NYU COURANT INSTITUTE OF MATHEMATICAL SCIENCES

Building RESTful Services with Python and Flask

Fall 2020, CSCI-GA 2820, Graduate Division, Computer Science

Instructor:

John J Rofrano

Senior Technical Staff Member | DevOps Champion
IBM T.J. Watson Research Center
rofrano@cs.nyu.edu (@JohnRofrano)

Source for This Lab

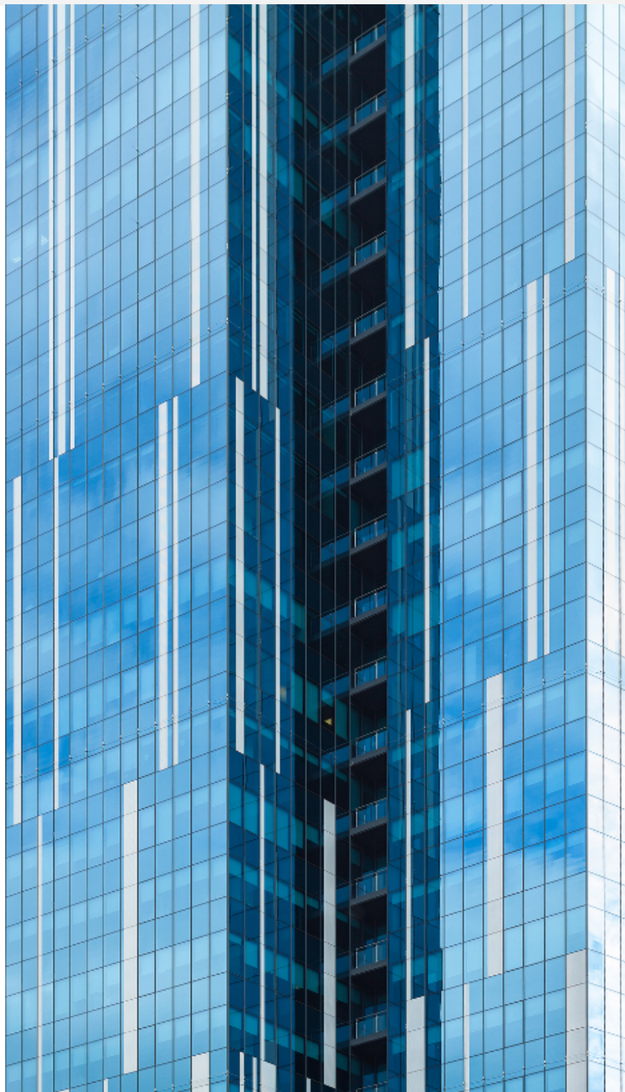
- The source for this lab can be found on GitHub at:

```
git clone https://github.com/nyu-devops/lab-flask-rest.git

cd lab-flask-rest
vagrant up
vagrant ssh
```

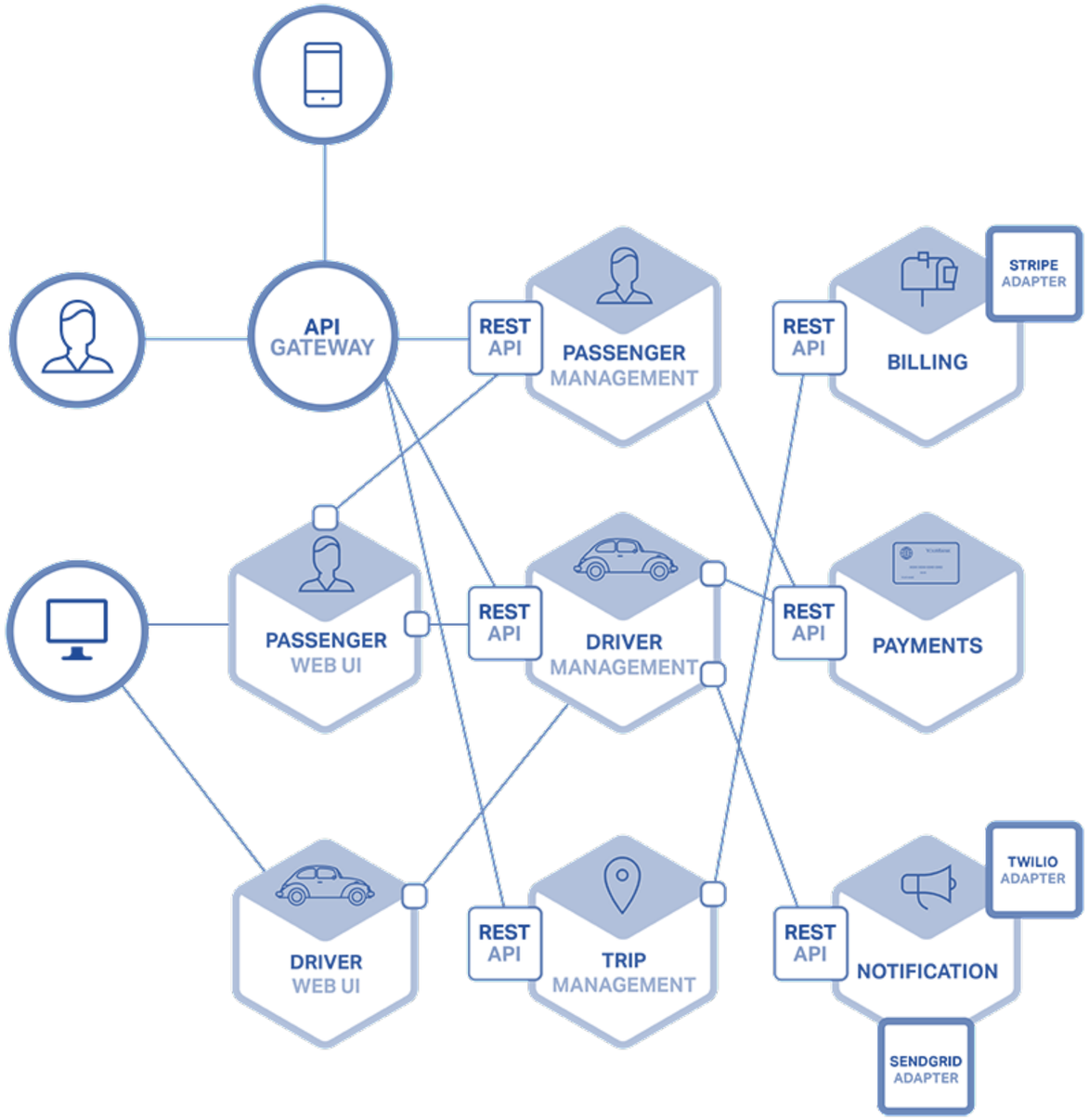
What Will You Learn?

- Understand what a REST API is
- Understand the Guidelines and Best Practices
- How to build a more RESTful service
- How to use Python with Flask to build a REST API



Cloud Native Applications

- The Twelve-Factor App describes patterns for cloud-native architectures which leverage microservices.
- Applications are designed as a collection of stateless microservices.
- State is maintained in separate databases and persistent object stores.
- Resilience and horizontal scaling is achieved through deploying multiple instances.
- Failing instances are killed and re-spawned, not debugged and patched.
- DevOps pipelines help manage continuous delivery of services.

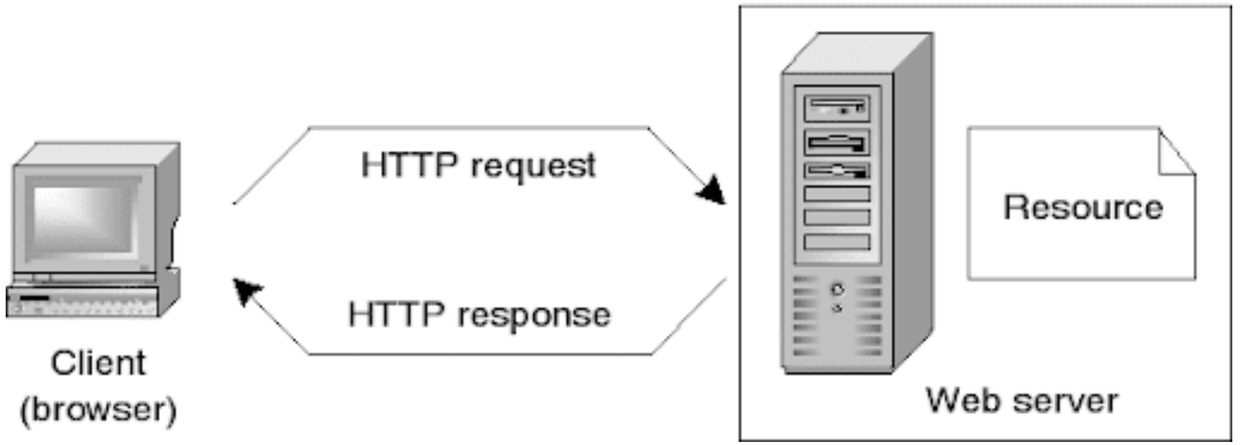


https://www.nginx.com/blog/introduction-to-microservices/

Before we get started
… how does the web work?

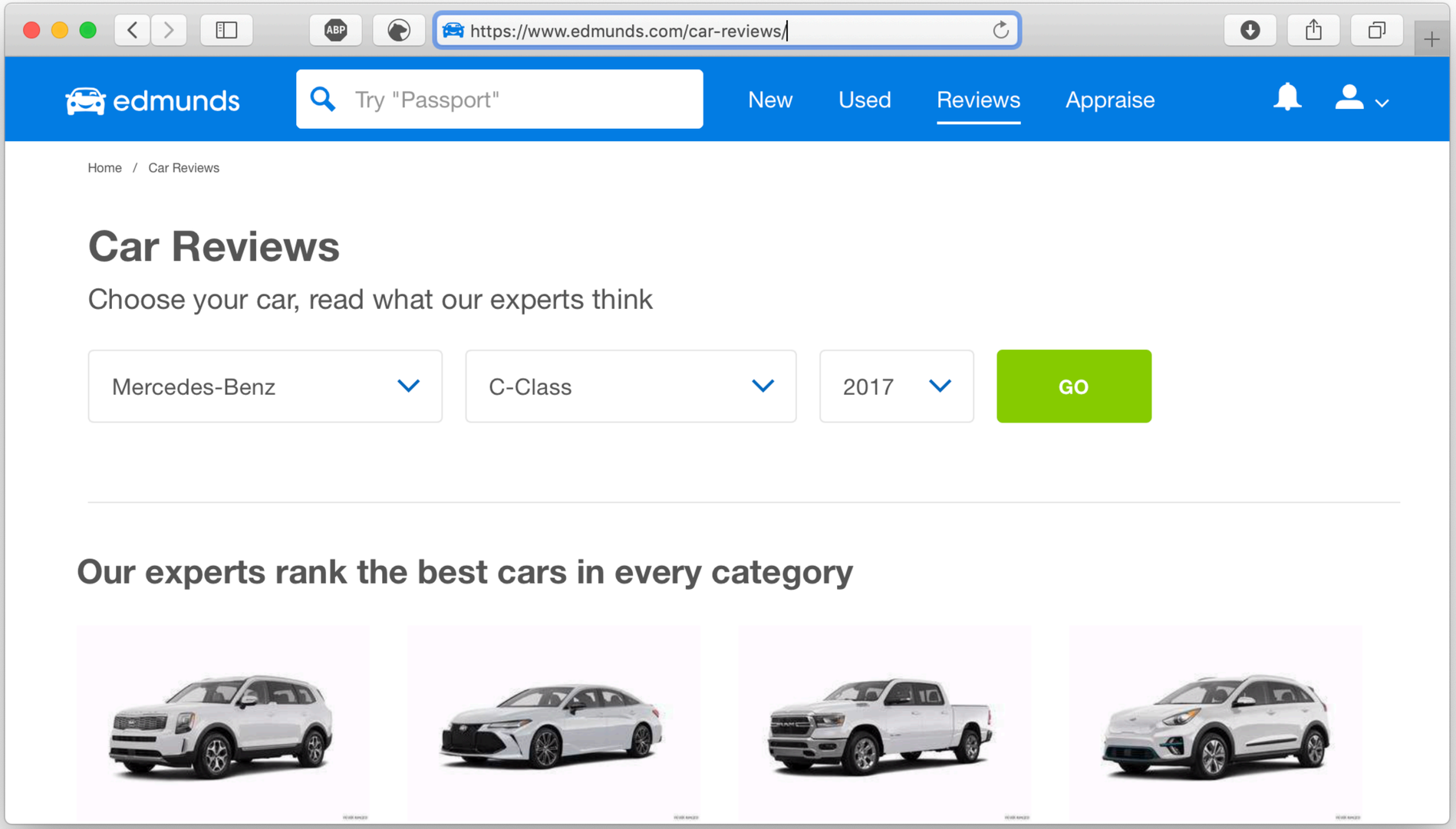
The Web: 101

- The Internet is a collection of servers that have resources (e.g., html pages, databases, etc.)
- These resources can be static web pages or they can be applications
- Application resources usually serve up resources that are stored in a database
- Web resources can be accessed via a program or web browser
- The HyperText Transport Protocol (HTTP) is how web browsers talk to servers



[Source: http://www.ic.unicamp.br/~921234/IntroZope/slide-04.html]

Example Web Form



Anatomy of an HTTP Request

An HTTP request consists of a:

- URL
- Header
- Body

URL:

```
https://www.edmunds.com/car-reviews
```

Header:

```
POST /car-reviews HTTP/1.1
User-Agent: Mozilla/4.0 (compatible; MSIE5.01; Windows NT)
Host: www.edmunds.com
Content-Type: application/x-www-form-urlencoded
Content-Length: 48
Accept-Language: en-us
Accept-Encoding: application/json
Connection: Keep-Alive
```

Body:

```
make="Mercedes-Benz"&model="C-Class"&year="2017"
```

Anatomy of an HTTP Response

An HTTP response consists of a:

- Return Code
- Header
- Body

Return Code:

```
HTTP/1.1 200 OK
```

Header:

```
Date: Sun, 23 Feb 2020 18:44:35 GMT
Cache-Control: private, max-age=0
X-Frame-Options: SAMEORIGIN
Content-Type: application/json
Content-Length: 1048
```

Body:

```
{
    id: "278449015",
    make: "Mercedes-Benz",
    model: "C-Class",
    year: 2017,
    overall_rating: 4.5,
    reviews: ["blah", "blah", "blah"]
}
```

Parts of a URL

- A Uniform Resource Locator points to a resource or collection of resources
- It is made up of a protocol, host name, and optional path, and query string

```
http://www.car-reviews.com/reviews/sedans?min_rating=good
```

Parts of a URL

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```
http://www.car-reviews.com/reviews/sedans?min_rating=good
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Protocol

Parts of a URL

- A Uniform Resource Locator points to a resource or collection of resources
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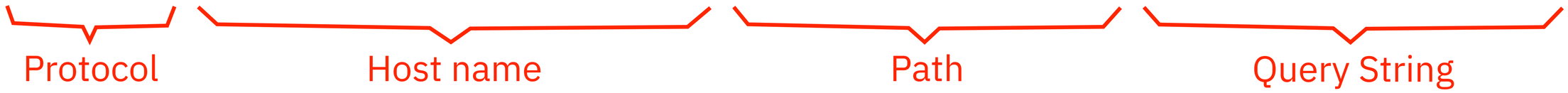
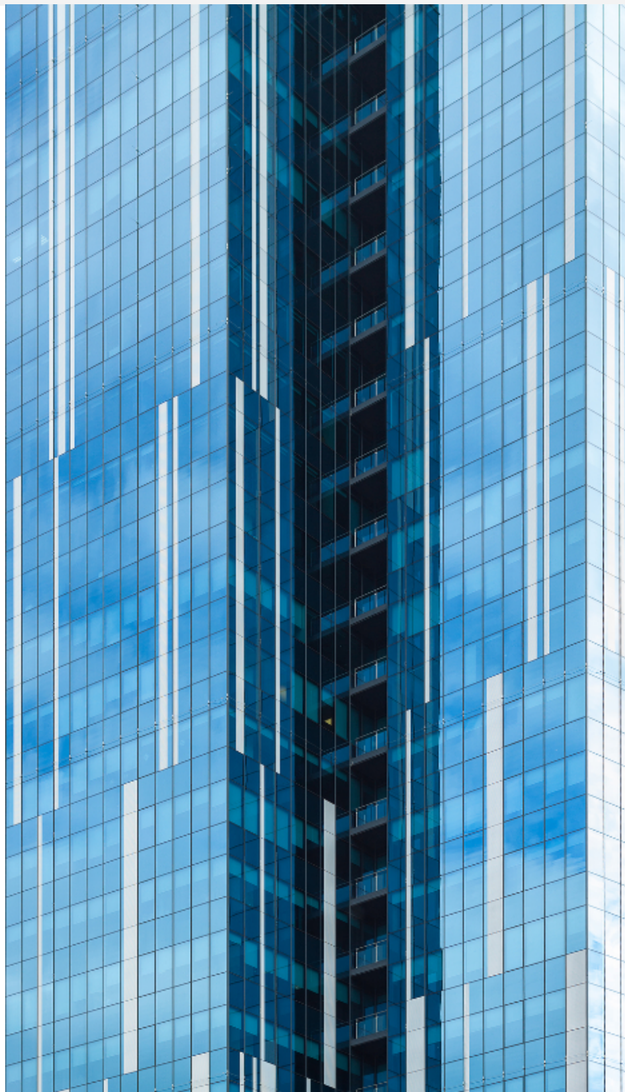


Types of URL Parameters

- Parameters are additional data that you need to pass in to qualify the request
- There 3 parameter types
  - Path parameters
  - Query parameters
  - Header parameters (more like metadata)



Path Parameters

- Can be used to identify a particular resource
- The value of the parameter is passed in to the operation by the HTTP client as a variable part of the URL path
- For example, the customer ID can be passed in as a path parameter named customer_id:

```
/customers/{customer_id}
```

Query Parameters

- The value of a query parameter is passed in to the operation by the HTTP client as a key value pair in the query string at the end of the URL
- Query parameters are separated from the URL path by a question mark {?} and multiple parameters are delimited by an ampersand {&}
- As an example, query parameters can be used to pass in a filter to be applied to the results that should be returned by a particular operation:

```
/customers?city=Middletown&state=NY
```

Header Parameters

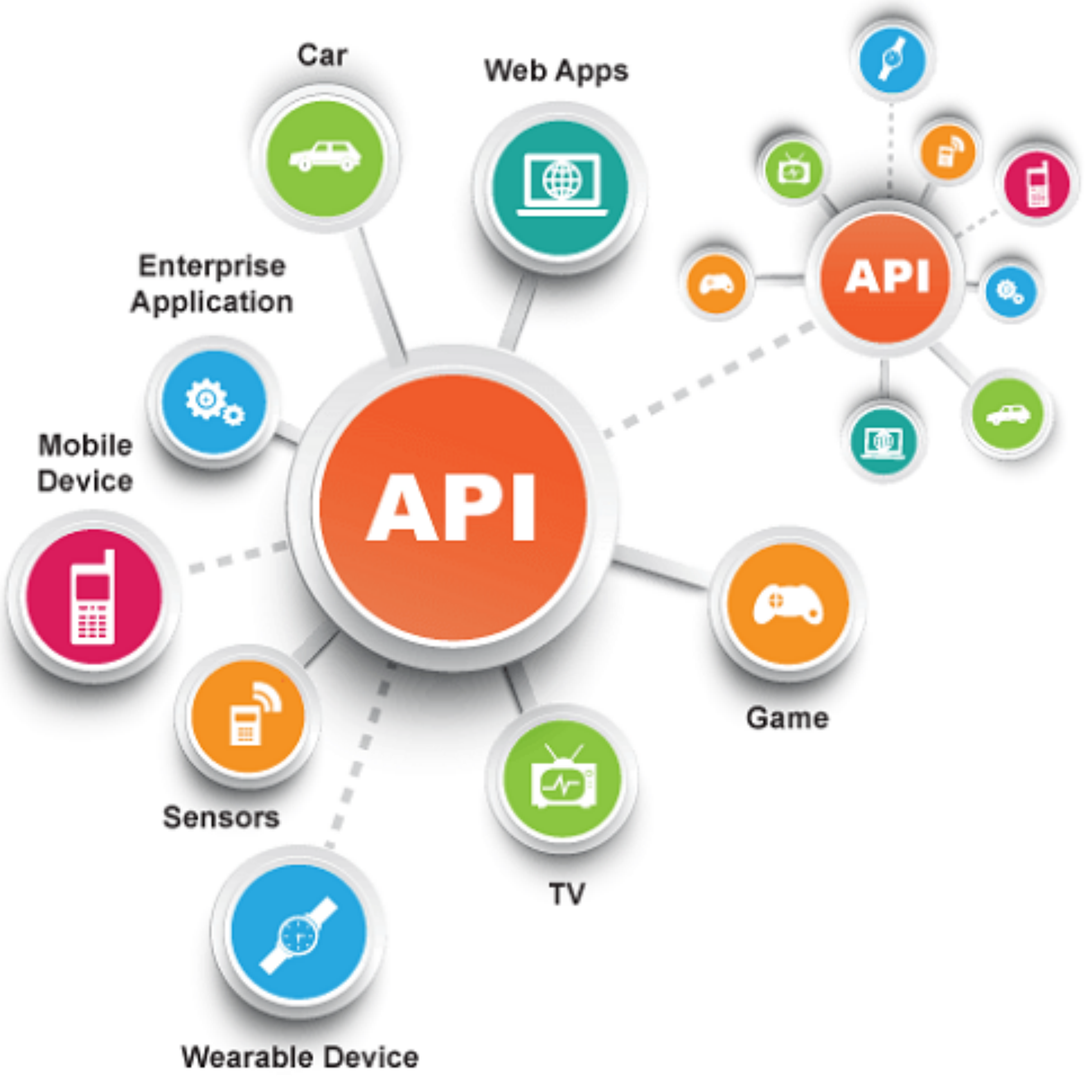
- The HTTP client can pass header parameters to an operation by adding them as HTTP headers in the HTTP request
- Headers are additional metadata that is sent with the request but not part of the URL
- As an example, header parameters might be used to pass in a unique identifier that identifies the HTTP client that is calling the operation:

```
X-Client-Id: a8c4cb0c-500e-11ea-bc47-acde48001122
```

AND NOW BACK TO OUR REGULARLY SCHEDULED PROGRAM

What is an API?

- **A**pplication **P**rogramming **I**nterface
- A documented way to interact with a program or service
- Defines the **requests** that you can make of the service
- Defines the **data** that you can interchange with the service
- Defines the **results** that will be returned by the service



API Analogy

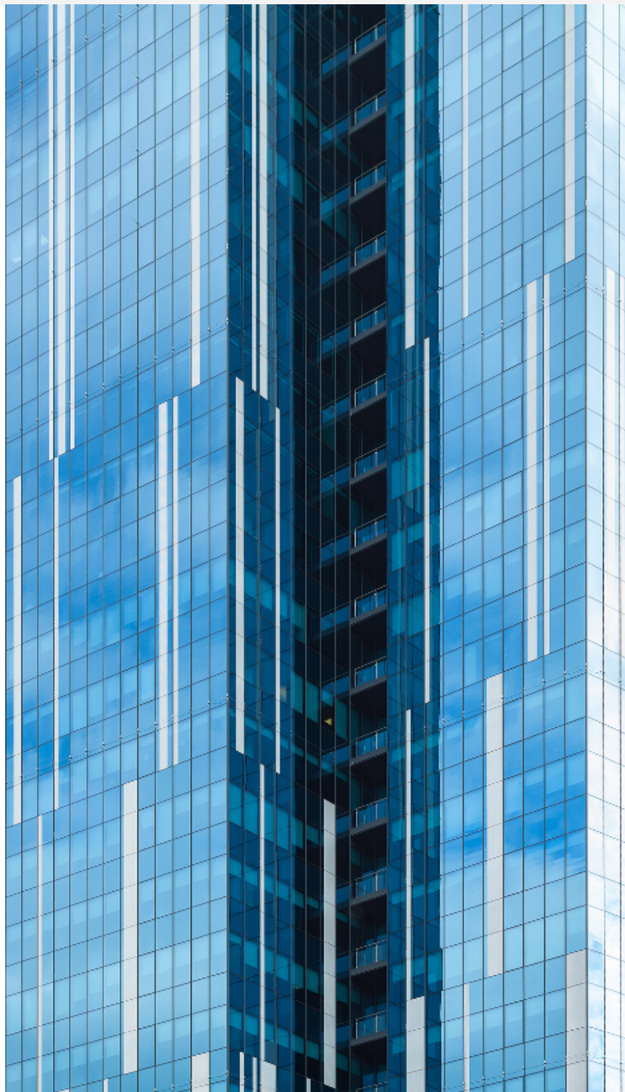
Every VCR and DVD Player has the same interface

“Microservices need a consistent way of communicating.”

REST Architecture and RESTful Services

What is REST?

- **RE**presentational **S**tate **T**ransfer
  - A REST API describes a set of resources
  - A simple way to transfer and manipulate the state of a resource
- A service based on REST is called a RESTful service
- A RESTful service is exposed through a Uniform Resource Locator (URL)
- A client would issue a Hypertext Transfer Protocol (HTTP) request to manipulate it



REST Architecture

- REST is a **client-server** architecture
  - The client and the server provide a separation of concerns which allows both the client and the server to evolve independently as it only requires that the interface stays the same
- REST is **stateless**
  - The communication between the client and the server always contains all the information needed to perform the request. There is no session state in the server.
- REST is **cacheable**
  - The client, the server can cache resources in order to improve performance
- REST provides a **uniform interface** between components
  - All components follow the same rules to speak to one another
- REST is a **layered system**
  - Individual components cannot see beyond the immediate layer with which they are interacting

What Does It Mean To Be RESTful?

- Everything is represented as a Resource
- Resource identification through URI (Uniform Resource Identifier)
  - e.g., `GET http://myservice.com/users/123`
- Uniform interface (I should be able to guess the interface given a resource name)
- Self-descriptive messages are used to represent Resources (usually XML or JSON)
- Stateful interactions through hyperlinks
- A service based on REST is called a RESTful service

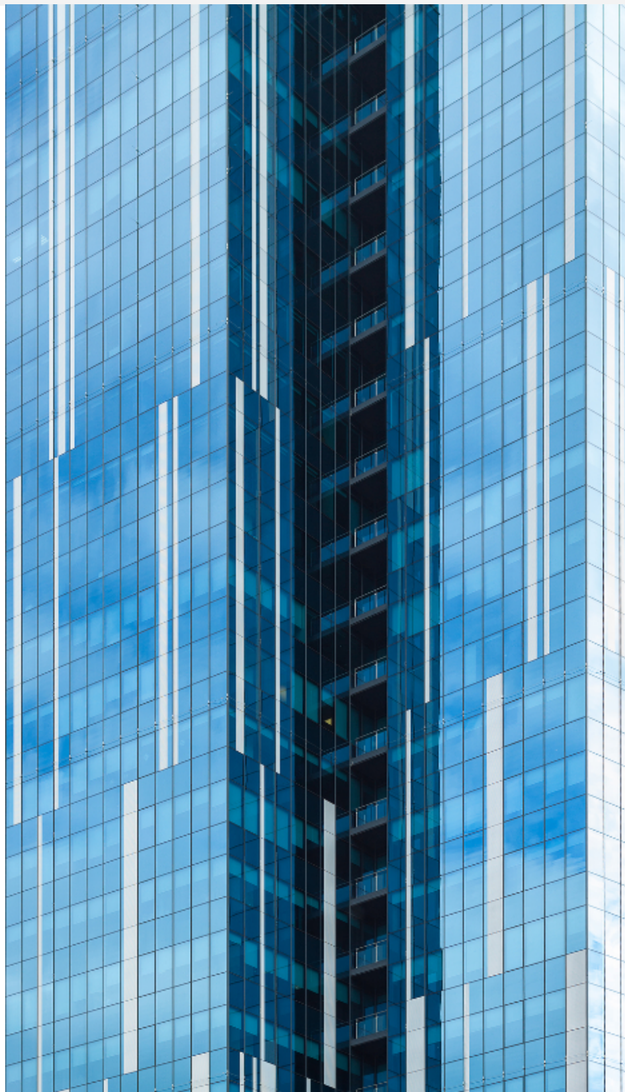
A REST API describes a set of resources

- Example REST API for Customer resource

Resource Path	Description
`/customers`	All the customers in the database
`/customers/12345`	Customer #12345
`/customers/12345/orders`	All orders for customer #12345
`/customers/12345/orders/67890`	Order #67890 for customer #12345

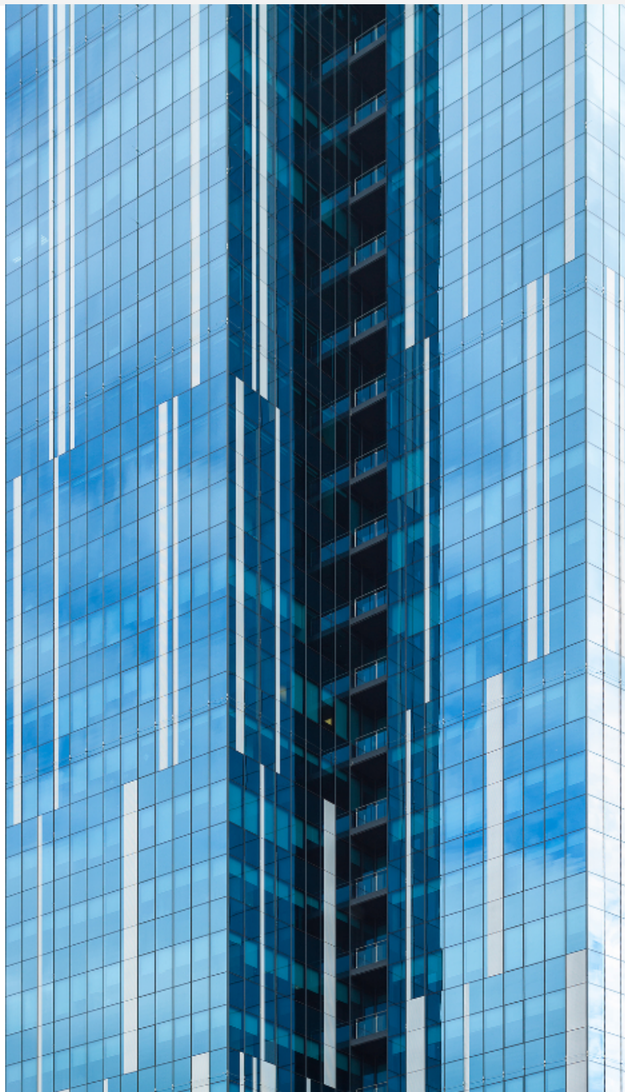
What is a Resource

- The fundamental concept in any RESTful API is the resource
- A resource is an object with a type, associated data, relationships to other resources, and a set of methods that operate on it
- Only a few standard methods are defined for the resource corresponding to the standard HTTP GET, POST, PUT and DELETE methods



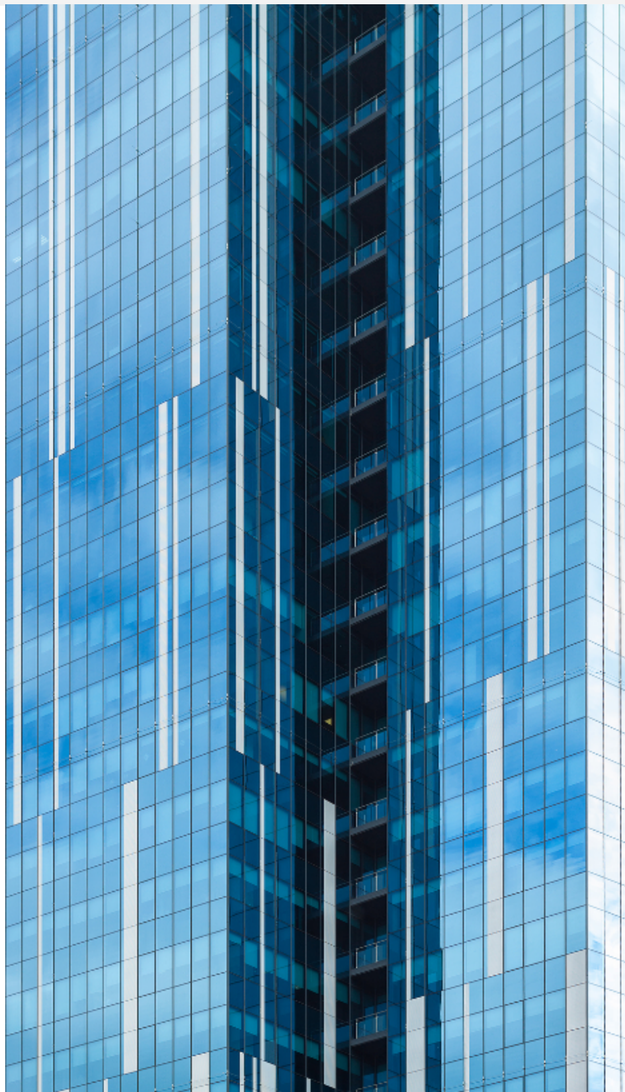
What Does Resource Based Mean?

- Things vs Actions
- Nouns vs Verbs
- Not a Remote Procedure Call mechanism
- Everything is Identified by URI’s
  - Multiple URI’s can manipulate the same Resource using different HTTP Verbs



REST Provides a Uniform Interface

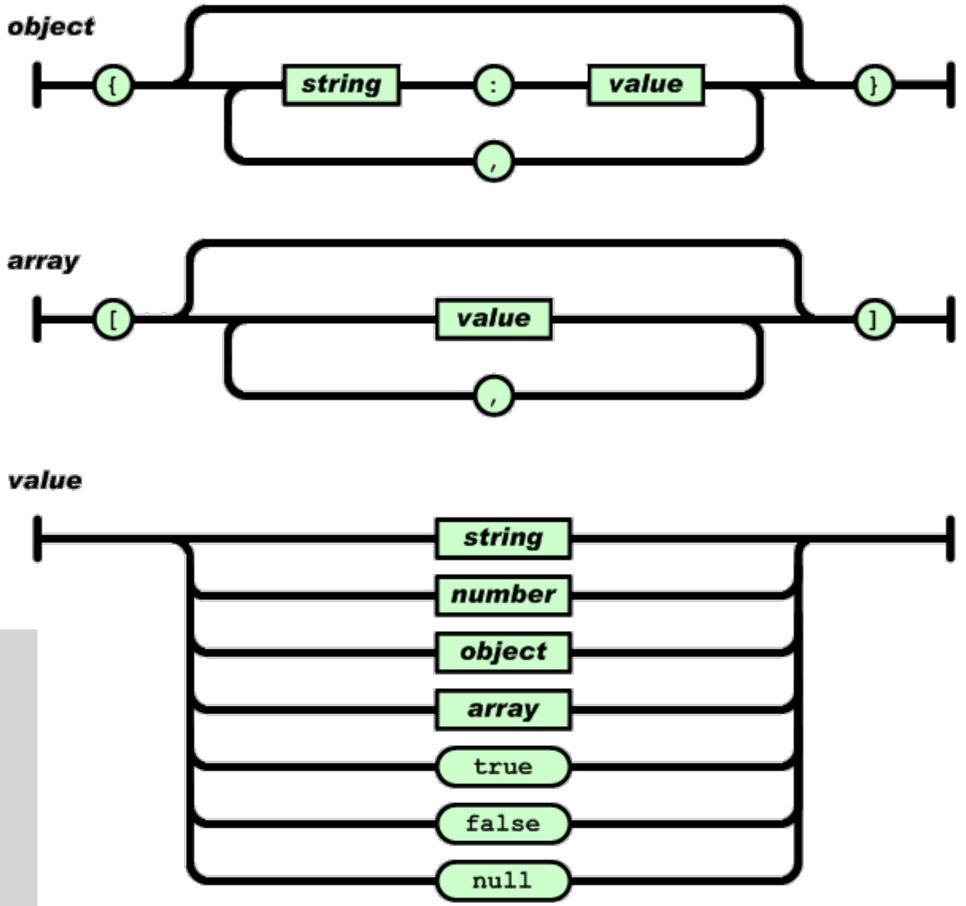
- Simplifies and decouples the architecture
- Fundamental to RESTful design is an interface that almost be guessed
  - Perform CRUD on Resources
- Uses HTTP verbs (`POST, GET, PUT, DELETE`)
- Uses URL's to address resources
- Uses HTTP Response (status, body)



Resources Represented as JSON

- While XML is a valid representation, JSON is more popular
- In JSON, just three types of data exist:
  - scalar (number, string, boolean, null).
  - array
  - object

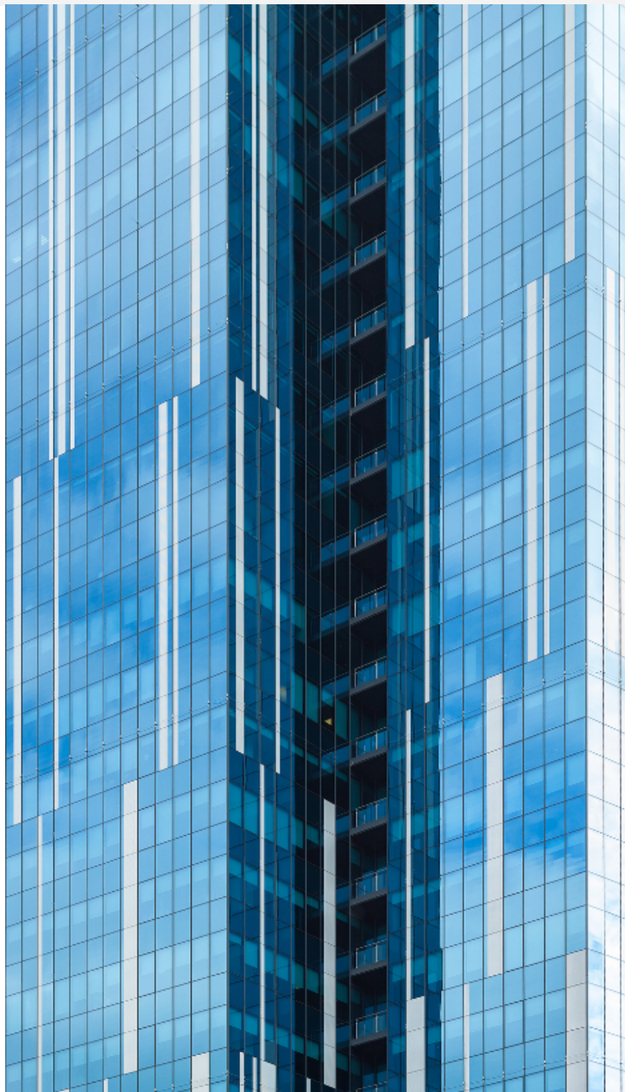
```
{
   name: "John Smith",
   rating: 24,
   address: "123 Main St, Buffalo, NY",
   birthDay: "1990-10-05"
}
```



Images from http://www.json.org/

Stateless Applications

- Server maintains no client state
- Each request contains enough context to process the message
- Any application state must be held on the client side
- Allows easy horizontal scaling of application services



What REST is Not

- REST is not a Remote Procedure Call (RPC) or just a bunch of verbs as URI's
- For example, these are NOT RESTful API's:

```
GET  http://api.myapp.com/getUser/123
POST http://api.myapp.com/addUser
GET  http://api.myapp.com/removeUser/123
```

- These are the RESTful equivalents:

```
GET    http://api.myapp.com/users/123
POST   http://api.myapp.com/users
DELETE http://api.myapp.com/users/123
```

Guidelines for Well Formed URI’s

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  - e.g., `/users` not `/user`

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  - e.g., `/users/123/agreement`
- Variable path segments may be substituted with identity-based values
  - e.g., `/users/123/addresses/2`

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  - e.g., `/users/123/agreement`
- Variable path segments may be substituted with identity-based values
  - e.g., `/users/123/addresses/2`
- CRUD function names should not be used in URIs
  - e.g., never use: `/getUsers/123`

REST API conventions

- Use REST API conventions to provide a consistent and easy to use interface for clients.
- REST API conventions define specific behavior for each type of HTTP method. Use the following guidelines as a starting point for designing your API.
  - **GET** (read) operations only query data. A GET request should never modify data.
  - **POST** (create) operations create new resource but do not modify existing resources.
  - **PUT** and **PATCH** (update) operations modify existing resources. (PUT is more common)
  - **DELETE** (delete) operations destroy resources.

Guidelines for Well Formed URI’s

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- A singular noun should be used for document names
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URI Format Guidelines

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- Forward slash separator (/) must be used to indicate a hierarchical relationship

```
http://api.myapp.com/users/{id}/addresses
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http://api.myapp.com/users/{id}/addresses
```

- A trailing forward slash (/) should not be included in URIs

```
http://api.myapp.com/users/   <- not recommended
http://api.myapp.com/users    <- recommended
```

URI Format Guidelines

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```
http://api.myapp.com/users/{id}/addresses
```

- A trailing forward slash (/) should not be included in URIs

```
http://api.myapp.com/users/   <- not recommended
http://api.myapp.com/users    <- recommended
```

- Hyphens (-) should be used to improve the readability of URIs

```
http://api.myapp.com/userGroups     <- not recommended
http://api.myapp.com/user-groups    <- recommended
```

URI Format Guidelines (cont)

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- Underscores (_) should not be used in URIs

```
http://api.myapp.com/user_groups     <- not recommended
http://api.myapp.com/user-groups     <- recommended
```

URI Format Guidelines (cont)

- Underscores (_) should not be used in URIs

```
http://api.myapp.com/user_groups     <- not recommended
http://api.myapp.com/user-groups     <- recommended
```

- Lowercase letters should be preferred in URI paths

```
http://api.myapp.com/Groups/Reset     <- not recommended
http://api.myapp.com/groups/reset     <- recommended
```

URI Format Guidelines (cont)

- Underscores (_) should not be used in URIs

```
http://api.myapp.com/user_groups     <- not recommended
http://api.myapp.com/user-groups     <- recommended
```

- Lowercase letters should be preferred in URI paths

```
http://api.myapp.com/Groups/Reset     <- not recommended
http://api.myapp.com/groups/reset     <- recommended
```

- File extensions should not be included in URIs

```
http://api.myapp.com/users/123/adresses.json     <- not recommended
http://api.myapp.com/users/123/adresses          <- recommended
```

RESTful API for USER Resource

- Using the example of a User as a resource the API would be:

```
GET  /users              <- retrieve a list of Users
GET  /users?tag="sw"     <- retrieve a list of Users with a
                            tag of "sw"
GET  /users/123          <- retrieves the User with Id 123
POST /users              <- creates a new User
PUT  /users/123          <- updates the User with Id 123
DELETE /users/123        <- deletes the User with Id 123
```

Amazon S3 Buckets

Consider Amazon's Simple Storage Service (AWS S3)

Purpose	HTTP	Request	Method Name
Create an object in my bucket	POST	my-bucket.s3.amazonaws.com	CreateObject
View objects in my bucket	GET	my-bucket.s3.amazonaws.com	ReadObject
Change an object in my bucket	PUT	my-bucket.s3.amazonaws.com	UpdateObject
Remove an object from my bucket	DELETE	my-bucket.s3.amazonaws.com	DeleteObject

What About Subordinates

- Subordinate resources can be addressed with multiple resources and ids in the URI:

```
GET /resource/{id}/subordinate/{id}
```

- Example: A User has multiple Addresses. Get Address with id = 2

```
GET /users/123/addresses/2
```

Create with POST

- Use POST to Create a Resource
- If a resource has been created on the origin server, the response **SHOULD be 201** (Created) and contain an entity which describes the status of the request and refers to the new resource, and a Location header
- Hypertext Transfer Protocol -- HTTP/1.1
  - https://www.ietf.org/rfc/rfc2616.txt

Idempotence

- **PUT** and **DELETE** operations are **idempotent**
- If you DELETE a resource, it’s gone. If you DELETE it again, it’s still gone (i.e., do not throw a 404 Not Found error!)
- Some systems might want to send a 404 on DELETE if the original resource never existed (but this could be difficult to prove)
- If you use PUT to change the state of a resource, you can resend the PUT request and the resource state should remain the same.

Side-Effects

- GET must NEVER modify the resource

  - Never code: `GET https://api.del.icio.us/posts/delete`

- GET must have no side-effects (*see above*)
- GET should return a representation of the resource(s) it was called on... period!

Safety

- While GET means "Read"... (and is safe)
- POST is neither safe nor idempotent
- Making two identical POST requests to a resource will probably result in creating two resources containing the same information
- With overloaded POST’s that may have different behavior based on data passed in, all bets are off

Use HTTP Headers

- Information about what to send or accept should be expressed in HTTP headers
- Some examples are:

```
{
    'Accept': 'application/json',
    'Content-Type': 'application/json',
    'Authorization': 'bearer %s' % token
}
```

The Root URL

- The root url '/' should return helpful information about the API:

```
200 OK
{
    "url": "https://api.spire.io/",
    "resources": {
        "sessions": {
            "url": "https://api.spire.io/sessions"
        },
        "accounts": {
            "url": "https://api.spire.io/accounts"
        },
        "billing": {
            "url": "https://api.spire.io/billing"
        }
    }
}
```

What About Actions?

- Actions are more like RPC than REST
- REST doesn’t prescribe how to handle actions but there are best practices
- But some times you need to make an action based call on a resource
  - e.g., Start, Stop, Reboot, Shutdown, Register, Deregister

Actions as State Changes

- Let’s say you want to disable a resource like a user group
- If the resource had a representation of it’s status you could use a PUT request to change that status
- **RESTful Example:** Disable UserGroup with id 123

```
PUT http://api.myapp.com/user-group/123
{
    ...
    status: "disabled"
}
```

State Changes that are Ambiguous

- Sometimes, it is required to expose an operation in the API that inherently is non RESTful
- One example of such an operation is where:
  - You want to introduce a state change for a resource
  - But there are multiple ways in which the same final state can be achieved
  - And those ways actually differ in a significant but non-observable side-effect. (e.g. "shutdown" vs "power off" a server)

```
PUT http://api.myapp.com/servers/123/shutdown
PUT http://api.myapp.com/servers/123/poweroff
```

Actions as A URI

- Let’s say you want to reboot a resource that is running
- If the resource doesn’t have a representation of it’s state that you can change, you could create a URI for the action
- **Example:** Reboot server with id 123

```
PUT http://api.myapp.com/servers/123/reboot
```

How to Handle Queries

- If the resource is a collection, you can implement a simple query using URL parameters
- Example: Find all pets that are poodles

```
GET http://api.myapp.com/pets?breed="poodle"&sort_by=created
```

Create Useful Error Messages

- The more you can tell the client about what went wrong the better
- If there is a required parameter like "name" that is missing:
  - Rather than returning an error message that says: '`missing parameter`'
  - Return more information like: '`required name parameter is missing`'
- This will give the caller more information about why their call failed

Error Message Example

An example from the twilio api:

```
GET https://api.twilio.com/2010-04-01/Accounts.json
```

results in:

```
401 Unauthorized
WWW-Authenticate: Basic realm="Twilio API"
{
      "code": 20003,
      "detail": "Your AccountSid or AuthToken was incorrect.",
      "message": "Authentication Error - No credentials provided",
      "more_info": "https://www.twilio.com/docs/errors/20003",
      "status": 401
}
```

Use Proper HTTP Return Codes

200	Indicates that the request was **completed** successfully. All GET requests that are successful should return 200
201	Indicates that a record was **created** successfully. All POST requests that successfully create a resource should return 201
204	Indicates that a record was **deleted** successfully. All DELETE requests that completed successfully should return 204 and the body should be empty.
40X (401, 404)	Status codes in the 400 range indicate a client error, such as 400 for invalid request syntax and 401 Unauthorized for not having proper credentials are probably the most common.
50X (500, 503)	Status codes in the 500 range indicate that a server error occurred. The client request may have been valid or invalid, but a problem occurred on the server that prevented it from processing the request.

Responses (Happy Path)

- `GET /users`
  - 200 + Array of Users [{...},{...},{...}]
- `GET /users/12345`
  - 200 + User {...}
- `POST /users`
  - 201 + User {...}
  - Location Header for GET
- `PUT /users/12345`
  - 200 + User {...}
- `DELETE /users/12345`
  - 204 + empty body

Common REST API Return Codes

Code: 200 (“OK”) should be used to indicate nonspecific success
Code: 200 (“OK”) must not be used to communicate errors in the response body
Code: 201 (“Created”) must be used to indicate successful resource creation
Code: 202 (“Accepted”) must be used to indicate successful start of an asynchronous action
Code: 204 (“No Content”) should be used when the response body is intentionally empty
Code: 301 (“Moved Permanently”) should be used to relocate resources
Code: 302 (“Found”) should not be used
Code: 303 (“See Other”) should be used to refer the client to a different URI
Code: 304 (“Not Modified”) should be used to preserve bandwidth
Code: 307 (“Temporary Redirect”) should be used to tell clients to resubmit the request to another URI
Code: 400 (“Bad Request”) may be used to indicate nonspecific failure
Code: 401 (“Unauthorized”) must be used when there is a problem with the client’s credentials
Code: 403 (“Forbidden”) should be used to forbid access regardless of authorization state
Code: 404 (“Not Found”) must be used when a client’s URI cannot be mapped to a resource
Code: 405 (“Method Not Allowed”) must be used when the HTTP method is not supported
Code: 406 (“Not Acceptable”) must be used when the requested media type cannot be served
Code: 409 (“Conflict”) should be used to indicate a violation of resource state
Code: 412 (“Precondition Failed”) should be used to support conditional operations
Code: 415 (“Unsupported Media Type”) must be used when the media type of a request’s payload cannot be processed
Code: 422 ("Unprocessable entity") must be used if the server can not process the property, for example, if an image cannot be formatted or if required fields are missing from the payload
Code: 500 (“Internal Server Error”) should be used to indicate API malfunction

Case Study: Unreal Engine API

Attracting Developers to your API

- Cry engine from CryTek used to be one of the best game engines in the world. Head and shoulders above the Unreal Engine (UE) in visual quality.
- Are they as widely used by developers to develop games today? No. Why? Because it was hard to use and meaningful documentation was non-existent. Whatever documentation was there, was cryptic.
- If you frustrate your developers they won't stick around. UE has thousands of online tutorials, youtube videos, and twitch channel to give developers all the help they need.
- Epic Games, the makers of UE is valued at $15 billion today

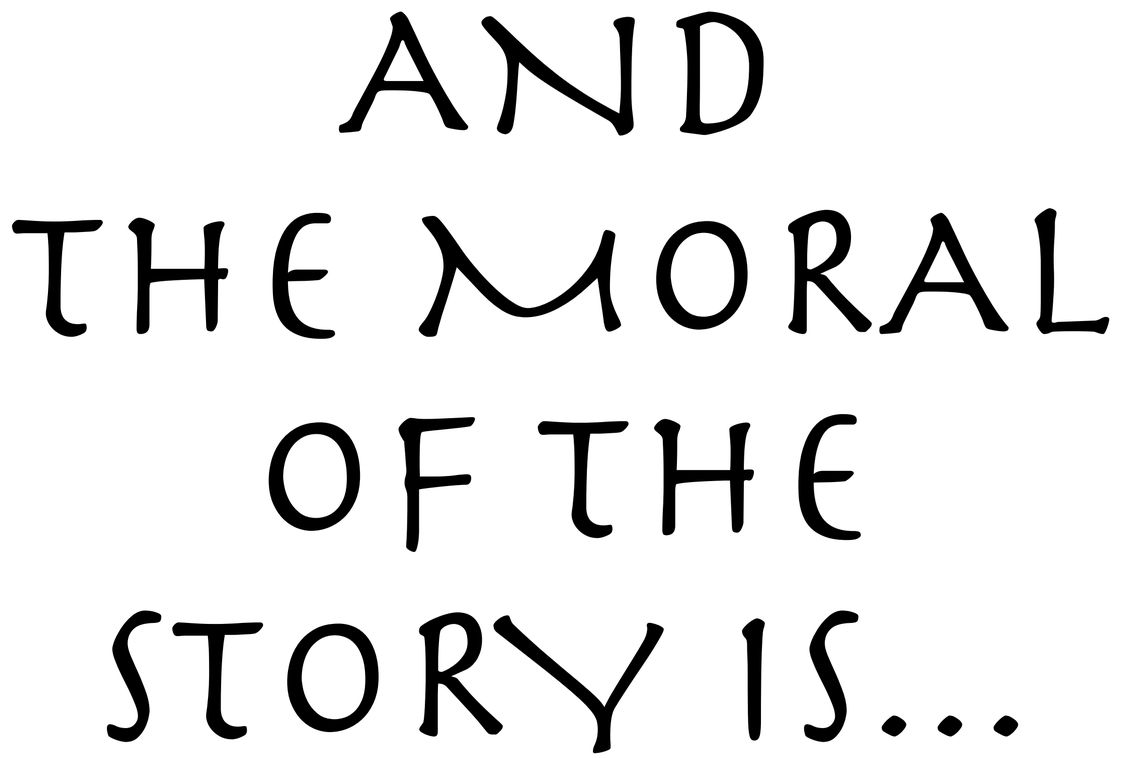
Case Study: Unity Engine API

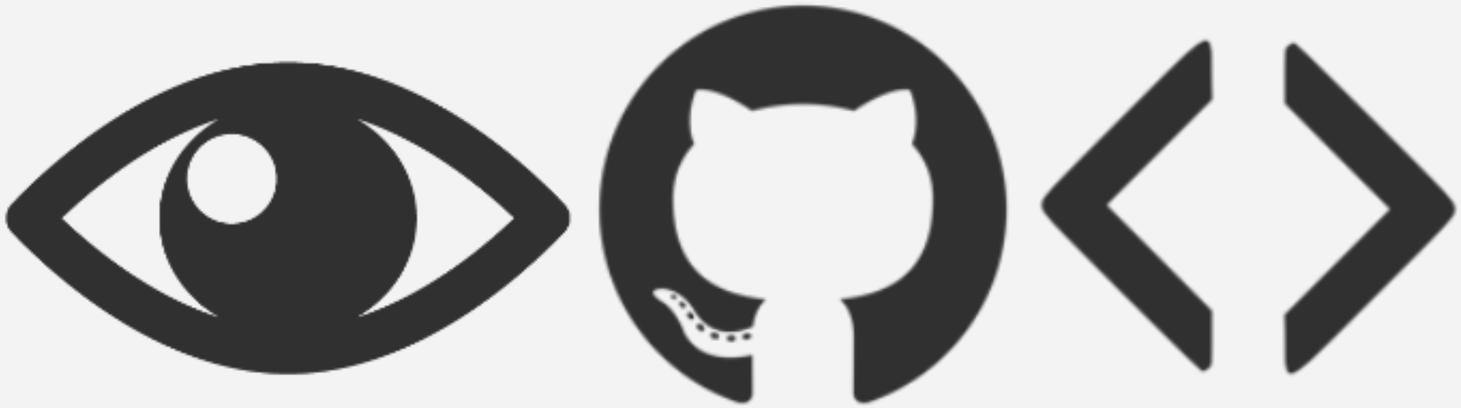
Attracting Developers to your API

- Unity, the most popular game engine doesn't come close to the visual fidelity of either UE, Cry, Frostbite, Fox, or Snowdrop.
- But, it is the most widely used in the game engine market.
- They focus on making it easy for people to learn Unity. They have become a University of sorts providing Unity certification courses.
- They have the largest developer community where people can find answers and plugins to Unity itself.
- Unity is valued at $3 billion dollars today and 45% of the games on the app store and Play store is written in Unity.

Moral of the Story

- Make your product accessible to developers and provide them with the help they need with your API
- Developers will go where they want to go
- They'll stay where they are appreciated





Let's look at some RESTful Code!

Hands-On

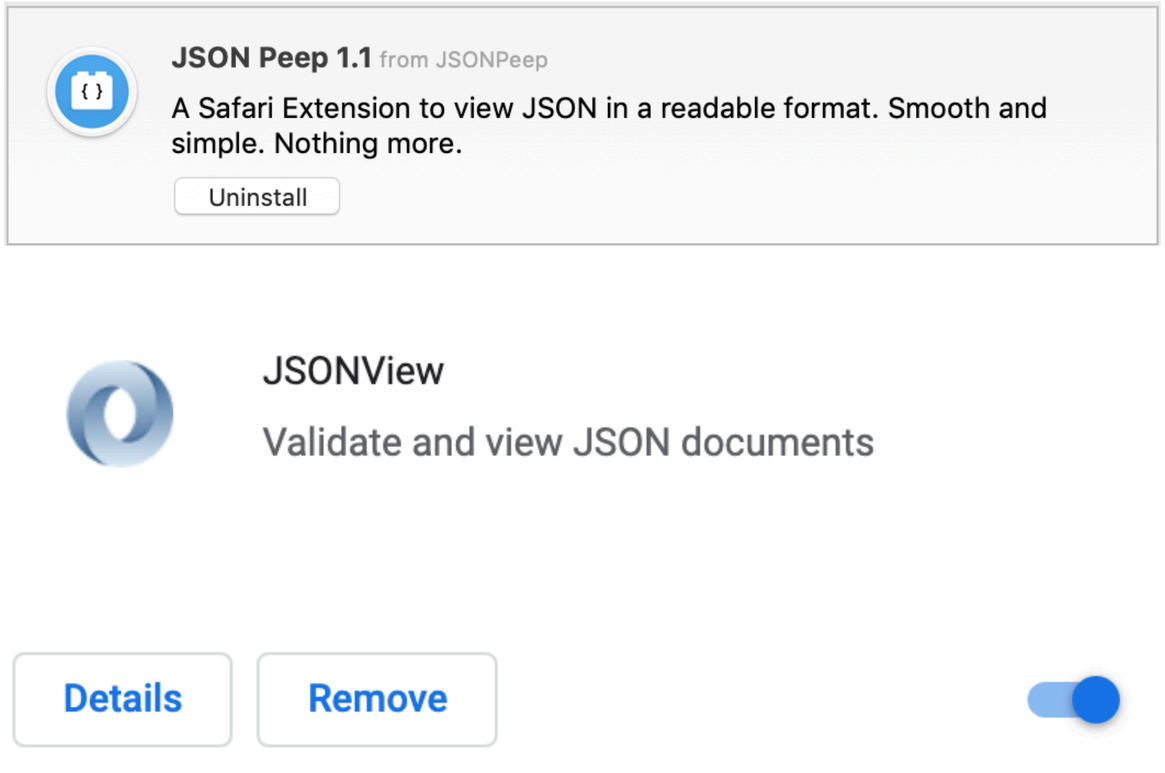
“live session”

Some Assembly Required

- Tools you will need to complete this lab:
  - Github Account (github.com)
  - Git Client
  - Text Editor (...i like VS Code)
  - Vagrant and VirtualBox
  - (Optional) JsonView, Simple REST Client

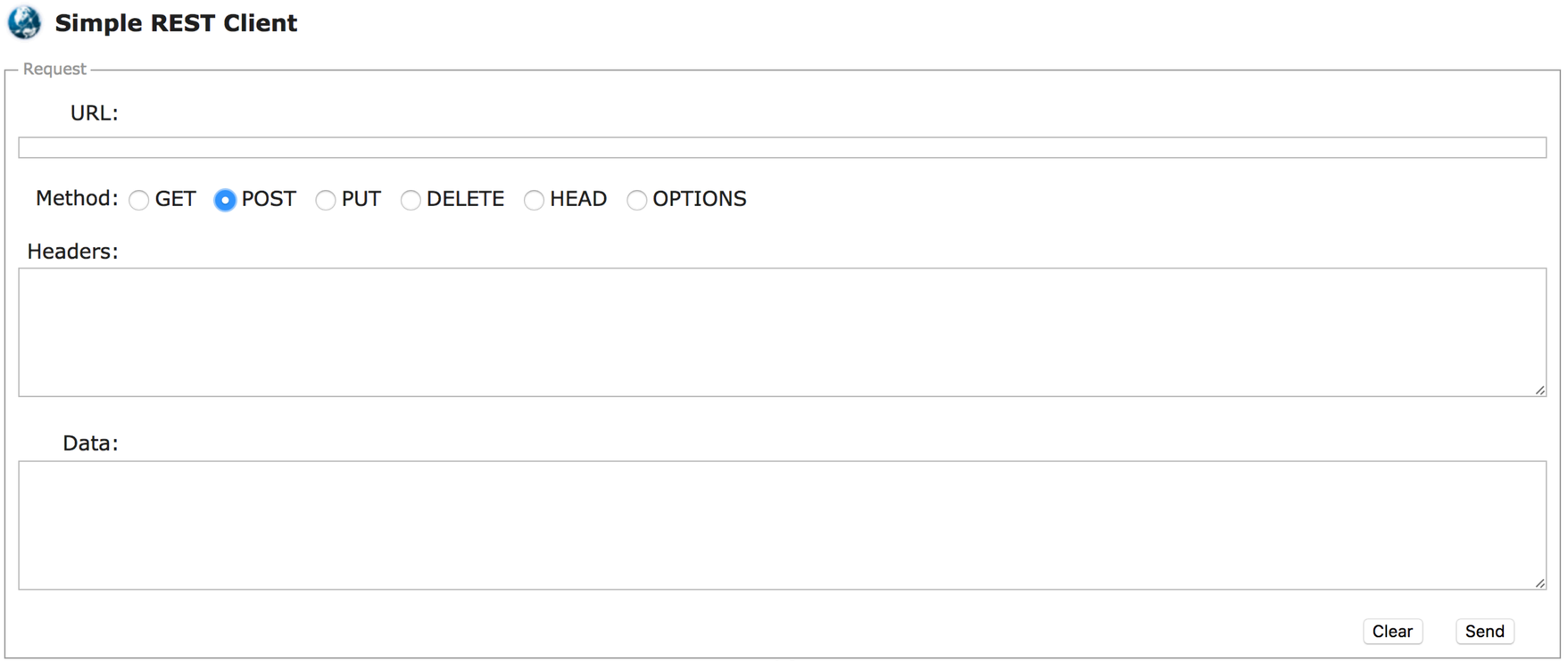
Optional Browser Plugin

- **JsonView or JSON Peep** — will format Json output so that even humans can read it
- Browser extensions for Safari, Chrome, Firefox
- When working with REST APIs it comes in handy



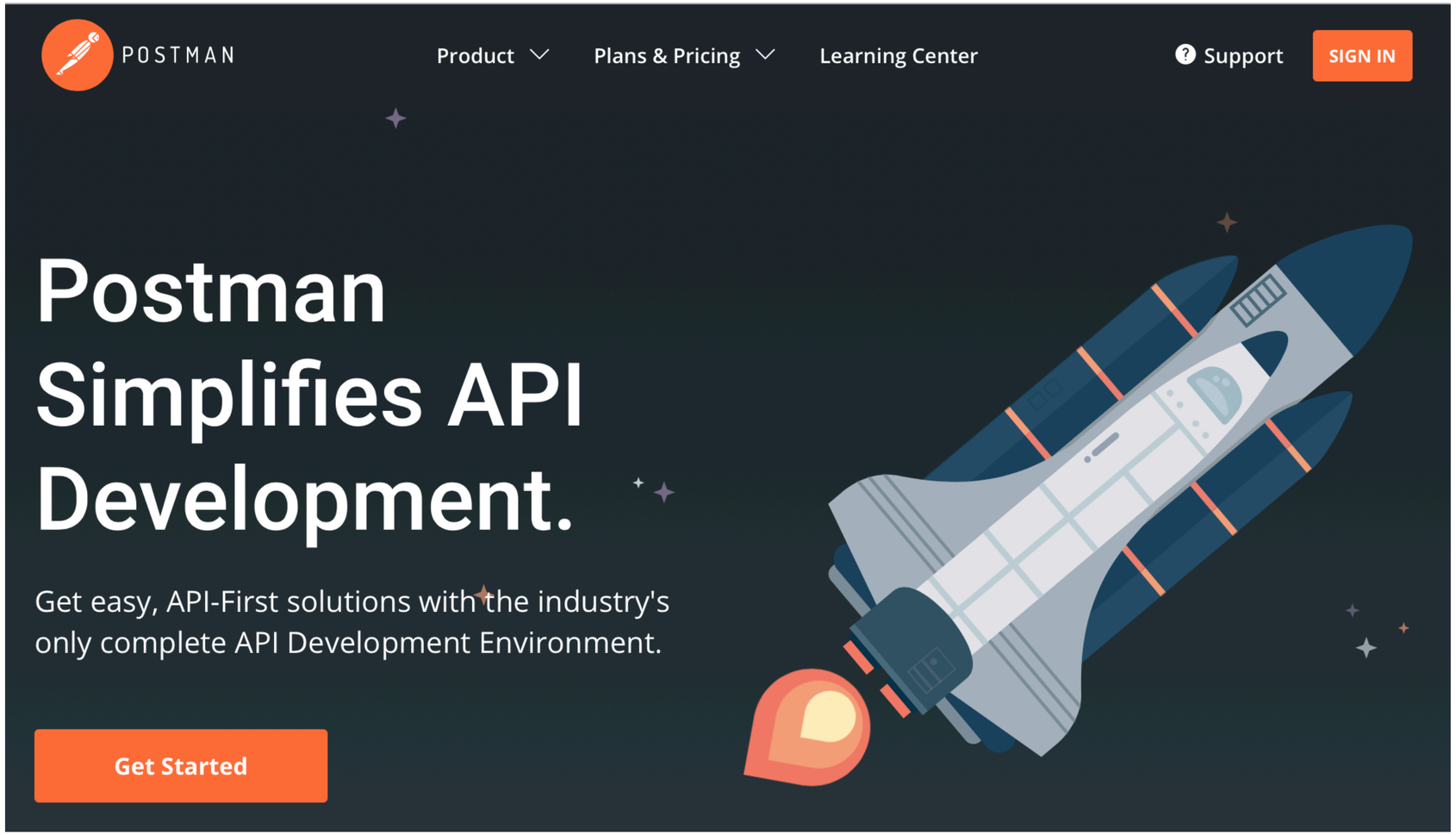
Optional Browser Plugin

- **Simple REST Client** allows you to make POST, PUT, DELETE calls in addition to GET (which your browser can do)



Postman REST Client

https://www.getpostman.com



Hello Flask

- Flask is a light-weight web framework that is idea for microservices

  pastebin.com/WmzQ6FVT

```
from flask import Flask
app = Flask(__name__)

@app.route('/')
def index():
    return 'Hello Flask!'

if __name__ == '__main__':
    app.run()
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Import Flask module

Create an instance of Flask app

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Define a function to handle the route

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Import Flask module

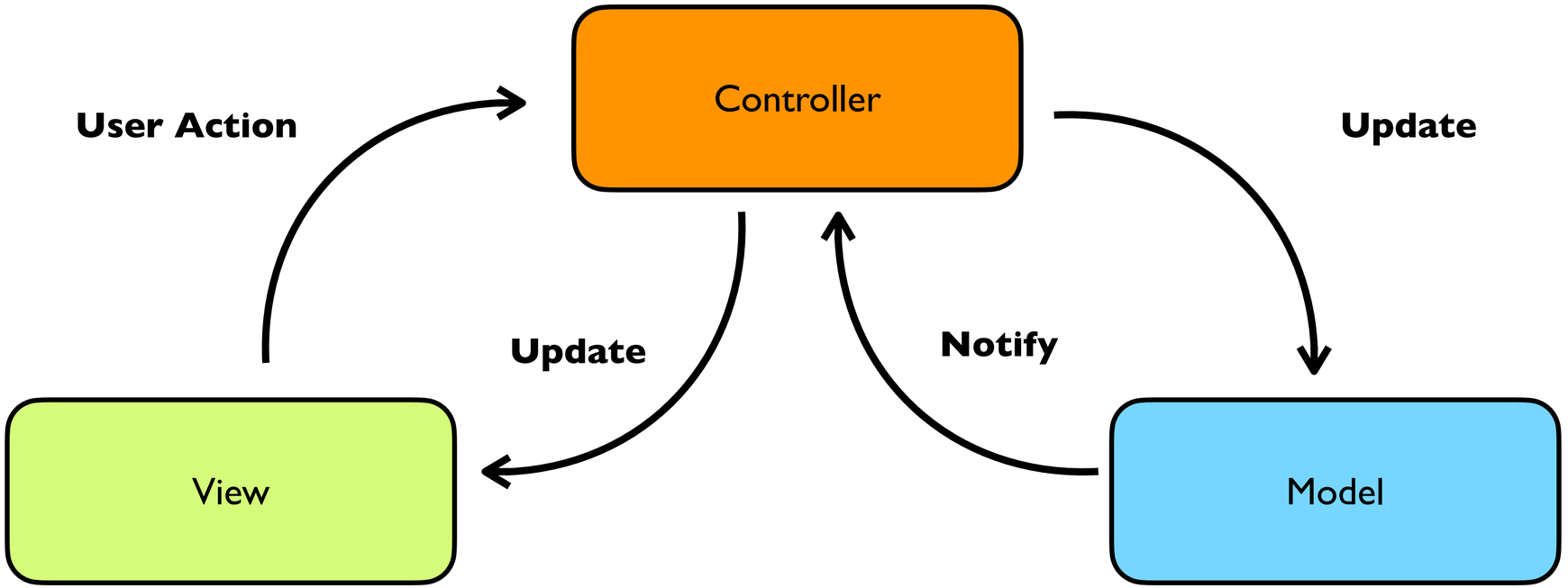
Create an instance of Flask app

Create a route (url)

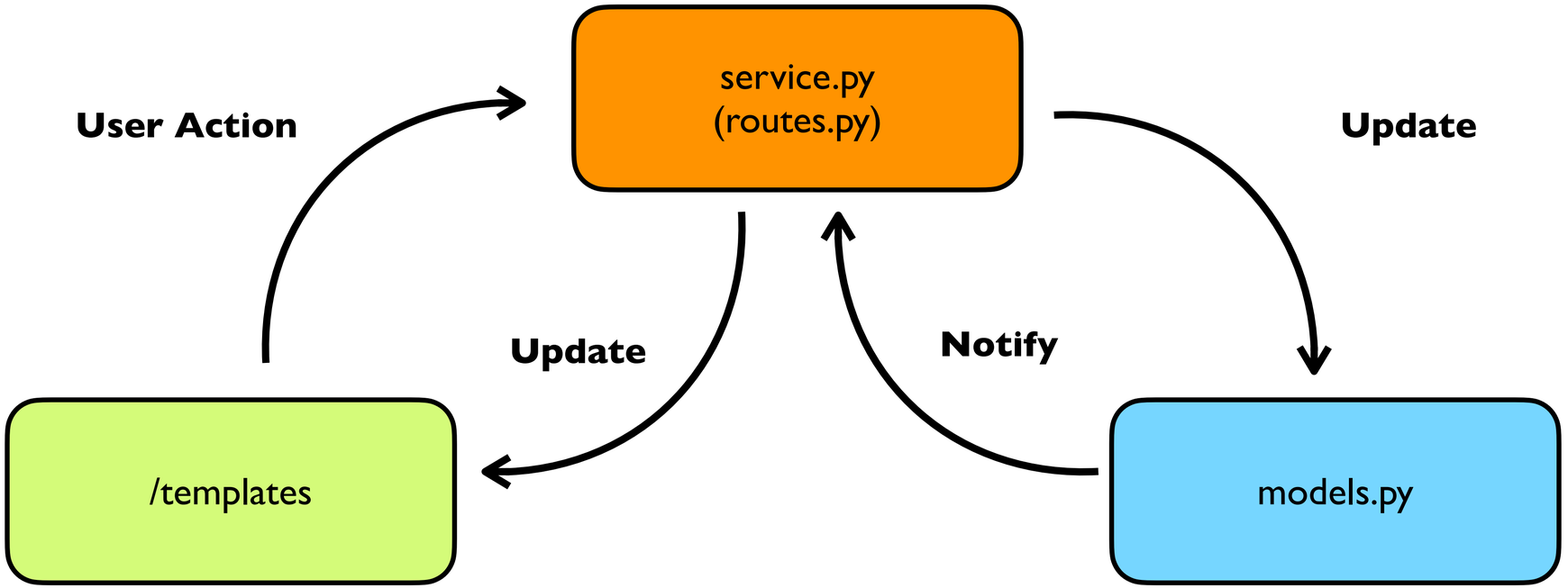
Define a function to handle the route

Run the web server

Model / View / Controller



MVC with Flask



Simple RESTful Pet Service

Allows lifecycle operations on a collection of pets

Config from Environment

- The main routine gets it’s configuration information like what port to bind to from the environment in true 12-factor style

```
# Pull options from environment
DEBUG = (os.getenv('DEBUG', 'False') == 'True')
PORT = os.getenv('PORT', '5000')
HOST = os.getenv('HOST', '0.0.0.0')

. . . CODE HERE . . .

if __name__ == "__main__":
   app.run(host=HOST, port=int(PORT), debug=DEBUG)
```

Root URL Request

- This code is called on the root URL

```
@app.route('/')
def index():
    return jsonify(name='Pet Demo REST API Service',
                   version='1.0',
                   url=url_for('list_pets', _external=True)), status.HTTP_200_OK
```

- It returns the following JSON

```
{
  "name": "Pet Demo REST API Service",
  "url": "http://localhost:5000/pets",
  "version": "1.0"
}
```

LIST ALL PETS

- This code is called on the URL GET /pets

```
@app.route('/pets', methods=['GET'])
def list_pets():
    results = []
    category = request.args.get('category')
    if category:
        app.logger.info('Getting Pets for category: {}'.format(category))
        results = Pet.find_by_category(category)
    else:
        app.logger.info('Getting all Pets')
        results = Pet.all()

    return jsonify([pet.serialize() for pet in results]), status.HTTP_200_OK
```

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        results = Pet.find_by_category(category)
    else:
        app.logger.info('Getting all Pets')
        results = Pet.all()

    return jsonify([pet.serialize() for pet in results]), status.HTTP_200_OK
```

```
200
[
  {
    "id": 2,
    "category": "cat",
    "name": "kitty"
  },
  {
    "id": 1,
    "category": "dog",
    "name": "fido"
  }
]
```

RETRIEVE A PET

- This code is called on the URL GET /pets/<id>

```
@app.route('/pets/<int:pet_id>', methods=['GET'])
def get_pets(pet_id):
    app.logger.info('Getting Pet with id: {}'.format(pet_id))
    pet = Pet.find(pet_id)
    if not pet:
        raise NotFound('Pet with id: {} was not found'.format(pet_id))

    return jsonify(pet.serialize()), status.HTTP_200_OK
```

RETRIEVE A PET

- This code is called on the URL GET /pets/<id>

```
@app.route('/pets/<int:pet_id>', methods=['GET'])
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    pet = Pet.find(pet_id)
    if not pet:
        raise NotFound('Pet with id: {} was not found'.format(pet_id))

    return jsonify(pet.serialize()), status.HTTP_200_OK
```

```
200
{
  "id": 2,
  "category": "cat",
  "name": "kitty"
}
```

Create a Pet

- This code is called on the URL POST /pets

```
@app.route('/pets', methods=['POST'])
def create_pets():
    app.logger.info('Create Pet requested')
    pet = Pet()
    pet.deserialize(request.get_json())
    pet.save()
    app.logger.info('Created Pet with id: {}'.format(pet.id))
    return make_response(jsonify(pet.serialize()),
                         status.HTTP_201_CREATED,
                         {'Location': url_for('get_pets', pet_id=pet.id, _external=True)})
```

Create a Pet

- This code is called on the URL POST /pets

```
@app.route('/pets', methods=['POST'])
def create_pets():
    app.logger.info('Create Pet requested')
    pet = Pet()
    pet.deserialize(request.get_json())
    pet.save()
    app.logger.info('Created Pet with id: {}'.format(pet.id))
    return make_response(jsonify(pet.serialize()),
                         status.HTTP_201_CREATED,
                         {'Location': url_for('get_pets', pet_id=pet.id, _external=True)})
```

```
201
{
  "id": 3,
  "category": "lion",
  "name": "leo"
}
```

Update an Existing pet

- This code is called on the URL PUT /pets

```
@app.route('/pets/<int:pet_id>', methods=['PUT'])
def update_pets(pet_id):
    app.logger.info('Updating with id: {}'.format(pet_id))
    pet = Pet.find(pet_id)
    if not pet:
        raise NotFound('Pet with id: {} was not found'.format(pet_id))

    # process the update request
    pet.deserialize(request.get_json())
    pet.id = pet_id # make id matches request
    pet.save()
    app.logger.info('Pet with id {} has been updated'.format(pet_id))
    return jsonify(pet.serialize()), status.HTTP_200_OK
```

Update an Existing pet

- This code is called on the URL PUT /pets

```
@app.route('/pets/<int:pet_id>', methods=['PUT'])
def update_pets(pet_id):
    app.logger.info('Updating with id: {}'.format(pet_id))
    pet = Pet.find(pet_id)
    if not pet:
        raise NotFound('Pet with id: {} was not found'.format(pet_id))

    # process the update request
    pet.deserialize(request.get_json())
    pet.id = pet_id # make id matches request
    pet.save()
    app.logger.info('Pet with id {} has been updated'.format(pet_id))
    return jsonify(pet.serialize()), status.HTTP_200_OK
```

```
200
{
  "id": 2,
  "category": "tabby",
  "name": "kitty"
}
```

Delete a Pet

- This code is called on the URL POST /pets

```
@app.route('/pets/<int:pet_id>', methods=['DELETE'])
def delete_pets(pet_id):
    app.logger.info('Request to delete Pet with id: {}'.format(pet_id))
    pet = Pet.find(pet_id)
    if pet:
        pet.delete()
    return make_response('', status.HTTP_204_NO_CONTENT)
```

Delete a Pet

- This code is called on the URL POST /pets

```
@app.route('/pets/<int:pet_id>', methods=['DELETE'])
def delete_pets(pet_id):
    app.logger.info('Request to delete Pet with id: {}'.format(pet_id))
    pet = Pet.find(pet_id)
    if pet:
        pet.delete()
    return make_response('', status.HTTP_204_NO_CONTENT)
```

```
204
''
```

Delete a Pet

- This code is called on the URL POST /pets

```
@app.route('/pets/<int:pet_id>', methods=['DELETE'])
def delete_pets(pet_id):
    app.logger.info('Request to delete Pet with id: {}'.format(pet_id))
    pet = Pet.find(pet_id)
    if pet:
        pet.delete()
    return make_response('', status.HTTP_204_NO_CONTENT)
```

```
204
''
```

What should we do if there is no Pet with that ID?

Pet Model

- This is a summary of the methods in the Pet Model

```
class Pet(object):
    def __init__(self):
    def __repr__(self):
    def save(self):
    def delete(self):
    def serialize(self):
    def deserialize(self, data):

    @classmethod
    def all():
    def find(id):
    def find_by_category(category):
```

Pet Model

- Data Attributes

```
class Pet(db.Model):
    """ Represents a single pet """
    id = db.Column(db.Integer, primary_key=True)
    name = db.Column(db.String(63))
    category = db.Column(db.String(63))

    def __repr__(self):
        return '<Pet %r>' % (self.name)
```

Pet Model

- Persistence Methods

```
    def save(self):
        """ Saves an existing Pet in the database """
        # if the id is None it hasn't been added to the database
        if not self.id:
            db.session.add(self)
        db.session.commit()

     def delete(self):
        """ Deletes a Pet from the database """
        db.session.delete(self)
        db.session.commit()
```

Pet Model

- Conversions for transmission

```
    def serialize(self):
        return { "id": self.id, "name": self.name, "category": self.category }

    def deserialize(self, data):
        try:
            self.name = data['name']
            self.category = data['category']
        except KeyError as e:
            raise DataValidationError('Invalid pet: missing ' + e.args[0])
        except TypeError as e:
            raise DataValidationError('Invalid pet: body of request contained bad or no data')
        return self
```

Pet Model

- Query Methods

```
    @classmethod
     def all(cls):
         """ Returns all of the Pets in the database """
         return cls.query.all()

     @classmethod
     def find(cls, pet_id):
         """ Finds a Pet by it's ID """
         return cls.query.get(pet_id)

     @classmethod
     def find_by_category(cls, category):
         """ Returns all of the Pets in a category """
         return cls.query.filter(cls.category == category)
```

What About testing?

- It is critical to have test cases for all of your REST APIs

```
class TestPetService(unittest.TestCase):

    @classmethod
    def setUpClass(cls):
        """ Run once before all tests """
       app.config['SQLALCHEMY_DATABASE_URI'] = DATABASE_URI

    def setUp(self):
        """ Runs before each test """
        db.drop_all()    # clean up the last tests
        db.create_all()  # create new tables
        Pet(name='fido', category='dog').save()
        Pet(name='kitty', category='cat').save()
        self.app = app.test_client()

    def test_index(self):
        """ Test the Home Page """
        resp = self.app.get('/')
        self.assertEqual(resp.status_code, status.HTTP_200_OK)
        data = resp.get_json()
        self.assertEqual(data['name'], 'Pet Demo REST API Service')
```

Summary

- You should now have a good overview what a REST API is
- You now know the guidelines for creating a good RESTful API
- You should also be able to create a REST API for any Resource using Python and Flask

Additional Reading

- **RESTful Web Services Cookbook** by Subbu Allamaraju, Publisher: O'Reilly Media, Inc.
- **REST API Design Rulebook** by Mark Masse, Publisher: O'Reilly Media, Inc.
- **REST in Practice**, by Savas Parastatidis, Jim Webber, Ian Robinson,Publisher: O'Reilly Media, Inc.
- **RESTful Web Services**, by Sam Ruby, Leonard Richardson, Publisher: O'Reilly Media, Inc.
- **Microservice Architecture**, by Martin Fowler (https://martinfowler.com/articles/microservices.html)