House Prediction using Both Images and Textual Information

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Abstract— **House market plays an important role in shaping the economy. Recent studies shows there has been increase in sales rate of houses. In this project we propose an automatic house price prediction that can help retailers and customers to make a decision. The traditional methods involved use of textual information like area, its neighbourhood, no of bedrooms etc. In this project we propose finding an estimation using categorical , numerical as well as visual (images) dataset. We will make use of keras architecture that accepts multiple inputs and data. We will combine both textual and visual inputs and train a model which has input as mixed data.**

Keywords— **Regression, CNN, Neural network, Keras Functional API**

I. Introduction

Increase in Sales and construction of the new houses leads to increase the economy plans. It is very important that we improve analysis of prices of houses which can help us to improve the market demand. [1] Moreover, the housing sector acts as a vital indicator of both the economy's real sector and the assets prices which help forecast inflation and output. Recent studies in Artificial intelligence and Machine learning has shown the tremendous improvements in shaping the economy. House price prediction is one the problems we are trying to solve in this paper. Predicting house prices is quite difficult because of its geographical areas and also the taking in perspective of its physical locations. Previous studies has demonstrated this problem using only textual attributes of the houses . In this paper we are combining the textual attributes with the images of houses to make better analysis for house price prediction. In this we are using a Houses dataset[2] which has both images and textual information which is used for estimating prices. It is open source dataset for research purposes.

II. Problem Formulation

In artificial intelligence curriculum, we learned different models regression and classification. We studied many models with categorical data, text data. We implemented CNN for image classification. We never implemented such a model that has capability of taking all these inputs at same time. In this project we briefly review how to combine these inputs and train our model on mixed data inputs. We will do comparison of all models and make a judgment whether adding visual images for houses was useful or not to predict prices.

Our dataset consists of the images of the houses. Each house is represented by both visual and textual data. The visual data is a set of 4 images which include frontal image of the house, the bedroom, the kitchen and the bathroom.

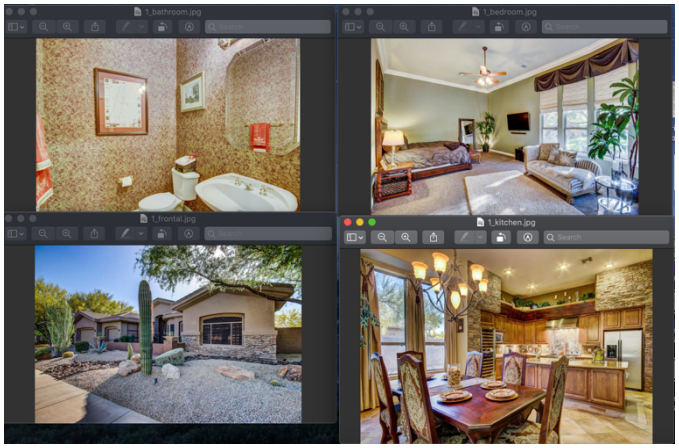

Fig. 1 Example of Images of house

The textual dataset consists of the attribute such as number of bedrooms and bathroom in which zip code it is located, and area covered by the house.

	Bedrooms	Bathrooms	area	zipcode	price
0	4	4.0	4053	85255	869500.0
1	4	3.0	3343	36372	865200.0
2	3	4.0	3923	85266	889000.0
3	5	5.0	4022	85262	910000.0
4	3	4.0	4116	85266	971226.0

Fig. 2 Textual attributes of houses

III. System / Algorithm Design

In this project we used following approach to design our algorithm for house price prediction

A. The first phase will be a neural network designed to handle the categorical/numerical inputs.

1) *Neural Networks:* We will be implementing the neural network to trail numerical and categorical data because Neural network offer a number of advantages which includes requiring less formal statistical training, ability to

detect all possible interactions between predictor variables and the availability of multiple training algorithms.

B. The second phase will be a Convolutional Neural Network to operate over the image data.

1) Convolution Neural Networks: For training the image data we will be using CNN model, As CNN performance well and it gives better accuracy. It covers local and global features. It also learns different features from images. CNN recognizes the components of an image (e.g., lines, curves, etc.) and then learn to combine these components to recognize larger structures (e.g., faces, objects, etc.)

C. These two phases will then be concatenated together to form the final multi-input Keras model.

1) Keras Functional API: Keras can multiple inputs using functional API. In neural networks, Convolutional neural network is responsible for images classifications. Objects detections, recognition faces etc., In this project we are using the dataset which not only includes numerical and categorical data, but image data as well — we call multiple types of data mixed data as our model needs to accept that are not of the same type and compute prediction on these inputs. For this we need to define the keras model which will be capable of accepting the multiple input which include numerical, categorical and image data at same time. Train an end-to-end model on the mixed data inputs. Evaluate our model using the multi-inputs.

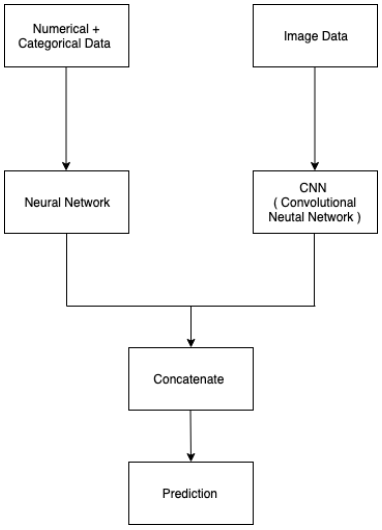

Fig. 3 System Design

IV. Experimental Evaluation

A. These two phases will then be concatenated together to form the final multi-input Keras model.

1) Using text/categorical data for model prediction:

Initially we processed dataset using attributes like Bedrooms, bathrooms, zipcode, area and price. We did data preprocessing as follows:

- For all missing values of price column we inserted the mean values
- Applying one hot encoding to zip code column.
- Split the data for training and testing.

We implemented neural network model .

2) Using text/categorical data and images model prediction:

We initially concatenated all four images (bedrooms , bathroom , images , frontal) into one image shown in figure 5.

```
[ ]  for i in  images_output:
         from matplotlib import pyplot as plt
         plt.figure(figsize=(16,6))
         plt.imshow(i, interpolation='nearest')
         plt.show()
```

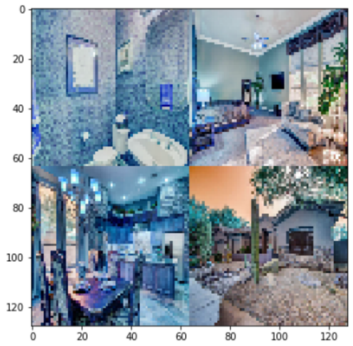

Fig. 5 Concatenated image after processing

Fig 6 is the detail implementation of layers used and design of model.

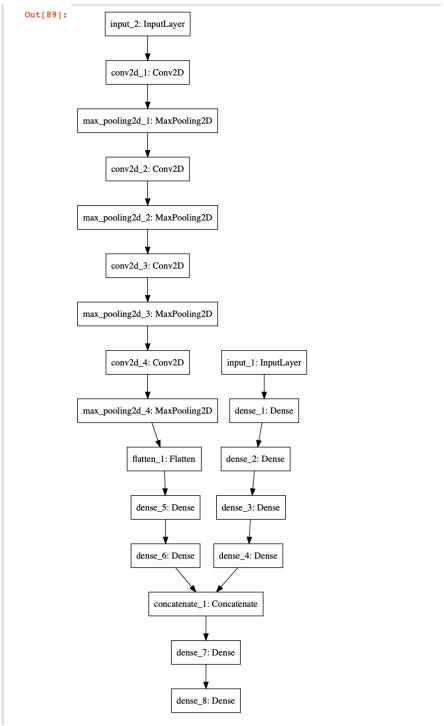

Fig. 6 CNN + NEURAL NETWORK

D. *Results*

No	Analysis of Mix data		
	Model	**RMSE**	**R2 score**
1	Using prices between 50000 to 900000	28.4275	0.99
2	After removing outliers	2.08	0.99
3	Using textual data	116488.2	0.61

Regression chart

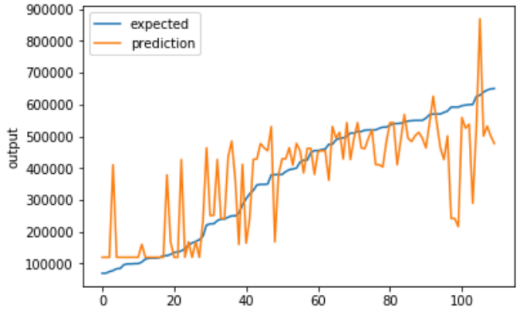

Fig. 5 Regression chart for text/categorical model prediction

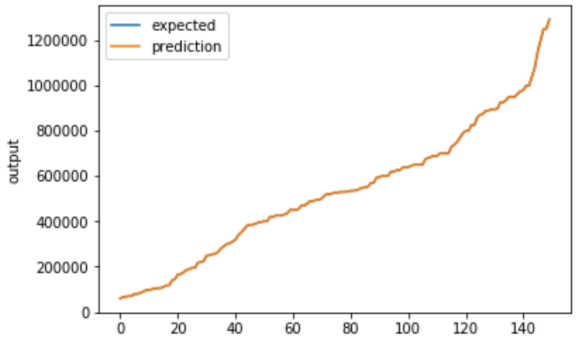

Fig. 5 Regression chart for text and images model prediction

V. Related Work

A. *Problems and Methods Used*

Their problem is to predict housing prices based on visual features and textual features. In their approach, they use SURF(Speeded Up Robust Features) feature extraction technique to find image features. To complete model is developed using SURF features and textual features followed by normalization. The same process is applied to develop SVR and NN models.

B. *Problems and Methods Used in our project*

Our problem is to tackle the same issue that is to find the closest estimate cost of a particular house using various features. We are using 4 house images for each house representation (bedroom, bathroom, frontal and kitchen)Moreover, we have successfully combined images and their features and developed a combined model using a fully connected neural network, and CNN.

C. *Difference between the two approaches used*

In our approach rather than using SURF technique to identify image features, we are using CNN to train our model on image feature dataset. Further, we combine this model with NN having textual features to get our final model. For this, we have used keras functional API.

VI. Conclusions

Successfully implemented AI model using keras functional API to predict housing prices based on image and textual dataset. Moreover, we concluded that our model with both images and textual data performs better than model developed using just text data.

VII. Work Division

- Data Pre Processing : Combine Efforts
- Textual Prediction with Neural Network: Rutvik
- Image Prediction with CNN : Riya
- Mix Input with Function api: Combine Efforts
- Data Analysis to improve model: Combine Efforts

VIII. Learning Experience

We learned various learning experiences throughout the development of the project. First understanding two different datasets images and textual data to visualize how our final model will look like was a challenging task as we have never combined these models in prior projects.

Understanding data and doing some exploratory data analysis was the key to achieve the desired result in our project. Learning keras functional API was fun to learn as we deeply researched each component of it from the documentation and based on our understanding tested different approaches.

We learned a lot from our mistakes done during project development and with the professor guidance, we were able to understand the the whole process very thoroughly and successfully complete the project with desired results.

References

[1] H. Ahmed E. and Moustafa M. (2016). “House Price Estimation from Visual and Textual Features”. In Proceedings of the 8th International Joint Conference on Computational Intelligence (IJCCI 2016)ISBN 978-989-758-201-1, pages 62-68. DOI: 10.5220/0006040700620068

[2] https://github.com/emanhamed/Houses-dataset

[3] https://machinelearningmastery.com/keras-functional-api-deep-learning/

[4] https://campus.datacamp.com/courses/advanced-deep-learning-with-keras-in-python/the-keras-functional-api?ex=1