

Loan Rate Assessment

for

eCars

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I. Executive Summary

The researchers aims to maximize profit by optimizing the interest rate of car loans to be offered to clients of e-Car loans. e-Car loans provided the data of approved car loans from 2002 to 2004 for a total of 208,085 loan agreements. The data contains the basic information of loan agreements such as term, amount, car type, interest rate, competitor's rate, cost of funds and if it was accepted or rejected by clients.

In order to maximize profit, machine learning model implemented was Logistic Regression (Classifier) with Lasso Regularization or the Rate Acceptance Prediction Supervised Algorithm (RAPSA)TM in order to check which information best predict/s the interest rate to be offered to clients and to estimate the additional profit if more clients accepted the loan offer.

From 2002 to 2004, only 22% of the total approved car loans were accepted by clients which translated to net profit of \$181.9M. After implementing the model, the researchers were able to maximize profit amounting to \$255.0M, a 40% increase from the actual profit in the past three years.

In order to increase profitability, the company must optimize the interest rates offered to clients to decrease the risk of rejected loan offers.

II. Problem Statement

e-Car loans offered a total of 208,085 car loans from 2002 to 2004 to various types of clients but only 22% of the total accepted the offer. The researchers would like to estimate the optimal interest rate to be offered to clients given their information and competitor's rate in order to maximize profit by increasing the company's loan portfolio.

III. Overview of Approved e-Car Loans

Overall, only 22% of the offered rates are being accepted. Some improvement was seen on a year-on-year basis as the acceptance rate increased to 26% in 2004 from 17% in 2002. The number of offered loans also increased from 27,713 in 2002 to 76,714 in 2004. This means that the number of offered loans further increased despite the consistently low acceptance rate (26%).

The company is currently making \$80M profit from the loans annually. There is still an opportunity to increase this and reduce the \$941M opportunity loss by improving the loan acceptance rate.

eCars offered rates are seen to increase in the higher tiers, which is expected due to higher risk. However, the competition offers rates that are relatively consistent across all tiers. The gap in interest rates between eCars and the competition is therefore higher at higher tiers. This could make the competition more attractive to the borrowers especially from higher tiers.

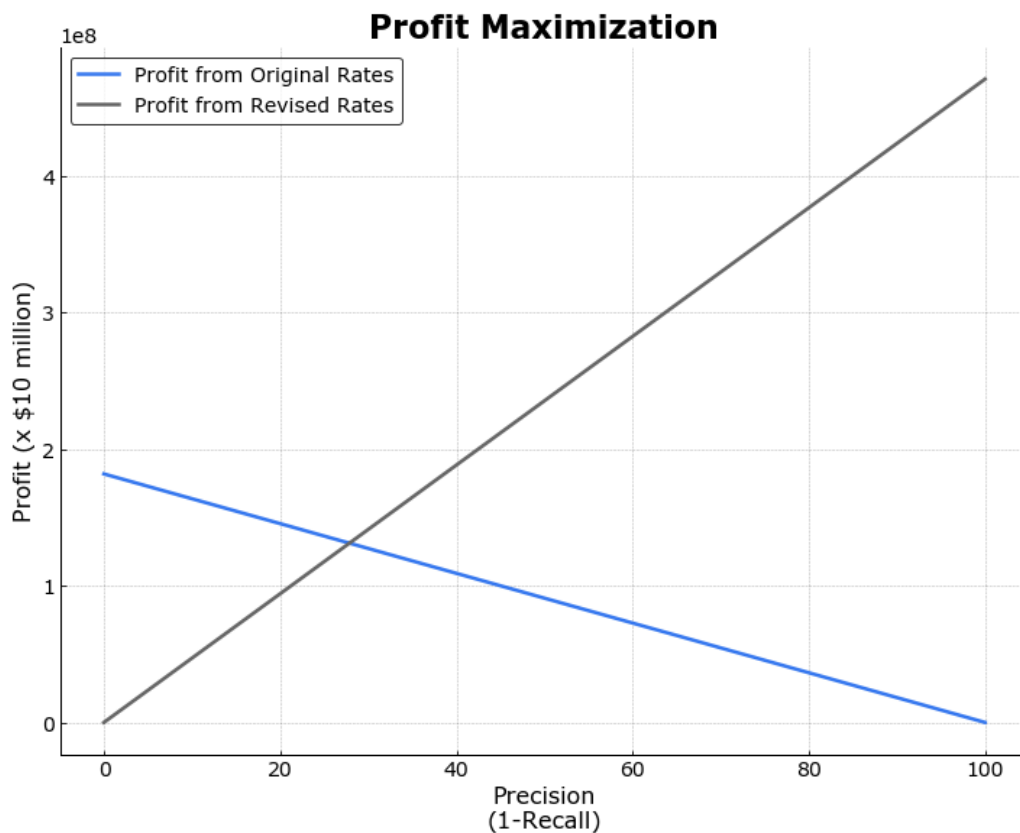
Even if the eCars rate is seen to increase at higher tiers, the cost of funds is relatively uniform across all tiers. This indicates that we have a profit window and can try to lower the eCars rate while still creating profit. Even if we get lower profits from lower rates, we can still earn more from the increased number of borrowers who will accept the offers.

IV. Sensitivity Analysis

A precision (percentage of correct predictions) and recall (percentage of target outcome which is correctly predicted) sensitivity analysis was prepared to estimate the projected profit.

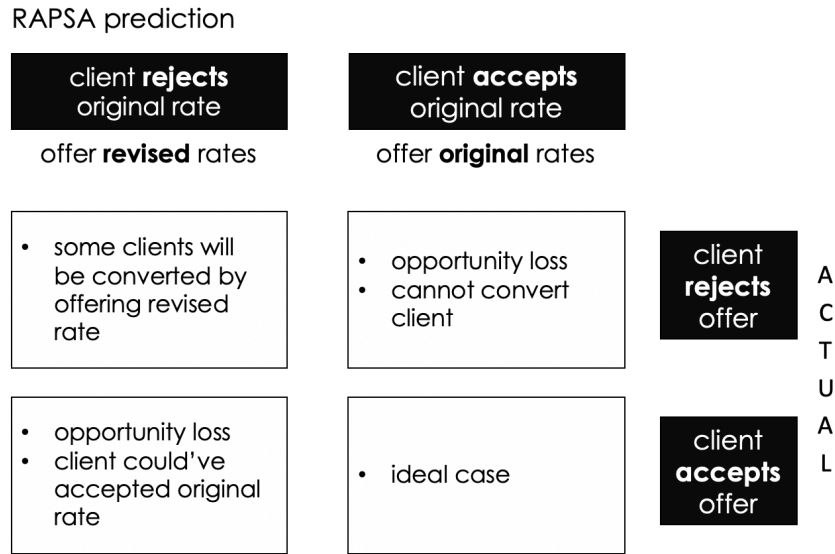
By maximizing the recall, eCars would be able to offer the original (risk-based) rates to the clients who are predicted to accept. The precision would then dictate the percentage of clients who could still be converted by offering them a lower rate.

However, in the actual case, we expecting to convert a lower portion since there is a possibility that the revised rates calculated for some clients would not be economical for eCars.



V. Our Approach

The information to be used in the machine learning models are **Amount, Competition Rate Ratio, Monthly Fee, Car Types** and **FICO**. RAPSA will predict the number of clients who will reject or accept based on the interest rate offered. If it is predicted that the client will reject the offer, a lower revised interest rate will be offered instead. Please refer to the matrix illustrated below.



VI. Results

From the final Logistic Regression model (RAPSA), we will be able to derive the interest rate to be offered from the car loan and get accepted by the client.

The model that yielded the best results is the logistic regression (classifier) with L2 lasso regularization.

$$\text{Logit}(p) = \omega_1 \times \text{CarType}_U + \omega_2 \times \text{MonthlyFee} + \omega_3 \times \text{CompRateRatio} + \omega_4 \times \text{CarType}_R + \omega_5 \times \text{FICO} + \omega_6 \times \text{Amount} + b$$

$$\text{Logit}(0.71) = 1.89 \times \text{CarType}_U - 11.79 \times \text{MonthlyFee} - 5.74 \times \text{CompRateRatio} + 1.37 \times \text{CarType}_R - 1.14 \times \text{FICO} - 0.66 \times \text{Amount} + 2.26$$

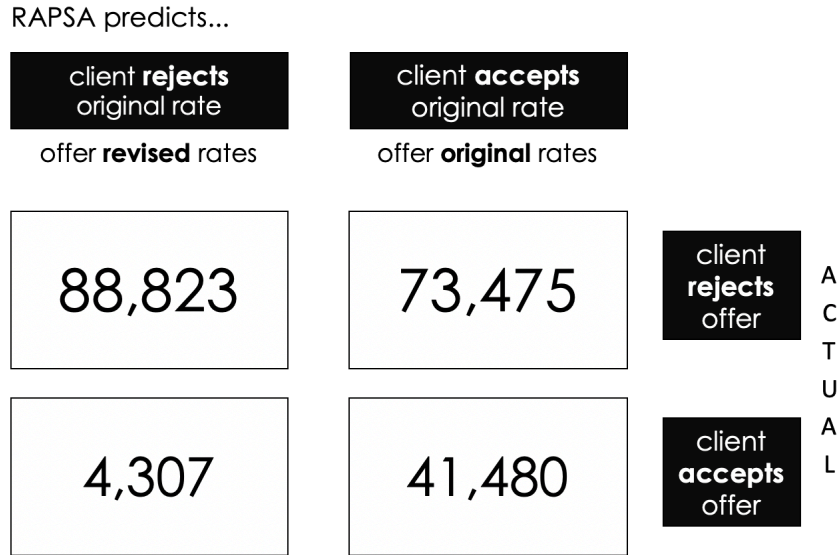
Given the equation above and the feature values from the data, we can compute for the optimal *CompRateRatio* which is the ratio of the e-Cars rate and the competition rate. From this, we can calculate the e-Cars revised rate to recommend for higher probability of acceptance.

VII. Simulation

At a 0.71 probability threshold, RAPSA successfully predicted 91% of the clients who accepted the Original Rate. The model wrongly predicted 73,475 (~64% of 73,475+41,480) as outcome 1. Therefore, we will not be able to offer them the lower rates (since we assumed that they accepted). We offer the original rate to 41,480 and they accept.

The model predicted 4,307 clients to be outcome 0. This means that we offer them the revised rate even if they would have accepted the original rate. We would therefore have some losses in profit from these clients. We then decide if we can offer a revised rate to the 88,823. We calculate first the revised rate and check against the cost of funds. If we could still turn a profit, we offer this rate to them. In calculating the projected profit, we used a revised rate that must be at least 1.5

times higher than the cost of funds. We only expect 36% of them to be converted (based on the outcome 1 precision of RAPSA).



We recommend for the company to use our machine learning model to potentially increase profit by 40%.