Report
House Price Prediction

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Data and Description

A dataset containing information on house prices and features such as bedrooms, bathrooms, house area, main road connection, etc., was utilized for the house price prediction task. The dataset is accessible on Kaggle. Minimal cleaning and preprocessing were necessary as it didn't contain any missing values or outliers. Categorical variables were transformed into dummy variables to facilitate regression analysis. For the purposes of the analysis, price is the target variable and all other housing related variables are the features.

Exploratory data analysis

Initial visualizations and summary statistics were generated to get a sense of the spread of the data and most importantly identify any outliers. The histograms in figure 1 show the skegness and spread of continuous variables. There seems to be a left skewness to the data but no apparent outliers.

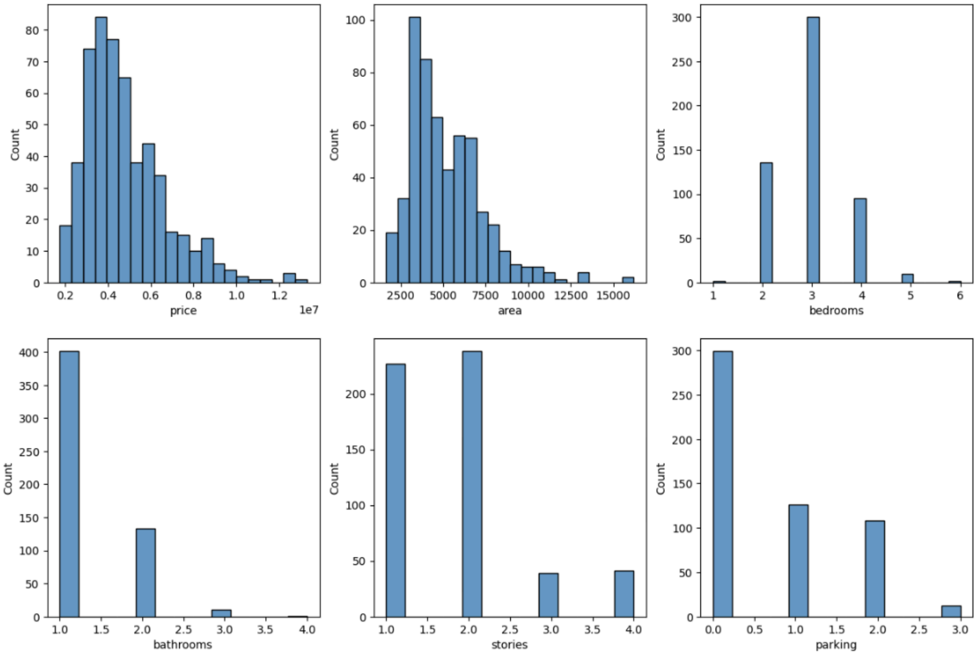


Figure: Histograms of numerical variables

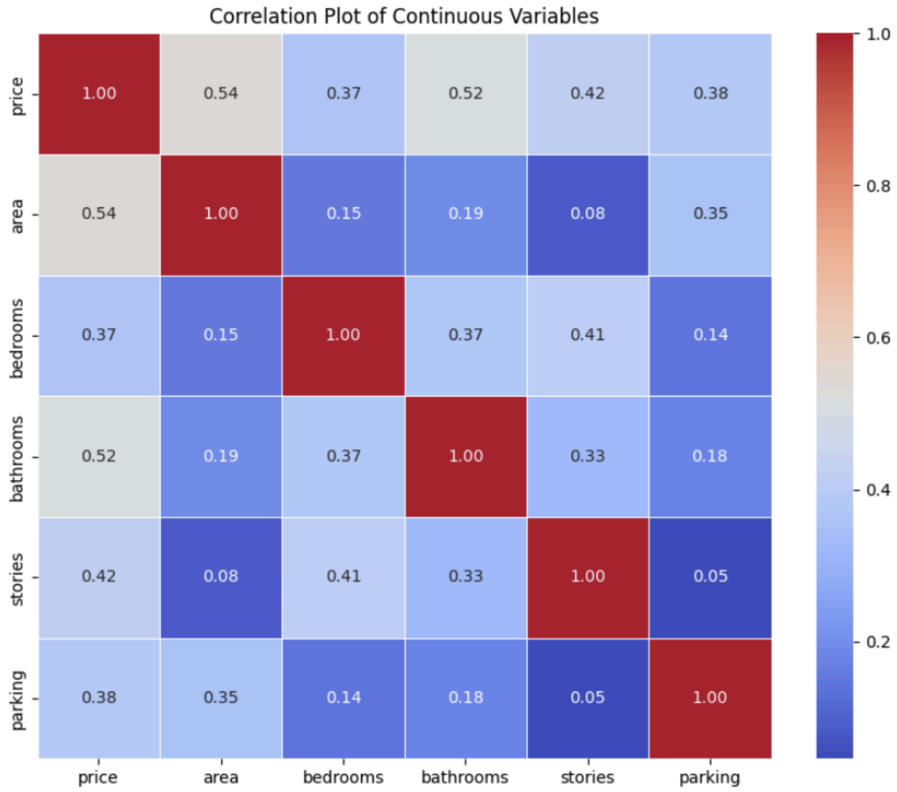


Figure 2: Correlation heatmap

Figure 2 shows the correlation between the numerical variables. Area and bathrooms have the highest positive correlation with the target variable.

Model Building

Notebook link

Approach

For regression, I decided to use a **Random Forest Regressor**. Post pre-processing of the data, a random forest regressor model was fitted into the data. The metrics were logged using MLflow for tracking and logging. For MLflow set-up instructions outlined in lab1 ‘MLflow Tracking Quickstart’ notebook were followed. The final parameters used for random forest are:
n_estimators: 50, max_depth: 25, max_features: sqrt

Model Comparison

The model was compared with two other models, one from the Zillow’s Home Value Prediction (Zestimate) Kaggle Competition and another from the GitHub repository on house price prediction models.

The specific parameters and details of the chosen models are:

1. **Lasso**(alpha=1e-6, normalize=True). https://www.kaggle.com/code/flennerhag/ml-ensemble-scikit-learn-style-ensemble-learning
2. **XGBRegressor**(n_estimators=900, learning_rate=0.04, n_jobs=4) https://github.com/vaibhavvikas/housing-price-predictor/tree/main

All three models were trained and the experiments were logged in a registry. Learning to work with MLflow was a steep learning curve. Having never worked with it before, getting started was challenging, but having worked on this project alone with three models, I appreciate its utility.

Model Performance and Evaluation

The chosen performance metric or loss function used to compare across models was the mean absolute error (MAE). MAE represents the average of the absolute differences between the predicted values and the actual values. Selecting MAE as the loss function emphasizes minimizing this difference as much as possible to identify the best model.
An interesting insight was the relatively poorer performance of XGBoost. In theory, XGBoost should outperform Lasso, which is a linear model. However, Lasso exhibited the lowest MAE. This underscores the importance for data scientists to begin with simpler models as potential baselines, as they can sometimes perform exceptionally well for specific datasets.

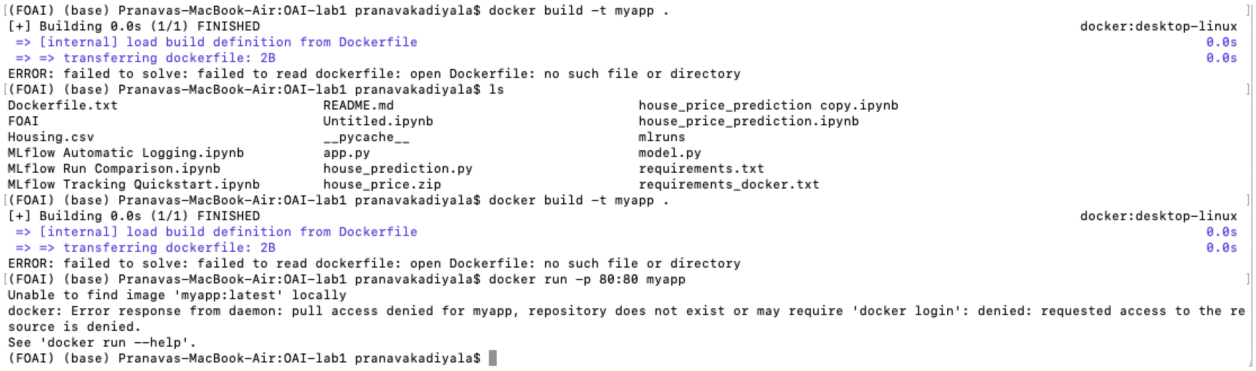
MAE for the three models:

Lasso:	820399.213
Random Forest Regressor:	821864.124
XGBoost:	927498.900

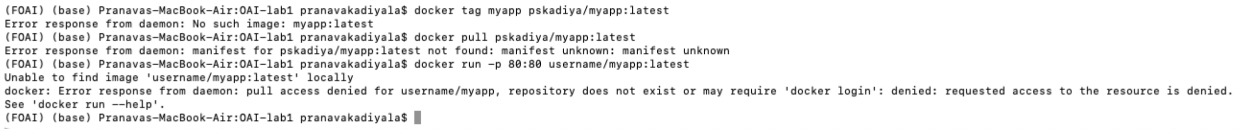
Docker

Unfortunately, I couldn’t use Docker to containerize. However, I highlight my steps below and provide context for my errors.

First, I generated a python script with the best model and the best parameters. Similar to the lab, I defined the generate_plot_metrics function which returns the metrics of choice - MAE in the house_prediction.py file. For the model, another app.py script created for displaying the metrics and generating a graph plotting the actual price against the predicted price. A Dockerfile and requirement files were also generated, and the necessary commands from the lab instructions were executed. However, during this process, the following errors were encountered:

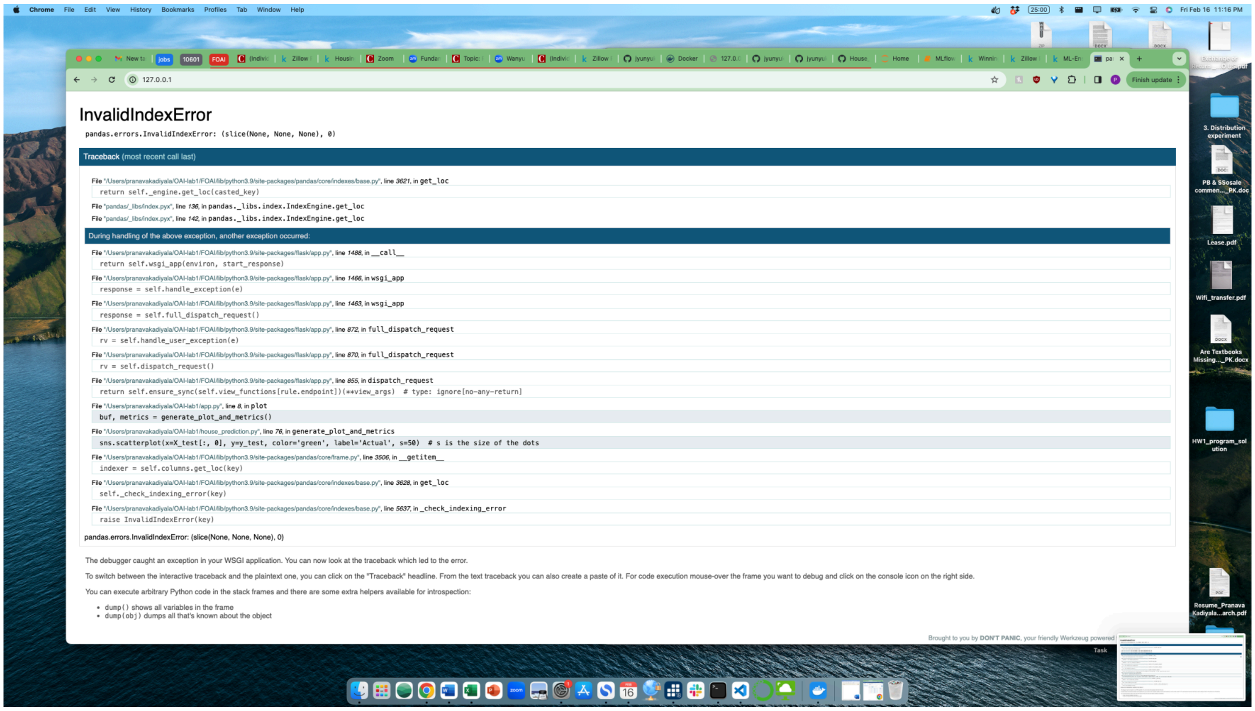


```
(FOAI) (base) Pranavas-MacBook-Air:OAI-lab1 pranavakadiyala$ docker build -t myapp .
[+] Building 0.0s (1/1) FINISHED                                                                    docker:desktop-linux
 => [internal] load build definition from Dockerfile                                                                0.0s
 => => transferring dockerfile: 2B                                                                                  0.0s
ERROR: failed to solve: failed to read dockerfile: open Dockerfile: no such file or directory
(FOAI) (base) Pranavas-MacBook-Air:OAI-lab1 pranavakadiyala$ ls
Dockerfile.txt                          README.md                               house_price_prediction copy.ipynb
FOAI                                    Untitled.ipynb                          house_price_prediction.ipynb
Housing.csv                             __pycache__                             mlruns
MLflow Automatic Logging.ipynb          app.py                                  model.py
MLflow Run Comparison.ipynb             house_prediction.py                     requirements.txt
MLflow Tracking Quickstart.ipynb        house_price.zip                         requirements_docker.txt
(FOAI) (base) Pranavas-MacBook-Air:OAI-lab1 pranavakadiyala$ docker build -t myapp .
[+] Building 0.0s (1/1) FINISHED                                                                    docker:desktop-linux
 => [internal] load build definition from Dockerfile                                                                0.0s
 => => transferring dockerfile: 2B                                                                                  0.0s
ERROR: failed to solve: failed to read dockerfile: open Dockerfile: no such file or directory
(FOAI) (base) Pranavas-MacBook-Air:OAI-lab1 pranavakadiyala$ docker run -p 80:80 myapp
Unable to find image 'myapp:latest' locally
docker: Error response from daemon: pull access denied for myapp, repository does not exist or may require 'docker login': denied: requested access to the re
source is denied.
See 'docker run --help'.
(FOAI) (base) Pranavas-MacBook-Air:OAI-lab1 pranavakadiyala$ 
```



```
(FOAI) (base) Pranavas-MacBook-Air:OAI-lab1 pranavakadiyala$ docker tag myapp pskadiya/myapp:latest
Error response from daemon: No such image: myapp:latest
(FOAI) (base) Pranavas-MacBook-Air:OAI-lab1 pranavakadiyala$ docker pull pskadiya/myapp:latest
Error response from daemon: manifest for pskadiya/myapp:latest not found: manifest unknown: manifest unknown
(FOAI) (base) Pranavas-MacBook-Air:OAI-lab1 pranavakadiyala$ docker run -p 80:80 username/myapp:latest
Unable to find image 'username/myapp:latest' locally
docker: Error response from daemon: pull access denied for username/myapp, repository does not exist or may require 'docker login': denied: requested access to the resource is denied.
See 'docker run --help'.
(FOAI) (base) Pranavas-MacBook-Air:OAI-lab1 pranavakadiyala$ 
```

I also get this error when trying to run app.py.


Chrome File Edit View History Bookmarks Profiles Tab Window Help
Fri Feb 16 11:16 PM
127.0.0.1
Finish update

InvalidIndexError

```
pandas.errors.InvalidIndexError: (slice(None, None, None), 0)
```

Traceback (most recent call last)

```
File "/Users/pranavakadiyala/OAI-lab1/FOAI/lib/python3.9/site-packages/pandas/core/indexes/base.py", line 3621, in get_loc
  return self._engine.get_loc(casted_key)
File "pandas/_libs/index.pyx", line 136, in pandas._libs.index.IndexEngine.get_loc
File "pandas/_libs/index.pyx", line 142, in pandas._libs.index.IndexEngine.get_loc
```

During handling of the above exception, another exception occurred:

```
File "/Users/pranavakadiyala/OAI-lab1/FOAI/lib/python3.9/site-packages/flask/app.py", line 1488, in __call__
  return self.wsgi_app(environ, start_response)
File "/Users/pranavakadiyala/OAI-lab1/FOAI/lib/python3.9/site-packages/flask/app.py", line 1466, in wsgi_app
  response = self.handle_exception(e)
File "/Users/pranavakadiyala/OAI-lab1/FOAI/lib/python3.9/site-packages/flask/app.py", line 1463, in wsgi_app
  response = self.full_dispatch_request()
File "/Users/pranavakadiyala/OAI-lab1/FOAI/lib/python3.9/site-packages/flask/app.py", line 872, in full_dispatch_request
  rv = self.handle_user_exception(e)
File "/Users/pranavakadiyala/OAI-lab1/FOAI/lib/python3.9/site-packages/flask/app.py", line 870, in full_dispatch_request
  rv = self.dispatch_request()
File "/Users/pranavakadiyala/OAI-lab1/FOAI/lib/python3.9/site-packages/flask/app.py", line 855, in dispatch_request
  return self.ensure_sync(self.view_functions[rule.endpoint])(**view_args)  # type: ignore[no-any-return]
File "/Users/pranavakadiyala/OAI-lab1/app.py", line 8, in plot
  buf, metrics = generate_plot_and_metrics()
File "/Users/pranavakadiyala/OAI-lab1/house_prediction.py", line 76, in generate_plot_and_metrics
  sns.scatterplot(x=X_test[:, 0], y=y_test, color='green', label='Actual', s=50)  # s is the size of the dots
File "/Users/pranavakadiyala/OAI-lab1/FOAI/lib/python3.9/site-packages/pandas/core/frame.py", line 3506, in __getitem__
  indexer = self.columns.get_loc(key)
File "/Users/pranavakadiyala/OAI-lab1/FOAI/lib/python3.9/site-packages/pandas/core/indexes/base.py", line 3628, in get_loc
  self._check_indexing_error(key)
File "/Users/pranavakadiyala/OAI-lab1/FOAI/lib/python3.9/site-packages/pandas/core/indexes/base.py", line 5637, in _check_indexing_error
  raise InvalidIndexError(key)
pandas.errors.InvalidIndexError: (slice(None, None, None), 0)
```

The debugger caught an exception in your WSGI application. You can now look at the traceback which led to the error.

To switch between the interactive traceback and the plaintext one, you can click on the "Traceback" headline. From the text traceback you can also create a paste of it. For code execution mouse-over the frame you want to debug and click on the console icon on the right side.

You can execute arbitrary Python code in the stack frames and there are some extra helpers available for introspection:

- dump() shows all variables in the frame
- dump(obj) dumps all that's known about the object

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