



# Cloud Computing Report Summary

Traditional Chinese (雲計算和機器學習在精算行業中的應用)





# Cloud Computing and Machine Learning Uses in the Actuarial Profession Report Summary (雲計算和機器學習在精算行業中的應用)

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## Cloud Computing and Machine Learning Uses in the Actuarial Profession Report Summary

### (雲計算和機器學習在精算行業中的應用)

Insurance companies are operating in a fast and ongoing technological and consumer transformation environment. Over the past decades, there have been tremendous advancements in technology and one of them is cloud computing.

如今保險公司在一種快速且持續的技術和消費者轉型環境中運營著。在過去的幾十年中，多種技術取得了巨大的發展，其中之一就是雲計算。

#### 4.1 HOW THE INSURANCE INDUSTRY AND ACTUARIAL PROFESSION ARE IMPACTED BY THE CLOUD (雲計算如何改變保險行業和精算業)

Insurtechs are gaining popularity with increasing investment from insurers to explore innovative ways on how insurance companies interact with their customers. For example, a need for more advanced analytical capabilities for dynamic pricing is required to provide immediate and individualized quotes for insurance products for Millennials and Gen Z, who prefer digital / Omni channel and 24/7 customer service availability. The agility and capacity offered by the cloud has enabled new forms of insurance to be introduced.

隨著保險公司為了探索與客戶互動的新方式而加大投資，保險科技日益受資本追捧。例如，保險公司需要拓展更先進的動態定價功能，才能為喜愛數字化和全方位渠道以及全天候客戶服務的千禧一代和Z世代提供即時且個性化的報價。雲計算所提供的敏捷性和容量使新的保險業務模式得以引入。

The use of cloud services by actuaries is not uncommon, and most cloud users expect cloud service to have a positive impact to their work. The most common use for actuaries is leveraging the cloud for faster computation (i.e. distributed computing).

精算師對於雲計算的使用並不罕見，大多數的雲用戶期望雲計算能夠為他們的工作帶來積極的影響。最常見的用途是利用雲資源進行更快的計算（即分佈式計算）。

#### 4.2 IMPACT ON THE ACTUARIAL PROFESSION (對精算師的影響)

Thanks to the widespread, personal health tracking apps, and other data-intensive technologies, an enormous amount of data are now available for insurers to do more analysis. Modeling actuaries are beginning to take on data science techniques, such as predictive analytics, and combine them along with their specialized training in insurance, statistics, and economics.

得益於廣泛使用的健康跟踪應用程序和其他數據密集型技術，保險公司現在可以對海量數據進行更多分析挖掘。建模師如今開始採用大數據技術，例如預測分析，並將其與保險、統計和經濟學方面的專門處理相結合。

### 4.3 THE USE OF THE CLOUD IN FINANCIAL MODELING AND ACTUARIAL PROCESSES (雲計算在金融建模和精算流程中的應用)

We have witnessed increasingly sophisticated actuarial financial reporting requirements around the world, such as Actuarial Guideline 43 and C-3 Phase II, Solvency II, and IFRS 17, which usually involves more complex modelling. The cloud provides actuaries with a new solution to data storage, run-time reduction, process streamlining, etc., to cope with ever-changing regulatory requirements.

近年來我們目睹了全球範圍內日益複雜的精算財務報告準則，例如 Actuarial Guideline 43 (美國精算準則第 43 號) 和 C-3 Phase II (美國風險基礎資本市場風險)、Solvency II (歐洲償付能力監管標準 II) 和 IFRS 17 (國際財務報告準則第 17 號)，而它們通常涉及更複雜的建模。為應對不斷變化的法規監管要求，雲計算為精算師提供了一種新的數據存儲模式，減少了運算時間，且簡化了流程。

The cloud changes the way in which data is collected with its massive capacity, connectivity, and ability to effectively leverage collected data. The cloud has practically no limit on storage, as it can expand on demand, with additional capacity at-the-ready. The cloud is also packed with application programming interfaces to ease connectivity to data of heterogeneous formats from multiple third-party vendors and public records, making it easier to enrich internal information with external data. Cloud providers continuously improve and push out new analytics capabilities, which insurers can utilize for their own analyses.

雲通過其大容量、連通性和高效處理的能力，改變了收集數據的方式。雲幾乎沒有存儲限制，因為它可以按需擴展，並隨時提供額外的容量。雲端還裝有應用程序接口，以簡化與多個第三方供應商和公共異構數據庫的鏈接，從而更輕鬆地利用外部數據豐富內部信息。雲提供商不斷對數據分析功能進行開發和迭代，使得保險公司可以將其用於數據處理。

The cloud is able to efficiently distribute nested stochastics or deterministic-on-stochastic runs, which translates into a tremendous advantage in reducing runtime. Sometimes, actuaries need to simplify their model to be efficient. This precept is particularly true for nested stochastic or deterministic-on-stochastic models. Using the cloud avoids oversimplification of the model, yet still maintains a reasonable runtime.

雲能夠高效地進行隨機嵌套模型或確定加隨機混合模型的計算，在縮短運算時間方面擁有巨大優勢。有時，精算師需要簡化模型以提高效率，尤其是對於嵌套隨機模型或隨機確定模型。使用雲則可避免模型的過度簡化，且保持合理的運行時間。

Using the cloud allows automation of the reporting pipeline. This is possible via migrating the model that produces the reporting of financial results to the cloud. Adjusted model output can be fed straight into visualizations and reporting frameworks using robust industry business analytic tools. Any authorized user can replace existing static report templates that are currently prepared using Microsoft Office tools with dynamic web-based dashboards accessible at any time.

雲計算可以支持自動化報告的生成，而這通過將財務報表模型遷移至雲端來實現。利用強大的行業內業務分析工具，用戶可以將調整後的模型輸出直接導入至可視化報告模板。任何授權用戶都可以隨時使用網頁上的動態概要面板來替代現在基於微軟 Office 的靜態報告模板。

#### 4.4 CONSIDERATIONS WHEN USING THE CLOUD (使用雲計算的注意事項)

There are two governance considerations for insurers: data governance and model governance. Insurers need to update their data and model governance framework, taking into account the use of the cloud. Using a cloud provider requires a lot of trust in their security protocols and may pose unexpected privacy concerns. A dedicated cloud model governance committee that spans the whole company would be ideal. Also, the model governance standards related to operating models in the cloud should be relatively consistent with and complementary to the model governance standards.

保險公司有兩個管理方面的考慮因素：數據管理和模型管理。保險公司在更新數據和模型管理框架時需要考慮雲技術的應用。使用雲提供商時，需要對其安全控制措施高度信任，並且需要考慮到可能意想不到的隱私問題。理想情況下，公司可成立一個專門的跨部門雲端模型管理委員會。此外，雲端和線下的模型管理標準都應一致並互補。

When thinking about the type of cloud structure to adopt, actuaries must be careful about the exact purpose and needs the cloud is meant to satisfy. Key considerations are budget; security and compliance requirements; hardware and virtual server control; failover control; service-level agreements; cloud resource utilization and consistency; what data will be used in the cloud environment; internal IT resources to support the services; how many teams or groups will be utilizing the cloud and how similar the processes are; and how much automation can be achieved if a private cloud is utilized.

在考慮採用的雲計算部署模式時，精算師必須考慮使用雲計算的確切用途和需求。關鍵因素包括預算、安全性和合規要求、硬件和虛擬服務器、故障轉移控制、服務等級協議、雲資源利用率和連貫性、雲環境中使用的數據、內部 IT 資源和技術支持、有多少部門將利用雲以及這些計算過程的相似性、以及利用私有云可以實現的自動化程度。

#### 4.5 USE OF ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING BY ACTUARIES (人工智能和機器學習對精算師的用途)

Artificial intelligence (AI) can be defined as any attempt to make machines learn from experience and to perform human tasks, whereas machine learning is a subfield of AI that allows machines, programs, or algorithms to learn and improve from data. Currently, AI and machine learning are becoming increasingly important thanks to big data, ever-improving algorithms, and the greater capacities of storage and computing.

人工智能 (AI) 可定義為使機器從經驗中學習並執行人類的行為，而機器學習是人工智能的一個分支，它允許機器、程序或算法從數據中學習並改進。當前，由於大數據、不斷改進的算法以及更大的存儲和計算能力，人工智能和機器學習正蓬勃發展。

The most common uses of machine learning in actuarial science include pricing, claims, in-force management, risk, underwriting, valuation, and disease management. In this research report, four case studies were presented, providing insight into how actuaries employ machine learning in their daily work. Machine learning algorithms are efficient in analyzing large and granular datasets. It is believed that will AI will play an increasingly important role in the process of decision-making going forward.

對於精算師而言，機器學習的最常見用途包括定價、理賠、業務管理、風險、承保、估值和疾病管理。這份研究報告闡述了四個案例研究，以深入體現精算師如何在日常工作中運用機器學習。機器學習算法可以有效地分析大量的高精度數據。人們相信，人工智能將在未來的決策過程中扮演越來越重要的角色。

#### 4.6 COMMON MACHINE LEARNING ALGORITHMS AND TOOLS (機器學習常用算法及工具)

In machine learning, there are two kinds of tasks, supervised learning and unsupervised learning. The goal of supervised learning is to determine the model that best fits the data so as to predict an output given a new set of input. Unsupervised learning, however, is used to draw inferences that are not explicit using the characteristics of data. Examples of supervised learning include classification and regression tree (CART) and random forest, which are commonly used in pricing analysis, creating reserving algorithms, and evaluating risks with complex interactions. A common unsupervised learning algorithm is the k-means algorithm, which is frequently used in marketing campaigns to identify similar exposures for claims management and process optimization. R and Python are ordinary programming languages used to perform machine learning analysis. Different packages in R and Python allow a community to easily implement machine learning.

機器學習領域包括兩種學習方法：監督學習和無監督學習。監督學習的目標是找到一個最適合既定數據的模型，以便在給定新的輸入值時輸出預測值。無監督學習則是在沒有標籤的數據裡發現潛在結構的一種訓練方式。監督學習包括分類回歸樹 (CART) 和隨機森林算法，通常用於定價分析、創建準備金算法以及評估具有複雜交互作用的風險。一種常見的無監督學習算法是 K-均值 (k-means) 算法，在銷售中經常使用來識別風險，以進行理賠管理和流程優化。R 和 Python 是用於進行機器學習分析的常用編程語言。它們提供的多種軟件包允許各式群體輕鬆實現機器學習。

#### 4.7 CONSIDERATIONS FOR MODEL SELECTION & RESULTS INTERPRETATIONS (選擇模型和分析結果的注意事項)

There are plenty of algorithms available and, when selecting the model, we have to carefully tradeoff between complexity and interpretability. When implementing a new machine learning algorithm, it is crucial to understand the theory behind it in order to understand how it works, in what instances it is appropriate, and what range of parameters is appropriate for a given situation. It is as important to analyze results closely to understand what is hidden behind models.

當我們選擇模型時，有許多算法可供考慮，而我們需要在複雜性和可解釋性之間謹慎權衡。在實施新的機器學習算法時，至關重要的是要了解其背後的理論，以便了解工作原理，在什麼情況下合適以及對於給定情況合適的參數範圍。與此同時，需要仔細分析結果以了解模型背後隱藏的信息。

Overall, cloud technology has the potential to impact many practice areas of actuaries, including, but not limited to, pricing; valuation and reserving; enterprise risk management; and experience analyses and assumptions. In order to benefit from the opportunities presented by cloud computing and granular analyses, actuaries will need to either become data and technology experts or become familiar enough with these topics to effectively provide the required solutions and skill sets to employers.

總體而言，雲技術可深刻影響精算師的多種實踐領域，包括但不限於產品定價、評估準備金、風險管理、經驗分析和精算假設。為了從雲計算以及粒計算所提供的機會中受益，精算師將需要成為數據和技術專家或對這些專題足夠熟悉，以有效地為雇主提供所需的解決方案和技能。

The full research report can be found here:

請點開以下網址查閱完整的研究報告:

<https://www.soa.org/globalassets/assets/files/resources/research-report/2019/cloud-computing.pdf>.

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