



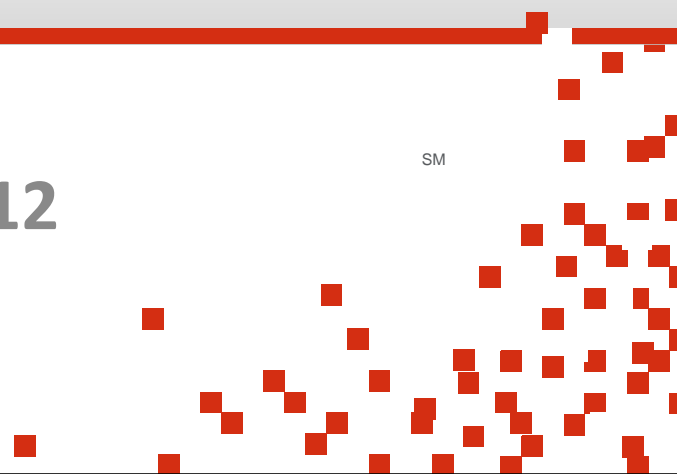
$$\sum_{k=1}^N [n_k \ln n_k]$$

Using Novel Data for Vehicle Rating

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CAS Spring Meeting 2012

SM

MEASURE, MANAGE, & REDUCE RISK



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Outline

1. Vehicle Characteristics vs. Series
2. Collecting and attaching data
3. Developing and Implementing Models
4. Some illustrative results



Vehicle Series

Working Definition: A vehicle series is an collection of vehicles that shares a number of characteristics in common and is used to aggregate loss experience.

- Different companies or organizations will partition the universe of vehicles in different ways, so the specific set of series will be similar across organizations but not identical.



Vehicle Series

- Common aggregations include:
 - Model year
 - Make
 - Model name
 - Additional attributes include:
 - Body Style &/or # of doors
 - # of drive wheels
 - Engine
 - Trim packages.
- Multiple price points (MSRPs) within series sharing common experience may lead to further refinement.



Vehicle Series

sounds simple but...:

- Model year (or range of model years).
 - ***When does the design change “significantly” enough to warrant a new series?***
- Make (manufacturer).
 - ***Chevy vs. GMC ?***
- Model name.
 - ***VW Jetta / GTI / Fox / Golf?***
 - ***Ford Escape vs. Mazda Tribute?***
- Additional attributes, ...
 - ***Irrelevant alternatives?***

...Credibility? ...



Vehicle Characteristics

Alternate approach:

- Instead of defining a series, *link the loss experience directly to the characteristics of the vehicle.*
- Let a model *discover* the relationship between claims and the *relevant* aspects of a vehicle:

Model year	Price	Body style
# of doors	# of cylinders	# of drive wheels
Displacement	Horsepower	Torque
ESC	ALB	DRL
Curb weight	Wheelbase	<i>etc.</i>



Vehicle Characteristics

- *When does the design change “significantly” enough to warrant a new series?*
 - *When / as much as the characteristics do.*
- *Chevy vs. GMC ?*
 - *The relevant differences are the characteristics, not the nameplate.*
- *VW Jetta / GTI / Fox / Golf?*
 - *Design changes are considered, “branding” isn’t.*
- *Ford Escape vs. Mazda Tribute?*
 - *Share platform and common attributes, but some differences exist and are accounted for.*
- *Irrelevant alternatives?*
 - *Not significant in models.*



Collecting Data

In order to develop a model on vehicle characteristics, ...

what data do we need?

- Exposures and Losses at the specific exposure level.
- Other relevant rating factors (covariates):
 - Other applicable elements of the rating plan (Territory, Driver, etc.)
- Some vehicle specific characteristics (e.g. price, year, body style, # of cylinders, # of doors, etc.)

What data do we want?

- As much detailed, *relevant* vehicle specific characteristic data as we can *reasonably* get our hands on.

Where does detailed vehicle data come from?

- *A lot of hard work!*
 - ...and multiple public and proprietary sources.



Obtaining 3rd Party Data

Outline

1. Qualifying data sources
2. Match keys
3. String matching tools
4. Level of aggregation
5. Process and QC

* Thanks to Leila Mortazavi of ISO Innovative Analytics and the team.



Qualifying Data Sources

- Is the data (*potentially*) predictive of losses?
- Is the data accurate? Can it be accurately matched?
- Completeness: does the data cover:
 - Adequate history (older model years)?
 - Adequately large proportion of insured vehicles?
- Will the data continue to be available in the future?
- Is the data allowable for use?
- Do you have (or can you obtain) appropriate rights of use?
- Does the data contain enough novel information to justify its cost (both the price and the time and effort to use it)?



Match Keys

Some working definitions:

- “**Base**” dataset: containing exposures, losses, covariates and vehicle VIN for the specific risk.
 - The match keys should be *at least* as refined (disaggregated) as the 3rd party data.
- “**3rd Party**” dataset(s): Multiple sources.
 - Different match keys and levels of aggregation.
- **Ideally** (i.e. unrealistically) we would be able to match all of our 3rd party data to our base data by VIN or some common *decoded* VIN.
 - *What follows is a discussion of what to do when the ideal situation doesn't hold.*



Match Key Cascade

Conceptually, the process of matching 3rd party data to the base can be thought of as hierarchical or a “cascade”.

1. Model year
2. Manufacturer (Make)
3. Model Name
4. Body Style
5. Doors
6. Drive Wheels
7. Tie breakers (*data source specific*)

- If an exact match is found, then merge / join to base.
- If not, then roll up to next higher levels of hierarchy and resolve ambiguous cases.
- Hierarchy may differ for various 3rd party sources.
- Some pre-processing (clean-up) of keys helps a lot.



Match Key Details

1. Model Year: matches are relatively easy

- Some sources provide data in model year ranges (e.g. 2003-2007).

2. Manufacturer (Make): also relatively easy

- Differences easily resolved (e.g. 'ACUR' ⇔ 'ACURA')

3. Model Name: not easy at all – a great deal of source specific detail and some idiosyncrasies.

- Some sources have two fields (e.g. “model” and “sub model”).
- Model names in one source can be parsed to create tie breakers (or keys) with a defined field in another source e.g.:
 - Drive wheels: “4X4” vs. “4X2”, “AWD”
 - Engine type: “TURBO”, “HYBRID”, “FLEX”
 - Engine cylinders or displacement: “(V6)”, “(V8)” or “2.0”, “3.2”
- Other differences / idiosyncrasies not easily resolved.
 - Some tools to aid in matching or disambiguation of model names will be described in detail below.



Match Key Details

4. Body Style ...

5. ...and **doors**: keep an eye out for differences

Base Data	3 rd Party Data	
Body Style	Body	Doors
SEDAN 4D	SEDAN	4
COUPE 2D	COUPE	2
HCHBK 3D	HATCHBK	2

6. Drive wheels: '2' or '' vs. '4' (or 'AWD' or '6')

7. Tie Breakers:

- Common fields that exist across the base and 3rd party source (or that can be parsed from name).
- Will differ from source to source.
- Sometimes measurements differ slightly among sources (rounding, definitions) – need to accommodate differences.



Matching Summary

- “Cascade” approach automates the discovery of exact matches and allows efforts to focus on disambiguation.
- A lot of pre-processing of fields is required to align them.
- String matching tools can aid in the process:
 - Each function has different aspects (costs, features and options).
 - Use multiple functions, and resolve disagreement (special cases).
- There is still a large manual effort.
 - EDA (Exploratory Data Analysis), data queries (group by, unique, ...).
- Every different source requires unique solution details.
- The process needs to be replicable, in order to accommodate the introduction of new model years.



Using 3rd Party Data

Process and Quality Control

- Initial matching process is very large:
 - > 25 model years.
 - > 100K distinct vehicles.
- Annual updates need to be executed quickly.
 - About 4,000 distinct vehicle make / model / trims per year.
 - Some percentage are new model introductions, some models are significantly redesigned , and some features are added / introduced or made standard equipment.
- A robust process with built in QC is required for the production process.



Developing Models

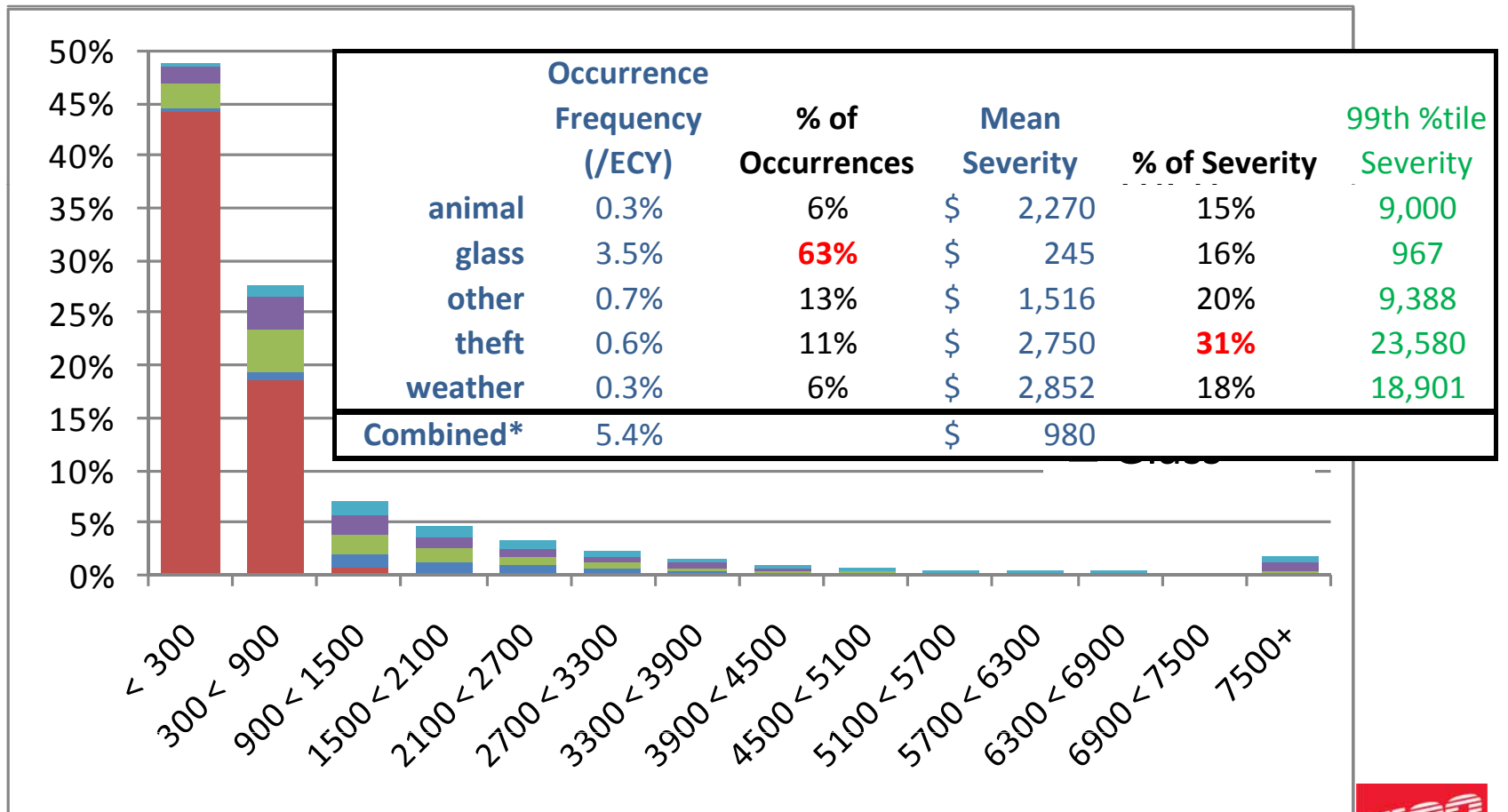
- When developing models from characteristics:
 - The variable selection task becomes challenging.
 - Need to adequately control for covariates (other elements of risk) like garaging address, driver, policy, etc.
 - Different characteristics may be associated with the likelihood (frequency) and the magnitude (severity) of losses, including antagonistic relationships (+/-).
 - Within a multi-peril coverage like comprehensive, different vehicle characteristics may be related to different perils.
 - The aspects of a vehicle that make it attractive to a thief may not matter to a deer.



Comprehensive Perils

By Peril - Frequency and Severity Distributions

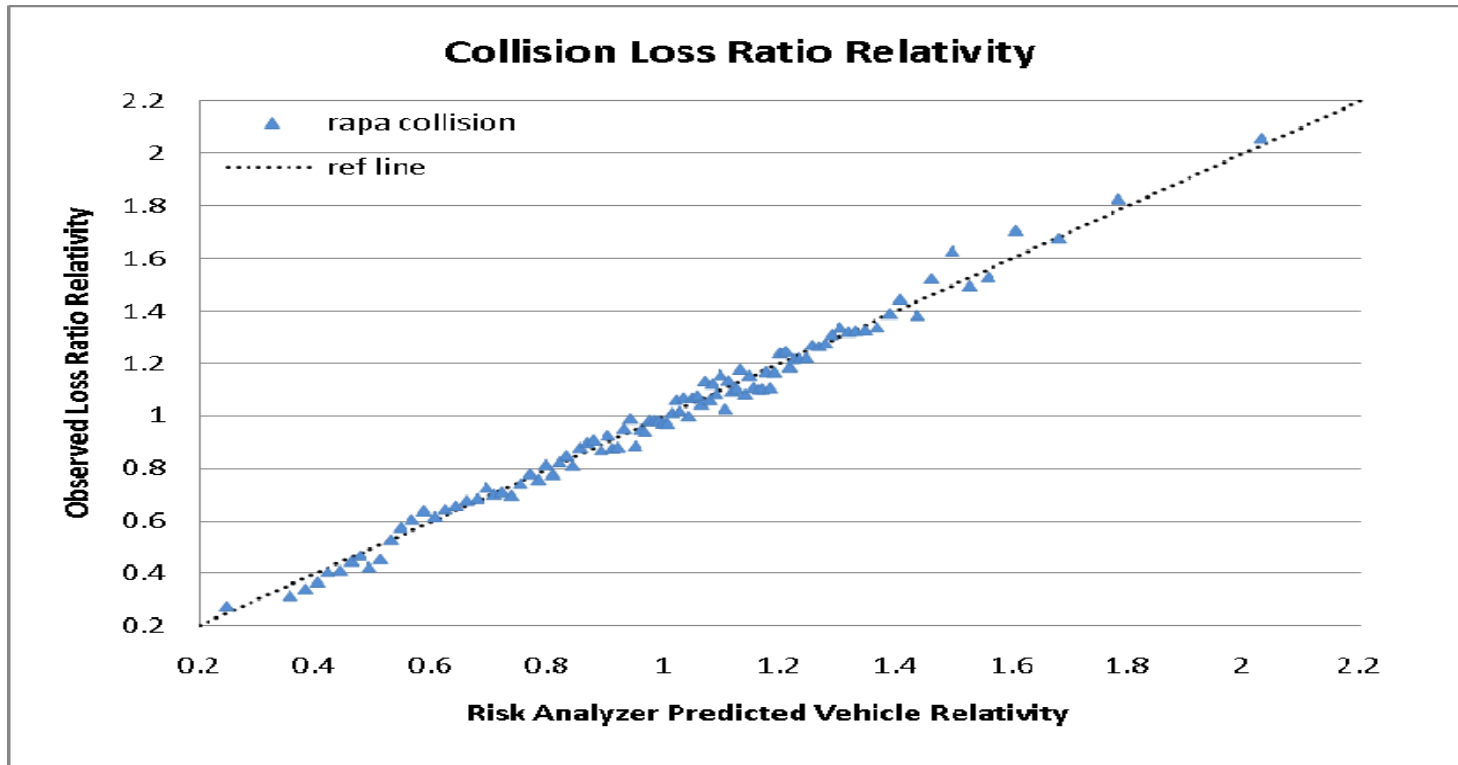
Comprehensive Losses – Severity Distribution



Some illustrative results



Collision Model Validation Predicted Vs Actual

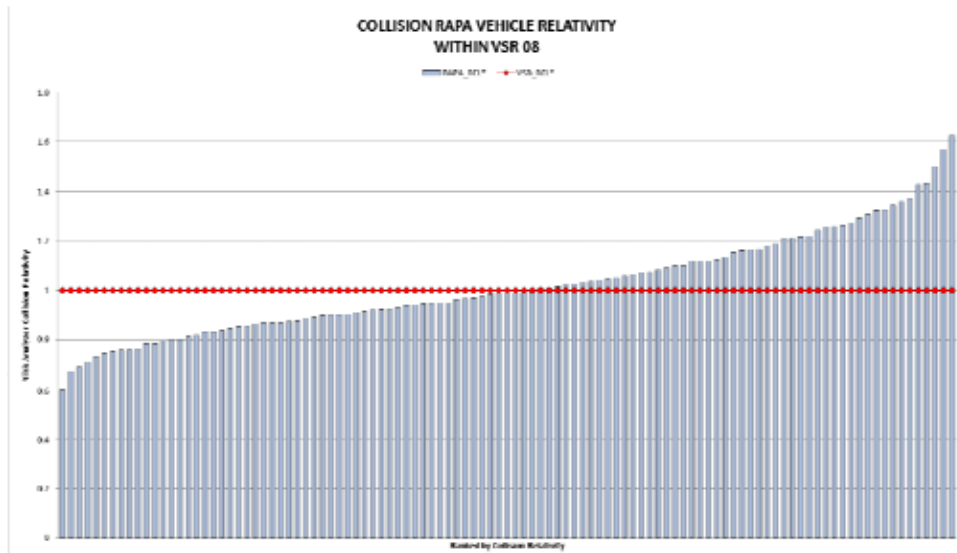


The vehicle model produces highly accurate predictions
in line with the observed losses

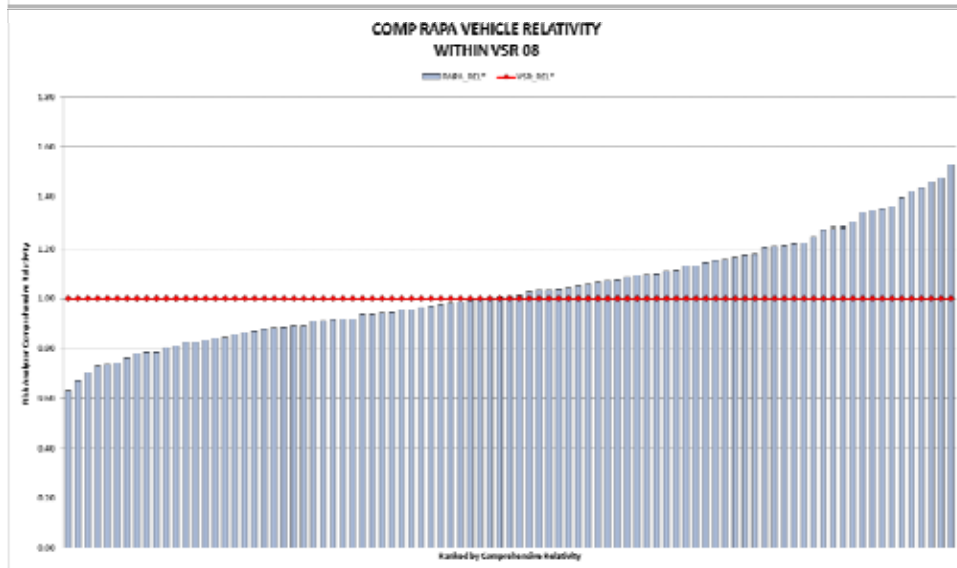
Note: results against a holdout test dataset



Segmentation within VSR SYMBOL 08



Collision
Coverage



Comprehensive
Coverage

Predictive
Modeling using
Vehicle
Characteristics
provides
significant
segmentation
within VSR
Symbols

Example 1: Differentiation within series

2007 Ford Explorer Limited

Selected Attributes				RAPA Symbols/Relativities				VSR Symbols/Relativities		
Cyl	Horse-power	Curb-weight	Price New	COL SYM	COL REL	COM SYM	COM REL	SYM	COL REL	COM REL
6	210	4615	\$34,070	LN	-	LJ	-	'12'	-	-
8	292	4615	\$35,365	LP	+2%	LT	+19%	'12'	Same	Same

RAPA

➤ RAPA Vehicle Module is able to pick up differences among several different styles of a common line, and differentiate the risks.

VSR

➤ The VSR Symbol Set sometimes groups different model trims within a series together under a common VSR symbol.

Example 2: Performance Matters

2007 Honda Accord

Selected Attributes				RAPA Symbols/Relativities				VSR Symbols/Relativities		
Model Trim	Horse power	Engine Size	Cyl	COL SYM	COL REL	COM SYM	COM REL	SYM	COL REL	COM REL
EX	166	2.4L	4	HU	-	HT	-	'13'	-	-
SE	244	3.0L	6	HV	+5%	HV	+7%	'13'	Same	Same

COMP

➤ The relativity for the EX model in RAPA is about 7% higher, compared to a 0% differential in VSR.

COLL

➤ The relativity increase for the EX model in RAPA is about 5%, compared to a 0% differential in VSR.

Example 3: Redesigned Vehicle Series

Toyota Camry 4-Door SE

Selected Attributes			RAPA Symbols/Relativities				VSR Symbols/Relativities		
Model Year	Accel Rate	Price New	COL SYM	COL REL	COM SYM	COM REL	SYM	COL REL	COM REL
2006	X	\$19,925	FR	-	FM	-	'11'	-	-
2007	1.6X	\$18,270	EW	+15%	ER	+8%	'10'	-5%	-9%

COMP

- The 2007 redesign produces an 8% **increase** in relativity over the prior version in RAPA.
- Contrast with a 9% **decrease** in relativity in VSR

COLL

- The 2007 redesign produces an 15% **increase** in relativity over the prior version in RAPA.
- Contrast with a 5% **decrease** in relativity in VSR

Summary

- Vehicle series rating and vehicle characteristic driven modeling
- Techniques and challenges: vehicle data for modeling and results
- Questions?

