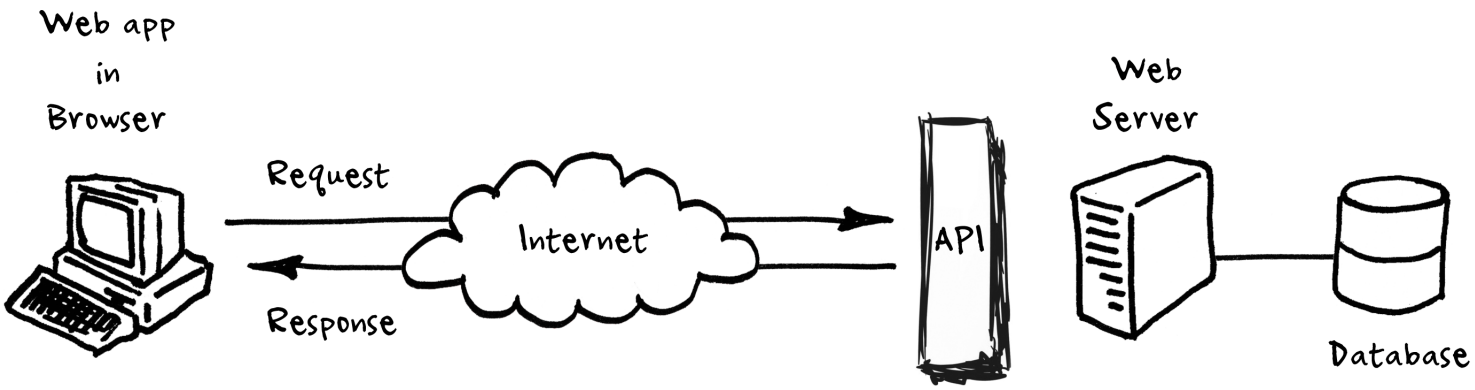
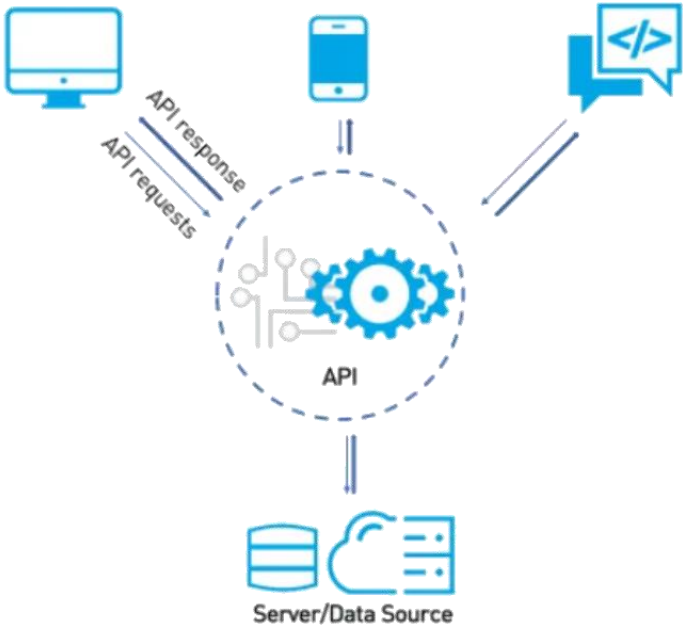
# Web API using JavaScript



# Outline




1. Web and HTTP
2. Web API
3. Web API using Next.js

# Course Roadmap

Web Client

Request

Response

Web Server

Frontend development

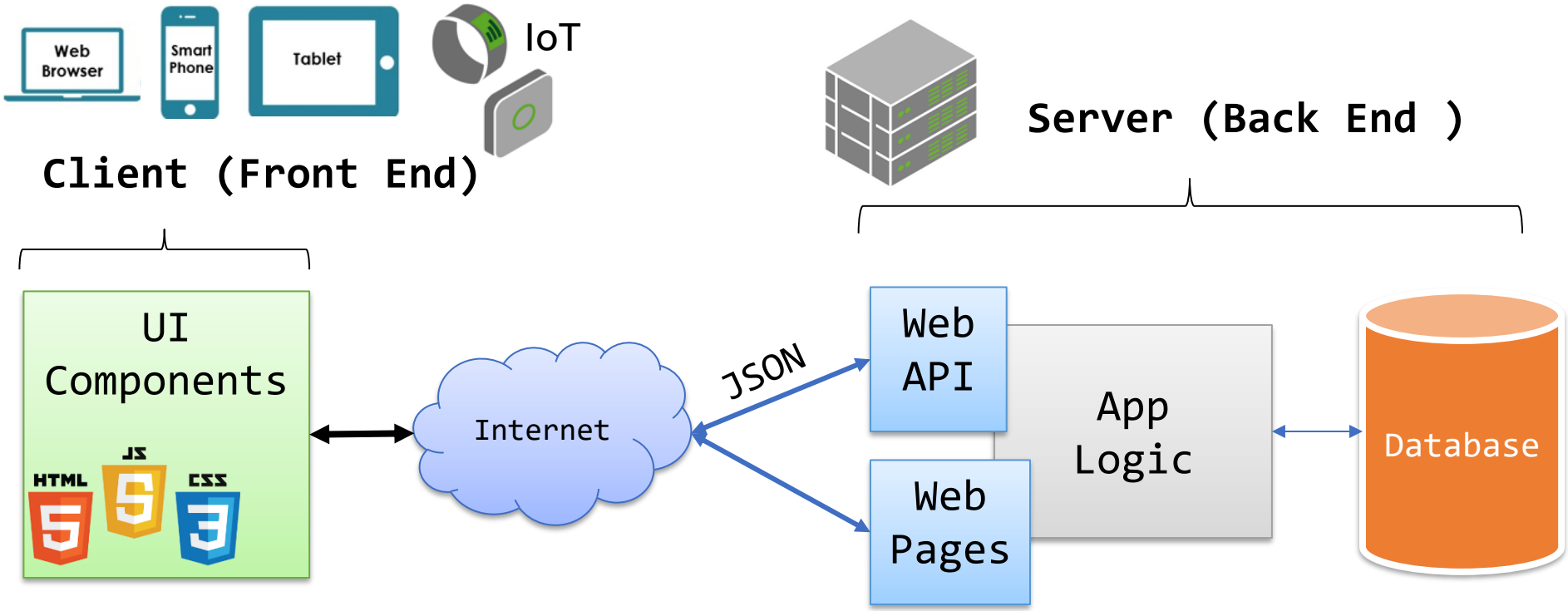
- HTML for page content & structure
- CSS for styling
- JavaScript for interaction

Backend development

- Web API
- Web Pages
- Data Management

# Web App Architecture

- Front-end made-up of **multiple UI components loaded** in response to user actions
- Back-end Web API and Web pages



# What is a Web API

- Web API: A set of methods exposed over the web via HTTP to allow **programmatic access to applications**
- Web API are designed for **broad reach**:
  - Can be accessed by a broad range of clients including browsers and mobile devices
  - Can be implemented or consumed in any language
- Uses HTTP as an **application protocol**

# Web and HTTP

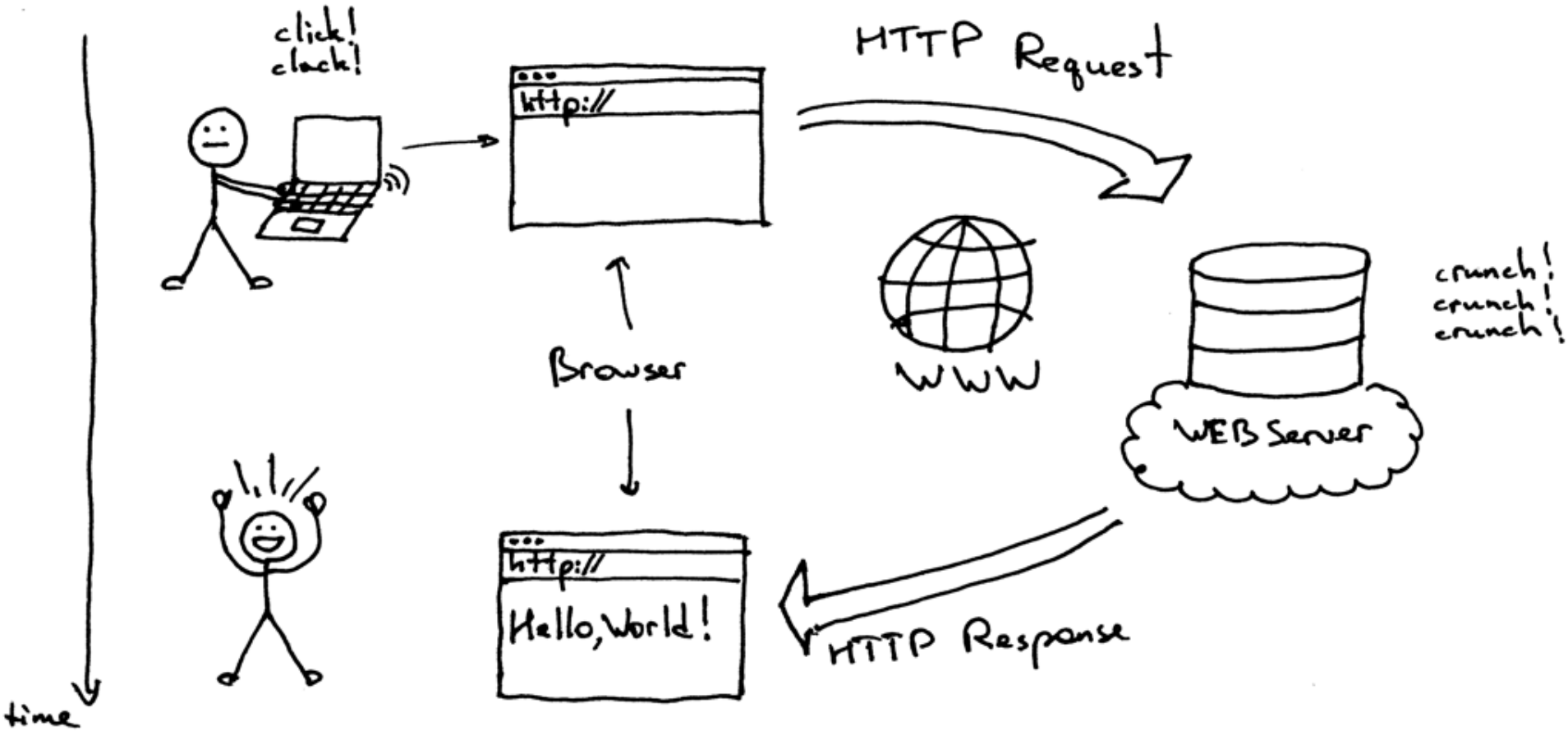

Back

# What is Web?

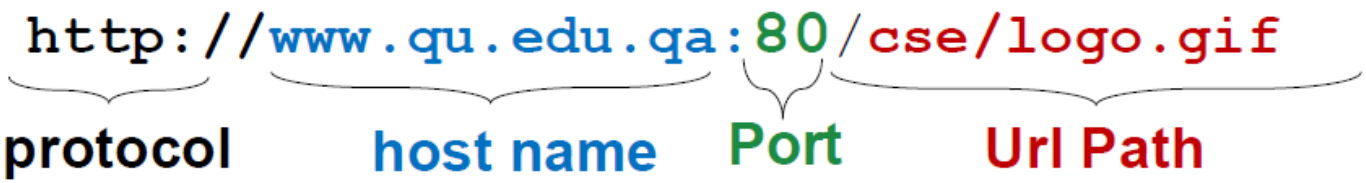
- Web = **global distributed system of interlinked resources accessed over the Internet using the HTTP protocol**
  - Consists of set of **resources** located on different servers:

    HTML pages, images, videos and other resources
  - Resources have unique **URL** (Uniform Resource Locator) address
  - Accessed through standard **HTTP** protocol
- The Web has a Client/Server architecture:
  - **Web browser** (client) requests resources (using HTTP protocol) and displays them
  - **Web server** sends resources in response to requests (using HTTP protocol)

# How the Web Works?



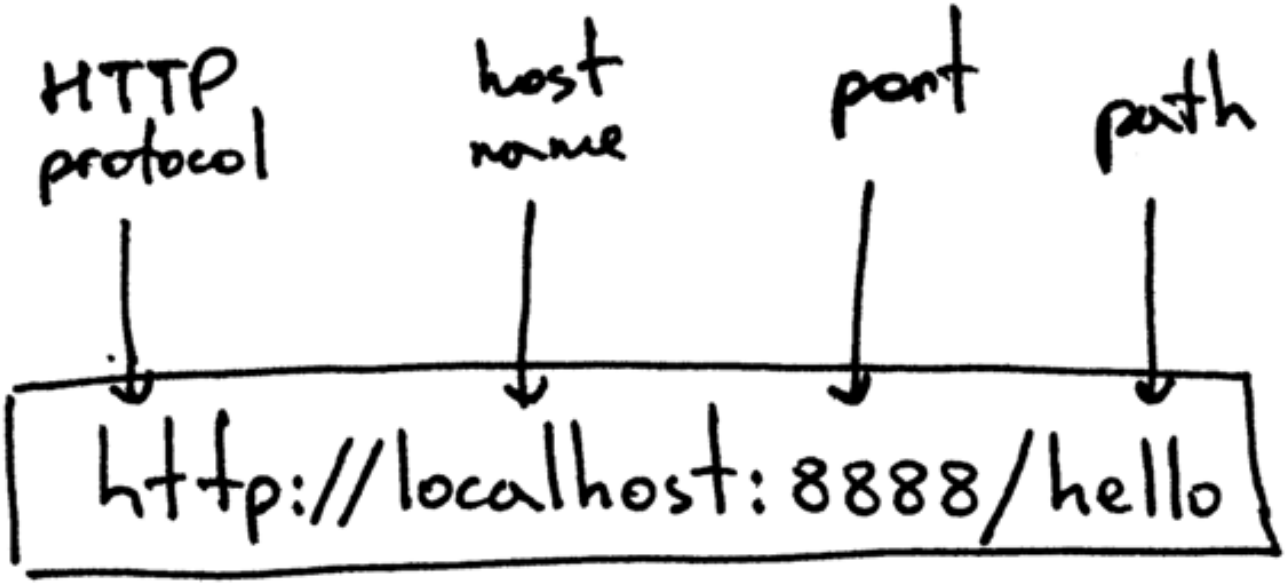
# Uniform Resource Locator (URL)




- URL is a formatted string, consisting of:
  - **Protocol** for communicating with the server (e.g., http, https, ...)
  - **Name of the server or IP** address plus port (e.g. qu.edu.qa:80, localhost:8080)
  - **Path of a resource** (e.g. **/ceng/index.html**)
  - **Parameters** aka **Query String** (optional), e.g.

https://www.google.com/search**?q=qatar%20university**

# URL Example






10

# URL Encoding

- According RFC 1738, the characters allowed in URL are alphanumeric [0-9a-zA-Z] and the special characters $-_.+!*'()
- Unsafe characters should be encoded, e.g.,

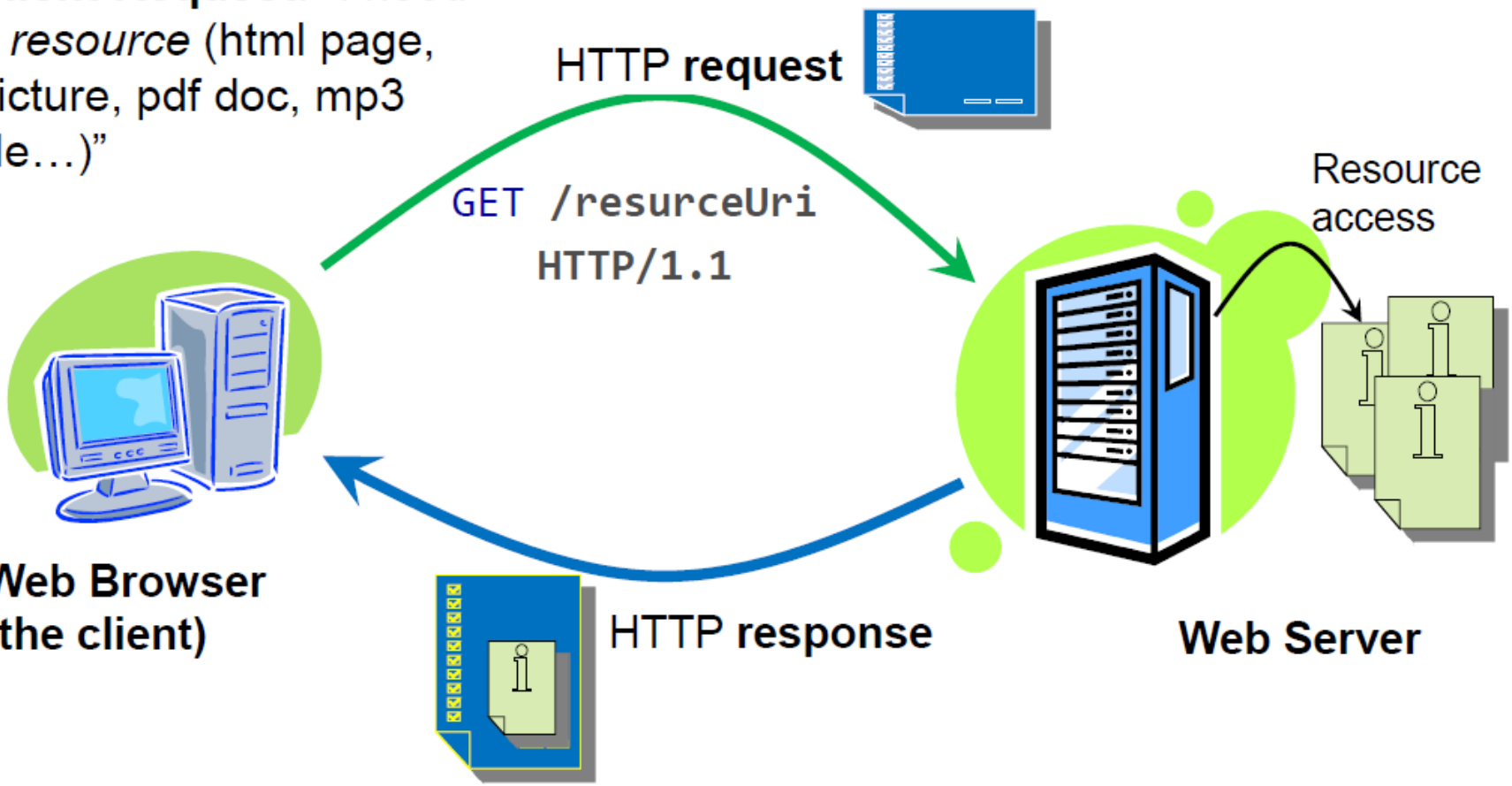
http://google.com/search?q=qatar%20university

Commonly encoded values:

| ASCII Character | URL-encoding |
|---|---|
| space | %20 |
| ! | %21 |
| " | %22 |
| # | %23 |
| $ | %24 |
| % | %25 |
| & | %26 |

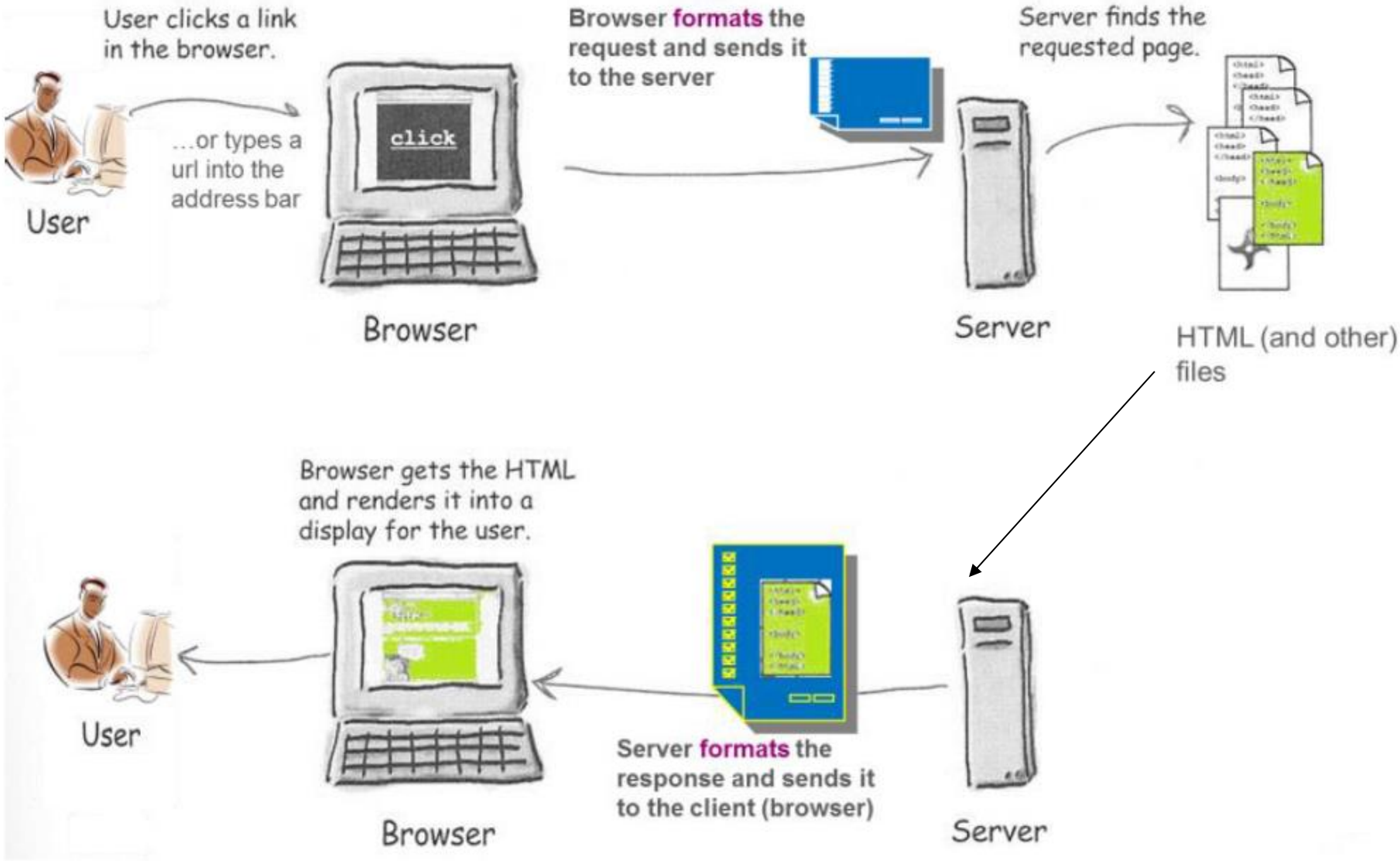
# Web uses Request/Response interaction model
# HTTP is the *message protocol* of the Web

**Client Request**: "I need a *resource* (html page, picture, pdf doc, mp3 file…)"




**Server Response**: "Here you go!"

# The sequence for retrieving a resource



# Request and Response Examples

- **HTTP request:**

**request line** (GET, POST, HEAD commands)

header lines

```
GET /index.html HTTP/1.1
Host: localhost:800
User-Agent: Mozilla/5.0
<CRLF>
```

The empty line denotes the end of the request header

- **HTTP response:**

```
HTTP/1.1 200 OK
Content-Length: 54
<CRLF>
<html><title>Hello</title>
Welcome to our site</html>
```

The empty line denotes the end of the response header

# HTTP Request Message

- Request message sent by a client consists of

– **Request line** – request method (GET, POST, HEAD, ...), resource URI, and protocol version

– **Request headers** – additional parameters

– **Body** – optional data

  - e.g. posted form data, files, etc.

```
<request method> <URI> <HTTP version>
<headers>
<empty line>
<body>
```

# HTTP Request Methods

- **GET**
  - **Retrieve a resource** (could be static resource such as an image or a dynamically generated resource)
  - Input is appended to the request URL E.g.,

  **http://google.com/?q=Qatar**
- **POST**
  - **Create or Update a resource**
  - Web pages often include form input. Input is submitted to server in the **message body.** E.g.,

20 | * | 10 | Submit

```
POST /calc HTTP/1.1
Host: localhost
Content-Type: application/x-www-form-urlencoded
Content-Length: 27
num1=20&operation=*&num2=10
```

# HTTP Response Message

- Response message sent by the server

– **Status line** – protocol version, status code, status phrase

– **Response headers** – provide metadata such as the Content-Type

– **Body** – the contents of the response (i.e., the requested resource)

```
<HTTP version> <status code> <status text>
<headers>
<empty line>
<response body>
```

# HTTP Response – Example

**status line**
(protocol
status code
status text)

Try it out and see HTTP in action using **HttpFox**

```
HTTP/1.1 200 OK
Content-Type: text/html
Server: QU Web Server
Content-Length: 131
<CRLF>
<html>
  <head><title>Calculator</title></head>
  <body>20 * 10 = 200
      <br><br>
      <a href='/calc'>Calculator</a>
  </body>
</html>
```

**HTTP response headers**

**The empty line denotes the end of the response header**

**Response body.** e.g., requested HTML file

# Common Internet Media Types

- The **Content-Type** header describes the media type contained in the body of HTTP message
- **Full list @** http://en.wikipedia.org/wiki/MIME_type
- Commonly used media types (**type/**subtype):

| Type/Subtype | Description |
|---|---|
| application/json | JSON data |
| image/gif | GIF image |
| image/png | PNG image |
| video/mp4 | MP4 video |
| text/xml | XML |
| text/html | HTML |
| text/plain | Just text |

# HTTP Response Status Codes

- Status code appears in 1st line in the response message
- HTTP response code classes
  - 2xx: success (e.g., “200 OK”)
  - 3xx: redirection (e.g., "302 Found")

  "302 Found" is used for redirecting the Web browser to another URL
  - 4xx: client error (e.g., “404 Not Found”)
  - 5xx: server error (e.g., “503 Service Unavailable”)

# Popular Status Codes

| Code | Reason | Description |
|---|---|---|
| 200 | OK | Success! |
| 301 | Moved Permanently | Resource moved, don't check here again |
| 302 | Moved Temporarily | Resource moved, but check here again |
| 304 | Not Modified | Resource hasn't changed since last retrieval |
| 400 | Bad Request | Bad syntax? |
| 401 | Unauthorized | Client might need to authenticate |
| 403 | Forbidden | Refused access |
| 404 | Not found | Resource doesn't exist |
| 500 | Internal Server Error | Something went wrong during processing |
| 503 | Service Unavailable | Server will not service the request |

# Browser Redirection

- HTTP browser redirection example
  - HTTP GET requesting a moved URL:

| | |
|---|---|
| (Request-Line) | GET /qu HTTP/1.1 |
| Host | localhost:800 |
| User-Agent | Mozilla/5.0 (Windows NT 6.3; WOW64; rv:27.0) Gecko/20100101 Firefox/27.0 |
| Accept | text/html,application/xhtml+xml,application/xml;q=0.9,*/*;q=0.8 |

  - The HTTP response says that the browser should request another URL:

| | |
|---|---|
| (Status-Line) | HTTP/1.1 301 Moved Permanently |
| Location | http://qu.edu.qa |

2

# Web API
# (aka REST Services)

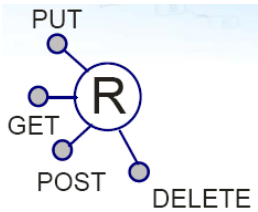
Back

# What is a Web API?

- Web API = Web accessible Application Programming Interface. Also known as REST Services.
- Web API is a web service that accepts requests and returns **structured data** (JSON in most cases)
  - Programmatically accessible at a particular URL
  - You can think of it as a Web page returning JSON instead of HTML


- Major goal = **interoperability between heterogeneous systems**

# REST Principles




- **Resources have unique address** (**nouns**) i.e., a URI

e.g., http://example.com/customers/123

- **Can use a Uniform Interface** (**verbs**) to access them:

  - HTTP verbs: GET, POST, PUT, and DELETE

- **Resource has representation(s)** (**data format**)

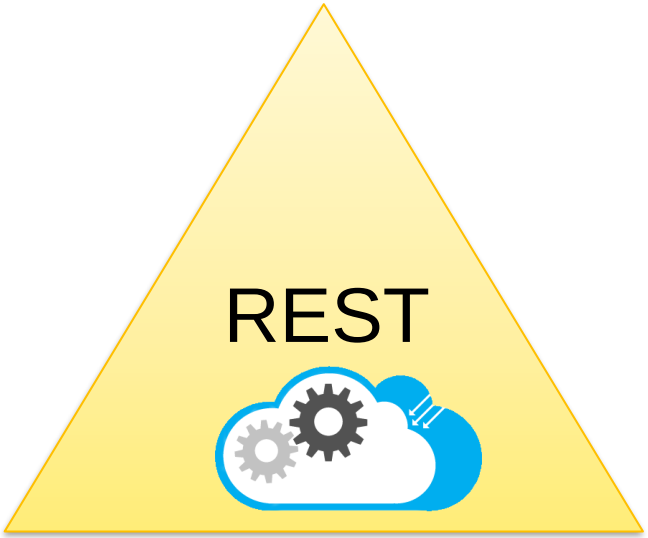
  - A resource can be in a variety of data formats: JSON, XML, RSS..

# Resources

- The key abstraction in REST is a **resource**
- A resource is a conceptual mapping to a set of entities
  - Any **information that can be named can be a resource**: a document or image, a temporal service (e.g. "today's weather in Doha"), a collection of books and their authors, and so on

# REST Services Main Concepts

**Nouns (Resources)**
e.g., http://example.com/employees/12345




**Verbs**
e.g., GET, POST

**Representations**
e.g., XML, JSON

# Naming Resources

- REST uses URL to identify resources

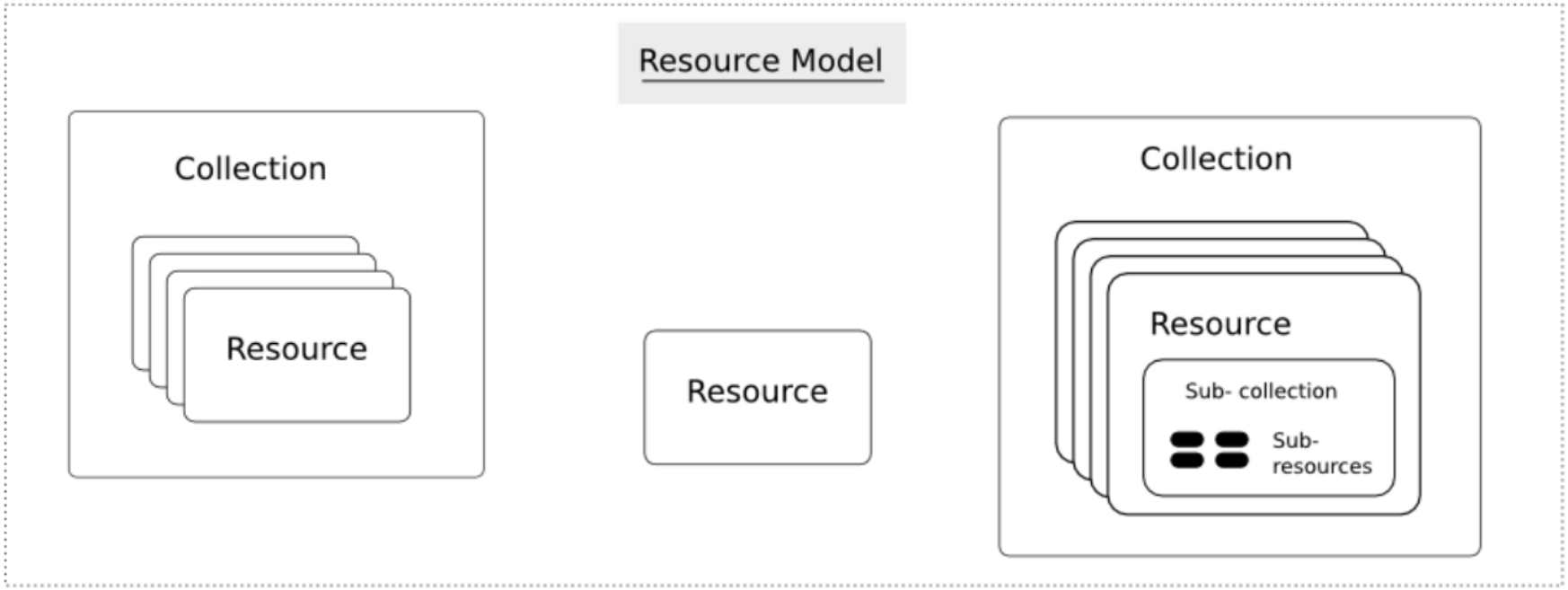
Dedicated **api** path is recommended for better organization

  - http://localhost/api/books/
  - http://localhost/api/books/ISBN-0011
  - http://localhost/api/books/ISBN-0011/authors

  - http://localhost/api/classes
  - http://localhost/api/classes/cmps350
  - http://localhost/api/classes/cmps350/students

- As you traverse the **path** from more generic to more specific, you are navigating the data

# A Collection with Resources




A Collection with Resources

A Singleton Resource

Sub-collections and Sub-resources

# Example CRUD (Create, Read, Update and Delete) API that manages books

- Create a new book
  - **POST** /books
- Retrieve all books
  - **GET** /books
- Retrieve a particular book
  - **GET** /books/:id
- Replace a book
  - **PUT** /books/:id
- Update a book
  - **PATCH** /books/:id
- Delete a book
  - **DELETE** /books/:id

# Representations

Two main formats:

- **JSON**

```
{
    code: 'cmp123',
    name: 'Web Development'
}
```

- **XML**

```
<course>
    <code>cmp123</code>
    <name>Web Development</name>
</course>
```

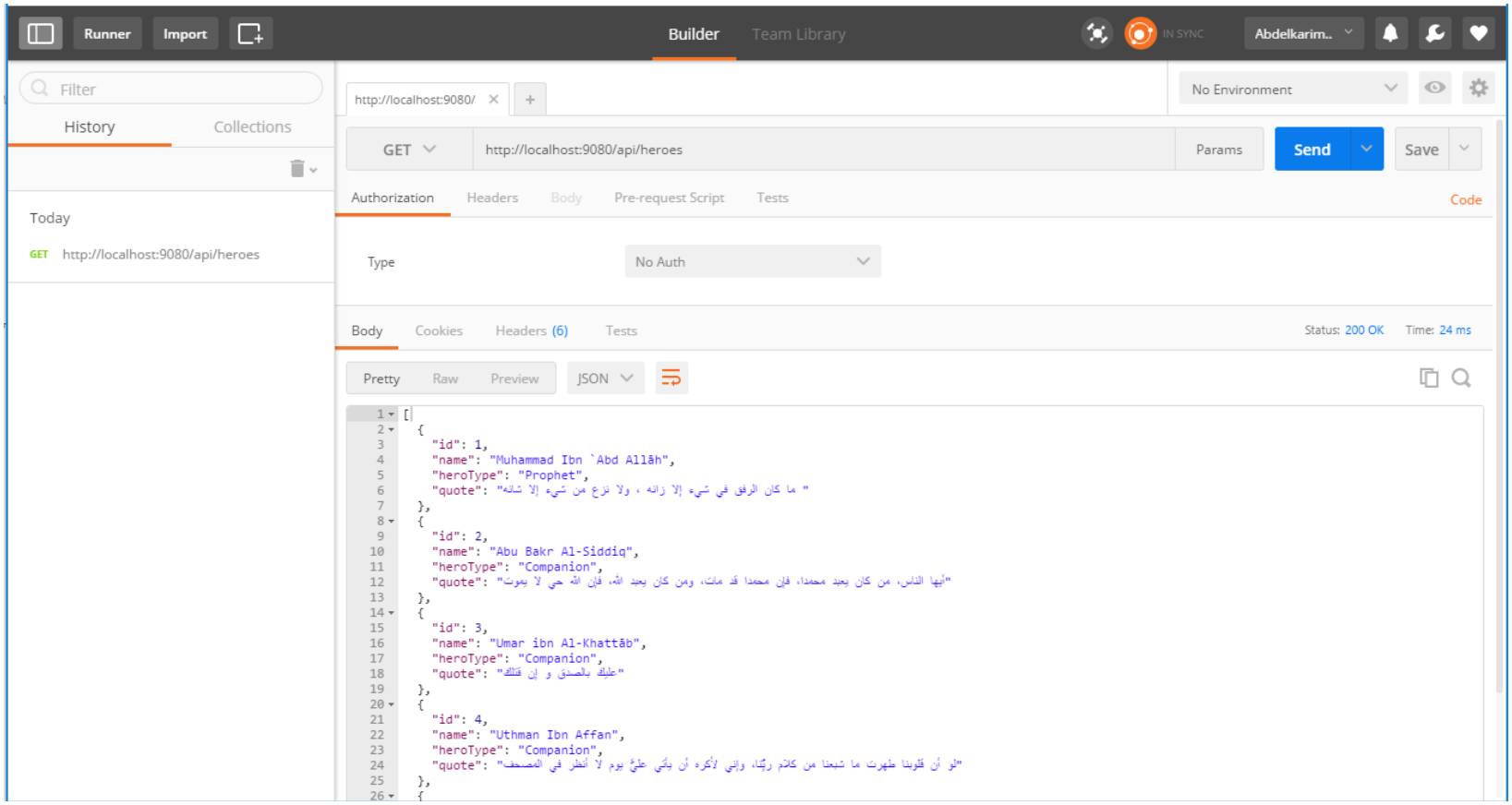
# HTTP Verbs

- Represent the actions to be performed on resources
- Retrieve a representation of a resource: **GET**
- Create a new resource:
  - Use **POST** when the server decides the new resource URI
    - Post is not repeatable
  - Use **PUT** when the client decides the new resource URI
    - Put is repeatable
- **PUT** is typically used for update
- Delete an existing resource: **DELETE**
- Get metadata about an existing resource: **HEAD**
- Get which of the verbs the resource understands: **OPTIONS**

# Testing REST Services

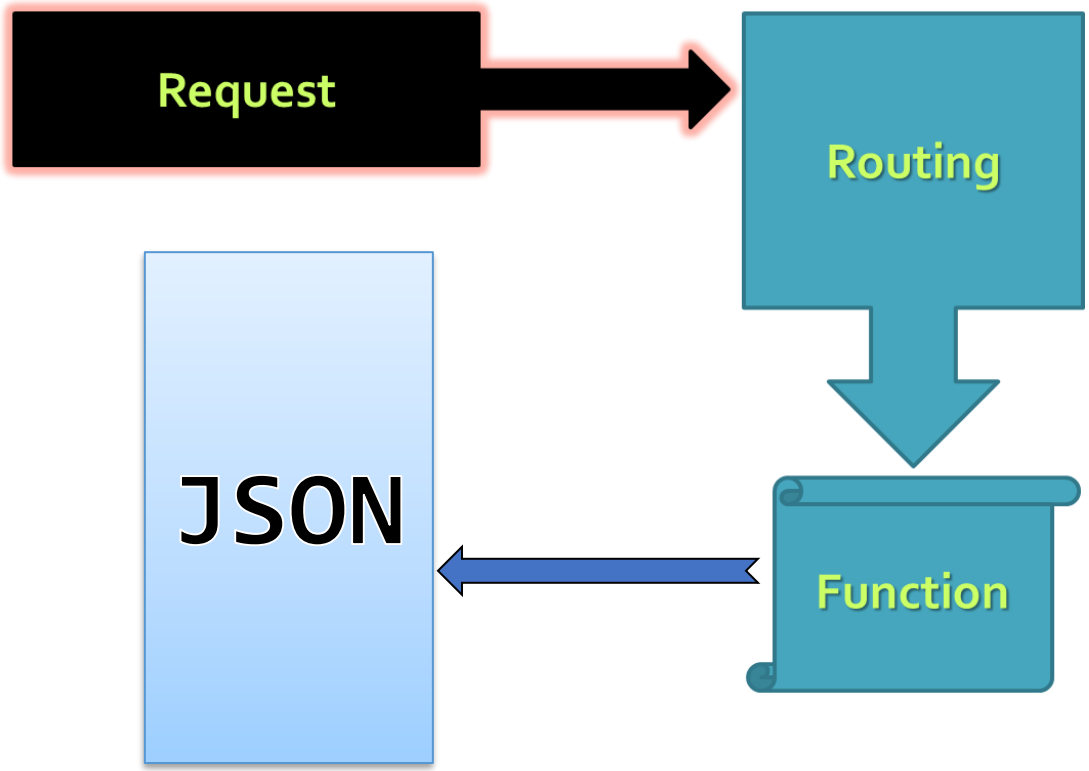
- Using Postman to test Web API

https://www.getpostman.com/postman



3

# Web API using NEXT.JS




Back

# Getting started

- Create an empty folder (with no space in the name use **dash -** instead)
- Create next.js app (select **No** for all questions)

```
npx create-next-app@latest .
```

```
√ Would you like to use TypeScript with this project? ... No / Yes
√ Would you like to use ESLint with this project? ... No / Yes
√ Would you like to use `src/` directory with this project? ... No / Yes
√ What import alias would you like configured? ... @/*
```

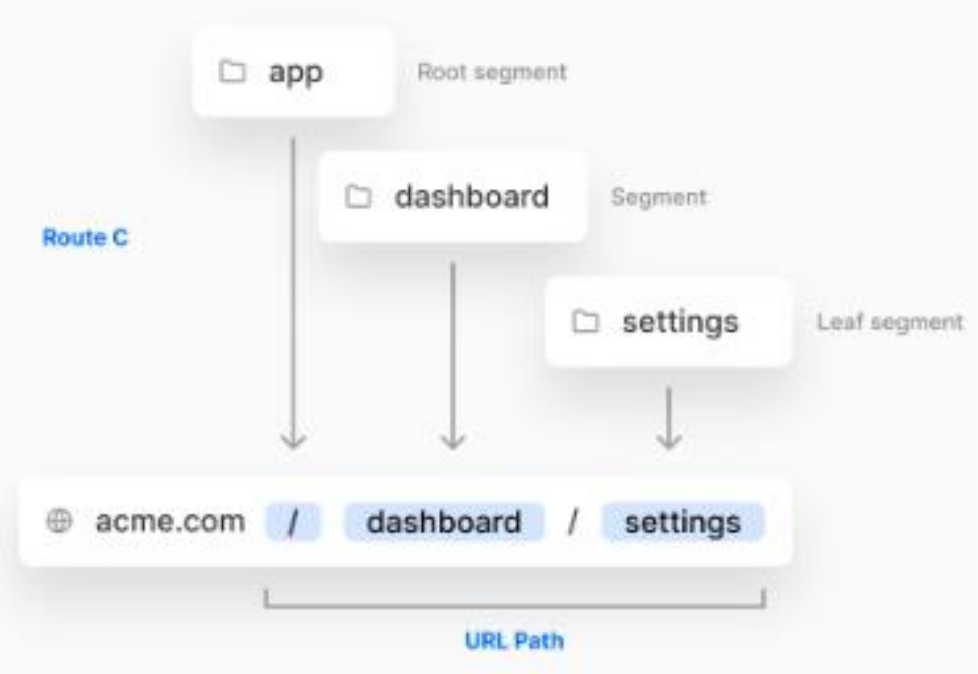
- Creates a new **`Next.js`** project and downloads all the required packages
- Run the app in dev mode: **`npm run dev`**

# Next.js Routing


- Next.js has a **file-system based App Router**:
  - Folders inside the **app** directory are used to define routes
    - A route is a single path of nested folders, from the root folder down to a leaf folder
  - Files are used to create Web pages (`page.js`) or Web API (`route.js`)

- Each folder in the subtree represents a route segment in a URL path

- E.g., create `/dashboard/settings` route by nesting two subfolders in the app directory



# API Routes

- Add a **`route.js`** file under the **app** folder or within subfolders to define API routes
- A route.js file can export async functions named after HTTP methods (`GET`, `HEAD`, `OPTIONS`, `POST`, `PUT`, `DELETE`, `PATCH`) to handle requests
- Any subfolder within app containing a route.js file is treated as a Web API endpoint (e.g., app/api/hello/route.js).

```
export async function GET(request) {
  return new Response('Hello, Next.js!');
}
```

- Visiting http://localhost:3000/api/hello will return Hello, Next.js!

# Routing in Next.js

DELETE
GET
POST
PATCH
PUT

- Requests can be routed based on:
  - **HTTP Verbs**: GET, POST, PUT, DELETE
  - **URL Paths**: e.g., /users
- An App Route maps an HTTP Verb (e.g., GET, POST) and a URL path (e.g., /users/123) to a **route handler function**
  - The handler function receives a **request** object and returns a **response** object
  - The **request** object allows extracting data, such as the request body
  - The **response** object represents the HTTP response and is used to send the generated output


38

# Dynamic API Routes

- To create a dynamic route (having named path parameters) simply wrap the folder's name in square brackets `[folderName]`
  - Allows adding **path parameters** to the URL path. E.g., **/blogs/123**

| Route | Example URL | params |
|---|---|---|
| app/blogs/[id]/route.js | /blog/123 | { id: '123' } |
| app/blogs/[id]/route.js | /blog/234 | { id: '234' } |

- Dynamic segments are passed as **params** argument to the handler functions
  - E.g., if you have the path `/blogs/[id]`, then the "id" property is available as `(await params).id`

```
// app/blogs/[id]/route.js
export async function GET(request, { params }) {
  const id = (await params).id;
  return new Response(`Blog id# ${id}`)
}
```

# Catch-all dynamic routes

- **catch-all dynamic routes**: allows a dynamic route to catch all paths by simply adding ellipsis(...) inside the brackets [...folderName]
  - e.g., The catch all page in **app/blogs/[...filterBy]** will match any path underneath **/blogs** such as: /blogs/2025, /blogs/2025/3/10, and so on
  - Matched parameters array can be access using the **params**, so the path /blogs/2025/3/10 will have the following **params** object ["2025", "3", "10"]

| Route | Example URL | params |
|---|---|---|
| app/blogs/[...filterBy]/route.js | /blogs/2023 | { filterBy: ['2023'] } |
| app/blogs/[...filterBy]/route.js | /blogs/2023/3 | {filterBy: ['2003', '3']} |

# Optional Catch-all Segments

- Catch-all Segments can be made optional by including the parameter in double square brackets: **`[[...folderName]]`**
- For example, **`app/shop/[[...slug]]/route.js`** will also match `/shop`, in addition to `/shop/clothes`, `/shop/clothes/tops`, `/shop/clothes/tops/t-shirts`
- The difference between catch-all and optional catch-all segments is that with optional, the route without the parameter is also matched (`/shop` in the example above).

# Query Parameters

- Named **query parameters** can be added to the URL path after a **?** E.g., **/products?sortBy=price**
- Query parameters are often used for **optional** parameters (e.g., optionally specifying the property to be used to sort of results)
- **request.nextUrl.searchParams** is an object containing a property for each query parameter in the URL path
  - If you have the path /products**?sortBy**=**price**, then the "**sortBy**" property can accessed as shown below:

```
export async function GET(request) {
    const { searchParams } = request.nextUrl;
    const sortBy = searchParams.get("sortBy") || "default";
    const res = await fetch(`https://api.com/products?sortBy=${sortBy}`);
    const products = await res.json();
    return new Response(JSON.stringify(products), { status: 200 });
}
```

# Working with a Request Body

- The request body can be retrieved using one of the following request methods:

  **.json()** , **.text()** or **.formData()**

```
export async function POST(request) {
    let hero = await request.json()
    hero = await addHero(hero)
    return Response.json(hero, { status: 201 })
}
```

# Headers

- You can read http headers with the **headers** library from next/headers package
- You can also return a new Response with new headers

```
import { headers } from "next/headers";

export async function GET(request) {
  const headersList = await headers();
  const apiKey = headersList.get("apiKey");

  return new Response("Hello, Next.js!", {
    status: 200,
    headers: { apiKey: apiKey || "No API Key" },
  });
}
```

# Redirect

- Sends a redirect response to another Url

```
import { redirect } from 'next/navigation'

export async function GET(request) {
  redirect('https://nextjs.org/')
}
```

# Summary

- Next.js = React-based full stack web framework that allows creating server-side rendered pages, and Web API
- Next.js has a **file-system based router**: when a folder is added to the **app** directory, it's automatically available as a route
  - In Next.js you can add brackets to the folder name to create a dynamic route
- Add Web API Route Handlers inside the app/ directory (e.g., app/api/users/route.js)

# Summary (continued…)

- Build a public API if it need
  - to be shared by web, mobile, or third-party clients to consume your data/functionality
  - to proxy a backend /external service and include secret authentication headers
- Export HTTP methods (GET, POST, PUT, DELETE, etc.) in the route.js file
- Use Web Standard APIs to interact with the Request object and return a Response
- Fetch the API routes from the client with fetch('/api/…')

# Resources

- Learn Next.js

https://nextjs.org/docs

- Next.js blog

https://nextjs.org/blog