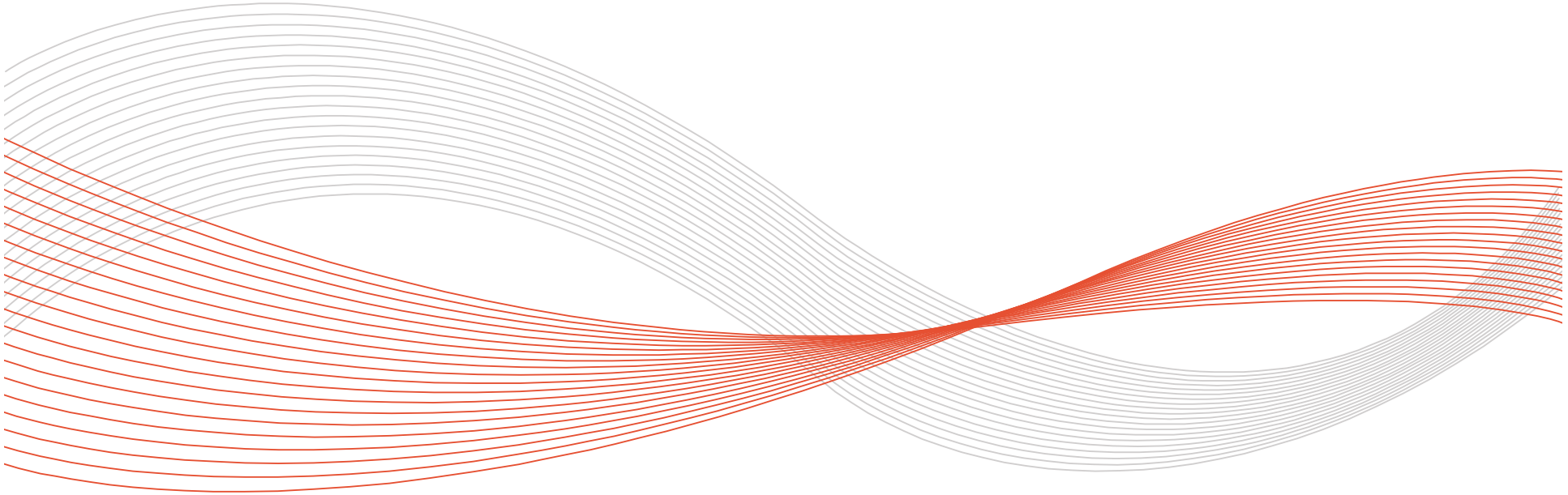

Advanced Uses of Predictive Modelling

3rd General Insurance Conference Singapore Actuarial Society

3rd June 2011

Jim Qin, FIAA, CFA, FSAS

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Agenda

- Predictive modelling in
  - General Insurance
  - Health Insurance
  - Life Insurance
- Predictive modelling in wider fields
  - Marketing science
  - Analytical CRM
  - Credit scoring
- Modelling techniques
- What makes a good GLM?

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What is predictive modelling?

- Predictive modelling is the process of discovering patterns of behaviour.
- A model is created to try to predict the probability of an outcome given a set amount of input data.

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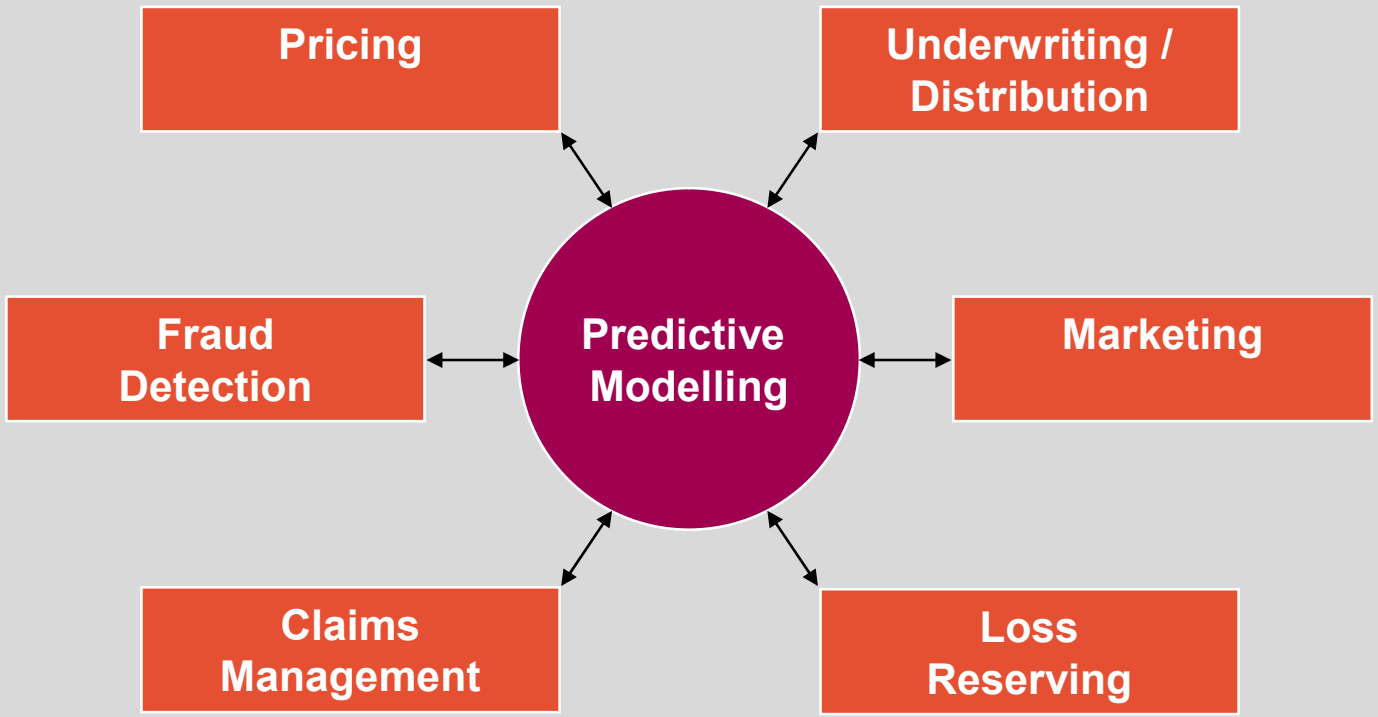
Insurance



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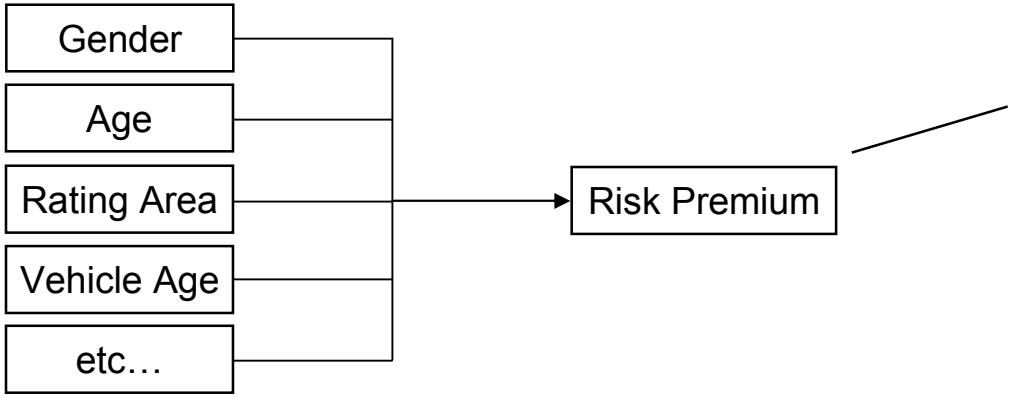
Pricing

- Aim to predict a response variable using a series of explanatory variables (rating factors)



- Increasingly used for other lines:
  - Motor
  - Property
  - Workers Compensation
  - Marine and Aviation
  - Credit and mortgage insurance
  - Personal Accident
  - Health Insurance
  - Life Insurance (mortality)

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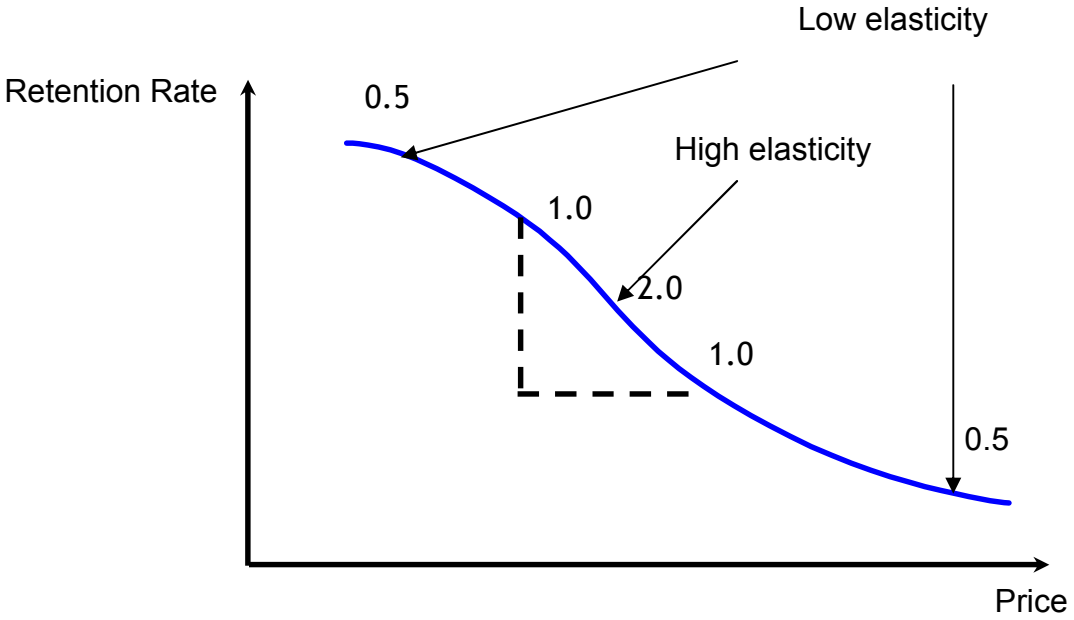
Demand modelling – price elasticity



- There are different definitions of elasticity
- Common definition is % change in demand for % change in price
- Price elasticity varies by price:
  - "Policyholder X has elasticity Y"
  - Be wary of assuming straight lines (even in linear predictor space)

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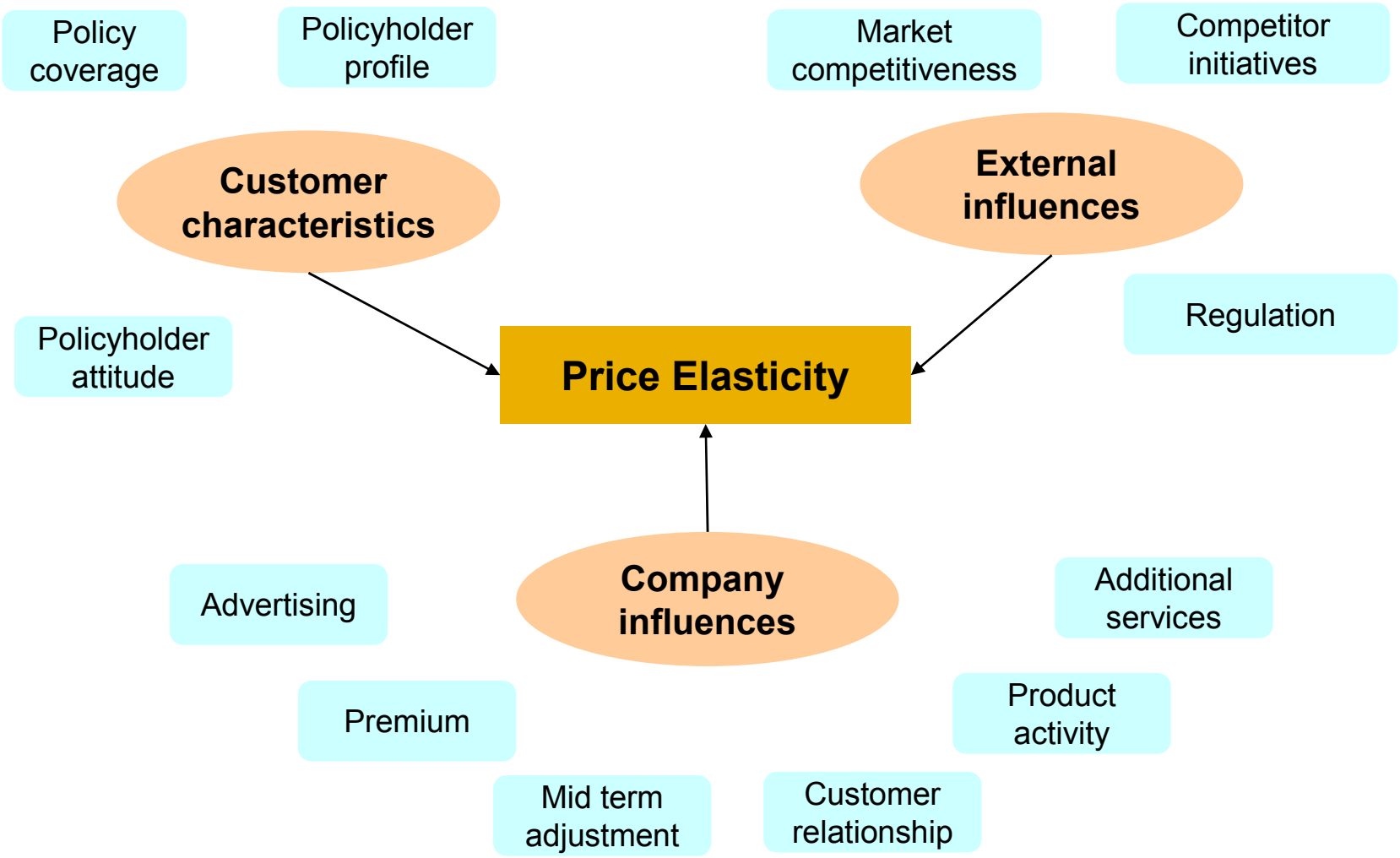
Elasticity drivers



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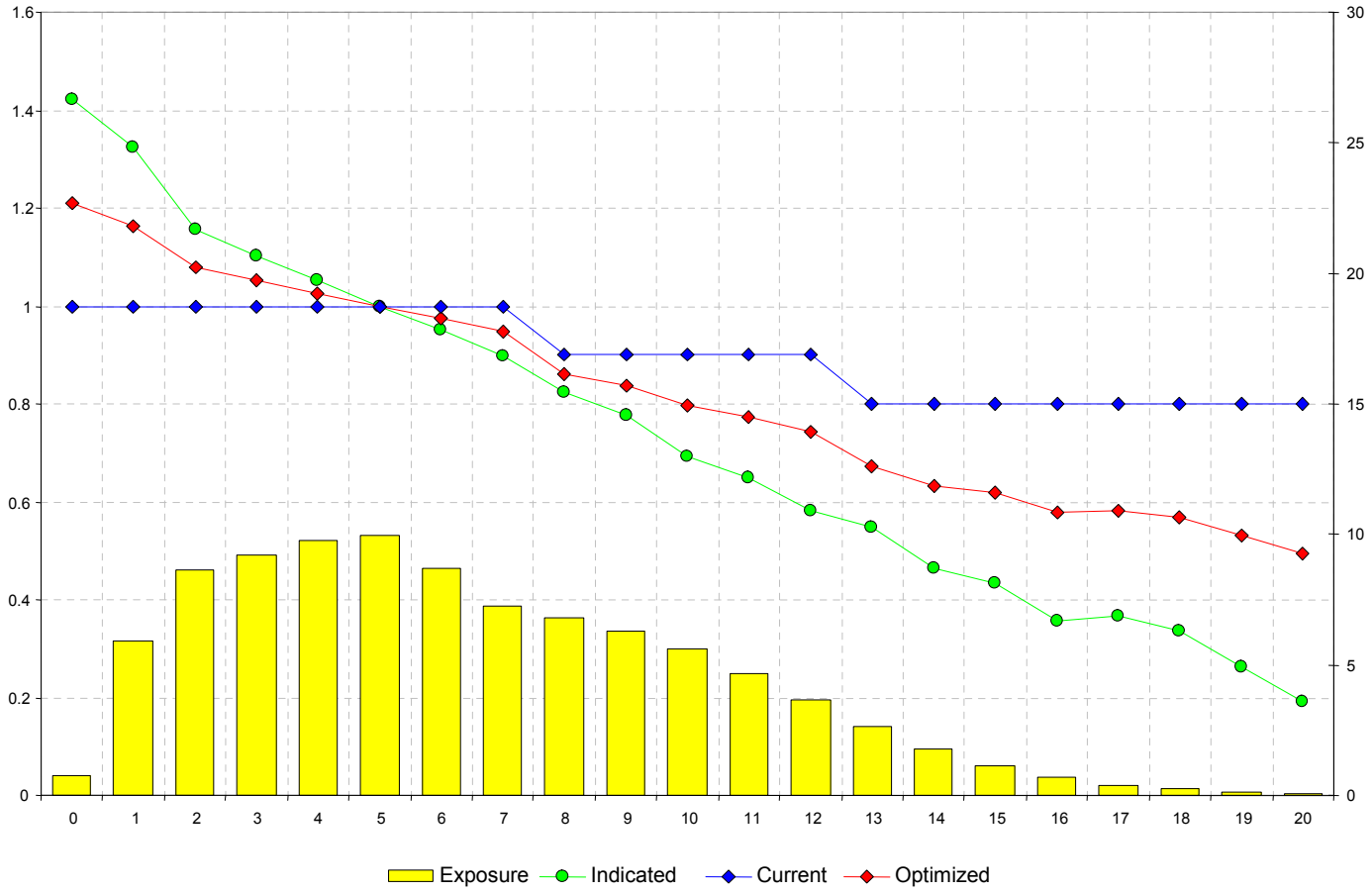
What is price optimization?



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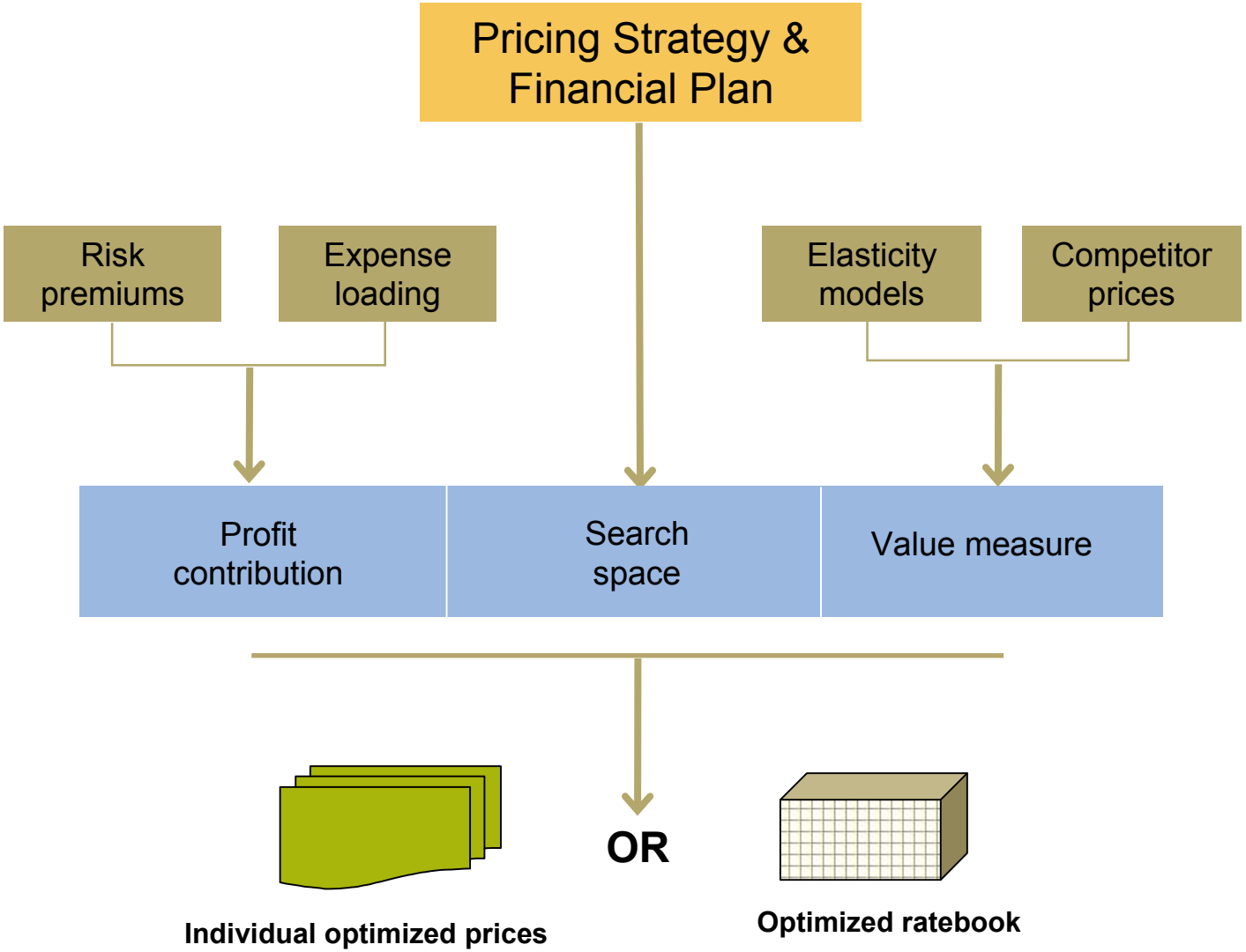
Price optimization



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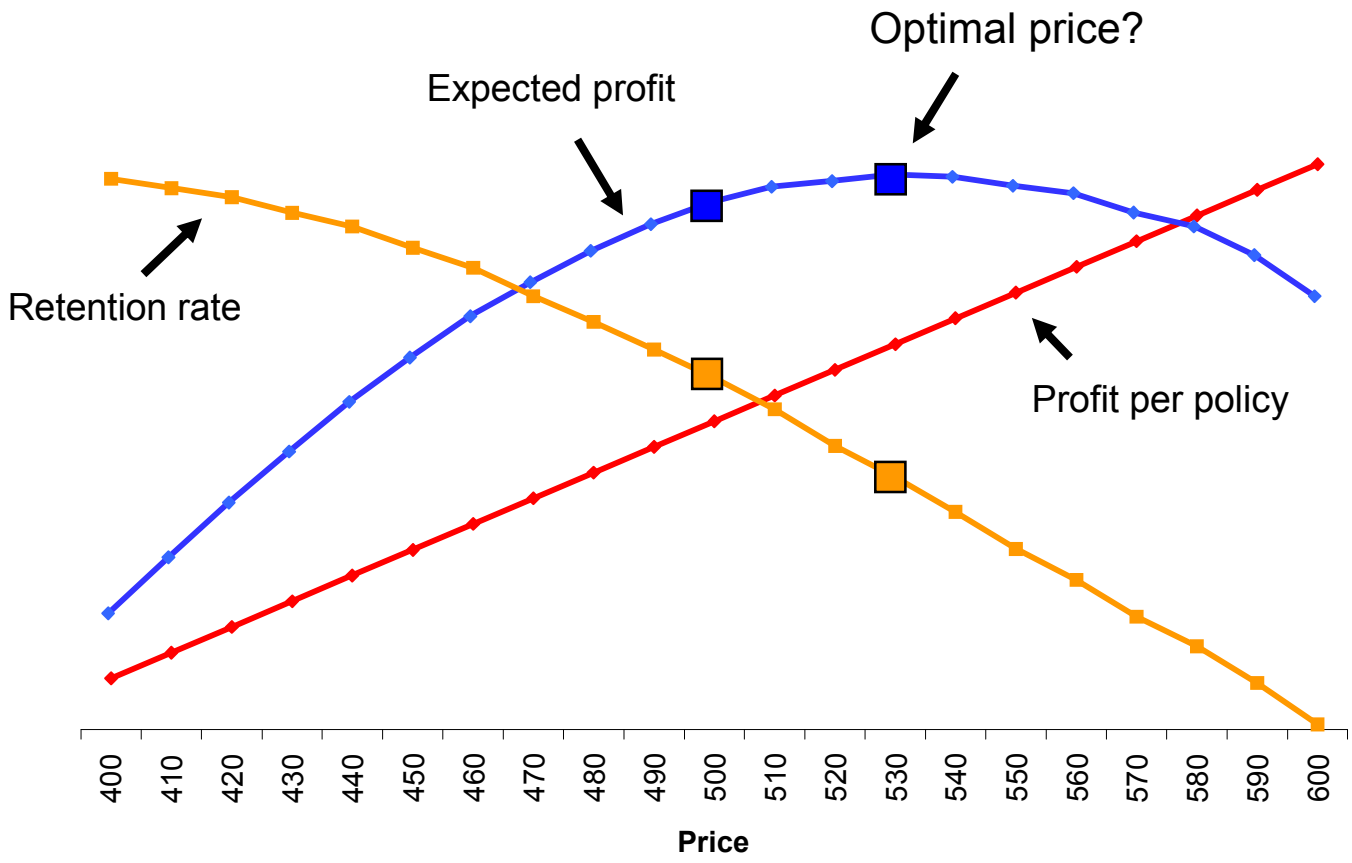
Case Study



Premium for policy in question

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Claims Related Predictive Modelling

Predictive Analytics	Response	Explanatory Variable
Statistical case estimate	Ultimate claims cost	Claim characteristics
Loss reserving	Transition Probability Ultimate claims cost	Claim characteristics Claim management
Drivers of Claims inflation	Average Claim Size	Claim characteristics Claims management Legislative changes
Claims Management	Claims Outcome	Claims characteristics Key Performance Measures
Fraud	Ultimate claims cost	Claim characteristics

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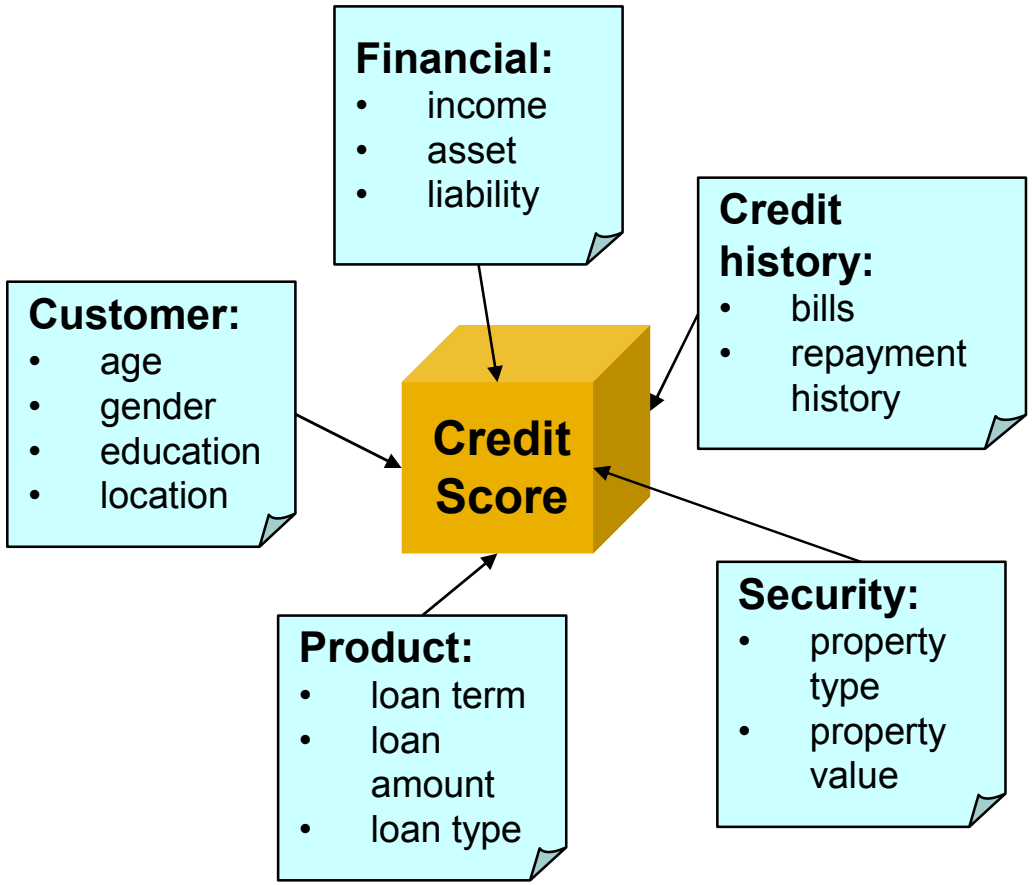
Case Study: Credit scoring

- Credit scorecard used for underwriting decisions:
  - Home loans
  - Credit cards
  - Personal loans
  - Business loans etc
- Model considerations:
  - Individual or policy scorecard?
  - Does the credit score of an individual change over time?
  - Binary outcome: logistic regression
  - Credit cycle



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Modelling techniques

- One way analysis
- Simple Regression
- Generalised Linear Modelling
- Generalised Non Linear Modelling
- Decision Tree
- Random Forest
- Neural Network

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One Way Analysis

- One way analysis focuses on one risk factor at a time: e.g. car brand
- Traditionally one-way tables and graphs were used to examine relative experience and to give an immediate view of exposures and trends.

The failings of one way analysis:

- It does not allow for random variation in experience.
- It fails to take into account the relationships between risk factors
- What is the relativity between male and female (see table)?

Risk	Urban	Rural
Male	20%	10%
Female	10%	5%

Exposure	Urban	Rural	Total
Male	200	100	300
Female	100	200	300
Total	300	300	600

Claims	Urban	Rural	Total
Male	40	10	50
Female	10	10	20
Total	50	20	70

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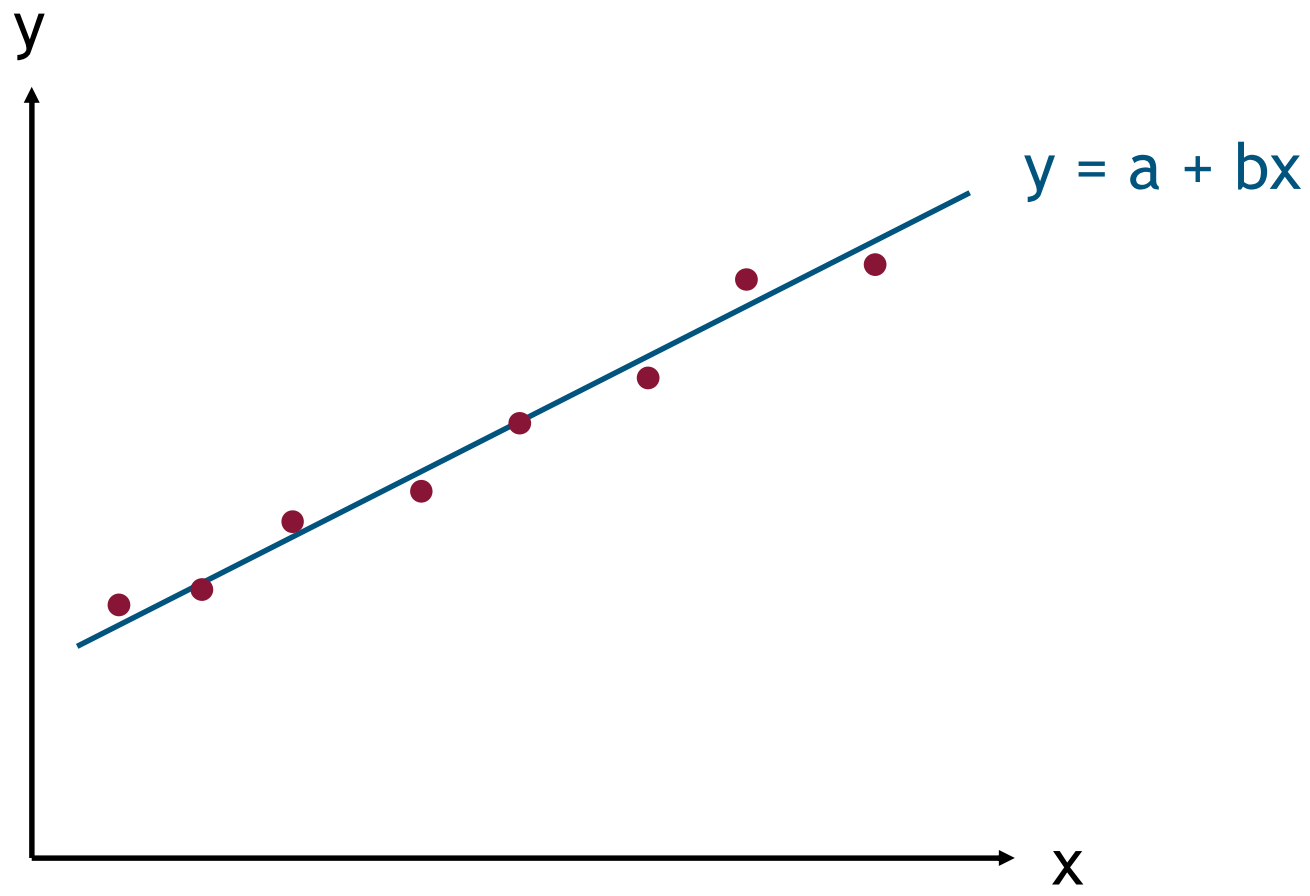
Simple (Classical) Regression



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Assumptions of Simple Regression / GLM

Simple Regression	GLM
Each observed response:	
Is independent	is independent
from a ***Normal Distribution***	is from a member of the ***exponential family*** of distributions
may have a different mean	may have a different mean
has the ***same*** variance	has a variance determined by the ***chosen*** distribution
The expected value of the response:	
is a ***linear*** combination of the covariates	is a ***function*** of a linear combination of the covariates

GLM is global standard for Insurance Pricing

- Consider all factors simultaneously
- Allow for nature of random process
- Robust and transparent

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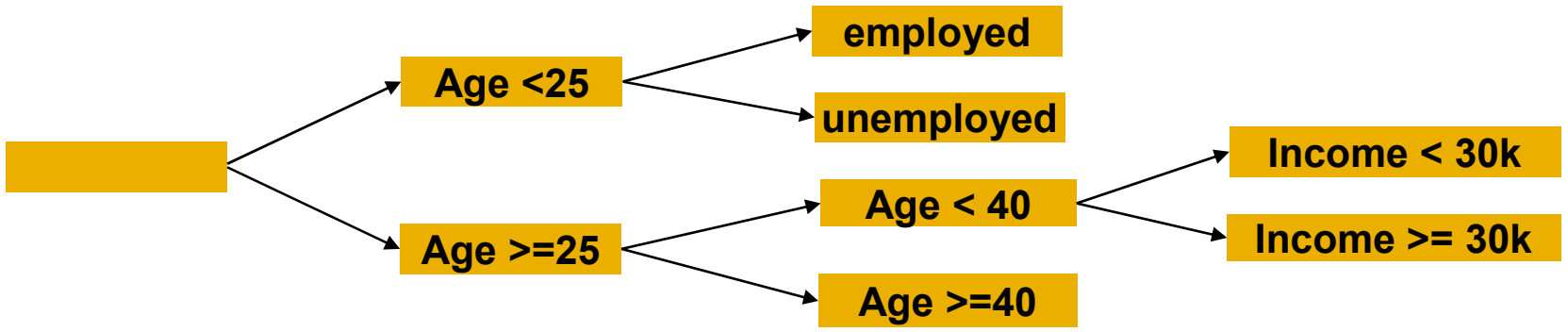
Decision Tree

- Decision trees are formed by a collection of rules to get the best split to differentiate observations based on dependent variables
- Classification and regression trees (CART) is a decision tree **learning** technique that produces either classification (categorical) or regression (numeric) trees.
- Machine learning technique / Random Forest



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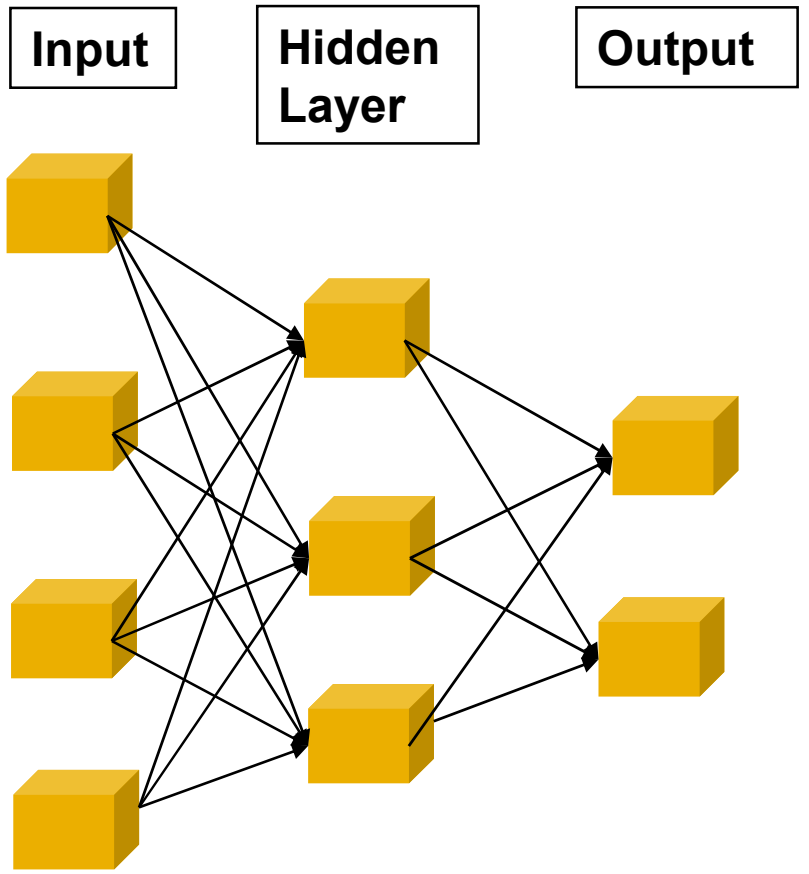
Neural Networks

- Neural networks are **nonlinear** sophisticated modelling techniques
- Neural networks are used when the exact nature of the relationship between inputs and output is unknown
- Neural networks learn the relationship through supervised and unsupervised training
- Difficult to explain the relationships modelled using neural networks.



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What makes a good GLM?

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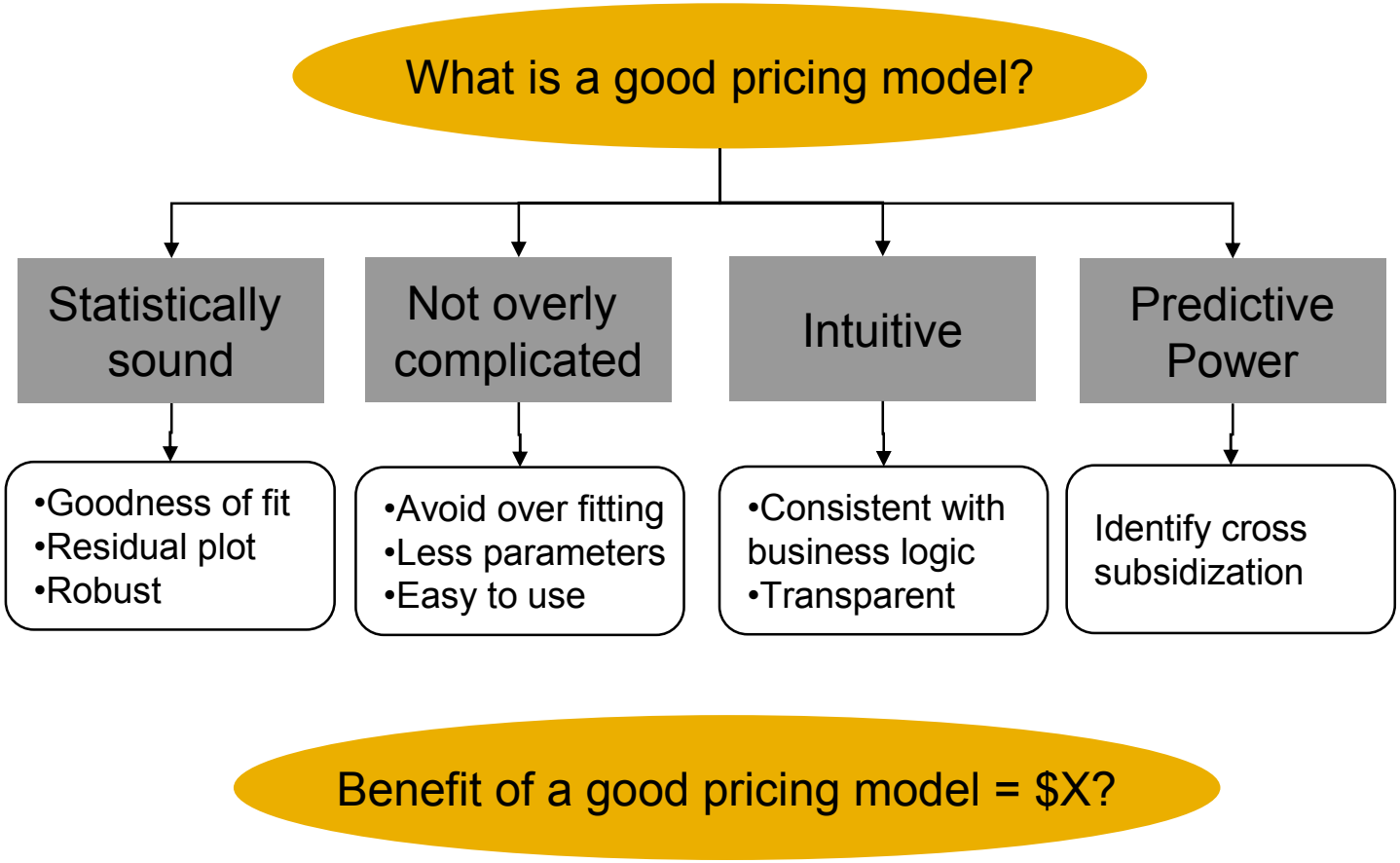
Power of a good pricing model



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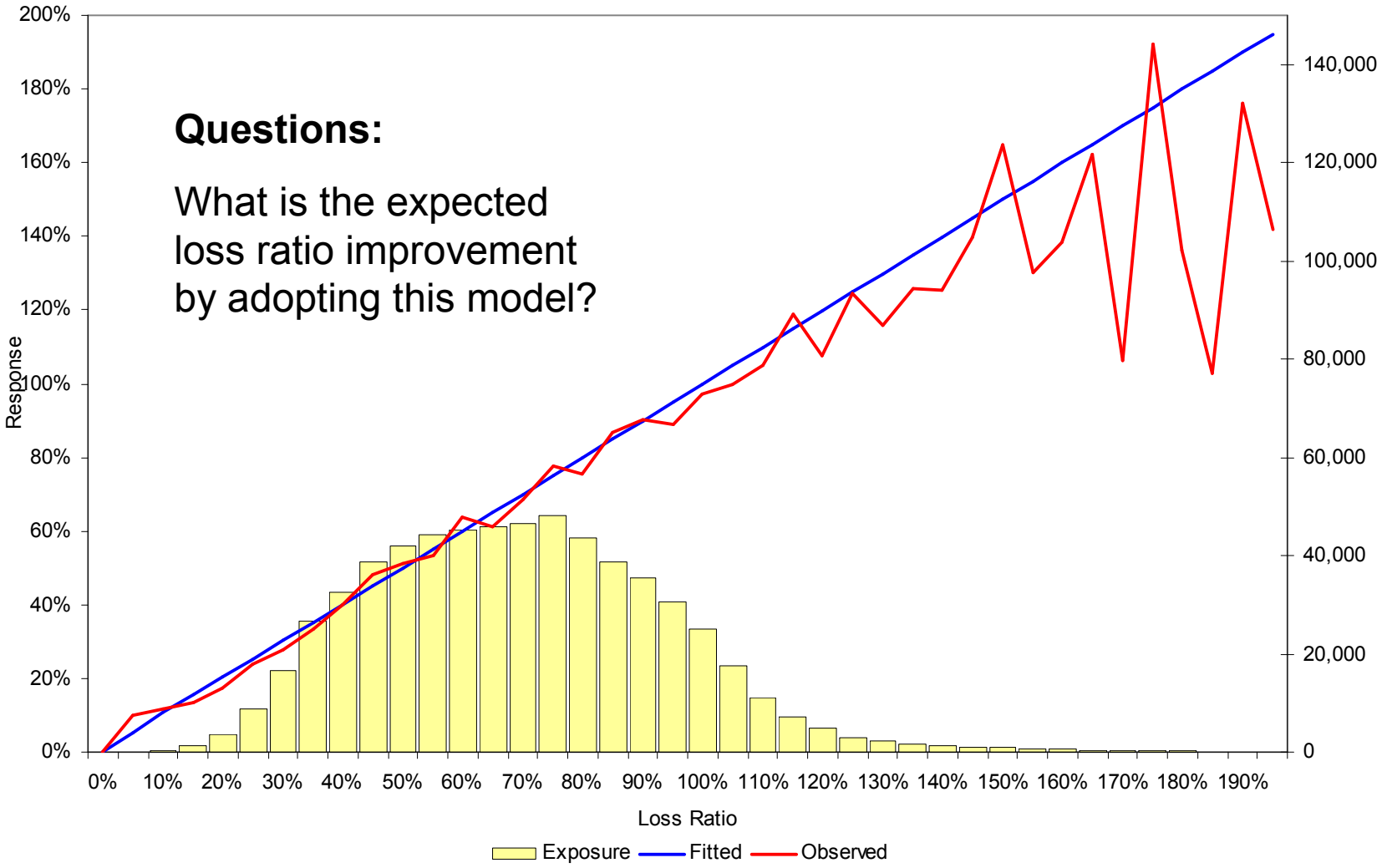
The power of a good model



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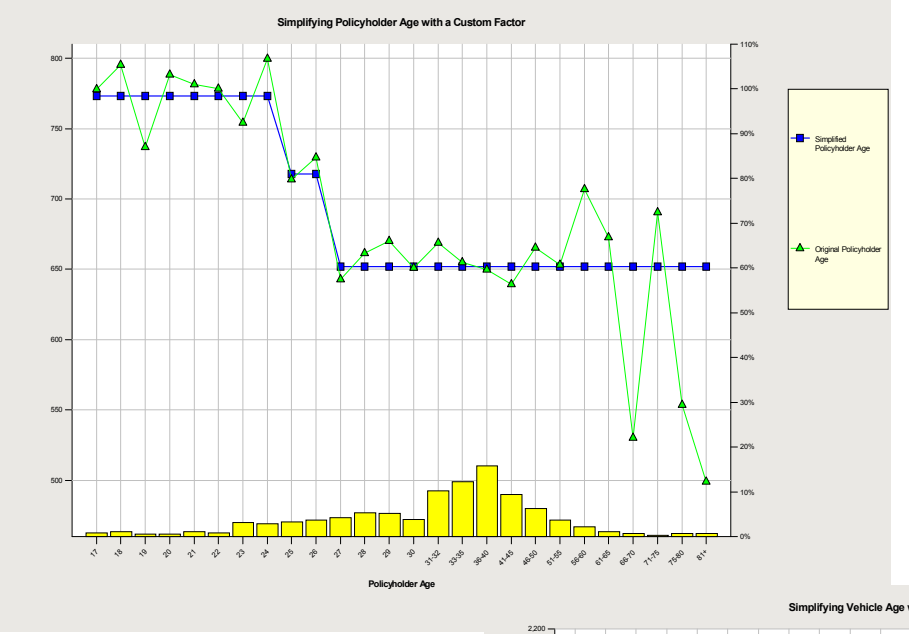
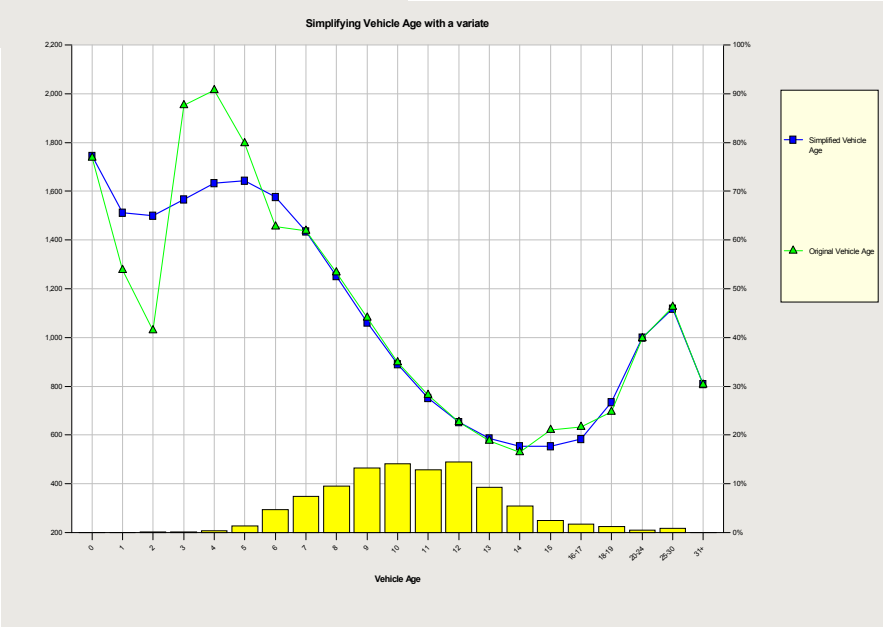
Simplifying Trends

> Simplify trends in rating factors in order to remove random noise



> Can do this by grouping factor levels …

> … or by fitting curves



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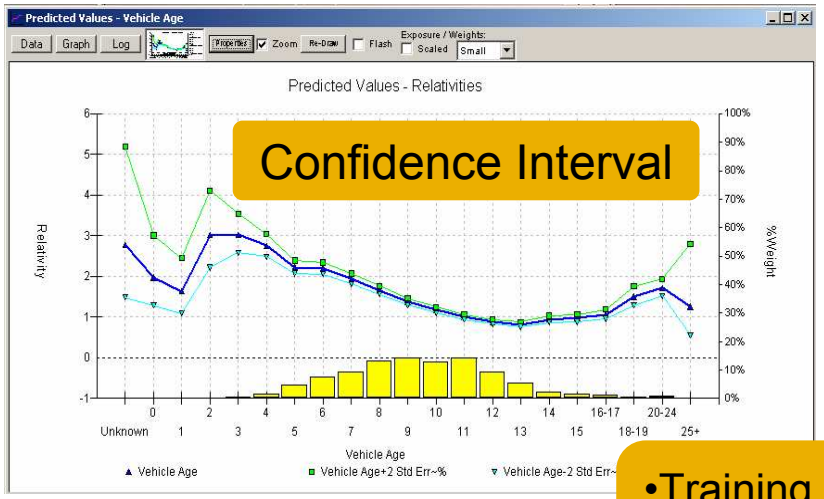
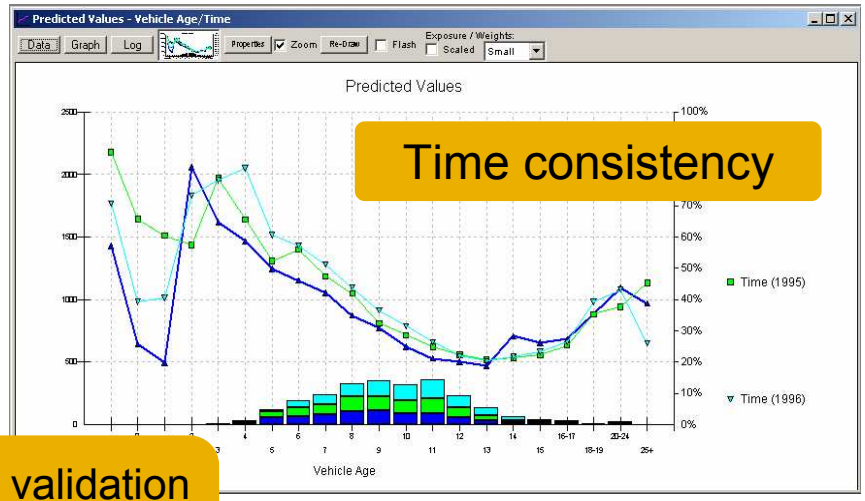
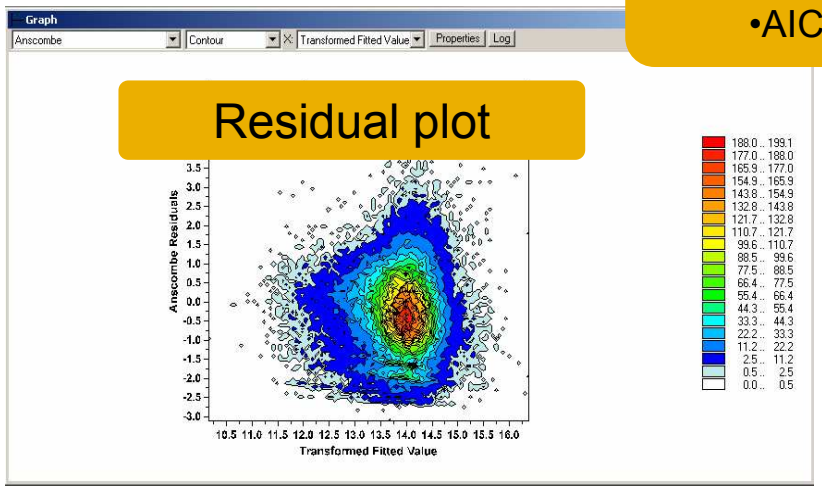
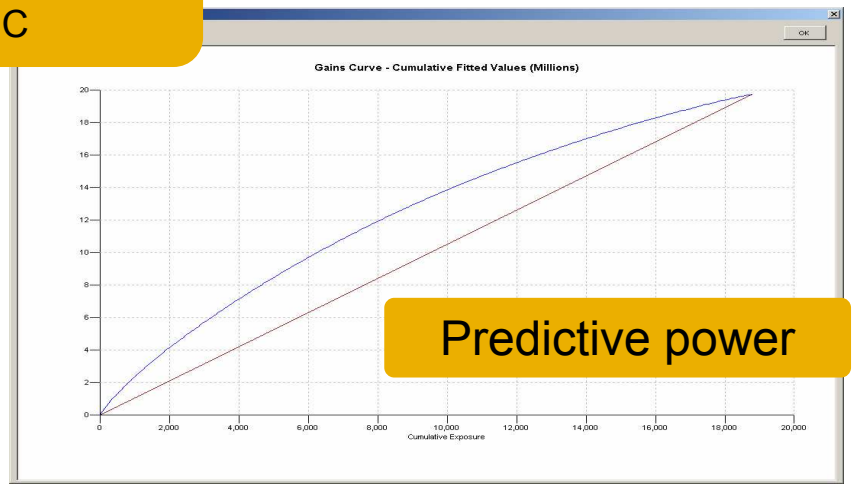
Model validation





- Training & validation
- Statistical test
  - Chi square, F
  - AIC, BIC





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Questions?

- Jim Qin
  - 135 Cecil Street, #09-01 Singapore 069536
  - (65) 6880 5685
  - Jim.qin@towerswatson.com

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