

Chapter 04

Applications of Actuarial Science in Insurance

This course provides actuarial students with in-depth knowledge of how actuarial science applies to the insurance industry. The course will focus on two core applications:

- 1. Risk Evaluation:** Analyzing the risks expected for the client
- 2. Pricing:** Creating models to determine premium costs based on incidents and claims

Each section includes examples and exercises to reinforce practical understanding.

1- Risk Evaluation – Analyzing the Risks Expected for the Client

Objective: Understand how to evaluate risks by assessing a client's likelihood of making a claim based on various risk factors.

1.1 Introduction to Risk Evaluation

Purpose of Risk Evaluation in Insurance:

The goal of risk evaluation is to estimate the probability and impact of potential future events that may lead to claims. Actuaries use statistical and analytical techniques to classify clients by risk level and predict the likelihood of future claims.

Factors Impacting Risk:

- **Demographic factors:** age, gender, occupation, health status, and lifestyle
- **Behavioral factors:** past insurance claim history, driving habits, or hobbies
- **Environmental factors:** region-specific risks like climate for property insurance or road conditions for auto insurance

1.2 Data Collection for Risk Assessment

Actuaries gather data from various sources:

- **Historical Claims Data:** Past claims by clients with similar profiles
- **Mortality and Morbidity Tables:** Used for life and health insurance to estimate death or illness probabilities
- **Statistical and Government Databases:** Data on accidents, crime rates, or health statistics

Example:

Suppose an insurer wants to assess the risk level of a potential client seeking life insurance. The actuary will:

1. **Analyze Mortality Rates:** Use mortality tables to see the general life expectancy for people of the client's age, gender, and health background.
2. **Incorporate Health Factors:** Factor in the client's lifestyle, including exercise frequency, smoking status, and family medical history.
3. **Estimate Risk Level:** Based on these inputs, calculate a probability score for mortality risk, which guides the insurer's decision to approve or deny coverage and influences pricing.

1.3 Modeling Risk for Different Types of Insurance

Each type of insurance has unique risks:

- **Life Insurance:** Actuaries use survival analysis and life tables.
- **Health Insurance:** Requires morbidity data and an understanding of disease prevalence.
- **Auto Insurance:** Involves modeling accident frequencies based on driver age, experience, and other behavioral factors.

Example: Auto Insurance Risk Evaluation

A 24-year-old driver with a 5-year driving history and two past minor accidents is applying for auto insurance. The actuary would:

1. **Evaluate Accident Probability:** Based on age and accident history, determine a higher likelihood of future claims compared to an older driver with a clean record.
2. **Apply Regional Data:** If the client lives in an urban area with high accident rates, this increases risk further.
3. **Assign a Risk Rating:** This driver would be rated as higher risk, which may influence both approval terms and premium pricing.

2: Pricing – Creating Models for Matching Incidents to Claims

Objective: Learn how to set premiums by creating models that predict the cost of claims based on risk assessment.

2.1 Basics of Insurance Pricing

Purpose of Pricing in Insurance:

Pricing is the process of setting premiums that reflect the expected costs of future claims, as well as other operational costs and desired profit margins. Effective pricing ensures the insurer can cover claim costs while remaining profitable and competitive.

Components of Insurance Pricing:

- **Expected Claim Cost:** Calculated based on estimated frequency and severity of claims.
- **Administrative Expenses:** Costs related to underwriting, claim handling, and other operations.
- **Profit Margin:** A buffer to ensure profitability.

2.2 Building a Pricing Model

Data and Methods Used in Pricing Models:

- **Historical Claims Data:** Past claim costs are analyzed to predict future trends.
- **Regression Analysis:** Commonly used to model the relationship between risk factors and claim frequency/severity.
- **Credibility Theory:** Weighs individual client data with general data for accurate predictions.

Steps in Creating a Pricing Model:

- 1. Data Collection:** Gather data on claim amounts and frequency from similar client profiles.
- 2. Model Selection:** Choose a model type (e.g., linear regression for simpler relationships or GLM for more complex ones).
- 3. Risk Adjustment:** Adjust premiums based on client-specific factors, such as high-risk behavior or location.

Example: Health Insurance Pricing Model

An actuary is tasked with pricing a health insurance policy for a 35-year-old non-smoker with no major health issues. The steps are:

- 1. Calculate Expected Claim Cost:** Use historical data to estimate the average healthcare costs for a similar client profile over the policy term.
- 2. Add Risk Adjustments:** Consider factors such as BMI, blood pressure, and family history of illness. This client's health background lowers expected costs compared to high-risk clients.
- 3. Set Premium:** Incorporate expenses and desired profit margin to set the client's premium rate.

2.3 Advanced Pricing Techniques and Dynamic Models

Pricing can vary for:

- **Types of Coverage:** Comprehensive vs. liability insurance.
- **Policy Customization:** Premium adjustments for policy add-ons or high-risk activities.
- **Dynamic Pricing:** Actuaries may use machine learning techniques to analyze real-time data and adjust prices for short-term policies.

Example: Dynamic Pricing for Auto Insurance

A telematics-based insurance policy adjusts premiums based on real-time driving behavior. For instance:

- 1. Data Collection:** The client's driving data (e.g., speed, braking, time of driving) is recorded.
- 2. Behavioral Analysis:** The model predicts accident likelihood based on detected behaviors.
- 3. Premium Adjustment:** The client's monthly premium adjusts up or down based on driving behavior, rewarding safer habits with lower premiums.

Course Exercises and Practical Application

Exercise 1: Conduct a risk evaluation for a hypothetical life insurance client based on demographic and lifestyle information.

- **Instructions:** Given data for age, gender, smoking status, and health history, calculate an estimated mortality risk.

Exercise 2: Build a pricing model for a simplified auto insurance policy.

- **Instructions:** Use sample data to apply regression analysis and calculate premiums based on age, driving record, and location.

Exercise 3: Create a dynamic pricing model.

- **Instructions:** Simulate a pricing adjustment for a telematics-based auto insurance policy, where driving behaviors affect monthly premium rates.