Predicting The Best Starting Price for Ebay Auctions

Course Project Milestone 1: Data Preparation and Future Plan

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Abstract: Online auctions are one of the most popular methods to buy and sell items on the internet. With more than 100 million active users globally, eBay is the worlds largest online marketplace, where anyone can buy and sell anything. In order to successfully selling products on ebay, a reasonable starting price does not only determine whether the product will be sold or not but also affects the profit you can make from the transaction. In this project, we use the historical auction data collected from eBay from April 2013 to the first week of May 2013 which contains information about 296,048 successful and unsuccessful auctions. Different statistical models and machine learning algorithms will be utilized to study online auction patterns and predict the starting price that maximizes profits. Furthermore, we will compare the performance of different methods and summarize the pros and cons in different situations.

Keywords: Ebay Auction • Predictive Analytics • Data Mining

1. Introduction (Data and Business Understanding)

EBay is the worlds largest marketplace for sports autographs, the vast majority of the sites membership uses it to buy and/or sell items via auction format. The ability to provide a method to estimate auction sale prices is desirable to this community. Members of most communities related to collectibles have reported they most often try to predict how much an auction would sell for by performing a search for item and manually calculating the average sales price. In this project, our first objective is to determine whether an auction listing will result in a sale. In addtion, we aim to predict the final sales price as well as the best starting price using data mining techniques.

2. Data Preparation

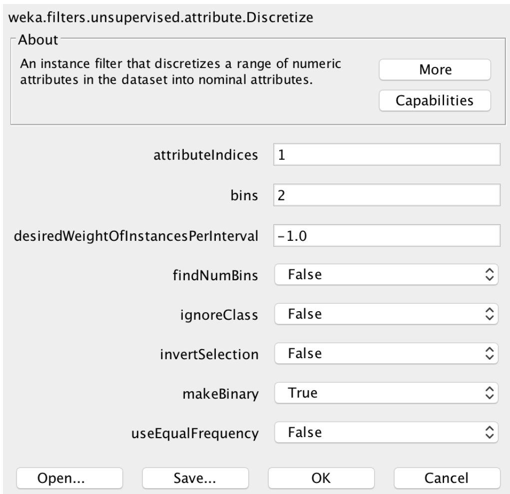
Data Preparation is an crucial and time-consuming part of our data mining project. It involves selecting data to include, cleaning data to improve data quality, constructing new data that may be required, integrating multiple data sets, and formatting data. We first preprocessed the downloaded data sets using shell scripts. To gain more experience on feature selection, we have performed the selection procedure on all three tools used in the class, RapidMiner, Weka and R. With different algorithms and parameters, we get slightly different but generally consistent results.

Data Preprocessing

Before any data can be used for later feature reduction and selection, we preprocessed our data sets. Here the tool we use is shell scripts. Initially, the raw data consists of training sets and test sets. Since we intend to do cross-validation on the whole data set, we merge all the separate data sets as one complete sets. Then we carefully go through all the data attributes and deleted all that obviously contain meaningless or irrelevant information to our analysis, such as ebayID, sellerName, etc. In addition, some attributes with ambiguous meanings are also discarded.

2.1. Feature Selection Using Weka

First, we perform feature selection in Weka. To enable Weka to better handle the data, the first step is establishing a nominal class label. Below is a snapshot of the method we use here to discretize the class field here, which is originally a numeric type with value 0 and 1.



Two algorithms are used in Weka: Information Gain and Feature Subset Selection. We first used Information Gain Algortihm and the result is as below. According to the information gain results we have, if we set the entropy threshold to 0.95, we will need the top 8 features.

```
Ranked attributes:
 0.318735    3 SellerClosePercent
 0.25068     2 StartingBidPercent
 0.20478    11 SellerAuctionCount
 0.119311    4 StartingBid
 0.07023     7 SellerItemAvg
 0.041762   12 AuctionMedianPrice
 0.040966    5 AvgPrice
 0.031772    9 AuctionCount
 0.028263   10 AuctionSaleCount
 0.005359    6 ItemAuctionSellPercent
 0.000207    8 IsHOF_1
```

Using the number of features obtained above, we set the number of features to 8 and try feature subset selection. We start with empty subset, and we use CfsSubsetEval as the evaluation of each subset, and we use GreedyStepWise search method, which basically select the best next feature based on current subset. Here is the result we get.

```
Ranked attributes:
 0.1038    3 SellerClosePercent
 0.1328    2 StartingBidPercent
 0.1245    4 StartingBid
 0.1138    9 AuctionCount
 0.1076   11 SellerAuctionCount
 0.1023   12 AuctionMedianPrice
 0.0983    6 ItemAuctionSellPercent
 0.0931    8 IsHOF_1
```

2.2. Feature Selection Using R

The caret R package provides tools automatically report on the relevance and importance of attributes in your data and even select the most important features for you. Here we perform three different feature selection method on our dataset, namely entropy based filter, Chi-square based filter and Correlation based filter. We apply all three filters to get a better sense of what attributes are more important, and we have the results below.

Entropy based filter

	attr_importance	rank
StartingBidPercent	0.142113054	5
SellerClosePercent	0.191431639	2
StartingBid	0.071807352	8
AvgPrice	0.462173422	1
ItemAuctionSellPercent	0.002012785	10
SellerItemAvg	0.042062863	9
IsHOF	0.000000000	11
AuctionCount	0.152471109	4
AuctionSaleCount	0.098943728	7
SellerAuctionCount	0.128577549	6
AuctionMedianPrice	0.176666755	3

Chi-square based filter

	attr_importance	rank
StartingBidPercent	0.26196726	5
SellerClosePercent	0.29670612	2
StartingBid	0.18784361	8
AvgPrice	0.47460475	1
ItemAuctionSellPercent	0.06509426	10
SellerItemAvg	0.14541187	9
IsHOF	0.00000000	11
AuctionCount	0.26282938	4
AuctionSaleCount	0.20983745	7
SellerAuctionCount	0.24177050	6
AuctionMedianPrice	0.29014051	3

Correlation based filter

	attr_importance	rank
StartingBidPercent	0.05002078	10
SellerClosePercent	0.62856687	1
StartingBid	0.16766258	3
AvgPrice	0.10793493	6
ItemAuctionSellPercent	0.08816751	7
SellerItemAvg	0.07423485	8
IsHOF	0.01689967	11
AuctionCount	0.11040403	5
AuctionSaleCount	0.16330465	4
SellerAuctionCount	0.07086579	9
AuctionMedianPrice	0.18235711	2

As a result, we summarize all the three different methods and compute average rank for each attribute. The result is presented in table 1.

2.3. Feature Selection Using RapidMiner

First we choose a feature selection method from RapidMiner. Here we use Forward Selection. Forward selection operator selects the most relevant attributes of the given ExampleSet through a highly efficient implementation of the forward selection scheme.

Forward selections uses wrapper method to select attributes. Basically, it starts with an empty attribute set. It them add one attribute to run the model and measures the performance. The process keep adding attributes to the model to see if there is performance gain. Depending on the parameter set, it will terminate until there is

Table 1. **Feature Selection Using R Result**

Attribute Name	Entropy based filter	Chi-square based filter	Correlation based filter	Average Rank
SellerClosePercent	2	2	1	1.7
AvgPrice	1	1	6	2.7
AuctionMedianPrice	3	3	2	2.7
AuctionCount	4	4	5	4.3
AuctionSaleCount	7	7	4	6.0
StartingBid	8	8	3	6.3
StartingBidPercent	5	5	10	6.7
SellerAuctionCount	6	6	9	7.0
SellerItemAvg	9	9	8	8.7
ItemAuctionSellPercent	10	10	7	9.0
IsHOF	11	11	11	11.0

no performance improvement or no significant performance improvement. Here we also use cross-validation to measure the performance of the model as well as the current attributes set the operator.

For predicting the whether the given item can be sold or not, we use several classification algorithms, including: Naive Bayes, Decision Tree, Random Forest, Rule Induction, Neural net, Logistic Regression, Support Vector Machine. We will consider efficiency and prediction accuracy for each model to decide which one to adopt.

2.3.1. Naive Bayes modeling

A. The attribute weight

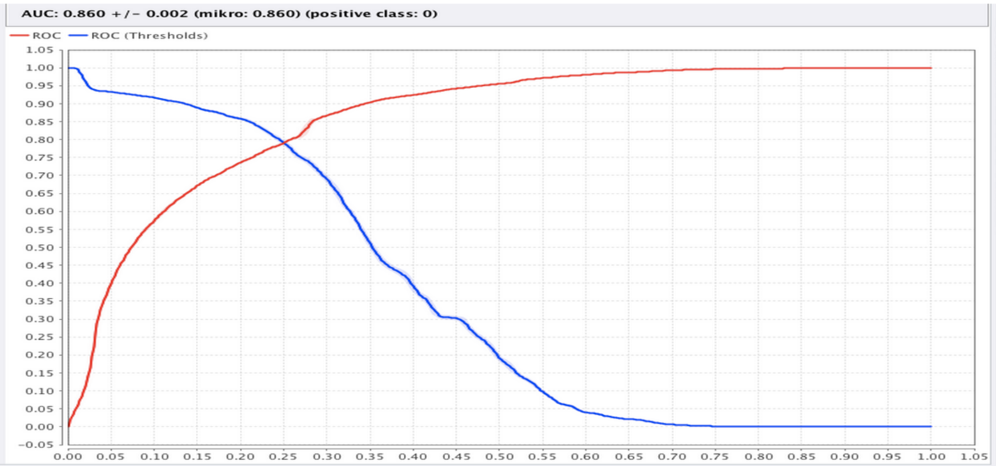
attribute	weight
StartingBidPercent	0
SellerClosePercent	1
StartingBid	1
AvgPrice	1
ItemAuctionSellPercent	1
SellerItemAvg	0
IsHOF	0
AuctionCount	0
AuctionSaleCount	0
SellerAuctionCount	0
AuctionMedianPrice	1

B. The prediction model result and auc curve

Table View   Plot View

accuracy: 82.76% +/- 0.19% (mikro: 82.76%)

	true 1	true 0	class precision
pred. 1	57688	19560	74.68%
pred. 0	31466	187334	85.62%
class recall	64.71%	90.55%	



2.3.2. Decision Tree modeling

A. The attribute weight

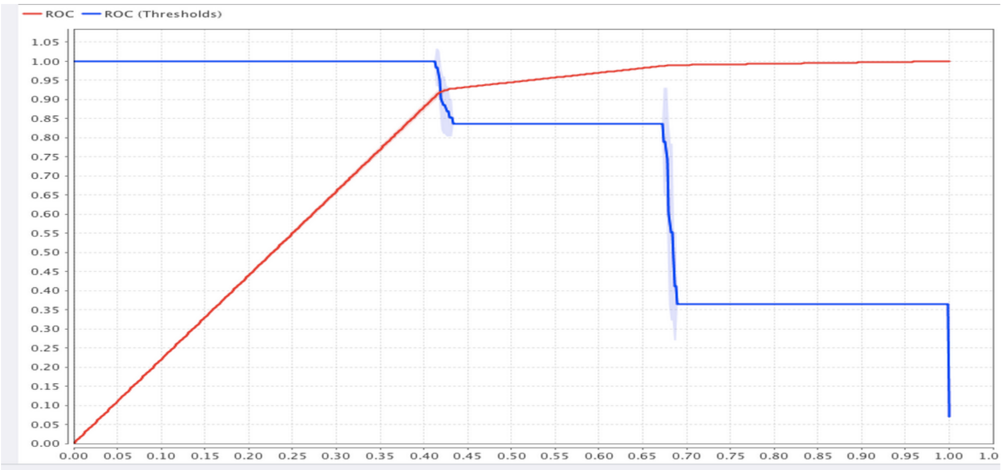
attribute	weight
StartingBidPercent	0
SellerClosePercent	1
StartingBid	0
AvgPrice	0
ItemAuctionSellPercent	0
SellerItemAvg	0
IsHOF	0
AuctionCount	0
AuctionSaleCount	0
SellerAuctionCount	0
AuctionMedianPrice	0

B. The prediction model result and auc curve

Table View Plot View

accuracy: 82.11% +/- 0.11% (mikro: 82.11%)

	true 1	true 0	class precision
pred. 1	51612	15409	77.01%
pred. 0	37542	191485	83.61%
class recall	57.89%	92.55%	



2.4. Other Trials

The other methods including Random Forest, Rule Induction, Neural net, Logistic Regression, Support Vector Machine takes a very long time to finish (more than one hour). Since the dataset we are using is not very large, we consider them not suitable for our problem.

2.5. Final Feature Selection

After integrating all results from 3 different tools, we narrowed the features down to these list.

StartingBidPercent

SellerClosePercent

StartingBid

AvgPrice

AuctionCount

AuctionSaleCount

SellerAuctionCount

AuctionMedianPrice

And from here on, unless specified otherwise, we are using the reduced dataset with only these features.

3. Team Members Responsibilities and Plan for the Next Phase

Right now, all group members are actively participate in the project. An approximate list of each team members' responsiblity is:

- Jiacheng Liao: data preprocessing, report write-up

- Yi Wan: data preprocessing, feature selection in Rapidminer
- Shuang Zhou: data preprocessing, feature selection in Weka
- Zhaoyin Zhu: data preprocessing, feature selection in R

For the next phase,we intend to build different models to make predictions. We plan to apply various statistical machine learning model and use cross-validation to test each model. Also, we would study some economic aspects of the auction theory to help us build the model.

4. Modeling

Modeling involves selecting suitable modeling techniques, generating test designs to validate the model, building predictive models and assessing these models.
A predictive model is a mathematical function that predicts the value of some output variables based on the mapping between input variables. Historical data is used to train the model to arrive at the most suitable modeling technique. For example, a predictive model might predict the risk of developing a certain disease based on patient details. Some commonly used modeling techniques are as follows: Regression analysis that analyzes the relationship between the response or dependent variable and a set of independent or predictor variables. Decision trees that help explore possible outcomes for various options. Cluster analysis that groups objects into clusters to look for patterns. Association techniques that discover relationships between variables in large databases.

4.1. Modeling for Sale / No Sale

In all three tools here, we tried to use different type of classification algorithms to

4.1.1. Modeling in Weka

4.1.2. Modeling in RapidMiner

4.1.3. Modeling in R

We ran Logistic Regression algorithm from the famous "Generalized Linear Model" package in R to start with,

5. Evaluation (ToDo)

Evaluation involves evaluating the results against the business success criteria defined at the beginning of the project.

6. Deployment (ToDo)

Deployment involves consolidating the findings, determining what might be deployed and planning the monitoring and maintenance required to keep the model relevant.

7. Conclusion (ToDo)

TODO

Acknowledgements

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