

Welcome Introduction to API Design and Development

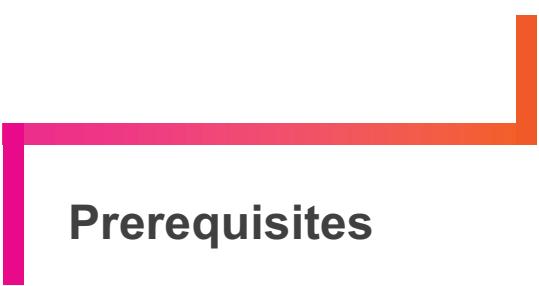
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Hello...



About me...

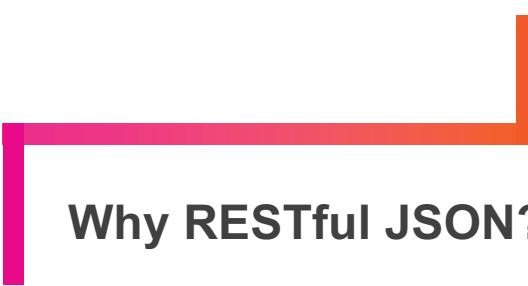
- 24+ years experience
- Architect & TDD Coach
- Consultancy
- Distributed architecture
- Microservices
- DevOps
- Java / Scala / Go



Prerequisites

This course assumes you:

- This course assumes you are familiar with the concepts of server-client relationship and the core needs of data delivery to/from servers/clients.
- This course will cover the common concepts of API Design and development focusing on RESTful JSON API design.



Why RESTful JSON?

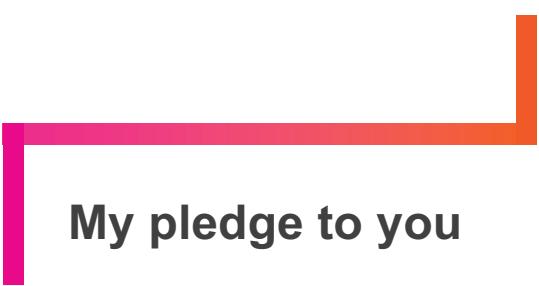
- Widely used, supported API structure
- Flexible but defined
- Focused on data (not functionality)
- Can be a facade
- Human Readable
- Cross-platform, language, etc.

We teach over 400 technology topics



You experience our impact on a daily basis!

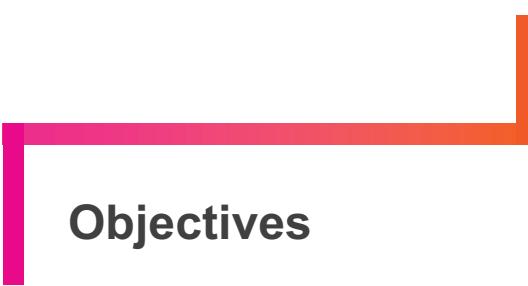




My pledge to you

I will...

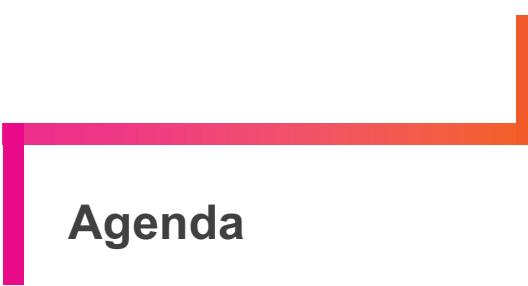
- Make this as interesting and interactive as possible
- Ask questions in order to stimulate discussion
- Use whatever resources I have at hand to explain the material
- Try my best to manage verbal responses so that everyone who wants to speak can do so
- Use an on-screen timer for breaks so you know when to be back



Objectives

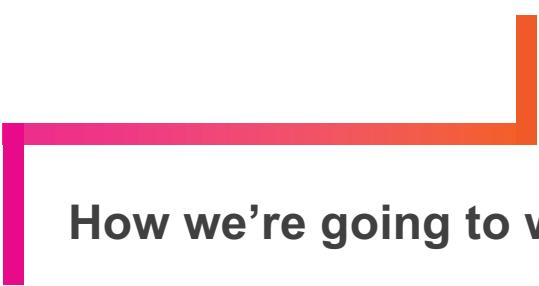
At the end of this course you will be able to:

- Understand the design and structure of a RESTful API
- Be able to define a RESTful JSON spec (OpenAPI)
- Become familiar with tools related to API design/development
- Understand various concepts and approaches to API design
- Understand concepts related to API testing
- Determine a course of action for developing an API



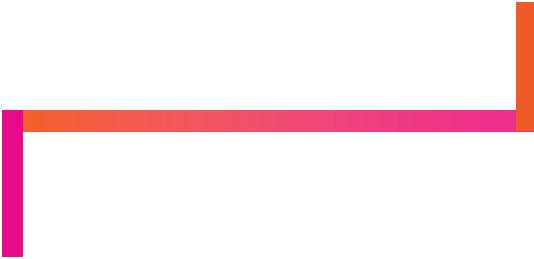
Agenda

- Introduction
- JSON
- Key Aspects of REST
- API Design
- OpenAPI API Specification
- Design Concepts
- Richardson Maturity Model
- Testing and Development
- Development Standards
- Contracts
- Design First vs Code First
- Automated Testing
- Versioning
- Security
- API Design Details
- Automated Testing Details



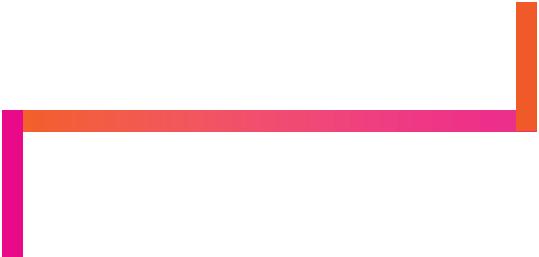
How we're going to work together

- Discussion
- Demo
- Do!



Breaks

10 mins break every hour



Housekeeping



If I drop, I'll be back



Working with virtual machines

We will be doing most of our work in virtual machines

1. Please login to <https://cloud.datacouch.io/pluralsight/> in an incognito window in Chrome
 - Just do File -> New Incognito Window
2. Note that to copy/paste to/from the VM you will need to use **CTRL+SHIFT+C** and **CTRL+SHIFT+V** on the mac
3. Note that Firefox, VSCode and other tools are already installed



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Introduction to API Design and Development

Understanding APIs in Software Delivery: Introduction

Understanding APIs in Software Delivery: Introduction

- **Install Insomnia**

<https://insomnia.rest/download>

The screenshot shows the Insomnia website on the left and its application window on the right.

Website Header:

- Insomnia by Kong
- 18,478 stars
- Products ▾
- Docs
- Pricing
- Plugins
- Login
- Get Started for Free →

Website Content:

Download Insomnia

Start building, designing, testing better APIs through spec-first development driven by an APIOps CI/CD pipelines.

[Download Insomnia for MacOS](#)

By downloading and using Insomnia, I agree to the [Privacy Policy](#) and [Terms](#).

What's New? [Changelog](#)

Not your OS? Download for [Windows](#) / [Ubuntu](#) or See all downloads.

Insomnia Application Window:

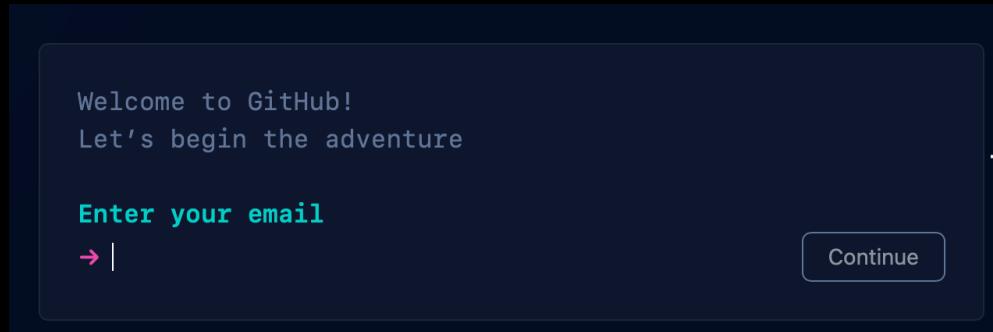
- DOCUMENT** dropdown: No Environment
- POST** method selected in the header bar.
- base_url /pet** is set in the URL field.
- JSON** tab is selected in the message body dropdown.
- Send** button is visible.
- Message Body:**

```
1 {
2   "id": 0,
3   "category": {
4     "id": 0,
5     "name": "string"
6   },
7   "name": "doggie",
8   "photoUrls": [
9     "string"
10 ],
11 "tags": [
12   {
13     "id": 0,
14     "name": "string"
15   }
16 ],
17 "status": "string"
18 }
```
- Header** tab is visible.
- Endpoints:** A list of API endpoints categorized under **pet**, **store**, and **user**. The **pet** endpoint is currently selected.
- Actions:** Buttons for **DOC**, **ENV**, **COOKIES**, and **CLIENT CERTIFICATES**.

Understanding APIs in Software Delivery: Introduction

- **Create Github Account**

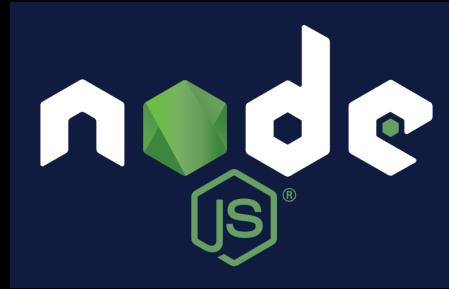
<https://github.com/signup>



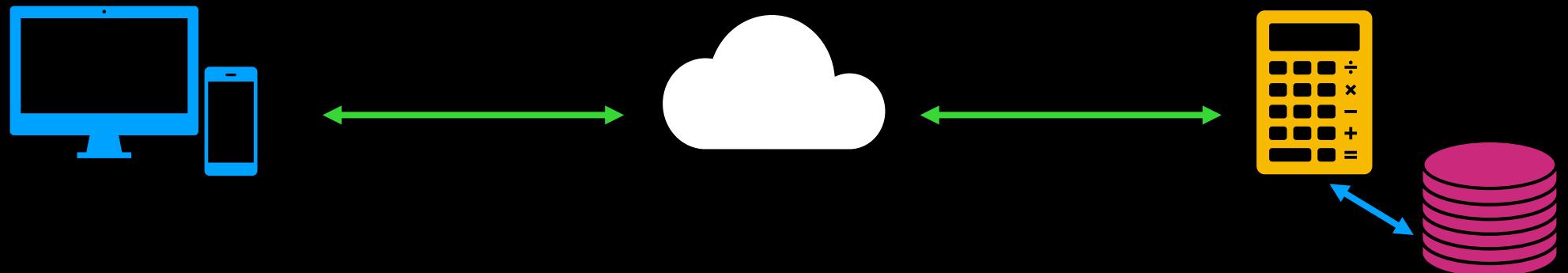
Understanding APIs in Software Delivery: Introduction

- **Optional: Install Nodejs/npm**

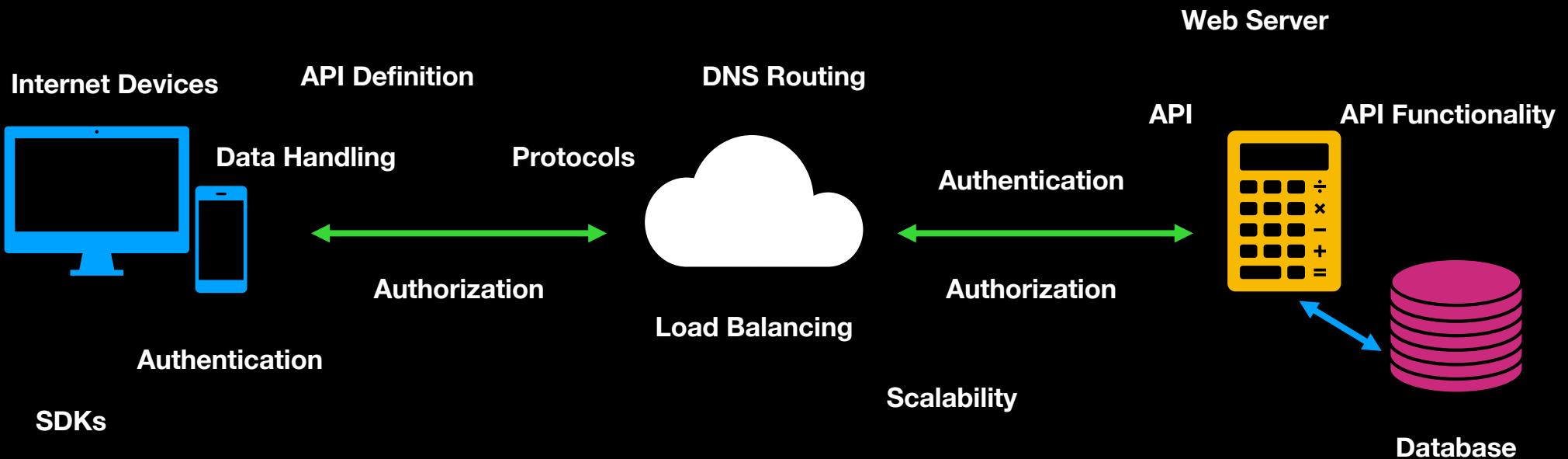
<https://nodejs.org/en/download/>



API Design: Introduction

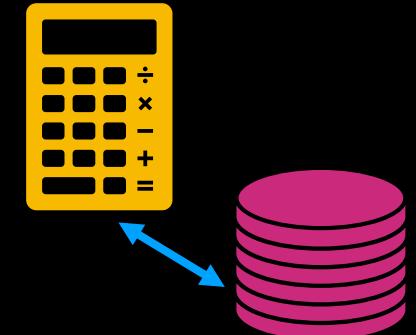


API Design: Introduction



API Design: Introduction

- **API Backend Servers (e.g., Apache, Tomcat)**
Web Server Apps
Processes API Requests
Functionality
Java, C#, Python, PHP, etc.
Data
Database (e.g., Oracle, MySQL)



API Design: Introduction

- **API Routing & Security**

DNS

Load Balancing

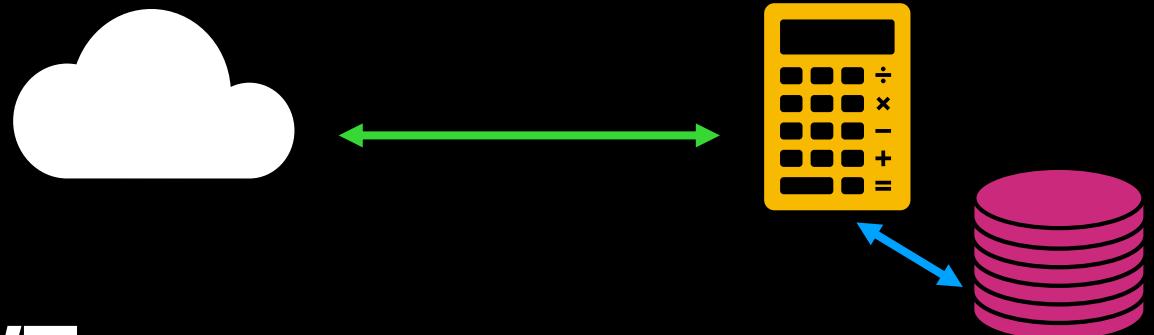
Scalability

Authentication

OAuth, Token/JWT

Authorization

Permissions

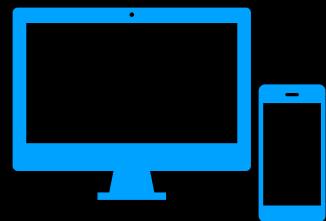


API Design: Introduction



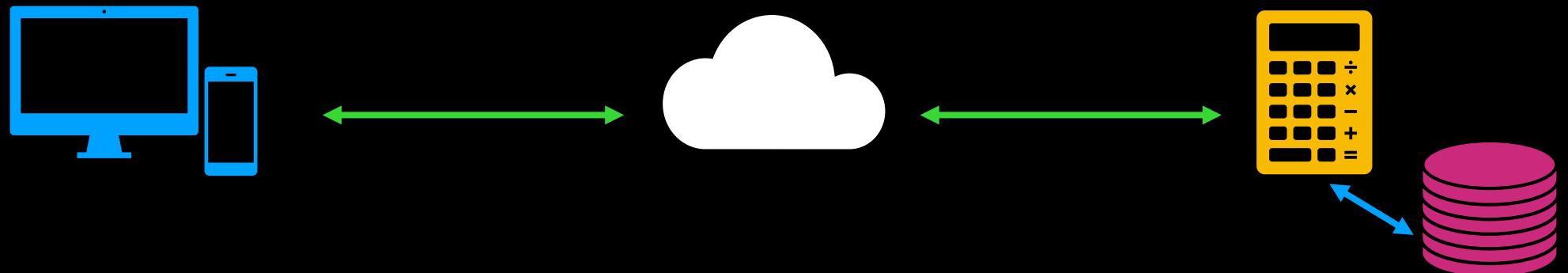
- **API Client**
Device on Internet
Understands API
Endpoints (Nouns, Verbs)
Data formats (JSON)
Login/Authentication
e.g., Token Header

API Design: Introduction

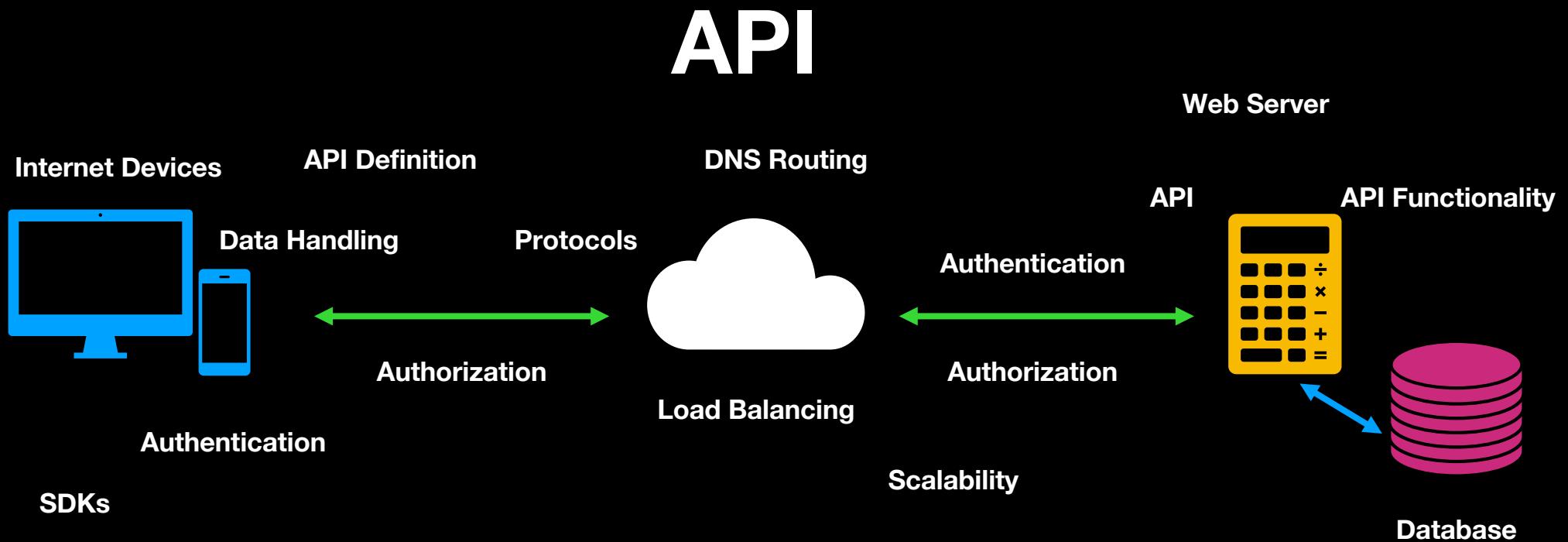


- **Client Communication**
HTTP
JSON, XML, etc.
API Endpoints
Provided SDKs
Generated code

API Design: Introduction



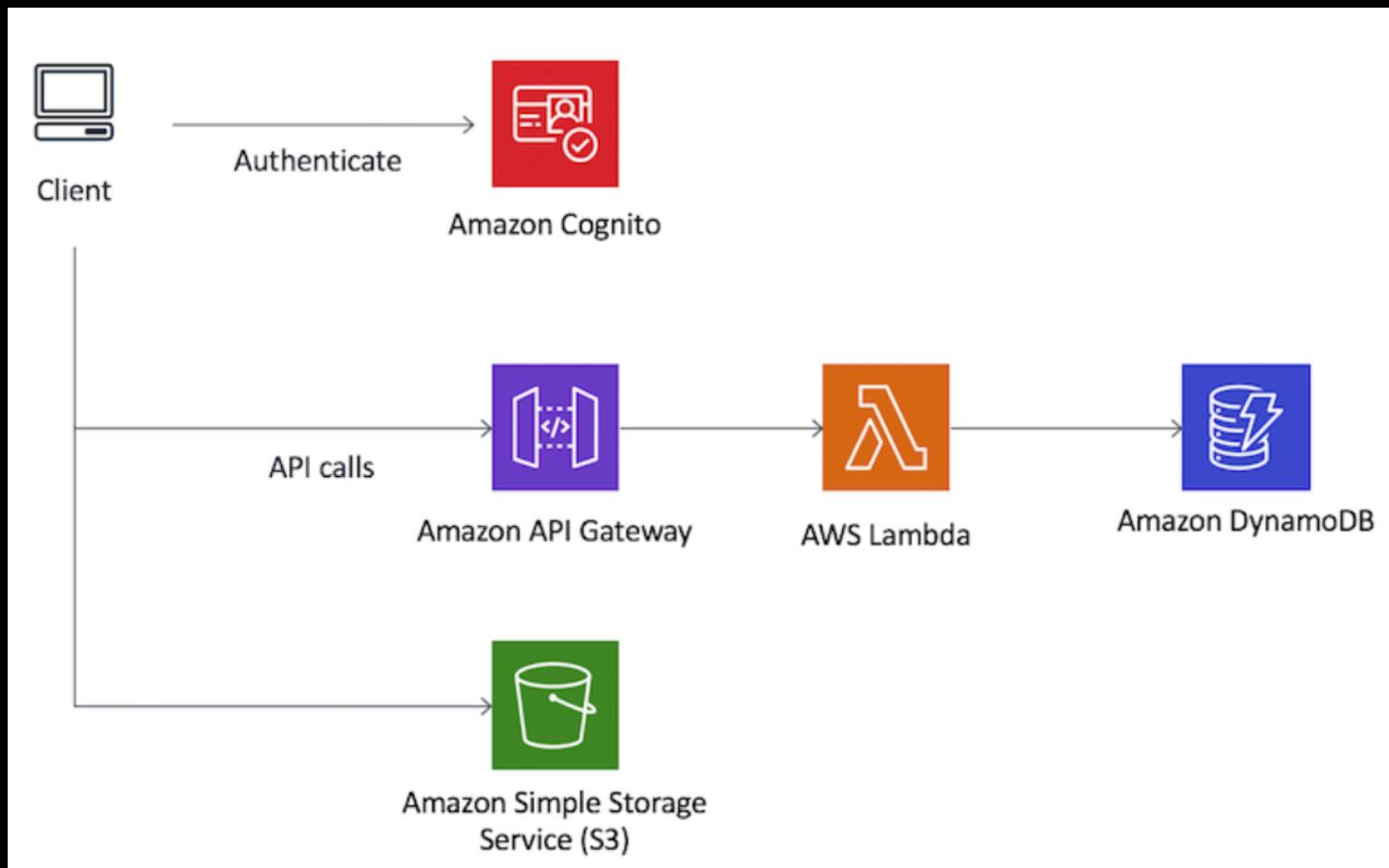
API Design: Introduction



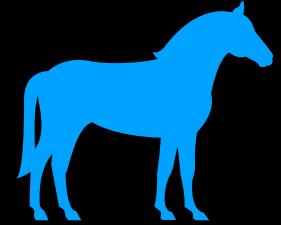
OpenAPI Spec

API Design: Introduction

- **AWS**



API Design: Introduction



- **Past:**

- API Wild West**

- URL/Query String, Form Data, etc.**

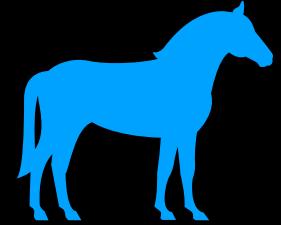
- SOAP/WSDL**

- XML, text, etc.**

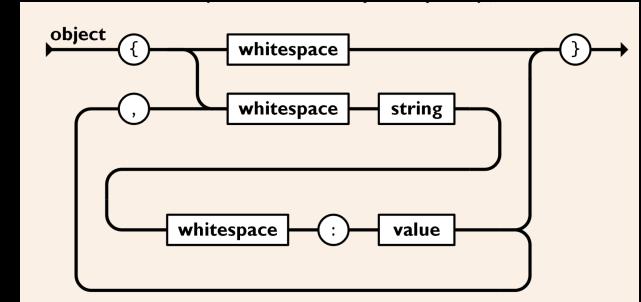
Everything was proprietary, complex

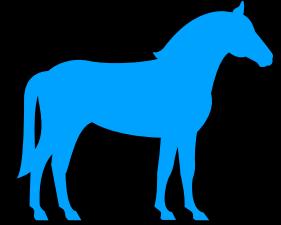
Needed a Standard

API Design: Introduction



- 2000:
Roy Fielding's doctoral dissertation on REST (REpresentational State Transfer)
- 2001:
JSON by Douglas Crockford
JavaScript Object Notation
json.org





**Early 2000s - Money to be made
Access data
Useful functionality, storage
eBay, Flickr, Amazon, Twitter, etc.
The standard is key**



- REST (or other) API is expected now
Libraries/frameworks/SDKs abound
Variations cause problems
Downside: better solutions will suffer
from inertia

API Design: Introduction



gRPC - [grpc.io](#)

g = ?

Remote Procedure Call

"a client application can directly call a method on a server application on a different machine as if it were a local object"

GraphQL

flexible

data efficient

Facebook 2012, open-source 2015

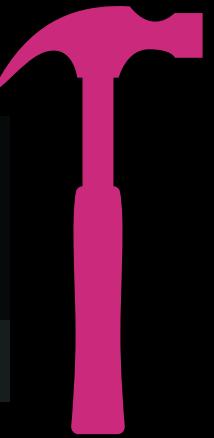
```
{
  "data": {
    "user": {
      "id": "4802170",
      "name": "Lee Byr",
      "isViewerFriend": true,
      "profilePicture": {
        "uri": "cdn://",
        "width": 50,
        "height": 50
      },
      "friendConnection": {
        "totalCount": 305,
        "friends": [
          {
            "id": "305",
            "name": "S"
          },
          {
            "id": "310",
            "name": "B"
          }
        ]
      }
    }
  }
}
```

Image from: <https://engineering.fb.com/2015/09/14/core-data/graphql-a-data-query-language/>



- **Enter: OpenAPI Standard Versioned (e.g., 3.0.1)**

API OpenAPI spec
Provides details of implementation
Contract/Standard
Versioned (e.g., 1.1)
Starts with Info section



- **Editor: Info**

editor.swagger.io

Start with version

Errors

Insert > Info



Swagger Editor™

Supported by SMARTBEAR

1 **openapi: 3.0.1**

Errors

Structural error at
should have required property 'info'
missingProperty: info
[Jump to line 0](#)

Structural error at
should have required property 'paths'
missingProperty: paths
[Jump to line 0](#)

API Design: Introduction



- **Editor**

Insert > Info

Enter text in fields

License/Contact options

Click 'Add Info'

Insert ▾

General

Add Path Item

Add Operation

Add Info

Add Info to Document

Title *

REQUIRED. The title of the application.

My API

Description

A short description of the application. Comma

Best API ever

Version *

REQUIRED. The version of the OpenAPI d

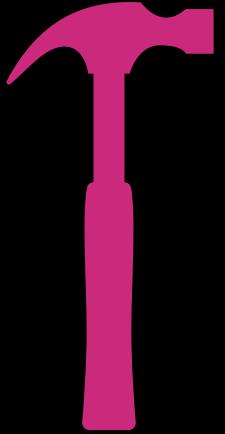
1.0

Terms of Service

A URL to the Terms of Service for the API. I

<https://www.example.com/>

API Design: Introduction



- **Text inserted**

```
1 openapi: 3.0.1
2 info:
3   title: My API
4   version: '1.0'
5   description: Best API ever
6   termsOfService: https://www.example.com/
7   contact:
8     email: bear@brainwashinc.com
9     name: Bear Cahill
10    url: http://www.example.com/contact
11    license:
12      name: My License
13      url: http://www.example.com/license
```

End of lab

API Design: JSON

- RESTful JSON
JSON

JavaScript Object Notation

json.org

Arrays, Dictionaries of values

Represented in text

**Parseable across platforms,
languages, etc.**



```
value
object
array
string
number
"true"
"false"
"null"

object
{' ws '}
{' members '}

members
member
member ',' members

member
ws string ws ':' element

array
[' ws ']
[' elements ']
```



- **JSON Object Example:**
User

userId: String

userName: String

isActive: Boolean

rank: Integer

address: Dictionary/Hash

API Design: JSON



- **JSON Object Example:**
User

userId: String

userName: String

isActive: Boolean

rank: Integer

address: Dictionary/Hash

```
{  
  "userId": "ABC12341",  
  "userName": "brainofbear",  
  "isActive": true,  
  "rank": 5,  
  "address": {  
    "street": "500 Main St.",  
    "city": "Denton",  
    "postal": 76201  
  }  
}
```

API Design: JSON

- **JSON**
Object name (User) not included
Arrays []
Dictionary {}
Keys are Strings
Values vary
Strings, Ints, Bool,
Dictionaries, Array

value
object
array
string
number
"true"
"false"
"null"



object
'{} ws {}'
'{} members {}'

members
member
member ',' members

member
ws string ws ':' element

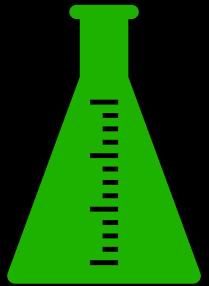
array
'[] ws []'
'[elements]'



- **JSON**
RESTful JSON - very common combo
SDKs often provide parsing
Sometimes built into languages
JS, Swift (Codeable)

- **Lab**

<https://jsonlint.com/>



Create an array of Elements

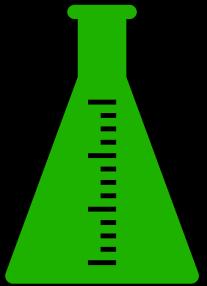
Each element has 3 members:

name of type string

description of type string

age of type integer

See next slide for hints



- **Lab**

json.org has details

Arrays are within [and]

Elements are within { and }

Element members are key-value pairs

"name" : "test"

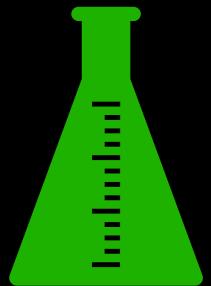
Members and Array elements are comma separated

See next slide for example

API Design: JSON

- **Lab**

```
1 ▼ [  
2 ▼   {  
3     "name": "thing 1",  
4     "description": "just a thing",  
5     "age": 4  
6   },  
7 ▼   {  
8     "name": "thing 2",  
9     "description": "just another thing",  
10    "age": 10  
11  },  
12 ▼  {  
13    "name": "thing 3",  
14    "description": "just a third thing",  
15    "age": 25  
16  }  
17 ]
```



End of lab



- Key Concepts

HTTP for communication

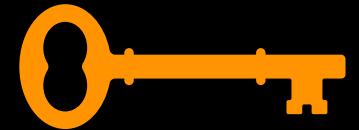
State is...

Value(s) of data at a given time

Cookies, Parameters, etc. represent state

REST Statelessness

Nothing stored by server (or possibly even sent by client) about state



Key Aspects

Nouns - resource based

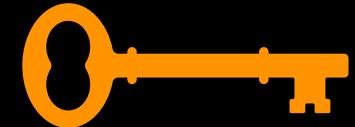
e.g., User, Comment, Post

Verbs to URLs

e.g., GET, POST

Stateless - each request has it all

**Scaleable - doesn't need same server
for next request**



Key Aspects

Nouns - resource based

e.g., **Users**

<domain>/users

<http://www.example.com/api/users>

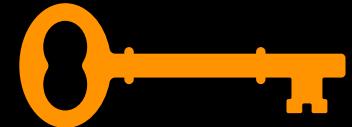
Array of User objects (JSON): []

<domain>/users/<id>

<http://www.example.com/api/users/234>

1 User object: { }

API Design: Design



Key Aspects

Example: DB Tables

.../customers

.../customers/{customer_id}

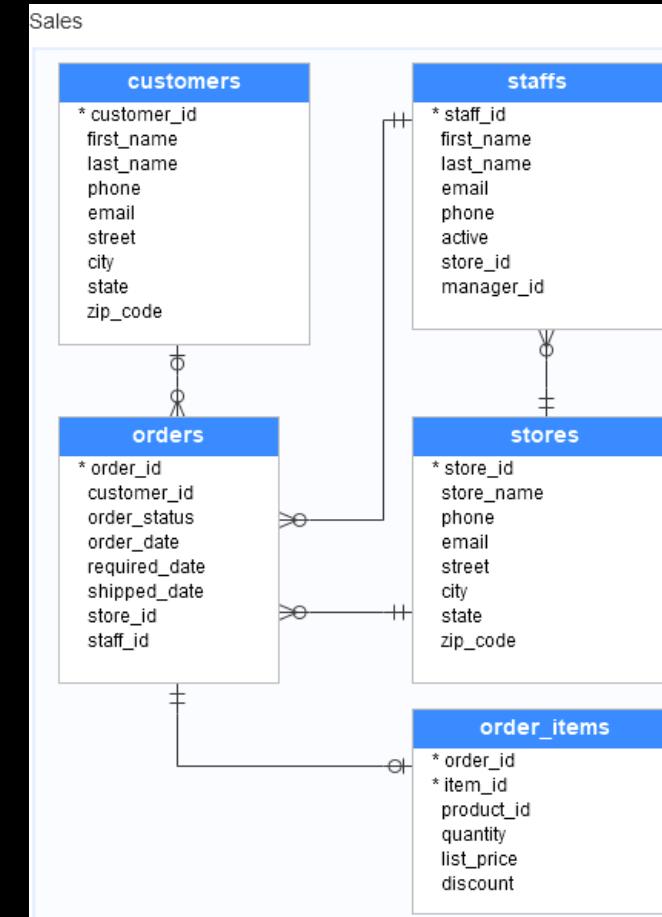
.../staffs

.../orders

.../stores

.../orderItems

Could be other resources



API Design: Design

- **Key Aspects**

**Nouns - resource based
Relationships in URL**

Comments relates to Post 1

**/posts/1/comments - returns 2
comments**

**/comments/1/posts - returns 1
post**

Data Source ->



```
{  
  "posts": [  
    {  
      "id": 1,  
      "title": "Post 1"  
    },  
    {  
      "id": 2,  
      "title": "Post 2"  
    },  
    {  
      "id": 3,  
      "title": "Post 3"  
    }  
  "comments": [  
    {  
      "id": 1,  
      "body": "some comment",  
      "postId": 1  
    },  
    {  
      "id": 2,  
      "body": "some comment",  
      "postId": 1  
    }  
}
```

API Design: Design

Verbs - CRUD

POST = Create

GET = Read

PATCH = Update

DELETE = Delete

Data Source ->



```
{  
  "posts": [  
    {  
      "id": 1,  
      "title": "Post 1"  
    },  
    {  
      "id": 2,  
      "title": "Post 2"  
    },  
    {  
      "id": 3,  
      "title": "Post 3"  
    }  
  "comments": [  
    {  
      "id": 1,  
      "body": "some comment",  
      "postId": 1  
    },  
    {  
      "id": 2,  
      "body": "some comment",  
      "postId": 1  
    }  
}
```

API Design: Design

Verbs - CRUD

GET - read

.../posts - all

.../posts/1 - post with id = 1

.../comments - all

.../comments/1 - one

**.../posts/1/comments -
comments related to post
via postId**

Data Source ->



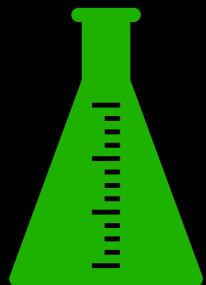
```
{  
  "posts": [  
    {  
      "id": 1,  
      "title": "Post 1"  
    },  
    {  
      "id": 2,  
      "title": "Post 2"  
    },  
    {  
      "id": 3,  
      "title": "Post 3"  
    }  
],  
  "comments": [  
    {  
      "id": 1,  
      "body": "some comment",  

```

Lab: GET

API Design: Design

<https://my-json-server.typicode.com/typicode/demo>



View db.json file

Via browser:

GET posts, single post, comments, single comment, comments for 1 post

How to

1. Create a repository on GitHub ([<your-username>/<your-repo>](https://github.com/your-username/your-repo))
2. Create a `db.json` file
3. Visit <https://my-json-server.typicode.com/<your-username>/<your-repo>> to access your server

No registration. Nothing to install.



Sponsor

Share

Fork

demo

by typicode

Available resources

• posts³

```
{  
  "posts": [  
    {  
      "id": 1,  
      "title": "Po  
    },  
    {  
      "id": 2,  
      "title": "Po  
    },  
    {  
      "id": 3,  
      "title": "Po  
    },  
  ],  
  "comments": [  
    {  
      "id": 1,  
      "body": "so  
      "postId": 1  
    },  
    {  
      "id": 2,  
      "body": "so  
    }  
  ]  
}
```

Verbs - Create, Update

POST = Create

PATCH = Update

PUT

If exists, replace

Otherwise, create

Idempotent - multiple requests,
same result



API Design: Design

Verbs - CRUD

POST = Create

GET = Read

PATCH = Update

DELETE = Delete

POST/PUT/PATCH

Overlap

Require HTTP body





Query String

Additional parameters:

Filtering

Searching

Paging

Embedding

etc.

.../api/posts/1?_embed=comments

```
{  
  "id": 1,  
  "title": "Post 1",  
  "comments": [  
    {  
      "id": 1,  
      "body": "some comment",  
      "postId": 1  
    },  
    {  
      "id": 2,  
      "body": "some comment",  
      "postId": 1  
    }  
  ]  
}
```

API Design: Design



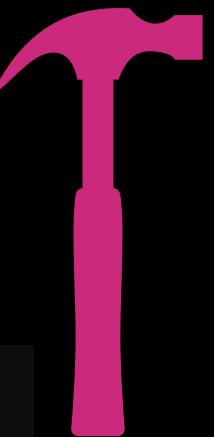
- All defined in...

OpenAPI Spec
Contract Description
Information
Servers
Paths & Methods
Model
Security
All Interested Parties

Field Name	Type
openapi	string
info	Info Object
servers	[Server Object]
paths	Paths Object
components	Components Object
security	[Security Requirement Object]
tags	[Tag Object]
externalDocs	External Documentation Object

```
1  swagger: "2.0"
2  info:
3    description: "This is a sample server Petstore server
   can find out more about Swagger at [http://swagger.io] or on [irc.freenode.net, #swagger]
   ://swagger.io/irc/]. For this sample, you can
   api key `special-key` to test the authorization
   ."
4  version: "1.0.0"
5  title: "Swagger Petstore"
6  termsOfService: "http://swagger.io/terms/"
7  contact:
8    email: "apiteam@swagger.io"
9  license:
10   name: "Apache 2.0"
11   url: "http://www.apache.org/licenses/LICENSE-2.0.h
12 host: "petstore.swagger.io"
13 basePath: "/v2"
14 tags:
15 - name: "pet"
16   description: "Everything about your Pets"
17   externalDocs:
18     description: "Find out more"
19     url: "http://swagger.io"
20 - name: "store"
21   description: "Access to Petstore orders"
22 - name: "user"
23   description: "Operations about user"
24   externalDocs:
25     description: "Find out more about our store"
26     url: "http://swagger.io"
27 schemes:
28 - "https"
29 - "http"
30 paths:
31 /pet:
32   post:
33     tags:
34       - "pet"
35     summary: "Add a new pet to the store"
36     description: ""
37     operationId: "addPet"
```

API Design: Design Concepts



- Now that we have one...

Add Server

[editor.swagger.io](#)

Insert > Add Servers

Insert ▾ Generate

Add Path Item

Add Operation

Add Info

Add External Doc

Add Tag Declaration

Add Tags To Operation

Add Servers

Add:

<https://my-json-server.typicode.com/typicode/demo/>

Add Servers

Server

An object representing a Server.

URL *

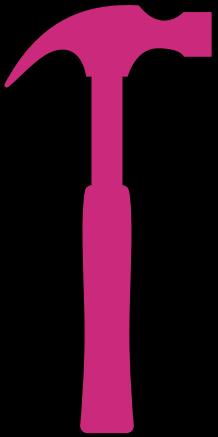
REQUIRED. A URL to the target host. This URL supports Server Variables relative to the location where the OpenAPI document is being processed. {brackets}.

`https://my-json-server.typicode.com/typicode/demo/`

Description

An optional string describing the host designated by the URL.

`Demo Server`



API Design: Design Concepts

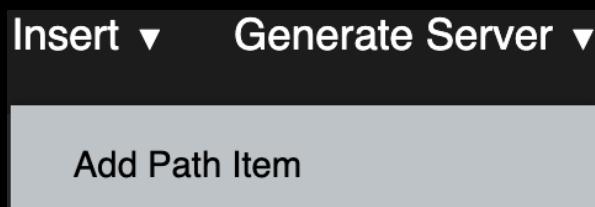
- **Server**

```
1  openapi: 3.0.1
2  info:
3    title: My API
4    version: '1.0'
5    description: Best API ever
6    termsOfService: https://www.example.com/
7    contact:
8      email: bear@brainwashinc.com
9      name: Bear Cahill
10     url: http://www.example.com/contact
11    license:
12      name: My License
13      url: http://www.example.com/license
14    servers:
15      - url: https://my-json-server.typicode.com/typicode/demo/
16        variables: {}
17        description: Demo Server
```

End of Lab

API Design: Design Concepts

- **Lab: OpenAPI**
- **Add Path Insert > Add Path Item**
- **Fill in form**
- **Click Add Path**



Add Path

Path *
REQUIRED. The path to add.

Summary
Enter a summary of the path.

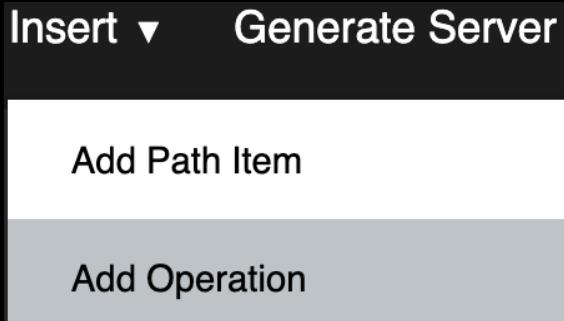
Description
An optional, string description.

Creates:

```
paths:  
  /users:  
    summary: user level operations  
    description: create and read users
```

API Design: Design Concepts

- **Lab: OpenAPI Add Path Method: GET**
- **Insert > Add Operation**
- **Fill in form**
- **Click Add Operation**



Add Operation to Document

Path *
REQUIRED. The path to add the operation to.
`/users`

Operation *
REQUIRED. Select an operation.
`get`

Summary
Add a short summary of what the operation does.
`fetch users`

Description
A verbose explanation of the operation behavior. Comm
`read users from server`

Operation ID
Unique string used to identify the operation. The id MU
operationId to uniquely identify an operation, therefore,
`fetchUsers`

Tags
A list of tags for API documentation control. Tags can b
`users`

Tag *
REQUIRED. The name of the tag.
`users`

Creates:

paths:

`/users:`

`summary: user level operations`

`description: create and read users`

`get:`

`summary: fetch users`

`description: read users from server`

`operationId: fetchUsers`

`responses:`

`default:`

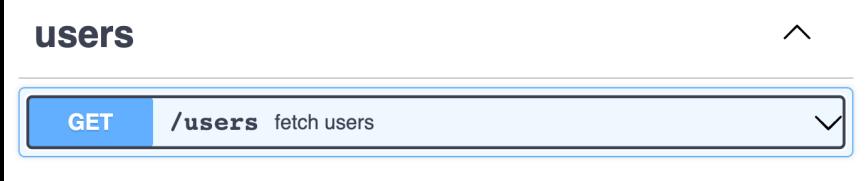
`description: Default error sample response`

`tags:`

`- users`

API Design: Design Concepts

- Lab: OpenAPI Add Path Method: GET
- Notice updated documentation
- Execute GET



The screenshot shows an API documentation tool with the following details:

- Method:** GET
- Path:** /users
- Description:** fetch users
- Parameters:** No parameters
- Responses:**
 - Curl:** curl -X 'GET' '\n "https://my-json-server.typicode.com/bearc0025/api/users'\n -H 'Accept: */*'
 - Request URL:** https://my-json-server.typicode.com/bearc0025/api/users
 - Server response:** 200 Response body (JSON array of user objects)

The 'Response body' section displays the following JSON data:

```
[{"id": "1234abc", "username": "bear", "score": 55, "active": true}, {"id": "xyz123", "username": "schmeh", "score": 550, "active": false}, {"id": "qwerty", "username": "jed", "score": 553, "active": true}]
```

- End of lab

API Design: Design

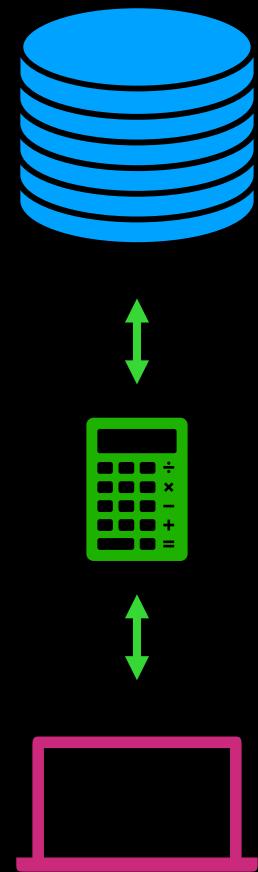


For more... PluralSight

➤ APIs- Application Programming
Interface: Executive Briefing

[Dan Appleman](#)

API Design: Design Concepts



API Design: Design Concepts

Separation of Concerns

Gathering Data - e.g., from database

Formatting Data - e.g., JSON

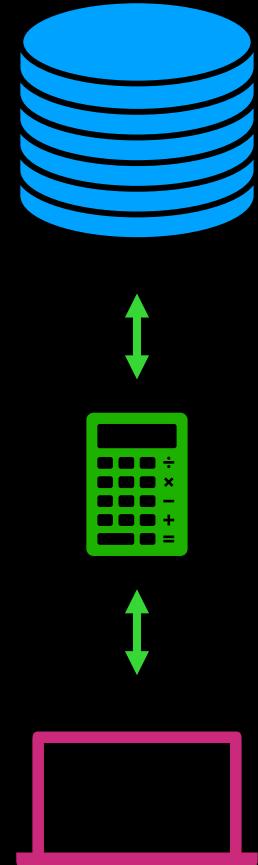
Delivering Data - e.g., HTTP, streaming

Security

Scalability

Reliability

Etc.



Separation of Concerns

Gathering Data

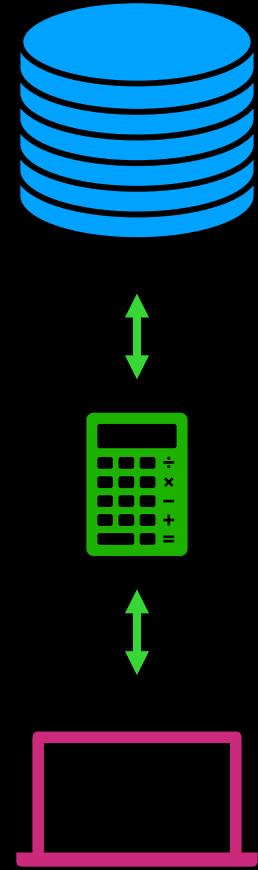
When requested by client

Very important on the server

Good database design

Cache if possible

Efficient queries



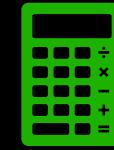
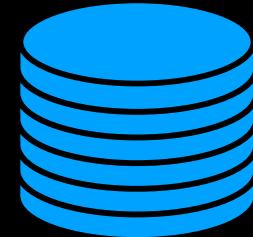
Separation of Concerns

Formatting Data

When sending/returning to client

Important to client

Directed by server (one-for-all)



Separation of Concerns

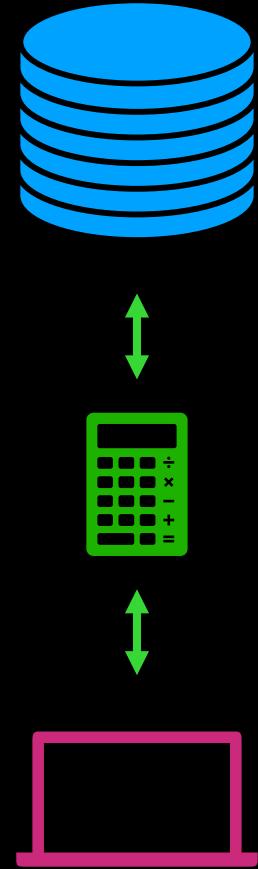
Delivering Data

How it is sent: protocol, etc.

Important to client

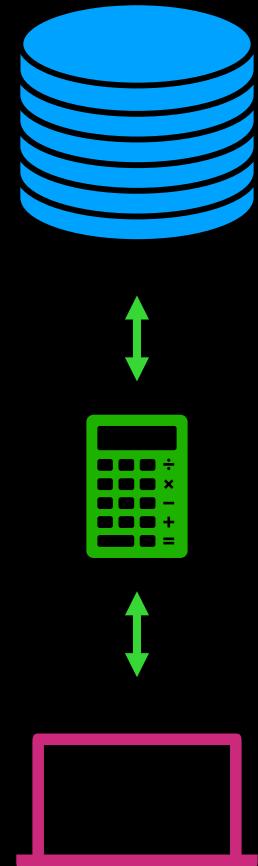
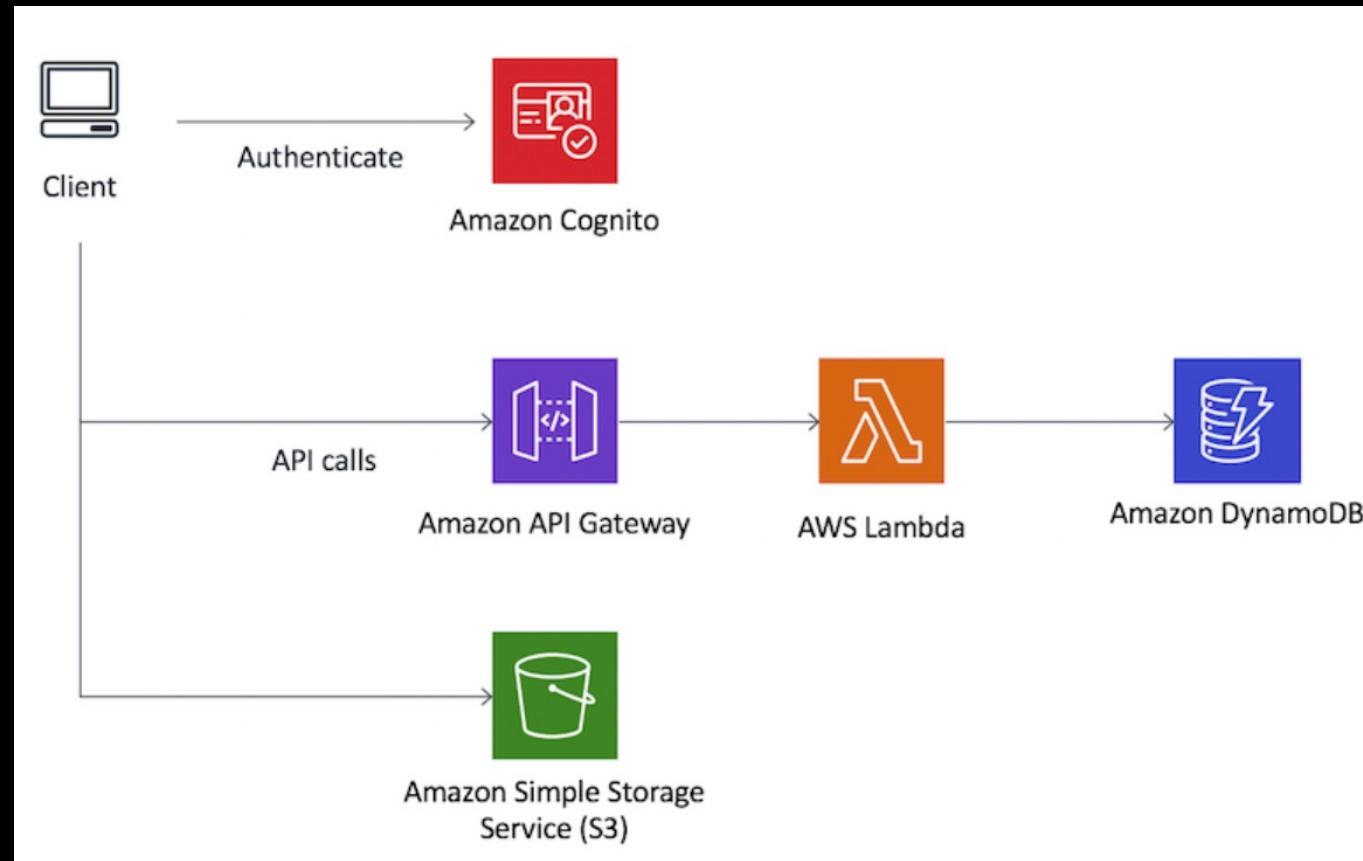
Directed by server

Usually the same for all clients



API Design: Design Concepts

AWS - Separation of Concerns



- Operations: Responses
 - Default Response
 - Specified by Status Code (e.g., 200, 404, etc.)
 - Includes:
 - Description
 - Content
 - Content Type
 - Schema

```
get:
  summary: fetch users
  description: read users from server
  operationId: fetchUsers
  responses:
    default:
      description: Default error sample response
  tags:
    - users
```

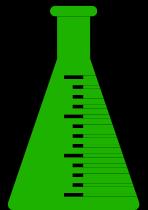
- For all 200-299 response
- application/json content
- Schema is an object
- With properties

Users
id : String
username: String
score : Integer
active : Boolean

```

get:
  summary: fetch users
  description: read users from server
  operationId: fetchUsers
  responses:
    '2XX':
      description: successful fetch
      content:
        application/json:
          schema:
            type: object
            properties:
              id:
                type: string
                example: "abc123"
              username:
                type: string
                example: "bear"
              score:
                type: integer
                example: 55
              active:
                type: boolean
                example: true
  
```

- Lab: OpenAPI Add GET Response
- NOTE: We'll make this an array later.



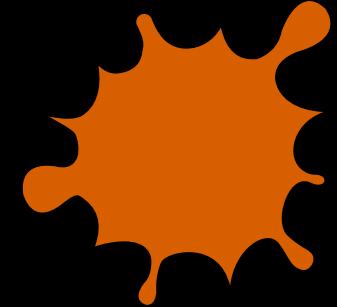
```
get:  
  summary: fetch users  
  description: read users from server  
  operationId: fetchUsers  
  responses:  
    '2XX':  
      description: successful fetch  
      content:  
        application/json:  
          schema:  
            type: object  
            properties:  
              id:  
                type: string  
                example: "abc123"  
              username:  
                type: string  
                example: "bear"  
              score:  
                type: integer  
                example: 55  
              active:  
                type: boolean  
                example: true
```

Responses

Code	Description
2XX	successful fetch Media type application/json Controls Accept header. Example Value Schema

```
{  
  "id": "abc123",  
  "username": "bear",  
  "score": 55,  
  "active": true  
}
```

- End of lab



Errors

HTTP

Response Codes

1xx: Informational

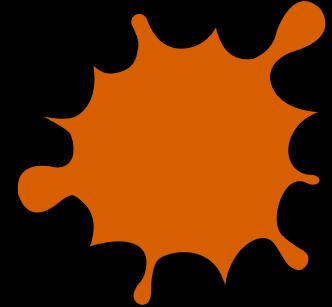
2xx: Success

3xx: Redirection

4xx: Client Error

5xx: Server Error

<https://www.w3.org/Protocols/rfc2616/rfc2616-sec10.html>



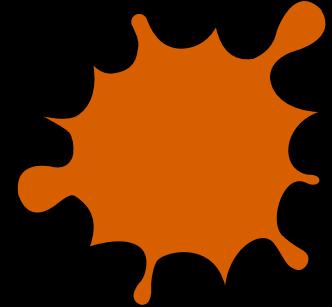
Errors - Best Practices

Use the correct codes

Use the right code granularity (not every single status code)

Consider the response message depth - e.g., do you specify the first thing that's wrong with the request or everything?

Security - don't give away secrets



Errors - Best Practices

**"Helpful" information is best
Readable message**

Meaningful codes (http and internal)

Hints/Details when possible and appropriate



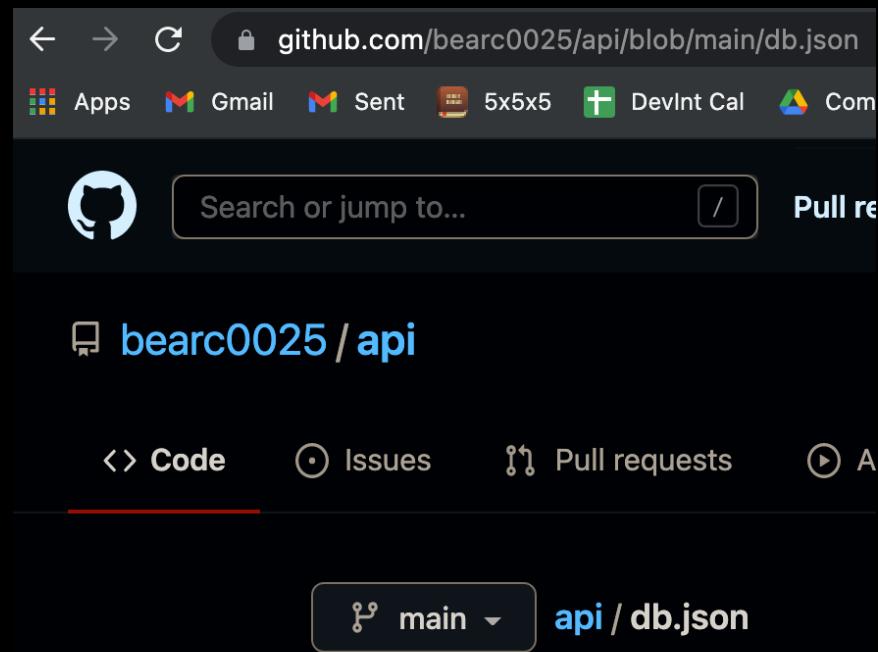
Environment
Development
Staging
Production
Other
Internal/External
OpenAPI supports multiple servers

API Design: Design

Demo:

GitHub Repo with db.json file

github.com/bearc0025/api/blob/main/db.json



```
{  
  "posts": [  
    {  
      "id": 1,  
      "title": "Post 1"  
    },  
    {  
      "id": 2,  
      "title": "Post 2"  
    },  
    {  
      "id": 3,  
      "title": "Post 3"  
    }  
  "comments": [  
    {  
      "id": 1,  
      "body": "some comment",  
      "postId": 1  
    },  
    {  
      "id": 2,  
      "body": "some comment",  
      "postId": 1  
    }  
  "profile": {  
    "name": "typicode"  
  }  
}
```

API Design: Design



Demo:

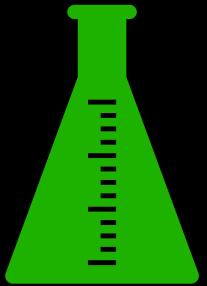
- <https://my-json-server.typicode.com/bearc0025/api>
- <https://my-json-server.typicode.com/bearc0025/api/posts>
- https://my-json-server.typicode.com/bearc0025/api/posts/1?_embed=comments

```
{  
  "posts": [  
    {  
      "id": 1,  
      "title": "Post 1"  
    },  
    {  
      "id": 2,  
      "title": "Post 2"  
    },  
    {  
      "id": 3,  
      "title": "Post 3"  
    }  
  ],  
  "comments": [  
    {  
      "id": 1,  
      "body": "some comment",  
      "postId": 1  
    },  
    {  
      "id": 2,  
      "body": "some comment",  
      "postId": 1  
    }  
  ]  
},
```



```
{  
  "id": 1,  
  "title": "Post 1",  
  "comments": [  
    {  
      "id": 1,  
      "body": "some comment",  
      "postId": 1  
    },  
    {  
      "id": 2,  
      "body": "some comment",  
      "postId": 1  
    }  
  ]  
}
```

API Design: Design



Lab

If you have a git repo...

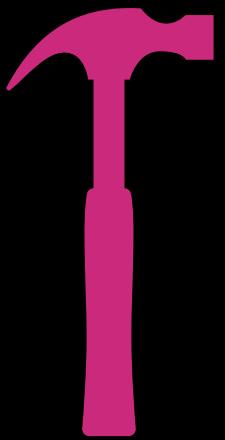
<https://my-json-server.typicode.com/>

Demo data @ <https://my-json-server.typicode.com/typicode/demo/db>

How to

1. Create a repository on GitHub (`<your-username>/<your-repo>`)
2. Create a `db.json` file
3. Visit <https://my-json-server.typicode.com/<your-username>/<your-repo>> to access your server

API Design: Design Concepts

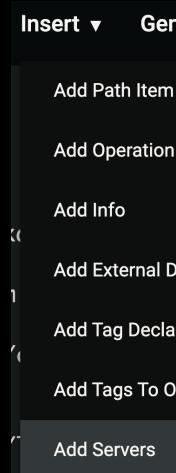


- Now that we have two...

Add Another Server

[editor.swagger.io](#)

Insert > Add Servers



Add Servers

Server

An object representing a Server.

URL *

REQUIRED. A URL to the target host. This URL supports Server Variables relative to the location where the OpenAPI document is being processed. {brackets}.

`https://my-json-server.typicode.com/bearc0025/api`

Description

An optional string describing the host designated by the URL.

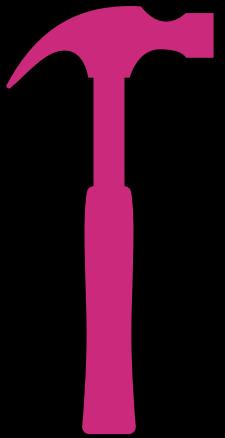
`My GIT server`

Server Variables

A map between a variable name and its value. The value is expanded at runtime.

Add your server or mine:

`https://my-json-server.typicode.com/bearc0025/api`



- **Server**

```
servers:  
  - url: https://my-json-server.typicode.com/typicode/demo/  
    variables: {}  
    description: Demo Server  
  - url: https://my-json-server.typicode.com/bearc0025/api  
    variables: {}  
    description: My GIT server
```

End of Lab

API Design: Richardson Maturity Model



API Design: Richardson Maturity Model

- **Breakdown**

<https://martinfowler.com/articles/richardsonMaturityModel.html>

Four Levels:

Level 0: Uses HTTP

Level 1: Resources (nouns)

Level 2: HTTP Verbs

**Level 3: Hypermedia Controls (HATEOAS =
Hypertext As The Engine Of Application
State)**



API Design: Richardson Maturity Model

- **Level 0: Uses HTTP**
Mostly just HTTP plus anything...
XML, YAML, JSON, etc.
RPC
Might be one endpoint for all requests
Content specifies details for request and response
And/or GET query string



API Design: Richardson Maturity Model

- **Level 1: Resources (nouns)**

Various endpoints

e.g., /posts, /posts/1

Body/GET still specifies details

Request, Response

Various formats: XML, etc.



API Design: Richardson Maturity Model

- **Level 2: HTTP Verbs**

GET

Same request, same results

Cacheable

POST (create)

201 Created

409 Conflict

PUT, PATCH, DELETE, etc.



API Design: Richardson Maturity Model

- **Level 3: Hypermedia Controls (HATEOAS = Hypertext As The Engine Of Application State)**

What to do next and how

Can be dynamic

Client doesn't need knowledge



```
{  
  "departmentId": 10,  
  "departmentName": "Administration",  
  "locationId": 1700,  
  "managerId": 200,  
  "links": [  
    {  
      "href": "10/employees",  
      "rel": "employees",  
      "type" : "GET"  
    }  
  ]  
}
```

API Design: Richardson Maturity Model

- **HATEOAS**

No official OpenAPI format

Common practice includes:

href: URI

rel: relation type

**type: expected media resource type (e.g.,
JSON or <https://restfulapi.net/hateoas/>)**

**See [RFC5988](#) and Hypertext Application
Language (HAL)**

```
{  
    "departmentId": 10,  
    "departmentName": "Administration",  
    "locationId": 1700,  
    "managerId": 200,  
    "links": [  
        {  
            "href": "10/employees",  
            "rel": "employees",  
            "type" : "GET"  
        }  
    ]  
}
```



API Design: Richardson Maturity Model



- **OpenAPI 3.0**
Added links section in responses
operationId or operationRef
parameters or requestBody
Optional: server and description

```
responses:  
  '201':  
    description: Created  
    content:  
      application/json:  
        schema:  
          type: object  
          properties:  
            id:  
              type: integer  
              format: int64  
              description: ID of the created user.  
# -----  
# Links  
# -----  
links:  
  GetUserByUserId: # <---- arbitrary name for the link  
    operationId: getUser  
    # or  
    # operationRef: '#/paths/~1users~1{userId}/get'  
    parameters:  
      userId: '$response.body#/id'  
    description: >  
      The `id` value returned in the response can be used as  
      the `userId` parameter in `GET /users/{userId}`.  
# -----
```



- operationId or operationRef specifies the related method of the link operationRef by path (internal / escaped w/ ~1) parameters based on referenced operation (name) and properties**

```

responses:
  '201':
    description: Created
    content:
      application/json:
        schema:
          type: object
          properties:
            id: <-->
              type: integer
              format: int64
              description: ID of the created user.
    links:
      GetUserByUserId:
        description: >
          The `id` value returned in the response can be used as
          the `userId` parameter in `GET /users/{userId}`.
        operationId: getUser
        # or
        # operationRef: '#/paths/~1user~1{userId}/get'
        parameters:
          userId: $response.body#/id
<-->

/user/{userId}:
  get:
    summary: Get a user by ID
    operationId: getUser
    parameters:
      - in: path
        name: userId
        required: true
        schema:
          type: integer
          format: int64
    responses:
      '200':
        description: A User object
  
```

API Design: Richardson Maturity Model



- **Links can be defined in the components section**

Links can be reused

e.g., /users and /users/{userId}

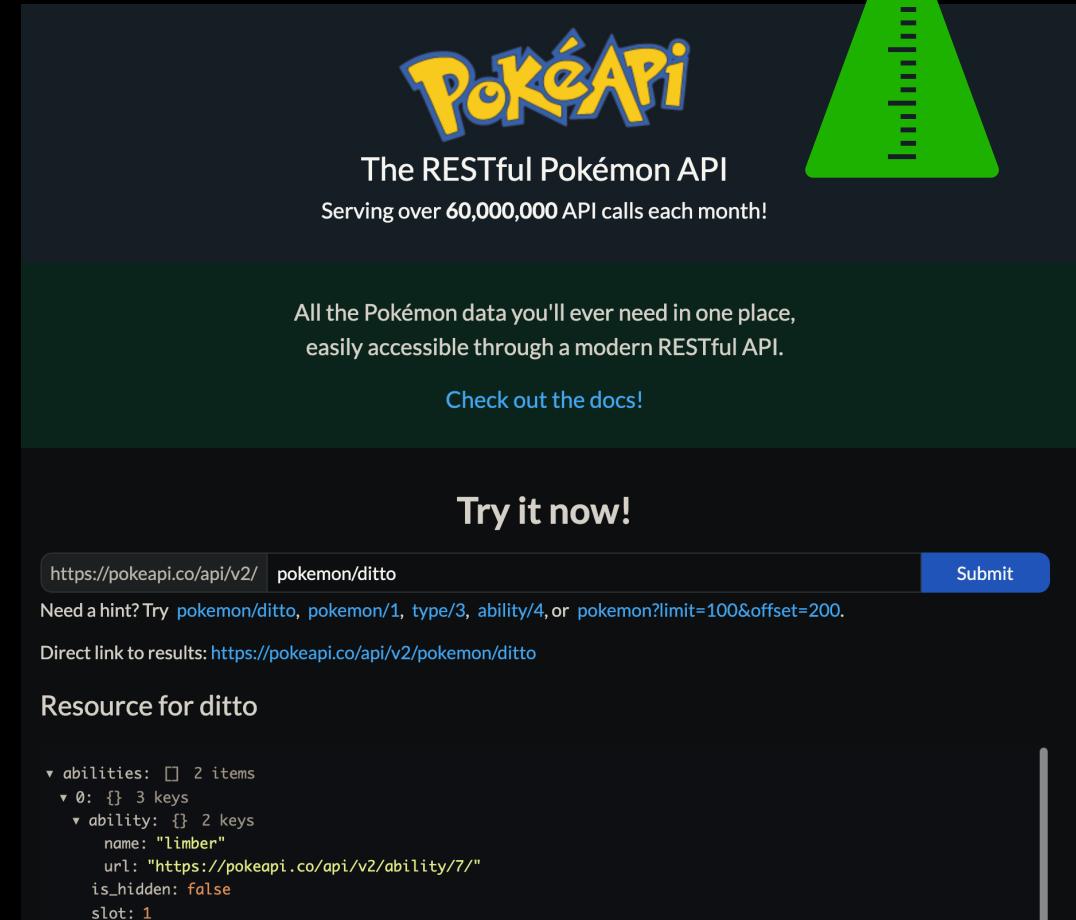
```
links:  
  GetUserById:  
    $ref: '#/components/links/GetUserById' # -----  
  
  get:  
    summary: Get a user by ID  
    operationId: getUser  
    ...  
  
components:  
  links:  
    GetUserById: # ----- The $ref's above point here  
    description: >  
      The `id` value returned in the response can be used as  
      the `userId` parameter in `GET /users/{userId}`.  
    operationId: getUser  
    parameters:  
      userId: '$response.body#/id'
```

API Design: Design

Lab

<https://pokeapi.co/>

Fetch data and drill
down into more
Try with limit and offset



The screenshot shows the homepage of the PokeéAPI website. At the top right is a large green funnel icon with a vertical scale. The header features the "PokeéAPI" logo in yellow and blue, followed by the text "The RESTful Pokémon API" and "Serving over 60,000,000 API calls each month!". Below this, a dark green banner contains the text "All the Pokémon data you'll ever need in one place, easily accessible through a modern RESTful API." and a "Check out the docs!" button. A "Try it now!" button is prominently displayed in the center. Below it is a search bar with the URL "https://pokeapi.co/api/v2/pokemon/ditto" and a "Submit" button. A hint below the search bar suggests trying "pokemon/ditto", "pokemon/1", "type/3", "ability/4", or "pokemon?limit=100&offset=200". A direct link to the results is provided at "https://pokeapi.co/api/v2/pokemon/ditto". A detailed resource view for Ditto is shown, listing its abilities: "limber", "url: https://pokeapi.co/api/v2/ability/7/", "is_hidden: false", and "slot: 1".

API Design: Design

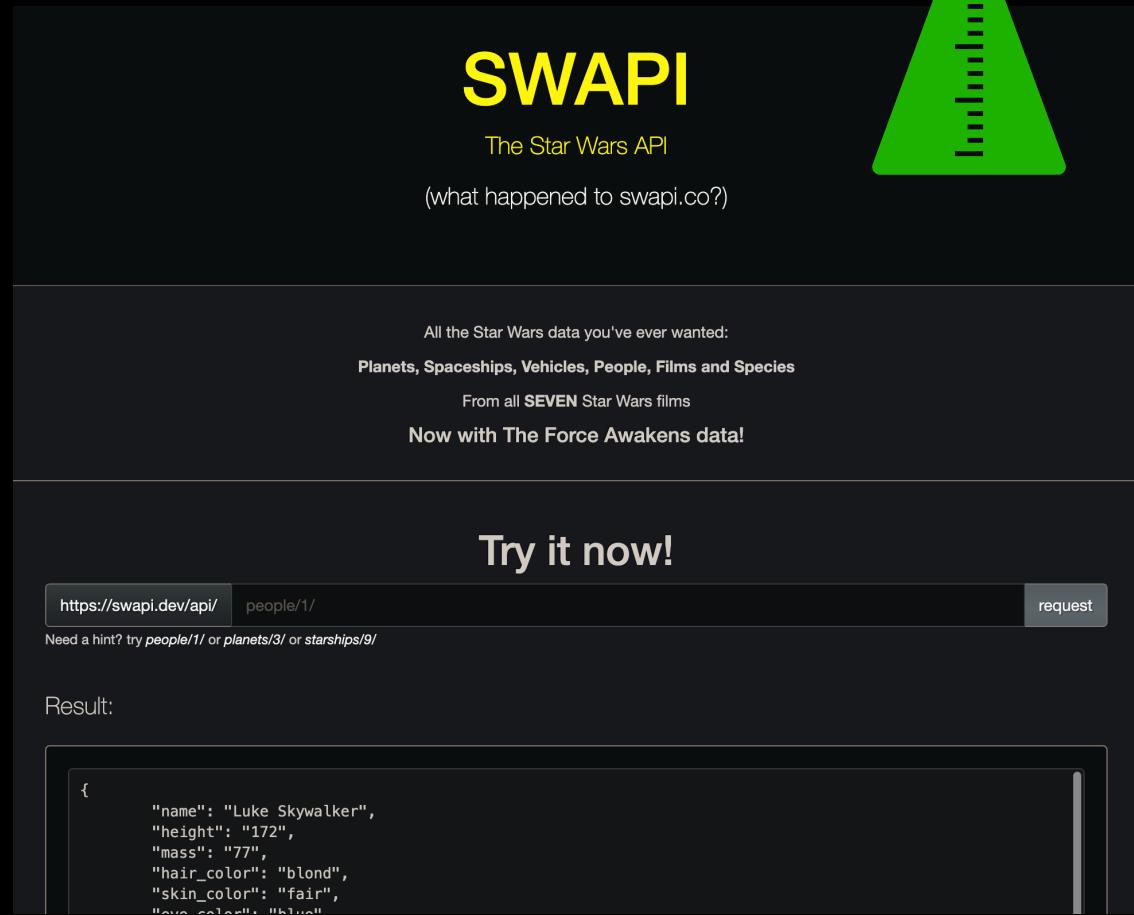
- **Lab**

<https://swapi.dev/>

**Fetch data and drill
down into more
Try with page query
string parameter**

https://swapi.dev/api/

people?page=5



The screenshot shows the official SWAPI (Star Wars API) documentation page. At the top right is a large green chemistry flask icon. The title "SWAPI" is in large yellow letters, followed by "The Star Wars API" and a note "(what happened to swapi.co?)". Below this, a dark banner contains the text "All the Star Wars data you've ever wanted: Planets, Spaceships, Vehicles, People, Films and Species From all SEVEN Star Wars films Now with The Force Awakens data!". A "Try it now!" button is prominently displayed with a "request" button next to it. Below the button is a code input field showing the URL "https://swapi.dev/api/people/1/" and a hint "Need a hint? try people/1/ or planets/3/ or starships/9/". The "Result:" section displays a JSON response for Luke Skywalker:

```
{  
  "name": "Luke Skywalker",  
  "height": "172",  
  "mass": "77",  
  "hair_color": "blond",  
  "skin_color": "fair",  
  "eye_color": "blue"
```

API Design: Dev Standards



API Design: Dev Standards

- **Contract communicates details**
- **Maintaining the contract helps keep all parties consistent/correct**
- **Changes should be driven via the contract**
 - **Centralized update for all**



API Design: Dev Standards



- **API Spec**
 - **Swagger/OpenAPI**
 - **Endpoints (paths)**
 - **Methods (verbs)**
 - **Requests bodies**
 - **Response bodies**
 - **Model**
 - **Parameters**

API Design: Dev Standards

- **Benefits**
 - **Source of Truth**
 - **Contract with agreement**
 - **Communication**
 - **Reliable, dependable, predictable**
 - **Otherwise - opposite of above**
- **Remember: An API is meant to be used - don't make it difficult**



API Design: Dev Standards

- **Richardson Maturity Model**
 - **Use HTTP, resources, verbs and (possibly) Hypermedia**
 - **Security - OAuth, SSL**
 - **Documentation**
 - **Readily available**
 - **Updated**
 - **Versioning - in URL, header, both**



API Design: Dev Standards

- **Filtering/Sorting/Search/Limiting/Pagination**
 - **Query string parameters**
 - **Route alias for complex/common**
 - **/posts/most_recent**
 - **Embed/expand**
- **Caching**
 - **Custom, ETag (hash version of resource) or Last-Modified**
 - **304 Not Modified response**



API Design: Dev Standards

- **POST/PUT/PATCH - return resource**
- **JSON**
 - Including PUT/POST/PATCH http body
 - Not key-value: name=bear&ver=1.1
 - Content-type: application/json
- **Camel case vs Snake case**
 - Camel for JavaScript and similar
 - camelCase vs snake_case



API Design: Dev Standards

- **HEAD**
 - **Identical to GET but no body for response**
 - **Meta info in headers per resource**
 - **Last mod, length, content type**
 - **Can be used for URL validity tests**
 - **Cacheable**



```
HTTP/1.1 200 OK
Accept-Ranges: bytes
Content-Type: text/html; charset=UTF-8
Date: Wed, 08 May 2013 10:12:29 GMT
ETag: "780602-4f6-4db31b2978ec0"
Last-Modified: Thu, 25 Apr 2013 16:13:23 GMT
Content-Length: 1270
```

- **OPTIONS**

- **API options (Allow/Content-type)**
- **Doesn't initiate data fetch/storage**
- **May apply to server or specific resource**
- **Non-Cacheable**
 - **It's not a true resource (GET)**
 - **<https://www.w3.org/Protocols/rfc2616/rfc2616-sec9.html>**



```
HTTP/1.1 200 OK
```

```
Allow: GET,HEAD,POST,OPTIONS,TRACE  
Content-Type: text/html; charset=UTF-8  
Date: Wed, 08 May 2013 10:24:43 GMT  
Content-Length: 0
```

9.2 OPTIONS

The OPTIONS method represents a request for information about the communication options available on the request/response chain identified by the Request-URI. This method allows the client to determine the options and/or requirements associated with a resource, or the capabilities of a server, without implying a resource action or initiating a resource retrieval.

Responses to this method are not cacheable.

API Design: Dev Standards

- **TRACE**
 - **Should reflect the message received back to client as the body**
 - **Allows client to see what/how is being received on the other end**
 - **See**
<https://www.w3.org/Protocols/rfc2616/rfc2616-sec9.html>



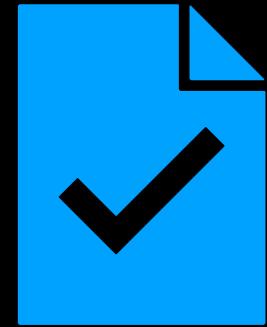
API Design: Dev Standards

- **Error handling**
 - **Thorough and consistent**
 - **HTTP status codes**
 - **Unique codes**
 - **Message for user**
 - **Message for log**



API Design: Contracts

**Describes/Defines the API
OpenAPI 3.0 (Swagger tools)
JSON, YAML and others
Includes info, server, paths, etc.**



```
openapi: 3.0.1
info:
  title: Swagger Petstore
  description: 'This is a sample server Pe
    find out more about
    Swagger at [http://swagger.io](http://
      .freenode.net, #swagger)](http://swag
    this sample, you can use the api key `
      the authorization filters.'
  termsOfService: http://swagger.io/terms/
  contact:
    email: apiteam@swagger.io
  license:
    name: Apache 2.0
    url: http://www.apache.org/licenses/LI
  version: 1.0.5
```

```
servers:
  - url: https://petstore.swagger.io/v2
  - url: http://petstore.swagger.io/v2
```

```
paths:
  /pet:
    put:
      tags:
        - pet
      summary: Update an exist
      operationId: updatePet
```

API Design: Contracts

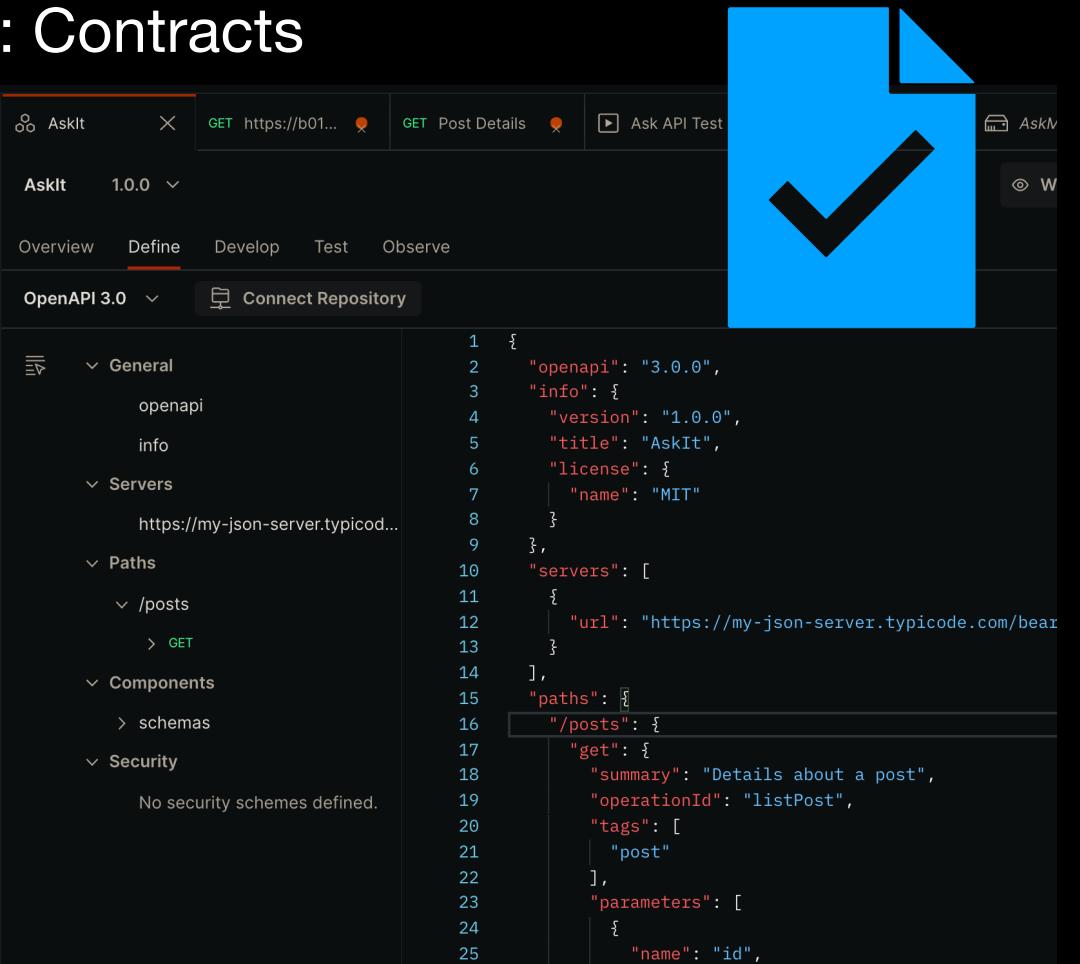
OpenAPI
Documentation
<https://swagger.io/specification/>

Various sections and
types

Field Name	Type	Description
openapi	string	REQUIRED. This string MUST be the semantic version number of the OpenAPI Specification version that the OpenAPI document uses. The <code>openapi</code> field SHOULD be used by tooling specifications and clients to interpret the OpenAPI document. This is <i>not</i> related to the API <code>info.version</code> string.
info	Info Object	REQUIRED. Provides metadata about the API. The metadata MAY be used by tooling as required.
servers	[Server Object]	An array of Server Objects, which provide connectivity information to a target server. If the <code>servers</code> property is not provided, or is an empty array, the default value would be a Server Object with a <code>url</code> value of <code>/</code> .
paths	Paths Object	REQUIRED. The available paths and operations for the API.
components	Components Object	An element to hold various schemas for the specification.
security	[Security Requirement Object]	A declaration of which security mechanisms can be used across the API. The list of values includes alternative security requirement objects that can be used. Only one of the security requirement objects need to be satisfied to authorize a request. Individual operations can override this definition. To make security optional, an empty security requirement (<code>{}</code>) can be included in the array.
tags	[Tag Object]	A list of tags used by the specification with additional metadata. The order of the tags can be used to reflect on their order by the parsing tools. Not all tags that are used by the Operation Object must be declared. The tags that are not declared MAY be organized randomly or based on the tools' logic. Each tag name in the list MUST be unique.
externalDocs	External Documentation Object	Additional external documentation.

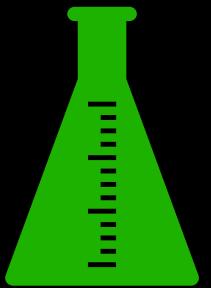
API Design: Contracts

- Tools
 - **SwaggerUI/Hub**
 - **Insomnia**
 - **OpenAPI Generator**
 - **Postman**
 - **PAW**
 - **Stoplight**
 - **Swashbuckle**
- **Can help generate or consume**



```
1  {
2   "openapi": "3.0.0",
3   "info": {
4     "version": "1.0.0",
5     "title": "AskIt",
6     "license": {
7       "name": "MIT"
8     }
9   },
10  "servers": [
11    {
12      "url": "https://my-json-server.typicode.com/bear"
13    }
14  ],
15  "paths": {
16    "/posts": {
17      "get": {
18        "summary": "Details about a post",
19        "operationId": "listPost",
20        "tags": [
21          "post"
22        ],
23        "parameters": [
24          {
25            "name": "id",
26            "in": "query",
27            "required": true,
28            "type": "string"
29          }
30        ]
31      }
32    }
33  }
34}
```

API Design: Code First

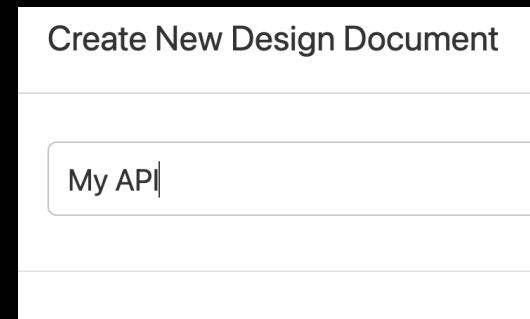
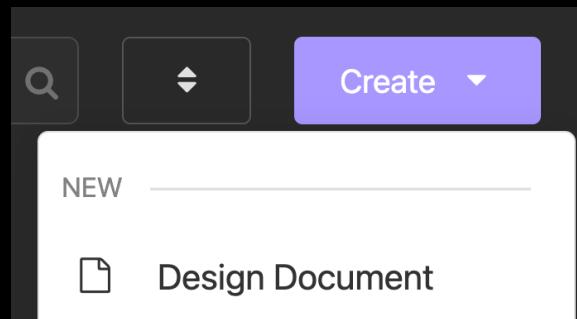


Create API in Insomnia

Open Insomnia

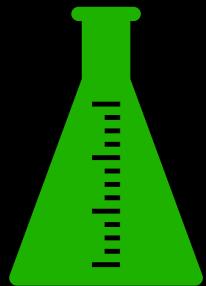
Click Create > Design Document

Give it a name and click Create



API Design: Code First

- Paste your texts from the Swagger editor into the Insomnia editor

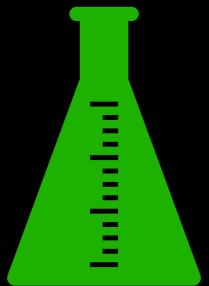


The screenshot shows the Insomnia interface with a Swagger specification document. The left sidebar lists sections: My API, Base Environment, Add Cookies, Add Certificates, SPEC (selected), Preview, INFO, SERVERS, PATHS, REQUEST BODIES, SCHEMAS, and SECURITY. The right panel displays the following OpenAPI specification:

```
1 openapi: 3.0.3
2< info:
3   title: My API
4   version: '1.0'
5   description: Best API ever
6   termsOfService: https://www.example.com
7   license:
8     name: Apache 2.0
9   url: http://www.apache.org/licenses/LICENSE-2.0.html
10< externalDocs:
11   description: Find out more about Swagger
12   url: http://swagger.io
13< servers:
14   - url: https://petstore3.swagger.io/api/v3
15   - url: https://my-json-server.typicode.com/typicode/demo/
16     variables: {}
17     description: Demo Server
18< tags:
19   - name: pet
20     description: Everything about your Pets
21   - externalDocs:
22     description: Find out more
23     url: http://swagger.io
24   - name: store
```

API Design: Code First

- **Test on the right**



The screenshot shows a dark-themed API documentation interface. At the top, it says "My API" with version "1.0" and "OAS3". Below that is a button "test with typicode". Under "Servers", there is a link "https://my-json-server.typicode.com/bearc0025/api - github api". A dropdown menu is open, showing "default". Inside the dropdown, there is a purple "GET" button next to the endpoint "/posts" with the description "fetch all posts". Below this, the response "return all posts from server" is shown. Under "Parameters", it says "No parameters" and has a "Try it out" button.

End of lab

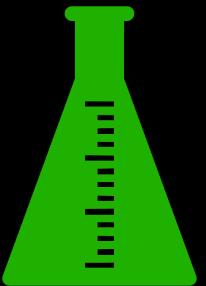
API Design: Contracts

- For more... PluralSight



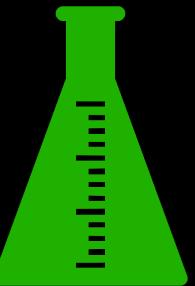
[Designing RESTful Web APIs](#)

[Shawn Wildermuth](#)



- **Lab: Local Typicode JSON Server**
 - Local server
 - Same data as Typicode db.json file
 - Add server in OpenAPI design

API Design: RESTful API Basics



- Lab: github.com/typicode/json-server

- **npm install -g json-server**

Create db.json file with contents like previous test server

<https://my-json-server.typicode.com/typicode/demo/>

Getting started

Install JSON Server

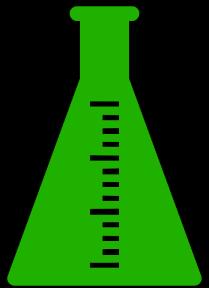
```
npm install -g json-server
```

Create a `db.json` file with some data

```
{
  "posts": [
    { "id": 1, "title": "json-server", "author": "typicode" }
  ],
  "comments": [
    { "id": 1, "body": "some comment", "postId": 1 }
  ],
  "profile": { "name": "typicode" }
}
```

```
{
  "posts": [
    { "id": 1, "title": "json-server", "author": "typicode" }
  ],
  "comments": [
    { "id": 1, "body": "some comment", "postId": 1 }
  ],
  "profile": { "name": "typicode" }
}
```

API Design: RESTful API Basics



- **Lab**
- **json-server --watch db.json**
In the same folder as db.json

<http://localhost:3000/posts>

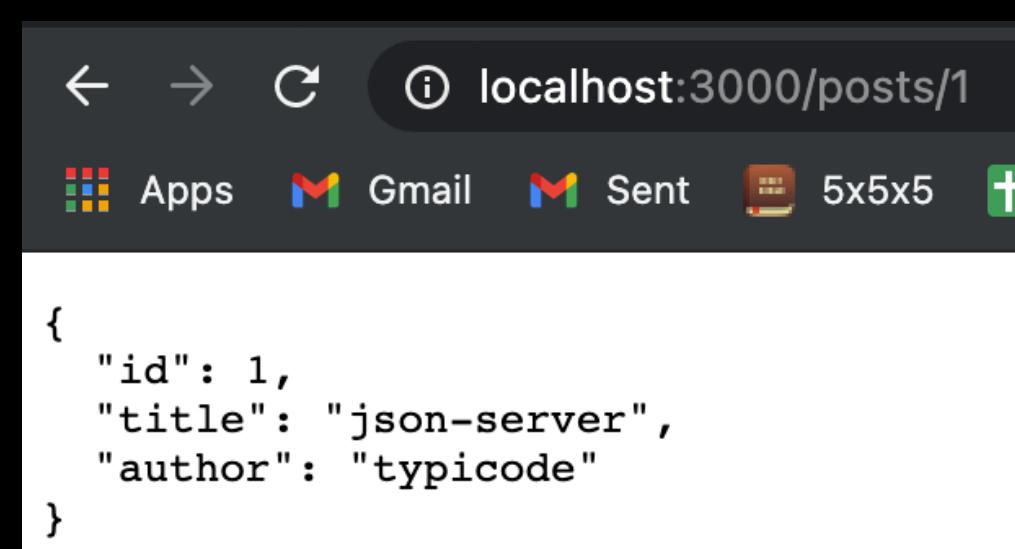
<http://localhost:3000/posts/1>

```
[Bear-MBP:json-server bearc2020$ json-server --watch db.json
\{^_^\}/ hi!
Loading db.json
Done

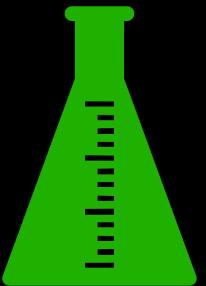
Resources
http://localhost:3000/posts
http://localhost:3000/comments
http://localhost:3000/reviews
http://localhost:3000/profile

Home
http://localhost:3000

Type s + enter at any time to create a snapshot of the database
Watching...
```



API Design: RESTful API Basics



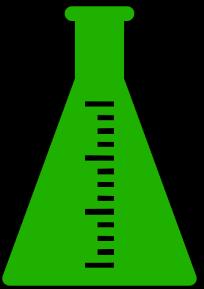
- **Lab**

<http://localhost:3000/posts/1/comments>

A screenshot of a web browser window. The address bar shows the URL `localhost:3000/posts/1/comments`. The page content displays a JSON array of comments:

```
[  
  {  
    "id": 1,  
    "body": "some comment",  
    "postId": 1  
  }  
]
```

API Design: RESTful API Basics



- **Lab**
Add Server to Swagger editor

Insert ▾ Generate

- Add Path Item
- Add Operation
- Add Info
- Add External Doc
- Add Tag Declaration
- Add Tags To Operations
- Add Servers

Add Servers

Server
An object representing a Server.

URL *
REQUIRED. A URL to the target host relative to the location where the API is being served. Use brackets to indicate optional segments.

Description
An optional string describing the host.

Server Variables
A map between a variable name and its value.

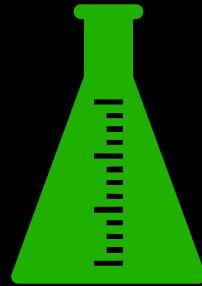
```
servers:  
- url: https://my-json-server.typicode.com/bearc0025/api  
  variables: {}  
  description: Test server  
- url: http://localhost:3000/  
  variables: {}  
  description: local json server
```

Servers

- ✓ <https://my-json-server.typicode.com/bearc0025/api> - Test server
- <http://localhost:3000/> - local json server

API Design: RESTful API Basics

- **Lab**
Test against local server



Servers
http://localhost:3000 - local json server

default

GET /posts GET posts

fetch all posts

Parameters

No parameters

Execute

Responses

Curl

```
curl -X 'GET' \
'http://localhost:3000/posts' \
-H 'accept: application/json'
```

Request URL

```
http://localhost:3000/posts
```

Server response

Code Details

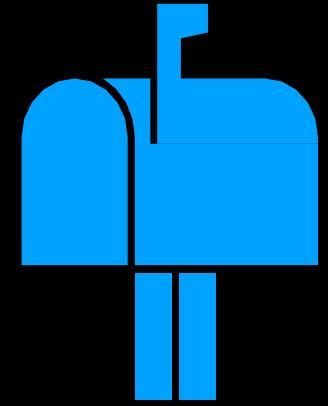
200 Response body

```
[  
  {  
    "id": 3,  
    "title": "seb",  
    "author": "some person"  
  },  
  {  
    "id": 4,  
    "title": "test3",  
    "author": "bear"  
  },  
  {  
    "id": 5,  
    "title": "test4",  
    "author": "test"  
  }]
```

End of lab

API Design: RESTful API Basics

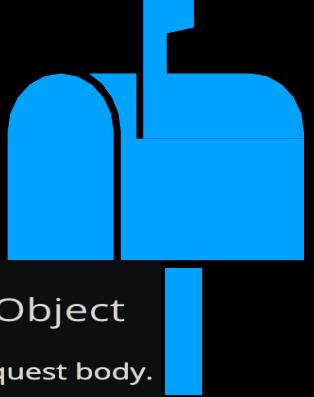
- **CRUD: Create POST HTTP Method**
- **Usually on base path e.g. /users HTTP**
- **Body with data: JSON**
- **Server creates ID**
- **Request Body without ID**



```
{  
  "username": "bear",  
  "score": 55,  
  "active": true  
}
```

API Design: RESTful API Basics

- <https://swagger.io/specification/#parameter-object>
- Similar to Response/schema
- Not per-HTTP code
- Can be defined in Components



Request Body Object	
Describes a single request body.	
Fixed Fields	
Field Name	Type
description	string
content	Map[string, Media Type Object]
required	boolean

API Design: RESTful API Basics

- Lab: Add /users POST
- Add POST operation

Add Operation to Document

Path *
REQUIRED. The path to add the operation to.

Operation *
REQUIRED. Select an operation.

Summary
Add a short summary of what the operation does.

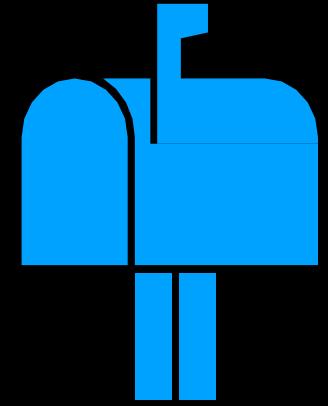
Description
A verbose explanation of the operation behavior. Consider adding links to external documentation.

Operation ID
Unique string used to identify the operation. The id MUST be unique across all operations in the API. It is recommended to use the same id as the operation path.

Tags
A list of tags for API documentation control. Tags can be used to scope documents, filter results, etc.

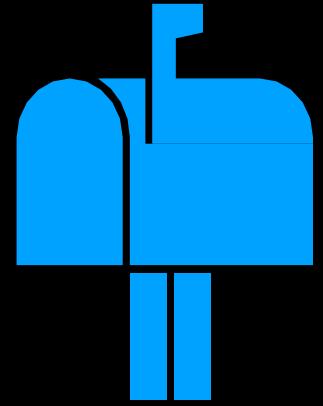
- /users
- post

```
post:  
  summary: create user  
  description: store user on server  
  operationId: createUser  
  responses:  
    default:  
      description: Default error sample response  
  tags:  
    - users
```



API Design: RESTful API Basics

- Lab
- Without a Request Body section, the documentation doesn't specify what to send
- Add Request Body (typed out on next slide)



```
post:  
  summary: create user  
  description: store user on server  
  operationId: createUser  
  responses:  
    default:  
      description: Default error sample response  
  tags:  
    - users
```

API Design: RESTful API Basics

- **Lab**
- **requestBody:**
 - Starts section
- **required: true**
- **content:**
 - **application/json**
 - **schema**
 - **object**

```
post:  
  summary: create user  
  description: store user on server  
  operationId: createUser  
  requestBody:  
    required: true  
    content:  
      application/json:  
        schema:  
          type: object  
          properties:  
            username:  
              type: string  
              example: bear  
            score:  
              type: integer  
              example: 55  
            active:  
              type: boolean  
              example: true
```

API Design: RESTful API Basics

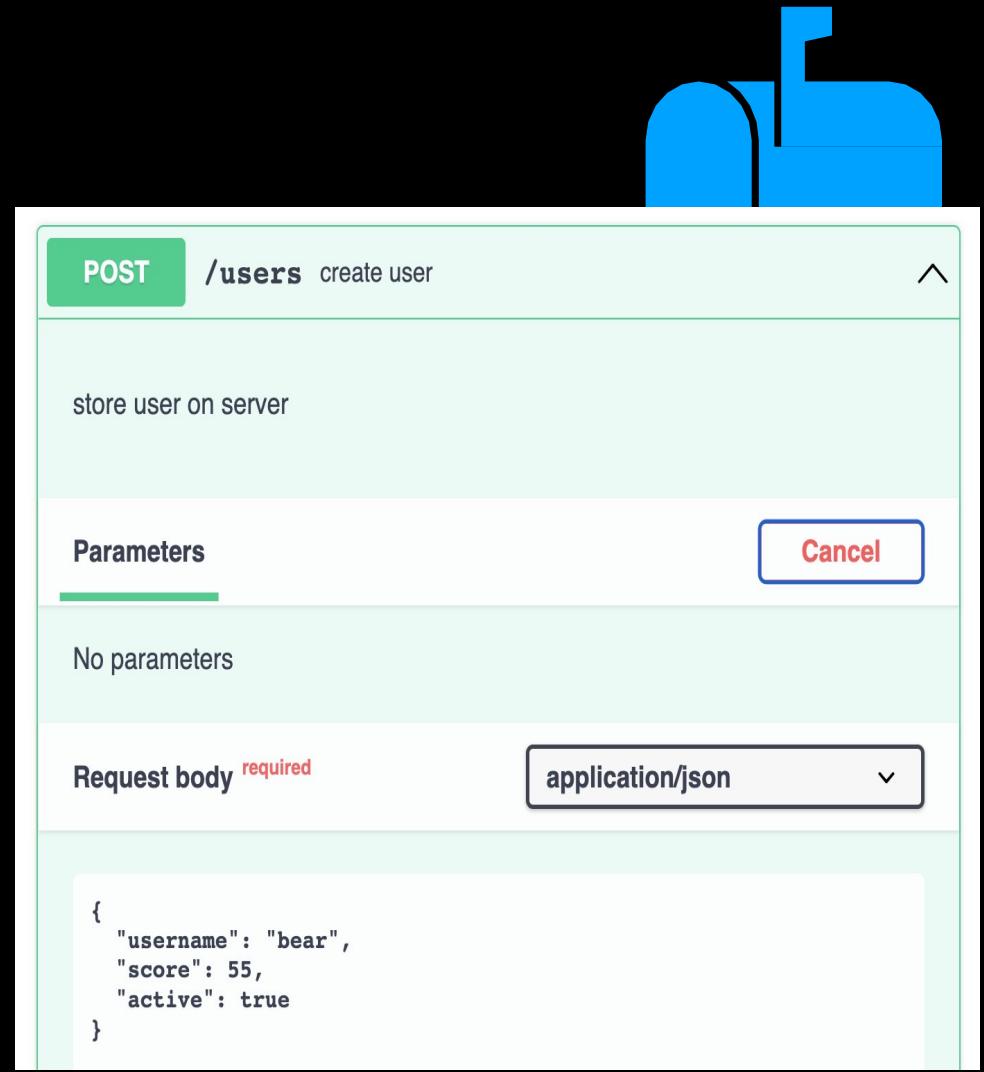
- Lab
- properties:
 - Object data
- <name> e.g., title
- type:
 - String, Integer, etc.
 - See <https://swagger.io/specification/#data-types>
- Can be required (otherwise, optional)

```
post:
  summary: create user
  description: store user on server
  operationId: createUser
  requestBody:
    required: true
    content:
      application/json:
        schema:
          type: object
          properties:
            username:
              type: string
              example: bear
            score:
              type: integer
              example: 55
            active:
              type: boolean
              example: true
  required:
    - username
```

API Design: RESTful API Basics

- **Lab**
- **Test in documentation**
- **Verify response**

- **End of lab**



The screenshot shows a mobile application interface for managing a RESTful API. At the top, there is a blue navigation bar with a back arrow and the text "API". Below the navigation bar, the main content area has a white background.

The main content area displays a single API endpoint:

- Method:** POST
- Path:** /users
- Description:** create user

Below the endpoint details, there is a section titled "Parameters" with a "Cancel" button. It displays the message "store user on server".

Under the "Parameters" section, there is another section titled "Request body" with the word "required" in red. It shows the content type "application/json" and a dropdown menu with a downward arrow.

Finally, there is a code block showing the JSON request body:

```
{  
  "username": "bear",  
  "score": 55,  
  "active": true  
}
```

API Design: RESTful API Basics

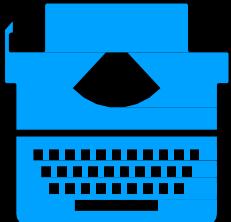
- **Lab: Add Request to POST**
- **Add PostNewUser to schemas:**
- **Add ref in post method requestBody:**

```
requestBody:  
  required: true  
  content:  
    application/json:  
      schema:  
        $ref: '#/components/schemas/PostNewUser'
```

- **End of lab.**



```
PostNewUser:  
  type: object  
  properties:  
    username:  
      type: string  
      example: bear  
    score:  
      type: integer  
      example: 55  
    active:  
      type: boolean  
      example: true
```



API Design

- OpenAPI: Schemas
- Also supports:
- Wildcards contents: image/*
- anyOf, oneOf, allOf
- Files
- Multipart POSTs Form Data

```
Dog:      # "Dog" is a value for the pet_type property
  allOf: # Combines the main `Pet` schema with `Dog`
    - $ref: '#/components/schemas/Pet'
    - type: object
      # all other properties specific to a `Dog`
      properties:
        bark:
          type: boolean
        breed:
          type: string
          enum: [Dingo, Husky, Retriever, Shepherd]
```

```
requestBody:
  description: A JSON object containing pet information
  content:
    application/json:
      schema:
        oneOf:
          - $ref: '#/components/schemas/Cat'
          - $ref: '#/components/schemas/Dog'
          - $ref: '#/components/schemas/Hamster'

examples:
  hamster: # <--- example name
  summary: An example of a hamster
  value:
    # vv Actual payload goes here vv
    name: Ginger
    petType: hamster
```

API Design

- OpenAPI: Schemas
- FullUser is the same as PostNewUser plus id
 - Define FullUser as PostNewUser and id

```
schemas:  
  FullUser:  
    type: object  
    properties:  
      id:  
        type: string  
        example: abc123  
      username:  
        type: string  
        example: bear  
      score:  
        type: integer  
        example: 55  
      active:  
        type: boolean  
        example: true  
  PostNewUser:  
    type: object  
    properties:  
      username:  
        type: string  
        example: bear  
      score:  
        type: integer  
        example: 55  
      active:  
        type: boolean  
        example: true
```

API Design



- OpenAPI: Schemas
- Set the schema to be ‘allOf:’
- Array (“-“)
 - Ref to FullUser
 - “type: object” like now but just id

```
schemas:  
  FullUser:  
    allOf:  
      - $ref: '#/components/schemas/PostNewUser'  
      - type: object  
        properties:  
          id:  
            type: string  
            example: abc123
```

- End of lab



API Design

- **OpenAPI: Request Bodies**
- **Can be defined in Components**
- **Referenced in operations**

```
post:  
  summary: create user  
  description: store user on server  
  operationId: createUser  
  requestBody:  
    required: true  
    content:  
      application/json:  
        schema:  
          $ref: '#/components/schemas/PostNewUser'
```

```
post:  
  summary: create user  
  description: store user on server  
  operationId: createUser  
  requestBody:  
    $ref: '#/components/requestBodies/UserPostBody'
```

```
components:  
  requestBodies:  
    UserPostBody:  
      description: new user request  
      required: true  
      content:  
        application/json:  
          schema:  
            $ref: '#/components/schemas/PostNewUser'
```

- **End of lab**

API Design



- OpenAPI: Responses
- Can be defined in Components
- Referenced in operations

```
post:  
  summary: create user  
  description: store user on server  
  operationId: createUser  
  requestBody:  
    $ref: '#/components/requestBodies/UserPostBody'  
  responses:  
    2XX:  
      description: successful fetch  
      content:  
        application/json:  
          schema:  
            $ref: '#/components/schemas/FullUser'
```

```
post:  
  summary: create user  
  description: store user on server  
  operationId: createUser  
  requestBody:  
    $ref: '#/components/requestBodies/UserPostBody'  
  responses:  
    2XX:  
      $ref: '#/components/responses/UserRespBody'  
      default:  
        description: Default error sample response  
    tags:  
      - users
```

```
components:  
  responses:  
    UserRespBody:  
      description: user response  
      content:  
        application/json:  
          schema:  
            $ref: '#/components/schemas/FullUser'
```

- End of lab



API Design

- **OpenAPI: Responses**
- **Arrays**
- **/users GET returns an array**
- **That can be another schema in another response use in /users GET**

```
schemas:  
  UserArray:  
    type: array  
    items:  
      $ref: '#/components/schemas/FullUser'  
  
responses:  
  UserArrayResponseBody:  
    description: user array response  
    content:  
      application/json:  
        schema:  
          $ref: '#/components/schemas/UserArray'
```

```
/users:  
  summary: user level operations  
  description: create and read users  
  get:  
    summary: fetch users  
    description: read users from server  
    operationId: fetchUsers  
    responses:  
      2XX:  
        $ref: '#/components/responses/UserArrayResponseBody'  
      default:  
        description: Default error sample response
```

- **End of Lab**

API Design



- Components
- Reusable items
 - Request bodies, responses, schemas, parameters, etc.
 - Can become the bulk of your spec
 - Helps keep the paths/operations:
 - Concise
 - Description
 - Many references

API Design



- OpenAPI: Servers
Server Variables
Port
Version
Environment
Test, dev, etc.

API Design

Add Servers

Server

An object representing a Server.

URL *

REQUIRED. A URL to the target host. This URL supports Server Variables and MAY be relative, to indicate that the host location is relative to the location where the OpenAPI document is being served. Variable substitutions will be made when a variable is named in {brackets}.

`http://localhost:{port}`

Description

An optional string describing the host designated by the URL. CommonMark syntax MAY be used for rich text representation.

local server

Server Variables

A map between a variable name and its value. The value is used for substitution in the server's URL template.

Variable Name *

The name of the server variable.

port

Default *

REQUIRED. The default value to use for substitution, and to send, if an alternate value is not supplied. Unlike the Schema Object's default, this value MUST be provided by the consumer.

3000

Enum

An enumeration of string values to be used if the substitution options are from a limited set.

Enum Value

A value in the enumeration of possible variable values.

3000

Enum Value

A value in the enumeration of possible variable values.

3001



- **OpenAPI: Servers**

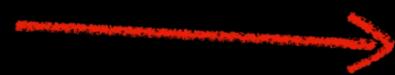
Multiple URLs

e.g., scheme://host[:port][/path]

Variables

Client responsible for providing URL

```
- url: http://localhost:{port}
variables:
  port:
    default: '3000'
    enum:
      - '3000'
      - '3001'
    description: ''
  description: local server
```



Servers

http://localhost:{port} - local server

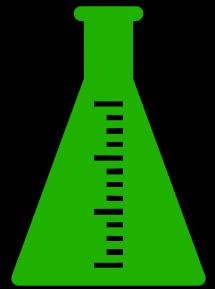
Computed URL: http://localhost:3000

Server variables

port

✓ 3000
3001

A screenshot of a user interface showing the configuration of a local server. On the left, there's a code snippet from an OpenAPI specification defining a port variable with a default value of '3000' and an enum of '3000' and '3001'. A red arrow points from this code to a dropdown menu labeled 'Servers' which contains the URL 'http://localhost:{port} - local server'. Another red arrow points from the 'enum' values in the code to a 'Server variables' section where the port value is set to '3000' with a checkmark.



- **Lab: OpenAPI: Servers**

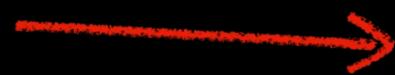
Multiple URLs

e.g., scheme://host[:port][/path]

Variables

Client responsible for providing URL

```
- url: http://localhost:{port}
variables:
  port:
    default: '3000'
    enum:
      - '3000'
      - '3001'
    description: ''
  description: local server
```



Servers

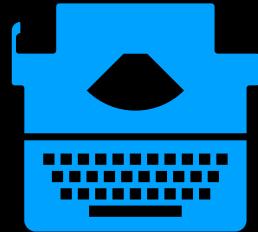
http://localhost:{port} - local server

Computed URL: http://localhost:3000

Server variables

port

✓ 3000
3001



- **OpenAPI: Paths and Parameters**

May be templated:

/users/{userId}

/department/{deptId}/employees

/employees/{empld}/department

**Client responsible for providing
values**

**parameters (array) describes
variables**

```
parameters:  
- name: userId  
  in: path  
  required: true  
  description: Parameter  
  schema:  
    type : integer  
    format: int64  
    minimum: 1
```



- **OpenAPI: Parameters**

in:

path - URL

query - Query String

header - request header

cookie - Cookie

```
parameters:  
  - name: userId  
    in: path  
    required: true  
    description: Parameter  
    schema:  
      type : integer  
      format: int64  
      minimum: 1
```



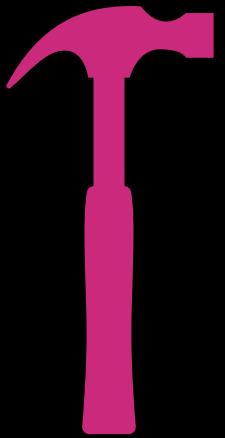
- **OpenAPI: Parameters**

path - URL

/user/{userId}

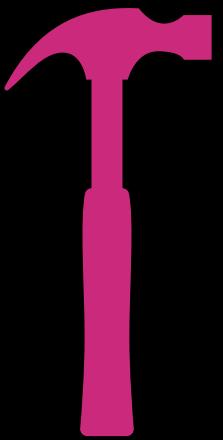
e.g., /user/223

```
parameters:  
  - name: userId  
    in: path  
    required: true  
    description: Parameter  
    schema:  
      type : integer  
      format: int64  
      minimum: 1
```



- **Lab: /posts/{postId}**
Add /posts/{postId}
Add GET method
Include id parameter of type Integer

API Design



- **Lab: /posts/{postId}**
Add /posts/{postId}

Insert ▾ Generat

Add Path Item

Add Path

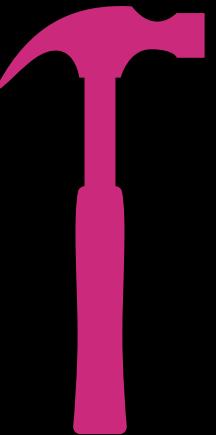
Path *
REQUIRED. The path to add.
`/posts/{postId}`

Summary
Enter a summary of the path.
`individual post operations`

Description
An optional, string description,
`fetch, delete, update`

`/posts/{postId}:`
`summary: individual post operations`
`description: fetch, delete, update`

API Design



- **Lab: /posts/{postId}**
Add GET Operation

Insert ▾ Generate

Add Path Item

Add Operation

Add Operation to Document

Path *
REQUIRED. The path to add the operation to.
`/posts/{postId}`

Operation *
REQUIRED. Select an operation.
`get`

Summary
Add a short summary of what the operation does.
`fetch a post`

Description
A verbose explanation of the operation behavior. Commonly used for POST operations.
`GET a post by id`

Operation ID
Unique string used to identify the operation. The id MUST be unique across all operations in the document. It is recommended to use the same value as the operation name, separated by underscores.
`getPost`

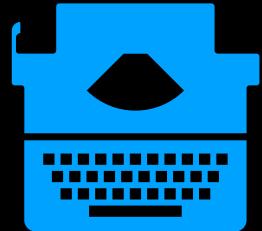
```
/posts/{postId}:
  summary: individual post operations
  description: fetch, delete, update
  get:
    summary: fetch a post
    description: GET a post by id
    operationId: getPost
    responses:
      default:
        description: Default error sample response
```



- **Lab: /posts/{postId}**

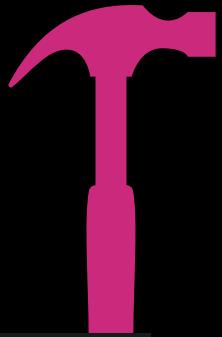
Add GET parameters section (type in editor)

```
/posts/{postId}:
  summary: individual post operations
  description: fetch, delete, update
  get:
    summary: fetch a post
    description: GET a post by id
    operationId: getPost
    parameters:
      - in: path
        required: true
        name: postId
        schema:
          type: integer
          minimum: 0
          example: 5
```



- **OpenAPI: Parameters**
query - Query String
e.g., /posts?offset=20

```
- in: query  
  name: offset  
  schema:  
    type: integer  
  description: The number of items to skip
```



- Lab

Add query string parameters

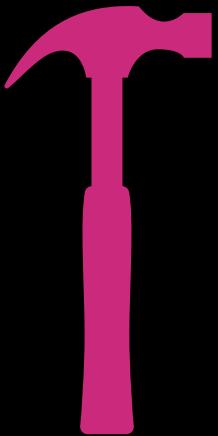
/posts path item
parameters section

Add offset

Add limit

Test Get method

```
paths:  
/posts:  
  summary: posts level operations  
  description: create new post, fetch all posts  
  get:  
    summary: fetch all posts  
    description: returns all posts from server  
    operationId: fetchPosts  
    parameters:  
      - name: offset  
        in: query  
        schema:  
          type: integer  
          minimum: 0  
          example: 20  
      - name: limit  
        in: query  
        schema:  
          type: integer  
          minimum: 1  
          example: 20
```



- Lab
Test Get method

End of lab

GET /posts fetch all posts

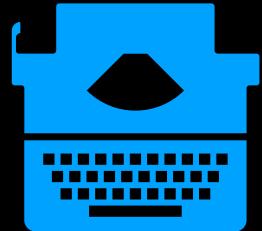
return all posts from server

Parameters

Name	Description
offset	20 integer (query)
limit	20 integer (query)

Request URL

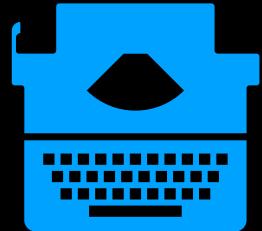
`https://my-json-server.typicode.com/bearc0025/api/posts?offset=20`



- **OpenAPI: Parameters
header - request header**

e.g., X-Request-ID: 77e1c83b-7bb0-437b-bc50-a7a58e5660ac

```
paths:  
  /ping:  
    get:  
      summary: Checks if the server is alive  
      parameters:  
        - in: header  
          name: X-Request-ID  
          schema:  
            type: string  
            format: uuid  
            required: true
```



- **OpenAPI: Parameters**

cookie - Cookie

e.g., **Cookie: debug=0;**

csrftoken=BUSe35dohU3O1MZvDCUOJ

```
parameters:  
  - in: cookie  
    name: debug  
    schema:  
      type: integer  
      enum: [0, 1]  
      default: 0  
  - in: cookie  
    name: csrftoken  
    schema:  
      type: string
```



- **OpenAPI: Parameters**

Required: true/false
schema

Used for primitive types

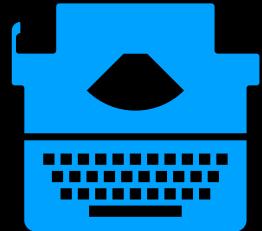
Arrays

Serialized (to string) objects
content for more complex serialization

See

<https://swagger.io/docs/specification/serialization/>

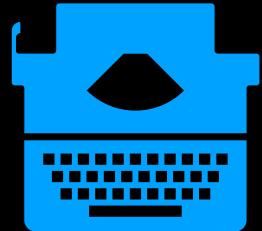
```
parameters:  
  - name: userId  
    in: path  
    required: true  
    description: Parameter  
    schema:  
      type : integer  
      format: int64  
      minimum: 1
```



- **OpenAPI: Parameters**
May have default values
Not needed for required values
May have min/max

```
parameters:  
  - in: cookie  
    name: debug  
    schema:  
      type: integer  
      enum: [0, 1]  
      default: 0  
  - in: cookie  
    name: csrftoken  
    schema:  
      type: string
```

```
parameters:  
  - name: userId  
    in: path  
    required: true  
    description: Parameter  
    schema:  
      type : integer  
      format: int64  
      minimum: 1
```



- **OpenAPI: Parameters**

May have an example(s)

May be an enum

```
parameters:
```

```
  - in: query
```

```
    name: limit
```

```
schema:
```

```
  type: integer
```

```
  minimum: 1
```

```
example: 20
```

```
parameters:
```

```
  - in: query
```

```
    name: status
```

```
schema:
```

```
  type: string
```

```
enum:
```

```
  - available
```

```
  - pending
```

```
  - sold
```

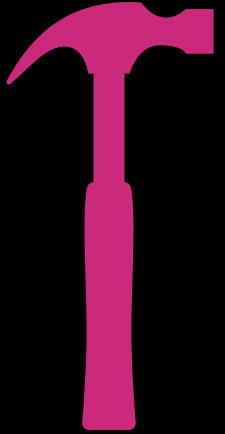


- **OpenAPI: Parameters**

**Parameters shared by multiple methods
may be defined on the path level.**

e.g., Used by GET and DELETE

```
/posts/{postId}:
  summary: individual post operations
  description: fetch, delete, update
  parameters:
    - in: path
      required: true
      name: postId
      schema:
        type: integer
        minimum: 0
        example: 5
```



- **Lab: /posts/{postId}**

Put parameters section on path level
Applies to all operations for this path

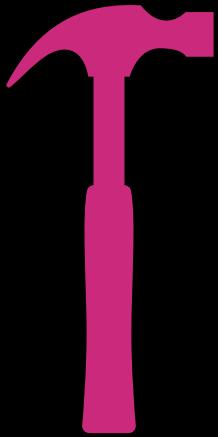
```
/posts/{postId}:
  summary: individual post operations
  description: fetch, delete, update
  parameters:
    - in: path
      required: true
      name: postId
      schema:
        type: integer
        minimum: 0
        example: 5
```



- **OpenAPI: Parameters
May be in components
Referenced with \$ref**

```
components:  
  parameters:  
    PostId:  
      in: path  
      required: true  
      name: postId  
      schema:  
        type: integer  
        minimum: 0  
      example: 5
```

```
/posts/{postId}:  
  summary: individual post operations  
  description: fetch, delete, update  
  parameters:  
    - $ref: '#/components/parameters/PostId'
```



- **Lab: /posts/{postId}**

Put parameter in parameters section of components

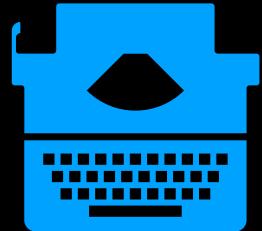
Refer from operation /posts/{postId}

```
components:  
parameters:  
  PostId:  
    in: path  
    required: true  
    name: postId  
    schema:  
      type: integer  
      minimum: 0  
    example: 5
```

```
/posts/{postId}:  
  summary: individual post operations  
  description: fetch, delete, update  
  parameters:  
    - $ref: '#/components/parameters/PostId'
```



- **OpenAPI: Parameters - Serialization**
For transmitting data structures/objects
Keywords:
 - style** - how values are delimited
 - Various by parameter location (e.g., path)
 - explode (boolean)**- specifies if values should be separate parameters (e.g., arrays)



- **Path Parameters**

Styles:

simple (default)

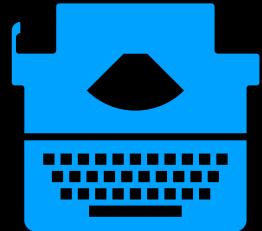
label

matrix

Explode

true

false (default)



- **Styles: simple - primitive**
Looks like /rates/{id}
Parameter as we've seen it before
Required
Schema type: integer

r.typicode.com/bearc0025/api/rates/1

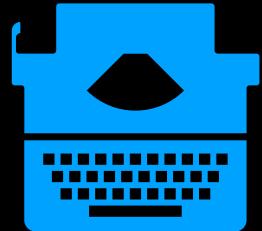
```
/rates/{id}:
  summary: review stuff
  description: operations on item
  get:
    summary: fetch data
    description: returns data from db
    parameters:
      - in: path
        required: true
        name: id
        schema:
          type: integer
```



- **Styles: simple - array**
Array of integers
explode true: /rates/{id*}
explode false: /rates/{id}
URL the same

```
/rates/{id*}:
  summary: review stuff
  description: operations on item
  get:
    summary: fetch data
    description: returns data from db
    parameters:
      - in: path
        style: simple
        explode: false
        required: true
        name: id*
        schema:
          type: array
          items:
            type: integer
```

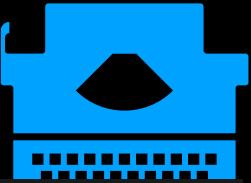
on-server.typicode.com/bearc0025/api/rates/1,2,4



- **Styles: simple - object
Object
explode: false
Comma separated**

-json-
apicode.com/bearc0025/api/rates{id,1,text,this%20post}

```
/rates/{item}:
  summary: review stuff
  description: operations on item
  get:
    summary: fetch data
    description: returns data from db
    parameters:
      - in: path
        style: simple
        explode: false
        required: true
        name: item
        schema:
          type: object
          properties:
            id:
              type: integer
              example: 1
            text:
              type: string
              example: this post
```



- **Styles: simple - object
Object
explode: true
Key/Value pairs**

.com/bearc0025/api/rates?id=1,text=this%20post

```
/rates/{item*}:
  summary: review stuff
  description: operations on item
  get:
    summary: fetch data
    description: returns data from db
    parameters:
      - in: path
        style: simple
        explode: true
        required: true
        name: item*
        schema:
          type: object
          properties:
            id:
              type: integer
              example: 1
            text:
              type: string
              example: this post
```



- **Styles: label - primitive/array**
Dot-prefixed (aka Label Expansion)

{.item}

Request URL

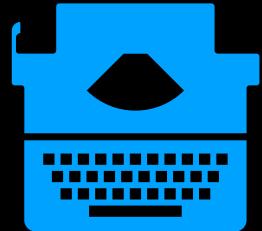
```
https://my-json-server.typicode.com/bearc0025/api/rates/.1
```

{.item*} for array

: URL

```
://my-json-server.typicode.com/bearc0025/api/rates/.1.2
```

```
/rates/{.item}:
  summary: review stuff
  description: operations on item
  get:
    summary: fetch data
    description: returns data from item
    parameters:
      - in: path
        style: label
        explode: false
        required: true
        name: .item
        schema:
          type: integer
```



- **Styles: label - object**
explode: false

URL

```
//my-json-
.typicode.com/bearc0025/api/rates/.id.1.text.this%20post
```

- explode: true**

```
y-json-
picode.com/bearc0025/api/rates/.id=1.text=this%20post
```

parameters:

- in: path
style: label
explode: false
required: true
name: .item

schema:

- type: object
properties:
 - id:
 - type: integer
example: 1
 - text:
 - type: string
example: this post



- **Styles: matrix**
Primitive

Request URL

```
https://my-json-server.typicode.com/bearc0025/api/rates/;item=1
```

Array - Explode
False

Request URL

```
https://my-json-server.typicode.com/bearc0025/api/rates/;item=1,2
```

True

Request URL

```
https://my-json-server.typicode.com/bearc0025/api/rates/;item=1;item=2
```



- **Styles: matrix Object**
Explode false

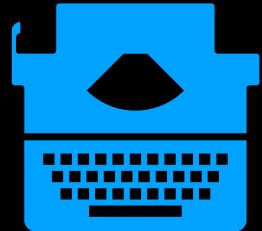
Request URL

```
https://my-json-
server.typicode.com/bearc0025/api/rates/;item=id,1,text,this%20post
```

Explode true

Request URL

```
https://my-json-
server.typicode.com/bearc0025/api/rates/;id=1;text=this%20post
```



- **Query Parameters**
Styles
form
spaceDelimited
pipeDelimited
deepObject

API Design

Query Parameter Styles

form

Request URL

```
https://my-json-server.typicode.com/bearc0025/api/rates?item=1
```

Array
Explode false

Explode true

```
/rates:  
  summary: review stuff  
  description: operations on item  
  get:  
    summary: fetch data  
    description: returns data from db  
    parameters:  
      - in: query  
        name: item  
        style: form  
        explode: true  
        schema:  
          type: integer
```

Request URL

```
https://my-json-server.typicode.com/bearc0025/api/rates?item=1,2
```

Request URL

```
https://my-json-server.typicode.com/bearc0025/api/rates?item=1&item=2
```



- **Query Parameter Styles**
spaceDelimited - (explode false)

Request URL

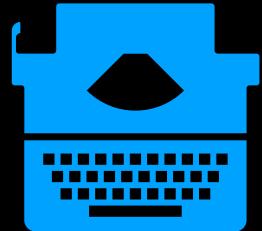
```
https://my-json-server.typicode.com/bearc0025/api/rates?item=1%202
```

pipeDelimited - (explode false)

Request URL

```
https://my-json-server.typicode.com/bearc0025/api/rates?item=1|2
```

For explode = true, looks like form



- **Query Parameter Styles**

deepObject (Object)

%5B = [

%5D =]

?item[id]=1&item[text]=this post

Request URL

```
https://my-json-server.typicode.com/bearc0025/api/rates?
item%5Bid%5D=1&item%5Btext%5D=this%20post
```