Software Development Concepts

Fundamental Concepts and Paradigms in the Software Engineering Profession

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https://softuni.bg

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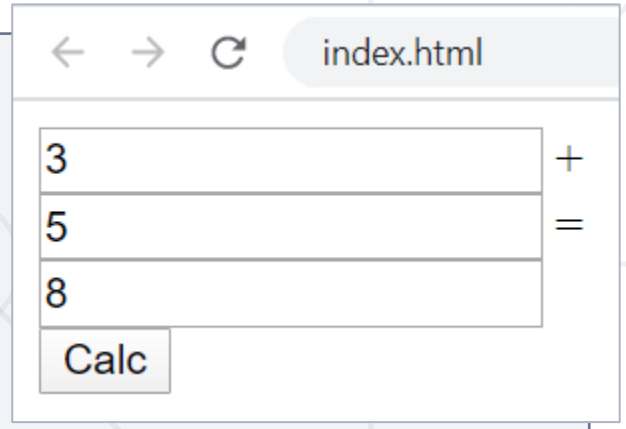
Front-End

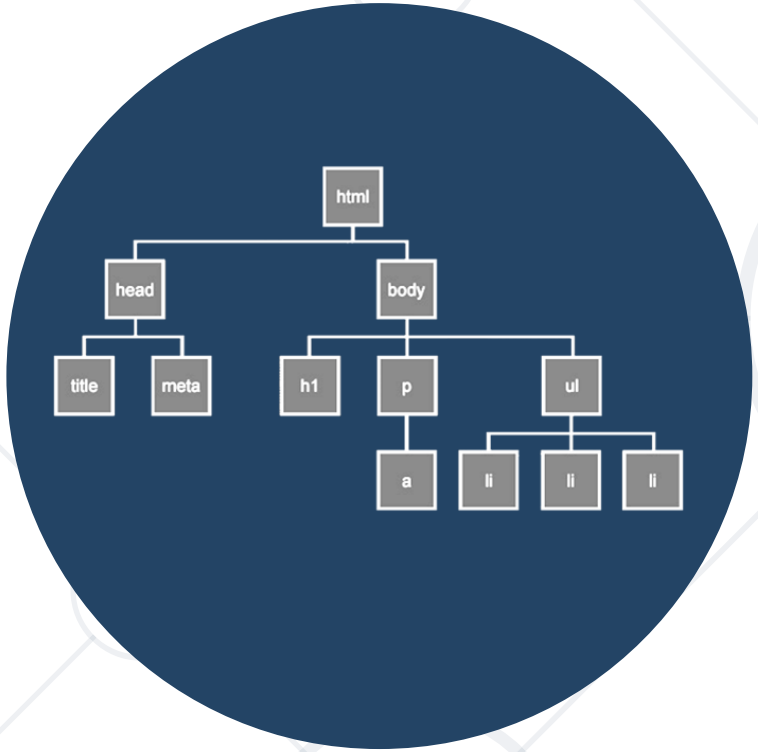
Web Front-End and DOM

- **Web front-end technologies** (see https://platform.html5.org)
  - HTML, CSS, JavaScript, DOM, AJAX
  - JS front-end frameworks (e.g. React, Angular, Vue)
- **DOM** (the Document Object Model)
  - DOM == a tree of UI and other elements
  - Documents in the Web browser are represented by a **DOM tree**
  - The **DOM API** allows changing the DOM from JS

Using the DOM API – Example

```
<input type="text" id="firstNum" /> +
<input type="text" id="secondNum" /> =
<input type="text" id="sum" />
<button id="calc">Calc</button>
<script>
  document.getElementById("calc").onclick = function() {
    document.getElementById("sum").value =
      Number(document.getElementById("firstNum").value) +
      Number(document.getElementById("secondNum").value);
  }
</script>
```





DOM Interaction

Live Demo

https://repl.it/@nakov/summator-js-dom

AJAX and RESTful APIs

- **AJAX** is a technology for asynchronous execution of HTTP requests from client-side JavaScript

```
let httpRequest = fetch('https://some-url...');
httpRequest.then(function(httpResponse) {
  // Process the HTTP response here and update the DOM tree ...
});
```

- **RESTful APIs** are HTTP-based Web services
  - The HTTP methods **GET**, **POST**, **PUT** and **DELETE** retrieve, create, modify and delete data

AJAX and REST

Live Demo

https://repl.it/@nakov/RESTful-API-js

https://repl.it/@nakov/RESTful-API-client-example

Templating Engines

- **Templating engines** render data as HTML through a **template**

template

```
<h1>Students ({{students.length}})</h1>
<ul>
{{#each students}}
  <li>{{name}} (graduated {{year}})</li>
{{/each}}
</ul>
```

data

```
{
  "students" : [
    {"name" : "Marry", "year" : 2019},
    {"name" : "Steve" , "year" : 2020},
    {"name" : "Teddy" , "year" : 2020}
  ]
}
```

templating engine

HTML

```
<h1>Students (3)</h1>
<ul>
  <li>Marry (graduated 2019)</li>
  <li>Steve (graduated 2020)</li>
  <li>Teddy (graduated 2020)</li>
</ul>
```

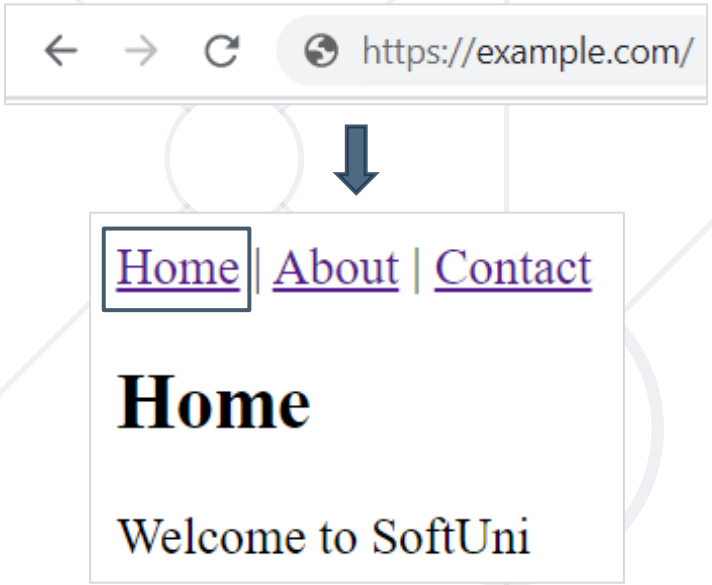
Rendering UI with a Templating Engine

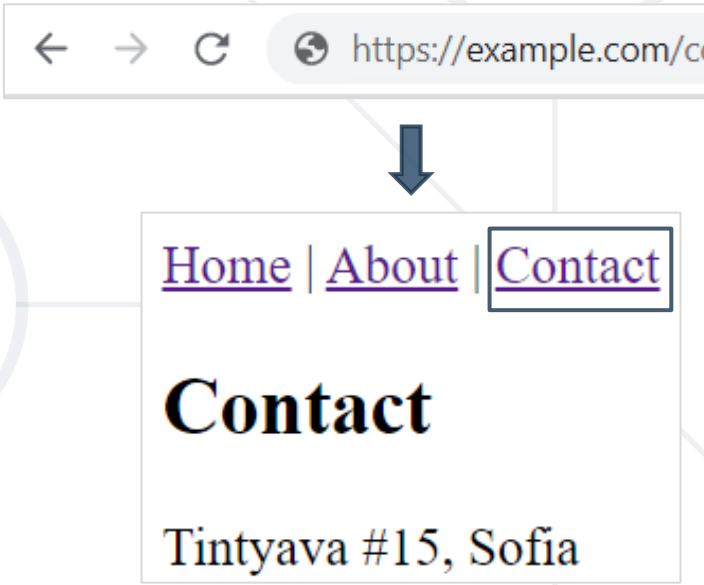
Live Demo

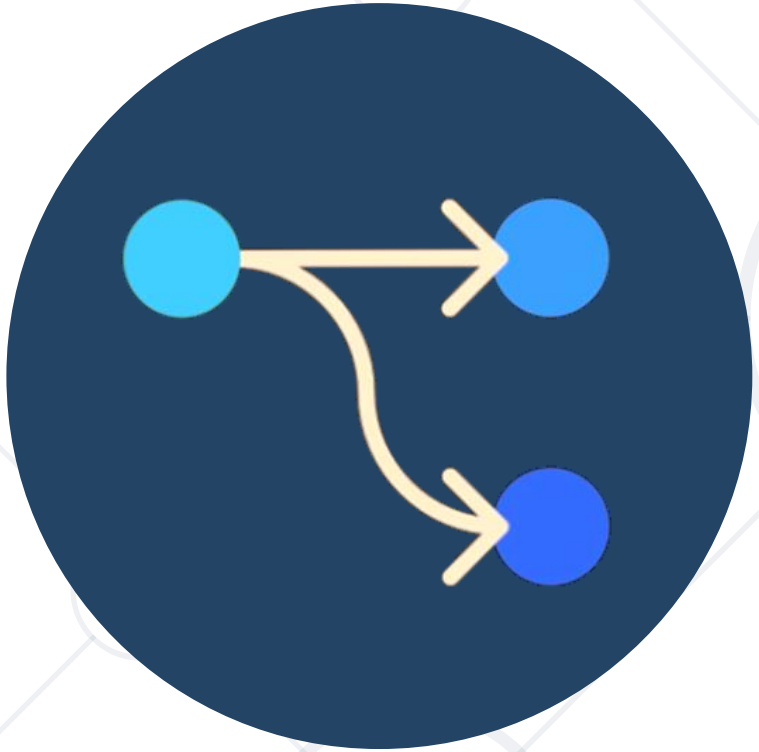
https://repl.it/@nakov/Handlebars-example-JS

Routing and Routing Libraries

- **Routing** is about switching between different **UI views**, based on the changes of the current **URL** (holding the route)
- **Routing libraries** switch the view by URL like this:







Navigation with Routing Library

Live Demo

https://repl.it/@nakov/routing-with-sammy-js

User Interface and Front-End Frameworks

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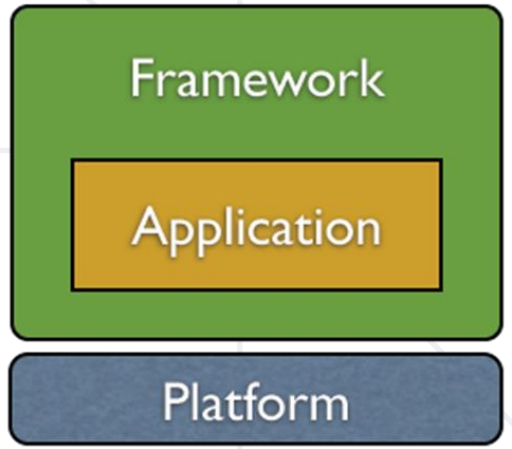
- **Graphical User Interface** (**GUI**) systems provide forms, dialogs and UI controls for desktop and mobile apps
  - Examples: Windows Forms, XAML, WPF, Qt
- **Mobile UI** toolkits / frameworks provide UI controls and structure for mobile apps
  - Examples: Apple UIKit, Android UI, Flutter
- **Web front-end frameworks** and **UI libraries** provide user interface elements and structure for **Web apps**
  - Examples of **UI frameworks**: Angular, React, Vue.js, Meteor
  - Examples of **UI libraries**: Kendo UI, Sencha Ext JS, Onsen UI

Libraries vs. Frameworks

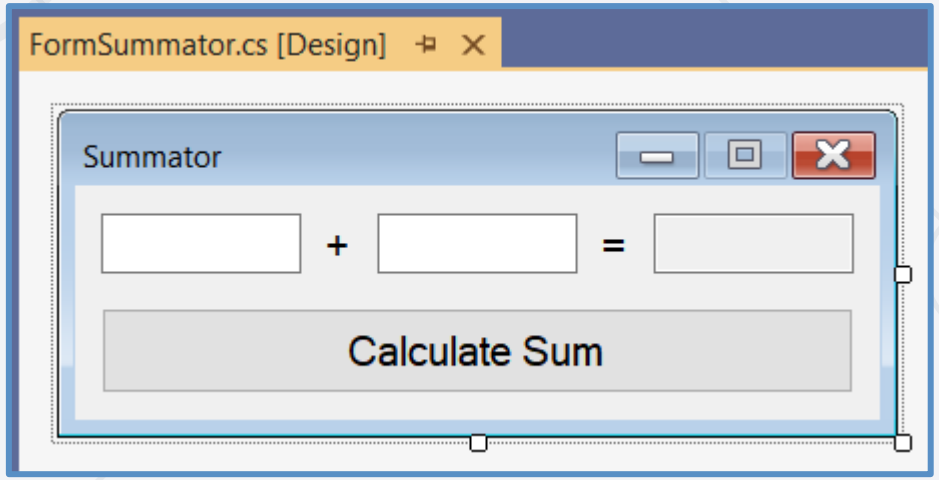
- **Libraries** provide **components** / **functionality** / **UI controls** for integration into existing apps
  - The **app controls the library** components
  - Examples: UI control library, Excel reader
- Development **frameworks** are foundations, which developers extend to build an app
  - The framework **controls the app lifecycle** and your code plugs in it (**inversion of control** – IoC)
  - Examples: MVC framework, ORM framework



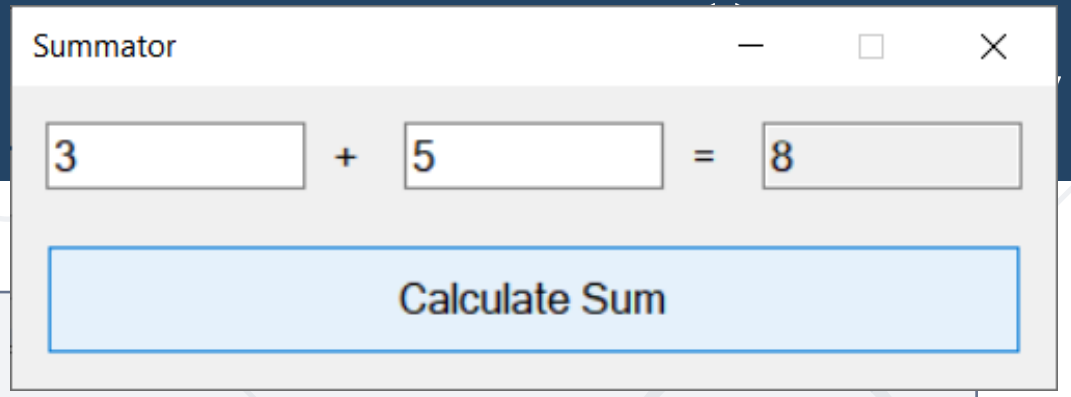
Windows Forms – Example

- **Windows Forms** is GUI framework for .NET developers
  - Provides programming model and rich UI control library

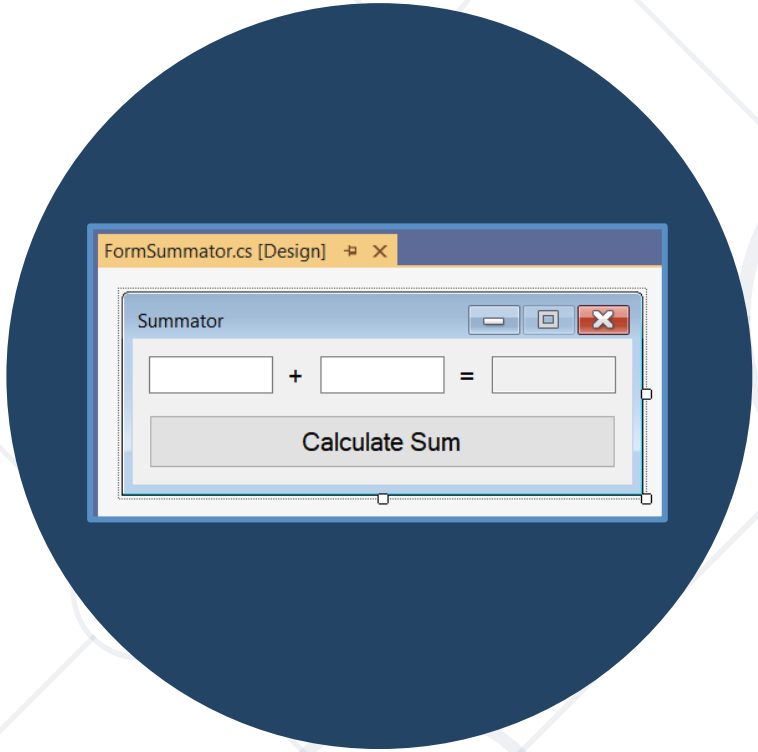
```
public partial class FormSummator : Form
{
  private TextBox textBox1;
  private Label labelPlus;
  private Label labelEqual;
  private TextBox textBox2;
  private TextBox textBoxSum;
  private Button buttonCalc;
}
```



Windows Forms – Example (2)




```
public partial class FormSummator
{
  private void buttonCalc_Click(object sender, EventArgs e)
  {
    decimal firstNum = decimal.Parse(this.textBox1.Text);
    decimal secondNum = decimal.Parse(this.textBox2.Text);
    decimal sum = firstNum + secondNum;
    this.textBoxSum.Text = sum.ToString();
  }
}
```



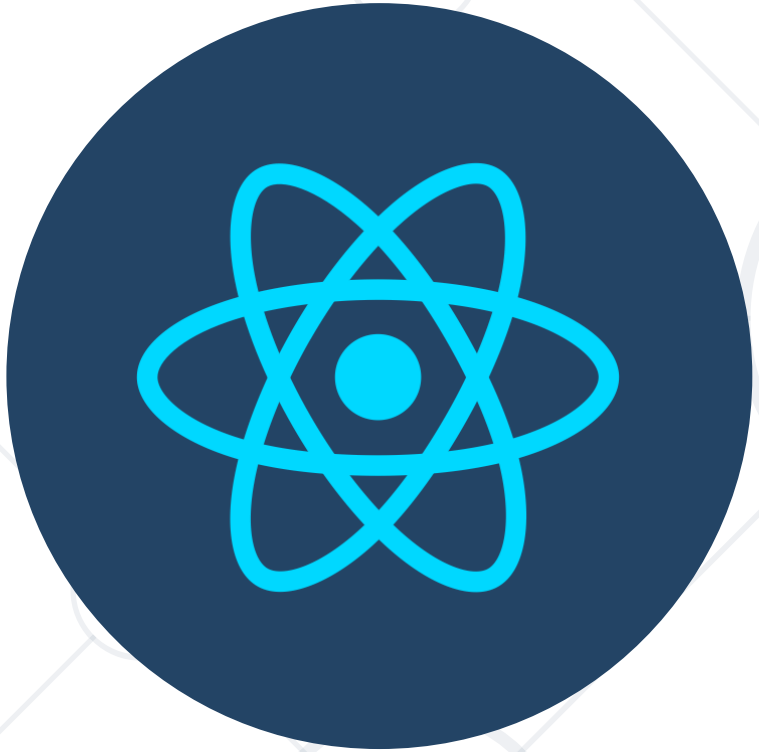
Windows Forms

Live Demo

React

- **React** is a powerful **JavaScript library** from Facebook for building Web UI using HTML, CSS and JS
  - The UI is built from **JSX components**, which combine HTML + JS

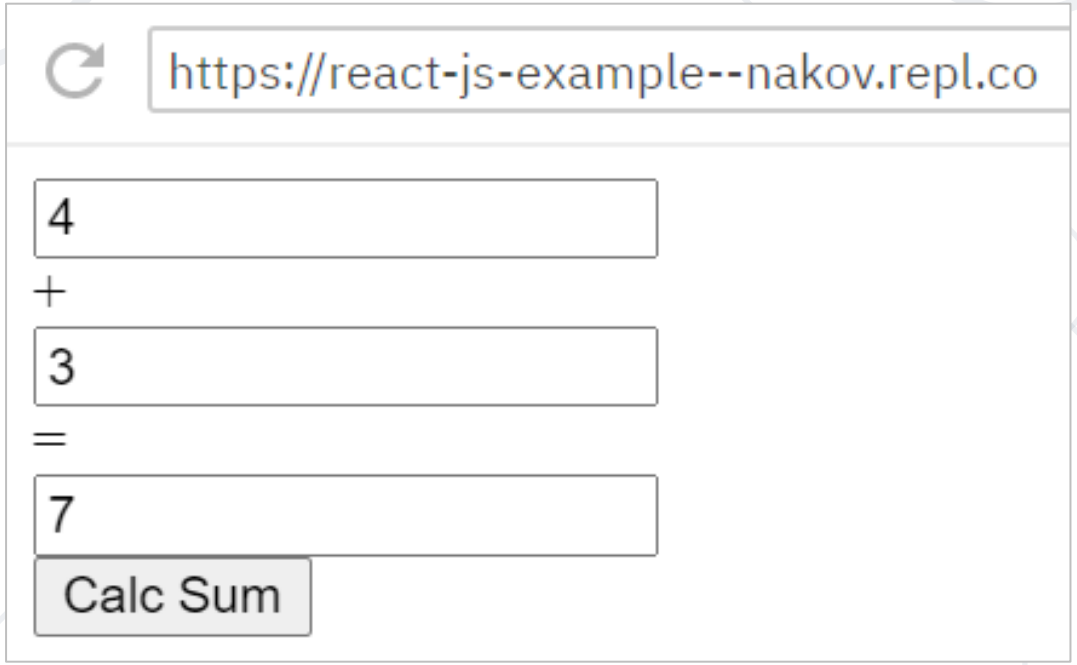
```
class HelloMessage extends React.Component {
  render() {
    return (<div>Hello, {this.props.name}!</div>);
  }
}

ReactDOM.render(<HelloMessage name="SoftUni" />,
  document.getElementById('root'));
```



React

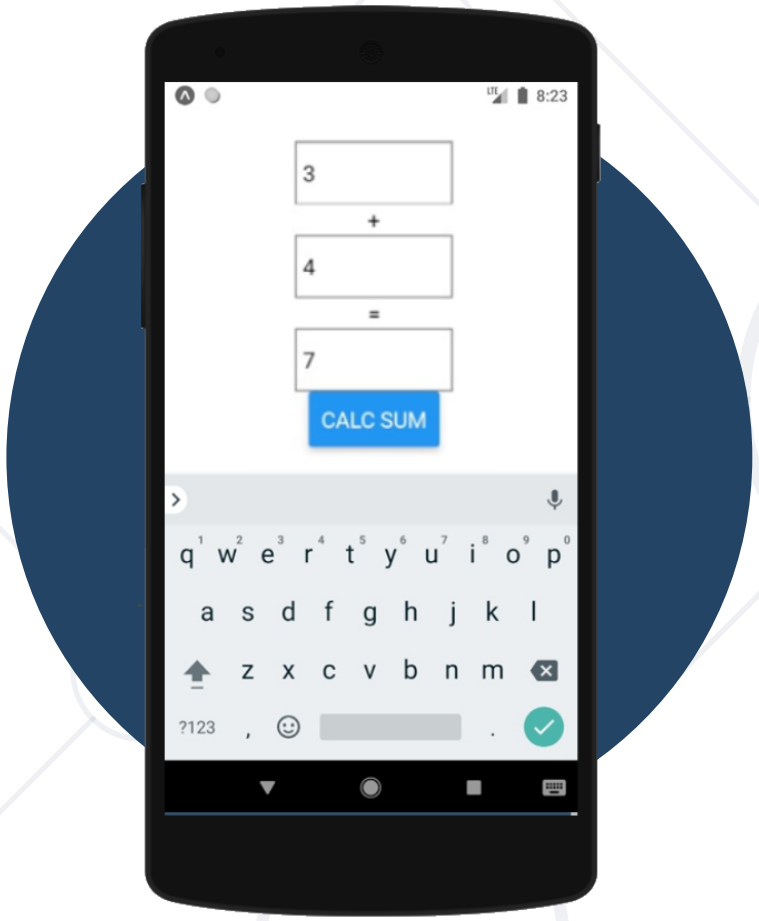
Live Demo

https://repl.it/@nakov/react-js-example



Mobile Apps – Technologies

- Two major mobile app platforms: **Android** and **iOS**
- **Mobile app** development technologies
  - **Android**: Java / Kotlin + Android SDK + Android Studio
  - **iOS**: Swift (or Objective-C) + iOS SDK + Xcode + Mac
  - **Hybrid mobile apps**: JS + HTML5 + WebView (e.g. Cordova)
  - **Native JS mobile apps**: JavaScript + native UI
    - Examples: React Native, NativeScript
  - **Others**: Xamarin (C#), Flutter (Dart)



React Native App

Live Demo

https://snack.expo.io/@nakov/summator-react-native

Back-End

Back-End Technologies

- **Back-end technologies** are about server-side programming
  - **Data management** technologies and **ORM frameworks**
  - Backend **Web frameworks** and **MVC** frameworks
  - **REST API** frameworks, **reactive** APIs, other services and APIs
  - **Microservices**, **containers** and **cloud**

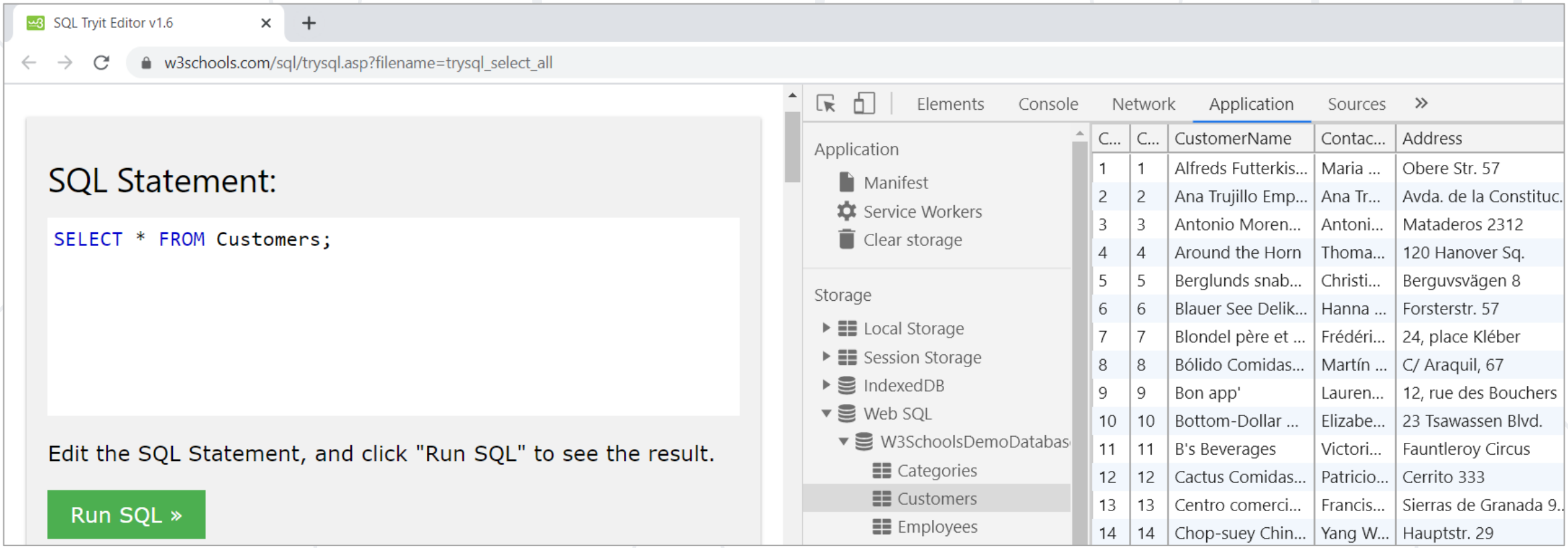
- **Back-end developers** work on the server-side
  - They deal with the business logic,
    data processing, data storage, APIs

Databases

- **Databases** hold and manage data in the back-end systems
- **Relational databases** (**RDBMS**)
  - Hold data in **tables** + **relationships**
  - Use the **SQL** language to query / modify data
  - Examples: MySQL, PostgreSQL, Web SQL in HTML5
- **NoSQL databases**
  - Hold collections of documents or key-value pairs
  - Examples: MongoDB, IndexedDB in HTML5

Web SQL – Example

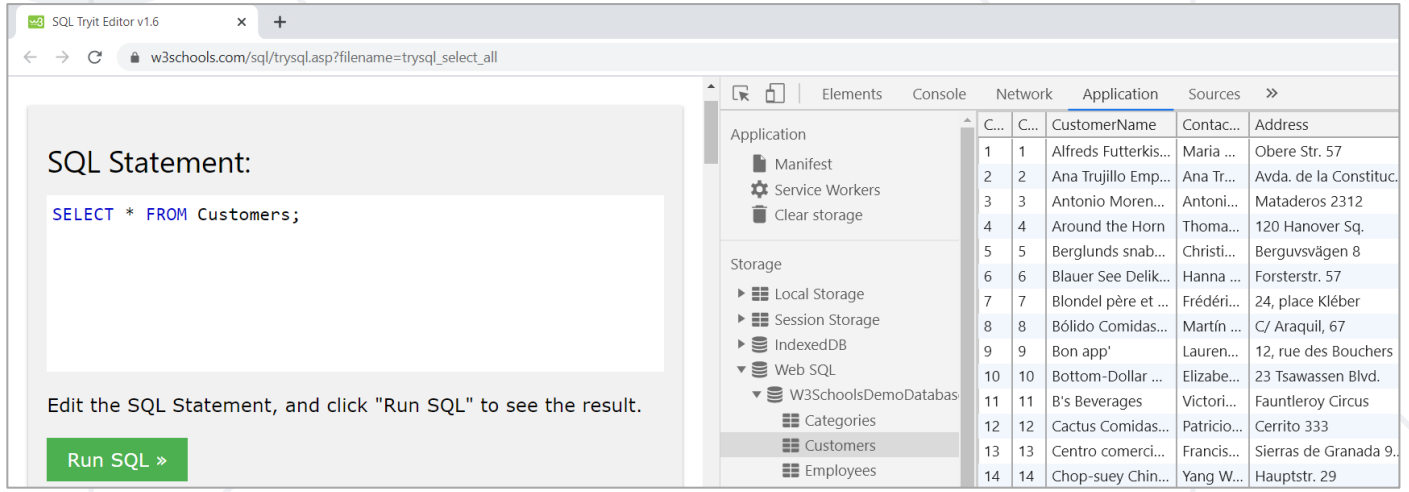
- **Web SQL** is a relational database, embedded the Web browsers
  - It is fully functional **RDBMS system**, runs at the **client-side**



Web SQL

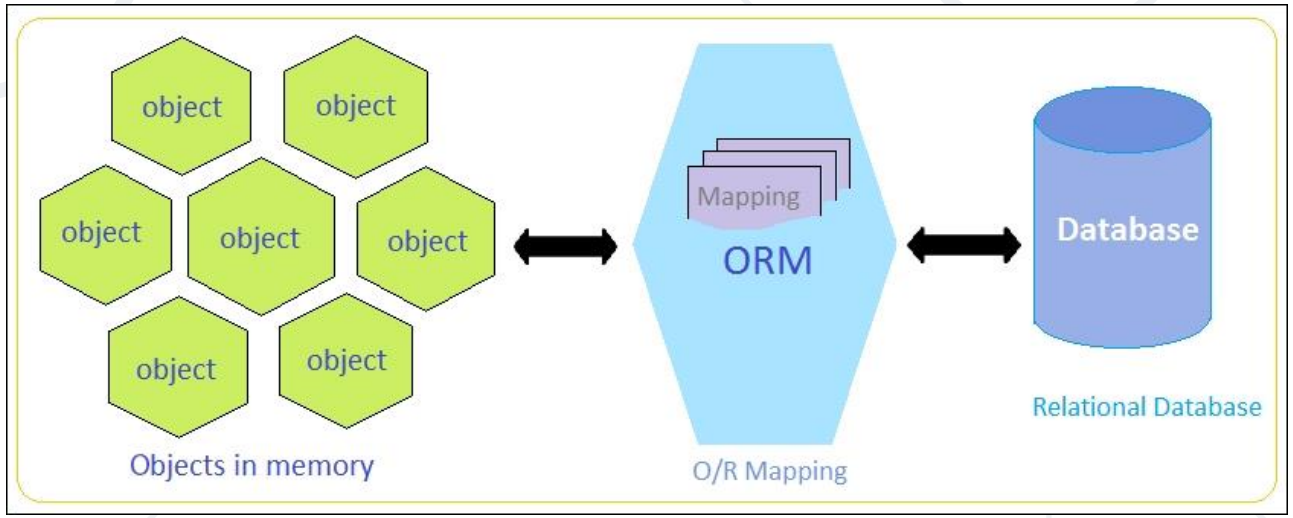
Live Demo

https://w3schools.com/sql/



ORM Frameworks

- **ORM frameworks** (object-relational mapping) allow persisting objects in relational database (by mapping classes to tables)
  - E.g. store JS objects in MySQL database
- Popular ORM frameworks:
  - **Entity Framework** (C#)
  - **Hibernate** (Java)
  - **Sequelize** (JavaScript)
  - **SQLAlchemy** (Python)



JayData ORM for Web SQL

Live Demo

https://repl.it/@nakov/jaydata-orm-example

The Model-View-Controller (MVC) Pattern

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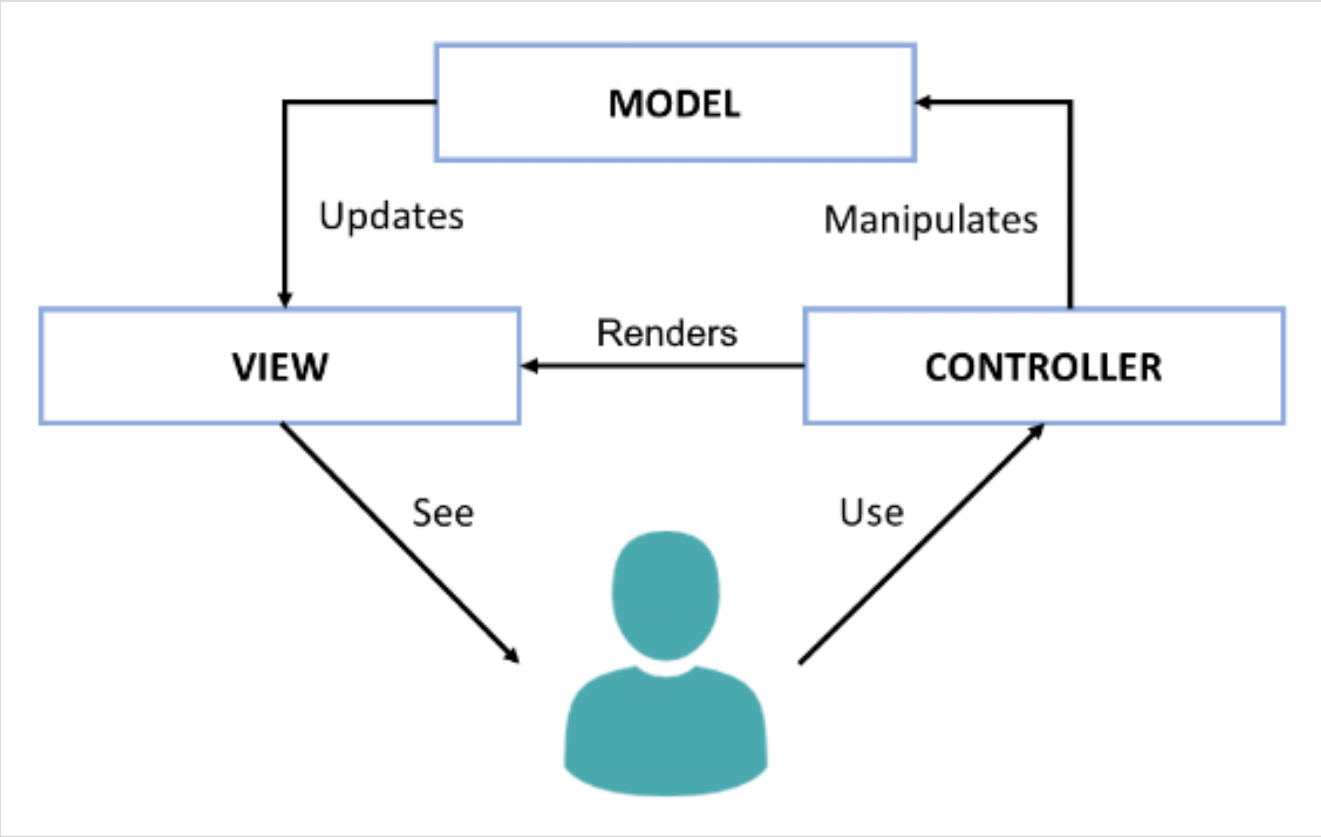
- The **Model-View-Controller** (**MVC**) pattern



- **Controller**
  - Handles user actions
  - Updates the model
  - Renders the view (UI)
- **Model**
  - Holds app data
- **View**
  - Displays the UI, based on the model data

Web MVC Frameworks

- **Web MVC frameworks** are used build Web applications
  - **Controllers** handle HTTP GET / POST and render a view
  - **Views** display HTML + CSS, based on the models
  - **Models** hold app data for views, prepared by controllers
- Examples of Web MVC frameworks:
  - **ASP.NET MVC** (C#), **Spring MVC** (Java),
    Express (JS), **Django** (Python), **Laravel** (PHP),
    Ruby on Rails (Ruby), **Revel** (Go), …

MVC Frameworks

Live Demo

https://repl.it/@nakov/MVC-express-pug-example

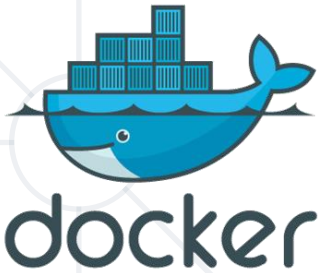
Virtualization and Cloud

- **Virtualization** == running a **virtual machine** (VM) / virtual environment inside a physical hardware system
  - E.g. run Android VM or Linux inside a Windows host
  - Storage, memory, networking, desktops can also be virtual

- **Cloud** == computing resources, virtual machines, storage, platforms and software instances, available on demand
  - **IaaS** (infrastructure as a service) – virtual machines on demand
  - **PaaS** (platform as a service) – app deployment environments
  - **SaaS** (software as a service) – software instances, e.g. Office 365

Containers and Docker

- **Container image** == software, packaged with its dependencies, designed to run in a virtual environment (like Docker)
  - E.g. WordPress instance (Linux + PHP + Apache + WordPress)
  - Simplified installation, configuration and deployment
- **Docker** is the most popular containerization platform
  - Runs **containers** from local **image** or downloaded from the **Docker Hub** online repository
  - Open-source, runs on Linux, Windows, Mac



Docker – Example

- Install **Docker** on your local computer
  - Or use the Docker online playground: https://labs.play-with-docker.com (with a free Docker Hub registration)
- Download and **run a Docker image** in a new container:

```
docker run -d -p:8080:80 dockersamples/static-site
```

- Open the exposed URL: http://localhost:8080
- View currently running Docker containers

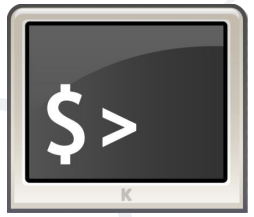
```
docker ps
```

Play with Docker

Live Demo

https://labs.play-with-docker.com

Operating Systems



- Working with **operating systems** (Linux, Windows, others) is an important skill for software engineers
  - Installation, configuration and basic system administration
  - Process management, file system, users and permissions
- Sample **Linux shell commands**:
  - Create a file: `cat > hello.txt`
  - Rename a file: `mv hello.txt welcome.txt`
  - View file contents: `cat welcome.txt`

```
GNU bash, version 4.4.12(1)-release (x86_64-pc-linux-gnu)
ls -al
total 12
drwxr-xr-x 1 runner runner   36 May  5 21:39 .
drwxr-xr-x 1 runner runner 4096 May  5 21:39 ..
-rw-r--r-- 1 runner runner   16 May  5 21:38 main.sh
-rw-r--r-- 1 runner runner   12 May  5 21:39 welcome.txt
> ps
  PID TTY          TIME CMD
   13 pts/0    00:00:00 bash
   17 pts/0    00:00:00 ps
> cat > hello.txt
Hello Linux Shell!
^Z
[1]+  Stopped                 cat > hello.txt
> mv hello.txt welcome.txt
> cat welcome.txt
Hello Linux Shell!
>
```

Linux Shell Commands

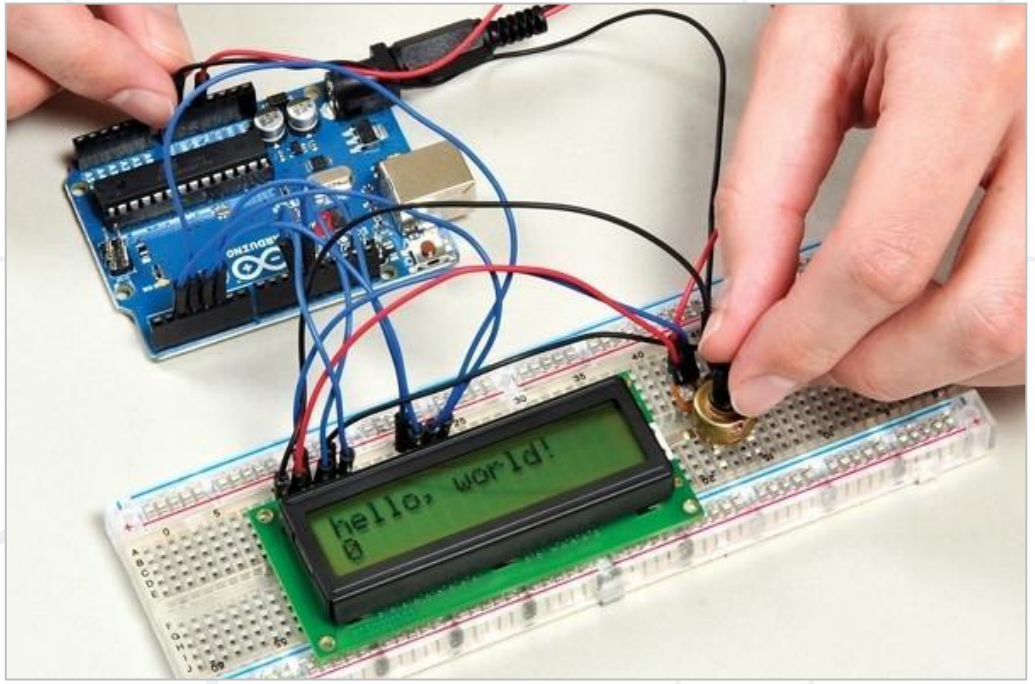
Live Demo

https://repl.it/@nakov/bash-shell-example

Internet of Things (IoT)

Embedded Systems and IoT

- **Embedded systems**
  - **Hardware** + **software**, dedicated to certain task, e.g. control the lights or the heating at home
  - The hardware has **limited resources** (CPU, RAM, battery, …)
- **Internet-connected** embedded systems are known as "Internet of Things" devices (**IoT devices**)



IoT Microcontrollers

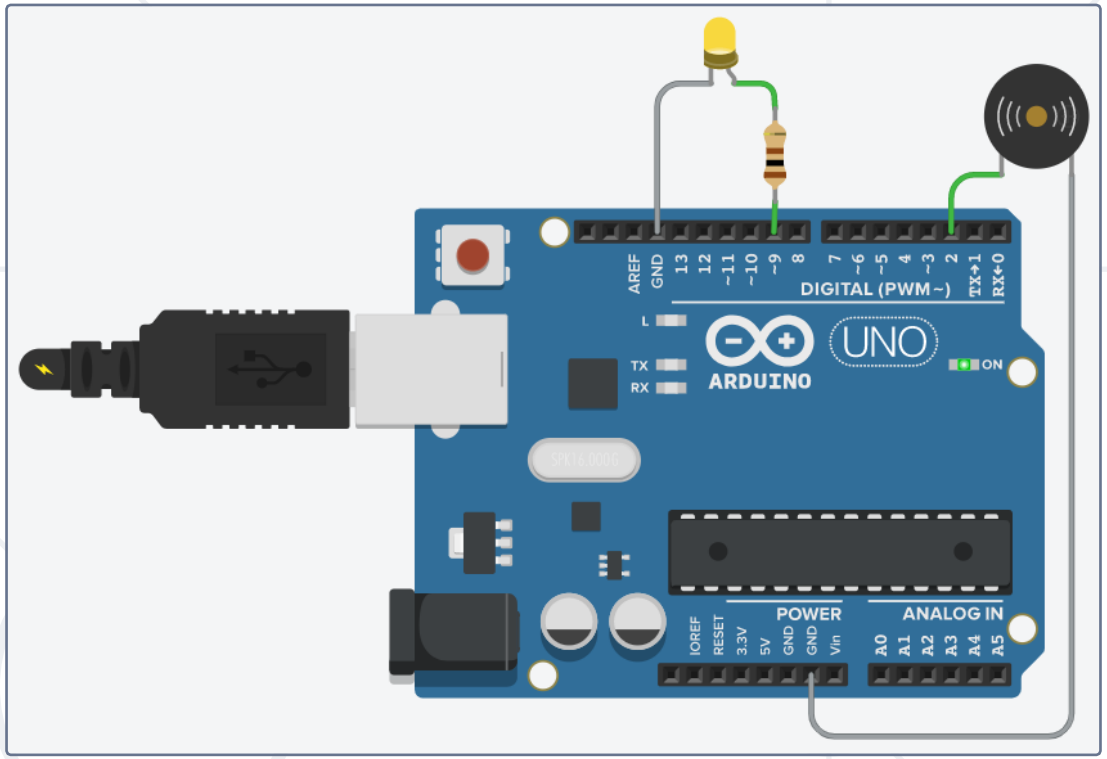
- **Microcontrollers** == microchip (CPU + RAM + GPIO) on a board
  - Examples: Arduino, ESP8266, ESP32, Micro:bit, ATmega328
- **IoT systems** consist of **microcontroller** (or mini-computer) + peripheries + software + Internet connectivity + back-end
  - **Peripherals**: LED lights, buttons, sensors, buzzers, relays, displays
  - **Back-end**: cloud-based (e.g. Blynk, Thinger) or local (home computer)
  - **Connectivity**: WiFi, Bluetooth, LoRa, 4G LTE (with SIM card), 5G
- **Programming languages** for IoT devices:
  - **C**, **C++**, JS / Python / C# (some devices)

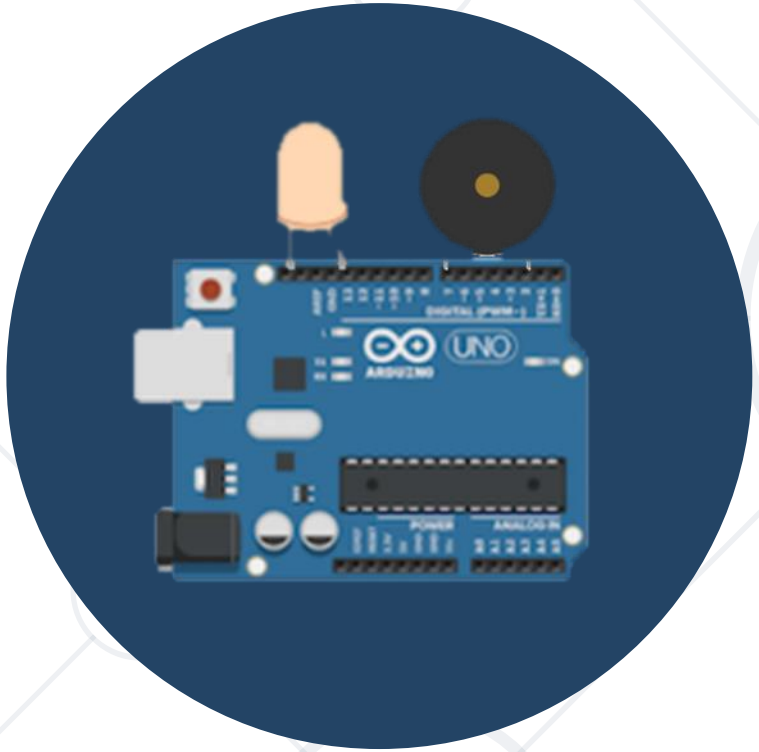
Microcontroller Arduino – Example

```
#define LED_PIN 9
#define BUZZER_PIN 2

void setup() {
  pinMode(LED_PIN, OUTPUT);
}

void loop() {
  int brightness = 0;
  while (brightness <= 255) {
    analogWrite(LED_PIN, brightness);
    delay(15);
    brightness += 3;
  }
  tone(BUZZER_PIN, 300, 100);
}
```





Arduino @ Tinkercad

Live Demo

https://www.tinkercad.com/things/hjgbxEoS5TX

Software Engineering

Software Development Lifecycle (SLDC)

- **Software engineering** is not just coding!
- The **SDLC** includes the following activities:
  - **Requirements** analysis
  - Software **design**
  - **Construction**
  - **Release**
  - **Testing**
  - **Maintenance**

Software project **management**

- **Development processes** (Waterfall / Scrum / Kanban) define workflow and key practices

Software Quality Assurance (QA)

- What is **software quality assurance** (**QA**)?
  - Ensures the **software quality**
  - Performed by the **QA engineers**
- Two approaches:
  - **Testing** (manual and automated)
  - **Code reviews** and quality inspections
- Goal: to **find** and report the **defects** (bugs)
  - Defect are tracked in an **issue tracker**

Issue Tracker

Live Demo

https://github.com/twbs/bootstrap/issues

Unit Testing

- **Unit test** == a piece of code that tests specific functionality in certain software component (unit)


```
function testSum() {
  if (sum([1, 2]) != 3)
    throw "1+2 != 3";
  if (sum([-2]) != -2)
    throw "-2 != -2";
  if (sum([]) != 0)
    throw "empty sum != 0";
}
```

```
function sum(arr) {
  let sum = 0;
  for (let item of arr)
    sum += item;
  return sum;
}
```

Unit Testing Framework

- **Unit testing frameworks** simplify unit testing and reporting
  - Example: **Mocha** JS testing framework

```
const assert = require('assert');

suite('sum(arr)', function() {
  test('sum([1+2]) == 3', function() {
    assert.equal(sum([1, 2]), 3); });
  test('sum([-2]) == -2', function() {
    assert.equal(sum([-2]), -2); });
  test('sum([]) == 0', function() {
    assert.equal(sum([]), 0); });
});
```

```
> mocha --ui tdd index.test.js

  sum(arr)
    ✓ sum([1+2]) == 3
    ✓ sum([-2]) == -2
    1) sum([]) == 0

  2 passing (10ms)
  1 failing
```

Unit Testing with Mocha

Live Demo

https://repl.it/@nakov/mocha-unit-test-example-js

Source Control Systems

- **Source control systems** keep the source code (+ other project assets) in a shared **repository**
  - Developers can **clone** a repository, **pull** the latest version, **commit** & **push** local changes, view the change logs, etc.
- **Git** is the most popular source control system
  - Other version control systems: SVN, TFS, Perforce
- **GitHub** is the #1 site for Git project hosting
  - Git hosting + issue tracker + project tracker + build system

GitHub – Example

- **Clone** a repository from GitHub

```
git clone https://github.com/SoftUni/playground
```

- Modify local files

```
notepad README.md
```

- Commit changes (local)

```
git add . & git commit -m "Added something"
```

- Push the changes to GitHub

```
git push
```

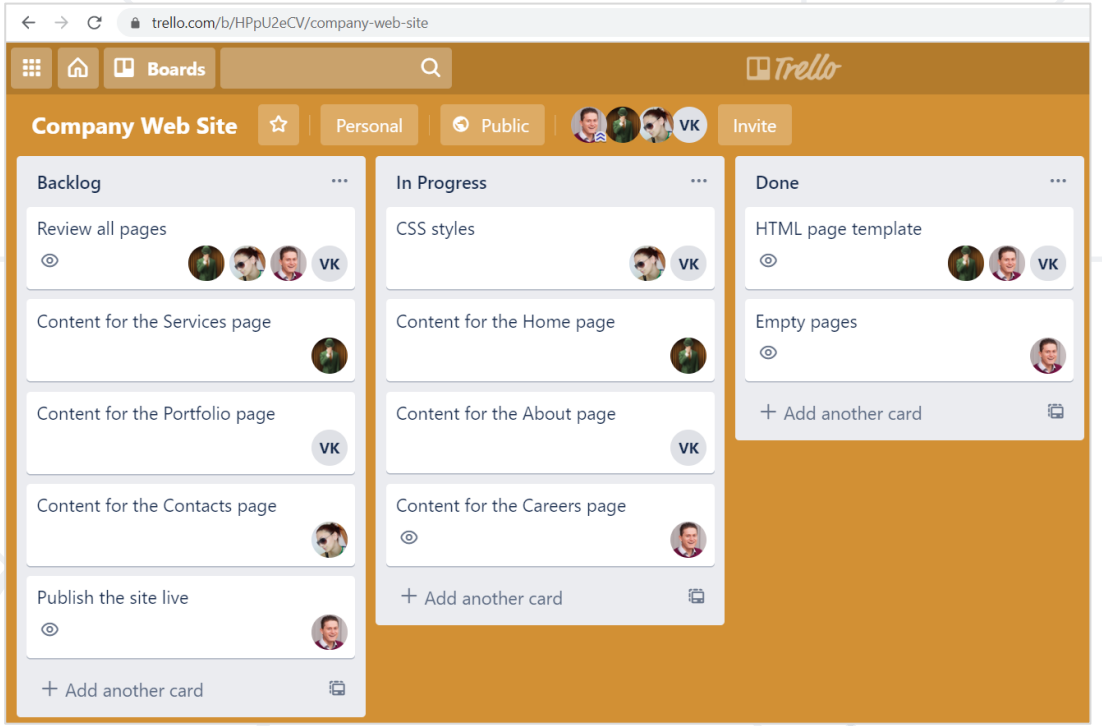
Git and GitHub

Live Demo

https://github.com/SoftUni/playground

Project Trackers and Kanban Boards

- **Project trackers** organize and track project tasks
  - **Tasks** may have description, sub-tasks, assigned people, deadline
- **Kanban boards** visualize the work on a project
  - Typical columns: Backlog, In Progress, Done
  - Examples: Trello, GitHub Projects



Trello Project Board

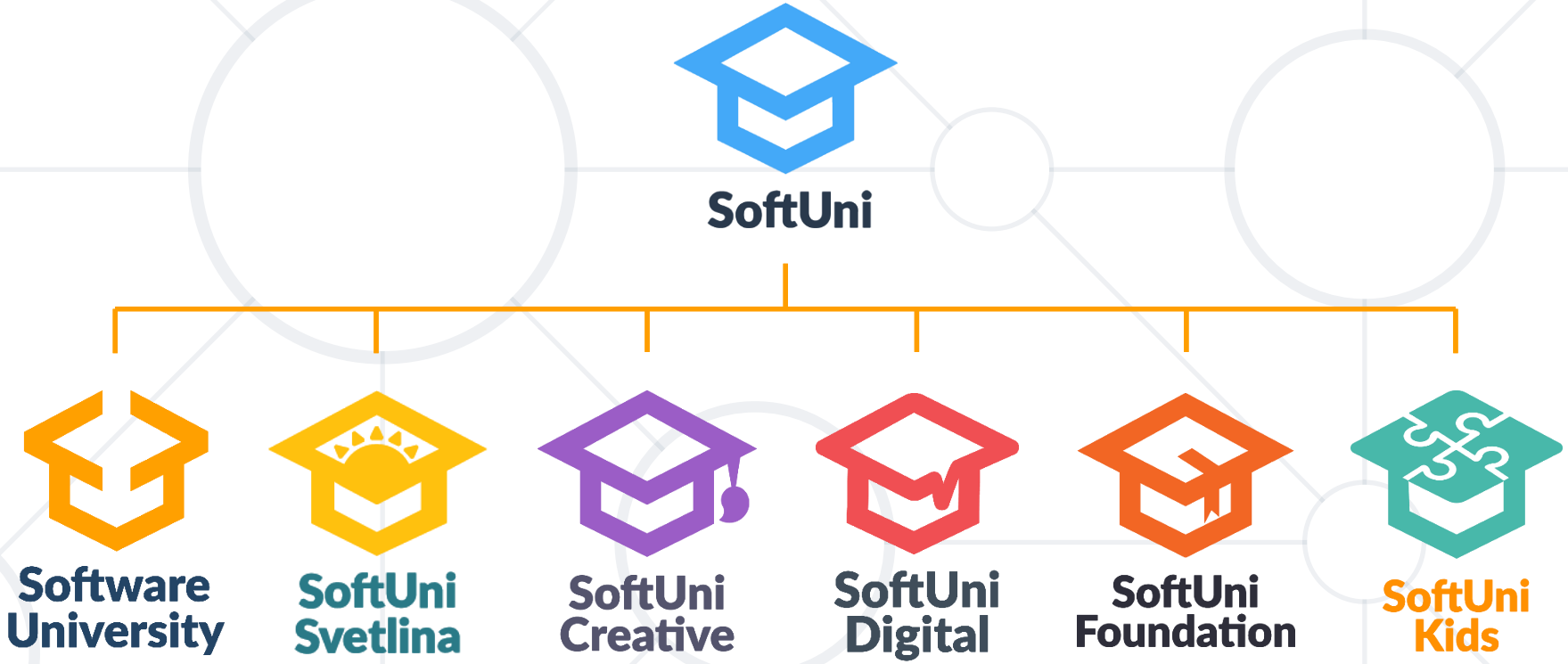
Live Demo

https://trello.com/b/HPpU2eCV/company-web-site

Summary

- **Front-end** development concepts: front-end, UI concepts, DOM, AJAX, routing, templating, UI frameworks
- **Back-end** development concepts, RESTful services, databases, ORM frameworks, MVC architecture, cloud, containers, Docker, …
- **Embedded systems** and IoT, Arduino, ESP32
- **Software engineering**, source control systems, QA, unit testing, Kanban, …

Questions?



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FORUM

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