Term Project CSCI 4360, Housing Market Forecasting

Ayush Kumar, Faisal Hossain, Brandon Amirouche

April 27, 2021

Contents

1 Problem Statement: Forecasting Housing Market **2**

2 The Datasets **2**

3 Preprocessing Techniques **2**
3.1 Zillow Data 2
3.2 HMDA Data 2

4 Exploratory Data Analysis **3**

5 Modeling **4**
5.1 Auto-Regressive Model 4
5.2 Seasonal Auto-Regressive Integrated Moving Average 4
5.3 Gated Recurrent Unit RNN 4
5.4 Long Short-Term Memory 4

6 Results & Conclusion **4**

7 Recommendations of Study **4**

1 Problem Statement: Forecasting Housing Market

The goal of our project was to determine if future housing market pricing can be explained by previous housing market data. We also wanted analyze the usage of exogenous variables in our time-series modeling, and whether it makes a difference. This task is distinct from housing market prediction, which relies on the features of the market, and the house. Using time-series data presented our group a new and novel challenge.

2 The Datasets

We identified two datasets for potential use in our projects.

1. Quandl Data from Zillow
2. USA Home Mortgage Disclosure Act Data

Each dataset has very different forms, and presented different challenges. The Housing Mortgage Disclosure Act was passed by congress in 1975, and requires multiple federal agencies to keep track of all mortgage loans filed for and denied. The datasets that we are using from the HMDA contain all mortgages filed for in America for a given year. This data is very large, and we decided to use only a subset of the the available data from 2014-2017. These 4 datasets combined were around 40GB of data, and so we required a different approach for data analysis. We got around the large nature of the data using an SQLite3 database and querying it for EDA using the corresponding sqlite3 python library.

The Zillow data comes from Quandl, a web api for many types of time-series data. This data has over 70,000 regions and corresponds to years of aggregated monthly home sales. For the purposes of this project we downloaded 43 different regional data, mostly from the state of Washington. These different regions will be used for testing our models, and we will try to compare them to one another. A key drawback of this approach is that some regions have data that goes further back than other regions, as long as the future housing values aren't affected by values from further in the past than 10+ years the results should be directly comparable.

We will decide on which datasets to use for our modeling after taking into account the preprocessing that we will need, and doing some exploratory data analysis.

3 Preprocessing Techniques

3.1 Zillow Data

Different models will require different data manipulation techniques, but the Quandl curates clean easy to use datasets. For this reason all our group had to do was take out the required columns, and cast them to the correct types. The columns we used for our analysis were:

1. date - the date of the observation, always the 1st of the month
2. value - the average home sell value in that particular location

We simply cast the date to a numpy date-time object and left the values as were. For the RNN models we did rescale the data using a MinMaxScaler, but we will cover that more in depth in the modeling section of the report.

3.2 HMDA Data

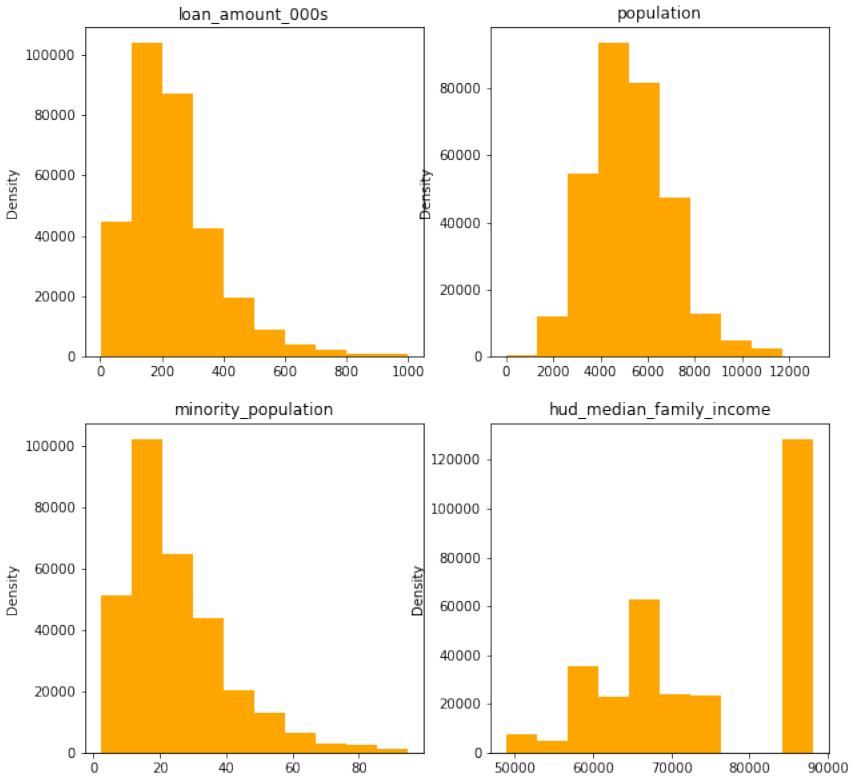
The HMDA data is much dirtier and much more complicated to use. We applied the following filters before undergoing any sort of EDA.

1. Property Type - limited to one-to-four family dwellings
2. Approved Mortgages - Houses were actually sold
3. loan purpose - only home purchase
4. state - Washington State Only because of Zillow regions

Since we will be focusing on aggregated data we will simply be ignoring data that was missing. We aggregated the following columns for further analysis, as they were based on characteristics of the region overall rather than specific to a particular mortgage application.

1. Loan Amount (Thousands)
2. Population
3. Minority Population (Expressed as a percentage)
4. HUD Median Family Income

4 Exploratory Data Analysis



5 Modeling

5.1 Auto-Regressive Model

5.2 Seasonal Auto-Regressive Integrated Moving Average

5.3 Gated Recurrent Unit RNN

5.4 Long Short-Term Memory

6 Results & Conclusion

7 Recommendations of Study