ATM

Cash Optimization

1 THE PROBLEM

How much cash should a bank keep in an ATM daily? This seemingly simple question has significant implications.

There are almost 2 lakh ATMs in India. These have to be stocked with cash. The bank has to decide what is the optimum level of cash which should be maintained in each ATM daily. The daily cash level needs to be determined irrespective of whether the ATM is refilled daily or on alternate days. If the cash kept in ATM is more than the cash withdrawals by customers, it is idle cash which is not earning interest for the bank. On the other hand, if the cash in the ATM falls short of the cash withdrawals, it results in cash out leading to poor customer service and, at worst, a rumour which can spark a run on the bank.

We used predictive data analytics to determine the optimum cash level for a bank. This was done using the open source tool R and modeling on real sample data.

2 PREDICTIVE DATA ANALYTICS

Predictive data analytics uses statistical modeling on past data to determine patterns. These are used to predict future values. Typically the models are built using some past data called Train data. The Train data contains the independent variables (inputs) and the dependent variable (output). The model built using this is tested on another set of past data called Test data. There are various techniques which are employed such as linear regression, logistic regression, decision trees, neural networks, etc. However, one should keep in mind that data analytics can unearth a pattern only if it exists. If the underlying data is random, no technique or model can predict accurately.

3 THE MODEL

To determine the optimum cash level for an ATM, the only variable which needs to be predicted is the cash withdrawal by customers. But this is the toughest part given the variability in this variable. The first decision we took was to build a model for each ATM. Local factors play an important role. For example, an ATM which is in a shopping mall would get used more on the weekends while an ATM in a corporate office building would get used mostly on weekdays even though both ATMs might be in the same area. So though there is an overall demand pattern at national or state level, finally the local pattern at the ATM is important. The local pattern would also incorporate the national and state level pattern to some degree.

There are two modeling approaches which can used –

1. Using demand drivers such as day of week, part of month, holidays, etc. and their effect on the cash withdrawal demand
2. Time based changes in demand – decomposing the time series into trend, seasonality and cyclicality.

For the first approach we decided to use decision trees and for the second approach we used autoregressive integrated moving average (ARIMA) model. The predicted demand for each day was the maximum of the output predicted by each method for that particular day.

The independent variables or inputs which were considered for decision trees were –

1. Part of month – We divided the month into 5 parts to account for salary days, month ends, etc. The month was divided based on dates 1 to 3, 4 to 7, 8 to 11, 12 to 27 and 28 to 31.
2. Weekday – The day of the week (Monday, Tuesday...)
3. Month
4. Year
5. Holiday Band – We considered state-wise holidays and classified holidays as Major and Minor. For Major holidays like Diwali we looked at 4 days in advance and 2 days later in addition to the holidays as the holiday band. For Minor holidays, we looked at the holiday and 1 day in advance as a band.

6. Past withdrawals – We looked at moving averages of past cash withdrawals from the same ATM. We looked at yesterday's cash withdrawal, 5 day moving average, 7 day moving average and 30 day moving average.

We considered various other factors such as dip in gold prices and elections but did not find any strong correlation between these and the ATM cash demand in the sample data.

Then there was the issue of new ATMs. The decision trees will work for recently opened ATMs if they have some history. But if it is a very new ATM there will not be adequate data points to build a robust model. Time series models do not work unless there is a sizeable history. They need a longer history than that needed for decision trees. The alternative in both cases is to use a similar ATM as a guide or exclude the new ATMs till some history is built up.

The past data was broken based on period into Train data and Test data. The models were built using this Train data. The models were then used to predict cash demand for the Test data. The predicted cash demand of Test data was compared against the actual cash demand in this period to determine the accuracy of the model.

The past data had to be sanitized for cash out days. If there was cash out at an ATM, we assumed a demand of 10% more for that day. This was not a big concern since the cash out days were minimal.

4 Findings

The maximum of the predicted outputs generated from both models was taken as the predicted demand. We observed that the actual demand was more volatile than the demand predicted by the ensemble of the models.

There are two ways to handle this in practice. One is to add a buffer (say 20%) to the predicted demand and stock the ATM accordingly. The other is to manage it operationally. The ATM cash stock levels can be monitored remotely and can be used as a trigger to refill an ATM out of turn if the cash falls below the threshold. There is an extra cost of this refilling which had to be traded off against adding more buffer at an overall level.

> **In conclusion, predictive data analytics provides a better forecast than simple heuristic forecasts. However, given the demand volatility, proactive operational management is still needed for optimum results.**

Analytics

Software

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