Team Asteroid: EV Charging Stations Map

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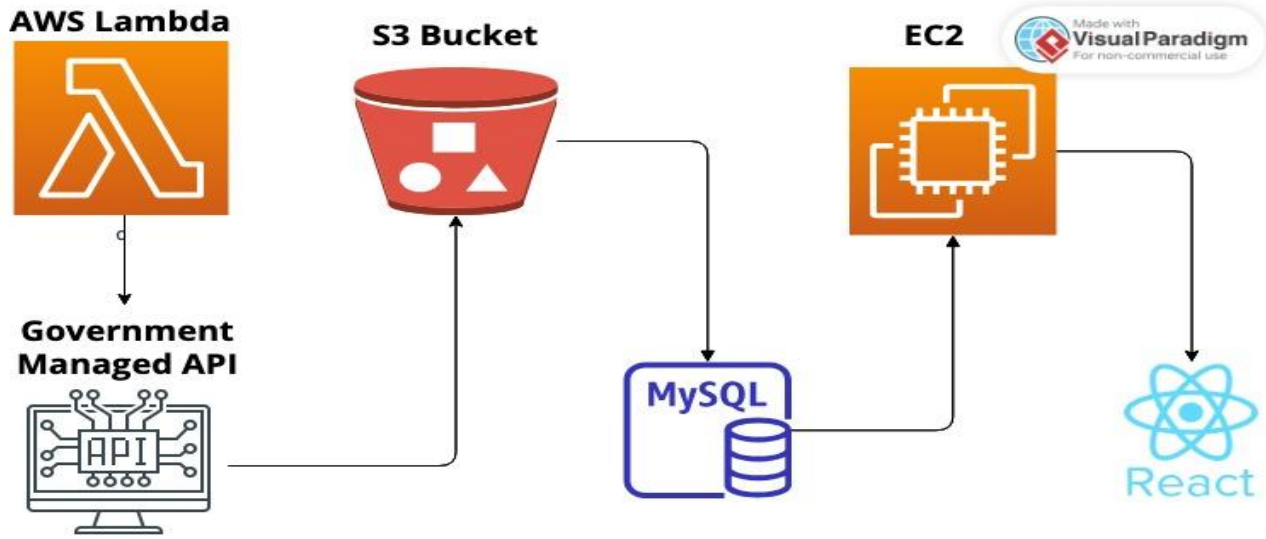
Abstract

Forbes, Ernst & Young, *Wired* agree on one thing: data is the new gold. The need for data has spurred innovations in data engineering (i.e. Snowflake, Kafka, Airflow, etc.) working to get data into a usable format in the least expensive way possible. We wanted to create a project that leveraged common data engineering tools in order to build a useful web application. With this idea we decided to use a common data engineering stack, AWS S3, RDS, Lambda, EventBridge, and StepFunctions to display how you can inexpensively get data into a usable format to power a web application. This displays how clean data powers not only data analysis but other use cases as well. The project pulls from the National Renewable Energy Laboratory API for electric vehicle fuel stations. We then use a front end to prompt the user for a zip code and display the locations and addresses of charging stations located in the zip code. This is done with a web application built in React which leverages Google Maps API.

Architecture

Two lambda functions, APItoS3 and S3toRDS are run using StepFunctions which is triggered by EventBridge Scheduler every 24 hours. APItoS3 calls and moves the data into S3. Then S3toRDS grabs the data from the S3 buckets, changes it to tabular formatting using Python's pandas library and then moves it into MySQL using SQLAlchemy. No version control is used since we only want the most up to date data from the API. The EC2 instance uses nginx for the routing to run the web application using data from the MySQL table. Node.js is used for the backend and API of the web application.



Features

In this section, we describe the features which we used to build our project which has the ability to be used as a pipeline, web application deployment service, or both as we have done with our application.

1. The data pipeline component flows through the following AWS Services: EventBridge → Step Functions → Lambda Function → S3 → Lamba Function → MySQL. This flow can be leveraged for a variety of other use cases. For instance, if we wanted to scale our application to not only show customers EV charging station locations but also other information about the surrounding area, we can use the same steps for other data sources. Our code has the potential to ingest CSV or JSON data. This can also expand to other data types if needed. S3 is used as a dumping ground for all data in its raw format and provides cheap storage should we need it. Finally, the data is cleaned using Python and placed into a MySQL database.
2. The most important piece of this portion of the project is the hosting in the cloud. Once the database is in RDS, the web application can make use of the data in the EC2 instance in a variety of ways, from data analysis, to creating APIs, to targeted advertising, trend prediction and so much more. Hosting a web application on EC2 allows our application to be more failure resistant, cheaper through auto-scaling, and have complete control over instances and who accesses them. The web application part of the code can take a large database of electric vehicle charger locations and return the closest locations through zip code, and can easily be updated to provide even more targeted data through more endpoints, change the data source to a completely different project, or display the data in a different manner.
3. In order to fully make use of the tools described above, a user would need to set up a VPC with access to the RDS from the EC2. Once this is complete, an individual can implement this type of service for their use case.
4. This project can be used with an API to get current, up-to-date data that refreshes daily and only returns the desired fields. Here, we use an API of Electric Vehicle location data to create a web application that displays the closest EV locations to the user.

How it Works

1. Backend
    a. **APItoS3**: The first step in order to begin the project is to create two lambda functions APItoS3 and S3toRDS. These functions leverage the classes Store.py, Ingest.py, and Process.py in order to run. APItoS3 uses an API key from the National Renewable Energy Laboratory and sets parameters to bring in EV charging stations in the USA. A main piece in making this work is

using boto3 to make the connection to the S3 bucket after the API call has completed. Our function needed 1024 MB of memory in order to complete both of these calls because of the large amount of data (~70,000 rows with ~80 columns) being brought in. We also set the timeout to 2 ½ minutes. We also used Python 3.10 as the runtime for the functions as well as the layers.

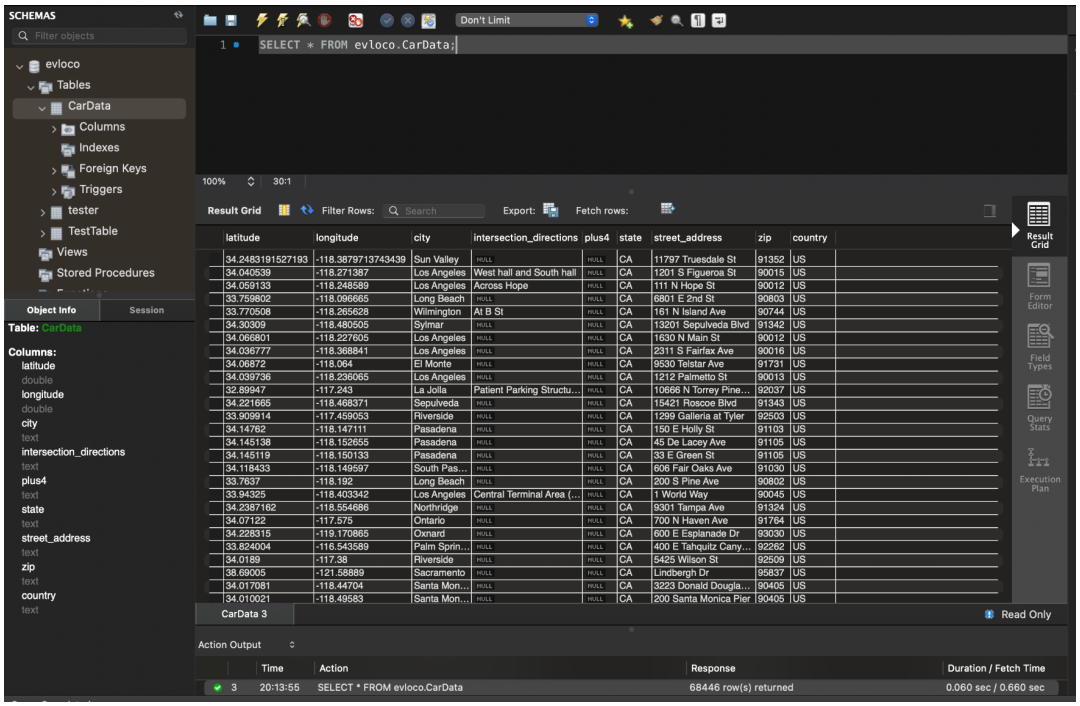
b. **S3toRDS** leverages boto3 as well as pandas and SQLAlchemy in order to take the data, clean it, and move it to a MySQL database. We included these dependencies as Lambda Layers. We also only included the needed nine columns for the web application to run effectively when moving the data to the MySQL database. These are the columns involving latitude, longitude, and address. We decided to overwrite the database as opposed to using version control because we only want the data provided by the most recent API call.
c. The actual code for these functions can be accessed via the public GitHub repo provided at the end of the post.

2. Frontend
    a. EC2 instance hosts web application
        i. An EC2 instance is created for the web application. We used an Ubuntu 20.04 instance with t2.micro.
        ii. The client portion of the React app was built and pushed to the private repository, and was modified to run from starting the backend server with express
        iii. pm2, npm, nginx used
            1. Pm2, a Production Process Manager with a built-in Load Balancer, is used to keep the application running indefinitely. We use it to start our updated backend.
            2. Npm is used to install react dependencies
            3. Nginx is used as a proxy server that handles the routing
        iv. VPC needed between RDS and EC2 instance so that the application can query data from the database
    b. React, Node.js, and express used for web application
        i. Backend
            1. The Node.js and express backend uses express to serve the static build files.
            2. An endpoint queries the database with a SQL query using a mysql connection, taking a zip code as a parameter.
        ii. Frontend/Client in typescript

1. When a user enters a zipcode into the input bar and submits, the event is handled and a function that fetches from the endpoint using the zipcode as a parameter is called.
    a. The URL for the fetch changes depending on the production environment
2. The Google maps api is given the formatted values from the list of data returned and then we create the markers, format and concatenate the data for the info window that shows up when the marker is clicked, create a link that takes the user to the same location on Google Maps, and center the map around the list of EV charger locations.

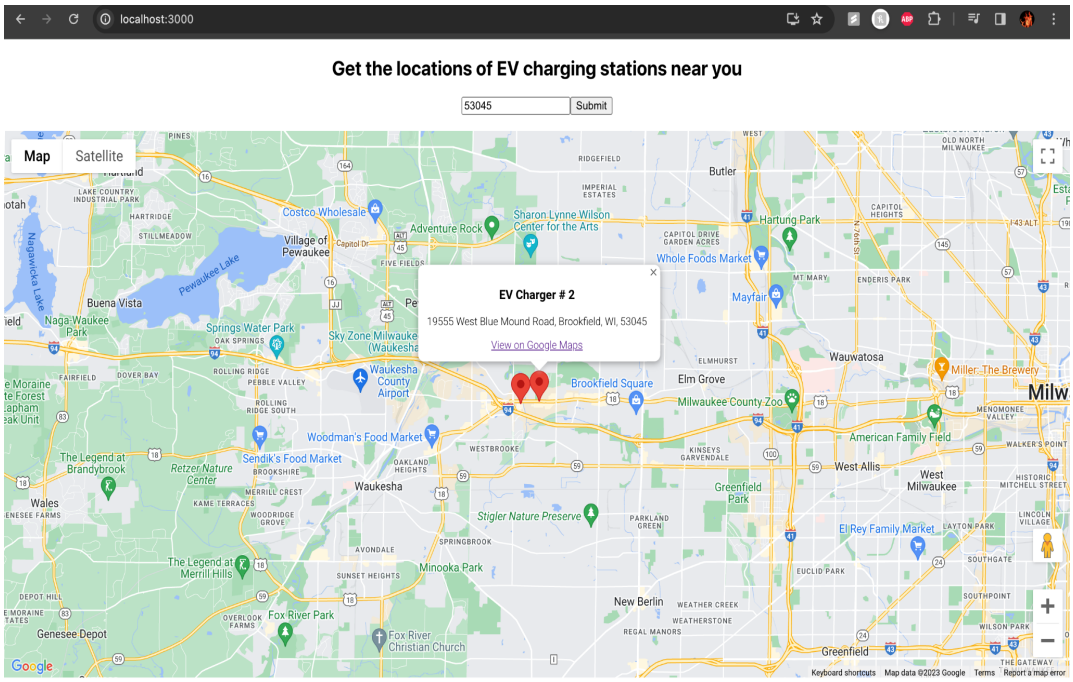
Running the React App locally

1. Once you have the database detailed above, check to make sure you can access it from MySQLWorkbench. You should have over 60 thousand records. You will need this database for the React app to run.



2. The React app can be downloaded and run on your local machine by creating a terminal for the client and backend folder. Navigate to the server.js file in the backend folder and update the mysql connection variable with the ip address of the server running mysql, as well as the username, password, and name of the database. Cd into the respective folders in two separate terminals, run npm install, and then npm run start for both of them. [Get a Google Maps api key] and put it in a .env file.

3. When the React app starts, you will see a search bar and submit button, and when you enter and submit a zip code, a map will show up and be populated with the EV charging station closest to you.



Try it Yourself

Below you will find a link to our public github repo which can be used to download our code as well as instructions with the best way to leverage the code to create a similar application on your own!

A user can adjust the code to run on their local machine quite easily by making use of an .env file. However, since this is for a Cloud Computing course, we will focus on how to use the code to operate on AWS.

1. Download Code from GitHub repo and/or clone it to also make sure you can run the React app.
2. Create API keys for both for the National Renewable Energy Laboratory (https://developer.nrel.gov/signup/) as well as Google Maps API.
3. Create Access Keys and Secret keys for AWS account in order to use boto3 and access S3 buckets
4. Create S3 buckets and MySQL database by chosen names (our code points to the same S3 bucket object each time).
5. Create Lambda functions and put in Environment variables as described in the code for each lambda function.
6. Add in Lambda Layers via the zip files included in the GitHub repo.

7. Create Access Keys for the EC2 instance.
8. Update the environment variables in backend/server.js in order to connect to the MySQL database.
9. Create a .env file with your Google Maps API key.
10. Run npm run build in the client folder.
11. Push to your updated version of the git repository.
12. Create an EC2 instance in the same VPC as MySQL database and connect the instance to the database.
13. Install nginx, pm2, and node.js. Make sure you can see the nginx web page when you are at your instance's ipv4 address.
14. Clone your updated git repository into the instance.
15. Update the .conf file. Check to make sure the syntax is valid.
16. Use pm2 to start the server.js file. Check the logs using pm2 and make sure you can see the log saying that the port is running.
17. Install React code onto EC2 instance and update environment variables in order to connect to the MySQL database.

Link to public GitHub repo: https://github.com/mhangsterfer24/Team-Asteroid