Cloud and API Deployment with Heroku

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Deployment Steps

Step 1: Model Building

Created *Linear Regression Model* that predicts house prices in the City of Hamilton, Ontario (Canada) with Census Tract data.

1. Preparing the Tools

In [1]:
```
# Importing EDA and Plotting Libraries
import pandas as pd
import numpy as np
import geopandas as gpd

# Regression Model for Machine Learning
from sklearn.linear_model import LinearRegression

# Regression Model Tools
from sklearn.model_selection import train_test_split
from sklearn.metrics import mean_squared_error
from sklearn.pipeline import Pipeline

# Model Deployment Tools
from flask import Flask, request, jsonify, render_template
import json
import pickle

# Ignore warnings
import warnings
warnings.filterwarnings("ignore")
```

2. Importing Data

In [2]:
```
# Hamilton House Pricing & Boundary Data
url = "https://raw.githubusercontent.com/gisUTM/GGR376/master/Lab_1/houseValues.geojson"
house_prices_boundaries = gpd.read_file(url)
house_prices_boundaries.head(5)
```

Out[2]:

	CTUID	houseValue	geometry
0	5370001.09	420276.0	POLYGON ((-79.85586 43.18790, -79.85592 43.187...
1	5370120.02	601551.0	POLYGON ((-79.94562 43.16920, -79.94637 43.167...
2	5370140.03	525073.0	POLYGON ((-79.89977 43.33088, -79.89977 43.330...
3	5370140.04	524777.0	POLYGON ((-79.89286 43.32909, -79.89226 43.328...
4	5370001.08	400617.0	POLYGON ((-79.85362 43.19320, -79.85380 43.192...

In [3]:
```
# Hamilton Housing Features Data
house_attributes = pd.read_csv("hamilton_census_data.csv")
house_attributes.head(5)
```

Out[3]:

	CTUID	priv_dwellings_by_bedroom	priv_dwellings_by_rooms	major_repairs	monthly_housing_costs	percent_mortgage	income_after_tax	house_by_pers
0	5370000.00	293345	293345	18370	1294	60.6	66100	
1	5370001.01	760	760	35	1269	57.9	69530	
2	5370001.02	1760	1760	70	1493	70.2	72590	
3	5370001.04	1900	1895	50	1367	59.7	83257	
4	5370001.05	1605	1610	45	1569	65.3	75136	

In [4]:
```
# Merge Features Data & House Pricing/Boundary Data
df = house_prices_boundaries.merge(house_attributes, on = "CTUID")
df.head(3)
```

Out[4]:

	CTUID	houseValue	geometry	priv_dwellings_by_bedroom	priv_dwellings_by_rooms	major_repairs	monthly_housing_costs	percent_mortgage	income_
0	5370001.09	420276.0	POLYGON ((-79.85586 43.18790, -79.85592 43.187...	1390	1390	25	1612	72.3	
1	5370120.02	601551.0	POLYGON ((-79.94562 43.16920, -79.94637 43.167...	690	685	75	1460	55.5	
2	5370140.03	525073.0	POLYGON ((-79.89977 43.33088, -79.89977 43.330...	2505	2505	50	1883	78.3	

3. Data Preprocessing

In [6]:
```
# Split the data into X and y
X = df.drop("houseValue", axis = 1)

y = df["houseValue"]
```

In [7]:
```
# Inspect X
X.head(5)
```

Out[7]:

	priv_dwellings_by_bedroom	priv_dwellings_by_rooms	major_repairs	monthly_housing_costs	percent_mortgage	income_after_tax	house_by_person_per_room
0	1390	1390	25	1612	72.3	78976	139
1	690	685	75	1460	55.5	87211	68
2	2505	2505	50	1883	78.3	98624	250
3	1320	1315	25	1705	63.5	94948	132
4	2050	2050	35	1513	66.7	80576	205

In [8]:
```
# Inspect y
y.head(5)
```

Out[8]:
```
0    420276.0
1    601551.0
2    525073.0
3    524777.0
4    400617.0
Name: houseValue, dtype: float64
```

In [9]:
```
# Set random seed for consistency and reproducibility
np.random.seed(42)

# Split data into train & sets
X_train, X_test, y_train, y_test = train_test_split(X, # independent variables
                                                    y, # dependent variable
                                                    test_size = 0.2) # percentage of data to use for test set

# Sizes of test & training sets
# Sizes of test & training sets
print("The shape of X_train is:", X_train.shape)
print("The shape of X_test is: ", X_test.shape)
print("The shape of y_train is:", y_train.shape)
print("The shape of y_test is: ", y_test.shape)
```

```
The shape of X_train is: (149, 10)
The shape of X_test is:  (38, 10)
The shape of y_train is: (149,)
The shape of y_test is:  (38,)
```

4. Model Building

```
In [10]: # Instantiate Linear Regression Model
         lm_reg = LinearRegression()

         # Fit Model to Training Data
         lm_reg.fit(X_train, y_train)

Out[10]: LinearRegression()
```

```
In [11]: # Obtain Predictions of Model from Training Data
         y_pred = lm_reg.predict(X_test)
         print(y_pred)
```

```
[596387.12803    480896.92267824 476224.5802106  367575.11673828
 351865.10308534 456056.27568041 192322.88930761 259228.3522551
 375951.18284039 452391.01240462 408266.73433746 284941.20311671
 506087.78903799 342262.56313031 419726.11973444 384849.97199765
 444869.90434751 478481.94049903 196444.74973795 283961.41623627
 489293.36258692 430700.39853896 601440.69392218 380113.38579982
 304920.81985184 850140.29680267  13538.43240843 403399.53371897
 344473.79676943 478111.17279516 375967.31249919 699060.43153693
 297323.75558971 464661.57886319 368901.60541925 273769.63600779
 556244.11125234 496297.49030709]
```

Step 2: Saving Model

Saved trained *Linear Regression Mode*l to local device using *Pickle* and re-imported model to test predictions with mock-data.

5. Saving the Model

```
In [12]: # Save Model as Pickle File to Local Device
         pickle.dump(lm_reg, open('model.pkl', 'wb'))
```

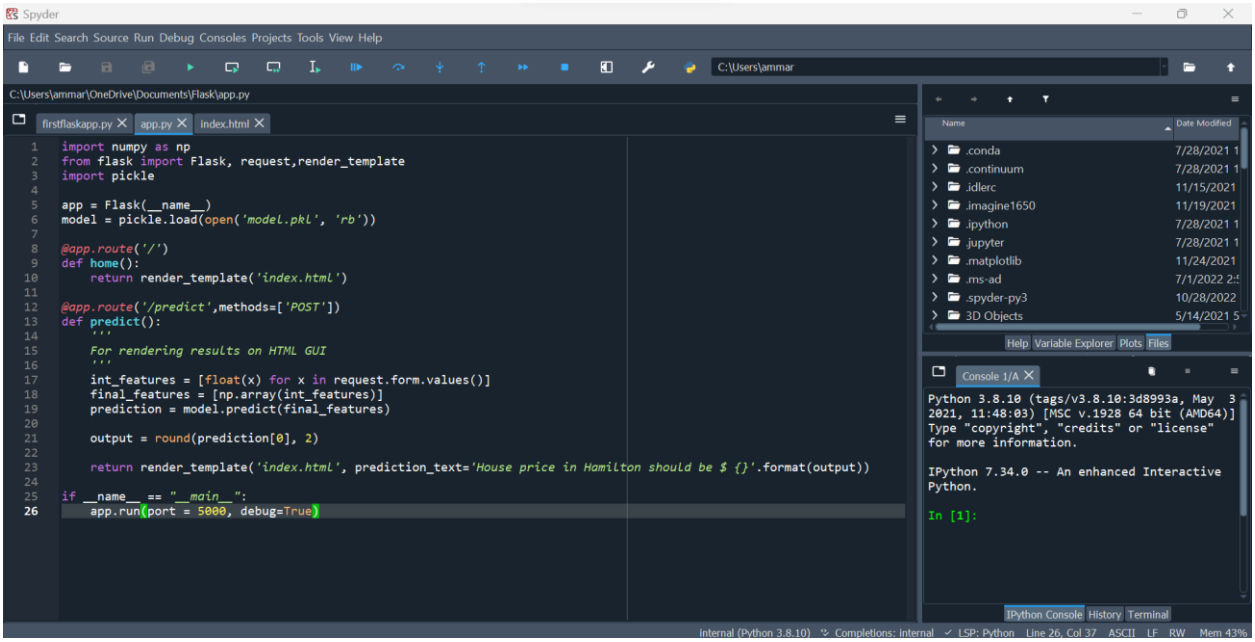
```
In [13]: # Load Linear Regression Model
         lm_model = pickle.load(open('model.pkl','rb'))

         # Test Model Predictions with Dummy Data
         print(lm_model.predict([[1390, 1390, 25, 1612, 72.3, 78796, 1395, 3.3, 4566, 1.97]]))
```

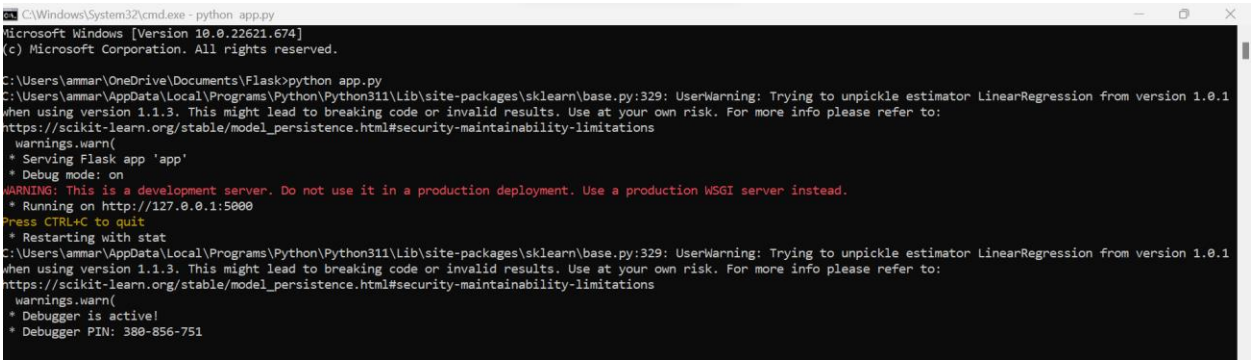
```
[439013.16362958]
```

Step 3: Model Deployment with Flask

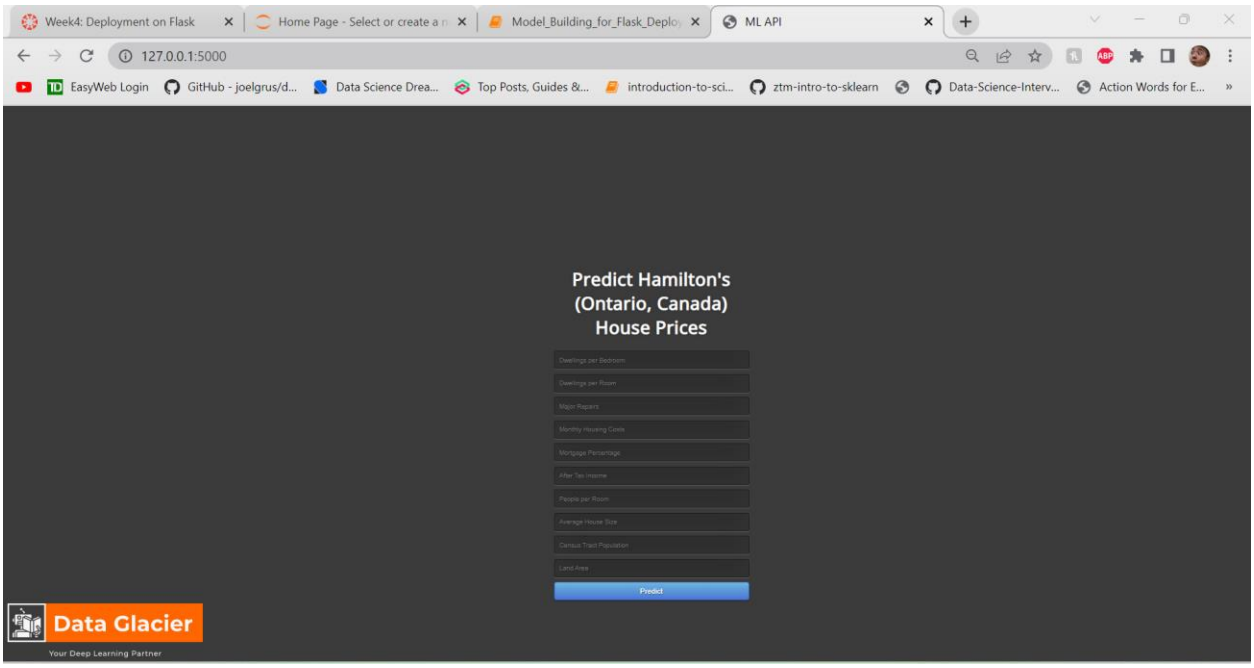
Created a *Flask script* to deploy the model by allowing users to input Hamilton house features and submit their input by pressing the *'Predict'* button to receive a prediction of the house's price.



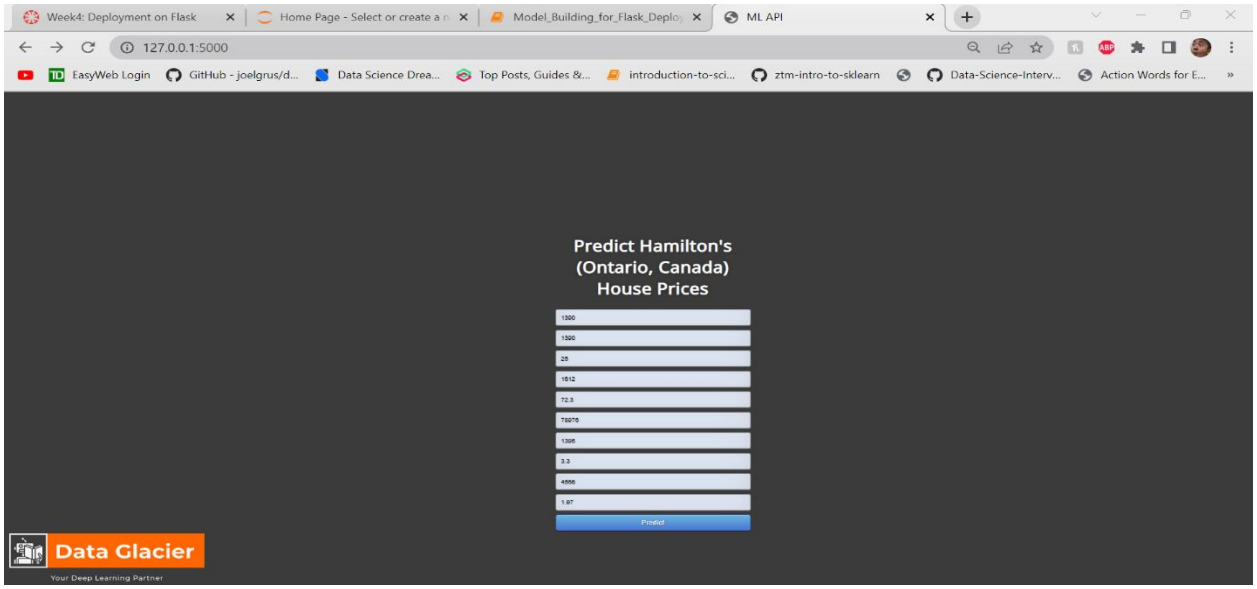
Step 4: Acquiring Flask App's URL from CMD



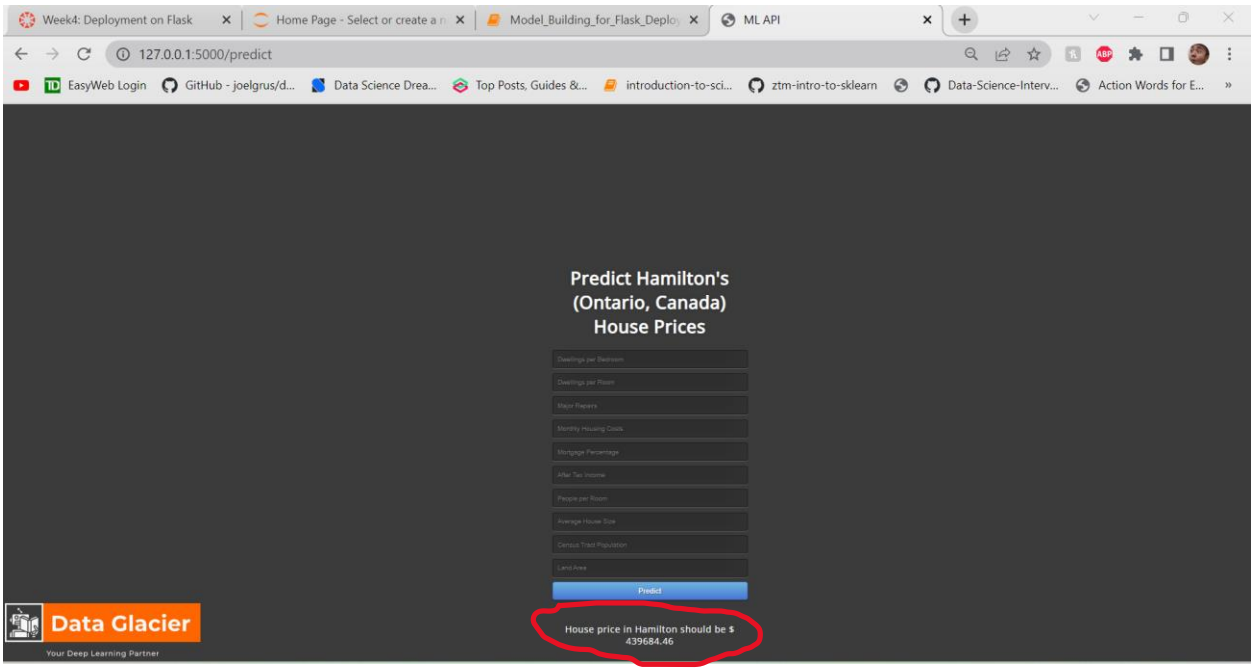
Step 5: Inputting URL to Create Flask Web App



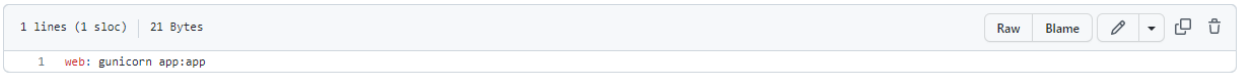
Step 6: Inputting House Features for Predictions



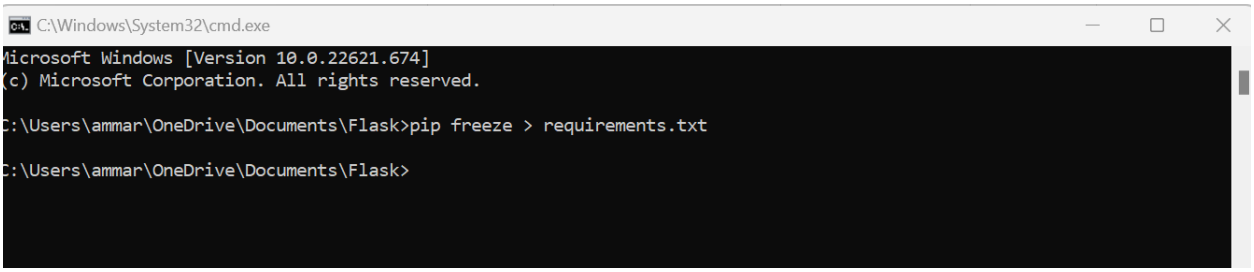
Step 7: Acquire Predictions by Pressing Prediction Button

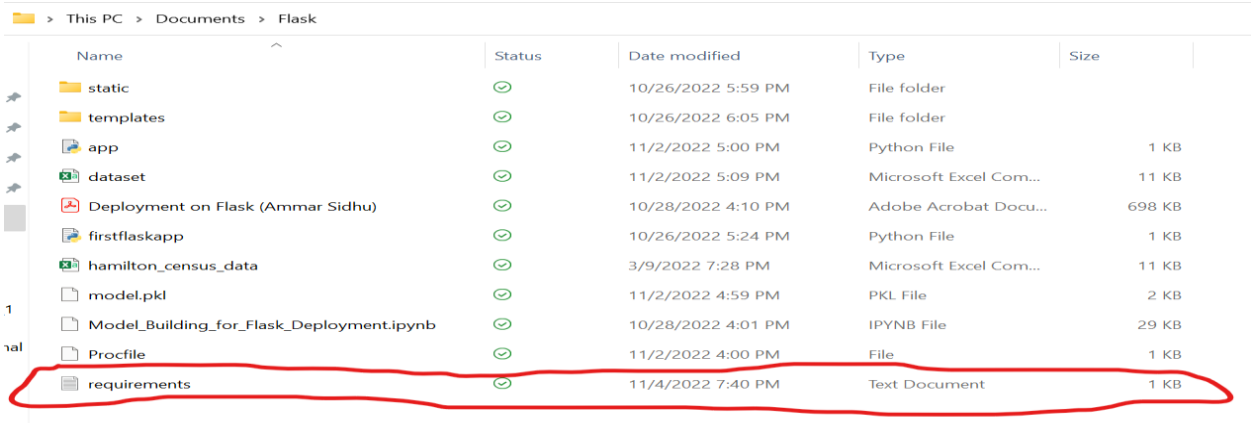


Step 8: Create Procfile for Heroku App to Execute

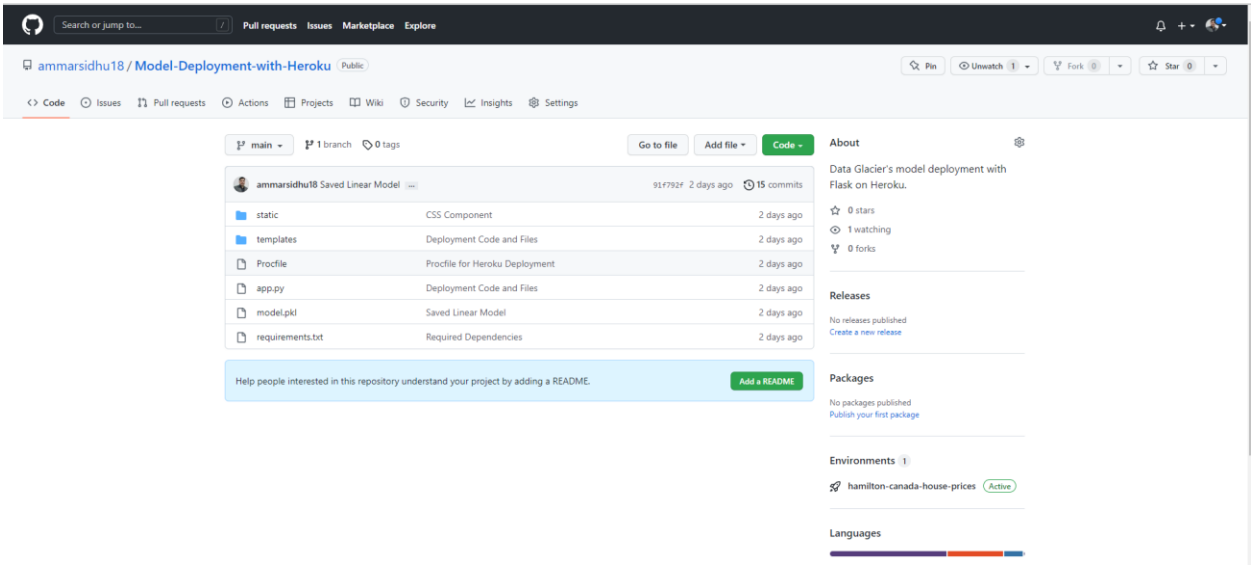


Step 9: Create .txt file containing required Packages for Flask App

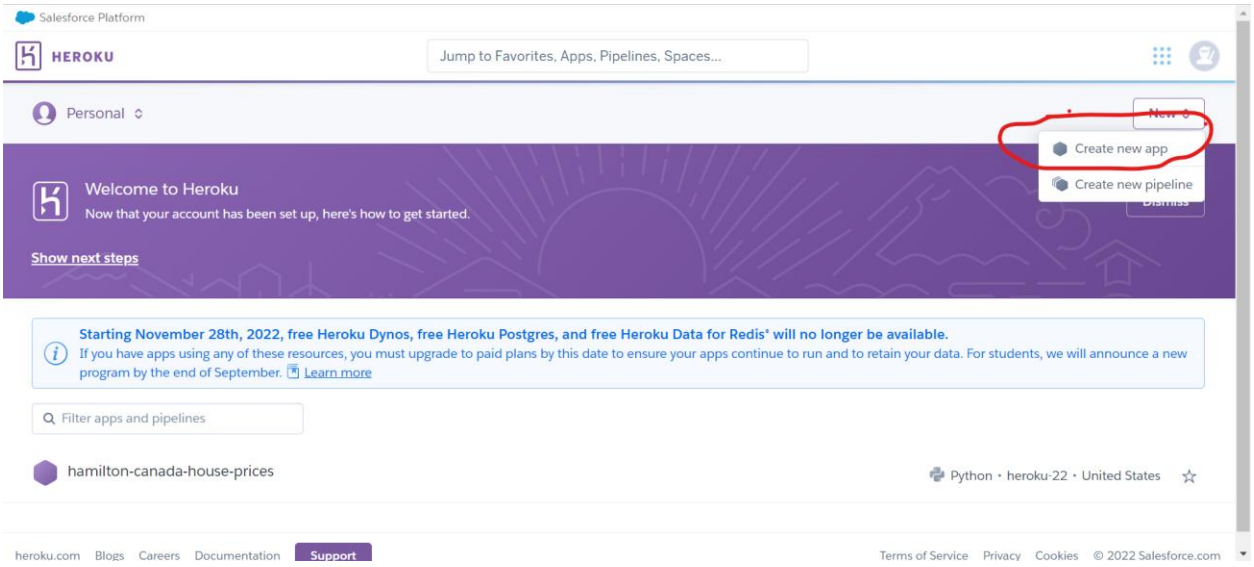




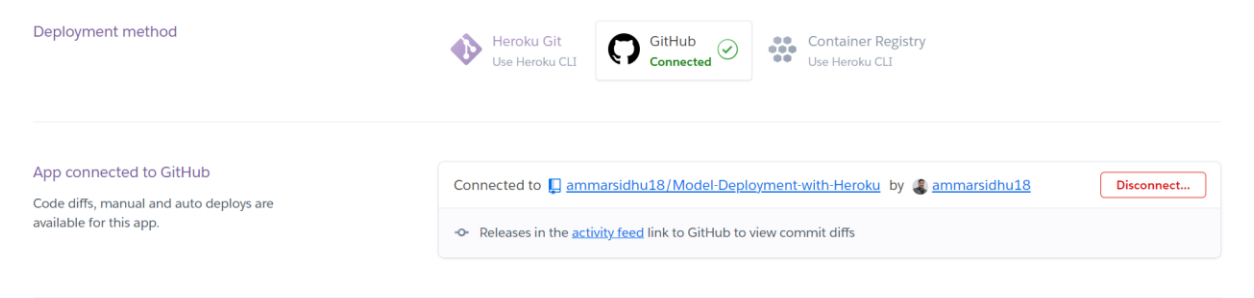
Step 10: Create Github Repository with Flask Code and Deployment Files



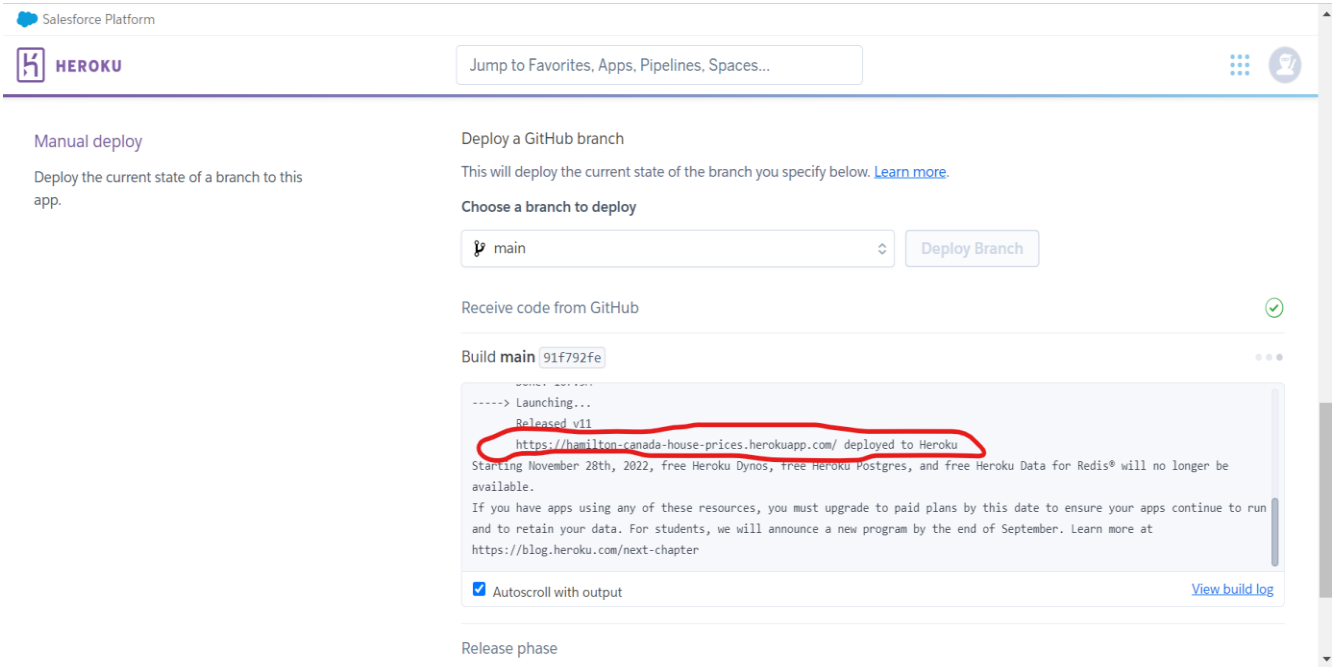
Step 11: Create a Heroku App on Heroku Website



Step 12: Link Github Repo to App



Step 13: Deploy Flask App on Heroku



Step 14: Copy Deployed URL and Paste on New Tab to View and Test App