

Databases In Other Applications

By the end of this session you will:

- Understand what is meant by system architecture, layers and tiers.
- Understand and give examples of applications using the three layer model and two and three tier architectures.
- Learn about ReST APIs and build a simple web app.

One, Two and Three Tier Architectures and Layers

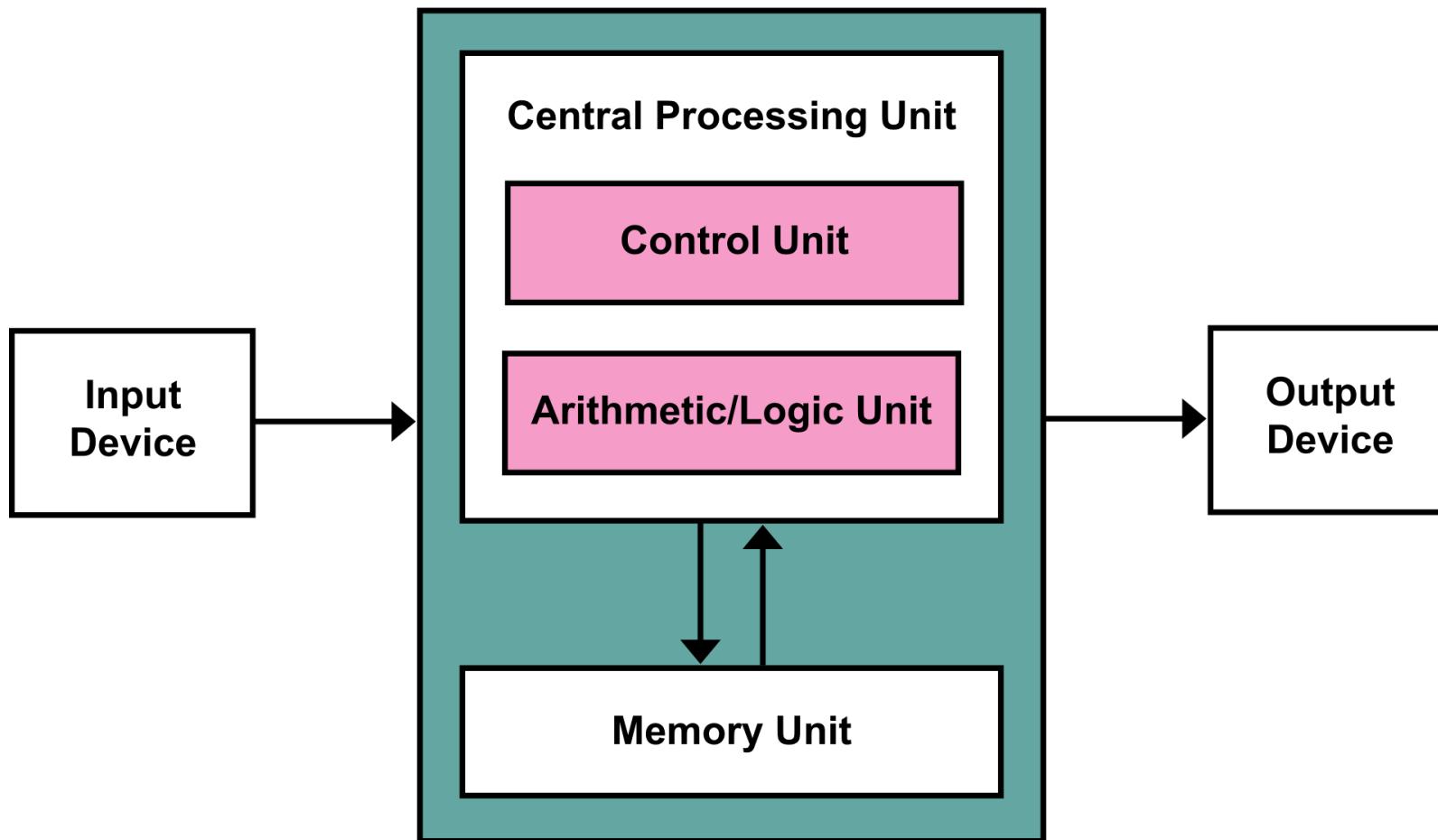
Architecture, tiers and layers

- **Architecture:** splitting a computer system up into its components.
 - Here we'll mostly be looking at hardware architecture.
- **Tier:** collection of hardware components -- the system is split into tiers.
 - Historically physical, but could also include logical.
 - Typically **1**, **2**, and **3** tier architectures.
- **Layers:** different from tiers, another way of dividing up a system by splitting up logical components.

Hardware Architecture

- Each piece of hardware is viewed as a black box.
- So we only need to care about **what it does** and **how it communicates**.
- E.g., a database server stores data, which is manipulated or accessed using some kind of program.

Computer system architecture



One tier architecture

- Everything is contained in one (physical or virtual) server or computer.
- All programs you've made on this course so far are (likely) one tier.
- Simplest but least secure -- if it breaks or is compromised then all is lost!



Back to layers

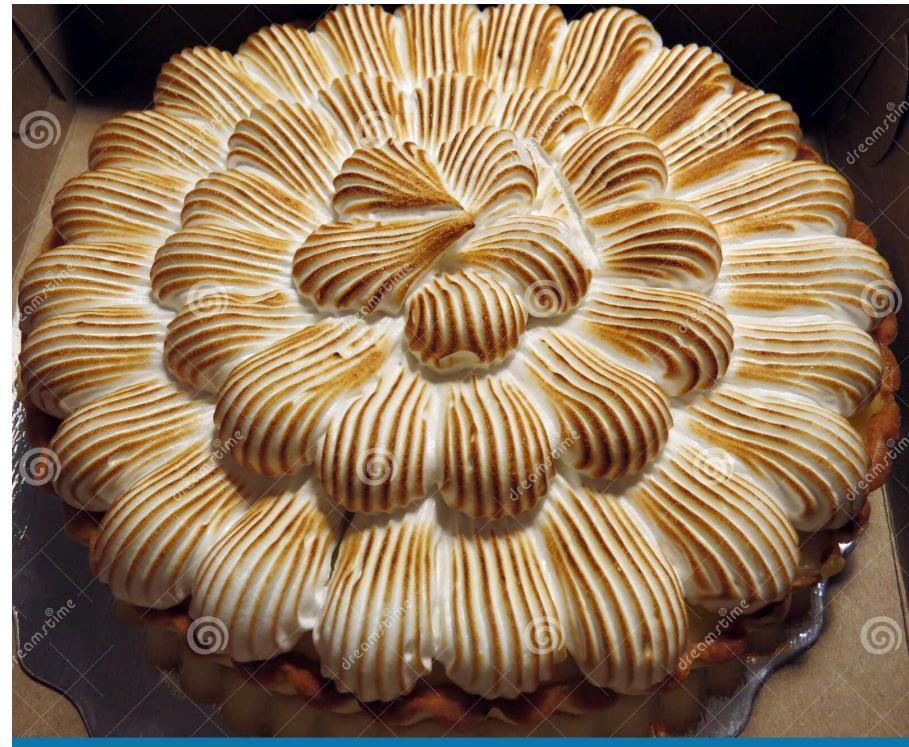
- Typically (optimistic) software is not a mess, so a lemon meringue pie, a **layered** desert might be a better analogy. Three layers:
 1. **Presentation:** the crisp top of the meringue,
 2. **Application:** (or business logic) the gooey meringue,
 3. **Data:** tart (bitter?) lemon curd.



Three Layer Architecture

1. Presentation: the crisp top of the meringue

- User interface -- the pretty part which the user sees and interacts with.
- Typically HTML/CSS/JavaScript, or a graphics package for C, C++, C#, Java.



Three Layer Architecture

2. **Application:** (or business logic) is the gooey meringue, providing shape to the system.

- handles calculations and operations, providing a link between the user interface and the database.
- Potentially any language, in web apps it's typically PHP but could be Python, JavaScript, Java. etc.



Three Layer Architecture

3. **Data:** the tangy, slightly bitter lemon curd.
 - Where all data is stored, application layer modifies / inserts / retrieves data and passes it to the presentation layer to be shown to the user.
 - Commonly SQL, but could also be NoSQL.



Three Layer Example

Bob wants to buy a non-existent chocolate bar from Alice's Codelab I vending machine.

- **Presentation:** Bob runs the application and is greeted with a user interface only a programmer could love. With some difficulty, Bob chooses a chocolate bar.
- **Application:** Alice's code stores Bob's choice and checks whether the item is in stock.

- **Data:** Stock is stored in a text file. Alice's program determined that there is at least one chocolate bar in stock, deducts one from the stock remaining, and stores this value back in the text file.
- **Application:** having determined the item is in stock and Bob has entered sufficient (non-existent) money, it returns a success value to the `display` function, ...
- **Presentation:** ...which displays the amount of (fake) change and the fact that Bob's (pretend) chocolate has been dispensed.

2 Tier Architecture

- Three layers are divided across two (physical or logical) tiers.
- There will be a communication layer between the two tiers.



There are two options

1. **Top:** caramel and chocolate
 - Presentation
 - Application
2. **Bottom:** shortbread biscuit
 - Data



There are two options

1. **Top:** Royal icing
 - Presentation
2. **Bottom:** cake
 - Application
 - Data



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Three Tier Architecture

- Like a correctly constructed scone.
- A presentation layer of clotted cream,
- with an application layer of jam sticking it all together.



Tiers and Layers

Determine how the three layers in the following examples could be distributed across a two-tier architecture:

1. Vending machine example we saw earlier.
2. Minerva (submitting an assignment).
3. Ticket machine in a train station.

Web Apps and ReSTful APIs

Another Three Layer Architecture

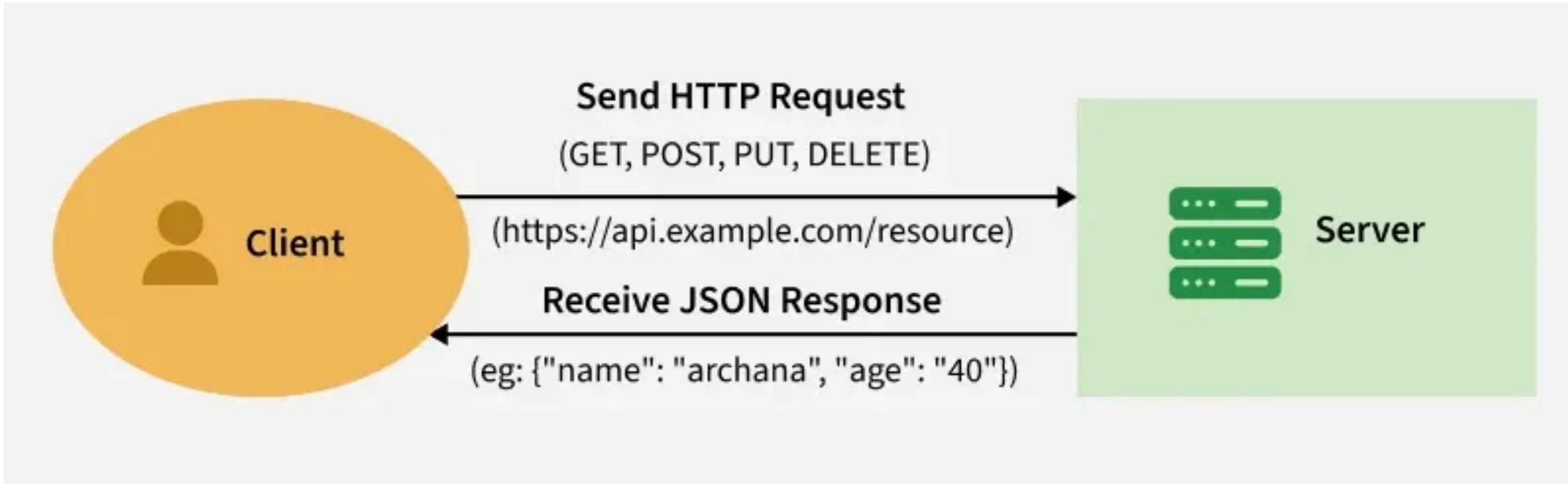
- Pretty web frontend
- Uses HTTP requests to communicate with a server backend.
- Server processes HTTP requests.
- It retrieves data from and modifies data in the database.

Tiered Architecture

- Two or three tier architecture?
- If two tier, then how would you split the layers?

ReSTful APIs

- **REsource State Transfer** application programming interface.
- Based around **resources**: i.e., documents, data entities.
- Uses HTTP methods to create a specification for how client and server should interact in order to manipulate resources.



REST APIs must

- be **stateless**, i.e., no session data is stored on the server and each request contains all data needed to complete it;
- allow resources to be **cached**;
- define a **client-server** architecture. Clients don't care about data storage, servers don't care about user interface;
- conform to the **layered** model;
- provide a **consistent interface**.

How it works

- Client makes an HTTP request to an **API endpoint**, :q
 - identified by its url, e.g., `api/v1/discworld/characters`,
 - **HTTP method** tells server what action to perform, methods match up with *CRUD* operations, e.g., `GET` is *read*,
 - client sends data in a standard format, e.g., *JSON*.
- server processes the request: accesses the database and get data ready to return.

- Server returns a response.
 - The **status code** reports on the outcome of the request,
 - The **response body** contains data, represented in a standard format, e.g., *JSON*.
- Client does whatever it likes with the response. That's the point: one tier doesn't need to know about the other.

HTTP Methods

- **GET**: (*read*) retrieves a resource or resources.

- Request: GET api/v1/discworld/characters ,
- Response: status 200 (OK), body

```
[  
    {"id": 1, "name": "Granny Weathervax", ... },  
    {"id": 2, "name": "Death", ... },  
    {"id": 3, "name": "Rincewind (Wizzard)", ... },  
    ...  
]
```

HTTP Methods

- **POST** (*create*) add a new resource.

- Request `POST api/v1/discworld/characters`, body

```
{  
  "name": "Rincewind",  
  "occupation": "wizzard",  
  "location": "Unseen University"  
  "books": [ 1, 2, 4, ... ]  
}
```

- Response: status 201 (Created), body

```
{"id": 4, "name": "Rincewind", ...}
```

HTTP Methods

- **PUT** (update, see also *PATCH*) modifies an existing resource.

- Request: PATCH api/v1/dicworld/characters/4 , body
{"location": "4X"}

- Response: status 200 (OK), body
{"id": 4, "name": "Rincewind", ... }

HTTP Methods

- **DELETE** (*figure it out yourself!*) removes a resource.
 - Request: `DELETE api/v1/discworld/characters/4`
 - Response: status 200 (OK), empty body.

Responses

- Common status codes
 - **200** OK
 - **201** Created
 - **400** Bad Request (failed validation)
 - **403** Forbidden (not allowed to do that, e.g., not logged in, can't delete Death)
 - **404** Not Found (nonexistent resource)
 - **500** Internal Server Error (naughty programmer)

Task: Make a REST API

- In `setup-db_starter.py`, define your schema and insert some test data.
- Take a look at `app_starter.py` and start up the web server (instructions in the README).
 - Complete the `GET` endpoint in `app_starter.py` to return all books, along with their average rating and number of ratings.
 - Complete the `POST` endpoint in `app_starter.py` to add a rating.