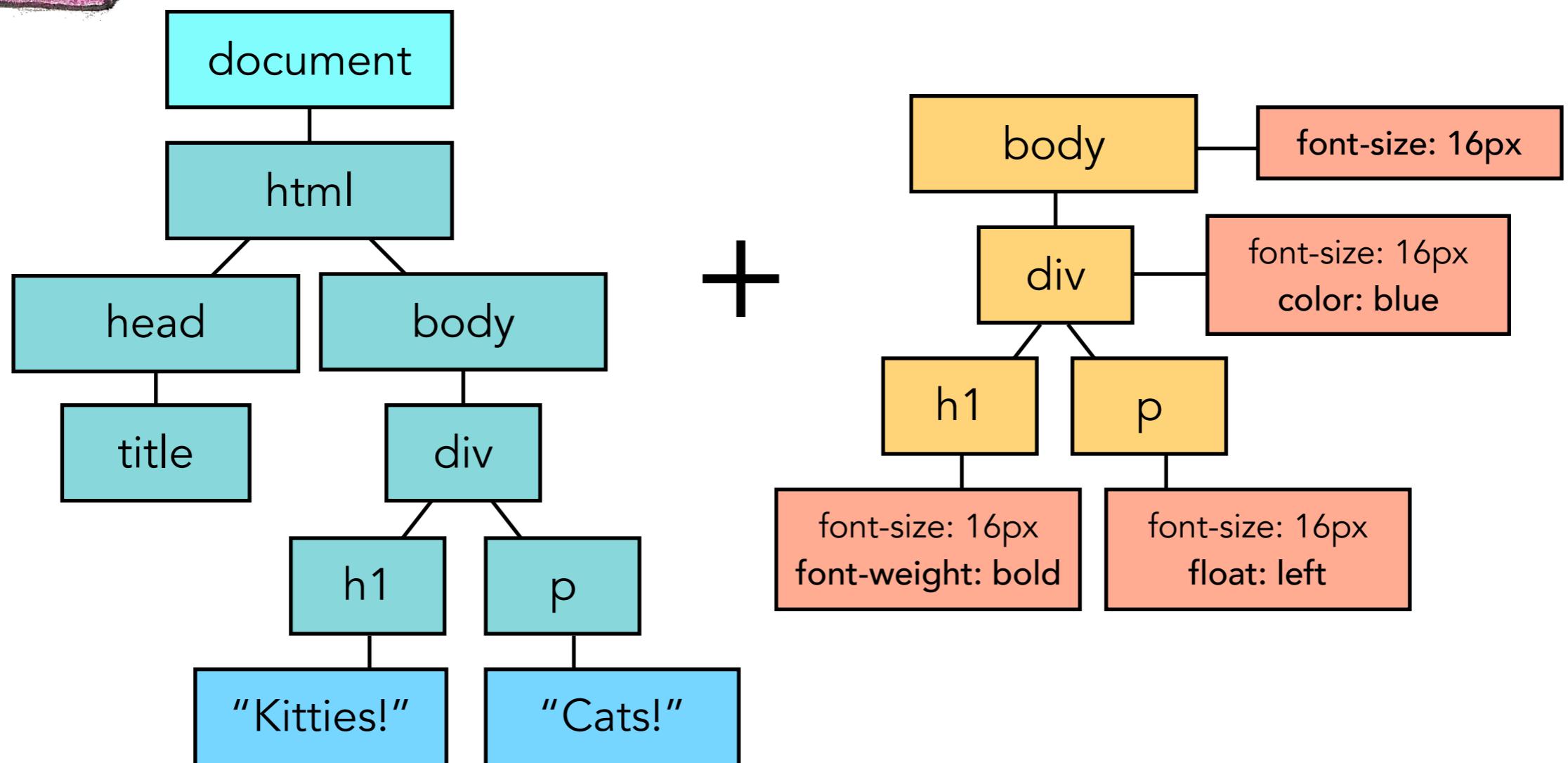


# Rendering

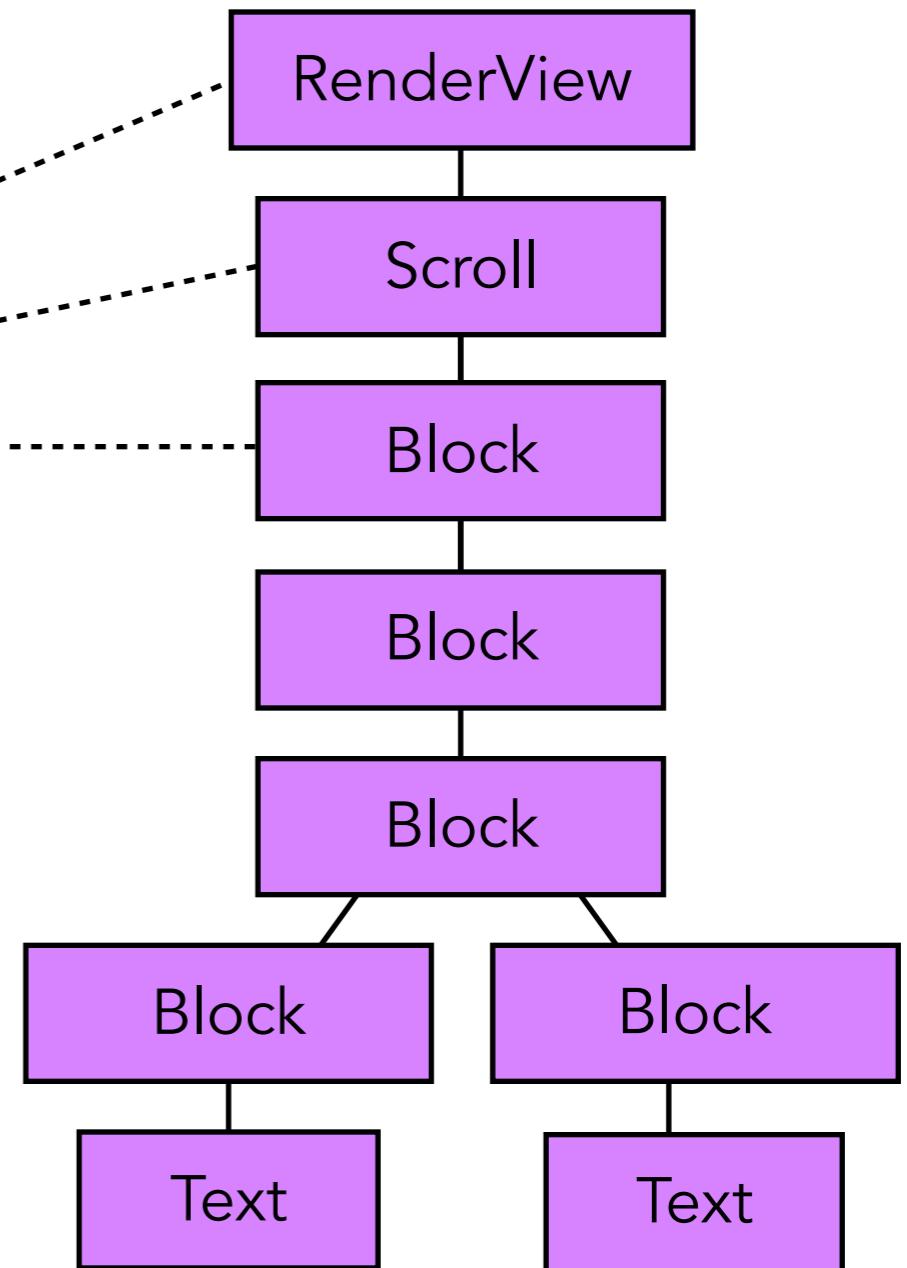
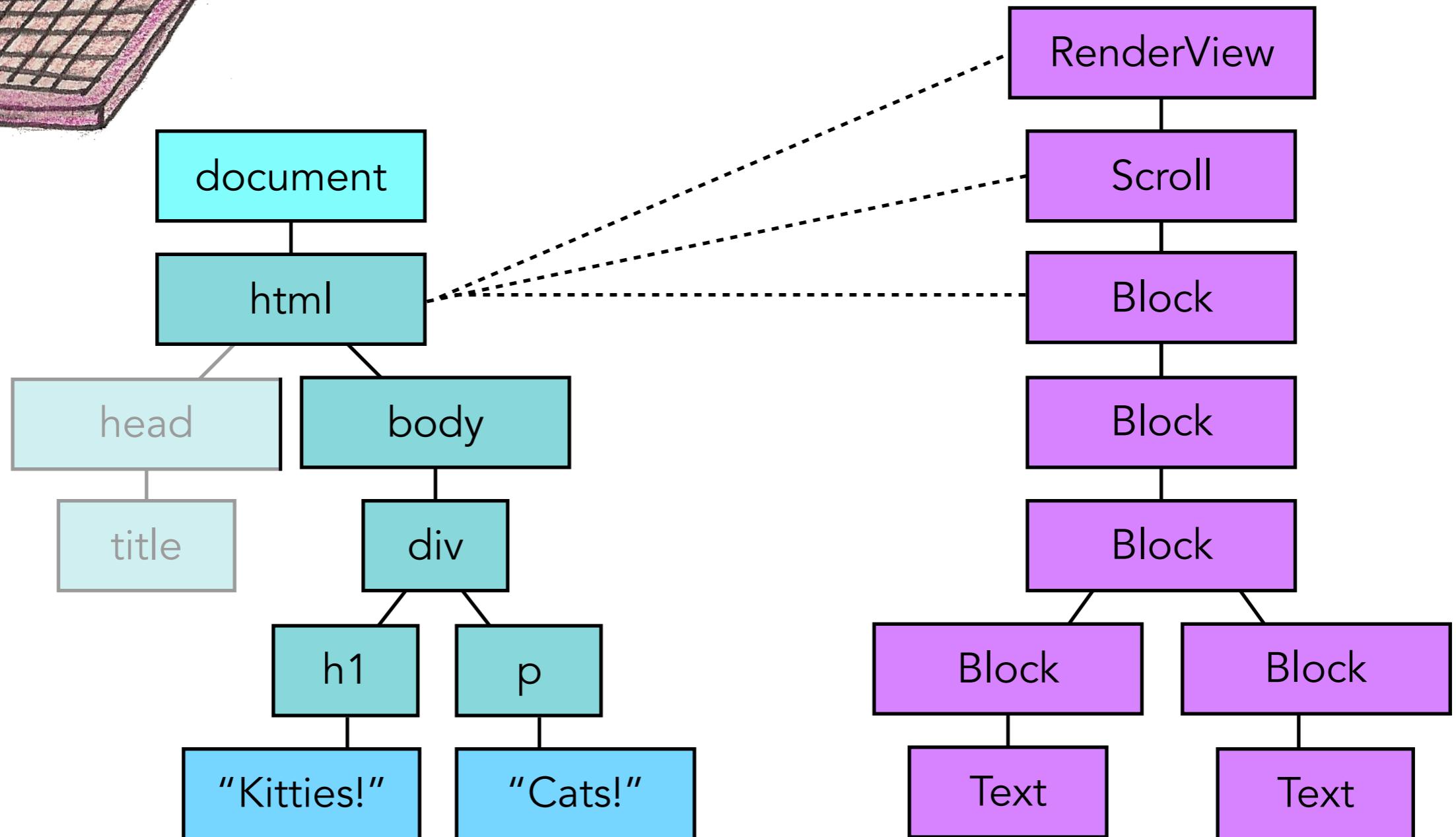
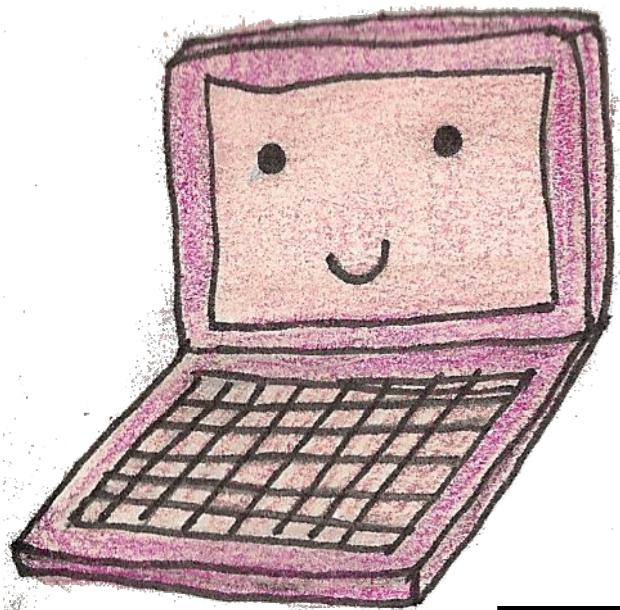




# Rendering

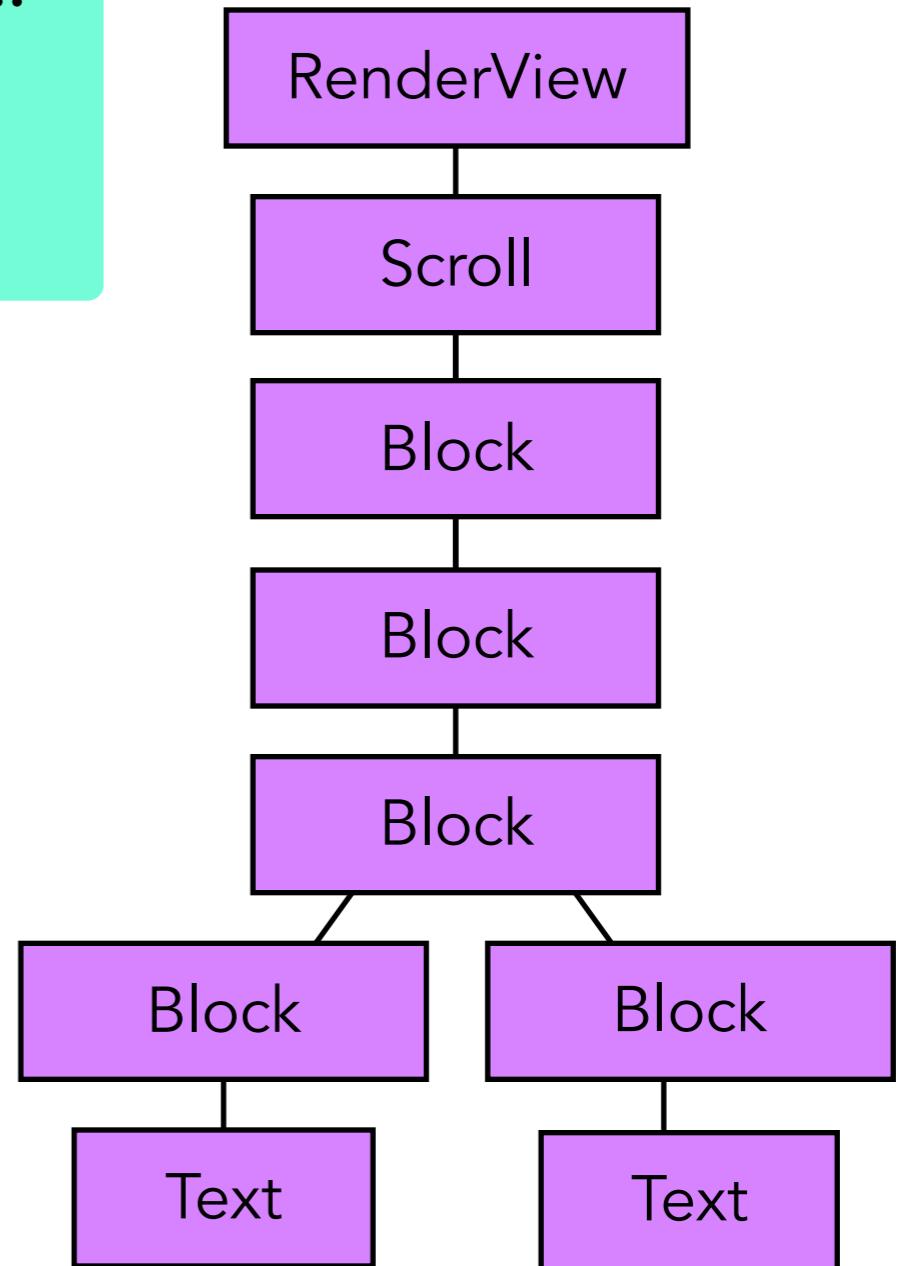
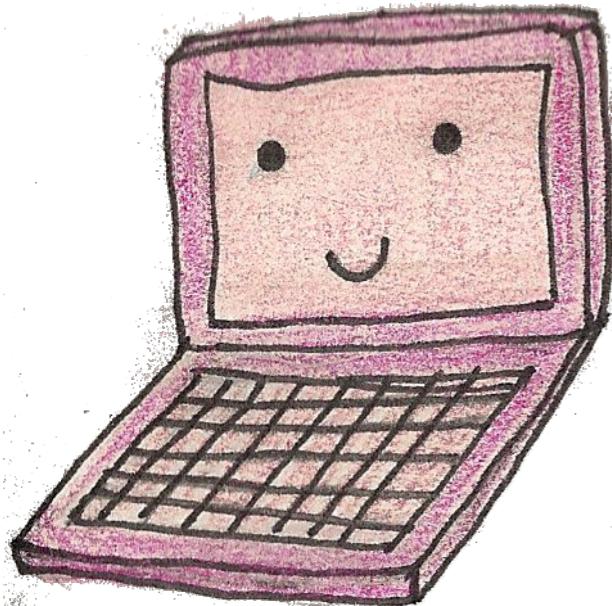


# Rendering



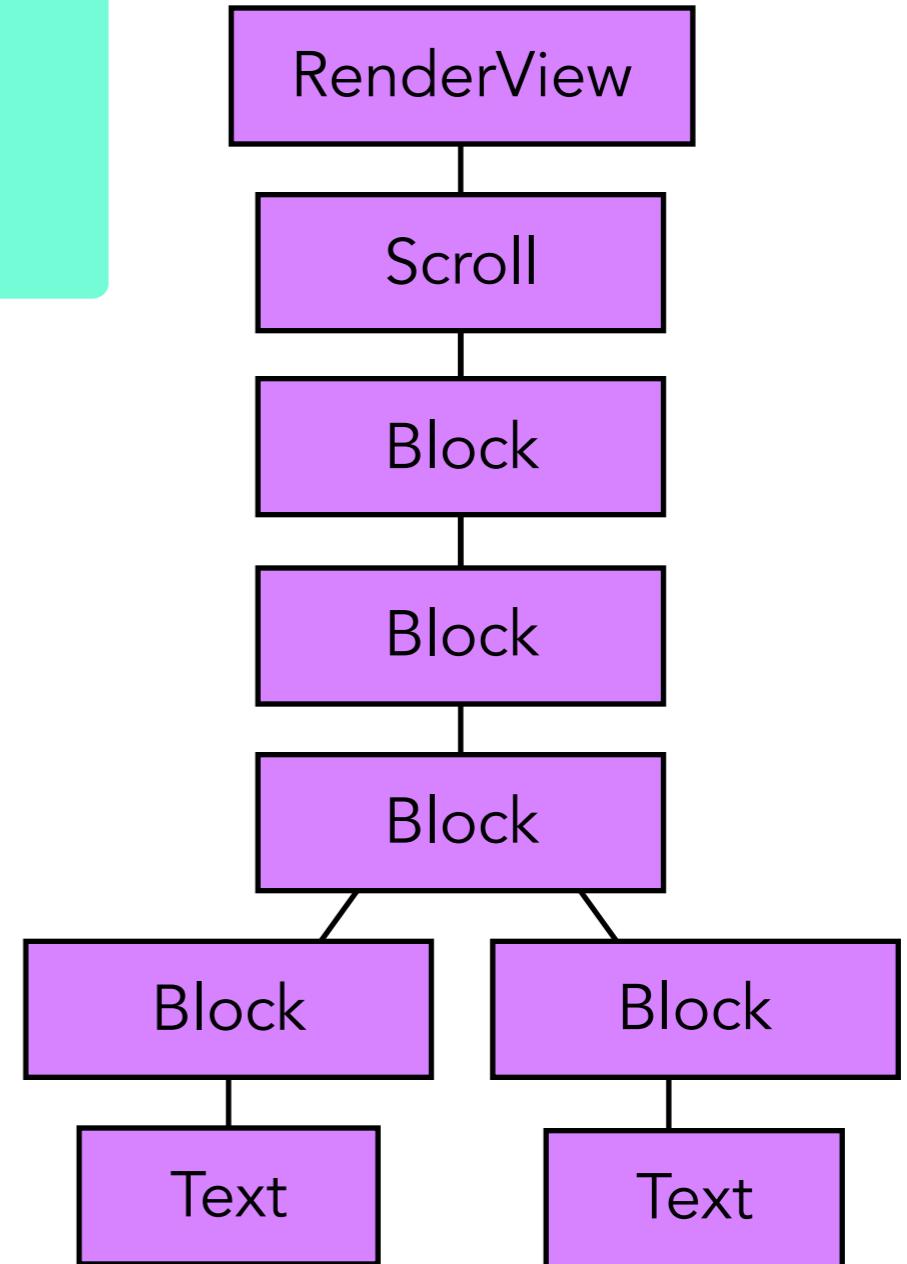
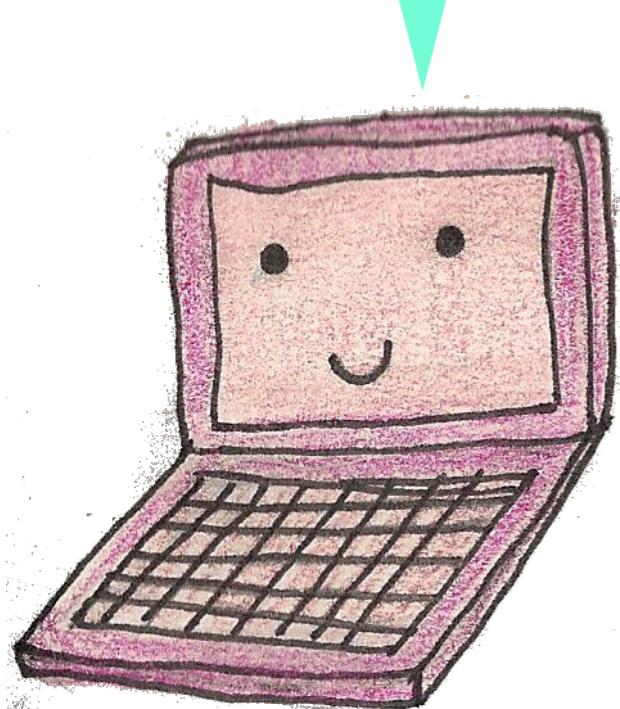
# Rendering

Cause the render's gonna...  
rend, rend, rend?



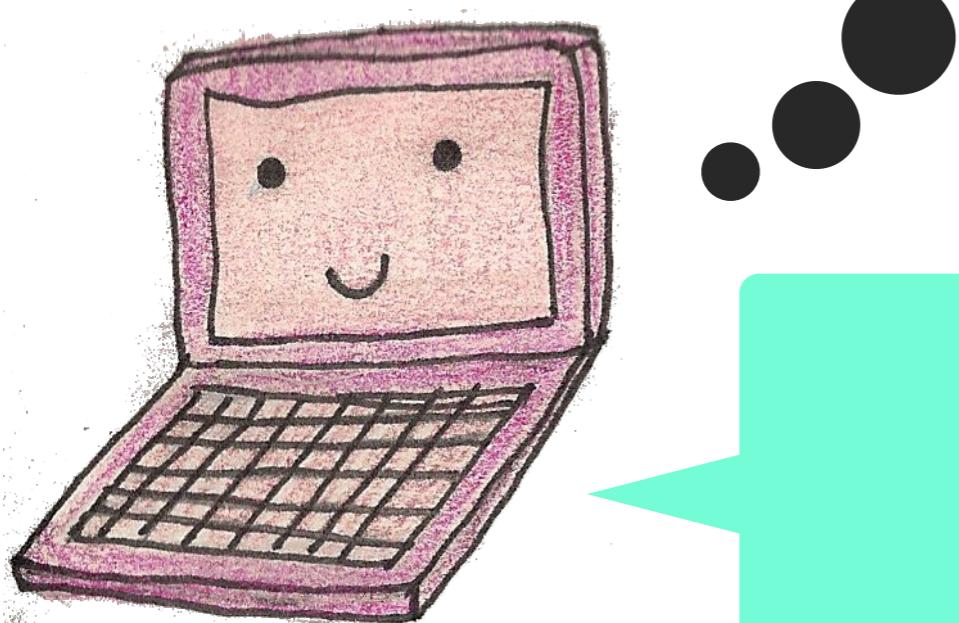
# Rendering

And the painter's gonna  
paint, paint, paint...



# HTML Parsing

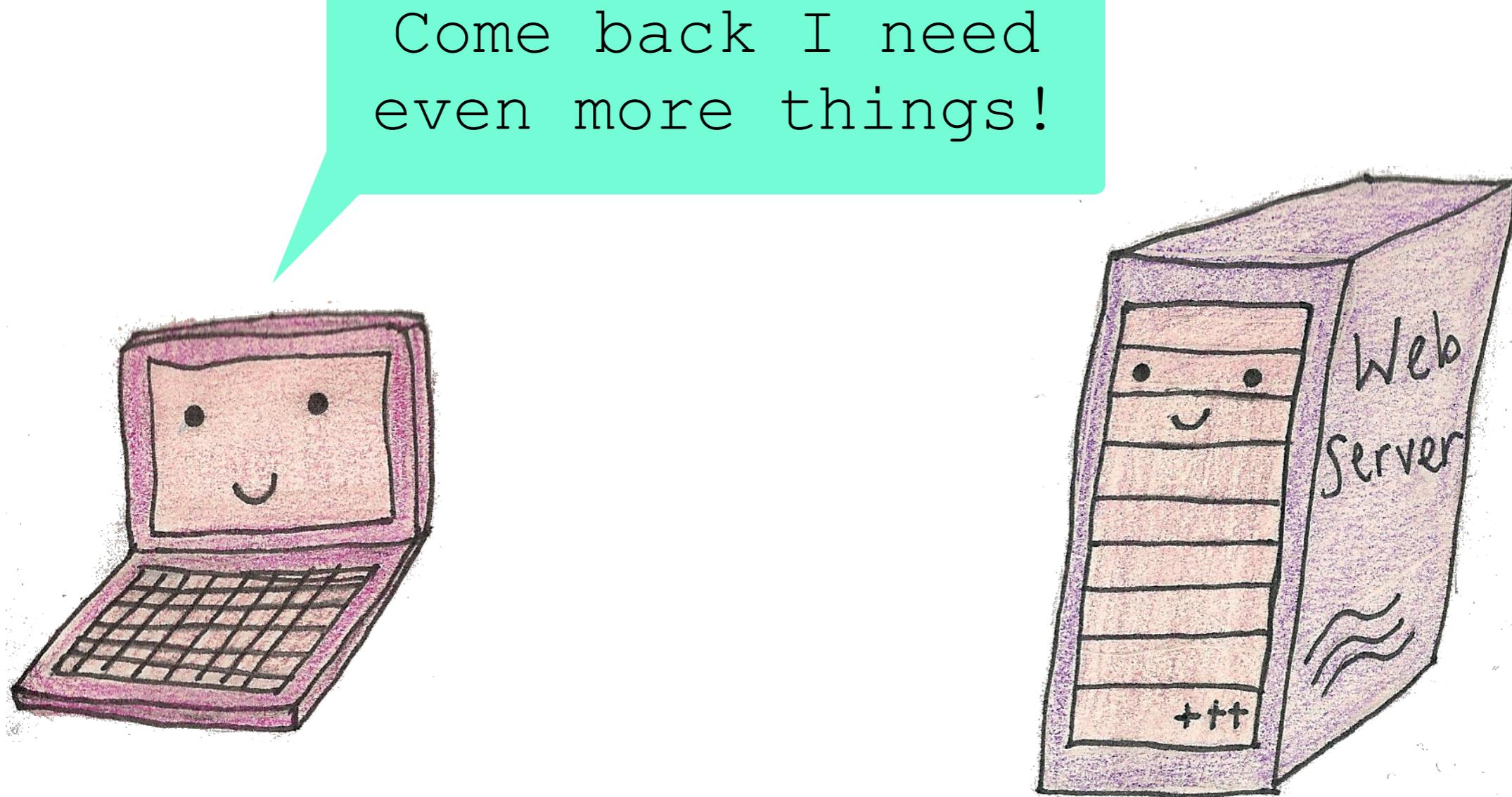
```
1 <!doctype html>
2 <html>
3   <head>
4     <script type="text/javascript" src="library.js"></script>
5     <link rel="stylesheet" type="text/css" href="styles.css">
6     <script type="text/javascript" src="website.js"></script>
7   </head>
8   <body>
9     <div>Let's pretend this is all of google</div>
10   </body>
11 </html>
```



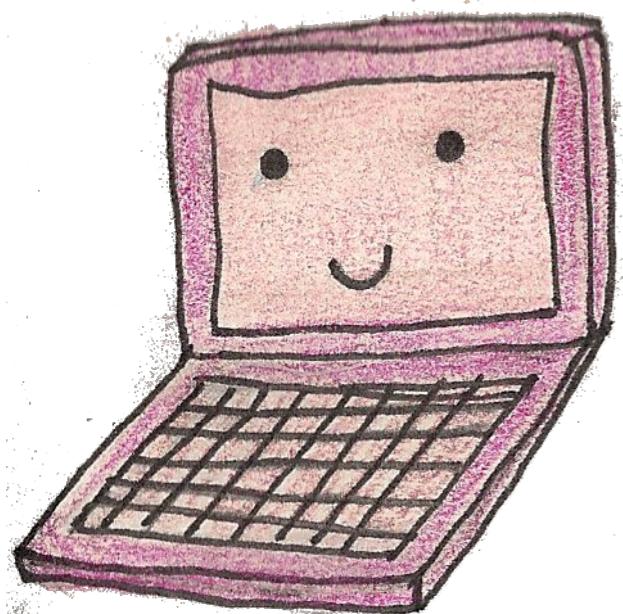
Whoa, oh, oh, oh, oh  
Whoa, oh, oh, oh,  
The DOM's interactive  
DOM's interactive



# HTML Parsing



# HTML Parsing



In your eyes  
The light, the heat  
In your eyes  
The DOM's complete

♪ ♪ ♪

# Overview

1. IP Address Lookup
2. Opening a socket
3. Security Stuff
4. HTTP Request
5. Server Things
6. HTTP Response
7. Parsing
8. Rendering

# Resources

## General

- [What Happens When \(Github\)](#)

## Transport

- [DNS \(Wikipedia\)](#)
- [UDP \(Wikipedia\)](#)
- [TCP \(Wikipedia\)](#)
- [TLS \(Wikipedia\)](#)

## Parsing, Rendering, and Painting

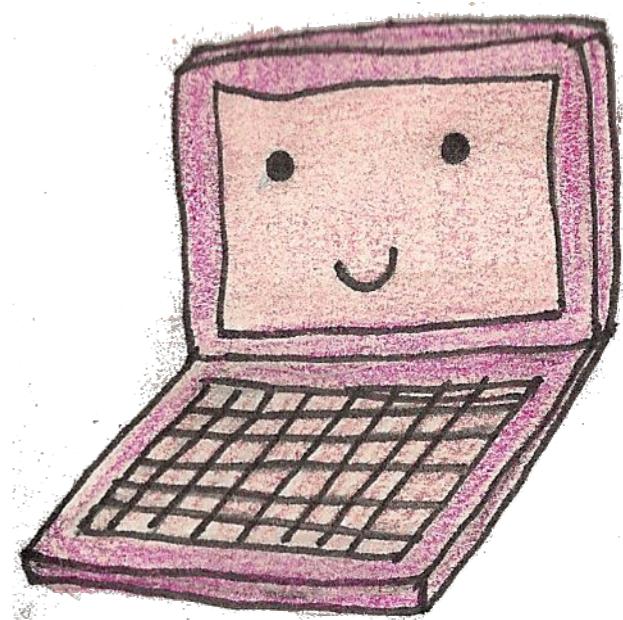
- [How Browsers Work \(HTML5 Rocks\)](#)
- [Critical Rendering Path \(Google Developers\)](#)

## Performance

- [Best Practices for Speeding Up Your Web Site \(Yahoo Developer Network\)](#)
- [Raul Fraile: How GZIP compression works \(JSConfEU 2014\)](#)

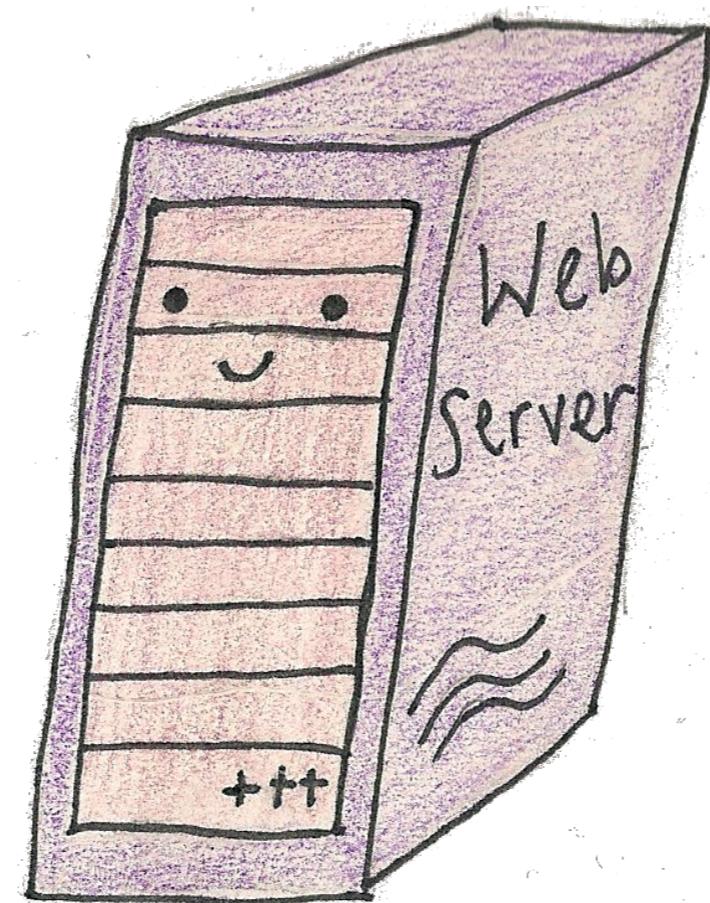
## HTTP/2

- [Andy Davies: The Case for HTTP/2 \(TXJS 2015\)](#)



jenna.is/manhattanjs-jan16

jenna.is/server-farm-to-table-annotated



# Complete Tracklist

The Beatles - You Know My Name (Look Up The Number)

Carly Rae Jepsen - Call Me Maybe

Radiohead - Creep

Taylor Swift - Blank Space

Taylor Swift - We Are Never Ever Getting Back Together

Taylor Swift - Wildest Dreams

Capital Cities - Safe and Sound

Imagine Dragons - Demons

Young Chris – Racks

Beastie Boys - So What'cha Want

Gotye - Somebody That I Used To Know

The Temptations - My Girl

Calvin Harris ft. Ellie Goulding - Outside

Jimmy Eat World - Sweetness

Rilo Kiley - The Execution of All Things

Shakira - Whenever, Wherever

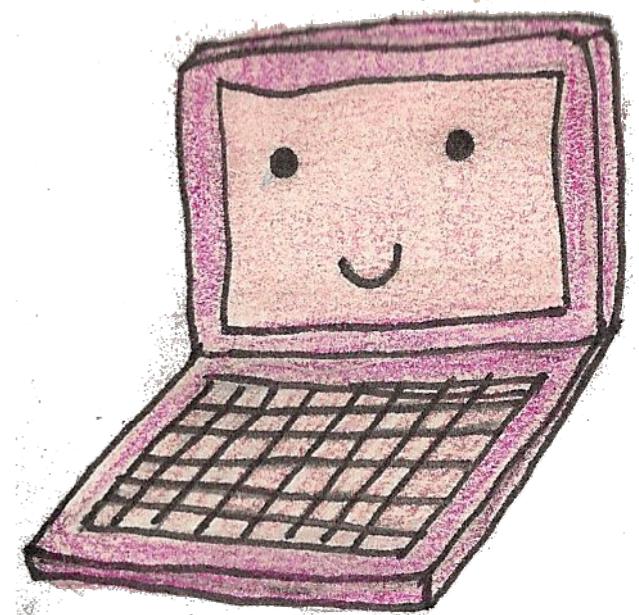
MC Hammer - U Can't Touch This

Taylor Swift - Style

Taylor Swift - Shake It Off

Imagine Dragons - Radioactive

Peter Gabriel - In Your Eyes



# Complete Tracklist

The Beatles - You Know My Name (Look Up The Number)

Carly Rae Jepsen - Call Me Maybe

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Taylor Swift - Blank Space

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Taylor Swift - Wildest Dreams

Capital Cities - Safe and Sound

Imagine Dragons - Demons

Young Chris – Racks

Beastie Boys - So What'cha Want

Gotye - Somebody That I Used To Know

The Temptations - My Girl

Calvin Harris ft. Ellie Goulding - Outside

Jimmy Eat World - Sweetness

Rilo Kiley - The Execution of All Things

Shakira - Whenever, Wherever

MC Hammer - U Can't Touch This

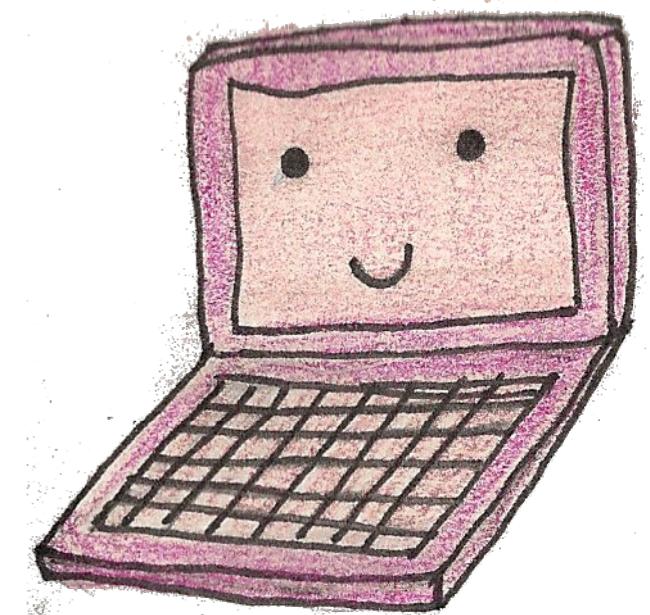
Taylor Swift - Style

Taylor Swift - Shake It Off

Imagine Dragons - Radioactive

Peter Gabriel - In Your Eyes

\*something  
witty about a  
POP server...\*



# Thanks!

