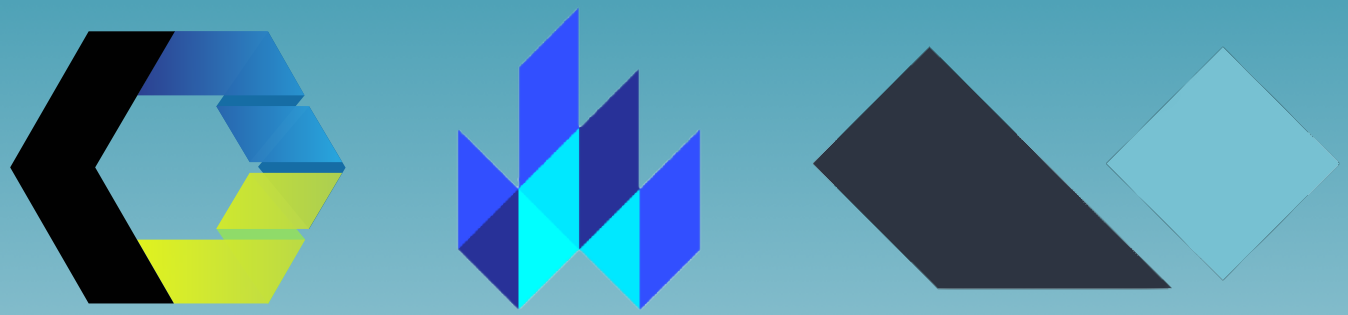

Making HTML More Expressive

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OBJECT COMPUTING
YOUR OUTCOMES ENGINEERED

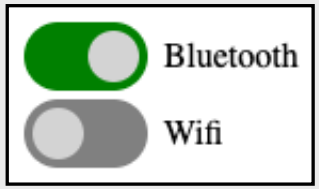
Slides at **https://github.com/mvolkmann/talks/**

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 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

public/index.html

```
<!DOCTYPE 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>
```

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);
});
```

Toggle Switch CSS ...

surrounds entire component

public/toggle-switch.css

```
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);
```

configurable via CSS variables (aka custom properties)

content created by CSS

```
    /* 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);
    }
```

... 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 the 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 the DOM

Vanilla Web Component ...

must extend **`HTMLElement`**

src/toggle-switch-wc.js

```
export class ToggleSwitchWC extends HTMLElement {
  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>
    `;

    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

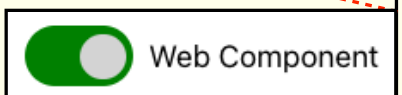
public/index.html

```
<!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




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

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

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

must extend **`LitElement`**

`?checked` and **`$@change`** are specific to Lit

The HTML for 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 vanilla JavaScript with no framework.
- Built with Lit
- Can use from CDN or install from npm
- https://shoelace.style/

Shoelace `sl-switch`

public/index.html

```
<!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>
```

using Alpine for event handling (`@sl-change`)

required to activate Alpine

Alpine

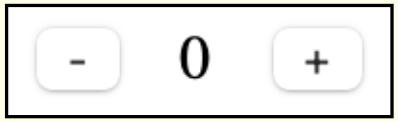
- “Lightweight JavaScript framework that uses **custom HTML attributes** to add dynamic behavior”
- “Offers you the **reactive and declarative** nature of big frameworks like Vue or React at a much lower cost”
- **Small library**
- **No build process**
- Provides a large number of “**directives**” that 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="if (count > 0) count--">-</button>
      <span x-text="count"></span>
      <button @click="if (count < 10) count++">+</button>
    </div>
  </body>
</html>
```

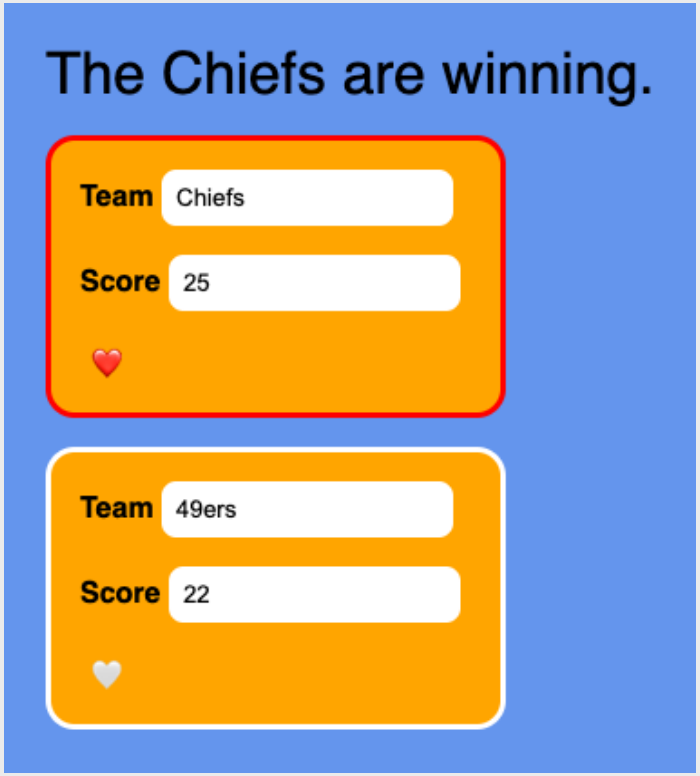


`x-data` is the Key!

- Serves two purposes
  - declares reactive properties
  - activates use of Alpine
- 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

```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

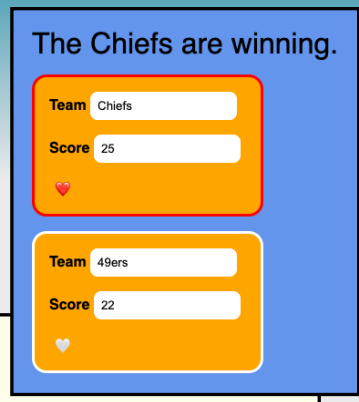
score-keeper.html

```
<html>
  <head>
    <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 = () => ({
        dislikeColor: "white",
        likeColor: "red",
        score1: 0,
        score2: 0,
        team1: "Chiefs",
        team2: "49ers",
        // This is like a computed property.
        report() {
          return this.score1 > this.score2
            ? `The ${this.team1} are winning.`
            : this.score2 > this.score1
            ? `The ${this.team2} are winning.`
            : "The score is tied.";
        },
      });
    </script>
  </head>
```

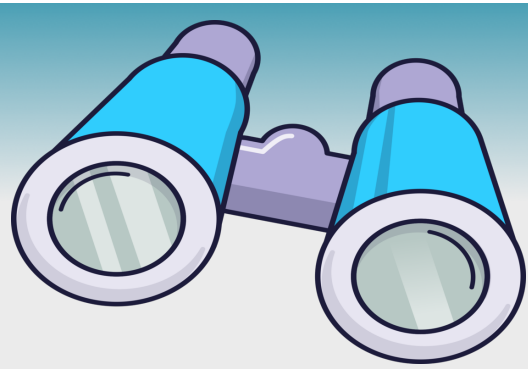
outer **x-data** scope

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: ${like ? likeColor : dislikeColor}`"
        x-data="{like: false}"
      >
        <label>Team <input type="text" x-model="team1" /></label>
        <label>Score <input type="number" x-model="score1" /></label>
        <button @click="like = !like" x-text="like ? '❤️' : '🤍'"></button>
      </section>
      <!-- We could avoid this repetition by creating a web component. -->
      <section
        class="column team"
        :style="`border-color: ${like ? likeColor : dislikeColor}`"
        x-data="{like: false}"
      >
        <label>Team <input type="text" x-model="team2" /></label>
        <label>Score <input type="number" x-model="score2" /></label>
        <button @click="like = !like" x-text="like ? '❤️' : '🤍'"></button>
      </section>
    </main>
  </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 `form` 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

</> htmx

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) without relying on string concatenation

or my npm package js2htmlstr

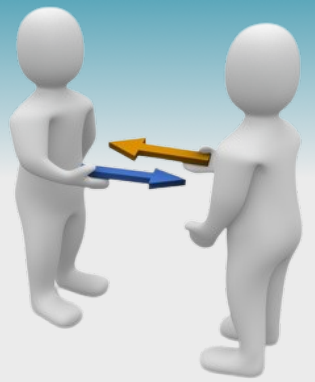
  - **syntax highlighting** of HTML in code editors

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

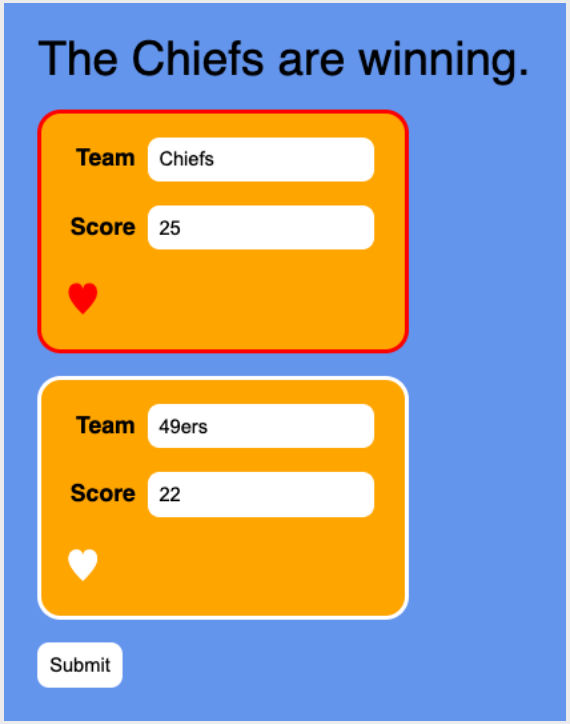
htmx Score Keeper

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

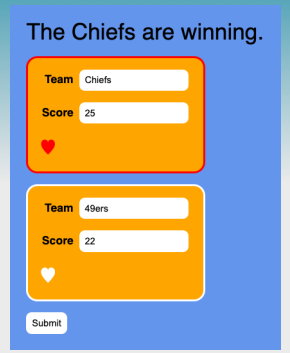
index.html

```
<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>
```

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



htmx Score Keeper - CSS



styles.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

```
#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 ...

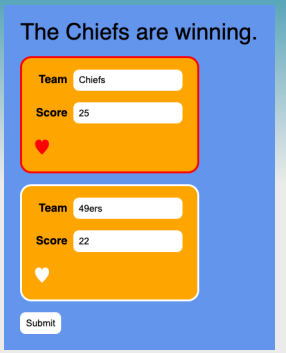
server.tsx

```
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.';
}
```

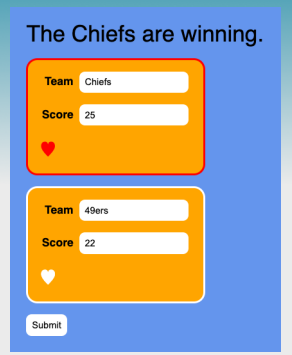
Checkbox is used to hold state, but is not displayed.

```
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>
  );
}
```

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'}));

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/
- **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