

Software Development Concepts

Fundamental Concepts and Paradigms
in the Software Engineering Profession



SoftUni Team
Technical Trainers



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Software University

<https://softuni.bg>

Have a Question?

sli.do

#fund-common

1. Front-End Development Concepts

- Web Front-End and DOM
- AJAX and RESTful APIs
- Templating Engines
- Routing and Routing Libraries
- Libraries vs. Frameworks
- UI Frameworks
- Mobile Apps



2. Back-End Development Concepts

- Databases and DBMS Systems
- ORM Frameworks
- The MVC Pattern
- Virtualization, Cloud and Containers
- Operating Systems and Linux Shell

3. Embedded Systems and IoT



4. Software Engineering Concepts

- Software Development Lifecycle
- Software Quality Assurance (QA)
- Unit Testing
- Source Control Systems
- Project Trackers and Kanban Boards





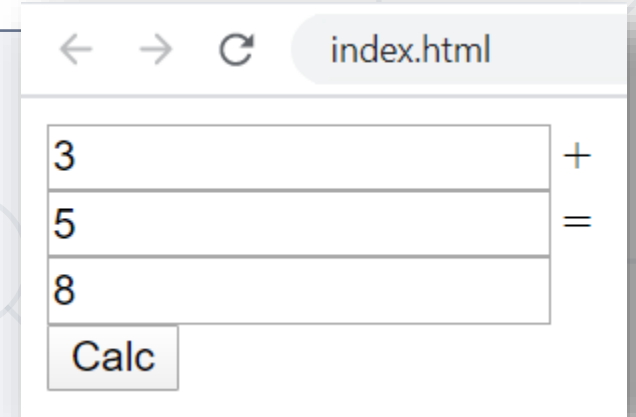
Front-End

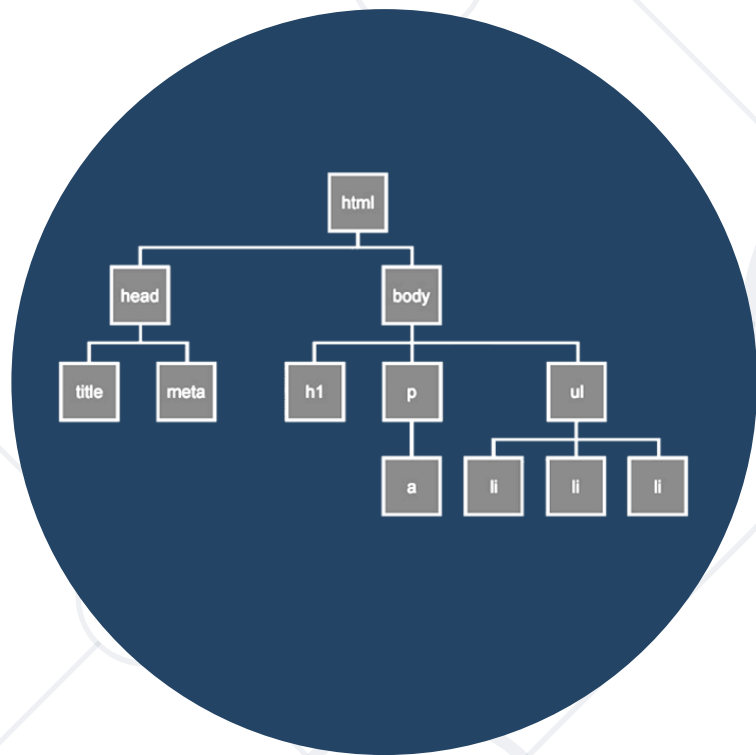
- **Web front-end technologies** (see <https://platform.html5.org>)
 - HTML, CSS, JavaScript, DOM, AJAX
 - JS front-end frameworks (e.g. React, Angular, Vue)
- **DOM** (the Document Object Model)
 - DOM == a tree of UI and other elements
 - Documents in the Web browser are represented by a **DOM tree**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



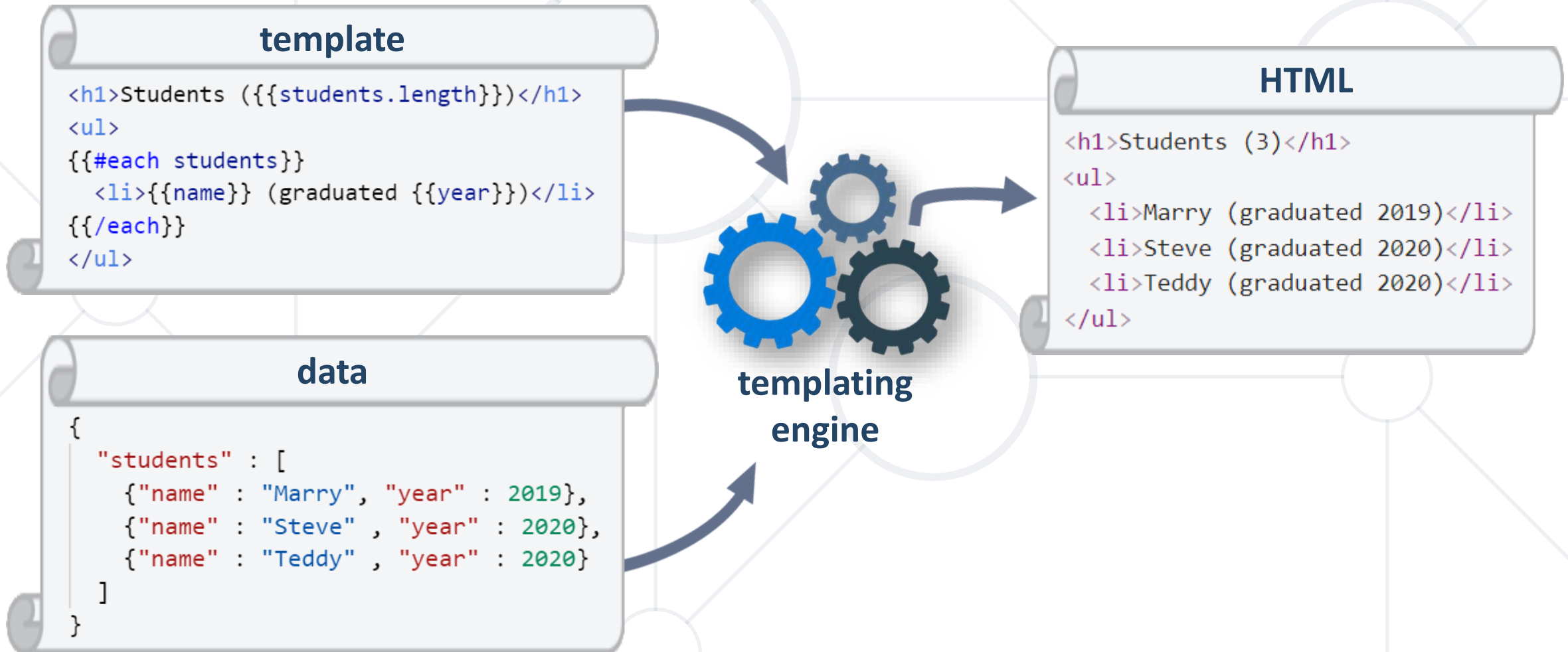
AJAX and REST

Live Demo

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

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

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



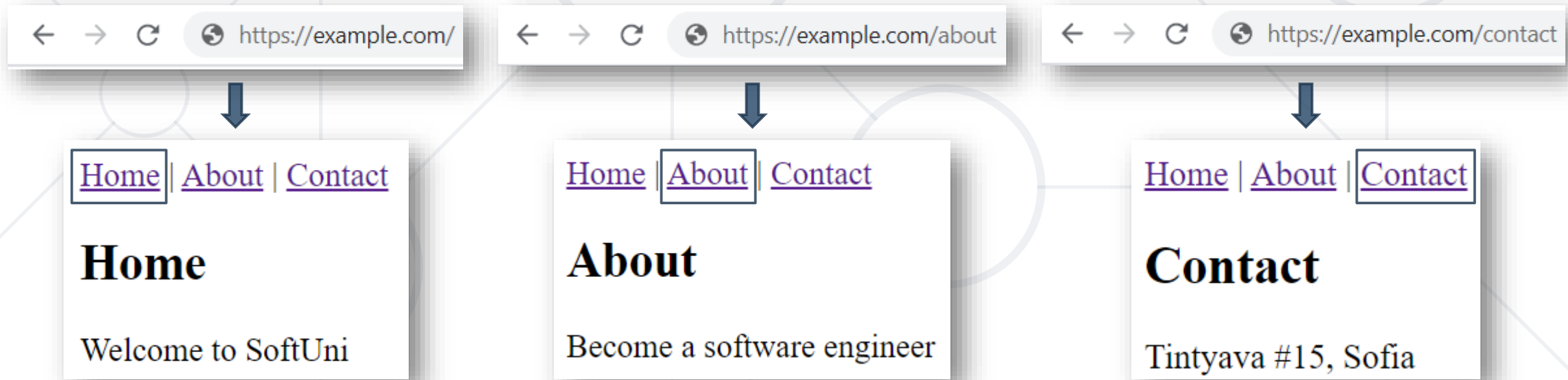


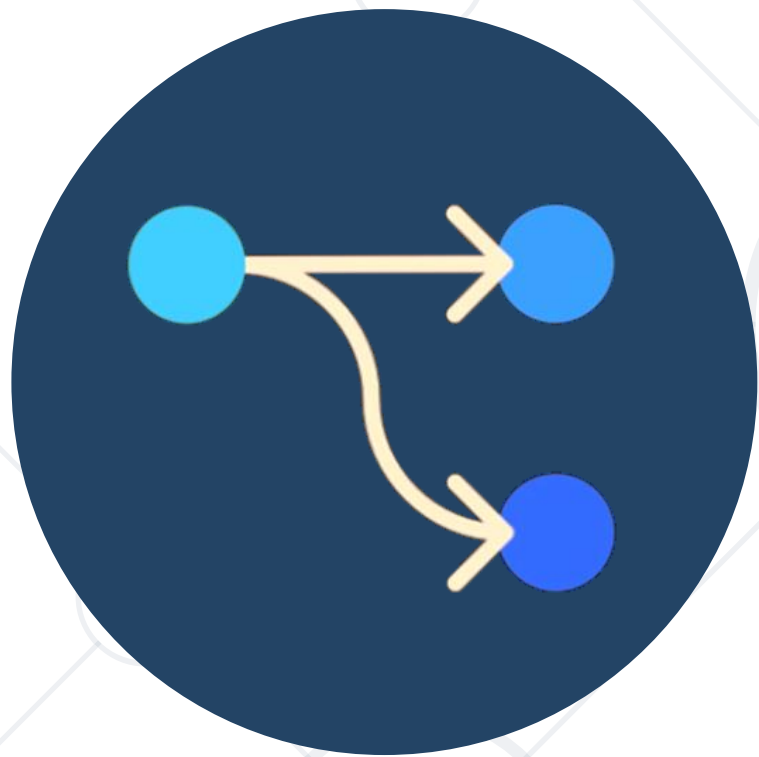
Rendering UI with a Templating Engine

Live Demo

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

- **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

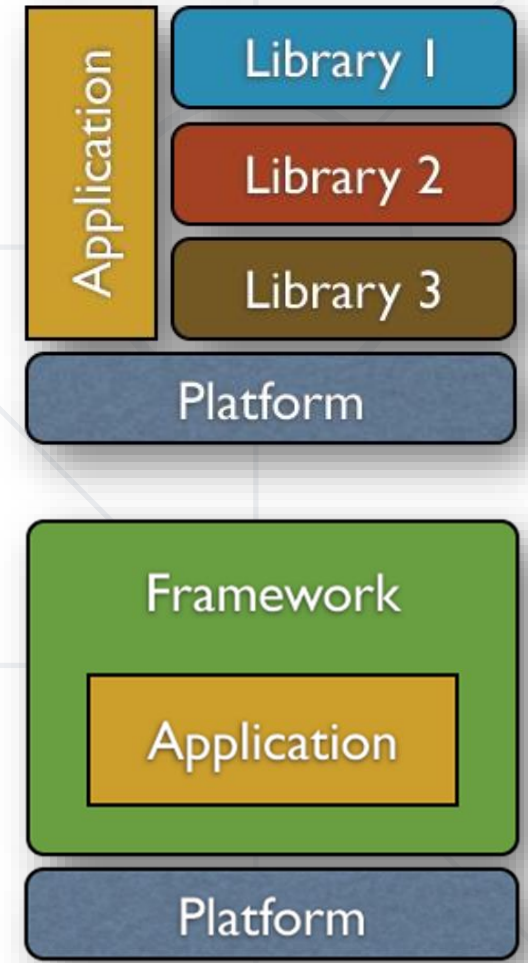
Live Demo

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

- **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

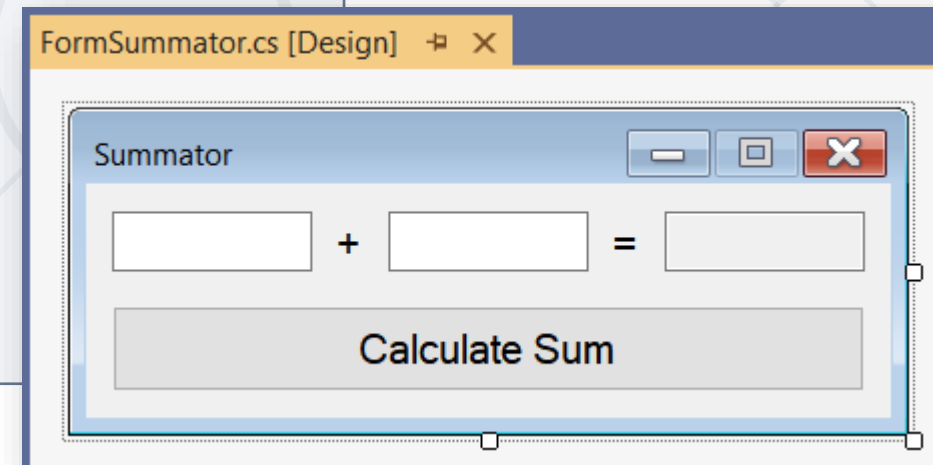
- **Libraries** provide **components / functionality / UI controls** for integration into existing apps
 - The **app controls the library** components
 - Examples: UI control library, Excel reader
- Development **frameworks** are foundations, which developers extend to build an app
 - The framework **controls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



Windows Forms – Example

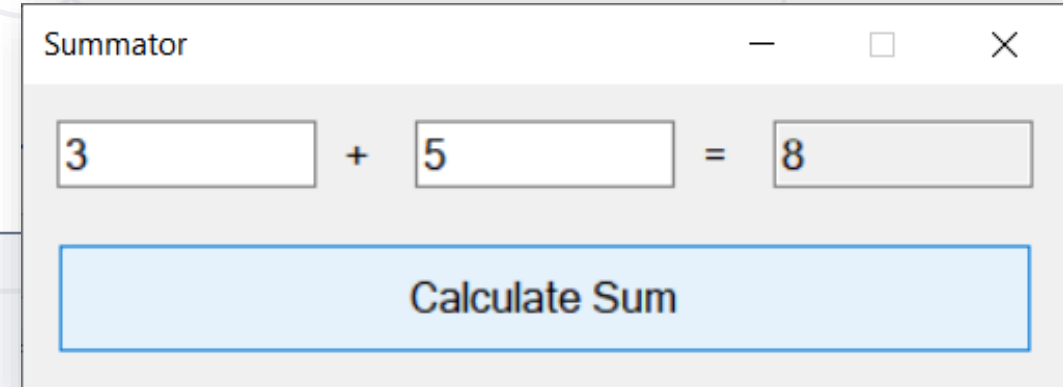
- **Windows Forms** is GUI framework for .NET developers
 - Provides programming model and rich UI control library

```
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

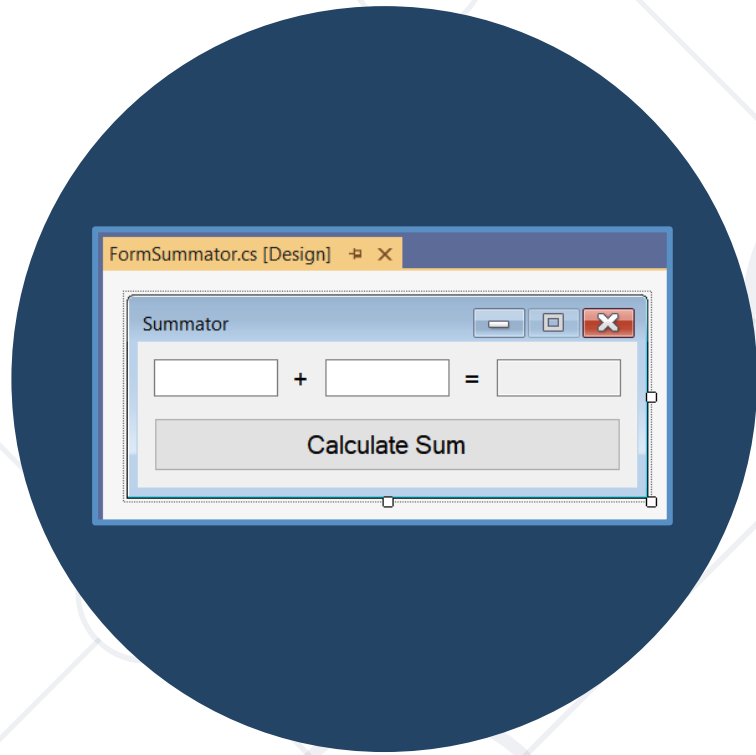
```
public partial class FormSummator
{
    private void buttonCalc_Click(object sender, EventArgs e)
    {
        decimal firstNum = decimal.Parse(this.textBox1.Text);
        decimal secondNum = decimal.Parse(this.textBox2.Text);
        decimal sum = firstNum + secondNum;
        this.textBoxSum.Text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



Summator

3 + 5 = 8

Calculate Sum

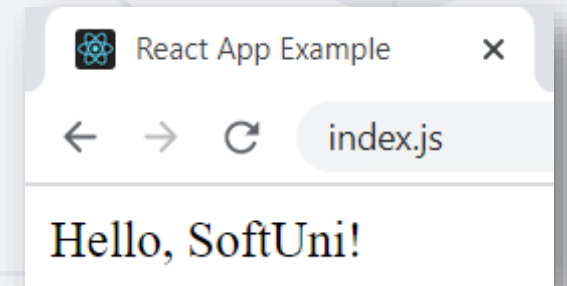


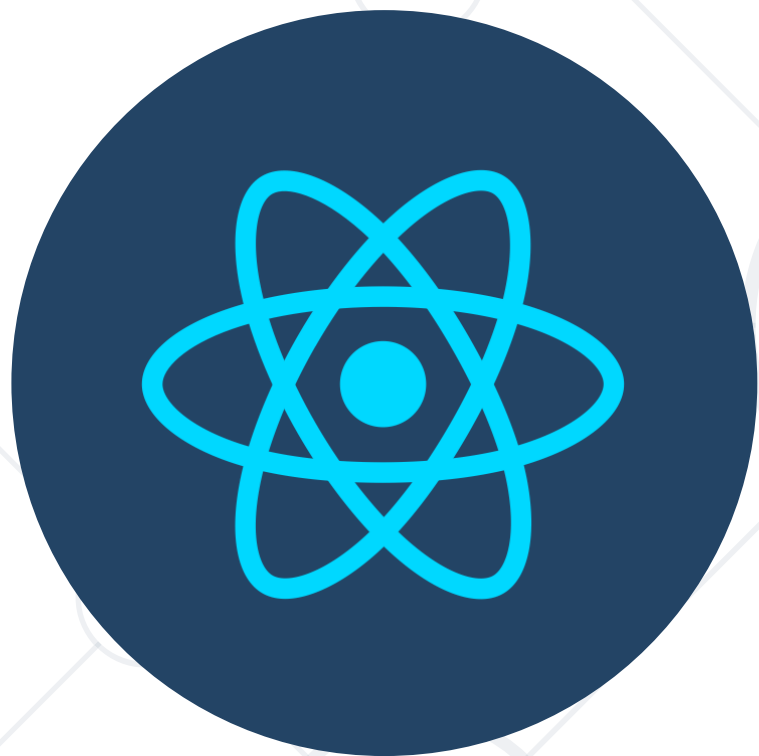
Windows Forms

Live Demo

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






React

Live Demo

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

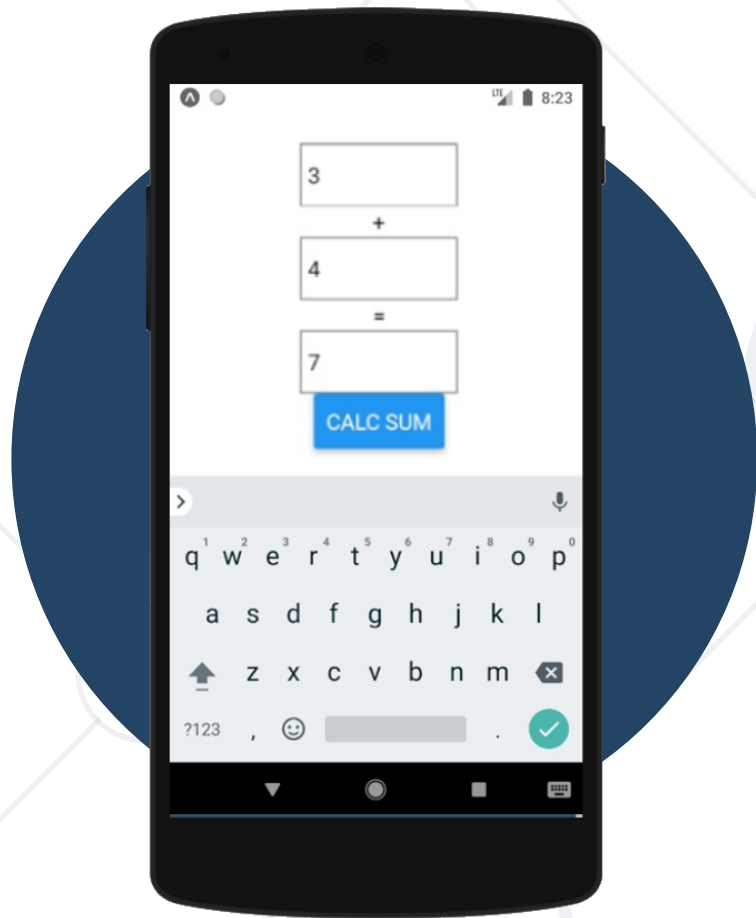


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- Two major mobile app platforms: **Android** and **iOS**
- **Mobile app** development technologies
 - **Android**: Java / Kotlin + Android SDK + Android Studio
 - **iOS**: Swift (or Objective-C) + iOS SDK + Xcode + Mac
 - **Hybrid mobile apps**: JS + 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** 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

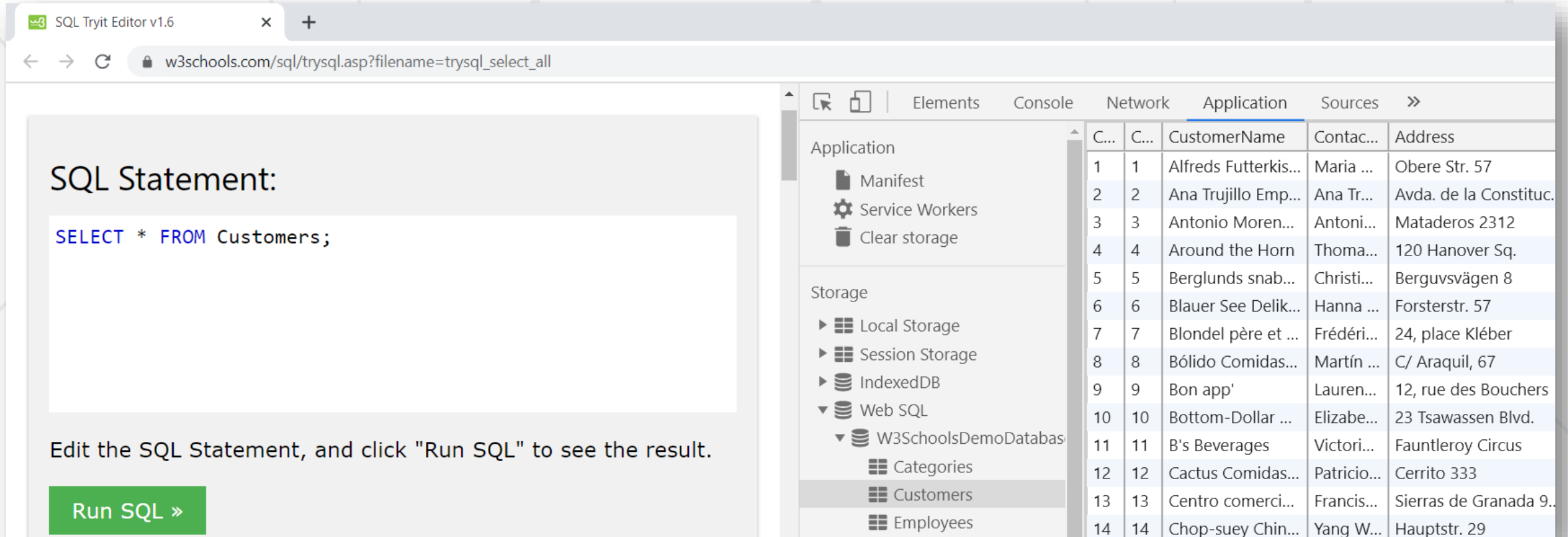


- **Databases** hold and manage data in the back-end systems
- **Relational databases** (RDBMS)
 - Hold data in **tables + relationships**
 - Use the **SQL** language to query / modify data
 - Examples: MySQL, PostgreSQL, Web SQL in HTML5
- **NoSQL databases**
 - Hold collections of documents or key-value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



The screenshot shows the SQL Tryit Editor v1.6 interface. The main area displays the SQL statement: `SELECT * FROM Customers;`. Below the statement, there is a green button labeled "Run SQL »". To the right of the editor, there is a sidebar with tabs for Elements, Console, Network, Application, and Sources. The Application tab is selected, showing a tree view of the application's storage. Under the "Web SQL" section, the "W3SchoolsDemoDatabase" is expanded, showing tables: Categories, Customers, and Employees. The "Customers" table is selected, and its data is displayed in a table on the right.

	C...	C...	CustomerName	Contact...	Address
1	1	Alfreds Futterkis...	Maria ...	Obere Str. 57	
2	2	Ana Trujillo Emp...	Ana Tr...	Avda. de la Constituc.	
3	3	Antonio Moren...	Antoni...	Mataderos 2312	
4	4	Around the Horn	Thoma...	120 Hanover Sq.	
5	5	Berglunds snab...	Christi...	Berguvsvägen 8	
6	6	Blauer See Delik...	Hanna ...	Forsterstr. 57	
7	7	Blondel père et ...	Frédéri...	24, place Kléber	
8	8	Bólido Comidas...	Martín ...	C/ Araquil, 67	
9	9	Bon app'	Lauren...	12, rue des Bouchers	
10	10	Bottom-Dollar ...	Elizabe...	23 Tsawassen Blvd.	
11	11	B's Beverages	Victori...	Fauntleroy Circus	
12	12	Cactus Comidas...	Patricio...	Cerrito 333	
13	13	Centro comerci...	Francis...	Sierras de Granada 9..	
14	14	Chop-suey Chin...	Yang W...	Hauptstr. 29	



Web SQL

Live Demo

<https://w3schools.com/sql/>

SQL Tryit Editor v1.6

w3schools.com/sql/trysql.asp?filename=trysql_select_all

SQL Statement:

```
SELECT * FROM Customers;
```

Edit the SQL Statement, and click "Run SQL" to see the result.

Run SQL »

Application

- Manifest
- Service Workers
- Clear storage

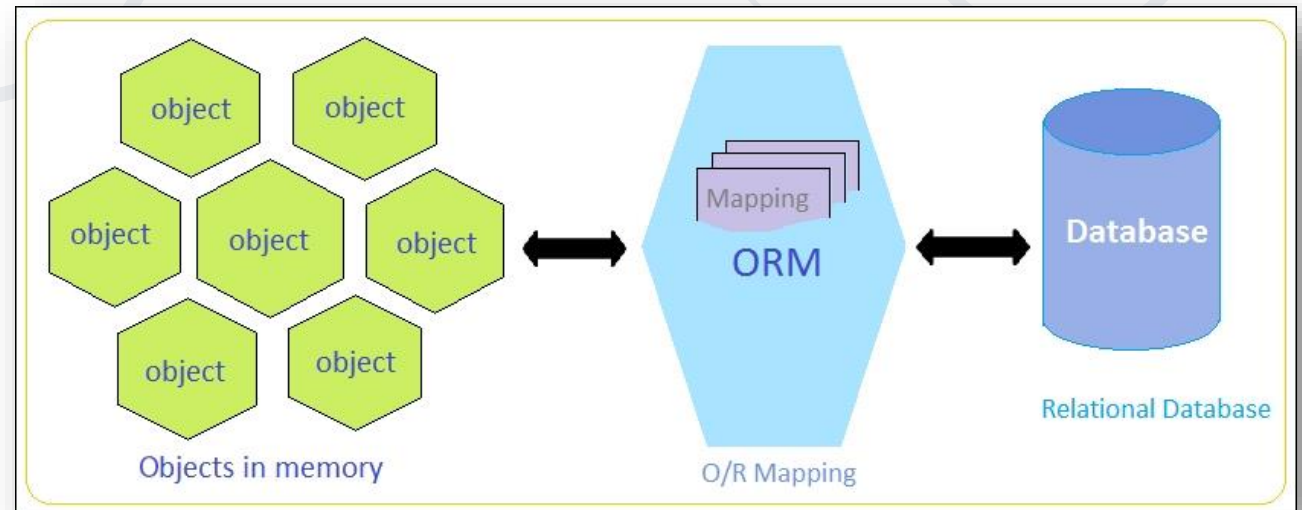
Storage

- Local Storage
- Session Storage
- IndexedDB
- Web SQL
 - W3SchoolsDemoDatabases
 - Categories
 - Customers
 - Employees

Elements Console Network Application Sources >>

	C...	C...	CustomerName	Contact...	Address
1	1	Alfreds Futterkis...	Maria ...		Obere Str. 57
2	2	Ana Trujillo Emp...	Ana Tr...		Avda. de la Constituc.
3	3	Antonio Moren...	Antoni...		Mataderos 2312
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9	9	Bon app'	Lauren...		12, rue des Bouchers
10	10	Bottom-Dollar ...	Elizabe...		23 Tawassen Blvd.
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12	12	Cactus Comidas...	Patricio...		Cerrito 333
13	13	Centro comerci...	Francis...		Sierras de Granada 9.
14	14	Chop-suey Chin...	Yang W...		Hauptstr. 29

- **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)





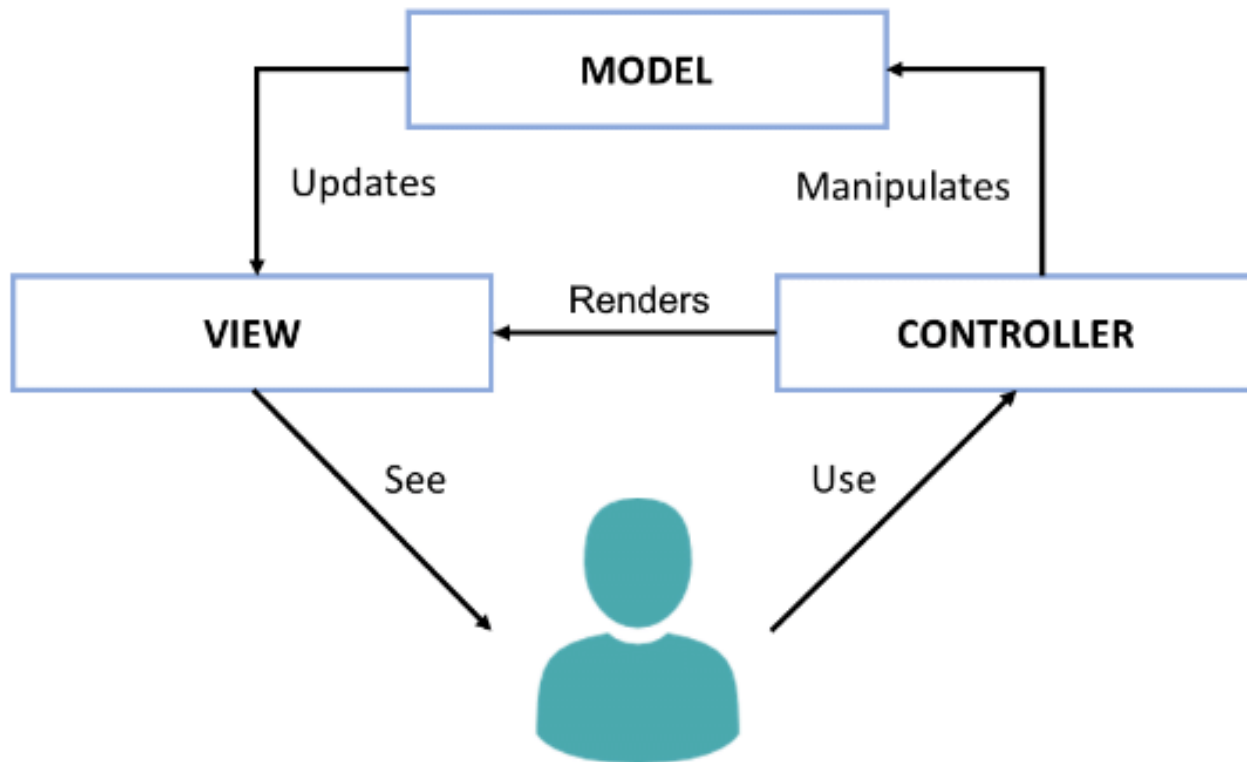
JayData ORM for Web SQL

Live Demo

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

The Model-View-Controller (MVC) Pattern

- 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** 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

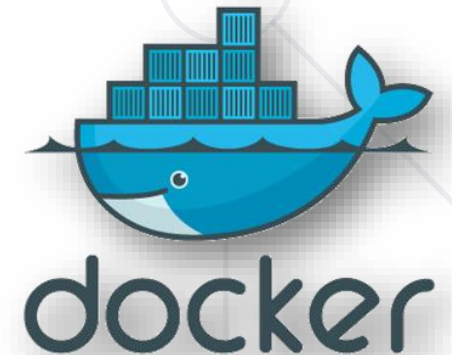
Live Demo

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

- **Virtualization** == 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



- **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



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

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

```
docker ps
```



Play with Docker

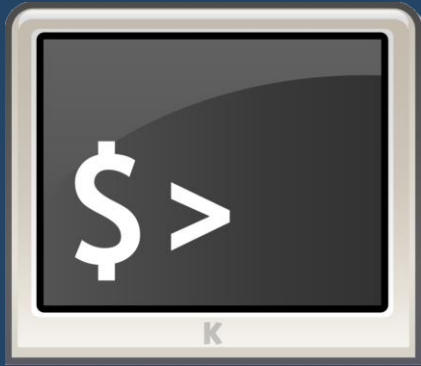
Live Demo

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

- 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

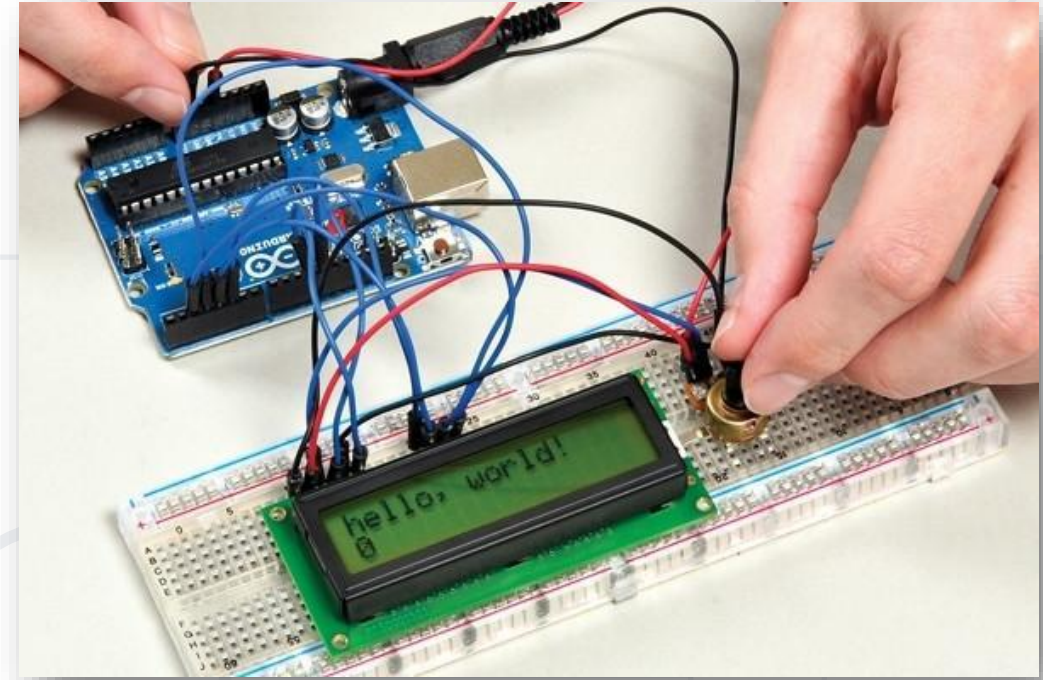
Live Demo

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



Internet of Things (IoT)

- **Embedded systems**
 - **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)



- **Microcontrollers** == microchip (CPU + RAM + GPIO) on a board
 - Examples: Arduino, ESP8266, ESP32, Micro:bit, ATmega328
- **IoT systems** consist of **microcontroller** (or mini-computer) + peripherals + 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)

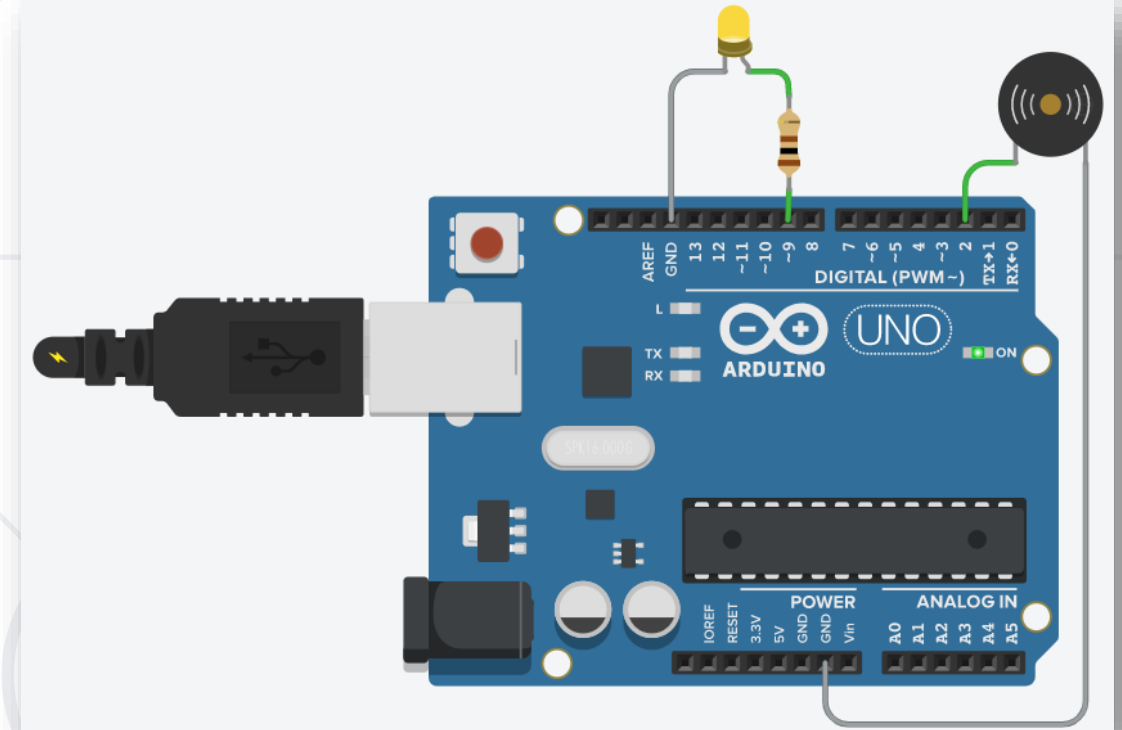


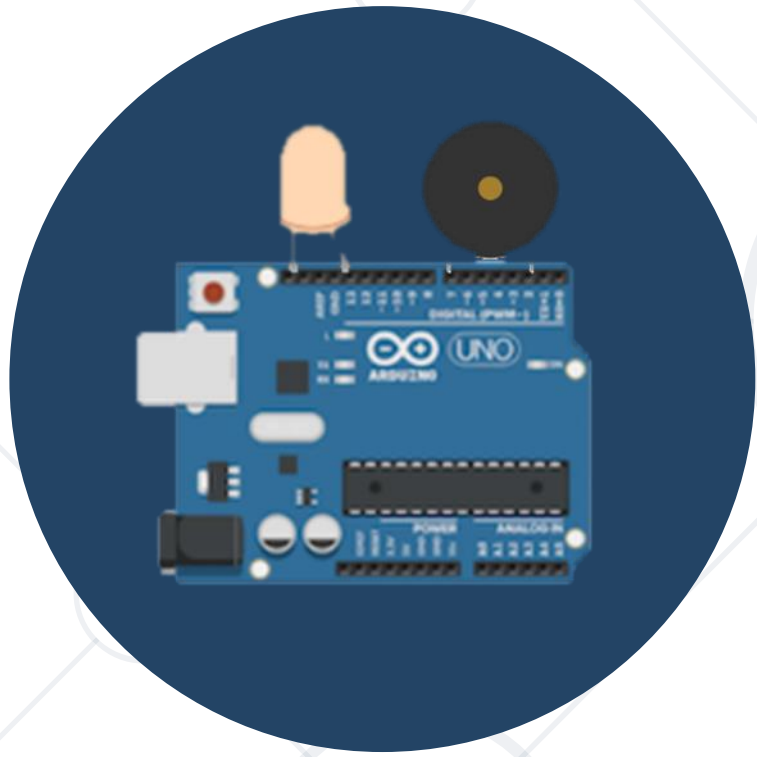
Microcontroller Arduino – Example

```
#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 (SDLC)

- **Software engineering** is not just coding!
- The **SDLC** includes the following activities:
 - **Requirements** analysis
 - Software **design**
 - **Construction**
 - **Testing**
 - **Release**
 - **Maintenance**
- **Development processes** (Waterfall / Scrum / Kanban) define workflow and key practices

Software
project
management



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

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

2 passing (10ms)
1 failing
```


```
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 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** 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



- 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
```



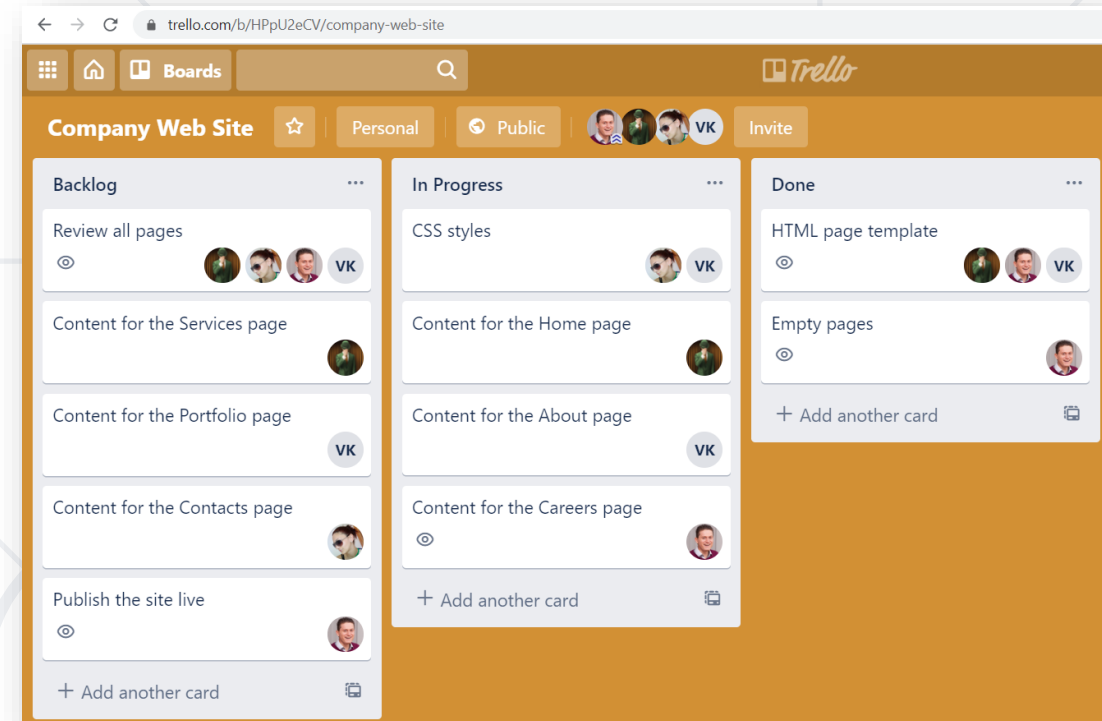
Git and GitHub

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

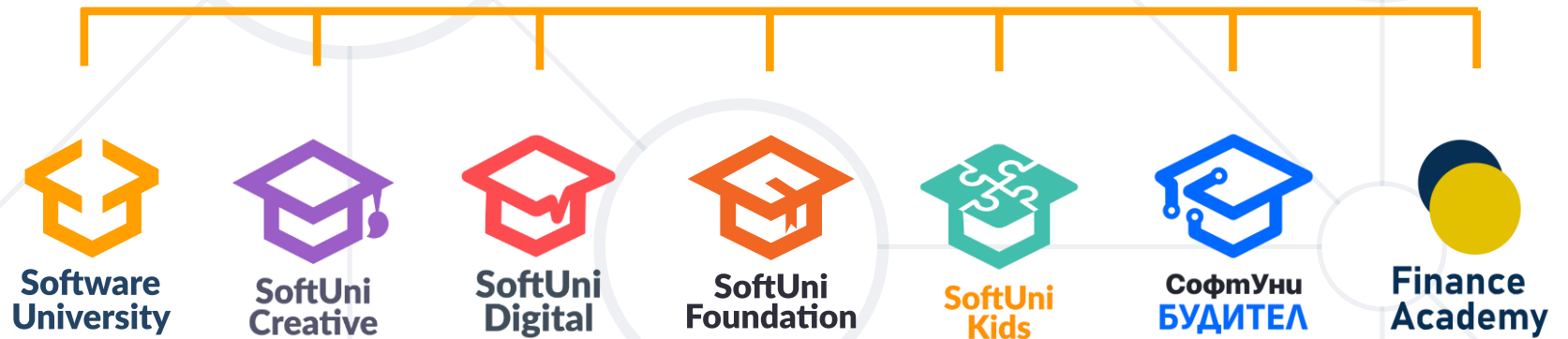
Live Demo

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

- **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?



SoftUni Diamond Partners



Trainings @ Software University (SoftUni)



- Software University – High-Quality Education, Profession and Job for Software Developers

- softuni.bg, softuni.org

- Software University Foundation

- softuni.foundation

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