Homework 13

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Question 18.1

Describe analytics models and data that could be used to make good recommendations to the power company.

Here are some questions to consider:

- The bottom-line question is which shutoffs should be done each month, given the capacity

  constraints. One consideration is that some of the capacity – the workers' time – is taken up by travel, so maybe the shutoffs can be scheduled in a way that increases the number of them that can be done.

- Not every shutoff is equal. Some shutoffs shouldn't be done at all, because if the power is left on, those people are likely to pay the bill eventually. How can you identify which shutoffs should or shouldn't be done? And among the ones to shut off, how should they be prioritized?

  Think about the problem and your approach. Then talk about it with other learners, and share and combine your ideas. And then, put your approaches up on the discussion forum, and give feedback and suggestions to each other.

  You can use the {given, use, to} format to guide the discussions: Given {data}, use {model} to {result}.

  Have fun! Taking a real problem, and thinking through the modeling and data process to build a good solution framework, is my favorite part of analytics.

Answer

The problem is broken down into 3 main parts. Identifying customers who won't pay, what the cost is for leaving the power on, and what the cost would be for turning those customers off (and later turning them back on). If it costs more to turn the customer off than it does to just leave the power on, we shouldn't turn the customer's power off at all.

There are a few things to consider when determining whether or not a customer is deliberately not paying their bill. Is the customer a business or a person? There may be seasonality to the late payments, the customer could have recently had an illness and temporarily can't afford to pay, they may be part of a low-income assistance program. The first thing we need to do is identify customers who did not pay their bill and were sent shutoff notices.

- Given
    - Customer type – is it a residential or business customer
    - Customer address – is the address a residential or business address
    - Customer Response – did the customer respond to a shutoff notice
    - Assistance Program Participation – is the customer part of a low-income assistance program
    - Proof of illness – is the customer affected by an illness affecting their ability to pay
- Use
    - Decision Tree
- To
    - Include customer in model to turn power off

The customers that haven't paid due to being part of an assistance program, are ill, or who have responded to the shutoff notice and worked out a payment program have been removed from the data set for our model. A decision needs to be made on the remaining customers if they are a high risk for continued non-payment. If the customer is a business, and is located at a residential address, they should be included in the residential model. If the business customer is located at a commercial address, the customer would be included in a separate business customer model that will not be explored in this analysis. If a customer randomly just forgot to pay their bill on a given month, their power should not be turned off. An analysis will need to be performed on customer payment history to determine if a customer has a history of being late and subsequently paying their bill.

First a determination needs to be made on the probability that a customer is intentionally not paying their bill.

- Given:
    - Prior History of payments – is the customer habitually late
    - Customer Income - what is the customer's estimated income
    - Credit Scores – What is the customer's credit score, are they currently late in paying other accounts?
    - Rent vs Own – Does the customer rent or own their home? Did their lease end and forgot to close their account?
    - Length as a customer
- Use:
    - Logistic Regression

- To:
    - Determine probability of Intentional late payment.

We would also need to take the customer's prior payment history into account and get an estimate for next month's potential nonpayment.

- Given:
    - Individual Customer Prior Payment History
- Use:
    - ARIMA Model
- To:
    - Determine if seasonality is a factor in not paying, estimate the loss of revenue for next months' potential non-payment

After we have the probability of intentional late payment and the cost of continued nonpayment, we need an estimate for the cost of sending a worker to turn off the power.

- Given:
    - Customers addresses likely to not pay
    - Cost of customers continued non-payment
- Use:
    - Kmeans Clustering
- To:
    - Determine the Service Areas

With the introduction of smart meters being installed throughout the country, there also needs to be a determination if the power can be turned off remotely. If so, the cost to turn off the client drops dramatically. If not, a worker will need to be sent to the customer's address to turn off the power. The worker can be sent either during the day or at night, but we would want to avoid sending the worker into a high crime rate area at night. The worker will also replace the meter with a new smart meter, so the power can be turned on remotely once the customer pays the bill. The cost of the smart meter, and the proportion of time it takes to install the smart meter, should be considered an upgrade cost, and not applied as a cost towards turning off the power in our model.

The cost associated with turning the power off (and subsequently back on) is then dependent on whether or not the address has a smart meter. This model would need run for each cluster identified from the kmeans clustering model.

- Given:
    - Address does not have a smart meter.
    - Number of employees available to perform the work
    - Number of utility trucks with the proper tools to perform the work.
    - Number of smart meters available to install

    - State regulation of time constraints for turning power off (no weekends, no holidays).
    - Distribution model of time it takes employee to turn off residential power.
    - Distribution model of time it takes to install a new smart meter
    - Service area maps with included traffic models to estimate time between service call
- costs
    - Crime rate of service areas
    - 1 month of service window simulation.
    - Overtime/night rates for night work.
    - Distribution model of time it takes an employee to remotely turn the power back on.
- Use:
    - Stochastic Optimization Model
- To:
    - Minimize the cost of employee resources to turn off the power and install a new smart meter and turn the power back on remotely.

- Given:
    - Address has a smart meter.
    - Distribution model of time it takes employee to remotely turn off power.
    - Distribution model of time it takes employee to remotely turn the power back on.

- Use:
    - Empirical Bayesian Model
- To:
    - Determine the cost to turn the power off then back on remotely.

The probability of nonpayment has been considered. There is an estimate of the current unpaid bill + next month's bill. The cost of turning the power off and on has been determined. The possibility or recouping some losses through a collection agency should also be considered. From prior experience the company will know what the average recovery rate is from using a collection agency to recoup debts.

- Given:
    - Current Unpaid bill
- Use:
    - Empirical Bayesian Model
- To:
    - Estimate the revenue recovered by sending the bill to a collection agency.

There is also the possibility that the customer will file a complaint with the state utility commission.

- Given:
  - Current Unpaid Bill
  - Probability Distribution that the customer will file a complaint with the utility commission.
  - Cost of compliance with regulator requests.
- Use:
  - Empirical Bayesian Model
- To:
  - Estimate the costs associated with a customer filing a complaint with the state

There is also the possibility that the customer will file a lawsuit against the company. Given the costs of litigation could likely be high and also have greater variability, build a linear regression model.

- Given:
  - All prior customers with unpaid bills with that resulted in shutoffs
  - Was a lawsuit filed
  - Prior cost of litigating lawsuit
  - Customer income
- Use:
  - Linear Regression
- To:
  - Estimate the costs associated with a customer filing a lawsuit against the company

With all the prior modeling done there is now a way to determine if the customers power should be turned off.

- Given:
  - Probability of intentional nonpayment
  - Cost of continued nonpayment (lost revenue)
  - Cost of handing unpaid debt over to collection agency
  - Cost of state customer complaint
  - Cost of customer lawsuit
  - Cost of turning the power off and back on (not including smart meter installation)
- Use:
  - Optimization Model
- To:

- Minimize the cost of nonpayment.

The objective function would be:

Probability of nonpayment * cost of continued nonpayment > Cost of turning the power off then back on – collection agency cost (we recoup a fraction of our losses here) + cost of customer complaint + cost of customer lawsuit.