2009 Actuarial Research Conference

The Role of Research at ISO

Glenn Meyers
ISO Innovative Analytics
The IIA Team

To develop and deliver IIA’s sophisticated predictive modeling tools, IIA has pooled the talent of a highly credentialed group of individuals with more than 300 years combined experience in analytics. The members of this multidisciplinary team hold more than 30 advanced academic degrees with backgrounds in:

- statistics
- actuarial science
- mathematics/applied mathematics
- data management, warehousing, and mining
- analytics and modeling
- machine learning
- computer science
- personal and commercial insurance
- industrial/operational research
- finance
- economics/applied economics
- engineering geoscience

14 Ph.D.’s in the fields of Statistics, Mathematics, Economics, Finance, Machine Learning, Engineering

Three Fellows of Casualty Actuarial Society plus access to other ISO personnel.
More on iiA

Predictive Modeling Projects
- Refined Underwriting Tools (example to follow)
- Fraud Detection
  - Property/Casualty Claims
  - Mortgage
  - Health Care
- Premium Audit
- Insurance Marketing

Analytic Tools
- PC SAS, SAS Enterprise Miner, R
- Mapping Software
Territorial Ratemaking

- Territories should be big
  - Have a sufficient volume of business to make credible estimates of the losses.
- Territories should be small
  - “You live near that bad corner!”
  - Driving conditions vary within territory.
Some Environmental Features Related to Auto Accidents

- Proximity to Business Districts
  - Workplaces
    - Busy at beginning and end of work day
  - Shopping Centers
    - Always busy (especially on weekends)
  - Restaurants
    - Busy at mealtimes
  - Schools
    - Busy and beginning and end or school day
Some Environmental Features Related to Auto Accidents

- **Weather**
  - Rainfall
  - Temperature
  - Snowfall (especially in hilly areas)

- **Traffic Density**
  - More traffic sharing the same space increases odds of collision

- **Others**
Combining Environmental Variables at a Particular Garage Address

- Individually, the geographic variables have a predictable effect on accident rate and severity.
- Variables for a particular location could have a combination of positive and negative effects.
- ISO has built a model to calculate the combined effect of all variables.
  - Based on countrywide data – Actuarially credible
Data Used in Building Model

- Obtained loss, exposure, classification and address for individual policies from cooperating insurers
- ISO Statistical Plan data
- Third-Party Data
  - Traffic
  - Business Location
  - Demographic
  - Weather
  - etc
- Approximately 1,000 indicators
Environmental Module Examples

- Comprised of over 1000 indicators

**Weather:**
- Measures of snowfall, rainfall, temperature, wind and elevation

**Traffic Density and Driving Patterns:**
- Commute patterns
- Public transportation usage
- Population density
- Types of housing

**Traffic Generators**
- Transportation hubs
- Shopping centers
- Hospitals/medical centers
- Entertainment districts

**Experience and trend:**
- ISO loss cost
- State frequency and severity
trends from ISO lost cost analysis

**Traffic Composition**
- Demographic groups
- Household size
- Homeownership
Techniques Employed in Variable Reduction

- Variable Selection – univariate analysis, transformations, known relationship to loss
- Sampling
- Sub models/data reduction – neural nets, splines, principal component analysis, variable clustering
- Spatial Smoothing – with parameters related to auto insurance loss patterns
In Depth for Weather Component

- Environmental Model Loss Cost by Coverage
- Frequency x Severity
- Causes of Loss Frequency
- Sub Model
- Data Summary Variable
- Raw Data

Coverage

Frequency
- Traffic Generators
- Traffic Composition
- Weather

Severity
- Traffic Density
- Experience and Trend

Weather
- Temperature Model
- Weather Severity Scale 1
- Weather Severity Scale 2
- Neural Net Weather Model 1
- Neural Net Weather Model 2

Weather Summary Variables

35 Years of Weather Data
Environmental Model

Loss Cost = Pure Premium

= Frequency x Severity

Frequency = \[ \frac{e^\lambda}{1 + e^\lambda} \]

\[ \lambda = \text{Intercept} + \text{Weather} + \text{Traffic Density} + \text{Traffic Generators} + \text{Traffic Composition} + \text{Experience and Trend} \]
Environmental Model

Loss Cost = Pure Premium
= Frequency x Severity

\[ \mu = \text{Intercept} + \text{Weather} + \text{Traffic Density} + \text{Traffic Generators} + \text{Traffic Composition} + \text{Experience and Trend} \]
Environmental Model

Loss Cost = Pure Premium
= Frequency x Severity

- Separate Models by Coverage
  - Bodily Injury Liability
  - No-Fault
  - Property Damage Liability
  - Collision
  - Comprehensive
Constructing the Components
Frequency Model as Example

\[ \lambda = \text{Intercept} \]

\[ + \alpha_1 \cdot x_1 + \ldots + \alpha_{n_1} \cdot x_{n_1} \]

\[ + \alpha_{n_1+1} \cdot x_{n_1+1} + \ldots + \alpha_{n_2} \cdot x_{n_2} \]

\[ + \alpha_{n_2+1} \cdot x_{n_2+1} + \ldots + \alpha_{n_3} \cdot x_{n_3} \]

\[ + \alpha_{n_3+1} \cdot x_{n_3+1} + \ldots + \alpha_{n_4} \cdot x_{n_4} \]

\[ + \alpha_{n_4+1} \cdot x_{n_4+1} + \ldots + \alpha_{n_5} \cdot x_{n_5} \]

\[ + \text{Other Classifiers} \]

= Weather

= Traffic Density

= Traffic Generators

= Traffic Composition

= Experience & Trend
Customized Model

Loss Cost = Pure Premium
= Frequency x Severity

Frequency = \frac{e^{\lambda}}{1 + e^{\lambda}}

\lambda = \alpha_0 + \alpha_1 \cdot \text{Weather} + \alpha_2 \cdot \text{Traffic Density} + \alpha_3 \cdot \text{Traffic Generators} + \alpha_4 \cdot \text{Traffic Composition} + \alpha_5 \cdot \text{Experience and Trend} + \text{Other Classifiers}

\alpha_1 \ldots \alpha_5 \equiv 1

in industry model

Severity model

customized similarly
Newark NJ Area
Combined Relativity
Research Activities Connected with Modeling

- Evaluate data sources
- Treating partial year exposures in GLM
- Discrepancies in geographic parameters
- Pure premium vs Frequency/Severity?
  - Settled on Tweedie for pure premium
- Correlation between coverages/perils
- Evaluating models
  - Goodness of fit does not work
  - Target audience is customers
Evaluating the Lift of the Environmental Model

- Demonstrate the ability to select the more profitable risks
- Demonstrate the adverse effect of competitors “skimming the cream”
- Calculate the “Value of Lift” statistic

- Once insurers see the value of lift other actions are possible
  - Change prices (etc)
Effect of Selecting Lower Relativities

Selective Underwriting for BI

Selective Underwriting for PD

Selective Underwriting for Comp

Selective Underwriting for Coll
Effect of Competitors
Selecting Lower Relativities

- Antiselection for BI
- Antiselection for PD
- Antiselection for Comprehensive
- Antiselection for Collision

Bar charts showing the effect of premium lost to competition on % increase in loss ratio for different types of insurance.
Assumptions of The Formula Value of Lift (VoL)

- Assume a competitor comes in and takes away the business that is less than your class average.
- Because of adverse selection, the new loss ratio will be higher than the current loss ratio.
- *What is the value of avoiding this fate?*
- VoL is proportional to the difference between the new and the current loss ratio.
- Express the VoL as a $ per car year.
The VoL Formula

- $L_C = \text{Current losses}$
- $P_C = \text{Current Loss Cost}$
- $L_N = \text{New losses of business remaining}$
  - After adverse selection
- $P_N = \text{New Loss Cost}$
  - After adverse selection
- $E_C = \text{Current exposure in car years}$
The VoL Formula

\[ \text{VoL} = \frac{\left( \frac{L_N}{P_N} - \frac{L_C}{P_C} \right) \cdot P_N}{E_C} \]

- The numerator represents $ value of the potential cost of competitors skimming the cream.
- Dividing by \( E_C \) expresses this value as a $ value per car year.
## Value of Lift Results on Pilot Testers

<table>
<thead>
<tr>
<th>Coverage</th>
<th>Value of Lift</th>
</tr>
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<tbody>
<tr>
<td>BI Liability</td>
<td>$4.99</td>
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<tr>
<td>PD Liability</td>
<td>$3.63</td>
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<tr>
<td>Collision</td>
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<tr>
<td>PIP</td>
<td>$15.04</td>
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<td>Combined</td>
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ISO is committed to making use of cutting edge research to solve industry problems.