



Making HTML More Expressive

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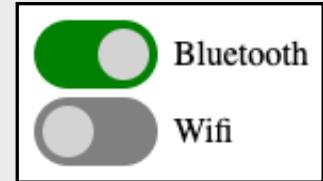
Approaches

- There are many ways to make HTML more expressive
 - **template element** and a bit of JavaScript
 - **web components** (vanilla, Lit, and Shoelace)
 - **new attributes on HTML elements** (Alpine, _hyperscript, and htmx)
- Let's review each of these



Quotes

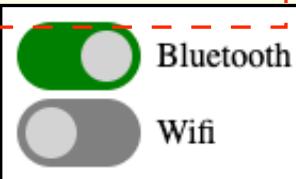
- “Life is like a box of chocolates.”
 - Forrest Gump
- “A checkbox is like a toggle switch.”
 - Me
- “You never know what you’re gonna get.”
 - Forrest Gump
- “You will get a form component that represents a Boolean state.”
 - Me
- “A toggle switch is better than a box of chocolates.”
 - Me



template Element



```
<!DOCTYPE html>                                public/index.html
<html>
  <head>
    <title>Template Toggle</title>
    <link rel="stylesheet" href="./toggle-switch.css" />
    <script defer src="./toggle-switch.js"></script>
  </head>
  <body>
    <template id="toggle-switch-template">
      <label class="toggle-switch">
        <input class="thumb" type="checkbox" />
        <div class="switch"></div>
        <span class="label"></span>
      </label>
    </template>
    <div id="target1"></div>
    <div id="target2"></div>
  </body>
</html>
```



The code shows the HTML structure for a template element. It includes a template with a label containing an input checkbox and a switch div, and two target divs below it. The target divs are visually represented as toggle switches with labels 'Bluetooth' and 'Wifi'.

```
public/toggle-switch.js
```

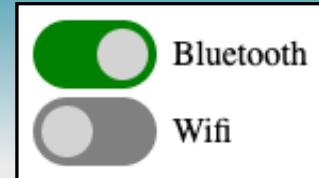
```
function toggleSwitch(targetId, label, checked, callback) {
  const template = document.getElementById('toggle-switch-template');
  const clone = template.content.cloneNode(true); // deep
  const labelSpan = clone.querySelector('.label');
  labelSpan.textContent = label;
  const input = clone.querySelector('[type=checkbox]');
  input.checked = checked;
  input.addEventListener('change', callback);

  const target = document.getElementById(targetId);
  target.appendChild(clone);
}

toggleSwitch('target1', 'Bluetooth', true, e => {
  console.log('Bluetooth:', e.target.checked);
});
toggleSwitch('target2', 'Wifi', false, e => {
  console.log('Wifi:', e.target.checked);
});
```

The code defines a `toggleSwitch` function that creates a clone of a template element and appends it to a target element. The function takes four parameters: targetId, label, checked, and callback. It uses querySelector to find the label and input elements within the template and sets their values based on the checked parameter. It then adds an event listener to the input element's change event. Finally, it appends the cloned template content to the target element. Two calls to the `toggleSwitch` function are shown, one for 'target1' (Bluetooth) and one for 'target2' (Wifi), each with its own callback.

Toggle Switch CSS ...



surrounds entire component

```
label.toggle-switch {  
    --use-padding: var(--padding, 0.25rem);  
    --use-switch-height: var(--switch-height, 2rem);  
    --switch-width: calc(var(--use-switch-height) * 1.8);  
    --thumb-size: calc(  
        var(--use-switch-height) -  
        var(--use-padding) * 2  
    );  
    --use-transition-duration: var(--transition-duration, 0.3s);  
  
    display: inline-flex;  
    align-items: center;  
    gap: 0.5rem;  
    color: var(--label-color, black);  
    cursor: pointer;  
  
    & .switch {  
        background-color: var(--off-bg, gray);  
        border-radius: calc(var(--use-switch-height) / 2);  
        height: var(--use-switch-height);  
        position: relative;  
        transition: background var(--use-transition-duration);  
        width: var(--switch-width);  
    }  
}
```

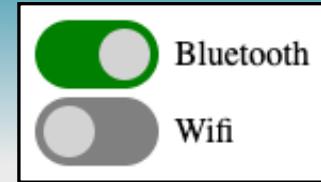
public/toggle-switch.css

configurable via CSS variables
(aka custom properties)

```
/* This renders the thumb.  
   It is absolutely positioned inside the switch. */  
&:before {  
    content: '';  
    background-color: var(--thumb-bg, lightgray);  
    border-radius: 50%;  
    transition: left var(--use-transition-duration);  
  
    position: absolute;  
    top: var(--use-padding);  
    left: var(--use-padding); /* unchecked position */  
  
    width: var(--thumb-size);  
    height: var(--thumb-size);  
}
```

content created by CSS

... Toggle Switch CSS



```
/* The thumb is a preceding sibling of the switch. */
.thumb:checked + & {
  background-color: var(--on-bg, green);
  &:before {
    /* checked position */
    left: calc(
      var(--switch-width) -
      var(--use-switch-height) +
      var(--use-padding)
    );
  }
}

/* The thumb input is only used to hold the checked state.
   It is not rendered. Instead, the before content of the switch
   is used for the thumb. */
& .thumb {
  position: absolute;
  visibility: hidden;
}
}
```

not visible

Web Components



- Define **custom HTML elements** that can be used just like standard HTML elements
 - names must be all lower-case and contain at least one hyphen
 - tags cannot be self-closing ex. `<oci-toggle></oci-toggle>`, not `<oci-toggle />`
- Can be used in any web page, with **any web framework**, and in Markdown files
- Requires **a bit more effort** than implementing components using a framework like Svelte
 - worthwhile for components that may someday be used in multiple apps written using multiple frameworks
- **Standards-based:** Custom Elements, Shadow DOM, ES Modules, and HTML Templates

WC Lifecycle Methods



- **constructor**
 - called when an instance is initially created
- **connectedCallback**
 - called after an instance is added to DOM
- **attributeChangedCallback**
 - called when the value of any “observed” attribute changes
 - specify with

```
static get observedAttributes() { return ['name1', 'name2', ...]; }
```
- **disconnectedCallback**
 - called after an instance is removed from DOM

Vanilla Web Component ...



must extend `HTMLElement`

```
export class ToggleSwitchWC extends HTMLElement {    src/toggle-switch-wc.js
  constructor() {
    super();

    const label = this.getAttribute('label');
    const checked = this.getAttribute('checked');

    this.attachShadow({mode: 'open'});
    const root = this.shadowRoot;
    root.innerHTML =
      <style>${ToggleSwitchWC.styles}</style>
      <label>
        <input class="thumb" type="checkbox" checked=${checked}/>
        <div class="switch"></div>
        <span class="label">${label}</span>
      </label>
    ;

    const checkbox = root.querySelector('input');
    checkbox?.addEventListener('change', this.handleChange.bind(this));
  }
}
```



```
handleChange(event: Event) {
  const root = this.shadowRoot!

  const {checked} = event.target;
  const newEvent = new CustomEvent(
    'toggle',
    {detail: {checked}}
  );
  this.dispatchEvent(newEvent);
}

static styles = `...same as before...`;

customElements.define(
  'toggle-switch-wc',
  ToggleSwitchWC
);
```

setting `innerHTML` removes the need to use low-level
DOM methods like `createElement` and `appendChild`

Alternative

This approach supports updating UI when attribute values are changed by calling **setAttribute** OR **removeAttribute**.

```
export class ToggleSwitchWC extends HTMLElement {
  constructor() {
    super();
    src/toggle-switch-wc.js

    this.attachShadow({mode: 'open'});
    const root = this.shadowRoot;
    root.innerHTML =
      <style>${ToggleSwitchWC.styles}</style>
      <label>
        <input class="thumb" type="checkbox" />
        <div class="switch"></div>
        <span class="label"></span>
      </label>
    ;
    <img alt="A toggle switch component with the text 'Web Component' next to it." data-bbox="205 588 365 635"/>
    const checkbox = root.querySelector('input');
    checkbox?.addEventListener(
      'change',
      this.handleChange.bind(this)
    );
  }

  static get observedAttributes() {
    return ['checked', 'label'];
  }
}
```

```
attributeChangedCallback(
  name: string,
  _: string | null,
  newValue: string | null
) {
  const root = this.shadowRoot!;
  if (name === 'checked') {
    const checkbox = root.querySelector('input');
    if (checkbox) {
      if (newValue === null) {
        checkbox.removeAttribute('checked');
      } else {
        checkbox.setAttribute('checked', 'checked');
      }
    }
  } else if (name === 'label') {
    const span = root.querySelector('.label');
    if (span) span.textContent = newValue;
  }
}

handleChange(event: Event) {
  const root = this.shadowRoot!;
  const {checked} = event.target;
  const newEvent = new CustomEvent(
    'toggle',
    {detail: {checked}}
  );
  this.dispatchEvent(newEvent);
}

static styles = `...same as before...`;

customElements.define('toggle-switch-wc', ToggleSwitchWC);
```

... Vanilla Web Component

public/index.html

```
<!DOCTYPE html>
<html>
  <head>
    <style>
      toggle-switch-wc {
        --label-color: purple;
        --off-bg: red;
        --on-bg: blue;
        --padding: 1rem;
        --switch-height: 4rem;
        --thumb-bg: yellow;
        --transition-duration: 1s;
      }
    </style>
    <script defer
      src="https://cdn.jsdelivr.net/npm/alpinejs@3.x.x/dist/cdn.min.js"></script>
    <script type="module" src="/src/toggle-switch-wc.js"></script>
    <script>
      function handleToggle(event) {
        const {checked} = event.detail;
        console.log('checked =', checked);
      }
    </script>
  </head>
```

demonstrates setting all the CSS custom properties used in the component CSS

using Alpine for event handling (@toggle)

a real app would do more here

Web Component

```
<body>
  <toggle-switch-wc
    label="Web Component"
    checked
    @toggle="handleToggle($event)"
  ></toggle-switch-wc>
</body>
</html>
```

@toggle and \$event are specific to Alpine



Lit

<https://lit.dev/>



- Lit components
 - are native web components
 - can be used everywhere web components can be used
 - can be implemented in JavaScript (no build step) or TypeScript
 - require loading the Lit library
 - use `html` and `css` tagged template literals
- Decorator syntax requires TypeScript
- Provides a large amount of functionality
 - goes well beyond just implementing web components
 - can be used as a replacement for SPA frameworks like React

Lit Web Component

```
src/toggle-switch-lit.js

import {css, html, LitElement} from 'lit';
import {customElement, property} from 'lit/decorators.js';

@customElement('toggle-switch-lit')
export class ToggleSwitchLit extends LitElement {
  @property() label = '';
  @property({type: Boolean}) checked = false;

  render() {
    return html`
      <input
        class="thumb"
        type="checkbox"
        ?checked=${this.checked}
        @change=${this.handleChange}
      />
      <div class="switch"></div>
      <span class="label">${this.label}</span>
    `;
  }
}

must extend LitElement
```

?checked and @change are specific to Lit

```
handleChange(event: Event) {
  const {checked} = event.target;
  const newEvent = new CustomEvent(
    'toggle',
    {detail: {checked}}
  );
  this.dispatchEvent(newEvent);
}

static styles = css`...same as before...`;
```

HTML to use this would be similar to that for the vanilla web component.



- Large collection of open source web components that can be used with all web frameworks or JavaScript with no framework
- Built with Lit
- Can use from CDN or install from npm
- <https://shoelace.style/>

Shoelace sl-switch

```
<!DOCTYPE html>
<html lang="en">
  <head>
    <title>Shoelace Demo</title>
    <link
      rel="stylesheet"
      href="https://cdn.jsdelivr.net/npm/@shoelace-style/shoelace@2.14.0/cdn/themes/light.css"
    />
    <script
      defer
      src="https://cdn.jsdelivr.net/npm/alpinejs@3.x.x/dist/cdn.min.js"></script>
    <script
      type="module"
      src="https://cdn.jsdelivr.net/npm/@shoelace-style/shoelace@2.14.0/cdn/shoelace-autoloader.js"></script>
    <script>
      function handleChange(event) {
        const {checked} = event.target;
        console.log('checked =', checked);
      }
    </script>
  </head>
  <body x-data>
    <div>
      <sl-switch size="large" checked @sl-change="handleChange">
        Shoelace
      </sl-switch>
    </div>
  </body>
</html>
```

public/index.html

using Alpine for event handling (@sl-change)

required to activate Alpine



Alpine



- “Lightweight JavaScript framework that uses **custom HTML attributes** to add dynamic behavior”
- “Offers you the **reactive and declarative** nature of big frameworks like Vue or React at a much lower cost”
- **Small library**
- **No build process**
- Provides a large number of “**directives**” that are applied as HTML attributes
 - ex. **x-bind**, **x-data**, **x-for**, **x-if**, **x-model**, **x-on**, **x-show**, and **x-text**

shorthand is :

shorthand is @

Alpine Counter

```
<!DOCTYPE html>
<html>
  <head>
    <title>Alpine Counter</title>
    <script
      defer
      src="https://cdn.jsdelivr.net/npm/alpinejs@3.x.x/dist/cdn.min.js"></script>
  </head>
  <body>
    <div style="display: flex; gap: 1rem" x-data="{count: 0}">
      <button @click="count--" :disabled="count === 0">-</button>
      <span x-text="count"></span>
      <button @click="count++" :disabled="count === 10">+</button>
    </div>
  </body>
</html>
```

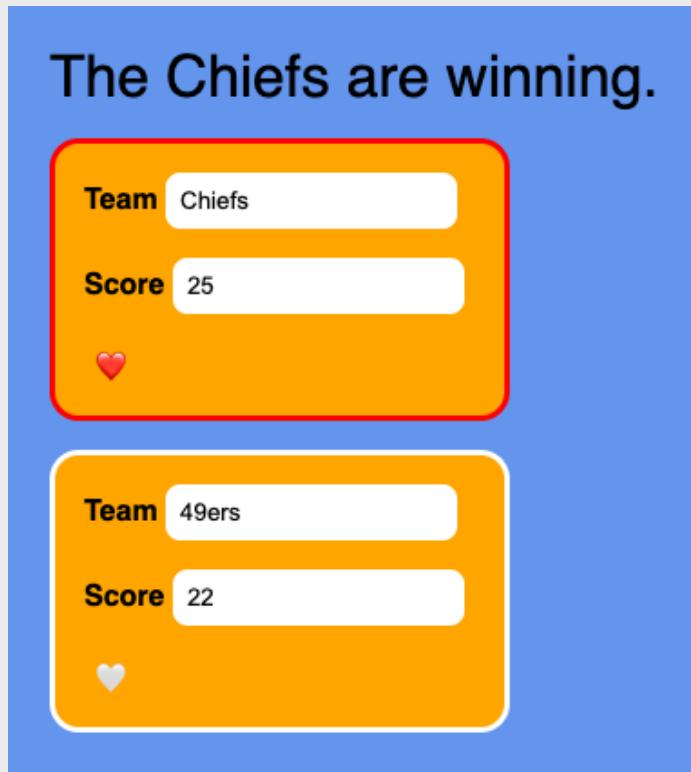


x-data is the Key!

- Serves two purposes
 - activates use of Alpine
 - declares reactive properties
- Can apply to multiple elements
 - each defines a scope
 - scopes can be nested

Forgetting this is the #1 source of issues because other directives are ignored if not on or inside an element with this.

Alpine Score Keeper ...



```
score-keeper.css
```

```
body {  
    background-color: cornflowerblue;  
    font-family: sans-serif;  
    font-size: 1rem;  
    padding: 1rem;  
}  
  
button {  
    background-color: transparent;  
    border: none;  
}  
  
.column {  
    display: flex;  
    flex-direction: column;  
    align-items: start;  
    gap: 1rem;  
}  
  
input {  
    border: none;  
    border-radius: 0.5rem;  
    padding: 0.5rem;  
}
```

```
label {  
    font-weight: bold;  
}  
  
#report {  
    font-size: 2rem;  
}  
  
.team {  
    background-color: orange;  
    border: 3px solid white;  
    border-radius: 1rem;  
    padding: 1rem;  
    width: 13.5rem;  
}
```

... Alpine Score Keeper ...

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

score-keeper.html

```
    <title>Alpine Score Keeper</title>
    <link rel="stylesheet" href="score-keeper.css" />
    <script
        defer
        src="https://cdn.jsdelivr.net/npm/
            alpinejs@3.x.x/dist/cdn.min.js"
    ></script>
```

```
    <script>
        const getData = () => ({
            team1: {name: 'Chiefs', score: 25},
            team2: {name: '49ers', score: 22},
            color(like) {
                return like ? 'red' : 'white';
            },
            heart(like) {
                return like ? '❤️' : '🤍';
            },
            // This is like a computed property.
            report() {
                const s1 = Number(this.team1.score);
                const s2 = Number(this.team2.score);
                return s1 > s2
                    ? `The ${this.team1.name} are winning.`
                    : s2 > s1
                    ? `The ${this.team2.name} are winning.`
                    : "The score is tied.";
            },
        });
    </script>
</head>
```

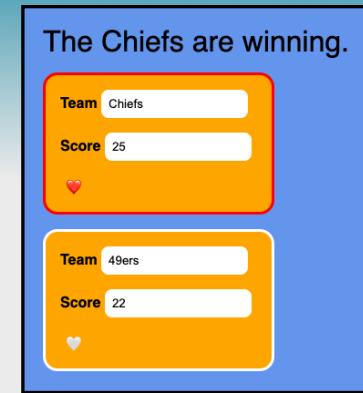


... Alpine Score Keeper

outer x-data scope

inner x-data scopes

```
<body>
  <main class="column" x-data="getData">
    <div id="report" x-text="report"></div>
    <section
      class="column team"
      :style="`border-color: ${color(like)} `"
      x-data="{like: false}"
    >
      <label>Team <input type="text" x-model="team1.name" /></label>
      <label>Score <input type="number" x-model="team1.score" /></label>
      <button @click="like = !like" x-text="heart(like)"></button>
    </section>
    <!-- We could avoid this repetition by creating a web component. -->
    <section
      class="column team"
      :style="`border-color: ${color(like)} `"
      x-data="{like: false}"
    >
      <label>Team <input type="text" x-model="team2.name" /></label>
      <label>Score <input type="number" x-model="team2.score" /></label>
      <button @click="like = !like" x-text="heart(like)"></button>
    </section>
  </main>
</body>
</html>
```

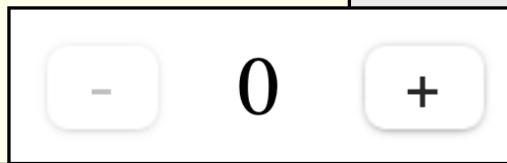


hyperscript

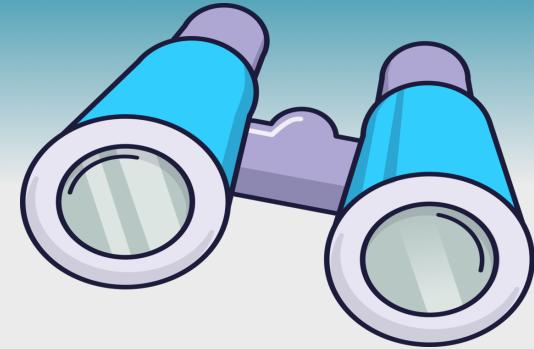
- Programming language used in HTML to implement interactivity
- Created by Carson Gross who also created htmx
- Emphasizes readability over writability with English-like syntax
- Based on the HyperTalk language
which was used in Apple's HyperCard
- Adds a single attribute named _

_hyperscript Counter

```
<!DOCTYPE html>
<html>
  <head>
    <script src="https://unpkg.com/_hyperscript.org@0.9.12"></script>
  </head>
  <body>
    <div style="display: flex; gap: 1rem">
      <button
        disabled
        _="on click
          remove @disabled from the next <button/>
          decrement the.textContent of #count
          if it is 0 then add @disabled to me
        "
      >
        -
      </button>
      <span id="count">0</span>
    </div>
    <button
      _="on click
        remove @disabled from the previous <button/>
        increment the.textContent of #count
        if it is 10 then add @disabled to me
      "
    >
      +
    </button>
  </div>
  </body>
</html>
```



htmx Overview



- Client-side JavaScript library for implementing hypermedia-driven applications (HDAs)
 - adds support for new HTML attributes that make HTML more expressive
 - uses endpoints that return HTML rather than JSON
 - free and open-source
- Sponsored by 19 companies (as of Feb. 2024)
 - including GitHub and JetBrains
- <https://htmx.org/>

htmx Improves HTML

| HTML | htmx |
|--|--|
| only anchor and <code>form</code> elements trigger HTTP requests | any element can trigger HTTP requests |
| only triggered by clicking an anchor or submitting a form | any event can trigger |
| only GET and POST requests are sent | any verb can be used, including PUT, PATCH, and DELETE |
| response causes a full page refresh | response can be inserted into current page |

SPA Frameworks vs htmx

- **SPA approach**

- HTTP responses contain JSON
- client-side code parses JSON
- client-side code uses result to build DOM
- framework code inserts new DOM into current page



- **htmx approach**

- HTTP responses contain HTML
- browser automatically builds DOM from HTML
- htmx inserts new DOM into current page



faster due to elimination of
JSON generation and parsing



HATEOAS



- Stands for Hypermedia As The Engine Of Application State
- Major focus of htmx
- **Hypermedia:** any data format that can describe branching from one “media” (ex. a document) to another
- HTML is a kind of hypermedia, but JSON is not
- **Hypermedia client:** software that understands and renders a hypermedia format, such as web browsers with HTML
 - no custom client-side code is required



htmx Tech Stacks ...



- Can use any programming language and framework that can implement an **HTTP server** whose endpoints return **HTML responses**
- Referred to as “Hypermedia On Whatever you’d Like” (**HOWL**)
- **Good choices make it easy to**
 - create new endpoints for any HTTP verb
 - specify type checking and validation of request data
 - get request data from headers, path parameters, query parameters, and bodies
 - send HTTP responses that include headers and bodies that contain text or HTML



... Tech Stacks

- **Good choices have tooling that supports**
 - **fast server startup** with no build process or a simple one
 - **automatic server restarts** after source code changes are detected
 - **good HTML templating** support (such as JSX) or my npm package js2htmlstr without relying on string concatenation
 - **syntax highlighting** of HTML in code editors



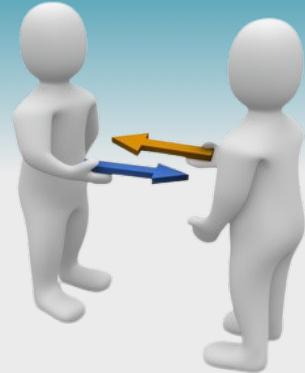
htmx Basics



- Add htmx attributes to elements that trigger HTTP requests
- Specify events that trigger the request
 - **hx-trigger** comma-separated list of event names with optional modifiers
- Specify HTTP verb to use and endpoint URL
 - **hx-get**, **hx-post**, **hx-put**, **hx-patch**, and **hx-delete**
- Specify element where response HTML will go
 - **hx-target** can be CSS selector and/or use several keywords; defaults to **this**
- Specify where to place HTML relative to target
 - **hx-swap** see next slide

All elements have a **default trigger**.
form elements trigger on **submit**.
input, **textarea**, and **select** elements trigger on **change**.
All other elements trigger on **click**.

hx-swap



Assume **hx-target** refers to the **ul** element.

Options to
insert content

beforebegin

afterbegin

beforeend

afterend

```
<p>before list</p>
<ul>
  <li>Red</li>
  <li>Green</li>
  <li>Blue</li>
</ul>
<p>after list</p>
```

Options to
replace content

outerHTML

innerHTML (default)

Options that do not
use response HTML

delete

removes target element

none

leaves target element as-is

htmx Score Keeper

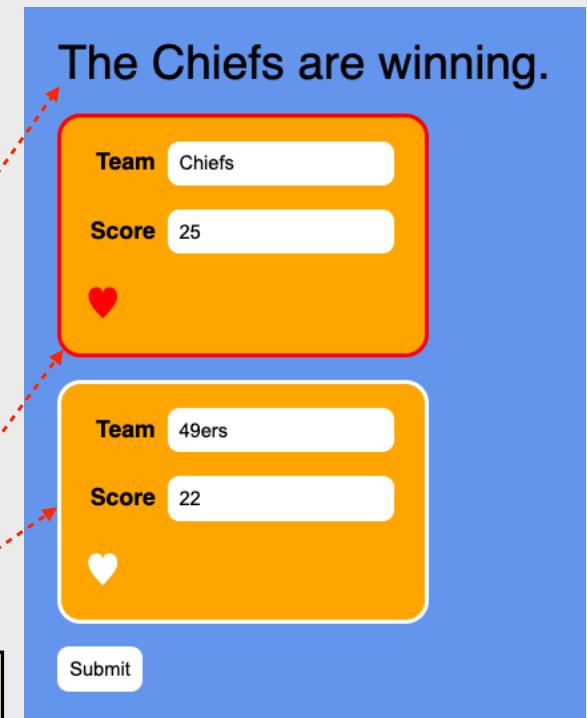
- Let's implement the same app again using htmx
- Scores are sent to a server
 - requirement for many applications

also Bun and Hono

```
<html>
  <head>
    <title>htmx Score Keeper</title>
    <link rel="stylesheet" href="styles.css" />
    <script src="https://unpkg.com/htmx.org@1.9.10"></script>
  </head>
  <body>
    <div hx-trigger="load" hx-get="/report" id="report"></div>
    <form class="column" hx-post="/update" hx-target="#report">
      <div hx-trigger="load" hx-get="/team/1" hx-target="this"></div>
      <div hx-trigger="load" hx-get="/team/2" hx-target="this"></div>
      <button>Submit</button>
    </form>
  </body>
</html>
```

index.html

In elements with an ancestor that triggers HTTP requests, **hx-target** defaults to that ancestor. That is why **hx-target="this"** is required on these **div** elements.



htmx Score Keeper - CSS

```
body {  
    background-color: cornflowerblue;  
    font-family: sans-serif;  
    font-size: 1rem;  
    padding: 1rem;  
}  
  
button {  
    background-color: white;  
    border: none;  
    border-radius: 0.5rem;  
    padding: 0.5rem;  
}  
  
.column {  
    display: flex;  
    flex-direction: column;  
    align-items: start;  
    gap: 1rem;  
}  
  
input {  
    border: none;  
    border-radius: 0.5rem;  
    padding: 0.5rem;  
}
```

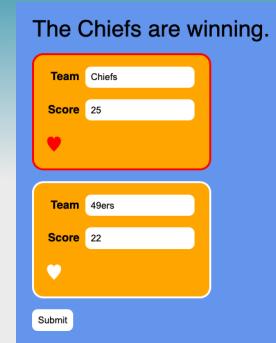
mostly same as CSS for Alpine version

```
input[type='checkbox'] {  
    display: none;  
}  
  
input[type='checkbox'] + label {  
    color: white;  
    font-size: 1.5rem;  
}  
  
input[type='checkbox']:checked + label {  
    color: red;  
}  
  
label > div {  
    display: inline-block;  
    font-weight: bold;  
    margin-right: 0.5rem;  
    text-align: right;  
    width: 3rem;  
}
```

see red dashed box on next slide

heart color

```
#report {  
    font-size: 2rem;  
    margin-bottom: 1rem;  
}  
  
.team {  
    background-color: orange;  
    border: 3px solid white;  
    border-radius: 1rem;  
    padding: 1rem;  
    width: 13.5rem;  
}
```



htmx Score Keeper - TS ...

```
server.tsx
import {type Context, Hono} from 'hono';
import {serveStatic} from 'hono/bun';

type Team = {
  name: string;
  score: number;
  like: boolean;
};
const team1: Team = {
  name: 'Chiefs',
  score: 25,
  like: true
};
const team2: Team = {
  name: '49ers',
  score: 22,
  like: false
};

function report(): string {
  return team1.score > team2.score
    ? `The ${team1.name} are winning.`
    : team2.score > team1.score
    ? `The ${team2.name} are winning.`
    : 'The score is tied.';
}
```

```
function teamHtml(number: string): JSX.Element {
  const team = number === '1' ? team1 : team2;
  const borderColor = team.like ? 'red' : 'white';
  return (
    <section class="column team"
      style={`border-color: ${borderColor}`}>
      <label>
        <div>Team</div>
        <input type="text" name={'team' + number}
          required value={team.name} />
      </label>
      <label>
        <div>Score</div>
        <input type="number" name={'score' + number}
          required value={team.score} />
      </label>
      <input
        type="checkbox"
        id={'like' + number}
        checked={team.like}
        hx-get={'/toggle-like/' + number}
      />
      <label for={'like' + number}>&hearts;</label>
    </section>
  );
}
```

Checkbox is used to hold state, but is not displayed.

Clicking a label associated with a checkbox toggles it.



... htmx Score Keeper - TS

```
const app = new Hono();

// Serve static files from public directory.
app.use('*', serveStatic({root: './public'})); ← index.html and styles.css

app.get('/team/:number', (c: Context) => {
  const number = c.req.param('number');
  return c.html(teamHtml(number));
});

app.get('/report', (c: Context) => c.text(report()));

app.get('/toggle-like/:number', (c: Context) => {
  const number = c.req.param('number');
  const team = number === '1' ? team1 : team2;
  team.like = !team.like;
  return c.html(teamHtml(number));
});

app.post('/update', async (c: Context) => {
  const formData = await c.req.formData();
  team1.name = formData.get('team1') as string;
  team2.name = formData.get('team2') as string;
  team1.score = Number(formData.get('score1'));
  team2.score = Number(formData.get('score2'));
  return c.text(report());
});

export default app;
```



Resources

- **Web components** MDN page -
https://developer.mozilla.org/en-US/docs/Web/API/Web_components
- **Lit** home page - <https://lit.dev>
- **Shoelace** home page - <https://shoelace.style>
- **Alpine** home page - <https://alpinejs.dev>
- **_hyperscript** home page - <https://hyperscript.org/>
- **htmx** home page - <https://htmx.org>
- **My blog** - <https://mvolkmann.github.io/blog>
- **“Hypermedia Systems” book** - <https://hypermedia.systems/>



Wrap Up

- We have seen many ways to make HTML more expressive
- All of these can be used without a build process ... just open an HTML file in a web browser
- Large frameworks with sizable learning curves are not required to build fully functional, highly interactive web applications

