

6.1040: Software Design

Reactive Programming

Arvind Satyanarayan & Daniel Jackson



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Replies

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Activity

📌 Blog posts: what we're looking for

Announcements

Seeing lots of interesting blog posts, but wanted to encourage you all going forward to focus your posts more on applying the ideas taught in class. For example, this intriguing post explored how concept structuring coul... read more



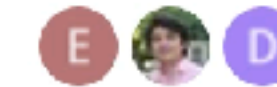
1

48

4d

Assignment 3: App Synchronizations

Assignments



2

42

41m

Full working implementation of concepts for milestone 1

Assignments a4



1

9

43m

Global Data Models for Different Types of Concepts

Assignments a4



2

37

1h

Assignment 4: Abstract Data Model

Assignments



2

26

1h

Abstract Data Model

Assignments



2

23

1h

Data Modeling

Assignments a4



1

12

1h

R5 draft

Staff



1

13

1h

Using Python for Concept Pseudocode

Assignments assignments



2

18

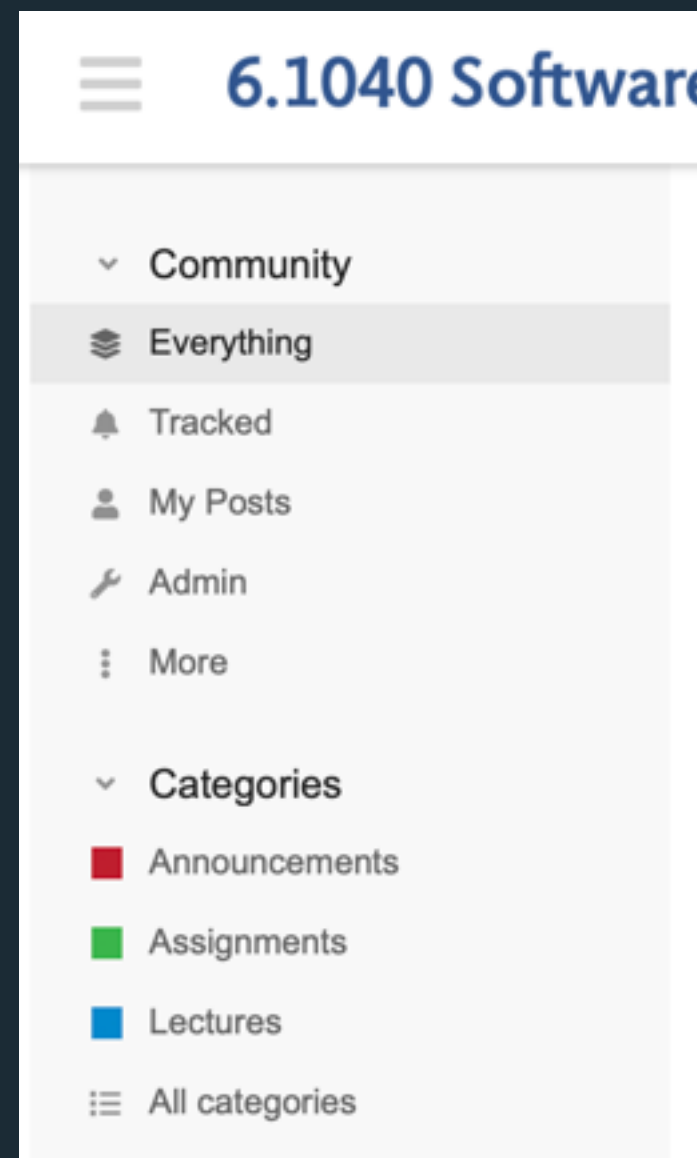
2h

Pseudo Code

```
while (true) {  
    read mouse click  
  
    if (clicked on Toggle button) showSidebar()  
    else if (clicked on Search button) showSearchbar()  
    else if ...  
}
```



toggle.ts

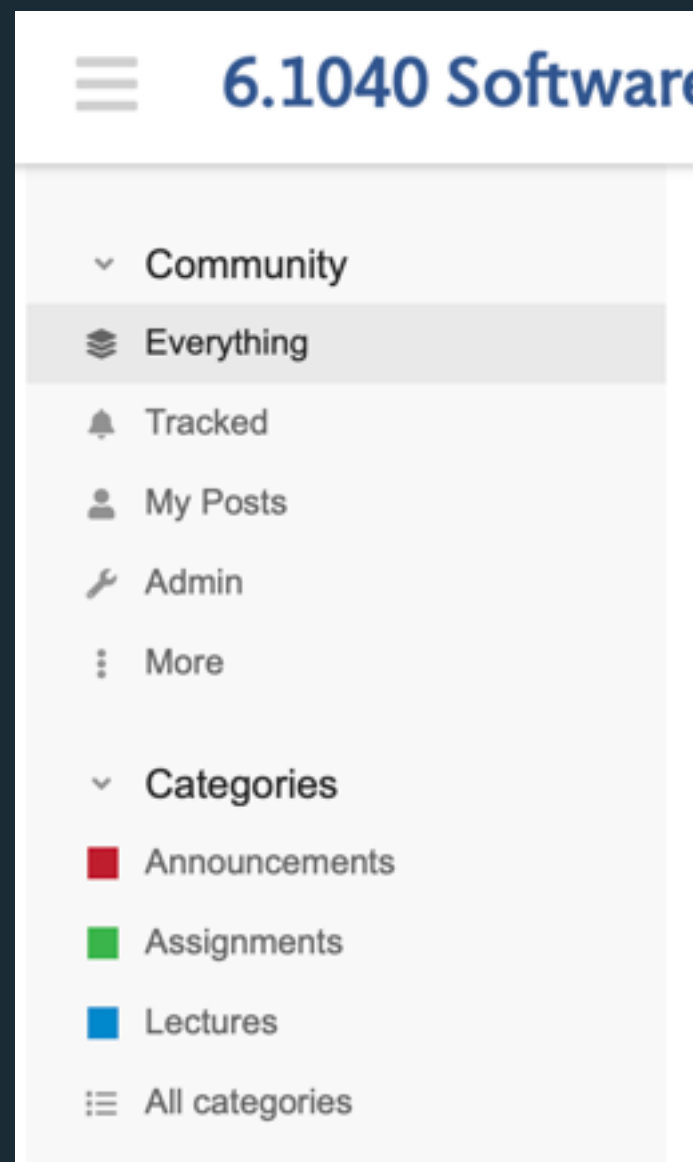


sidebar.html

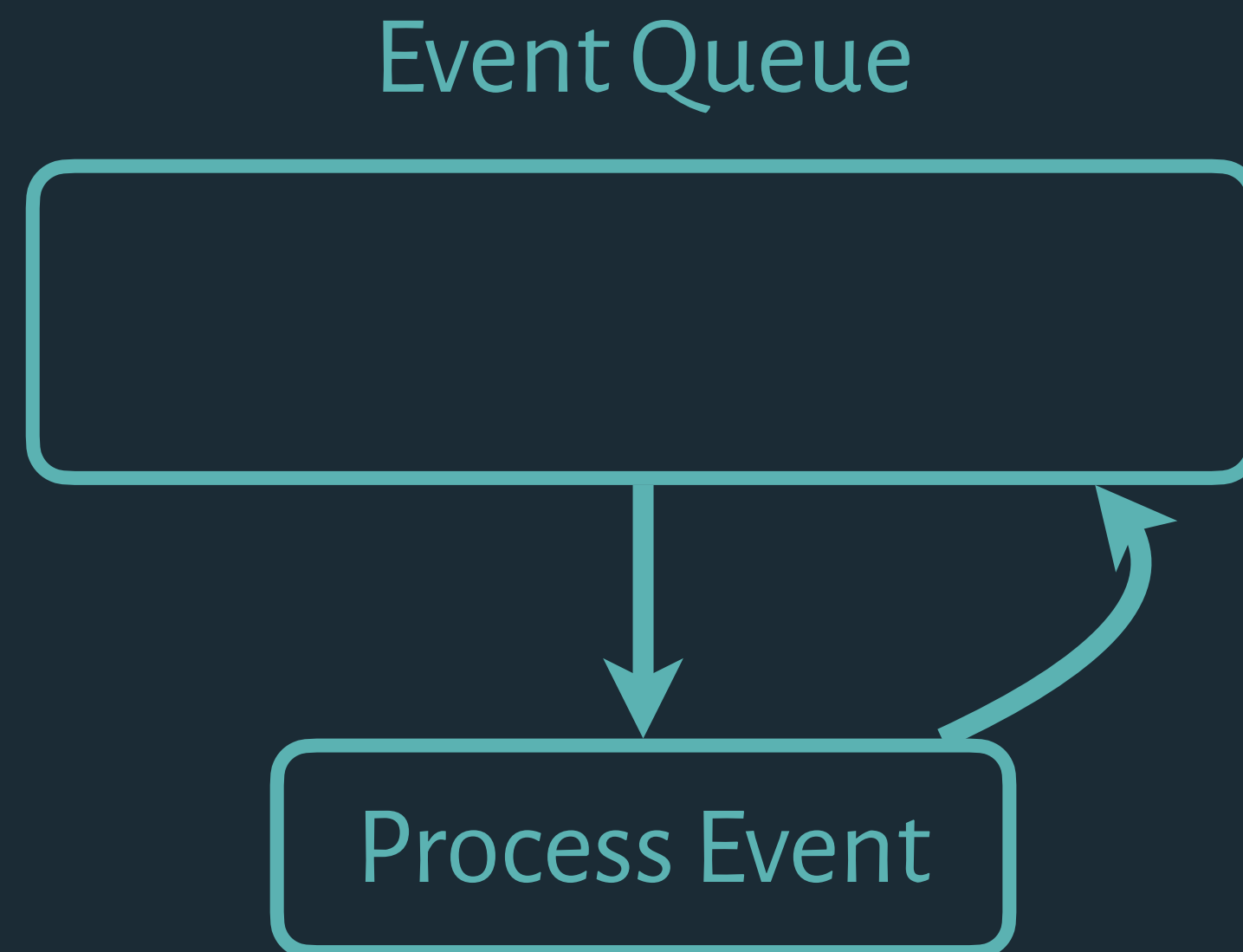
The JavaScript *Event Loop*



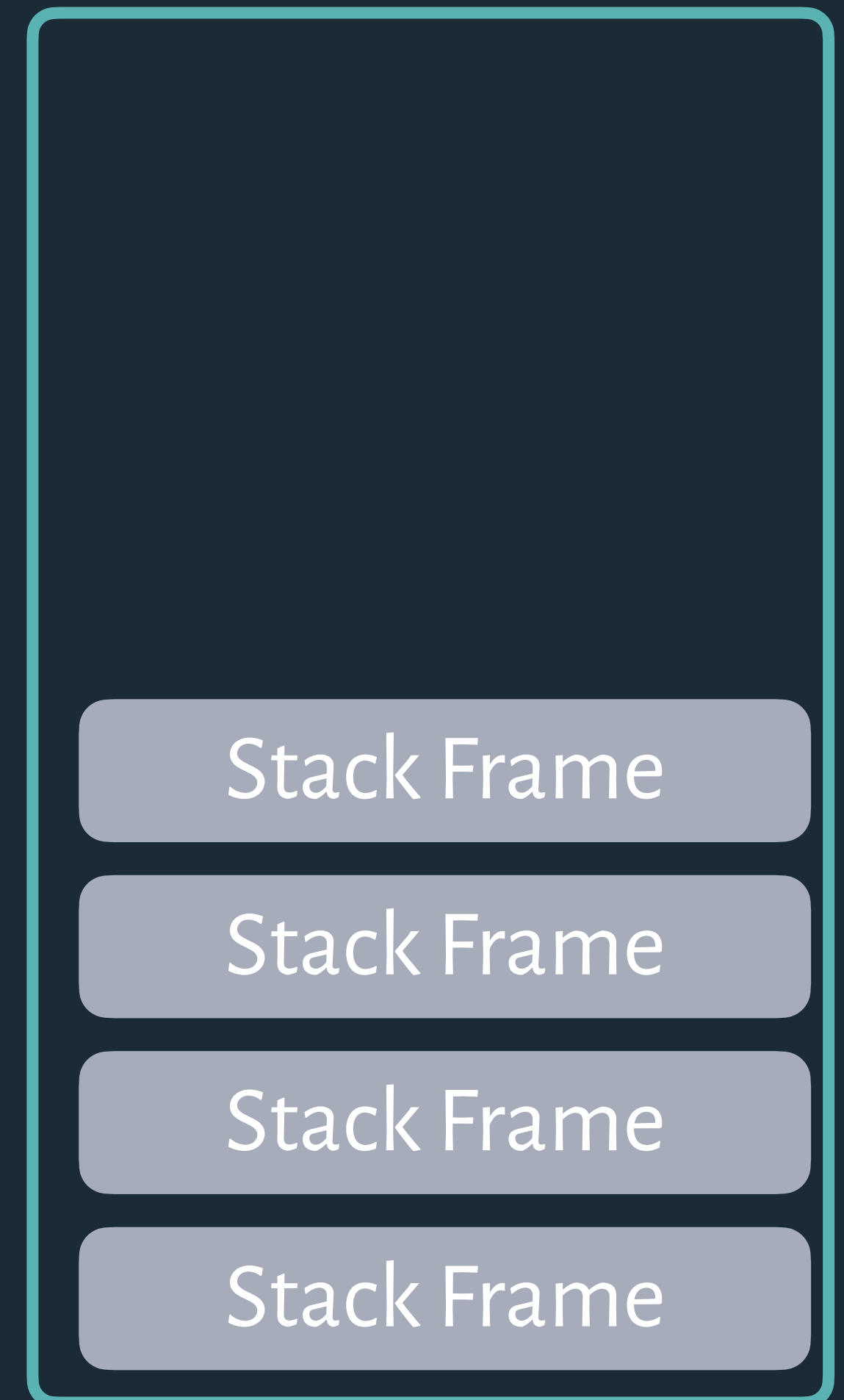
toggle.ts

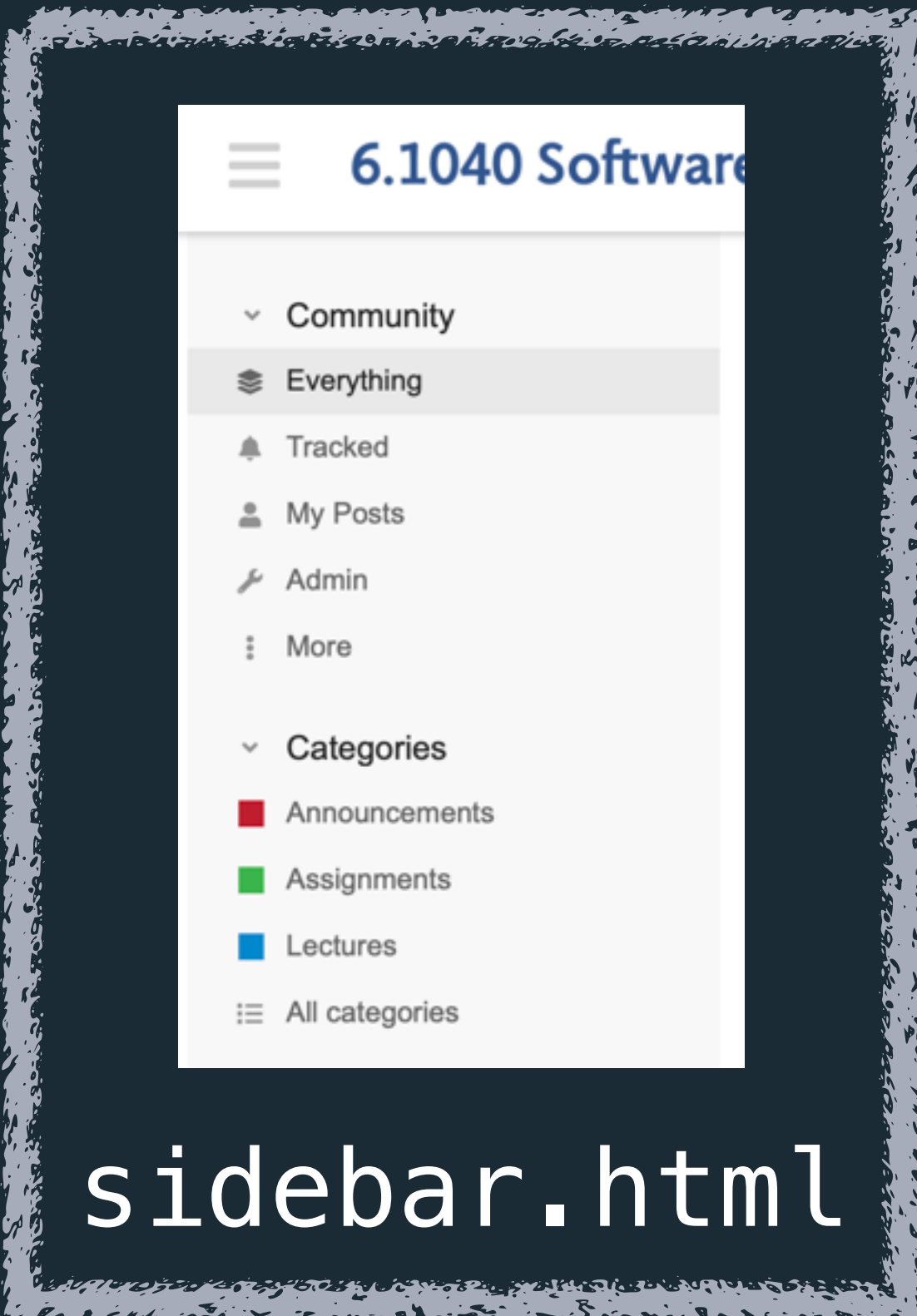


sidebar.html

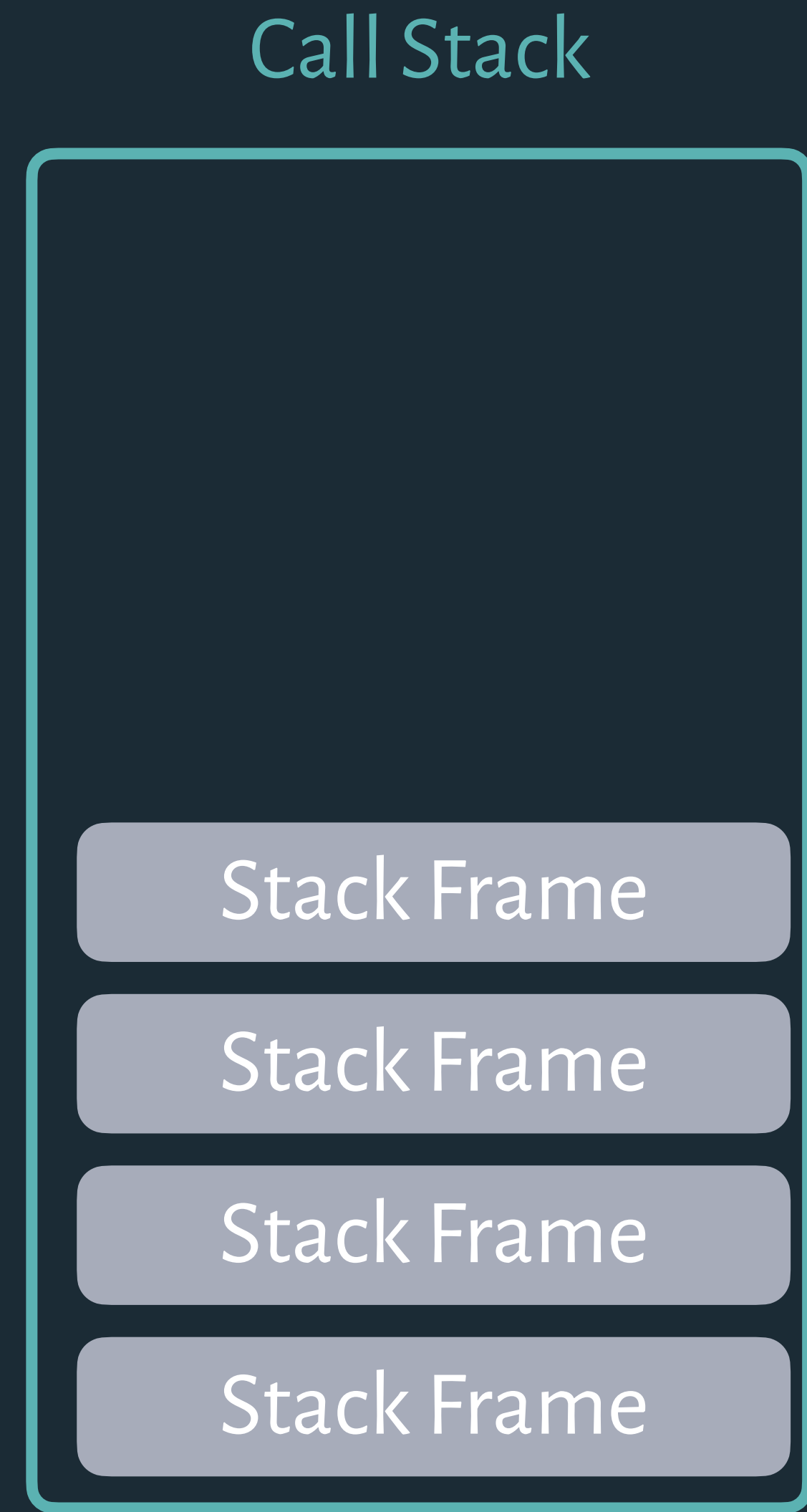
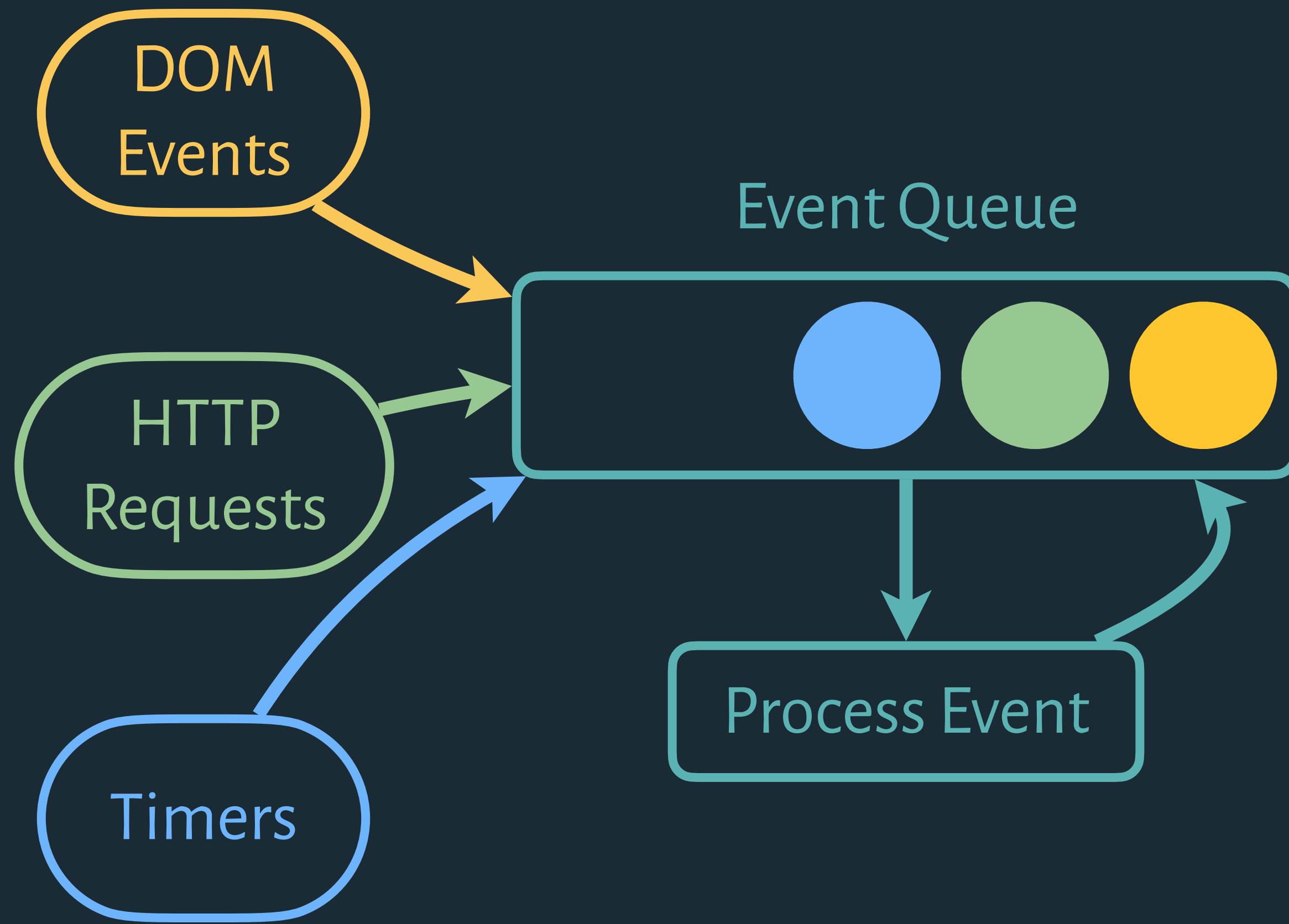


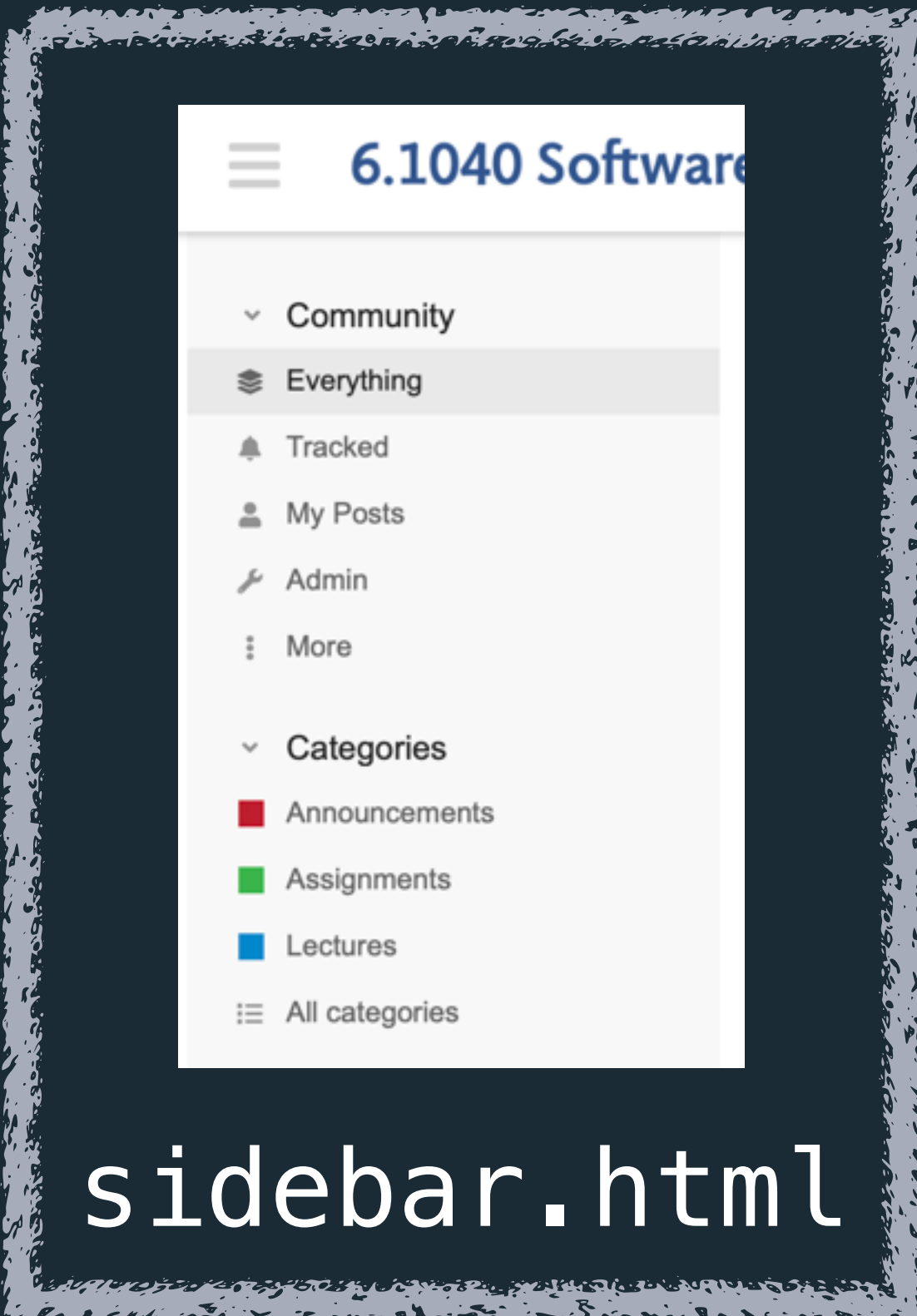
Call Stack



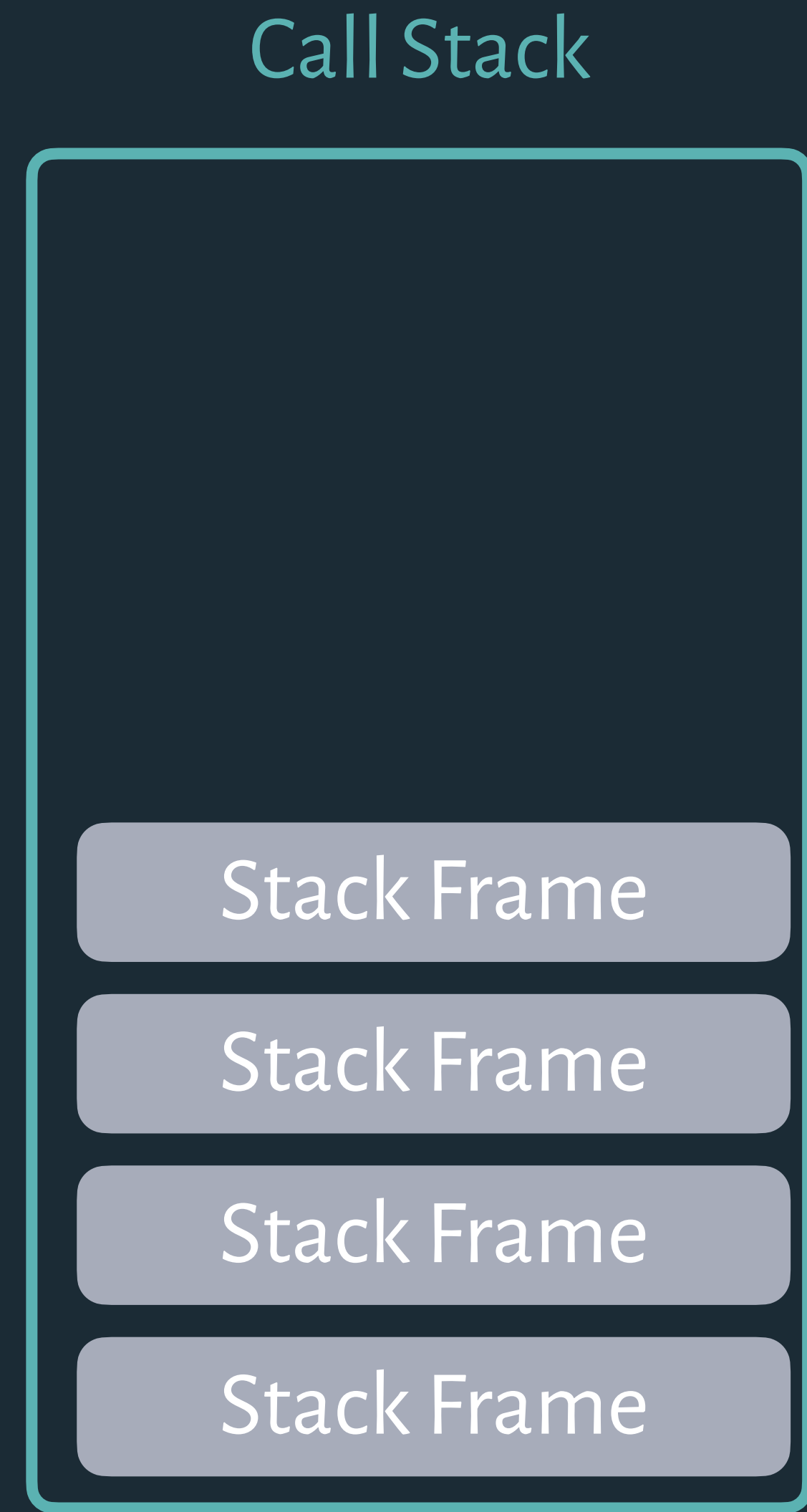
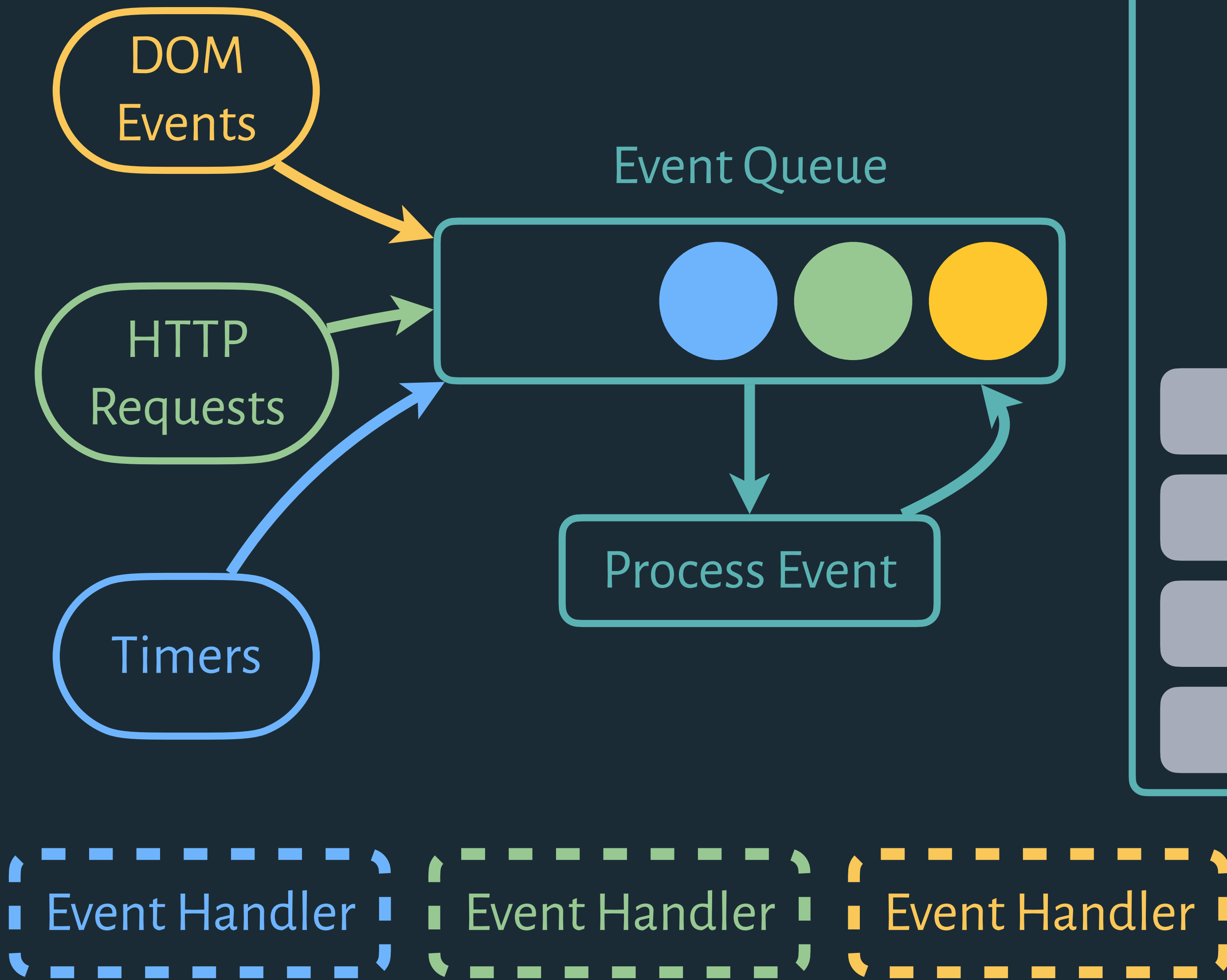


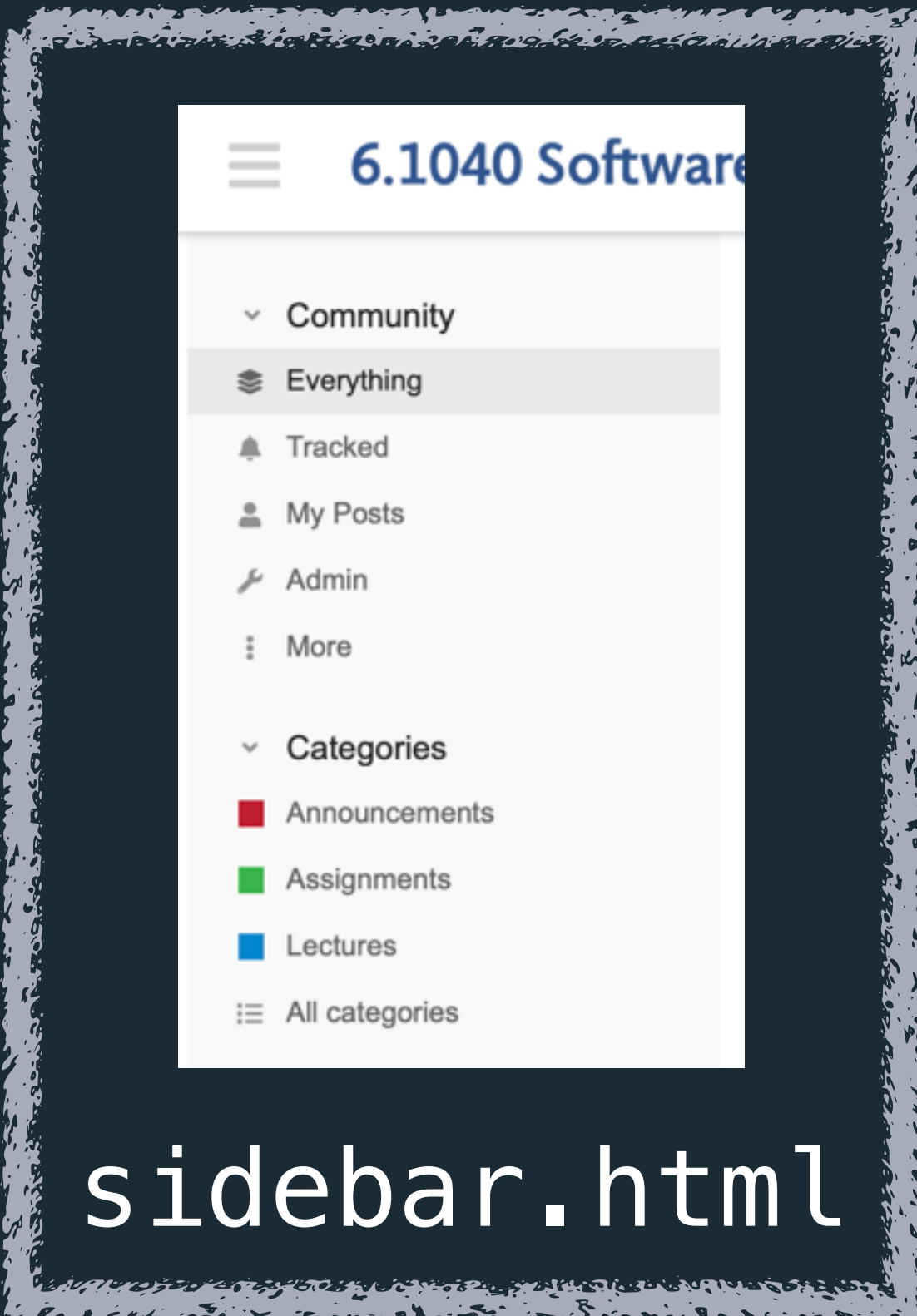
The JavaScript *Event Loop*



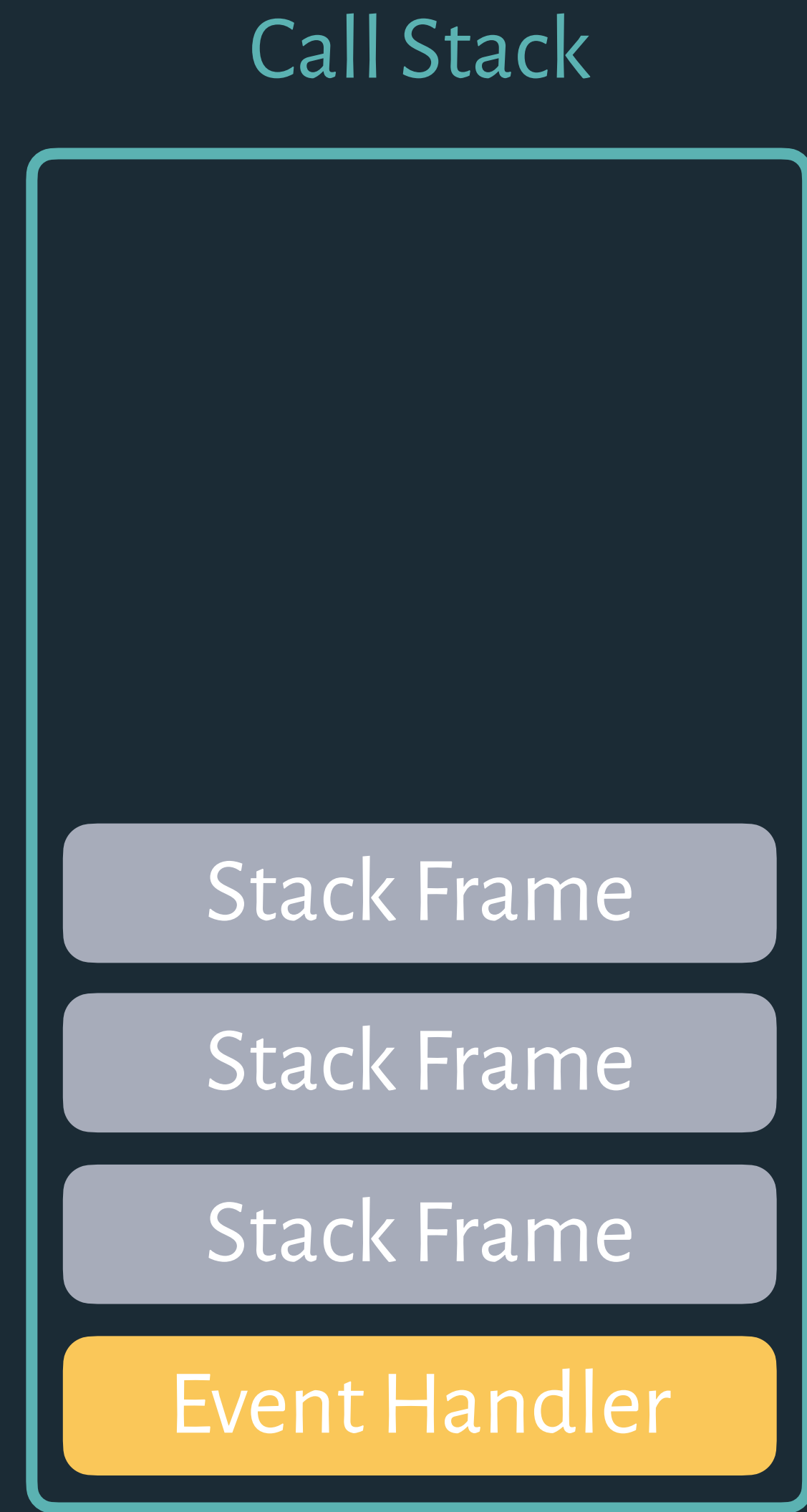
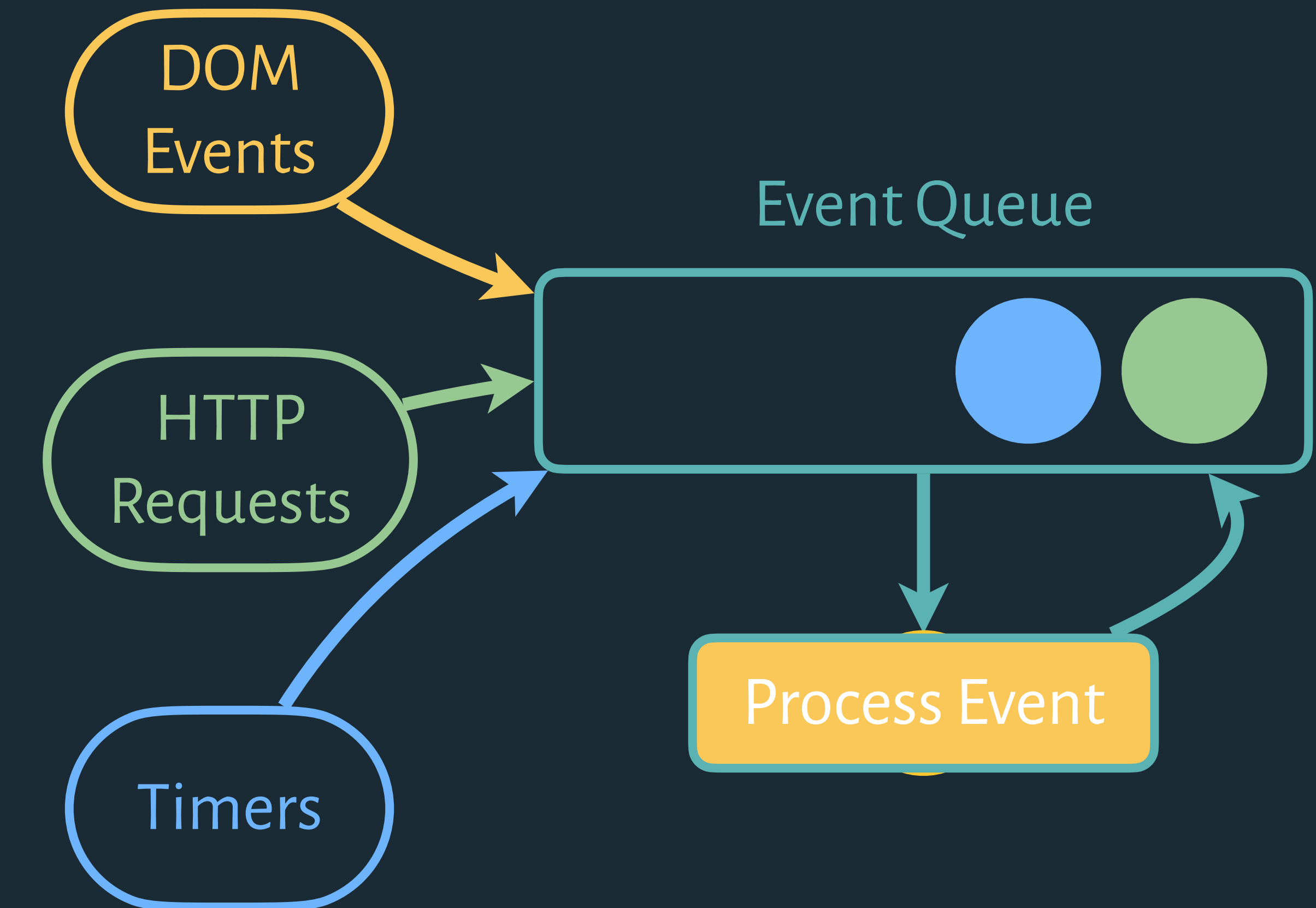


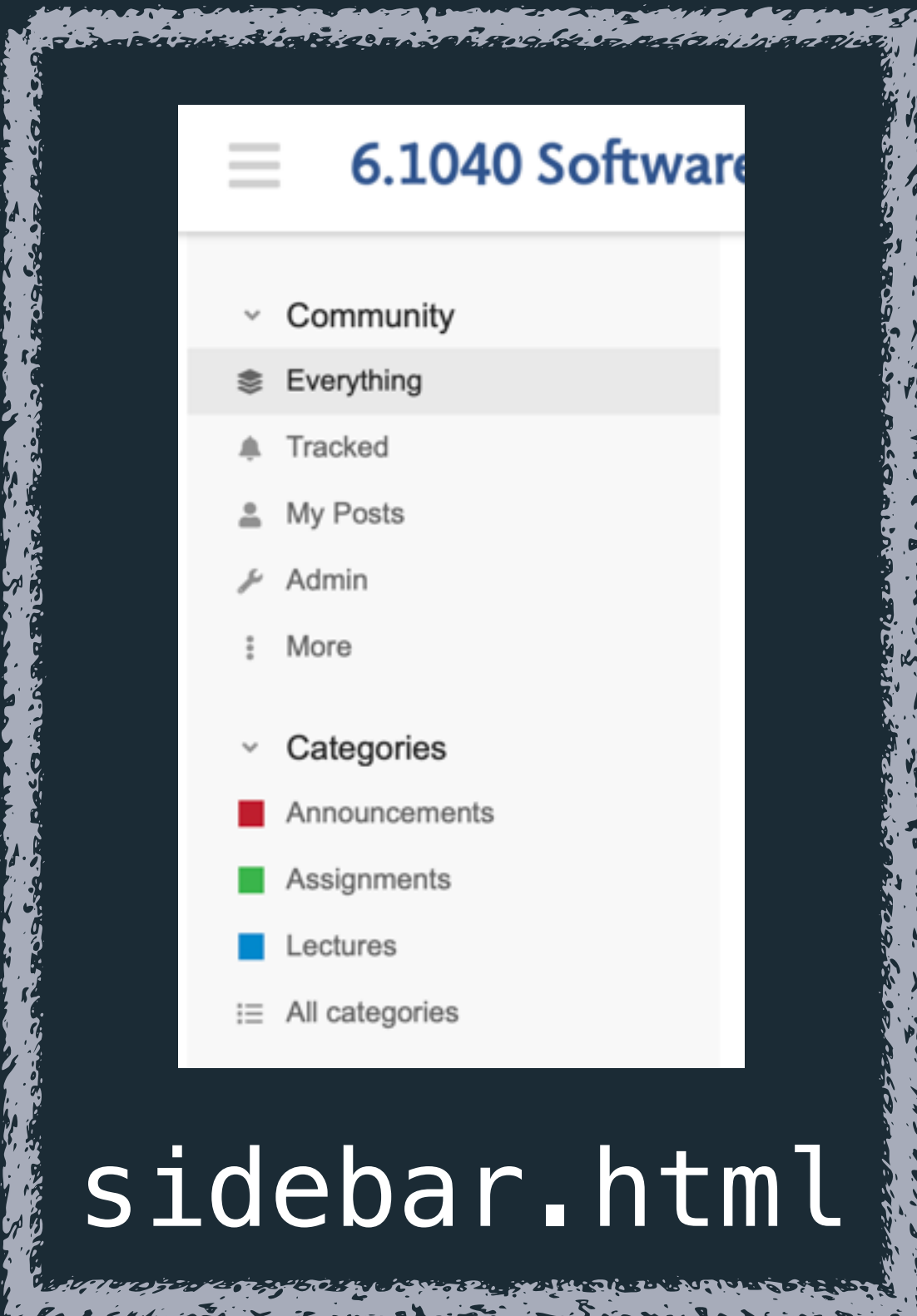
The JavaScript *Event Loop*



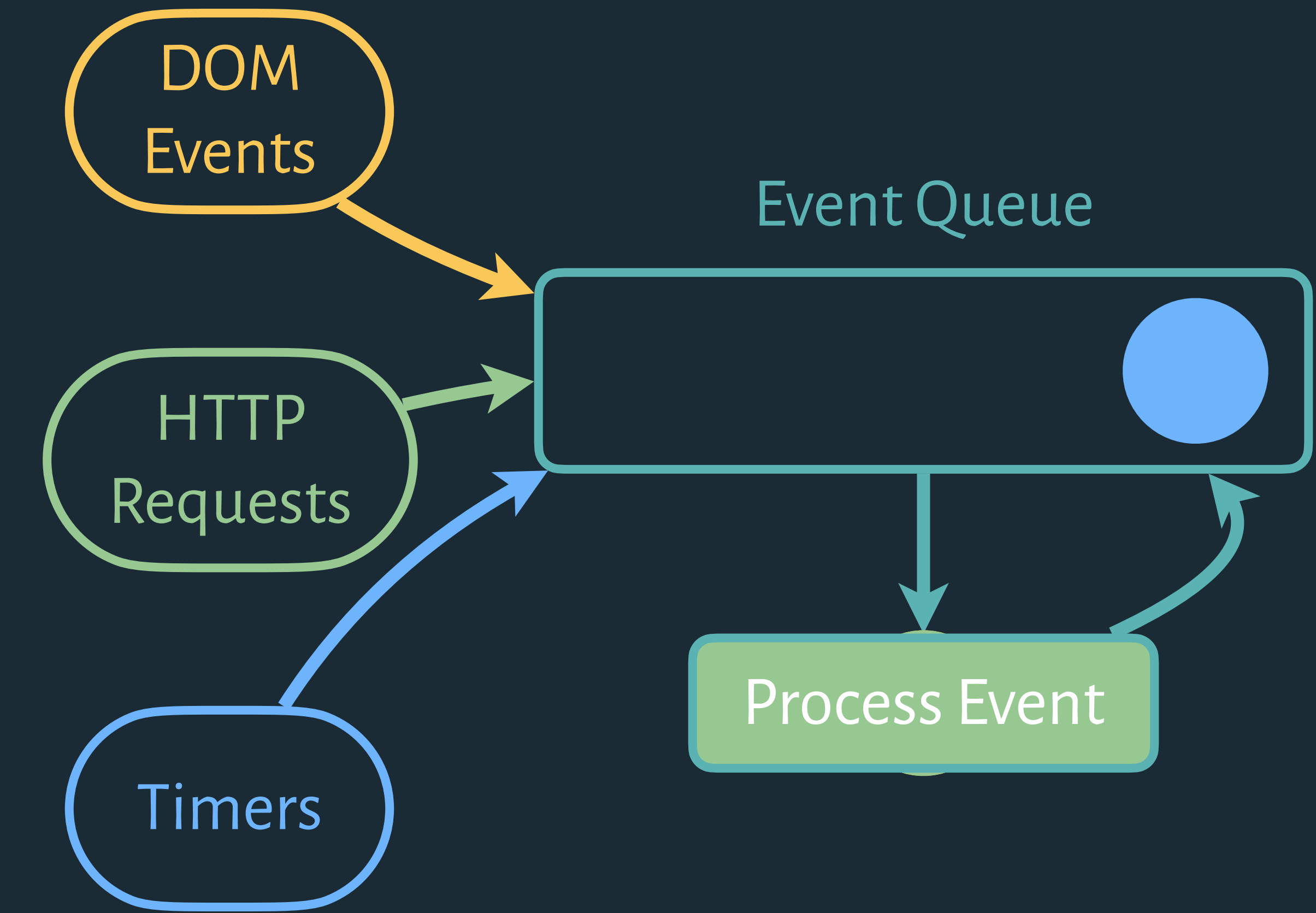


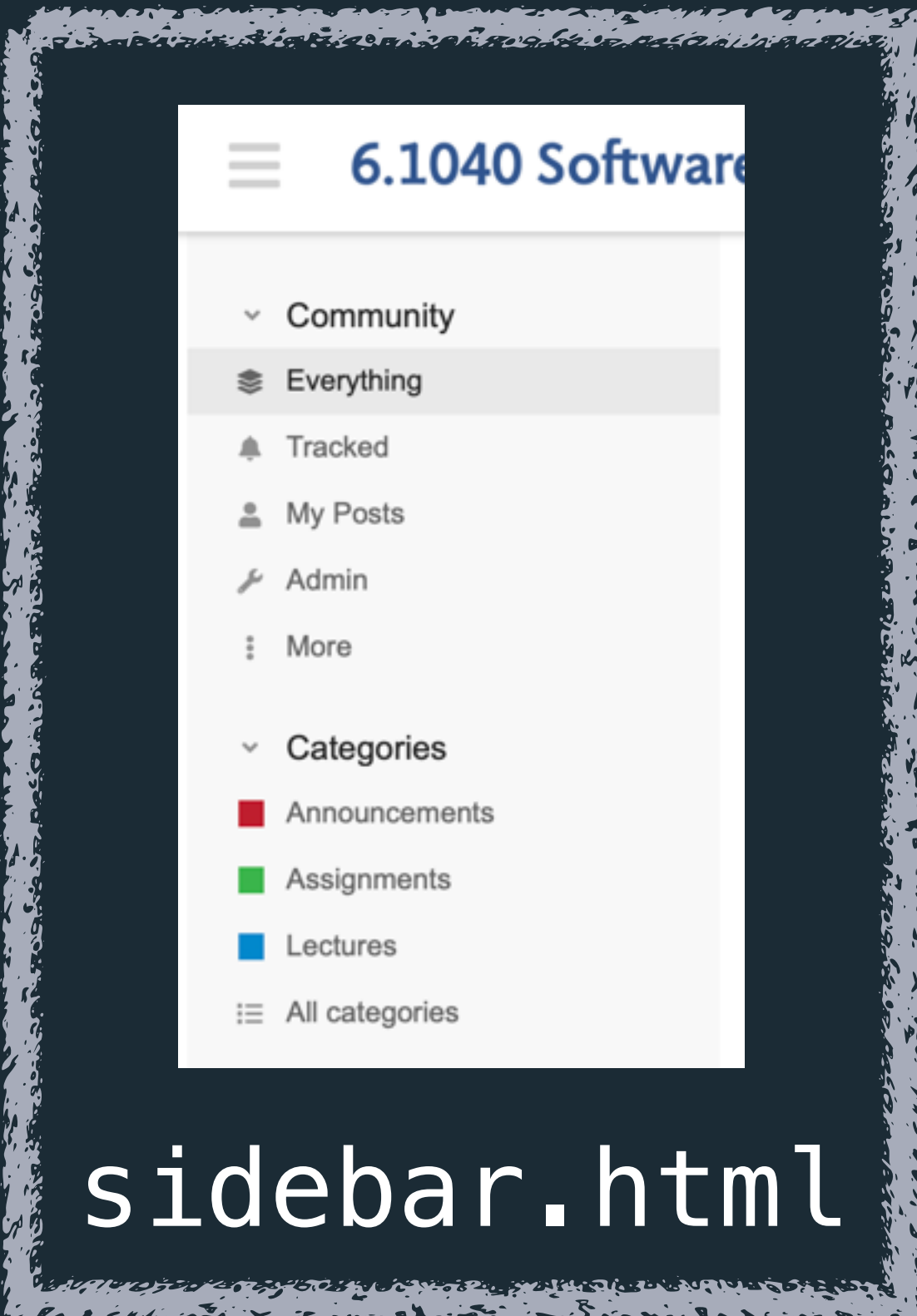
The JavaScript *Event Loop*



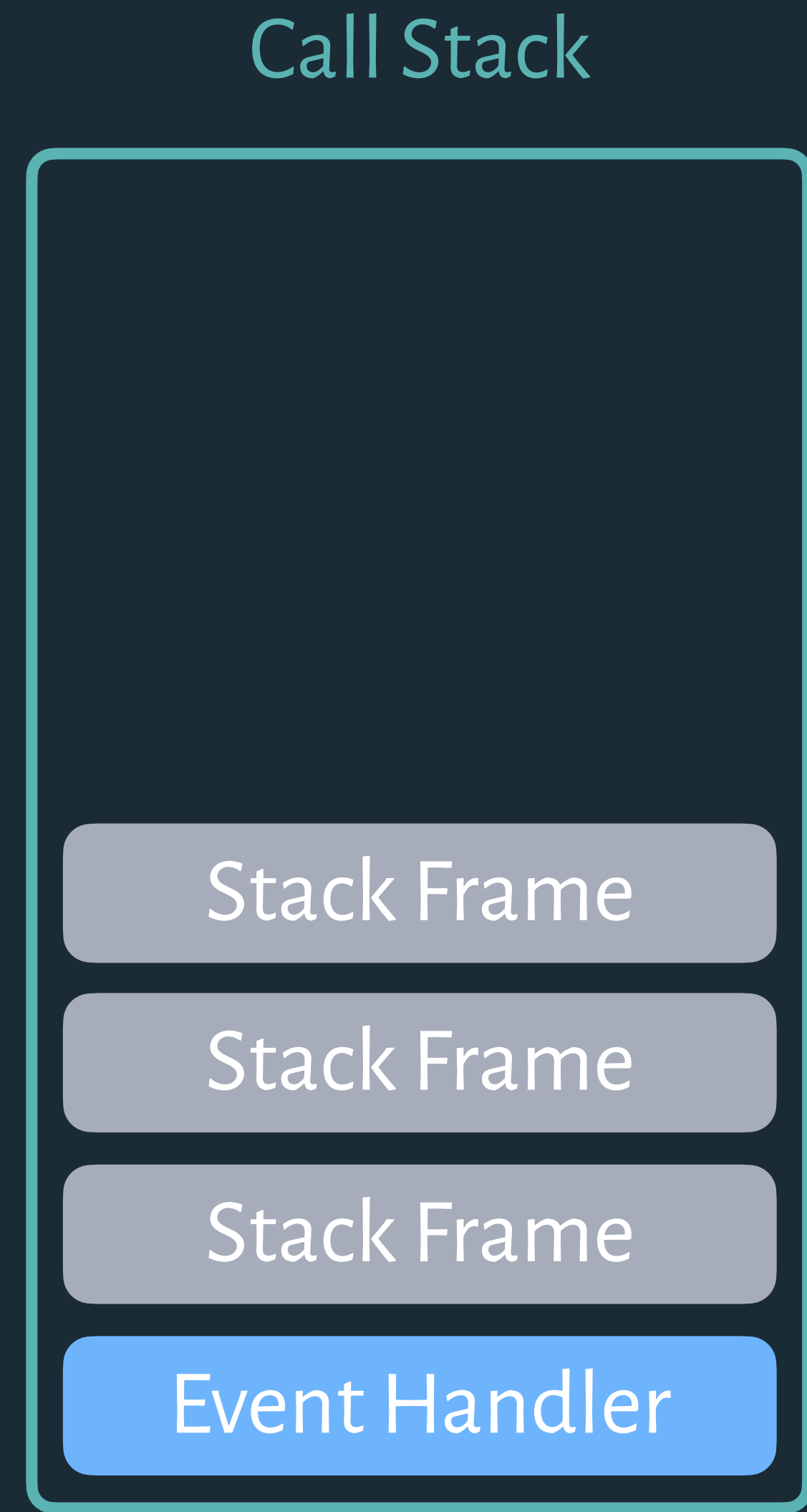
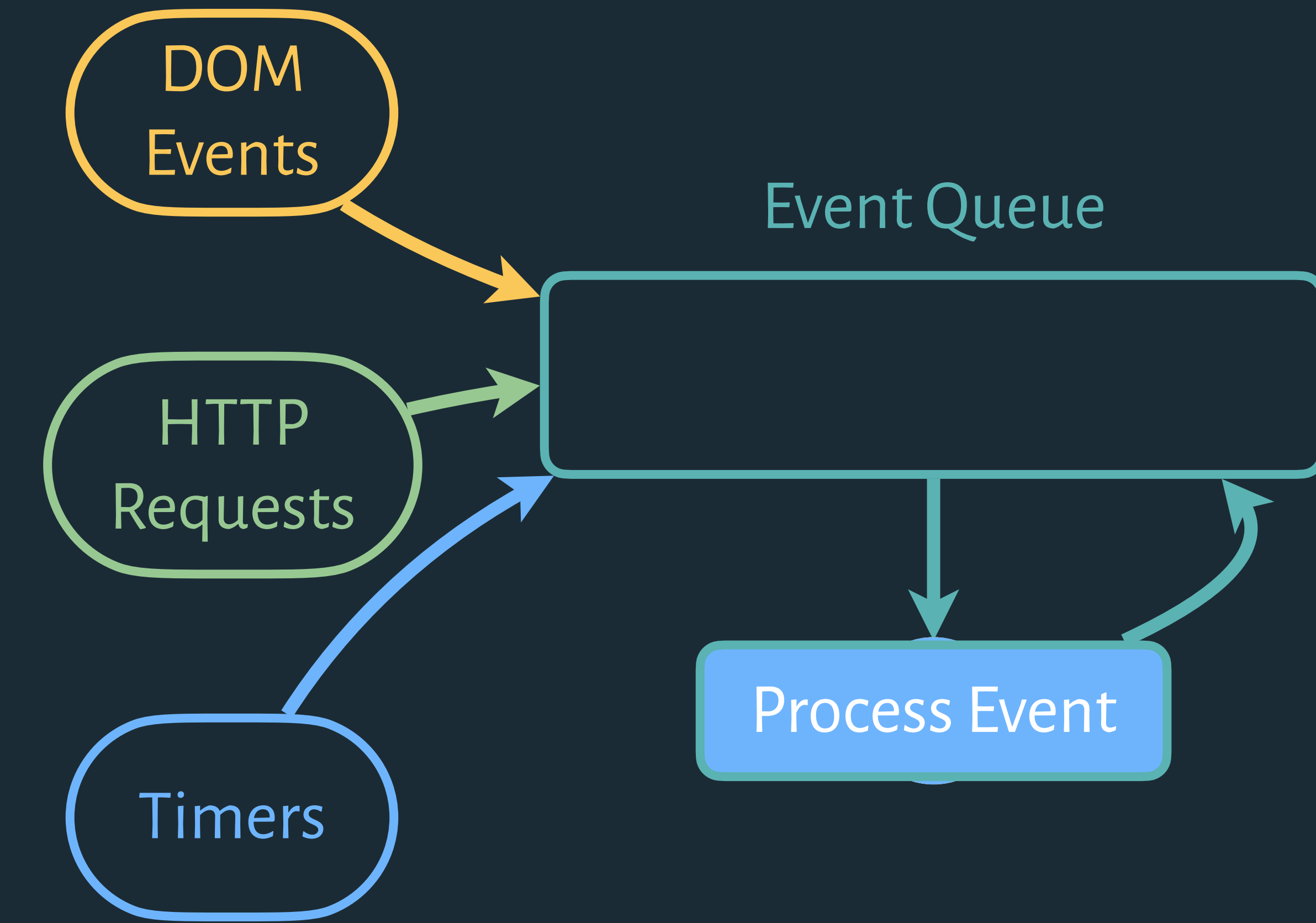


The JavaScript *Event Loop*





The JavaScript *Event Loop*



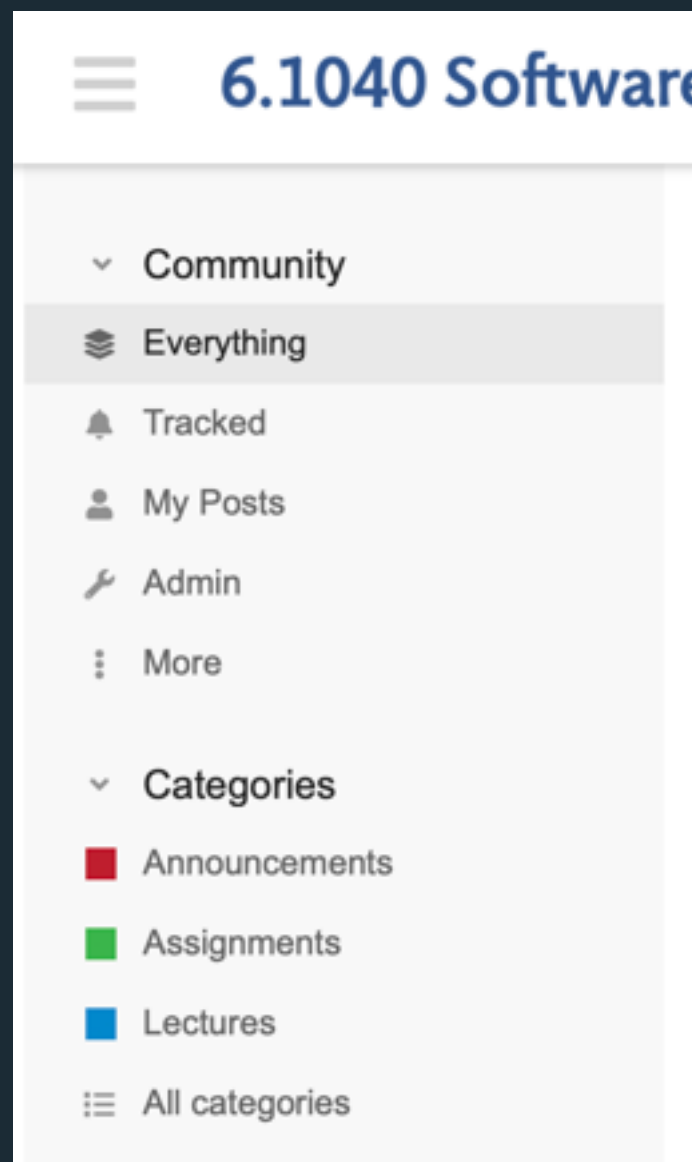


toggle.ts

```
import {Sidebar} from './Sidebar.html';
```

```
ToggleBtn.addEventListener('click', (event) => {  
  const opacity = Sidebar.style.opacity;  
  if (opacity === 0) Sidebar.style.opacity = 1;  
  else Sidebar.style.opacity = 0;  
});
```

Pseudo Code



sidebar.html

- ✗ Poor separation of concerns.
Neither toggle nor sidebar state is *well-encapsulated*.
Sidebar's state is being modified externally, and the Toggle button causes external effects (called "*side effects*").
- ✗ State is scattered across the app => makes debugging harder.

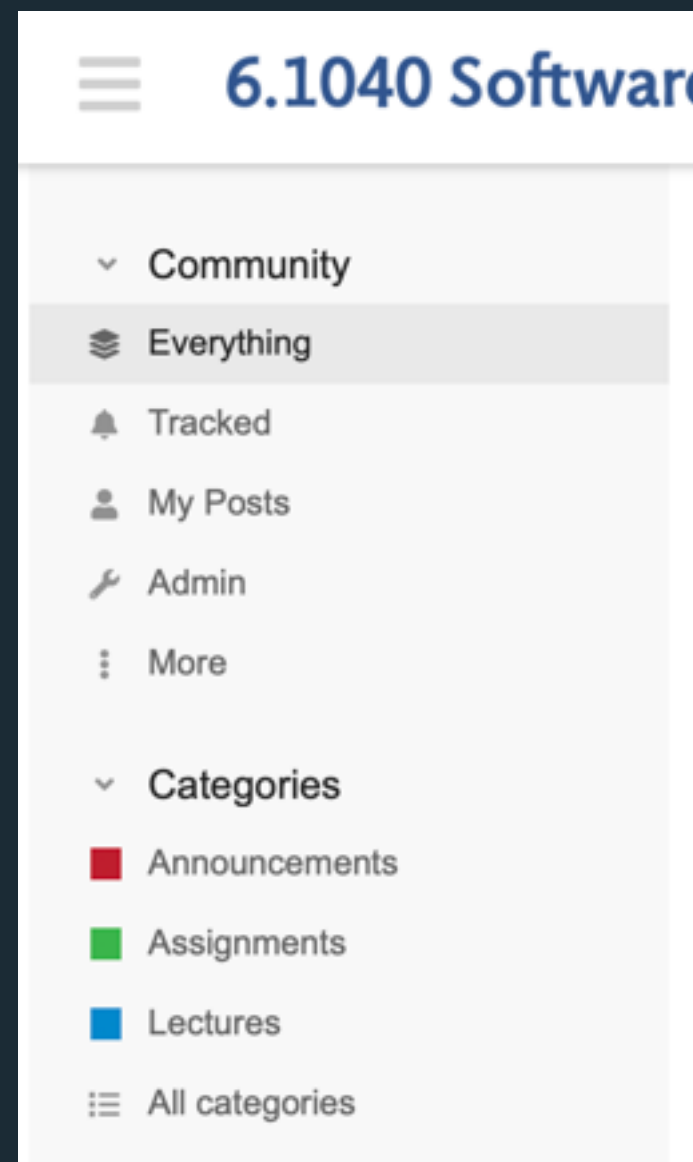


toggle.ts

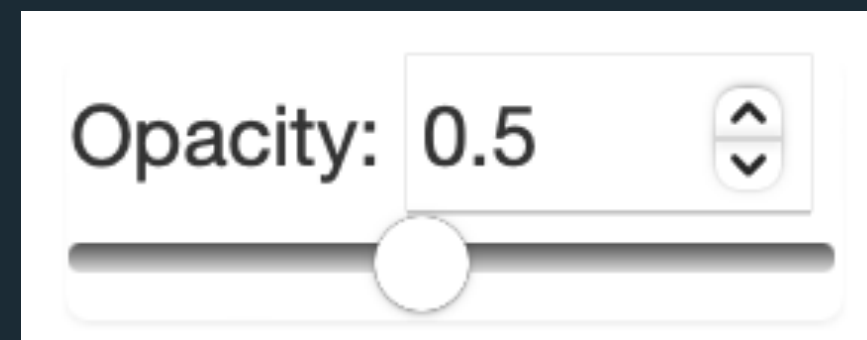
```
import {Sidebar} from './Sidebar.html';

ToggleBtn.addEventListener('click', (event) => {
  const opacity = Sidebar.style.opacity;
  if (opacity === 0) Sidebar.style.opacity = 1;
  else Sidebar.style.opacity = 0;
});
```

Pseudo Code



sidebar.html



widget.ts

```
import {Sidebar} from './Sidebar.html';

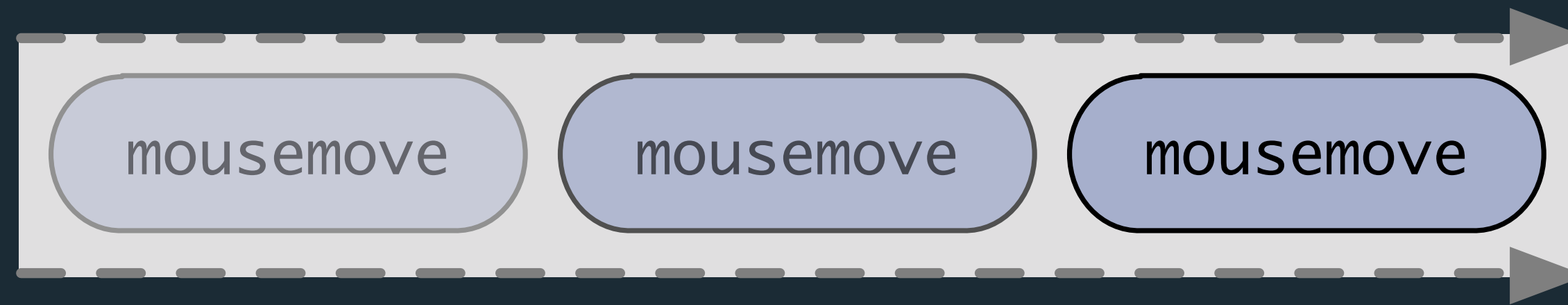
Textbox.addEventListener('change', () => {
  Sidebar.style.opacity = Textbox.value
  Slider.value = Textbox.value;
});

Slider.addEventListener('change', () => {
  Sidebar.style.opacity = Slider.value
  Textbox.value = Slider.value;
});
```

✗ Infinite loop between Textbox and Slider event handlers!

Reactive Programming

From *Event Listeners* to *Event Streams*



Event *streams*: an **abstraction** that treats events as a **continuous** data streams (rather than one-off occurrences that must be captured and handled ad hoc).



In practice, few libraries expose event streams directly.

Instead, event streams are constructed in the background, and their most recent values are available as *reactive variables*.

fx

A

B

C

◀ ▶

M

N

O

P

Q

1

2

Expenses

Oct

Nov

Dec

Total

Average

45

Everyday

Monthly totals:

\$0

\$0

\$0

\$0

\$0

46

Groceries

\$0

\$0

47

Restaurants

\$0

\$0

48

Entertainment

\$0

\$0

49

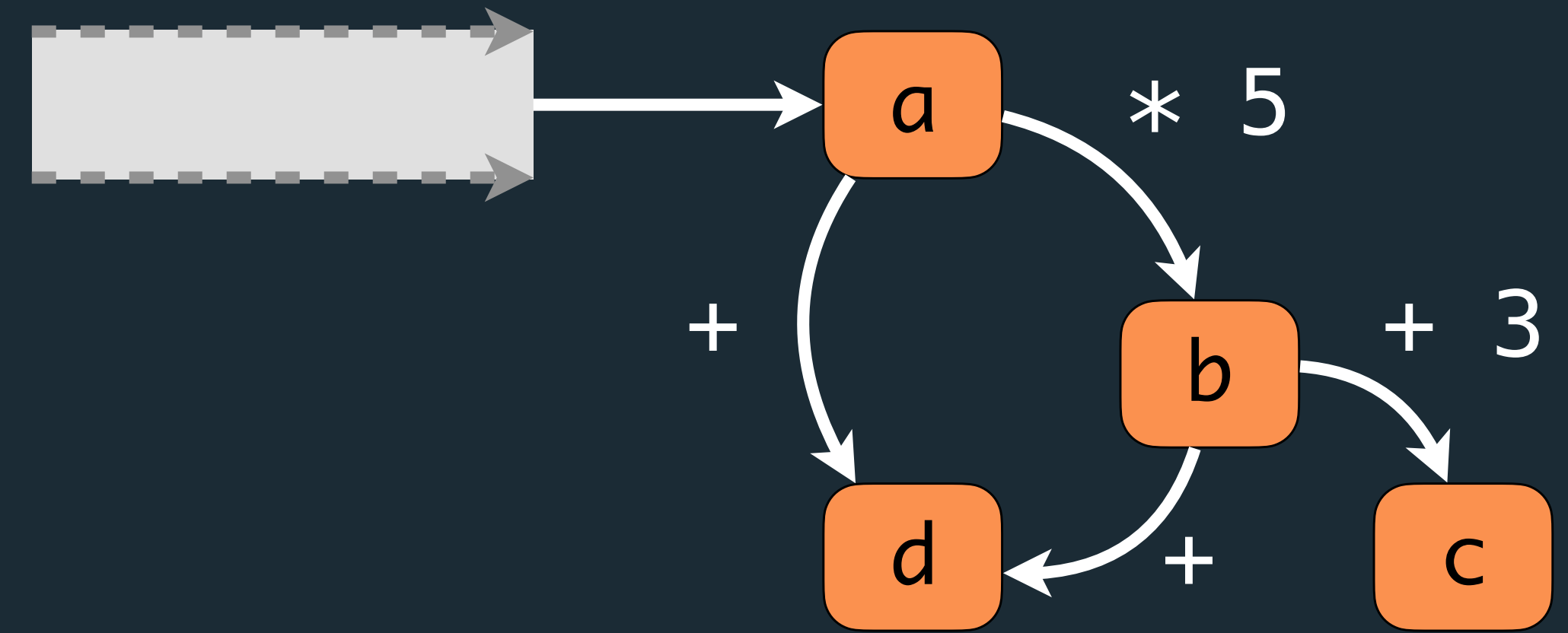
Clothes

\$0

\$0

Reactive Programming is *Dataflow Programming*

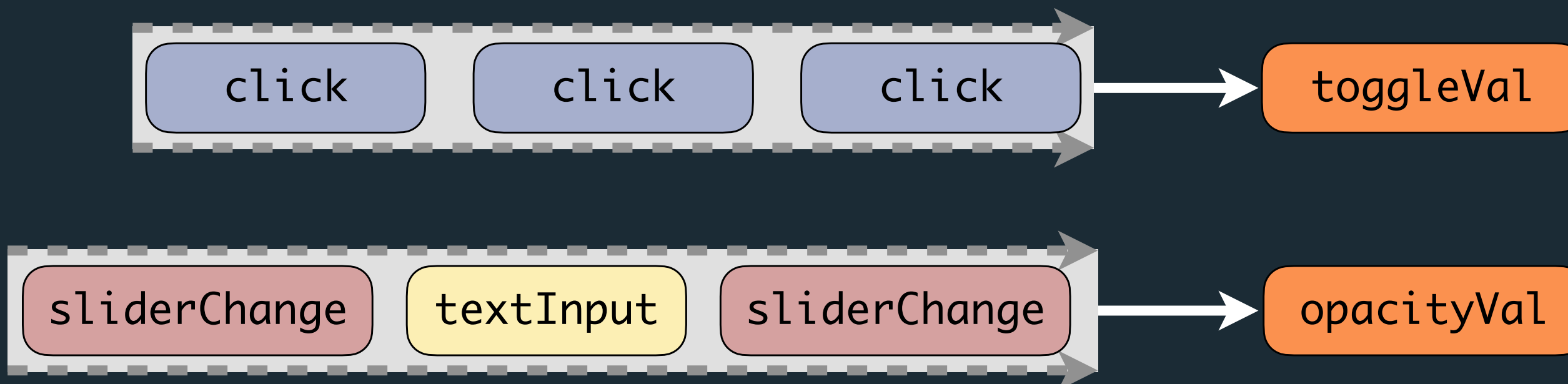
```
a; <-- data streams in  
b = a * 5;  
c = b + 3;  
d = a + b;  
pseudo-code
```



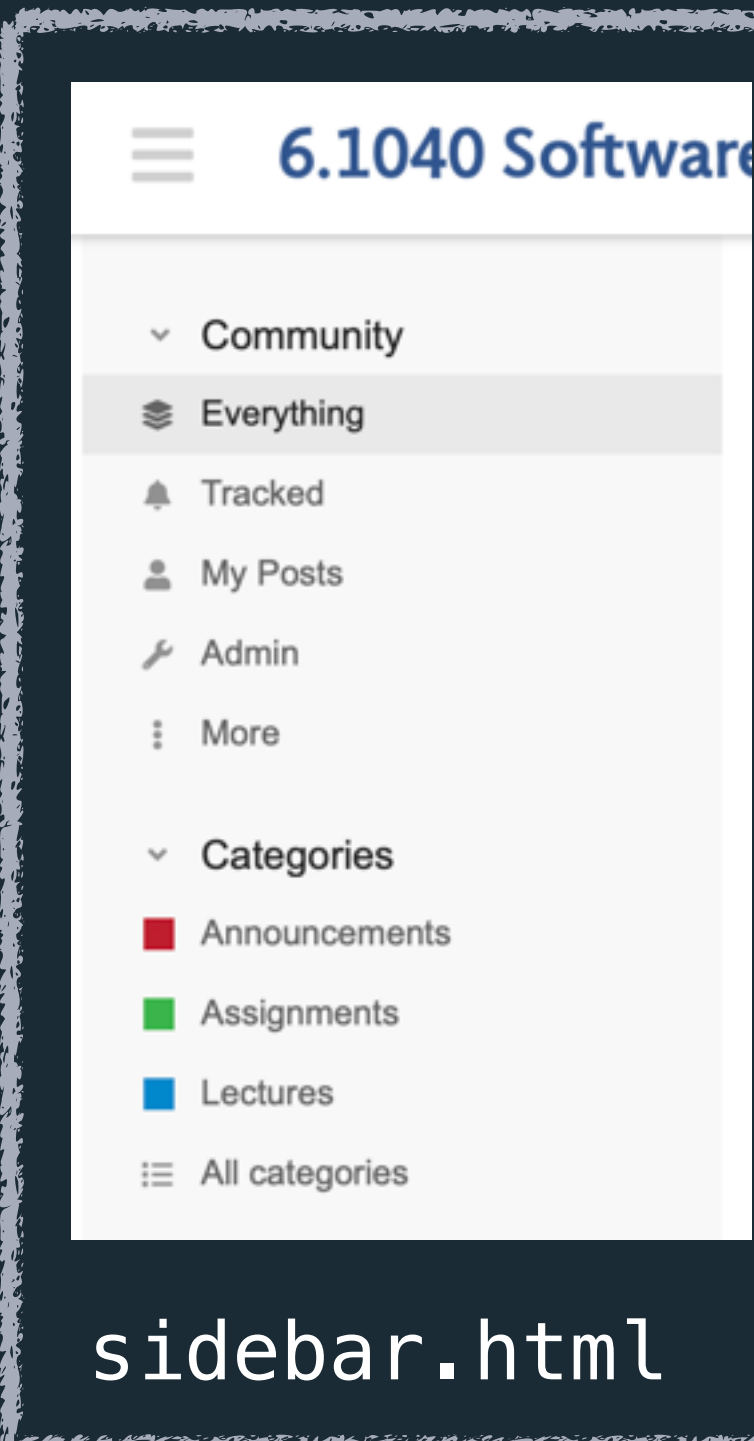
When new data streams in, **a** is automatically updated, and its new value propagates to variables that depend on it (**b**, **d**).

These variables update, and their values continue forwards (**b** → **c**).

Updates are *topologically sorted*: a variable is only updated once *all* of its dependencies have been updated.



Pseudo Code



```
import {toggleVal} from './Toggle.ts'
import {opacityVal} from './Widget.ts'

Sidebar.style.opacity = (toggleVal, opacityVal) => {
  if (toggleVal === 0) return 0;
  else return opacityVal;
}
```

- ✓ Sidebar state is now well encapsulated.
- ✓ Much clearer insight into what this state depends on.



Jose Aguinaga Follow
Web Engineer. Previously @numbrs, @plaidhq, @getflynt, currently @MyBit_DApp. Javascript, #people, startups, fintech, privacy, blockchain.
Oct 3, 2016 · 13 min read

How it feels to learn JavaScript in 2016

Cool. I need to create a page that displays the latest activity from the users, so I just need to get the data from the REST endpoint and display it in some sort of filterable table, and update it if anything changes in the server. I was thinking maybe using jQuery to fetch and display the data?

-Oh my god no, no one uses jQuery anymore. You should try learning React, it's 2016.

Oh, OK. What's React?

-It's a super cool library made by some guys at Facebook, it really brings control and performance to your application, by allowing you to handle any view changes very easily.

That sounds neat. Can I use React to display data from the server?

-Yeah, but first you need to add React and React DOM as a library in your webpage.

Wait, why two libraries?

-So one is the actual library and the second one is for manipulating the DOM, which now you can describe in JSX.

JSX? What is JSX?

-JSX is just a JavaScript syntax extension that looks pretty much like XML. It's kind of another way to describe the DOM, think of it as a better HTML.

What's wrong with HTML?

-It's 2016. No one codes HTML directly anymore.



vue.js

- ✓ Small surface area (i.e., fewer new things to learn).
- ✓ Thriving ecosystem + community (i.e., easy to find help).

Note: We are use Vue v3, not v2.



vue.js

- ✓ Small surface area (i.e., fewer new things to learn).
- ✓ Thriving ecosystem + community (i.e., easy to find help).
Note: We are use Vue v3, not v2.
- ✓ Better modularity + separation of concerns via components.

HTML

```
<html>
  <head>
    <link rel="stylesheet"
          href="photos.css">
  </head>

  <body>
    <button>Load More!</button>

    <div id="photos">

    </div>
  </body>
</html>
```

Structure + Content

CSS

```
#photos {
  display: flex;
  background: #ccc;
  padding: 5px;
  border: 1px solid #999;
  border-radius: 5px;
}

.photo {
  flex: 1;
  padding: 5px;
  background: white;
}
```

Presentation

JavaScript

```
const photos =
  document.querySelector('#photos');

document.querySelector('button')
  .addEventListener(function() {
    get('/photos')
      .then(function(data) {
        for (const d of data) {
          const p =
            document.createElement('img');
          photo.src = d.src;
          photos.appendChild(photo);
        }
      });
  });
```

Behavior

HT

```

<html>
  <head>
    <link rel="stylesheet" href="photos.css" />
  </head>


  <body>
    <button>Load Photos</button>

    <div id="photos">
      <img alt="A placeholder for a photo of Adam Liptak." />
    </div>
  </body>
</html>

```

Structure

The New York Times **POLITICS** | Back on the Bench, the Supreme Court Faces a Blockbuster Term

 By [Adam Liptak](#)

Oct. 3, 2021 Updated 12:30 p.m. ET

WASHINGTON — A transformed Supreme Court returns to the bench on Monday to start a momentous term in which it will consider eliminating the constitutional right to abortion, vastly expanding gun rights and further chipping away at the wall separating church and state.

The abortion case, a challenge to a Mississippi law that bars most abortions after 15 weeks, has attracted the most attention. The court, now dominated by six Republican appointees, seems poised to use it to undermine and perhaps overturn [Roe v. Wade](#), the 1973 decision that established a constitutional right to abortion and barred states from banning the procedure before fetal viability.

The highly charged docket will test the leadership of Chief Justice John G. Roberts Jr., who lost his position at the court’s ideological center with the arrival last fall of Justice Amy Coney Barrett. He is now outflanked by five justices to his right, limiting his ability to guide the court toward the consensus and incrementalism he has

Special offer. Subscribe for ~~\$4.25~~ \$1 a week. **EXPAND** ^

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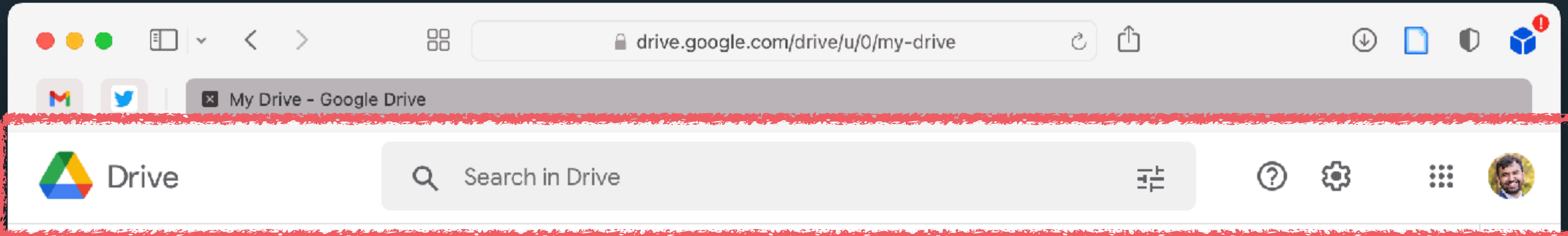
```

for('#photos');
button')
ion() {
) {
ata) {
teElement('img');
rc;
ild(photo);

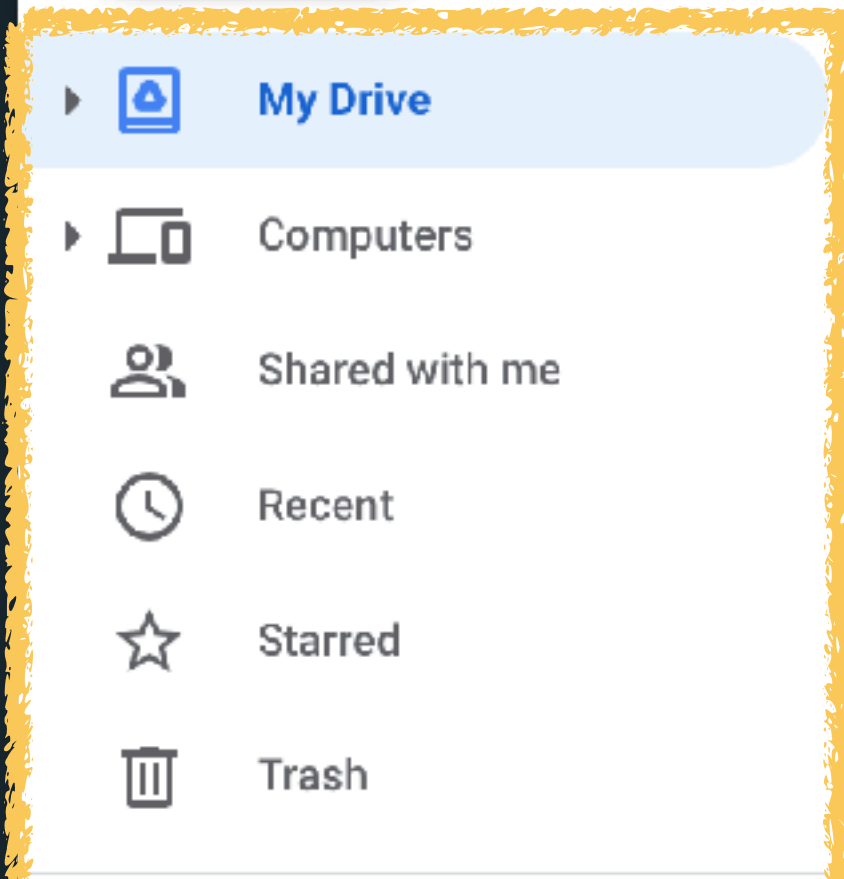
```

or

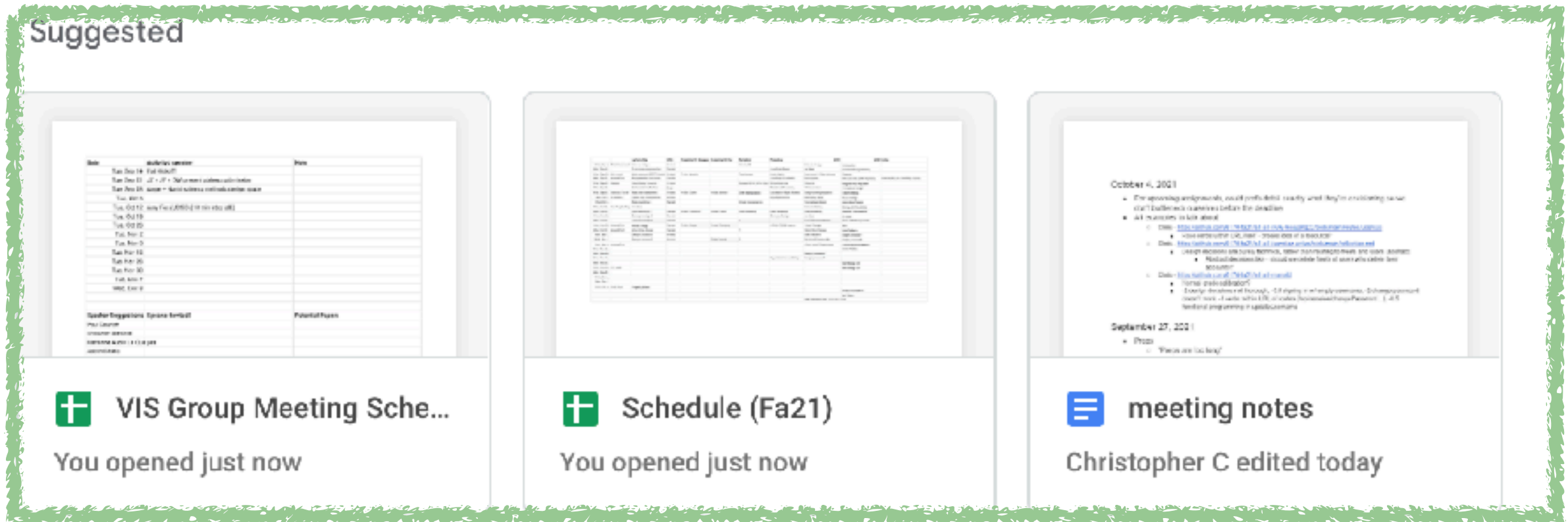
Toolbar



Locations



Suggestions



File Listing

Name	Owner	Last modified
2018 Dagstuhl VIS	Hanspeter Pfister	Nov 14, 2018
2019-07-01_Arvind Satyanarayan	Lourdes M. Aleman	Jul 2, 2019
2020 SSRC COVID rapid response grant		
6170	me	Jan 6, 2020
6894	me	Jan 6, 2020
AwardsReview	Miriah Meyer	Feb 9, 2020
Colab Notebooks	me	Nov 7, 2018