**Predicting Housing Price Fluctuation in Urban Neighborhoods Using Yelp and Zillow Data**

Christian Conroy and Lawrence Doppelt

Yelp has created an opportunity for research-minded academics to study and develop unique insights into the relationships between local restaurants and the greater fabric of the neighborhoods around them. Our goal is to use geocoded Yelp data to develop a model that can predict changes in housing prices based on Yelp rankings and text reviews. As part of the Yelp Challenge, some of the data behind the online and app-based platform has been publicly released.

While many have developed models using Yelp data to improve the efficiency or profitability of businesses, few have examined the relationship between business reviews and rankings and the broader economic development within specific neighborhoods. Our hypothesis is that an increase in average restaurant ratings, the advent of key positive words in reviews, and an increase in check-ins will lead to a detectable rise in housing prices and rents. The logic behind this is that more and better restaurants in a neighborhood will prompt other businesses to move into the neighborhood, resulting in higher property values due to increased access to amenities and overall development of the neighborhood.

There are several interrelated research questions we will explore in testing this hypothesis. What words signal an improvement in a restaurant’s overall rating? What kind of words in reviews for early entrants into a community signal increases in restaurant openings and overall investment into an area? What kind of words in reviews indicate that property values and rents will increase in a neighborhood? What is the relationship between the number of check-ins in restaurants and the property values in that neighborhood?

To develop the predictive model, we plan to merge some datasets to get a complete picture of neighborhood effects, property values, and businesses. The data from Yelp includes unique business and user ID tags, text of reviews, review dates, the star ratings provided in a review, check-ins for various businesses, and user reactions to reviews (“cool,” “useful,” “funny”). The data from Zillow includes zip-codes and geographic coordinates, median listing prices for different housing types, median rental prices for different housing types, and other supplementary metrics.

One analytical component we plan to use is sentiment analysis, which is method of parsing opinions from text, such as social media or online review systems, and categorizing them as positive, negative, neutral, etc. This process will be particularly useful since we want to analyze how reviews affect housing prices; naturally, we expect positive reviews to be an indicator for higher rents, while negative reviews would signal an unpopular area and therefore cheaper housing. We can also use sentiment analysis to parse information like text length (if the length is correlated with more positive or negative reviews), review comments and replies (other viewers ranking if a review was helpful, funny, or irrelevant), and review dates (e.g., if positive reviews for a business occur in clusters and negative reviews are more spread out). Using exploratory data analysis, we hope to glean other information such as the frequency of words and phrases that are associated with positive and negative reviews. We could eliminate stopwords and analyze the “importance” of the text using a TFIDF function.

Once we’ve developed an accurate model to glean the nature of word sentiment within reviews, the next step will be to turn the time series data into something that supervised machine learning can be applied to by using something like a sliding window method to use values at previous time periods to predict values at subsequent time periods for individual variables. Following this step, we can apply a variety of supervised machine learning approaches to the data to identify predictive trends. We can use a simple ARIMA approach to regress the variable for housing prices on its own lagged values. We can use Gaussian Processes to model the word sentiments, star ratings, and check-ins as multivariate normal random variables in a regression equation and develop predictive probabilities related to housing price fluctuations. We can use support vector regression to determine what kinds of words have the most influence on housing price fluctuations and the model parameters. While it will no doubt be much more challenging, we can also attempt to apply a long short-term memory (LSTM) approach to capture sequence dependence if we feel particularly ambitious.

Regardless of which approaches we employ, we will use a train-test model to check the initial accuracy of our predictions, such as whether a review’s text accurately predicts the number of stars received or if the number of check-ins to local businesses could predict changes in area housing prices over time. A well validated model could ultimately be used by real estate investors seeking to value investments using a classic “buy low, sell high” strategy. At the same time, policymakers can use the model to detect if and when development might stimulate inequality often associated with gentrifying neighborhoods, pricing residents out with rising property values. By better understanding the timing of gentrification, policymakers can target inclusive zoning, low-income housing and development credits, and other policies aimed at mitigating the negative inequality effects of urban gentrification.

**Notes**

1. Can’t import all in at once.
   1. Prob best to look at business document and try and restrict first to DMV. Then somehow try to import only those reviews with matching tags.