Model Deployment

Creating a Flask Application/ API

Democratizing Data Science Learning

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Learning Objectives

- API
- Flask
- Creating an API from a machine learning model using Flask
- HTTP Methods
- JSON and jsonify
- Testing your API in Postman

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You might be thinking

Now that I have built the ML model and saved it, I should be able to deploy it directly.

Well, not really.
Think about how an investor or a non data science person will be able to use your model. Will she/he be able to load it and run it?

What you'll do in such a case is create a simple interface (possibly a web application) for the person to interact.

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Breaking down the whole application

There are several things we need to put together for the web app.

The first two are:

1. The Python code that will load our model, get user input from a web form, do predictions, return results.

2. The HTML templates that flask with render. These allow the user to input their own data and will present the results.

Let’s get started with the 1st one in this unit.

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What are APIs?

In simple words, an API is a (hypothetical) contract between 2 softwares saying if the user software provides input in a pre-defined format, the latter will extend its functionality and provide the outcome to the user software.

A majority of the cloud providers, and smaller machine learning focused companies provide ready-to-use APIs. They cater to the needs of developers/businesses that do not have expertise in ML, who want to implement ML in their processes or product suites.

Google Vision API is an excellent example which provides dedicated services for Computer Vision tasks.

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Web Service/API

Now, you might think what is a web service?

Web service is a form of API only that assumes that an API is hosted over a server and can be consumed.

Web API, Web Service - these terms are generally used interchangeably.

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Flask - A web services’ framework in Python

Coming to Flask, it is a web service development framework or a micro-framework built in Python, which means it provides various tools and libraries for building web applications.

It is not the only one in Python, there are couple others as well such as Django, Falcon, Hug, etc.

Flask is very minimal and easy to learn and start working with—as long as you understand Python.

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Why Flask

Basic benefits:

- Easy to use.
- Extensively documented.
- A good tool to get started with model deployment.

Advance benefits:

- Built in development server and debugger.
- Integrated unit testing support.
- RESTful request dispatching.

It’s okay if you don’t understand some of the terms above.
You’ll appreciate Flask as you use it.

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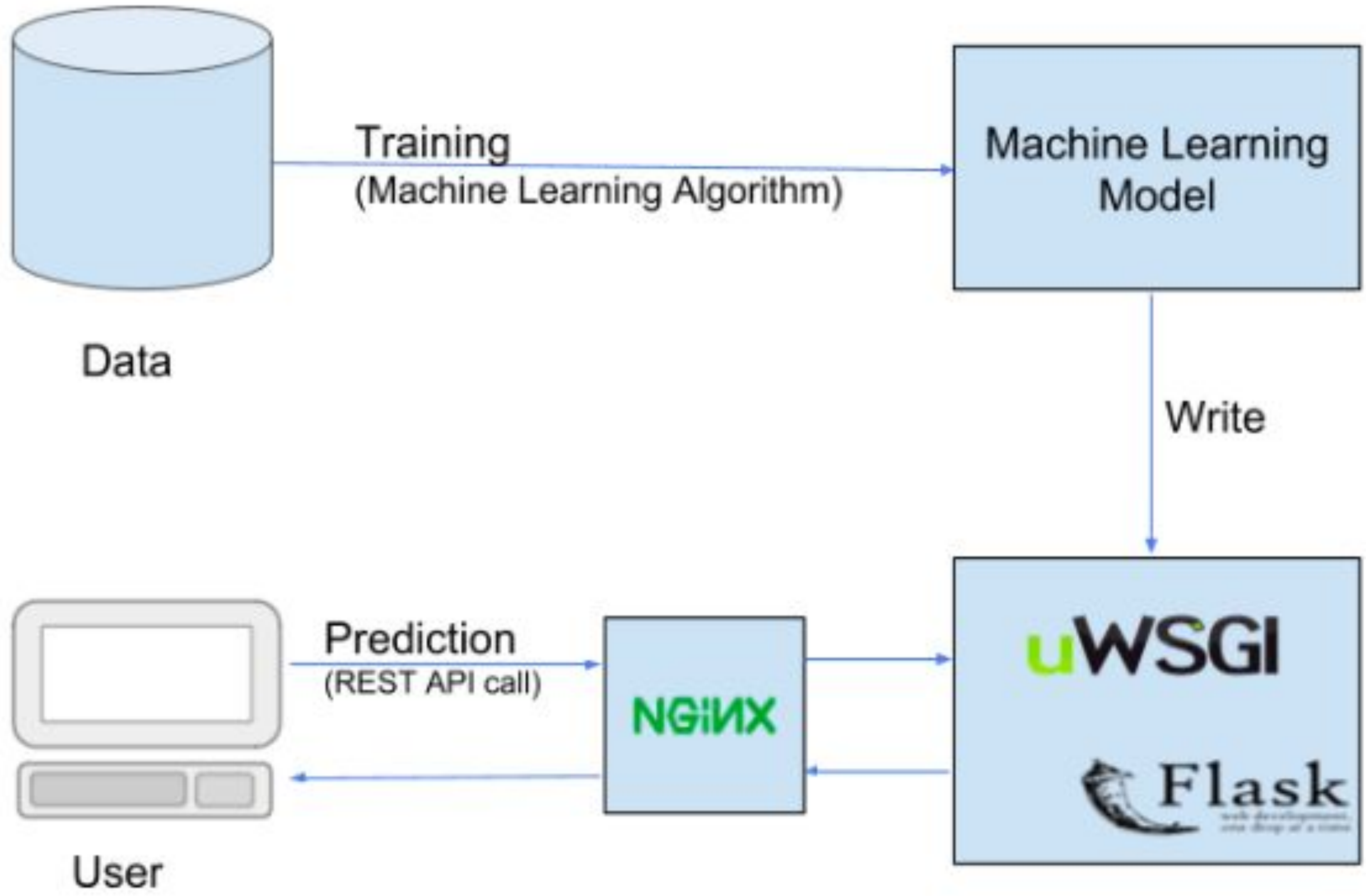
Pipeline for deployment of a Machine Learning model



Some points to be noted

- Jupyter Notebooks are great for anything related to markdowns, R and Python. But when it comes to building a web server, it may show inconsistent behavior. So, it is a good idea to write the Flask codes in a Python IDE or text editor like Sublime and run the code from the terminal/command prompt.

  You can download Sublime from here.

- Make sure you don't name the file as flask.py or it might create some conflicts.

- Flask runs on port number 5000 by default.

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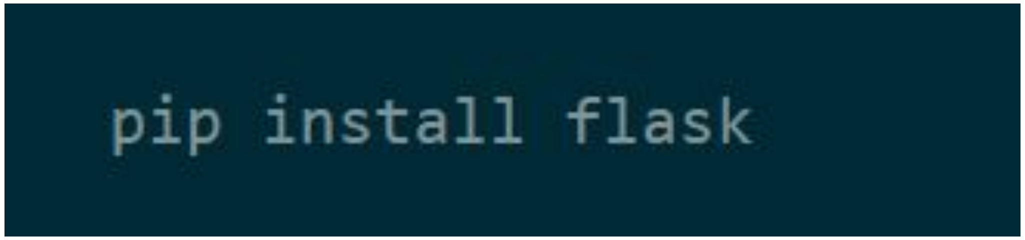
Installing Flask

If you downloaded the Anaconda distribution, you already have Flask installed. Otherwise, you will have to install it yourself with:



```
pip install flask
```

Creating an API from a machine learning model using Flask

For serving your model with Flask, you will do the following two things:

- Load the saved model into memory when the application starts.
- Create an API endpoint that takes input variables, transforms them into the appropriate format, and returns predictions.

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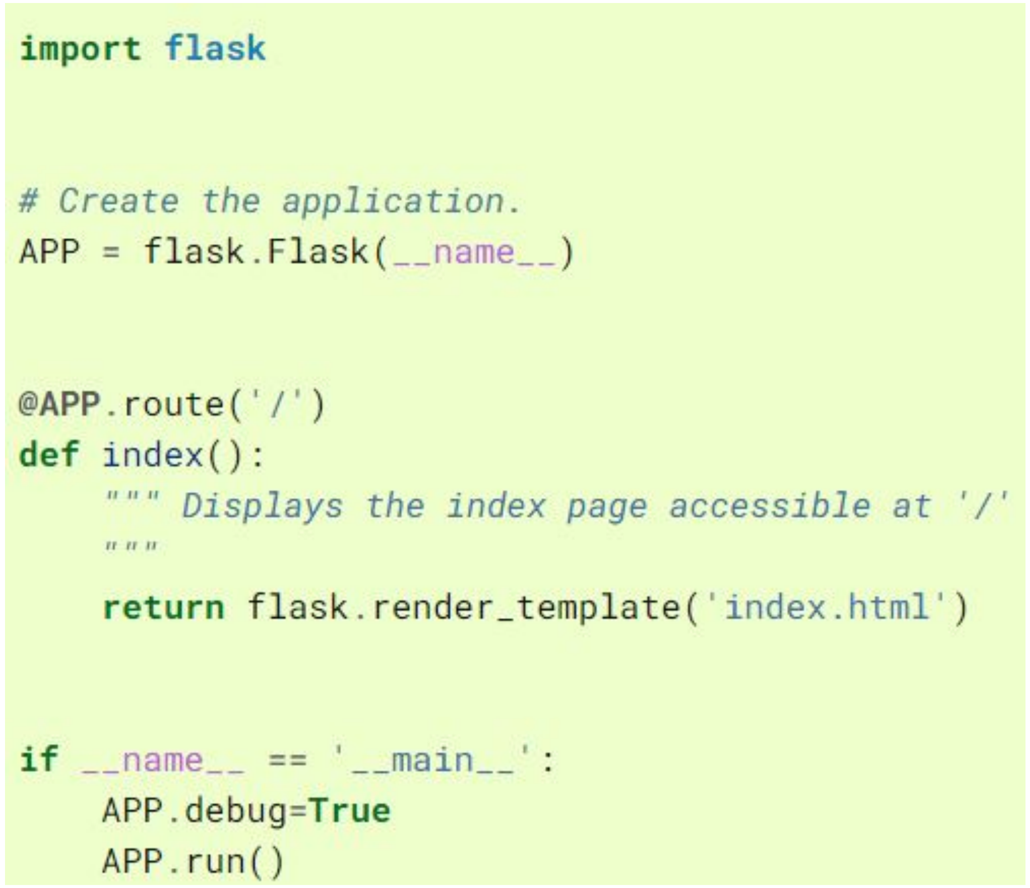
Let's get started

A Flask application is nothing but a Python file (a file saved with .py extension) that utilises Flask.

The basic template of any Flask file is like:



```
import flask


# Create the application.
APP = flask.Flask(__name__)


@APP.route('/')
def index():
    """ Displays the index page accessible at '/'
    """
    return flask.render_template('index.html')


if __name__ == '__main__':
    APP.debug=True
    APP.run()
```

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Let’s get started

In order to test Flask installation, type the following code in the editor and save it as ‘app.py’. Note that the underscores being used are double underscores and not single.

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

@app.route('/')
def hello_world():
   return 'Hello World!’

if __name__ == '__main__':
   app.run(debug=True)
```

For running the file, if you’re in sublime, you can simply do Ctrl+B. Otherwise, you can type `python app.py` or `flask run` in the terminal.

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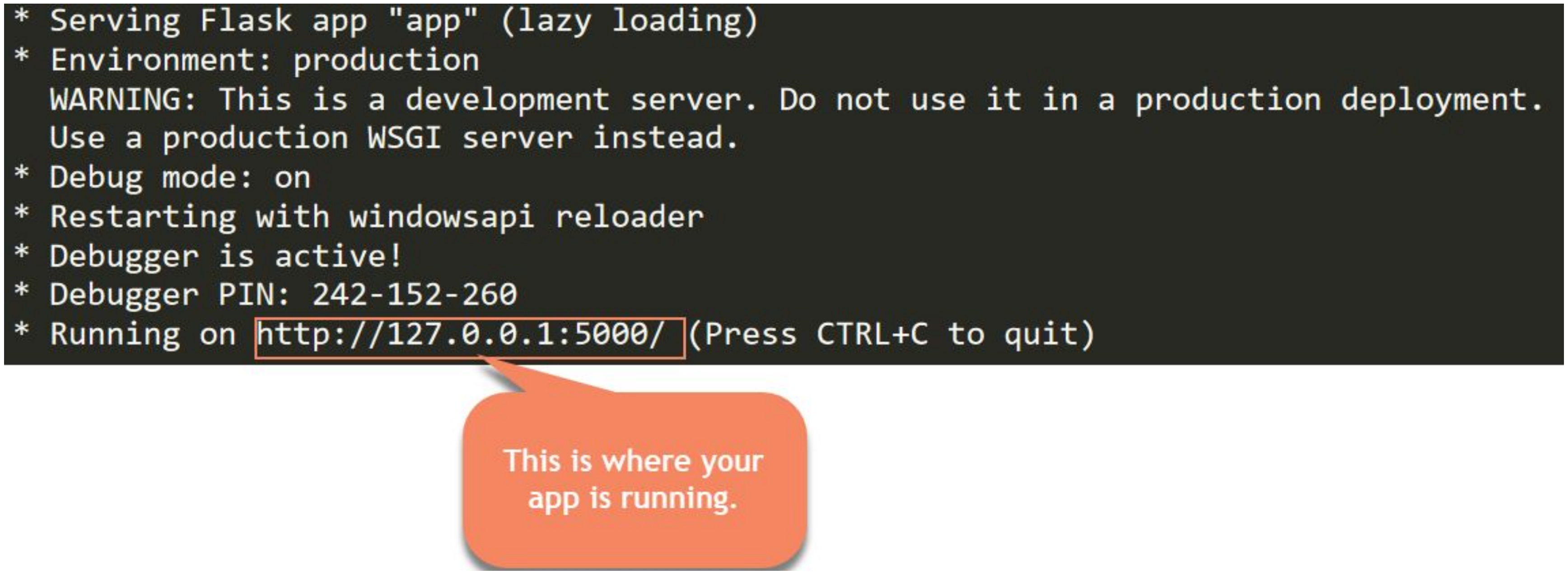
Let's get started

You will see an output like this:

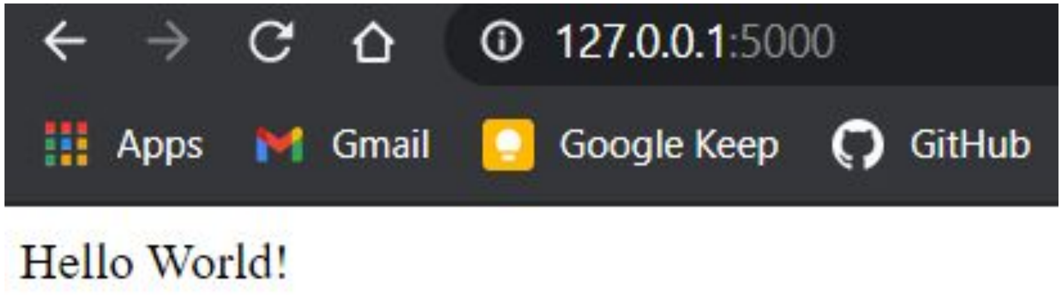


```
* Serving Flask app "app" (lazy loading)
* Environment: production
  WARNING: This is a development server. Do not use it in a production deployment.
  Use a production WSGI server instead.
* Debug mode: on
* Restarting with windowsapi reloader
* Debugger is active!
* Debugger PIN: 242-152-260
* Running on http://127.0.0.1:5000/ (Press CTRL+C to quit)
```

Copy the link displayed and paste it in your browser. (The default port will be 5000 unless you specify it otherwise).

Let's get started

And you'll be able to see this on the link:



```
Hello World!
```

Did we just create a basic functioning website? Yes we did!!

If you want the website to stop running, you can press Ctrl+C in the terminal or simply close the window.

Understanding the code

Let's understand the components of our Flask application briefly. We don't need to go into much detail at the moment.

- Flask constructor takes the name of **current module (__name__)** as argument.

- The **route()** function of the Flask class tells the application which URL should call the associated function.
  It has the syntax:
  `app.route(rule, options)`
  ➔ The rule parameter represents URL binding with the function i.e on which URL will the function be called.
  ➔ The options is a list of parameters to be forwarded to the underlying Rule object i.e what parameters should we pass when accessing a URL.

In our example, '/' URL is bound with hello_world() function. Hence, when the home page of web server is opened in browser, the output of this function will be rendered(displayed).

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Understanding the code

For understanding how route triggers different functions on different URLs, let's take the example of the DPhi website.

- If you go to https://dphi.tech// , you'll land at the home page. The route defined here might be something like

```
@app.route('/')
def home():
```

- Now, if you go to https://dphi.tech/learn/ , you'll land at the learn page where you'll see content different from what was present at the home page. There are a number of courses here. The route defined here might be something like

```
@app.route('/learn')
def learn():
```

Similarly, many other routes can be defined. These are also called **endpoints**.

Did you get it now how different routes can perform different tasks?

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Understanding the code

- Finally the **run()** method of Flask class runs the application on the local development server. This is what we call running an application locally.
  Its syntax is as follows:

  ```
  app.run(host, port, debug, options)
  ```

  All parameters are optional

  ➔ host defaults to 127.0.0.1 (localhost).
  ➔ port defaults to 5000
  ➔ That is why the default URL of the website is http://127.0.0.1:5000/ . This can also be accessed by the URL `localhost:5000`

A Flask application is started by calling the run() method. However, while the application is under development, it should be restarted manually for each change in the code. To avoid this inconvenience, enable debug support. The server will then reload itself if the code changes. It will also provide a useful debugger to track the errors if any, in the application.

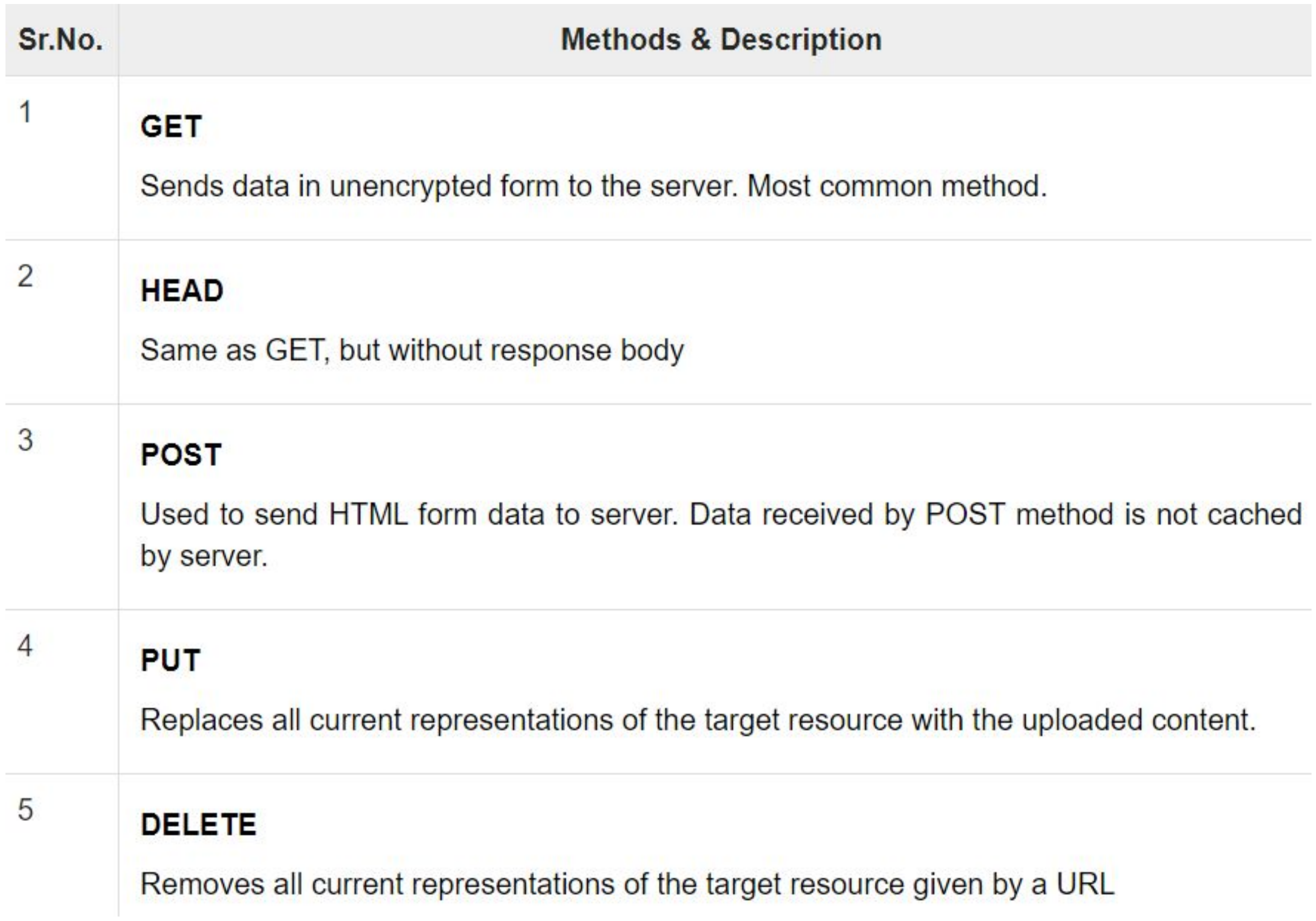
The Debug mode is enabled by **setting the debug property of the application object to True** before running or passing the debug parameter to the run() method.

```
app.run(debug=True)
```

HTTP Methods

HTTP protocol is the foundation of data communication in world wide web. Different methods of data retrieval from specified URL are defined in this protocol.

The following table summarizes different HTTP methods −



Sr.No.	Methods & Description
1	**GET** Sends data in unencrypted form to the server. Most common method.
2	**HEAD** Same as GET, but without response body
3	**POST** Used to send HTML form data to server. Data received by POST method is not cached by server.
4	**PUT** Replaces all current representations of the target resource with the uploaded content.
5	**DELETE** Removes all current representations of the target resource given by a URL

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HTTP Methods

In short, when a user loads your website, a GET request will occur. Whereas, when a user submits some input to get a predicted output, POST request will occur.

The default request Flask responds to is GET request. However, this preference can be altered by providing methods argument to route().

JSON and Jsonify

Remember that we learned about JSON in one of our previous units? Python supports JSON through a built-in package called json.

- **json.loads()** function is used to convert JSON object to dictionary.
- **jsonify()** is a helper method provided by Flask to properly return JSON data.

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flask.request.form

In any web app, you'll have to process incoming request data from users. Flask, like any other web framework, allows you to access the request data easily.

Flask extracts the data from the form with the flask.request.form functionality, which works like a dictionary. We can grab the data we want from the form by referring it to the name. This name will be set in our HTML template, later on.

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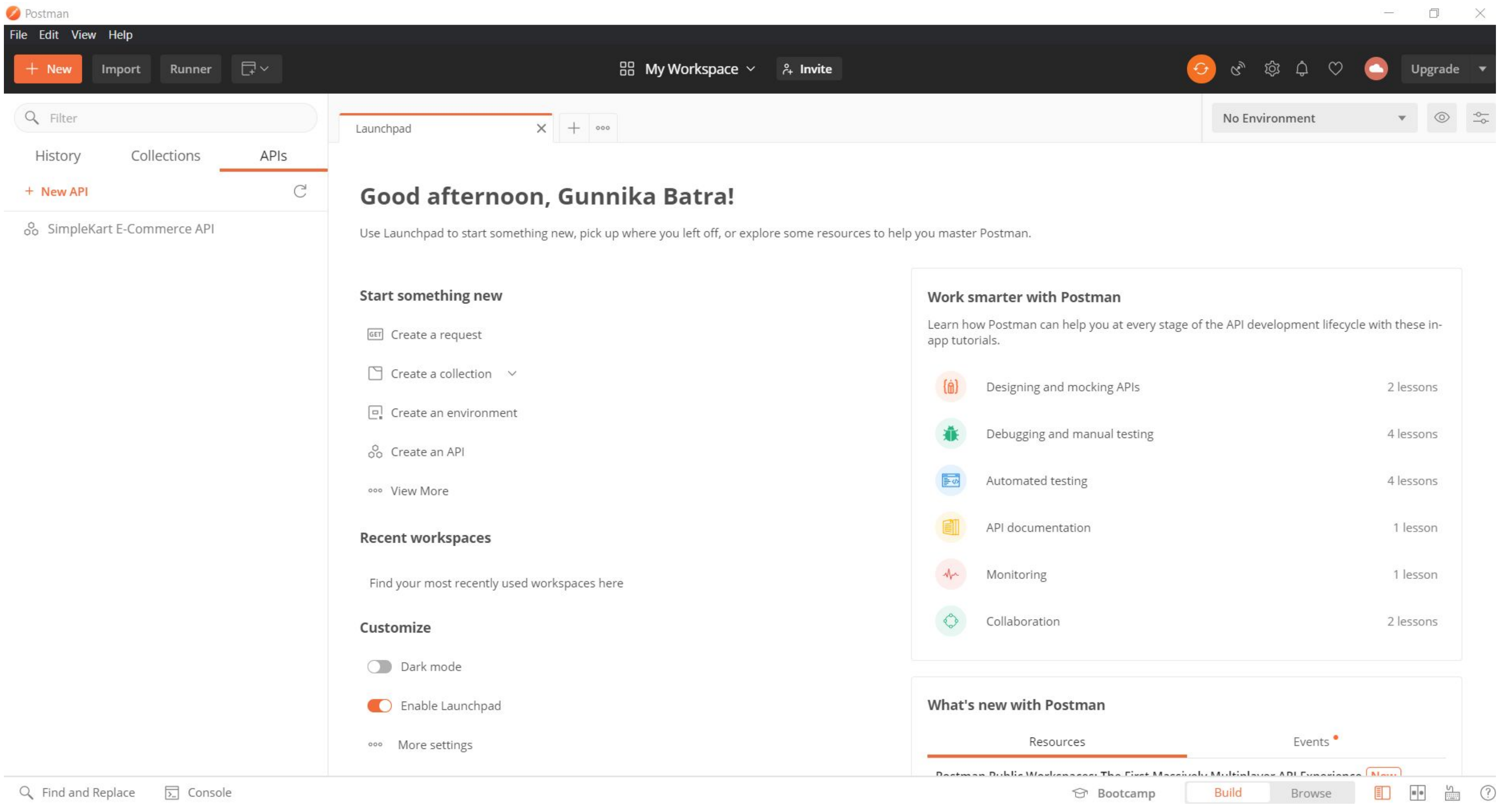
Testing your API in Postman

In order to test your API, you will need some kind of API client.

Postman is undoubtedly one of the best ones out there. You can easily download Postman from here. This is how the Postman application will look like:



Good afternoon, Gunnika Batra!

Use Launchpad to start something new, pick up where you left off, or explore some resources to help you master Postman.

Start something new

- Create a request
- Create a collection
- Create an environment
- Create an API
- View More

Recent workspaces

Find your most recently used workspaces here

Customize

- Dark mode
- Enable Launchpad
- More settings

Work smarter with Postman

Learn how Postman can help you at every stage of the API development lifecycle with these in-app tutorials.

Designing and mocking APIs	2 lessons
Debugging and manual testing	4 lessons
Automated testing	4 lessons
API documentation	1 lesson
Monitoring	1 lesson
Collaboration	2 lessons

What's new with Postman

Resources Events

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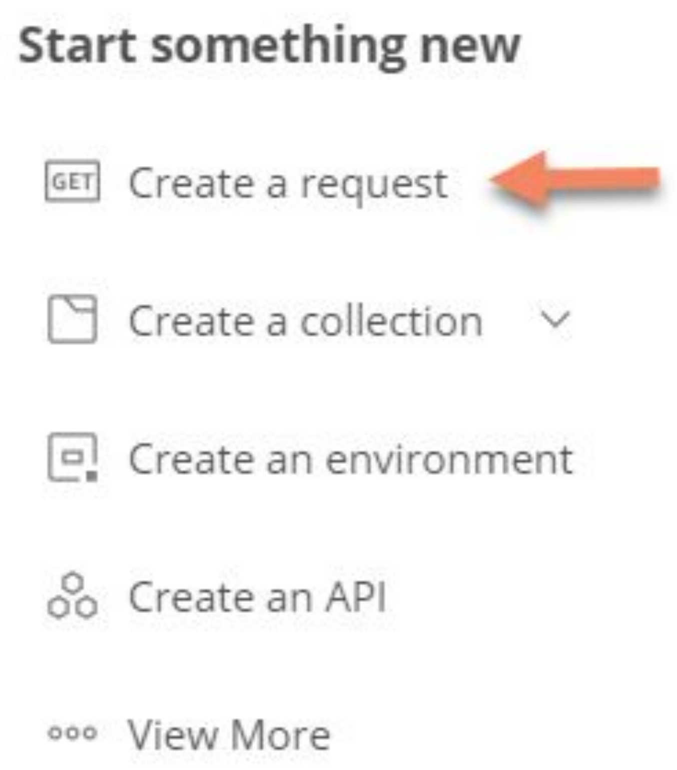
Testing your API in Postman

In order to start providing input in the form of GET or POST request, you need to click on ‘Create a request’ under the “Start something new” section.



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Basic Structure of a Flask web app

The most basic structure of a Flask app looks like this:

```
webapp/
    ├── model/
    │     └── saved model.pkl
    ├── templates/
    │     └── index.html
    └── app.py
```

- Here, webapp is the name of the folder that comprises ALL the files that will be required for the application.

- saved_model.pkl inside the model folder is the model we pickled earlier and that can be directly loaded and used.

- index.html inside templates defines how our website will look like.

- app.py is the main code of the Flask app that defines the URLs at which user can access the app and handles the operations performed by the user by displaying an appropriate result.

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The directory structure

The structure of all the files that'll be used in creating the application for predicting Bengaluru's Home Prices will be somewhat like this:

```
webapp/
    ├── server/
    │    ├── artifacts/
    │    │    ├── banglore_home_prices_model.pickle
    │    │    └── columns.json
    │    ├── server.py
    │    └── util.py
    ├── client/
    │    ├── app.html
    │    ├── app.css
    │    └── app.js
    └── model/
         └── model.ipynb
```

Creating the model folder is completely optional as that won't be required in your application. We'll mainly be working with the server folder in this unit.

Artifacts are nothing but the model you saved as a pickle and the column names you saved as a json file.

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Writing the main logic

We now know how to create a basic Flask app now and have some knowledge about HTTP Methods. We are also equipped with Postman - a tool that'll help us test the API we create.

Now, you'll be completely able to follow along the next video that covers writing the actual Python code that will load our model, get user input from a web form, do predictions and return results. You'll even be testing that out with Postman.

Unless you do it along and create the website on your own, you won't be able to understand it properly. If you get stuck anywhere, we are there to help you out.

You can find all the files created and used in the tutorial here: https://github.com/dphi-official/Micro-Courses/tree/master/Introduction_Model_Deployment/server

Writing the main logic

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Writing the main logic

The functions in `util.py` can also be incorporated inside `server.py` itself. A separate file was created just to make things more organised.

Okay, so what does our API do?

- When a user accesses the **/get_location_names** route, it simply returns all the locations in Bengaluru for whom price predictions can be made.

- When a user accesses the **/predict_home_price** route, it expects the user to fill in some details about the home. After those details are filled in, the API sends those details to the model and generates a prediction. The prediction is then displayed to the user.

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Writing the main logic

Note: You always need to pre-process any input data in the same way you processed your training data.

That is, if you performed scaling on the train data, make sure you scale the inputs as well.

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Congratulations! You just built your first ever machine learning API.

Your API can predict the price of a house in Bengaluru given their total square feet area, location, bhk and no. of bathrooms.

Next, you'll call it from your front-end code and process the output of the API into something fascinating.

References

- https://www.tutorialspoint.com/flask/index.htm
- https://www.datacamp.com/community/tutorials/machine-learning-models-api-python
- https://blog.cambridgespark.com/deploying-a-machine-learning-model-to-the-web-725688b851c7

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Slide Download Link

You can download this unit from the below link:

https://docs.google.com/presentation/d/1QdT83slDrJM__SB7IYUmwi6BfGQMKsjIA7_k5bbAn4I/edit?usp=sharing

That’s it for this unit. Thank you!

Feel free to post any queries on Discuss.

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