WEBCOMPONENTS.ORG Building blocks for the web

Use
The
Platform

Modulares Web

ES6 Module, lit-html, LitElement, Web Components, Komponenten-Marktplätze

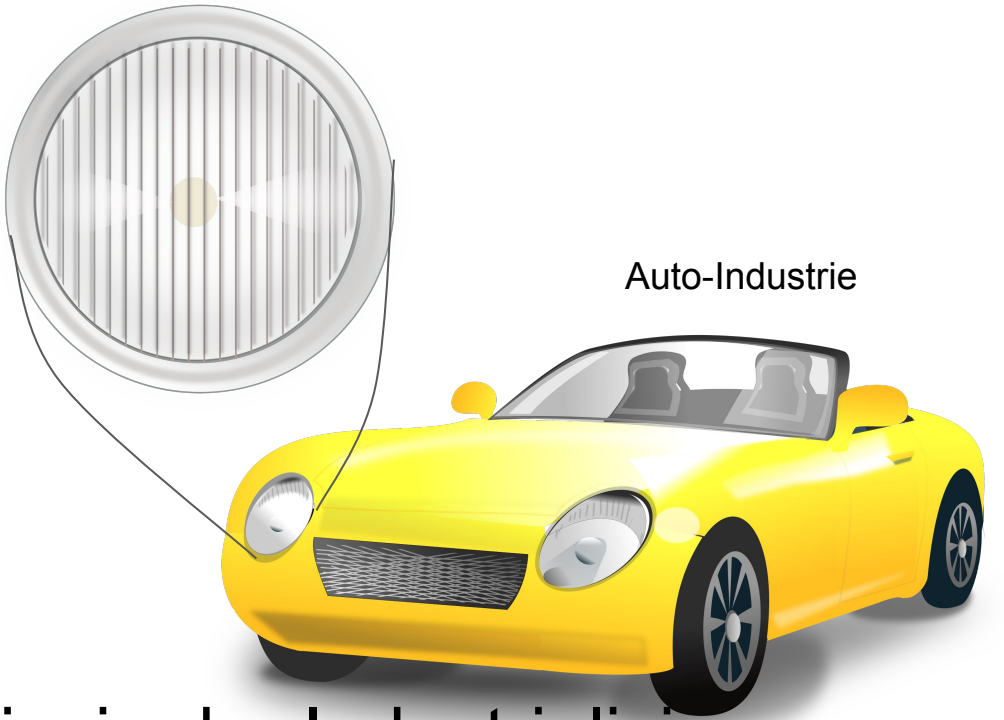
Modulares Web

- Modulares JavaScript ⇒ ES6 module import & export
- Modulares HTML ⇒ Custom Elements
- Modulares CSS ⇒ Shadow DOM

Use
The
Platform

Ausgangsfrage: Warum überhaupt Modularität?

- Professionalisierung
- Arbeitsteilung
  - Taylorismus
  - Spezialisten
- Modul-Industrie
  - Autos aus Modulen



⇒ Modularität als Prinzip der Industrialisierung

Woran erkennt man den Reifegrad einer Industrie?

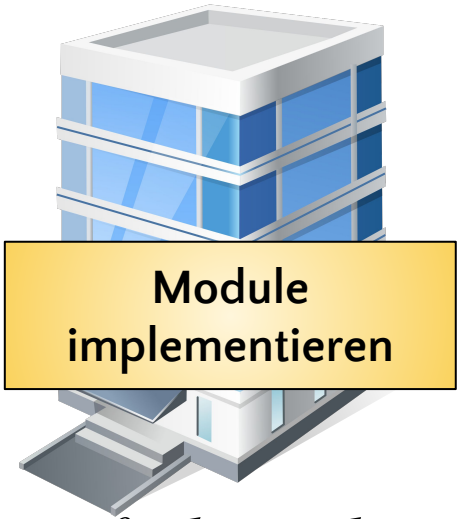
- Das Rad wird nicht mehr neu erfunden.
- Modularisierung
- Arbeitsteilung, Spezialisierung
- Markt
  - Angebot und Nachfrage
  - ⇒ Komplexität

Wie reif ist die Informatik-Industrie?

Arbeitsteilung

"select the right person for the right job"

Entwickler



funktional
objekt-orientiert

Designer

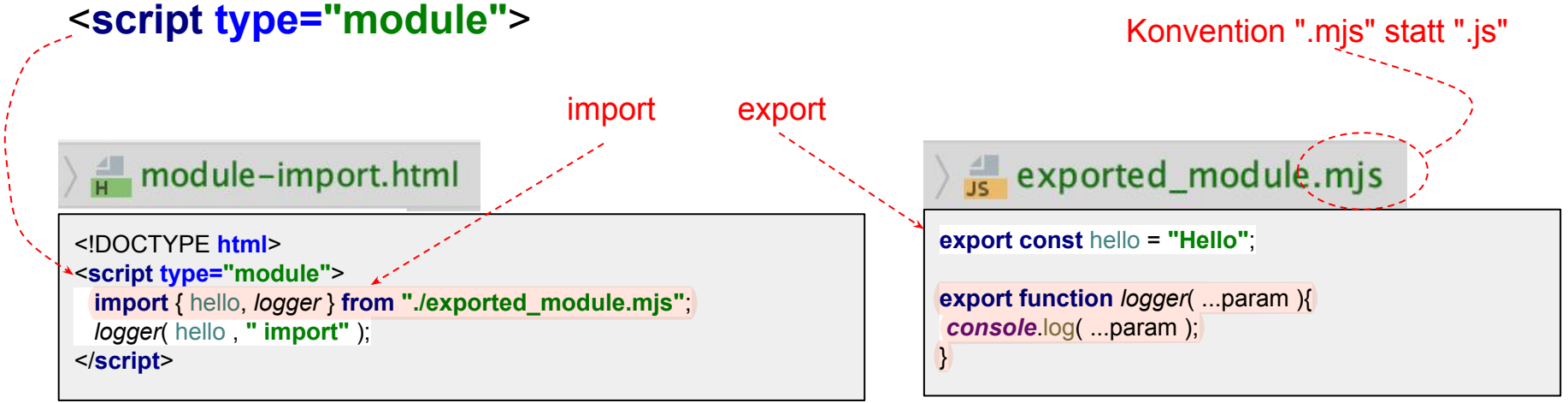
deklarativ
HTML-Spracherweiterung

Frederic W. Taylor (1856-1915)
Quelle: Wikipedia
"select the right person
for the right job"

Gliederung

1. JavaScript-Module (ES6 module)
2. Web-Komponenten
3. lit-html
4. LitElement
5. Marktplätze für Komponenten

ES6 Modules



https://jakearchibald.com/2017/es-modules-in-browsers/
https://v8.dev/features/modules
https://developer.mozilla.org/en-US/docs/Web/JavaScript/Reference/Statements/import

ES 6 Import Syntax

```
import defaultExport from "module-name";
import * as name from "module-name";
import { export1 } from "module-name";
import { export1 as alias1 } from "module-name";
import { export1 , export2 } from "module-name";
import { foo , bar } from "module-name/path/to/specific/un-exported/file";
import { export1 , export2 as alias2 , [...] } from "module-name";
import defaultExport, { export1 [ , [...] ] } from "module-name";
import defaultExport, * as name from "module-name";
import "module-name";
var promise = import("module-name");
```

https://developer.mozilla.org/en-US/docs/Web/JavaScript/Reference/Statements/import

ES6 import: default

You could also export a *default* value from a module:

```
// 🗏 lib.mjs
export default function(string) {
  return `${string.toUpperCase()}!`;
}
```

Such `default` exports can be imported using any name:

```
// 🗏 main.mjs
import shout from './lib.mjs';
//     ^^^^^
```


https://developers.google.com/web/fundamentals/primers/modules

ES6 import

- ES6 modules are stored in files
- one module per file
- one file per module
- rekursives Laden
  - Module dürfen auch selbst wieder andere Module importieren
- nur einmal laden
- zirkuläre imports führen *nicht* zu Endlosschleifen

```
<!doctype html>
<script type="module">
 import defaultExport from "module-name";
 import * as name from "module-name";
 import { export1 } from "module-name";
 import { export1 as alias1 } from "module-name";
 import { export1 , export2 } from "module-name";
 import { foo , bar } from "module-name/path/to/specific/file";
 import { export1 , export2 as alias2 , [...] } from "module-name";
 import defaultExport, { export1 [ , [...] ] } from "module-name";
 import defaultExport, * as name from "module-name";
 import "module-name";
 const promise = import("module-name");
</script>
```

https://developer.mozilla.org/de/docs/Web/JavaScript/Reference/Statements/import

Some restrictions apply to module specifiers in browsers. So-called “bare” module specifiers are currently not supported. This restriction is specified so that in the future, browsers can allow custom module loaders to give special meaning to bare module specifiers like the following:

```
// Not supported (yet):
import {shout} from 'jquery';
import {shout} from 'lib.mjs';
import {shout} from 'modules/lib.mjs';
```

On the other hand, the following examples are all supported:

```
// Supported:
import {shout} from './lib.mjs';
import {shout} from '../lib.mjs';
import {shout} from '/modules/lib.mjs';
import {shout} from 'https://simple.example/modules/lib.mjs';
```

For now, module specifiers must be full URLs, or relative URLs starting with `/`, `./`, or `../`.

https://v8.dev/features/modules

Unterschiede <script> und <script type="module">

- Modules have strict mode enabled by default.
  - "use strict"; ⇒ https://www.w3schools.com/js/js_strict.asp
  - https://developer.mozilla.org/de/docs/Web/JavaScript/Reference/Strict_mode

- Modules have a **lexical top-level scope**. This means that for example, running `var foo = 42;` within a module does *not* create a global variable named `foo`, accessible through `window.foo` in a browser, although that would be the case in a classic script.

- The new static `import` and `export` syntax is only available within modules — it doesn't work in classic scripts.

- Because of these differences, **the same JavaScript code might behave differently when treated as a module vs. a classic script**. As such, the JavaScript runtime needs to know which scripts are modules.

https://developers.google.com/web/fundamentals/primers/modules

Vergleich <script> und ES6 module

	Scripts	Modules
HTML element	`<script>`	`<script type="module">`
Default mode	non-strict	strict
Top-level variables are	global	local to module
Value of `this` at top level	`window`	`undefined`
Executed	synchronously	asynchronously
Declarative imports (`import` statement)	no	yes
Programmatic imports (Promise-based API)	yes	yes
File extension	`.js`	`.js`

.mjs vorgeschlagen

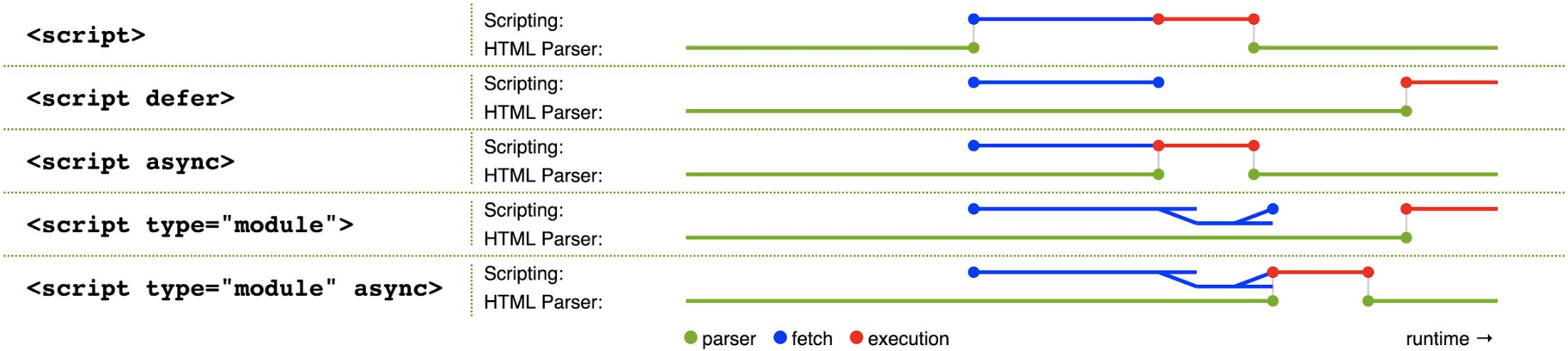
http://exploringjs.com/es6/ch_modules.html#sec_overview-modules

<script type="module" async defer>

to defer
aufschieben; verschieben; verzögern; zurückstellen *{vt}*

Modules are deferred by default

Classic `<script>`s **block** the HTML parser by default. You can work around it by adding the `defer` attribute, which ensures that the script download happens **in parallel** with HTML parsing.



Modules are deferred by default

https://v8.dev/features/modules

Dynamic import()

The `import` keyword may be called as a function to dynamically import a module. When used this way, it returns a promise.

```
1  import('/modules/my-module.js')
2    .then((module) => {
3      // Do something with the module.
4    });
```

This form also supports the await keyword.

```
1  let module = await import('/modules/my-module.js');
```

https://developer.mozilla.org/en-US/docs/Web/JavaScript/Reference/Statements/import

https://developers.google.com/web/updates/2017/11/dynamic-import

Gliederung

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Vier W3C-Standards für Web-Komponenten

1. ES6 import
2. Custom Element
3. Shadow DOM
4. Template Element

Web Components Standards History v0 and v1

Wenn Sie Beispiele im Web finden, achten Sie zuerst darauf, ob v0 oder v1:

Unterschiede siehe:
https://hayato.io/2016/shadowdomv1/

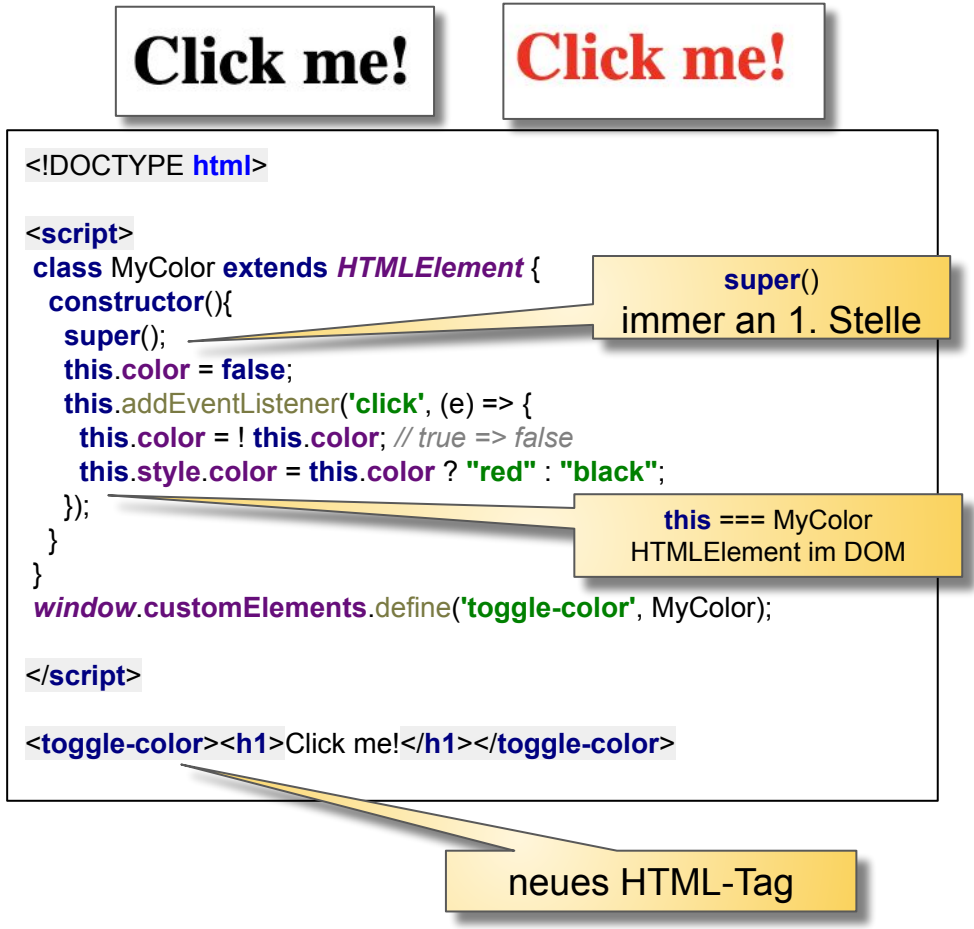
	v0	v1
seit Datum	**seit 2014-07-15**	**seit 2016-10-19**
Chrome Version	**ab Chrome 36+**	**ab Chrome 54+**
Custom Elements API	**document.registerElement()**	**customElements.define()**
JavaScript	**ES5**	**ES6**

https://developers.google.com/web/fundamentals/getting-started/primers/customelements#historysupport

https://en.wikipedia.org/wiki/Google_Chrome_version_history

Custom Elements v1

- HTML-Spracherweiterung: eigene Tags definieren
- <my-tag></my-tag>
  - immer mit Bindestrich
  - immer mit schließendem Tag
    - keine *self-closing tags*
  - jeden <Tag> nur einmal definieren (sonst `DOMException`)
- Browser-Weiche
  - 'customElements' in window ⇒ v1
  - 'registerElement' in document ⇒ v0
  - sonst Polyfills
    - https://github.com/webcomponents/custom-elements



https://developers.google.com/web/fundamentals/web-components/customelements

WHATWG

Spec. § 4.13.2 Requirements for custom element constructors:

When authoring custom element constructors, authors are bound by the following conformance requirements:

- A parameter-less call to `super()` must be the **first statement in the constructor body**, to establish the correct prototype chain and *this* value before any further code is run.
- A return statement must not appear anywhere inside the constructor body, unless it is a simple early-return (return or return this).
- The constructor must not use the `document.write()` or `document.open()` methods.
- **The element's attributes and children must not be inspected, as in the non-upgrade case none will be present, and relying on upgrades makes the element less usable.**
- **The element must not gain any attributes or children, as this violates the expectations of consumers who use the `createElement` or `createElementNS` methods.**
- In general, work should be deferred to `connectedCallback` as much as possible—especially work involving fetching resources or rendering. However, note that `connectedCallback` can be called more than once, so any initialization work that is truly one-time will need a guard to prevent it from running twice.
- In general, the constructor should be used to **set up initial state and default values**, and to set up event listeners and possibly a shadow root.

Several of these requirements are checked during element creation, either directly or indirectly, and failing to follow them will result in a custom element that cannot be instantiated by the parser or DOM APIs. This is true even if the work is done inside a constructor-initiated microtask, as a microtask checkpoint can occur immediately after construction.

https://html.spec.whatwg.org/multipage/custom-elements.html#custom-element-conformance

Custom Elements dürfen am Anfang keine Kinder haben

- Fehler durch `this.innerHTML = "Hello World";`
- "The element must not gain any attributes or children, as this violates the expectations of consumers who use the createElement or createElementNS methods."

"Requirements for custom element constructors" section of the spec

```
<script>

 class MyElement extends HTMLElement {
   constructor() {
     super();
     this.innerHTML = "Hello World";
   }
 }
 window.customElements.define('my-tag', MyElement);

</script>

<my-tag></my-tag>
```

DOMException: Failed to execute 'createElement' on 'Document': The result must not have children

https://html.spec.whatwg.org/multipage/scripting.html#custom-element-conformance

http://stackoverflow.com/questions/40181683/failed-to-execute-createelement-on-document-the-result-must-not-have-childr

Custom Elements dürfen keine Attribute im Konstruktor benutzen

- Fehler durch `this.className = "class1"`
- "The element must not gain any attributes or children, as this violates the expectations of consumers who use the createElement or createElementNS methods."

"Requirements for custom element constructors" section of the spec

```
<!doctype html>
<h1>SquareLetter</h1>
<script>
 class SquareLetter extends HTMLElement {
   constructor() {
     super();
     this.className = "class1"
   }
 }
 customElements.define("square-letter", SquareLetter);
</script>

<square-letter></square-letter>
```

Uncaught DOMException: Failed to construct 'CustomElement': The result **must not have attributes**

https://stackoverflow.com/questions/43836886/failed-to-construct-customelement-error-when-javascript-file-is-placed-in-head

Lösung: Kinder in connectedCallback() hinzufügen

- In general, work should be deferred to **connectedCallback** as much as possible—especially work involving fetching resources or rendering. However, note that **connectedCallback** can be called *more than once*, so any initialization work that is truly one-time will need a guard to prevent it from running twice.
- That is, add children in the connected callback.

  "Requirements for custom element constructors" section of the spec

```
<script>
 class MyElement extends HTMLElement {
   connectedCallback() {
    this.innerHTML = "<h1>Hello World</h1>";
    this.className = "class1";
   }
 }
 window.customElements.define('my-tag', MyElement);

</script>

<my-tag></my-tag>
```

http://stackoverflow.com/questions/40181683/failed-to-execute-createelement-on-document-the-result-must-not-have-childr

Aufgabe Counter

- soll anzeigen, wie oft geklickt wurde
- hat eine Zahl als Kind-Element
- soll universell einsetzbar sein

```
<!DOCTYPE html>

<script>
 customElements.define( 'simple-counter',
                                class extends HTMLElement {
  constructor(){
    super();
    this.counter = 0;
    this.addEventListener( 'click',
                                () => this.textContent = ++this.counter );
  }
  connectedCallback(){
    this.textContent = this.counter;
  }
 } );
</script>

<simple-counter></simple-counter>
```

super() an 1. Stelle

neues HTML-Tag

https://developers.google.com/web/fundamentals/web-components/customelements

Spec §4.13.6 Important Custom element reactions

Name	Called when
`constructor()`	An instance of the element is created or upgraded. Useful for initializing state, setting up event listeners, or creating a shadow dom. See the spec for restrictions on what you can do in the `constructor`.
`connectedCallback()`	Called every time the element is inserted into the DOM. Useful for running setup code, such as fetching resources or rendering. Generally, you should try to delay work until this time.
`disconnectedCallback()`	Called every time the element is removed from the DOM. Useful for running clean up code.
`attributeChangedCallback(attrName, oldVal, newVal)`	Called when an observed attribute has been added, removed, updated, or replaced. Also called for initial values when an element is created by the parser, or upgraded. Note: only attributes listed in the `observedAttributes` property will receive this callback.

https://developers.google.com/web/fundamentals/web-components/customelements

observedAttributes
attributeChangedCallback(attr, oldVal, newVal)

- Attribute in HTML
- Properties in JS
- **static** *observedAttributes* ist die Liste aller Attribute, die beobachtet werden sollen

init

Kinder

Attribute

```
<script>
 customElements.define( 'simple-counter',
  class extends HTMLElement {
    static get observedAttributes(){ return ['start'] };
    constructor(){
      super();
      this.counter = 0; // init property
      this.addEventListener( 'click',
        () => this.textContent = ++this.counter );
    }
    connectedCallback(){
      this.textContent = this.counter;
    }
    attributeChangedCallback( attr, oldVal, newVal ){
      if ( oldVal !== newVal ) {
        this.textContent = newVal; // Kinder-Inhalte ändern
        this.counter = parseInt( newVal ); // Properties ändern
      }
    }
  } );
</script>

<simple-counter start="100"></simple-counter>
```

nur bei Prop. 'start' wird attributeChangedCallback aufgerufen

https://developers.google.com/web/fundamentals/web-components/customelements

Update Kinderelemente, Attribute & Properties separat

```
<script>
 class MyColorCounter extends HTMLElement {
   static get observedAttributes(){ return ['start'] };
   constructor(){
     super();
     this.counter = 0;
     this.color = false;
     this.addEventListener('click', () => {
       this.color = ! this.color; // true => false
       this.style.color = this.color ? "red" : "black";
       this.counter += 1;
       this.counterElement.textContent = this.counter;
     });
   } connectedCallback(){...} attributeChangedCallback(){...}
 }
 window.customElements.define('toggle-color', MyColorCounter);

</script>

<toggle-color start="10"><h1>Click me!</h1></toggle-color>
```

```
connectedCallback(){
  this.counter = parseInt( this.getAttribute('start') );
  this.innerHTML += `<h1>Anzahl Klicks:
    <span id="counter">${this.counter}</span></h1>`;
  this.counterElement = this.querySelector('#counter');
}
attributeChangedCallback( attr, oldVal, newVal ){
  if (oldVal !== newVal) {
    this.counter = parseInt( newVal );
    if ( this.counterElement ) this.counterElement.textContent = this.counter;
  }
}
```

Property

Inhalt Kinderelement

https://developers.google.com/web/fundamentals/web-components/customelements

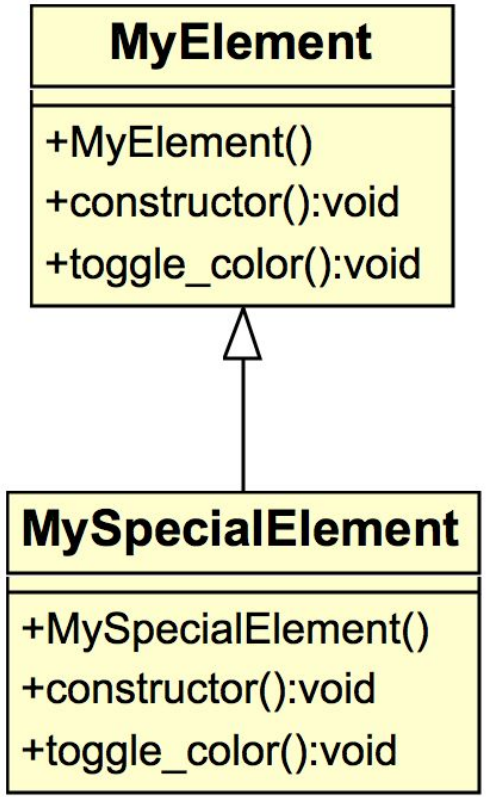
4.13.6 All Custom element reactions

- When upgraded, its constructor is run, with no arguments.
- When it becomes connected, its `connectedCallback` is called, with no arguments.
- When it becomes disconnected, its `disconnectedCallback` is called, with no arguments.
- When it is adopted into a new document, its `adoptedCallback` is called, given the old document and new document as arguments.
- When any of its attributes are changed, appended, removed, or replaced, its `attributeChangedCallback` is called, given the attribute's local name, old value, new value, and namespace as arguments. (An attribute's old or new value is considered to be null when the attribute is added or removed, respectively.)
- When the user agent resets the form owner of a form-associated custom element and doing so changes the form owner, its `formAssociatedCallback` is called, given the new form owner (or null if no owner) as an argument.
- When the form owner of a form-associated custom element is reset, its `formResetCallback` is called.
- When the disabled state of a form-associated custom element is changed, its `formDisabledCallback` is called, given the new state as an argument.
- When user agent updates a form-associated custom element's value on behalf of a user, its `formStateRestoreCallback` is called, given the new value and a string indicating a reason, "`restore`" or "`autocomplete`", as arguments.

https://html.spec.whatwg.org/multipage/custom-elements.html#custom-element-reactions

Wie kann man Komponenten anpassen?
Implementation Inheritance for Customizing

```
class MySpecialElement extends MyElement {
 constructor() {
   super();
 }
 toggle_color() {
   this.color = ! this.color; // true => false
   this.style.color = this.color ? "yellow" : "green";
 }
}

customElements.define('my-tag', MySpecialElement);
```



Einfache Anpassbarkeit: Das Verhalten nur dort abändern, wo es nötig ist.

Shadow DOM introduces **scoped styles** to the web platform

```
<script>
customElements.define('my-shadowdom', class extends HTMLElement {
  constructor() {
    super();
    // Attach a shadow root to the element.
    let shadowRoot = this.attachShadow({mode: 'open'});
    shadowRoot.innerHTML = `
      <style>
        p {
          color: red;
          border: thin solid;
          margin: 0.2rem;
        }
      </style>
      <p><b>Text inside Shadow DOM</b></p>
    `;
  }
});
</script>
```

```
<style>
  p {
    background-color: lightgreen;
    border: thin solid;
    margin: 0.2rem;
  }
</style>
  <p>Text outside of custom element</p>
  <my-shadowdom>
    <p>Text inside of custom element (in Light DOM)</p>
  </my-shadowdom>
  <p>Text outside of custom element</p>
```

Text outside of custom element

Text inside Shadow DOM

Text outside of custom element

https://developers.google.com/web/fundamentals/web-components/shadowdom

Open and Closed Shadow Root

- ⇒ Scopes for Custom Elements
- {mode: 'open'}
  - von außen Zugriff erlaubt
- {mode: 'closed'}
  - shadowRoot will return null

```
<!DOCTYPE html>
<html>
  <head></head>
▼<body> == $0
    <h1>Custom Element with Shadow DOM</h1>
  ▶<script>…</script>
  ▼<hello-world>
    ▼#shadow-root (open)
        <style>h1 { color: red; }</style>
        <h1>Hello World!</h1>
    </hello-world>
  </body>
</html>
```

```
// Use custom elements API v1 to register a new HTML tag and define its JS behavior
// using an ES6 class. Every instance of <hello-world> will have this same prototype.

<!doctype html>
<h1>Custom Element with Shadow DOM</h1>
<script>
customElements.define('hello-world', class extends HTMLElement {
  constructor() {
    super();
    // Attach a shadow root to <hello-world>.
    const shadowRoot = this.attachShadow({mode: 'open'});
    shadowRoot.innerHTML = `
    <style>h1 { color: red; }</style>
     <h1>Hello World!</h1>
     `; // style is scoped to hello-world
 }
});
</script>

<hello-world></hello-world>
```

Anonymous ES6 class

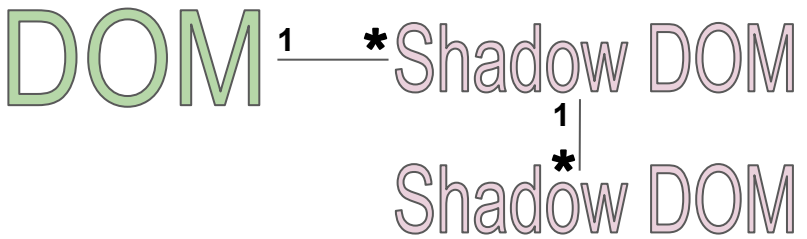
Backtick for ES6 template string

Custom Element with Shadow DOM

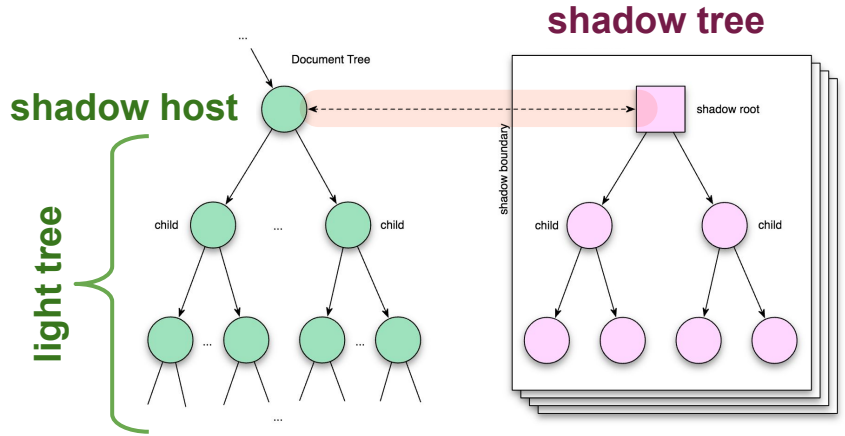
Hello World!

https://developers.google.com/web/fundamentals/getting-started/primers/shadowdom

Shadow Tree - Definitions



- A shadow tree is a node tree whose root is a shadow root.
- A shadow root is always attached to another node tree through its shadow host. A shadow tree is therefore never alone. The node tree of a shadow root's host is sometimes referred to as the light tree.
- A shadow tree's corresponding light tree can be a shadow tree itself.
- An element is **connected** if its shadow-including root is a document.



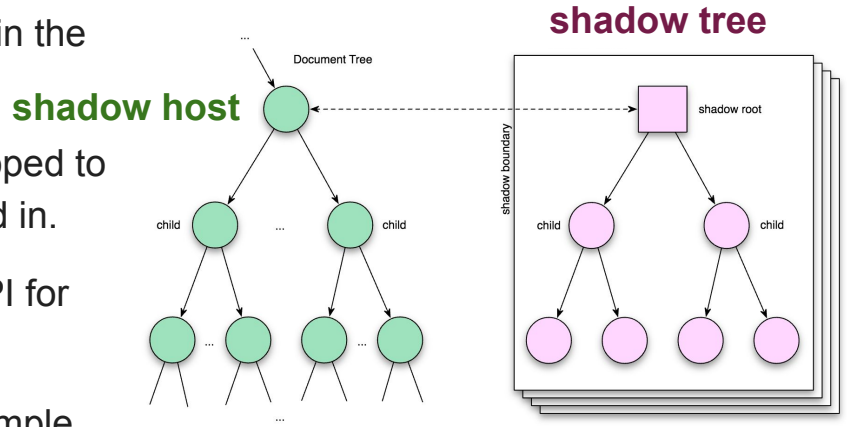
https://www.w3.org/TR/2013/WD-components-intro-20130606/#shadow-dom-section

http://w3c.github.io/webcomponents/spec/shadow/

Haupt-DOM

Vorteile des Shadow DOM

- **Isolated DOM**: A component's DOM is self-contained (e.g. `document.querySelector()` won't return nodes in the component's shadow DOM).
- **Scoped CSS**: CSS defined inside shadow DOM is scoped to it. Style rules don't leak out and page styles don't bleed in.
- **Composition**: Design a declarative, markup-based API for your component.
- **Simplifies CSS** - Scoped DOM means you can use simple CSS selectors, more generic id/class names, and not worry about naming conflicts.
- **Productivity** - Think of apps in chunks of DOM rather than one large (global) page.



https://www.w3.org/TR/2013/WD-components-intro-20130606/#shadow-dom-section

https://developers.google.com/web/fundamentals/getting-started/primers/shadowdom

Slots als Platzhalter, wo der Light DOM in den Shadow DOM kommt

```
<script>
 customElements.define('my-shadowdom', class extends HTMLElement {
  constructor() {
    super();
    // Attach a shadow root to the element.
    let shadowRoot = this.attachShadow({mode: 'open'});
    shadowRoot.innerHTML = `
       <style>
         p {
            color: red;
            border: thin solid;
            padding: 0.2rem;
            margin: 0.2rem;
         }
       </style>
       <p><b>Text inside Shadow DOM</b></p>
       <p><slot></slot></p>
    `;
  }
 });
</script>
```

Text outside of custom element

Text inside Shadow DOM

Text inside of custom element (in Light DOM)

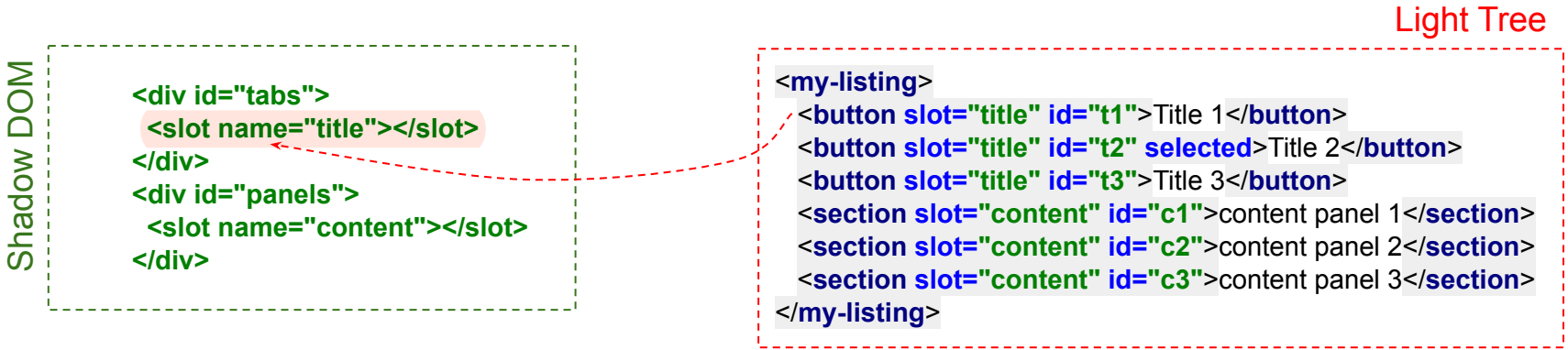
Text outside of custom element

```
<style>
  p {
     background-color: lightgreen;
     border: thin solid;
     margin: 0.2rem;
     padding: 0.2rem;
  }
</style>
  <p>Text outside of custom element</p>
  <my-shadowdom>
     <p>Text inside of custom element (in Light DOM)</p>
  </my-shadowdom>
  <p>Text outside of custom element</p>
```

https://developers.google.com/web/fundamentals/web-components/shadowdom

Named Slots als Platzhalter im Shadow DOM

The **HTML `<slot>` element**—part of the Web Components technology suite—is a placeholder inside a web component that you can fill with your own markup, which lets you create separate DOM trees and present them together.



https://developer.mozilla.org/en-US/docs/Web/HTML/Element/slot

Named Slots for Shadow DOM Composition

Deklarativ in HTML statt imperativ in JavaScript

Definition

```
<script>
 customElements.define('my-listing', class extends HTMLElement {
  constructor() {
    super(); // always call super() first in the ctor.
    const shadowRoot = this.attachShadow({mode: 'open'});
    shadowRoot.innerHTML = `
      <style>#panels { border-style: solid;}</style>
      <div id="tabs">
       <slot name="title"></slot>
      </div>
      <div id="panels">
       <slot name="content"></slot>
      </div>
    `;
    this.addEventListener('click', e => {
      console.log( e.target.id );
    });
 }
});
</script>
```

Shadow DOM

Shadow DOM with slots

Title 1 | Title 2 | Title 3

content panel 1
content panel 2
content panel 3

Anwendung — Light Tree

```
<my-listing>
   <button slot="title" id="t1">Title 1</button>
   <button slot="title" id="t2" selected>Title 2</button>
   <button slot="title" id="t3">Title 3</button>
   <section slot="content" id="c1">content panel 1</section>
   <section slot="content" id="c2">content panel 2</section>
   <section slot="content" id="c3">content panel 3</section>
</my-listing>
```

Im Light Tree werden die slot-Werte spezifiziert, die in die slot-Platzhalter im Shadow Tree eingefügt werden.

`<slot>` ohne name für den Rest

https://developers.google.com/web/fundamentals/getting-started/primers/shadowdom

Wie kann man das Web-Komponenten-Layout parametrisieren?

CSS Custom Properties

- Deklaration mit --name
- Benutzung mit var(--name)
- Kaskade mit var(x,y,z)
  - erst x, dann y, dann z

kein Teil des Web Components - Standards, aber gute Ergänzung

ohne Web-Komponenten

```
:root {
  --main-color: #06c;
}

h1 {
  color: var(--main-color);
  background-color: var(--main-color, blue);
}
```

mit Web-Komponenten

```
/* Outside Web Component */
fancy-tabs {
 margin-bottom: 32px;
 --background-color: black;
}
```

Parameter setzen

```
// Inside Web Component
// Create shadow DOM for the component.
let shadowRoot = this.attachShadow({mode: 'open'});
shadowRoot.innerHTML = `
 <style>
   :host {
     background: var(--background-color, #9E9E9E);
   }
</style>
```

Parameter definieren

https://developer.mozilla.org/en-US/docs/Web/CSS/--*
https://www.w3.org/TR/css-variables/
https://developers.google.com/web/updates/2016/02/css-variables-why-should-you-care

Das HTML <template> - Element

- **<template>** ist ein zusätzliches HTML-Tag, das zum W3C Web Components Standard gehört.
- Mit dem Template-Element kann man HTML-Dokument-Fragmente deklarieren und vorbereiten, die beim Laden noch ***nicht*** gerendert werden.
- Sie werden geklont und in den DOM per Skript eingefügt. Erst dann werden sie "live" geschaltet.
- Vorteile:
  - DRY ⇒ Wiederverwendung
  - Performanz

```
<!doctype html>
<h1>W3C HTML Template</h1>
<div id="main"></div>
<template id="template">
  <div>Hello from <span
class="name">Template</span>
  </div>
</template>

<script>
 var host = document.querySelector('#main');
 var template = document.querySelector('#template');
 host.appendChild(template.content.cloneNode(true));
 host.appendChild(template.content.cloneNode(true));
 host.appendChild(template.content.cloneNode(true));
</script>
```

deep copy

https://www.webcomponents.org/specs#the-html-template-specification

https://www.w3.org/TR/html5/scripting-1.html#the-template-element

HTML Templates are Document Fragments

DOM

```
<html>
  <head></head>
▼<body>
    <h1>W3C HTML Template</h1>
  ▶<div id="main">…</div>
  ▼<template id="template">
    ▼#document-fragment
      ▼<div>
          "Hello from "
          <span class="name">Template</span>
        </div>
    </template>
  ▶<script>…</script>
  </body>
</html>
```

HTML

```
<!doctype html>
<h1>W3C HTML Template</h1>
<div id="main"></div>
<template id="template">
  <div>Hello from <span
class="name">Template</span>
  </div>
</template>

<script>
 var host = document.querySelector('#main');
 var template = document.querySelector('#template');
 host.appendChild(template.content.cloneNode(true));
 host.appendChild(template.content.cloneNode(true));
 host.appendChild(template.content.cloneNode(true));
</script>
```

https://www.webcomponents.org/specs#the-html-template-specification

https://www.w3.org/TR/html5/scripting-1.html#the-template-element

HTML Template Praxisbeispiel

Tabellenzeile als Template

für große Tabellen Performanzgewinne

Vertiefung:

https://www.html5rocks.com/en/tutorials/webcomponents/template/

```
<script>
 var data = [
   { name: 'Pillar', color: 'Ticked Tabby', sex: 'Female (neutered)', legs: 3 },
   { name: 'Hedral', color: 'Tuxedo', sex: 'Male (neutered)', legs: 4 },
 ];
</script>
<table>
   <template id="row">
      <tr><td><td><td><td>
   </template>
</table>
<script>
 var template = document.querySelector('#row');
 for (var i = 0; i < data.length; i += 1) {
   var cat = data[i];
   var clone = template.content.cloneNode(true);
   var cells = clone.querySelectorAll('td');
   cells[0].textContent = cat.name;
   cells[1].textContent = cat.color;
   cells[2].textContent = cat.sex;
   cells[3].textContent = cat.legs;
   template.parentNode.appendChild(clone);
 }
</script>
```

https://www.webcomponents.org/specs#the-html-template-specification

https://www.w3.org/TR/html5/scripting-1.html#the-template-element

Kombination W3C Template & Shadow DOM

```
<!DOCTYPE html>
<html> == $0
  <head></head>
 ▼<body>
    <h1>Template & Shadow</h1>
   ▼<div id="shadowHost">
     ▼#shadow-root (open)
        <style>*{ color: red; }</style>
       ▶<div>…</div>
    </div>
   ▼<template id="tmpl">
      #document-fragment
    </template>
   ▶<script>…</script>
  </body>
</html>
```

```
<!doctype html>
<h1>Template &amp;amp; Shadow</h1>
<div id="shadowHost"></div>
<template id="tmpl">
  <style>*{ color: red; }</style>
  <div>Hello from <span class="name">Shadow DOM</span></div>
</template>

<script>
 var shadowHost = document.querySelector('#shadowHost');
 var shadowRoot = shadowHost.createShadowRoot();
 shadowRoot.appendChild(document.querySelector('#tmpl').content);
</script>
```

https://www.youtube.com/watch?v=SDs4xmMcVS4

https://jsfiddle.net/jspatel/bducoqja/

Kombination Template & Slots

Deklaration der Slots im Template:

```
<template id="element-details-template">
  <style>
  details {font-family: "Open Sans Light",Helvetica,Arial}
  .name {font-weight: bold; color: #217ac0; font-size: 120%}
  h4 { margin: 10px 0 -8px 0; }
  h4 span { background: #217ac0; padding: 2px 6px 2px 6px }
  h4 span { border: 1px solid #cee9f9; border-radius: 4px }
  h4 span { color: white }
  .attributes { margin-left: 22px; font-size: 90% }
  .attributes p { margin-left: 16px; font-style: italic }
  </style>
  <details>
    <summary>
      <span>
        <code class="name">&lt;<slot name="element-name">NEED NAME</slot>&gt;</code>
        <i class="desc"><slot name="description">NEED DESCRIPTION</slot></i>
      </span>
    </summary>
    <div class="attributes">
      <h4><span>Attributes</span></h4>
      <slot name="attributes"><p>None</p></slot>
    </div>
  </details>
  <hr>
</template>
```

Nutzung der Slots:

```
<element-details>
  <span slot="element-name">slot</span>
  <span slot="description">A placeholder inside a web
    component that users can fill with their own markup,
    with the effect of composing different DOM trees
    together.</span>
  <dl slot="attributes">
    <dt>name</dt>
    <dd>The name of the slot.</dd>
  </dl>
</element-details>

<element-details>
  <span slot="element-name">template</span>
  <span slot="description">A mechanism for holding client-
    side content that is not to be rendered when a page is
    loaded but may subsequently be instantiated during
    runtime using JavaScript.</span>
</element-details>
```

https://developer.mozilla.org/en-US/docs/Web/HTML/Element/slot

HTML oder JavaScript?
Deklarativ oder Imperativ?

- Imperativ geht immer: in JavaScript kann man alles programmieren
- aber vieles geht auch deklarativ ⇒ HTML, Templates
- Allgemeines Ziel: Benutzung so deklarativ wie möglich
  & Komplexität der Implementierung möglichst verbergen
- möglichst weitreichende Kombinationsmöglichkeiten erlauben
- ⇒ Zielkonflikt: Je weitreichender, desto mehr geht es wieder in Richtung Programmierung
  - Beispiel: BPML erfindet Programmierung auf höherer Ebene neu

Parametrisierungsmöglichkeiten für Web-Komponenten

- HTML-Attribute <custom-element name="xyz" class="a" id="b" width="123">
  - Custom-Attribute: Im Shadow-DOM: `this.getAttribute('name')`
  - Standard-Attribute this.class, this.id und this.width
- Properties und Setter des CustomElement-Objektes
  - `element.property = { key: value, array: [ a, b, c ] }`
- Slots
  - benannt `<slot name="aaa">`
  - unbenannt <slot>
- EventHandler + CustomEvents für Parametrisierung und Kom. nutzen
- CSS Custom Properties als Parameter nutzen
- Light DOM als Parameter nutzen
  - Im Shadow-DOM: this.innerHTML => Komponente kann eigenen Interpreter besitzen
- Globale Funktionen, Werte, Objekte, …
  - myFunction als offizielle Schnittstelle einer Komponente
  - Aufruf: if (window.myFunction) myFunction(x);

software-technisch unschön

Gliederung

1. JavaScript-Module (ES6 module)
2. Web-Komponenten
3. lit-html
4. LitElement
5. Marktplätze für Komponenten

ES6 Template Strings with Backticks `...`

```
// Basic literal string creation with ES6 Backtick strings
const s = `In JavaScript '\n' is a line-feed.`

// Multiline ES6 Backtick strings
const t =  `In JavaScript this is
 not legal.`

// ES6 Backtick string interpolation
const name = "Bob", time = "today";
console.log( `Hello ${name}, how are you ${time}?` );

// even with expressions to be evaluated
console.log( `The time is ${new Date().toLocaleTimeString()}.` );
```

https://developer.mozilla.org/de/docs/Web/JavaScript/Reference/template_strings

ES6 Tagged Template Strings with Backticks

```
<script>
  const person = { name: 'Mike', age: 28 };

  console.log( myTag`The person ${person} is a ${person}.` );
               // The person Mike is a youngster.

  function myTag( strings, person ){
    console.log( strings );  // ["The person ", " is a ", "."]
    return strings.slice(0,-1)  // Kopie bis zum vorletzten Element
        .join( person.name ) +  // Array nach String
         ( person.age > 30 ? 'oldie' : 'youngster' ) +
          strings.slice(-1);  // letztes String-Fragment
  }
</script>
```

https://developer.mozilla.org/de/docs/Web/JavaScript/Reference/template_strings

3kB Templating Library "lit-html"

CDN

Transformation von CommonJS **require** nach ES6 **import**

```
// inside <script type="module">
import {html, render} from 'https://unpkg.com/lit-html?module';

// This is a lit-html template function. It returns a lit-html template.
const helloTemplate = (name) => html`<div>Hello ${name}!</div>`;

// Call the function with some data, and pass the result to render()

// This renders <div>Hello Steve!</div> to the document body
render(helloTemplate('Steve'), document.body);

// This updates to <div>Hello Kevin!</div>, but only updates the ${name} part
render(helloTemplate('Kevin'), document.body);
```

http://exploringjs.com/impatient-js/ch_template-literals.html

https://lit-html.polymer-project.org/

https://github.com/Polymer/lit-html

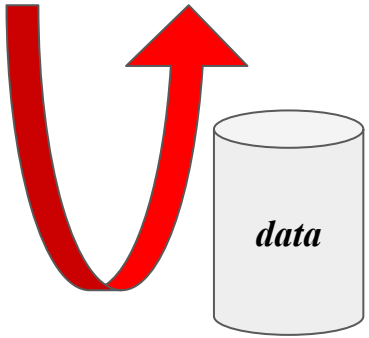
lit-html

```
let ui = (data) => html`...${data}...`;
```

Funktionales Paradigma

$$UI = f(data)$$

re-rendering when
data change



- avoid caching intermediate state,
- or doing manual DOM manipulation

https://lit-html.polymer-project.org/

Vorteile von lit-html

Efficient

lit-html is **extremely fast**. It uses fast platform features like **HTML `<template>`** elements with native cloning.

Unlike VDOM libraries, lit-html only ever updates the parts of templates that actually change - **it doesn't re-render the entire view**.

Expressive

lit-html gives you the full power of JavaScript and **functional programming** patterns.

Templates are values that can be computed, passed to and from functions and nested. Expressions are real JavaScript and can include anything you need.

lit-html supports many kind of values natively: strings, DOM nodes, heterogeneous lists, nested templates and more.

Extensible

lit-html is extremely customizable and extensible. Directives customize how values are handled, allowing for asynchronous values, efficient keyed-repeats, error boundaries, and more. lit-html is like your very own **template construction kit**.

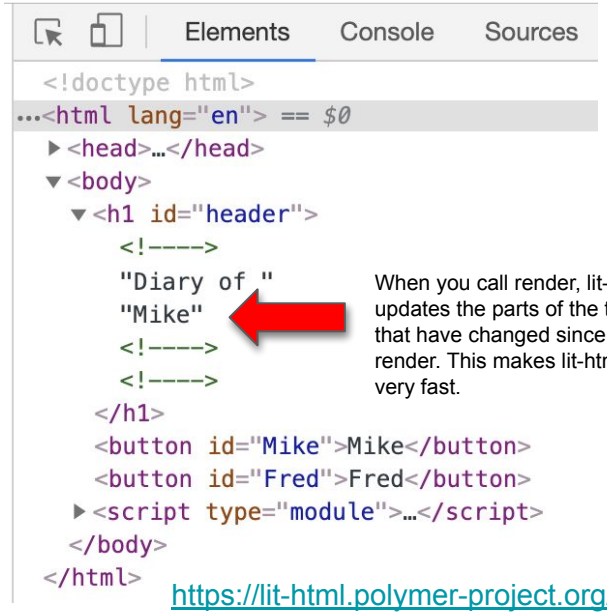
Efficiently creating and updating DOM

lit-html is **not a framework**, nor does it include a component model. It focuses on one thing and one thing only: efficiently creating and updating DOM. It can be used **standalone** for simple tasks, or **combined with a framework or component model, like Web Components,** for a full-featured UI development platform.

https://lit-html.polymer-project.org/

Efficient Re-Rendering

```
<body>
<h1 id="header"></h1>
<button id="Mike">Mike</button>
<button id="Fred">Fred</button>

<script type="module">
  import { html, render } from "https://unpkg.com/lit-html?module";

  const personTemplate = ( name ) => html`Diary of ${name}`;

  const header = document.getElementById('header');
  let clickedPerson = null;

  ['Mike', 'Fred'].forEach( person => {
    const button = document.getElementById( person );
    button.addEventListener( 'click', e => {
      clickedPerson = person;
      render( personTemplate( clickedPerson ), header );
    });
  });

</script>
```



https://lit-html.polymer-project.org/

lit-html: types of bindings mit " ? . @ "

- Text:

```
html`<h1>Hello ${name}</h1>`
```

- Attribute:

```
html`<div id=${id}></div>`
```

- Boolean Attribute:

```
html`<input ?disabled=${disabled}>`
```

- Property:

```
html`<input .value=${value}>`
```

- Event Listener:

```
html`<button @click=${(e) => console.log('clicked')}>Click Me</button>`
```

https://polymer.github.io/lit-html/guide/writing-templates

lit-html: Ternary Operator

```
html`
  ${user.isloggedIn
      ? html`Welcome ${user.name}`
      : html`Please log in`
  }
`;
```

https://polymer.github.io/lit-html/guide/writing-templates

lit-html: Nesting Templates in Template

```
const header = html`<h1>Header</h1>`;

const page = html`
  ${header}
  <p>This is some text</p>
`;
```

https://polymer.github.io/lit-html/guide/writing-templates

lit-html: DOM nodes in Templates

```
const div = document.createElement('div');
const page = html`
  ${div}
  <p>This is some text</p>
`;
```

https://polymer.github.io/lit-html/guide/writing-templates

lit-html: Looping

```
html`
  <ul>
    ${items.map((i) => html`<li>${i}</li>`)}
  </ul>
`;
```

https://polymer.github.io/lit-html/guide/writing-templates

lit-html: Looping -2-

```
const itemTemplates = [];
for (const i of items) {
  itemTemplates.push(html`<li>${i}</li>`);
}

html`
  <ul>
    ${itemTemplates}
  </ul>
`;
```

https://polymer.github.io/lit-html/guide/writing-templates

Awesome lit-html

https://github.com/web-padawan/awesome-lit-html

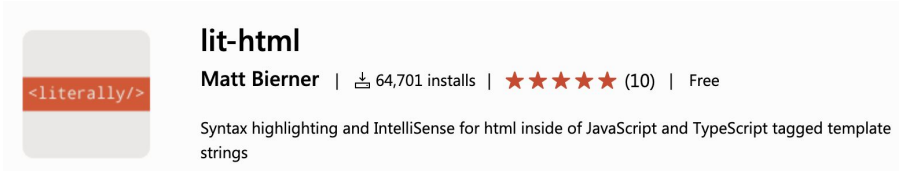
A curated list of awesome lit-html resources.

lit-html — an efficient, expressive, extensible HTML templating library for JavaScript.

Contents

https://github.com/web-padawan/awesome-lit-html

VS Code Plugin for lit-html




```
const buttonTemplate = (title = 'submit') => html`
    
`

render(buttonTemplate(), document.body)
```

https://marketplace.visualstudio.com/items?itemName=bierner.lit-html

Gliederung

1. JavaScript-Module (ES6 module)
2. Web-Komponenten
3. lit-html
4. LitElement
5. Marktplätze für Komponenten

LitElement

- A simple base class for creating fast, lightweight web components
- LitElement makes it easy to define Web Components – ideal for sharing elements across your organization or building a UI design system.
- Use your components anywhere you use HTML: in your main document, a CMS, Markdown, or a framework like React or Vue.

Delightfully declarative

LitElement's simple, familiar development model makes it easier than ever to build Web Components.

Express your UI declaratively, as a function of state. No need to learn a custom templating language – you can use the full power of JavaScript in your templates. Elements update automatically when their properties change.

Fast and light

Whether your end users are in emerging markets or Silicon Valley, they'll appreciate that LitElement is extremely fast.

LitElement uses lit-html to define and render HTML templates. DOM updates are lightning-fast, because lit-html only re-renders the dynamic parts of your UI – no diffing required.

Seamlessly interoperable

LitElement follows the Web Components standards, so your components will work with any framework.

LitElement uses Custom Elements for easy inclusion in web pages, and Shadow DOM for encapsulation. There's no new abstraction on top of the web platform.

https://lit-element.polymer-project.org/

LitElement

- Attribut-Werte werden immer automatisch in Properties konvertiert.
- Property-Werte werden nur in Attributen gespiegelt, falls **reflect: true**

```
<script type="module">
 import { LitElement, html } from 'https://unpkg.com/lit-element/lit-element.js?module';

 class MyElement extends LitElement {
  static properties = {  // Welche Props soll LitElement verwalten?
     prop1: { type: String },
     prop2: { type: Number, reflect: true }
  };   // if attribute should reflect property changes
  constructor() {
     super();
     this.prop1 = '';
     this.prop2 = 0;
  }
    render() {
       return html`
          <p>prop1 ${this.prop1}</p>
          <p>prop2 ${this.prop2}</p>
          <button @click="${this.changeProperties}">change properties</button>
          <button @click="${this.changeAttributes}">change attributes</button>
       `;
    }
    changeAttributes() {
       let randy = Math.floor(Math.random()*10);
       this.setAttribute('prop1', randy.toString());
       this.setAttribute('prop2', randy.toString());
       this.requestUpdate();
    }
    changeProperties() {
       let randy = Math.floor(Math.random()*10);
       this.prop1 = randy.toString();
       this.prop2 = randy;
    }
 }
 customElements.define('my-element', MyElement);
</script>
<my-element></my-element>
```

Declared Properties

Initialisierung

re-render if declared property or attribute changes

https://lit-element.polymer-project.org/guide/properties#conversion

LitElement Garantien

- Re-Render bei jeder Property Change
  - nur in static properties deklarierte Properties
  - minimales Re-Rendering: nur die Teile im DOM, die sich wirklich geändert haben
- Attribut-Konvertierung typkonform
  - Attribute: String ⇒ Property: String, Number, Boolean, Object, Array.
- Property ⇒ Attribut
  - toString()

LitElement - Tutorial
https://dev.to/link2twenty/litelement-using-web-components-580a

The following options are available:

- `type`: Use LitElement's default attribute converter.
- `converter`: Convert between properties and attributes.
- `attribute`: Configure observed attributes.
- `reflect`: Configure reflected attributes.
- `noAccessor`: Whether to set up a default property accessor.
- `hasChanged`: Specify what constitutes a property change.

https://lit-element.polymer-project.org/guide/properties

LitElement Styles

```
import { LitElement, html, css } from 'lit-element';

const mainColor = css`red`;

class MyElement extends LitElement {
  static get styles() {
    return css`
      div { color: ${mainColor} }
    `;
  }
  render() {
    return html`<div>Some content in a div</div>`;
  }
}

customElements.define('my-element', MyElement);
```

aus Sicherheitsgründen nur CSS Templates

https://lit-element.polymer-project.org/guide/styles

Gliederung

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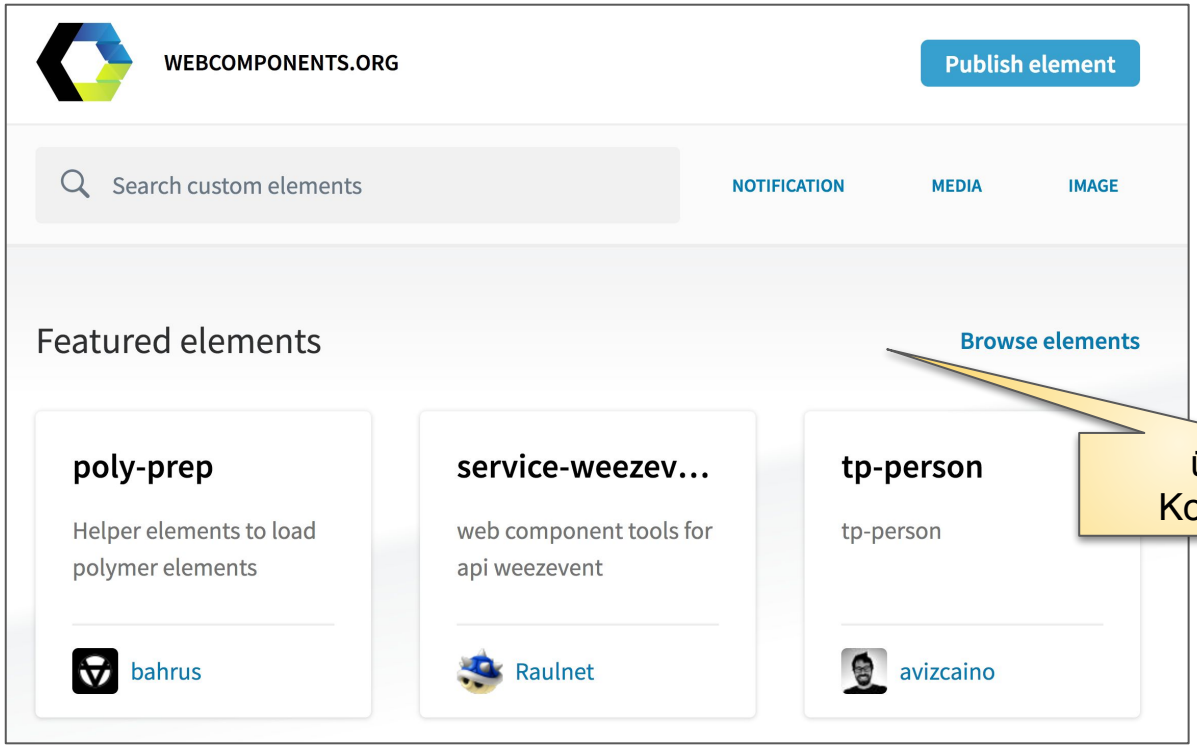
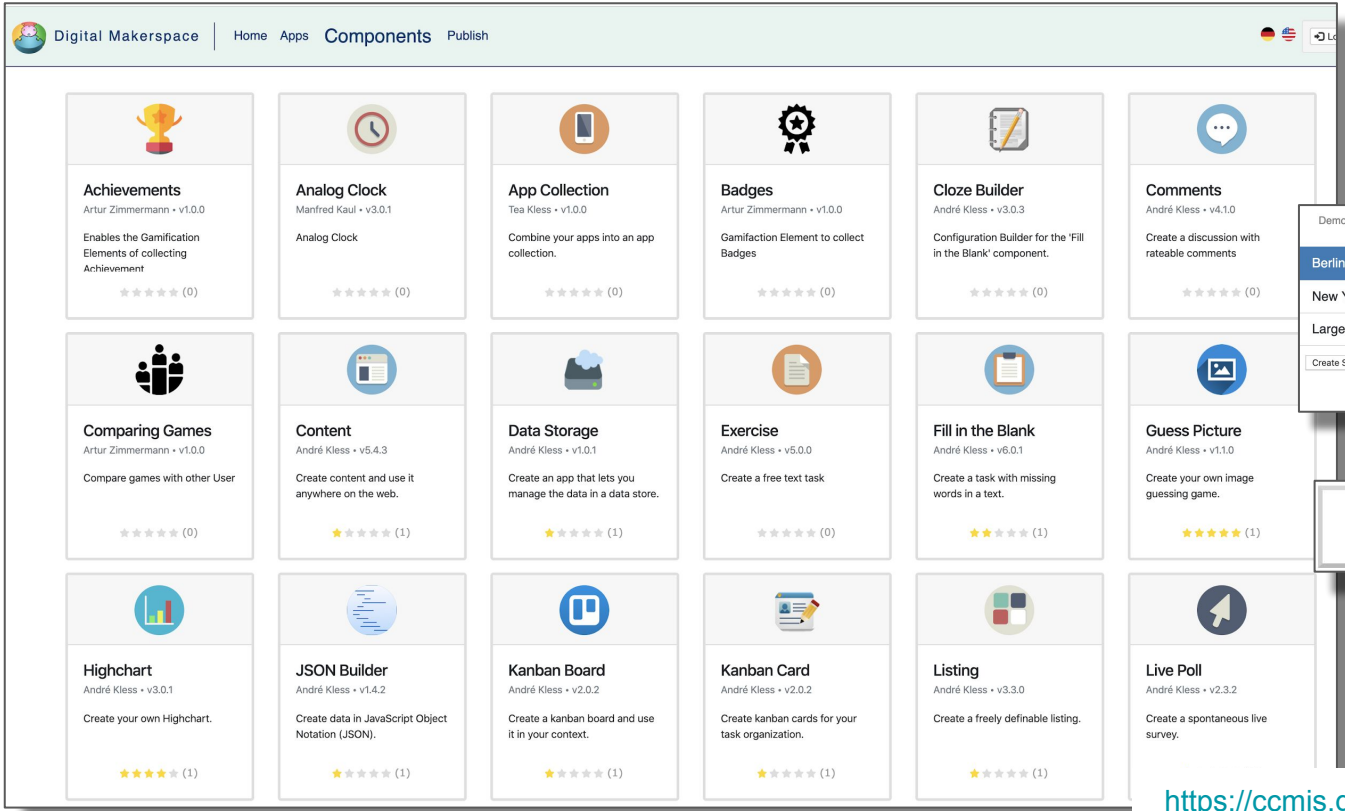
Komponentenmarkt für W3C-Web-Komponenten



https://www.webcomponents.org/

Hochschule
Bonn-Rhein-Sieg

Digital Makerspace: App = Komponente + Konfig



https://ccmjs.github.io/digital-maker-space/

"frameworkless"

Marktplätze für Web-Komponenten

- Amber Components - Web Components implementation of the Amber Design System.
- Blackstone UI - Web components for creating interfaces built with lit-html and LitElement.
- Bronconents - Modern Web Components built with Lit-Element.
- Carbon Custom Elements - Experimental variant of Carbon Design System built with Web Components.
- Chartjs Web Components - Web components for chartjs.
- Clever components - Collection of Web Components made by Clever Cloud.
- Ink Components - Web components for interactive scientific writing.
- LRNWebComponents - ELMS:LN produced web components for any project.
- Material Web Components - Material Design implemented as Web Components.
- Microsoft Graph Toolkit - Collection of web components for the Microsoft Graph.
- UI5 Web Components - Enterprise-flavored sugar on top of native APIs!
- VSCode-Webview-Elements - Components for creating VSCode extensions which use the Webview API.
- Weightless - High quality web components with a small footprint.
- Wired Elements - Collection of elements that appear hand drawn.
- https://developer.salesforce.com/docs/component-library/overview/components
- https://custom-elements-everywhere.com
- https://getmdl.io/
- https://bit.dev also with frameworks like React, Angular, Vue, ...

Frameworkless movement

Zusammenfassung

1. JavaScript-Module (ES6 module)
2. W3C Web-Komponenten
3. lit-html für Tagged Template Strings
4. LitElement als Superklasse von Web-Komponenten
5. Marktplätze für universell kombinierbare Web-Komponenten

Use
The
Platform

WEBCOMPONENTS.ORG Building blocks for the web