Understanding Consumer Behavior in Electronic Commerce with Image Sentiment

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1 Introduction

Customers in electronic commerce translate available information into buying decisions based on needs and behavioural tendencies. For this purpose, shopping sites provide detailed information on products and services ranging from simple figures (e.g., dimensions) to textual descriptions, user-generated reviews and visual images. All of the aforementioned sources of information may have a substantial impact on the decision-making of customers.However, little is known about the ways in which visual information is processed and used in decision-making. As a remedy, this research seeks to shed light on the informativeness of visual content in electronic commerce. This objective represents a highly relevant area of research, since visual information plays a major role in determining price, choice and thus willingness to buy (see [1], [2]). Unfortunately, such an undertaking is challenging as we are not aware of any existing methods for measuring the degree of informativeness of images. The main focus of visual sentiment analysis has been on the classification of the sentiment of images stemming from a fairly heterogeneous set. In contrast, we aim to build a model addressing a somewhat homogeneous set of images. In our case, we use photographs from real estate listings in order to predict the rent price. As an immediate implication, our findings show operators of e-commerce or recommender systems how to optimize the presentation of their products and services.

2 Dataset

In our paper, we demonstrate the added value of visual cues in electronic commerce. More precisely, we investigate how images in apartment listings can work as a predictor of the corresponding rent price. For that purpose, we utilize the data as follows: our dataset consists of 2,500 apartment listings for the Boston area, which we collected from Craigslist1 in June 2016. For each listing, we retrieved both the monthly rent and the size of the apartment, as well as the first picture shown on the webpage.

3 Method Development

Figure 1 illustrates our research framework. We train different machine learning models to predict rent prices based merely on the image content. We chose to utilize both a Support Vector Regression (SVR) and a Random Forest (RF), as these models are already suitable for smaller datasets and allow for comparatively fast computation. To evaluate the predictive performance of our proposed method, we randomly partition our dataset into two subsets, a training set of 1800 and a test set of the remaining 700 listings.
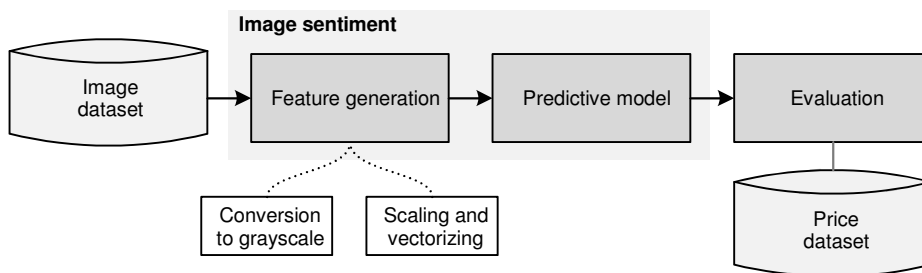

Figure 1. Research framework shows the steps of preprocessing for feature generation and the subsequent predictive model in order to calculate a sentiment metric for images.

4 Empirical Findings

The research framework shows the steps of preprocessing for feature generation and the subsequent predictive model used to calculate a sentiment metric for images. In table 1, we present the results from our predictive approach in comparison to our benchmark. We note that the SVR, as well as the Random Forest model, outperforms the benchmark by a substantial margin for both RMSE and MAE. The best results are obtained in the case of the random forest model, with improved prediction accuracy in terms of RMSE and MAE of 50.81% and 62.96 %, respectively. To provide a statistical underpinning for our results, we also performed a Diebold-Mariano test.

5 Contribution and Implications

This research paper contributes to our understanding of human behaviour in electronic commerce as well as, for instance, recommender systems. We propose an innovative approach to scoring the polarity of an image in a computerized fashion and introduce the concept of image sentiment, which refers to the positive or negative characteristics of the object in the image. In contrast to previous research, we avoid judgment as to whether humans perceive the object itself in a positive or negative manner. Instead, we suggest a sentiment measure that ranks images depicting the same object on a continuous scale from a low to a high appraisal.

We have implemented a predictive approach to forecast the price of objects on the basis of their product image. The above case study demonstrates that our predictions can considerably outperform a naïve baseline. This approach can be a viable extension to existing models that describe real estate prices, since the image sentiment is likely to make up for a substantial portion of the error term.

Overall, our research suggests numerous new applications, each of which can yield an immediate impact for professionals. Operators of e-commerce or recommender systems can leverage our method to optimize the presentation of their products and services. Such advances reveal the potential benefits and insights that can be derived from unstructured information.

Table 1. A validation set is used to assess the performance of our trained models. We compare these in terms of (1) RMSE and (2) MAE with the price per square foot in our validation set. Furthermore, we apply a Diebold-Mariano (DM) test to the trained models and the sample mean to test for the same forecasting accuracy.

Method	RMSE	MAE	DM test (test statistic)	DM test (p-value)
Benchmark				
Sample mean	1.1159	0.8549	—	—
Predictive models				
SVR (linear kernel)	0.9536	0.6006	-2.3048	0.0216*
	-14.54%	-29.74%		
SVR (radial kernel)	0.8907	0.5572	-4.3236	0.0001***
	-20.18%	-34.82%		
Random forest	0.5489	0.3166	-7.137	0.0001***
	-50.81%	-62.96%		

Statistical significance levels: *** 0.001, ** 0.01, * 0.05

References

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