And The Winner Is…?
How to Pick a Better Model
Model Lift – 2015 CAS RPM Seminar

Motivation
• Models that appear to be strong may have weaknesses
  – Fit may not be good
  – Model may be overfit
  – Wrong distribution may have been chosen
  – Results may not be stable across data subsets or over time
  – Results may be highly influenced by several records
  – Model may underperform the status quo

Some Models Used by Actuaries
• Linear regression
• Exponential regression
• Logistic regression
• Minimum bias procedures
• Generalized linear models
• Classification and regression trees
• Clustering procedures
Understanding & Validating a Model

- **Model Lift**
  - How well does the model differentiate between best and worst risks?
  - Does the model help prevent adverse selection?
  - Is the model better than the current rating plan?

- **Goodness of Fit**
  - What kind of model statistics are available, and how do you interpret them?
  - What kind of residual plots should you consider, and how do you interpret them?
  - What are some considerations regarding actual versus predicted plots?

- **Internal Stability**
  - How well does the model perform on other data?
  - How will the model perform over time?
  - How reliable are the model’s parameter estimates?

Model Lift

- Ability to differentiate between low and high cost policyholders
  - Sometimes called the “economic value” of the model

- Some tools for measuring and illustrating model lift
  - Simple Quantile plots
  - Double lift charts
  - Gini index
  - Loss ratio charts

Model Lift – Simple Quantile Plots

- Creating a quantile plot
  - Use holdout sample.
  - Sort data based on predicted value (frequency, severity, loss cost).
  - Subdivide sorted data into quantiles (quartiles, quintiles, deciles) with equal weight (exposure, claim count).
  - Calculate average actual value and predicted value for each quantile and index to overall average.
Model Lift – Simple Quantile Plots

- Sorted by Loss Costs
- Underlying Current Rates

- Sorted by Model’s Predicted Loss Costs

- Sorted by Loss Costs
- Underlying Current Rates

- Sorted by Model’s Predicted Loss Costs

- Underlying Current Rates

- Model Lift – Double Lift Charts

- Creating a double lift chart
  - Sort data by ratio of model prediction to current premium.
  - Subdivide sorted data into quantiles with equal exposure.
  - For each quantile calculate average actual loss cost, average model predicted loss cost and the average loss cost underlying the current manual premium .
  - Index the quantile averages to the overall averages.

- Economics – The Gini Index

- Gini coefficient or Gini ratio
  - Named after Corrado Gini

- Measure of income inequality
  - Horizontal axis = percentage of country’s population
  - Vertical axis = percentage of country’s income
  - A = Area between line of equality and Lorenz Curve
  - B = Area beneath Lorenz Curve
  - Gini index = A / ( A + B )
Model Lift – Simple Gini Index

- Adapting to car insurance
  - Assume claim frequency = 5%

- “The perfect model”
  - Prediction = actual loss, which is $0 for 95% of vehicles insured.
  - Sort holdout data set by model prediction.
  - Horizontal axis = percentage of total earned car years.
  - Vertical axis = Percentage of total incurred loss.
  - Gini Index = \( \frac{A}{A+B} \) is very high.

Model Lift – Simple Gini Index

- Exercise:
  - Model X prediction = expected loss cost
  - Model Y prediction = 0.5 (expected loss cost)
  - Model Z prediction = 2.0 (expected loss cost)
  - Which model has the highest Gini index?

- Model A has a Gini index of 15.9 and B has a Gini index of 15.4
  - Is that difference significant, or is it just a quirk of the holdout data?

Model Lift – Loss Ratio Charts

- Lift charts and Gini index
  - May be unfamiliar to some stakeholders

- Loss ratios
  - Widely used and understood in the industry

- Ranking by predicted loss cost
  - Rank data into quantiles by predicted model loss cost
  - Calculate loss ratio for each quantile
Model Lift – Summary

• Simple Quantile plots
  – Illustrate how well the model helps prevent adverse selection

• Double lift charts
  – Compare competing models
  – Compare new model against current rating plan

• Simple Gini index
  – Summarizes model lift into one number

• Loss ratio charts
  – Puts lift in context most people in insurance industry can understand
  – Can be distorted by redundancy or inadequacy of current rating plan

References


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