Front-end Development

These are some of the fundamentals not **specific** to front-end development, only, rather every aspect of life.

Framework

A well-structured plan or tool to execute an action of a specific category is a **framework**. For instance, in order to crack an egg, the steps to follow are,

- Pick up the egg
- Strike it, gently, with a hard surface
- Crack it open with ease

This is the ***framework*** *to crack an egg*.

Library

A framework is a methodical way of completing a task. A **library** is built in a way that makes it easy to work with the framework.

For instance, instead of cracking the egg with bare hands, use an egg-cracker. Here, the device acts as a **library**.

API

Standing for **Application Programming Interface**, it is a medium to access and use databases and servers from **client-side**.

Examples

Here are some of the APIs and their functions.

API	Function
Browser	Interpret JavaScript code in the browser
RESTful	Access data from server or database
Sensor-Based	Communicate with sensors (IoT)

An IP standing for **Hyper Text Transfer Protocol**.

Methods

Functions to modify, retrieve or delete data on the web.

HTTP Method	Description
GET	The client requests a resource on the web server.
POST	The client submits data to a resource on the web server.
PUT	The client replaces a resource on the web server.
DELETE	The client deletes a resource on the web server.

Request

The request contains:

- Method
- Host Web Address
- HTTP Version
- Other info alike

```
GET / HTTP/1.1
Host: developer.mozilla.org
Accept-Language: en
```

Response

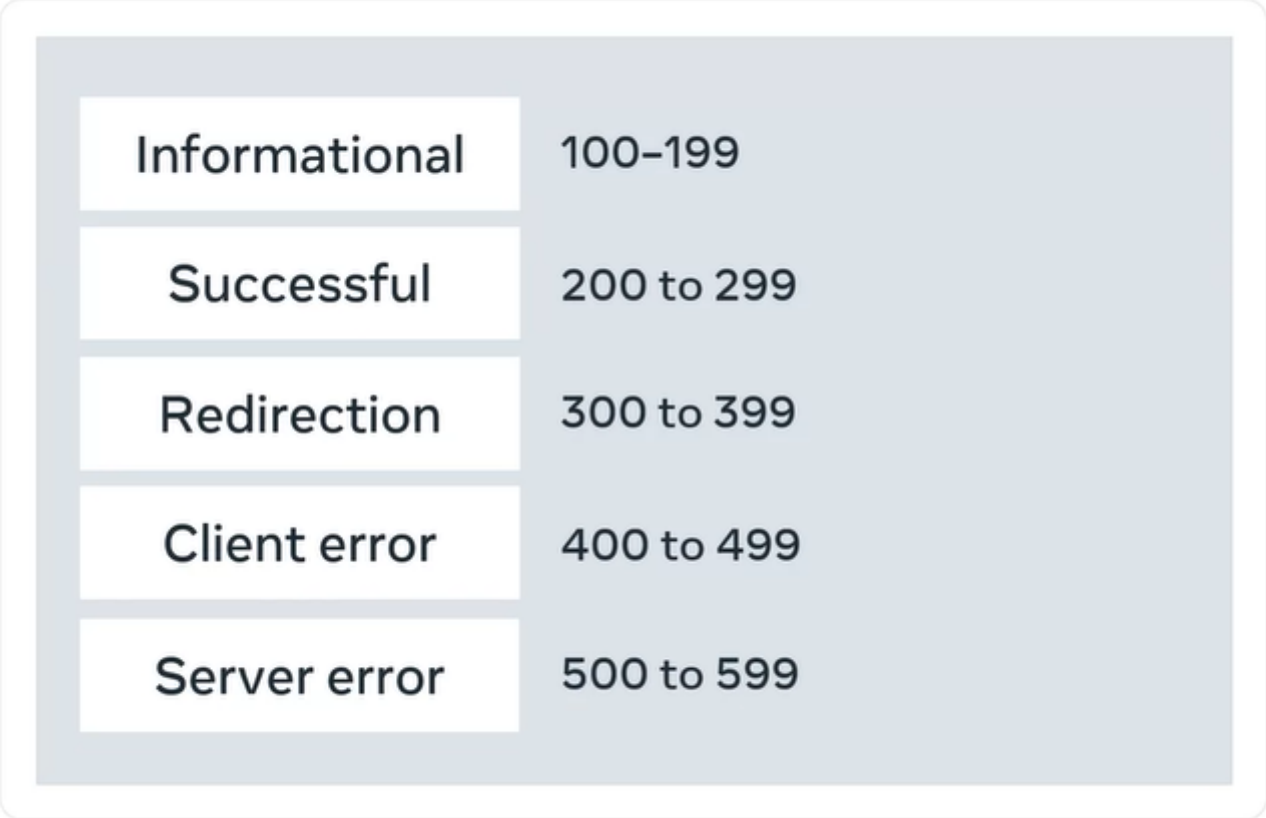
The response contains:

- Status Code
- Body of the content
- Server
- HTTP Version
- Other info alike

```
HTTP/1.1 200 OK
Date: Sat, 09 Oct 2010 14:28:02 GMT
Server: Apache
Last-Modified: Tue, 01 Dec 2009 20:18:22 GMT
ETag: “51142bc1-7449-479b075b2891b”
Accept-Ranges: bytes
Content-Length: 29769
Content-Type: text/html
```

Status Codes

The codes within an HTTP response indicating the category of the response and its **status**.



A framework that caters to the **Request-Response Cycle** by delivering *data packets* back and forth the Server-Client pathway.

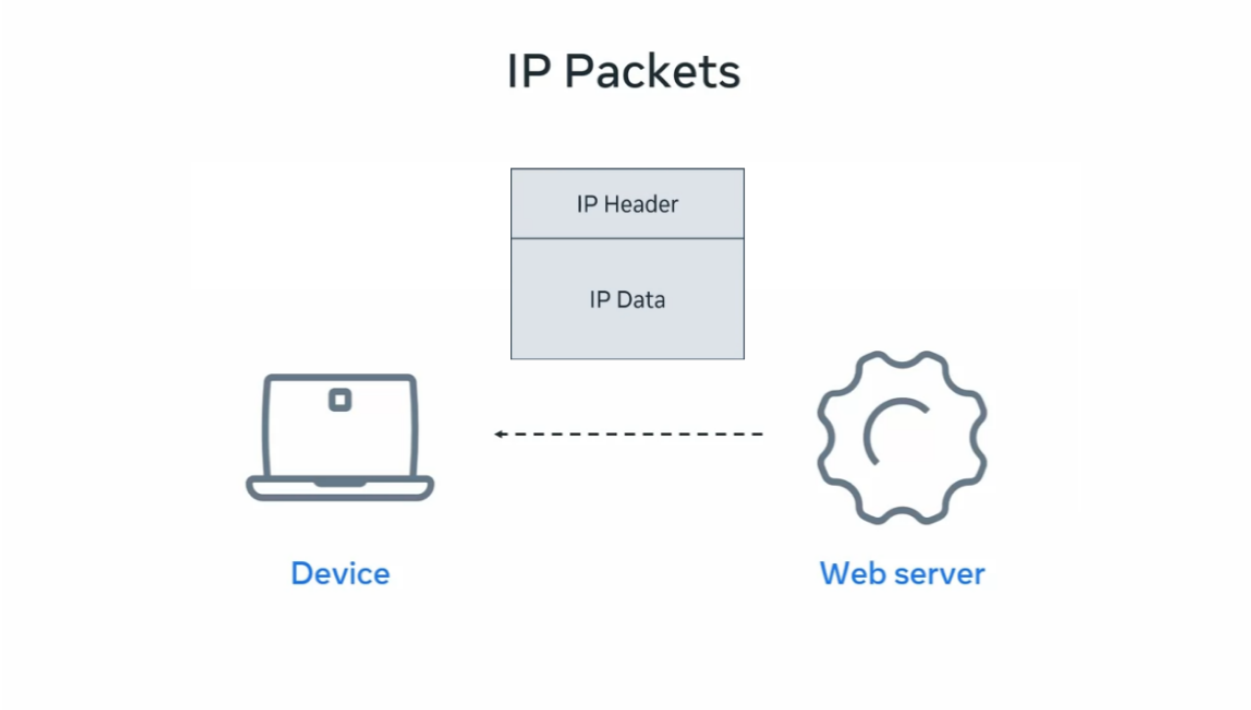
Why?

- Data packets' order might get disturbed in transit.
- They may get misrouted.
- The data may get corrupted.

How?

Just as the real-time conventional postal system.

The client sends a request to the server and gets the desired response via IP.



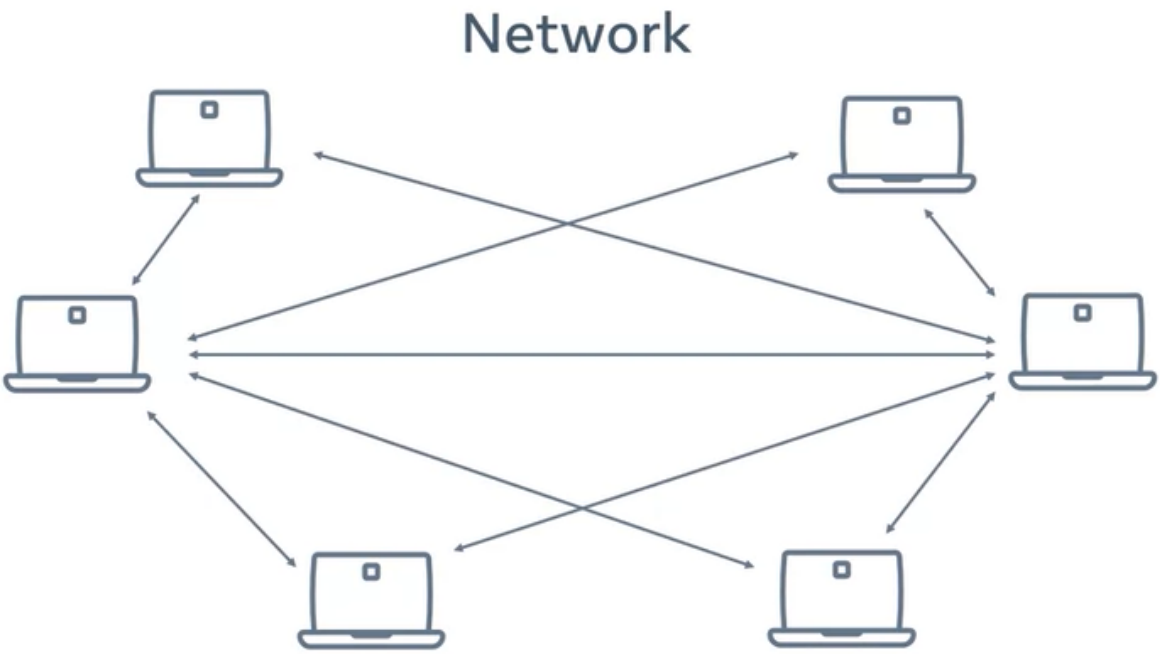
Property	Postal System	Internet Protocol
Address	H-3, Street lane	192.162.0.5
Parcel	A mail	
Mode	Mailman	HTTP, TCP, UDP,...

Some Examples

IP	Full Form	Application
HTTP	Hyper Text Transfer Protocol	Transfer web pages across the web

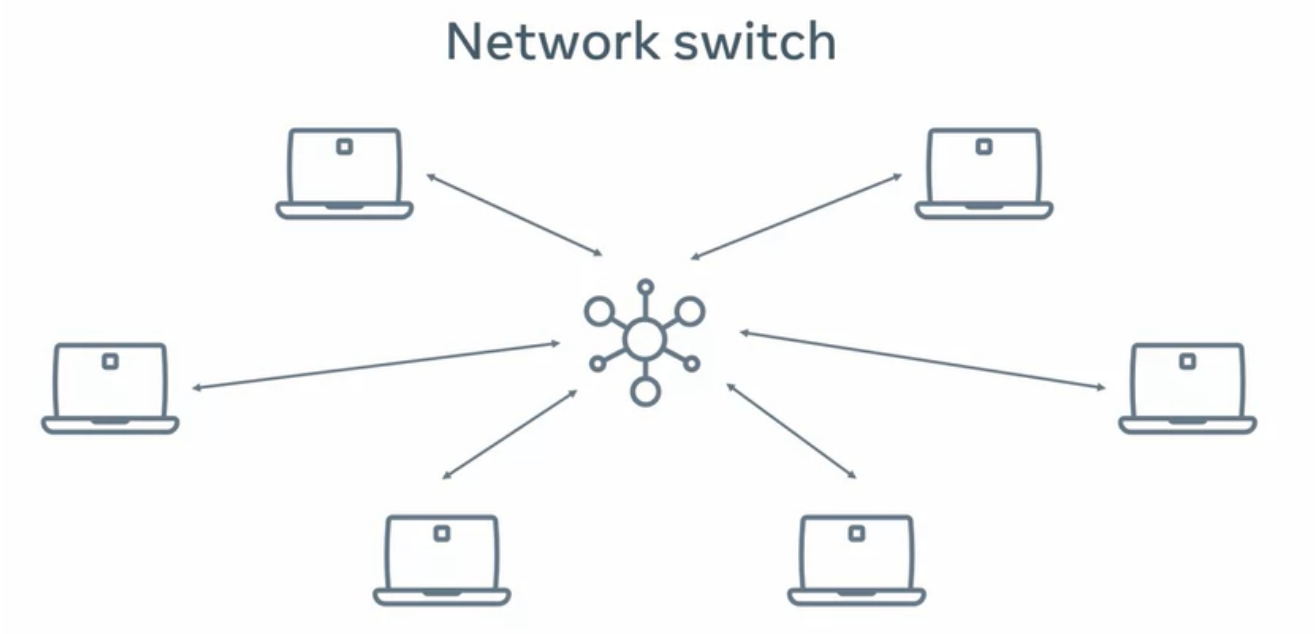
IP	Full Form	Application
TCP	Transmission Control Protocol	Transfer data across the web in precise order and to the right client
UDP	User Datagram Protocol	Transfer data on the web corruption-free
DHCP	Dynamic Host Configuration Protocol	Gives each client its IP address and redirects responses to the correct ones.
DNS	Domain Name System Protocol	Regulates the corresponding website of an IP address.
IMAP	Internet Message Access Protocol	Retrieve messages and mails on the server
FTP	File Transfer Protocol	Send, receive, retrieve and delete files on a server
SMTP	Simple Mail Transfer Protocol	IMAP, but just for mails
SSH	Secure Shell Protocol	Access the server from client system, remotely

Computers connect and communicate with other computers forming a network. This creates a messy graph with the systems at its nodes.



Network Switch

An interface which serves as a two-way connection between the switch itself and the computer or the client.



Multiple network switches connect each and all to form **Internet** or **Inter**connected-**Net**work.

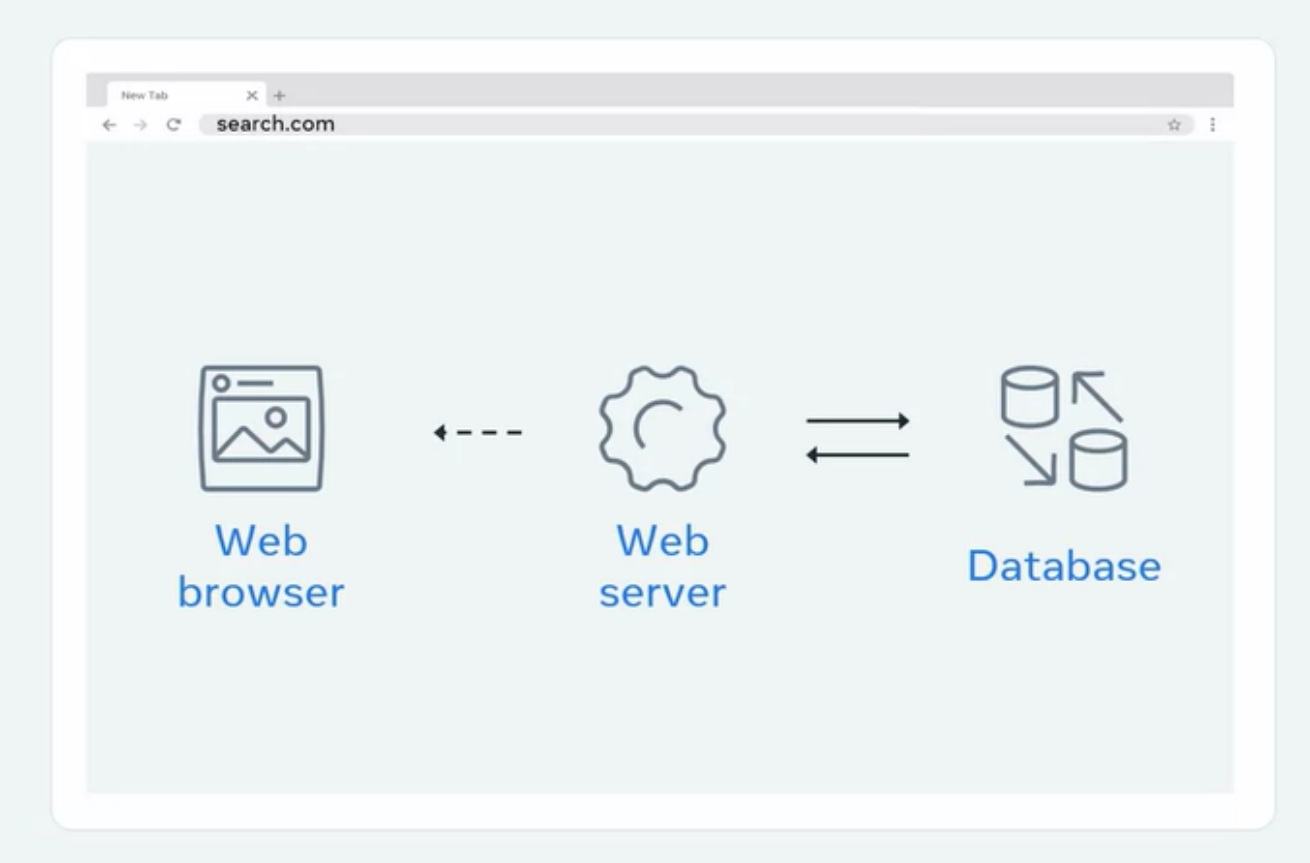
Also, the services we access via internet are provided via the **Server-Client Model** wherein the Client (user's system) requests the Server (hosting the service) by the medium of Internet.

An application that acts as an interface to the web.

Functionality

- The User specifies the address of the website also called its **URL** or **Uniform Resource Locator**.
- The Browser sends a request to the Web Server which then processes and returns the webpage in document form.

- The Browser then renders the document form into a visual format.



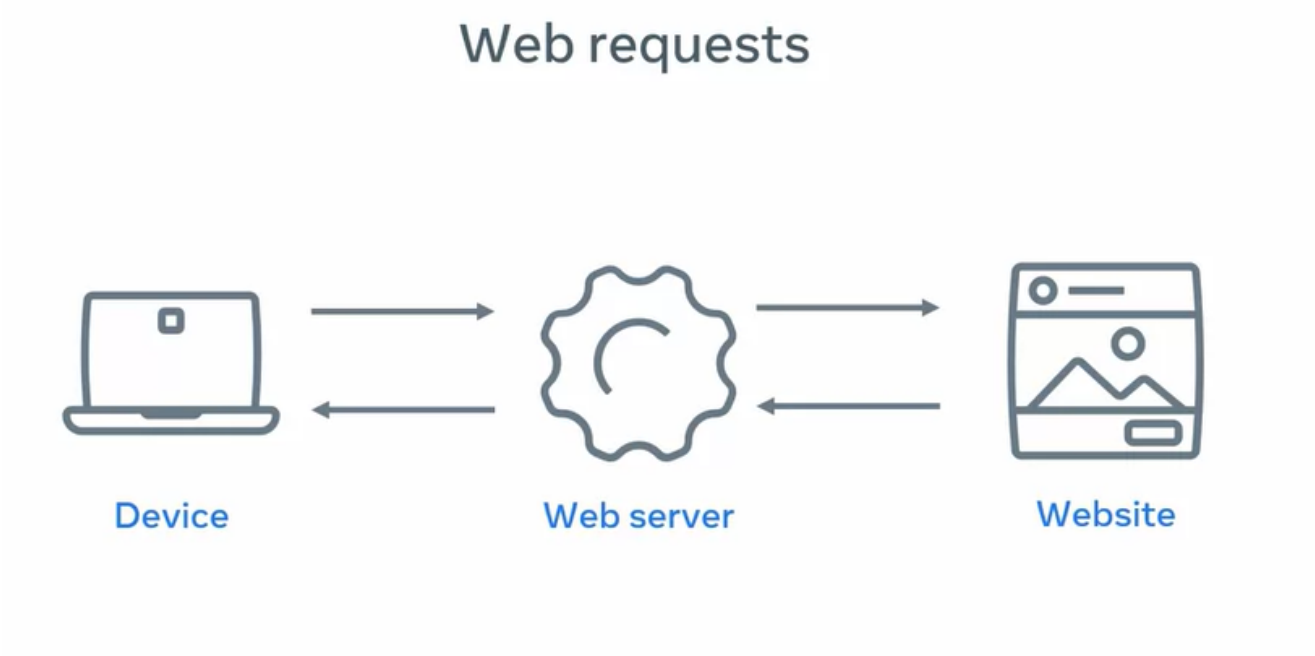
A service provided by owners of large data centers wherein specific memory and computational power is allocated to the client to **host** or bring a website online.

Types

- **Shared Hosting**
  The bandwidth and memory of a physical server is shared with other users and thus, the user with higher power and memory demand would use the majority of it.
- **Virtual Private Hosting**
  The memory and power supply is pre-determined and remains constant regardless of the demand.
- **Dedicated Hosting**
  A full-fledged physical server is allocated to the user which, too, has upper bounds on memory and power usage but a lot more higher than VPS.
- **Cloud Hosting**
  Both physical server and a cloud server is solely dedicated to a single user with extreme power and memory.

A piece of hardware that provides or **serves** on the **web**. Hence the term Web Server. Some functions are enlisted

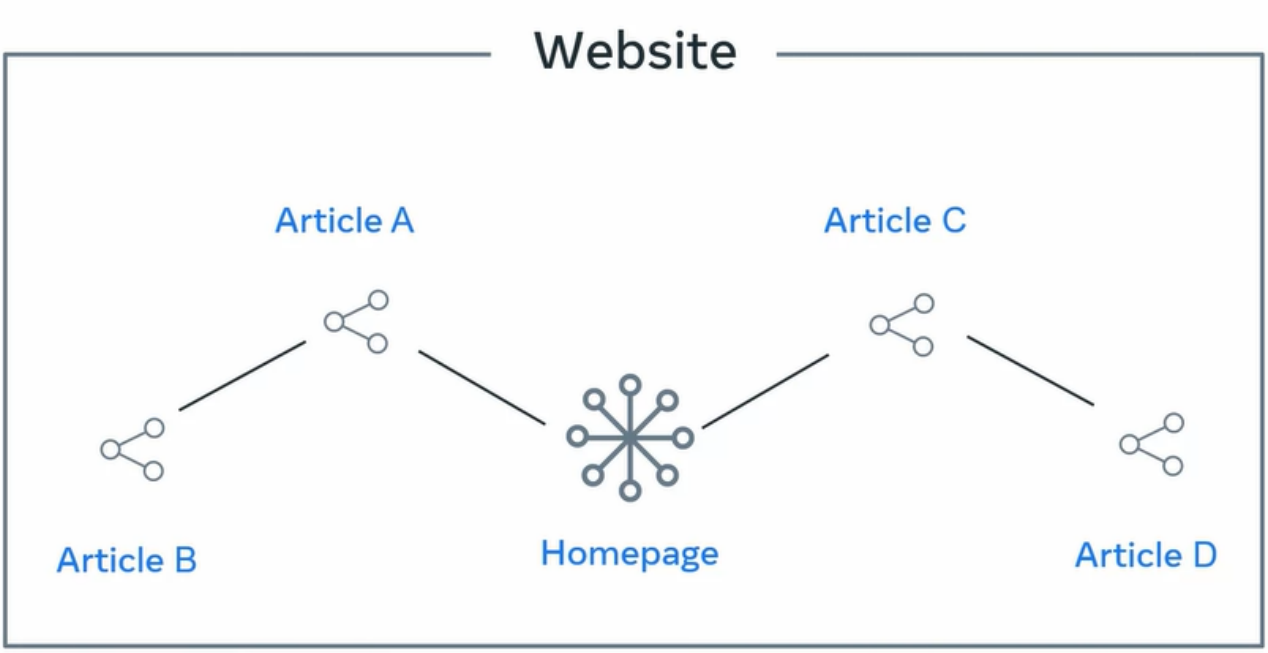
- Email Management
- Security
- Authorization
- Request-Response Cycle



Data Center

Such hardware is located all around the globe to access the data and services from the nearest hotspot called a Data Center.

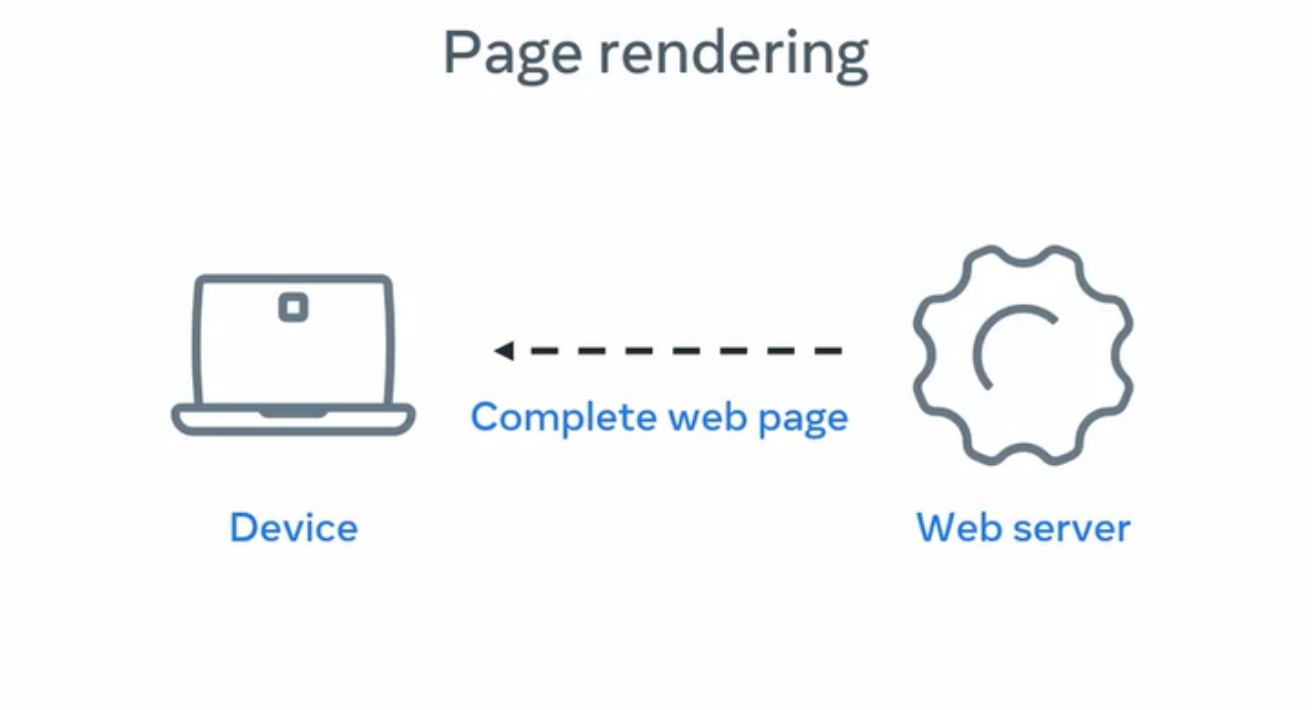
A collection of documents on the web is a **Website**. The documents themselves are called **Webpages**.



Webpage Rendering

Webpages being documents, are written in languages such as HTML, CSS and JavaScript and not visually created by drag-drop.

These documents are further interpreted and designed by the browser. This function of the browser is **Webpage Rendering**.



CSS stands for **Cascading Style Sheet** and serves the function of styling an HTML document or simply, a webpage.

Syntax

Each element in an HTML document can be styled separately and collectively. Below is called a **CSS Rule**.

```
p {
        color: green;
        font-size: 2em;
}
```

Component	Function
`p`	Stylize all elements with this tag called the **Selector**
`{}`	Contain the style declaration block
`color`	The property that needs to be modified
`green`	The value of the property to be modified

Selector

In a CSS rule, the tag name before the opening curly bracket is called a **selector**. It *selects* the elements of a tag to be modified.

CSS Precedence and Specificity

A property of CSS which allows the user to modify specific elements by using different selectors.

Property	ID Selector	Class Selector	Descendant Selector
Usage	Modifies all elements with same `id` attribute	Modifies all elements with the same `class` attribute	Modifies all elements with a specified tag within another tag
Syntax	Use a `#` before the selector	Use a `.` before the selector	Use `#id_of_parent element > tag_to_modify`
Example	Sets the color of all elements with `id` as `para_id` to green CSS `#para_id { color: green; }`	Set the color of all elements with `para_class` as the attribute of `class` to green CSS `.para_class { color: green; }`	Sets the color of all `<p>` elements within the `para_class` element to green CSS `#para_class > p { color: green; }`

Elements in an HTML document need to be *understood* by the browser to stylize and display them further with CSS. For instance,

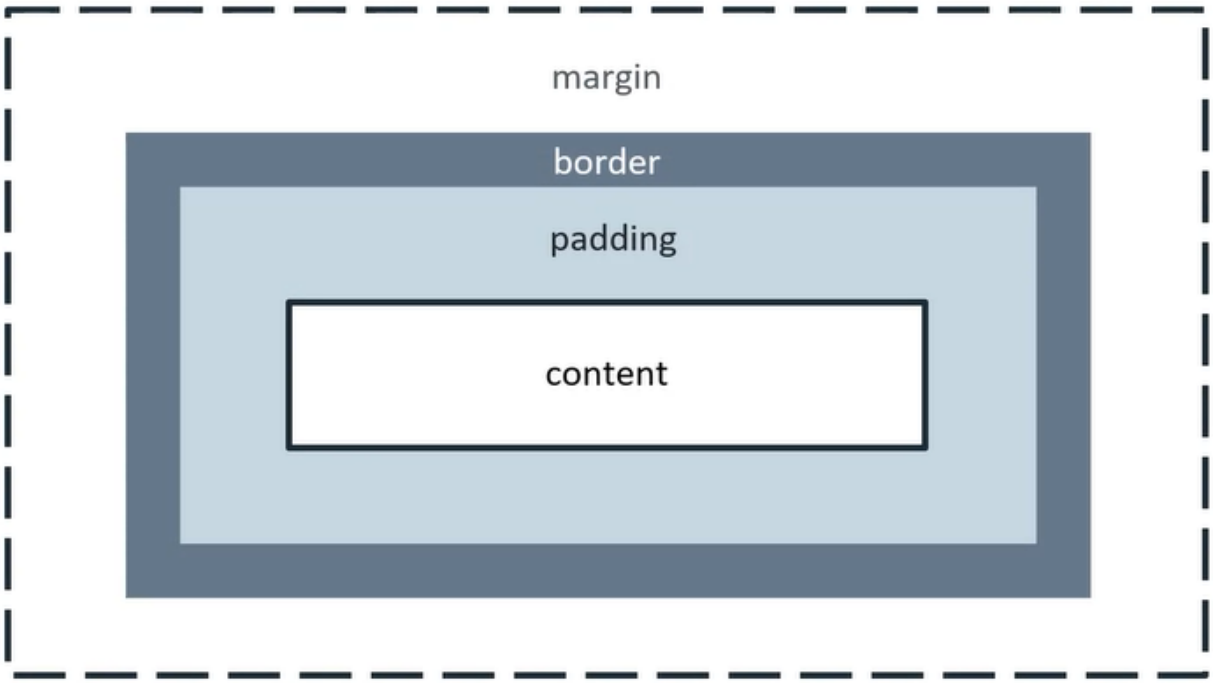
```
<html>
  <body>
    <h1>Hello World!</h1>
  </body>
</html>
```

```
h1 {
        color: rgba(0, 0, 0, 1);
}
```

How does the browser know as to where shall each letter of `<h1>` be located?

Box Model

Browsers use what's called a **box model** to solve the above problem. Each HTML element is assigned a bounding box around it.



Boundary	What it means
Content	This is the actual width and height of the content
Padding	The space between the content size and its bounding box
Border	The width of the border of the bounding box
Margin	The space between the complete element and another one alike

Document Flow

The bounding boxes to the elements have been allocated but where shall they be positioned on a webpage?
Document Flow specifies the orientation of elements on a webpage.

Inline Format

Elements can be specified to have an arrangement such that every next element appears in the same line as the previous or in other words **occupy the space of the content size only**.

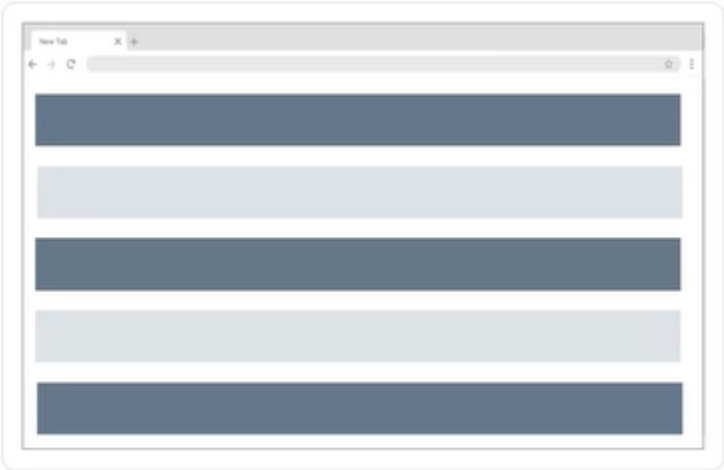
This can be done by-

- -choosing elements that are pre-defined as inline elements such as `<span>` and `<form>`.
- -declaring a CSS rule that specifies the layout

```
h1 {
        display: inline;
}
```

Block Format

Elements which always occupy a new line or in other words **have the height of an element and the width of the parent element**.



This can be done by-

- -choosing elements that are pre-defined as block elements such as `<div>` and `<input>`.

- -declaring a CSS rule that specifies the layout

```
h1 {
        display: block;
}
```

Alignment

The above models are for positioning the elements but aligning a piece of text is different than setting it to a block-level element.

Text

Text can be aligned in CSS by modifying the `text-align` property in broadly four ways.

Alignment	Visual
`left`	Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam
`right`	Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam
`center`	Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam
`justify`	Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam

Also, to wrap text around an element the `float` property is edited via CSS.

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam

Element

Aligning elements just requires the following line of code

```
child_span {
        transform: translate(-x%, -y%);
}
```

The style of text wrapped by elements around can be modified using some basic declarations.

Font Size and Family

The `font-size` property accepts units such as `px`, `em` along others and the `font-family` demands for the font-style followed by the family to which it belongs.

```
p {
        font-size: 20px;
        font-family: "Roboto", sans-serif;
}
```

Text Decoration

Text can be *decorated* or stylized by underlining or striking the text.

```
p {
        text-decoration: underline red dash 3px;
}
```

Value	Usage
`underline`	Type of decoration
`red`	Color of the decoration (underline here)
`dash`	Stroke of the decoration (----- here)
`3px`	Width of the decoration

Color

Color of font and other elements can be customized in CSS using multifarious color models.

RGBA

Standing for **Red-Green-Blue-Alpha**, RGBA is a very popular color model. Each one of RGBA is a parameter which tells how much of that color is mixed to get a composite color.

```
p {
        color: rgba(255, 255, 255, 1);
}
```

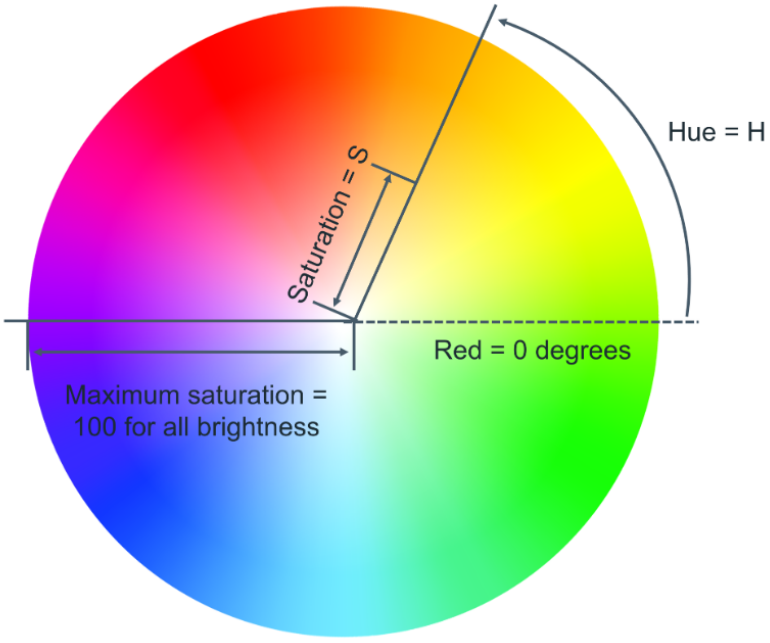
Parameter	Usage	Range
RGB	Saturation of RGB in the color	[0-255]
Alpha	Transparency of the mixed color	[0-1]

HSL

Standing for **Hue-Saturation-Lightness**, HSL is yet another color model which CSS supports.

```
p {
        color: hsl(120, 100%, 50%);
}
```

Parameter	What it means	Range
Hue	The color	[0°-360°]
Saturation	How much of the color is in there	[0-100%]
Lightness	How light the color is	[0-100%]



HTML stands for **Hypertext Markup Language**.

Hypertext → Link to other texts
Markup → Content of the document (Tags and Elements)

Syntax

Set of rules to abide while writing code in a certain programming language. **Semantics** refers to how coherent the code is.

Element

The building blocks of an HTML document or structure are regarded as **elements**. Just as a paragraph of a blog post or a component of a mobile phone.

```
<p>A paragraph</p>
```

Tags

In HTML, **tags** denote an **element** in a code. Tags often contain what's called **attribute** which provides more information about the **element** and how it should be structured in the document.

```
<element> is the opening tag of the element </element> is the closing tag of
the
element

<element attribute="description">
  denotes the provision of an attribute and associated value</element
>
```

> Note → The value of an attribute need not be enclosed in double or single quotes.

Common Tags

Tags	Function
`<hn>`	Heading with the nth-largest font
`<head>`	Encapsulates the meta-data of the document
`<p>`	Paragraph
`<body>`	The main content of the document
`<html>`	Denotes the start and end of the file
`<title>`	Title of the website to be displayed on the tab
`<form>`	A form-like layout for user-input

Sample Code

```
<!DOCTYPE html>
<html>
  <head>
    <title>Sample Webpage</title>
  </head>
  <body>
    <h1>Hello World!</h1>
    <p>This is my first website!</p>
  </body>
</html>
```

HTML also supports and avails built-in structures for data management.

Lists

An element in HTML for displaying point-based data.
HTML supports two broad types of lists.

- **Ordered List**
  List with bullet points as numbers or index-based bullets.
  1. Apple
  2. Pineapple
  3. Custard Apple

```
<ol></ol>
acts as a container of the ordered list
```

- **Unordered List**
  List with basic bullet points.
  - Apple
  - Pineapple
  - Custard Apple

```
<ul></ul>
acts as the container of an unordered list
```

Table

Unlike regular tables, tables in HTML aren’t represented in a purely tabular format but somewhat resembles it.

A1	A2

B1	B2

```
<table>
  <tr>
    <td>A1</td>
    <td>A2</td>
  </tr>
  <tr>
    <td>B1</td>
    <td>B2</td>
  </tr>
</table>
```

```
<table>
  contains the rows and columns
  <th>
    is for the table header
    <tr>
      is for the table row
      <td>is for the table data</td>
    </tr>
  </th>
</table>
```

The approach to filling out the table is to work your way row-wise.

- **Row A**
  - `<tr>`
  - Cell A1 or `<td>A1</td>` is added
  - Cell A2 or `<td>A2</td>` is added
  - `</tr>`
- **Row B**
  - `<tr>`
  - Cell B1 or `<td>B1</td>` is added
  - Cell B2 or `<td>B2</td>` is added
  - `</tr>`

Forms

Pre-built and structured modes of obtaining user input via HTML.

Username:

Password:

```
<form action=/authorization method=POST>
        <label for=username>Username:</label>
        <input type=text id=username>
        <br>
        <label for=password>Password:  </label>
        <input type=password>
</form>
```

Component	Function
`<form>`	Encapsulates the contents of the form
`<input>`	Prompts for input from user
`<label>`	A description of what to do

Input Types

Type	Function
`text`	Input text from user
`password`	Inputs hidden text from user
`checkbox`	Input the choices of user from given options Option 1 Option 2
`radio`	Input a single choice from user Option 1 Option 2
`file`	Input a file from the user Choose File No file chosen
`email`	Input email of correct format from user

Some other Input Elements

These elements are not attributes of the `<input>` tag but rather are tags themselves used for taking user input

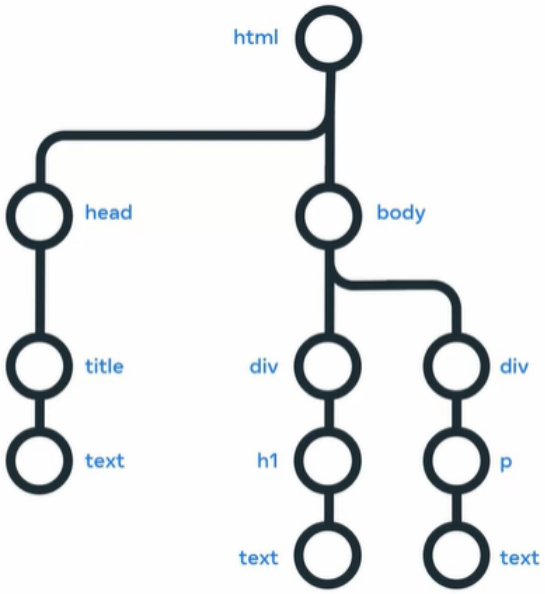
Element	Function
`textarea`	Input lengthy text from user
`select`	Input the choice of user from a drop-down menu Burger

Attributes

- `<form>`
  - `action` → The address to forward the input
  - `method` → The HTTP method to use
- `<input>`
  - `name` → Name of the input element
  - `id` → Identity to denote the element
  - `type` → The mode of input
- `<label>`
  - `for` → The element for which the label is
  - `id` → Identity to denote the label

Document Object Model or **DOM** is a specific structure of an HTML document that allows for modification of any or all elements of the document via **JavaScript**.

```
<!DOCTYPE html>
<html>
  <head>
     <title>My Website</title>
  </head>
  <body>
     <div>
        <h1>This is the heading</h1>
     </div>
     <div>
        <p>This is the paragraph</p>
     </div>
  </body>
</html>
```



What **DOM** does is, it creates a tree of the elements in an HTML document. This is also known as **parsing**.

Anchor Tags

Elements in HTML used to connect or **hyperlink** webpages or sections of webpages to one-another.

```
<a href="linking-site">Alt text</a>
```

Here,

- `<a> </a>` is the anchor tag which creates the hyperlink.
- `Alt text` is the text to be displayed in the form of link.

Color of Link	State
Blue	Link not visited
Purple	Visited Link
Red	Active link: Clicked and being processed

- `href="linking-site"` is the attribute of the anchor tag which gives the *reference* or file of target site by the name `linking-site`.

HTML provides built-in elements that support images and videos.

Images

The `<img>` tag is used as a placeholder of the image and is an **empty tag**.

```
<img src="sample.jpg" />
```

Component	Usage
`<img>`	Declaration of an image element
`src`	Attribute of `<img>` referring to the image file

Also known as the **Backend**, the **application server** generates content on user-demand which is influenced by certain properties.

Say you want to look for an email from your personal account.

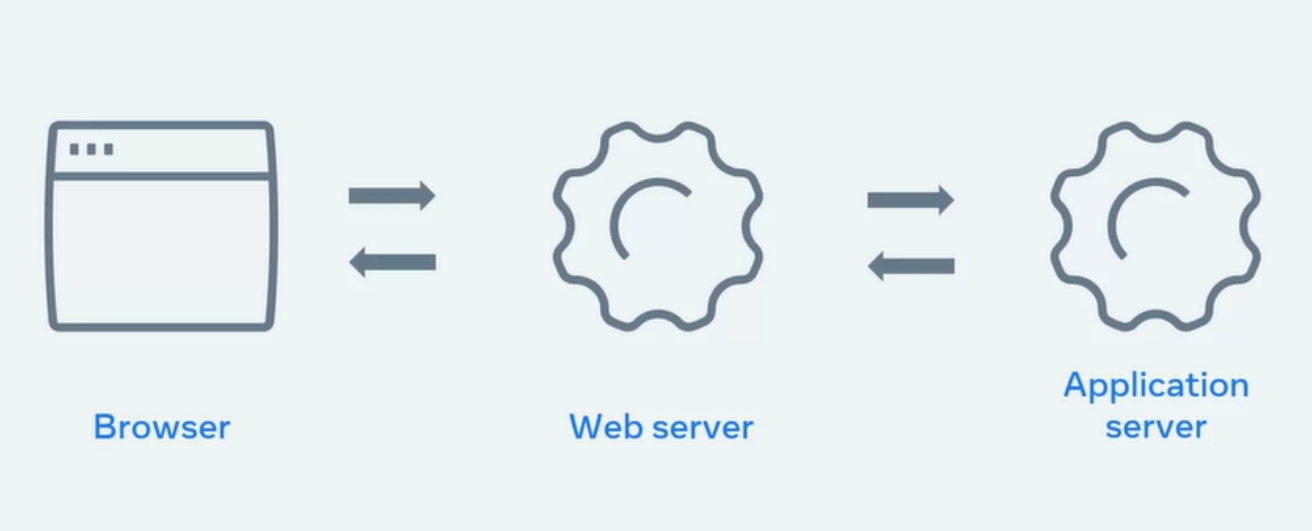
- You open up the Mail webpage on your browser and login to your account. Up till this point everything is the same for everyone. This is called **Static content**.
- Then appears your inbox and you get the mail you wanted. The inbox that appears is personalized by the **application server** and is called **Dynamic content**.

Static	Dynamic
Does not depend on other attributes	Modified in accordance with certain properties

Static	Dynamic
Processed by Web server	Processed by an **Application server**

How does it work?

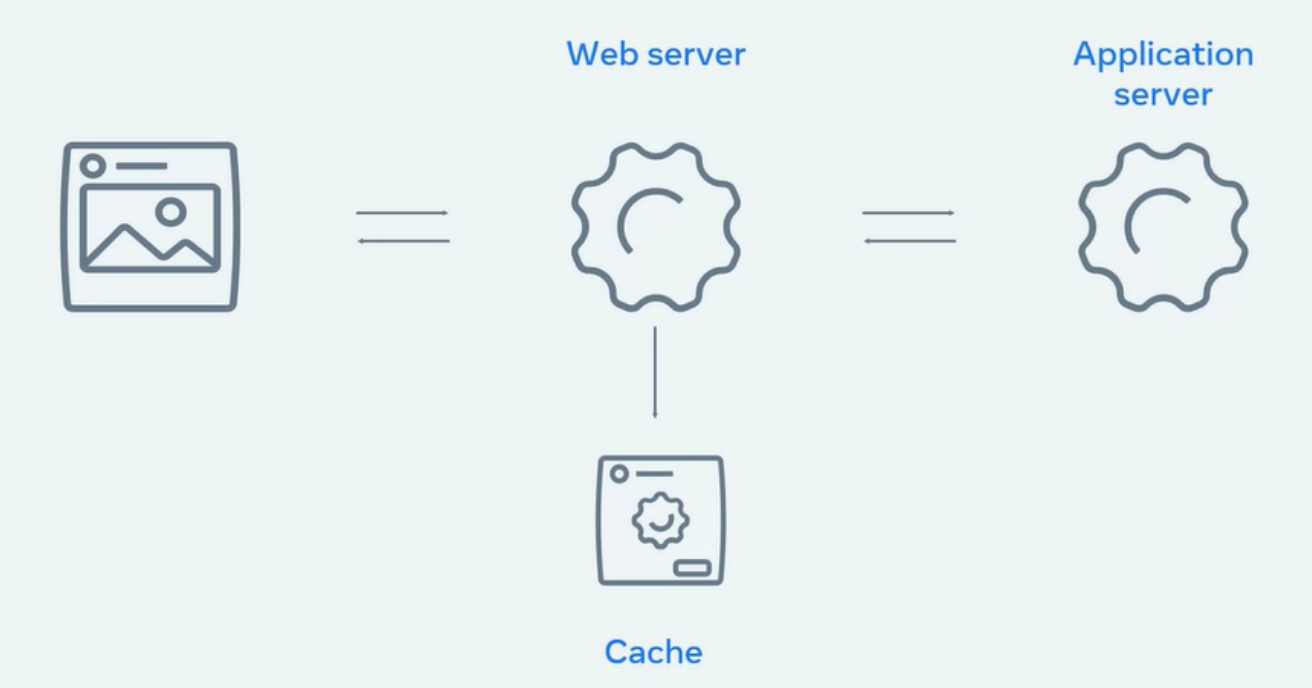
- The **application server** on getting the user input via the **web server** interacts with the database.
- Searches for the data you want.
- Sends it back to you via the **web server**.



Efficiency

Application servers are quick-to-respond thanks to the web servers. Web servers use **caching**.

Caching → The content requested by the user gets temporarily stored in the web browser to easily re-deliver it on request.



We have already discussed about **libraries and frameworks** in Module 1.

> ## Framework
>
> A well-structured plan or tool to execute an action of a specific category is a **framework**. For instance, in order to crack an egg, the steps to follow are,
>
> - Pick up the egg
> - Strike it, gently, with a hard surface
> - Crack it open with ease
>
> This is the ***framework** to crack an egg*.

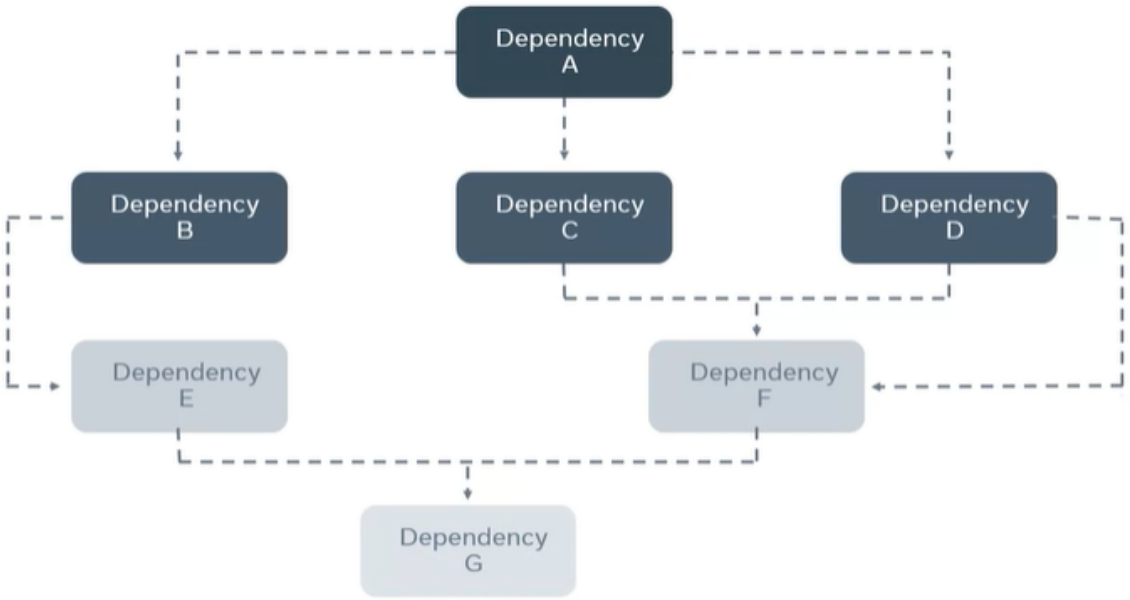
> ## Library
>
> A framework is a methodical way of completing a task. A **library** is built in a way that makes it easy to work with the framework.
>
> For instance, instead of cracking the egg with bare hands, use an egg-cracker. Here, the device acts as a **library**.

Dependencies

Using reusable and pre-built functions in code is an efficient practice.
If our code doesn't include the **dependencies** used, it will not respond to the API and get an error.
Thus, our code gets *dependent* on the **frameworks or libraries** used. Thus, they are called **dependencies**.

Package Manager

Numerous frameworks and libraries are built on top of others and thus, they are **dependent** on other frameworks and libraries. Thus, those are also **dependencies** of the original code and must be included in the code.



To simplify it, **package-managers** download all the dependencies associated with a single dependency and the correct version of them as well.

The same websites when viewed on a mobile phone and a laptop differ in the orientation of components and the layout of the webpage. The following are responsible for the same.

Fluid Images

Images via CSS can be assigned maximum dimensions so they can adjust their size in accordance with the device and its display.

Say an image of a flower is to be displayed on a webpage. We want the original size of the image if enough space is available else it must adapt itself to the device it's viewed on.

```
img {
        max_width: 100%;
}
```

This makes the image adjustable or **fluid**.

Flexible Grids

Just like fluid images, content grids, too, can be **fluid** or **flexible**. They instead of the conventional `width` and `height` CSS declarations, are associated with a percentage of the space on the webpage.

Parts	Structure	Reference
Gutter	The space between consecutive content grids	The blue line
Margins	The space between the browser window and the content grid	The black lines
Columns	The grids of content	The grey area

Media Queries

These are CSS rules to specify the orientation and layout of a webpage beforehand using CSS. Each condition which triggers the use of the specified rule is called a **Breakpoint**.

Desktop

```
@media only screen and (min-width: 700px) {
        .col-1 {
                width: 33.33%;
        }
        .col-2 {
                width: 33.33%;
        }
        .col-2 {
                width: 33.33%;
        }
}
```

The **media query** above specifies that the width of each column must be ⅓ (*one-third*) of the total space available on the webpage.

Also, `@media only screen and (min-width: 700px)` this basically means that any screen with a minimum width of 700px must have this layout. This is the **breakpoint** for the layout.

Keyword	Meaning
`@media`	To indicate a media query block
`only screen`	To indicate the target. We want the orientation to be just in case of *screens* and not *print* or *speech*
`(min-width: 700px)`	The condition which acts as a trigger point for the code

Mobile

```
@media only screen and (max-width: 700px) {
        [class *='col-'] {
                width: 100%;
        }
}
```

This code `@media only screen and (max-width: 700px)` is the **breakpoint**.

`[class *= "col-"]` declares the same CSS rule for every class-name that begins with *col-*. It can also be rephrased as

```
@media only screen and (max-width: 700px) {
        .col-1 {
                width: 100%;
        }
        .col-2 {
                width: 100%;
        }
        .col-3 {
                width: 100%;
        }
}
```

Bootstrap associates UI elements with pre-defined `class` names for `<div>` containers.

How to use it?

Class names usually have a format of `{Base-Class}-{Contextual-Class}`

- Base-Class → The basic Bootstrap component to be added
- Contextual-Class → The modification to be applied to the component

```
<html>
  <head>
    <link
```

```
      rel="stylesheet"

href="https://cdn.jsdelivr.net/npm/bootstrap@4.4.1/dist/css/bootstrap.min.cs
s"
    />
  </head>
  <body>
    <div class="container">
      <div class="row">
        <div class="alert alert-primary">Message</div>
      </div>
    </div>
  </body>
</html>
```

Here, the `container` has been used to create a grid and `row`, to place the alert message in the first row of the grid.

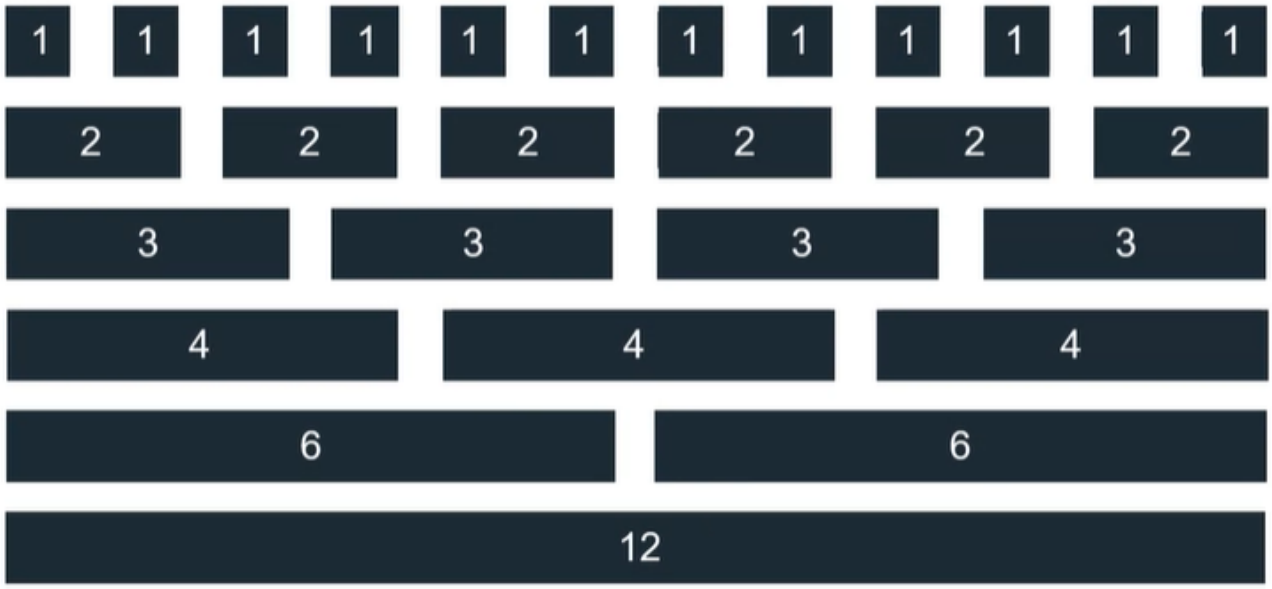
Some Common Bootstrap Components

Bootstrap Component	Bootstrap Classes	Description
Grid System	`container`, `container-fluid`, `row`, `col-*`	Used for creating responsive layouts based on a 12-column grid system.
Typography	`text-*`, `font-weight-*`	Provides text styling options for headings, paragraphs, and alignment.
Buttons	`btn`, `btn-primary`, `btn-secondary`, ...	Creates interactive buttons with various styles.
Forms	`form-group`, `form-control`, `input-group`, ...	Styles form elements like inputs, checkboxes, and select boxes.
Navigation	`navbar`, `nav`, `nav-item`, `nav-link`, `dropdown`, ...	Helps create responsive navigation menus and bars.
Alerts	`alert`, `alert-*`	Displays alert messages and notifications.
Badges	`badge`, `badge-*`	Creates badges or labels for highlighting content.
Cards	`card`, `card-header`, `card-body`, ...	Structured containers for content presentation.
Modals	`modal`, `modal-dialog`, `modal-content`, ...	Displays modal dialogs for additional content or forms.
Carousel	`carousel`	Creates image sliders or galleries.
Utilities	Margin and padding classes, text alignment, ...	Provides utility classes for spacing and alignment.

Bootstrap Component	Bootstrap Classes	Description
Responsive Classes	`d-*-none`, `d-*-block`, `d-*-inline`, `d-*-flex`, ...	Controls element visibility and behavior on different screen sizes.

Grid System

A way of *containerizing* or structuring elements within a document provided by Bootstrap. There are 3 main constituents of a **grid system**.



- **Container**
  It is the *box* which encompasses all the elements within.

- **Row**
  It is, as the name conveys, a *row* or a horizontal sub-box with a percent width of the **container** with the length of the **container**.

Prefix	Description	Instance
`-cols-{breakpoint}-#`	Size of each column in the row	`.row-cols-sm-3`

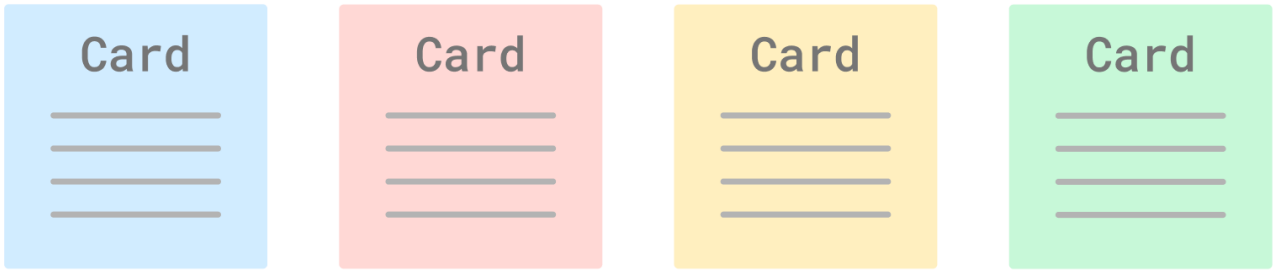
- **Column**
  It is just a **row** but vertical.

Prefix	Description	Instance
`-sm, -md, -lg, -xl, -xxl`	Breakpoints for `min-width` of device	`.col-*`

Prefix	Description	Instance
`-1, -2, -3, -4, -6, -12`	Width of the column	`.col-{breakpoint}-*`

Card

A flashcard-like structure useful for product catalogue, features and cases alike.




```
<!DOCTYPE html>

<html lang="en">
  <head>
    <link
      rel="stylesheet"

href="https://cdn.jsdelivr.net/npm/bootstrap@4.4.1/dist/css/bootstrap.min.css"
    />
  </head>
  <body>

    <div class="container">

      <div class="row">

        <div class="col">

          <div class="card"></div>

        </div>

        <div class="col">

          <div class="card"></div>

        </div>

      </div>
```

```
      <div class="row">
        <div class="col">
          <div class="card"></div>
        </div>
      </div>
    </div>

    <script src="../Bootstrap/bootstrap-4.3.1-dist/js/bootstrap.min.js">
</script>
  </body>
</html>
```

> **Note**
>
> The height of the card is variable, i.e. it depends on the *amount* of content that is in the card.

Bootstrap is a library of pre-written JavaScript and CSS codes for efficient website-making.

Functionality

Bootstrap provides with pre-designed UI elements that can be used just by modifying the value of `class` of a `<div>` container.

- **Bootstrap CSS**
  It can be used simply by adding the `<link>` element to `<head>`

```
<link
  rel="stylesheet"

href="https://cdn.jsdelivr.net/npm/bootstrap@4.4.1/dist/css/bootstrap.min.cs
s"
  integrity="sha384-
Vkoo8x4CGsO3+Hhxv8T/Q5PaXtkKtu6ug5TOeNV6gBiFeWPGFN9MuhOf23Q9Ifjh"
  crossorigin="anonymous"
/>
```

- **Bootstrap JS**
  It can be used simply by adding the `<script>` element to `<body>`.

```
<link
  rel="stylesheet"

href="https://cdn.jsdelivr.net/npm/bootstrap@4.4.1/dist/js/bootstrap.min.js"
  integrity="sha384-
Vkoo8x4CGsO3+Hhxv8T/Q5PaXtkKtu6ug5TOeNV6gBiFeWPGFN9MuhOf23Q9Ifjh"
  crossorigin="anonymous"
/>
```

React is a JavaScript library developed by Meta to create UI components.

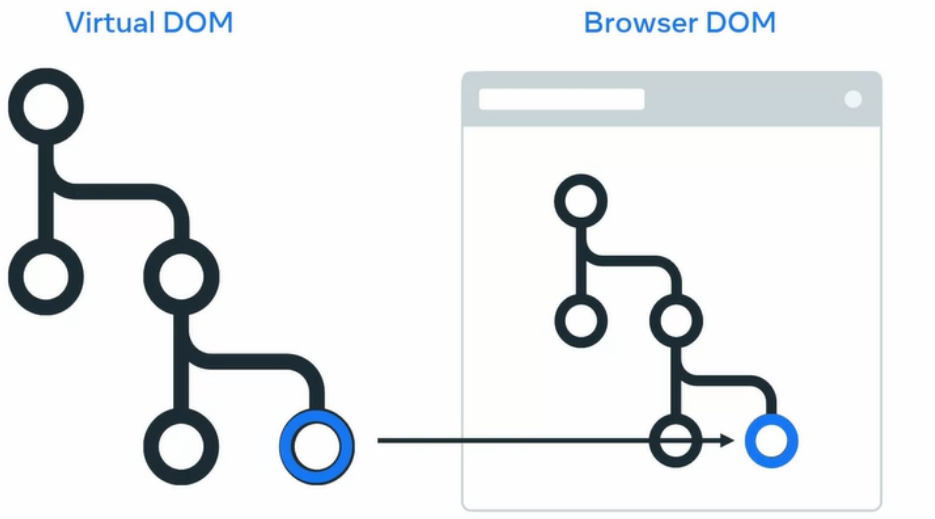
Approach

React breaks down documents into components by making a **component hierarchy** each of which is reusable. Also, React solves the problem of frequent browser updates due to changes in the DOM by a process called **reconciliation**.

Reconciliation

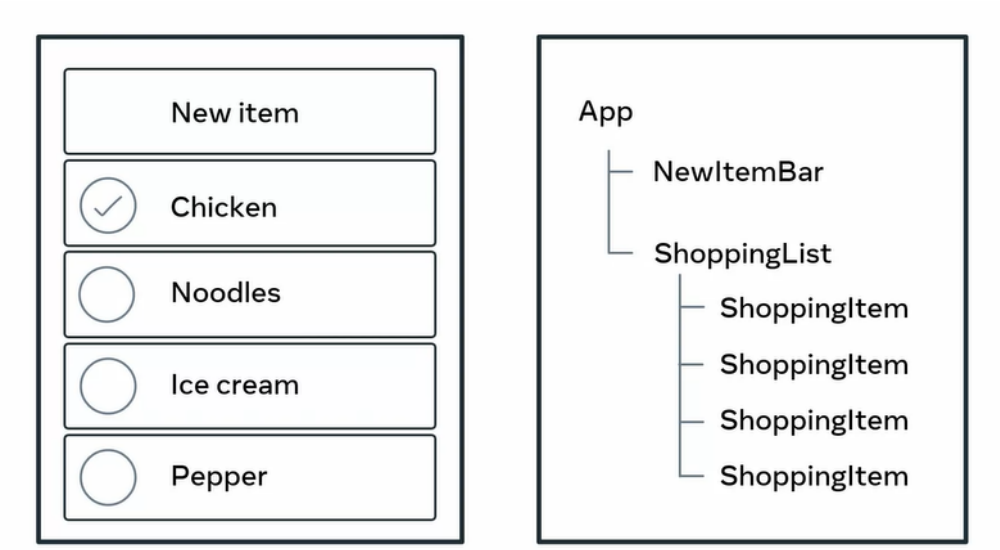
React creates a virtual representation of the browser DOM in memory and compares it with the browser DOM to check for changes.

- A change in the document would first lead to a change in the virtual DOM of React
- The updated version of the Dom will be compared with the previous version to identify the change.
- The change will then be made to the browser DOM



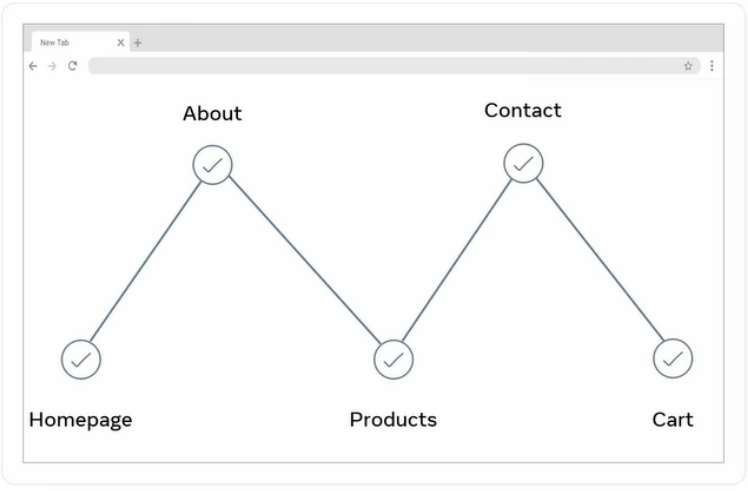
Component Hierarchy

Often, in web applications, elements *house* other elements. For instance, the shopping list below



Single Page Application or an **SPA** is a webpage that uses **Dynamic content** and updates when needed rather than being replaced by other webpages.

A traditional website is basically *a web of pages with static elements linked to each other*.



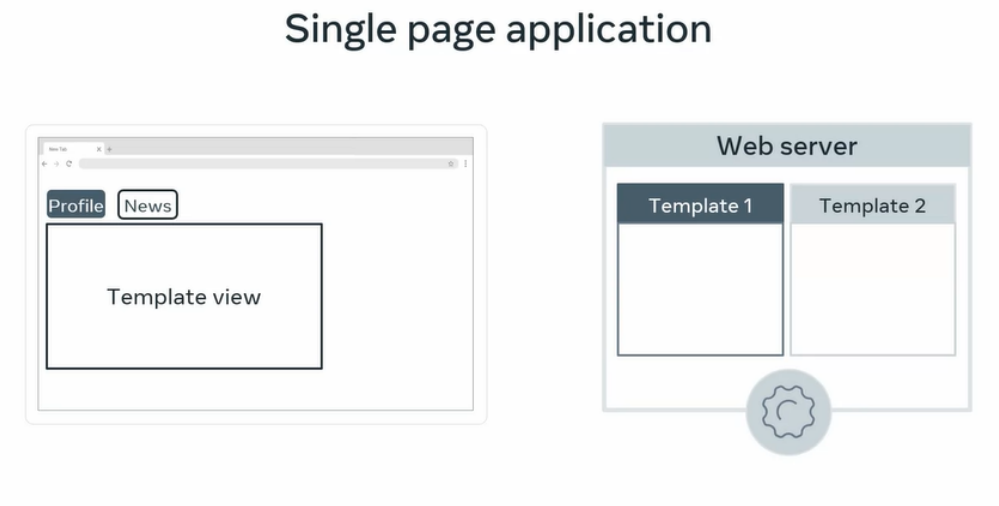
It would be inefficient for the web browser to render and reload different pages for every request. Thus **SPAs** are used.

How they work

There are two types of working of SPAs

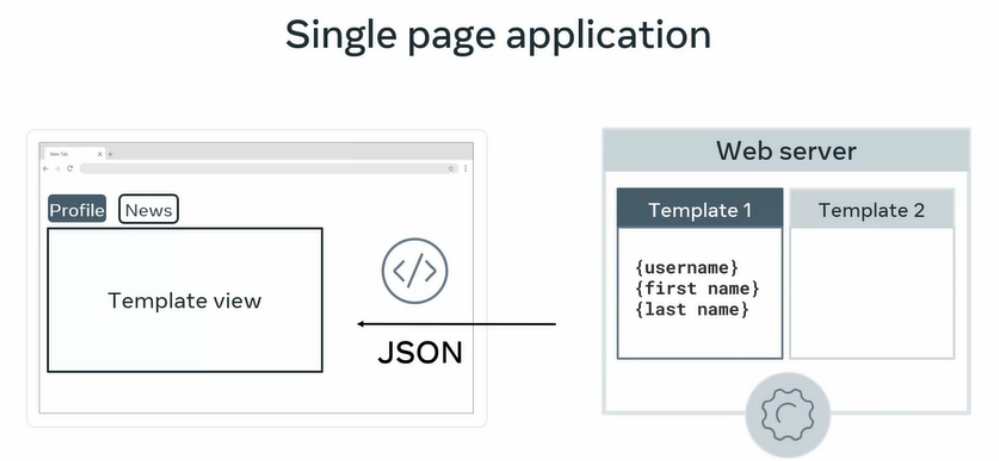
Bundling

The web server on the initial request for a webpage unloads and sends back all the required HTML, CSS and JavaScript documents.



Lazy Loading

On every subsequent request, the web server delivers data packets in the **JSON** format which are rendered in the same webpage and updated.

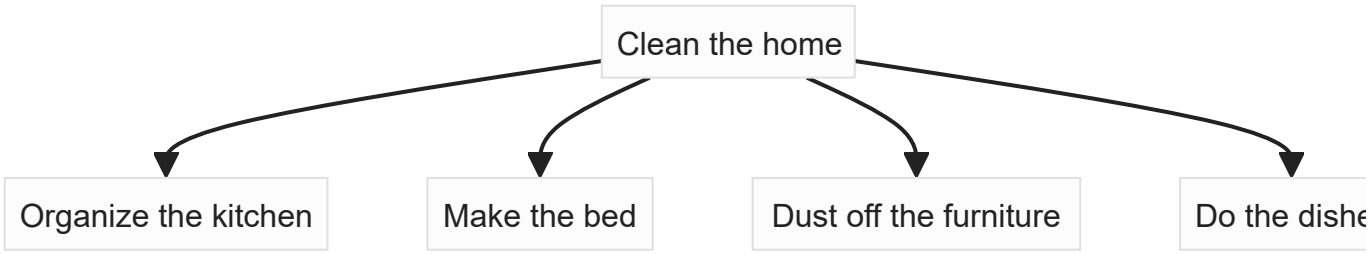


Programming is just a **tool** to solve real-world problems effectively. But translating the real-world problem into a coding one is another problem. We can use some techniques to solve such problems.

Decomposition

Tackling a complex problem can be tough. We can, therefore, *break the problem into smaller ones and solve them first* or ***decompose*** the problem.

Say for example you have the task of *cleaning your home*. Decompose it into smaller tasks.



They are symbols (not these ones) that tell the computer, what to do with the mentioned objects.

Arithmetic Operators

Operators used with numbers.
The answers to all the examples below will be 8.

Operator	Meaning	Example
+	Addition	7 + 1
-	Subtraction	14 - 6
*	Multiplication	2 * 4
/	Division	32 / 4
%	Modulus (returns the remainder on division)	18 % 10
**	Exponential	2 ** 3

Comparison Operators

To compare objects and get a Boolean value. All the examples are true below.

Operator	Meaning	Example
>	Greater than	5 > 2
<	Less than	3 < 7
==	Checks if the LHS value is equal to RHS value	9 == 9
===	Checks for the equality of value **and** data type	16 === 16
!=	Checks for unequal value	8 != 4
!==	Checks for unequal value **or** data type	1 !== "1"

Note

In the example of the **equality operator** `==` , the LHS is a **number** while the RHS is a **string**.

Since, the value of LHS and RHS is equal, the statement is true but not in the case of **strict equality operator** `===`.

Logical Operators

To logically analyze a given statement and get a Boolean value. All the examples are true below.

Operator	Meaning	Example
&& (and)	Checks if both the statements are True	5 < 8 && 4 > 2
|| (or)	Checks if either of the statements is True	5 < 8 || 4 > 2
! (not)	Returns for the logical inverse of the statement	!(2 > 3)

Placeholders to store data. The term **variable** itself refers to something which can change.

Syntax

```
/*To declare a variable and assign it a value*/
var name = "John";
```

Component	What it means
`var`	It is a **keyword** that declares a variable
`name`	Name of the variable
`=`	Assignment operator
`"John"`	Value of the variable
`;`	End of line of code

Usage

Variables are generally used when the data to store is unknown or is bound to change.

- **Input**
  In the case of inputs, we do not know the value beforehand and thus, variables are used.

- **Repetition**
  Often, a value is to be used several times in a code and variables make the code cleaner.

Example

```
/*Declare a variable*/
var marks = 90;

/*Print "Your Grade: 90" in the console*/
console.log("Your Grade: ", marks);

/*Updating the value of the variable*/
marks = 94;

/*Print "Your Grade: 94" in the console*/
console.log("Your Grade: ", marks);
```

In the above example, the variable `marks`, initially, is assigned a value of `90`. Later, its value is updated to `94`.

> **`var` keyword isn't used while updating the value of an already declared variable.**

Number data type only deals with numbers in a certain range. The rest is dealt by **BigInt**. It is a **big number** data type, indeed.

Syntax

It can be assigned in two methods.

- By adding or *appending* an `n` at the end of the number.
- By *calling the function* **BigInt()**.

```
/*Adding an 'n'*/
var bigNumber1 = 929902948475894003873n;
console.log(typeof bigNumber);

/*Calling the bigint function*/
var bigNumber2 = BigInt(9299938748890298373);
console.log(typeof bigNumber2);
```

Anything is either **true** or **false**. This represents a **Boolean** data type.

Syntax

Nothing but the words `true` and `false`, themselves.

```
/*Assigning the boolean vallue, false, to the variable, attractive*/
var attractive = false;

console.log(typeof attractive);
```

Logical Operations

Using logical operators on Boolean values, we can manipulate them.

```
/*I have a dog but I don't have a cat*/
var hasDog = true;
var hasCat = false;

/*I have a pet means I atleast have one of them ⟹ OR logical operator*/
console.log("I have a pet:", hasDog || hasCat);

/*I must have both of the pets ⟹ AND logical operator*/
console.log("I have both a dog and a cat:", hasDog && hasCat);

/*Opposite of the statement, "I have a dog: true" ⟹ NOT logical operator*/
console.log("I don't have a dog:", !hasDog);
```

It is a data type or an object that means an absence of a value, intentionally. **Null** means **nothing**.

Syntax

Just type `null`.

```
var success = null;
console.log(typeof success);
```

Simply put, **number** data type contains integers and decimals of a certain range.

```
/*Data type*/
console.log(typeof 100);

/*When enclosed in quotation marks, numbers are treated as strings*/
console.log(typeof "100");
```

Syntax

Numbers do not need any extra add-ons.

```
console.log(198);

console.log(3.14);

console.log(-1 / 2);

console.log(8 % 3);
```

Concatenation

Numbers do **concatenate** with numbers only if even one of the is a **string**.

```
var a = "10";
var b = 20;

console.log(a + b);
```

Numbers **concatenate** with strings, too.

```
var name = "John";
var age = 32;

console.log(name + age);
```

A sequence of alphabetical characters is called a **string**. In simpler terms, text is of **string** data type.

```
/*Here we assign a string ("John") to a variable*/
var name = "John";

/*This statement prints the data type of the value of the variable.*/
console.log(typeof name);
```

Syntax

Strings must be enclosed within **single-quotes** `''` or **double-quotes** `""`.

```
/*Below is a string*/
console.log("I am a Human");

/*This is the same as above*/
console.log("I am a Human");
```

```
/*Below is an exception*/
console.log('It's sunny today');
```

Note

The error above occurred because the symbol for apostrophe and single-quotes is the same.
Thus, the compiler treats the apostrophe as the end of the statement, `'It'` in this case.
A better practice is to use **double-quotes** for **strings**.

```
/*Below is an exception*/
console.log("It's sunny today");
```

Concatenation

It basically means to join or adhere. In the context of **strings**, it means to join two or more strings into one using the addition operator.

```
/*Declaring two variables and assigning them a string*/
var string1 = "Hello";
var string2 = "World";

/*This is what "concatenating two strings" mean*/
var greeting = string1 + string2;

console.log(greeting);
```

Empty Strings

Strings with no value, generally used as placeholders.

```
var name = "";
console.log(name);
```

Generally used in **cryptography**, symbols are unique objects that are used in identifying other objects.

For instance, your fingerprint or your DNA is a **symbol** to you and this **symbol is never same**.

Syntax

It can be used by calling the **Symbol()** function.

```
var id = Symbol("MachoMan");

console.log(id);
console.log(typeof id);
```

Working

Symbols are randomly generated. They are not dependent on the content.
As an example, many companies have employees with the same name. To differentiate them, we assign them an **Employee ID** that is different for every employee.

```
/*Generating Employee IDs (symbols) of the same name "Harry"*/
var id1 = Symbol("Harry");
var id2 = Symbol("Harry");

/*Despite of the symbols with the same content, the symbols are not same,
they are unique*/
console.log(id1 == id2);
```

Another data type similar to Null which, as well, indicates the absence of a value **but unintentional**.
For instance, the value of a variable when it is not assigned a value at the time of declaration is **undefined**.

```
var name;
console.log(name);
```

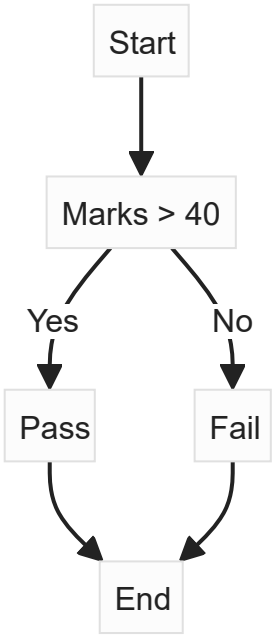
Conditions are involved in day-to-day working.
For example, *If I get my work done on time, I might get an appraisal* or *If I workout today as well, I will get in shape soon*.

Notice the pattern: ***If an event takes place, another event will occur***
Such statements are called **Conditionals**.

Approach

Often, we encounter problems in programming involving conditionals.

Say you are an examiner and have to mark answer sheets as **pass or fail**.
If the marks add up to 40%, the result is **pass**. The result would be **fail**, otherwise.



This is a **flowchart** depicting the scenario.

In JavaScript, we create **conditionals** using the `if` and `else` statements.

Syntax

Here, `condition` is replaced with the condition to be met. If the statement is true, `Event 1` is executed. Otherwise, `Event 2` will be executed.

```
if (condition) {
        Event 1
} else {
        Event 2
}
```

Example

Taking up the previous example of the examiner, we can write a JS code for it.

```
/*Arbitrary marks for testing the program*/
var marks = 80;

/*If marks are greater than 40, print "Pass" in the console.*/
if (marks > 40) {
  console.log("Pass");
```

```
} else {

/*Otherwise, print "Fail"*/
  console.log("Fail");
}
```

Multiple Conditions

Often, multiple conditions are to be met. For instance, only an adult of the Indian nationality can participate in the General Elections.

In such cases, we can use any of the below.

- `||` or `&&` logical operators
- `and` or `or` keywords

```
var age = 26;
var nationality = "Canadian";

if (age > 18 && nationality == "Indian") {
  console.log("Eligible to vote");
} else {
  console.log("Not eligible to vote");
}
```

Multiple Cases

Say you are a data analyst and have to sort out the *Children*, *Adult* and *Senior Citizen* based on their age.
Here, we use the `else if` statements to support multiple cases.

```
var age = 56;

if (age < 18) {
  console.log("Child");
} else if (age > 18 && age < 60) {
  console.log("Adult");
} else {
  console.log("Senior Citizen");
}
```

Note

> The `else if` statement can be used multiple times in a conditional but the `if` and `else` statements must be used only once, each.

As an alternative to the if-else statement, **switch** statement can be used.

Syntax

Just as in **if-else** statements the **conditionals** act as a trigger point to an event, **cases** act as the trigger points to those events in **switch** statements.

Here, `expression` is replaced with the parameter that might have many values.

If the value of the `expression` is `value1`, `event1` will take place. If the value is `value2`, `event2` will take place and so on.
If no case matches the value of the expression, the default case will be executed.

```
switch (expression) {
  case value1:
    event1;
    break;

  case value2:
    event2;
    break;

  default:
    event0;
}
```

The code above when programmed in `if-else` statements would be the understated.

```
if (expression === value1) {
  event1;
} else if (expression === value2) {
  event2;
} else {
  event0;
}
```

Example

You are a Software Engineer in an automotive company. You have been assigned the project to display on the car's dashboard screen, when to move, stop or halt, given the state

of traffic light.

```
/*For testing the program*/
var light = "green";

/*The variable "light" can have many possible cases, so it is the
expression*/
switch (light) {
  /*When `light = "green"`, "You can go" will be printed*/
  case "green":
    console.log("You can go");
    break;

  case "red":
    console.log("Stop!");
    break;

  case "yellow":
    console.log("Halt");
    break;

  default:
    break;
}
```

A high-level programming language generally used in making web applications and IoT devices.

Properties

- **Direct Interaction**
  Allows to interact with the server-side from the client-side, dynamically and remotely.

- **Backwards Compatibility**
  Makes old version of a software also called **legacy code** usable in the future as well.

- **Convenient**
  It's easy-to-use and has human-readable syntax

- **Vast Community**
  Being the most popular programming language on the planet, it has a huge community and thus, solutions to numerous problems, various packages and much more.

Syntax

Below is a code snippet of JavaScript.

```
/*To print 'Hello World' in the console */
console.log("Hello World");
```

Term	What it means
`console`	Accessing the console
`.log()`	Function to print in the console
`"Hello World"`	**Parameter** of `console.log()` or the statement to be printed
`;`	To indicate the end of line of code
`/**/`	Multiline comment in JavaScript

Next: Variables

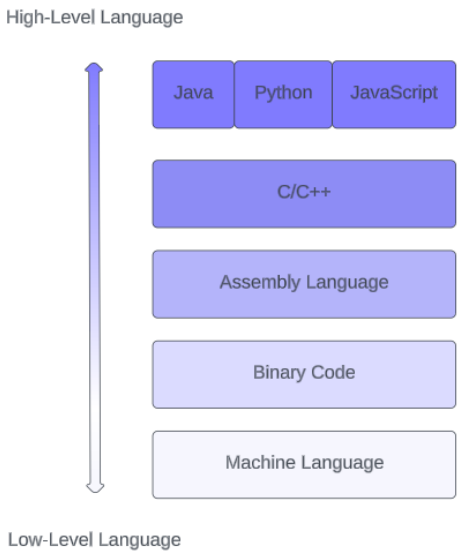
Instructing a machine to perform specific tasks or to **program** it to do something is **programming**.

Programming Languages

Machines are just a bunch of electrical circuits and therefore, to communicate with them, **programming languages** are used.

Property	Low-Level Languages	High-Level Languages
Readability	Closer to machine language and are easily understood by machines.	More human-readable and are first converted to low-level languages.

Example	Binary
	`01101001001001110100101l0`
		Python
		`def func(statement):`
		`  print(statement)`

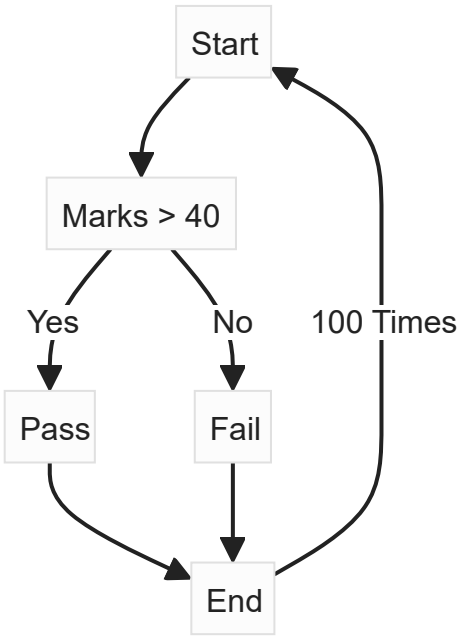


Looping basically means to repeat an action over and over again up till a given point.
For instance, *Read the text until you understand it* or *Keep running until you are tired*.

Notice the pattern: ***Keep doing action until a condition is satisfied***.
This is the basic structure of a **loop**.

Approach

Take up the scenario where you were an examiner, you have to mark 100 such answer sheets.
In such a case, the conditional needs to be **looped** over 100 times.



The above **flowchart** would depict the scenario.

Structure

Loops in JS have the similar basic structure.

Component	Function
Counter variable	To count the number of repetitions done
Condition	The loop will be executed up till the condition is satisfied or until the condition is satisfied.
Code Block	The code to be executed in each repetition

Loops can be executed in JavaScript in two ways. `for` loop is one of them.

Syntax

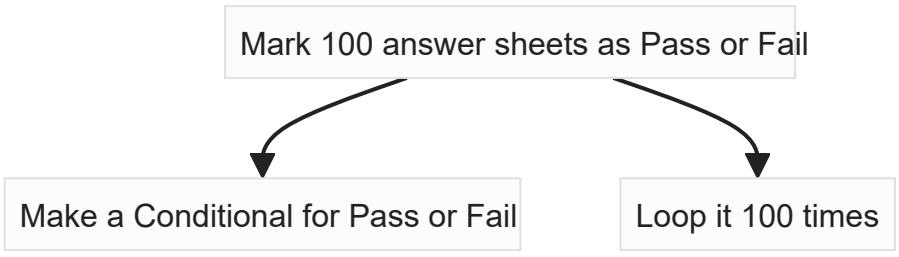
This is the crude structure of `for` loops in JS. Notice, we declare the counter variable variable inside the `for` loop.

```
for (var i; condition; increment / decrement) {
  //Code Block
}
```

Component	What it means
`for`	Initiating the `for` loop
`var i;`	Declaring a counter variable
`condition;`	The `condition` here is to be replaced with the one to satisfy
`increment/decrement`	The counter variable can either be incremented `i++` or decremented `i--`

Example

Let's take up the example of the examiner. We can use problem decomposition here.



- **Making a Conditional for Pass or Fail**
  If the `marks` are greater than 40%, the result is **Pass** else **Fail**.

```
if (marks > 40) {
  console.log("Pass");
} else {
  console.log("Fail");
}
```

- **Loop for the Conditional**
  A Counter variable `k` will be incremented until its value becomes `100`.

```
for (var k; k =< 100; k++) {

}
```

- **Add them up**
  This will be looped 100 times over and print the result of all the candidates in the console.

```
for (var k; k ≤ 6; k++) {
  if (marks > 40) {
    console.log("Pass");
  } else {
    console.log("Fail");
  }
}
```

> **Note**
>
> This is not an actually executable code. It is just a representation of how the code would look like. It is used to depict the approach of solving this problem.

A loop in another loop is called a **nested loop**.

Syntax

It is essentially made up of the `for` loops and `while` loops. Therefore, there is no different syntax for nested loops. In the each iteration of the outer loop, the inner loop completes all of its iterations.

```
for (expression1) {
                //Code block
                for (expression2) {
                        //Code Block
                }
}
```

Example

Say you have to print the days of two consecutive weeks.

```
for (var i = 1; i ≤ 2; i++) {
  console.log("Week", i);

  for (var k = 1; k ≤ 7; k++) {
    console.log("Day", k);
```

```
  }
}
```

- On running the code, when `i = 1`, `Week 1` will be printed
- Then the inner loop will be completed.
- The second iteration of the outer loop starts at `i = 2`
- The complete inner loop is executed.

The second type of loop in JS is the `while` loop.

Syntax

Its syntax is somewhat similar to the `if` statement but its components resemble the `for` loop. The `condition` will be replaced by the actual condition. Notice how the counter variable is declared outside the loop.

```
var i = 0;

while (condition) {
  //Code block
}
```

Example

We can construct a `while` loop for the same examiner problem.
The above loop will be executed until `k = 100`.

```
var k = 0;

while (k ≤ 100) {
  if (marks > 40) {
    console.log("Pass");
  } else {
    console.log("Fail");
  }
}
```

Often, while writing and executing code, we face **errors** and **bugs** which prevent the code from running the way we wanted it to.

Bugs

Mistakes or rather the code, that gets executed in another way which we didn't want.
For instance,

```
// Declaring two variables with numbers
var a = 10;
var b = "20";

// Adding the two numbers together
console.log(a + b);
```

Instead of `30`, the result is `"1020"` which is not the desired one. This is a **bug**.

Error

These are bugs that prevent the code from further execution. For instance,

```
console.log(c + d);
console.log("Hello World!");
```

Here, the variables `c` and `d` have not been declared, earlier. Thus, it *throws the* **Reference error** and the `Hello World!` statement doesn't get printed as the execution stops.

There are various predefined errors.

Error	Trigger Point	Example
Reference Error	Using undeclared variables	`console.log(x + y);`
Syntax Error	When the syntax is not correct	`var name = "John;`
Type Error	When incorrect methods are used with data types	`var age = 10; age.pop();`

The Solution

To tackle **errors** and **bugs**, we must first know where they are and then, prevent them from terminating the execution of the code. The `try-catch` statements serve this purpose.

Syntax

In the `try` statement, the code block which might produce an error, is placed. If an error is caught, the the code block inside the `catch` statement gets executed. Here, `err` is the parameter of the `catch` statement which is the error caught.

```
try {
  //Code Block
} catch (err) {
```

```
  //Code Block
}
```

Example

The code block inside `try` statement uses an undeclared variable `d` instead of `b`. This must raise the `ReferenceError()` which, in turn, would trigger the code block inside `catch` statement.

```
try {
  var a = 10;
  var b = 20;
  console.log(a + d);
} catch (err) {
  console.log(err);
  console.log("An error is caught in the above code");
}
```

Note that there is no error in the code block inside the `try` statement and thus, the `catch` block wouldn't be executed.

```
try {
  console.log("Hello World!");
} catch (err) {
  console.log("There was an error");
}
```

Info

Often, in high-level programs, there is a need of raising errors, willingly. This can be done using the `throw` statement.

```
try {
  throw new SyntaxError();
} catch (err) {
  console.log("This error was raised at will");
}
```

Now that you have marked the answer sheets as the examiner, it's time to declare the result. You have to print the marks against the name of each candidate.

`Name ⟹ Marks`

It's code would be

```
var name = "Some Name";
var result = 70;

console.log(name, "⟹", result);
```

To write this over and over again for different names, numerous variables would have to be declared. Thus, we use **functions**.
Re-usable pieces of code which perform a given *function* are called **functions**.

Syntax

```
//Defining a function
function functionName(parameter1, parameter2) {
  //Code Block
}

//Calling the function
functionName(argument1, argument2);
```

Component	What it means
`function`	It indicates that the following code is a function
`functionName()`	Name of the function
`parameter1`, `parameter2`	**Parameter** is the variable that acts as a placeholder. There can be multiple **parameters**
`Code Block`	This is the body of the function. It tells the computer what to do
`argument1`, `argument2`	**Argument** is the input given to the function while calling it. It is also the value of the **parameter**

Application

The function `result` for printing the result in the given format would be the following.

```
function result(name, marks) {
  console.log(name, "⟹", marks);
}

result("John", 80);
```

```
result("Mary", 65);
result("Isiaha", 90);
```

Note

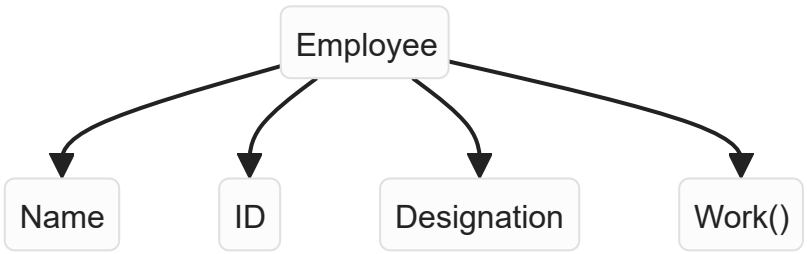
The same parameter name must be used throughout the function for the same parameter.

Hundreds of employees work in a company. Keeping track of their data can be difficult especially if it is unorganized.

```
//Employee 1
var employee1Name = "John";
var employee1Id = 1000;
var employee1Designation = "Manager";
var employee2Work = function () {
  console.log("Supervise and lead the team");
};

//Employee 2
var employee2Name = "Mary";
var employee2Id = 1002;
var emplyee2Designation = "Analyst";
var employee2Work = function () {
  console.log("Predict the market");
};
```

For just 2 employees, we have 6 different variables and 2 functions which is way inefficient. In such a situation, the data of each employee can be grouped under a single unit called **object**.



Note

> The container `Employee` is an **object**. The data `Name`, `ID` and `Designation` are called **properties**. The function `Work()` is a **method** of the object.

Syntax

Creating an **object** of name, `objectName` with two **properties** and corresponding values and one **method**.

```
var objectName = {
  property1: value1,
  property2: value2,
  method1: function () {
    //Code Block
  },
};
```

Data Type

Object is one of the many data-types in JavaScript. Other data types can be converted to the Object data type using the `Object()` constructor.

```
// Declaring a variable with a numerical value
var num = 3;

// Making it an object
num = Object(num);

console.log(num);
console.log(typeof num);
```

Some methods of `Object()`

- `create()`
  Used to create an instance of the object.

```
var food = {
  taste: "savoury",
  drl: "non-veg",
};
```

```
var chicken = Object.create(food);
console.log(chicken.taste);
```

- `keys()`
  Keys are the properties of an object.
  Lists all the *keys* or properties of an object.

```
var food = {
  taste: "savoury",
  drl: "non-veg",
};

var chicken = Object.create(food);
console.log(Object.keys(chicken));
```

- `values()
  Values are the values of the properties or **keys** of an object.
  Lists all the *values* or the values of the properties of an object.

```
var food = {
  taste: "savoury",
  drl: "non-veg",
};

var chicken = Object.create(food);
console.log(Object.values(chicken));
```

Example

Now, an object for John can be constructed using JS as follows.

```
var employee = {
  name: "John",
  id: 1001,
  designation: "Manager",
  work: function () {
    console.log("supervises and leads the team");
  },
};
```

Using the **dot-notation**, we can access the data or **properties** of the object `john`.

```
console.log(john.name);
john.work();
```

Info

Imagine, you are a manufacturer and produce the same item daily. Every aspect of every item is the same except for its `manufacturingID`. Another way of creating instances of objects can be used here.

```
// Creating an object prototype for the item
var item = {
  name: "Somename",
  pkgUnit: 0001,
  id: 0,
};

// Creating its instances
var item1 = Object.create(item);
item1.id = 1;

var item2 = Object.create(item);
item2.id = 2;
```

For increasingly complex programs, loops must also be up to the par.

- **For-of Loop**
- **For-in Loop**

Similar to the for-of loop, it is used to iterate over JavaScript components. The difference is that `for-of` loop is better suited for iterable objects like *arrays* and the `for-in` loop is suitable for objects.

Why?

Using a `for-of` loop and a `for-in` loop on a `car` object and an array, gives the following result.

- **On Object**

```
const car = {
  speed: "slow",
  weight: 1000,
};

for (let property in car) {
  console.log(property);
}

for (let property of car) {
  console.log(property);
}
```

`for-of`	`for-in`
Returns the keys of the object	raises `TypeError()` saying `car object is not iterable`

- **On Arrays**

```
const parts = ["engine", "chassis", "battery"];

for (part of parts) {
  console.log(part);
}

for (part in parts) {
  console.log(part);
}
```

`for-of`	`for-in`
Yields the elements of the array	Returns the indexes of those elements

Thus, the `for-of` loop is better for iterable components.

Say, an object has been created with some transactions in it.

```
const transactions = {
  John: -100,
  Mary: +30,
  Isiaha: +170,
  Ali: -80,
};
```

In order to list all the transactions, the following program would have to be used.

```
console.log(transactions.John);
console.log(transactions.Mary);
console.log(transactions.Isiaha);
console.log(transactions.Ali);
```

Syntax

```
for (item of iterable) {
  // Code Block
}
```

Component	What it means
`for`	Indicates a `for` loop
`item`	Variable that iterates over
`iterable`	An *iterable* object or an object that can be iterated over

Example

Here, we need to iterate over the values of the `transaction` object. We thus use the `values()` method of the `Object` constructor.

```
const transactions = {
  John: -100,
  Mary: +30,
  Isiaha: +170,
  Ali: -80,
};

for (person of Object.values(transactions)) {
  console.log(person);
}
```

A few of the less used operators in JavaScript are **spread** operator and **rest** operator.

Spread Operator

Printing out the names of hundreds of students stored in an array or an object is quite tedious. The fast way is the **spread** operator `...`

```
const students = ["John", "Mary", "Isiaha", "Ali", "Michael"];

console.log( ... students);
```

Rest Operator

It is used in creating sub-arrays out of lengthier arrays.

```
// Creating an array
const students = ["John", "Mary", "Isiaha", "Ali", "Michael"];

// The first three variables are assigned to the first three elements and
the rest of the elements are pushed in the participants array
const [john, mary, isiaha,  ... participants] = students;

console.log(john, mary, isiaha);
console.log(participants);
console.log(students);
```

ⓘ De-structuring

In the above code, the `students` array is de-structured or in other words, it is broken down into several components.

```
const toppers = ["Isiaha", "Michael", "Mary", "John", "Ali"];
const [first, second, third, …consolation] = toppers;

console.log(first);
console.log(consolation);
```

Each of the variables `first`, `second` and `third` have the values as the first three elements of the array and the rest are stored in the `consolation` array.

One way of creating variable strings is

```
var name = "John";
console.log("Hey!", name);
```

But using it for multiple variables isn't much maintainable.

Syntax

Here, the variable that is to be included in the string, is wrapped inside `{}` *curly-brackets* preceded by a `$` and the string is to be wrapped in `` *backticks*.

```
var name = "John";

console.log(`Hey! ${name}`);
```

A few more methods to manipulate arrays and retrieve the desired data

`forEach()`

What it says is, *for each element in the array, perform a function*.

Say, you have a list of the students who have passed. The task is to add `Pass` against each of their names.

One way is using a `for` loop.

```
const students = ["John", "Isiaha", "Mary"];
const newArray = [];

for (student of students) {
  newArray.push(`${student} : Pass`);
}

console.log(newArray);
```

The other way is `forEach()` method.

```
const students = ["John", "Isiaha", "Mary"];

// For each student in the array, replace the string at the index with
"Name: Pass"
students.forEach(function (name) {
  students[students.indexOf(name)] = `${name} : Pass`;
});

console.log(students);
```

`map()`

It is similar to `forEach()` but the slight difference is that it transforms the array into a new one where `forEach()` performs some action on the same array.

`map()` methods accepts the array, executes the function for each element and stores the result in a new array.

```
const students = ["John", "Isiaha", "Mary"];

const newStudentArray = students.map(function (name) {
  return name + ": Pass";
});

console.log(newStudentArray);
```

`filter()`

As the name suggests, it *filters* out the unwanted and returns what we input.

```
const students = ["John", "Mary", "Isiaha"];

const studentsWithNameJohn = students.filter(function (name) {
  return name === "John";
});

console.log(studentsWithNameJohn);
```

Containers are used as storage units. Arrays, too, are such containers.

Syntax

This is the basic structure of an array. Each of the elements has an **index** or the position in the array. `element1` has the index `0`, `element2` has `1` and `element3` has `2`.

```
var array = [element1, element2, element3];
```

Component	What it means
`array`	Name of the array
`[]`	Container
`element1, element2, element3`	**Elements** or the data stored in the array

Operations

Just storing data and not being able to retrieve it or edit it would make the container useless. Understated are some of the operation on arrays.

- **Retrieving**
  Accessing or getting the data back from the array is retrieval. Any element can be accessed if its index is known or vice-versa.

```
var fruits = ["papaya", "melon", "litchi"];

// Getting the element using index
console.log(fruits[1]);

// Getting the index using the element
console.log(fruits.indexOf("melon"));
```

- **Length**
  Arrays can contain virtually infinite elements. Knowing the number of elements can be simplified.

```
var fruits = ["papaya", "melon", "litchi"];

console.log(fruits.length);
```

- **Appending**
  Adding elements to an array is called **appending**.

```
var fruits = ["papaya", "melon", "litchi"];

fruits.push("mango");
console.log(fruits);
```

Example

An array containing some books would be

```
var books = ["The Alchemist", "The Hobit", "Think and Grow Rich"];
```

```
// Getting a book
var hobit = books[books.indexOf("The Hobit")];
console.log(hobit);
```

```
// Adding another book
books.push("Rich Dad Poor Dad");
console.log(books);
```

```
// Getting the length of the array
var len = books.length;
console.log(len);
```

Not the locations ones, they essentially hold data but in a *key-value pair*.

There are 3 boxes each with a label and uniquely colored set of balls.

A simple way to remember the box containing a specific color of balls would be to associate them.

- Box 1 → Yellow
- Box 2 → Green
- Box 3 → Pink

This is called a **map** and each of these is called a **key-value pair**.

Syntax

Here a **map** is created using the `Map()` constructor.

```
const colorBalls = new Map();
```

Component	What it means
`colorBalls`	Name of the map
`new`	To create a new instance of the object `Map()`
`Map()`	Constructor function of the `Map()` object

Methods

Some of the methods used on **maps** are as follows.

- `set()`
  To add a key-value pair

- `get()`
  To get the value of a key

Example

Taking up the instance of box containing balls.

```
const colorBalls = new Map();

// Adding key-value pairs using set() method
colorBalls.set("Box 1", "Yellow");
colorBalls.set("Box 2", "Green");
colorBalls.set("Box 3", "Pink");

// Retrieving the value of a key
const box2 = colorBalls.get("Box 2");

console.log(colorBalls);
console.log(box2);
```

They basically are arrays with the only difference being that **sets** cannot contain duplicate elements.

Syntax

```
var array = [1, 2, 3, 4];

const sampleSet = new Set(array);
```

Component	What it means
`sampleSet`	Name of the set
`new`	To create a new instance of the object `Set()`
`Set()`	Constructor function of the `Set()` object
`array`	A sample array that the `Set()` constructor takes in as an argument

Initially, there isn't much use of **sets**. Thus, extra methods aren't mentioned here.

Example

Repeating items in a grocery list would neither be nice to the pocket nor to the storage.

```
let groceryList = ["milk", "oatmeal", "bread", "eggs", "cereal", "milk"];
```

```
groceryList = new Set(groceryList);
console.log(groceryList);
```

Here, the repeated item `milk` has been removed as **sets** can not contain duplicates.

DOM or Document Object Model can be accessed using JavaScript in the browser.

`document` Object

Each webpage is stored in a DOM, and precisely, inside a JavaScript object named `document` which can be accessed through the console as follows.

```
document;
```

Creating Elements

Elements can be created using JavaScript, as well.

```
document.createElement("h1");
```

This creates an `<h1>` element in the webpage.

Accessing Elements

The elements inside the `document` object can be accessed by using the `querySelector()` method which takes in the element as an argument.

```
// This will return the first <h2> element
document.querySelector("h2");
```

These elements can be accessed by `class` and `id` as well.

- `class`
  This can be done using the `getElementbyClassName()` method.

```
document.getElementbyClassName("primary");
```

- `id`
  This can be done using the `getElementbyId()` method.

```
document.getElementbyId("heading");
```

Editing the Elements

Just accessing and not being able to edit these elements would be meaningless. This can be achieved using the `innerText()` or `innerHtml()` methods.

```
const heading = document.querySelector("h1");
heading.innerText = "Hello World!";
```

This changes the text of the heading to `Hello World!`.

JavaScript is used to add interactivity to websites and this is where it begins. Handling events basically means to *look out for any interaction made by the user*.

Click or Tap

Say, you are building a webpage which accepts user input and prints it in the console on the click of a button. How will the button know what to do?

One way of assigning a function to a button is using the `addEventListener()` method.
It takes in two arguments.

- Type of event, click in this case
- The function to assign the component.

Example

A button can be assigned a function of printing `Hello World!` in the console.

```
function print() {
  console.log("Hello World!");
}

const btn = document.querySelector("button");
btn.addEventListener("click", print);
```

The second method is by adding the `onClick` attribute to the element in the HTML document itself.

```
// index.js
function print() {
  console.log("Hello World!");
}
```

```
%% index.html %% <button onClick="print()">Print<button></button></button>
```

One of the ways of writing code professionally and minimizing the effort is using **modules** which basically are pieces of JavaScript code that can be re-used.

Say, for instance, you have been creating a Banking System in JavaScript.

```
class Bank {
  // A lot of code
}

class Account {
  // Some Code
}

class Savings extends Account {
  // Some code
}

class Current extends Account {
  // Some Code
}
```

In such a case, managing multiple classes in a single file is confusing. These classes can be written and accessed over independent files.

```
// bank.js

class Bank {
  // Some Code
}
```

```
// account.js

class Account {
  // Some code
}

class Savings {
  // Some code
}

class Current {
  // Some code
}
```

Each of the files is called a **module**. All of them can be accessed using `import`.

```
// main.js

import Bank from "./bank.js";
import Account from "./account.js";
```

Component	What it means
`import`	Importing means receiving
`Bank, Account`	The classes or methods to import
`./bank.js`	The file which contains the classes or methods

Just as in Apparel and Clothing, it's not the clothes, what matters is the sense of color and combination. In programming, *what makes the code cleaner and more professional is the style of writing it*.

These styles are called **paradigms**. The difference is not in the syntax but in the order and style. Two of them are

- Functional Programming
- Object-Oriented Programming

FP for short, functional programming majorly involves **functions** to write programs. The variables are separated from the functions, herein.

Example

A program, in the FP paradigm, for calculating the total price of a transaction.

```
// Function separated from the data
function totalPrice(cost, taxRate) {
  return cost + (cost * taxRate) / 100;
}

// Data in the form of variables
var sampleCost = 100;
var sampleTaxrate = 3;

// Invoking the function with the data
var amount = totalPrice(sampleCost, sampleTaxrate);
console.log(amount);
```

Recursion means *repeating an action*, just like loops. But, recursion can also be achieved using functions.

Approach

Say you have to make a counter of n days in the console.

- **Using Loops**
  A `for` loop would do the work.

```
// Sample variable to test the loop
var n = 5;

// The loop
for (var i = n; i ≥ 1; i--) {
  console.log("Day", i);
}
```

- **Using Functions**
  Herein, we call the function inside itself.

```
// The function
function getDays(n) {
  console.log("Day", n);
  if (n === 1) {
    return;
  } else {
    getDays(n - 1);
  }
}

// Sample call to test the program
getDays(5);
```

On running the program,

- First, `Day 5` is printed.
- If the value of `n` is `1`, exit the function and terminate the program else call `getDays(n - 1)`.
- The function `getDays()` then gets called for `n - 1 = 5 - 1 = 4`.
- The above steps are repeated until `n === 1`.

Note

> The bottom limit for `n` was chosen to be `1` as the function would be called for `n - 1` which would be `0` in the case, printing `Day 0` which didn't make much sense.

A function for calculating the speed of a car would be

```
function getSpeed(distance, time) {
  console.log(distance / time);
}
```

What about acceleration?

```
function getAcceleration(speed, time) {
  console.log(speed / time);
}
```

But, the speed is calculated by another function `getSpeed()`. The result of the `getSpeed()` function can be used as an input in the `getAcceleration()` function using `return` **statements**.

```
// Defining the functions
function getSpeed(distance, time) {
  return distance / time;
}

function getAcceleration(speed, time) {
  return speed / time;
}

// Declaring the variables
var sampleDistance = 100;
var sampleTime = 2;

// Assigning the returned values to variables
var calaculatedSpeed = getSpeed(sampleDistance, sampleTime);
var acceleration = getAcceleration(calaculatedSpeed, sampleTime);

// Printing the values in the console
console.log(calaculatedSpeed, acceleration);
```

Here, the `return` statement gives back the output whenever the function is called.

Say, in this case, two students of the same name *Harry Snyder* belong to each of the classes. For the teachers, it would be easy to address them since there is only one *Harry*

Snyder in each class. But for the *Principal*, this would create confusion since both of them belong to the same school.

Example

Variables declared in a block of code are *scoped to that block*. Here, two variables of the same name co-exist only because one of them is scoped to the `for` **block**.

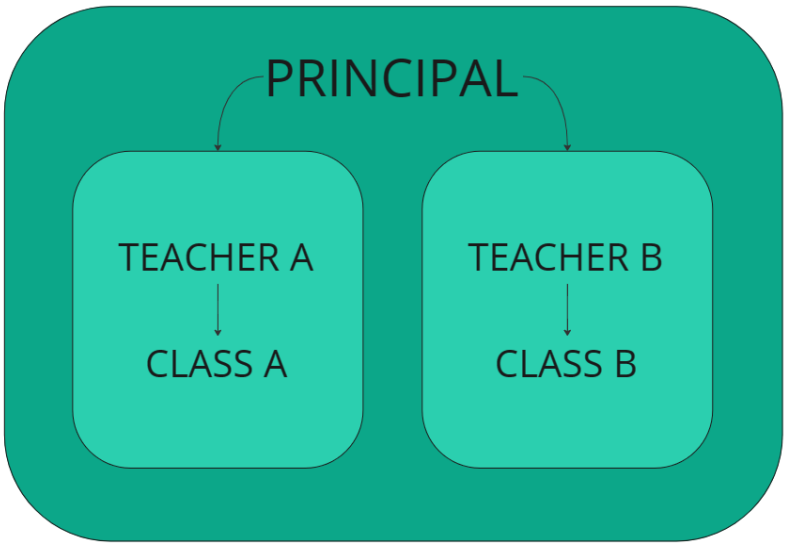
```
// Declaring a variable at global scope
let name = "Harry Snyder";

function getName(classRoom) {
  let name = "Harry Snyder";
  console.log(name + classRoom);
}

getName("A");
console.log(name);
```

> **Note**
>
> This only works with let and const declaration keywords.

In a school, there are many classrooms which all have a different set of students and a teacher.
The teacher can deal with the students of his/her own class but not of other classes.
But, the principal must deal with all of the students to keep a check on how well they perform.



Why?

Scope might seem unnecessary but is actually very useful.

- Commonly, extra variables have to be declared inside functions which are not significant in the program otherwise, `speed` and `acceleration` in this case. Scope allows for such variables to be inaccessible outside the code.

```
function getAcceleration(distance, time) {
  var speed = distance / time;
  var acceleration = speed / time;
  return acceleration;
}

console.log(speed);
```

- Using declaration keywords other than `var`, makes those variables absolute which can be used to store sensitive information.

```
// Declaring a variable using const
const name = "John";

// Its value cannot be updated
name = "Mary";
```

The *Principal* here must keep a check on students of the all the classes. She, thus, belongs to the **global scope**.

Variables declared at the **global scope** can be accessed anywhere within the program.

```
// Declaring a variable at the global scope
var name = "John";

// Defining a function using the variable declared above
function printName() {
  console.log(name);
}
```

In the scenario of a school, the students of *Class A* can be accessed only by *Teacher A* and same for *Class B*. Thus, the students of *Class A* belong to the **local scope** for *Teacher A*.

Variables in the **local scope** are *localized* or can be accessed only in the part of the program where it is declared.

```
fucntion declareName() {
        var name = "John";
}

console.log(name);
```

Here, the compiler *throws* the `Unexpected Identifier` error because `name` is in the **local scope** and can only be accessed within the function.

> **Note**
>
> The name has been printed outside the function

Just like `let`, it also used to scope a variable to a block. It is the most strict keyword in JavaScript.
It is generally used when **a variable's value must or should not change** making it a **const**-ant.

- It cannot be redeclared

```
// Initial declaration
const name = "John";

// Declaring the same variable again
const name = "Mary";
```

- It cannot be updated

```
// Initial Declaration
const name = "John";

// Updating its value
name = "Mary";
```

- It cannot be used before its declaration

```
// Using the variable
console.log(name);

// Declaring the variable
const name = "John";
```

The **keywords** used to declare variables. For instance, `var`.

- **var**
- **let**
- **const**

It is generally used when *scoped to a block*.

Properties

- It cannot be redeclared

```
// Initial declaration
let name = "John";

// Declaring the same variable again
let name = "Mary";
```

- It can be updated

```
// Initial Declaration
let name = "John";

// Updating its value
name = "Mary";
```

- It cannot be used before its declaration

```
// Using the variable
console.log(name);

// Declaring the variable
let name = "John";
```

The `var` keyword is the most lenient one.

Properties

- It can be redeclared

```
// Initial declaration
var name = "John";
```

```
// Declaring the same variable again
var name = "Mary";
```

- It can be updated

```
// Initial Declaration
var name = "John";

// Updating its value
name = "Mary";
```

- It can be used even before its declaration

```
// Using the variable
console.log(name);

// Declaring the variable
var name = "John";
```

We had created objects for the employees for efficient management. But creating hundreds of such objects would still be repetitive.

Also, notice that the properties and methods are the same for every employee, just the values differ. We, can, thus, create a framework of an **Employee** called **class** with the following properties and methods.

^906559

Each employee would thereby be called as an **instance** of the **class** Employee and *instantiating the class* would mean the creation of an employee.

Syntax

Below is a **class** named `className` with two methods `constructor` and `method1`.

```
class className {
  constructor(argument1, argument2) {
    this.property1 = argument1;
    this.property2 = argument2;
  }
  method1() {
    // Code Block
  }
}
```

Component	What it means
`class`	It is the keyword to make a class
`className`	Name of the class
`constructor`	A special method which is automatically called at the time of instantiation
`this.property1`	Referring to `property1` of the instance
`argument1`	The value assigned to `property1`

The method named `constructor` is a special type of method called **constructor**. It is called as soon as a class is *instantiated* or *an instance of the class is created*. It isn't required to call.

```
// Instantiating the class
const instance = new className();

// Calling a method of the class instance
instance.method1();
```

Example

- **Employee**
  A class named **Employee** can be created, similarly. An instance of the class `Employee` is an **object**, itself. Here `john` is an object.

```
// A basic framework for Employee
class Employee {
  // A function called at the time of instantiation
  constructor(name, id, designation, job) {
    // All the properties (data) of an employee
    this.name = name;
    this.id = id;
    this.designation = designation;
    this.job = job;
  }

  // A method which prints the job of the employee
  work() {
    console.log(this.job);
  }
}

// Instantiating the Employee class
const john = new Employee(
```

```
  "John",
  1001,
  "Manager",
  "Supervise and lead the team"
);

console.log(john);
```

- **Animal**
  Animal can be treated as a class which can have many different instances such as dogs and cats.

```
// Animal Class
class Animal {
  constructor(type, sound, color) {
    this.type = type;
    this.color = color;
    this.sound = sound;
  }
  makeSound() {
    console.log(this.sound);
  }
}

// Instantiating or creating an instance of the class
const dog = new Animal("Dog", "woof", "Black");
const cat = new Animal("Cat", "meow", "Snowwhite");

dog.makeSound();
cat.makeSound();
```

The term itself, Object-Oriented programming or **OOP** for short, means *programming with a profound use of objects*.

Herein, data with similar properties is grouped under an object, unlike **FP**.

Example

Writing this program in OOP paradigm,

```
// The object with all the data of the transaction
var transaction = {
  // Properties
  cost: 100,
  taxRate: 3,
```

```
  // Method
  totalPrice: function () {
    return transaction.cost + (transaction.cost * transaction.taxRate) /
100;
  },
};

// Calling the method totalPrice()
console.log(transaction.totalPrice());
```

The procedure of simplifying and generalizing things is called **abstraction**.

In the example of animals, the `Animal` class is not used or *instantiated* directly instead it forms the super-class of `Fish` and `Bird` classes. Here, `Animal` is an **abstract class**. The methods of such classes are, therefore, **abstract methods**.

Example

`Shape` forms the base-class of `Triangle` because triangle is a form of shape. Here, `area` is an abstract method as the dimensions of the shape are not accepted in the `Shape` class but it still has some unknown area.

```
// Abstract class
class Shape {
  constructor(sides) {
    this.sides = sides;
  }
  // Abstract method
  area() {
    console.log("Dimensions not known!");
  }
}

// Concrete class
class Triangle extends Shape {
  constructor(height, base, sides = 3) {
    super(sides);
    this.h = height;
    this.b = base;
  }
  area() {
    return this.h * this.b * 0.5;
  }
}
```

```
const triangle = new Triangle(5, 5);
console.log(triangle.area());
```

A sick person consumes medicines, which essentially are chemicals wrapped in a thin sheet or *encapsulated*, to get better. One need not know the exact working of the chemicals inside the capsule. It simplifies the process.

This is what **encapsulation** means. 'Hiding' or 'wrapping' code that is not useful for the user. In such a lengthy piece of code, the user can access the methods just by typing the last 2-4 lines.

Example

> ```
> // Animal Class
> class Animal {
>         constructor(type, sound, color) {
>                 this.type = type;
>                 this.color = color;
>                 this.sound = sound;
>         }
>         makeSound() {
>                 console.log(this.sound);
>         }
> }
>
> // Fish Class
> class Fish extends Animal {
>         constructor(color, habitat) {
>                 super(color);
>                 this.habitat = habitat;
>         }
>         move() {
>                 console.log("Swimming in the waters!");
>         }
> }
>
> // Bird Class
> class Bird extends Animal {
>         constructor(color, habitat, sound) {
>                 super(color, sound);
>                 this.habitat = habitat;
>         }
>         move() {
>                 console.log("Cutting through the air!")
>         }
> }
> ```

```
var sparrow = new Bird("brown", "forest", "chirp");
var dolphin = new Fish("black-white", "oceans");

sparrow.makeSound();
dolphin.move();
```

The act of taking possession from previous generations is called **inheritance**. For instance, a child inherits his/her ancestral property.

In the example of animals, knowing that animals can have numerous sub-categories such as mammals, birds, fishes, amphibians, etc. **Sub-classes** for the can be created, as well.

The two **sub-classes**, Birds and Fishes, have a common parent class, also called the **super-class**, Animal.

Syntax

The `extend` keyword is used to indicate inheritance. The `super` keyword instructs which argument is to be inherited.

```
class subClass extends superClass {
  constructor(arg1, arg2) {
    super(arg2);
    this.param2 = arg2;
  }

  method1() {
    /*Code Block*/
  }

  method2() {
    /*Code Block*/
  }
}
```

Example

```
// Animal Class
class Animal {
  constructor(type, sound, color) {
    this.type = type;
    this.color = color;
    this.sound = sound;
  }
```

```
  makeSound() {
    console.log(this.sound);
  }
}

// Fish Class
class Fish extends Animal {
  constructor(color, habitat) {
    super(color);
    this.habitat = habitat;
  }
  move() {
    console.log("Swimming in the waters!");
  }
}

// Bird Class
class Bird extends Animal {
  constructor(color, habitat, sound) {
    super(color, sound);
    this.habitat = habitat;
  }
  move() {
    console.log("Cutting through the air!");
  }
}

var sparrow = new Bird("brown", "forest", "chirp");
var dolphin = new Fish("black-white", "oceans");

sparrow.makeSound();
dolphin.move();
```

Note

We didn't write the `makeSound()` method for the `Bird` class but it was successfully called, for the `Bird` class inherits the methods of `Animal` class, as well.

poly means "many" and *morph* means "form". **Polymorphism** means taking multiple forms. In OOP, often the same method or object can output different results.

Example

Herein, the `+` operator is used in both the situations, similarly. But, the output is different. The first one yields the string `"Pineapple"` and the second one, the number `7`.

```
// Using '+' with strings
console.log("Pine" + "apple");

// Using '+' with numbers
console.log(3 + 4);
```

OOP is built, while keeping in mind, on four programming pillars.

- Inheritance
- Polymorphism
- Abstraction
- Encapsulation

There are many testing frameworks available for JavaScript. **Jest** is one of them. Writing tests for code using Jest is efficient as it supports **Code Coverage** which is the percentage of code covered in tests.

Setup

First, the Jest package is to be installed using **npm**.

```
npm install jest
```

A test file is created separately for testing.

```
// main.test.js

// The default framework to run the tests would be Jest and thus, it is
required in this file
const { default: TestRunner } = require("jest-runner");

// The function add() is to be tested and has to be imported from main.js
file
const { add } = require("./main.js");
```

A main file where a function to be tested is stored.

```
// main.js
function add(a, b) {
  return a + b;
}

module.exports = { add };
```

The `module.exports = {add}` means that *the following objects or functions can be accessed by other files*.

The test is created using the `test()` method.

```
// main.test.js

const { default: TestRunner } = require("jest-runner");
const { add } = require("./main.js");

// test() takes two arguments
// 1. A comment
// 2. A function or rather the test itself

test("Adds two numbers", () => {
  // Expect the value that this function returns to be 3. If not, the test
fails.
  expect(add(1, 2)).toBe(3);
});
```

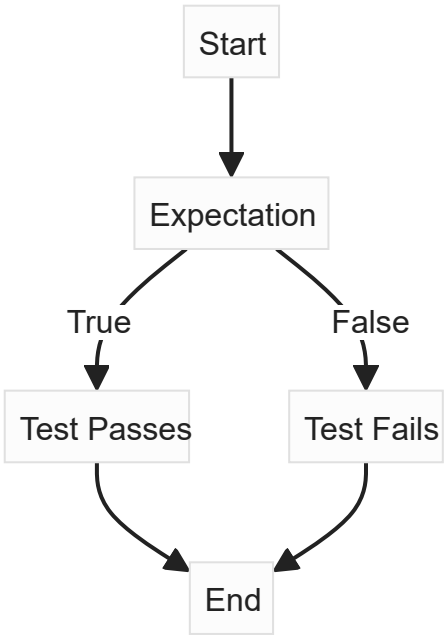
A teacher explains and educates the students. In order to check their knowledge, the teacher then examines them by taking their **tests**.

Tests, essentially, are a way to verify or check whether the expectations regarding some event are true or not.

If the students fail the tests, the teacher's expectation that the students understood the concepts was wrong. It would be right, otherwise.

Approach

In programming, it is important to verify that the code runs as expected. Thus, **tests** are used.



This is the basic structure of a test. A failed test is called **red** and a passed test is called **green**.

Improvement

The examination of students allows them to know where they were wrong to improve in the future. Programs are just like students.

Red-Green Refactor Cycle

It is just a fancy way of stating that **red** programs are corrected and updated to make them **green**. Following is the complete cycle of actions.

- A program fails in a test
- It is updated to make it **green**
- It is further optimized for better readability

The purpose of testing can vary. It might be the correct functioning of all the elements together or the output to be as expected.

e2e

Also known as **End-to-End** testing, e2e basically means testing the application as a user. Using the application just as a user would, allows developers to get the user experience.

Integration

Testing if all the components of an application work together in harmony, is the purpose of Integration testing.

Unit Testing

One of the many problem-solving techniques is decomposition. It can be applied to testing as well.
The program is broken down into smaller code blocks or **units**. Each of those units are then tested.

Workflow in Version Control System involves environments for testing and development.

Staging

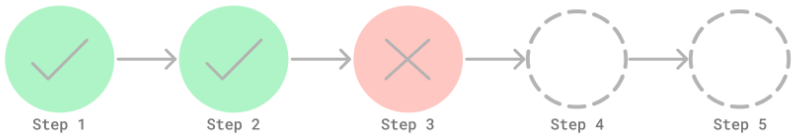
It basically acts as the first sieve which enables the developers to improve the software.

- Testing new features
- Catching obvious errors

Production

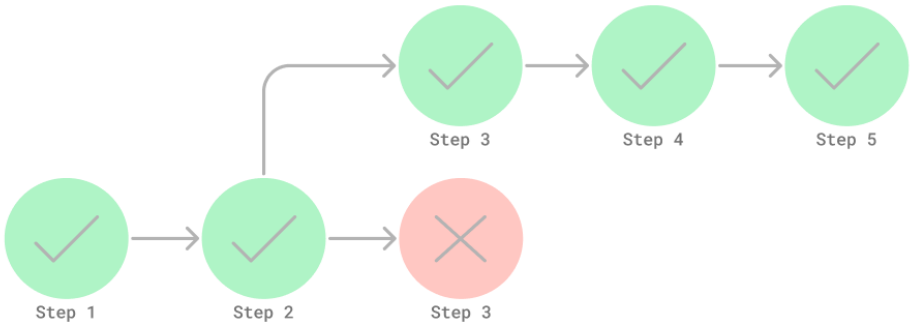
The next environment which is live for the users to interact with.

Assume yourself as a chef in a busy restaurant. While preparing a dish, you made an error in one of the steps to follow. This ruined the entire dish.



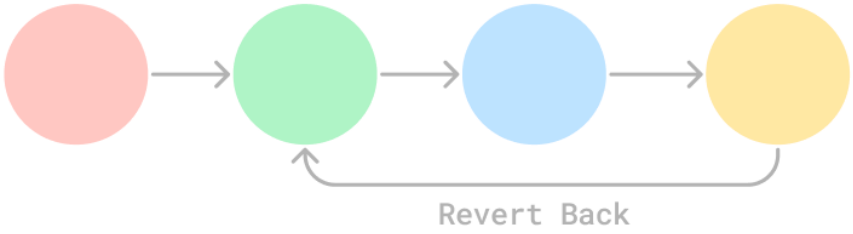
Preparing a Dish

What if, you could travel back in time to **Step 2** and prepare the dish, correctly?



Preparing a Dish

In programming, small changes in code cause errors that might even take days to resolve. A solution would be to revert back to the code when the change wasn't made, yet.

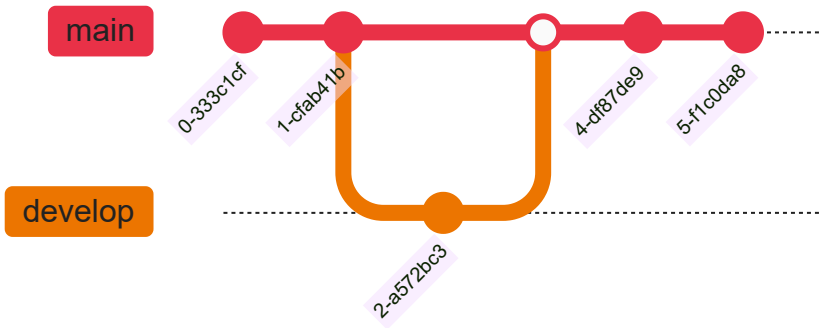


This is what **Version Control** does. It tracks all the changes made to a file and makes them available to the user to go back to in a specific folder called **Repository**.

Example

While testing the addition of some new feature in a project, the feature might not work. Modifying the code, over and over again would be inefficient.

A solution would be to make a testing version of the file. Modify it. If the code works, then update the version of the main file to this one. Else, leave it.



There are many reasons as to why use Version Control.

Revision History

It provides the history of all changes made in a file and the ability to *undo* the changes.

Identity

Not only does it record the changes, but also **who made them**.

Collaboration

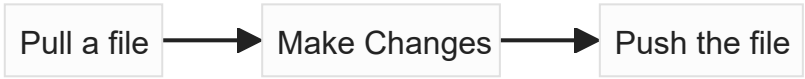
Provides the ability to access the changes and files from remote devices and thus, **collaborate** efficiently.

Version Control, itself, isn't sufficient. There are numerous tools and strategies that need to be implemented along with it.

Workflow

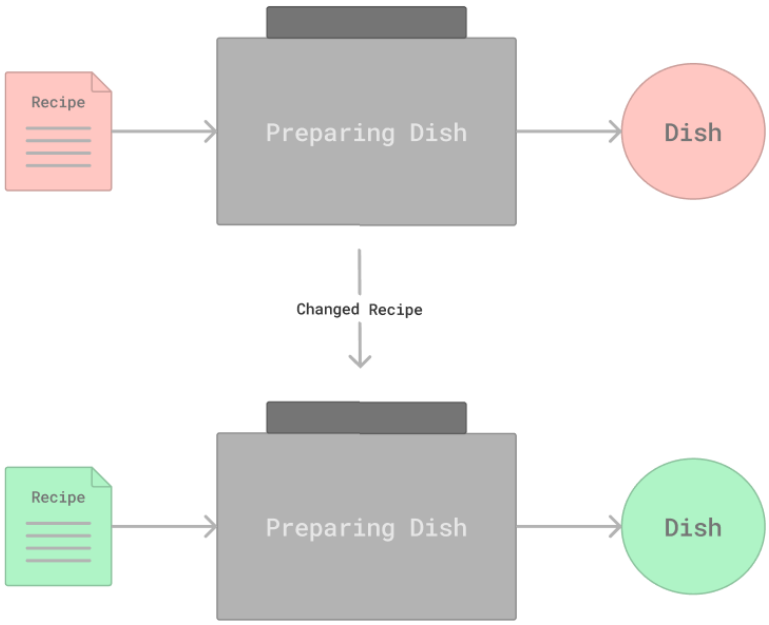
It is, essentially, a *protocol* or a set of steps that can be modified and are followed, while using a VCS.

This is a basic example of a workflow which is, usually, more complex than this.



Continuous Integration

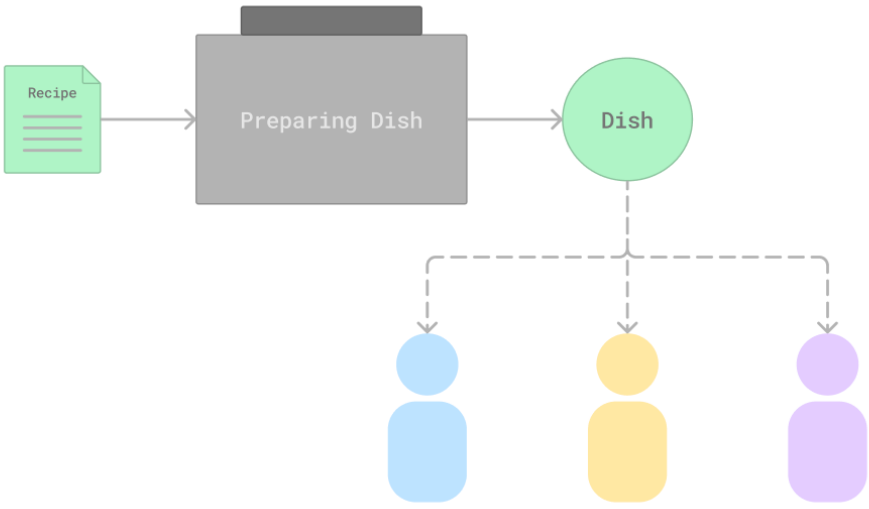
Being a chef, it is essential to get feedback on the dishes and make changes to the recipe. Making changes to the recipes is one part, *preparing dishes according to it is another part*.



In other words, ***any small change made must be implemented instantaneously***. This is **Continuous Integration** or **CI** for short.

Continuous Delivery

The next step after preparing the improved dish, is to deliver it to the customer to let them taste.



This is **Continuous Delivery**. ***Any small change implemented must be made available to use instantaneously***. It is an *extension* of **CI**. Together, they are called **CI/CD**.

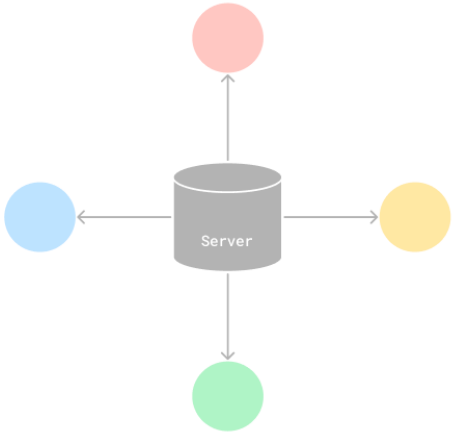
There are broadly two types of Version Control Systems (VCS).

Centralized

Centralized Version Control System, or **CVCS** for short, is a **Client-Server framework**.

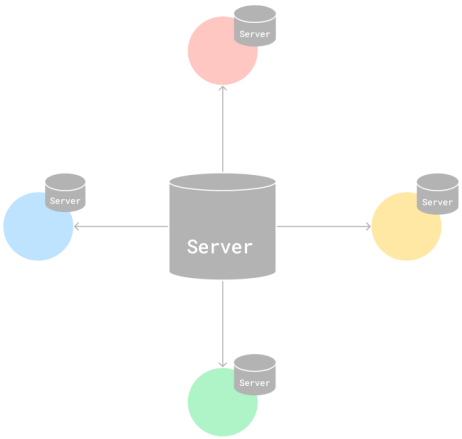
All the files and their **versions** are stored on the server. The client, then, can access and update the files as and when required.

- The client first ***pulls*** or retrieves a file from the server.
- Any update, to be made, is made.
- The client then ***pushes*** or stores the newer version of the file on the server.



Distributed

DVCS for short, it is essentially the same as **CVCS** but the difference is that it is a **Client-Client framework**. Here, the client acts as a server. So, all the data needs to be pulled once and pushing isn't required.



Command Line Interface or **CLI** is a **GUI** (*goo-ey*) or **Graphical User Interface** used to interact with the computer. It can be used to *command* the computer through an *interface* to perform numerous tasks.

Setup

The **Git Bash** program is a CLI which can be installed from the Git website. It is, generally, used to make Git commands.

Some actions

Some of the tasks that can be done via the **bash**.

Creating a Directory

A directory, essentially a folder, named `userdata` can be created using the `mkdir` command in the **bash**.

```
%% Make a directory named userdata %%
mkdir userdata
```

Changing Directory

Changing the current working directory to the previously created `userdata` using the `cd` command.

```
%% Change current directory to userdata %%
cd userdata
```

Create a File

A JavaScript file named `index` can be created using the `touch` command.

```
touch index.js
```

Flags

Often, simply using the commands doesn't suit our needs. **Flags** are the options and choices that are specified with the command to get the desired result.

For instance, while ordering a sandwich in Subway, you might customize the sandwich by providing your choices as

Ingredient	Preference
Mustard Sauce	Yes
Lettuce	No
Bread	Whole Wheat

These are flags which in **bash** could be written as

```
order -mustardSauce y -lettuce n -bread whole-wheat
```

> ⚠ **Warning**
>
> This is only an example and not an actual instance of the usage of flags in the bash or terminal.

As mentioned earlier, directory is just a folder. Using CLI, numerous other actions on such folders can be performed.

List Contents

What the directory contains can be printed out in the **bash** using the `ls` command.

```
ls
```

Flags

- `-la` → Print out all the hidden files and folders, as well.
- `-l` → Print the contents in a list format.

Current Working Directory

Or **cwd** for short, is the folder the user is in, currently. It can be printed using the `pwd` command.

```
pwd
```

Move Directory

Placing the `directory_to_move` directory into the `target_directory` can be done using the `mv` command.

```
mv directory_to_move target_directory
```

Several actions can be performed on files via the CLI.

Printing Content

The contents of a file , `LICENSE.electron.txt` here, can be printed in the CLI using the command `cat` .

```
cat LICENSE.electron.txt
```

Word Count

The total number of words in a file can, too, be printed in the CLI using `wc` along with the flag `-w`.

```
wc LICENSE.electron.txt -w
```

Standing for **Global Regular Expression Print**, **GREP** is used to filter out the results as wanted.

Using the command `ls`, prints out a whole list of items.

```
ls -l
```

To get what is needed, the results can be filtered using the command `grep` using pipes.

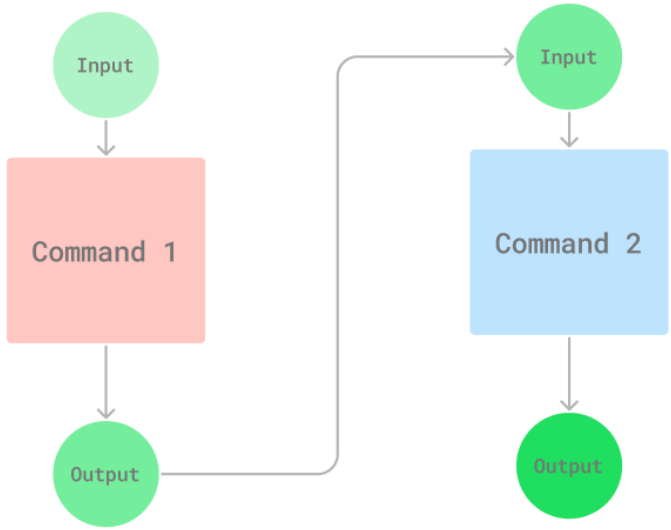
```
ls -l | grep resources
```

Flags

Flags	Usage
`-i`	Include partial results which may have the keyword wherever in the filename
`-w`	Results which have the name specified

Pipe establishes connection between points. It takes the input from one and transports it to the other end as output.

Pipes, in CLI, act the same way. They take the output from a command as the input to another command.



Example

To get the word count of a file, a way would be

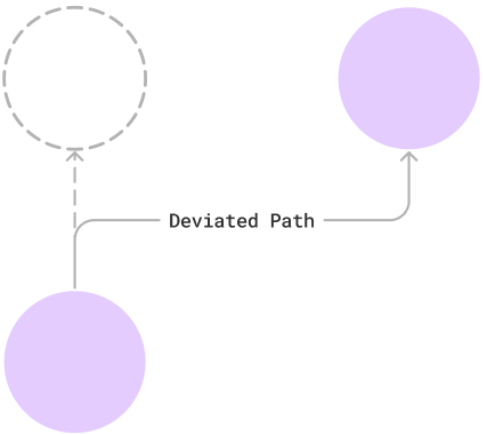
```
cat textfile.txt
wc textfile.txt -w
```

Using a **pipe**, it can be done as follows.

```
cat textfile.txt | wc -w
```

- First, `textfile.txt` is printed out
- The printed text, then, is taken as the input for the next command
- Word count of the text is then printed

Redirecting means deviating something from its original path.



In CLI, it means the same but in context of the location of files. All the inputs and outputs of

the commands in CLI go to the `stdout` standing for **Standard Output** and `stdin` standing for **Standard Input** which are files to store the data.

The location or file where the data goes can be customized or in other words, *it can be **redirected***.

Input

To accept input from the user, the `cat` command can be used. `Ctrl+D` can be used to stop accepting input.

```
cat
```

Redirecting the input to a custom file can be done using `>` operator which can be then read out using the `<` operator.

```
%% Accepting input %%
cat > input.txt

%% Printing output %%
cat < input.txt
```

Output

To store the output of a command, the `>` operator can be used here, as well.

```
wc textfile.txt -w > output.txt
```

Error

The `2>` can be used here to store any error caused by a command.

```
%% helloworld.txt does not exist %%
wc helloworld.txt -w 2> error.txt
```

As a chef, you made a mistake while cooking the dish. But corrected it by reverting back to before the mistake was made and starting from there.

This is called ***branching***. Creating a *new flow* or **branch** and continuing from there.

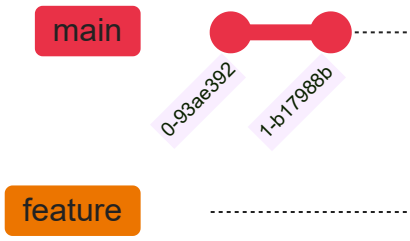
Application

Branching is quite common amongst developers.

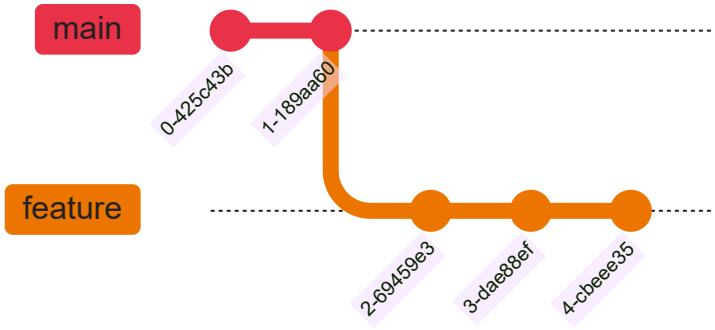
Say as a developer, you need to add a new feature to a program. The code of the new feature might cause errors in the working of the program, as it is under development.

This is a special case of branching called ***feature branching***

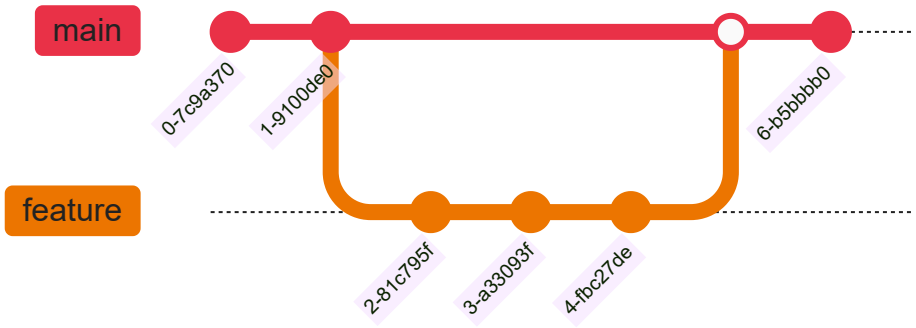
It will be a good practice to create a new **branch** where this feature would be added to the program and be tested for any errors.



The `feature` branch is like a copy of the `main` branch. Making changes in the copy won't affect the actual code.



If no errors arise, it can be ***merged back*** into the `main` branch, *i.e.* the code of the `feature` branch can be added to the `main` branch.



Commands

Purpose	Command	What it means
List all the branches	`git branch`	*Print all the branches that currently exist in this repository*

Purpose	Command	What it means
Create a branch	`git branch origin`	*Create a branch named origin*
Switch to the branch	`git checkout origin`	*Make all the changes from now on in the origin branch*
Merge branches	`git merge origin`	*Make all the changes, made in origin branch, in the master branch*
Delete branches	`git branch -d origin`	*Delete the branch named origin*

> **Info**
>
> After merging a branch into `master`, the branch still remains with the changes. Merging basically means copying all the changes made in a branch to `master`.

Application

The above scenario can be re-created, programmatically.

> **Note**
>
> This is just a recreation of the scenario and not an actual implementation of such a project.

Creating a project

```
%% Initialize a Repository %%
git init

%% Create a file and Write some Code %%
touch index.js
cat > index.js
```

Creating a Branch

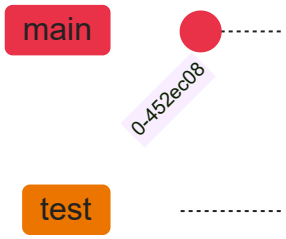
The need is of adding a feature to a program in JavaScript.

So, a branch must be created called `test`.

```
git branch test
```

Just creating a branch is not enough, switching to it is also important to implement. This can be done using the command `checkout`.

```
git checkout test
```

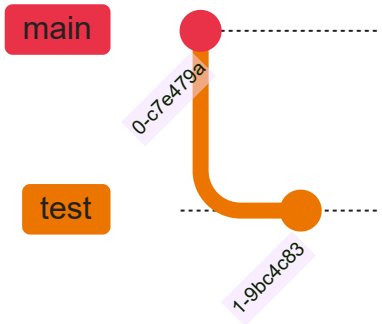


Making Changes

```
cat > index.js
git add .
```

Committing the Changes

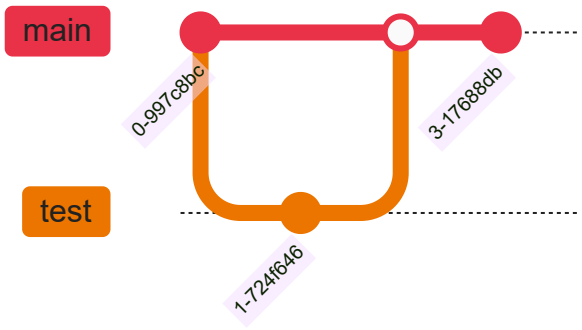
```
git stage .
git committ .
```



Merging in the Master branch

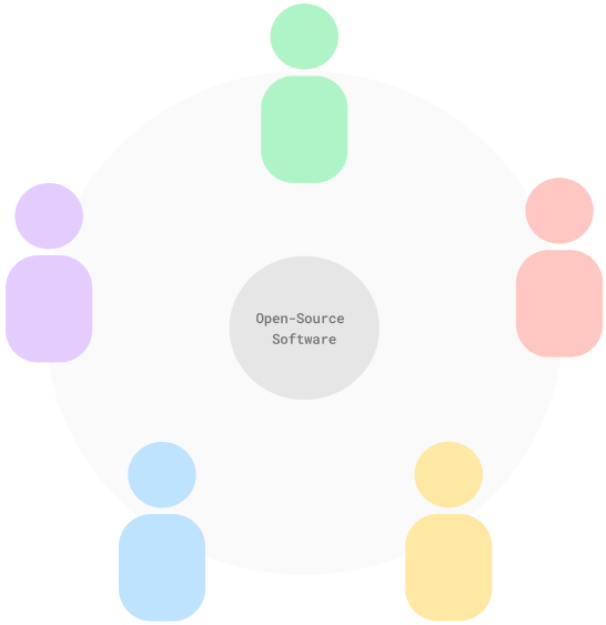
If the functioning is correct, `test` can be *merged into* `master` branch.

```
git checkout main
git merge test
```



Simply put, lending a helping hand is **contribution**.

On GitHub, there are numerous projects that are maintained by developers around the world called **Open Source Software**. These can be accessed, used or modified by anyone.
For instance, Linux and Python



Making a Contribution

Say a repository named `softdev` is an **Open Source** project created by `OpenTech`, *i.e.* it is a public repository. In order to *make a contribution* or change the *repo*, a series of steps must be implemented.

- **Forking the Repository**
  Any *repo* cannot be accessed directly. It, first, must be forked into the personal account.

```
gh repo fork opentech/softdev
```

- **Cloning the Repository**
  Cloning means installing a copy of the *repo* on the local device.

```
git clone https://www.github.com/SomeOrg/OpenTech
```

- **Creating a Feature Branch**
  To add a new feature and test it, a new branch is created. Such a branch is called a **feature branch**.

```
git branch feature
git checkout feature
```

- **Making the changes**

```
%% Some code %%
```

- **Pushing the changes**

```
git push origin feature
```

- **Making a Pull Request**
  Simply, making the changes in a copy of the Open Source project won't work. The changes must be merged with the main project.

  To do this, a request must be sent to the owner of the project to review and merge the changes. This is called a **Pull Request**.

```
gh pr create
```

Any repository, public or private, can be *copied* onto the personal GitHub account, including its contents. This is called ***forking***.

Command

There is no Git command for ***forking***. Instead, it can be done using the `gh` command which accesses the GitHub CLI.

```
gh repo fork URL_of_repo
```

Application

Say Microsoft's *repo* `vscode` is to be forked into your account. The *repo* name can be copied from the `GitHub CLI` tab besides the `HTTPS` tab.

```
gh repo fork microsoft/vscode
```

Git is a Distributed Version Control System which can be installed locally from the official Git website.

GitHub is a UI, *User Interface*, for Git which has its own CLI called **GitHub CLI** which can be installed from its official website.

Setup

Both of Git and GitHub require setup to work with them.

- **GitHub**
  It can be done by creating an account on GitHub.

- **GitHub CLI**
  For `gh`, the user must be authenticated via GitHub by executing the following command in GitHub CLI, itself, and proceeding with the inputs.

```
gh auth login
```

- **Git**
  - First, create an SSH key-pair using `ssh-keygen`
  - Two files will be created, after entering the right input
  - Copy the contents of `<filename>.pub`
  - Go to `GitHub > Menu > Settings > SSH and GPG keys > New SSH key`
  - Give it a name of choice
  - Paste the key and Add it

- In the Git Bash, run the command `git config --global credential.helper store`
- Done!

Creating a Repository

A repository or ***repo*** for short contains some files and mainly revision history.

- Head over to the `New` button on the left panel.
- Add the name of your repository
- Choose for
  - `Public` → Anyone can see it
  - `Private` → Only you can see
- Create the repository

The changes committed to a repository or file can be seen via the `git log` command. But ***what changes made***, ***who made them*** and at ***what time*** is accessed by the command `git blame`.

Command

```
git blame filename
```

Output Format

The `blame` command produces output in a specific format.

```
<Hash Id>
<Author>
<Timestamp>
<Content>
```

Working with a Version Control System like Git revolves around what and how to access repositories.

Remote

What cannot be accessed directly is **remote**. Similarly, a ***repo*** which cannot be accessed directly from the computer or machine is called a **remote repository**.
Every repository on GitHub is a remote *repo*.

Creating a Remote Repo

Every *repo* **created** on GitHub is a remote one.

Local

Every folder or *directory* and file on a computer is **local** to it. Thus, any repository on the computer itself, is called a **local repository**.

Creating a Local Repo

Using the Git command, `init`, a **local *repo*** can be *initialized* or created.

```
%% Changing to the directory where the repository is to be created %%
cd repofolder

%% Initializing a Git repo %%
git init
```

One of the most common and basic workflows in Git to maintain the revision history of a repository involves four states of a file.

The status of a repo can be verified using the `status` command.

```
git status
```

Untracked

Any new file created in an initialized local repo is **untracked**. In other words, Git doesn't have the ability to *track* the changes made in it.

To give this right to Git, the command `add` is used.

```
git add .
```

> `.` **is used to track all the files for every Git command.**

> **Info**
>
> Any changes made to Untracked files can be reverted using the command `git reset --hard HEAD`

Modified

Whenever a file is renamed, deleted or updated, it is considered **modified** in Git terminology.

```
cd my-repo
touch readme.md
```

Staged

After any changes in the file that need to be saved, the file is *brought onto the stage*.
Just like some subject brought onto the stage to get a photo clicked.

```
git stage readme.md
```

To remove the file from being **staged**, the `restore` command with the `--stage` flag.

```
git restore --stage readme.md
```

Committed

If the changes need to be saved, the changes in the files are **committed** or in other words, their photograph is finally clicked.

```
%% Adding some text in the file via input %%
cat > readme.md

git commit readme.md
```

This *photograph* or **commit** of the changes made goes to the `.git` folder where the **revision history** is stored.

Example

As a developer, you are assigned the task to write a JS program in a repository and **commit** it.

1. **Create a Repository**

```
%% Changing directory (if needed) %%
cd myprojects
```

```
git init
```

2. Create a file and Write the Program

```
touch index.js
cat > index.js
```

3. Add, Stage and Commit

```
%% Add %%
git add index.js

%% Stage %%
git stage index.js

%% Commit %%
git commit -m "Created a JS program called index" index.js
```

> ⚠ **Warning**
>
> Note that `add` command is to be used only once for a file and for every subsequent change made, use the `stage` followed by `commit` command.

> 🖉 **Note**
>
> Here, the `-m` flag is used to add a message to the commit made to indicate what change has been made.

After creating a remote repository, assume you have to make changes to it.

To do this,

- A *pipeline* or connection must be created which would join the computer and GitHub server.
- Then, the remote *repo* must be brought onto the **local** computer, via the *pipeline*.
- From the computer, the changes made can be pushed into the *pipeline*.
- These changes would be travel across the *pipeline* to GitHub where they would be made.

This *pipeline* is called a **remote**.

The next step to change a remote *repo* is to ***clone*** or download the remote repository onto the computer to make changes to it.

This can be done using the Git command `clone`.

```
git clone url_of_the_repo
```

Example

Cloning the repo `OpenTech`,

```
%% Changing Directory to opentech-repo %%
cd opentech-repo

git clone https://www.github.com/SomeOrg/OpenTech
```

Remotes can be added using Git command in the Bash.

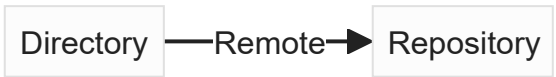
List the Remotes

To look for any *pipelines* or remotes currently linked, the Git command `remote` is used.

```
git remote -v
```

Add a Remote

A **remote** is created between one directory of the computer to a repository on GitHub




```
git remote add name_of_the_pipeline url_of_the_repo
```

Here,

- `name_of_the_pipeline` → Name of the remote or *an alias to the remote* .
- `url_of_the_repo` → URL of the repository which is `https://www.github.com/<username>/<repository>` .

Remove a Remote

After the work is done, the remote ***can***, not necessarily, be removed using the `remote remove` command.

```
git remote remove name_of_the_connection
```

Example

Add a remote or *pipeline* for a repository named `OpenTech` .

```
git remote add origin https://www.github.com/SomeOrg/OpenTech
git remote -v
```

Any changes made to the ***cloned*** repo must be, first, committed.

```
git stage file1 file2
git commit -m "Commit Message here"
```

Following that, these changes need to be pushed via the *pipeline* to the repository on GitHub.

This can be done using the Git command `push` .

```
git push pipeline from_where
```

Here,

- `pipeline` → Name of the remote
- `from_where` → The branch in which the changes are committed

Example

Pushing the changes to `OpenTech`

```
git push origin master
```

It means *push the changes from the master branch to the repo via origin*.

User data can be accepted in many forms and formats.

Text

For plain text such as *username*, *description* or fields alike.

```
<input type="text" />
```

Password

It includes a toggle button to show or hide the password. It is hidden by default.

```
<input type="password" />
```

File

To choose a file from the system memory.

```
<input type="file" />
```

Time

Data is input in the time format.

```
<input type="time" />
```

Reset

A button to reset all the input fields to empty in a form.

```
<input type="reset" />
```

> **Note**
>
> Despite being an `<input>` tag, it is rendered as a button.

URL

For entering a URL with the correct format.

```
<input type="url" />
```

Color

To select a color from a color picker.

```
<input type="color" />
```

Range

Renders a slider to select a value between an upper and lower limit.

```
<input type="range" min="-100" max="100" />
```

> **Tip**
>
> To display the current value of the slider, an `<output>` semantic element is used. Along with the `oninput` attribute which specifies *the function to execute when an input is given*.
>
> ```
> <input
>   type="range"
>   min="-100"
>   max="100"
>   value="5"
>   oninput="this.nextElementSibling.value = this.value"
> />
> <output>5<output></output></output>
> ```
>
> This code basically says *If an input is given to the slider, change the value of the next element, i.e. the output element to the current value of the slider.*

Radio

It can be used when to select only one value of some given options of the same property or `name`.

```
<input type="radio" name="input-type" value="Text" />
<input type="radio" name="input-type" value="Password" />
```

```
<input type="radio" name="input-type" value="Number" />
```

> **Tip**
>
> Radio buttons for the same property can be grouped using the `<fieldset>` HTML element.
>
> ```
> <fieldset id="input-type">
>   <input type="radio" value="Text" />
>   <input type="radio" value="Password" />
>   <input type="radio" value="Number" />
> </fieldset>
> ```
>
> It serves the same functionality as the `name` attribute.

Checkbox

Same functionality as radio, the difference being that it allows for multiple values to be chosen for the same property or `name`.

```
<input type="checkbox" name="input-type" value="Text" />
<input type="checkbox" name="input-type" value="Password" />
<input type="checkbox" name="input-type" value="Number" />
```

After filling out all the details in the fields of an Authentication System, the details travel to the server to get processed.

How?

The details travel to the server as a part of an HTTP request which acts as a link between the client and the server.

There are two HTTP methods which deliver such data.

- **GET**
  It is more insecure and unreliable than POST and is thus, not recommended. The data travels through as a part of the URL.
  For instance, the submission of an Authentication form would create the URL,
  `http://www.example.com/username=admin&password=welcome`

- **POST**
  It is a recommended option. The data is in the HTTP request's payload.

```
POST/ HTTP/1.1 Host: example.com Content-type: application/form Content-
length:
32 username=admin&password=welcome
```

Application

It can be implemented in HTML forms using its `action` and `method` attributes.

Attribute	What it does
`action`	Where to send the data
`method`	How to send the data

- `action`
  Its value is a URL. It takes the base address as the current address which for instance, is `http://www.example.com/profile`.

Semantics	What it means
`action="/login"`	`http://www.example.com/login`
`action="login"`	`https://www.example.com/profile/login`

- `method`
  It can have, broadly, two values. `GET` and `POST`.

For efficient verification of results, the data validation process is divided in two parts. The first one being **Client-Side Validation**. Some of the techniques used for the same are understated.

Input-type Comparison

The attribute `type` of the `<input>` tag is compared with the type of actual input. If it is correct, the process proceeds, else an alert message is prompted.

Significance

Another one is to check if data is entered in all the ***required*** fields or not. If not, an alert is shown.

> **Info**

A required field is the one that needs to be filled else the form won't be submitted. This can be done using the `required` attribute.

```
<input type="text" required />
```

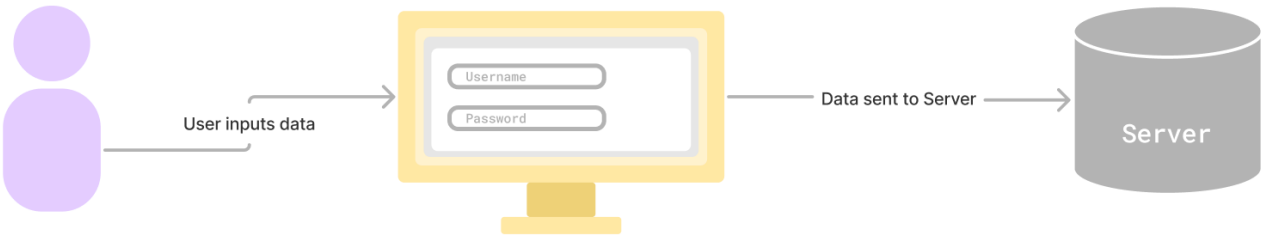
Specifying Range

Using `minlength` and `maxlength` to set limits to word count in text-type or number-type input field is another option.

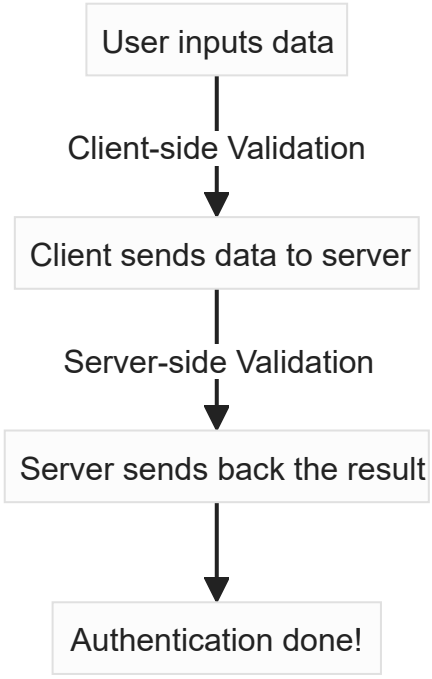
Websites use numerous ways to verify the data entered with *what **should** have entered*. Simply put, this is **form validation**. *form* because the user data is input via HTML forms.

Approach

Say, for instance, in an Authentication System, the user enters the input for Username and Password. If the credentials are correct, authentication will be successful else not.



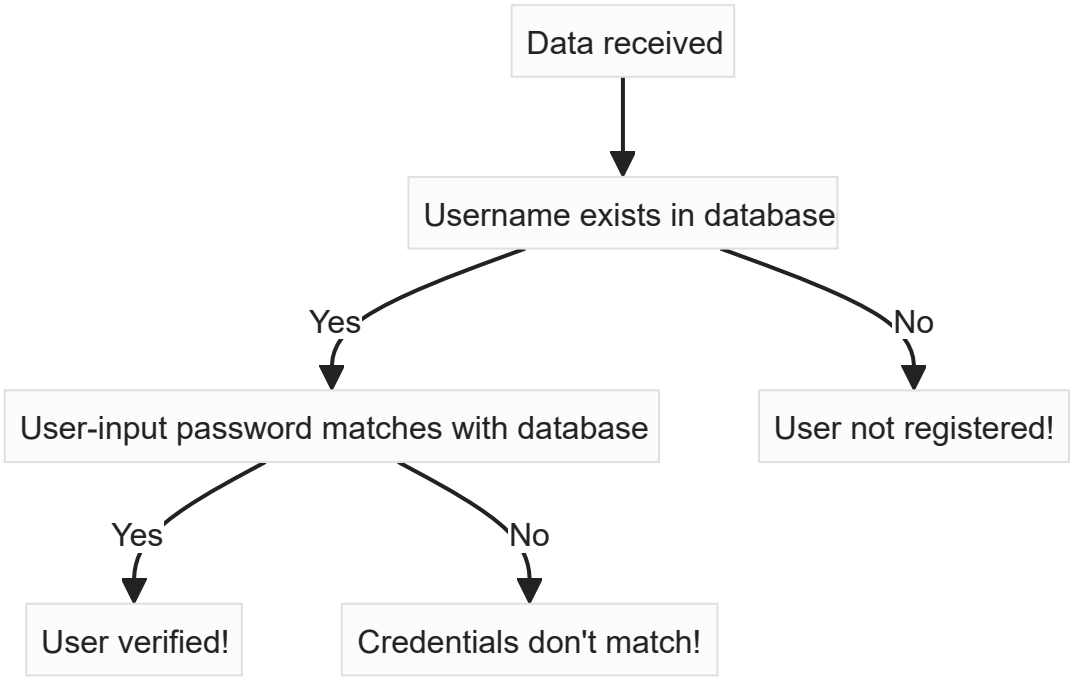
The actual process looks something like this.



The next *sieve* for data validation is when the data reaches the server. It can be broadly done using two methods.

Database Check

In cases of Authentication and alike, the user input must be checked with the database. For instance,



Validity

Checking with how valid or *semantic* the data is, is another type of validation. For instance, typing in the *Company name* in the *Username* section.

Just like videos, audio can be added in a webpage using HTML.

Tag

This can be done using the `<audio>` tag with the following attributes.

Attribute	Usage	Example
`controls`	Add controls like pause and fast-forward to the player	`<audio controls>`

It is also used along with the `<source>` tag which serves the same purpose of mentioning the location of the file.

Attribute	Usage	Example
`src`	Defines the actual source or location of the audio file	`<source src="videos/personal/dance.mp3">`
`type`	Specifies the format of audio used	`<source type="audio/mpeg">` `<source type="audio/wav">` `<source type="audio/ogg">`

Example

This will add an audio player with controls playing the audio `music` in `mp3` format.

```
<video controls>
  <source src="dance.mp3" type="audio/mpeg" />
</video>
```

> **`mp3` stands for `MPEG Audio Layer 3`. Thus, `mpeg` is used for `mp3`. Also, `MPEG` stands for *Media Players Experts Group*.**

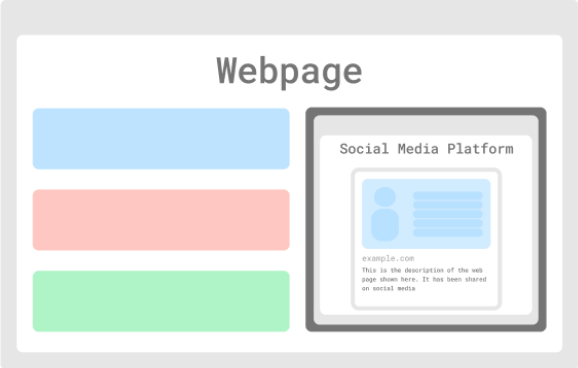
Rendering 2D and 3D graphics in HTML is made possible by canvas which works in the same way as a real one.

Tag

An HTML canvas can be added using the tag `<canvas></canvas>`. It has the attributes `height` and `width` to set its dimensions.

Graphics are rendered in a Canvas using CSS and JavaScript to add interactivity and logic to the animations or even games.

Not an Apple product rather an HTML element that allows to run a website inside another webpage.



It is used to run ads and mention social media posts in webpages and much more. But is considered insecure as the website to embed might be malicious.

Tags

To add an iFrame, the `<iframe>` tag is used which has the following attributes.

Attribute	Usage	Example
`src`	The URL of the website to embed	`<iframe src="https://www.google.com/search"> </iframe>`
`height`, `width`	Set the dimensions of the iFrame	`<iframe height="240" width="320"> </iframe>`
`allow`	To make the iFrame safe, certain restrictions can be imposed on it	`<iframe allow="geolocation 'none'; camera 'none'">`

Security

iFrames can be made more secure by using the attributes `allow` and `sandbox` to restrict certain permissions.

- `allow`
  It is used to enable or disable permissions to the website embedded.

```
<!— To allow permissions —>
<iframe allow="camera; microphone; geolocation;"></iframe>

<!— To disable permissions to the iframe —>
<iframe allow="camera 'none'; microphone 'none';"></iframe>
```

- `sandbox`
  To impose even more restrictions such as the permission for not using JavaScript files or downloading files.

```
<!— To apply all restrictions —>
<iframe sandbox=""></iframe>

<!— To allow certain permissions to the iframe —>
<iframe sandbox="allow-downloads allow-popups"></iframe>
```

HTML supports images, too.

Tag

Images are added using the `<img>` tag. It has the following attributes.

Attribute	Usage	Example
`height`, `width`	Dimensions of the image	`<img height="320" width="240">`
`src`	The source of the image file	`<img src="flower.jpeg">`
`alt`	If the image doesn't preview, a descriptive text will be shown. This text is called **alt text**	`<img alt="An image of a flower">`

Example

This will add a flower image to the webpage.

```
<figure id="flower">
  <img src="flower.jpeg" height="300px" width="500px" />
  <figcaption>A flower blooming in the daylight</figcaption>
</figure>
```

> **Tip**
>
> Using semantics is a good practice while creating webpages with a well-defined layout and better readability.

HTML allows for adding videos in a webpage.

Tag

This can be done using the `<video>` tag. It has the following attributes.

Attribute	Usage	Example
`width`, `height`	Define the dimensions of the video player	`<video height="300px" width="500px">`
`controls`	Add controls like pause and fast-forward to the player	`<video controls>`

It is paired with the open tag, `<source>`, which specifies from where the video file is added or its *source*.

Attribute	Usage	Example
`src`	Defines the actual source or location of the video file	`<source src="videos/personal/dance.mp4">`
`type`	Specifies the format of video used	`<source type="video/mp4">` `<source type="video/webm">` `<source type="video/ogg">`

Example

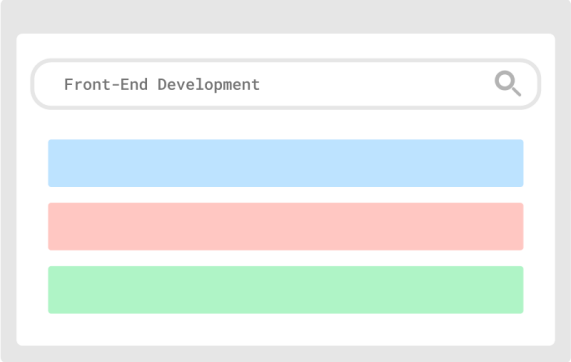
This will add a video player with controls of dimensions 300x500 playing the video `dance` in `ogg` format.

```
<video height="300px" width="500px" controls>
  <source src="dance.ogg" type="video/ogg" />
</video>
```

meta means *about or self-reference*. **Metadata**, thus, translates to ***data about data***.
It basically is a summary of data.

SEO

Say, on searching "*Front End Development*" on Google, certain results concerning Frontend Dev. appear. But how does the browser know what "*Front End Development*" means and come up with likewise results?



Search-Engine Optimization, or SEO for short, is a technique used by browsers to filter searches according to the ***Metadata** of a webpage*.

In the example above, the webpages that appear in the search results have the metadata of *Front-End Development*.

Meta Tags

To make the webpage appear in a certain search result, its metadata must be added.
The open HTML tag, `<meta>` is used in this case. It has two main attributes.

Attribute	Usage
`name`	The parameter whose metadata is to be specified
`content`	Value of the parameter

- `name`
  The attribute `name`, commonly, has the following values.

Value	What it means
`author`	It tells who the author of the webpage is
`language`	The language the webpage is in
`description`	A summary or brief of the content of the webpage
`robots`	Tells the Search Engine how to analyze the webpage
`rating`	For which age group is the webpage suited

- `content`
  It is the actual data or *value* of the `name` parameter.

`name`	`content`
`author`	John Doe
`language`	English
`description`	This webpage describes what Metadata is

`name`	`content`
`robots`	`index` → *read the page* `noindex` → *don't read the page* `follow` → *visit all the links in the page, as well* `nofollow` → *don't visit the links in the page*
`rating`	Suitable for all

Example

A webpage to show up in the search result *Front-End Development* would be

```
<!DOCTYPE html>
<html>
  <head>
    <meta name="author" content="John Doe" />
    <meta
      name="description"
      content="Describing the concepts of Front-End Development"
    />
  </head>

  <body>
    <header>
      <img src="logo.png" />
      <h1>Heading</h1>
    </header>

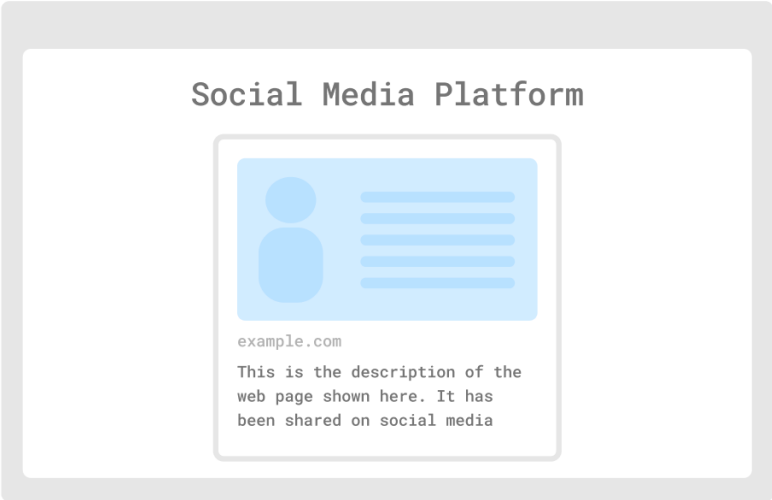
    <main>
      <section>
        <h3>What is it?</h3>
        <p>Lorem Ipsum Dolor Sit Amet ... </p>
      </section>
    </main>

    <footer>
      <h3>Contact Us</h3>
      <menu>
        <li>Youtube</li>
        <li>Facebook</li>
        <li>Instagram</li>
      </menu>
    </footer>
  </body>
</html>
```

Established by Meta, it basically creates a preview of a webpage, when shared, in terms of its metadata.

For instance, the ads posted on social media platforms like *Facebook* and *YouTube* have

- An Image for preview
- The URL of the webpage
- A brief description



This is made possible due to the Open Graph Protocol.

Usage

It, also, involves meta tags but with the the prefix `og` to depict `Open-Graph`. The five basic meta tags that **must** be in a webpage are understated.

`property`	`content`
`og:title`	The title of the webpage
`og:description`	A brief of what the webpage contains
`og:image`	A hyperlink to the image to be shown in preview
`og:url`	URL of the webpage
`og:type`	The type of webpage • image • website • video

> **Note**
>
> These are the values of the `property` attribute of the `<meta>` tag. The `content` attribute should contain the actual values.

Example

An example for the website would be

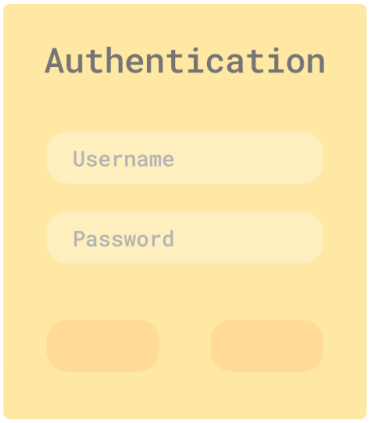
```
<!DOCTYPE html>
<html>
  <head>
    <meta property="og:title" content="Front-End Development Basics" />
    <meta
      property="og:description"
      content="Describing the concepts of Front-End Development"
    />
    <meta property="og:url" content="https://www.frontenddev.com/basics" />
    <meta property="og:image" content="./images/logo.png" />
    <meta property="og:type" content="website" />
  </head>

  <body>
    <header>
      <img src="logo.png" />
      <h1>Heading</h1>
    </header>

    <main>
      <section>
        <h3>What is it?</h3>
        <p>Lorem Ipsum Dolor Sit Amet ... </p>
      </section>
    </main>

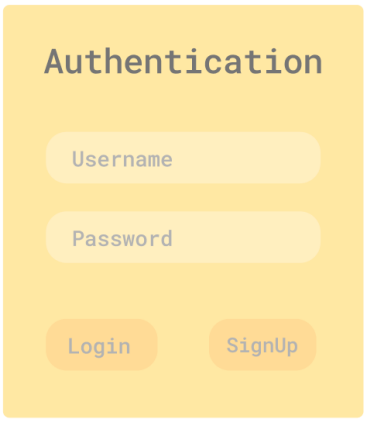
    <footer>
      <h3>Contact Us</h3>
      <menu>
        <li>Youtube</li>
        <li>Facebook</li>
        <li>Instagram</li>
      </menu>
    </footer>
  </body>
</html>
```

In a webpage, the function of a button cannot be known if it isn't labelled.



In such an Authentication form, how would the user know which button is to *Sign In* and which to *Sign Up*?

By simply using a label for each button.

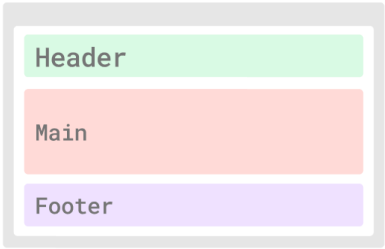


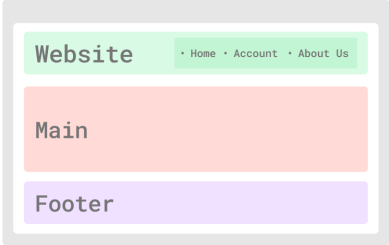
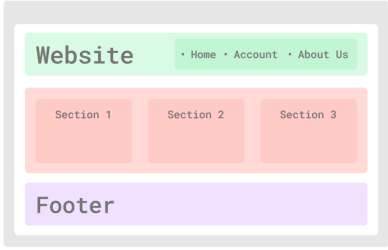
Here, the label acts as a ***sematic***. The term ***semantic*** means *meaningfulness* or *how meaningful something is*.

Semantic Tags

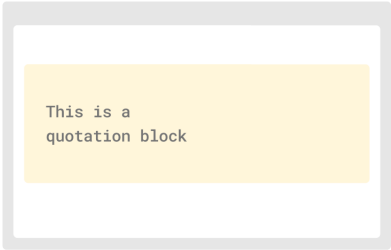
HTML provides numerous tags for serving specific purposes. Some of them are understated.

- **Sectioning Tags**
  Such tags are used to divide the webpage into smaller *sections*.

Tag	Usage	Application
`<header>`, `<main>` and `<footer>`	Divide the webpage into a header, main section and footer, respectively	

Tag	Usage	Application
`<nav>`	Short for *Navigation Bar*, it is a section within the header for all the links to other webpages	
`<section>`	Creates sections in a webpage	

- **Content Tags**
  Semantics which involve content or simply, text, are as follows.

Tags	Usage	Application
`<blockquote>`	To add a quotation	
`<figcaption>`	Creates a caption for an image	

- **Media Tags**

Tag	Usage
`<audio>`	Embeds audio in web pages.
`<canvas>`	Renders 2D and 3D graphics on web pages.
`<embed>`	Contains external content provided by an external application (e.g., media player).
`<iframe>`	Embeds a nested web page.
`<img>`	Embeds an image on a web page.
`<object>`	Similar to `<embed>`, but content is provided by a web browser plug-in.

Tag	Usage
`<picture>`	Contains one `<img>` element and one or more `<source>` elements for alternative images.
`<video>`	Embeds a video on a web page.
`<source>`	Specifies media resources for `<picture>`, `<audio>`, and `<video>` elements.

- **Inline Tags**

Tag	Usage
`<a>`	Anchor link to another HTML document.
`<abbr>`	Specifies that the containing text is an abbreviation or acronym.
`<b>`	Bolds the containing text (use `<strong>` for importance).
` `	Line break, moves subsequent text to a new line.
`<cite>`	Defines the title of creative work (usually rendered in italics).
`<code>`	Indicates that the containing text is a block of computer code.
`<data>`	Indicates machine-readable data.
`<em>`	Emphasizes the containing text.
`<i>`	Displays containing text in italics (for idiomatic or technical terms).
`<mark>`	Marks or highlights the containing text.
`<q>`	Contains a short quotation.
`<s>`	Displays containing text with a strikethrough or line through it.
`<samp>`	Represents a sample of code or output.
`<small>`	Represents small text (e.g., copyright and legal notices).
`<span>`	Generic element for grouping content for CSS styling.
`<strong>`	Displays containing text in bold (for importance).
`<sub>`	Contains subscript text (lowered baseline).
`<sup>`	Contains superscript text (raised baseline).
`<time>`	Used to display both dates and times.
`<u>`	Displays containing text with a solid underline.
`<var>`	Represents a variable in a mathematical expression.

Motion Graphics simply mean ***graphics****, which can be anything like a square or a cube,* ***that are in motion*** i.e.* ***moving objects***.

Approach

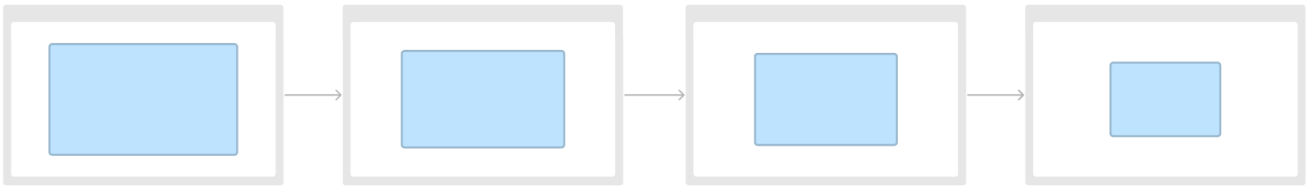
Animation is basically showing the changes done to a component, slowly, as a process and not an **instantaneous change**. It, using CSS, can be done in broadly two ways.

Transform and Transition

The first way is to define the change, initially, and execute it over a span of time.

Keyframe Animation

The second method is to define the what changes are to occur step-wise.
This would make it seem natural and ***in motion***.



To define the changes made at each step, the **At-rule** `@keyframes` is used.

> **Info**
>
> An **at-rule** is a specific statement which tells the browser, when to behave according to the properties inside it.

Herein, the animation is first defined step-wise. It can, then, be used for multiple components by assigning them the animation.

Syntax

```
@keyframes animation-name {
  0% {
    /* CSS rule here */
  }
  50% {
    /* CSS rule here */
  }
  100% {
    /* CSS rule here */
  }
}

.component {
```

```
  animation: animation-name duration;
}
```

Code	What it means
`@keyframes`	The **at-rule** to indicate the animation
`animation-name`	Name of the animation
`0% {}`, `50% {}`, `100% {}`	***Keyframes*** or *steps* of the animation
`animation`	Property assigned to the component that needs to be animated
`duration`	The duration of the animation

> **Note**
>
> Keyframes are percentage values. The above code will define what the components must look like when,
>
> - `0%` → when animation starts
> - `50%` → when animation is halfway-through
> - `100%` → when animation ends
>
> Also, the keyframes can have any percentage value.

Example

This will create an animation of a square ***morphing*** or *changing its shape* into that of a circle.

```
@keyframes sq-to-crc {
  0% {
    border-radius: 0;
  }

  100% {
    border-radius: 50%;
  }
}

.square {
  animation: sq-to-crc 2s;
}
```

First, the change to be made is defined. Then the duration and other properties are specified.

Properties

This method involves two properties.

- **Transform**
  It is a CSS property that is used to *alter* or *change* an HTML element's appearance.

  Some common functions to change the appearance using `transform`,

Function	What it does	Example
`scale()`	Increase or decrease the size of a component	`transform: scale(2);`
`skew()`	Tilt a component	`transform: skew(20deg);`
`rotate()`	Rotates a component	`transform: rotate(90deg);`

  Example

  For instance,

```
.box {
  transform: scale(1.5);
}
```

  This would make the box 1.5 times bigger than its original size.

- **Transition**
  It is also a CSS property and it describes *the **how** of an animation*.
  The basic value it accepts is of the **duration** of the animation.

  Example

  For instance,

```
.box {
  transform: scale(1.5);
  transition: 0.5s;
}
```

This would create an animation of the box getting 1.5 times bigger than its original size.

Positioning elements in a webpage is what makes it organized. It is one of the trickier tasks in creating a webpage, too.

CSS provides numerous ways to create custom layouts. Two of the most used display styles are

- **FlexBox**

- **Grid**

There are numerous units for the dimensions of the components in CSS which can broadly be categorized in two.

- ## Absolute Units
  As the name suggests, it's value does not depend on anything. It is **fixed**.

Unit	What it means
`px`	$1/96$ of an inch or about $0.026cm$
`cm`	$1cm$

- ## Relative Units
  These units change according to other factors or are **relative**.

Unit	What it means
`vw`	1% of the viewport width
`vh`	1% of the viewport height
`em`	When set to a parent element, all the children components will have the same value
`rem`	When set to a child element, it will have the specified value no matter what the parent font-size is

> **Tip**
>
> It's always a better practice to use Relative Units.

> **Note**
>
> Only the frequently used units are mentioned here. Rest of the units can be found here

Such properties define how the components are **positioned relative to the flexbox** or simply, inside the flexbox.

Justify-Content

It is used to *align* or *position* items along the main-axis. It can have the following possible values.

Value	What it means	Visual Depiction
`flex-start`	All the components aligned to left	
`flex-end`	All the components aligned to right or bottom	
`center`	Aligned to the center	
`space-between`	Space between the elements but not between them and the edges	

Value	What it means	Visual Depiction
`space-evenly`	Equal space between the elements and the edges	

Align-Items

It positions the child components on the cross-axis.

Value	What it means	Visual Depiction
`flex-start`	Places the components along the starting edge, top or left	
`flex-end`	Places the components along the starting edge, bottom or right	
`center`	Children aligned to the center	
`baseline`	Placed next to each other with their **baseline** or bottom edge aligned	

Value	What it means	Visual Depiction
`stretch`	Makes the children occupy the space across the cross axis evenly	

Align-Self

It is used on the child component to position it uniquely along the cross-axis. There is no need for the main-axis, thus, `align-self` doesn't exist for the main-axis.

Value	What it means	Visual Depiction
`flex-start`	Places the child component along the starting edge, top in the case of row or left in the case of column	
`flex-end`	Places the child component along the ending edge, bottom or right	
`center`	Aligned along the center	
`baseline`	Placed next to other components with their **baseline** or bottom edge aligned	

Value	What it means	Visual Depiction
`stretch`	Makes the child component occupy the space across the cross axis evenly	

Such properties define how the components occupy the space inside the flexbox.

Flex-Wrap

Determines if the contents of the flexbox occupy another line when needed or get squished. It can have the following values.

Value	What it does	Visual Depiction
`wrap`	Uses another line if the contents cannot fit in a single line	
`nowrap`	Squishes the components but doesn't occupy another line	

Flex-Grow

Determines how much of the available space the child components will acquire. It's value is a ratio which can be any number. When set to a specific child component, it occupies more space than the others.

Example

- `.container {flex-grow: 0;}`
  The children do not occupy the excess space.

- `.container {flex-grow: 1;}`
  The children stretch themselves to occupy equal space.

- `.child {flex-grow: 0.5;}`
  The child component grows 0.5 times less than the other one.

Flex-Shrink

Same functionality as `flex-grow`. The difference is that it specifies the rate at which the components shrink on decreasing the viewport size.

Example

- `.container {flex-shrink: 0;}`
  If the content width is more than that of the flexbox, the contents will start ***overflowing***.

- `.container {flex-shrink: 1;}`

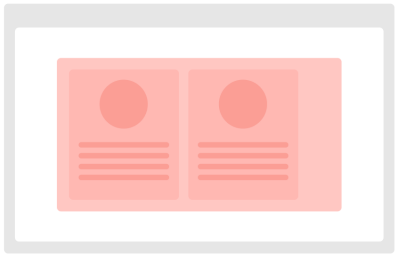
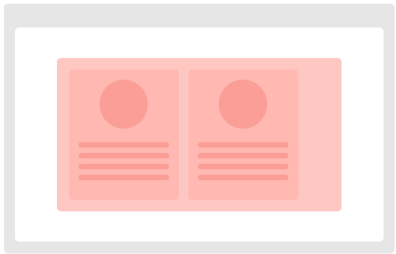
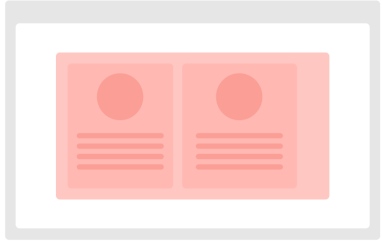
  Each box would **shrink** or get squished, equally, to fit into the flexbox.

- `.child1 {flex-shrink: 3;}`

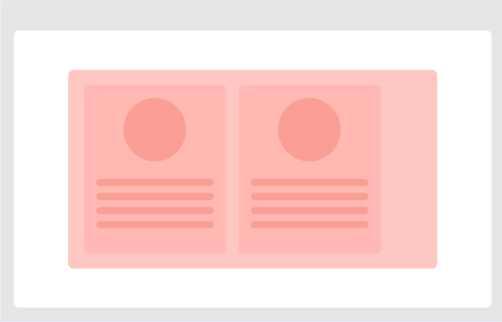
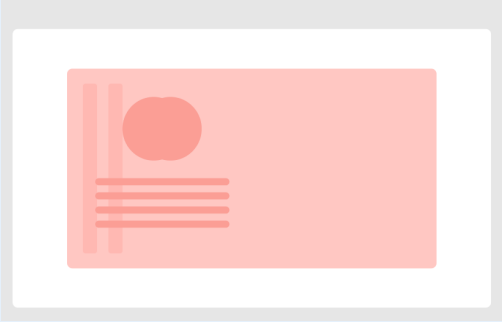
  The first child component will shrink 3 times more than others.

Flex-Basis

It is **like** the width of the child components but not exactly the width. It can have the following values.

Value	What it does	Visual Depiction
`content`	Checks for the width of the contents of the child component and sets the value such that they fit inside, properly	
`auto`	If the width is not specified, uses `content`; else, the width specified in the `width` property	
Any numerical value	Sets the width of the component	

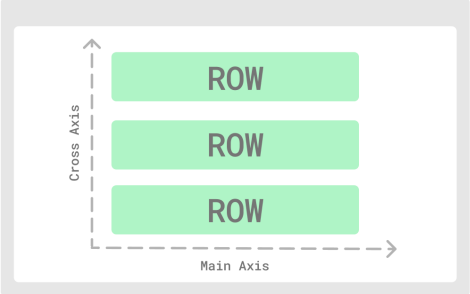
Value	What it does	Visual Depiction

> **Info**
>
> ### `width` *vs* `flex-basis`
>
> When `flex-basis: 0;`, the component will have the minimum size such that the contents inside the child component fit completely.
>
> 
>
> Whereas, in the case of width, the child component completely collapses.
>
> 

Flex-Flow

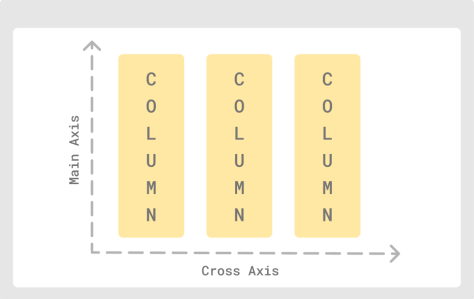
Specifies the direction of the flexbox. There can be two directions.

- **Row**
  Left-right direction

- **Column**

Top-bottom direction



Flexbox stands for **Flexible Box Model**. It is not actual HTML element. Rather a ***responsive*** CSS component.

What makes it responsive is not the component itself but the properties it has.

> **Responsive means *something which reacts or responds to an action.***
>
> In CSS, how **responsive** a component is depends on how it can adjust itself according to the screen-size and other components.

The What

Flexbox, simply put, is a container. It has two axes for adjusting *items* or ***children*** inside.

- Main Axis → In line with the direction of the flexbox
- Cross Axis → Perpendicular to the Main Axis

The Why

Again, it is a property which makes containers like `div` and `span` unique and special.

The properties, underlisted, are mainly of two types.

- **Alignment**

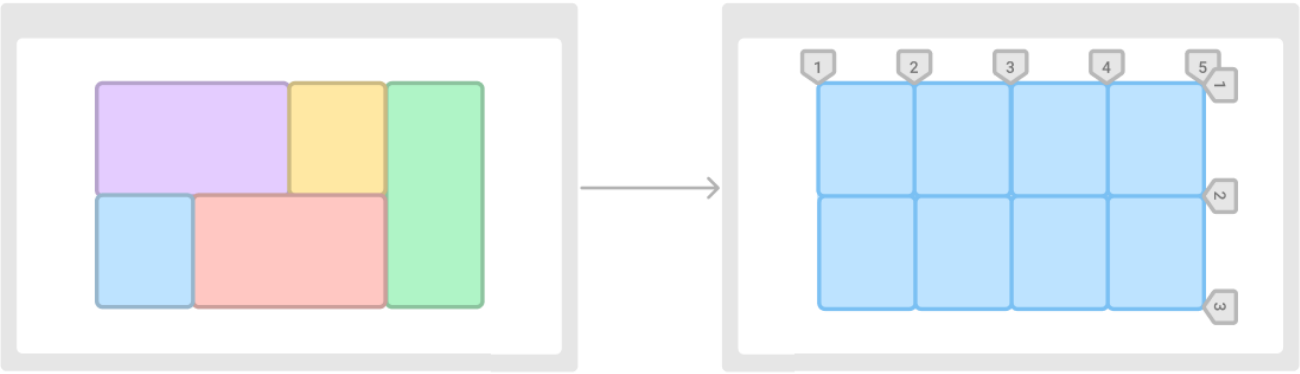
- **Arrangement**

This method, too, involves the usage of columns and rows.

Creating the Areas

To create the areas, first the columns and rows must be defined.

For instance, for such a layout, the container must be divided into equal rows and columns, first.



Next comes defining which space would an area occupy using a special format.

Properties

This is done using the `grid-template-areas` property.

```
grid-template-areas:
  "purple purple yellow green"
  "blue red red green";
```

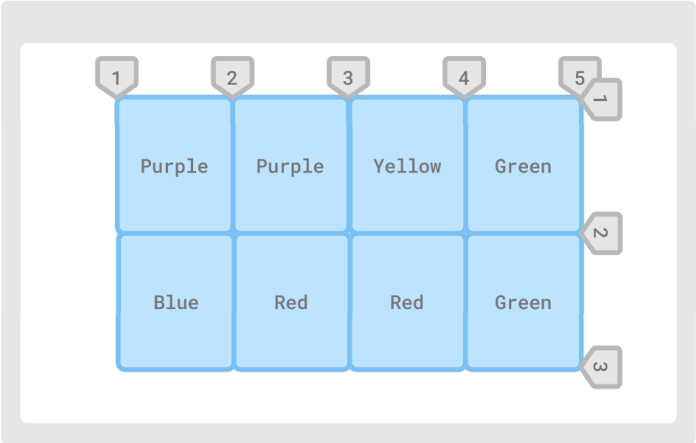
The value basically says,

In the first row,

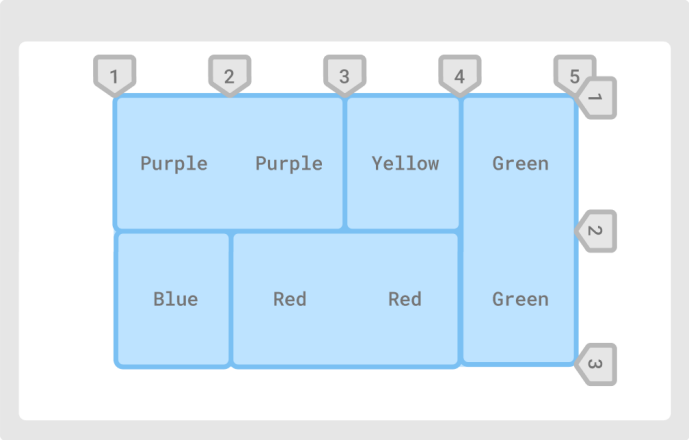
- The first two grid cells are to be grouped together and named **purple**.
- The third grid cell is to be named **yellow**.
- The fourth named **green**.

In the second row,

- The first grid cell must be named **blue**.
- The next two named **red**.
- The last one to be named **green**.



Then, the grid cells with sharing the same name are grouped together. This forms the desired layout.



Assigning the Areas

Now, the boxes are to be placed in their respective areas.

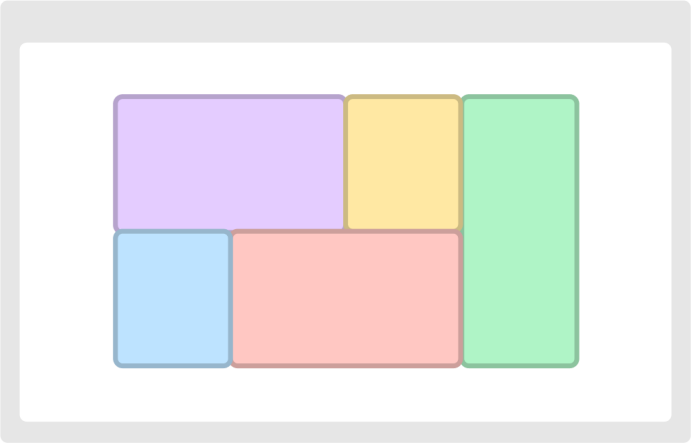
Properties

This is done using the `grid-area` property **which is used on the child component**.

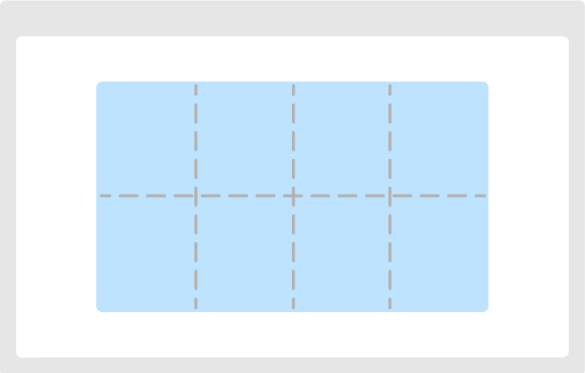
```
.child {
  background-color: purple;
  grid-area: purple;
}
```

> **Note**
>
> The name of the area could have been anything. For the sake of simplicity, it has been named `purple`.

The `grid-area` assigns the box to the area named `purple`. This, when done for all the child components, makes the following layout.

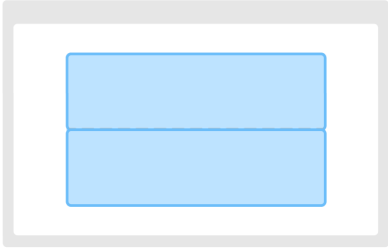


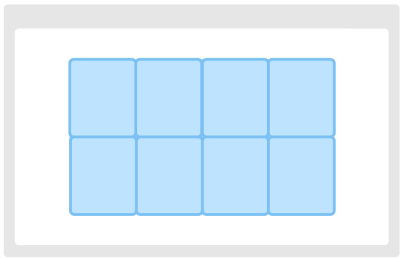
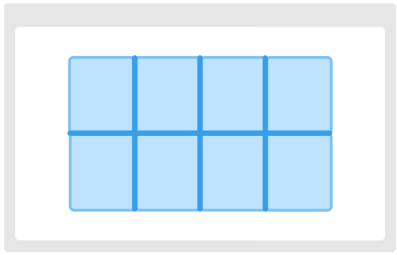
Grid, as the name conveys, is a two-dimensional CSS component.



The What

Grid, along with flexbox, is the most used CSS component because of its versatility. Following are its *constituents* or *what its made of*.

Part	What is it	Visual Depiction
Row	Space between the horizontal lines	
Column	Space between the vertical lines	

Part	What is it	Visual Depiction
Grid Cells	Boxes formed by the intersection	
Gutter	Space between consecutive rows and columns	

The Why and When

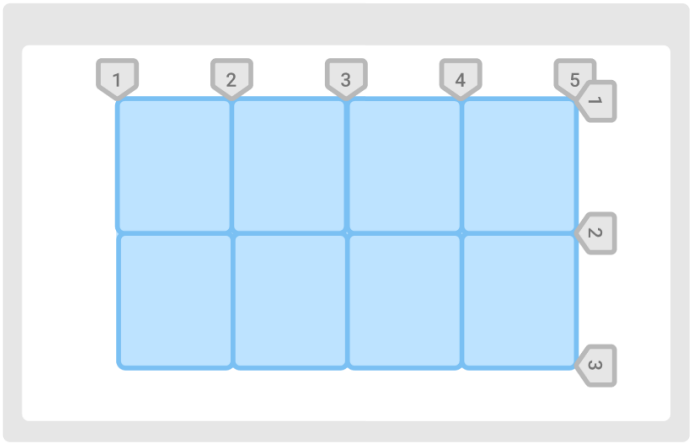
Grids are to be used for arranging components inside a container. For instance,

- Displaying the dishes in a menu card
- Creating a collage of photograph

The How

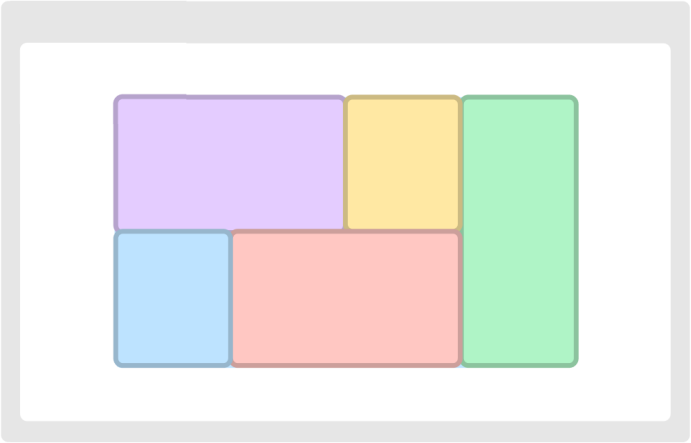
There are broadly two approaches to work with grids.

- **Positioning using Rows and Columns**
  Basically, the child components are placed inside the grid according to the **column number** and the **row number**.



- **Positioning using Areas**

Herein, the grid is divided into several areas. These areas are assigned to the components that need to be positioned in the specific arrangement. For instance,



It involves a series of steps to follow.

Defining Rows and Columns

In order to place children components according to the column and row numbers, **the columns and rows must first be defined**.

Properties

To define them, the CSS properties `grid-template-columns` and `grid-template-rows` are used.

```
grid-template-columns: col col col col;
grid-template-rows: row row row;
```

Code	What it means
`grid-template-columns`	Used to define columns in a grid
`col col col col`	The number of columns to create of width `col`
`grid-template-rows`	Used to define the rows of a grid
`row row row`	Creates 3 rows of width `row`

Example

This would create 3 columns of width, $200px$, $100px$ and $200px$, and 2 rows of width, $300px$ and $150px$.

```
grid-template-columns: 200px 100px 200px;
```

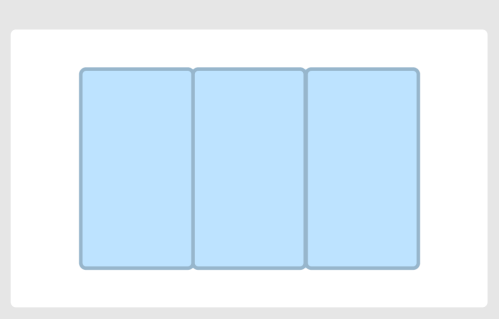
```
grid-template-rows: 300px 150px;
```

`fr`

It is another relative unit in CSS. It stands for `fraction`. So, `1fr` means *1 fraction*.

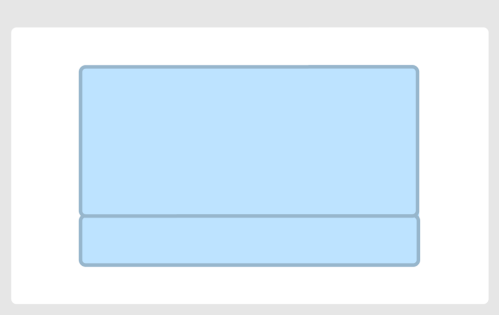
```
grid-template-columns: 1fr 1fr 1fr;
```

The above code says, *Create 3 columns with width 1 fraction or 1 part of the total width of the container.*



```
grid-template-rows: 3fr 1fr;
```

The above code would create 2 rows. The first row's width would be 3 parts and the second one's would be 1 part.



Tip

Say you have to create a grid with 10 columns. Rather than writing the code as

```
grid-template-columns: 1fr 1fr 1fr 1fr 1fr 1fr 1fr 1fr 1fr 1fr;
```

The `repeat()` function should be used to make the code cleaner. The above code can be written as,

```
grid-template-columns: repeat(10, 1fr);
```

It says, *Write `1fr` 10 times*.

Placing components

Next comes positioning the children with reference to the column and row numbers.

Properties

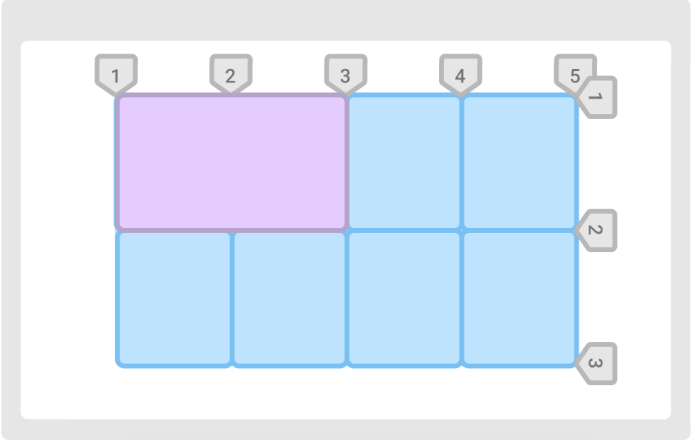
This is done using the properties `grid-column` and `grid-row`.

```
grid-column: start-column / end-column;
grid-row: start-row / end-row;
```

Code	What it means
`grid-column`	Used to define the position of a child with respect to column number
`start-column / end-column`	Place the child component from column number `start-column` to `end-column`
`grid-row`	Place the component according to the row number
`start-row / end-row`	Place the child from row number `row-start` to `row-end`

Example

To place a child component like this,



```
/* place the box from column line number 1 and cover the next 2 columns */
grid-column: 1 / span 2;

/* place the box from row line number 1 and cover the next 1 row */
grid-row: 1 / span 1;
```

> `span n` **basically means *cover n columns/rows*.**
>
> ```
> grid-column: 2 / span 3;
> ```
>
> This means *start from column 2 and cover the next three columns*. This is the same as,
>
> ```
> grid-column: 2 / 5;
> ```

As the name suggests, selectors that combine elements are called **combination selectors**.

- ## Child Selector

  Selects the immediate child component of the specified type.

  ### Example

  This will select just the text `Hey!` because it is the ***immediate child*** of the `<div>` element.

  ```
  /* styles.css */
  div h1 {
    /* CSS rule here */
  }
  ```

  ```
  <!— index.html —>
  <div>
    <h1>Hey!</h1>
    <span>
      <h1>How are you doing?</h1>
    </span>
  </div>
  ```

- ## Descendant Selector

  It selects the direct child of the element with the specified class or element type.

  ### Example

  This selects only `<h1>Hey!</h1>` and not `<h1>How are you doing?</h1>` because the first one is its direct child.

```
/* styles.css */
div h1 {
  /* CSS rule here */
}
```

```
<!— index.html —>
<div>
  <h1>Hey!</h1>
  <span>
    <h1>How are you doing?</h1>
  </span>
</div>
```

- ## General Sibling Selector

  Selects all the ***siblings*** of the specified element type.

  ### Example

  This selects all the `<p>` elements besides `<h1>` as they are ***siblings*** or **children to the same parent element**.

```
/* styles.css */
h1 ~ p {
  /* CSS rule here */
}
```

```
<!— index.html —>
<div>
  <h1>Hey!</h1>
  <span>
    <h1>How are you doing?</h1>
```

```
    <p>Hoping you are good,</p>
    <p>Let's go on a trip!</p>
  </span>
 </div>
```

```
<br>

* ### Adjacent Sibling Selector
Selects the immediate next sibling and not all of the siblings.

  ##### Example
  This selects `Hoping you are good,` besides `<h1>` and not all the
siblings.

  ```css
  /* styles.css */
  h1 + p {
          /* CSS rule here */
  }
```

```
<!— index.html —>
<div>
  <h1>Hey!</h1>
  <span>
    <h1>How are you doing?</h1>
    <p>Hoping you are good,</p>
    <p>Let's go on a trip!</p>
  </span>
</div>

Objects used to select items are called **selectors**. In CSS, it is the
same
way. In order to tell the computer, which CSS rule should be applied to
which
HTML element, CSS selectors are used. There are numerous of them.
<br />

* ### Element Selector Selects all the elements of a certain type. #####
Example
Selects all the `
<p>` elements in an HTML file. ```css p { /*CSS rule here*/ }</p>
```
```

- ## ID Selector

  Selects the element with the specified ID. It selects only 1 component because ID is unique to every element.

  ### Example

  Selects the element with `id="paragraph"`.

  ```
  #paragraph {
    /*CSS rule here*/
  }
  ```

- ## Class Selector

  Selects all the elements with the specified class name because multiple elements can have the same class name.

  ### Example

  Selects all the elements with `class="paragraph"`.

  ```
  .paragraph {
    /*CSS rule here*/
  }
  ```

- ## Child Selector

  Selects the child component at the specified position.

  ### Example

  Selects the second `<p>` element and applies the rule to it.

  ```
  p:nth-child(2) {
    /*CSS rule here*/
  }
  ```

- ## Attribute Selector

  Selects the element(s) with the specified attribute.

  ### Example

Selects the `<a>` element with `href` attribute having the value `https://www.example.com`

```
a[href="https://www.example.com"]
{
  /*CSS rule here*/
}
```

- ## Star Selector

  Selects all the elements in an HTML file.

  ### Example

  Applies the font-color `blue` to all the elements within the HTML file.

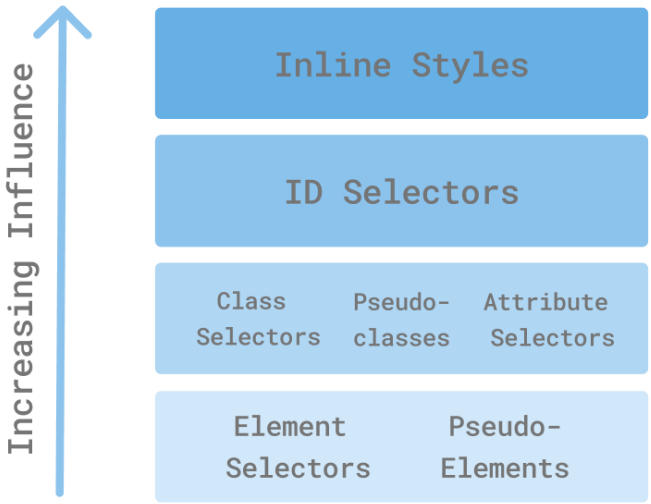
  ```
  * {
    color: blue;
  }
  ```

Just a fancy word meaning giving importance to certain objects on the basis of superiority.

CSS uses specificity in selectors. It is, thus, called **Selector Specificity**.

How?

CSS has a hierarchy of selectors. This means that some selectors are more *powerful* than others.



Example

A CSS rule written using an element selector will be overridden by the one written in the inline style.

```
/* styles.css */
p {
  color: blue;
}
```

```
<!— index.html —>
<p style="color: white;"></p>
```

Herein, the font-color of the `<p>` element will be `white` and not `blue` ***because the Inline style has a higher specificity than the Element selector**.**

Why?

When working with larger codebase, it is natural and often to have **rule conflicts**. Selector Specificity solves the issue of errors and unwanted design and layout.

Developers, therefore, use more ID selectors than other selectors because of its higher specificity.

> **Rule conflicts are when multiple CSS rules are meant for the same property of the same element.**

Pseudo means *something that is not actually what it is meant to be* or simply, *fake or unreal*.

Thereby, ***Pseudo-components*** are not actual HTML or CSS components but a part or state of them.

- **Pseudo-Elements**

  These are not actual HTML elements, rather, their parts. For instance, the first line of a paragraph.

  Pseudo-, because a part of an element is not an element in itself.

- **Pseudo-Classes**

Similarly, they are not actual classes. They are ***the states the elements are in***. For instance, a button being clicked is still a button, but in a different state.

They are used to indicate **user action**. If such a pseudo-class wasn't used on the button, how would the user know if the button got pressed or not?

There are mainly four categories of pseudo-classes.

User Action States

It is just a fancy phrase for *any action done by the user*. Thus, whenever a user performs a specific action, it changes the state of an HTML element. This state can be stylized.

- `:hover`
  Whenever the user **hovers** or *brings its cursor onto an element*, the `hover` state gets triggered and displayed.

  Example

  This will change the `background-color` of the button to `darkblue` when it is hovered over.

  ```
  .btn:hover {
    background-color: darkblue;
  }
  ```

- `:active`
  When a button, or element alike, is **being** clicked, its state at that point is ***active***.

  Example

  This will create `aqua` colored borders of the button during the click.

  ```
  .btn:active {
    border: 3px solid aqua;
  }
  ```

- `:focus`
  When an input field or element alike is clicked to enter the data, it is said to be in the **focused** state.

  Example

This will increase the `font-size` to `3rem` when the input is being entered.

```
.btn:focus {
  font-size: 3rem;
}
```

Form States

There are pseudo-classes specifically for the input-fields in forms.

- `:disabled`, `:enabled`
  It is, primarily, used to stylize buttons which are **disabled** which are *unclickable* or **enabled** which are *clickable*.

  Example

  This will make the disabled button have a lower opacity which is *visibility of an element*.

  ```
  .btn:disabled {
    opacity: 0.6;
  }

  .btn:enabled {
    opacity: 1;
  }
  ```

- `:checked`, `:indeterminate`
  Used with checkboxes.

  Example

  This will change the text to a strike-through one if the checkbox is checked else it will remain the same.

  ```
  .checkbox:checked {
    font-style: line-through;
  }
  ```

- `:valid`, `:invalid`

Used with input fields like `number` and `email` which tolerate only certain formats which are considered **valid**. Any other format is considered **invalid**.

Example

This will highlight the input field with green borders if the input is valid else red borders.

```
.checkbox:valid {
  border: 3px dash green;
}

.checkbox:invalid {
  border: 3px dash red;
}
```

Position-Based

These pseudo-classes are like, or in fact **are** child selectors. `:nth-type()` is one of such classes.

- `:nth-of-type()`
  The same functionality as `nth-type()`. Selects the component of mentioned type at the given position.

  Example

  Selects all the `<h2>` elements at even position numbers.

  ```
  h2:nth-of-type(even) {
    /* CSS rule here */
  }
  ```

- `:nth-last-of-type()`
  Same as `nth-of-type()`. The difference is that it starts from the end.

  Example

  This selects the second-last `<p>` element.

  ```
  p:nth-last-of-type(2) {
    /* CSS rule here */
  ```

```
}
```

- `:first-of-type()`
  Selects the first element of the given type.

- `:last-of-type()`
  Selects the last element of the given type.

Pseudo-elements are basically ***parts of the HTML elements***. **Pseudo-**, because these are not actual elements but *parts of the elements*.

Some of the most used ones are,

- `::marker`
  Creates and stylizes bullet points in a text.

```
p::marker {
  content: ">";
  color: blue;
}
```

- `::first-letter`
  Stylizes the first letter of a text

```
p::first-letter {
  color: orange;
  font-size: 4rem;
}
```

- `::first-line`
  Stylizes the first line in a text.

```
p::first-line {
  color: aqua;
  font-style: underline;
}
```

- `::selection`

Stylizes the text which is selected by the user.

```
p::selection {
  background-color: teal;
}
```

- `::before` **and** `::after`

  Creates and styles a component before the element and after the element.

```
p::before {
  content: "Start";
  color: red;
}

p::after {
  content: "End!!";
  color: green;
}
```

Pseudo-Classes

Pseudo-classes are **the different states of HTML elements**. These states can be stylized using selectors.

- When a button is being clicked
- A link that has been visited
- A checkbox which has been checked

Syntax

```
selector:pseudo-element {
  /* CSS rule here */
}
```

Code	What it means
`selector`	The HTML element whose pseudo-element needs to be stylized
`pseudo-element`	The pseudo-element that needs to be stylized

Some Pseudo-Elements

Pseudo-elements can be categorized for different HTML elements.

- **User Actions States**

Pseudo-class	When does it stylize	Example
`:hover`	Stylizes the state of the element when it is hovered over	`.item::hover { background-color: green; }`
`:active`	When the button is being clicked	`.item::active { border: 3px solid green; }`
`:focus`	When an element such as `<input>` gets clicked on for user input	`.item { font-size: 3rem; }`

- **Form States**

Pseudo-class	When does it stylize	Example

- **Position-Based States**

Standing for **JavaScript XML**, JSX is an *extension* of the JavaScript language. Simply put, JSX is a combination of HTML and JavaScript.

Embedded Expressions

Since, JSX is combination of HTML and JavaScript, JavaScript code can be added inside an HTML element and *vice-versa*.

Syntax

The JavaScript expression or code can be added inside *curly-braces*, `{}`.

```
const name = "John";

const nameElement = <h1>{name}</h1>;
```

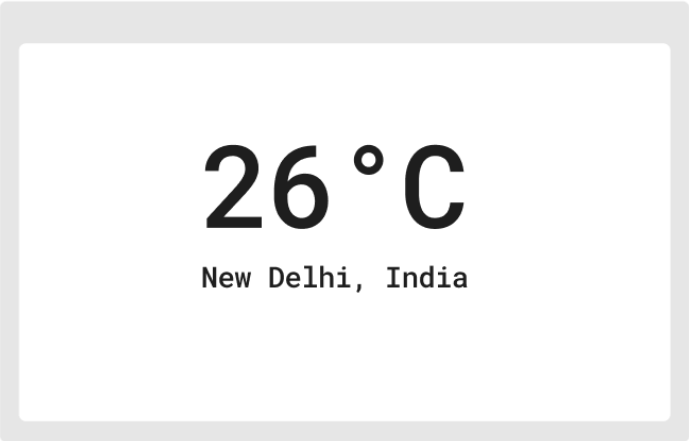
Example

In order to create an `<h1>` HTML element with the output of a JavaScript function, the following code will be used.

```
function addNumbers(a, b) {
  return a + b;
}

const numberElement = <h1>{addNumbers(3, 7)}</h1>;
```

Say, as a developer, you are asked to create a *Weather Application* which displays the **current temperature** and the **location**, just like so



The HTML code might look like this.

```
<div id="weather-details">
  <h1>26°C</h1>
  <h4>New Delhi, India</h4>
</div>
```

Here, the problems kick in.

- ***The temperature doesn't remain same all the time.***
- ***Updating the website will be inefficient.***

The Solution

For *dynamically* or *regularly-changing* components, something like a JavaScript **variable** would be effective.

```
<div id="weather-details">
  <h1>`${temperatureVariable} °C`</h1>
  <h4>New Delhi, India</h4>
</div>
```

> ⚠ **Warning**
>
> This is not an actual working piece of code. It is just for illustrative purposes.

This is one of the many functions of **React**.

- It enables combining HTML with JavaScript
- Making components dynamic
- Adding logic to HTML elements directly

Say, in order to create a `Heading` component, a series of steps can be followed.

- ## Create a Component File
  This can be done via the terminal.

```
touch Heading.js
```

- ## Code the Component

```
function Heading() {
        return(
                <h1>Hello World</h1>
                <p>This is a React component</p>
        );
}
```

In this case, the code won't work because there are two elements `<h1>` and `<p>` inside one component which is invalid.

Instead of using a `<div>` as a container for `<h1>` and `<p>`, a better option would be a **Fragment**.

```
function Heading() {
  return (
    <>
      <h1>Hello World</h1>
      <p>This is a React component</p>
    </>
  );
}
```

> **Info**
>
> A **Fragment**, `<></>`, is a special feature only in React that groups multiple elements.

- ## Export it
  The next step is to let the **root component** access the `Heading` component to add it into the webpage.

```
export function Heading() {
  return (
    <>
      <h1>Hello World</h1>
      <p>This is a React component</p>
    </>
  );
}
```

> **Tip**
>
> The keyword `default` can be used when the component name, `Heading` in this case, and the file name, `Heading.js` here, are the same, which they are in this case.
>
> ```
> export default function Heading() {
>   // JS code here
> }
> ```

- ## Import it
  In order to display the `Heading` component in the webpage, it must be added to the **root component** by importing it in the **root component's file**.

```
// index.js

import Heading from "./Heading";
```

Code	What it means
`import`	Bring the component in this file
`Heading`	Name of the component
`"./Heading"`	The path of the file wherein the component is stored, `.` means the current working directory or CWD

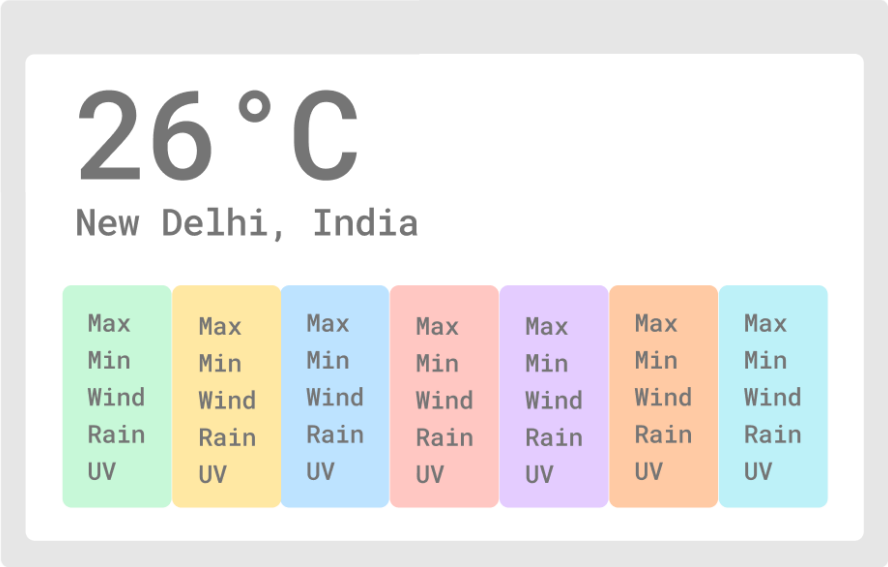
- ## Using the Component

> After importing the component in the `App.jsx` file, it must be ***rendered*** or *displayed on the webpage*.

```
function App() {
  <Header />;
}
```

The `Header` component is added in the `App` component as a **self-closing tag**.

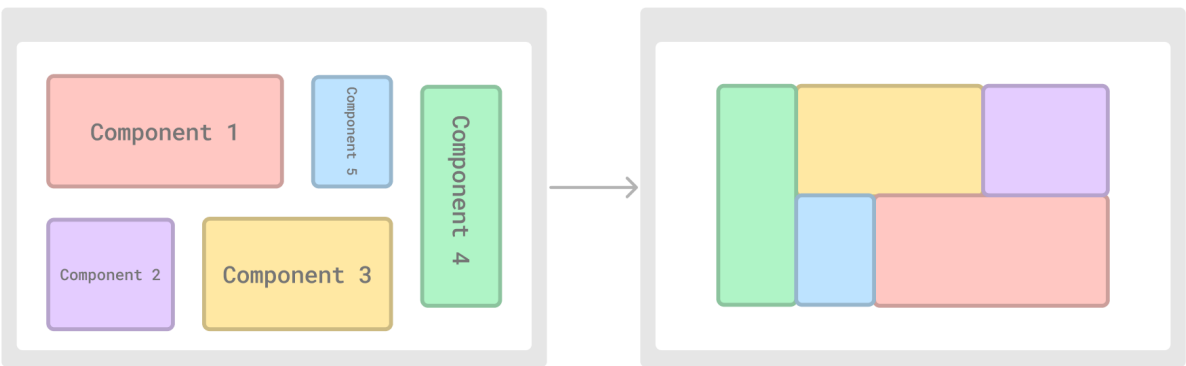
Your next assignment as a developer is to add the details for the complete week, day-wise, to the webpage.



Each *detail-card* is the same just with different values and color. Coding it over and over again isn't the best way.

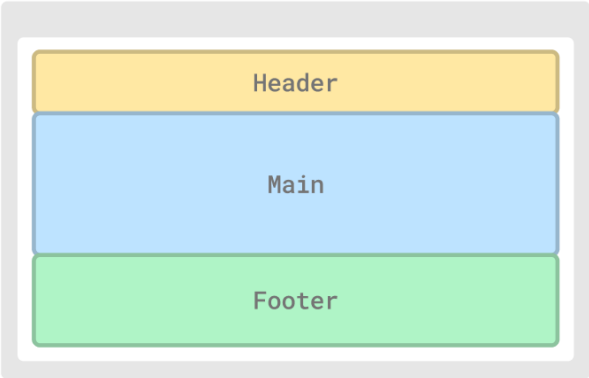
A better approach would be to create one card and use it, over and over again, just like JavaScript **objects' instances**.

This is called **Component Architecture**, which forms the basis of React.
React-apps are *built* using components, just like *Lego bricks*.

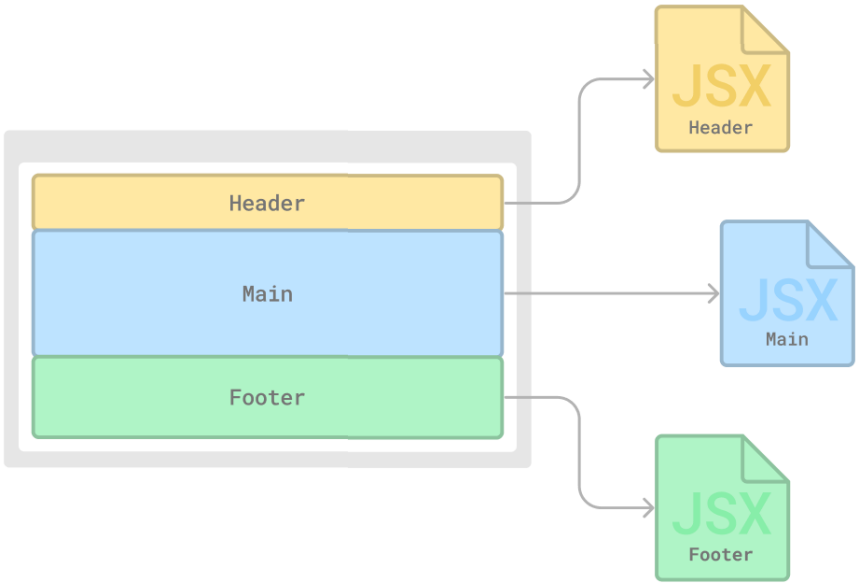


Approach

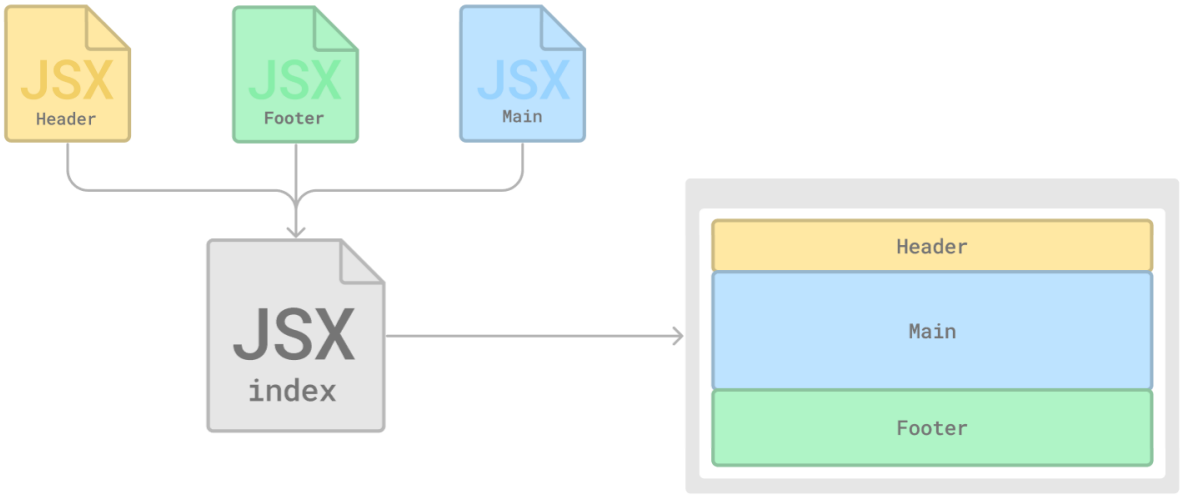
Say a website contains a *header*, a *main-section* and a *footer*. Each of the section can be a Component.



In React, each component, conventionally, has its own JSX file with **its name capitalized**. Each of the file will contain the actual HTML element which will be displayed onto the webpage.



The basic component called the **Root Component** gets created whenever a React app is created. All the components to be displayed on the webpage must be ***imported*** inside the **root component**.



Often, there is a need of a conditionals in webpages. For instance, *if a Boolean variable's value is **true**, display a heading else not*.

This can be achieved by the standard `if..else` statements. A better way is to use the **Ternary operator**.

Ternary Operator

Its functionality is the exact same as the `if..else` conditional just with simpler syntax.

Syntax

```
condition ? doThis : doThat;
```

It basically says, *is the **condition** true? if yes, **doThis**. else, **doThat** .*

Example

To print `Yes, you are right!` if a Boolean variable is true. Else, `No, you are wrong!`.

```
// Declaring the variable
let isRight = true;

// Using the ternary
isRight === true
  ? console.log("Yes, you are right!")
  : console.log("No, you are wrong!");

// Updating the variable
isRight = false;

// Re-using the ternary
isRight === true
```

```
  ? console.log("Yes, you are right!")
  : console.log("No, you are wrong!");
```

The component file which contains the component is written in a mix of JavaScript and other languages called JSX.

Components in React are broadly of two types.

- **Functional Components** → More commonly used
- **Class Components** → Not-so commonly used

Functional Components

It basically means ***components that are in the form of functions***.

Concept

In JavaScript, **functions** are created to be used whenever needed.
For instance, to log a greeting for a few people in the console, a better way than this,

```
console.log("Hello, John!");
console.log("How are you?");

console.log("Hello, Mary!");
console.log("How are you?");

console.log("Hello, Isiaha!");
console.log("How are you?");

console.log("Hello, Kumar!");
console.log("How are you?");
```

would be to declare a function and call it.

```
function greet(name) {
  console.log(`Hello ${name}!`);
  console.log("How are you?");
}

greet(John);
greet(Mary);
greet(Isiaha);
greet(Kumar);
```

Similarly, components can be created in the form of functions. So that they can be used whenever needed.

Syntax

It is much like declaring a JavaScript function.

```
function ComponentName() {
        return (
         <!— HTML code here —>
        )
}
```

Code	What it means
`function`	The keyword to denote a functional component
`ComponentName`	The name of the component should always be in CamelCase
`return()`	This tells the compiler to display the code, given here, on the webpage

Example

In order to create a basic React component named `Heading`,

```
// Heading.js

// Name in CamelCase
function Heading() {
  // If the HTML code is in one-line, brackets can be omitted
  return <h1>Hello World!</h1>;
}
```

Export Statement

These components need to be accessed by the **root component**, or *the first container of the file*, of the React app.

For this, the component needs to be ***exported*** or *make it available for the app to use from another file*.

```
export { Heading };
```

For multiple components or any JavaScript component like variables, functions, object,

```
export { name1, getName, Heading };
```

To create a `Header` component which displays the Brand name and its motto,

- **Create the `Header` Component**

```
// Header.jsx

function Header() {
        return(
        );
}
```

- **Add in the HTML Elements**

```
// Header.jsx
function Header() {
  return (
    <div>
      <h1></h1>
      <p></p>
    </div>
  );
}
```

- **Add the *Props* and its Properties**

```
// Header.jsx
function Header(props) {
  return (
    <div>
      <h1>{props.brandName}</h1>
      <p>{props.motto}</p>
    </div>
  );
}
```

- **Export and Import**

```
// Header.jsx
export default function Header(props) {
  return (
    <div>
      <h1>{props.brandName}</h1>
      <p>{props.motto}</p>
    </div>
```

```
  );
}
```

```
// App.js
import Header from "./components/Header.jsx";

function App() {}
```

- **Render the Component**

```
// App.js
import Header from "./components/Header.jsx";

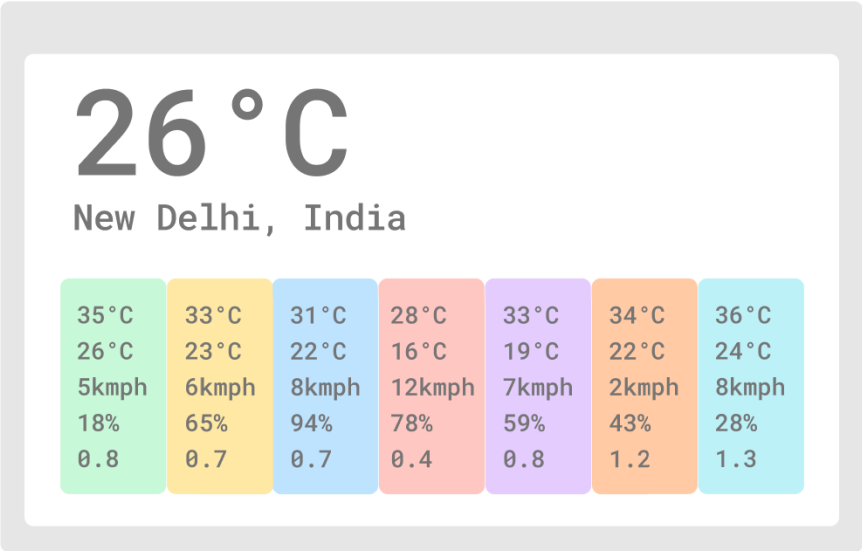
function App() {
  <Header />;
}
```

- **Add in the Attributes**

```
// App.js
import Header from "./components/Header.jsx";

function App() {
  <Header brandName="Open Tech" motto="Keep Teching" />;
}
```

Now comes the task of adding the actual weather data in each card of the webpage and displaying the actual temperature on the webpage.



This can't be done using *static* or *still* HTML as the current temperature is not always the same.

```
<h1>26°C</h1>

<li>35°C</li>
```

There should be something like a variable which when updated would update the current temperature on the webpage, as well.

Props are the solution, here.

The What

In JavaScript, to pass data to a function, a parameter is added.

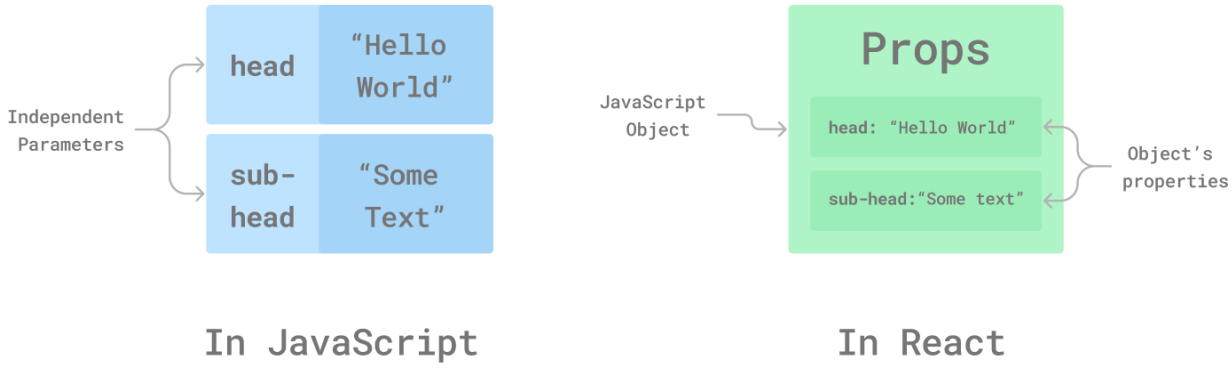
```
function func(param) {
  console.log(param);
}
```

In React, ***Props*** or **Properties** play the same role as the parameter of a JavaScript function.

```
function Component(props) {
        return (
                <h1>{ props.attribute1 }</h1>
                <h2>{ props.attribute2 }</h2>
        );
}
```

The difference is that, ***props*** is a JavaScript Object.

So, instead of defining many different *parameters* for a Component, all the *params* to be used in the Component are grouped under one Object, ***props***.



Next comes, calling the function.

In JavaScript, arguments are passed to the function when calling it.

```
func(arg);
```

Recall

`phrase` is a **parameter** or ***param***.

```
function greet(phrase) {
  console.log(phrase);
}
```

`"Hello"` is an **argument**.

```
greet("Hello");
```

In React, these *arguments* or ***attributes*** are mentioned while rendering the component.

```
<Component attribute1="someValue" attribute2="someValue" />
```

Here `someValue` will be the value of `attribute1`. The HTML code would, therefore, look like,

```
<h1>someValue</h1>
```

Tip

In React, using Functional Components is just like creating JavaScript functions but with different *terminology* or *choice of words*.

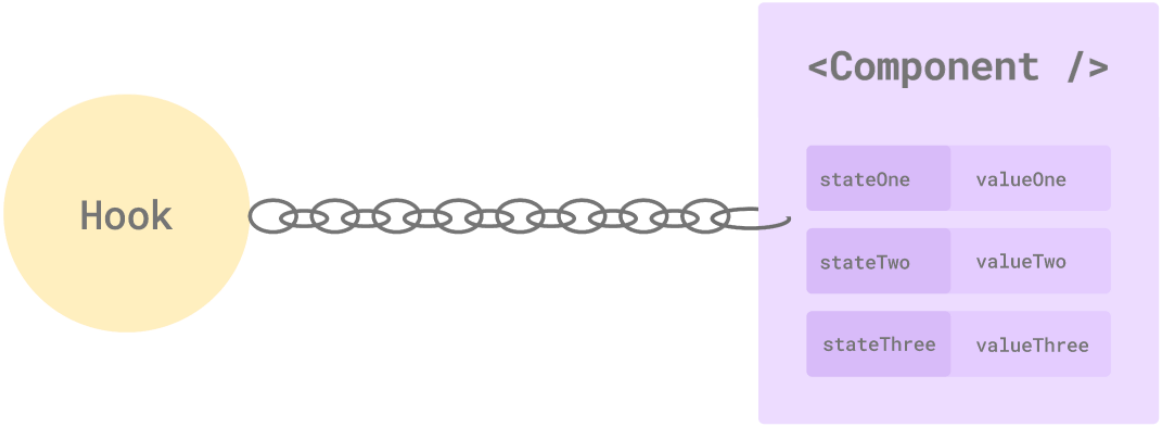
Vanilla JavaScript	React
Declaring a Function	Creating a Component
Calling the Function	Rendering the Component
Passing Arguments to the Function	Passing Attributes to the Component

A ***prop*** is passed as a *param* to the React component. Moreover, its properties can be accessed by the dot-notation inside a JSX embedded expression.

```
function Heading(items) {
        return(
                <h1>{ items.head }</h1>
                <h2>{ items.subHead }</h2>
        );
}
```

> ***Props* can have any name, just like any other JavaScript Object. It is just a convention to use `props`.**

Simply put, they are JavaScript functions to initialize, access and modify a React component's state.



Hooks in React

There are many pre-defined **hooks** in React for different purposes.

- `useState`
- `useEffect`
- `useMemo`

…and much more. The most used, however, is `useState`.

`useState`

It is a hook to ***create and update state variables***.

Syntax

Here, array deconstruction is used because `useState()` returns an array with a variable and an updater function, essentially a JavaScript function.

```
const [stateVariableName, setStateVariableName] = useState(initialValue);
```

Code	What it means	Example
`stateVariableName`	Name of the state variable to be *created* or *initialized*	`isTrue`
`setStateVariableName`	Name of the function to update the state variable	`setIsTrue`
`initialValue`	The initial value of the state variable, `stateVariableName` in this case	`true`

Example

Recreating this example using code,

```
export const Car = () => {
  const [hasStarted, setStart] = useState(false);
  const [isFuelOver, setFuelOver] = useState(true);
  const [distance, setDistance] = useState(102);

  return (
    <>
      // When clicked, sets the value of hasStarted to false
      <button
        onClick={() => {
          setStart(true);
          console.log(hasStarted);
        }}
      >
        Start
      </button>
      // When clicked, sets the value of hasStarted to true
      <button
        onClick={() => {
          setStart(false);
          console.log(hasStarted);
        }}
      >
        Stop the Car
      </button>
    </>
```

```
  );
};
```

Here, the approach is to

- First, create a component
- Initialize its State variables

For adding functionality to component using the state variables,

- Use the Event Handler `onClick` on the `<button>` element
- Declare a function which updates the State variable using the Updater function

Note

The Updater function cannot be called directly.

```
const Component = () => {
        const [data, setData] = useState("some data");

        // Like so
        setData("some other data");
}
```

It must be an action of an event.

```
const Component = () => {
        const [data, setData] = useState("some data");

        // Like so
        return (
                <div onMouseOver={() => {setData("some other data");}}>
</div>
        );

}
```

Just like Parent and Child classes in JavaScript, Components are named on the basis of hierarchy.

Example

Say there are two components named `Article` and `Main`.

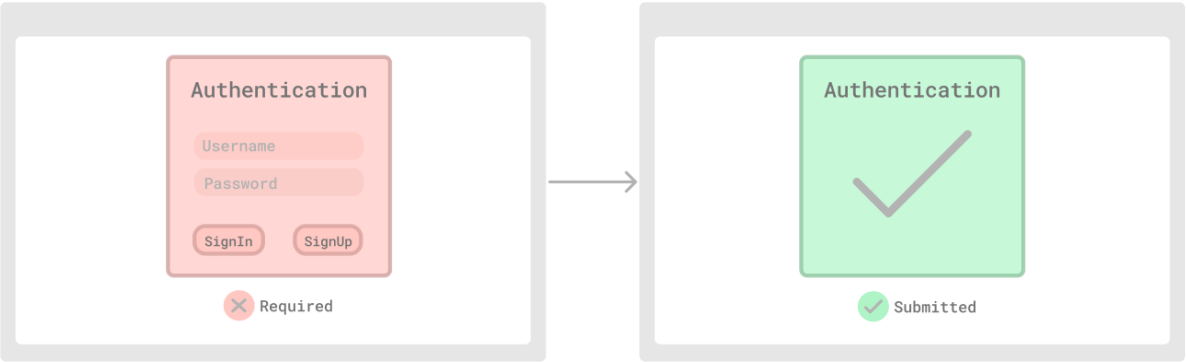
```
export default function Article() {
  return (
    <>
      <h1>Heading</h1>
      <p>Lorem ipsum dolor sit amet ... </p>
    </>
  );
}
```

```
export default function Main() {
  <Article />;
}
```

Here, `Article` is considered a ***Child*** of `Main` and `Main` is the ***Parent*** of `Child`.

There are many components in a website, each holding some data. This data might change on the occur some Event.

For instance, on submitting an Authentication form, the *status* of the form changes to `submitted`.



The *data* that a component holds about itself, internally, is called *the **state** of the component*. **State** is a JavaScript Object which holds data in the form of properties.

> **Info**
>
> State **resembles** a component's *props*.
>
> The difference is that state is a component's internal data.
> *Props* can be passed down to the children components and thus are external.

In the example above, the **state** of the form, `isSubmitted`, is initially `false`. When the form is submitted, `isSubmitted` is updated to `true`.

Here,

- **Event** → Submission of form or precisely, *Click of* `Submit` *button*
- **Action** → Form state, `isSubmitted`, changed to `true`.

Data Mutability

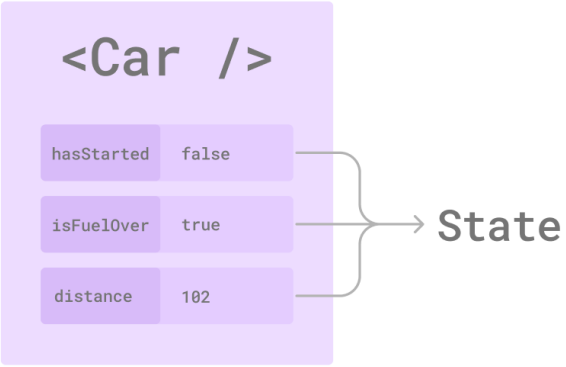
Data means, well, *data* and *Mutability* means *the ability to modify data*.

React components are broadly classified into two types, **Stateful** and **Stateless**.

Component Type	What it is	Mutability
Stateful	A React component with at least one state variable	Mutable Data from the state **can** be modified
Stateless	A react component with no state	Immutable Data through props **cannot** be modified by the React component

Example

Say, a React component named `Car` is to be created with the properties of the car.
Its state would look something like this,

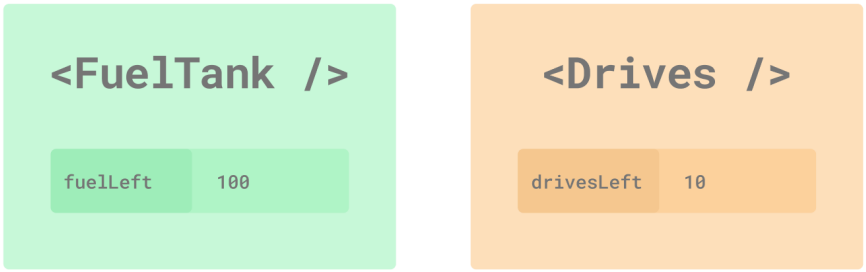


Note

The group of all the variables is the state of the component and not each of the variables.

Often, while building full-fledged React apps, some components need to access and use other components' state.

As an example, say, a React app consists of two components `Drives` and `FuelTank`.



Each `drive` costs 10% of the `fuelLeft`. In other words,

```
1 drive = 10 fuelLeft
```

So, `drivesLeft` is *a function of* `fuelLeft`. Or simply, `drivesLeft` needs to access `fuelLeft` for the calculations.

This is not possible as `fuelLeft` and `drivesLeft` are State variables and cannot be accessed by other components.

The Solution

There are multiple solutions for this problem.

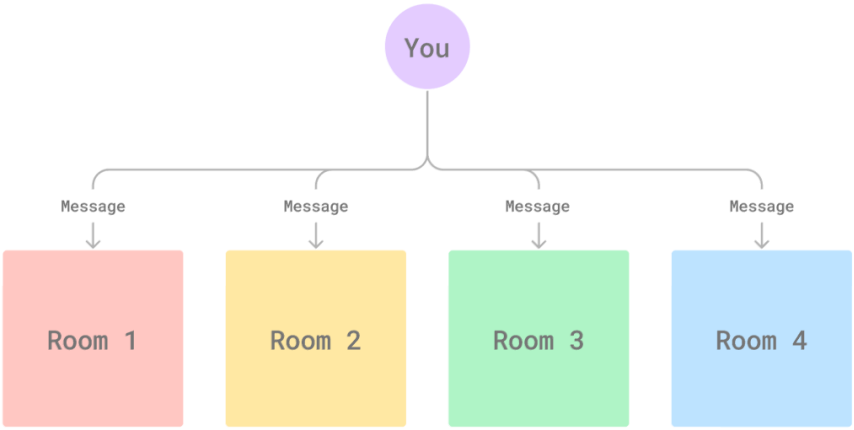
- **Prop-Drilling**
- **Lift the State Up**
- **Context API**

It is quite different from the other two.

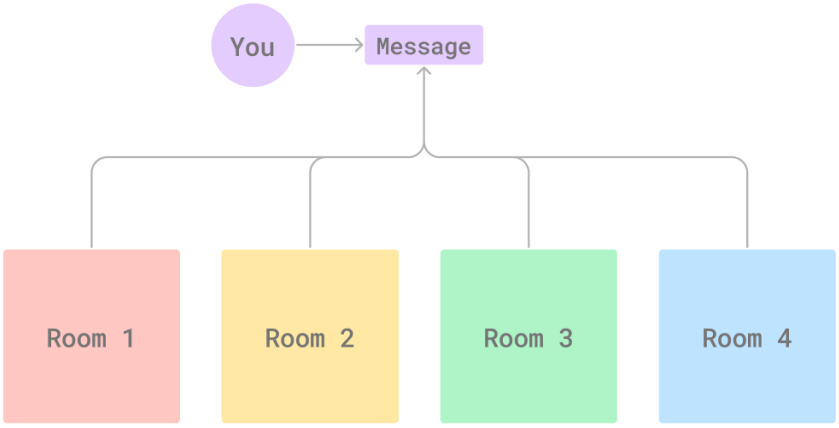
Concept

Say, you have to convey a message to the students in different classrooms.

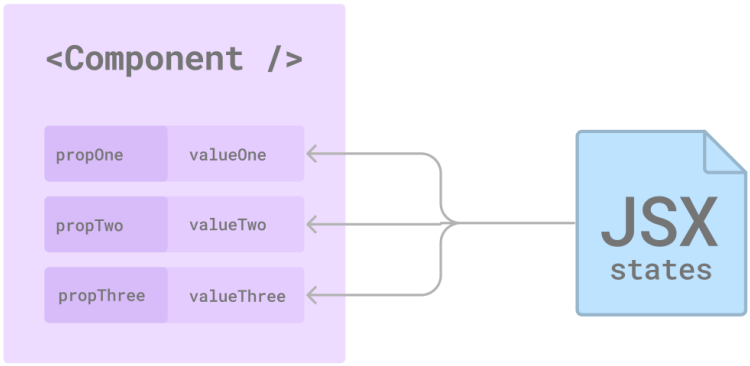
Going into each room, one-by-one, would be very inefficient.



A better way would be to post the message on a notice board outside and let the students read the message, themselves.



This is the approach of Context API. Simply put, all the State variables to be used are stored in a separate file. Any component can access the State variables in the file and use, according to need.

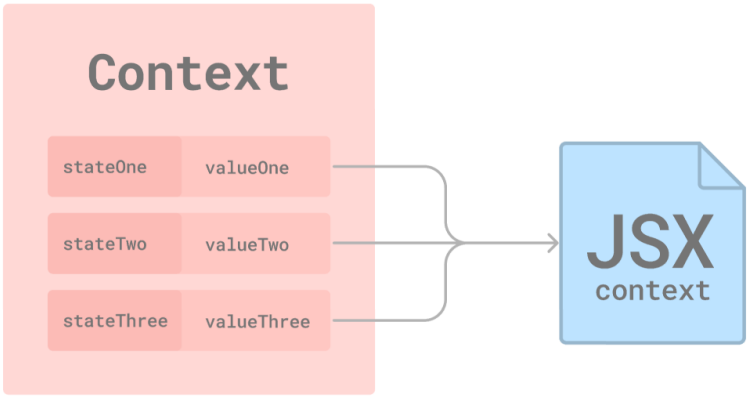


Approach

Using Context API involves multiple steps and files.

- **Creating the Context**

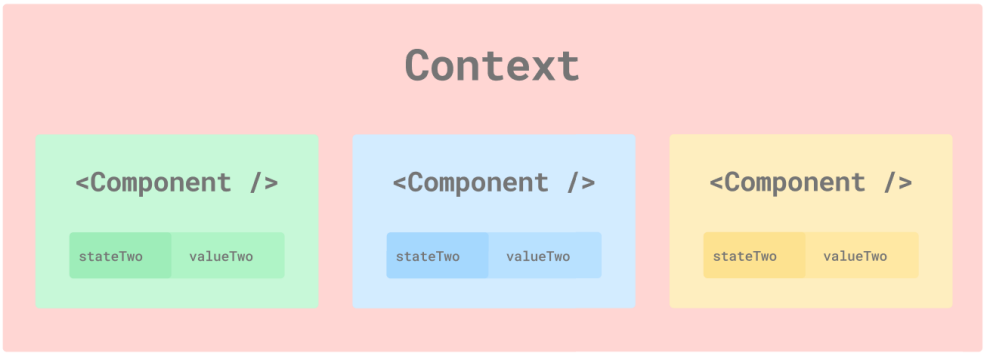
Context is basically the data that can be accessed by all the components which needs to be stored in a separate file.



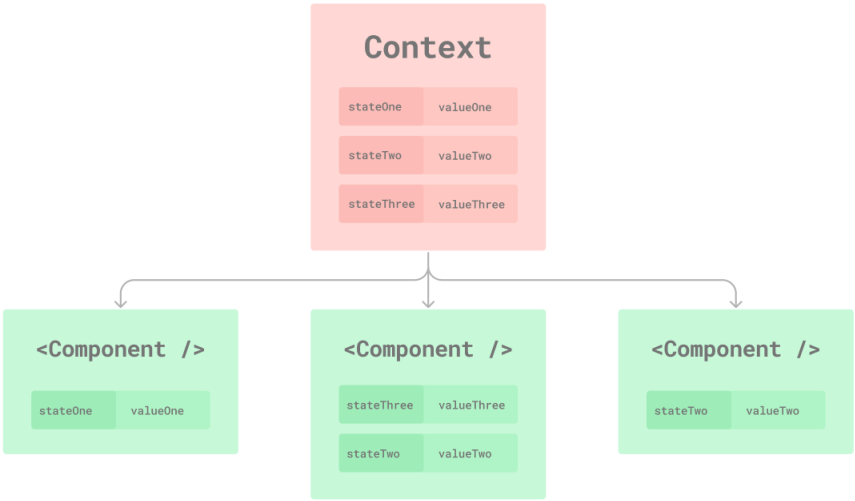
- **Providing the Context**
  The context created is then imported into the Root component file.

  It is further *wrapped around* the components that need to access the data inside. Much like scope in JavaScript, the components in the *scope* of the context can use it.

  This is called ***providing the context***.



- **Consuming the Context**
  Components ***consume*** the data in the State variables stored in the context using the `useContext()` hook, just like `useState()`.



Application

This is an implementation of a Context API for the [example] of `FuelTank` and `Drives`.

- **Creating the Context**

```
// Context.jsx
import { createContext } from "react";

// Create a knowledge base, and store the following data
const DataContext = createContext();

export default DataContext;
```

- **Providing the Context**

```
// App.jsx
import { useState } from "react";
import DataContext from "./Context";

function App() {
        // Creating a "variable" to store the data because data in the
context can change
        const [data, setData] = useState({drivesLeft: 10, fuelLeft: 100});

        // Provide the following components the access to this knowledge-
base
        <DataContext.Provider value={data}>
                <Component />
        </Data Context.Provider>
}
```

> **Info**
>
> The data to be stored in the Context wasn't stored while creating it.
>
> It is passed as an attribute to `<DataContext.Provider>` *via* `value` so that the data can be modified by the components using it.

- **Consuming the Context**

```
// Drives.jsx
import DataContext from "./Context";
import { useContext } from "react";

const Drives = () => {
  // Use the context and extract the data from it.
  const { drivesLeft } = useContext(DataContext);

  return <h1>Drives Left: {drivesLeft}</h1>;
};
```

Just the same as Prop-drilling.

The only difference is that the data to be passed *via props* is stored in State variables whereas in Prop-drilling, the data is stored in JavaScript containers and objects.

Example

Executing the same example as Prop-drilling, just with States.

- **Creating the Components**

```
// FuelTank.jsx
export const FuelTank = (props) => {
  return (
          <h1>Fuel left: { props.fuelLeft }</h1>
  );
}

// Drives.js
export const Drives = (props) => {
  return (
```

```
            <h1>Drives left: {props.drivesLeft}</h1>
  );
}

// App.js
import { Drives } from "./components/Drives"
import { FuelTank } from "./components/FuelTank"

export const App = () => {
  return (
            <Drives />
            <FuelTank />
  );
}
```

- **Storing the Data**

```
// App.js
import { Drives } from "./components/Drives"
import { FuelTank } from "./components/FuelTank"
import { useState } from "react"

export const App = () => {
  const [fuelLeft, setFuelLeft] = useState(100);
  const [drivesLeft, setDrivesLeft] = useState(10);

  const data = {
            fuelLeft,
            setFuelLeft,
            drivesLeft,
            setDrivesLLeft,
  };

  return (
            <Drives />
            <FuelTank />
  );
}
```

- **Drilling *via Props***

```
// App.js
import { Drives } from "./components/Drives"
import { FuelTank } from "./components/FuelTank"
import { useState } from "react"

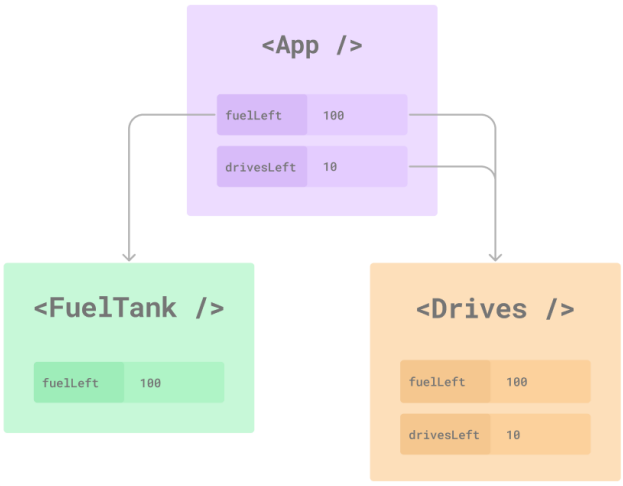
export const App = () => {
```

```
  const [fuelLeft, setFuelLeft] = useState(100);
  const [drivesLeft, setDrivesLeft] = useState(10);

  const data = {
          fuelLeft,
          setFuelLeft,
          drivesLeft,
          setDrivesLLeft,
  };

  return (
          <Drives { ... data} />
          <FuelTank {drivesLeft, setDrivesLeft} />
  );
}
```

Herein, the data to be accessed by the Sibling components is contained in the Parent component.
The data is then passed to the Children components *via props*.



`Drives` needs `fuelLeft` for the calculation and thus, it accepts both of them. `FuelTank` doesn't rely on `drivesLeft`. Thus, it only imports what's required.

Example

Executing the above example, programmatically, would be quite tedious. A relatively simpler one would be,

- **Creating the Components**

```
// FuelTank.jsx
export const FuelTank = (props) => {
  return (
```

```
            <h1>Fuel left: { props.fuelLeft }</h1>
  );
}

// Drives.js
export const Drives = (props) => {
  return (
            <h1>Drives left: {props.drivesLeft}</h1>
  );
}

// App.js
import { Drives } from "./components/Drives"
import { FuelTank } from "./components/FuelTank"

export const App = () => {
  return (
            <Drives />
            <FuelTank />
  );
}
```

- **Storing the Data**

```
// App.js
import { Drives } from "./components/Drives"
import { FuelTank } from "./components/FuelTank"

export const App = () => {
  const data = {
            fuelLeft: 100,
            drivesLeft: 10,
  };

  return (
            <Drives />
            <FuelTank />
  );
}
```

- **Drilling *via Props***

```
// App.js
import { Drives } from "./components/Drives"
import { FuelTank } from "./components/FuelTank"

export const App = () => {
```

```
    const data = {
            fuelLeft: 100,
            drivesLeft: 10,
    };

    return (
            <Drives { ... data} />
            <FuelTank fuelLeft={data.fuelLeft} />
    );
}
```

Tip

When all the properties of an object are to be used, the Rest operator can be used.

```
const data = {
        someProp1: “someValue1”,
        someProp2: “someValue2”,
        someProp3: “someValue3”,
};

<Component  {…data} />
```

A button, when clicked, should perform an action. That's what the function of a button is.

An action done by the user is considered an **Event**. What takes care of *what, then, should be done* is called a **Handler**.

Events in React

React allows for numerous **events** to be *handled*. For instance,

Event	What it means
`onClick`	When an element is clicked, an action is performed
`onMouseOver`	On hovering over an element, an action is performed
`onCopy`	When something is copied, an action is performed

There are many such events in React and HTML.

Syntax

Event Handling is supported by, both, HTML and React. In React, there are 3 ways to handle an event.

- **Using a plain function**
  The function is first declared and then assigned to the `onClick` attribute inside *curly-braces* `{}`.

```
function Button() {
  const displayMessage = () => console.log("Button was pressed!");

  return <button onClick={displayMessage}></button>;
}
```

- **Declaring an arrow function, therein**
  The arrow function is declared as the value of the `onClick` attribute.

```
function Button() {
  return <button onClick={() => console.log("Button was pressed!")}>
</button>;
}
```

- **Declaring a plain function, therein**
  The plain function is declared as the value of the `onClick` attribute.

```
function Button() {
  return (
    <button
      onClick={function () {
        console.log("Button was pressed!");
      }}
    ></button>
  );
}
```

Example

When hovered over a `<div>` container, log the message `Hovering over the div` in the console.

```
function EventHandler() {
  return <div onMouseOver={() => console.log("Hovering over the div")}>
```

```
</div>;
}
```

Any file, such as a stylesheet, image or an icon, used in a project is called an **asset**.
By convention, these **assets** are to be stored in the `assets` folder inside the `src` folder.

Accessing Assets

There are three ways to access and use assets in a React app.

- **Importing and Using, directly**
  Import the image and assign it a name using the `import..from` statements. Add in `logo` as the value of the `src` attribute.

```
import logo from "./assets/logo.png";
```

<img
src={ logo }

```
<br>

* ##### Using `require`
Call the function `require` with file path as the argument wherever needed.
```jsx
<img
        src={ require("./assets/logo.png") }
>
```

- **Using an External URL**
  Store the URL of an **external image**, *which is not locally downloaded on the system*, in a variable and use it wherever needed.

```
const logo = "https://www.example.com/images/logo.png";
<img
        src={ logo }
>
```

Using Assets
```

There are broadly two ways to use an asset in React.

- **Using the HTML elements**
  The conventional way of using assets using HTML tags such as, `<video>`, `<audio>` and `<img>`.

- **Using Third-party Libraries**
  There are numerous libraries provided by other developers which can be installed *via* `npm` and looked here. For instance, `react-audio-player` and `react-video-player`.

```
import Audio from "react-audio-player";

function App() {
  const aud = "./assets/audio.mp3";

  return <Audio src={aud} />;
}
```

To create a proper navigation system using ***routing***, another library, the `react-router-dom` which is paired along with `react`.

The approach to create the routing system can be broken down into steps.

- **Creating the Components**
  The components, which essentially are distinct webpages, are created into separate files just like other React components.

```
// Home.jsx
export function Home() {
  return <h1>This is the HomePage</h1>;
}

// Services.jsx
export function Services() {
  return <h1>Know our Services</h1>;
}

// Contact.jsx
export function Contact() {
  return <h1>Contact Us</h1>;
}
```

- ## Adding in the Routes

  Routes are just like roadways. The road is, first, created and named. Only then, is it added to the official maps. This is the creation step.

  Routes are created using the `Route` and `Routes` components from the `react-router-dom` library.

```
import { Route, Routes } from "react-router-dom";
import Home from "./components/Home";
import Services from "./components/Services";
import Contact from "./components/Contact";

export default function App() {
          return (
                  <Routes>
                          // Create a Route to the URL, *the same one*,
and webpage, Home
                          <Route to="/" element={<Home />}>

                          // Create a Route to the URL, /services, and
webpage, Services
                          <Route to="/servives" element={<Services />}>

                          // Create a Route to the URL, /contact, and
webpage, Contact
                          <Route to="/contact" element={<Contact />}>
                  </Routes>
          );
}
```

Component	What it does
`Routes`	Used to group the individual `Routes`
`Route`	Creates a URL for the webpage with the components to be rendered in it

- ## Linking Webpages to Routes

  This is done using the component `Link` from `react-router-dom`. It links the URL created above with the HTML elements of choice.

```
import { Link, Route, Routes } from "react-router-dom";
import Home from "./components/Home";
import Services from "./components/Services";
```

```
import Contact from "./components/Contact";

export default function App() {
          return (

                    // Create links to the URLs
                    <Link to="/">Home</Link>
                    <Link to="/services">Services</Link>
                    <Link to="/contacts">Contacts</Link>

                    <Routes>
                              // Create a Route to the URL, *the same one*,
and webpage, Home
                              <Route to="/" element={<Home />} />

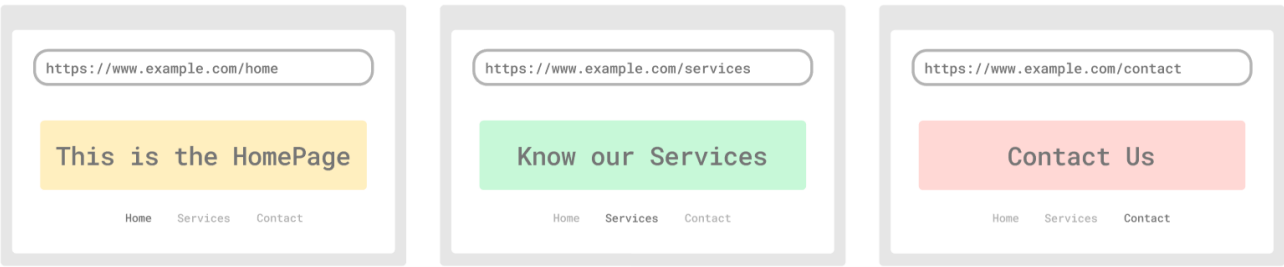
                              // Create a Route to the URL, /services, and
webpage, Services
                              <Route to="/servives" element={<Services />}
/>

                              // Create a Route to the URL, /contact, and
webpage, Contact
                              <Route to="/contact" element={<Contact />} />
                    </Routes>
          );
}
```

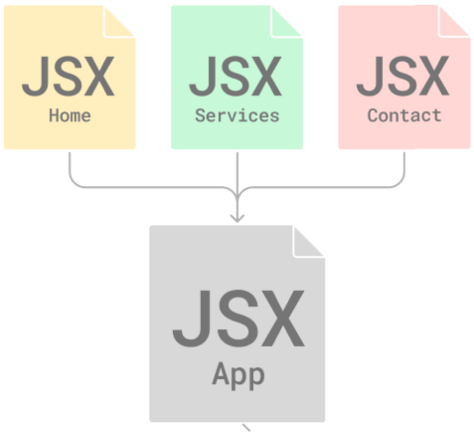
SPA or Single Page Applications are an efficient way of making websites. Simply put, the browser, instead of loading complete HTML files, loads only the components needed.

Approach

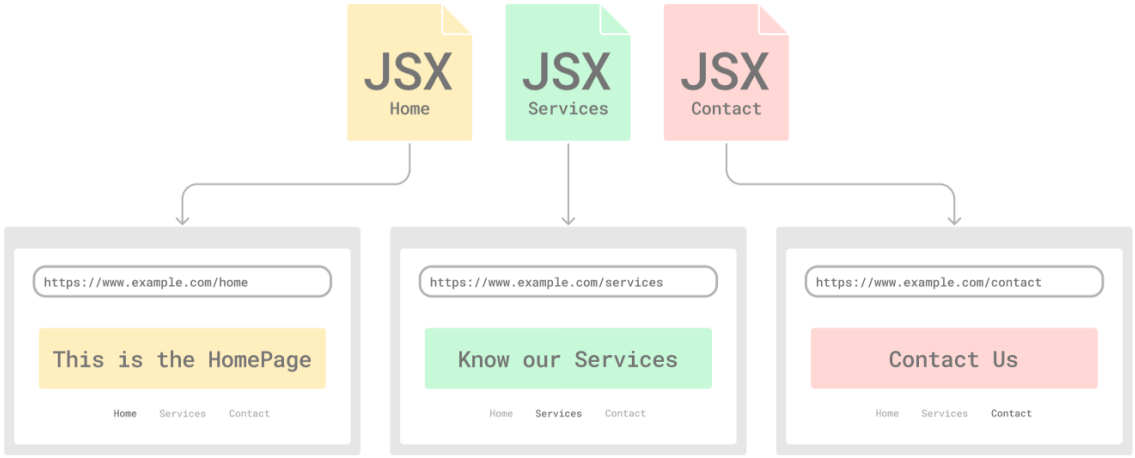
Say, a website has 3 webpages, `Home`, `Services` and `About`.



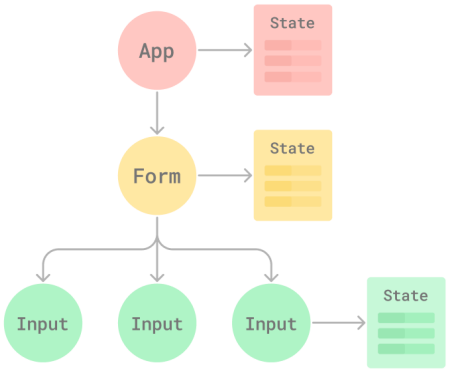
If this website is to be constructed as an SPA, each of the webpages will have its own React component. Whenever the user visits another webpage, only the component that changes will be rendered.



To achieve this, instead of using the anchor tag, `<a>`, a similar React component is used to link the webpages with the items of the ***Navbar*** or **Navigation Bar** called `Link`.



Every webpage has a DOM which has a pre-defined state of each HTML element. This pre-defined state, which stores the data of the HTML element, is controlled by the DOM.



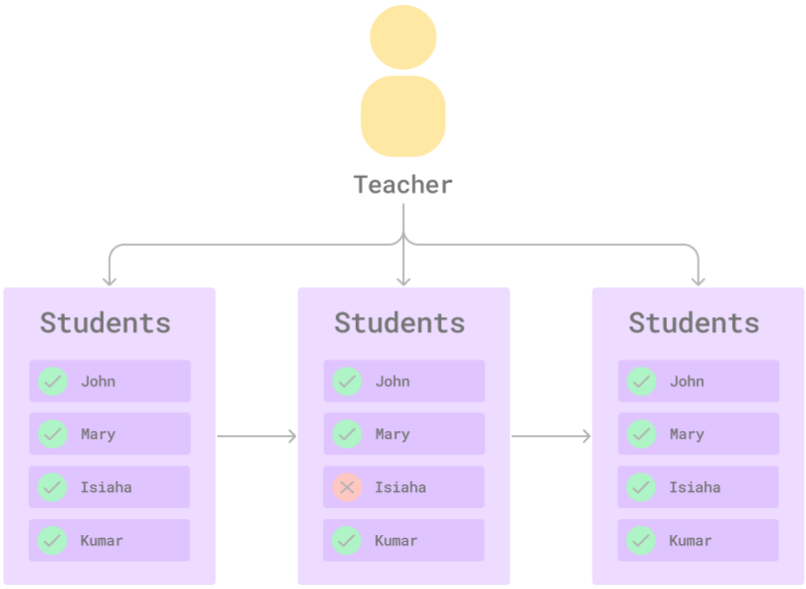
This doesn't make the page dynamic. Especially, in the case of HTML forms which requires event-action triggers.

React provides a way to create dynamic forms.

- **Using Controlled Components**

- ## Using Uncontrolled Components

Imagine being a teacher who has to look after the students on a picnic. A good way of ensuring that every student is present at all times would be to maintain a record of the students by calling for each student at regular intervals.



Here,

- **Teacher** → React code
- **Students** → Controlled Components
- **Presence Record** → State of the Controlled Components

The React code ***controls*** or *keeps track of* the state of the components. The components whose state is being **controlled** by React are **Controlled Components**. Thus, the data stored is **centralized**.

Also, whenever any change is made to the components' state, React *reflects* or *shows* it in the compiled React app.

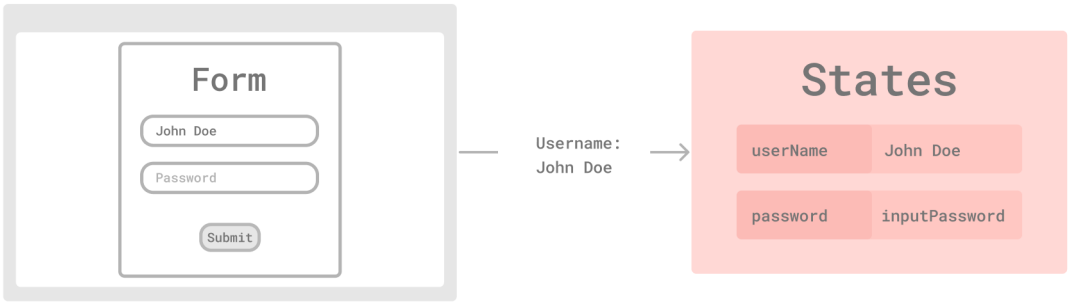
Just like, if any student got lost, it would be immediately be recorded and his search would begin.

Working

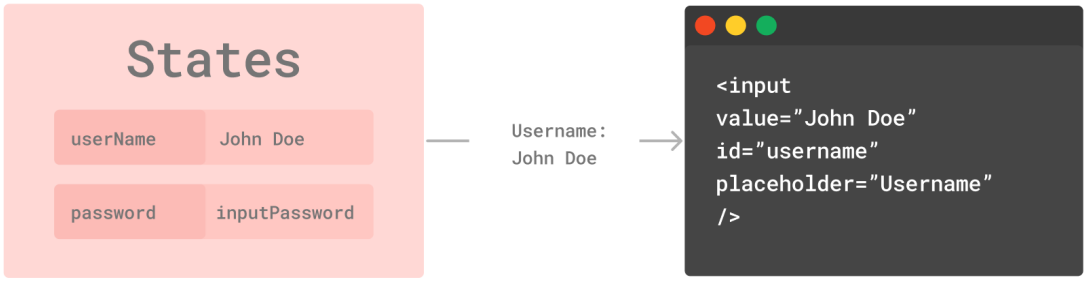
Controlled Components are, generally, used with forms.

Therefore, say for instance, an Authentication form has been created using Controlled Components. When the *Username* is entered in the field,

- The *Username* entered will be updated to the State variable linked to the component.



- The `value` attribute of the *Username* `<input>` element will be updated to the value of the State variable.



> **`value` is an attribute of the `<input>` element. Its value is what is displayed inside the field.**

If the `value` is set to `Default`, despite of whatever may be typed in the field, `Default` will be shown.

Also, the `value` will not store what was typed in this case.

Application

To achieve the proper working of a simple Authentication form created using controlled components,

- **Create the Input Elements**

  Two elements for *password* and *username* are to be created.

```
export function Form() {
  return (
    <form>
      <label forHtml="username">Username: </label>
      <input type="text" id="username" />

      <label forHtml="password">Password: </label>
      <input type="password" id="password" />
    </form>
  );
}
```

- **Create the State Variables**

  A State variable for each of the `<input>` elements are to be created to store the input.

```
import { useState } from "react";

export function Form() {
  const [username, setUsername] = useState("");
  const [password, setPassword] = useState("");

  return (
    <form>
      <label forHtml="username">Username: </label>
      <input type="text" id="username" />

      <label forHtml="password">Password: </label>
      <input type="password" id="password" />
    </form>
  );
}
```

- **Sync the System**

Syncing the system, here, means *to create a system which would automatically update the values to the current input*.

This is done by assigning the `value` and `onChange()` attributes to the `<input>` elements.

`onChange` is another Event Handler like `onClick` which is triggered whenever any character is added or deleted from the input field.

```
import { useState } from "react";

export function Form() {
  const [username, setUsername] = useState("");
  const [password, setPassword] = useState("");

  return (
    <form>
      <label forHtml="username">Username: </label>
      <input
        type="text"
        id="username"
        // The username State variable's value will be displayed in the
input field
        value={username}
        // It says, update the state variable's value to the current
input
        onChange={(event) => setUsername(event.target.value)}
      />

      <label forHtml="password">Password: </label>
      <input
        type="password"
        id="password"
        value={password}
        onChange={(event) => setPassword(event.target.value)}
      />
    </form>
  );
}
```

> **`event` is a JavaScript Object which carries all the information about an event that has occurred.**

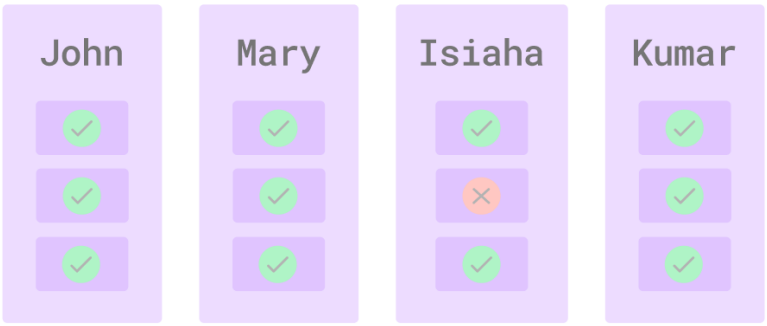
For instance,

```
event {
    type: 'click',
    timeStamp: 1674459983775,
    clientX: 100,
    clientY: 200,
    target: {
      id: 'someButton',
      tagName: 'BUTTON'
    }
}
```

The above event was a `click` on the `<button id="someButton">` at the coordinates `(100, 200)px`.

They are the counterpart of Controlled Components.

Herein, instead of the teacher keeping the record of the students, the students, themselves, check if they are still a part of the group or have been lost.



Here,

- **Students** → Uncontrolled Components
- **Presence Record** → The *data* or *state* of the components

The *students* take care of the *presence record*, themselves. In other words, the data of the Uncontrolled components is stored **in** the components. This makes the system **decentralized**.

Working

Uncontrolled components are way more easier to deal with. Say a similar Authentication form has been created using Uncontrolled components.

When the *Username* is entered in the field,

- The input in the *Username* field will be ***pulled*** or *retrieved*.

- This value can then be used wherever wanted.

It’s that simple.

Application

To do so,

- **Create the Components**

```
export function Form() {
  return (
    <form>
      <label forHtml="username">Username: </label>
      <input type="text" id="username" />

      <label forHtml="password">Password: </label>
      <input type="password" id="password" />
    </form>
  );
}
```

- ***Pull* the Input**
  The input is retrieved using the `useRef` hook. It is initialized with a value which can be accessed using the `current` property. This value can be *mutated* or *changed*, as well.

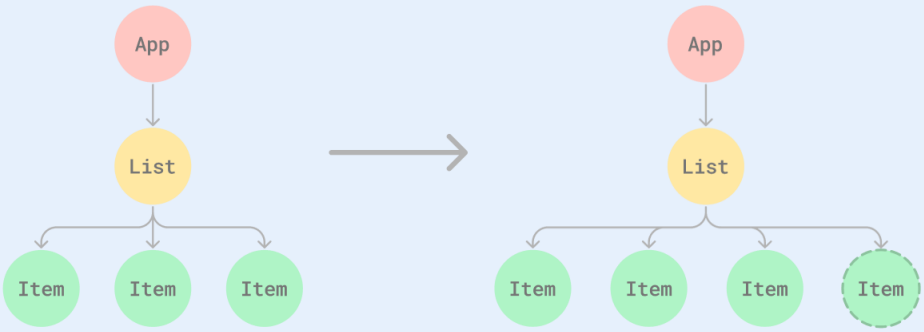
```
import { useRef } from "react";

export function Form() {
  const usernameRef = useRef(null);
  const passwordRef = useRef(null);

  return (
    <form>
      <label forHtml="username">Username: </label>
      <input type="text" id="username" ref={usernameRef} />

      <label forHtml="password">Password: </label>
      <input type="password" id="password" ref={passwordRef} />
    </form>
  );
}
```

Just like the **keys** of a JavaScript Object, ***keys*** in React are used as *identifiers* or *IDs* for the React components.

> ⓘ **The Diffing Algorithm**
>
> Let there be an unordered HTML list.
>
> If another item is added in the `<ul>`, React would compare the previous **VDOM** with the updated one. The changes will be then made into the **Real DOM**.
>
> 
>
>
> This is called the ***Diffing*** **Algorithm**.

The What

Keys, in React, are used to create an ***identity*** of a component. Primarily, it is used to make the ***Diffing*** **Algorithm** a lot more efficient.

The How

Keys helps React in *remembering* the elements.

Say, in the above example, the item to be added in the list is added at the top and not the bottom.

```
<ul>
  <li>Item 5</li>
  <li>Item 1</li>
  <li>Item 2</li>
  <li>Item 3</li>
  <li>Item 4</li>
</ul>
```

This will confuse the *Diffing* algorithm as it treats the last element as the appended one, always. So, instead of updating just the item appended in the VDOM, it will update the complete the list because the first item is not what it was earlier.

Application

Keys can be added to a React component using the `key` attribute.

```
const keys = ["five", "one", "two", "three", "four"];;

<ul>
        // Mapping the IDs in the keys list to actual <li> elements with
keys
        {keys.map((key, index) => {
                <li key={ key }>Item {index}</li>
        })}
</ul>
```

> **Tip**
>
> It is a good practice to use **keys** that are always unique. Using indexes of list items is not recommended because even on re-ordering the components, the previous order is maintained.

Say, for instance, you have been given a list of book titles.

```
const bookTitles = ["The Alchemist", "Karma", "The Hobbit", "Sapiens"];
```

The task is to create a `Book` instance of each of the list elements.

```
class Book {
  constructor(title) {
    this.title = title;
  }
}
```

One way would be to do it all, one-by-one.

```
const hobbit = new Book("The Hobbit");
const karma = new Book("Karma");
```

```
const alchemist = new Book("The Alchemist");
const sapiens = new Book("Sapiens");
```

The other, effective, way is to use the `map()` method.

Mapping

`map()` is a method in JavaScript to ***transform*** elements of a JS list to other components.

Application

It basically says, ***map*** *or* ***transform*** *each item in the list to* `objectTochangeTo` *and store the new list in* `mappedList`.

```
const someList = ["element1", "element2", "element3", "element4"];

const mappedList = someList.map((item) => {
  return objectToChangeTo;
});
```

Example

Implementing the above example, programmatically,

```
class Book {
  constructor(title) {
    this.title = title;
  }
}

const bookTitles = ["The Alchemist", "Karma", "The Hobbit", "Sapiens"];

const books = bookTitles.map((bookTitle) => {
  let bookInstance = new Book(bookTitle);
  return bookInstance;
});

console.log(books);
```

Tip

> This transformation or ***mapping*** can be done for lists of React components as well.

Filtering

Another tool for list transformation which ***filters*** or *excludes elements from lists that do not meet a certain condition*.

Application

This is done using the `filter()` method on lists.

It basically says, *filter all the items in the list which do not meet* `condition`. If the `condition` is true, the item will be kept else, excluded.

```
someList.filter((someItem) => {
  return condition;
});
```

Example

To filter out all the books which contain “the” in their title, the following code can be used.

```
bookList.filter((book) => {
  let pattern = new RegExp("the");
  return pattern.test(book.title());
});
```

Sorting

To ***sort** a list *means to* arrange the list items in a specific order*.

Application

This can be done using the `sort()` method on the lists with a function, called the **compare function**, as its argument.

```
someList.sort((item1, item2) => {
  item1 - item2;
});
```

Example

Sorting the book list in alphabetical order, doesn't require a **compare function**.

```
bookList.sort();
```

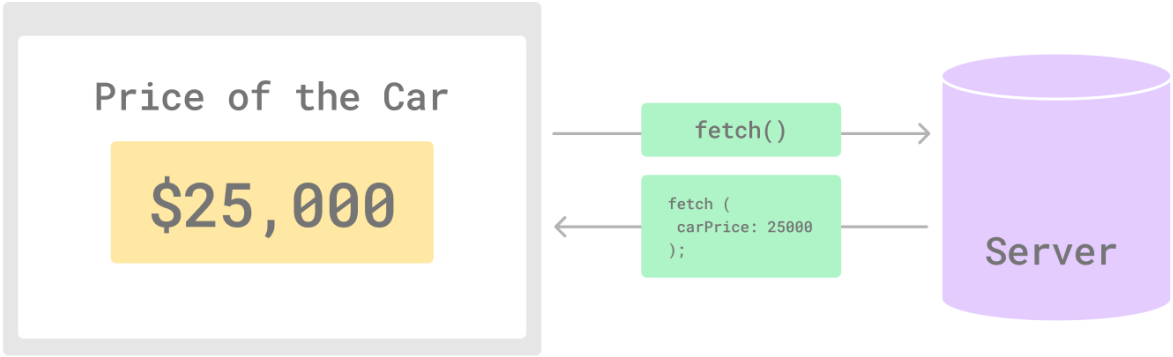
Say, you are assigned to build a webpage which displays the price of a car from another website.

Manually, updating the value of a state variable will be not be effective. Instead, something which would automatically get the data and update the state variable would do the work.

This is what's called ***fetching***. *Fetch* means *to get*. Thus, ***fetching** data *means* getting data from another source**.

Approach

For this, JavaScript has a special **Browser** API called `fetch()`. The `fetch()` function takes a URL as an argument. When `fetch()` is invoked, the data at the URL is brought into the web app.



Then, this data is converted into **JSON**. Then, it is stored in the state variable of the Car price.
Both these actions are done at the time of arrival of data using `then`.

JSON

Standing for **JavaScript Object Identifier**, it is a data format used to store data. It occupies very little storage and is the most efficient form of data storage.

An example of a JSON object storing the Car price would be,

```
”car”: {
        “carPrice”: 25000,
}
```

Example

The code for the above example would be,

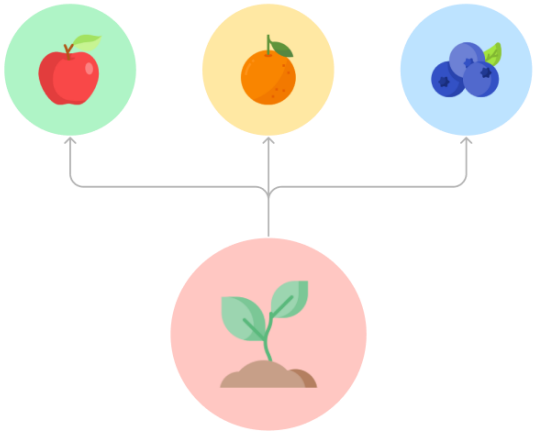
```
import { useState } from "react";

function App() {
        const [carPrice, setCarPrice] = useState(0);

        // Grab the data from the URL, convert it into JSON, update the
state variable
        fetch("https://www.thisisnotanactualurl.com/carprice")
        .then((response) => response.json())
        .then((data) => setCarPrice(data.carPrice));

        return (
                <p>The Car Price is:</p>
                <h1>{ carPrice }</h1>
        );
}
```

Say, you have planned to plant saplings of *Apple*, *Orange* and *Blueberry*.

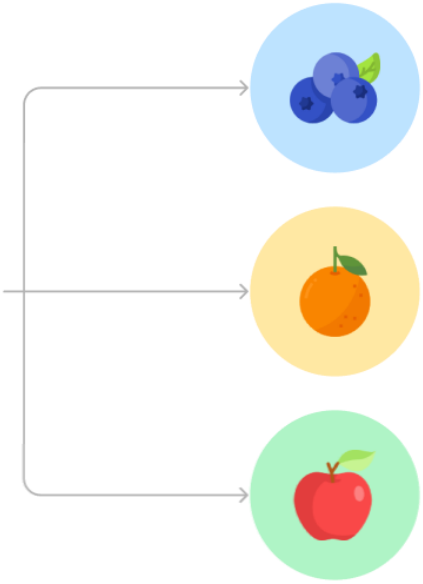


Planting the sapling of *Apple* and waiting for it to grow and then plant the sapling of *Orange* would make no sense, provided that you have multiple pots and resources.

This is called **synchronous process** which means *to execute the tasks one-by-one*.

This is also called a **single-thread execution** as there is only 1 **thread** which executes all the processes one-by-one.

An effective way would be to plant all of them at the same time. This is called an **asynchronous process** meaning that *the processes are executed are t the same time*.



This is also called **multi-thread execution** as there is one **thread** for each of the saplings.

Fetching

It is an **asynchronous process**. Meaning that whenever `fetch` is invoked, it is executed in a separate **thread**.

For instance,

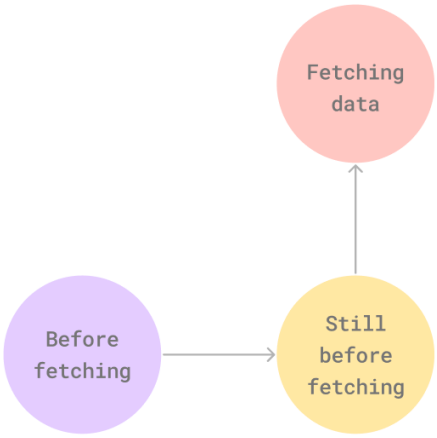
```
console.log("Before fetching");

fetch("https://www.thisisnotanactualurl.com/somedata")
  .then((response) => response.json())
  .then((data) => console.log(data));

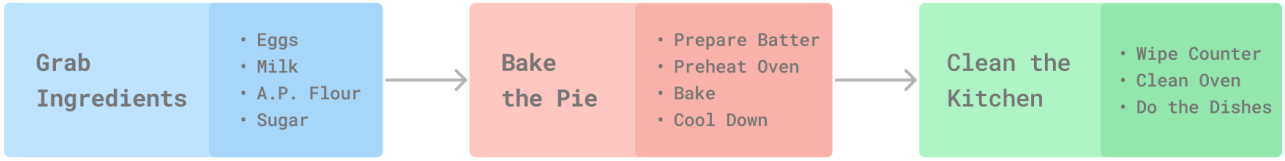
console.log("Still before fetching");
```

In the code above,

- First, `Before fetching` is logged in the console
- Then, `fetch` is invoked
- Simultaneously, `Still before fetching` is logged in the console



In order to cook a dish, several tasks need to be done before and after the actual cooking, such as *grabbing ingredients* and *cleaning the kitchen*.

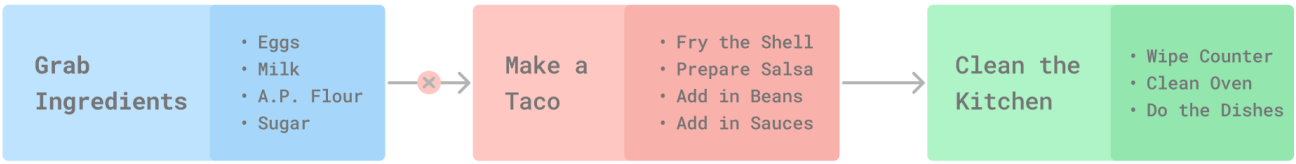


Although, these tasks are not directly involved in the cooking process, they still are necessary. Such tasks are called ***side-effects***.

In React, ***side-effects*** are processes like *fetching data from some source* and *logging data in the console*.

Also, *grabbing the ingredients for a specific dish* or tasks alike are done only when that dish is to be prepared and not every time a dish is prepared.

For instance, if a *pie* was baked initially followed by a *taco*, the ingredients of *pie* shouldn't be bought over again.



This is the problem with **side-effects**. They keep on repeating after every render in React.

Working

The `useEffect` hook allows to *separate* the side-effects and control *how frequently should they be executed*.

`useEffect` takes in two values, *the side-effect* and a ***dependency array***. The **dependency array** is a JavaScript list which contains some states or *props*.

When used, it tells the compiler, *execute the side-effect only if the values of states or props given in the dependency array change*. Re-rendering only the components which are changed makes the webpage more efficient.

Application

To create a simple webpage which has 2 `<button>` elements, one which executes the side-effect and the other which conditionally renders a `<p>` element.

```
import { useEffect, useState } from "react";

function App() {
  // A state for name
  const [name, setName] = useState("John")

  // A state for a random task that shouldn't invoke the side-effect
  const [toggle, setToggle] = useState(true);

  // It says, "execute this function if there is a change in the value of
name state"
  useEffect(() => console.log("Executing side-effect ... "), [name]);
```

```
  return (
    <>
      <h1>{name}</h1>

          <!— If toggle === true, <p> will be rendered, else not —>
      {toggle && <p>This shouldn't execute the side-effect</p>}

          <!— Toggling the name to John or Mary—>
      <button onClick={() => setName(name === "Mary" ? "John" : "Mary")}>
        Execute Side-effect
      </button>

          <!— Toggling the visibility of the <p> element —>
      <button onClick={() => setToggle(!toggle)}>Doesn't Execute</button>
    </>
  );
}
```

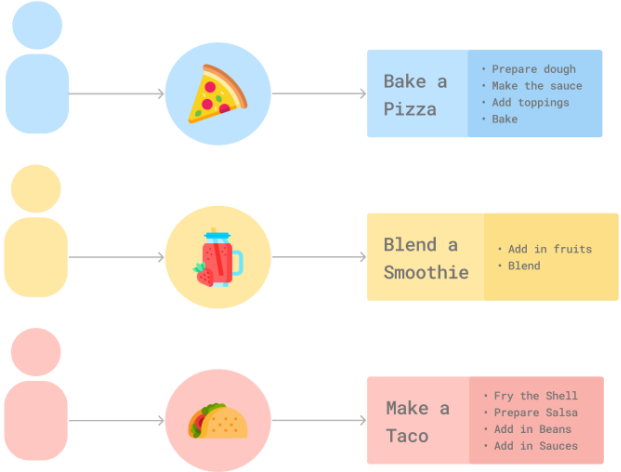
If `Execute Side-effect` button is clicked,

- Value of `name` changes to `Mary`
- `useEffect` gets invoked that value of `name` is changed
- Side-effect is executed

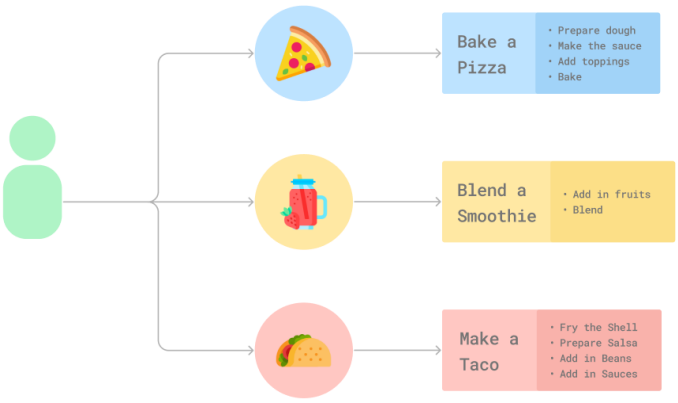
If the `Doesn't execute` button is clicked,

- Value of `toggle` changes to `false`
- `useEffect` doesn’t get invoked because the value of `name` state is still the same
- `<p>` gets hidden

Imagine that you have a chance to hire a chef to prepare dishes. Instead, of hiring multiple chefs for different dishes,



A single chef could be hired who would make all the dishes.



In React,

- **Chef** → State variable
- **Dishes** → Functions that use state variables

For multiple dishes, multiple state variables must be used which makes the code very vast and messy. The `useReducer` hook is the best fit, here.

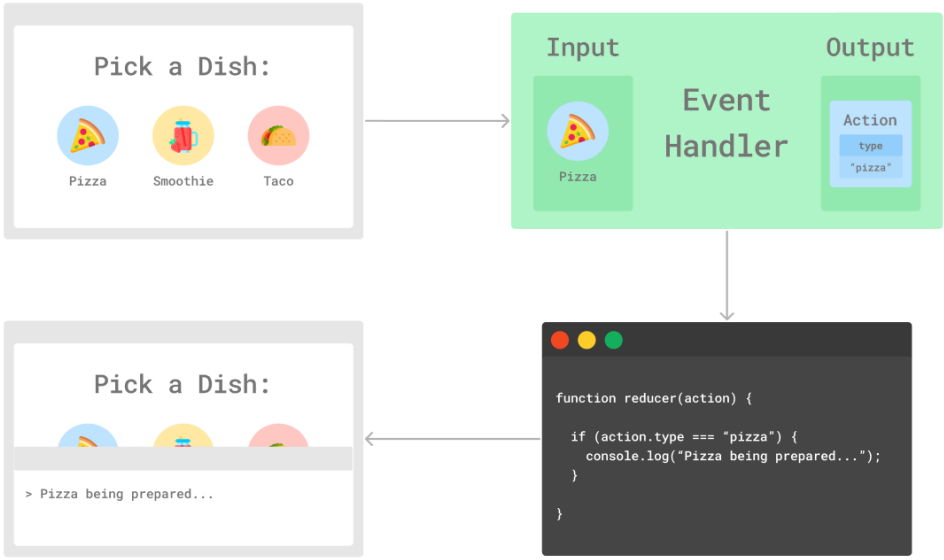
Working

The `useReducer` hook is just like `useState` but more capable. It can implement multiple functions depending upon the need.

Say, for instance, the above scenario is re-created, programmatically. The `useReducer` hook *maps* the elements with functions that are pre-defined.

If `Pizza` was to be selected,

- The `<button>` will ***dispatch*** or *send* the ***type*** *of dish* selected to a function
- This function will then use an `if..else` statement to look for *what to execute* for this *dish* ***type***
- The function will then log `Pizza being prepared...` in the console.



Application

To, finally, create the above scenario in code,

```
import { useReducer } from "react";

function App() {
        const initialState = { type: null };
        const [state, dispatch] = useReducer(reducer, initialState);

        function reducer(action, state) {
                if (action.type === "pizza") {
                        console.log("Pizza being prepared...");
                } else if (action.type === "smoothie") {
                        console.log("Smoothie blending...");
                } else if (action.type === "taco") {
                        console.log("Taco being wrapped...");
                }
        };

        return (
                <button
                  id="pizza"
                  onClick={ dispatch({ type: "pizza" }) }
                >
                Pizza
                </button>

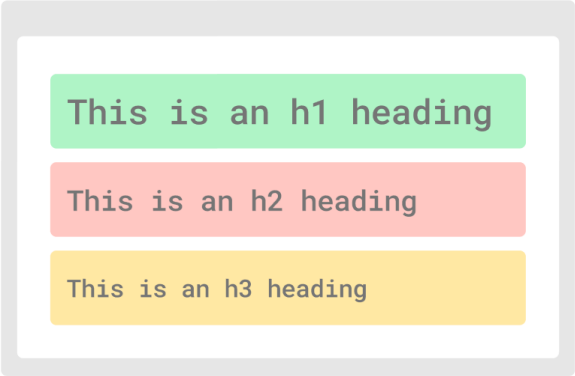
                <button
                  id="taco"
                  onClick={ dispatch({ type: "taco" }) }
                >
                Taco
                </button>
```

```
                <button
                  id="smoothie"
                  onClick={ dispatch({ type: "smoothie" }) }
                >
                  Smoothie
                </button>
        );
}
```

Here,

Code	What it means
`state`	It is just like state variable in `useState`
`dispatch`	It is like the updater function which sends data to `reducer`
`reducer`	A function which *reduces* the action to one of the given cases
`initialState`	Just like the argument given to `useState` hook

Assume that you have to create 3 components each with a different heading element. So, the only difference is in the children property of the VDOM.



Creating 3 different components which have the same structure would not be the most efficient way.

Component Composition

It basically means *the structure of components or what they contain*. It has two main features depending upon the children of the components.

- **Containment**

Often, the components do not know their children, beforehand. So, instead of creating the complete component, its children are included in the *props* to be passed to it.

For instance, a `Card` component that is re-used but with different children elements can be created as follows.

```
function Card({ children }) {
  <div className="card">{children}</div>;
}
```

At the time of rendering the component, the children can be specified just as in regular HTML.

```
function App() {
        <Card>
                <h1>This is an h1 heading</h1>
                <p>Lorem ipsum dolor sit amet</p>
        </Card>

        <Card>
                <img src="./assets/images/someimage.png" alt="Some
Image" />
                <p>Lorem ipsum dolor sit amet</p>
        </Card>
}
```

- **Specialization**
  When a component created using the Containment pattern, *i.e. creating a component and mentioning its children later on*, it can be used just like a base class while using Abstraction to create the **extended classes** or components, here.

For instance, the `Card` component created above can either have a `<img>` element or an `<h1>` element. In such a case, 2 components can be built on top of the `Card` component.

```
function Card({ children }) {
  <div className="card">{children}</div>;
}

function ImageCard({ imageSource }) {
  return (
    <Card>
      <img src={imageSource} />
```

```
      <p>Lorem ipsum dolor sit amet</p>
    </Card>
  );
}

function HeadingCard({ headingText }) {
  return (
    <Card>
      <h1>{headingText}</h1>
      <p>Lorem ipsum dolor sit amet</p>
    </Card>
  );
}
```

There are numerous APIs that React provides to create a web app. Two such are, `cloneElement` and `Children`.

`cloneElement`

As the name suggest, it is used to clone React **elements**. It takes in a React component, creates a clone of the component and adds in the desired *props* to it.

Example

Say, a `Button` component has 2 *props*, `type` and `children`. `type` is initially set to `null`.

```
function Button({type, children}) {
        return (
                <button key={type} >{children}</button>
        );
}

function App() {
        const loginButton = React.cloneElement(<Button />, {type: "login"});
        const signupButton = React.cloneElement(<Button />, {type:
"signup"});

        return (
                {loginButton}
                {signupButton}
        );
}
```

Here, the 2 clone of the `Button` component are created as the `type` for each of them was to be different.

`Children`

It is used to access the `childrens` *prop* of a React **element** and dynamically modify it.

Various operations can be done using the `Children` API. One such is `map()` which is just like *mapping* JavaScript lists.

Example

This changes the font color of each child of the component to `red`.

```
function Items({children}) {
        return (
                {React.Children.map(children, (child) => {
                        React.cloneElement(child,
                                {
                                        style: {
                                                ... child.props.style,
                                                color: "red",
                                        }
                                }
                        )
                })}
        );
}

function App() {
        return (
                <Items>
                        <p>This</p>
                        <p>is</p>
                        <p>React</p>
                        <p>API</p>
                </Items>
        );
}
```

At the time of compilation and rendering, the components created using JSX are converted into plain JavaScript objects called **JSX Elements**.

For instance, the following code,

```
function App() {
        return (
                <Header />
                <Main />
                <Footer />
```

```
        );
}
```

would look something like this,

```
{
        type: "App",
        props: {
                children: [
                        {
                                type: "Header"
                        },
                        {
                                type: "Main"
                        },
                        {
                                type: "Footer"
                        ]
                }
        }
}
```

Each component is represented by a JS object with two properties, `type` and `props`.

Properties	What it signifies
`type`	It's value is the name of the component
`props`	It has more nested properties such as `className` and `children`

These components are further broken down into the HTML elements they are made of.

```
function Header() {
  return <h1>This is some heading</h1>;
}
```

```
{
        type: "h1",
        props: {
                children: [
                        {
                                "This is some heading"
                        },
                ]
        }
}
```

This *simplification* or *conversion* of JSX components to **elements** creates the **Virtual DOM**, or **VDOM** for short, which React uses to create the UI.

Example

A simple React `Form` component would have the following **Elements' tree**,

```
function Form() {
  return (
    <form>
      <input type="text" placeHolder="Username" />
      <input type="password" placeHolder="Password" />
      <input type="submit" id="submit" />
    </form>
  );
}
```

```
{
        type: "form",
        props: {
                children: [
                        {
                                type: "input"
                                props: {
                                        type: "text",
                                        placeHolder: "Username"
                                }
                        },
                        {
                                type: "input"
                                props: {
                                        type: "password",
                                        placeHolder: "Password"
                                }
                        },
                        {
                                type: "input"
                                props: {
                                        type: "submit",
                                        id: "submit"
                                }
                        }
                ]
        }
}
```

As the name suggests, **User-centered Design** is a *design prepared by keeping in mind the needs and persona of the target audience*.

The user is the customer, here, who will use the product only if it fits the need of the user, well. Thus, designing must be according to their persona.

For this purpose, two of the most utilitarian methods to create such designs are as follows.

Interview

Testing, **User Research** and many more names but the core process remains **almost** the same. Interviewing the target audience before and after using the product is a good way to know the difference.

For this, testing is used which is very important for improvement.

Observation

Letting the users test the product is one part but **observing** their usage patterns and their reactions is another. One way of recording users' review is using a Customer Journey Map.

This map is then analyzed and necessary actions are taken which could improve the product.

It essentially is a **map** which highlights the **customer's journey** while testing a product.

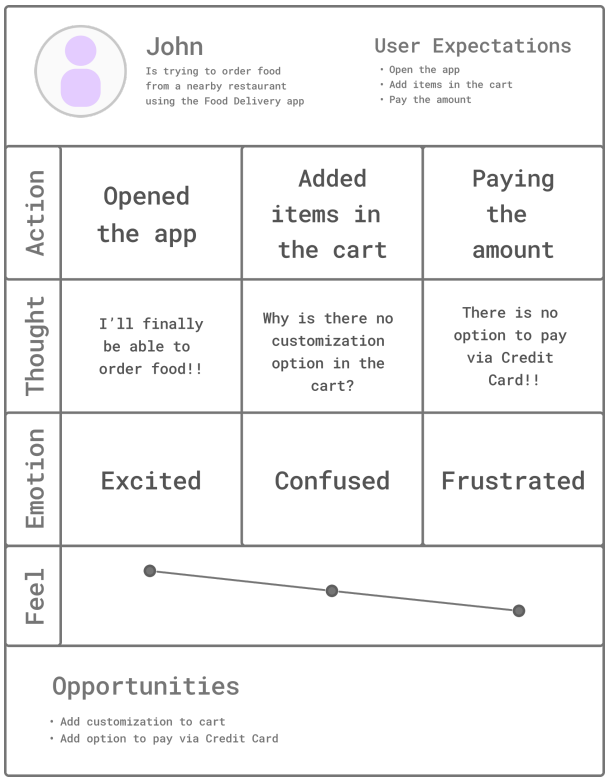
It records various factors such as,

- Objective of using the product
- Actions of the users
- Thoughts while testing the product
- Emotions at different stages

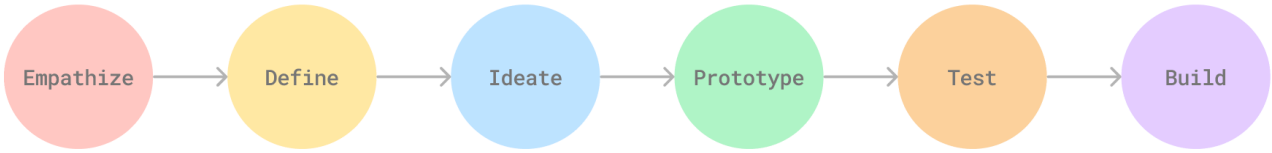
…and much more.

Example

Say, a man named John, uses a *Food Delivery* app to order food from a nearby restaurant. The Customer Journey Map would look like so,



Creating a UX design that stands all the quality and feedback tests involves a specific procedure with multiple steps.

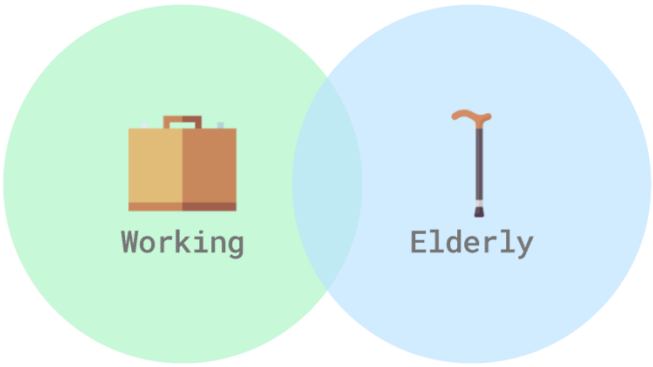


Empathize

Empathize itself means *to share feelings*. This is exactly what's done. The **target audience** is interviewed to get to know of what problems they deal with in context of the product to build.

> **Target audience means *potential customers*, *the people who are to fit to use your product.***
> **For instance, the target audience of a *Fitness app* would be individuals who are physically unfit.**

For instance, to build a food delivery app, the elderly and working people's group must be interviewed.



Define

With the given experience and problems faced by the target audience, the problems and their possible solutions need to be created.

For instance, if an elderly man states that *he is not able to **see** the buttons, clearly*, that's a point to be noted.

Here,

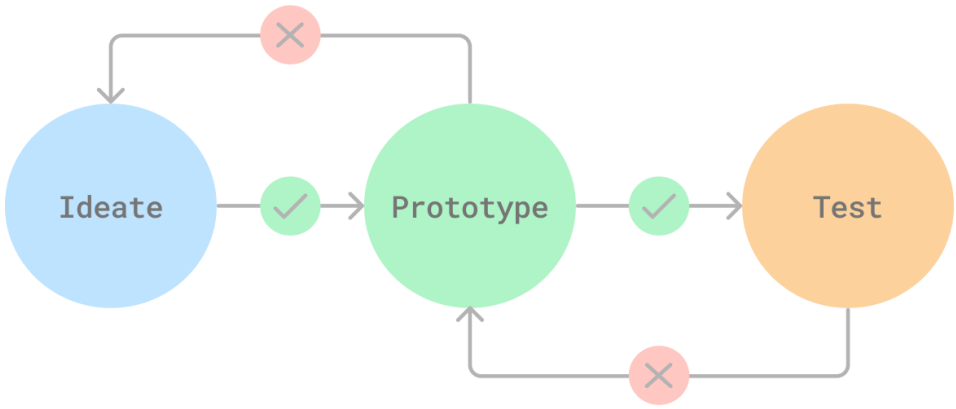
- **Problem** → Buttons appear small
- **Solution** → Make them bigger

Ideate

With the problem and solution, in hand, the process of **ideating** or *coming up with unique ways of implementing the solution* must be initiated.

Getting ideas is not a concrete process. It happens, instantaneously, some times and doesn't for months, the other.

Also, there is no perfect idea. So, waiting for *that perfect one* isn't efficient. The only perfect way is to implement the idea and see for it.



Prototype

The next step is to create a **prototype** of the product which, essentially is *a sample product works in the same way as expected*.

If the prototype fails to work as expected,

- Note down the failure points
- Re-work on the idea
- Create another prototype

If the overall implementation doesn't feel as it should, a good approach would be to jump back to the ideation process.

Test

Just like programming tests, the products must be tested by a group of random individuals to get their feedback on the UX. This is also called **User Research**.

The feedback can then be used to improve the product by **prototyping** or **ideating**.

Build

Finally, build the product and launch it. That's it.

Many components are used to guide a new user through a product with a sense of familiarity. Some of them are understated.

User Personas

These are mascot-like characters which resemble an individual from the target audience.

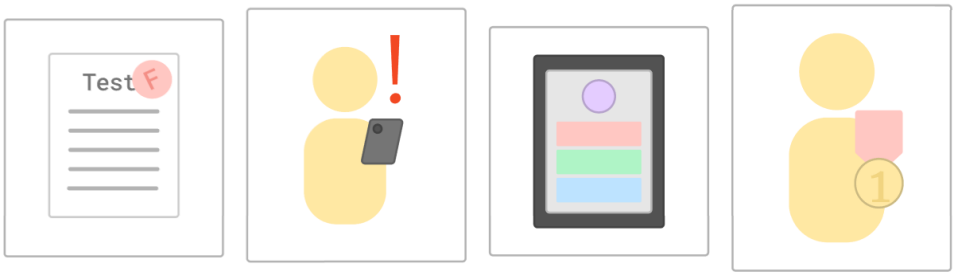
For instance, in a *Mathematical* app, the user persona might be either of,

- **Mathematician** → To make the users think, that they, too, can become one.
- **Student** → To give a sense of familiarity to the students.

Story Board

A storyboard is like a comic-book. It conveys the **objective** of the product in the form of a graphical story.

For a *Homework Solver* app, the story board would look like so,



Scenario

It's a way of letting the audience know the significance of the product. In other words, *where and why to use it*?

Say, for instance, a **scenario** for a *Cooking* app can be created as follows.

> **Example**
>
> Kayla is a great cook. Spices just flow through her hands. The veggies bloom when about to be cooked by her. But one dish that Kayla cannot have her hands over, is the humble **pie**.
>
> She, then, uses the app, *Cooking*, to bake the **pie** using the recipe crafted by MasterChefs.

It stands for **User Experience** and refers to how the overall *feel* of a product is.

A restaurant, for instance, is not just the website or the mobile app, it is much more than that which includes the hospitality, food, service, ambience and still more.

In the case of web or mobile apps, their usability plays a major role in determining the overall UX.

Also, it takes a specific approach to creating a UI/UX design which would, really, be **good**.

It, simply put, refers to *how convenient it is to work with a product* or *how **usable** it is*. It **cannot** be measured concretely but developers can get an idea of its state on the basis of UX.

Usability has five pillars.

Learnability

How easy it is for the customers to **learn** to use the product determine the product's **learnability** factor.

A food delivery app, that has an easy-to-understand process of ordering food will be considered to have good **learnability**.

Efficiency

It highlights how **efficient** it is to make any changes in a product.
Say, the items added in the cart need to be deleted or changed, an **efficient** app would require the least number of steps to do so.

Memorability

It focuses on how well the user gets familiar with the product in the least amount of time.
To change the password of the user account in such a product, the user must not be wandering in the app. It must be **accessible**

Errors

If a user commits an error, how much effort must be put in to correct it and how well the product handles it, decides how good of an *error-handler* the product is.

If, for instance, during the payment process, the transaction fails, a good error-handling product would let the user know of the possible causes of the error.

Satisfaction

A major chunk of the user's experience depends on how the user *felt* after using the product. A *satisfying* product, not ASMR, would not make the user feel troubled or confused.

Color represents mood. It has the power to create a specific aesthetic just be changing one of the colors, slightly.

Variations

Colors can and, in fact, **need** to be tweaked on the certain parameters.

- **Hue**
  It, basically, means *how much of **red**, **green** and **blue** is in the specified color*. Say, for instance, a color denoted by the RGB format, $(100, 50, 50)$, would mean that the *hue is about 0 degrees*.

  Hue is measured in `deg` because each color is at a certain point in the color wheel.

- **Saturation**
  It is *the amount of color added in the given color*. Imagine having a white canvas and some red-colored paint. If the paint is diluted in some water, its ***saturation** would decrease*.

- **Tint**
  It is, itself, a color, just that the specified color is mixed with some white to produce a **lighter shade** of the color.

- **Tone**
  Same as **tint**, the difference being that a color is mixed with **grey**.

- **Shade**

Yet again, same as **tint**, the difference being that the color is mixed with **black**.

The fundamental components of a design are lines. They can have multiple use-cases.

- Directing the user to another component
- Highlighting
- Building other components

Variations

Lines can be of various types on various basis.

- **Color**
  The color of a line is like a medium for the line to speak for itself. The color, alone, can indicate the meaning of the line.

- **Line Type**
  Dashed, *dotted*, *solid* and many other types which may indicate *use of the line*.

- **Direction**
  A line can have an *arrow*, *solid circle*, or a *rhombus* at either of its ends. An *arrowed* line can be used to point somewhere else.

- **Thickness**
  It is *how thick the line is* and signifies the *importance of the line*.

Typography defines *the **how*** of text. It can attract a user to a piece of text and be the only caveat of a webpage, all depending upon *how it is stylized*.

Variation

Surprisingly enough, typography has numerous details, even for a single letter! Though, these cannot be varied, there are numerous fonts available to use with different presets.

These are called **typography elements**.

- **Cap-height**
  It is the height of capital letters which should be consistent throughout the text.

- **Baseline**

  It is the line on which the text rests.

- **Ascender and Descender**

  The line on which the lowest letter rests in the text is called the **ascender line** and the highest one is called **descender line**.

- **X-height**

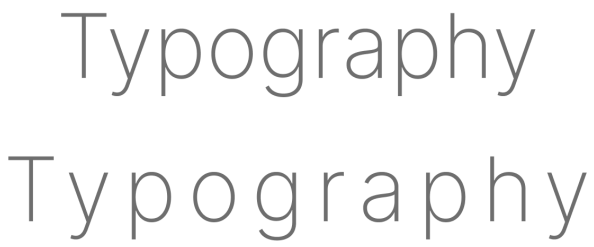
  It can be measured as the height from the baseline up to the letter *x*.

- **Kerning**

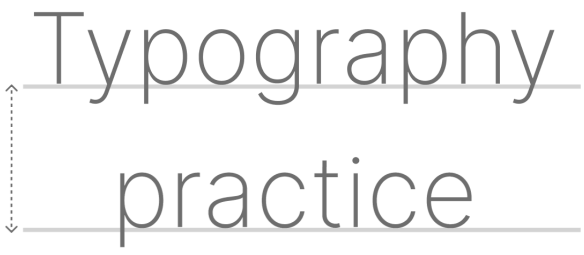
  It is the space between adjacent letters which can be decreased using **kerning**.

- **Weight**
  It is the *thickness* of each letter.

- **Tracking**
  Also known as **letter-spacing**, it is the space between letters in text.



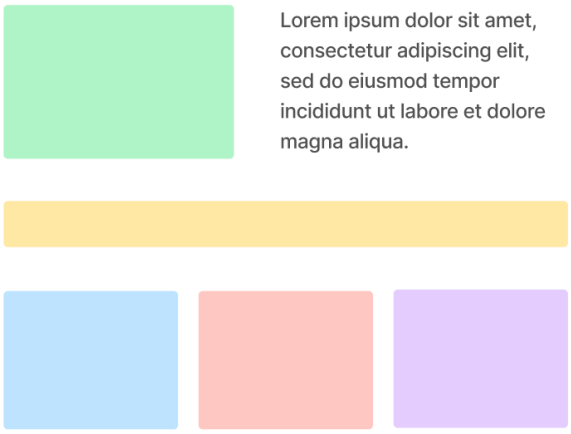
- **Leading**
  Also known as **line-height**, it is the space between two consecutive lines of text.



Spaces around or between components are called **whitespaces**. These whitespaces can be crucial to the webpage in the following manners.

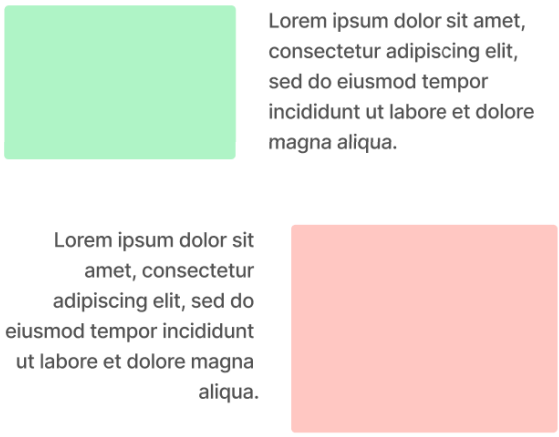
- **Layout**

  Whitespaces can be used to create a layout from the components.



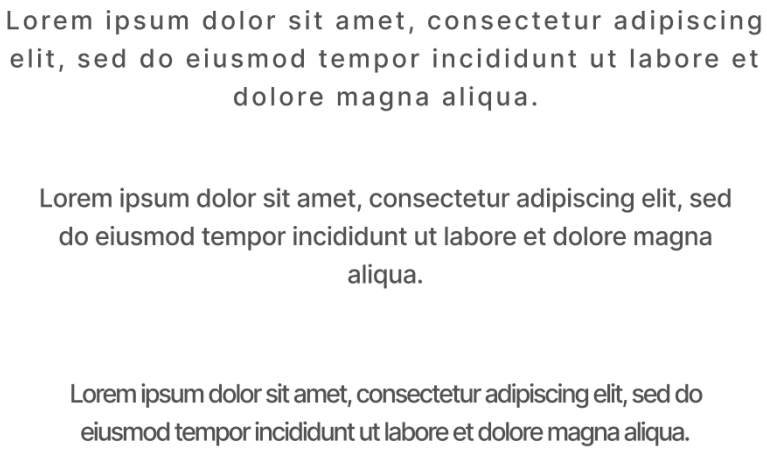
- **Grouping**

  By decreasing whitespaces between components of the same group and increasing whitespaces between other components, grouping can be done.



- **Ease-of-reading**

  Text should also have some whitespaces in-between to clearly distinguish between characters and words.



Evaluation Methodology is a fancy term for *a framework to evaluate a design*, *i.e. how good the design is, on some basis*.

There are multiple such *frameworks* or rather *guidelines* to follow, not mandatorily, but beneficially. These guidelines have some basic notions which when followed make a design *good*.

Some of them are,

- **Ram's Principles**
- **Schneidermann's Golden Rules**
- **Nielsen's Heuristics**

Heuristic itself means *aiding in learning*. These are 10 such principles derived by Jakob Nielsen.

- ### Visibility of system status
  The product should have the current status or all the information required by the user, in an accessible location.

- ### Match between the system and real world
  Allow the users to make connection between their past experiences and the new product by adding in some features which are, probably, accessed by the target audience.

- ### User control and freedom

Hand over the control and freedom to the user to use the product as wished.

- **Consistency and standards**
  A component should be the same on one page as on another page.

- **Error prevention**
  Prevent any errors as much as possible by giving feedback to users at various stages.

- **Recognition rather than recall**
  The product should not expect the user to make efforts by recalling information. Instead, make the user recognize the information.

- **Flexibility and efficiency of use**
  Any new user can and should use it as an experienced user.

- **Aesthetic and minimalistic design**
  The design must not have loads of components which might hide the utility.

- **Error handling**
  Allow for easy error-resolution.

- **Help documentation**
  The product should have a *how-to* documentation for a new user to get started with the product.

These are 10 principles derived by Dieter Ram which when adopted make a *good design*.

- **Good Design is innovative**
  A design should neither be copied nor be repeated. It must have a unique identity.

- **Good Design makes a product useful**
  Just focusing on the overall look of a product won't be enough. If possible, the design should also add in some utility to the product.

- ## Good Design is aesthetic
  It makes the user feel comfortable and familiar.

- ## Good Design is understandable
  The components of the design must be simple enough for a new user to get a hang of it.

- ## Good Design is unobtrusive
  Making a design *extravagant* by tossing in loads of features which have no utility isn't a good practice.

- ## Good Design is thorough
  Despite being simple, the components should have the finesse which would make the product consistent.

- ## Good Design is long-lasting
  Simply put, an evergreen design. A design that is not short-lived. A design that, even if not updated, lasts for considerable time.

- ## Good Design is honest
  It is what it looks like. No fixings or tricks with the user.

- ## Good Design is as little as possible
  It is **not** exactly **minimalism** but an adaptation of it. Make the design such that it makes sense all together.

- ## Good Design is environment-friendly

Design isn’t limited to the digital screen. It should not harm the environment just for good-looks or good-utility.

These are 8 golden rules derived by Ben Schneidermann which makes a design well-built.

- **Strive for consistency**
  The design should create its identity in the user’s mind.

- **Allow for shortcuts**
  Let the users traverse the complete product in the least number of actions.

- **Offer feedback**
  Let the users know where how they performed and can better use the product.

- **Design dialog to yield closure**
  Each interaction with the product should be indicated with a start and an end, so that the users can know where they are.

- **Offer simple error handling**
  Allowing the users to simply solve errors makes them feel *backed*.

- **Permit easy reversal of actions**
  The user should be able to undo the actions for convenience.

- **Support internal locus of control**
  Make the user feel as if they are in control of the product by not interrupting or initiating an action without user’s permission.

- **Reduce short-term memory load**
  Let the user select and use the product without much effort. Such a design should not let the user **remember** the information, instead **recognize** the information.

There are typically numerous interviews of a candidate prior to, actually, hiring.

Screening

This is the first interaction between the company and candidate. The introductory information such as,

- Suitability of the candidate for the role
- Programming languages used
- Work ethics of the company

…and more is exchanged.

Quiz

It is, essentially, a quiz for the candidate to test their knowledge and ability in the required field or tech stack.

Online Coding Assignment

The candidate is given a programmatic task or problem to solve, efficiently. This is generally remote and is thus, non-pressurized.

Technical Interview

It is a coding challenge, much like in the online coding assignment. Generally, it is not much complex as **problem-solving skills** are major chunk of the interviewer's judging criteria.

Take-home Assignment

This stage is the closest to hiring. Herein, the candidate is given a larger project such as, *building a web app*, which is to be done over a larger span of time, at home.

> **Tip**
>
> Communication is the most important aspect of an interview. The **STAR** method is a structural way of conveying the solution of a problem.
>
> - **S**ituation → What the problem is
> - **T**ask → What your responsibility would be to solve the problem
> - **A**ction → How you would solve the problem

- **R**esult → What the result of your actions would be

Bi- means **two**. Thus, *binary* means **consisting of two parts**.

Number System

As the name suggests, it is a system of numbers, *i.e. a way of writing numbers, mathematically*. There are numerous number systems *depending on the numbers they use*.

Base 10

Generally, to count and calculate, the **Base 10** number system is used which basically means, ***a system containing 10 different numbers***.

Base 10 because there can be 10 different remainders for any number divided by 10.
For instance,

- $18/10 \rightarrow$ remainder of 8
- $19/10 \rightarrow$ remainder of 9
- $20/10 \rightarrow$ remainder of 0
- $21/10 \rightarrow$ remainder of 1
- $22/10 \rightarrow$ remainder of 2

The remainders can range from 0 to 9 which are 10 different numbers. Also, *any number can be formed **using these remainders** and **powers of 10*** .

For instance,

- $18 = 10 + 8 = 1 * 10^1 + 8 * 10^0$
- $221 = 200 + 20 + 1 = 2 * 10^2 + 2 * 10^1 + 1 * 10^0$

The general breakdown looks like, $num = remainder * 10^p$.

> **Note**
>
> The numbers that are multiplied with the powers of 10 are, actually, the digits of the number.
>
> For instance, here, $403 = 4 * 10^2 + 0 * 10^1 + 3 * 10^0$, the numbers are 4, 0 and 3 which form the number 403.

This is stated as, *the number 403 is 403 in base 10* or *the base 10 representation of 403 is 403*.

Base 2

Also called **binary**, just like Base 10, it also is a number system involving 2 different numbers, 1 and 0.

With the same reasoning as Base 10, on dividing any number by 2, the possible remainders are 0 and 1. Thus, any number can be formed **using the remainders** and **powers of 2**.

For instance,

- $32 = 0 * 2^0 + 0 * 2^1 + 0 * 2^2 + 0 * 2^3 + 0 * 2^4 + 1 * 2^5$
- $87 = 1 + 2 + 4 + 16 + 64 = 1 * 2^0 + 1 * 2^1 + 1 * 2^2 + 0 * 2^3 + 1 * 2^4 + 0 * 2^5 + 1 * 2^6$
- $5 = 1 + 4 = 1 * 2^0 + 1 * 2^1$

Thus,

- $32 \rightarrow 000001$
- $87 \rightarrow 1110101$
- $5 \rightarrow 11$

Simply put, it is the ***measure of amount of resources required to complete an operation***. It is important as the code written should be as efficient as possible.

Time Complexity

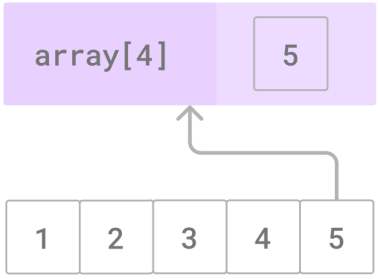
The **time complexity** of a piece of code is denoted by what's called, the **Big-O notation** or **O**. The time complexity depends on the code and data used.

- ### Constant Time Complexity
  As the name conveys, the time taken for such processes is constant, regardless of the data or other factors.

  For instance, to print the 5th item in the list,

  ```
  const array = [1, 2, 3, 4, 5];
  console.log(array[4]);
  ```

In the code above, even if the list contains 100 items, only the 5th item will be accessed. This code is said to have **constant time complexity**.



Constant Time Complexity is represented by **O(1)**.

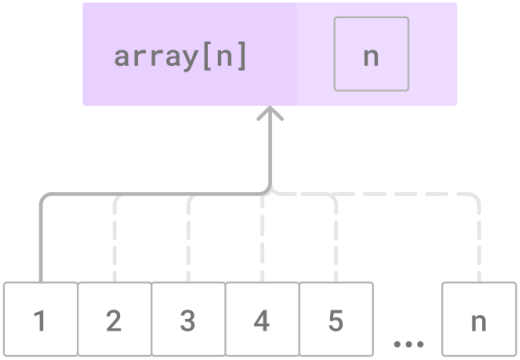
- **Linear Time Complexity**

  It, basically, means that the task to be done depends on *how big the data is*. It, generally, is in the case of single loops.

  For instance, to print each item in the list, the list must be iterated over.

```
const array = [1, 2, 3, 4, 5];
for (item of array) {
  console.log(item);
}
```

The time complexity, here, depends on the number of items the list contains. If it was 10 instead of 5, the time taken would be double than in the case of 5 items.



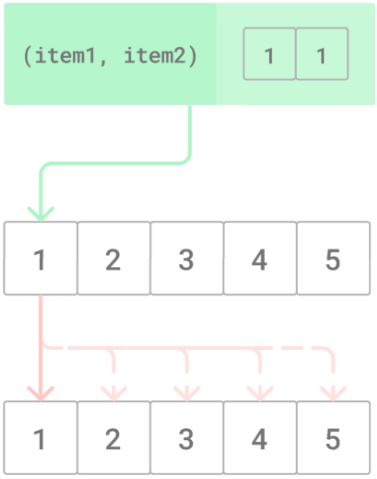
Linear Time Complexity is represented by **O(n)**.

- **Quadratic Time Complexity**
  It is one of the highest time complexities and this shouldn't be the case in any code. In such a case, if the input size is n, the time complexity would be n^2.

  For instance, the nested loop below will print every possible pair of items in the array.

```
const array = [1, 2, 3, 4, 5];
for (item1 of array) {
  for (item2 of array) {
    console.log(`(${item1}, ${item2})`);
  }
}
```

  This means that a loop would be executed for every item in the list. So, if an item is added, an extra loop would have to be executed.



  Quadratic Time Complexity is represented by **O(n^2)**.

Space Complexity

The concept of **space complexity** is just the same as that of **time complexity**, the difference being that instead of **time**, it measures the ***memory required by the operation*** or **space**.

A computer mainly has three types of memory,

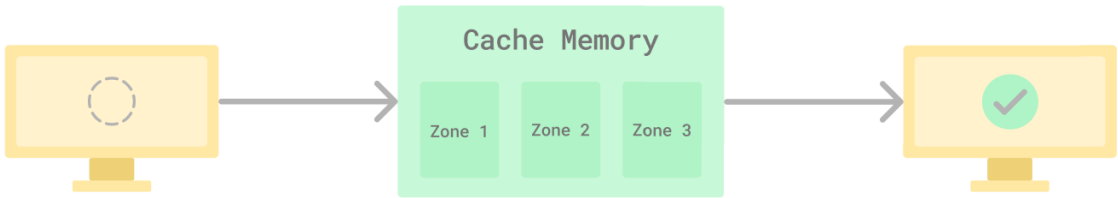
- Cache
- Main
- Secondary

Cache Memory

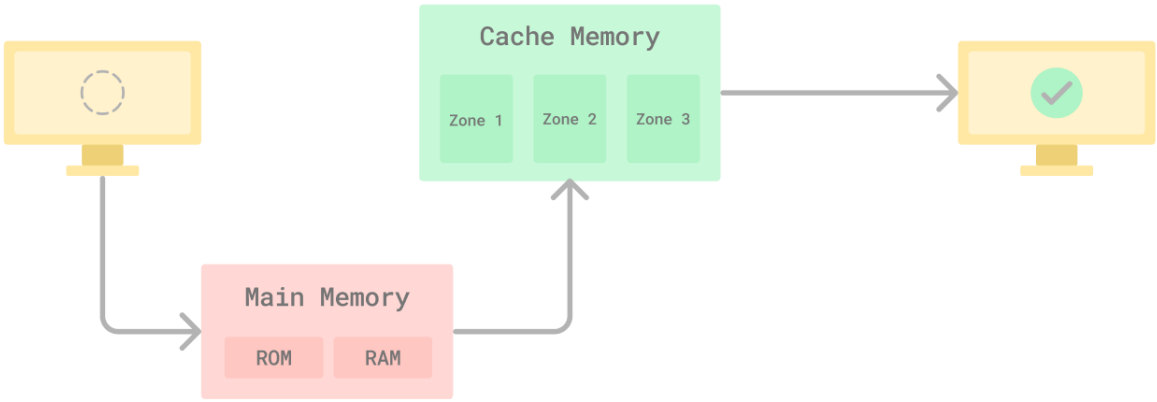
It is the most *expensive* type of memory, meaning that *it takes the most time to process*.

Whenever any task is to be performed,

- The computer checks for the requirements in the cache memory. If present, the task is executed



- Else, the computer checks for the requirements in the **main memory**. If present, they are brought into the cache memory and the task is executed.



Main Memory

It is where most of the data that, when not needed, is stored. It has two parts,

- **RAM** → Random Access Memory
- **ROM** → Read-Only Memory

RAM

It is **volatile** in nature, meaning that, *if some data is stored in **RAM** and the power goes off, all the data will be lost*.

Thus, it is like a *temporary work area*. All the data required to process is first brought to RAM and then is it processed.

ROM

It is **non-volatile** in nature, meaning that, *the data stored will remain stored in the ROM* . This is because it is a ***read-only*** memory, it cannot be modified.

Secondary Memory

External memory devices, cloud storage and types alike are considered as **secondary memory**. When used, all the memory needs to be loaded in RAM which makes it slower.

It is the simplest data structure which, simply, stores data in **sequential order**. It has the following characteristics,

- **Mutability** → It is a **mutable** structure, meaning the data can be changed, after creation
- **Ordered** → It retains its order, *i.e.* an element added at the end remains at the end
- **Dynamic** → It increases in size as per the data stored inside it

Example

In JavaScript, a list is basically an array.

```
let list = [1, 2, 3, 4, 5];
```

It is a collection data structure similar to lists. The difference being,

- **Mutability** → It is **immutable** meaning that data once entered cannot be changed
- **Order** → It is **unordered**. Thus, the first element added to the set might not be the first, anymore.
- **Duplication** → It doesn't allow for duplicate elements

Implementation

A set can be created using a list or, simply, by using the in-built **set** data structure.

In JavaScript, a set can be created using the *curly-braces* `{}` .

```
let set = {2, 4, 6};
```