Machine Learning Engineer Nanodegree

Arvato-Bertelsmann Customer Segmentation

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Domain Background

Maintaining healthy customer-relationships is of utmost importance for any company today. Therefore, it is crucial to strategically group customers into various groups based on demography and customer behavior. Customer segmentation helps us identify potential buyers, target the most profitable customers, and retain them over time. It can not only improve the marketing strategy but can also help in making better business decisions.

The success of any mailout marketing campaign depends on the customer list to which it is being targeted (Bult and Wansbeek, 1995; Bult et al., 1997; Dirk Van den Poel, 2003). Hence, it becomes critical to identify the target audience correctly and plan the strategies accordingly. The goal of this project will be to analyze the customer demographics and identifying the customer segments with the help of various machine learning algorithms.

Problem Statement

The goal of this project is to help a mail-order sales company in Germany to identify segments of the general population to target with their marketing to grow. The company has provided us with the demographic data of their current customers and the general population. We've to build a customer-segmentation machine learning model for the company, which correctly categorizes customers into groups and identifies the customers that the company should target.

Datasets and Inputs

There are four data files associated with this project:

- **Udacity_AZDIAS_052018.csv**: Demographics data for the general population of Germany; 891 211 persons (rows) x 366 features (columns).
- **Udacity_CUSTOMERS_052018.csv**: Demographics data for customers of a mail-order company; 191 652 persons (rows) x 369 features (columns).
- **Udacity_MAILOUT_052018_TRAIN.csv**: Demographics data for individuals who were targets of a marketing campaign; 42 982 persons (rows) x 367 (columns).

- **Udacity_MAILOUT_052018_TEST.csv**: Demographics data for individuals who were targets of a marketing campaign; 42 833 persons (rows) x 366 (columns).

The data required for the project has been provided by Bertelsmann Arvato Analytics.

Solution Statement

The solution to the above-defined problem can be broadly divided into two parts. First, comparing the general populating with the existing customers and identifying the segments of the general population that are more likely to be part of the company's main customer base, with the help of unsupervised learning techniques. Second is building a supervised learning model to predict the response of individual customers towards the marketing campaign. For the first part, we'll make use of demographics data of the general population and compare it to the customer demographic database, and for the later part, we'll use the demographic data with response labels of the customers to train the supervised learning model and make a prediction on our test set.

Benchmark Model

The benchmark performance for the given, over the Kaggle competition, problem statement has been about 0.80 AUC on the test set. To achieve this, various machine learning models, like K-means or Logistic Regression, can be applied and selected based on the defined metrics.

Evaluation Metrics

There will be mainly three evaluation metrics that will be used to evaluate the performance of the model:

1. **Silhouette score:** This metric will be used for the first part of the project to evaluate the customer segmentation model. It considers how well-separated groups are from each other. The higher value of silhouette represents higher cross-class separability and more tightly packed centroids. The silhouette coefficient *s* for a single sample is given as:

   $$s = \frac{b - a}{\max{(a, b)}}$$

   Where, **a**: the mean distance between sample and all other points in the same class,
   b: is the mean distance between a sample and all other points in the next nearest cluster.
2. **Accuracy:** For evaluating the supervised learning model accuracy will be used as an important metric. The formulation for which is given below:

   $$Accuracy = \frac{TP - TN}{TP + TN + FP + FN}$$

   Where, **TP:** True Positive, **TN:** True Negative, **FP:** False Positive, **FN:** False Negative.

3. **Area under the receiver operating curve (AUROC):** Since, there is a class imbalance, where most individuals don't respond to the mail out, thus AUROC metrics will be used for evaluating model performance on the training set as well as for the final test set.

An appropriate evaluation metric can only be chosen after the data has been analyzed properly.

Project Design

The proposed project design can be divided into the following steps:

1. **Data Pre-processing:** Data pre-processing is one of the most important steps in any machine learning workflow. In this stage, data cleaning processes will be performed to transform raw data to a clean dataset feasible for analysis and modelling. Some of the tasks that are generally performed in this step are, dealing with missing values, removing outliers, and formatting data and so on.
2. **Exploratory Data Analysis:** Exploratory data analysis is an open-ended process where we analyze our data and its type, identify the distribution of data, find correlation between various attributes, and finally visualize the data. Here, the goal is to understand the data at deeper level and get insights from it.
3. **Feature Engineering:** After carefully analyzing the data, insights built are applied to add new features or decompose the existing features to create a more interpretable model. This is followed by encoding categorical variables to numerical values and then normalizing or standardizing these values for the purpose of training the model.
4. **Model training:** In this step various machine learning models are compared based on their performance on evaluation matrix. Then the algorithm that performed the best on the given training set is selected.
5. **Fine-tuning model:** Hyperparameters of the selected model are tuned to improve the performance of the model on given evaluation metrics. Hyperparameter tuning can be performed with the help of grid search. It is also ensured that the tuned model does not over fit our training set and the final model is generalized to predict equally well on new data.
6. **Test Predictions:** The final model is now used to make prediction on the test set provided on Kaggle.

References

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[3] Vineet Maheshwari, Machine Learning Project Workflow. Available at: https://medium.com/datadriveninvestor/machine-learning-project-workflow-8137a401ed81