CAS RPM SEMINAR

Price Sophistication: from cost modelling to optimization…and beyond

by Yves Colomb

March 2015

TOWERS WATSON

Ratemaking vs. Pricing

- Actuarial Ratemaking

  Actuarial Statement of Principles on Ratemaking:
  A rate is reasonable and not excessive, inadequate, or unfairly discriminatory if it is an actuarially sound estimate of the expected value of all future *costs* associated with an individual risk transfer

- Pricing

  Taking into account *all factors*, such as costs, regulatory constraints, business constraints (e.g. competitive constraints) and strategic constraints when setting actual price charged

- Traditionally, actuaries provide the *actuarial indication* which was an input into the *pricing* decision

Today is about *pricing* analytics

Introduction: objectives, context & definitions

- Objectives
  - Price sophistication is a natural evolution
  - Why this phenomenon will continue
  - Prompt action

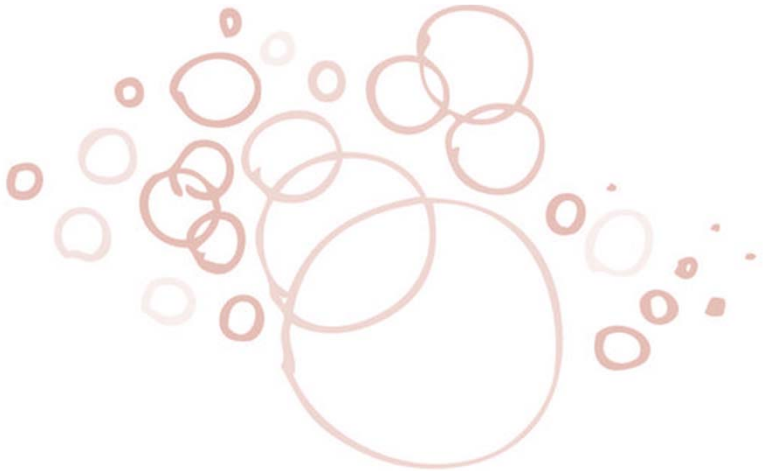
- In the context of an insurance book 

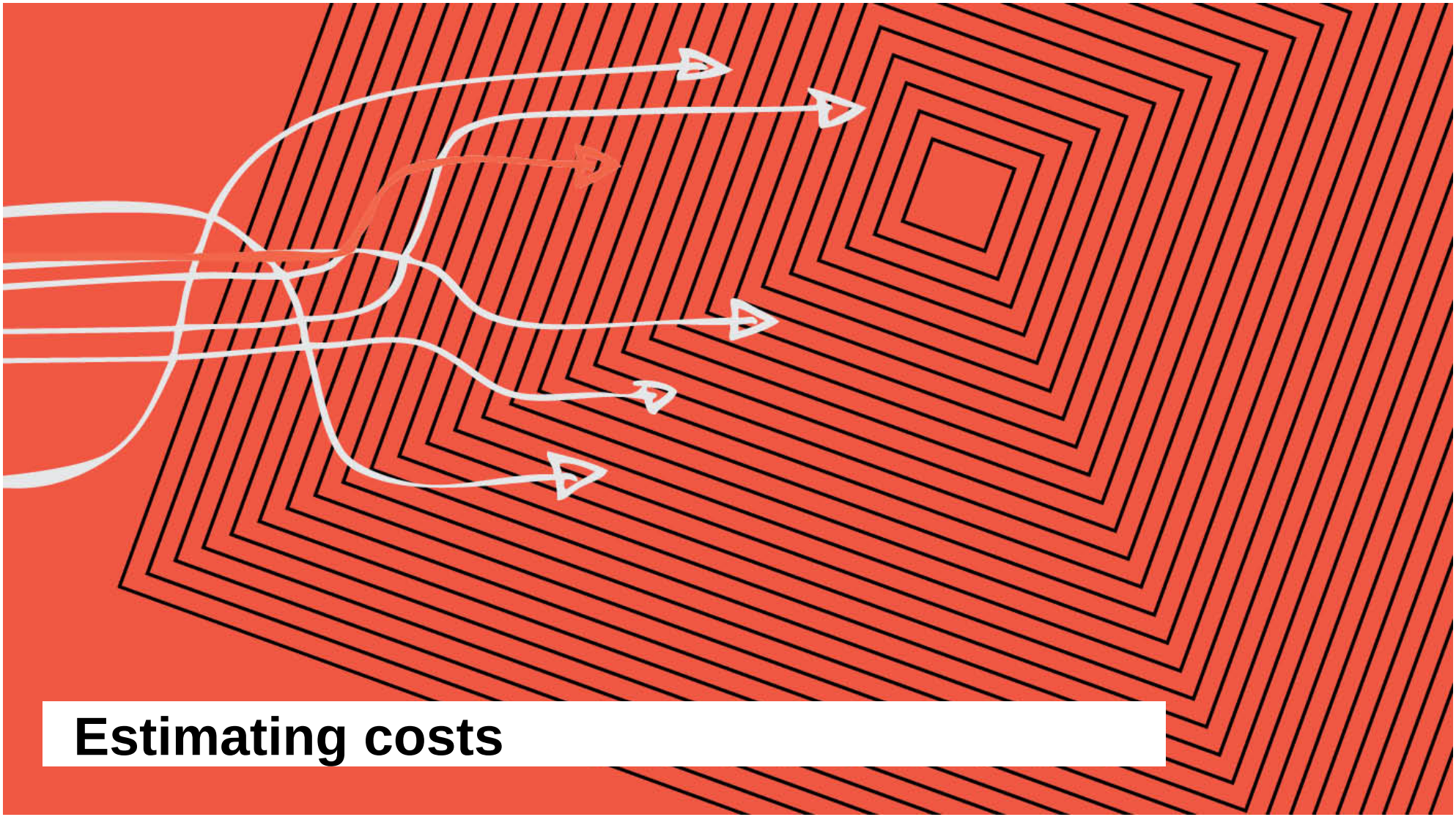
- Price is defined as the sum of several components
  - Loss estimate
  - Expenses and other costs
  - Profit margin

A history of pricing approaches

Agenda

- Estimating costs
- Estimating customer behavior
- An integrated framework
- Over and beyond …





Estimating costs

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Estimating Loss Costs

- The simplest of models is based on E(X)
- Why not use it? Since we are at book level….

- Because:
  - Price is a signal…
  - …leading to policyholder behavior…
  - …because E(X) has no consideration for individual risk of loss
- Need to modulate the signal sent to policyholders

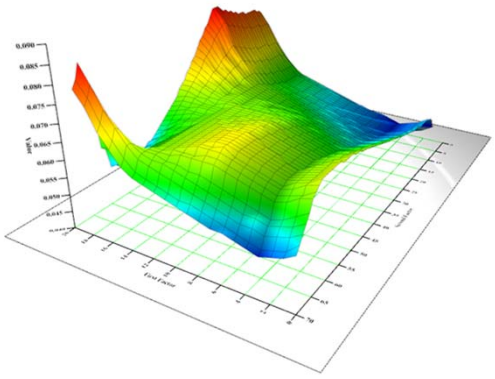
Estimating Loss Costs – with segmentation

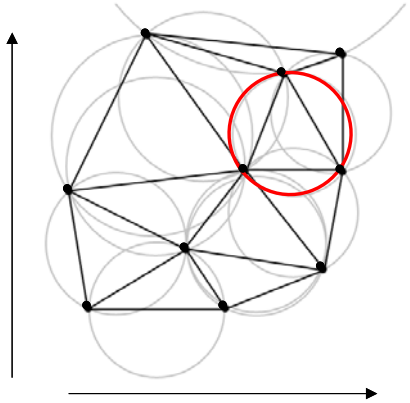
- Requirements
  - Risk level information (observations, predictors)
  - Model form?
- More accurate modelling
  - At granular level
  - Not dramatically so at book level

- The GLMs take over
- Refinements
  - Numerous possibilities accuracy and predictiveness

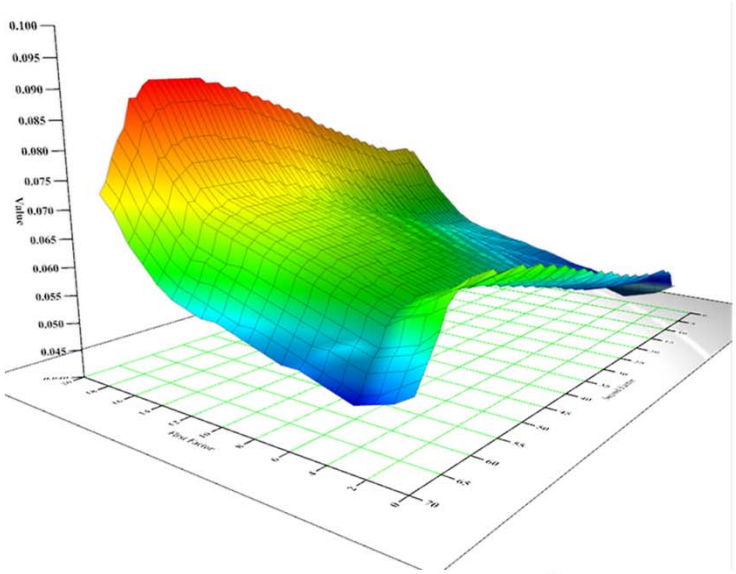
Estimating Loss Costs – with segmentation & refinement

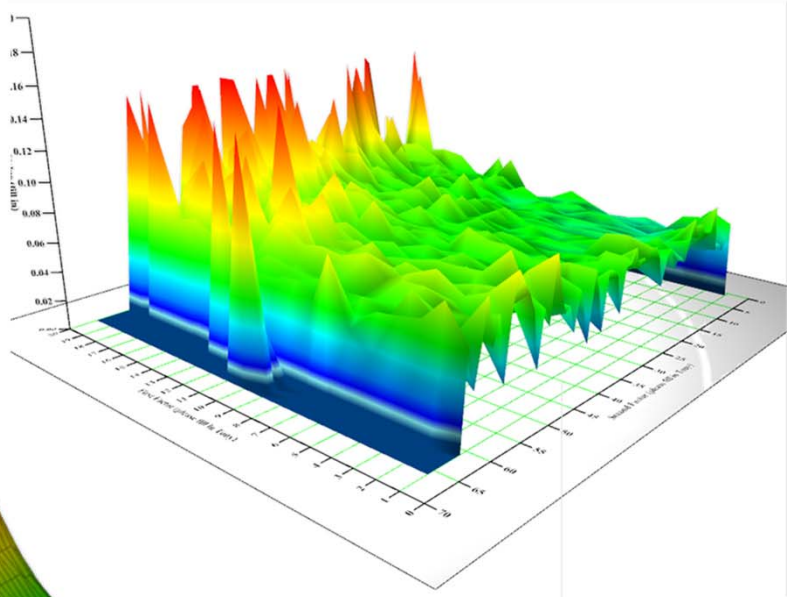
- New predictors
- Clustering techniques
- Spatial smoothing to create territory definitions or vehicle symbols
- Interaction detection, saddles
- UBI score for auto, devices for property

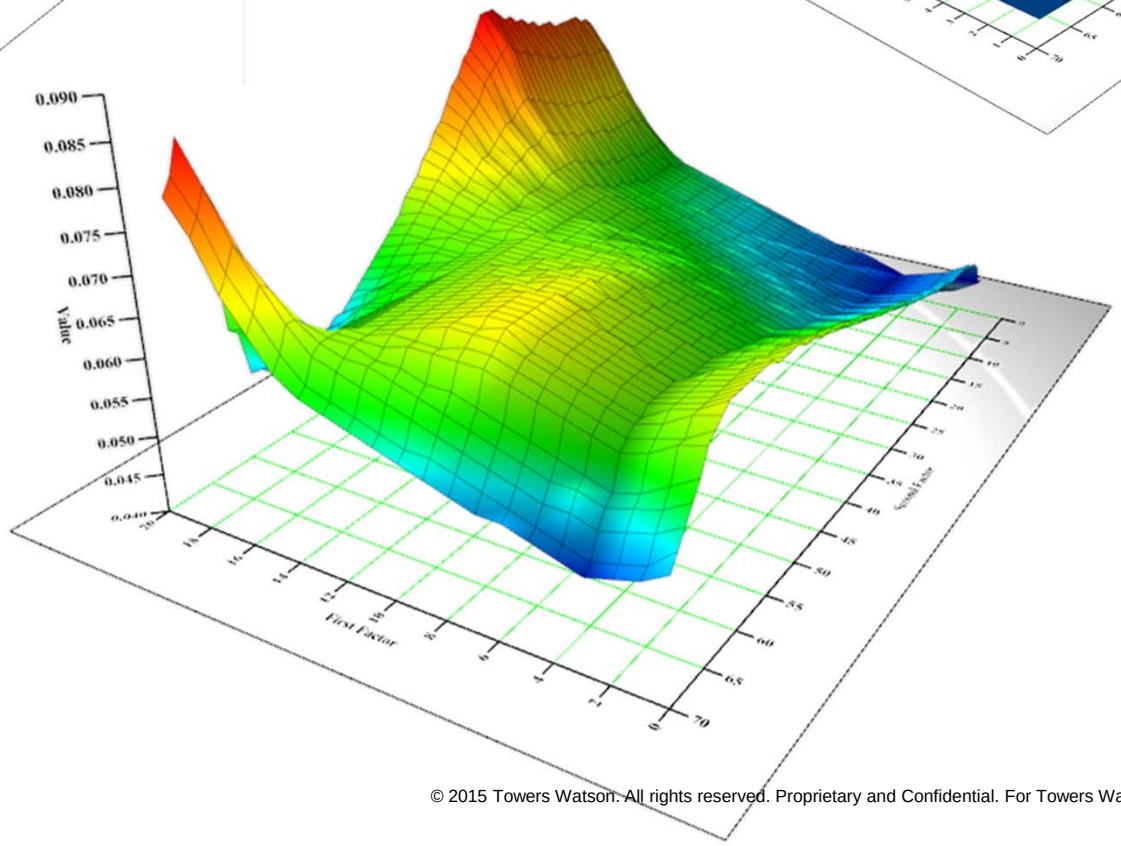




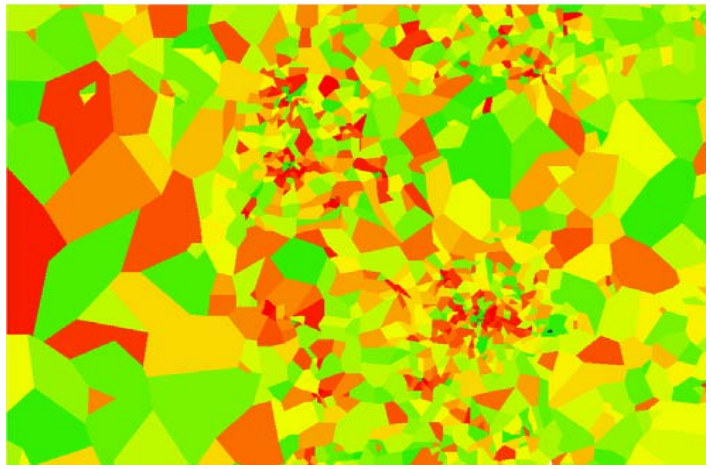
Interactions



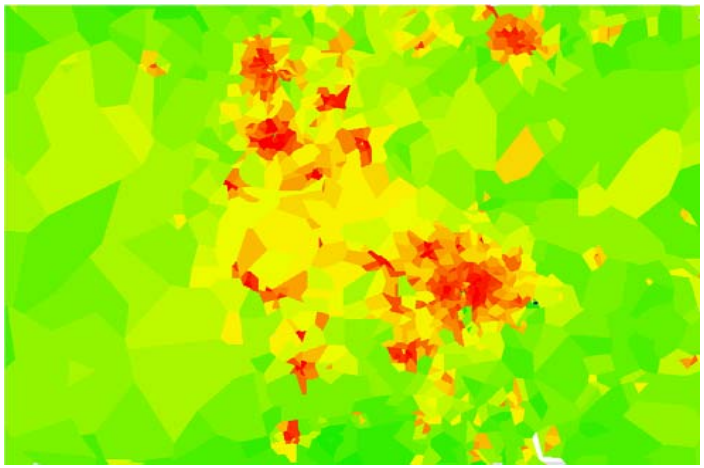




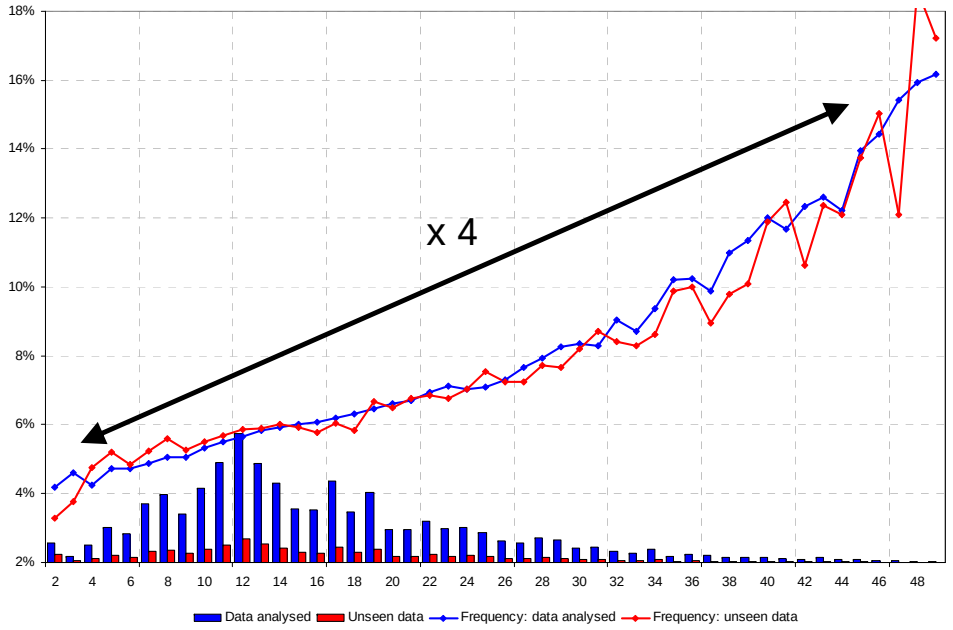
Spatial smoothing



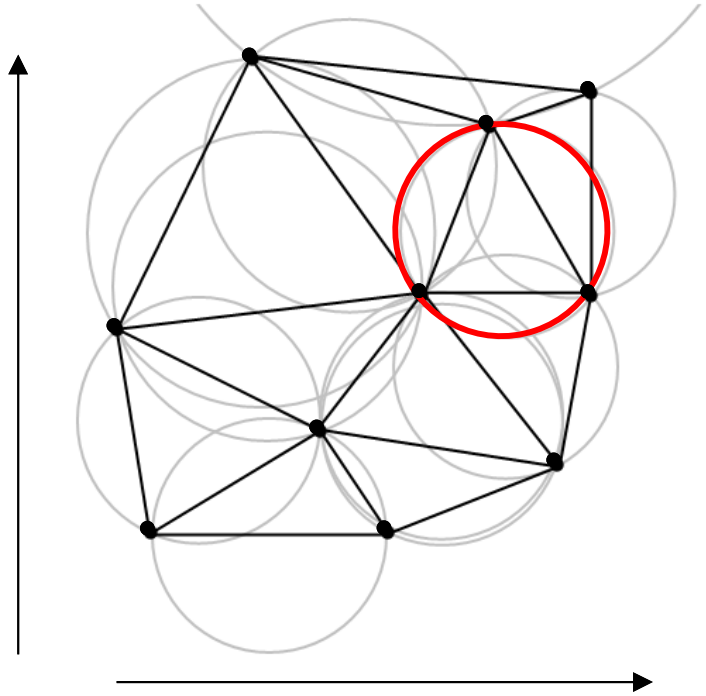
Unsmoothed

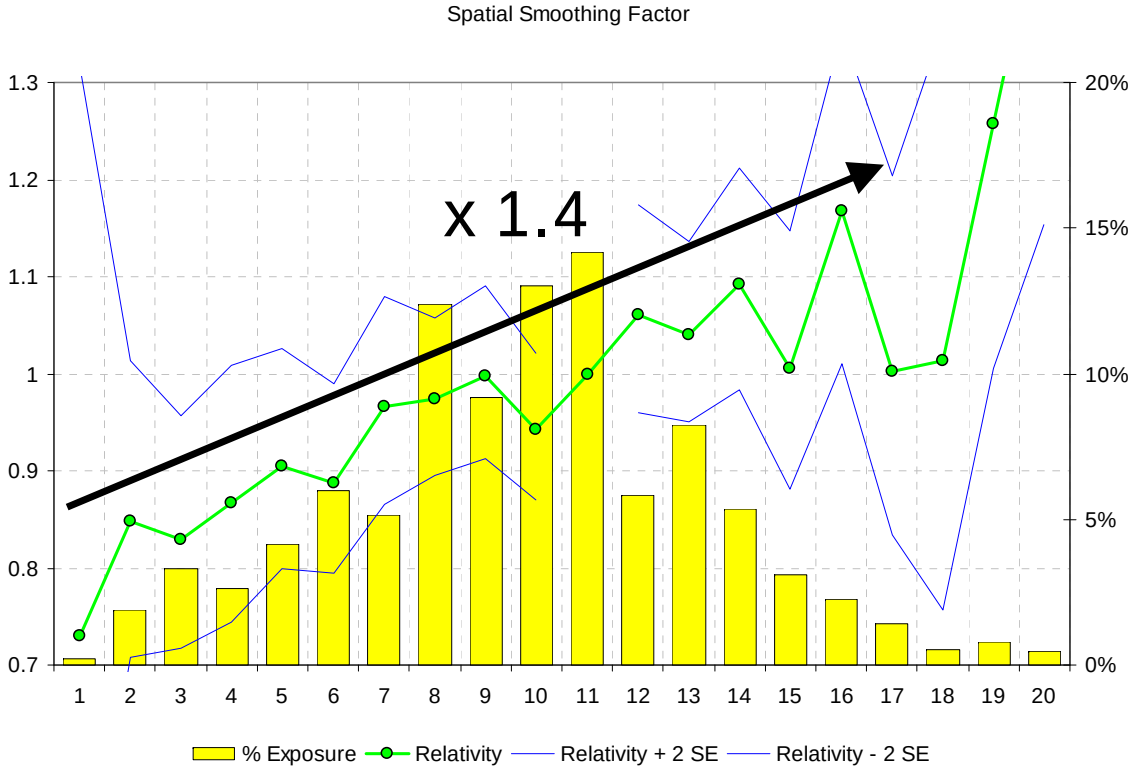


Smoothed

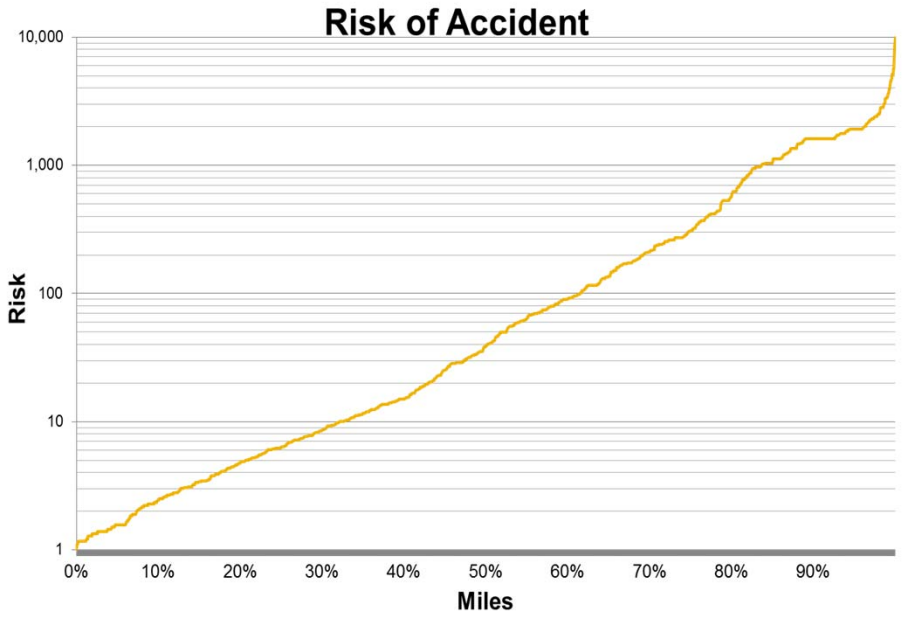


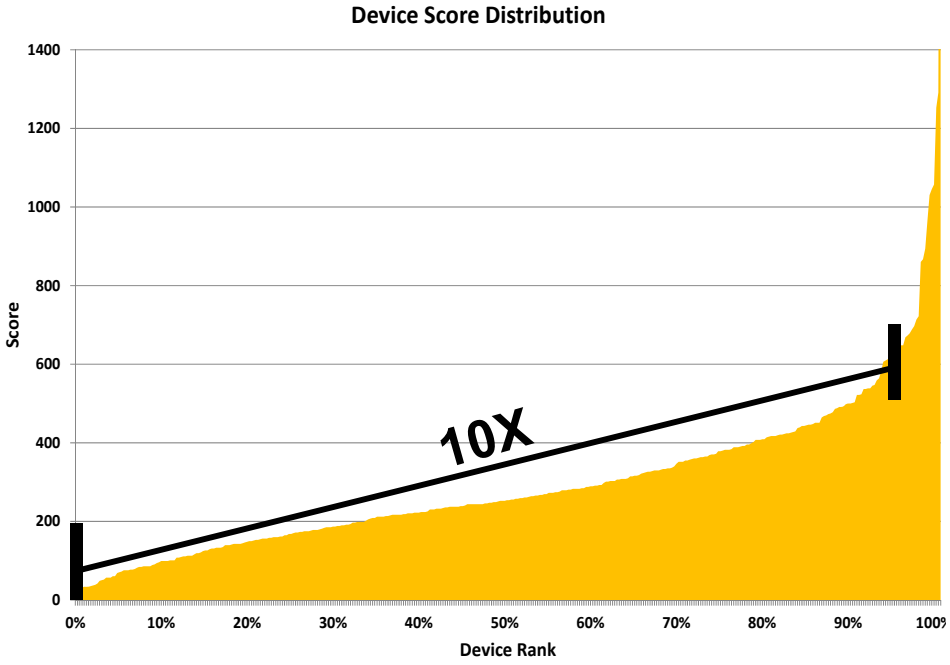
Analogous vehicle groupings techniques

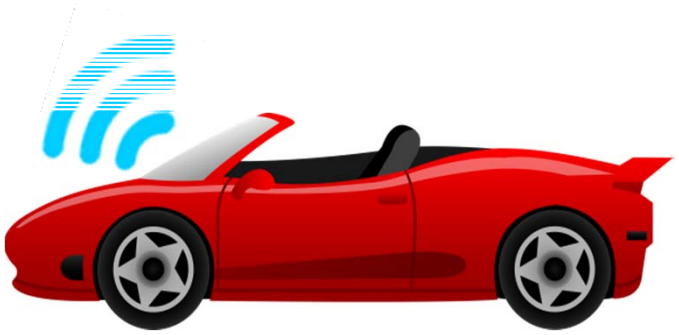




Usage Based Insurance







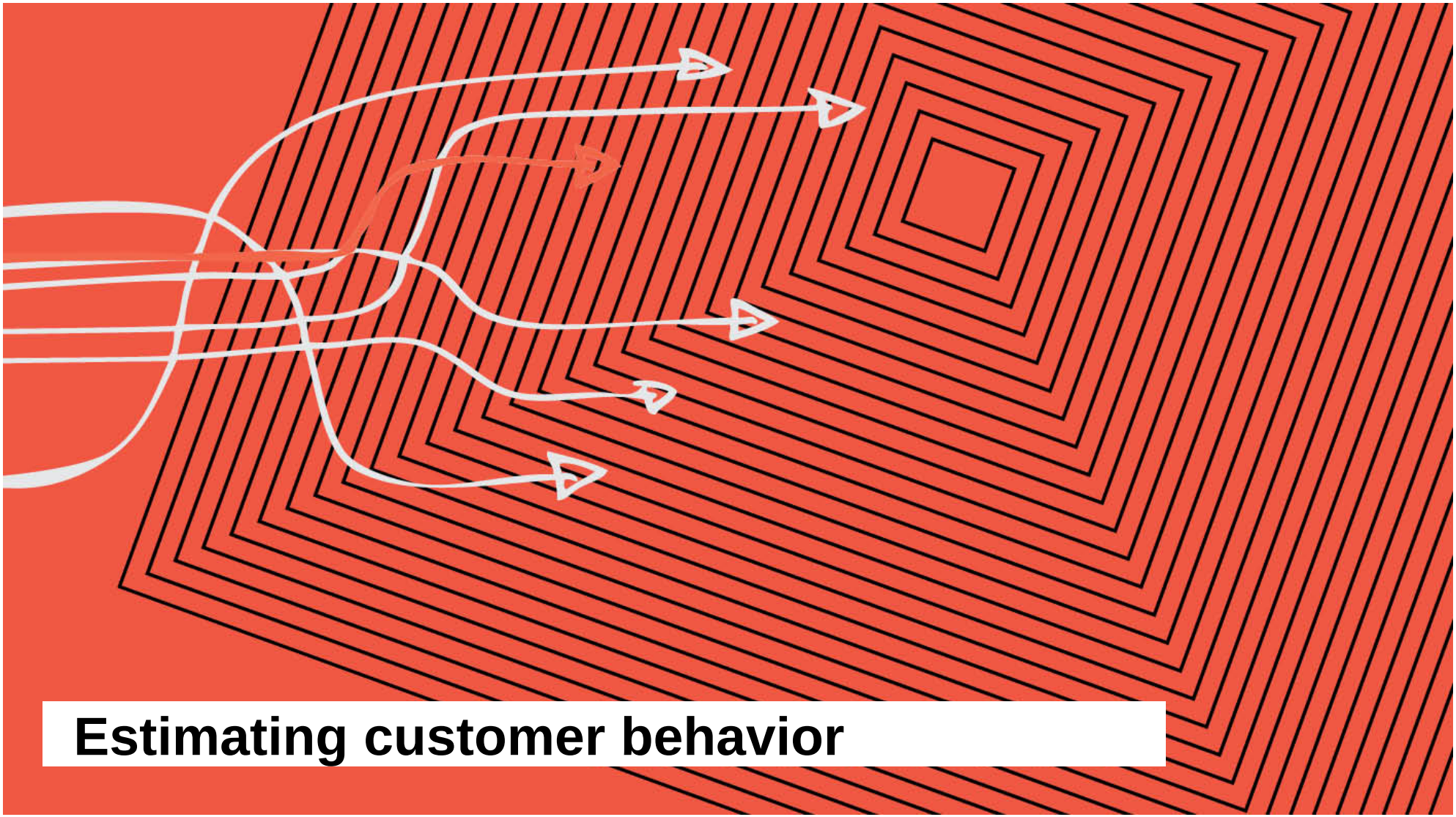
Estimating Loss Costs – with segmentation & refinement

- What can this be used for?
  - Indications (“CostPlus”)
  - Subsidies
  - Loss ratios, profit

- A thought experiment: what if charged = indicated?
  - Anti-selection remains
  - Volume and performance are typically inferior

- How is segmentation an improvement?
  - Some consideration of individual risk of loss (expected value basis)
  - Acknowledges price signal…
  - Mitigates anti-selection through price signal

- BUT some behaviors are left uncaptured (mix of business turn)



Estimating customer behavior

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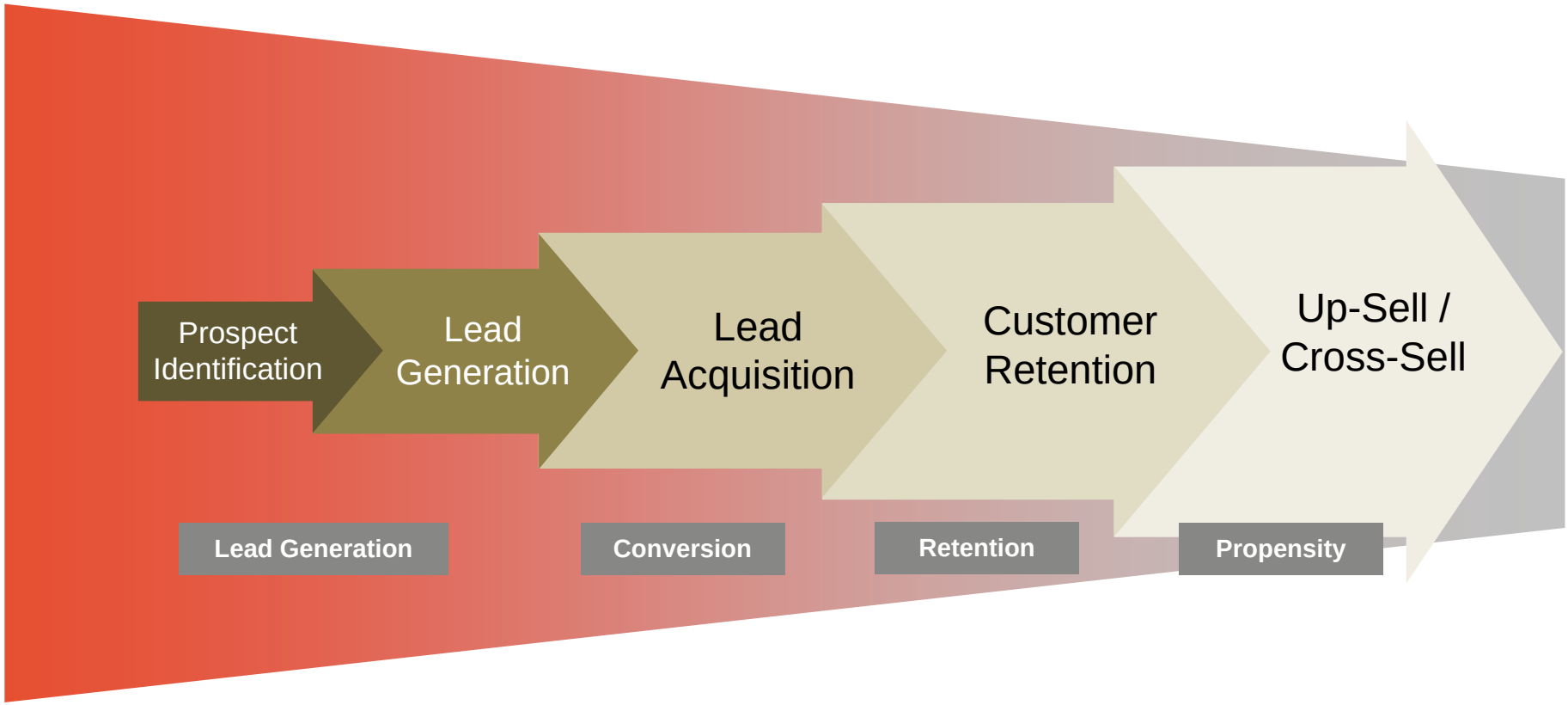
Estimating Customer Purchasing Behavior ('Demand')

- More complex than estimating loss
  - Multiple products/risks
  - Closely linked to distribution e.g. intermediaries
  - Multiple dimensions: quote conversion, acquisition, renewal, up-sell, cross-sell



Estimating Customer Purchasing Behavior ('Demand')

- Binary choices not well processed by humans

- Framing bias
  - *A deadly outbreak breaks in a town of 600 people. All 600 people in the town are expected to die if you do nothing. Two different programs are designed to fight to the disease:*
    - *With Program 1: 200 people in the town will be saved*
    - *With Program 2: There is a 1/3rd probability that 600 people will be saved, and a 2/3rds probability that no people will be saved.*
  - In the study, 72 percent of the subjects picked Program 1.
  - Now consider this other set of choices
    - *With Program 3: 400 people in the town will die*
    - *With Program 4: There is a 1/3rd probability that nobody will die, and a 2/3rds probability that 600 people will die.*
  - In the study, 78 percent of the subjects picked Program 4
  - These are the same scenarii – just worded differently…

Estimating Demand

- Requirements
  - Risk level information (observations, predictors)
  - Model form?

- The GLMs take over (again?)
  - A natural choice
  - GLMs are predictive and flexible
  - R&D continues

- Refinements
  - Accuracy and predictiveness

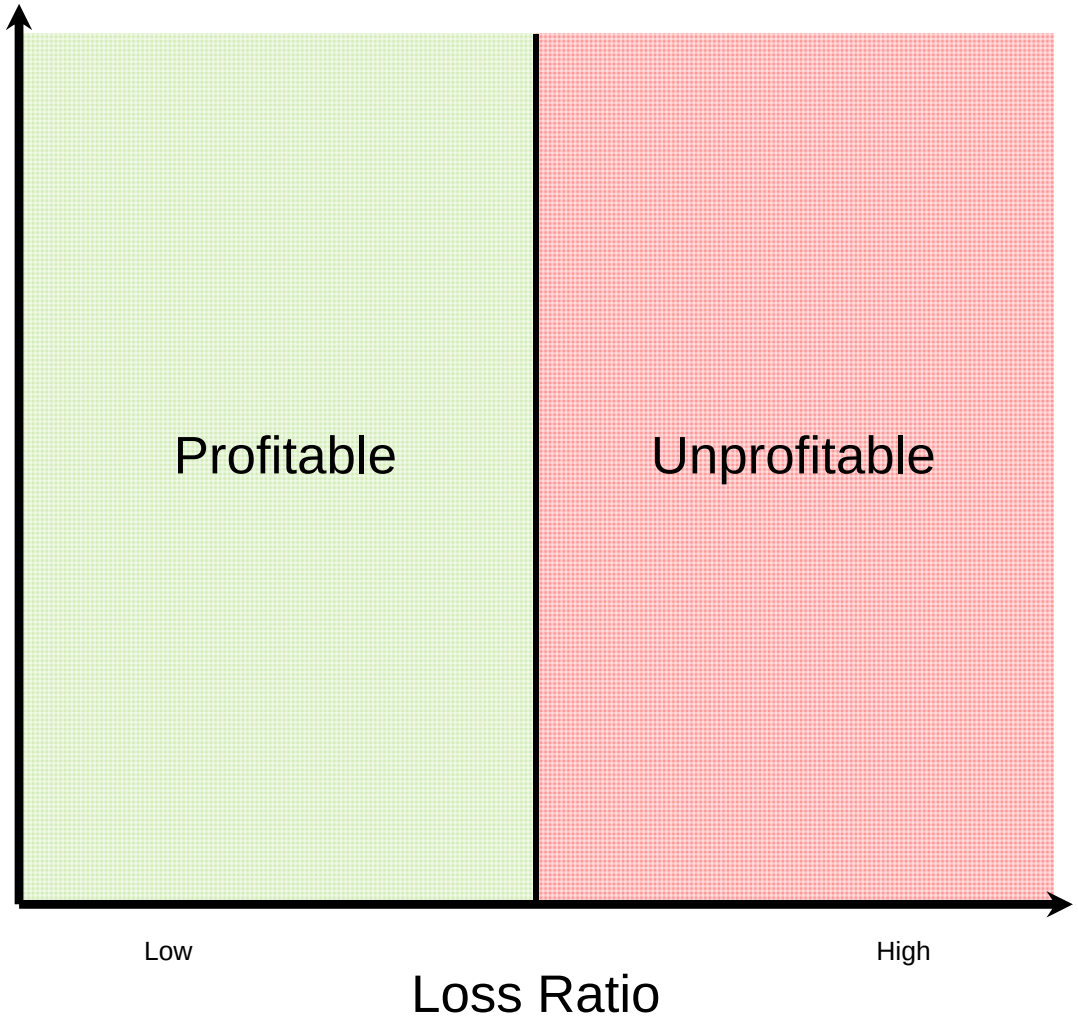
Estimating Demand

- What can this be used for?
  - Identify profiles and target/segment customer base
  - Identify profiles and determine UW action

- A prospective view

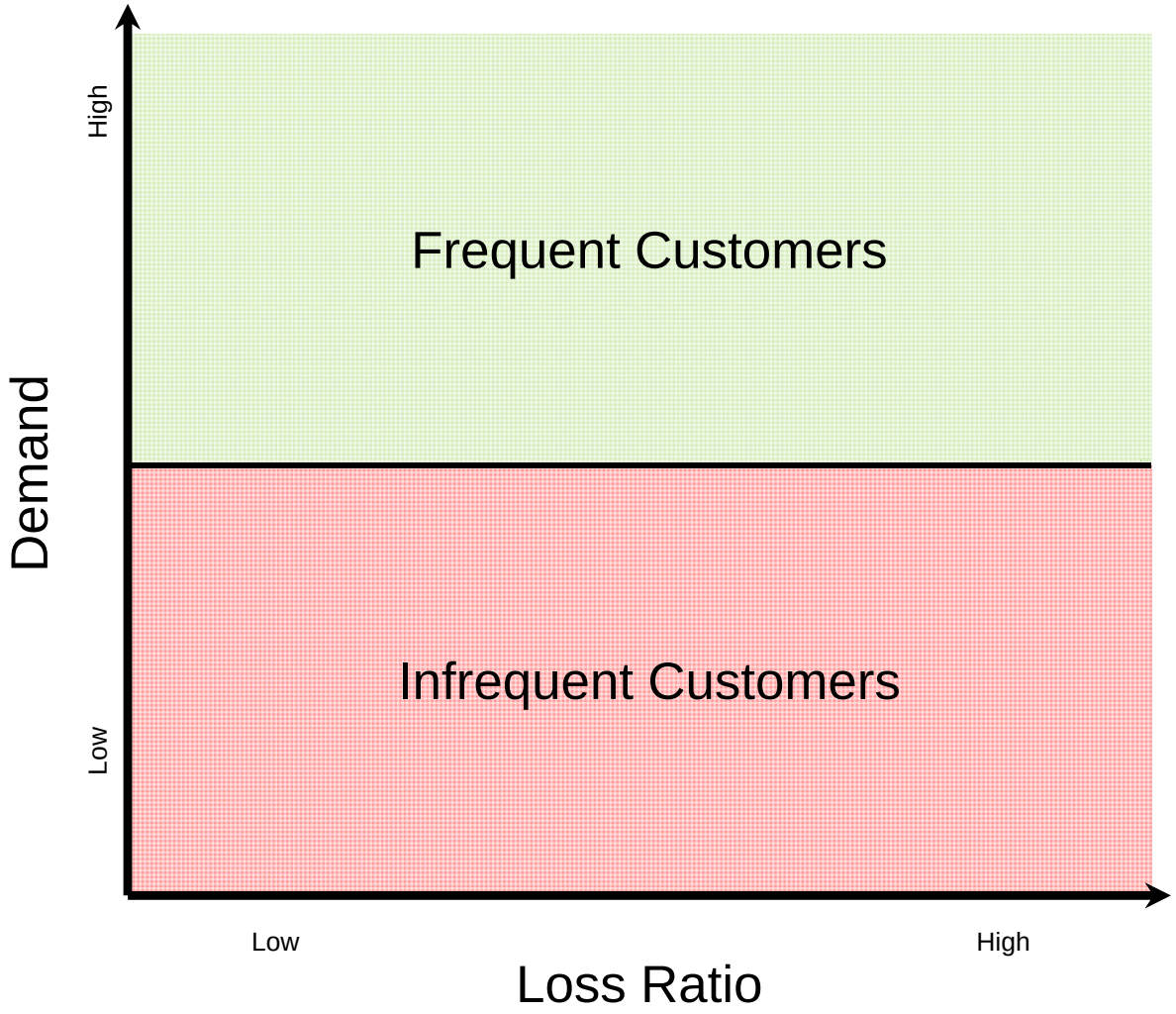
Plot Loss Ratio

Case Study



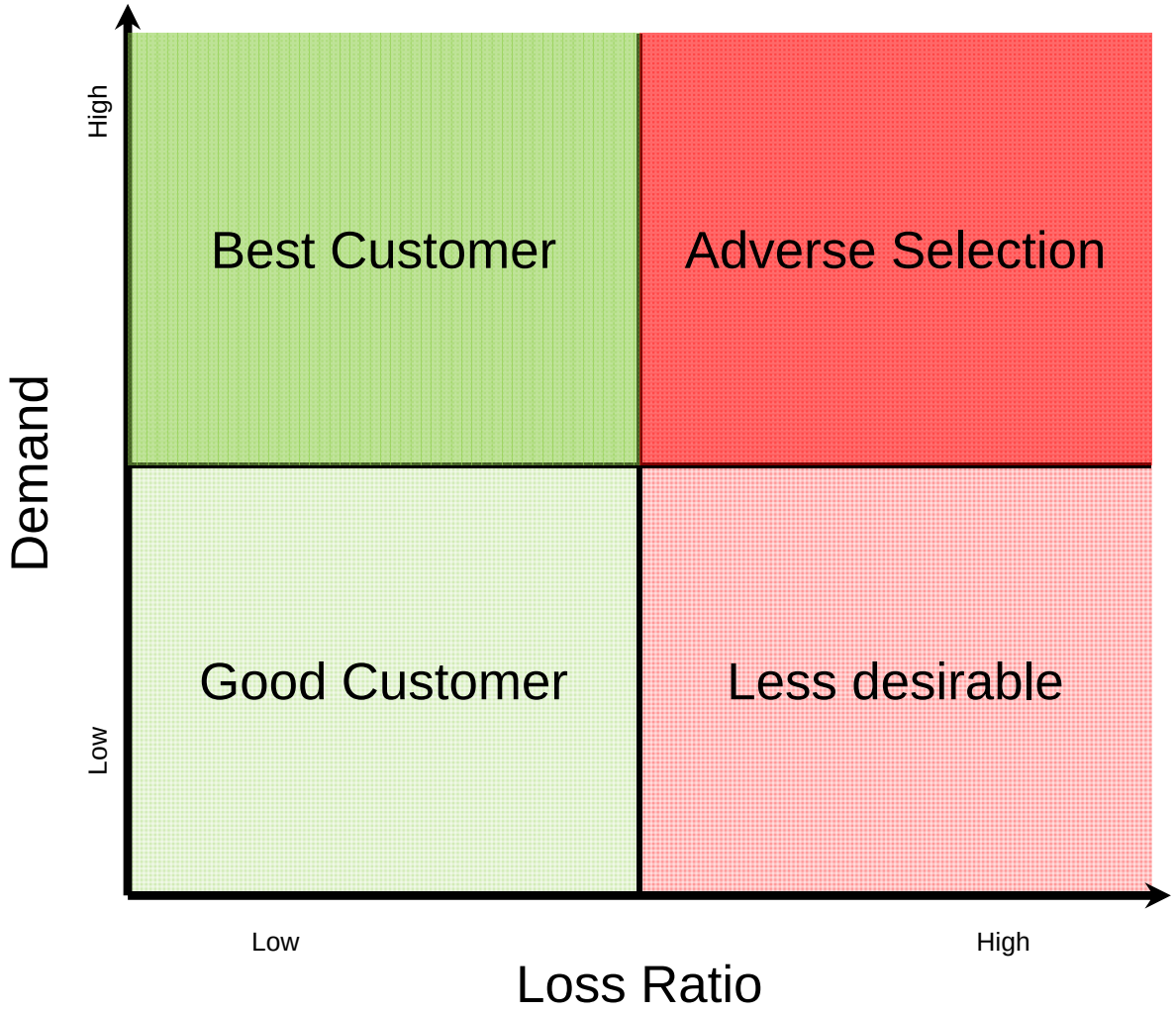
Plot Demand

Case Study

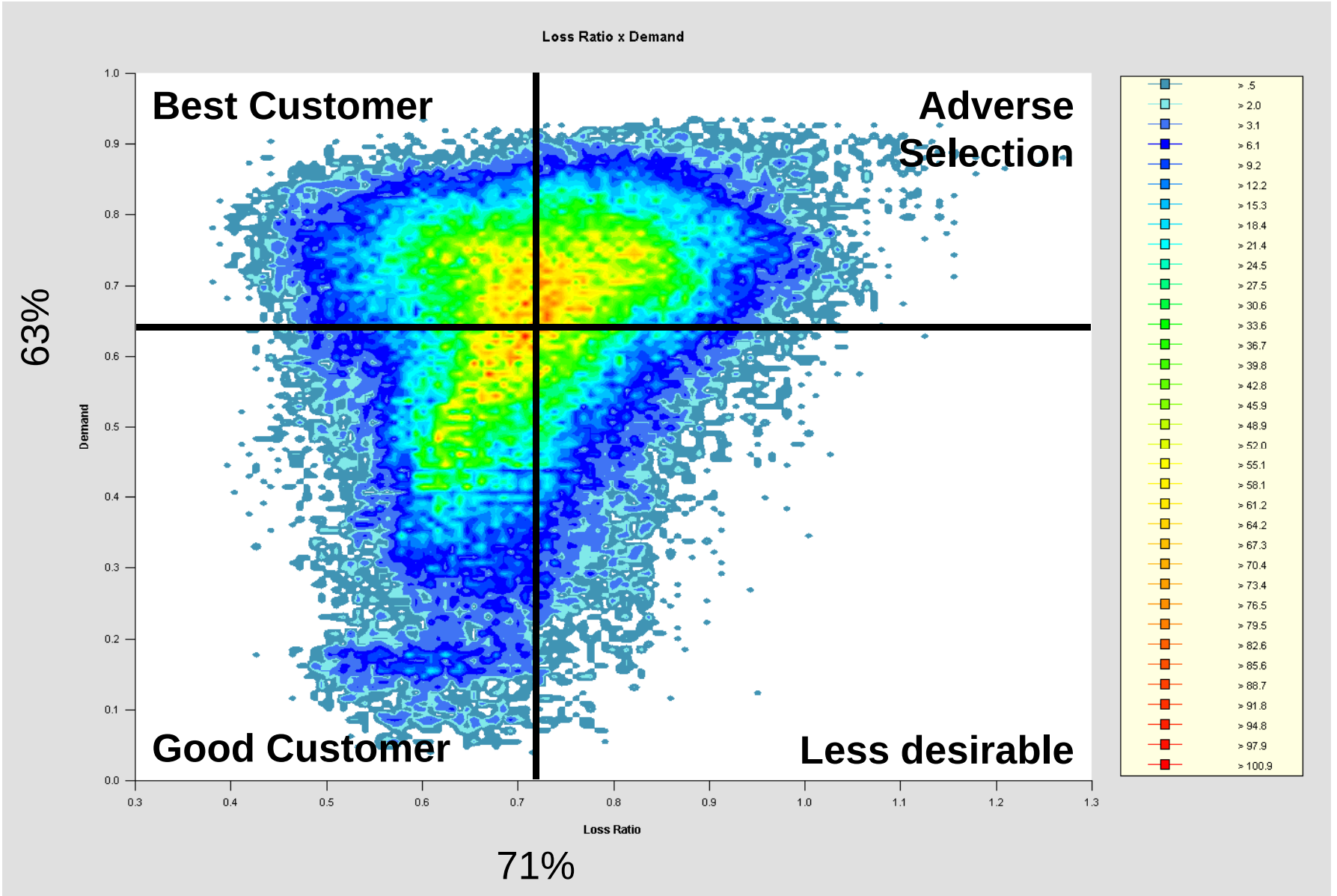


Loss Ratio and Demand Simultaneously

Case Study



Loss Ratio and Demand Across Company

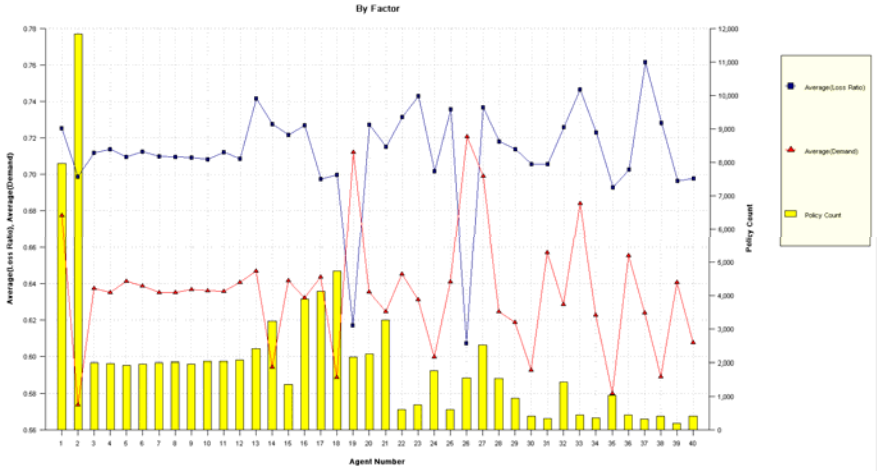


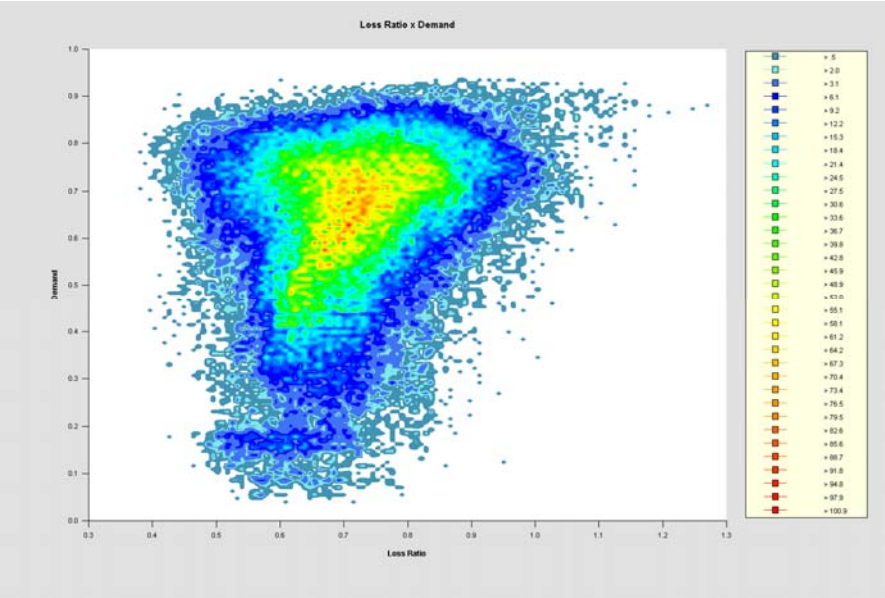
Predictive Modeling Marketing Application

Case Study

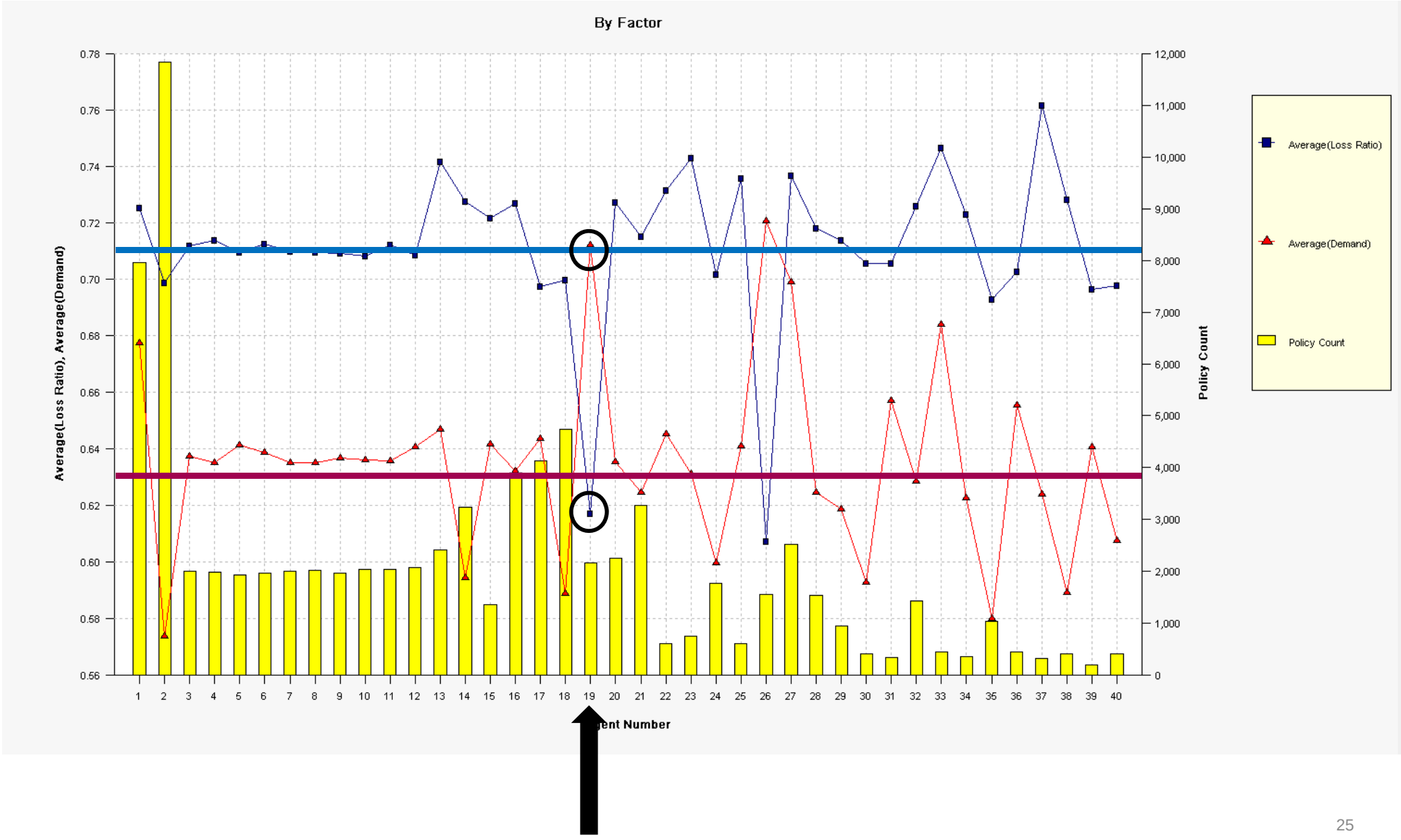
Identifying Best Agents

Simultaneously plot loss ratio and demand across each agent separately



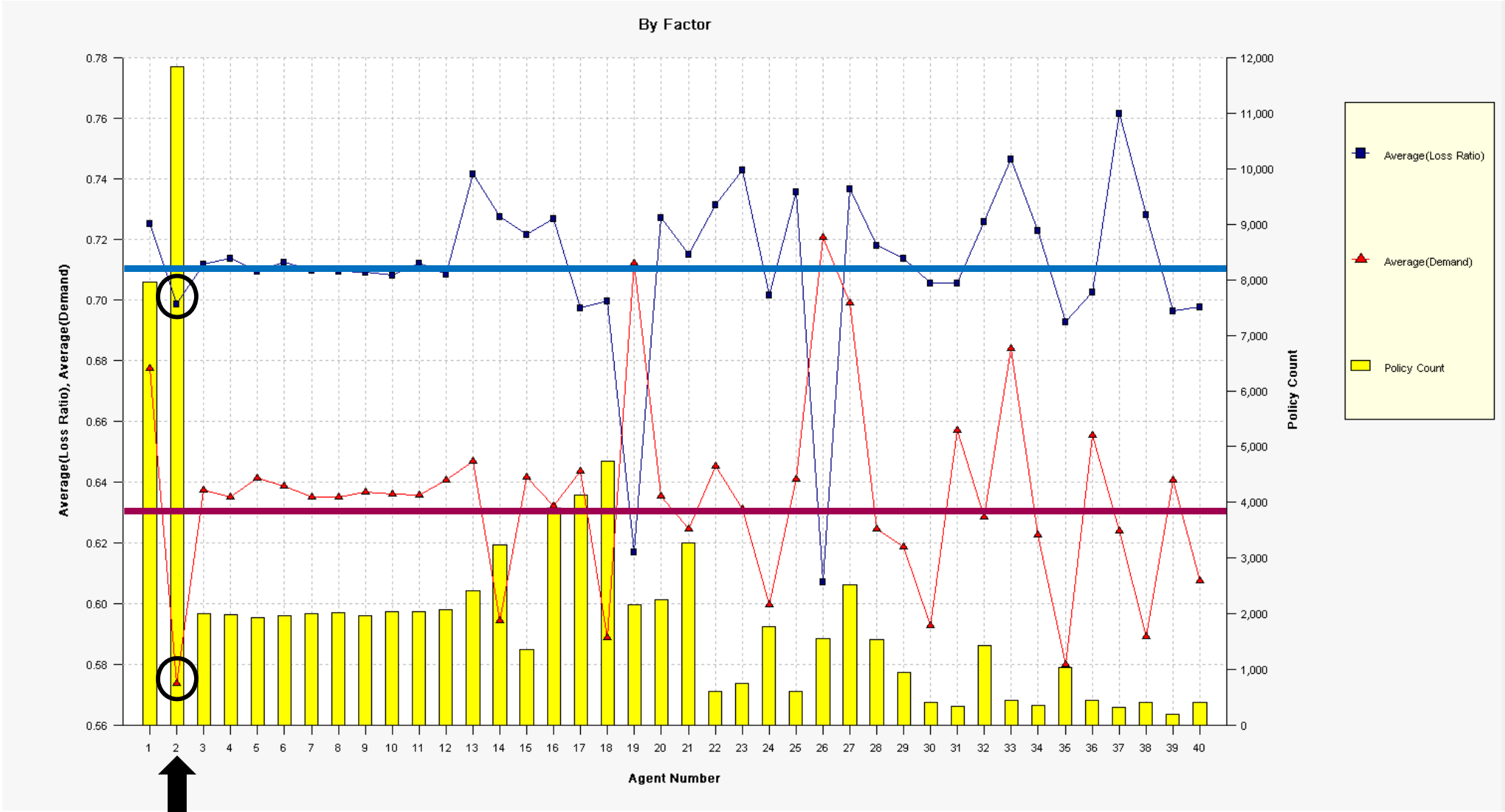


Agent 19 — Low Loss Ratio and High Demand

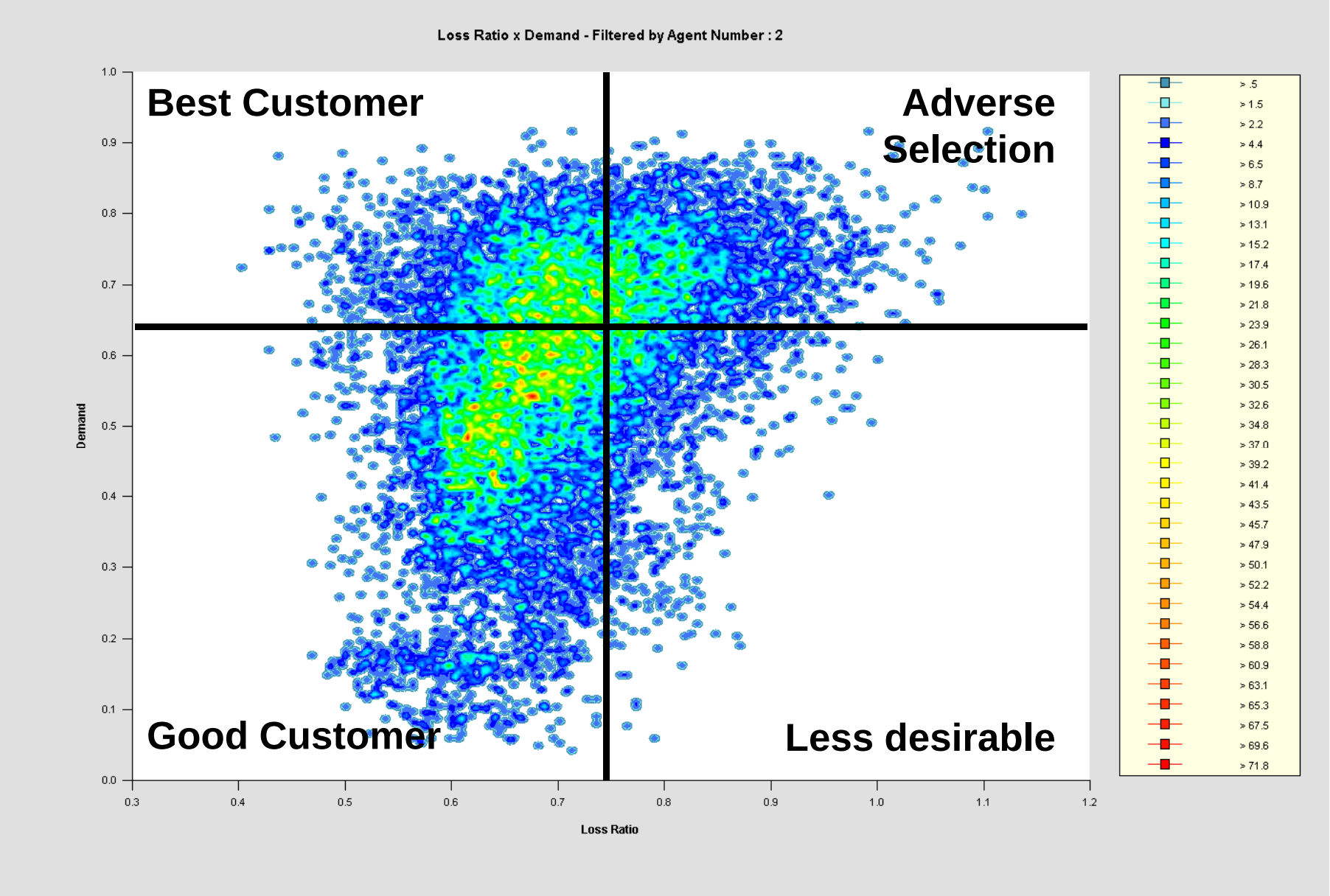


Agent 19 — Low Loss Ratio and High Demand

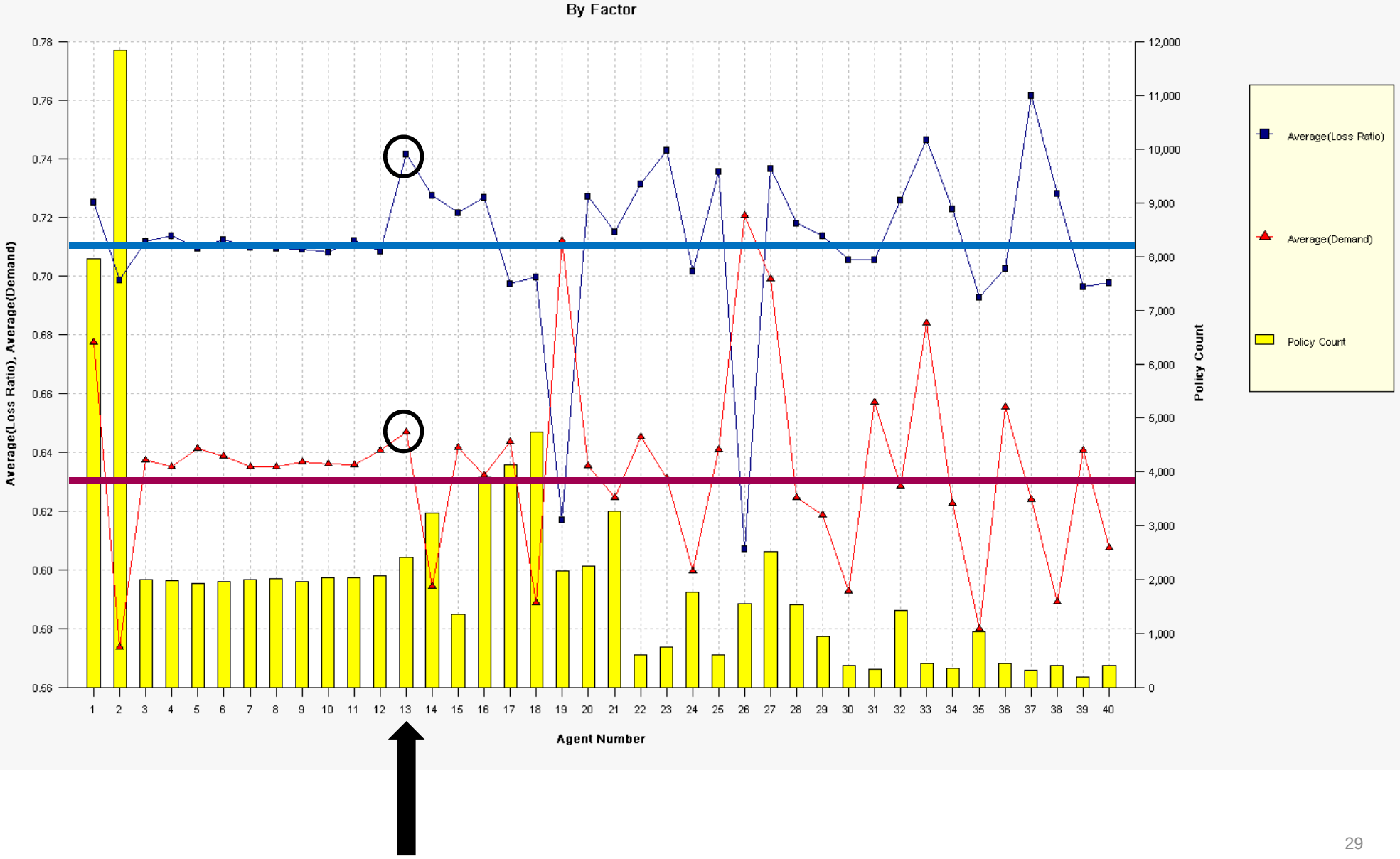
Agent 2 — Low Loss Ratio and Low Demand



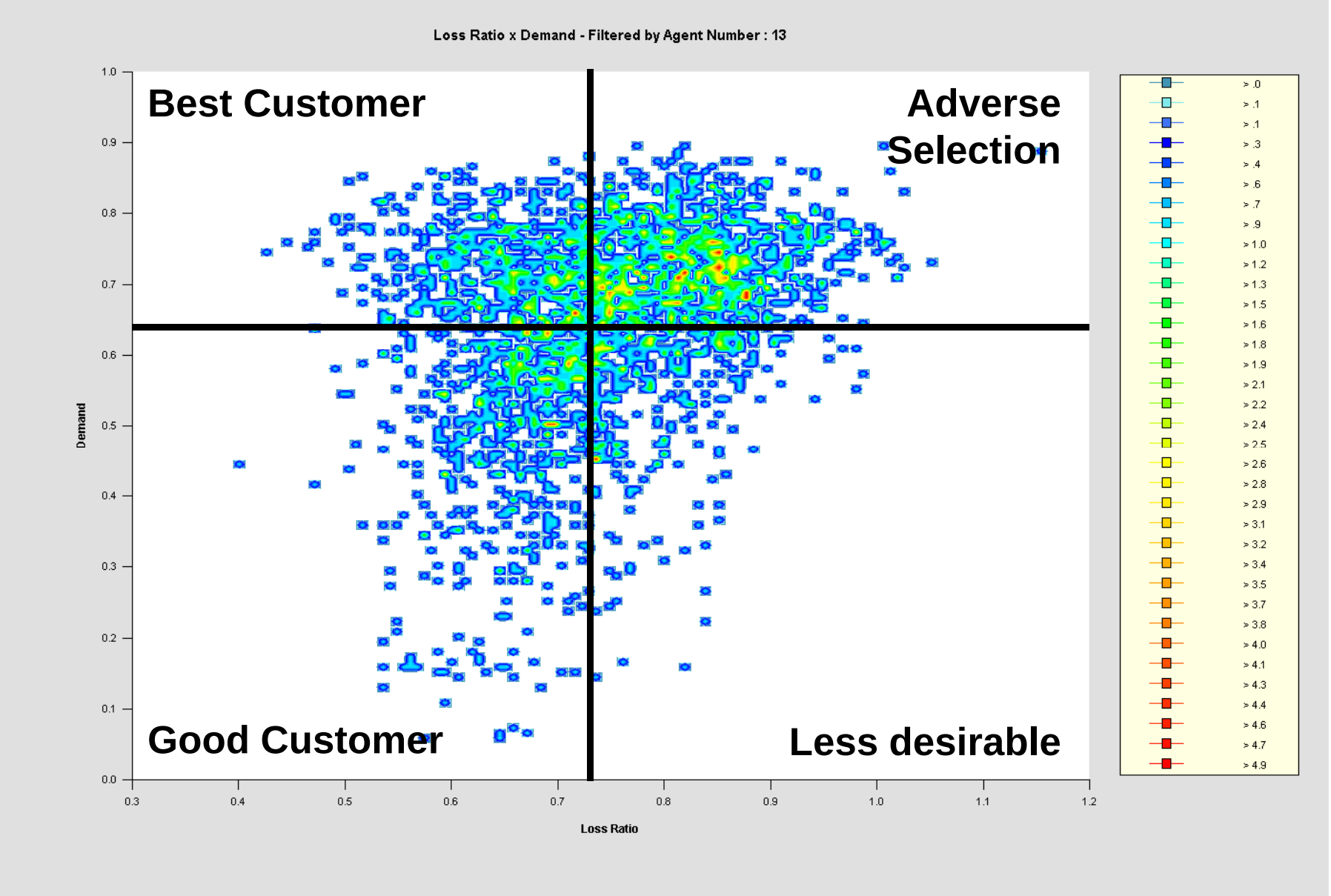
Agent 2 — Low Loss Ratio and Low Demand



Agent 13 — High Loss Ratio and High Demand



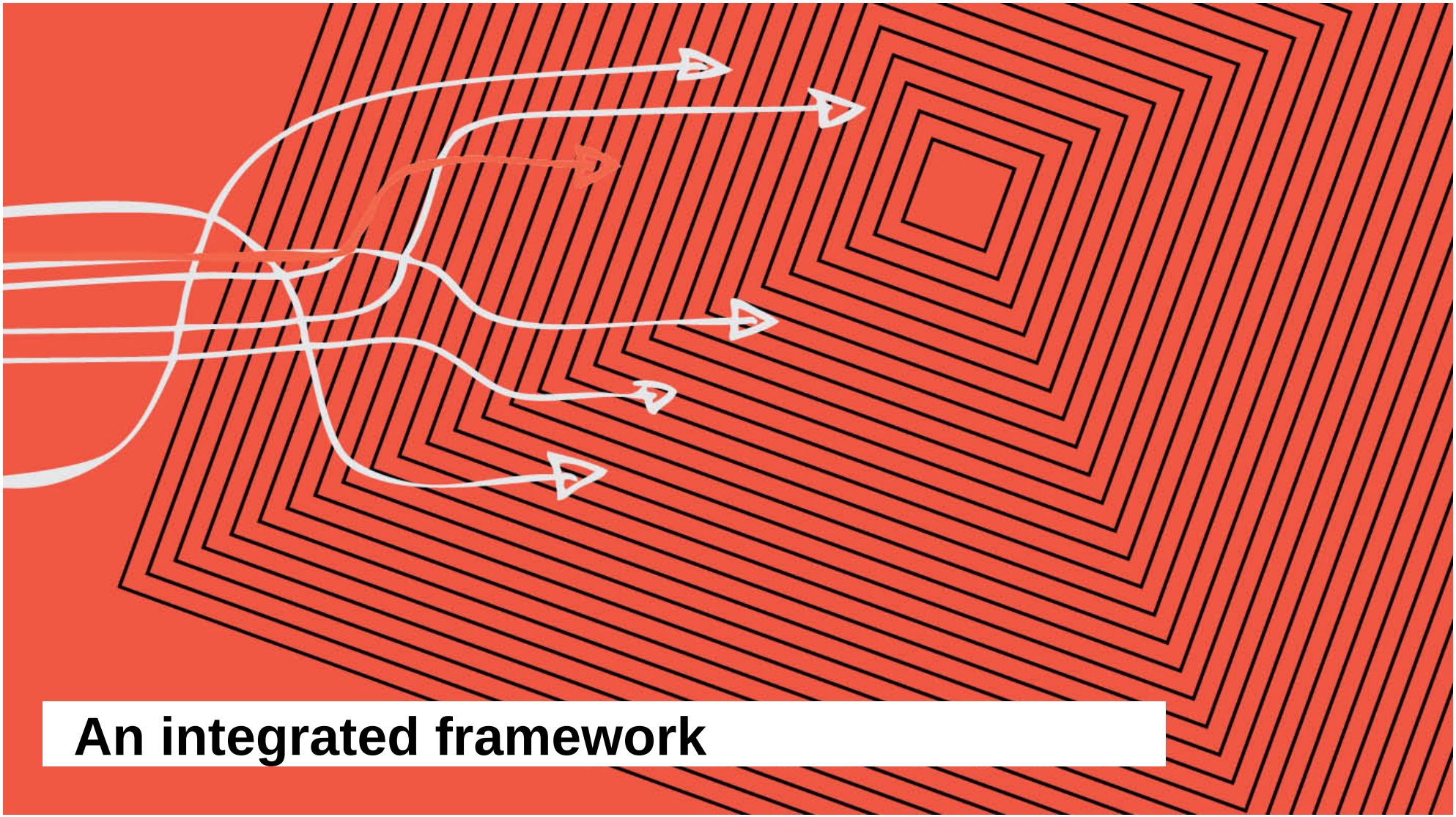
Agent 13 — High Loss Ratio and High Demand



Estimating Demand

- How is demand modelling an improvement?
  - Directly measures behavior
  - Better acknowledges “power of price” (if price predictors are selected)
  - Captures mix of business turn

- BUT removed from original intent – “how to decide if the price is right”
  - Presence of price information / predictors
  - Not directly ‘pricing’



An integrated framework

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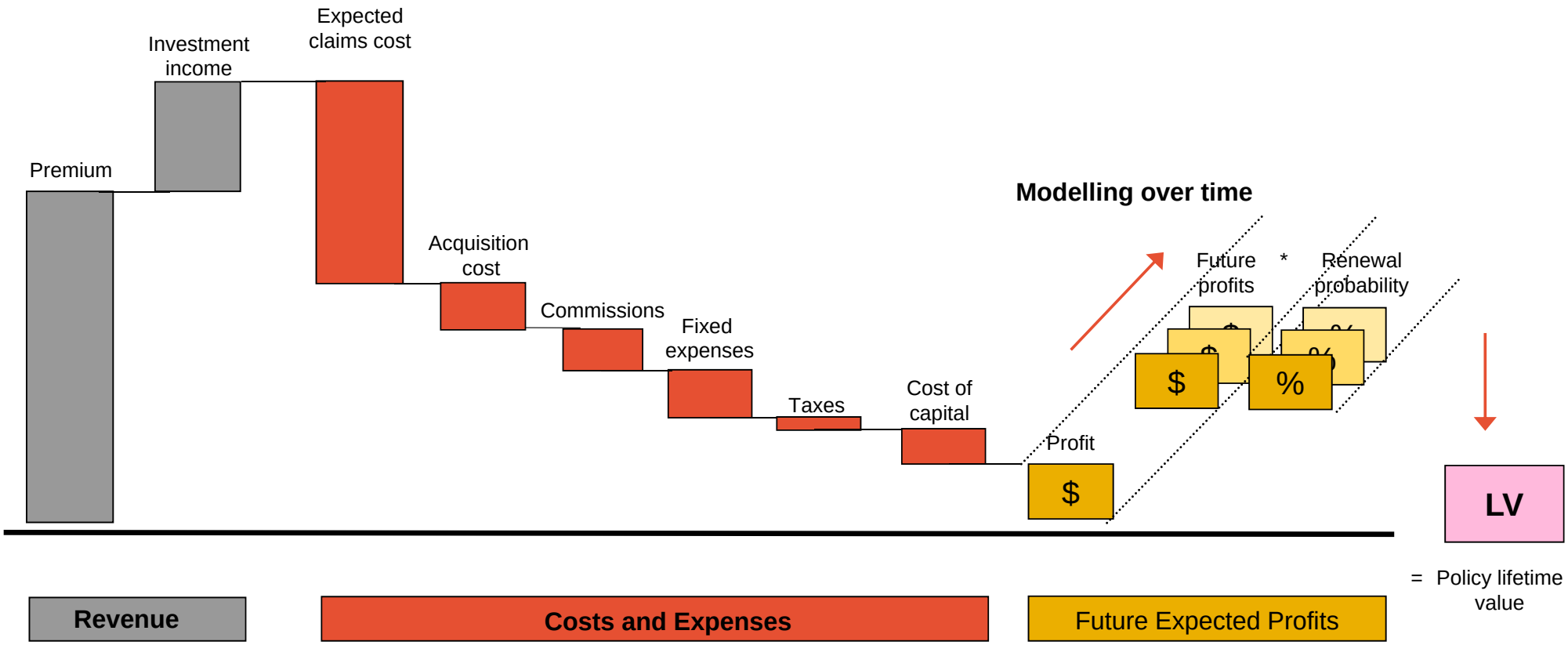
How it works

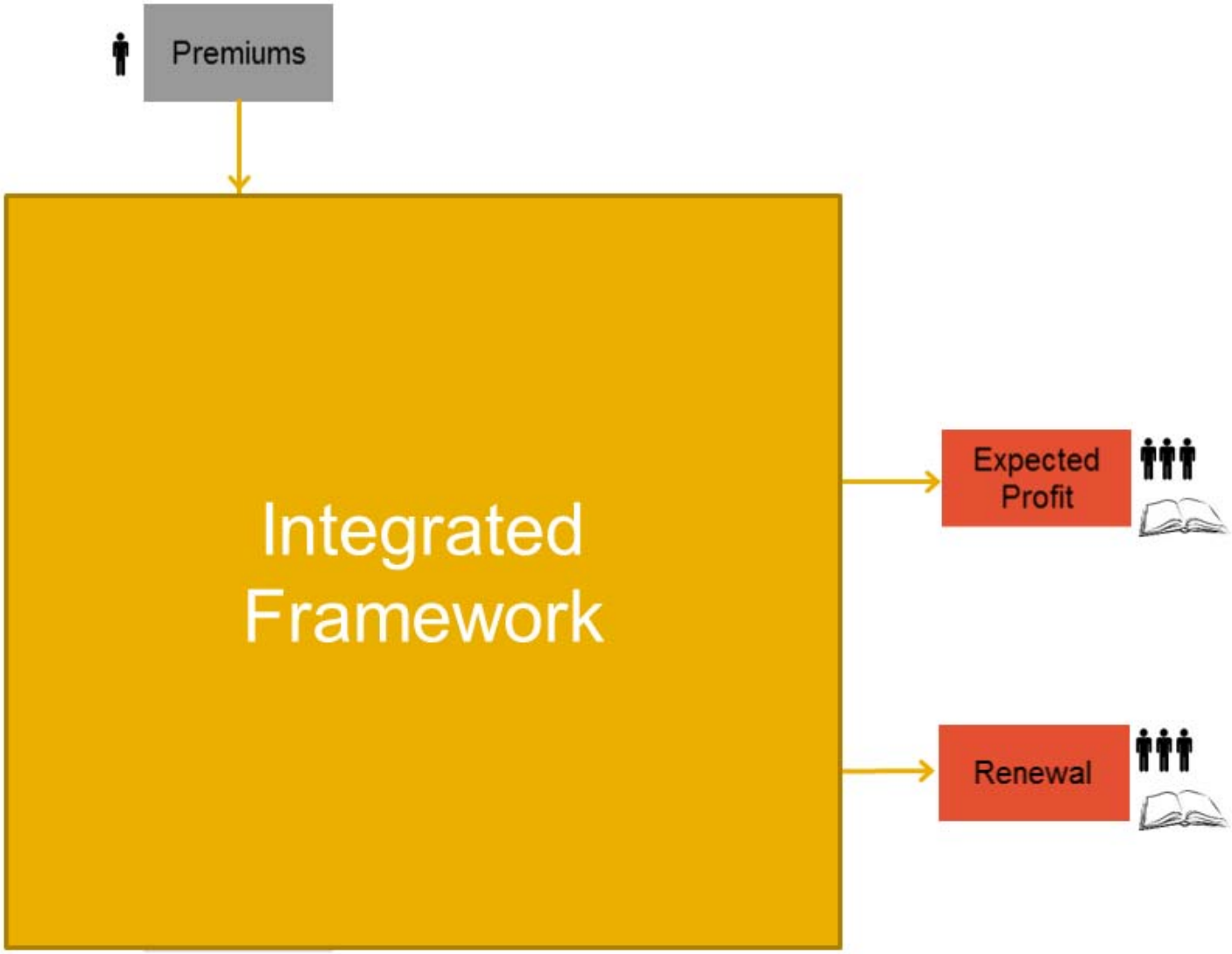
- Take a premium proposal
  - Current
  - Indicated
  - Proposed
- Take a set of risks
  - In-force
  - Quotes
- Score loss and demand models
- Calculate expected future cash-flow and volume
- *[Optional - Extrapolate over multiple years*
  - *Calculate expected Policy Lifetime Value (LV)*
  - *Calculate expected Policy Life Expectancy (PLE)]*
- Analyze results
- Iterate?

Calculation of a policy lifetime value

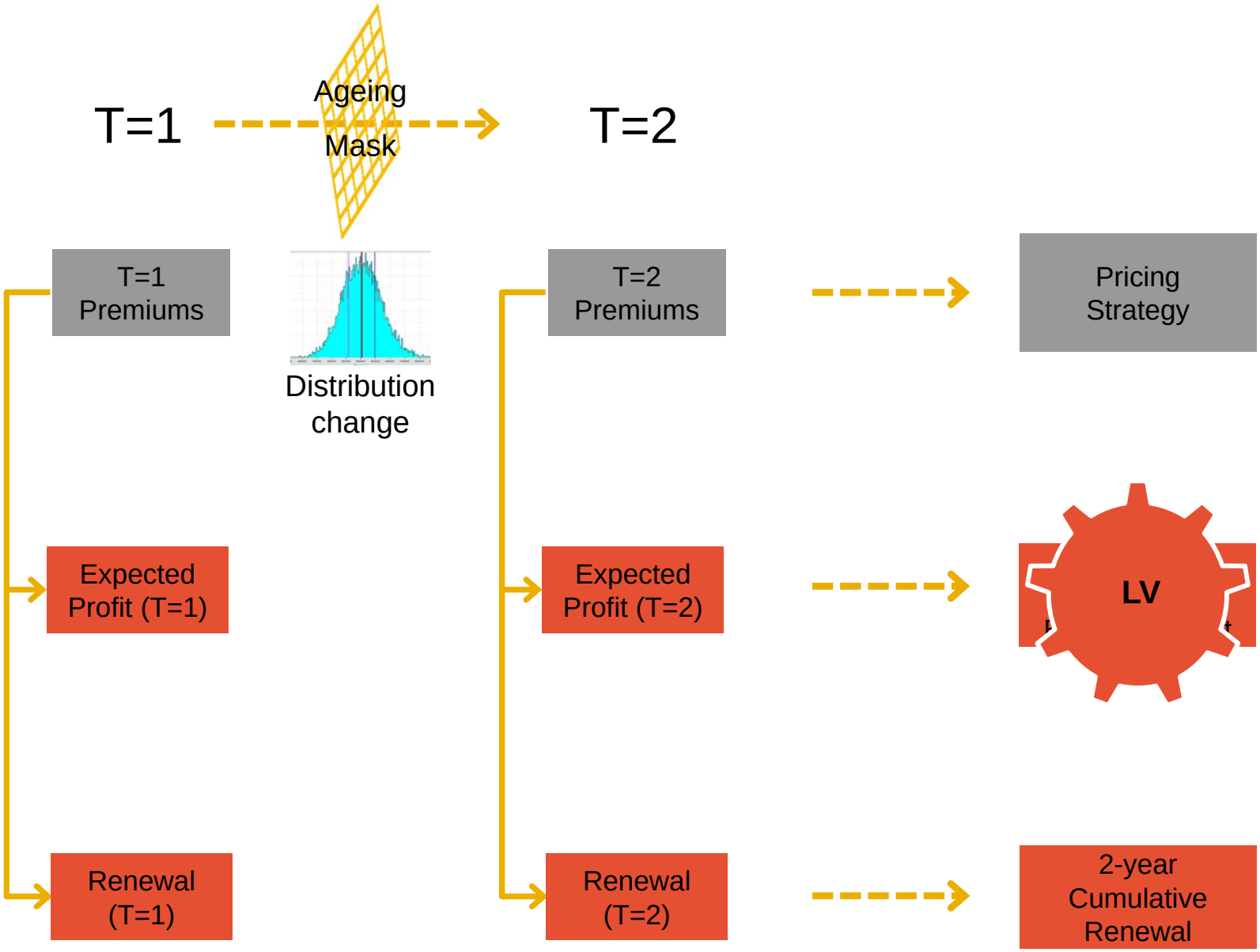
ILLUSTRATIVE



An integrated framework



Additional ingredients for estimating LV



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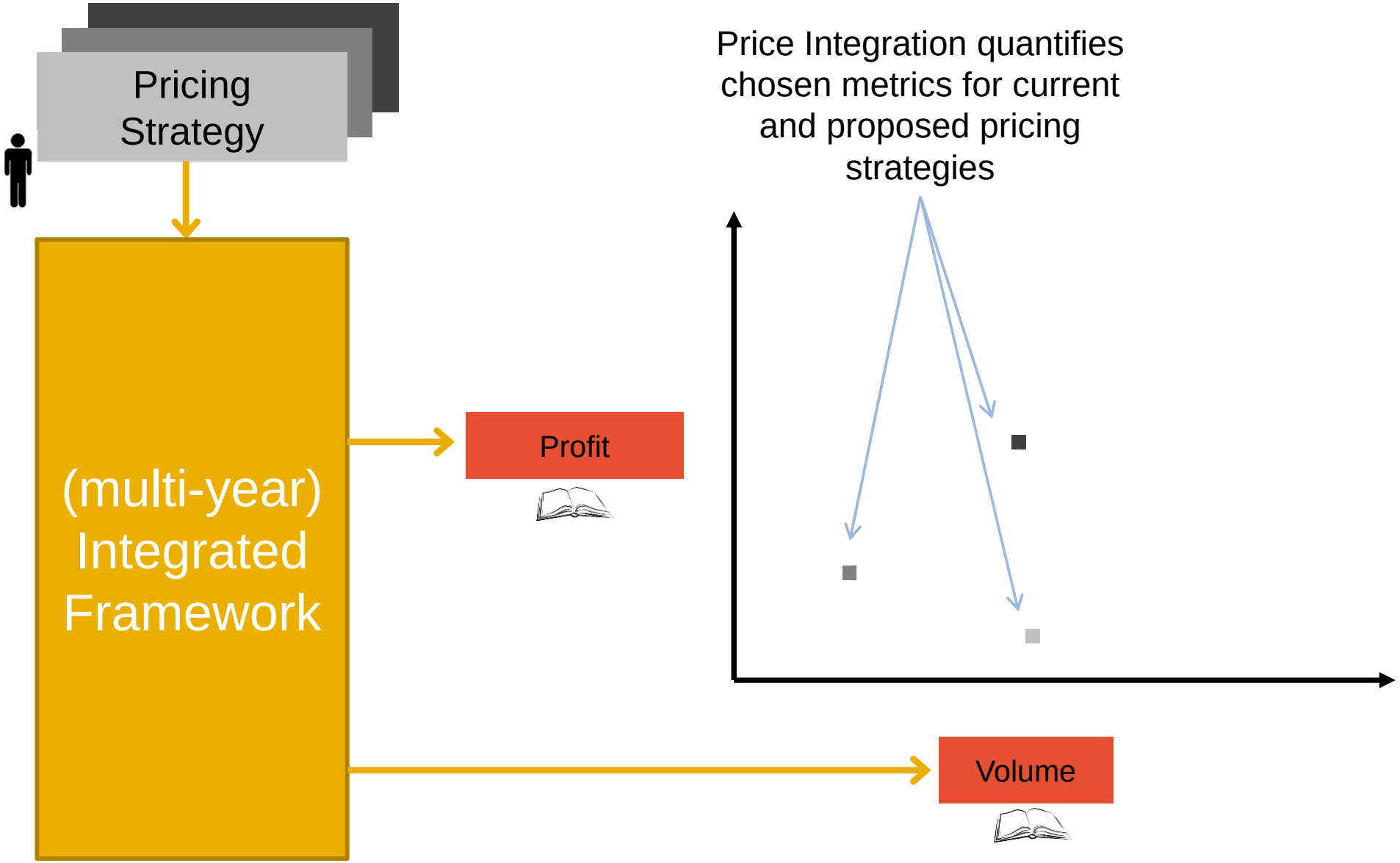
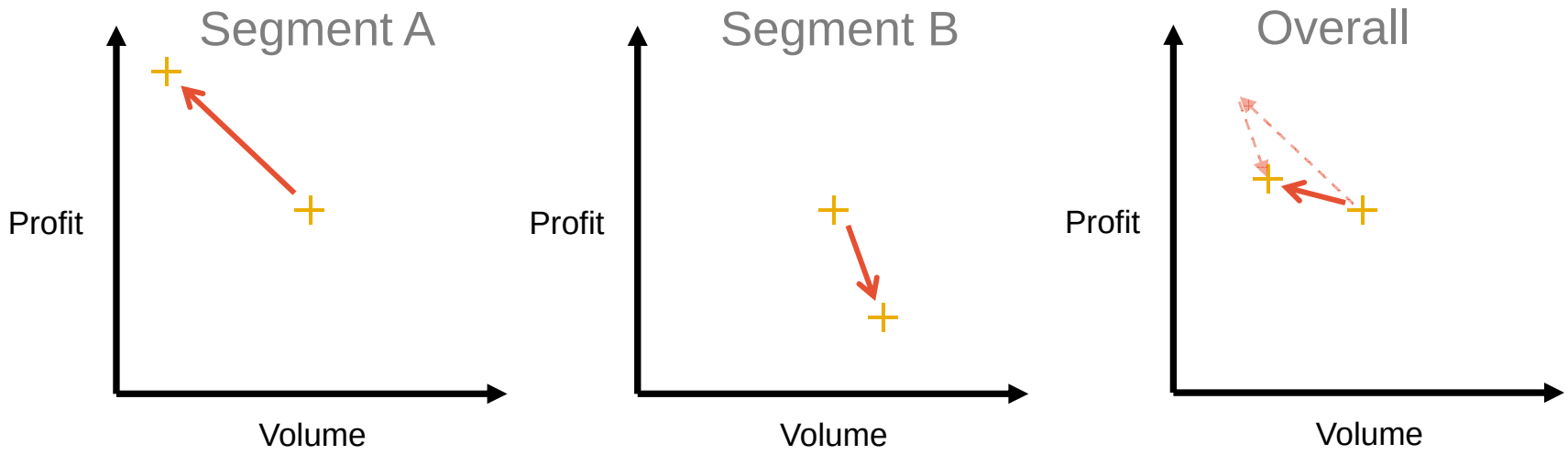
Integration

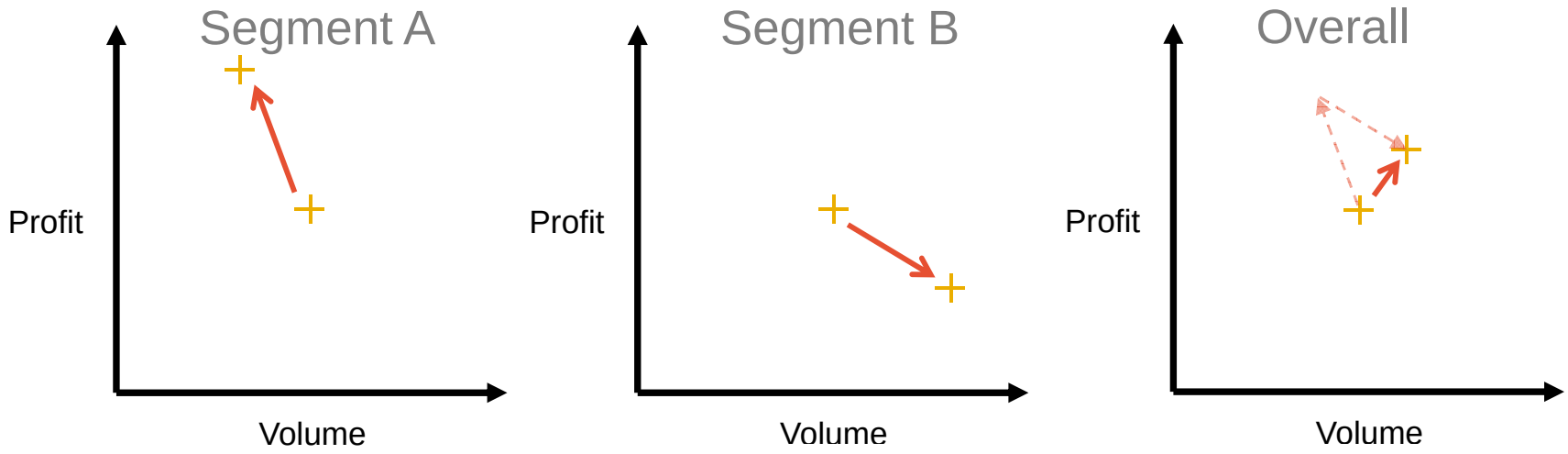


Modulating the book through manual premium setting

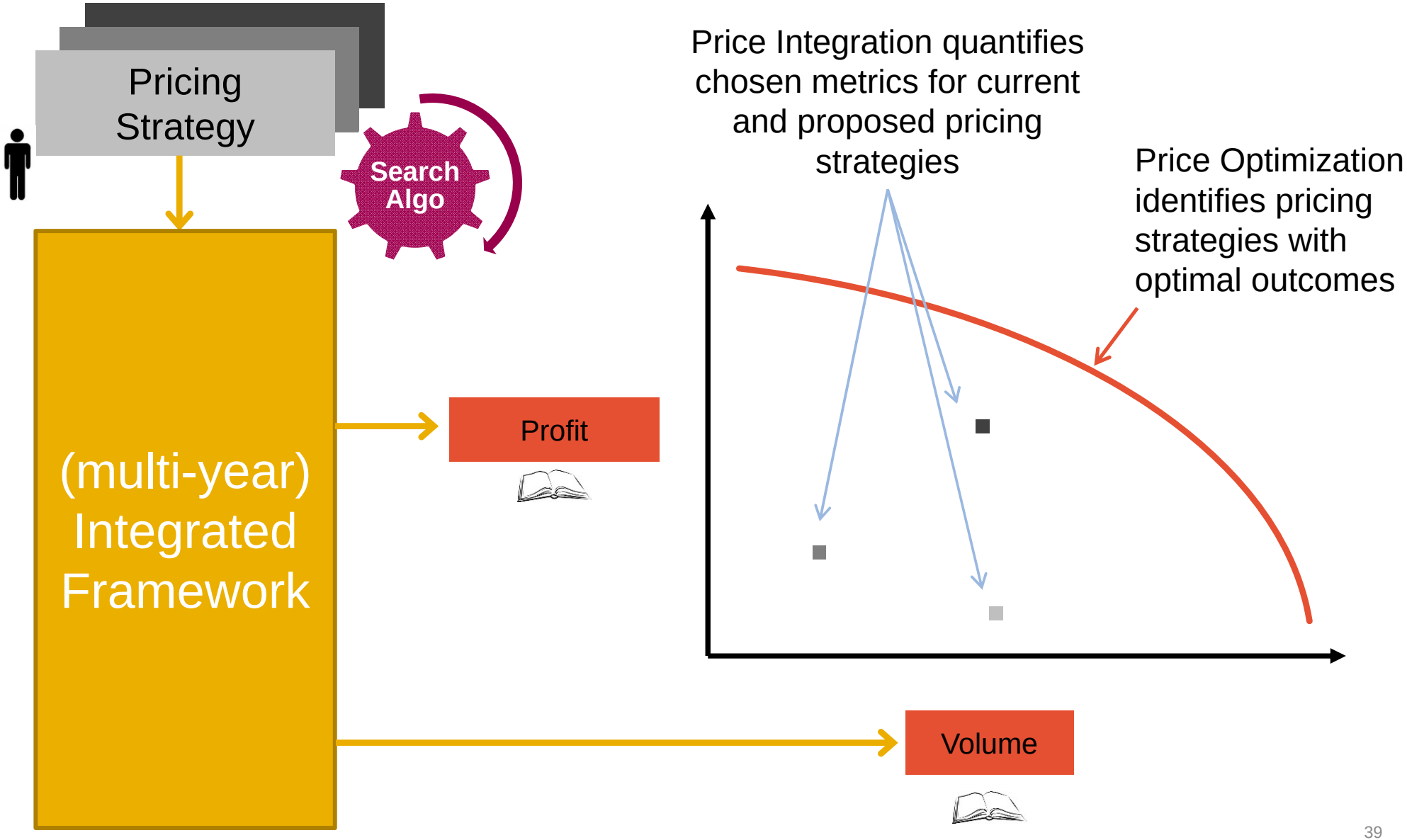
- Trade-off



- Improvement



Automated approach



More on this automated approach

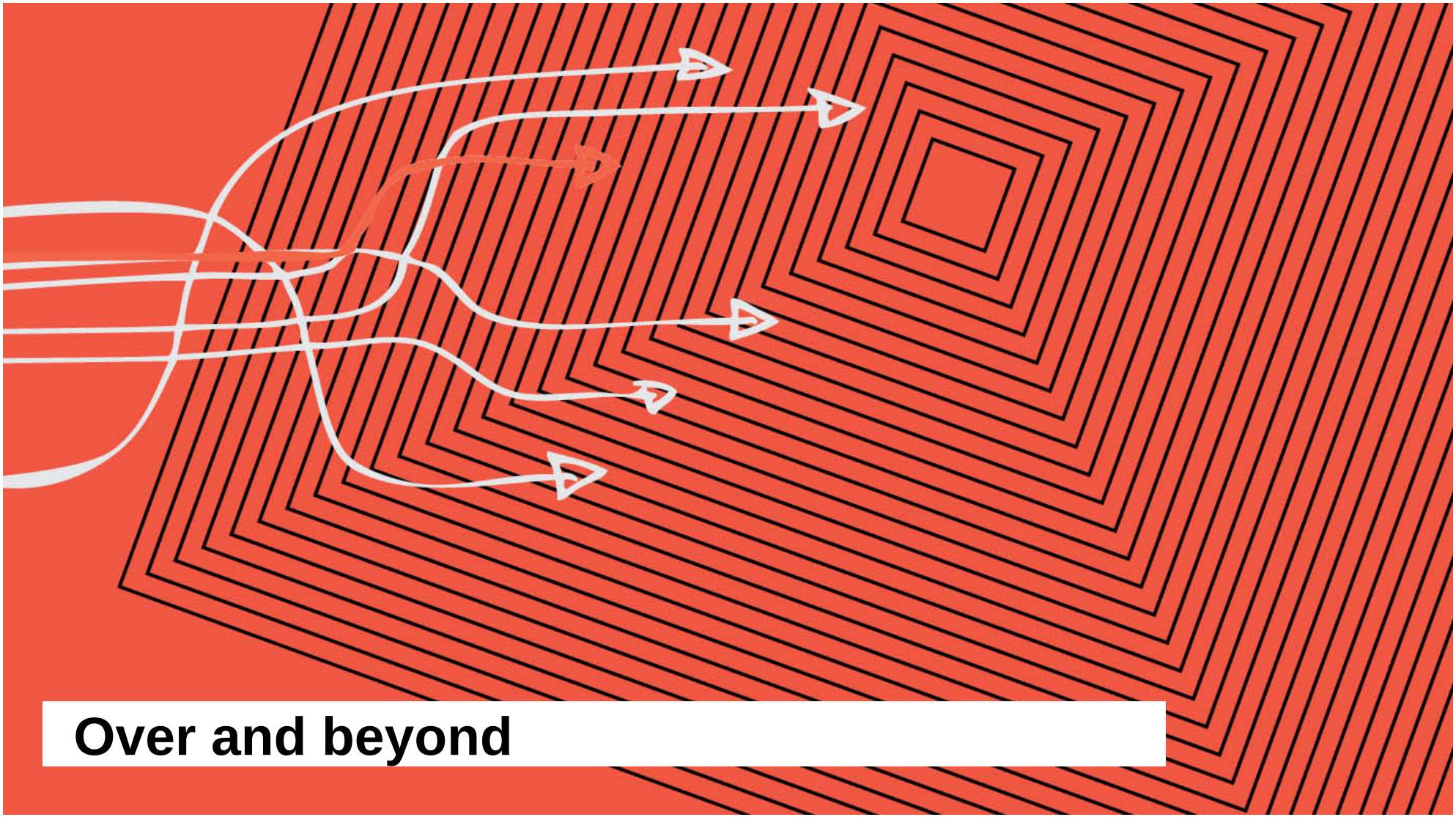
- Sound fundamentals are essential
- A double-edged sword

Integrated Framework

- What can this be used for?
  - Business planning and prospective testing
  - Inform selections for PL
  - Inform discretionary deviations in CL – inform UW

- How is this integrated framework an improvement?
  - Anticipates mix of business turn more accurately
  - Acknowledges “power of price” even better and helps mitigate naïve/penalizing decisions
  - We are back in the “how to decide if the price is right” framework

- BUT we rest on simplifying assumptions



Over and beyond

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Advanced Uses

- Confidence intervals
- A menu of possible investments
- Co-optimization
- Optimal Growth
- Incorporating reinsurance costs
- Other metrics being used/considered

Confidence Intervals

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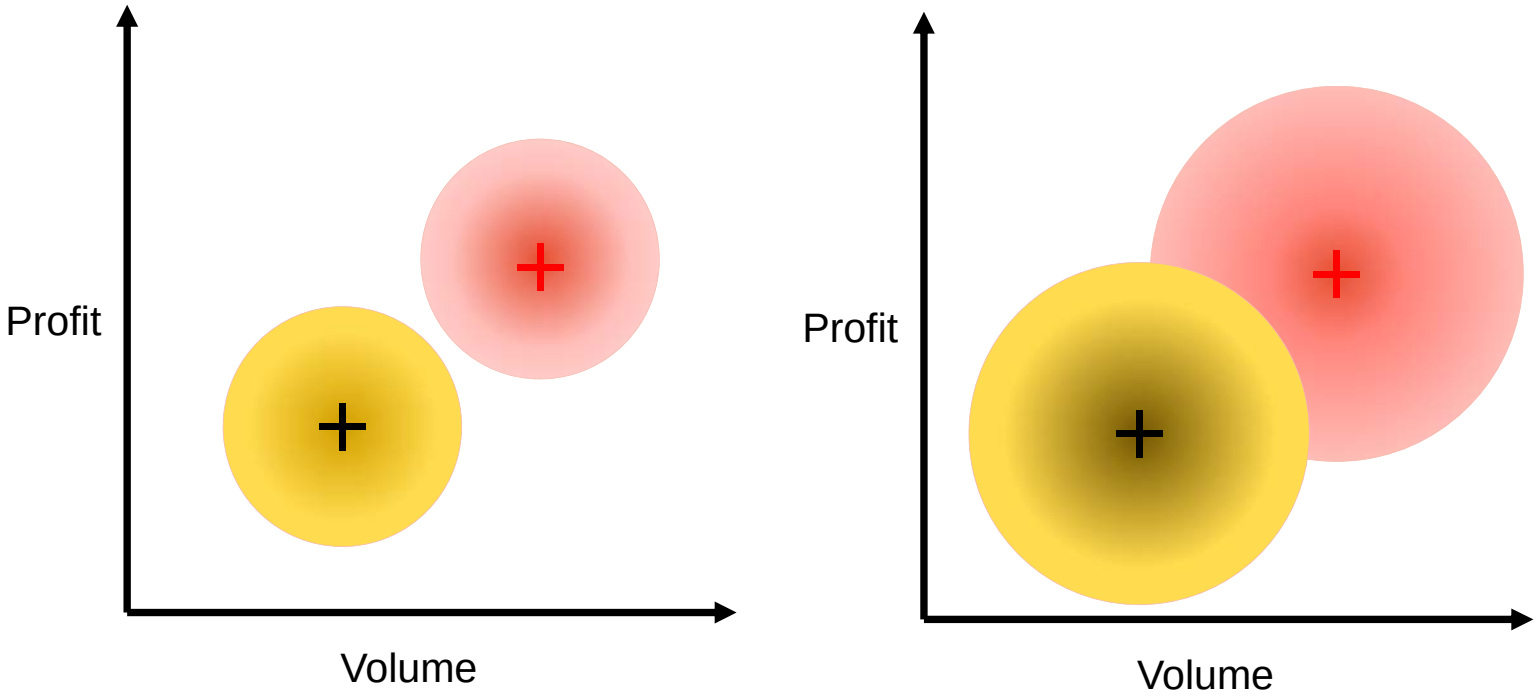
Confidence intervals

- How far are we from current position?



- Does risk increase?
- Quantify risk mitigation (reinsurance, securitization, etc.)

A Menu of possible investments

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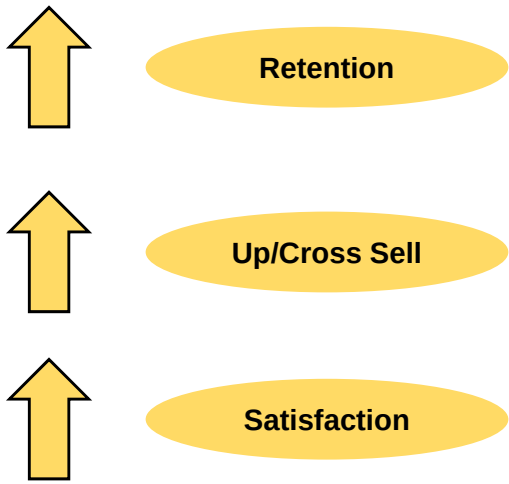
A menu of options

- Assume Cost at $60 and Profit is “mobile” between $30 and $40
- Standard = discount or not?
- More than 2 ways to “invest” the $10
  - Give $10 discount today
  - Invest $10 for targeted marketing
  - Invest $10 for superior client service



Which (mix) is the highest return?

Co-optimization

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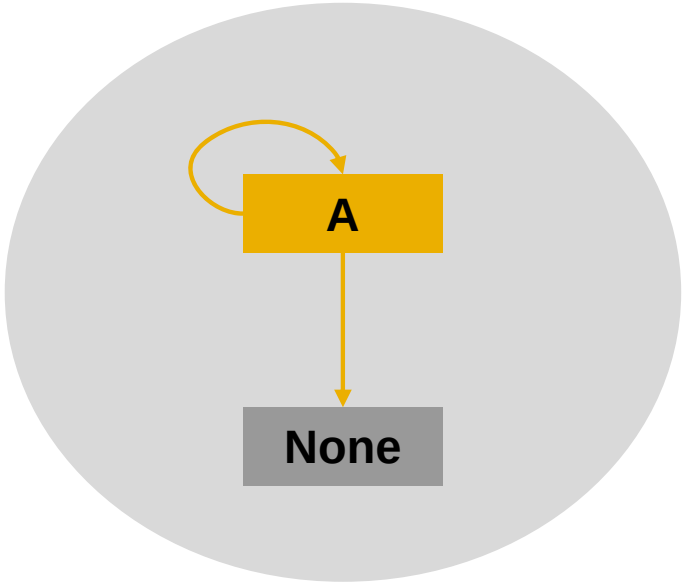
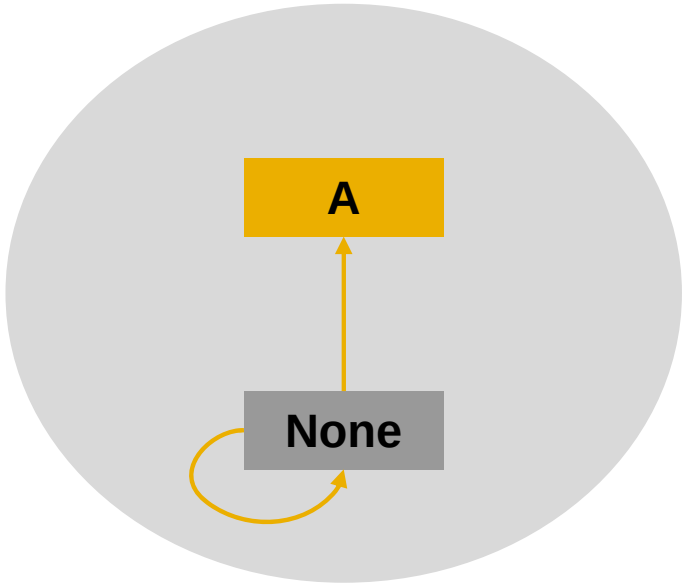
Co-optimization

- What is it?
  - Metric = F(price1, price2, etc.)
- Several products
- Up-sells
- Several price structures for the same product (when permitted)

Product Lifecycle – Standard Optimization

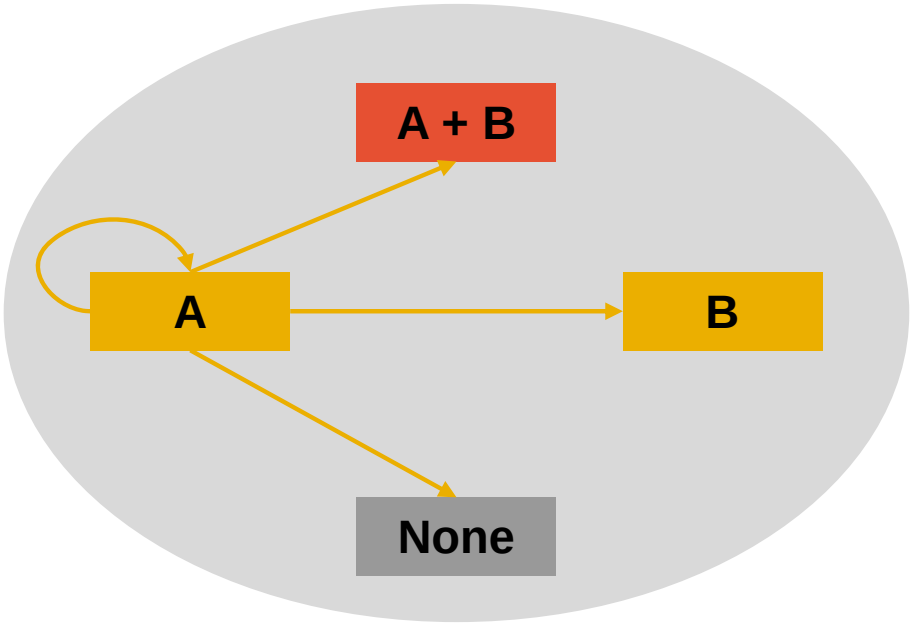


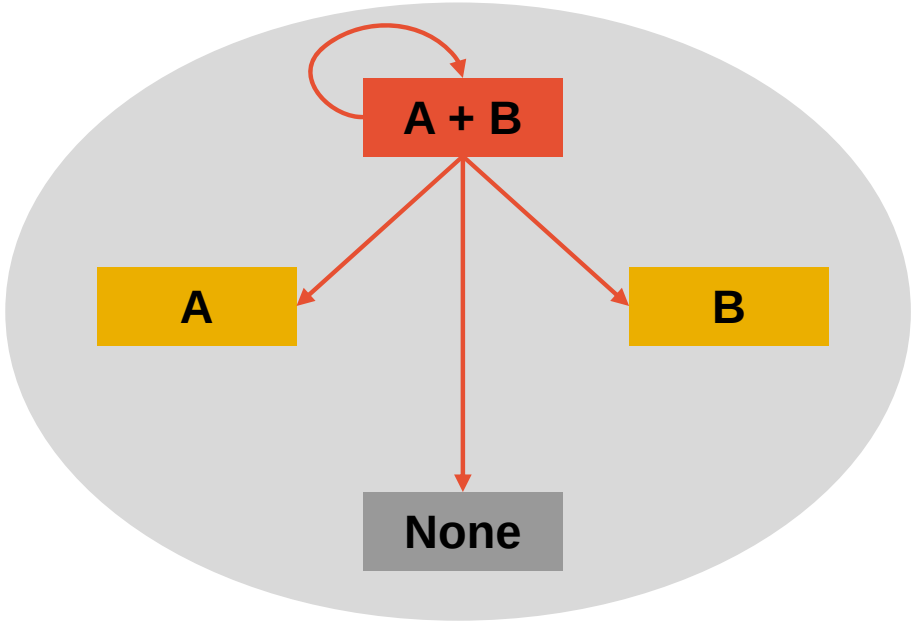
Retention Model



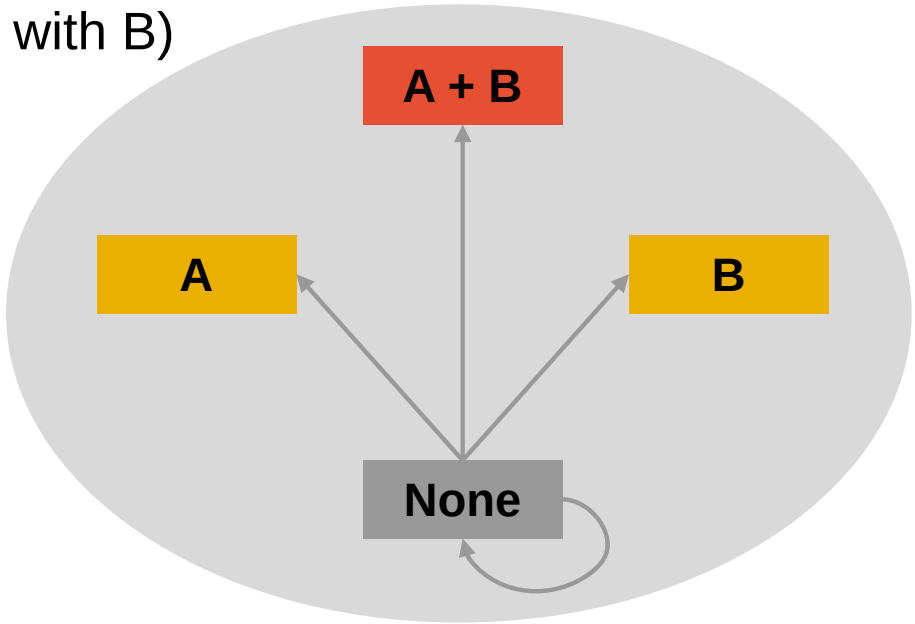
Conversion Model

Product Lifecycle – Co-optimization



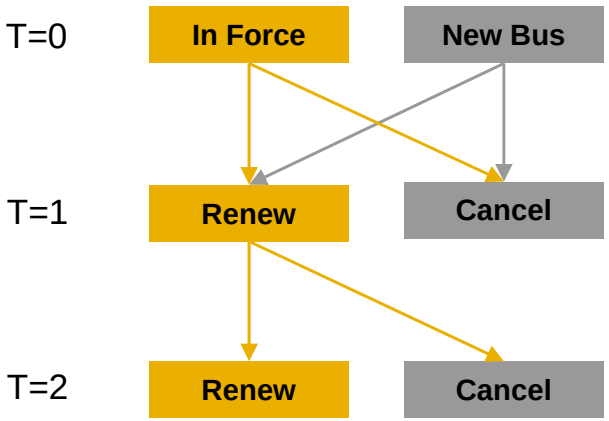


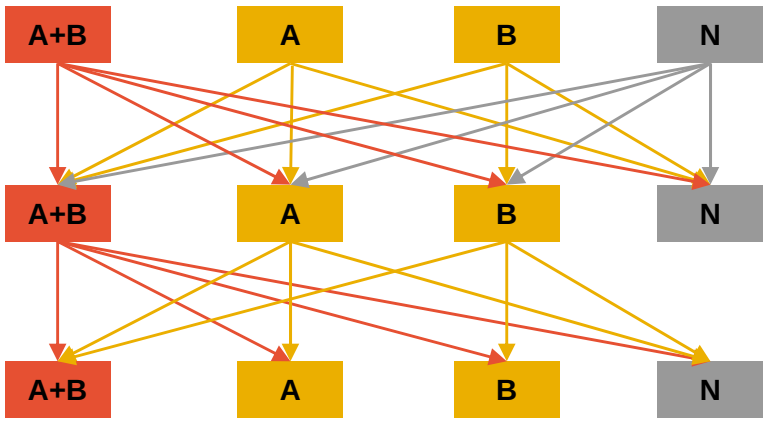
(& vice versa with B)



Other Thoughts

- Multinomial models– or combination of binomial models for disjointed events
- Four profiles now instead of two before
  - Each has its own demand model
  - Still one “black hole” profile but now 3 “live profiles”
  - Makes for more complex expected profit calculation
  - Even more if multi-year





Optimal Growth

TOWERS WATSON

Optimal Growth (Luyang Fu, *Variance vol 6 issue 1*)

- High-level summary
  - NB produces higher loss and expense ratios & lower retention than renewals
  - BUT high profits are required to add more NB
    - Generate additional capital needed to support exposure growth
  - How can we balance this?

- Similar approach:
  - Growth limit curve (CR declines with growth)
  - Growth impact curve (CR increases with growth)

- Optimal growth rate = maximizes the expected enterprise value over time
  - Useful for strategic planning process
  - Select a point on the frontier graph

Incorporating Reinsurance Costs

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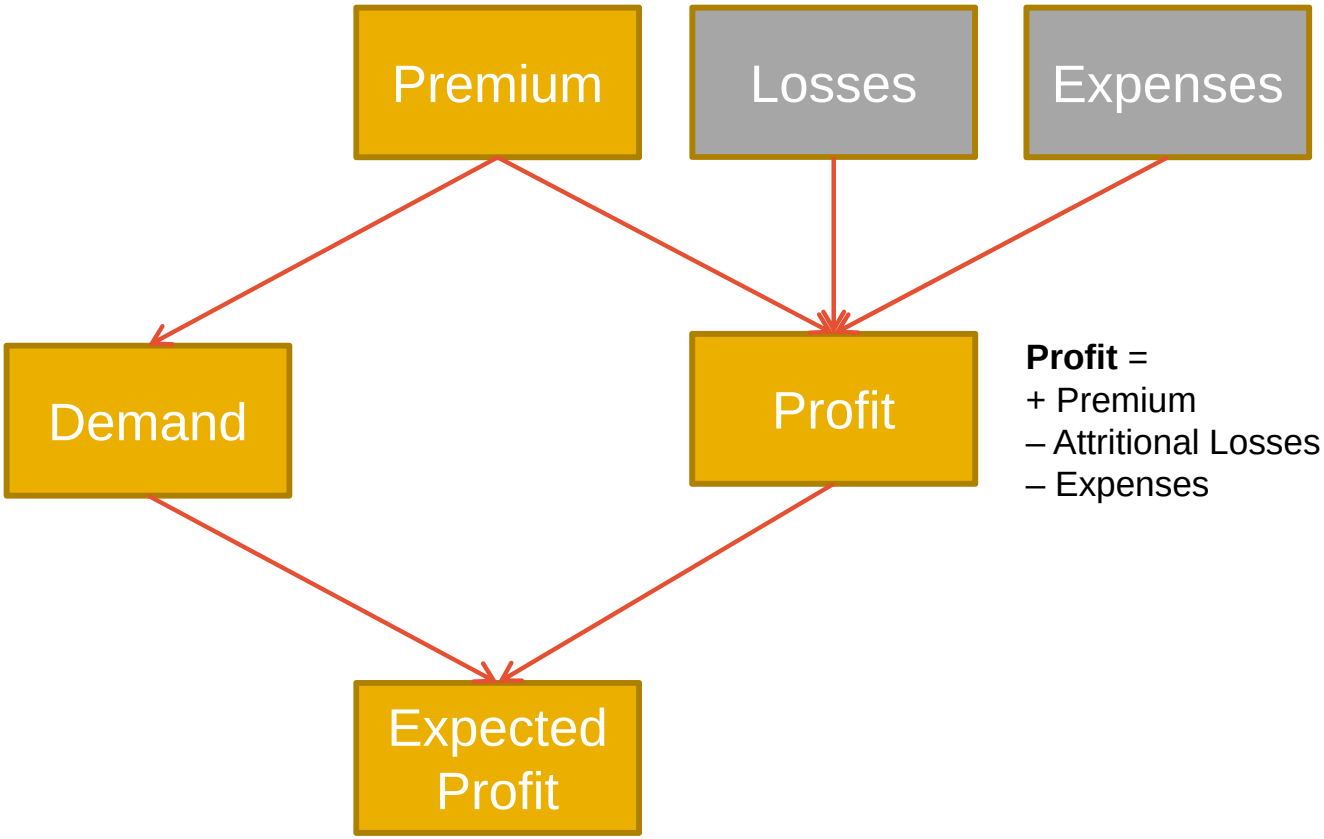
Standard Profit Calculation

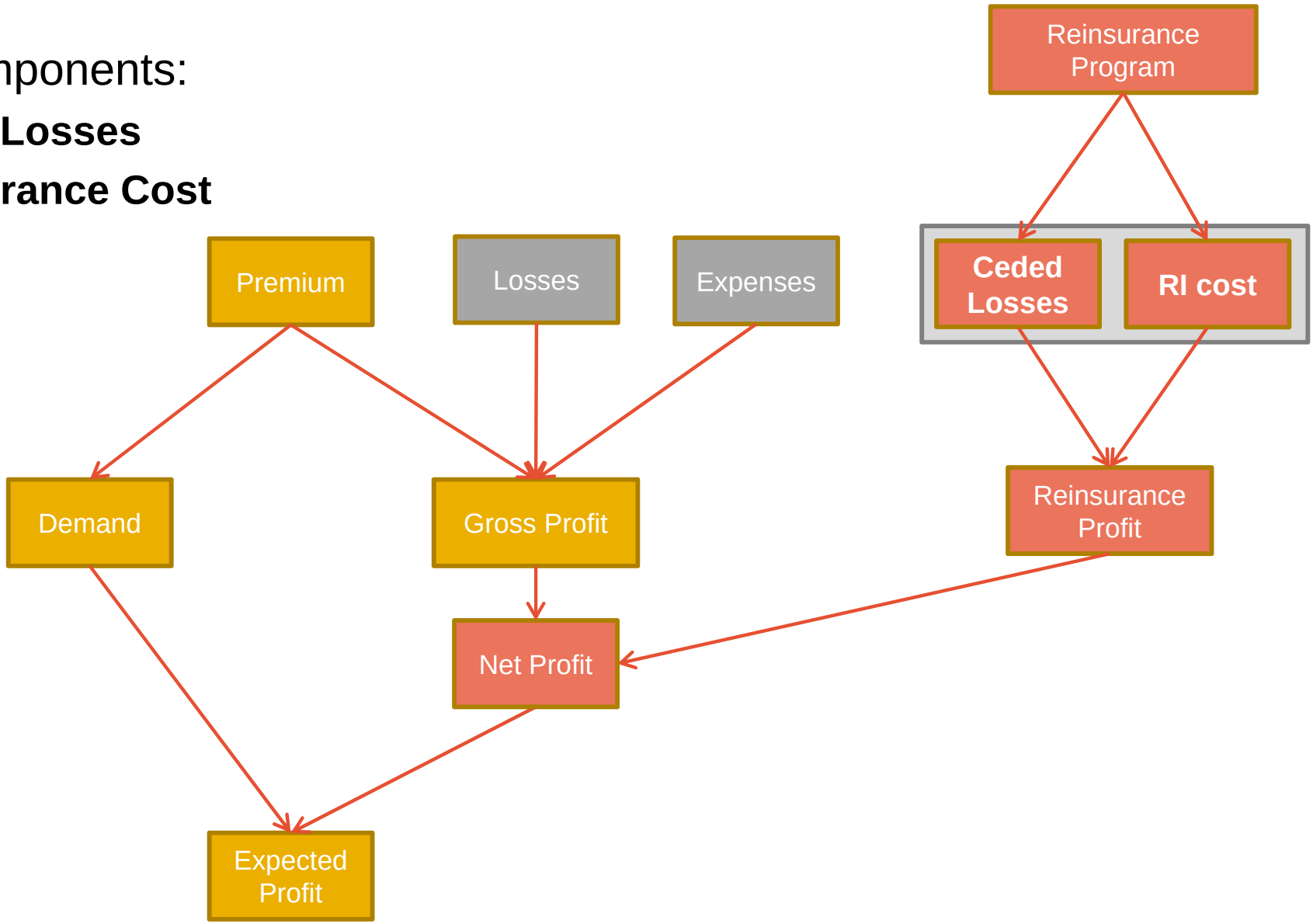
- Integration
  - Losses
  - Demand
  - Premiums
  - Expenses



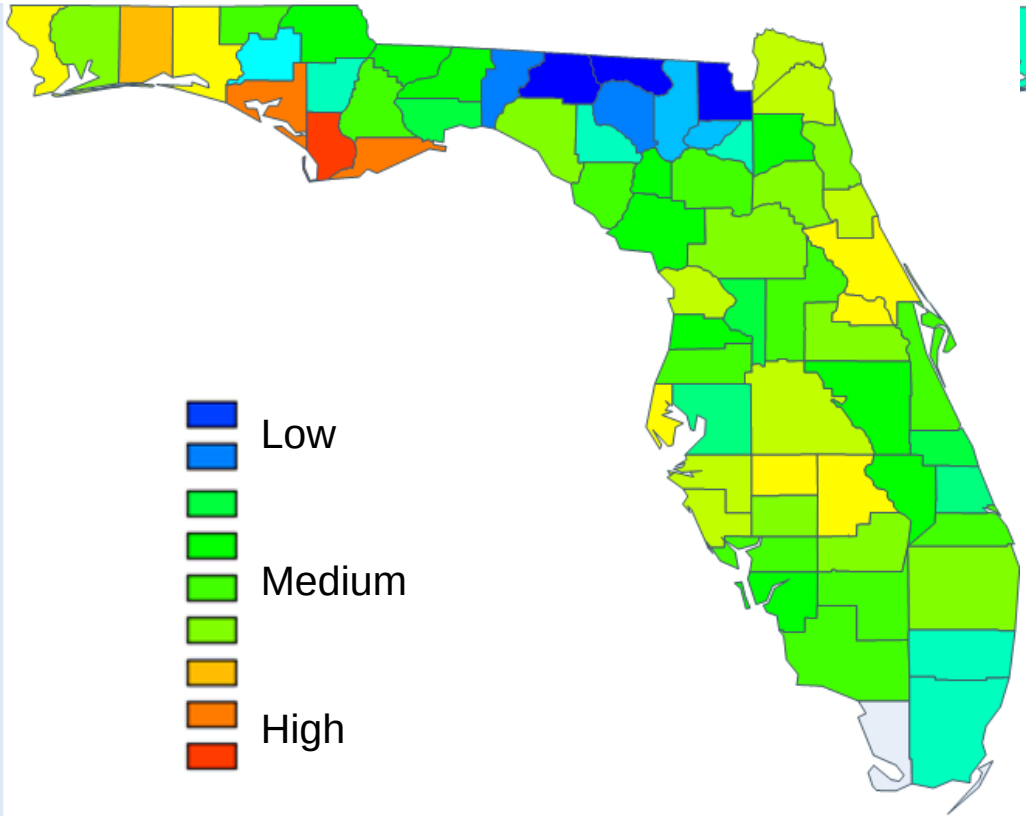
Profit =
+ Premium
– Attritional Losses
– Expenses

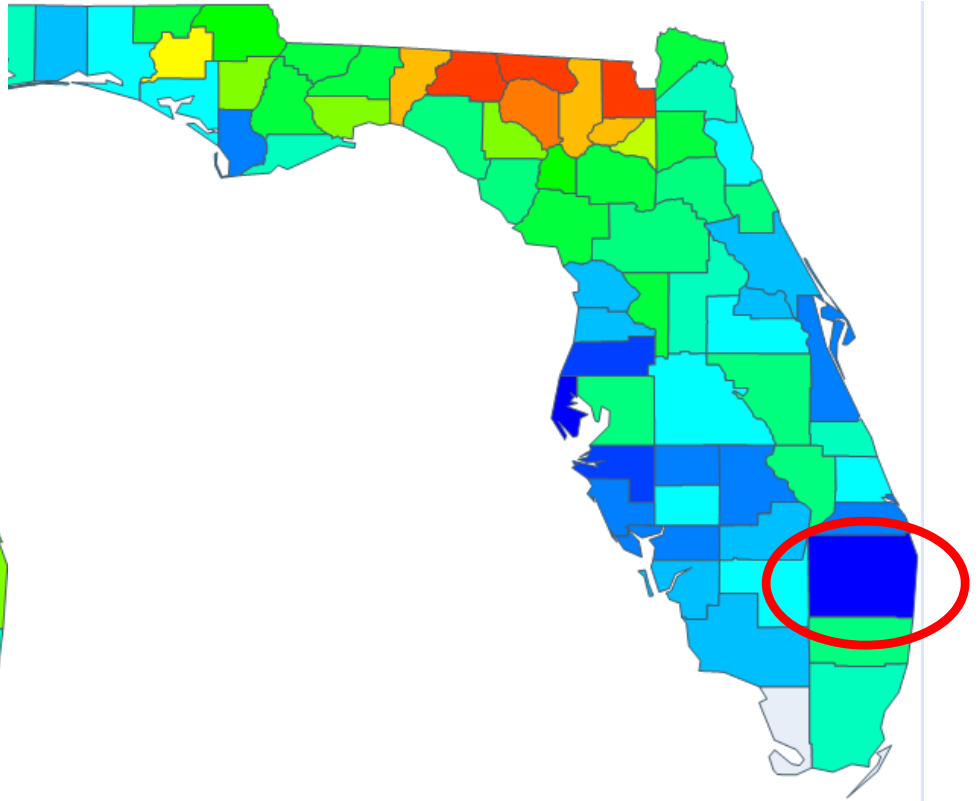
Enhanced Profit Calculation

- New Components:
  - **Ceded Losses**
  - **Reinsurance Cost**



Enhanced Profit Calculation





Other Metrics

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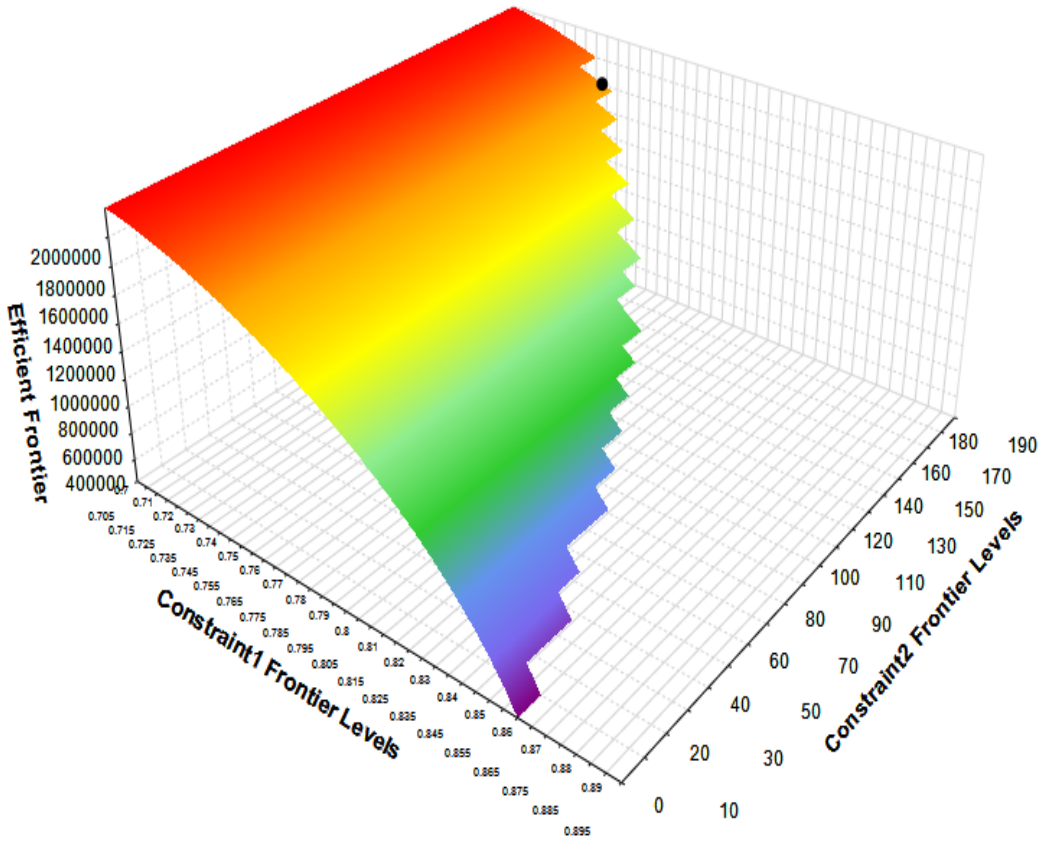
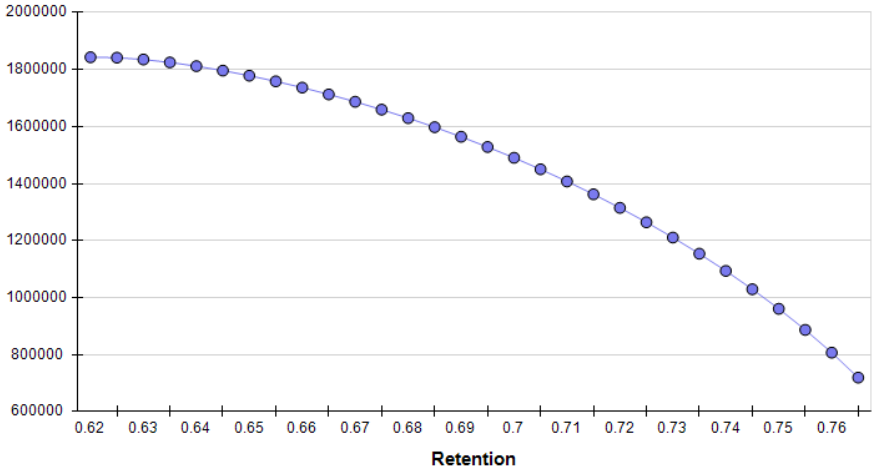
Advanced Uses:
Multiple constraints & Alternative Metrics

Standard goal is to seek maximum profit given a set retention rate:





- Other constraints can be added
- A wealth of alternative metrics:
- overall dislocation/impact, competitive ratio, long-term profit, win rate, cross-subsidy, mix of business change speed
- Helps to achieve a more refined selection

Customer Satisfaction

- Appealing but challenging
- Difficult to measure and hard to observe
- Costly
- Not clear how price influences customer satisfaction
  - other dimensions to customer service

2014 J.D. Power Reports:

“Customers Switch Auto Insurers Because of Poor Service; However, Savings with New Carrier Often Isn't Enough to Fully Satisfy”