# 再保險合約最佳化分析

## -運用「動態財務分析」軟體

中華民國精算學會研討會

2014.06.13

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# Agenda

- **Section 1**
  - DFA 軟體 及其原理
  - 風險量化及再保最佳化流程
  - 承保及損失經驗分析、情境調整 與 最適分配
  - 各式再保合約運算邏輯
  - 動態模擬 與 再保最佳化決策

- **Section 2**
  - 實例討論

# 風險決策

- **假設 A 產險公司目前承作三個險種:**

| | 淨保費 | 平均綜合率 |
|---|---|---|
| 車險 | 1,000 | 90% |
| 工程險 | 1,000 | 88% |
| 意外責任險 | 1,000 | 87% |

- 每個險種的淨核保損益為何?
- A 公司要如何讓利潤極大化?

# 舉例 B

- **當我們考慮到loss volatility的影響:**

| | 淨保費 | 平均綜合率 | 標準差 |
|---|---|---|---|
| 車險 | 1,000 | 90% | 8% |
| 工程險 | 1,000 | 88% | 12% |
| 意外責任險 | 1,000 | 87% | 30% |

- Volatility 是否改變你的想法?

動態財務分析（DFA）軟體 的強項之一，即協助使用者

**簡捷、快速** 量化風險，建立 風險決策 與 經濟資本 模型

Empower Results®

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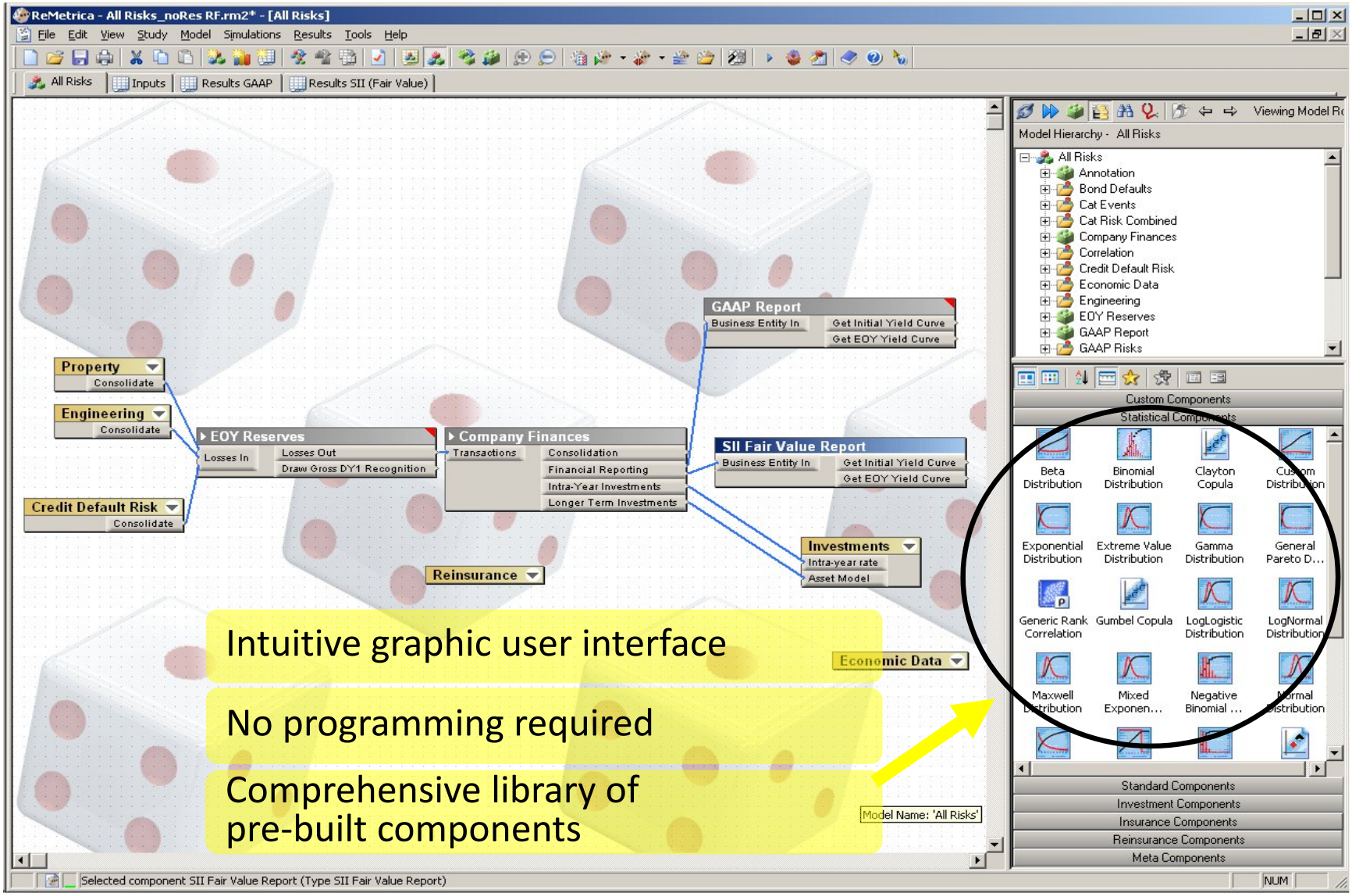
# DFA 軟體介面 – 以 ReMetrica 軟體為例



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# 靜態模型 與 動態隨機模型方法之差異

## 1） 傳統定值估計方法 Traditional Deterministic Approach

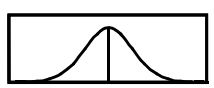
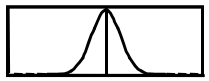
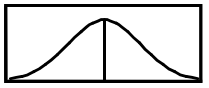
- Static estimates are used:

# Policies x Premium x (1-Combined Ratio) = Operating Profit

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| i.e. | 10,000 | x | $20,000 | x | (1 - 90%) | = | $20m |
| | 12,000 | x | $20,000 | x | (1 - 105%) | = | -$12m |

## 2） 動態財務分析方法 DFA（Stochastic）Approach

- Distributions around the above elements are modeled to generate a range of outcomes as the elements are combined.

i.e.  x  x (1-  ) = 

**10,000** **$20,000** **90%** **$20m**



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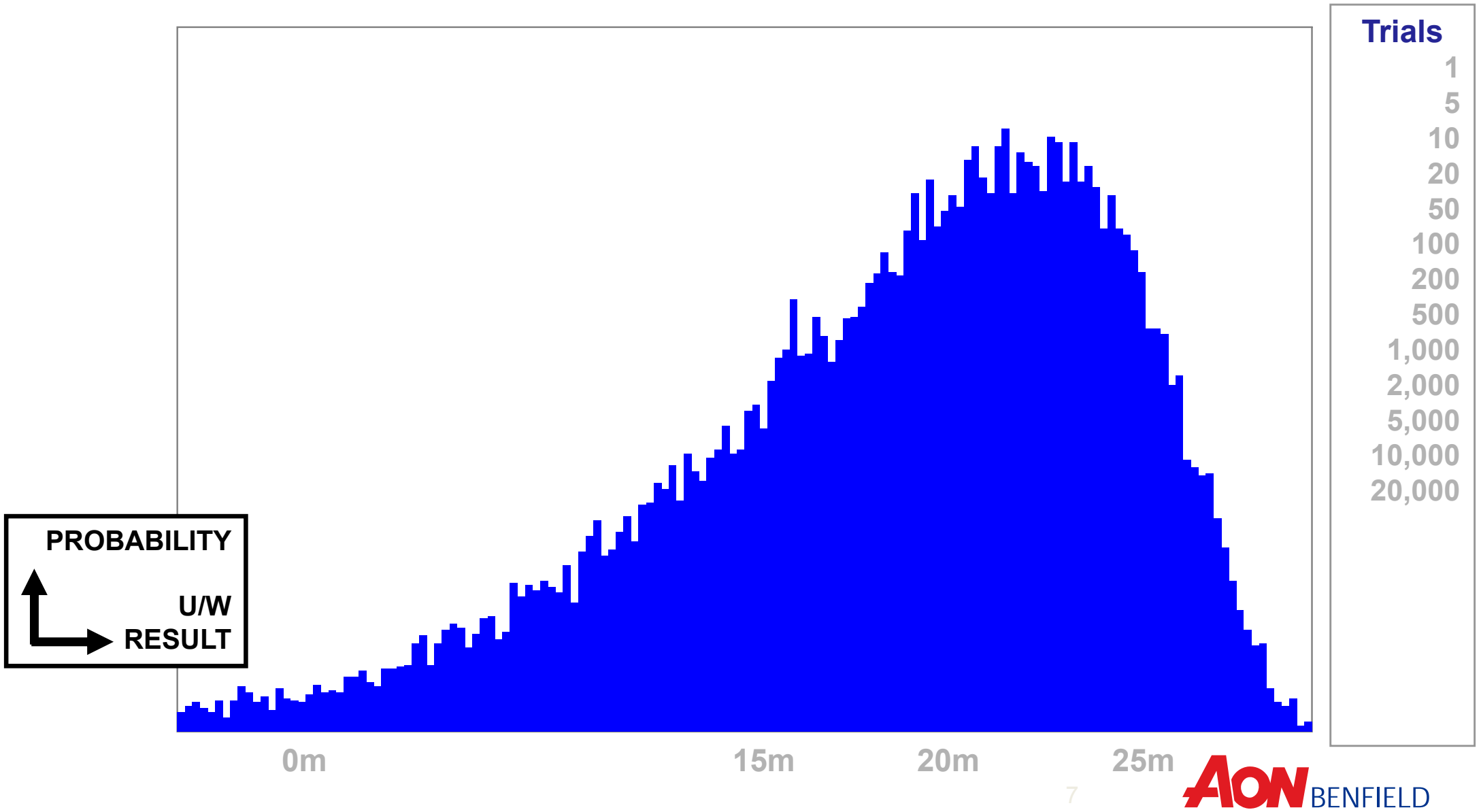
# 隨機模擬 Stochastic Simulation



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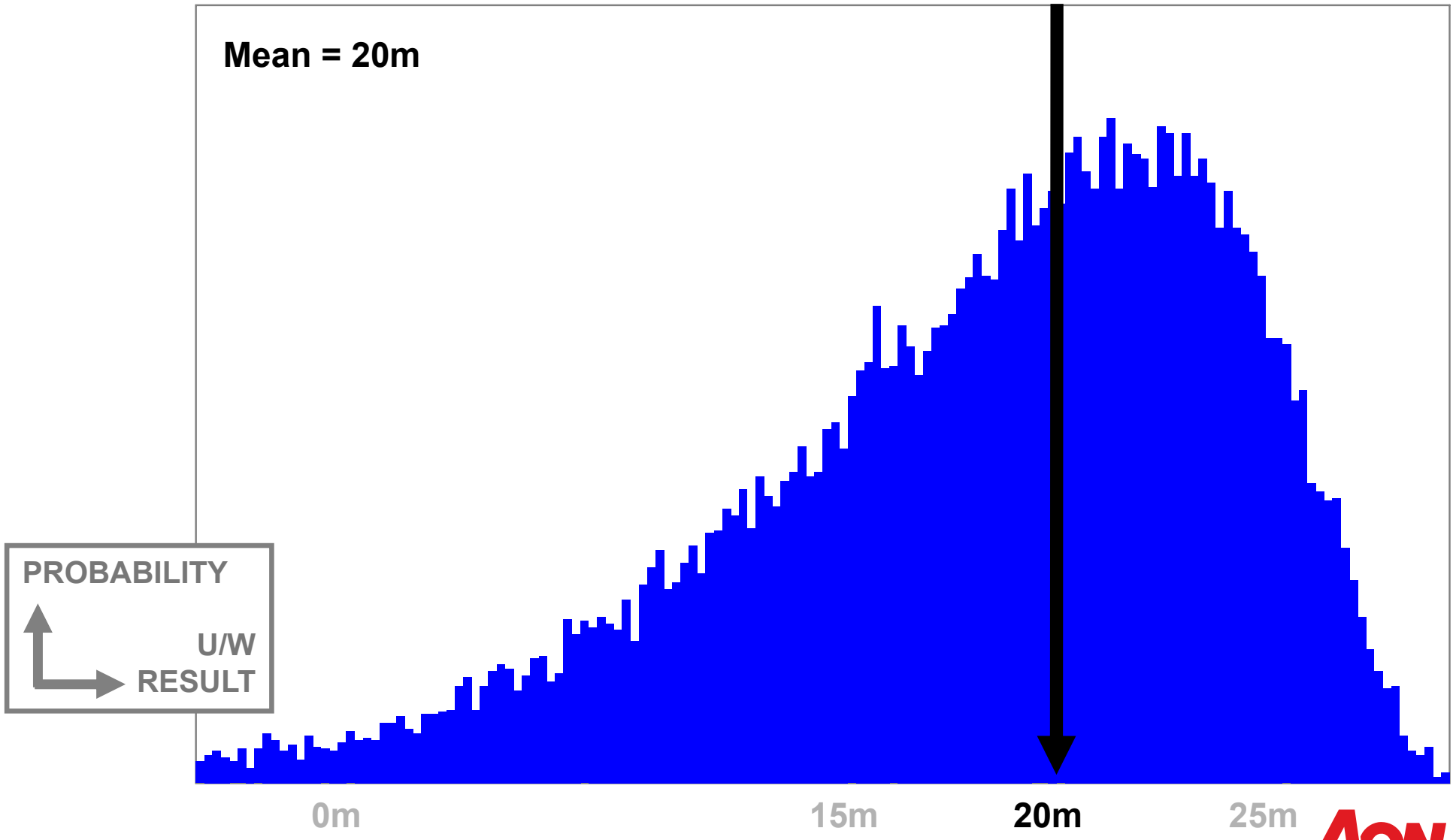
# 隨機模擬 Stochastic Simulation（續）



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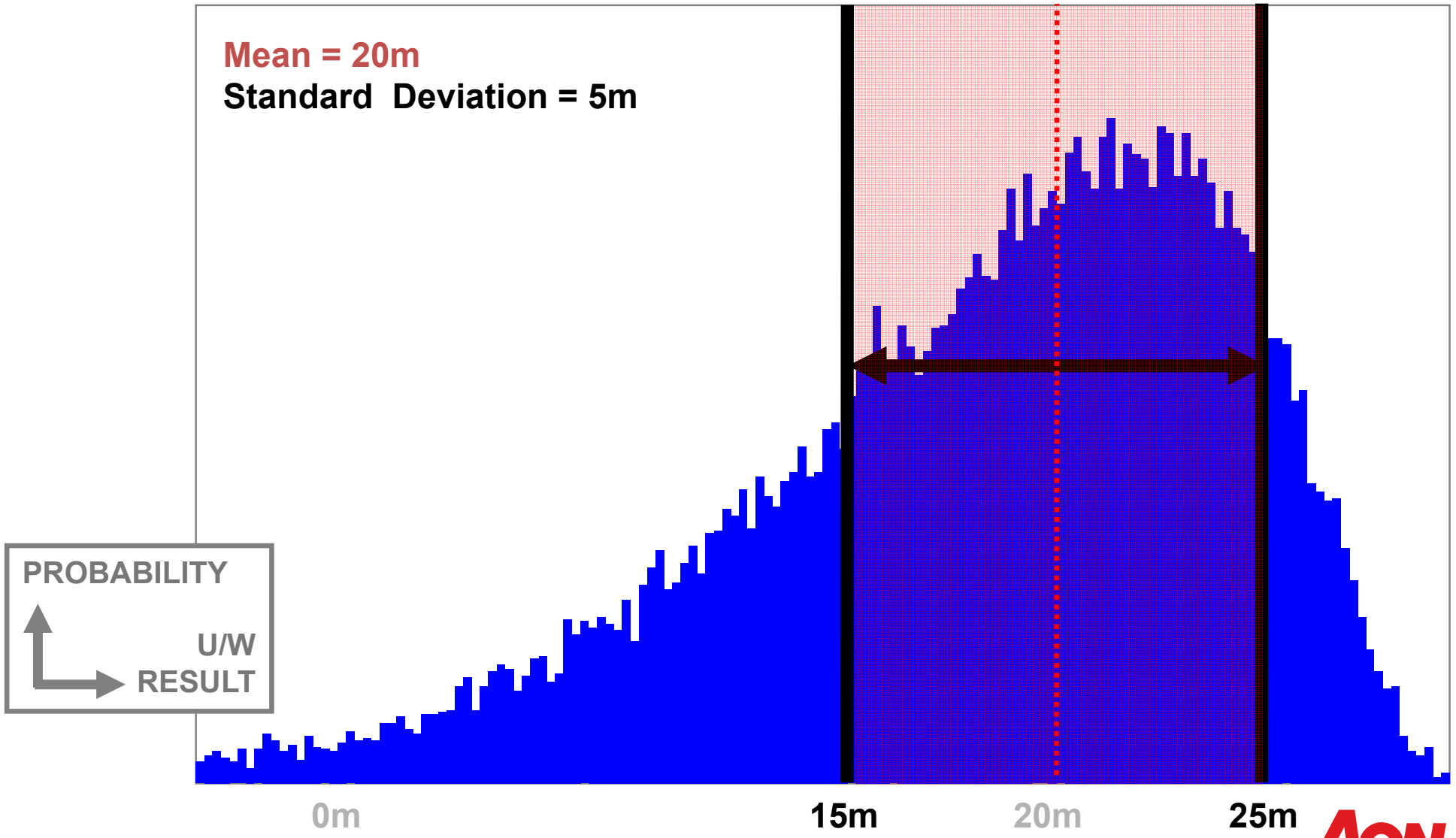




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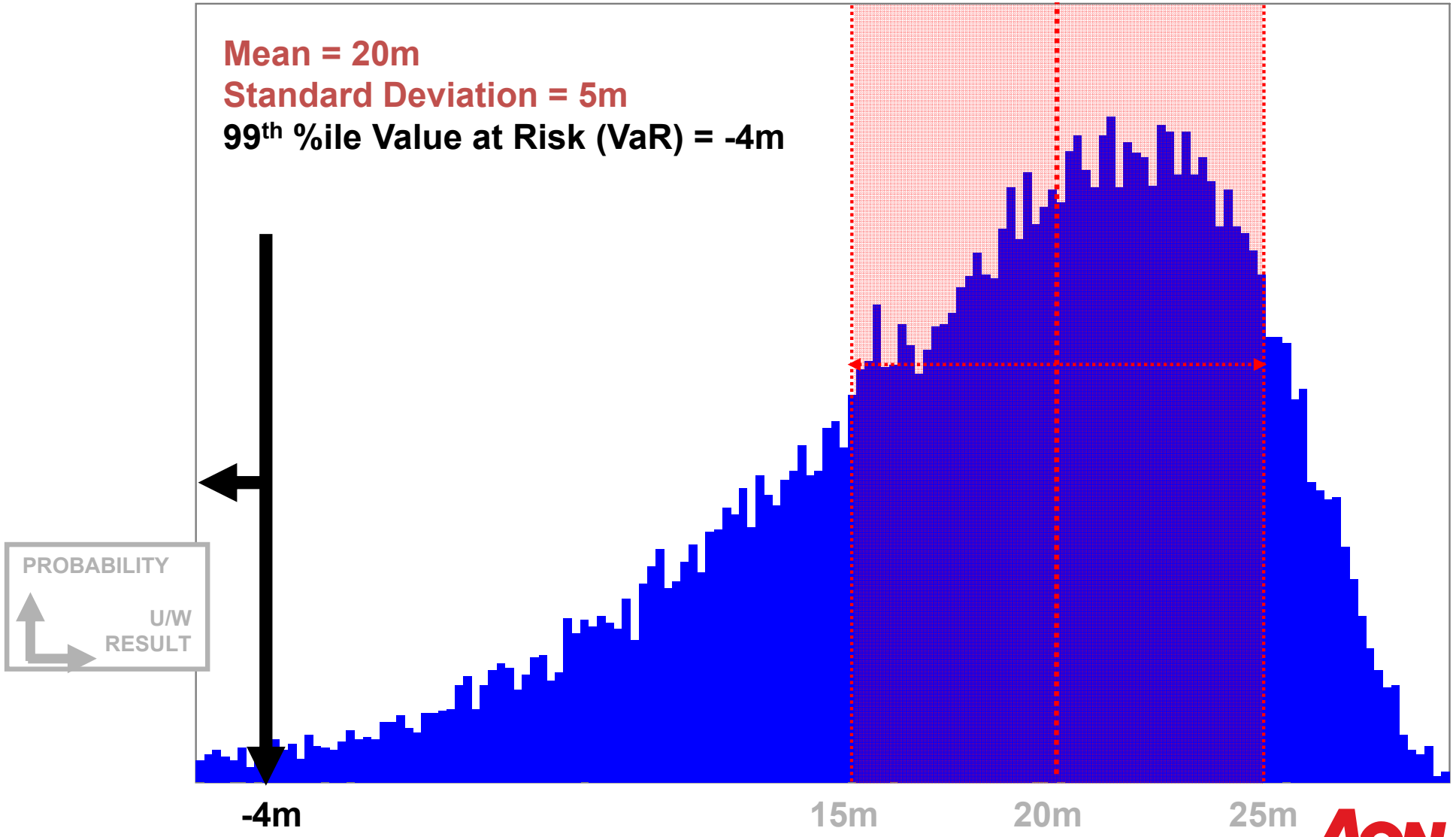




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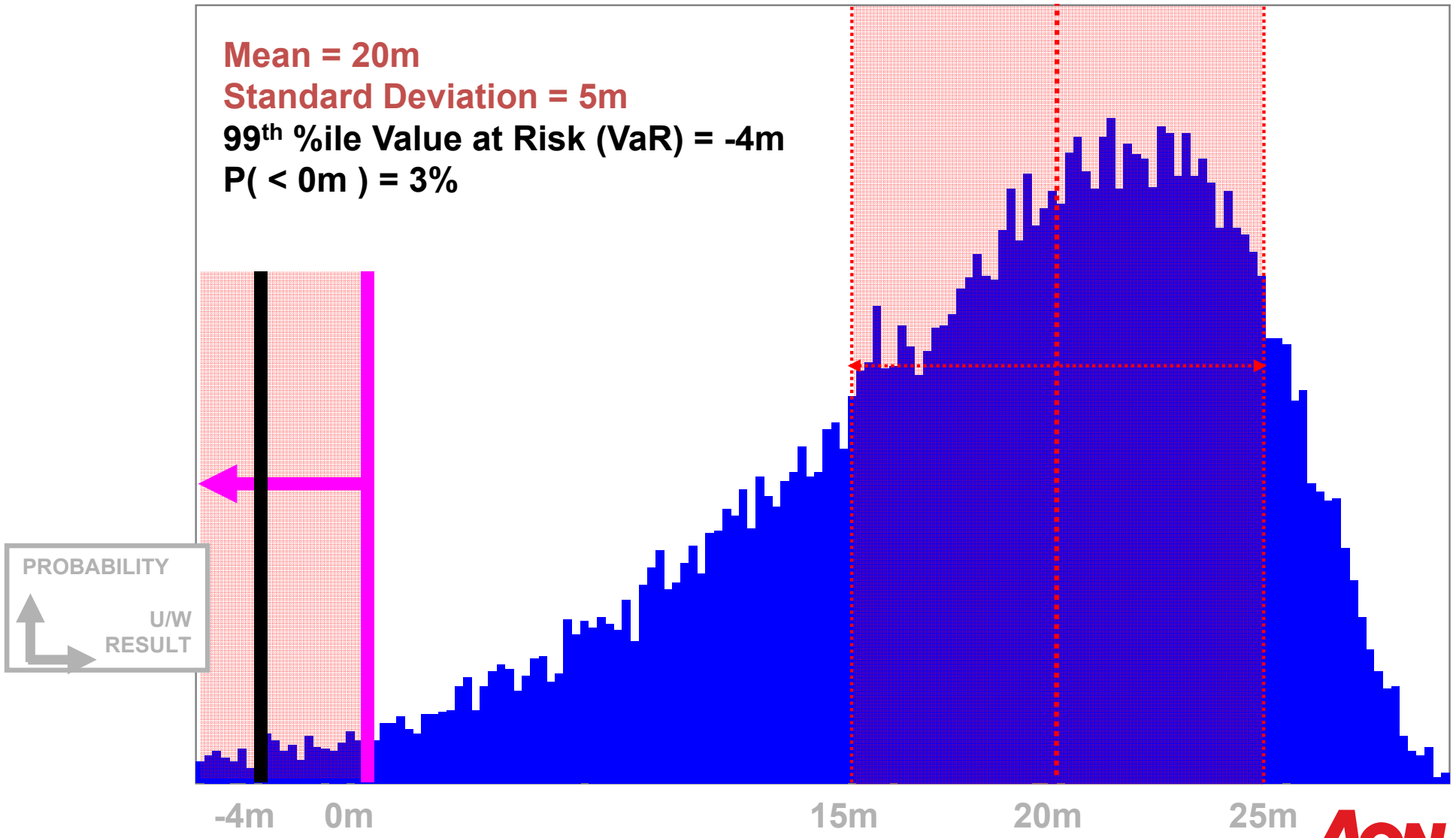




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人生的閱歷若可以延長數萬年，

所有風險情境將可了然於胸

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# Rules of Risk Management for Insurance Industry
# (保險業風險管理實務守則)

風險管理機制應……運用各種 質化 與 量化技術，管理保險業

可合理預期且具攸關性之重要風險*

* Negative Uncertainties
具負面影響之不確定因素



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# 保險業風險管理實務守則

- 風險是不確定因素 Risk is uncertainty
- 應衡量並彙總風險，包括 must to integrate Risk measurement for both:
  - 跨險種 cross lines, and
  - 公司整體 across the enterprise
- 宜考量風險之間的相關性 should consider correlation among risks

傳統定值計算方法 恐無法符合以上需求

Traditional method of "Deterministic Approach"

would be difficult not fit-in the above requirement

而且, 更難的是…

And more difficulties are …



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# 保險業風險管理實務守則（續）

- 應同時考量報酬及風險 must to judge the interactions between risks and rewards
- 資本適足性評估 Adequate Capital (AC) evaluation
  - 應限期完成資本適足率計算 must to calculate AC within time limit
  - 應了解營運策略對資本適足率之影響 must to understand the impact on AC against business strategies
  - 宜發展經濟資本量化技術 與 自我風險及清償能力評估機制 should develop techniques of quantifying Economic Capital (EC) and mechanisms of assessing his own risks and solvency capability



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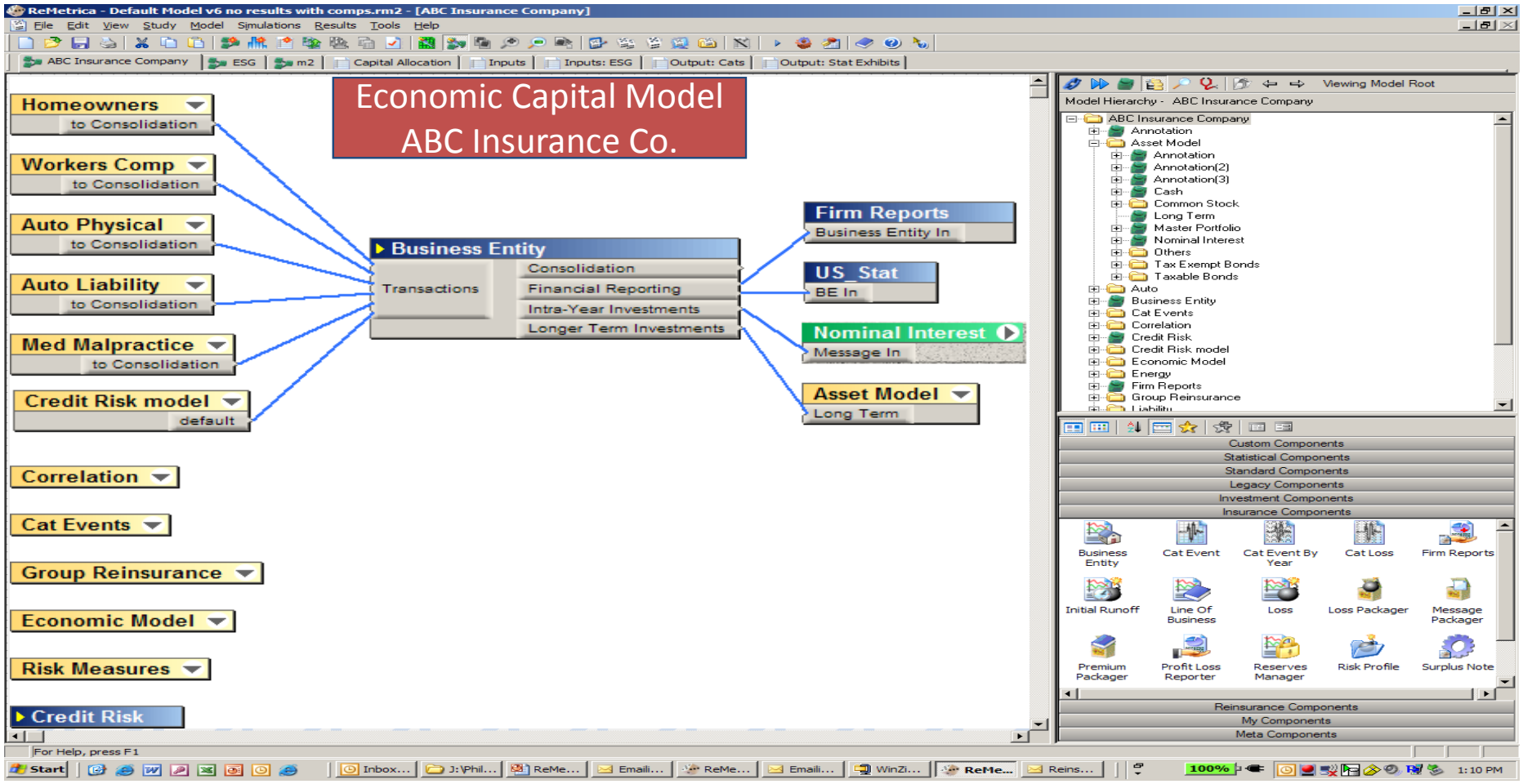
# 風險種類 Risk Categories

- DFA 軟體可合併分析市場、信用、作業、保險及資產負債配合等風險
  - the tool can integrate the Market Risk, Credit Risk, Operational Risk, Insurance Risk and Asset Liability Matching



# 風險衡量 Risk Assessment

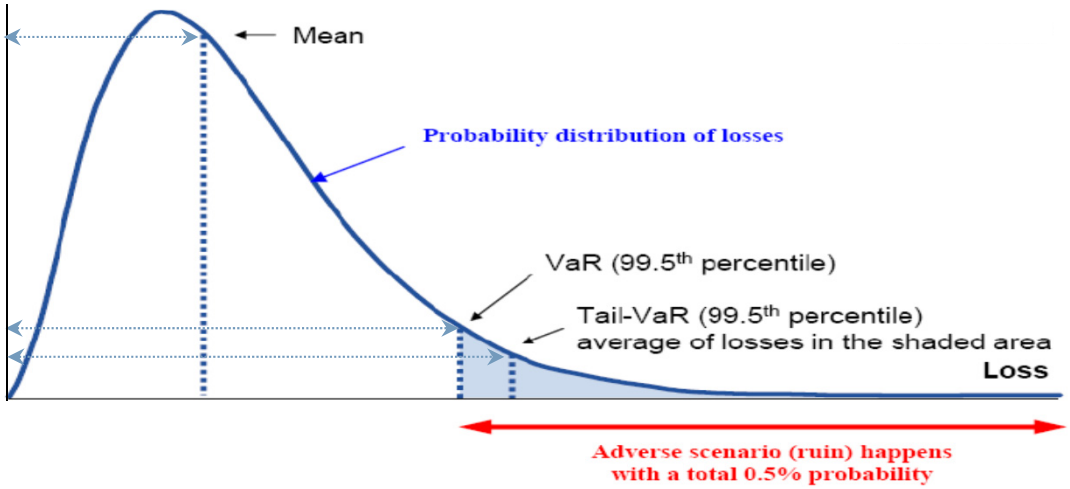
- 以風險量化技術協助風險衡量 performing "quantitative approach" to "Risk Assessment"
  - 藉由蒙地卡羅數值分析方法，DFA 軟體可獲得各風險指標之風險參數
    By Monte Carol simulation, ReMetrica catches parameters of risk indexes from numerical analysis results

    - 許多分析之數值可作為風險指標，如： A great number of outputs can be risk indexes, e.g.
      - 年度單一最大(淨)損失、全年總(淨)損失、核保損益、準備金短缺機率……

        max gross/net loss per year, annual losses, underwriting result, reserves shortfall ……etc.

    - 可直接套用多種內建統計參數 ，如： More than 20 parameter are imbedded in, e.g.
      - 平均值、標準差、風險值、尾端風險值……

        Mean, Standard Deviation, VaR and TVaR etc.




Mean, 200年VAR 與 200年TVAR 圖



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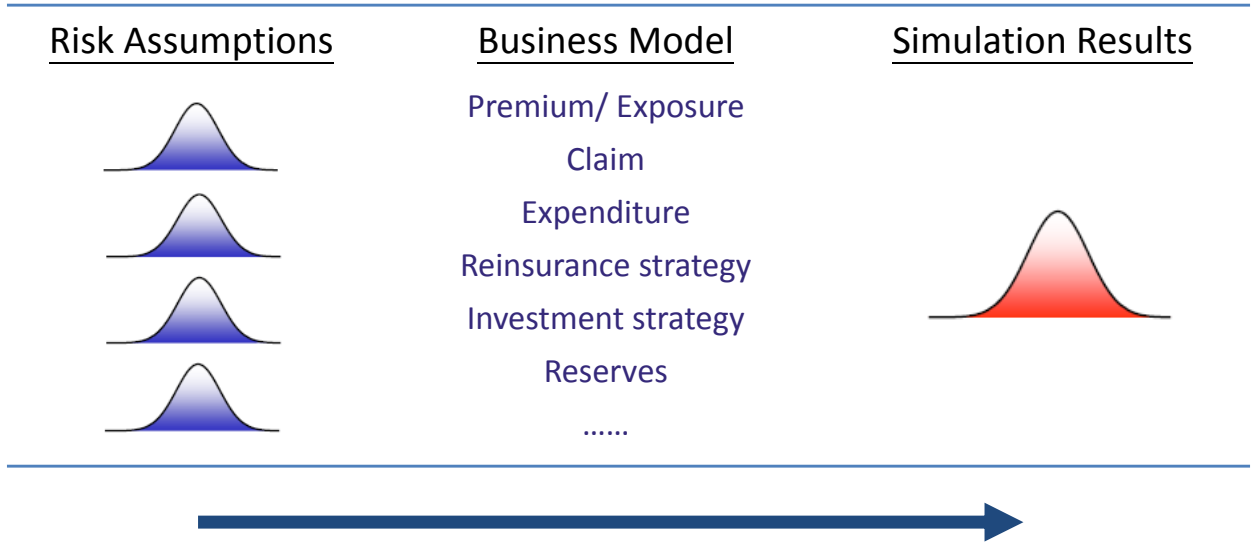
# DFA -動態模擬保險公司財務因子，用以分析營運決策

- **動態財務分析 DFA = Dynamic Financial Analysis**

- **DFA 軟體可以動態模擬保險公司營運的所有財務因子，包含:**
  - 保費收支/曝險
  - 理賠支出、攤回
  - 費用
  - 再保策略
  - 投資策略
  - 準備金
  - 其他現金流
  - ……



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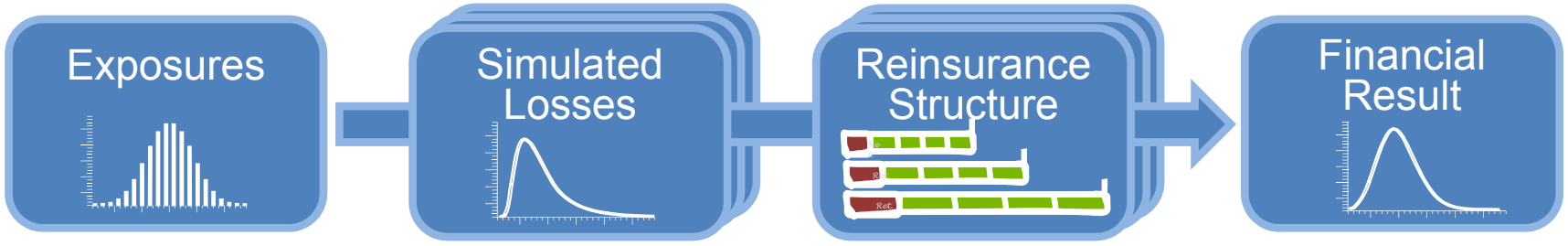
# 建置再保險合約最佳化分析流程




- **是否需要考量所有財務因子的全面 DFA?**
  - 全面 DFA
    - 優: 完整模擬所有風險因子
    - 缺: 設立所有財務因子的假設條件將耗時費力
  - 聚焦於再保險合約
    - 容易設立合理的假設條件
    - 迅速模擬各再保方案之風險與報酬
    - 易於量化評析，以利決策



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# 資料分析與假設條件

## Company Data

- Risk Locations
- Sums Insured
- Construction Materials
- Age of Construction
- Lines of Business
- Number of Risks
- Premiums by Band
- Limit/Deductible Profiles
- Number of Claims
- Loss Amounts
- Payout Patterns
- Large Claims

## Exposure Modelling

Catastrophe Models
IF AIR EQE RMS TRM

Event Loss Tables

Non-Cat Simulation
Assumptions Based on
Company Exposure

## Experience Modelling

Non-Cat Simulation
Assumptions Based on
Company Experience

**ReMetrica DFA tool**



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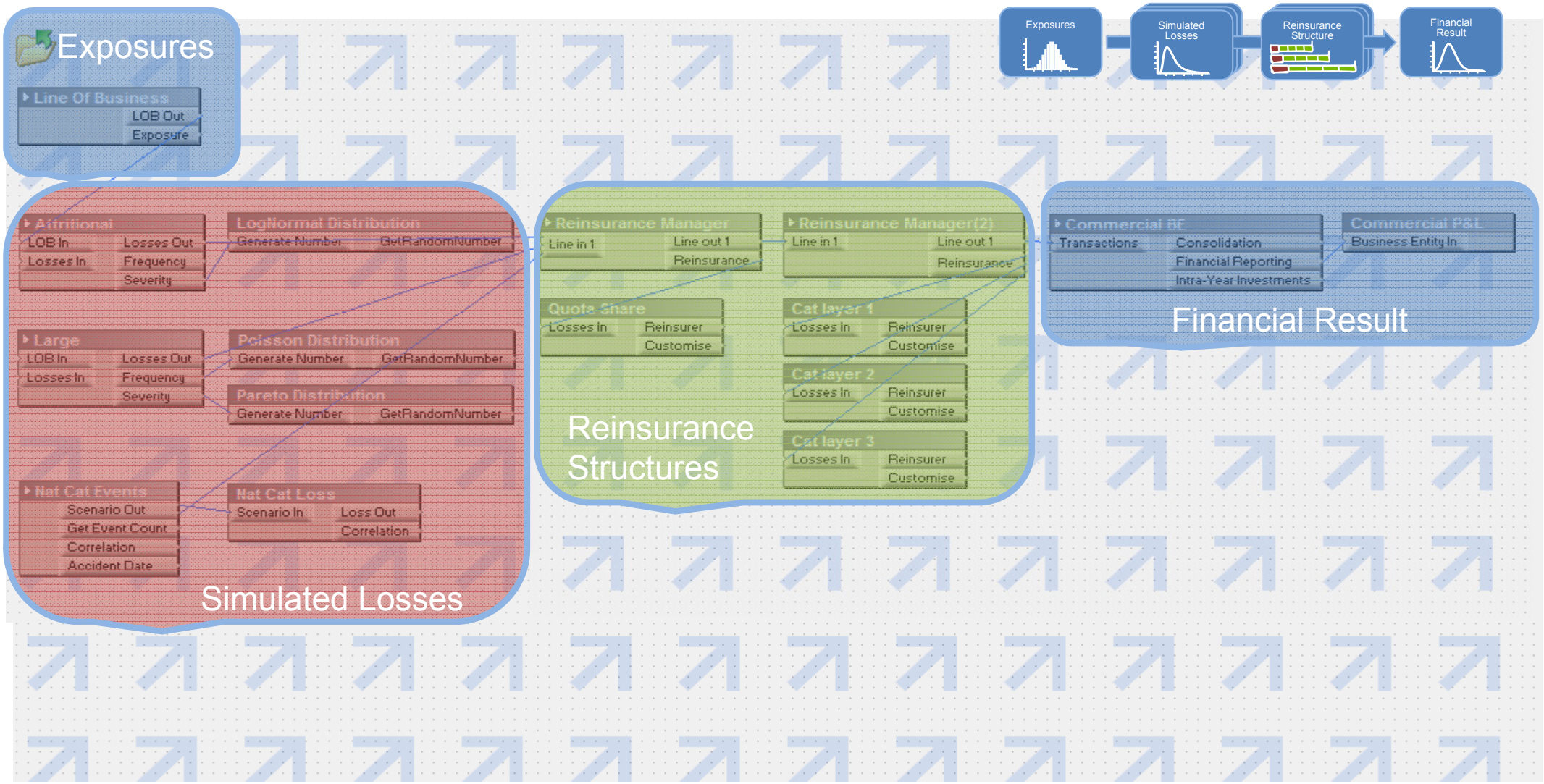
# 再保合約最佳化模型 – 以 ReMetrica 軟體為例



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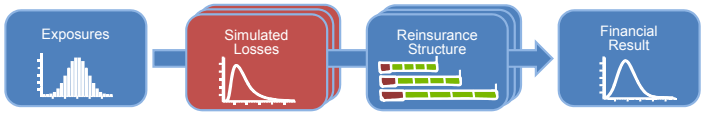
# 承保風險分析

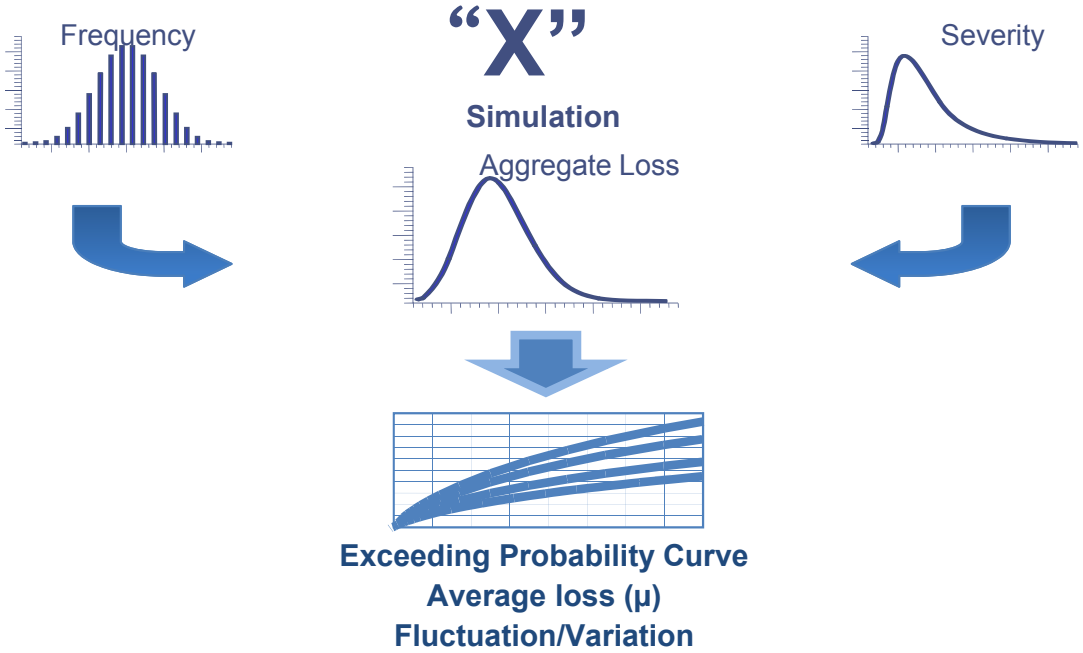


- **承保險種 Classes of business**
  - 非天災保障 Non-Catastrophe Risks (由DFA軟體直接運算)
    - Exposures (& its Distribution / Growth Trend / Earning Pattern)
    - Premium Rate (& its Distribution/Earning Pattern)
    - Expenses
      - Operating / Acquisition Costs (& its Payment Pattern)
  - 天災保障 Catastrophe Risks (另由天災模型獨立運算，再併入DFA軟體)
    - Risk locations (i.e. CRESTA/ZIP/Address)
    - Total Sums Insured, Sub-limit, Deductibles
    - Construction class, Occupancy and other assumptions

# 損失經驗分析




- **損失模擬**
  - 觀察過去的損失經驗，設立觀察門檻
  - 分析損失頻率 與 損失發生金額，並進行情境調整 (as-if assumptions)
  - 評選最適分配曲線
  - 使用頻率與損失金額分配曲線，模擬數萬種不同的損失情境組合



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# 損失情境調整

- **Payments made on known claims**

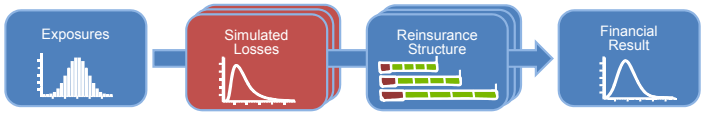
  + Case Estimates = Incurred

  + Indexed Inflation since each payment = Inflated

  + Further development of claims = Developed

  + Incurred But Not Reported claims (IBNR)

  = Ultimate claim amounts



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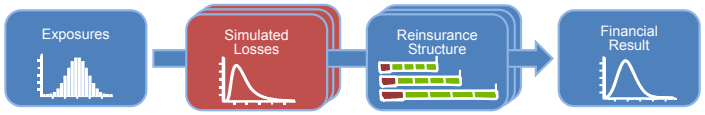
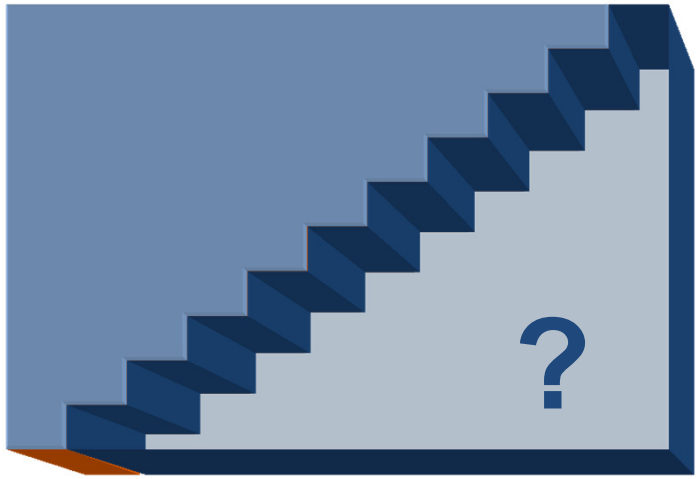
# 損失情境調整 (續)

- **Actuarial triangulation**
  - Chain ladder
  - Bornhuetter-Ferguson
  - Projected Case Estimates
  - Payments per Claim Finalised in Operational Time
  - Etc.




- **Need to consider the volatility of results**



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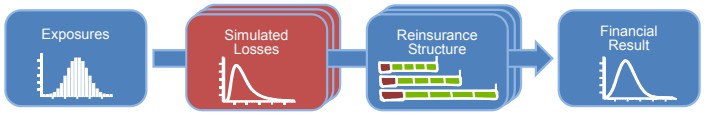


- **通貨膨脹 Inflation**
  - Past and future indexation
  - Usually based on CPI etc.
- **附加通貨膨脹 Superimposed Inflation**
  - Dependent on historic shifts in payment levels
- **貼現 Discounting**
  - The rate at which the company calculates present value of future cash flows



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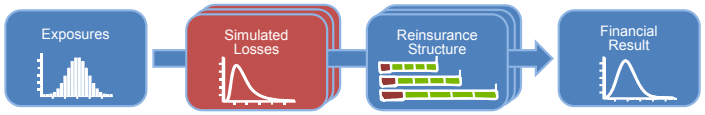
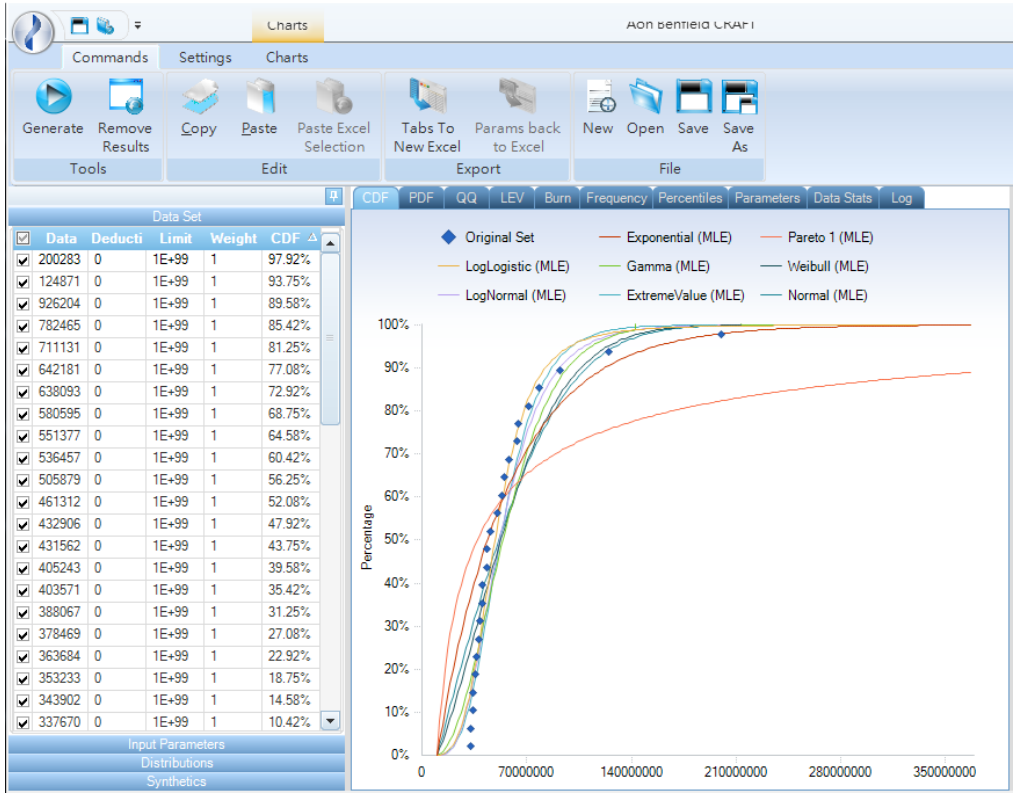
# 最適分配

- 依調整後之損失情境，分析最適分配
  - 可借助最適分配軟體
    - CRAFT (Aon Benfield)
    - @Risk (Best Fit)
    - …
  - 某些分配可以數學公式求解:
    - Poisson
    - Pareto
    - Normal
    - Lognormal

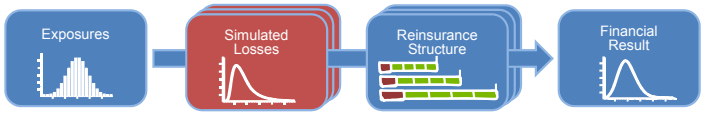


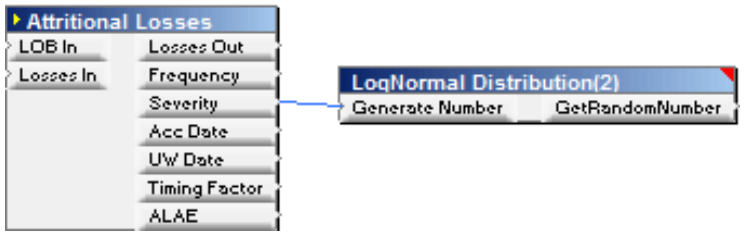

| Data | Deducti | Limit | Weight | CDF |
|---|---|---|---|---|
| 200283 | 0 | 1E+99 | 1 | 97.92% |
| 124871 | 0 | 1E+99 | 1 | 93.75% |
| 926204 | 0 | 1E+99 | 1 | 89.58% |
| 782465 | 0 | 1E+99 | 1 | 85.42% |
| 711131 | 0 | 1E+99 | 1 | 81.25% |
| 642181 | 0 | 1E+99 | 1 | 77.08% |
| 638093 | 0 | 1E+99 | 1 | 72.92% |
| 580595 | 0 | 1E+99 | 1 | 68.75% |
| 551377 | 0 | 1E+99 | 1 | 64.58% |
| 536457 | 0 | 1E+99 | 1 | 60.42% |
| 505879 | 0 | 1E+99 | 1 | 56.25% |
| 461312 | 0 | 1E+99 | 1 | 52.08% |
| 432906 | 0 | 1E+99 | 1 | 47.92% |
| 431562 | 0 | 1E+99 | 1 | 43.75% |
| 405243 | 0 | 1E+99 | 1 | 39.58% |
| 403571 | 0 | 1E+99 | 1 | 35.42% |
| 388067 | 0 | 1E+99 | 1 | 31.25% |
| 378469 | 0 | 1E+99 | 1 | 27.08% |
| 363684 | 0 | 1E+99 | 1 | 22.92% |
| 353233 | 0 | 1E+99 | 1 | 18.75% |
| 343902 | 0 | 1E+99 | 1 | 14.58% |
| 337670 | 0 | 1E+99 | 1 | 10.42% |

# 損失模擬

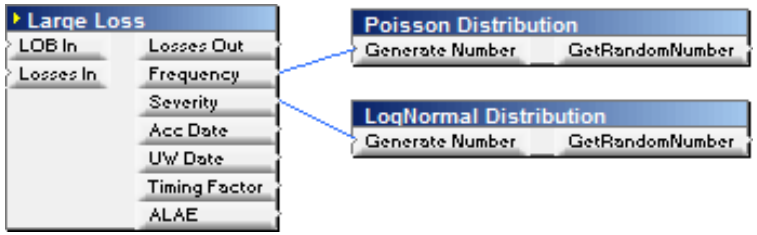
- 為方便整理、分析損失資料，通常將損失分為三類



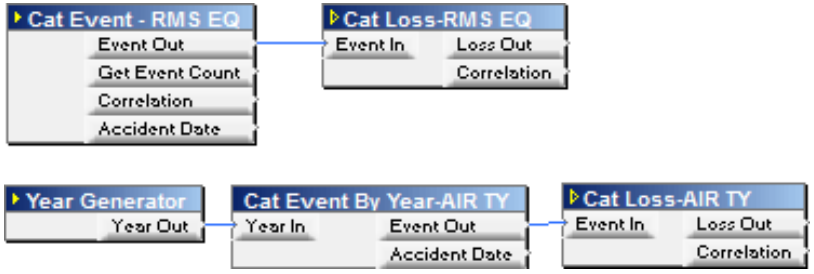

  - Attritional Loss (數量眾多的小型單一損失)




  - Large Loss (超過觀察門檻的中大型單一損失)




  - 巨災損失(巨災事件造成的累積性損失)



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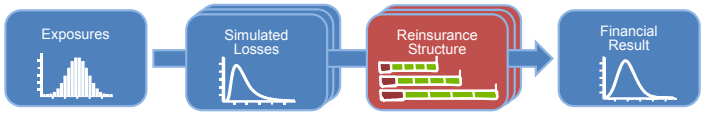
# 合約再保險




| 再保險型態 | 對於原保險人 | 對於再保險人 |
|---|---|---|
| 臨時再保險 | 可決定是否分出業務 | 可決定是否接受業務 |
| 合約再保險 | 必須分出業務 | 必須接受業務 |
| 預約再保險 | 可決定是否分出業務 | 必須接受業務 |



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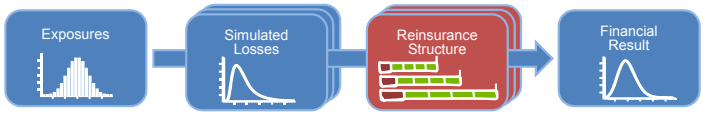
# 再保險合約的型態




- **再保險契約之型態**
  - 依保險金額與損失金額之別來分類:
  - 比例性再保險
    - 比率再保險
    - 溢額再保險
    - 預約再保險
  - 非比例性再保險
    - 超額損失再保險
      - 超額賠款再保險
      - 超過賠款率再保險
      - …



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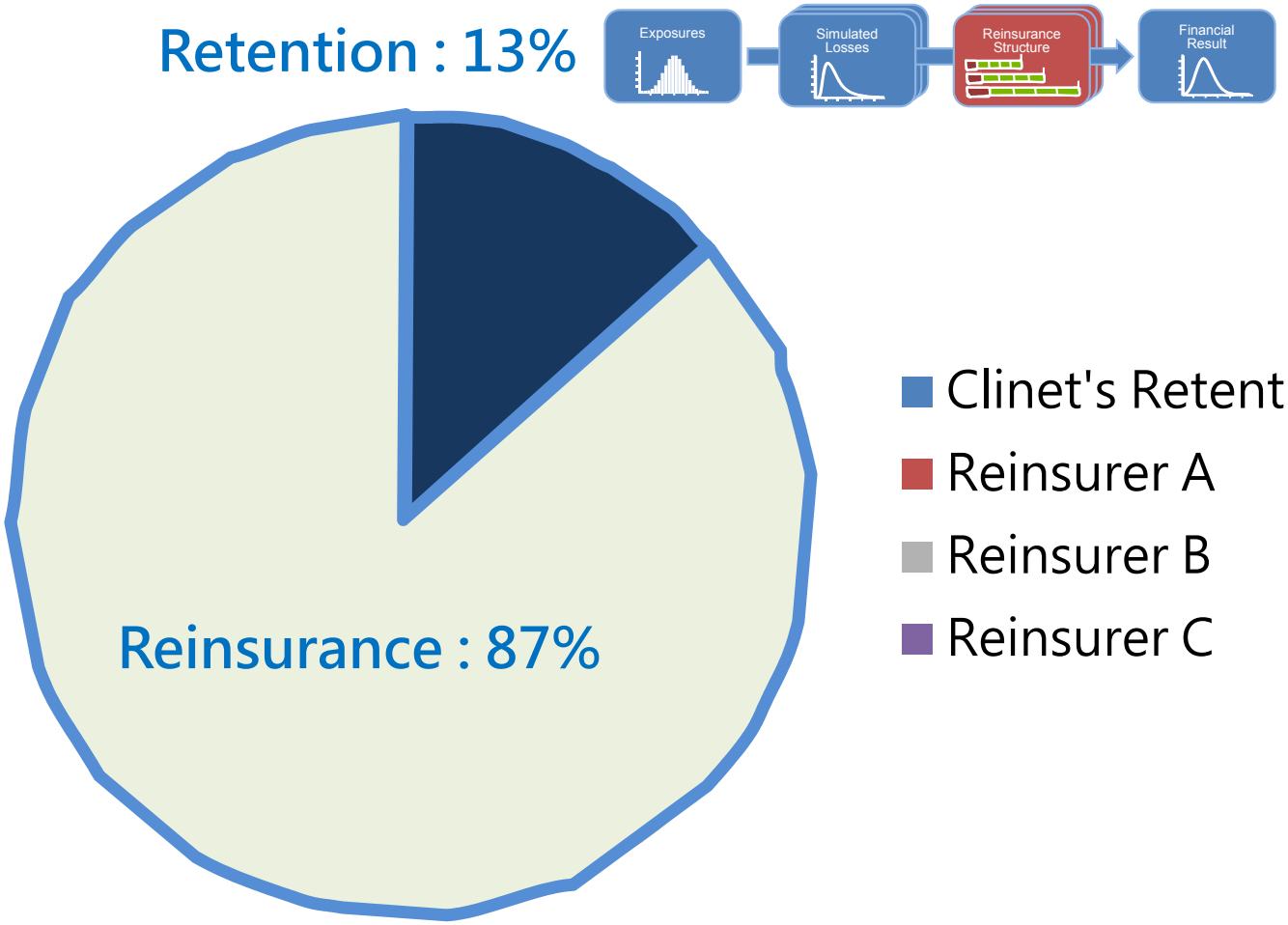
# 比率再保險 (Quota share reinsurance)

Net Pre = 100,000
→ Retention : 13,000
Re A : 20,000
Re B : 27,000
Re C : 40,000

If there is a loss = 5,000,000
→ Retention : 650,000
Re A : 1,000,000
Re B : 1,350,000
Re C : 2,000,000




Q/S : premium and loss are allocated proportionally !



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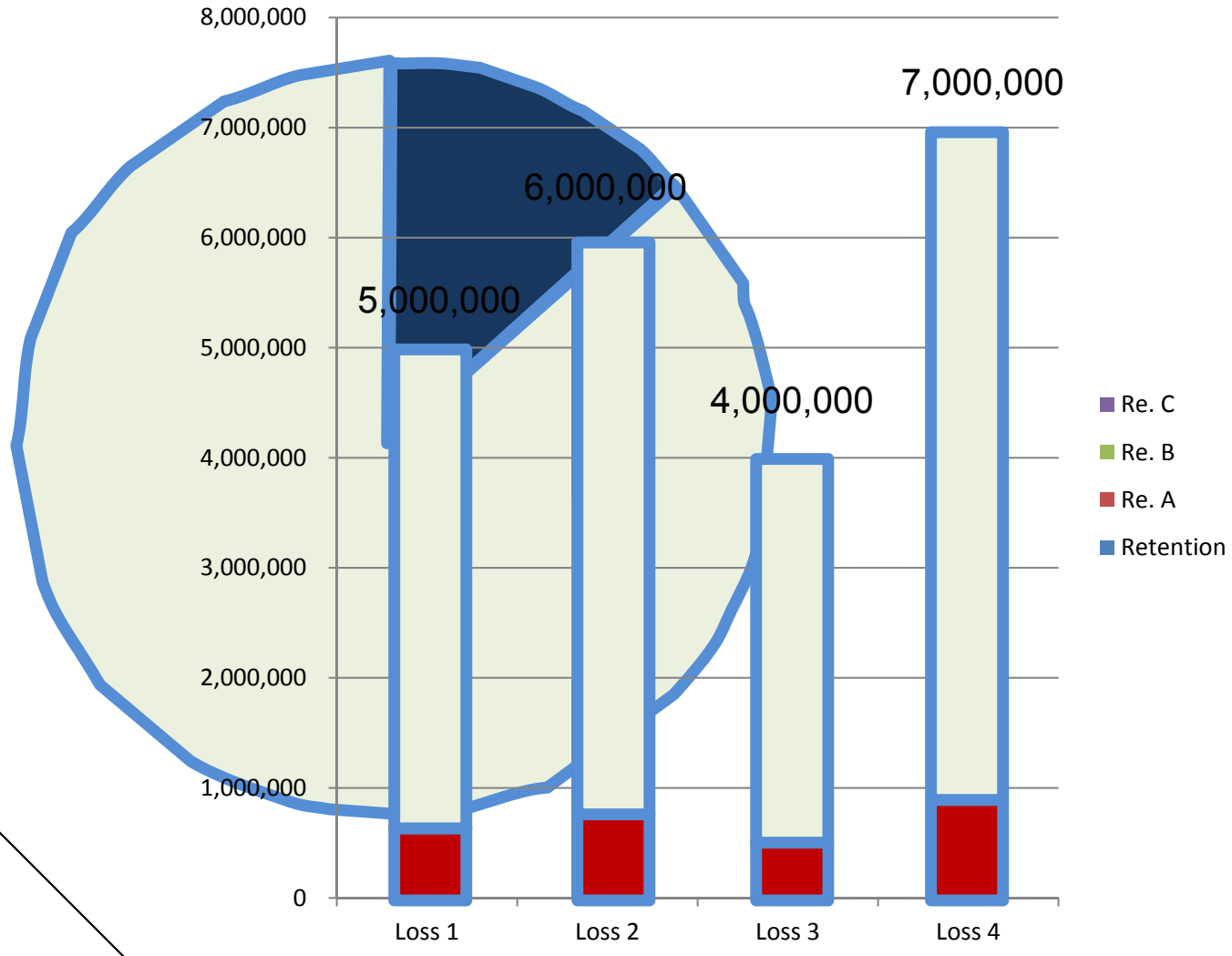
# 比率再保險 (Quota share reinsurance)

Reinsurance : 87%




Retention : 13%

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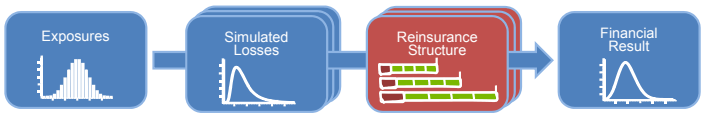
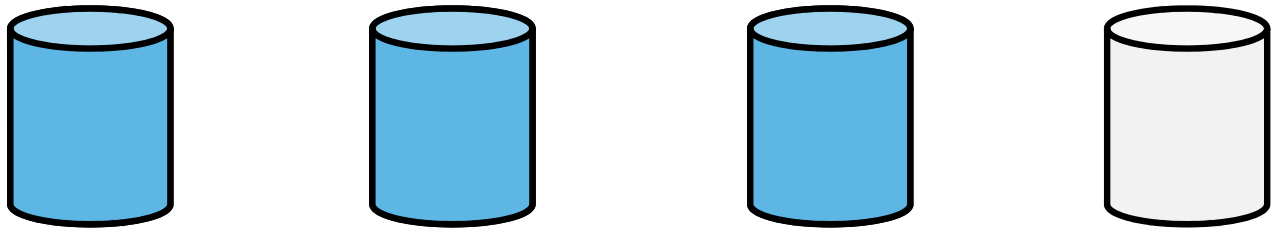
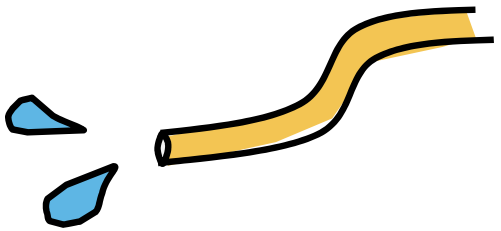
# 溢額再保險 (Surplus reinsurance)




Retention　　1st Line　　2nd Line　　3rd Line

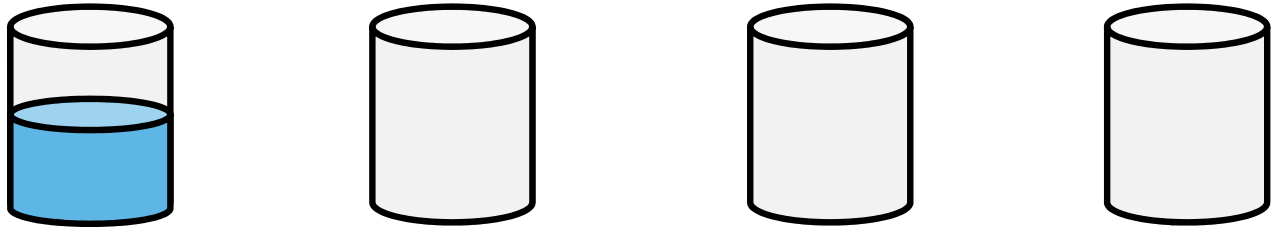


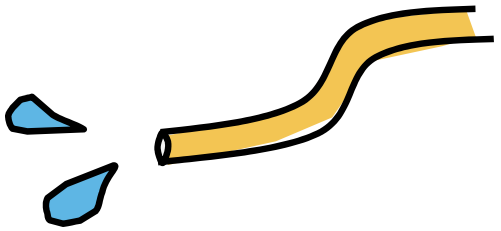



There is a risk= 3L

- Retention=1L , Reinsurance=2L
- Retention=33.33% , Reinsurance=66.66%

Retention　　1st Line　　2nd Line　　3rd Line



There is a risk = 0.5L

- Retention=0.5L , Reinsurance=0L
- Retention=100% , Reinsurance=0%

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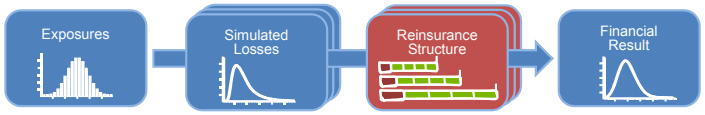
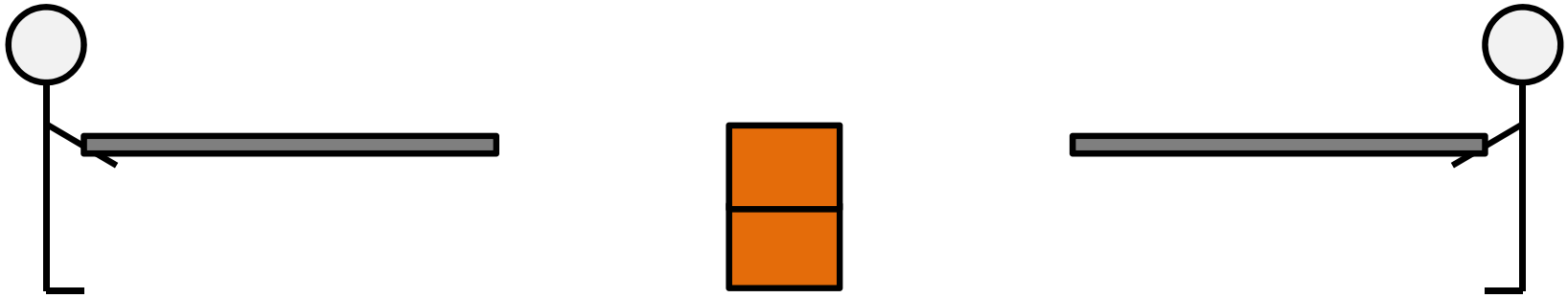
# 超額損失再保險 (Excess of loss reinsurance)




Retention : 2

Reinsurance : 8

if loss
two



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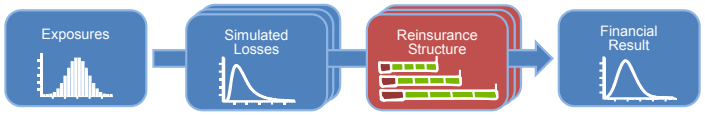
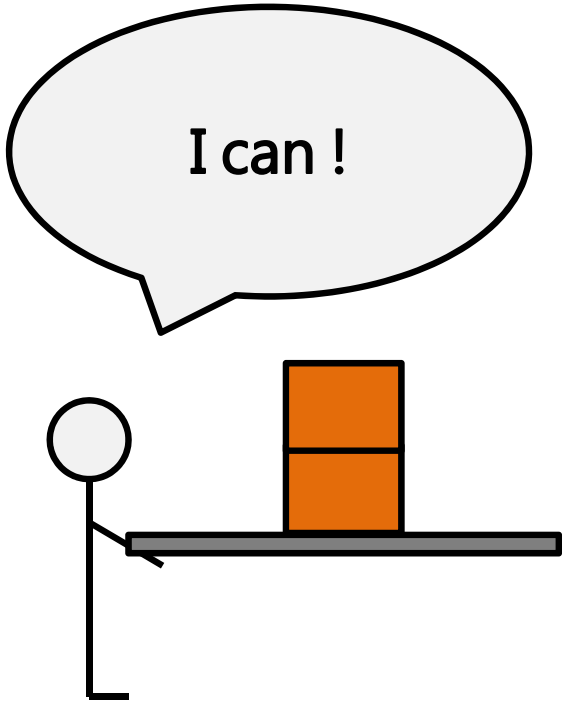
# 超額損失再保險 (Excess of loss reinsurance)

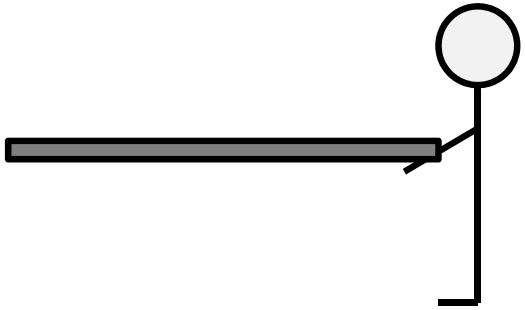



## Retention : 2

## Reinsurance : 8




if loss two



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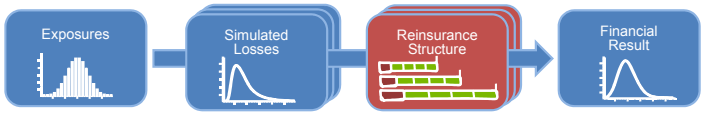
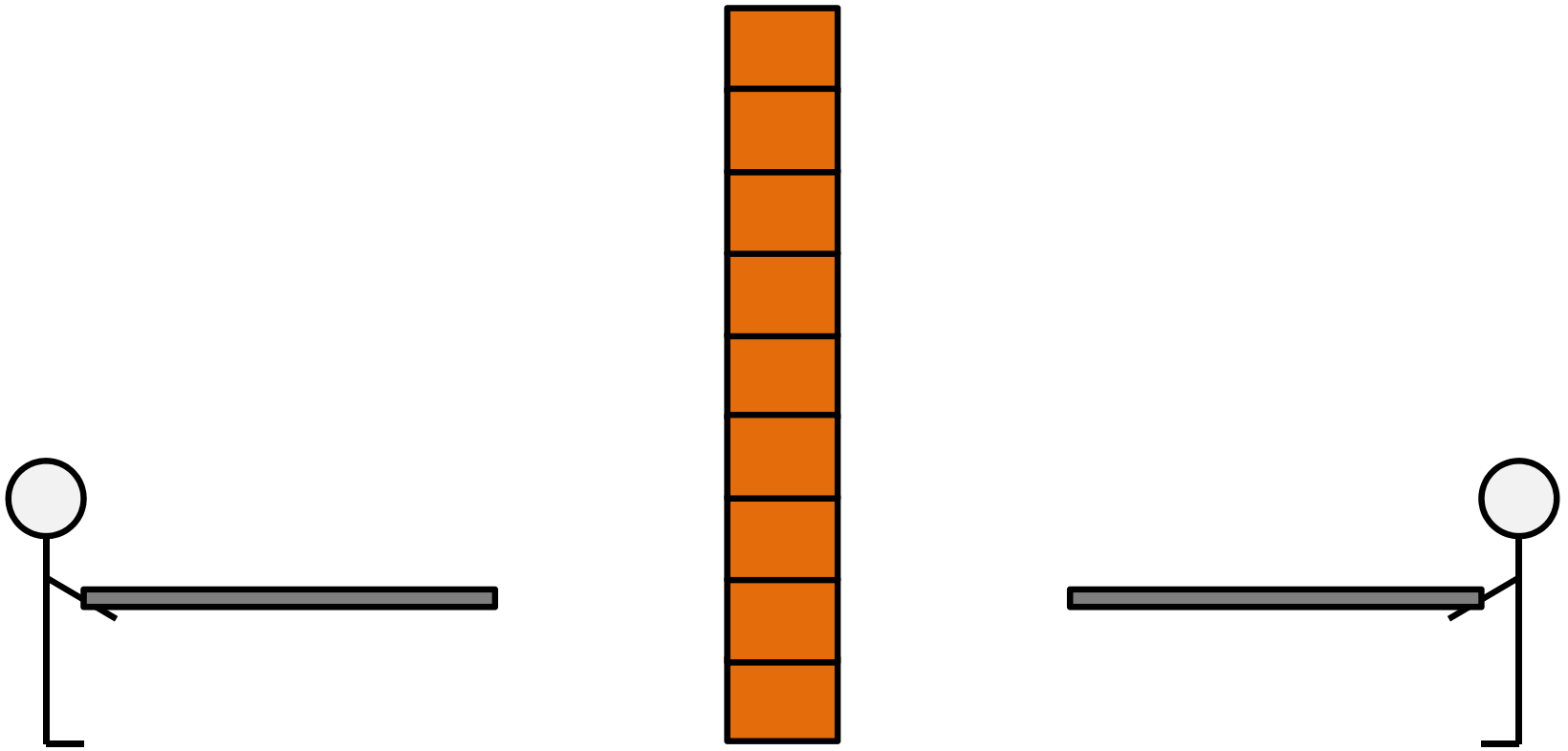
# 超額損失再保險 (Excess of loss reinsurance)




Retention : 2

if loss nine

Reinsurance : 8



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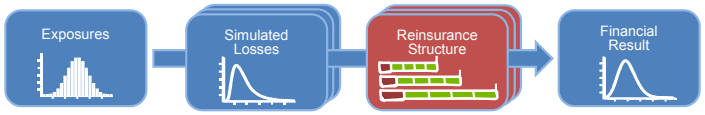
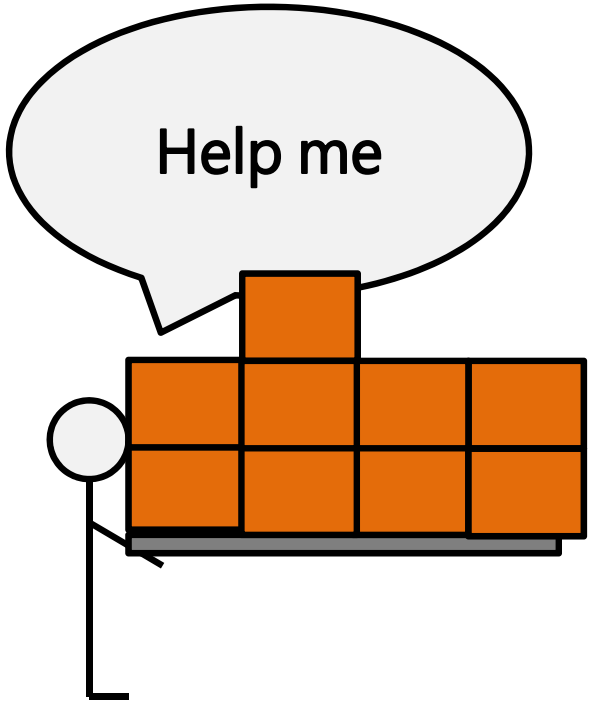
# 超額損失再保險 (Excess of loss reinsurance)

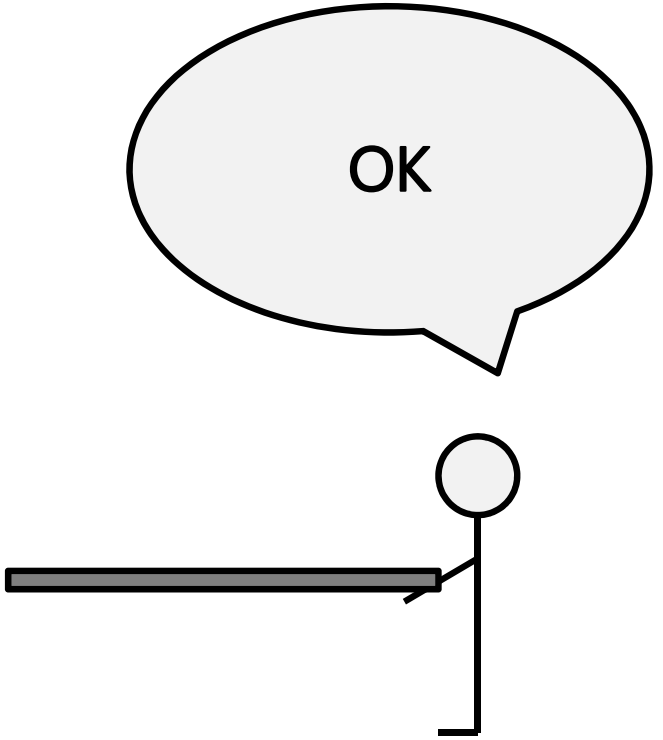



Retention : 2

if loss nine

Reinsurance : 8

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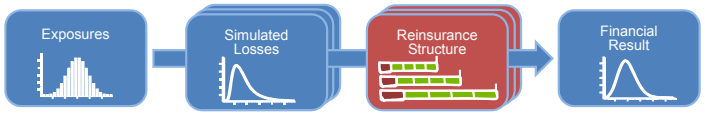
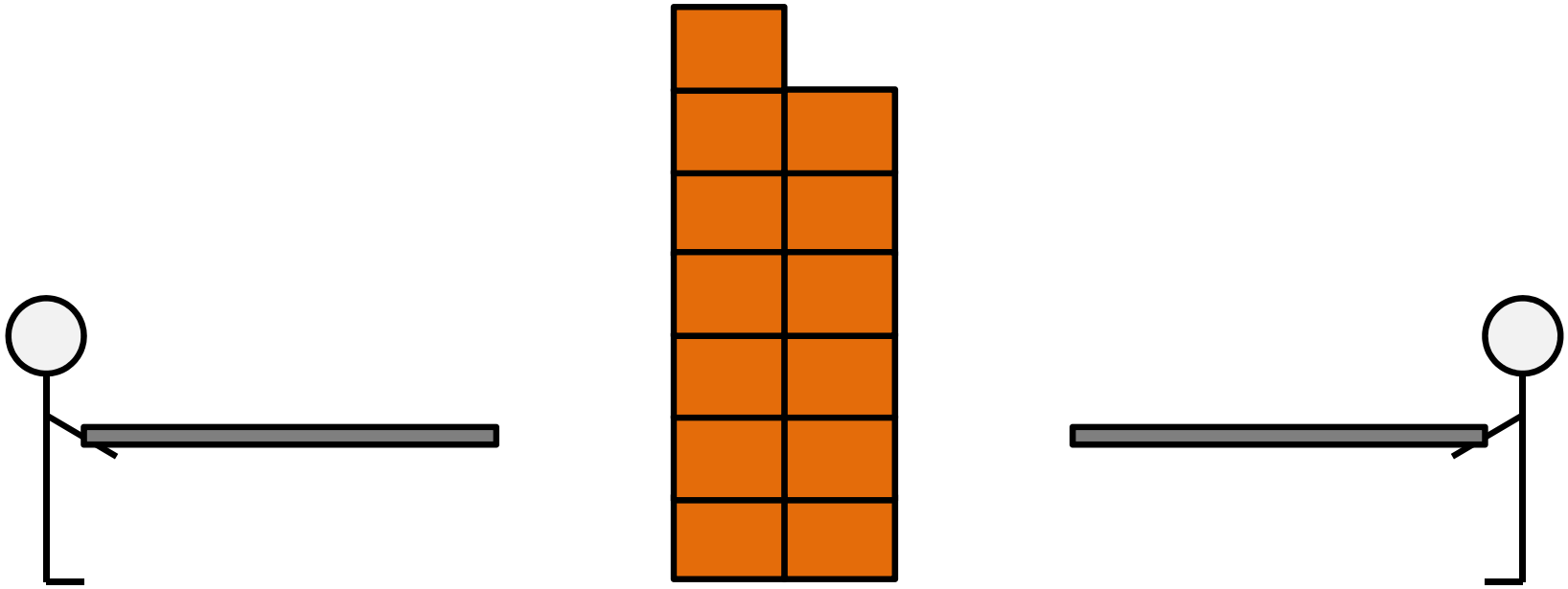
# 超額損失再保險 (Excess of loss reinsurance)




Retention : 2

if loss thirteen

Reinsurance : 8



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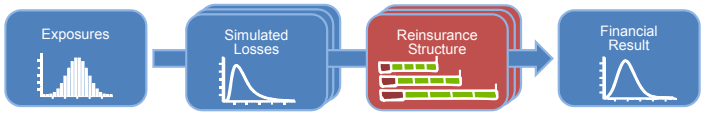
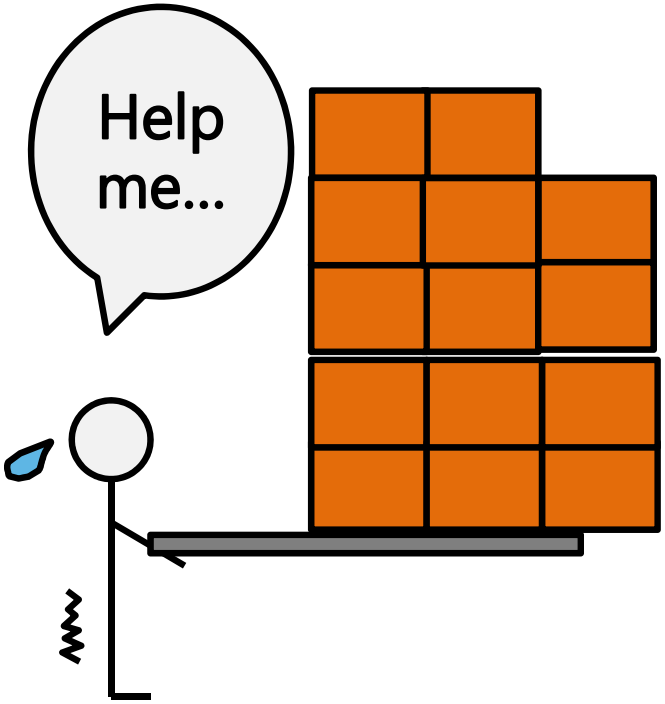
# 超額損失再保險 (Excess of loss reinsurance)

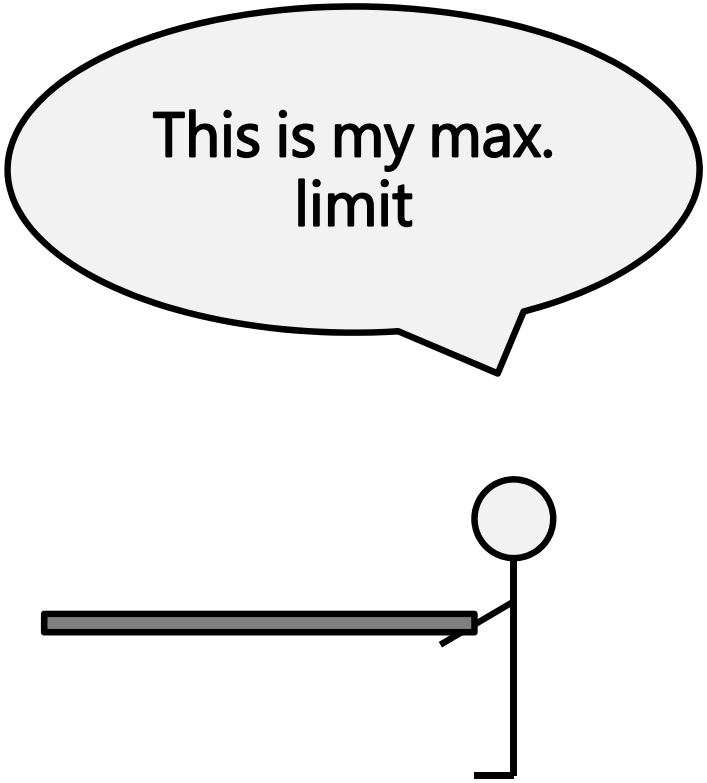



Retention : 2

if loss thirteen

Reinsurance : 8

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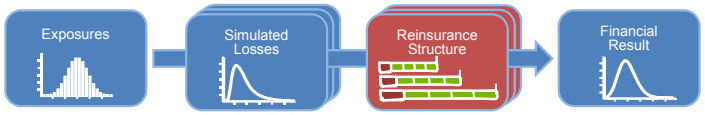
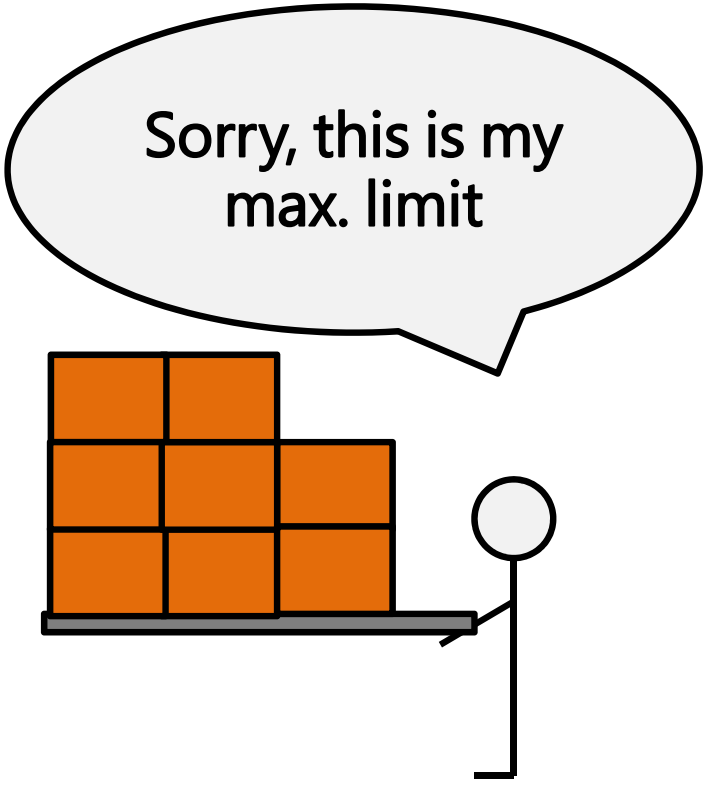
# 超額損失再保險 (Excess of loss reinsurance)




Retention : 2

if loss thirteen

Reinsurance : 8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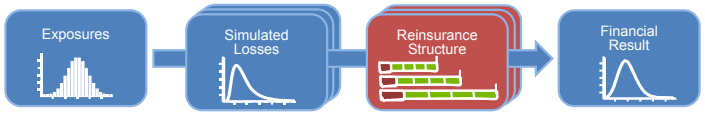
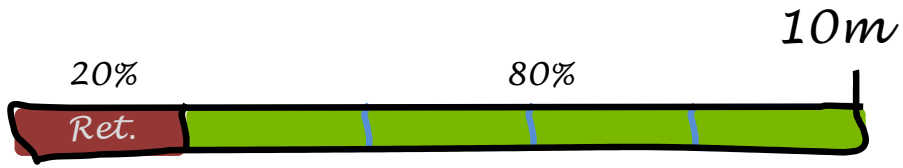
# 合約運算方式（例： Treaty Limit = 10,000,000）




某一風險保額 = 10,000,000
假設遭遇損失 = 10,000,000

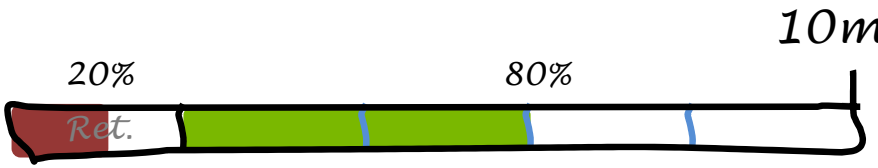
某一風險保額 = 8,000,000
假設遭遇損失 = 5,000,000

## 20% QS




Premium Allocation = 1:4

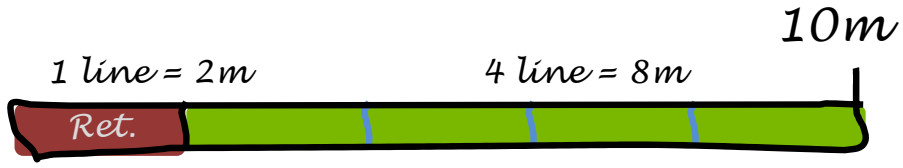
Ret. Loss=2m , Ceded Loss=8m




Premium Allocation = 1.6m : 6.4m = 1:4

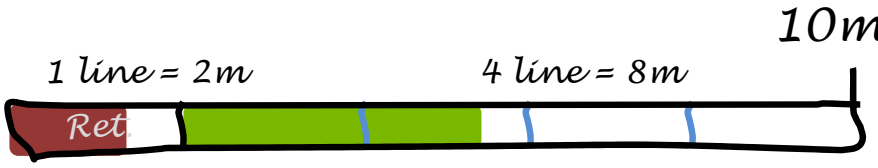
Ret. Loss=1.0m , Ceded Loss=4.0m

## 4 lines SPL




Premium Allocation = 1:4

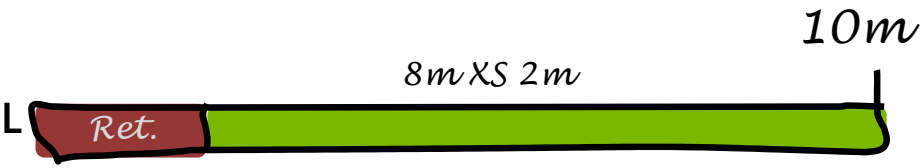
Ret. Loss=2m , Ceded Loss=8m




Premium Allocation = 2m : 6m = 1:3

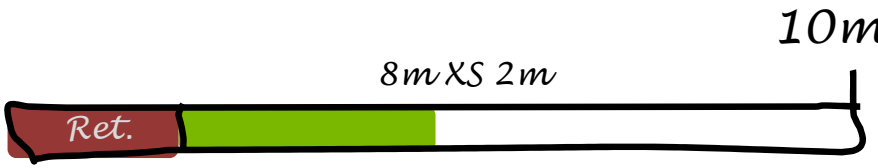
Ret.Loss=1.25m , Ceded Loss=3.75m

## 8m xs 2m XL




Premium Allocation = ?

Ret. Loss=2m , Ceded Loss=8m




Premium Allocation = ?

Ret. Loss=2.0m , Ceded Loss=3.0m

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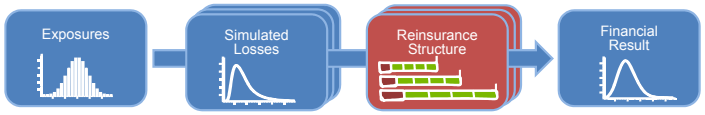
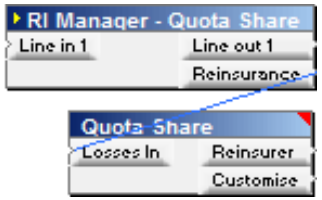
# 再保合約模擬

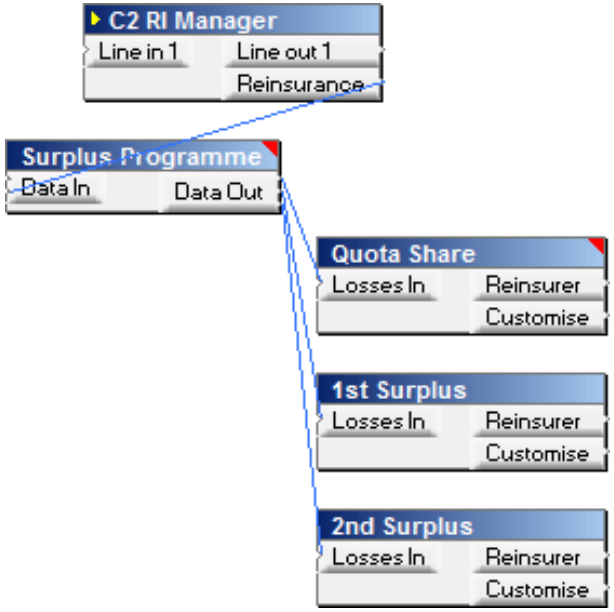



- **再保合約模組:**
  1. 接收前端模擬之業務組成、保險費 與 損失金額數據；
  2. 依據再保險合約屬性，分配自留 與 分出的保費與損失金額；
  3. 計算再保佣金收入、再保攤賠金額 與 信用風險

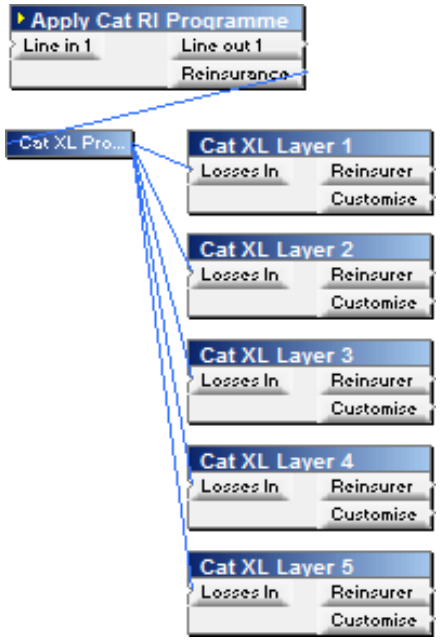
Quota Share treaty




Surplus treaty




Excess of Loss treaty



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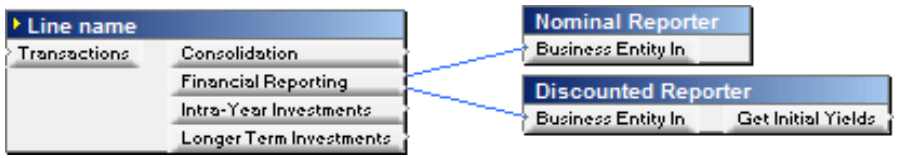
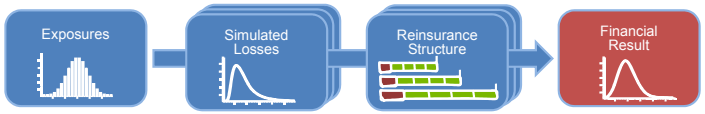
# Agenda

- **Section 1**
  - DFA 軟體 及其原理
  - 風險量化及再保最佳化流程
  - 承保及損失經驗分析、情境調整 與 最適分配
  - 各式再保合約運算邏輯
  - 動態模擬 與 再保最佳化決策

- **Section 2**
  - 實例討論

# 財務模組

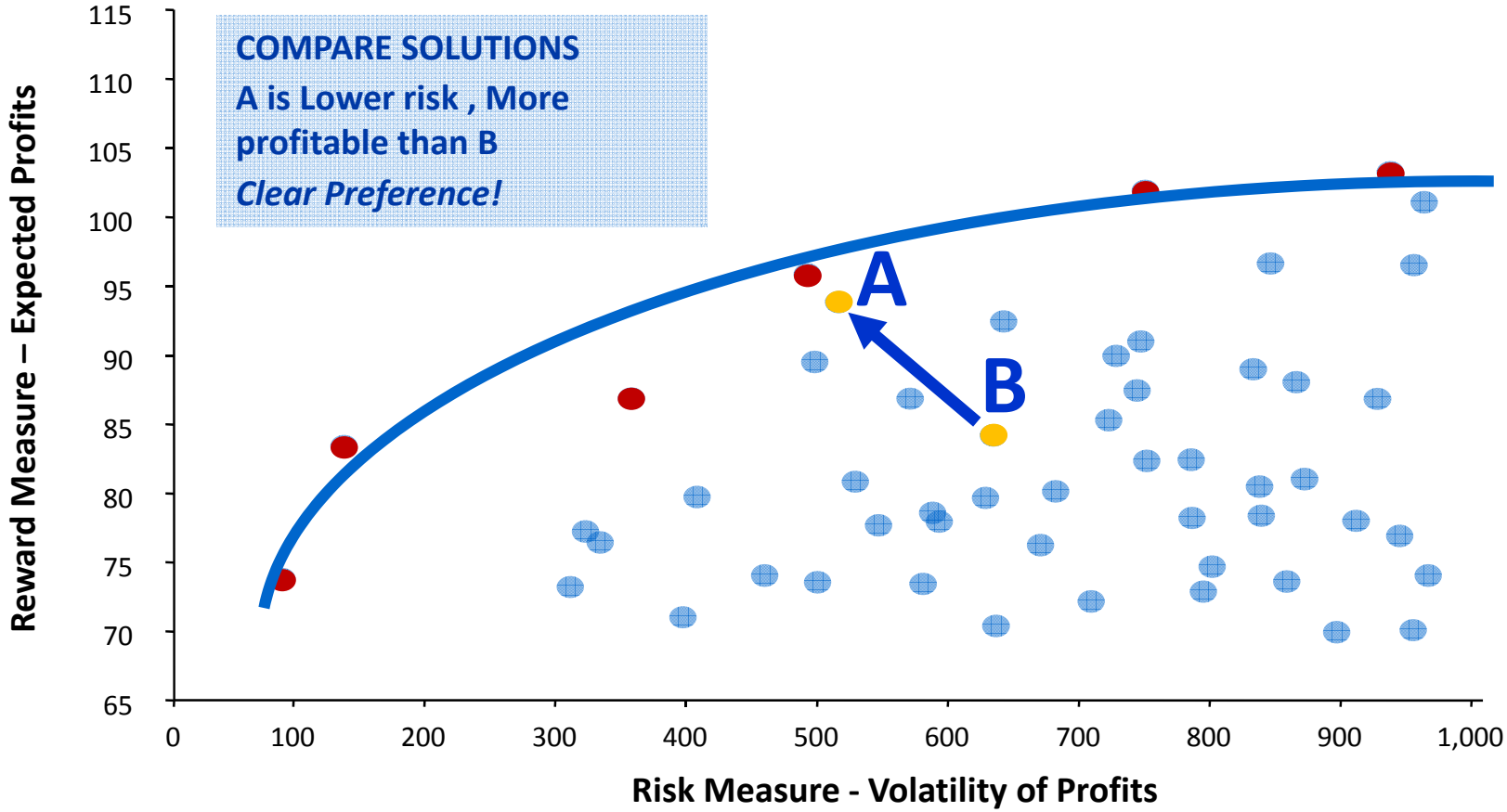



- **再保合約模組:**
  - 接收並記錄前端之財務數據模擬結果，作為風險、報酬指標
    - 包括: 核保損益、經濟資本 (EC) 、年度單一最大(淨)損失、全年總(淨)損失、準備金短缺機率……
    - 可同時記錄單一險種、多險種或全公司模擬資料
  - 可統合資產模組，整併市場風險模擬
  - “Solvency II” Fair Value
  - IFRS

# 報酬與風險承擔之關係


- 再保架構與其他風險管理策略之方案，可輕鬆地藉由 DFA 軟體評估其成效
  - 並獲得報酬與風險承擔之關係
    - 損益金額、股東權益報酬率等可作為報酬指標...
    - 標準差、風險值可作為風險指標



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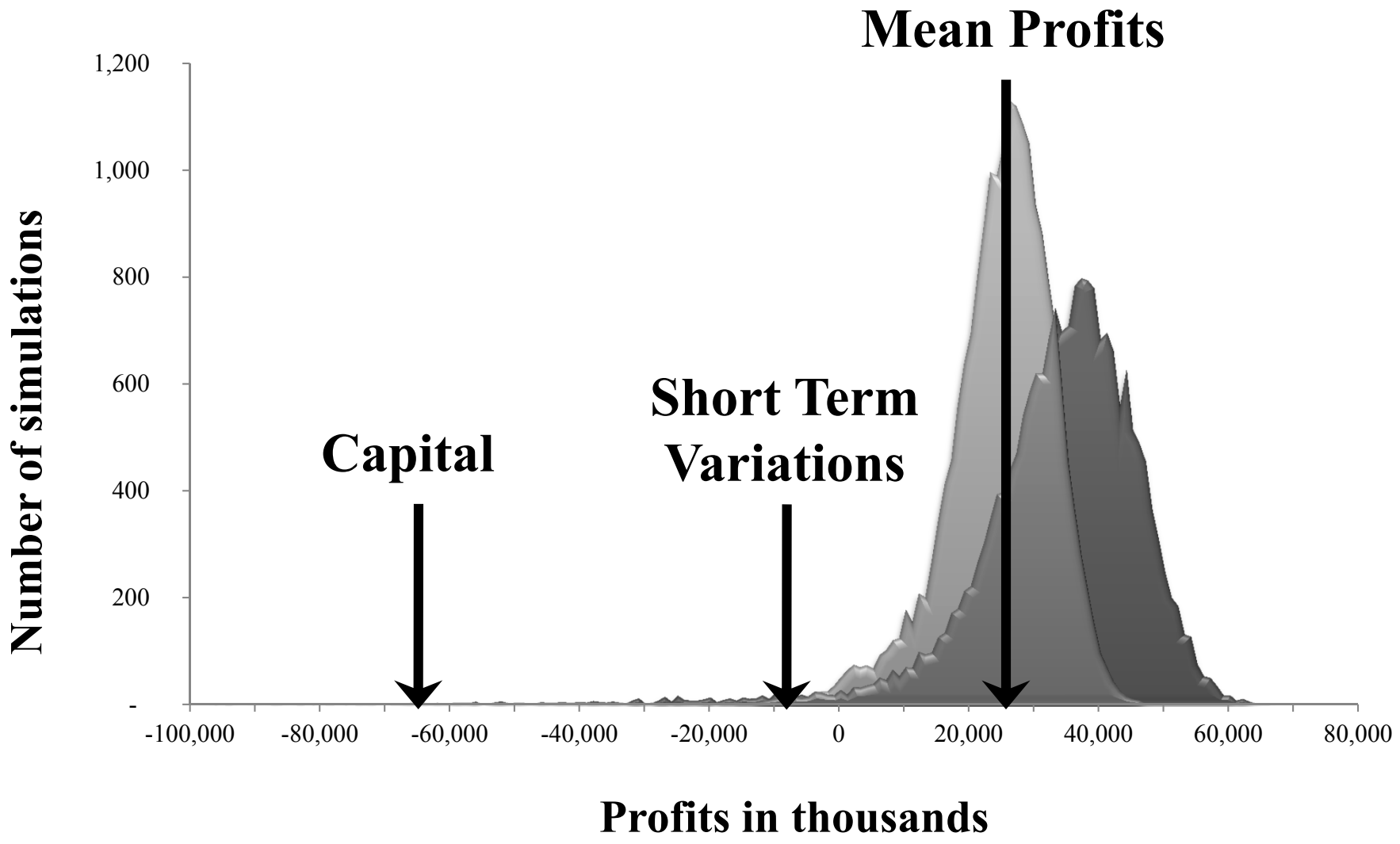
# 風險胃納 Risk Appetite

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# 以 DFA 分析節果訂定最佳再保策略


| | Mean Profits | Volatility* | Capital Required |
|---|---|---|---|
| **A** No reinsurance | 100 | 75 | 200 |
| **B** QS 50% | 80 | 38 | 100 |
| **C** QS 50% + Cat XL | 74 | 25 | 30 |
| **D** Risk XL + Cat XL | 90 | 26 | 35 |

* Standard deviation

Good | Medium | Bad



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# Agenda

- **Section 1**
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  - 各式再保合約運算邏輯
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- **Section 2**
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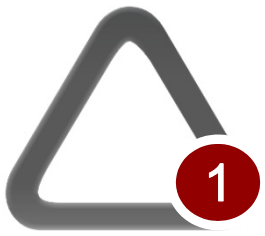
# Hands on - Stochastic Approach




**Define metrics**

- Maximise profit
- Minimise volatility
- Capital measure


**Build model**

- Parameterisation
- Build ReMetrica model
- Model reinsurance options


**Simulation & validation**

- Run model
- Sensitivity checks


**Examine results**

- Quantify and understand modelled results


**Compare reinsurance options**

- Risk and reward comparisons
- Impact on capital required

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# Appendix

## 範例軟體”ReMetrica®” 速覽

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## ReMetrica
### *Aon Benfield Analytics*

**ReMetrica® is Aon Benfield's award-winning dynamic financial analysis (DFA) modeling platform for enterprise risk management and economic capital modeling.**

ReMetrica is the preferred choice of more than 160 of the world's leading insurers, reinsurers and actuarial consulting firms. ReMetrica's powerful modelling capabilities allow firms to:

•Model the full balance sheet and all key risks

•Use this to test a range of different strategies and scenarios for a variety of applications

•Summarize the modeling results with clarity and impact so that management can make effective decisions

With more than 10 years of development, ReMetrica is regularly updated to keep abreast of industry and regulatory changes. The latest version (version 6) has evolved to help (re)insurers build partial or full internal models to meet the proposed regulatory requirements under Solvency II.

The enhanced functionality enables actuaries to make building and running models easier and faster, including:

•Super-components that reduce the size of the model to just 5% in some cases, to cut down on the complexity of modelling

•High performance computing (HPC) support for larger models enabling faster run times with sophisticated job management facilities

**The ReMetrica Advantage**

•**Robustness and ease of use**. ReMetrica's visual interface and extensive library of pre-developed insurance, reinsurance and statistical components allows clients to build sophisticated models without time consuming and costly programming and be confident the logic has been rigorously tested and validated.

•**Speed and versatility**. ReMetrica's standard library of components combined with a highly efficient simulation engine enables users to rapidly analyze the whole spectrum of risk – whether at business unit, line of business, company or group level. As models are constructed from discrete building blocks, models can be easily updated to take account of changes in the business or assumptions or to add greater levels of detail.

•**Modeling support services**. In-depth technical support and full product training is provided as standard with ReMetrica, and bespoke model building and auditing consultancy services are available from Aon Benfield and and some of the leading actuarial consulting firms.

**The Complete Modeling Tool**
•Capital Allocation and Adequacy
•ERM Risk Quantification & Analysis
•Reinsurance Strategy
•Capital Markets Transactions
•Asset & Liability Management
•Portfolio Optimization
•Product Pricing & Planning
•Corporate Structure Analysis, Mergers and Acquisitions

# ReMetrica users – over 100 insurers worldwide

Admiral
ADNIC
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Farmers Ins Group
First Central
Fuji Fire and Marine
GARD
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Hanover Group
Harel
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Heritage
Hollard
Horace Mann
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If P&C
Inter Hannover
Island Heritage
Itau Seguros
Jubilee
KGM
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Lexington
Lombard
Lloyd's Corporation
Mannheimer
Marketform
Maxum
Menorah
MSIG Asia
Mutual & Federal
Natixis
Navigators
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Nisshin
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North of England
Oberöesterreich
Omega
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QBE
Quest
Rheinland
RLI Corp
RMB
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SA Meacock
Sagicor
Saikyosairen
Samsung
Santam
Securis
Sentry Insurance
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Sompo Japan
Standard Bank Insurance
State Auto
Sunshine
Swiss Life
Swiss National
Telesure
Thelem
Thomas Miller
Topdanmark
Torus Insurance
Tower Hill
Tranquilidade
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# Q&A

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