Data transmission between server and client & database management

Sending data to server or vice versa

Client side data storage

Database

Database management systems

SQL

Previous week

HTML

- To design webpages

CSS

- For styles

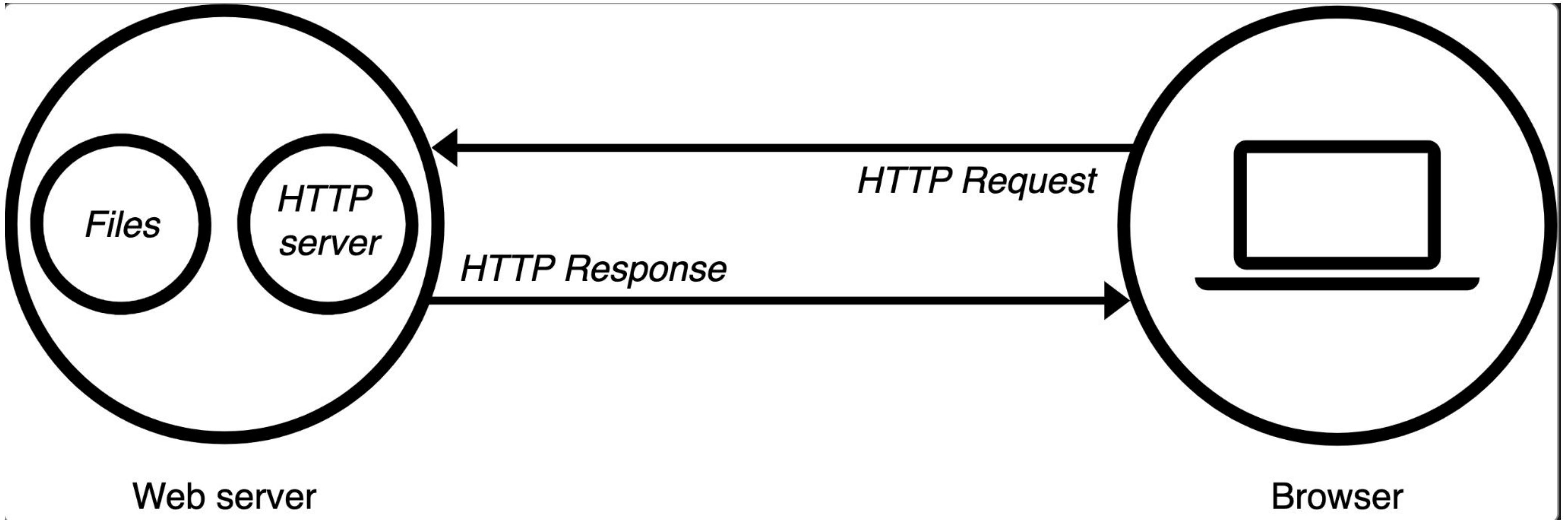
Javascript

- A programming language,
- We use to modify/add/remove HTML objects and website data

Event based programming

- E.g. onclick run a Javascript function

A web server



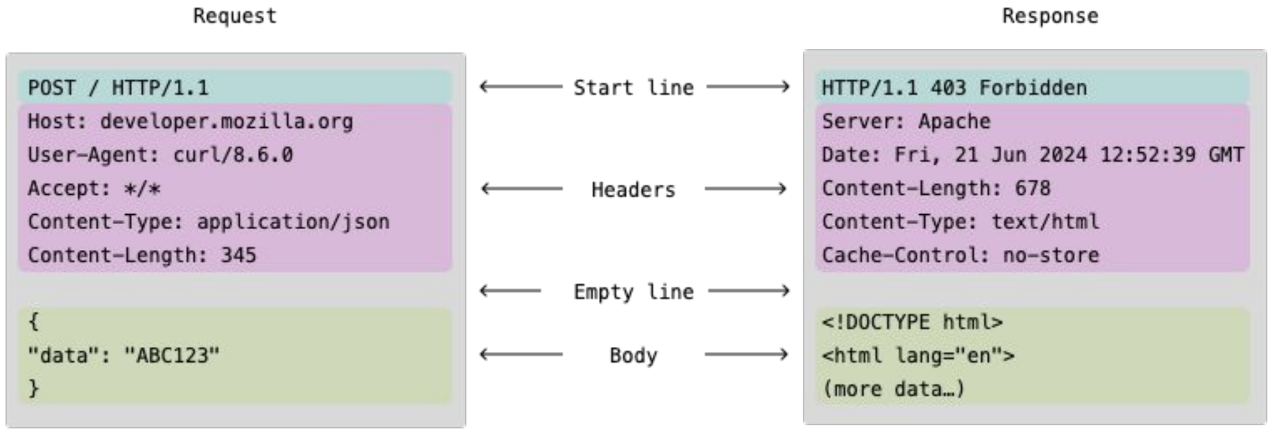
https://developer.mozilla.org/en-US/docs/Learn/Common_questions/Web_mechanics/What_is_a_web_server

HTTP

A **Protocol** is a set of rules for communication between two computers.

HTTP specifies how to transfer hypertext (linked web documents) between two computers.

example:



```
POST / HTTP/1.1
Host: developer.mozilla.org
User-Agent: curl/8.6.0
Accept: */*
Content-Type: application/json
Content-Length: 345

{
"data": "ABC123"
}
```

```
HTTP/1.1 403 Forbidden
Server: Apache
Date: Fri, 21 Jun 2024 12:52:39 GMT
Content-Length: 678
Content-Type: text/html
Cache-Control: no-store

<!DOCTYPE html>
<html lang="en">
(more data…)
```

https://developer.mozilla.org/en-US/docs/Web/HTTP/Messages

Javascript Fetch API

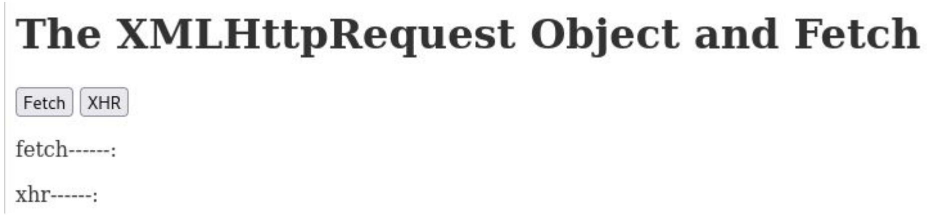
The Fetch API provides a JavaScript interface for making HTTP requests and processing the responses.

Fetch is the modern replacement for XMLHttpRequest:

unlike XMLHttpRequest, which uses callbacks, Fetch is promise-based and is integrated with features of the modern web such as service workers and Cross-Origin Resource Sharing (CORS).

Example

```html
<!DOCTYPE html>
<html>
<head><style>
        .fetch:before {
            content: 'fetch------:';
        }
        .xhr:before {
            content: 'xhr------:';
        }
   </style></head>
<body>
   <h1>The XMLHttpRequest Object and Fetch</h1>
   <button type="button" onclick="getData()">Fetch</button>
   <button type="button" onclick="loadDoc()">XHR</button>
   <p id="fetch" class="fetch"></p>
   <p id="xhr" class="xhr"></p>
```



The XMLHttpRequest Object and Fetch

fetch------:

xhr------:

I would like to fetch/get content of https://www.w3schools.com/jsref/fetch_info.txt

```
<h1>Fetch API</h1>

<p>The Fetch API interface allows web browser to make HTTP requests to web servers.</p>

<p>If you use the XMLHttpRequest Object, Fetch can do the same in a simpler way.</p>
```

Note: for cross origin requests; use JSONP-**script.src**, **form**, etc. See Fetch: Cross-Origin Requests

```
async function getData() {
    document.getElementById("fetch").innerHTML = "send";
    let response = await fetch("https://www.w3schools.com/jsref/fetch_info.txt");
    let text = await response.text();
    document.getElementById("fetch").innerHTML = text;
}
function loadDoc() {
    var xhttp = new XMLHttpRequest();
    xhttp.onreadystatechange = function () {
        if (this.readyState ==XMLHttpRequest.DONE
            && this.status == 200) {
            document.getElementById("xhr").innerHTML = this.responseText;
        }
    };
    xhttp.open("GET", "https://www.w3schools.com/jsref/fetch_info.txt", true);
    xhttp.send();
}
```

Note: you can only run this on www.w3schools.com

How to send formatted data?

XML

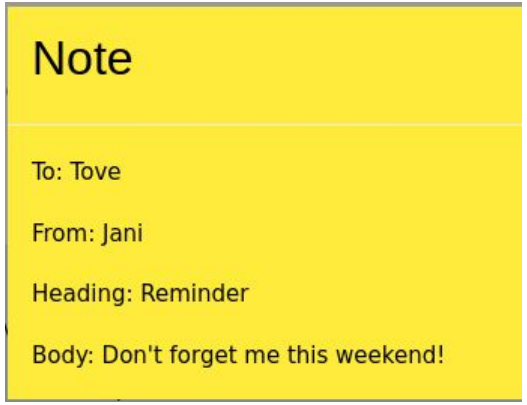
XML stands for eXtensible Markup Language.

- designed to store and transport data.
- designed to be both human- and machine-readable.

https://www.w3schools.com/xml/default.asp

note.xml

```
<note>
  <to>Tove</to>
  <from>Jani</from>
  <heading>Reminder</heading>
  <body>Don't forget me this weekend!</body>
</note>
```



Note

To: Tove

From: Jani

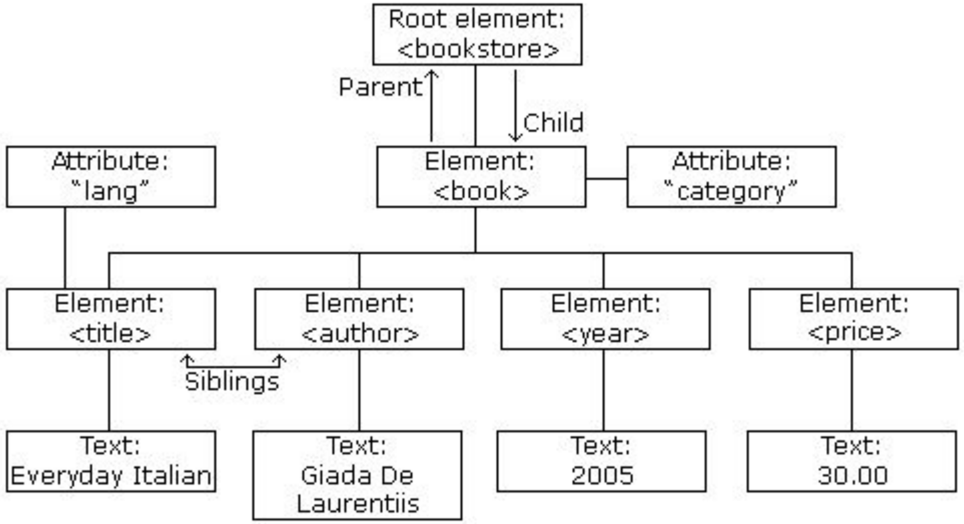
Heading: Reminder

Body: Don't forget me this weekend!

XML tree

```
<root>
  <child>
    <subchild>.....</subchild>
  </child>
</root>
```

```
<?xml version="1.0" encoding="UTF-8"?>
<bookstore>
  <book category="cooking">
    <title lang="en">Everyday Italian</title>
    <author>Giada De Laurentiis</author>
    <year>2005</year>
    <price>30.00</price>
  </book>
  <book category="children">
    <title lang="en">Harry Potter</title>
    <author>J K. Rowling</author>
    <year>2005</year>
    <price>29.99</price>
  </book>
  <book category="web">
    <title lang="en">Learning XML</title>
    <author>Erik T. Ray</author>
    <year>2003</year>
    <price>39.95</price>
  </book>
</bookstore>
```



https://www.w3schools.com/xml/default.asp

Javascript JSON

JSON stands for **J**ava**S**cript **O**bject **N**otation

```
{
"employees":[
  {"firstName":"John", "lastName":"Doe"},
  {"firstName":"Anna", "lastName":"Smith"},
  {"firstName":"Peter", "lastName":"Jones"}
]
}
```

https://www.w3schools.com/js/js_json.asp

String to JSON & JSON to string

```
<p id="demo"></p>
<p id="demo2"></p>
<script>
let text = '{ "employees" : [' +
'{ "firstName":"John" , "lastName":"Doe" },' +
'{ "firstName":"Anna" , "lastName":"Smith" },' +
'{ "firstName":"Peter" , "lastName":"Jones" } ]}';
const obj = JSON.parse(text);

document.getElementById("demo").innerHTML =
obj.employees[1].firstName + " " + obj.employees[1].lastName;
document.getElementById("demo2").innerHTML = JSON.stringify(obj);
</script>
```

https://www.w3schools.com/js/js_json.asp

Exercise

Design a weather page by using any of the free weather services

https://www.weather.gov/documentation/services-web-api

https://www.metoffice.gov.uk/services/data/datapoint/uk-observations-detailed-documentation

Note: Some servers may not allow cross origin requests; you can use JSONP-**script.src**, **form**, etc. See also Fetch: Cross-Origin Requests

Client-side storage of website data

Cookies

Web Storage API

IndexedDB (indexed database)

Cookies

HTTP cookies, **web cookies**, **Internet cookies**, **browser cookies**, or simply **cookies**

A **cookie** is a small piece of information left on a visitor's computer by a website, via a web browser.

Cookies are used to personalize a user's web experience with a website.

- It may contain the user's preferences or inputs when accessing that website. A user can customize their web browser to accept, reject, or delete cookies.

HTTP cookie - Wikipedia
Cookie - MDN Web Docs Glossary: Definitions of Web-related terms

```
document.cookie = "yummy_cookie=chocolate";
document.cookie = "tasty_cookie=strawberry";
console.log(document.cookie);
// logs "yummy_cookie=chocolate;
tasty_cookie=strawberry"

document.cookie = "yummy_cookie=blueberry";


console.log(document.cookie);
// logs "tasty_cookie=strawberry;
yummy_cookie=blueberry"
allCookies = document.cookie;
```

Ctrl+shift+c
Then open applications to see storages

Web Storage API

The **Web Storage API** provides mechanisms by which browsers can store key/value pairs, in a much more intuitive fashion than using cookies.

Two mechanisms

- `sessionStorage` maintains a separate storage area as long as the browser tab is open, including page reloads and restores.

- `localStorage` does the same thing, but persists even when the browser is closed and reopened.

https://developer.mozilla.org/en-US/docs/Web/API/Web_Storage_API
https://www.w3schools.com/html/html5_webstorage.asp

Web Storage API

```
// Save data to sessionStorage
sessionStorage.setItem("key1", "value1");

// Get saved data from sessionStorage
let data = sessionStorage.getItem("key1");

// Remove saved data from sessionStorage
sessionStorage.removeItem("key1");

// Remove all saved data from sessionStorage
sessionStorage.clear();
```

https://developer.mozilla.org/en-US/docs/Web/API/Window/sessionStorage

Web Storage API

```
localStorage.setItem("myCat", "Tom");


const user1 = {
 name: 'Jane Smith',
 age: 30,
 email: 'jane@example.com'
};

localStorage.setItem('user1',
     JSON.stringify(user1));
```

```
// Retrieving values
const cat = localStorage.getItem("myCat");
const name = localStorage.getItem('name');
const user =
JSON.parse(localStorage.getItem('user1'));

//to clear everything
//localStorage.clear();
```

https://developer.mozilla.org/en-US/docs/Web/API/Window/localStorage

IndexedDB

A **database** is an organized collection of structured information, or data, typically stored electronically in a computer system.

A database is usually controlled by a database management system (DBMS).

A database management system provides a mechanism for the storage and retrieval of data.

IndexedDB is a **NoSQL database management system**

We use on the client side!

Database Management Systems

- Hierarchical databases
- Network databases
- Object-oriented databases(object database management system)
  - Data is stored and managed as objects
  -
- Relational databases
  - Store data using tables, rows, and columns
- NoSQL databases
  - Document databases
  - **Key, value stores**
  - Column oriented databases
  - Graph databases

Example

We have a JSON data, key-values

To store this in **indexedDB**

- Open **a database**
  - `request = indexedDB.open("mydatabase", 3);`
    - `3 version of the database schema`
    - `E.g. new version of the app and changed schema`

```
const customerData = [
    {
        ssn: "444-44-4444",
        name: "Bill",
        age: 35,
        email: "bill@company.com"
    },
    {
        ssn: "555-55-5555",
        name: "Donna",
        age: 32,
        email: "donna@home.org"
    },
];
```

Checking whether open() request is successful

```
let db;
const request = window.indexedDB.open("testDB", 3);
request.onsuccess = function (){
     // Do something with request.result!
   document.write("testDB is created successfully");
}
request.onerror = function (){
     // Do something with request.error!
   document.write("testDB is not created");
}
request.onupgradeneeded = function (event) {
     // // Do something with request.result!
   document.write("testDB is not created");
}
```

[Using IndexedDB - Web APIs | MDN]()

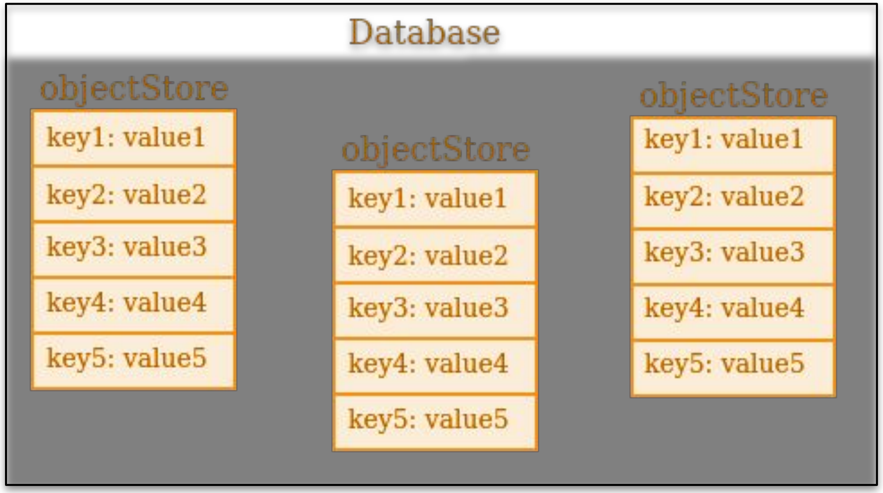
Ctrl+shift+c
Then open applications to see storages

ObjectStore

The data is stored in object stores

We may have multiple object stores in one db

Key is a unique value



https://javascript.info/indexeddb

```
db.createObjectStore('students', {keyPath: 'id'});
```

- Create **an object store** for **customerData**
  - Object stores are the data storage of IndexedDB
  - `db.createObjectStore("customers", {keyPath:"ssn"});`

Create an object store in the database.

```
let db;
const request = window.indexedDB.open("testDB", 2);
request.onerror = function (){
   document.write("testDB is not created");
}
request.onupgradeneeded = function (event){
   document.write("testDB is created successfully");
   db = event.target.result;
   // Create an objectStore to hold information about our customers.
   const objectStore = db.createObjectStore("customers", { keyPath: "ssn" });
   // Create an index to search customers by name and email
   objectStore.createIndex("name", "name", { unique: false });
   objectStore.createIndex("email", "email", { unique: true });
}
```

Using IndexedDB - Web APIs | MDN

Database transactions

A database transaction symbolizes **a unit of work**, performed against a database

```
const trans1 = db.transaction("foo", "readwrite");
const trans2 = db.transaction("foo", "readwrite");

const objectStore2 = trans2.objectStore("foo");
const objectStore1 = trans1.objectStore("foo");

objectStore2.put("2", "key");
objectStore1.put("1", "key");//this writes before trans2

//you can check whether the transaction is completed
trans2.oncomplete = function(){
      document.write("transactions completed");
      db.close;
};
```

Add customers

```
let db;
const request = window.indexedDB.open("testDB", 3);
request.onsuccess = function (event){
   db = event.target.result;
   const trans = db.transaction("customers", "readwrite");
   const objectStore = trans.objectStore("customers");
   //adds or error if exist
   objectStore.add(customerData[0]);
   //puts or updates
   objectStore.put(customerData[0]);
   // put each customer to objectstore
   customerData.forEach((customer) => {
       objectStore.put(customer);
   });
}
```

```
const customerData = [
   {
       ssn: "444-44-4444",
       name: "Bill",
       age: 35,
       email: "bill@company.com"
   },
   {
       ssn: "555-55-5555",
       name: "Donna",
       age: 32,
       email: "donna@home.org"
   },
];
```

Using IndexedDB - Web APIs | MDN

Retrieving data

```
<button type="button" onclick="getData()">getdata</button>
<script>
…
function getData() {
   parag = document.getElementById("parag");
   const trans = db.transaction("customers", "readwrite");
   const objectStore = trans.objectStore("customers");

   request = objectStore.get("444-44-4444");
   request.onsuccess = function (event) {
      parag.innerHTML = JSON.stringify(request.result);
      //parag.innerHTML = "email = "+ request.result.email;
   };
}
```

Using IndexedDB - Web APIs | MDN

Remove/delete data

```
<button type="button" onclick="removeData()">removedata</button>
<script>
…
function removeData() {
   parag = document.getElementById("parag");
   const trans = db.transaction("customers", "readwrite");
   const objectStore = trans.objectStore("customers");

   request = objectStore.delete("444-44-4444");
   request.onsuccess = function (event) {
       parag.innerHTML = "444-44-4444 deleted!";
   };
}
```

Using IndexedDB - Web APIs | MDN

server side

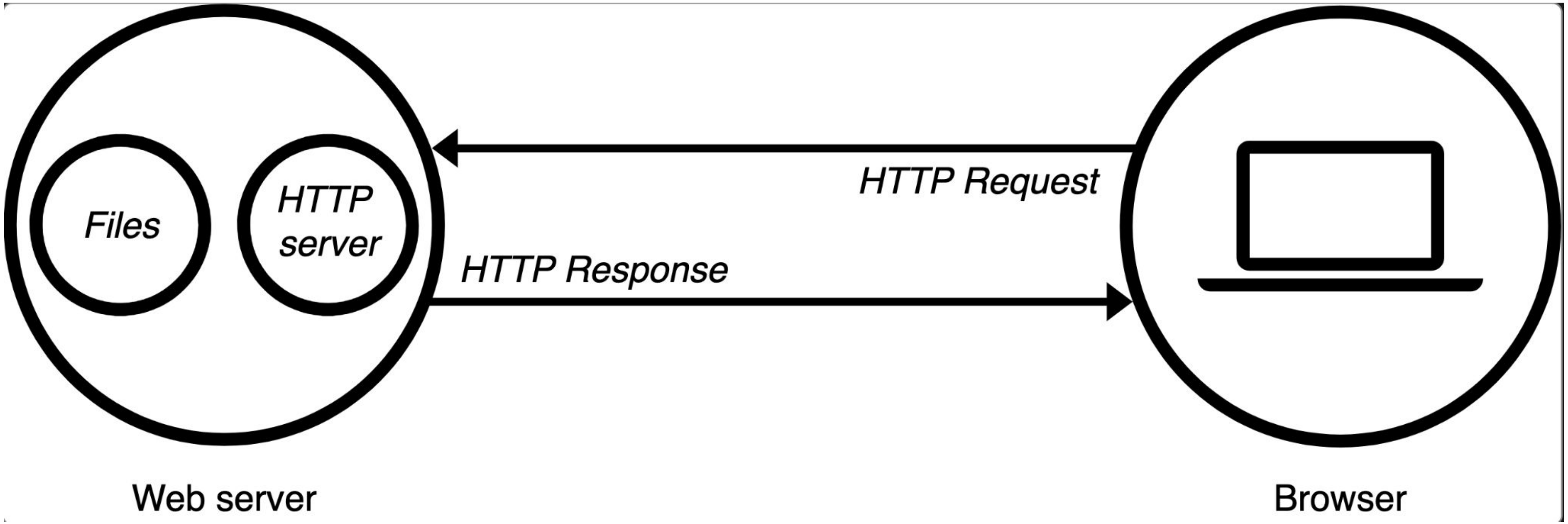
So far we have seen client side:

- Javascript, HTML, CSS
- Client sends/receive **JSON data** from/to server

On server side

- A more comprehensive database management system
  - Relational database or NoSQL database
- A programming language
  - Node.js, Php, Ruby, Java, Python, node.js(javascript) etc..
  - Executed by a webserver and the result is sent to client as HTML

A web server



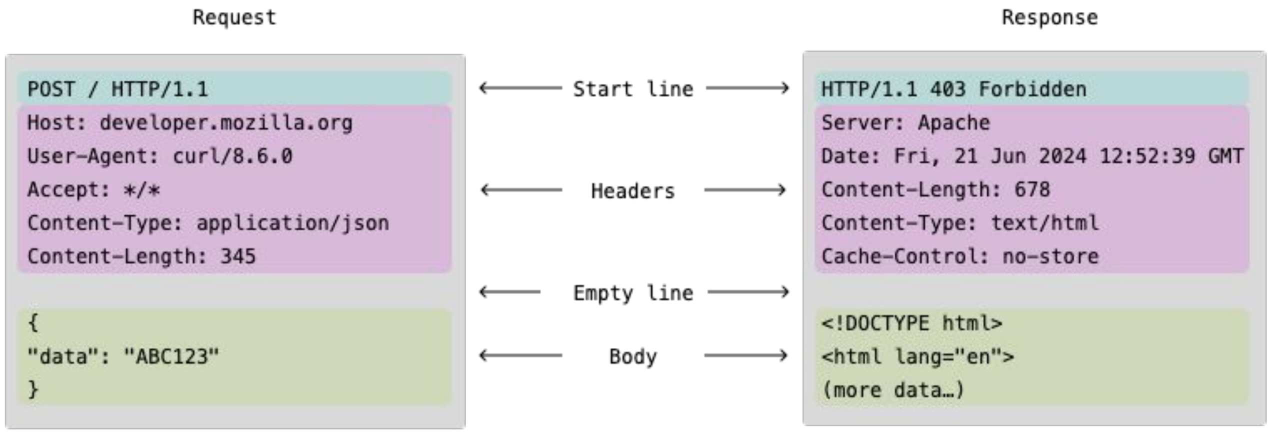
https://developer.mozilla.org/en-US/docs/Learn/Common_questions/Web_mechanics/What_is_a_web_server

HTTP

A Protocol is a set of rules for communication between two computers.

HTTP specifies how to transfer hypertext (linked web documents) between two computers.

example:

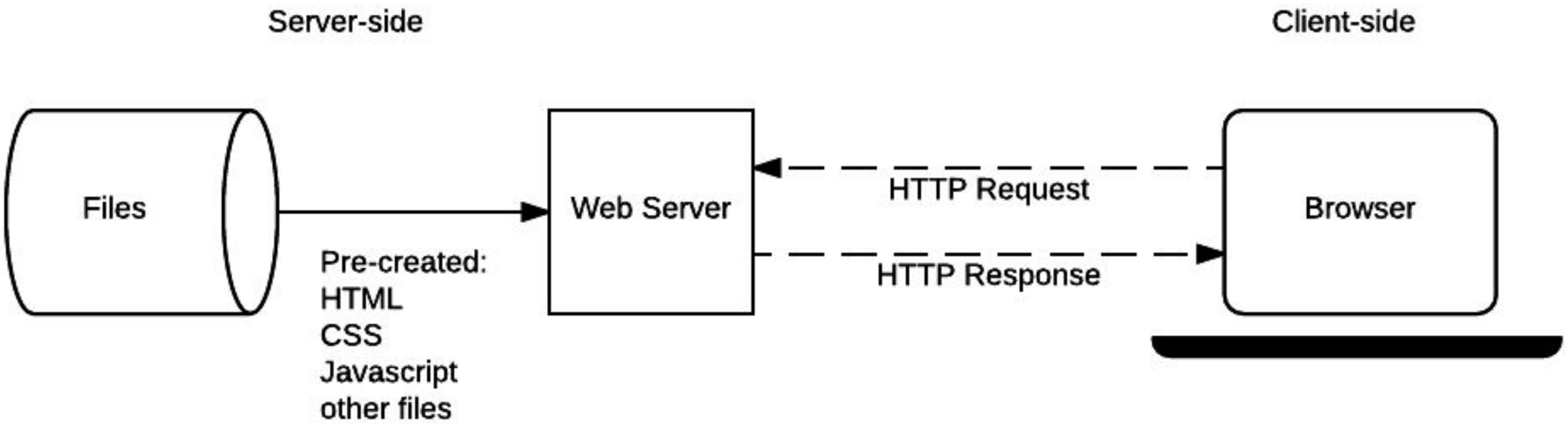


```
POST / HTTP/1.1
Host: developer.mozilla.org
User-Agent: curl/8.6.0
Accept: */*
Content-Type: application/json
Content-Length: 345

{
"data": "ABC123"
}
```

```
HTTP/1.1 403 Forbidden
Server: Apache
Date: Fri, 21 Jun 2024 12:52:39 GMT
Content-Length: 678
Content-Type: text/html
Cache-Control: no-store

<!DOCTYPE html>
<html lang="en">
(more data…)
```

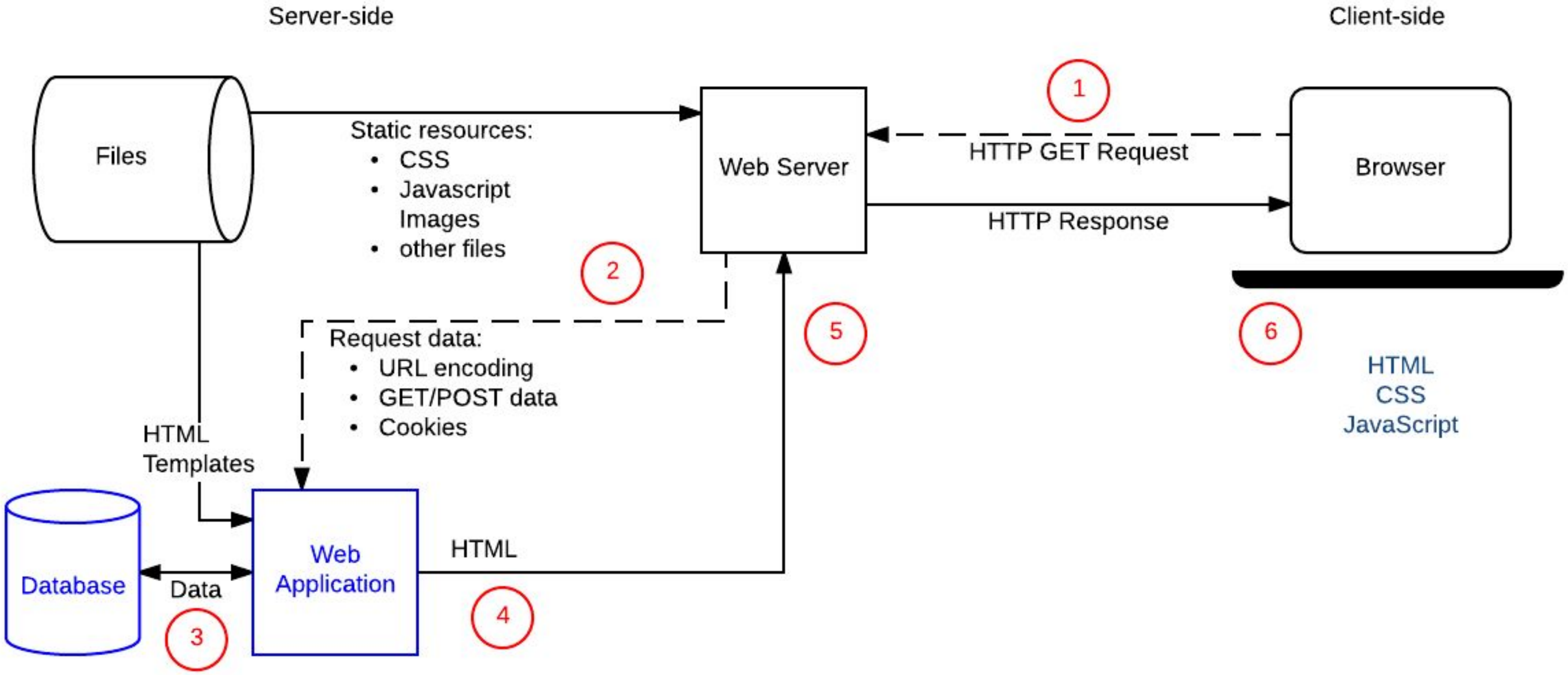
https://developer.mozilla.org/en-US/docs/Web/HTTP/Messages

Static sites



https://developer.mozilla.org/en-US/docs/Learn/Server-side/First_steps/Introduction

Dynamic sites



https://developer.mozilla.org/en-US/docs/Learn/Server-side/First_steps/Introduction

Applications of server side scripting

Database Interactions

User Authentication

Form Processing

Content Management Systems

Web Services

More secure

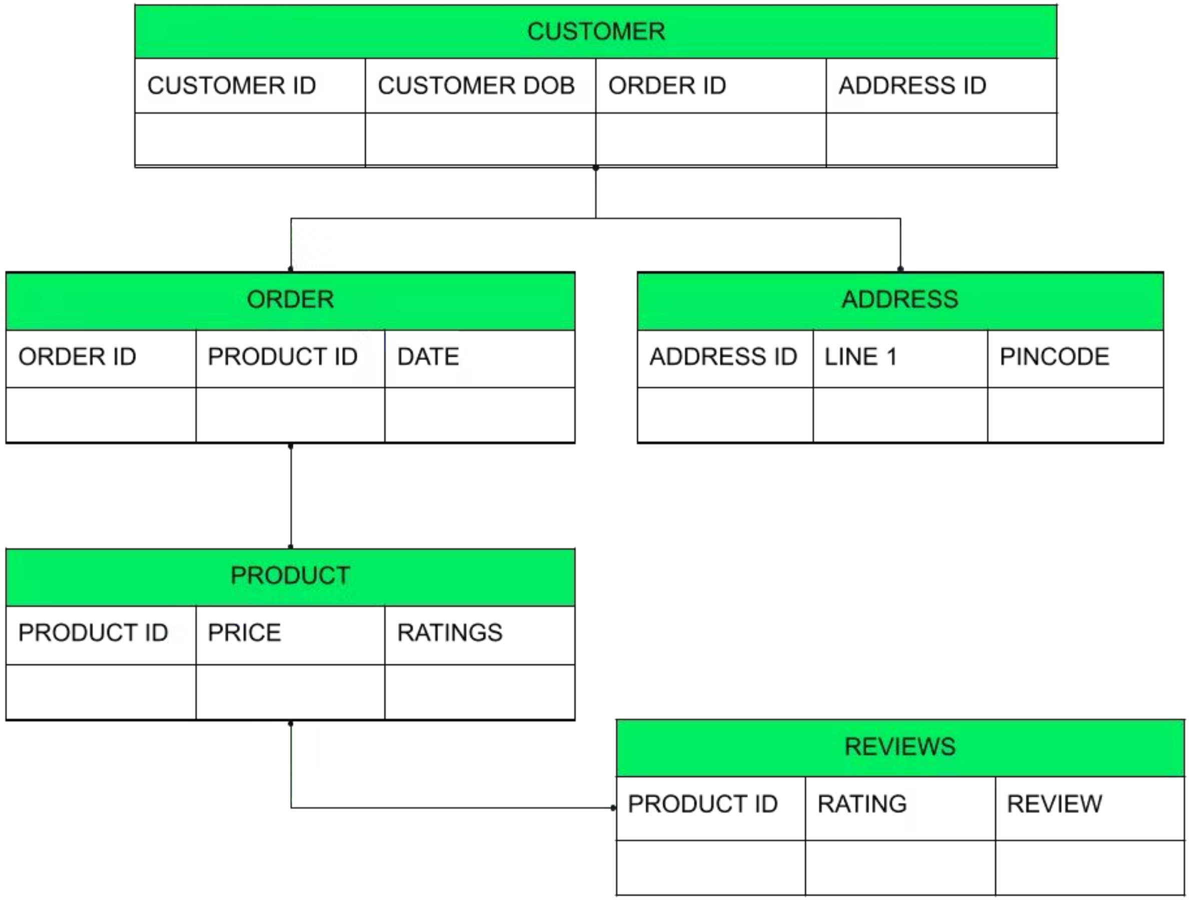
https://en.wikipedia.org/wiki/Server-side_scripting

More on databases and SQL

Relational(SQL) Database

Database schema organizes data in relational, tabular ways

- tables with columns or attributes and rows of records.
- A strictly predefined schema
  - You need to structure data before starting…
- Examples
  - MySQL
  - PostgreSQL
  - Oracle
  - MS SQL Server

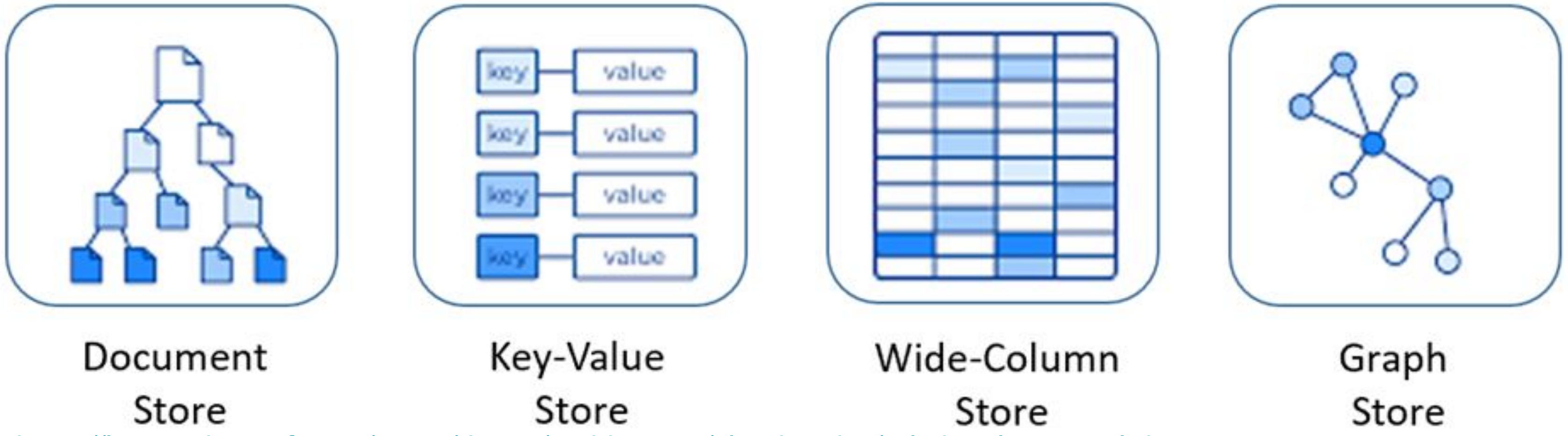


https://www.mongodb.com/resources/basics/databases/nosql-explained/nosql-vs-sql

NoSQL Database

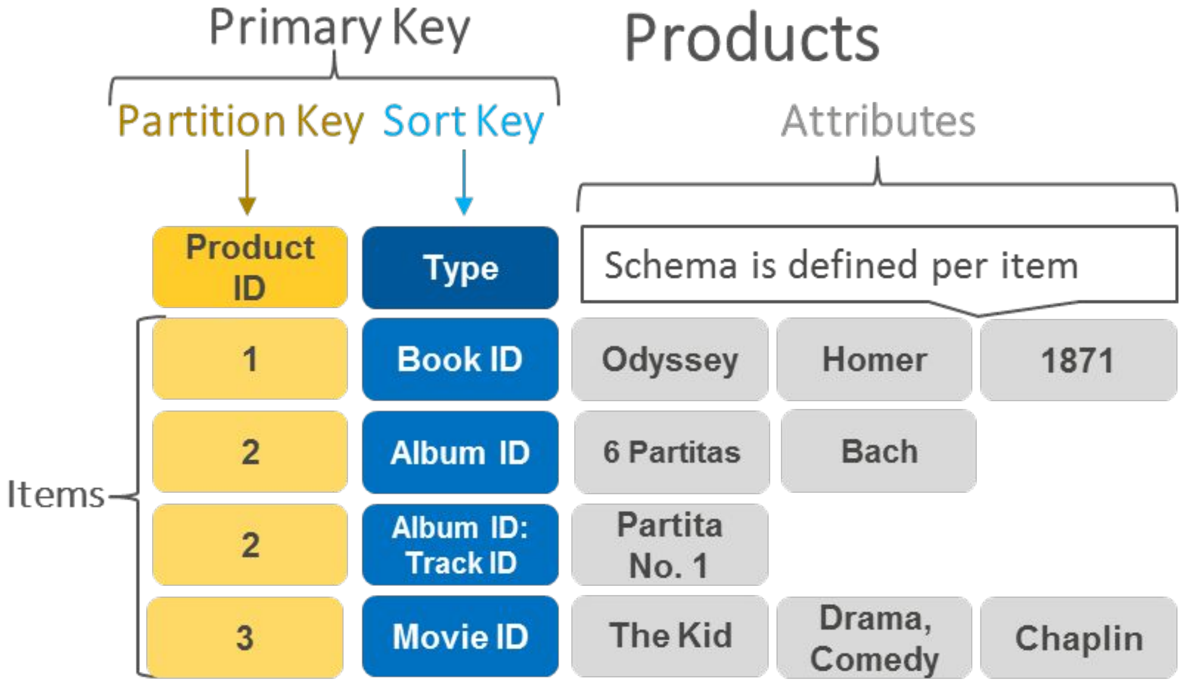
They are not structured as tables with relations

More flexible



https://learn.microsoft.com/en-us/dotnet/architecture/cloud-native/relational-vs-nosql-data

NoSQL: Key-Value



https://aws.amazon.com/compare/the-difference-between-relational-and-non-relational-databases/

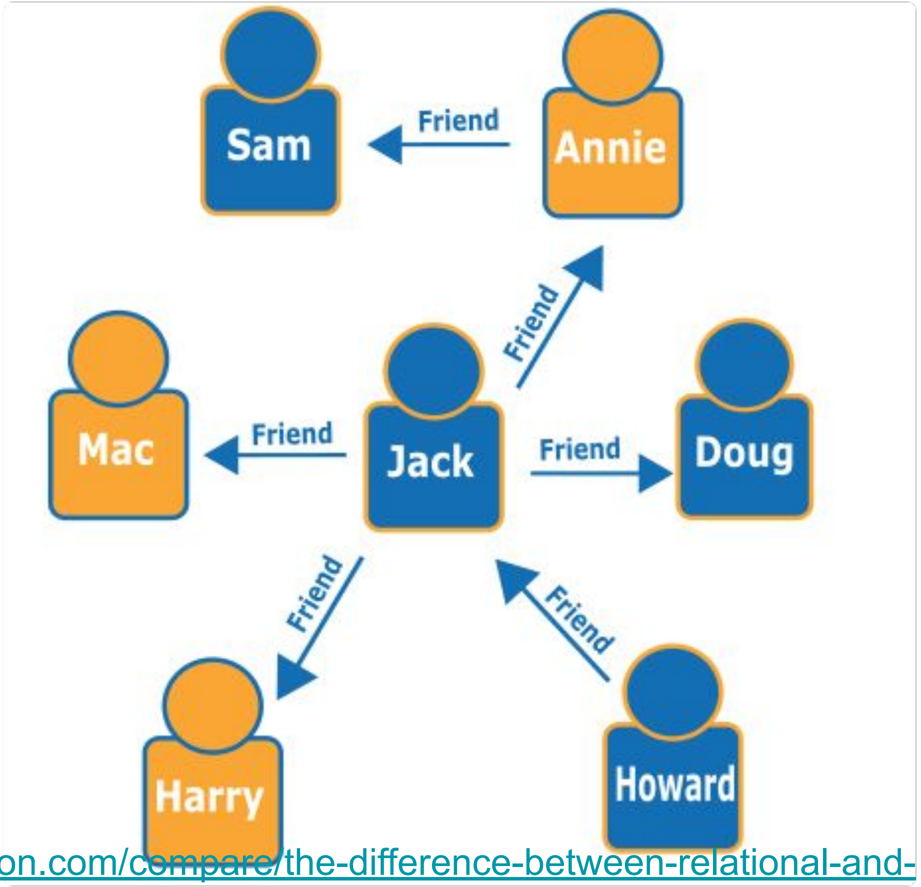
NoSQL: Document

XML, YAML, JSON.. etc

```
{
  company_name: "AnyCompany",
  address: {street: "1212 Main Street", city: "Anytown"},
  phone_number: "1-800-555-0101",
  industry: ["food processing", "appliances"]
  type: "private",
  number_of_employees: 987
}
```

https://aws.amazon.com/compare/the-difference-between-relational-and-non-relational-databases/

NoSQL: Graph



https://aws.amazon.com/compare/the-difference-between-relational-and-non-relational-databases/

Relational database(SQL) vs NoSQL

RDMS must follow ACID

Atomicity: All transactions must succeed or fail completely **(no partial complete)**.

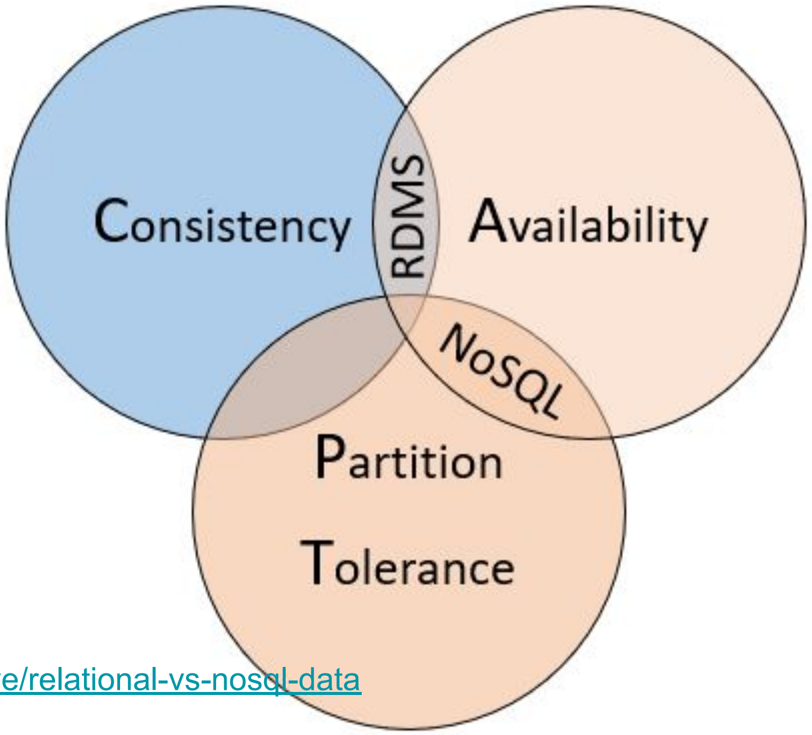
Consistency: The database must follow rules that validate and prevent corruption at every step.

Isolation: Concurrent transactions cannot affect each other.

Durability: Transactions are final, and even system failure cannot “roll back” a complete transaction.

https://www.ibm.com/think/topics/sql-vs-nosql

CAP theorem

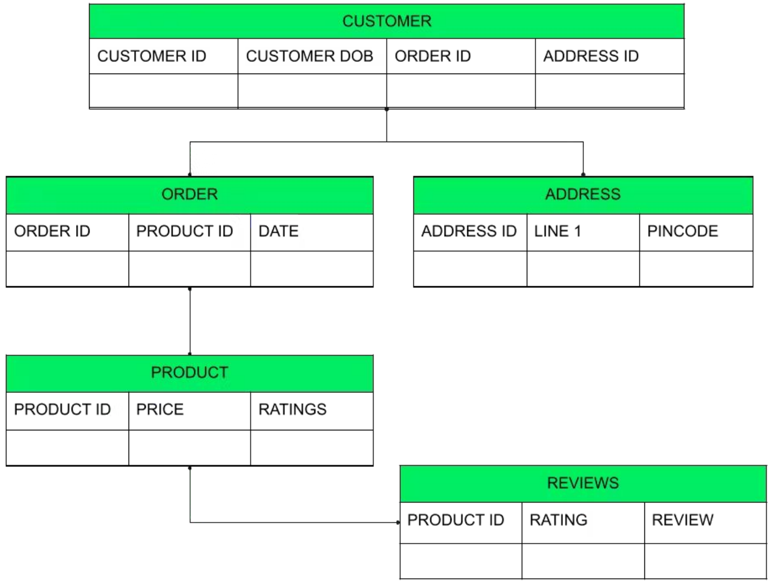


https://learn.microsoft.com/en-us/dotnet/architecture/cloud-native/relational-vs-nosql-data

SQL(Structured Query Language)

SQL is a standard language for storing, manipulating and retrieving data in databases.

You can use in MySQL, SQL Server, MS Access, Oracle, Sybase, Informix, Postgres, and other database systems.



```
sqlite> create table customer(custID INTEGER PRIMARY KEY, name TEXT NOT NULL);
sqlite> insert into customer values(1, 'aaa');
sqlite> insert into customer values(2, 'bbb');
sqlite> select * from customer;
1|aaa
2|bbb
```

Installation

For sql examples used in this class

It is enough to use sqlite: SQLite Download Page

Then $ ./sqlite3 test.db

You can also run from python, C, android

https://docs.python.org/3/library/sqlite3.html

https://www.sqlite.org/c3ref/intro.html

https://developer.android.com/training/data-storage/sqlite

You can also download more complex RDMS

MySQL

PostgreSQL

Or use them on azure, google cloud..

Some important SQL commands

- SELECT - extracts data from a database
- UPDATE - updates data in a database
- DELETE - deletes data from a database
- INSERT INTO - inserts new data into a database
- CREATE DATABASE - creates a new database
- ALTER DATABASE - modifies a database
- CREATE TABLE - creates a new table
- ALTER TABLE - modifies a table
- DROP TABLE - deletes a table
- CREATE INDEX - creates an index (search key)
- DROP INDEX - deletes an index

SQL keywords are NOT case sensitive: select is the same as SELECT

Identifiers are case sensitive: ID is not the same as id

https://www.w3schools.com/sql/sql_syntax.asp

```
create database testdb;

show databases;

use testdb;


create table  customers(

   id           int primary key not null,

   name         varchar (20) not null,

   age          int not null,

   address      varchar (25),

   salary        decimal (18, 2)

);
```

Select more

select

```
select column1, column2, … from table_name;

select customer_name, city from customers;


select * from customers;


select * from customers where country = 'mexico';

select * from customers where customer_id = 1;
```

```
select * from customers

where customer_id > 80;


select * from customers

where country = 'germany'

and city = 'berlin'

and postal_code > 12000;
```

https://www.w3schools.com/sql/sql_syntax.asp

Insert into

```
insert into table_name values (value1, value2, value3, ...);


insert into table_name (column1, column2, column3, ...)

values (value1, value2, value3, ...);


insert into customers (customername, contactname, address, city, postalcode, country)

values ('cardinal', 'tom b. erichsen', 'skagen 21', 'stavanger', '4006', 'norway');
```

https://www.w3schools.com/sql/sql_insert.asp

Update

```
update table_name

set column1 = value1, column2 = value2, … where condition;


update customers

set contactname =  'alfred schmidt', city = 'frankfurt'

where customerid = 1;
```

https://www.w3schools.com/sql/sql_update.asp

Delete from

```
delete from table_name where condition;

delete from table_name;

    delete from customers where customername='alfreds futterkiste';

    delete from customers;
```

- `to delete the table completely, use the drop table statement:`

```
    drop table customers;
```