



Session 27: Predictive Modeling for Risk Management

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Predictive Modeling for Risk Management

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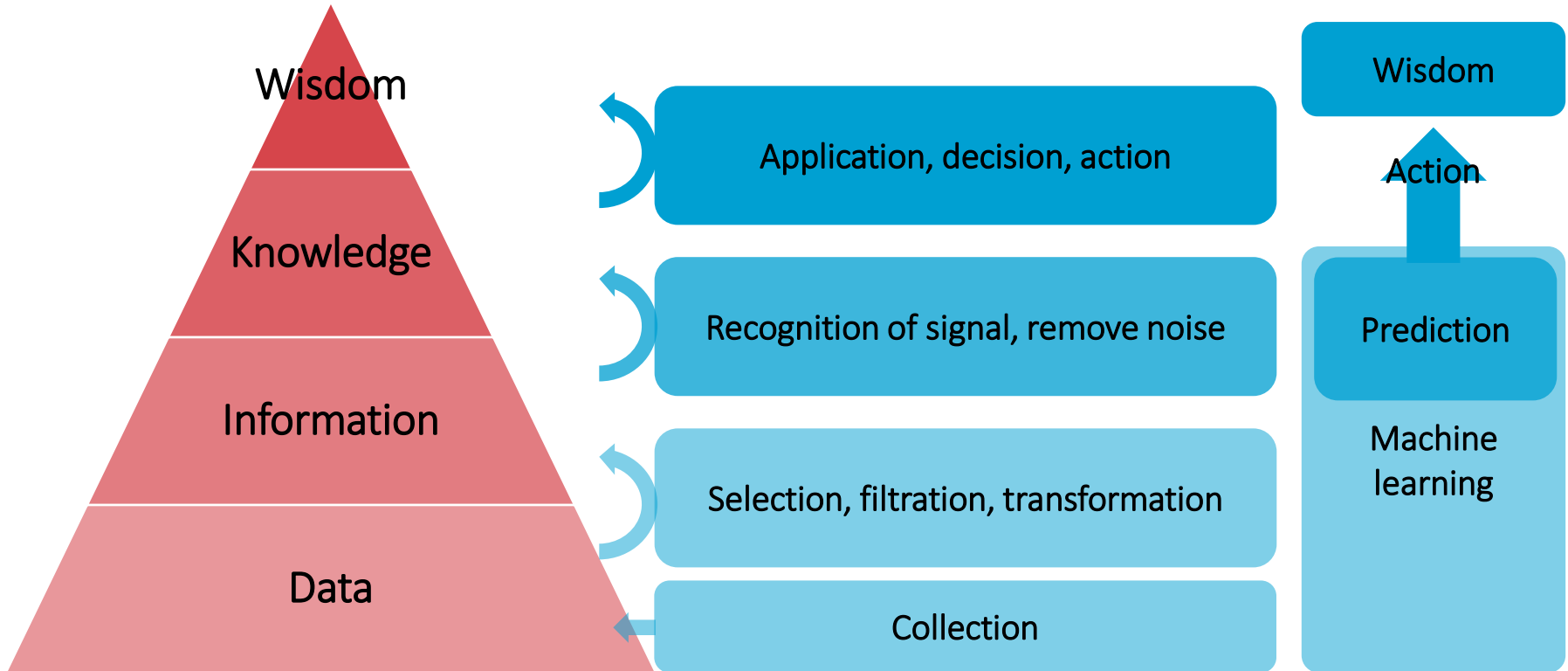


Agenda

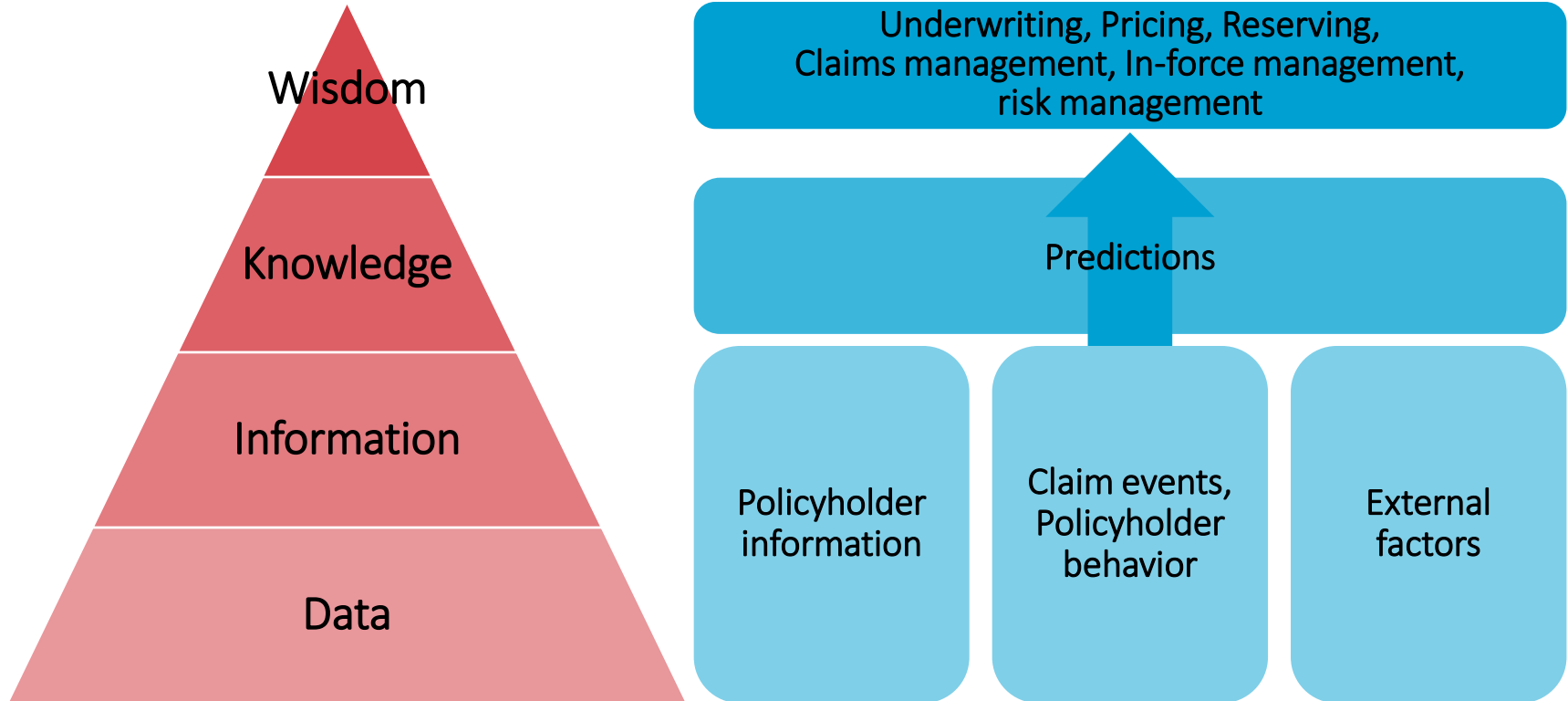
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- Predictive Modeling for Risk Management
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- Case study A: Interest rate risk and dimensionality reduction
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- Case study B: Predictive modeling and risk calibration
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- Case study C: Probabilistic decision making
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Predictive Modeling for Risk Management

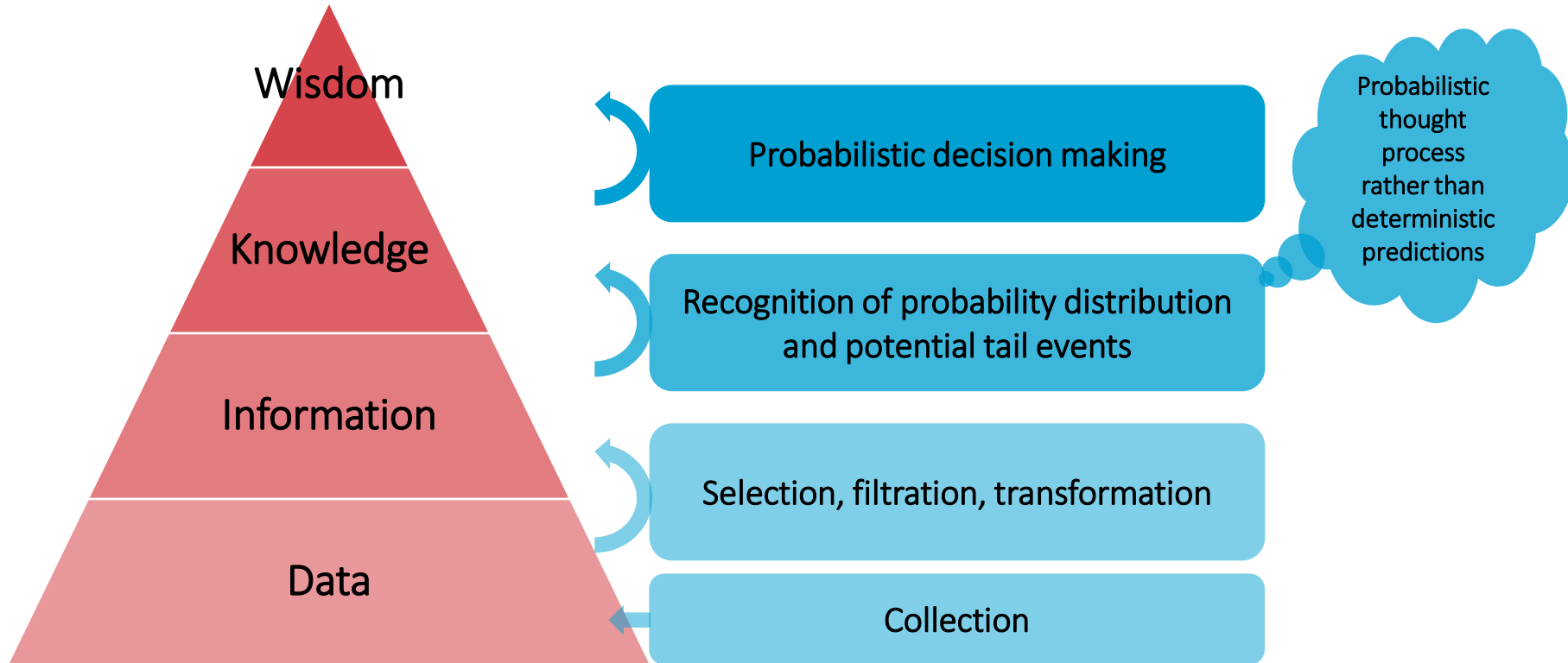
What is modeling framework



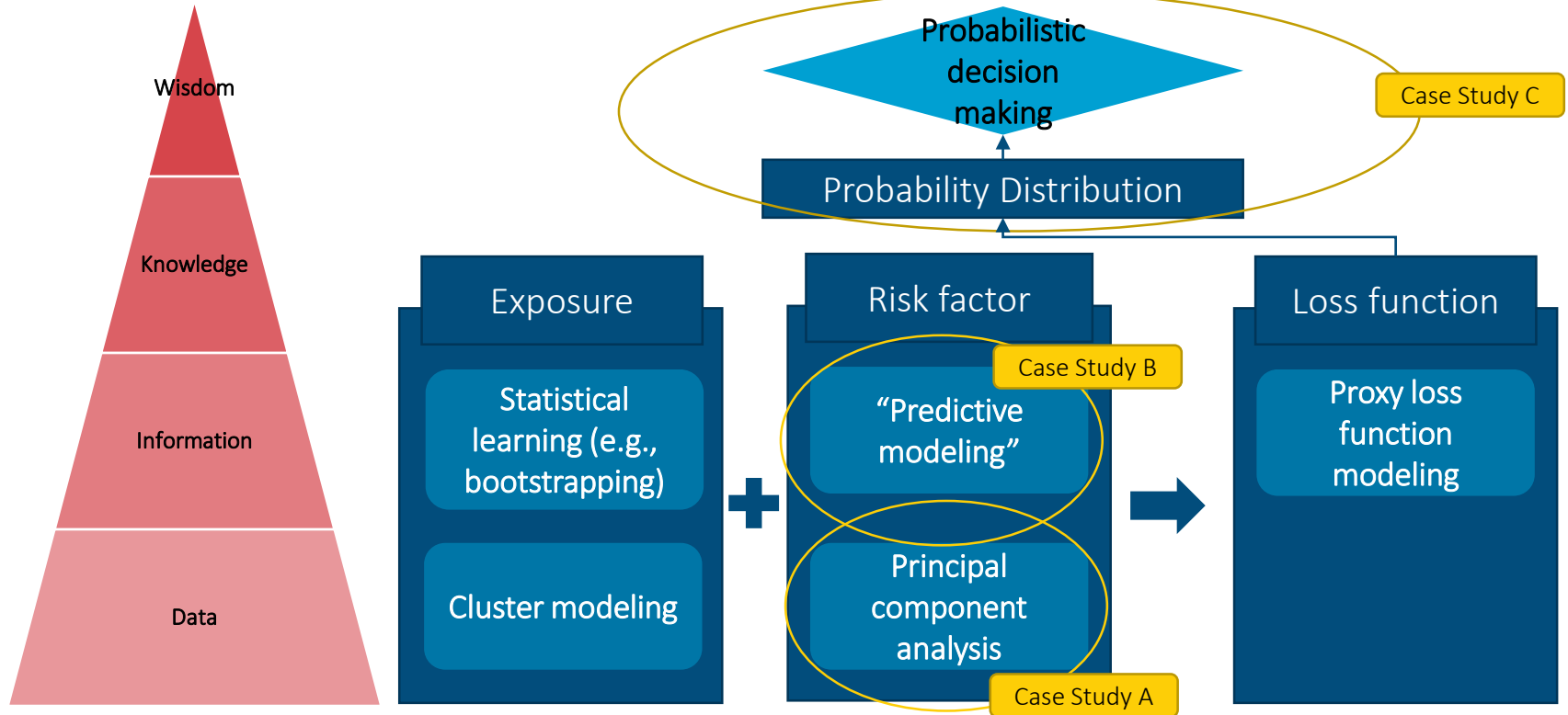
Applications in insurance business



Applications in risk management



Examples of modeling techniques used for risk management

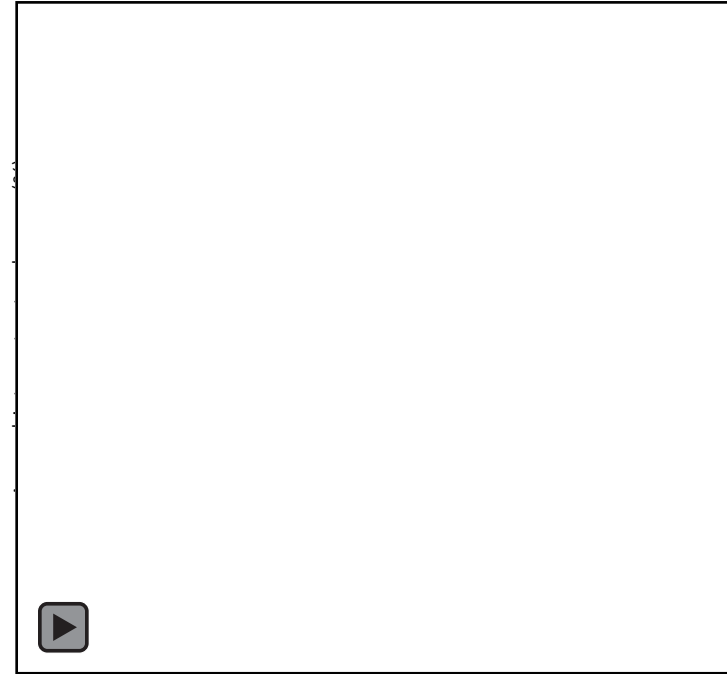


Case Study A: Interest rate risk and dimensionality reduction

Interest rate risk

Interest rate changes can appear complex

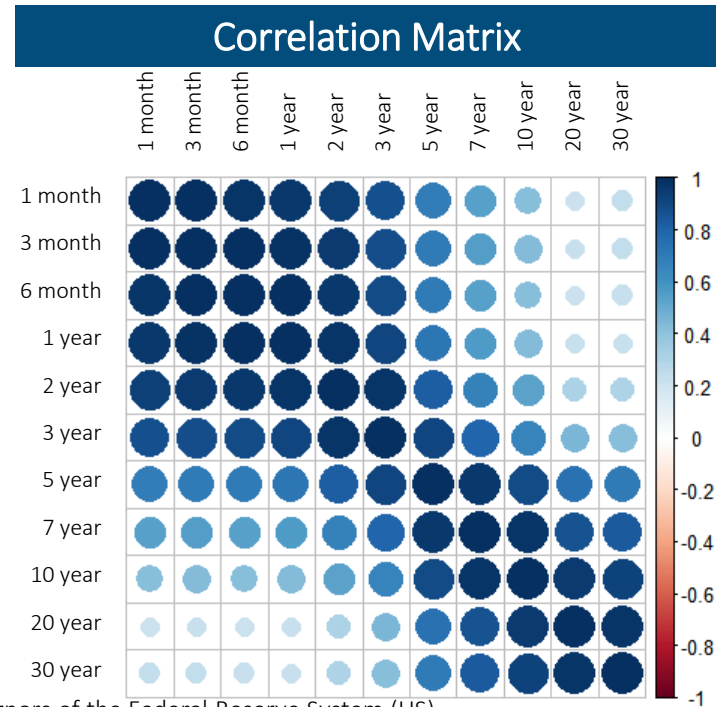
- Interest rate risk is one of key risk factors for insurance companies
- The chart illustrates annual interest rate changes (rolling 1-year window)
- However
 - 11 points in the yield curve
 - Too many factors to consider
 - The change in yield curve seems complex



Source: Analysis of Treasury Constant Maturity Rates from Board of Governors of the Federal Reserve System (US)

Further data exploration of annual interest rate changes

- High correlation for a pair of interest rate changes with close maturities
- High correlations imply the analysis could be simpler



Source: Analysis of Treasury Constant Maturity Rates from Board of Governors of the Federal Reserve System (US)

Principal component analysis (PCA)

A modeling technique for multi-variables

- **Definition (source: Wikipedia)**

- A statistical procedure that uses an orthogonal transformation to convert a set of observations of possibly correlated variables into a set of values of linearly uncorrelated variables called principal components

- **Why**

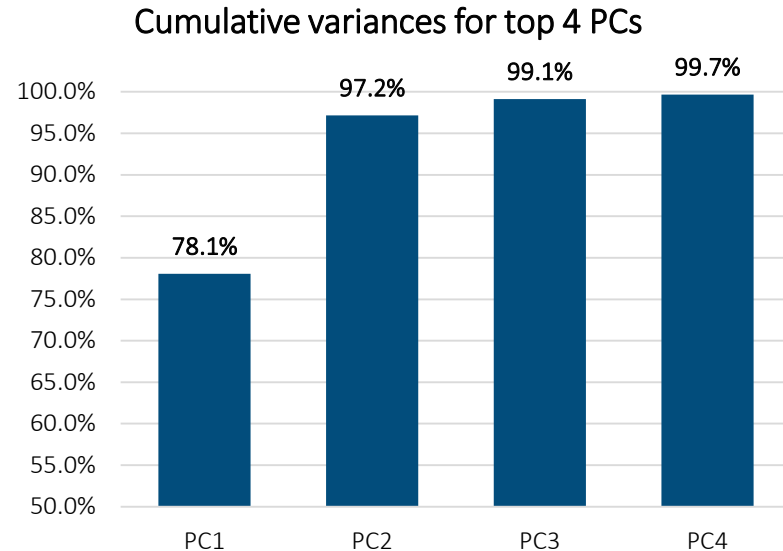
- Reduce dimensionality
- Identify “invisible” variables

- **Application**

- Transformation of highly correlated key rates into a smaller set of uncorrelated factors

Detecting number of key risks using principal component analysis

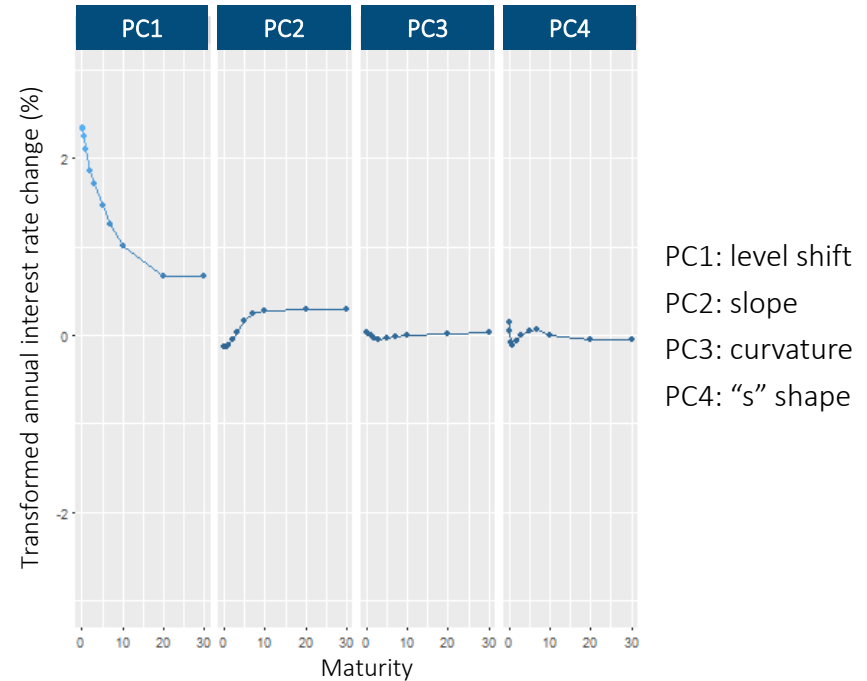
- Material portion of the interest rate change could be explained using first few principal components
- First three principal components explain more than 99% of the variances



PC: Principal Component
Partially shown among total of 11 PCs

Key interest rate risks identified

- Principal components (PCs) with top 4 eigenvalues for change in the interest rate curve
 - Charts show the annualized interest rate changes following normal distribution for each PC
 - PCs are independent each other
 - Level shift and slope changes are typical and common interest risk factors applied to economic capital model
- PCA is a useful data transformation tool to reduce dimensionality and complexity, and identify key risks among multiple variables



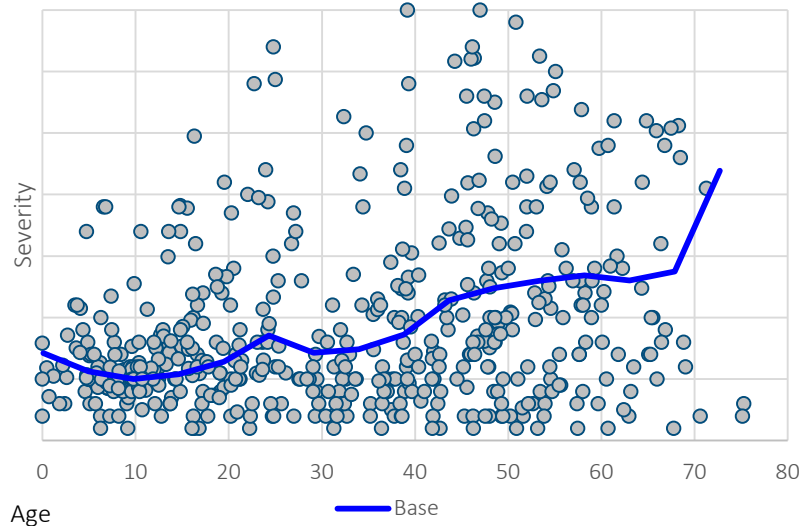
Case Study B: Predictive modeling and risk calibration

Predictive models for point predictions

- In life insurance industry, predictive models are used for underwriting, pricing, and valuation purposes
- Predictive models are used for mortalities/morbidities and policyholder behavior
- We have seen following benefits
 - Better data utilization
 - Better reflect interactions between predictors
 - Better accuracy in signal vs. noise

Expanding the questions for risk management

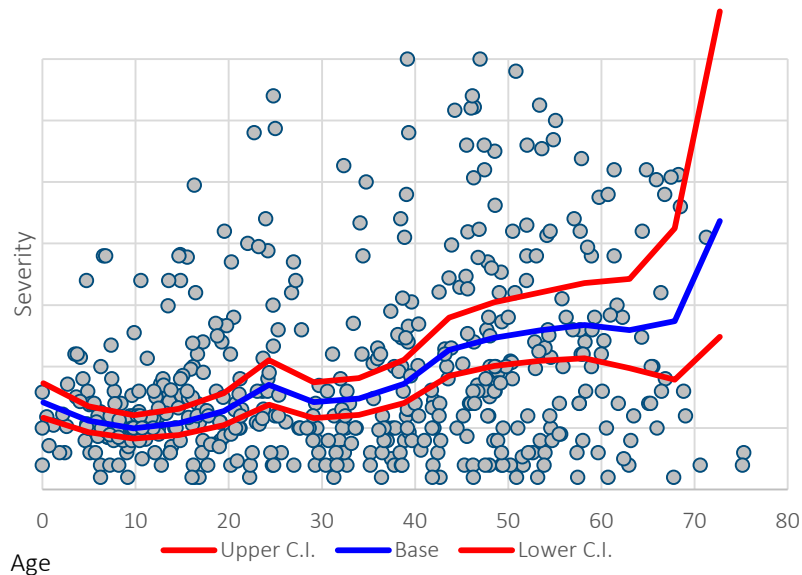
Illustrative analysis on a severity data
(# of days in hospital by age)



- What is the claims cost?
 - Key question being asked for point and best estimate
- Key questions for risk management
 - When to use actuarial and expert judgments?
 - How do prediction errors differ between certain cells, blocks?
 - Any extra safety margin needed?
 - Would the same risk stress apply if a business mix profile changes?

Confidence intervals provide a knowledge for risk management

Illustrative analysis on a severity data
(# of days in hospital by age)

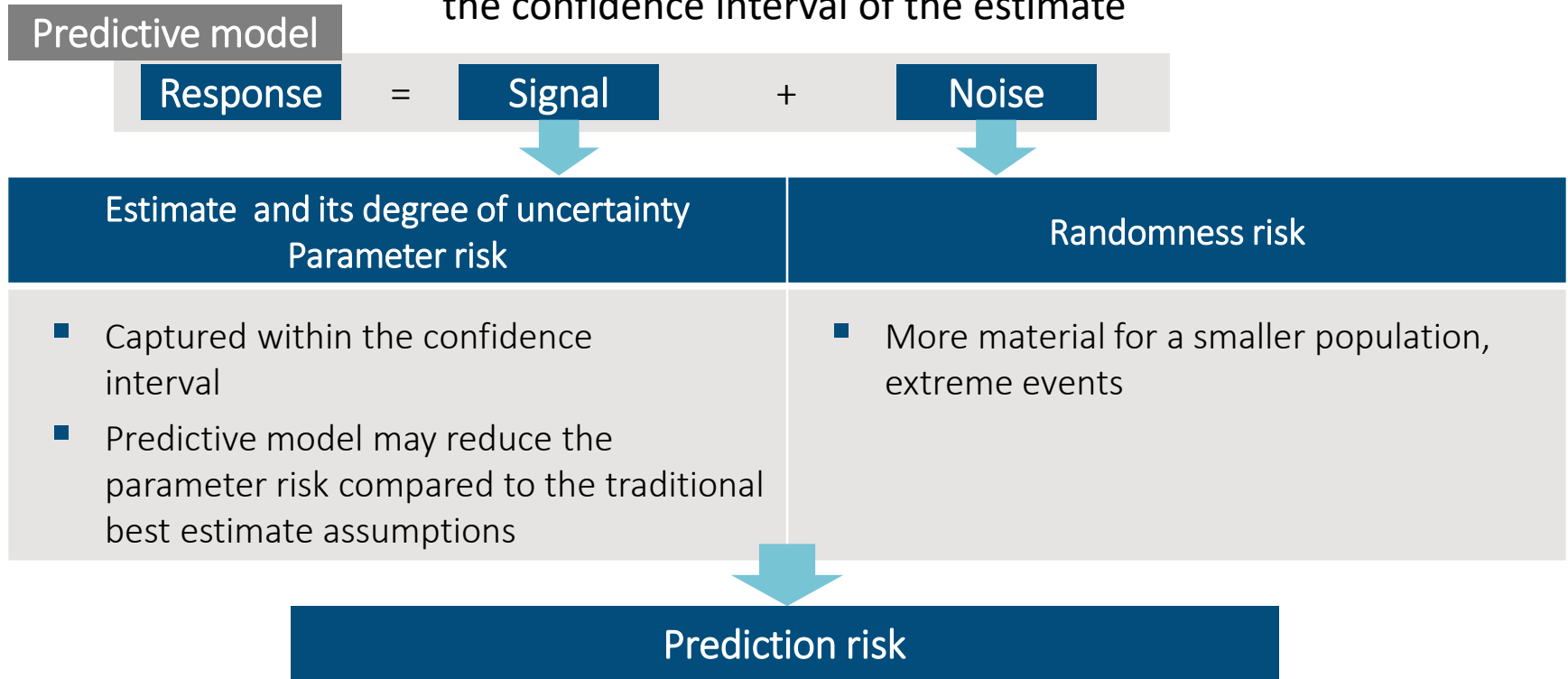


Implications

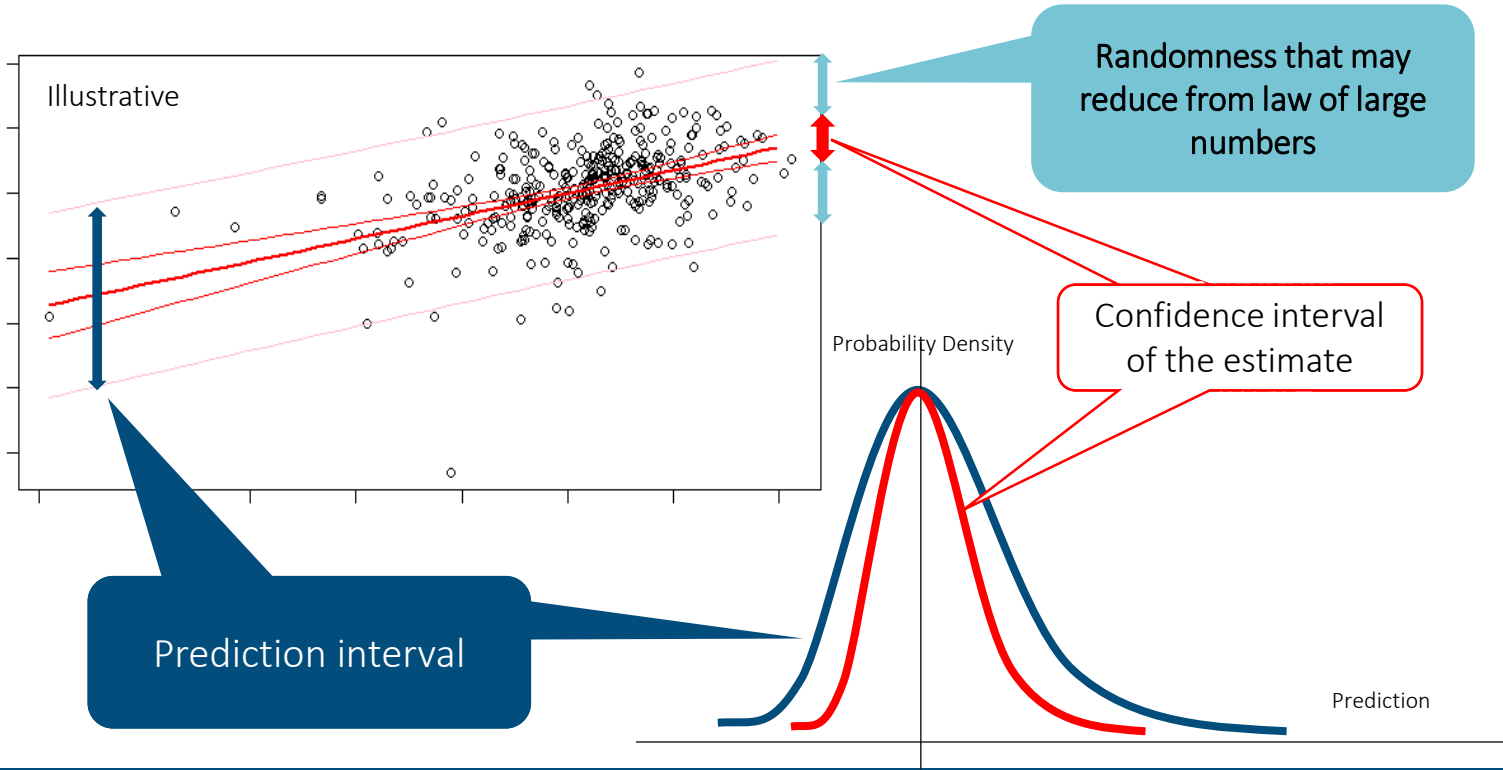
- Confidence:
 - Precision
 - Frequency
 - Other benchmarks (e.g., research on older ages)
 - Actuarial judgement
- Pricing: safety margin
- In-force management, reinsurance, capital management

One more question: what about randomness?

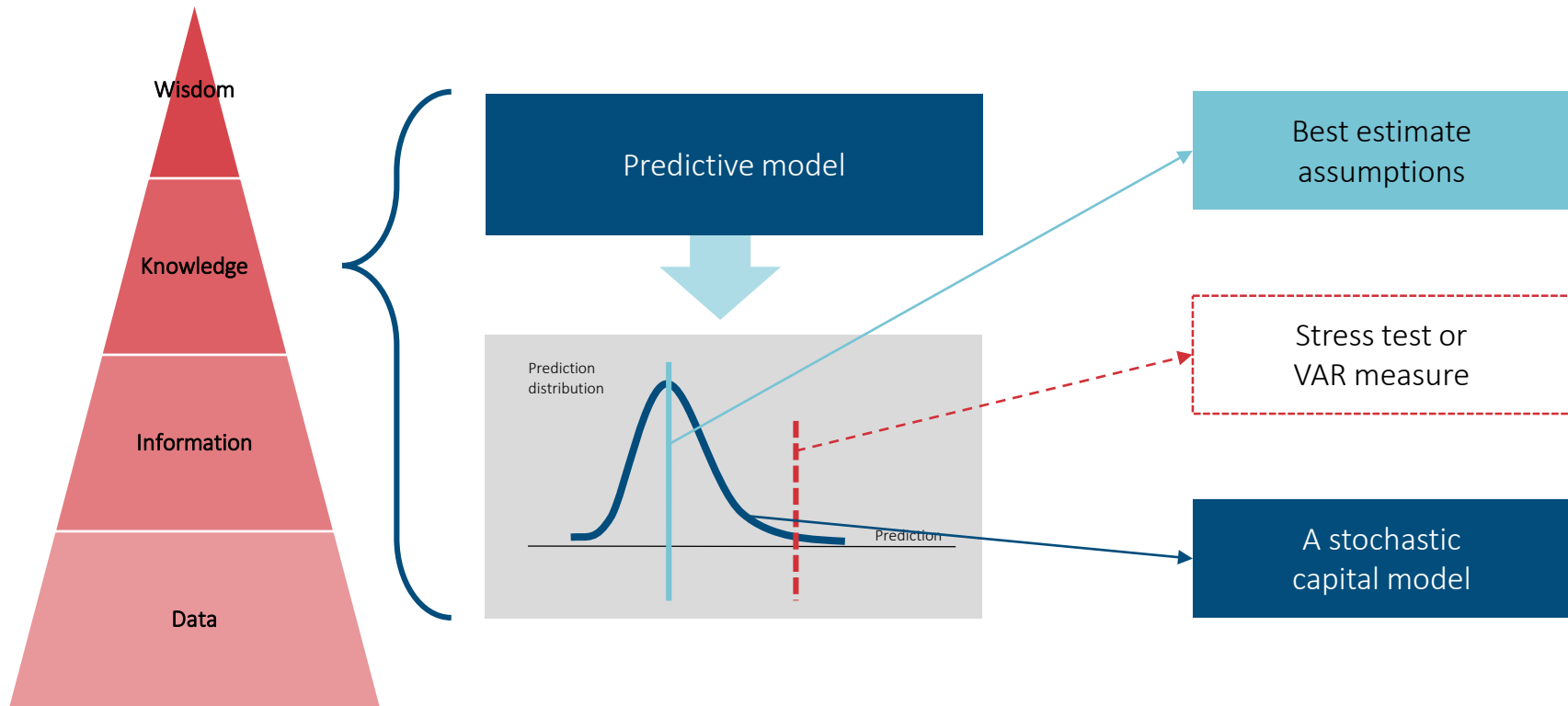
Prediction interval adds a randomness in addition to the confidence interval of the estimate



A distribution of predictions is a valuation information for risk management

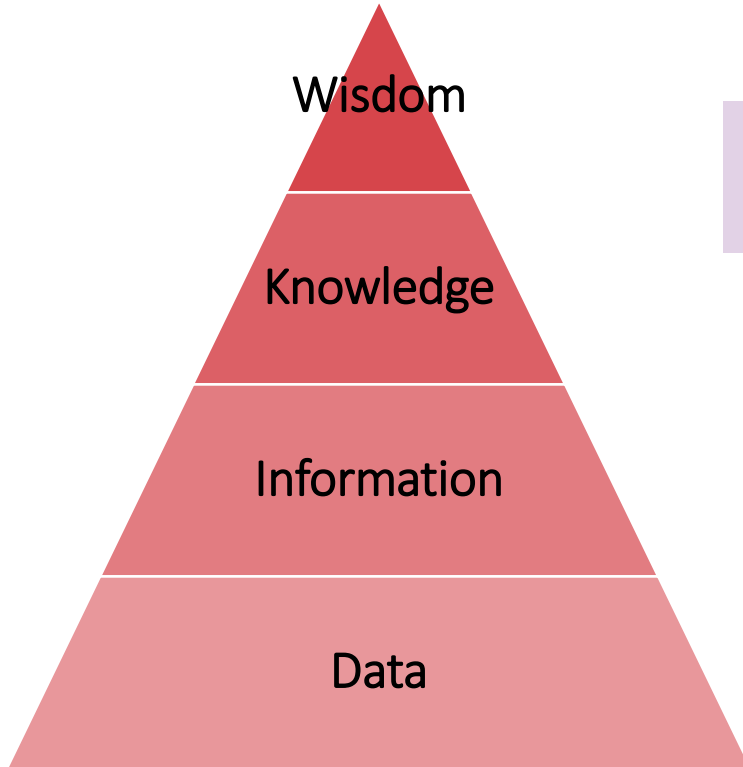


Linking predictive models to risk factor calibration



Case Study C: Probabilistic decision making

Models are process for wisdom



“All models are wrong but some are useful”
George Box

Q&A

Thank you!!

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