


# High or Low, What Will Interest Rate Be ?

*An End-to-End Predictive and Prescriptive Profit Optimization Approach*

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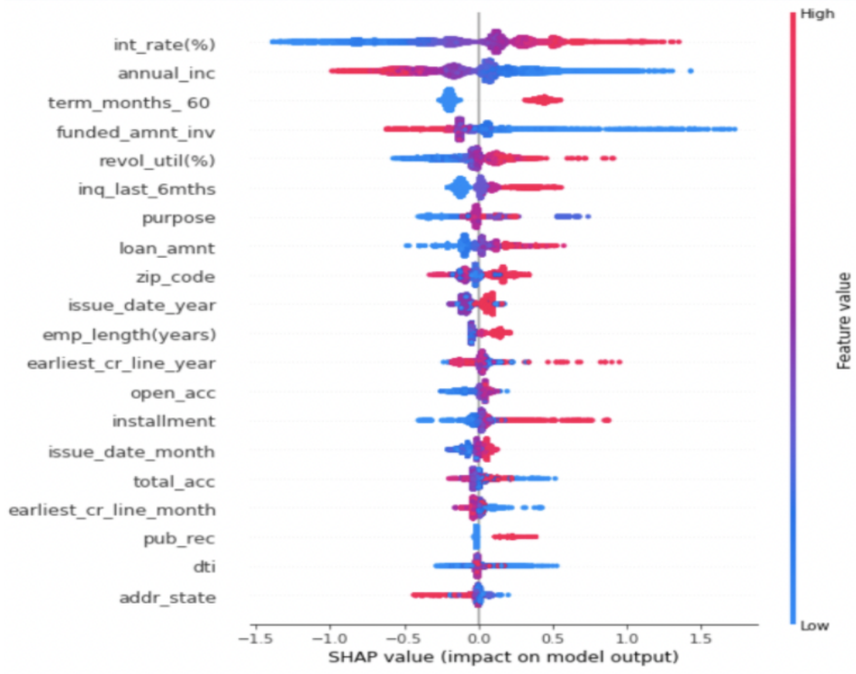
## Problem Statement

**Predict:** Which customers will default based on their historical data?

**Prescribe:** Which interest rate should we give to each cluster of customers to maximize our bank's profit?

**Optimize Considering Real-World Constraints:** How can we do that while considering next year's cut in budget?

## Explatory Data Analysis



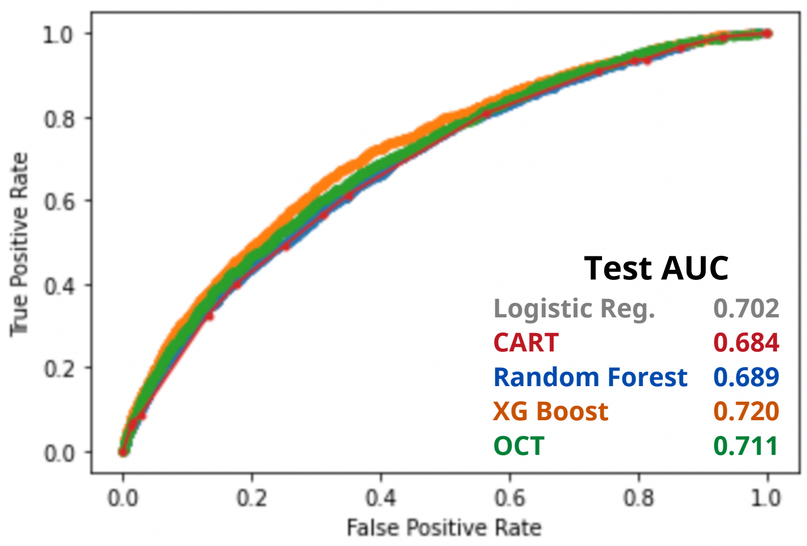

**Sparse**
**Logistic Regression**
**13** out of 33 Features

XG Boost Important Features

## Methodology

### 1 PREDICT LOAN DEAULT

***Optimal Classification Tree (OCT) As Good As XG Boost***




***OCT Gave More Interpretable Results than CART***

CART only showed 1 leaf predicting default while OCT gave a highly interpretable general clustering of customers (below)

**Shorter Term** ***(3-years)***

**High Interest Rate > 14%** — Default

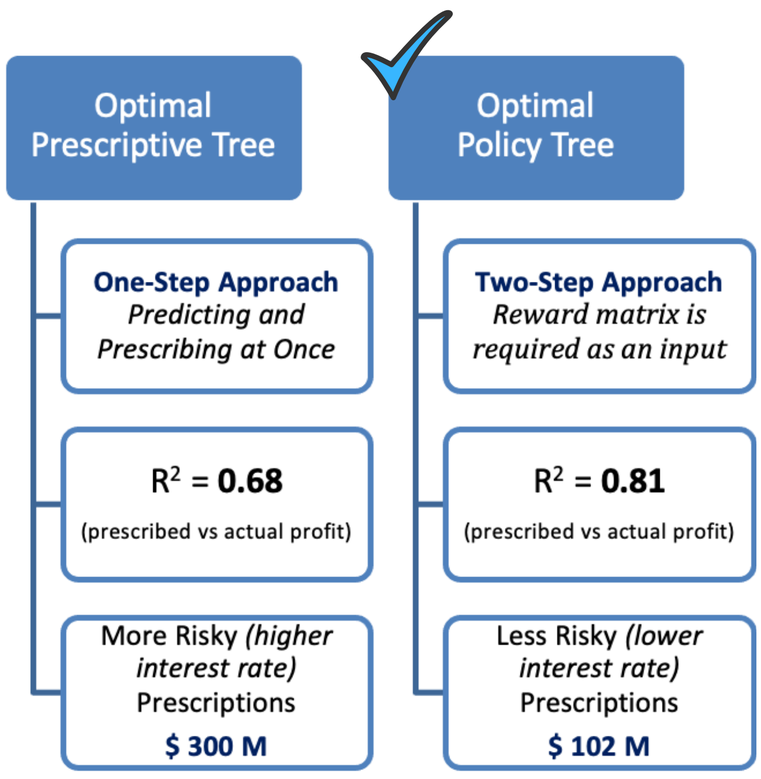
**Medium Interest Rate 8 – 14%** — Depend on loan amount, # of inquiries, amount committed by investors

**Low Interest Rate < 8%** — No Default

**Longer Term** ***(5-years)***

**Medium to High interest rate > 10%** — Default

### 2 PRESCRIBE OPTIMAL INTEREST RATE TO MAXIMIZE PROFIT




***Policy Trees proved to be a better and more flexible approach for this problem***

***Deep-dive on the Policy Tree Methodology***

**Inputs:** Sparse Features (more interpretable results) | Treatment = 3 Interest Rate Brackets

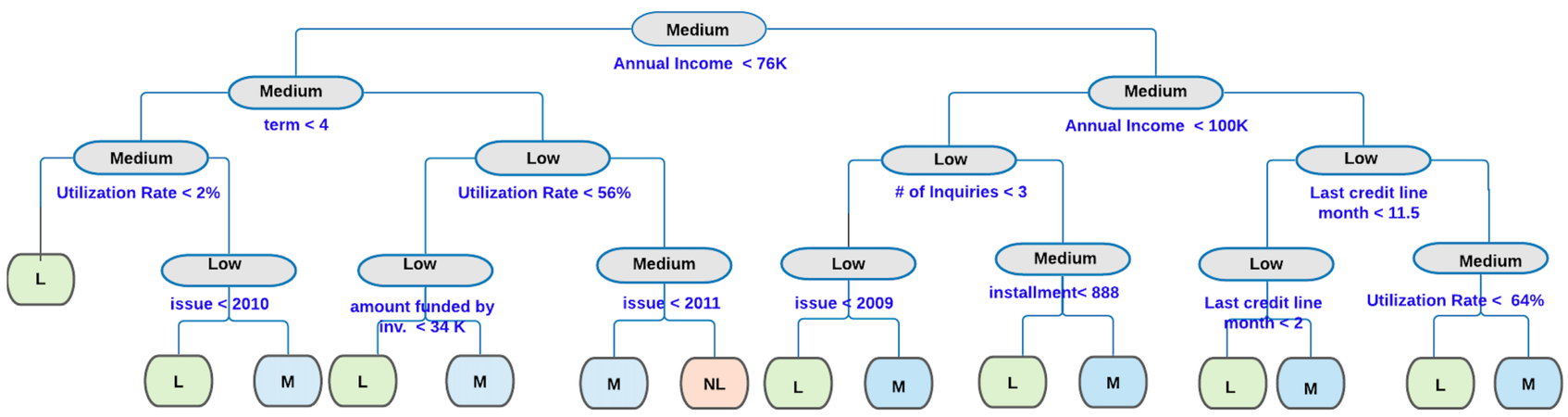
**Reward Matrix Calculation:** Calculating the profit or loss based on the probability of default under each interest rate (using threshold of 0.5). Manipulating the matrix to include a no loan category for very risky customers gives a flexible edge over the prescriptive trees as the bank can now give no loan instead of giving a high interest loan.

| Customer | No Loan | Low | Medium | High |
|---|---|---|---|---|
| 1 | 0 | 0.10 | 0.39 | 0.56 |
| 2 | 0 | 0.15 | 0.21 | 0.50 |
| 3 | 0 | 0.53 | 0.56 | 0.57 |

*Probability of Default Matrix*

| Customer | No Loan | Low | Medium | High |
|---|---|---|---|---|
| 1 | 0 | 1614.72 | -15639 | -21007.5 |
| 2 | 0 | 1983.51 | 7750.27 | -24120.6 |
| 3 | 0 | -3484.42 | -4691.83 | -6302.25 |

*Profit Reward Matrix*




### 3 OPTIMIZE - *Simulate Real-Life Constraints*

To develop a comprehensive methodology, an optimization model is formulated to maximize profit using the optimal prescriptions obtained from the previous step while simulating real-life budget and maximum # of customers constraints.

**Input Parameters:**
**n:** current number of customers
**m:** maximum number of customers to be credited
**b:** budget / total loan amount that can be credited
$\boldsymbol{\lambda}$: penalizes customers based on their risk of default
$\boldsymbol{r_i}$: risk of default for each customer *i* (from reward matrix)
$\boldsymbol{t_i}$: term of loan for each customer *i*
$\boldsymbol{int_i}$: interest rate prescribed by OPT for each customer *i*
$\boldsymbol{lmax_i}$: maximum loan amount for each customer *i*

**Decision Variables:**
$\boldsymbol{l_i}$: loan amount credited to customer *i*
$\boldsymbol{z_i}$: whether the bank credits customer *i* or not

$$\max_{z,l} \sum_{i=1}^{n} \left( l_i * z_i * \left(1 + \frac{int_i}{100 * 12}\right)^{12t} - l_i \right) - (\lambda * z_i * r_i)$$

$$s.t \quad \sum_{i=1}^{n} z_i \leq m$$

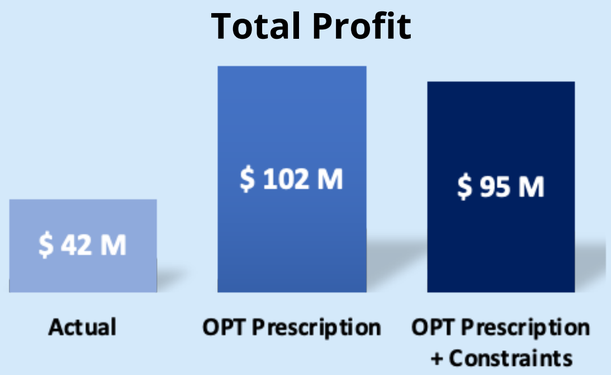
$$\sum_{i=1}^{n} l_i \leq b$$

$$l_i \leq z_i * lmax_i \quad \forall i \in \{1, \dots n\}$$

$$z_i \in \{0,1\} \quad \forall i \in \{1, \dots n\}$$

## RESULTS & CONCLUSIONS

Leveraging such an end-to-end methodology can help banks optimize their budgets by deriving optimal decisions in terms of who to lend to and at what interest rate to ultimately maximize their total profit




***+126%***
***overall increase in profit***