Capstone Project
Machine Learning Engineering Nanodegree
Starbucks Offers Classification Model

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Domain Background

Once every few days, Starbucks sends out an offer to users of the mobile app. An offer can be merely an advertisement for a drink or an actual offer such as a discount or BOGO (buy one get one free). Some users might not receive any offer during certain weeks.

A data set contains simulated data that mimics customer behavior on the Starbucks rewards mobile app including transaction, demographic and offer is given to determine which demographic groups respond best to which offer type. This data set is a simplified version of the real Starbucks app because the underlying simulator only has one product whereas Starbucks actually sells dozens of products.

Some basic data analysis are done on simulated data including which offer are most popular and who are mostly likely to complete an offer. A model is built to predict whether or note someone will respond to an offer to help better customer targeting in the future.

Problem Statement

There might be a pattern behind different demographic people responding an offer, if we build a model to predict a customer's likelihood to respond to an offer, this will improve customer targeting strategy.

Dataset and Inputs

The data is contained in three files:

- portfolio.json - containing offer ids and meta data about each offer (duration, type, etc.)
- profile.json - demographic data for each customer
- transcript.json - records for transactions, offers received, offers viewed, and offers completed

Here is the schema and explanation of each variable in the files and also some initial findings:

portfolio.json

- id (string) - offer id
- offer_type (string) - type of offer ie BOGO, discount, informational
- difficulty (int) - minimum required spend to complete an offer
- reward (int) - reward given for completing an offer
- duration (int) - time for offer to be open, in days
- channels (list of strings)

There are only 9 offers in total, and offer type consists of BOGO, informational, and discounts. The channels columns needs to be transformed to one-hot-coding to feed into the model later, and there are no missing values in this table.

profile.json

- age (int) - age of the customer
- became_member_on (int) - date when customer created an app account
- gender (str) - gender of the customer (note some entries contain 'O' for other rather than M or F)
- id (str) - customer id
- income (float) - customer's income

There are no duplicates for customer ID in profile data. 12.79% data are missing in terms of gender and income. Became_member_on should be a date field and a column can be created for customer staying length, the median of customer staying length is 1788 days, max staying length is 3253 days, minimum is 1430 days. In addition, there are 2,175 customers who are aged 118, these records miss income and gender too so are removed from the dataset. In terms of gender, 6,129 are females, 8,484 are males, and 212 are O. Income median is 64k, with a max of 120k and minimum of 30k. The buckets can be created for age, income and staying length for futher exploratary analysis.

transcript.json

- event (str) - record description (ie transaction, offer received, offer viewed, etc.)
- person (str) - customer id
- time (int) - time in hours since start of test. The data begins at time t=0
- value - (dict of strings) - either an offer id or transaction amount depending on the record

There are various columns consist of dictionaries, key is offer_id and amount, dictionary can be converted into columns. There are only three types of events which are offer received, offer reviewed and offer completed. Time column represents for hours which can be transformed to days so that is aligh with profile data.

Solution Statement

Various machine learning models inlcuding logistic regression, K Neighbors Classifer, Decision Tree Classifier, Random Forest Classifier, Grandient Boosting Classifier are used to picked out the best performance one to predict whether a customer is responding on an offer or not and feature importance are generated to illustrate which variable has the biggest impact on the model.

Benchmark Model

Logistic regression is picked as the the benchmark model. Serveral other machine learning algorithmns will be tested to see if it's outperformed than the benchmark model.

Evaluation Metrics

A classification model is built to predict whether a customer is responding an offer or not. The dataset will be splitted into training and testing dataset and confusion matrix, accuracy score, recall, precision, f1 score, AUC will be generated on both datasets to ensure there's no overfitting problem happening.

Project Design

There will be lots of efforts to clean the original dataset into training dataset. The final training dataset will be in a offer_id & person_id level, with all the features related including offer reward, offer difficulty, offer duration, offer sent by email/mobile/social/web, customer age, customer income, customer gender, customer staying length since first registered with Starbucks, offer type (BOGO,discount, informational), a label is generated on offer successful or not. Various machine learning models inlcuding logistic regression, K Neighbors Classifer, Decision Tree Classifier, Random Forest Classifier, Grandient Boosting Classifier are used to picked out the best performance one to predict whether a customer is responding on an offer or not and feature importance are generated to illustrate which variable has the biggest impact on the model.

Explortary Data Analysis

Which offer are most popular?
Through analysis, Buy one get one offers are most likely to be receieved, and completed by customers, whilst discount offers are most viewed by customers.

Who are most likely to complete an offer?
It shows that men will complete more offers compared with women, but it seems that women are more likely to completed 5-6 offers compared than men. High income people complete more offers than other income level people. The older people is, the more likely they finish an offer. People who are quite new to Starbucks are less likely to finish an offer.

Model Result

A classification model is built to predict if a customer is going to respond an offer or not. The features are used in the model including offer reward, offer difficulty, offer duration, offer sent by email/mobile/social/web, customer age, customer income, customer gender, customer staying length since first registered with Starbucks, offer type (BOGO,discount, informational), a label is generated on offer successful or not. Various machine learning models inlcuding logistic regression, K Neighbors Classifer, Decision Tree Classifier, Random Forest Classifier, Grandient Boosting Classifier are used to picked out the best performance one and gradient boosting model shows the be the best performance model. After hyperparametre tuning, it still shows the default gradient boosting model outperforms all the other model. Accuracy on train dataset is 72%, and accuracy

on testing dataset is 72% too, so there's no overfitting problem. Details about result is shown as in picture1. Shap value is calculated to infer the feature importance on the model which is shown in picture2. A high level of the "member staying length" has the highest and positive impact on the likelihood that customers' responding to an offer, followed by offer sent by social, high income etc all are more likely to make customers respond to the offers.

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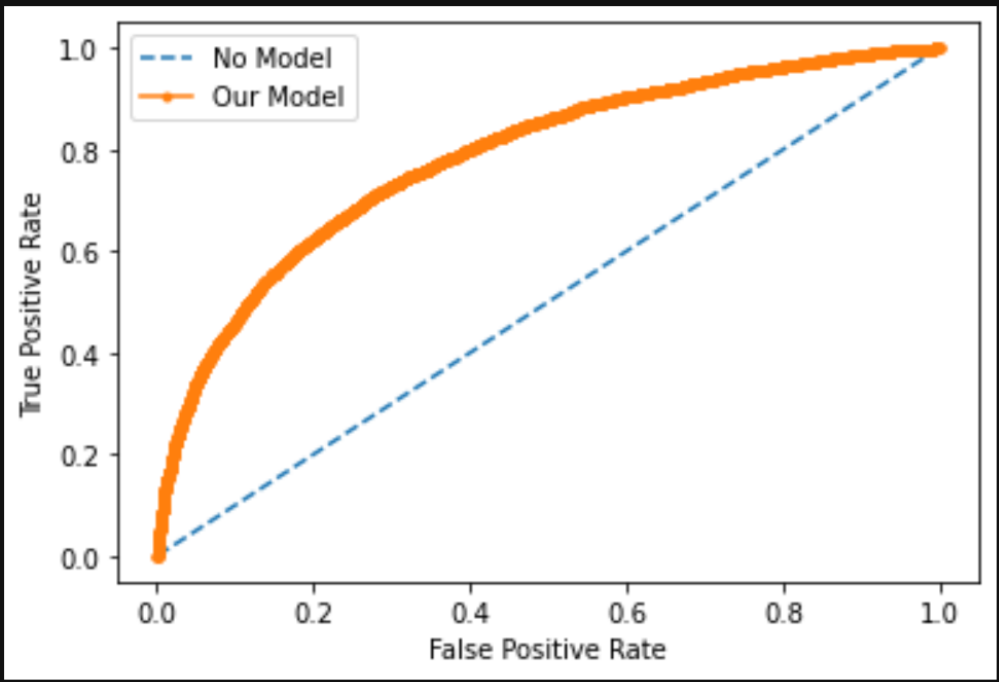
Performance on train dataset: 0.7243045112781955
Performance on test dataset: 0.7174648522667468

 Confusion Matrix on test dataset:

 [[5499 1650]
 [2108 4044]]

 ROC curve on test dataset:
```

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AUC score on test dataset: 0.7852761855623409
Precision on test dataset: 0.7102212855637513
Recall on test dataset: 0.6573472041612484
F1 score on test dataset: 0.6827621137936857
10-fold CV score on whole dataset: 0.7155831278692899
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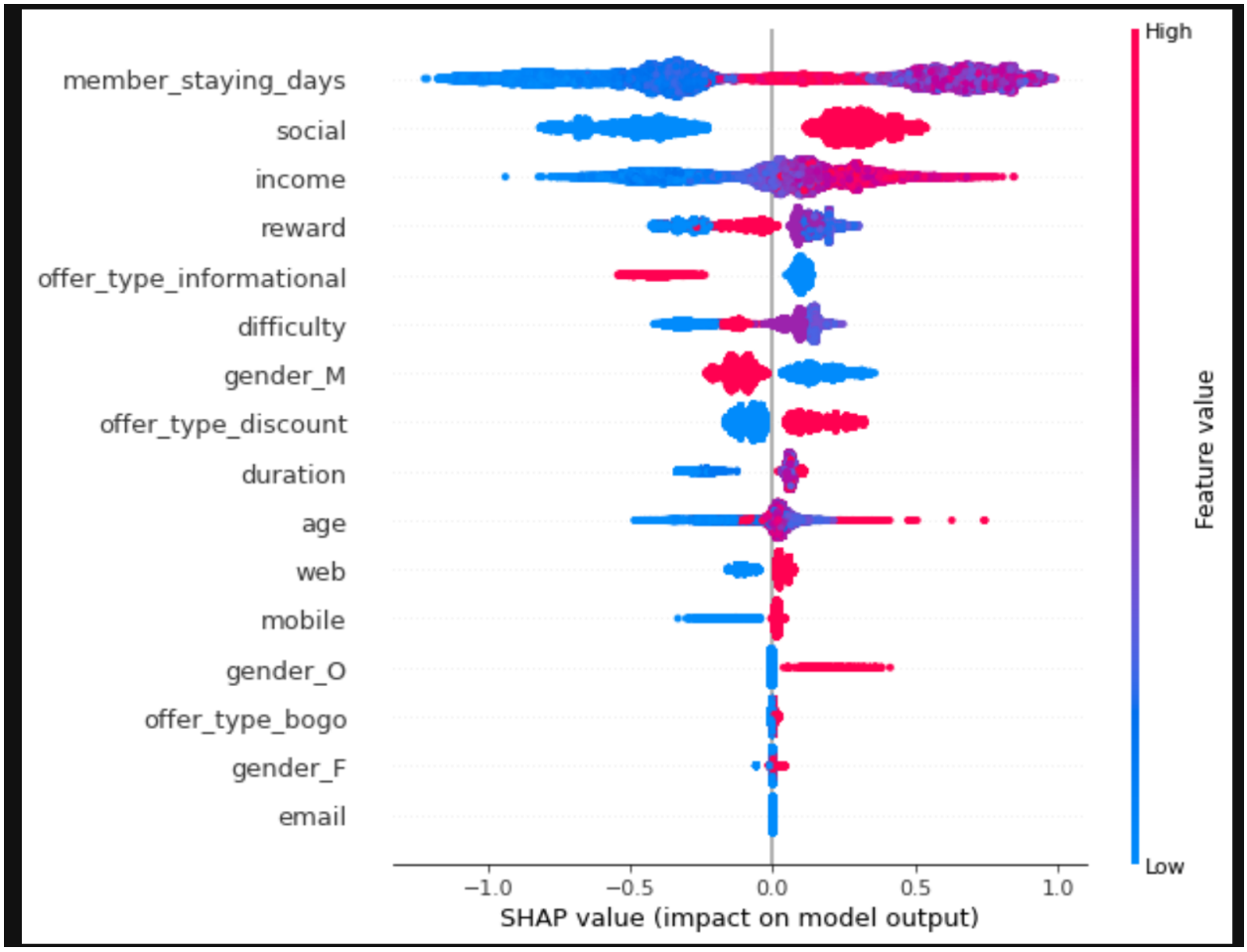
Picture1. Gradient Boosting Model performance



Picture2. Shap Values