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DATA VISUALIZATION AND VISUAL ANALYTICS

WEB APPLICATIONS ARCHITECTURE

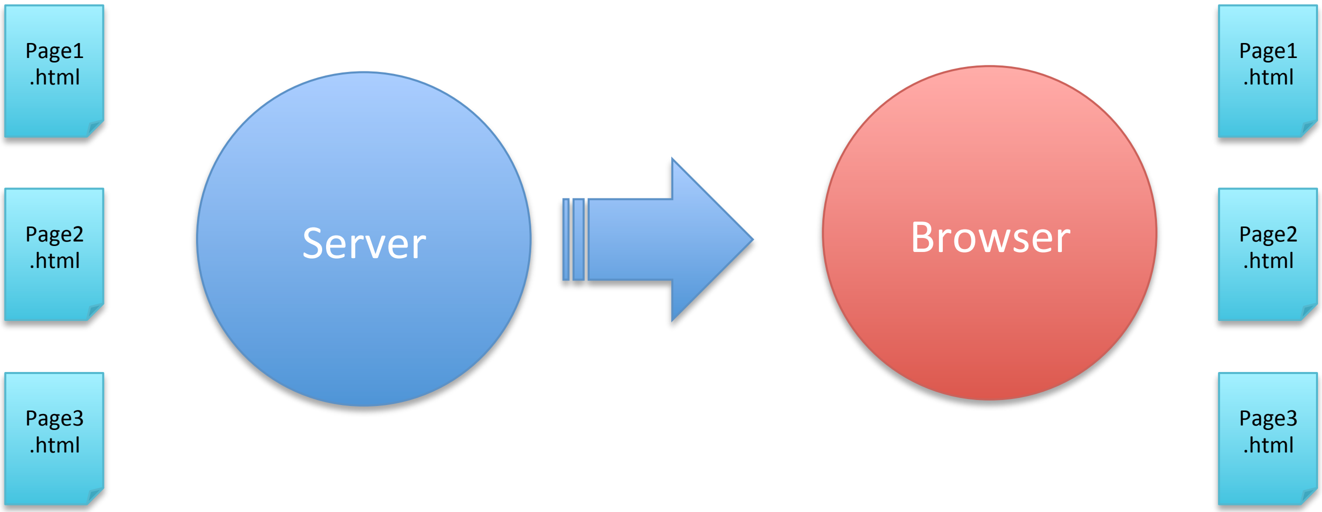
Outline

- Web Application Architecture
- Crash courses on:
  - HTML
  - CSS
  - Javascript
- Web Server
  - Node.js and NPM

WEB APPLICATIONS ARCHITECTURE

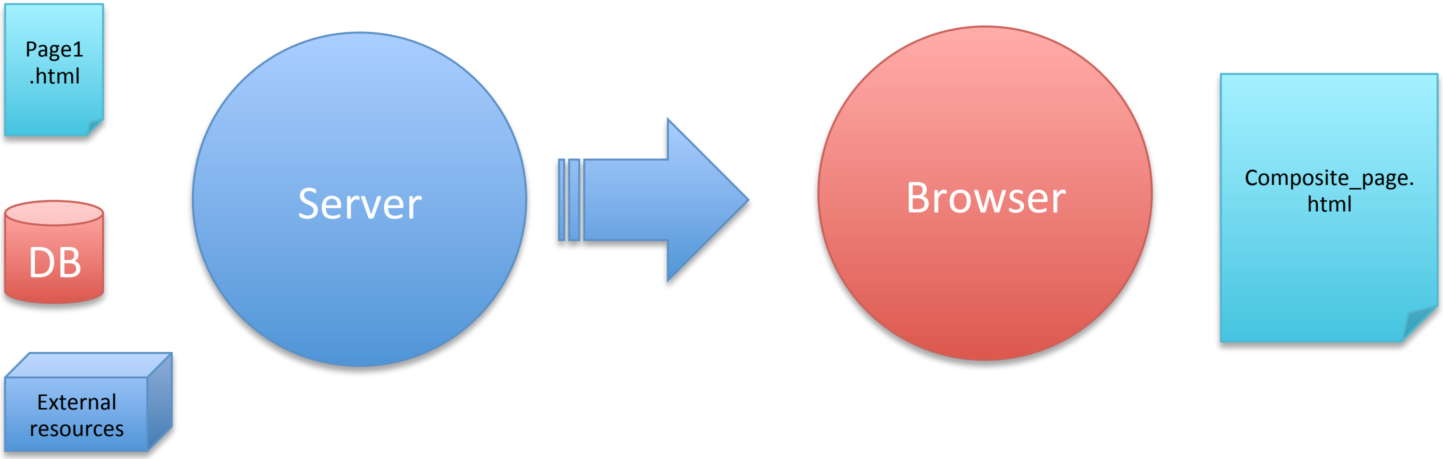
Static Websites

- The content of each page is sent AS IS from the server to the client



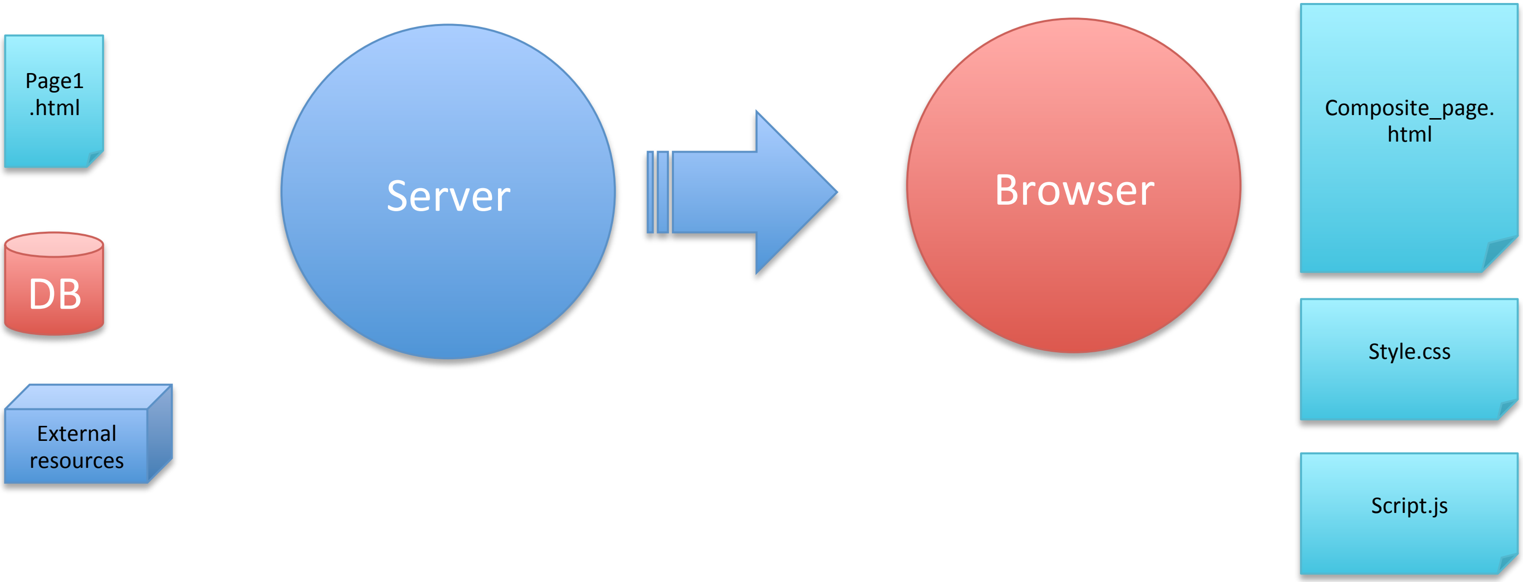
Dynamic website

- Web page content is composed on demand
- Content is stored in different forms: databases, external resources, other static web pages



Server Side vs Client Side

- Client-side coding includes HTML, CSS, and Javascript
- This code is transmitted AS IS and executed in the browser

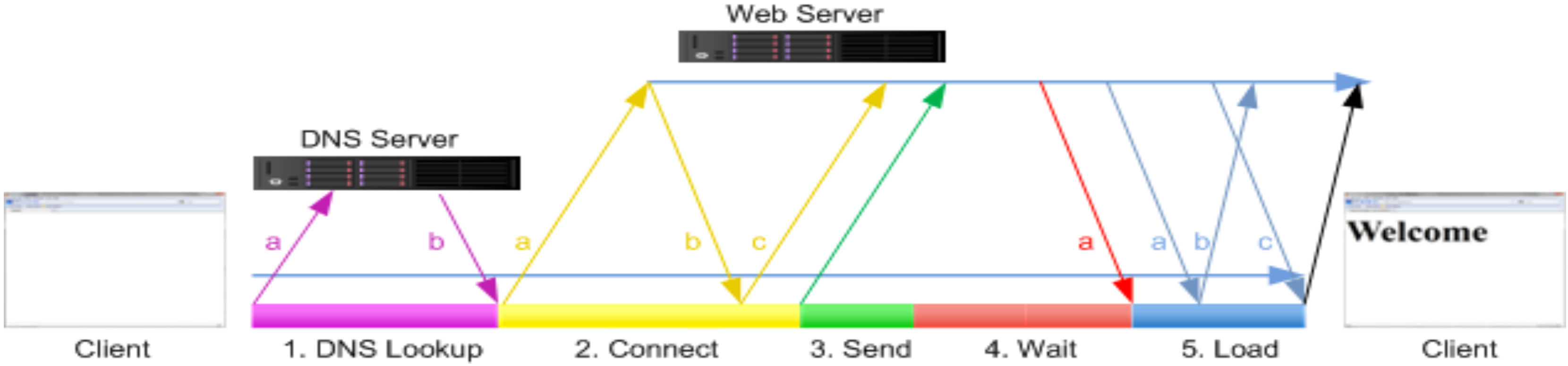


Web Server

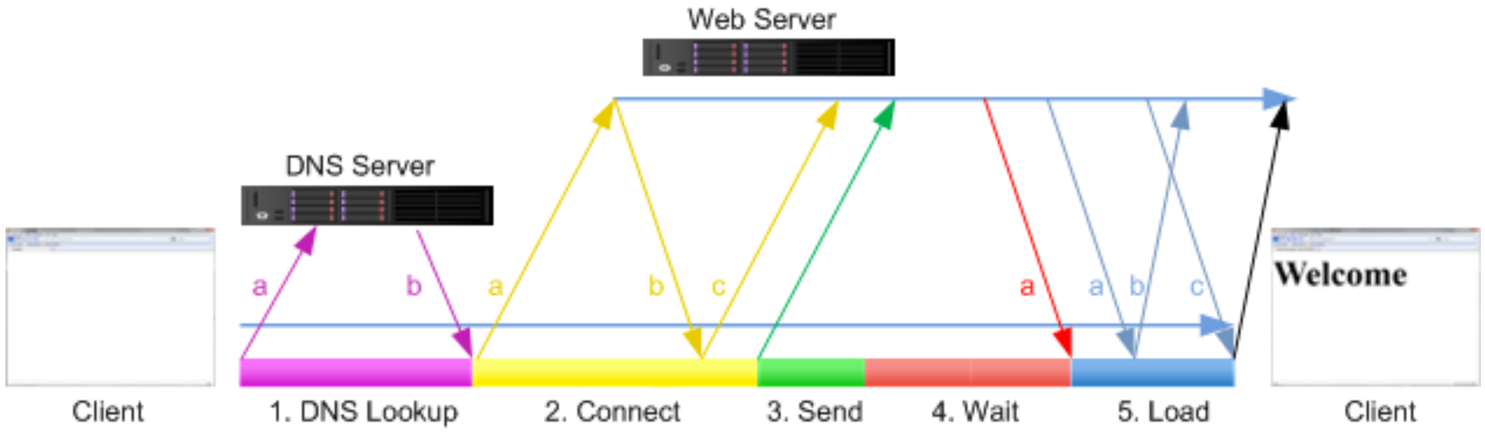
- Implements HTTP protocol
  - The web server handles a folder, called Document Root
  - For security reasons, only the files within the DocRoot are visible for the web server
- A web server is reachable via a URL
- A URL consists of 4 parts:
  - A selector of the protocol (http or https)
  - The domain name of the server (www.nytimes.com)
  - The port number (by default it is 80)
  - A path to localize additional information
  - Ex: http://www.nytimes.com:80/sport/baseball

HTTP

- 3. Send
- HTTP Request
  - Methods to tell server what the client need
- HTTP Methods:
  - GET; POST; PUT; DELETE; OPTIONS;…



HTTP



- 4. Wait and 5. Load
- HTTP Response
  - Read Response Codes
  - Read data

- HTTP Response Codes
  - 1xx – Informational
  - 2xx – Success
  - 3xx – Redirection
  - 4xx – Client Error
  - 5xx – Server Error

Example – Requesting page.html

Client

- GET ‘/page.html’
- … wait …
- Download and parse file
- GET ‘/css/style.css’
- … wait …
- Download and parse file
- GET /page.hhtml
- … wait …
- Page not found error

Web Server

- Search for the file page.html
- Send response 200
- Send the content of file
- Look in folder css for file
- Send response 200
- Send content of file
- Search for file page.hhtml
- Send response 404

HTML, CSS, and Javascript

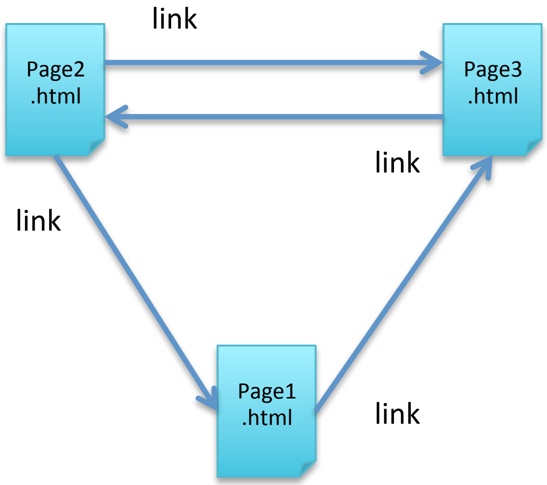
- HTML
- CSS
- Javascript

- Structure
- Presentation
- Behavior

HTML 101

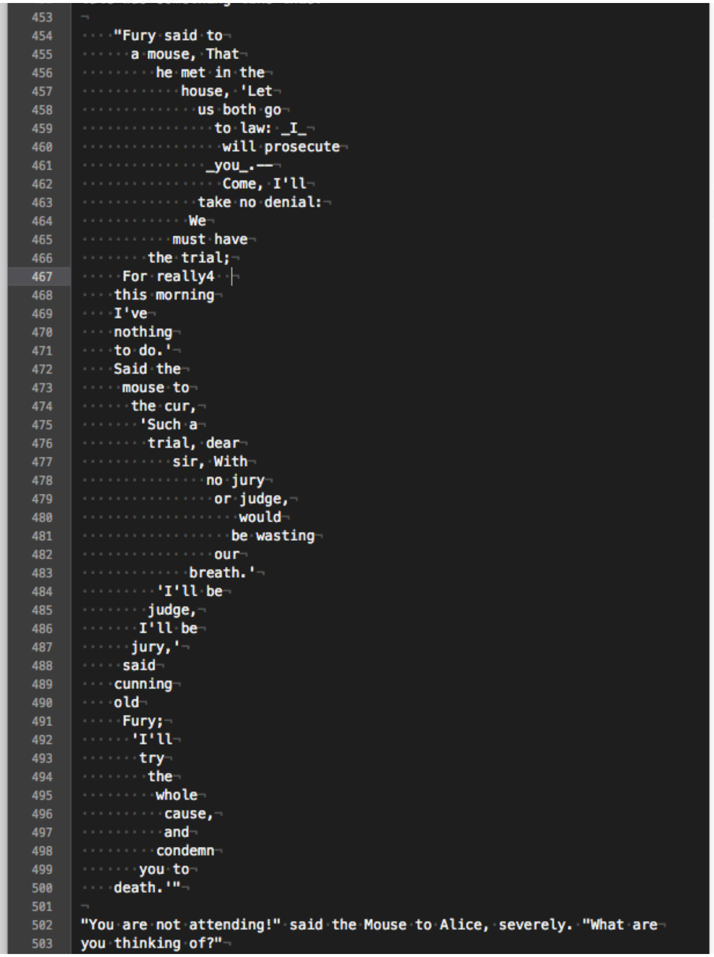
Hyper Text Markup Language (HTML)

- Hyper Text

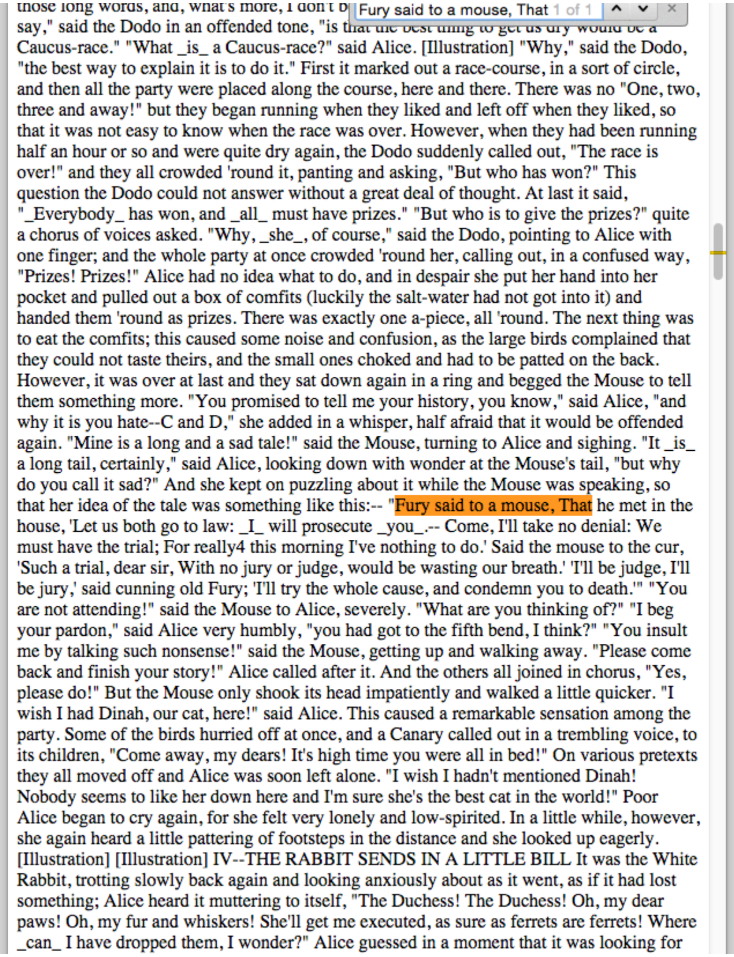


- Markup Language
  - Composed of markup tags
  - Tags group and describe page content

HTML Structure



```

    "Fury said to
      a mouse, That
         he met in the
            house, 'Let
              us both go
                to law: _I_
                 will prosecute
               _you_.—
                 Come, I'll
              take no denial:
             We
           must have
        the trial;
     For really4
    this morning
    I've
    nothing
    to do.'
    Said the
     mouse to
      the cur,
       'Such a
        trial, dear
           sir, With
               no jury
                or judge,
                   would
                  be wasting
                our
             breath.'
         'I'll be
        judge,
       I'll be
      jury,'
     said
    cunning
    old
     Fury;
      'I'll
       try
        the
         whole
          cause,
          and
         condemn
       you to
    death.'"

"You are not attending!" said the Mouse to Alice, severely. "What are
you thinking of?"
```

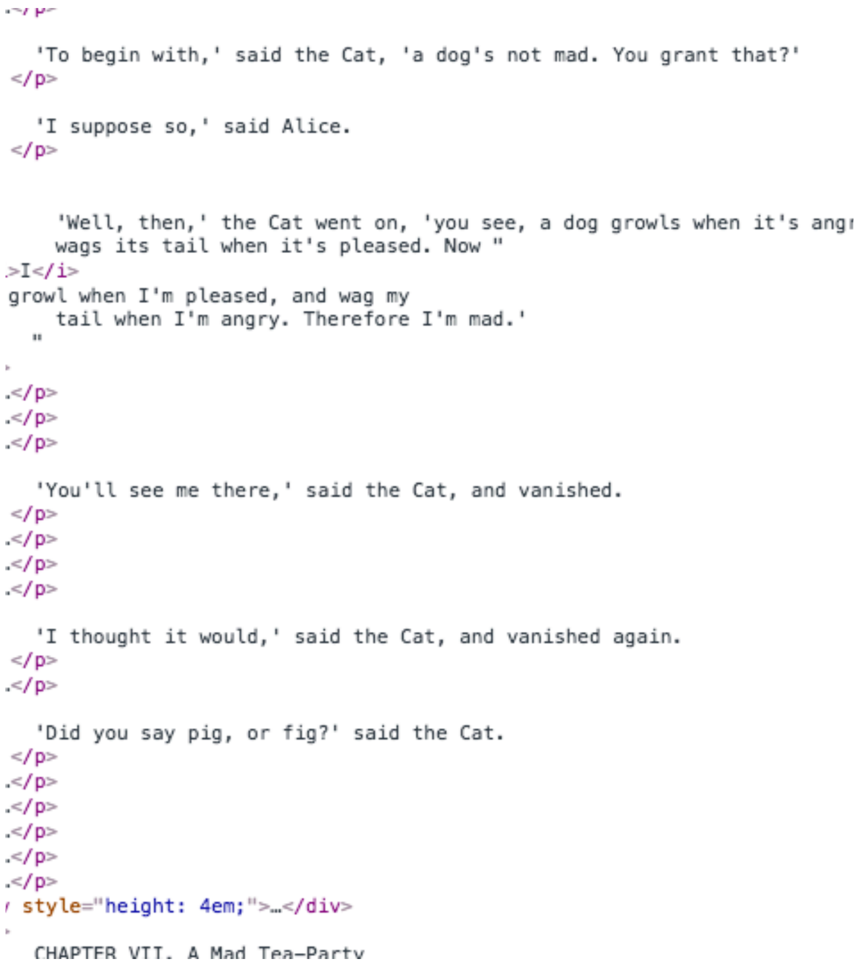


Fury said to a mouse, That 1 of 1

those long words, and, what's more, I don't b say," said the Dodo in an offended tone, "is that the best thing to get us dry would be a Caucus-race." "What _is_ a Caucus-race?" said Alice. [Illustration] "Why," said the Dodo, "the best way to explain it is to do it." First it marked out a race-course, in a sort of circle, and then all the party were placed along the course, here and there. There was no "One, two, three and away!" but they began running when they liked and left off when they liked, so that it was not easy to know when the race was over. However, when they had been running half an hour or so and were quite dry again, the Dodo suddenly called out, "The race is over!" and they all crowded 'round it, panting and asking, "But who has won?" This question the Dodo could not answer without a great deal of thought. At last it said, "_Everybody_ has won, and _all_ must have prizes." "But who is to give the prizes?" quite a chorus of voices asked. "Why, _she_, of course," said the Dodo, pointing to Alice with one finger; and the whole party at once crowded 'round her, calling out, in a confused way, "Prizes! Prizes!" Alice had no idea what to do, and in despair she put her hand into her pocket and pulled out a box of comfits (luckily the salt-water had not got into it) and handed them 'round as prizes. There was exactly one a-piece, all 'round. The next thing was to eat the comfits; this caused some noise and confusion, as the large birds complained that they could not taste theirs, and the small ones choked and had to be patted on the back. However, it was over at last and they sat down again in a ring and begged the Mouse to tell them something more. "You promised to tell me your history, you know," said Alice, "and why it is you hate--C and D," she added in a whisper, half afraid that it would be offended again. "Mine is a long and a sad tale!" said the Mouse, turning to Alice and sighing. "It _is_ a long tail, certainly," said Alice, looking down with wonder at the Mouse's tail, "but why do you call it sad?" And she kept on puzzling about it while the Mouse was speaking, so that her idea of the tale was something like this:-- "Fury said to a mouse, That he met in the house, 'Let us both go to law: _I_ will prosecute _you_.-- Come, I'll take no denial: We must have the trial; For really4 this morning I've nothing to do.' Said the mouse to the cur, 'Such a trial, dear sir, With no jury or judge, would be wasting our breath.' 'I'll be judge, I'll be jury,' said cunning old Fury; 'I'll try the whole cause, and condemn you to death.'" "You are not attending!" said the Mouse to Alice, severely. "What are you thinking of?" "I beg your pardon," said Alice very humbly, "you had got to the fifth bend, I think?" "You insult me by talking such nonsense!" said the Mouse, getting up and walking away. "Please come back and finish your story!" Alice called after it. And the others all joined in chorus, "Yes, please do!" But the Mouse only shook its head impatiently and walked a little quicker. "I wish I had Dinah, our cat, here!" said Alice. This caused a remarkable sensation among the party. Some of the birds hurried off at once, and a Canary called out in a trembling voice, to its children, "Come away, my dears! It's high time you were all in bed!" On various pretexts they all moved off and Alice was soon left alone. "I wish I hadn't mentioned Dinah! Nobody seems to like her down here and I'm sure she's the best cat in the world!" Poor Alice began to cry again, for she felt very lonely and low-spirited. In a little while, however, she again heard a little pattering of footsteps in the distance and she looked up eagerly. [Illustration] [Illustration] IV--THE RABBIT SENDS IN A LITTLE BILL It was the White Rabbit, trotting slowly back again and looking anxiously about as it went, as if it had lost something; Alice heard it muttering to itself, "The Duchess! The Duchess! Oh, my dear paws! Oh, my fur and whiskers! She'll get me executed, as sure as ferrets are ferrets! Where _can_ I have dropped them, I wonder?" Alice guessed in a moment that it was looking for

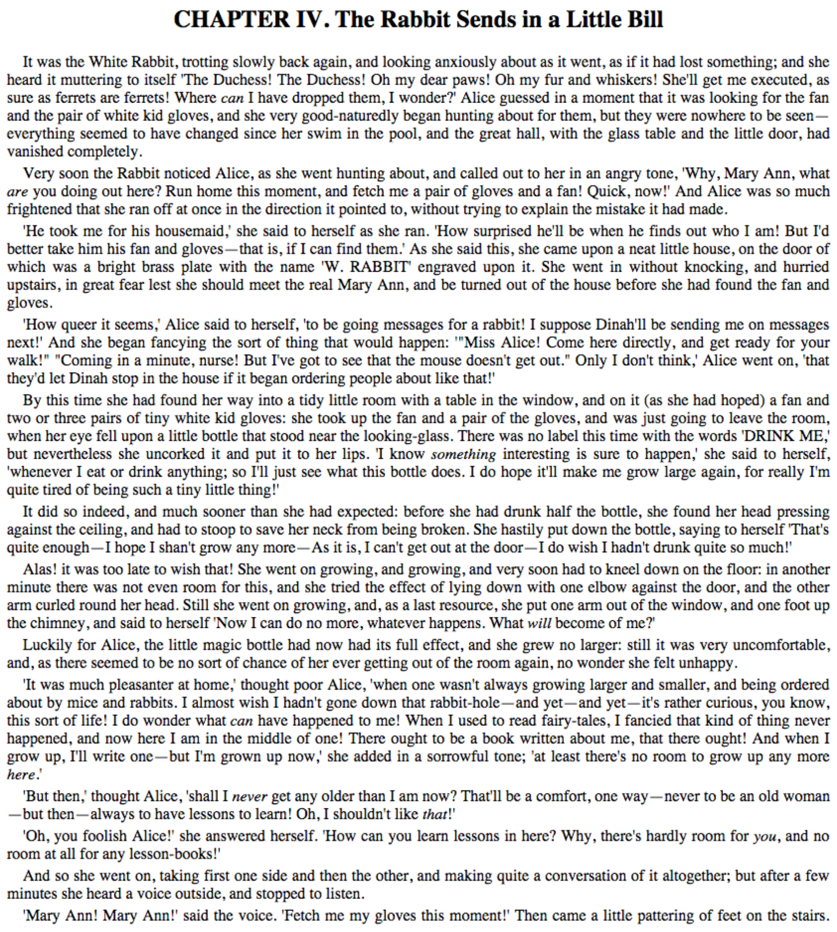
Markup Language

- HTML tags give structure
- They also provide semantics
  - Headings for headers
  - UL for unordered list
  - …



```
.</p>

  'To begin with,' said the Cat, 'a dog's not mad. You grant that?'
 </p>

  'I suppose so,' said Alice.
 </p>


    'Well, then,' the Cat went on, 'you see, a dog growls when it's angr
    wags its tail when it's pleased. Now "
>I</i>
growl when I'm pleased, and wag my
    tail when I'm angry. Therefore I'm mad.'
  "

.</p>
.</p>
.</p>

  'You'll see me there,' said the Cat, and vanished.
 </p>
.</p>
.</p>
.</p>

  'I thought it would,' said the Cat, and vanished again.
 </p>
.</p>

  'Did you say pig, or fig?' said the Cat.
 </p>
.</p>
.</p>
.</p>
.</p>
.</p>
 style="height: 4em;">…</div>

  CHAPTER VII. A Mad Tea-Party
```

- Browser applies built-in styles to each tag
- Even with default style, web pages should be readable and its hierarchy clear



CHAPTER IV. The Rabbit Sends in a Little Bill

It was the White Rabbit, trotting slowly back again, and looking anxiously about as it went, as if it had lost something; and she heard it muttering to itself 'The Duchess! The Duchess! Oh my dear paws! Oh my fur and whiskers! She'll get me executed, as sure as ferrets are ferrets! Where *can* I have dropped them, I wonder?' Alice guessed in a moment that it was looking for the fan and the pair of white kid gloves, and she very good-naturedly began hunting about for them, but they were nowhere to be seen—everything seemed to have changed since her swim in the pool, and the great hall, with the glass table and the little door, had vanished completely.

Very soon the Rabbit noticed Alice, as she went hunting about, and called out to her in an angry tone, 'Why, Mary Ann, what *are* you doing out here? Run home this moment, and fetch me a pair of gloves and a fan! Quick, now!' And Alice was so much frightened that she ran off at once in the direction it pointed to, without trying to explain the mistake it had made.

'He took me for his housemaid,' she said to herself as she ran. 'How surprised he'll be when he finds out who I am! But I'd better take him his fan and gloves—that is, if I can find them.' As she said this, she came upon a neat little house, on the door of which was a bright brass plate with the name 'W. RABBIT' engraved upon it. She went in without knocking, and hurried upstairs, in great fear lest she should meet the real Mary Ann, and be turned out of the house before she had found the fan and gloves.

'How queer it seems,' Alice said to herself, 'to be going messages for a rabbit! I suppose Dinah'll be sending me on messages next!' And she began fancying the sort of thing that would happen: '"Miss Alice! Come here directly, and get ready for your walk!" "Coming in a minute, nurse! But I've got to see that the mouse doesn't get out." Only I don't think,' Alice went on, 'that they'd let Dinah stop in the house if it began ordering people about like that!'

By this time she had found her way into a tidy little room with a table in the window, and on it (as she had hoped) a fan and two or three pairs of tiny white kid gloves: she took up the fan and a pair of the gloves, and was just going to leave the room, when her eye fell upon a little bottle that stood near the looking-glass. There was no label this time with the words 'DRINK ME,' but nevertheless she uncorked it and put it to her lips. 'I know *something* interesting is sure to happen,' she said to herself, 'whenever I eat or drink anything; so I'll just see what this bottle does. I do hope it'll make me grow large again, for really I'm quite tired of being such a tiny little thing!'

It did so indeed, and much sooner than she had expected: before she had drunk half the bottle, she found her head pressing against the ceiling, and had to stoop to save her neck from being broken. She hastily put down the bottle, saying to herself 'That's quite enough—I hope I shan't grow any more—As it is, I can't get out at the door—I do wish I hadn't drunk quite so much!'

Alas! it was too late to wish that! She went on growing, and growing, and very soon had to kneel down on the floor: in another minute there was not even room for this, and she tried the effect of lying down with one elbow against the door, and the other arm curled round her head. Still she went on growing, and, as a last resource, she put one arm out of the window, and one foot up the chimney, and said to herself 'Now I can do no more, whatever happens. What *will* become of me?'

Luckily for Alice, the little magic bottle had now had its full effect, and she grew no larger: still it was very uncomfortable, and, as there seemed to be no sort of chance of her ever getting out of the room again, no wonder she felt unhappy.

'It was much pleasanter at home,' thought poor Alice, 'when one wasn't always growing larger and smaller, and being ordered about by mice and rabbits. I almost wish I hadn't gone down that rabbit-hole—and yet—and yet—it's rather curious, you know, this sort of life! I do wonder what *can* have happened to me! When I used to read fairy-tales, I fancied that kind of thing never happened, and now here I am in the middle of one! There ought to be a book written about me, that there ought! And when I grow up, I'll write one—but I'm grown up now,' she added in a sorrowful tone; 'at least there's no room to grow up any more *here*.'

'But then,' thought Alice, 'shall I *never* get any older than I am now? That'll be a comfort, one way—never to be an old woman—but then—always to have lessons to learn! Oh, I shouldn't like *that*!'

'Oh, you foolish Alice!' she answered herself. 'How can you learn lessons in here? Why, there's hardly room for *you*, and no room at all for any lesson-books!'

And so she went on, taking first one side and then the other, and making quite a conversation of it altogether; but after a few minutes she heard a voice outside, and stopped to listen.

'Mary Ann! Mary Ann!' said the voice. 'Fetch me my gloves this moment!' Then came a little pattering of feet on the stairs.

Relevant tags: DOCTYPE

- It is not a common tag
  - No closing tag
  - Opening with “!”
- It is a declaration
- Select the correct dialect of HTML the page is using
- E.g.: <!DOCTYPE html> selects HTML5

Relevant tags: HTML

- This tag enclose the whole document
- <html></html>

Relevant tags: HEAD

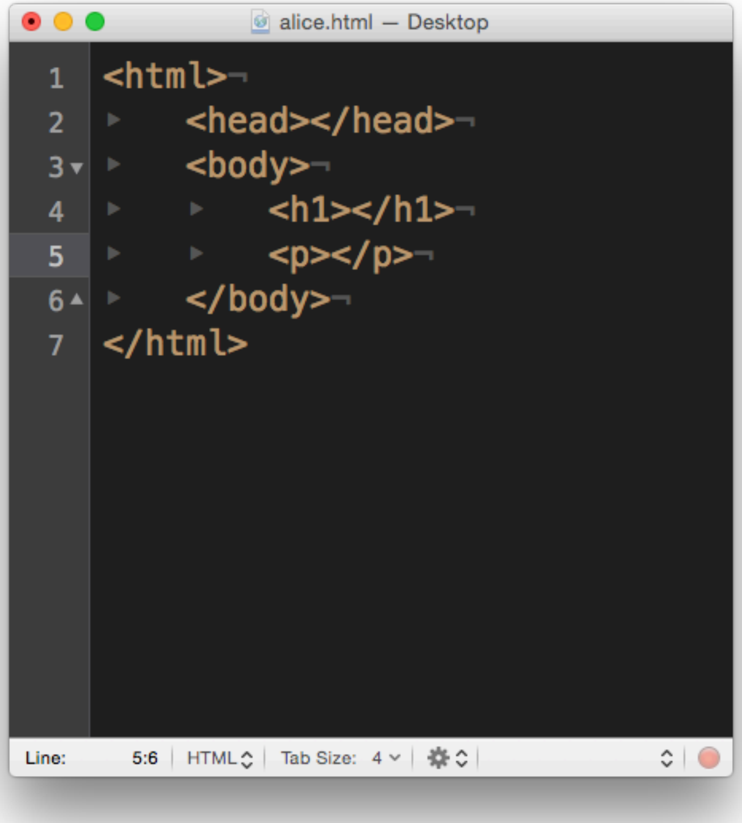
- It provides information to browser to retrive additional information for the page
  - Javascript, styles, information, meta, etc.
- <head></head>

Relevant tags: body

- Contaiins the documetn content
- The enclosed tags are showed in the browsere window
- <body></body>

Minimal Structure

- This is a basic structure for a web page
- HTML uses nesting to code hierarchies
- For readability, enclosed tags are indented w.r.t. container

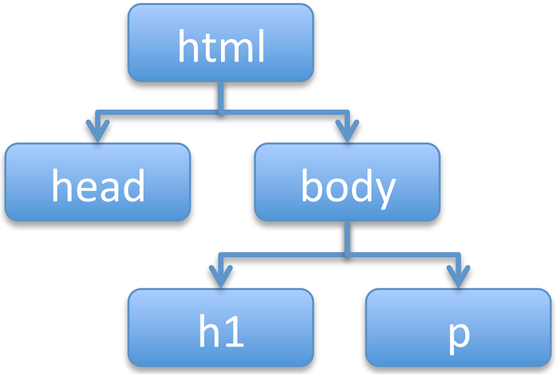


```
<html>
    <head></head>
    <body>
        <h1></h1>
        <p></p>
    </body>
</html>
```

Line: 5:6 | HTML | Tab Size: 4

Document Hierarchy

- Each tag has a parent
- A tag may have children or siblings
- Examples:
  - h1 is a child of body
  - body has two children
  - p is sibling of h1



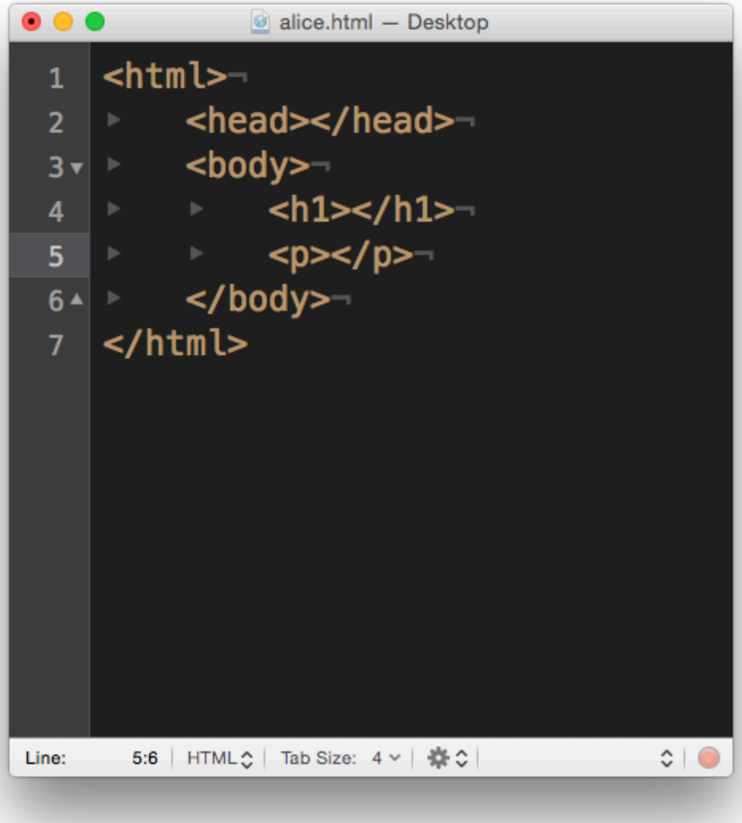
html

head

body

h1

p



```
<html>
    <head></head>
    <body>
        <h1></h1>
        <p></p>
    </body>
</html>
```

HTML Element

- An element is the union of two corresponding tags and their content
- Tags are usually present in pairs:
  - **Start tag**
  - **End tag**

<tag>Content**</tag>**

Named tags

- HTML has a set of predefined tag names, associated with special structures

```
<h1>My Title</h1>
```

Essential Tags

- Primary Structure
  - html
  - head
  - body
- Head Elements
  - title
  - meta
  - link
- Formatting elements (inline)
  - em, i
  - strong, b
  - q, blockquote
  - Span
- Structural Elements (blocks)
  - p
  - h1-h6
  - ul, ol
  - a
  - img
  - div

CSS 101

CSS – Cascading Stylesheet

- A stylesheet specifies a set of rules to define how html elements are presented on the browser
- Each rule applies to a specific set of elements of the page
- Rules have a cascading behaviour
  - Conflicts between multiple rules are resolved by priorities
  - Elements not covered by explicit rules inherit presentation of ancestors

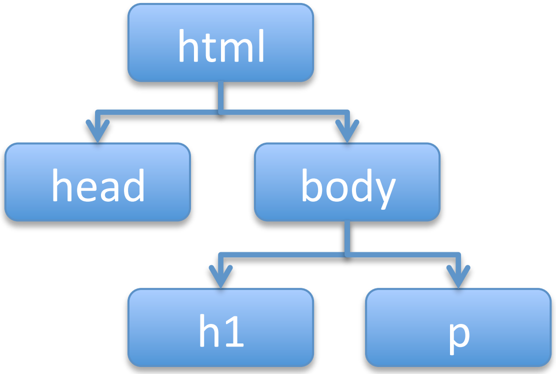
Rule priorities

- Browser stylesheet
- Linked external stylesheet
- Embedded stylesheet (tag `style`)
- Inline style (attribute `style`)

Inheritance

body
make font 16px, Verdana, red

p
make font blue



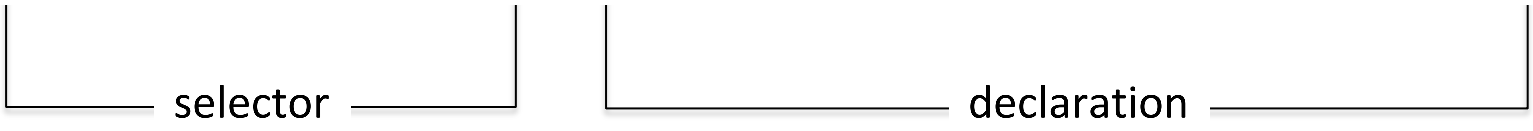
h1 is red

p is blue

Anatomy of a CSS Rule

- Every rule is composed of a selector and a declaration
- Declaration contains at least one pair property/ value

```
selector {property: value;}
```



selector

declaration

Basic CSS Selectors

- Type selectors
  - Target an element by name
    - `body {font-family: Verdana }`
    - `h1 {color: red}`
- ID selectors
  - An ID is an attribute added to an HTML element
    - `#logo {declaration}`
    - `<img id=“logo” src=“img/imga.jpg” alt=“description”/>`
- Class selectors
  - An identifier attribute added to a set of HTML elements
    - `.ingredients {declaration}`
    - `<ul class=“ingredients”>`

ID or Class

- There can be only one element with a given ID
- ID is more specific than a class
- An element can have both ID and classes

Descendant Selectors

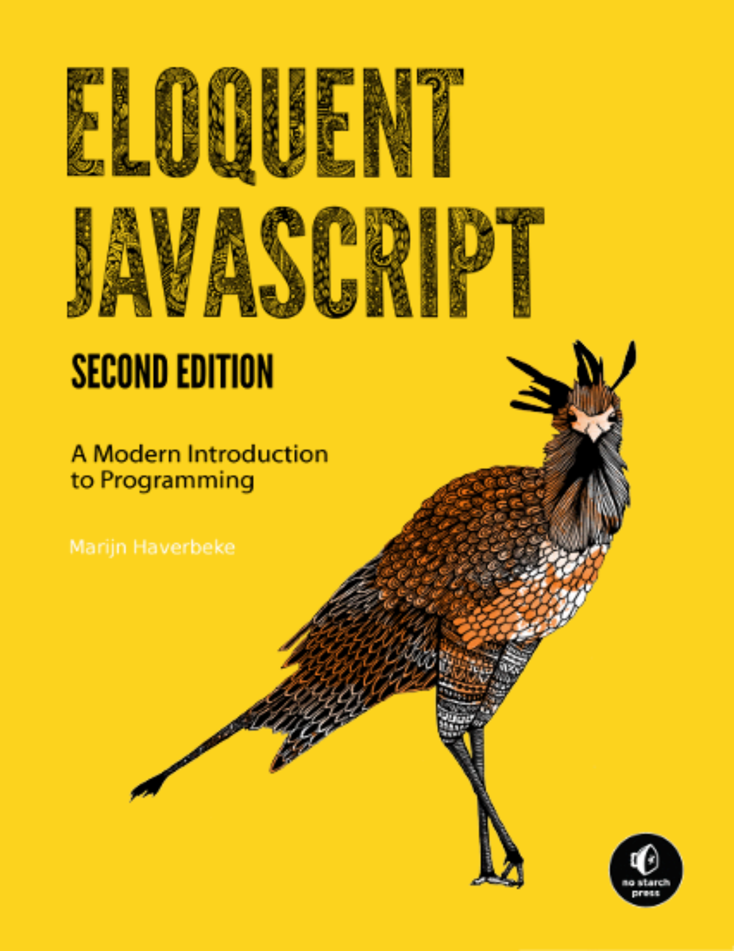
- Descendant selectors are composed of two basic selectors separated by a space
- The rule targets the elements of the second selectors that are descendant of the element of the first selector
- Example

  -
    ```
    #sidebar .author {declaration}
    ```

  -
    ```
    <div id=”sidebar”>
      <p class=”author”></p>
    </div>
    <p class=“author”></p>
    ```

JAVASCRIPT 101

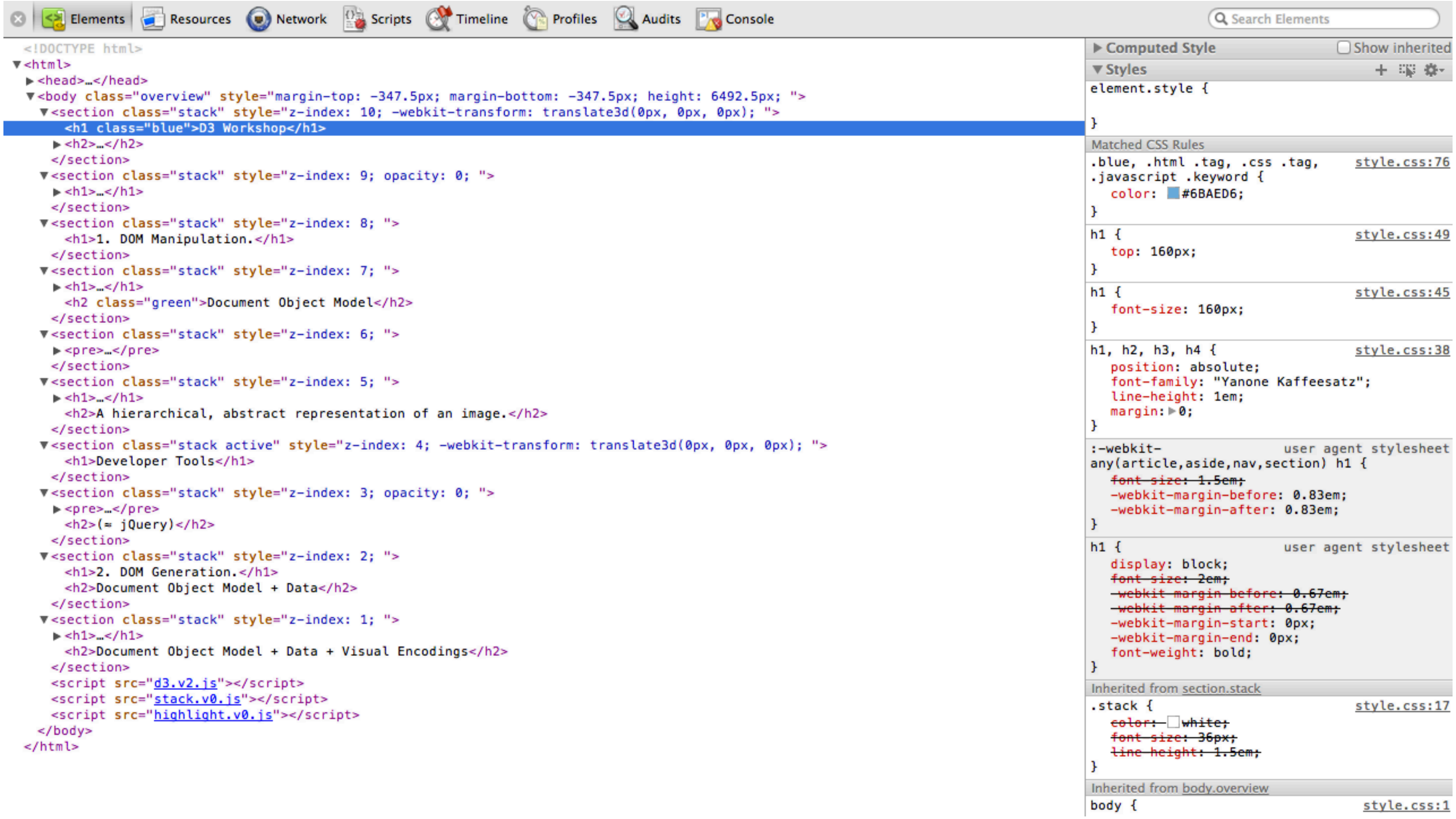
Javascript



Eloquent Javascript – Second Edition
Marijn Haverbeke
Licensed under CC license.

Available here: http://eloquentjavascript.net/

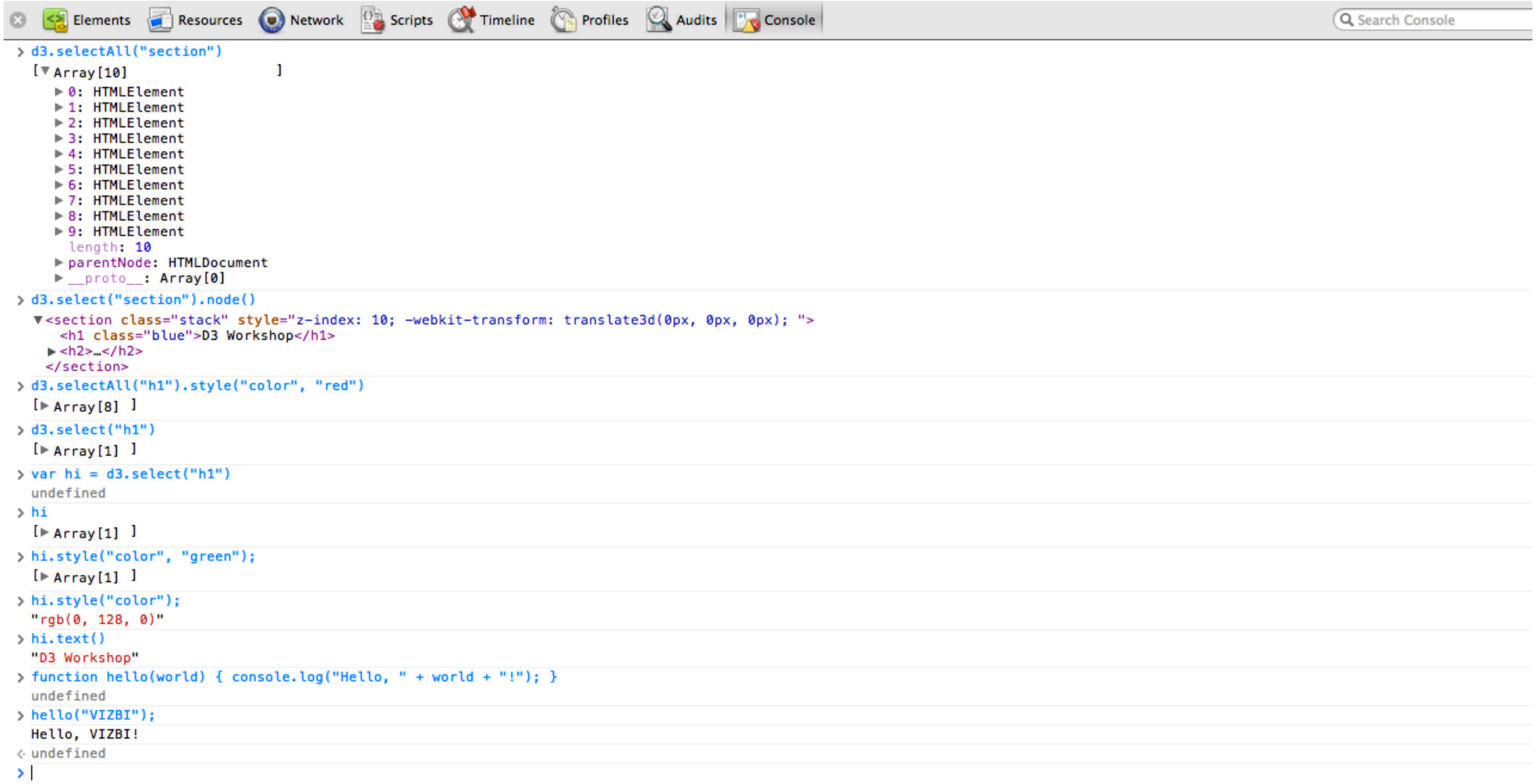
Developer Tools (Safari, Chrome, Firefox)



```
<!DOCTYPE html>
▼<html>
  ▶<head>…</head>
  ▼<body class="overview" style="margin-top: -347.5px; margin-bottom: -347.5px; height: 6492.5px; ">
    ▼<section class="stack" style="z-index: 10; -webkit-transform: translate3d(0px, 0px, 0px); ">
        <h1 class="blue">D3 Workshop</h1>
      ▶<h2>…</h2>
      </section>
    ▼<section class="stack" style="z-index: 9; opacity: 0; ">
      ▶<h1>…</h1>
      </section>
    ▼<section class="stack" style="z-index: 8; ">
        <h1>1. DOM Manipulation.</h1>
      </section>
    ▼<section class="stack" style="z-index: 7; ">
      ▶<h1>…</h1>
        <h2 class="green">Document Object Model</h2>
      </section>
    ▼<section class="stack" style="z-index: 6; ">
      ▶<pre>…</pre>
      </section>
    ▼<section class="stack" style="z-index: 5; ">
      ▶<h1>…</h1>
        <h2>A hierarchical, abstract representation of an image.</h2>
      </section>
    ▼<section class="stack active" style="z-index: 4; -webkit-transform: translate3d(0px, 0px, 0px); ">
        <h1>Developer Tools</h1>
      </section>
    ▼<section class="stack" style="z-index: 3; opacity: 0; ">
      ▶<pre>…</pre>
        <h2>(≈ jQuery)</h2>
      </section>
    ▼<section class="stack" style="z-index: 2; ">
        <h1>2. DOM Generation.</h1>
        <h2>Document Object Model + Data</h2>
      </section>
    ▼<section class="stack" style="z-index: 1; ">
      ▶<h1>…</h1>
        <h2>Document Object Model + Data + Visual Encodings</h2>
      </section>
      <script src="d3.v2.js"></script>
      <script src="stack.v0.js"></script>
      <script src="highlight.v0.js"></script>
    </body>
  </html>
```

```
element.style {

}
Matched CSS Rules
.blue, .html .tag, .css .tag,     style.css:76
.javascript .keyword {
   color: #6BAED6;
}
h1 {                              style.css:49
   top: 160px;
}
h1 {                              style.css:45
   font-size: 160px;
}
h1, h2, h3, h4 {                  style.css:38
   position: absolute;
   font-family: "Yanone Kaffeesatz";
   line-height: 1em;
   margin: ▶0;
}
:-webkit-          user agent stylesheet
any(article,aside,nav,section) h1 {
   ~~font-size: 1.5em;~~
   -webkit-margin-before: 0.83em;
   -webkit-margin-after: 0.83em;
}
h1 {               user agent stylesheet
   display: block;
   ~~font-size: 2em;~~
   ~~-webkit-margin-before: 0.67em;~~
   ~~-webkit-margin-after: 0.67em;~~
   -webkit-margin-start: 0px;
   -webkit-margin-end: 0px;
   font-weight: bold;
}
Inherited from section.stack
.stack {                          style.css:17
   ~~color: white;~~
   ~~font-size: 36px;~~
   ~~line-height: 1.5em;~~
}
Inherited from body.overview
body {                             style.css:1
```

Javascript Console (Safari, Chrome, Firefox)



```
> d3.selectAll("section")
  [▼Array[10]                   ]
     ▶ 0: HTMLElement
     ▶ 1: HTMLElement
     ▶ 2: HTMLElement
     ▶ 3: HTMLElement
     ▶ 4: HTMLElement
     ▶ 5: HTMLElement
     ▶ 6: HTMLElement
     ▶ 7: HTMLElement
     ▶ 8: HTMLElement
     ▶ 9: HTMLElement
       length: 10
     ▶ parentNode: HTMLDocument
     ▶ __proto__: Array[0]
> d3.select("section").node()
  ▼<section class="stack" style="z-index: 10; -webkit-transform: translate3d(0px, 0px, 0px); ">
      <h1 class="blue">D3 Workshop</h1>
    ▶<h2>…</h2>
    </section>
> d3.selectAll("h1").style("color", "red")
  [▶ Array[8] ]
> d3.select("h1")
  [▶ Array[1] ]
> var hi = d3.select("h1")
  undefined
> hi
  [▶ Array[1] ]
> hi.style("color", "green");
  [▶ Array[1] ]
> hi.style("color");
  "rgb(0, 128, 0)"
> hi.text()
  "D3 Workshop"
> function hello(world) { console.log("Hello, " + world + "!"); }
  undefined
> hello("VIZBI");
  Hello, VIZBI!
< undefined
> |
```

Variables

- Containers for data

```
let number = 5;
let address = “Largo Bruno Pontecorvo 5”;
```

Arrays

- Store sequences of values with a single name

```
let numberA = 5;
let numberB = 10;
let numberC = 15;
let numberD = 20;
let numberE = 25;
let numbers = [ 5, 10, 15, 20, 25 ];
numbers[0]  //Returns 5
numbers[1]  //Returns 10
numbers[2]  //Returns 15
numbers[3]  //Returns 20
numbers[4]  //Returns 25
```

Objects

- A sort of custom data structures
- Object is declared with curly brackets
- A sequence of property value pairs are separated by commas

```
let fruit = {
    kind: "grape",
    color: "red",
    quantity: 12,
    tasty: true
};
fruit.kind      //Returns "grape"
fruit.color     //Returns "red"
fruit.quantity  //Returns 12
fruit.tasty     //Returns true
```

Array of Object or Objects of Arrays

```
let fruits = [
    {
        kind: "grape",
        color: "red",
        quantity: 12,
        tasty: true
    },
    {
        kind: "kiwi",
        color: "brown",
        quantity: 98,
        tasty: true
    },
    {
        kind: "banana",
        color: "yellow",
        quantity: 0,
        tasty: true
    }
];
```

```
fruits[0].kind      ==  "grape"
fruits[0].color     ==  "red"
fruits[0].quantity  ==  12
fruits[0].tasty     ==  true

fruits[1].kind      ==  "kiwi"
fruits[1].color     ==  "brown"
fruits[1].quantity  ==  98
fruits[1].tasty     ==  true

fruits[2].kind      ==  "banana"
fruits[2].color     ==  "yellow"
fruits[2].quantity  ==  0
fruits[2].tasty     ==  true
```

Control Structures

- If statement

```
if (test) {
    //Code to run if true
}
```

- Example

```
if (3 < 5) {
    console.log("Eureka! Three is 
less than five!");
}
```

- for statement

```
for (initialization; test; update) 
{
    //Code to run each time 
through the loop
}
```

- Example

```
for (var i = 0; i < 5; i++) {
    console.log(i);  //Prints 
value to console
}
```

Functions

- Declaration

```
var functionName= function(arg1,
arg2){
  return something;
}
```

- Example

```
var calculateGratuity =
function(bill) {
    return bill * 0.2;
};
```

- Call of a function

```
functionName(arg1,arg2)
var tip = calculateGratuity(38);
console.log(tip);  //Prints 7.6 to
the console
```

Link to javascript from a web page

- Embedded within body element

```
<body>
    <script type="text/javascript">
        alert("Hello, world!");
    </script>
</body>
```

- Linked from the head section

```
<head>
    <title>Page Title</title>
    <script type="text/javascript"
src="myscript.js"></script>
</head>
```

DEVELOPMENT CHECKLIST

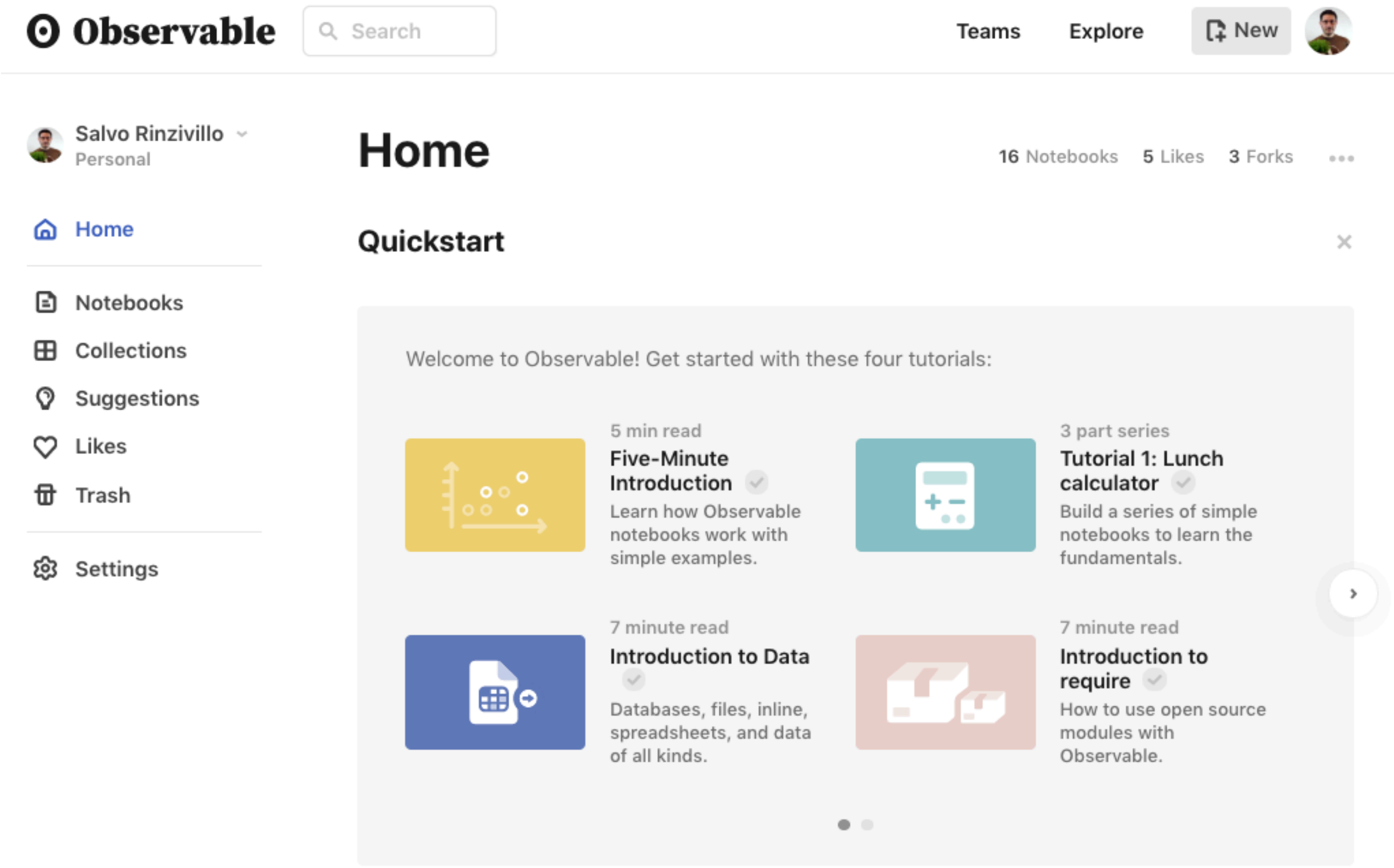
Tools

- A modern browser (Chrome, Firefox, etc)
- An integrated IDE, like WebStorm for example
- Node.js and NPM installed

Tools (old school)

- A modern browser (Chrome, Firefox, etc)
- A modern text editor (TextMate, Sublime, Atom, …)
- A terminal (Command prompt) to run an http-server [Terminal A]
- A terminal to handle code versioning [Terminal B]
- Node.js and NPM installed

Fast prototyping with Observables



Home

16 Notebooks 5 Likes 3 Forks

Quickstart

Welcome to Observable! Get started with these four tutorials:

5 min read
Five-Minute Introduction
Learn how Observable notebooks work with simple examples.

3 part series
Tutorial 1: Lunch calculator
Build a series of simple notebooks to learn the fundamentals.

7 minute read
Introduction to Data
Databases, files, inline, spreadsheets, and data of all kinds.

7 minute read
Introduction to require
How to use open source modules with Observable.

https://observablehq.com/collection/@rinziv/va602aa

https://observablehq.com/@uwdata/a-minimal-introduction-to-javascript-and-observable?collection=@uwdata/visualization-curriculum