SOCIETY OF ACTUARIES®

Chinese Report Summaries

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SOCIETY OF ACTUARIES

Chinese Report Summaries

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Chinese Report Summaries

Section 1: Behavior Science Report Summary (行為科學報告摘要）

The Behavioral Science Report is designed to provide general familiarity in the subject of Behavioral Economics (BE) and motivate readers to consider additional research on the topic. The research report was completed by RRC in June of 2019. RRC is an insurance consulting firm serving the regulatory community and has performed a range of research projects for the SOA.

行為科學報告旨在提供行為經濟學（BE）的總體認識，並鼓勵讀者對該主題進行其他研究。該研究報告是由 RRC 於 2019 年 6 月完成。RRC 是一家為監管機構服務的保險諮詢公司，並已為 SOA 進行了一系列的研究。

BE is a method of economic analysis that applies psychological insights into human behavior to explain and nudge economic decision-making. The field of BE blends insights of psychology and economics, and provides some valuable insights that individuals are not behaving in their own best interests. BE provides a framework to understand when and how people make errors. Systematic errors or biases recur predictably in particular circumstances.

BE 是一種將心理洞察力應用於人類行為，以解釋和推動經濟決策的經濟分析方法。BE 融合了對心理學和經濟學的見解，並對一些不符合個人利益最大化的行為提供了合理的解釋。BE 提供了一個框架以理解人們何時以及如何犯錯，亦可在特定情況下預測系統性錯誤或偏見的再次發生。

The brain is best thought of as an organization of systems that interact with each other. A crucial insight is that the brain is a democracy. That is, there is no leading decision-maker. Although the behavioral goal of an individual can be stated as maximizing happiness, attaining that goal requires contributions from several brain regions. BE attempts to integrate psychologists' understanding of human behavior into economic analysis.

大腦可被視為一種互動系統。一個重要的觀點是大腦是民主的，也就是說，沒有領先的決策者。雖然每個人的行為是以儘可能提高幸福感為目標，但是要達到這個目標則需要大腦不同區域的貢獻。BE 試圖將心理學家對人類行為的理解整合到經濟分析中。

Lessons from BE can be used to create environments that nudge people toward wiser decisions and healthier lives. There are many benefits of BE for insurance, including better educating applicants on the benefits of truthful and correct disclosure, which can improve the underwriting process and result. This, in turn, results in more reliable applications being submitted, which leads to a reduction in the time to obtain underwriting approval. An added benefit is the

來自 BE 的經驗可促使人們朝著更明智的決策和更健康的生活發展。BE 對保險業有很多好處，包括更好地教育申請人，讓他們了解如實告知的益處，這可以改善承保流程和結果，令提交的申請更為可靠，從而縮短承保的時間。另一個好處便是可以通過改善購買流程為更多的消費者提供更多的人壽保險，並使購買流程更具個性化和相關性。

opportunity to provide more life insurance to more consumers by improving the buying process and making the process more personalized and relevant.

There are potential drawbacks to BE and some elements to consider include a negative impact on client experience (if done poorly) and the resource-intensive nature of BE. While customer experience is critical, there is the balance of needing to mitigate mortality and morbidity risk with improvements to the client experience.

BE 也有潛在的弊端，BE 需要投入大量的資源，如果做得不好便有可能對客戶的體驗帶來負面影響。儘管客戶體驗很重要，我們需要在降低死亡率和發病率的風險和改善客戶體驗之間取得平衡。

The report reviews several BE techniques that could be applied to guide product design, modeling, and underwriting. The focus of this research is on life insurance underwriting, and much of the research being done is to test how BE can be utilized to improve applicant disclosures. Current insurance applications encourage fast thinking, resulting in people providing less accurate information in applications for insurance.

該報告回顧了幾種可用於指導產品設計，建模和承保的 BE 技術。這項研究的重點是人壽保險的承保，而正在進行的許多研究都是為了測試如何利用 BE 來改善申請人的信息披露。當前的保險申請過程鼓勵快速思考，導致人們在保險申請中提供不太準確的信息。

The research reviewed existing literature regarding industry approaches and primarily summarized industry perspectives from interviews conducted with 13 panelists using a questionnaire developed by RRC. Panelists included members from insurance, reinsurance, and consulting.

該研究回顧了有關行業的現有文獻，並利用 RRC 編制的問卷調查表對 13 位专家小組成員進行了訪談，初步總結了行業觀點。小組成員分別來自保險，再保險和諮詢公司的成員。

BE techniques considered in the report include Framing, Nudges, Cognitive aids, Social Norming, Availability heuristics, Anchoring, Messenger effect, Managing inertia, Fluency, Choice Architecture, Sentinel Effect, Scaling, Hovering Effect, Psychological Manipulation, and Prospect Theory. These BE techniques are evaluated against a series of improvements that can be made to the Underwriting process. Regulatory considerations are also briefly discussed as Regulatory requirements are often a concern around underwriting application changes. The techniques are also evaluated for their ability to improve marketing and distribution of products, to improve advisor behavior, and deliver post-sale customer engagement.

報告中考慮的 BE 技術包括框架，輕推，認知輔助，社會規範，可用性啟發法，錨定，信使效應，管理慣性，流利性，選擇架構，前哨效應，縮放，懸停效應，心理操縱和前景理論。這些 BE 技術是根據一系列可以改善承保過程的方法來進行評估的。報告中還簡要討論了監管方面的考慮。監管部門通常最為關注的，便是任何關於承保申請的變更。該報告還評估了這些技術在改善產品營銷和分銷，改善顧問行為以及提供客戶售後參與互動的能力。

In summary, the report provides an overview of how BE can be applied to introductory changes in the existing paradigm of Insurance customer journeys. Readers are also provided with additional resources to consider to further their understanding of BE.

The full research report can be found here: https://www.soa.org/globalassets/assets/files/resources/research-report/2019/behavioral-sciencereport.pdf.

總之，該報告概述了如何將 BE 應用於現有保險客戶的購買經驗，還為讀者提供了其他資源以進一步了解 BE。

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https://www.soa.org/globalassets/assets/files/resources/research-report/2019/behavioral-sciencereport.pdf.

Section 2: Big Data and the Future Actuary Report Summary (大數據與精算的未來報告摘要）

Access to big, non-traditional data has, is, and will affect every industry in the market, as well as usher in a few new ones. In insurance, access to big data means the relationship between insurers and their customers is increasingly complex and intimate. On the positive side, this encourages insurers to innovate and find ways to deliver value across the customer lifecycle. However, it also invites questions of privacy, transparency, and what constitutes taking data access 'too far.'

對大型非傳統數據的運用已經、正在且即將影響各行各業，並推動產生一些新的行業。在保險業中，使用大數據意味著保險公司與客戶之間的關係正變得日益複雜和親密。從積極的一面來看，這會鼓勵保險公司進行創新並為客戶持續創造價值。但同時，也引發了隱私、透明度，以及數據使用的尺度界限等問題。

2.1 USING NON-TRADITIONAL DATA IN TRADITIONAL WAYS (以傳統方式使用非傳統數據)

There's no shortage of ways that big data influences and encourages innovation in the more traditional insurance processes. New niche products can target small segments of the population for a fraction of the cost. AI can simplify and improve accuracy in underwriting. Drone footage can determine which properties are more at risk in a natural disaster zone. The possibilities across the broader industry are seemingly limitless.

在更傳統的保險流程中，大數據可以在各個層面鼓勵創新。新的利基產品可以做到用低廉的價格針對一小部分消費者。 AI 可以簡化承保流程並提高準確度。無人機錄像可以判定受自然災害風險更大的地區。大數據應用的可能性似乎是無限的。

Many forms of data that are not necessarily new to the insurance industry are changing. Whether that refers to the data's complexity, accessibility, or the way it's collected and analyzed completely depends on the data and the person/company collecting it. Data that will experience this kind of shift includes **demographic, financial, government, climate, medical, motor vehicle records, public records**, and **telematics**.

對於保險業的許多既有數據而言，形式正在發生變化。無論是數據的複雜性、可訪問性，還是數據的收集和分析方式，完全取決於數據本身以及收集數據的人員以及公司。經歷著這種轉變的數據包括**人口統計、財務、政府、氣候、醫療、機動車記錄、公共記錄和遠程信息處理。**

The industry will also have access to some relatively new kinds of data, particularly epigenetics data and digital behavioral data. **Epigenetics data** refers to information pertaining to 'cellular age.' This can predict how long one is likely to live, whether or not they're likely to avoid common diseases, etc. **Digital behavioral data** is possibly the most valuable source of big data to insurance and comes in the form of wearables, apps, and online platforms that constantly track behavior, habits, location, and health. This data can be used in everything from risk pricing, fraud prevention, underwriting products, and more.

與此同時，業界還將獲得一些相對較新的數據，尤其是表觀遺傳學數據和數字化行為數據。**表觀遺傳學數據**是指與"細胞年齡"有關的信息。它可以預測一個人可能活多久，是否有可能避免常見疾病等。對於保

險業而言，**數字化行為數據**則可能是最有價值的。這包括可穿戴設備、應用程序，以及不斷記錄用戶行為、習慣、位置和健康狀況的網絡平台。這些數據可應用於風險定價、預防欺詐、承保等。

With access to big data comes great responsibility. Insurers should be especially wary of predictive algorithms that have the potential to inherit societal discriminatory prejudices through machine learning. While significant advancements have been made, there is no agreed upon way to ensure AI and machine learning operate free of any bias. It is illegal for insurers to discriminate on the basis of race, religion, or national origin in the underwriting, pricing, and claims processes, making integrating these new technologies tricky.

非傳統大數據也同時給保險公司帶來了巨大的責任。保險公司應該特別警惕某些通過機器學習而繼承了帶有社會歧視或偏見的預測算法。儘管此方面已有重大進展，但目前仍沒有公認的方法來確保 AI 和機器學習在沒有任何偏見的情況下運行。在承保、定價和理賠過程中基於種族、宗教或國籍進行歧視是非法的，這使得保險行業整合新技術變得非常棘手。

On the more positive side of this equation, access to these big data sources provides endless opportunities for insurers to meaningfully engage their customers. Companies placing the customer at the center of business decisions regularly outperform those that don't, and the insurance industry has the tools to enable this. Insurers that recognize this potential and act on it can provide continuous value, helping customers live healthier, happier, and wealthier lives.

從積極的方面來看，大數據為保險公司提供了無盡的與客戶互動的機會。以客戶需求為中心的企業通常在競爭時處於上風，而保險行業如今擁有工具和技術來支持大數據的發展。意識到大數據的潛力並採取行動的保險公司可以不斷創造價值，幫助客戶過上更健康、幸福、富有的生活。

2.2 USING NON-TRADITIONAL DATA IN NON-TRADITIONAL WAYS (以非傳統方式使用非傳統數據)

Outside of using non-traditional data to improve and innovate long-standing industry practices and processes, there are plenty of new ways for actuaries and insurers to push traditional boundaries. At the center of this is the idea that the insurance industry is moving away from a 'detect and repair' industry towards a more proactive 'predict and prevent.' Here are a few ways in which the insurance industry is actively working towards this shift:

除了使用非傳統數據來改善與創新既有的行業慣例和流程外，精算師和保險公司還可以利用許多新方式來突破傳統界限。其中心思想是，保險業正經歷從"發現和補救"至更主動的"預測和預防"模式的變革。保險業可通過以下幾種方式積極致力於這一轉變：

1. **Risk Management and Wellness Programs**: Perhaps the most intuitive way insurers can drive value for customers is risk management and wellness programs, which provide insights and incentives to help consumers improve their mental and physical well-being.
2. **Patient Management Programs for the Chronically Ill**: Partnerships between healthcare providers and insurers can develop patient management programs for customers suffering from chronic diseases.
3. **Value-Based Payment Models**: These next-generation payment contracts can directly link individual behavior with the management of chronic diseases, providing incentives for customers to improve their lives through lifestyle insights and suggestions.
4. **Pay-as-you-live and usage-based insurance**: These pricing solutions will benefit consumers through seamlessly interconnected insurance products, delivering continuous value through insights on health, wealth, and safety.

5. Internet of things integration
6. Covering new risks

1. **健康管理計劃**：保險公司為客戶創造價值的最直觀的方法就是健康管理計劃，它提供了專業指導和激勵措施，可以使消費者的身心健康得到改善。

2. **慢性病患者管理計劃**：醫療機構與保險公司可以合作為患有慢性疾病的客戶制定管理計劃。

3. **互惠式模型**：這種保險形式可以將客戶行為與健康管理直接聯繫起來，通過日常指導和獎勵來鼓勵客戶養成健康的生活方式。

4. **先使用後付費模式**：這種模式通過無縫銜接的保險產品為客戶提供有形和無形的價值與保障。

5. **利用物聯網互聯互通**

6. **承保新的風險**

2.3 BECOMING AN ACTUARY OF THE FUTURE (精算師職業的未來)

Access to non-traditional, big data does more than shift the insurance industry, it changes what it means to be an actuary. The actuary of the future will be part mathematician, part data scientist, part digital strategist, part computer programmer, and part design thinker, integrating all these skills to make the most of new technologies and partnerships alike. New data sources will provide a wealth of both structured and unstructured data that will allow actuaries with the right programming skills to develop algorithms capable of efficiently working with massive datasets.

大數據不僅改變保險業，還改變了精算師職業的意義。未來的精算師將是數學家、數據科學家、數字戰略家、程序員和設計思想家的結合體，精算師將整合所有這些技能以充分利用新技術和跨行業合作的成果。新的數據源將提供大量的結構化和非結構化數據，具有編程技能的精算師從而可以開發高效處理海量數據的算法。

More than anything, the actuaries of tomorrow will see their role shift towards the customer in ways it never has before. As the insurance industry becomes simultaneously more customer centric and proactive, products, programs, and services will reflect a more engaged customer base, ready to be engaged throughout the duration of their policies through meaningful, value-driven initiatives. Actuaries will be at the center of this shift.

與過去不同，未來的精算師會將客戶視為導向。隨著保險業更加積極主動地向"以客戶為中心"轉型，保險產品和項目將與客戶在各個層面展開互動，全程以卓越服務為客戶創造價值並提升體驗。精算師正是推動這一變革的中堅力量。

請點開以下網址查閱完整的研究報告：

The full research report can be found here: https://www.soa.org/resources/research-reports/2019/big-datafuture-actuary/.

Section 3: Cancer Genomics Report Summary (癌症基因報告摘要）

Since 2017, treatment of advanced deadly cancers – particularly lung cancer and metastatic melanoma – has undergone a major paradigm shift. Traditional pillars of cancer treatment – surgery, radiation, and chemotherapy – have moved to 2 new efficacious approaches: tumor genomics and immunotherapy.

自 2017 年起，晚期致命癌症（包括肺癌和擴散的腫瘤）的治療發生了重大的變化。治療方案已由傳統的手法如手術、電療和化療變成用腫瘤基因治療和免疫治療這兩種更有效的療法。

The impact on the insurance industry is becoming increasingly profound. High morbidity and mortality are reduced significantly for roughly 30% of patients in these cancers, and increasingly other cancers, where 5- year survival rates have been below 50%.

這對於保險業有著越來越顯著的影響。對於五年存活率低於百分之五十的癌症，這種療法能幫大約百分之三十的病人降低發病率和死亡率，而對於其他癌症也日漸有效。

Oncologists' new weapon is a class of antibody drugs led by Keytruda® (Merck) that free up the previously blocked immune system to recognize and destroy tumors. Collectively, these drugs are called ImmunoOncology therapies, or I-O, sometimes called 'checkpoint inhibitors.' However, the release of the immune system can be overdone and cause side effects or worse. At least one tumor genetic test, TMB (tumor mutational burden), promises to pre-qualify patients for I-O, to lower this danger. TMB simply counts the number of mutations in biopsied tumor cells, without regard to the gene(s) or other fine detail. Counts over 15 generally qualify a patient for I-O treatment. For those with low numbers a second targeted genomic test, PD-L1, can still rescue and requalify treatment.

腫瘤科醫生的新武器便是一種由 Keytruda® (Merck) 主導的抗體，這種抗體能釋放之前被隔絕的免疫系統，從而識別並破壞的癌細胞。總括而言，這類型的藥物叫做免疫腫瘤治療 （I-O）或稱為抑製劑檢查。不過，過度釋放免疫系統會導致副作用或對身體有更壞的影響。至少有一種腫瘤基因測試 TMB （腫瘤突變負荷），保證對符合資格接受免疫腫瘤治療 （I-O） 的病人減低危險。TMB （腫瘤突變負荷）不需要知道基因的詳情，只需要計算在活體組織檢查中抽取的腫瘤細胞突變數。細胞突變數量超過 15 的病人一般都符合接受免疫腫瘤治療 （I-O）的資格。如果細胞突變數量較少，病人也可以接受另一種救治方法 – 基因標靶測試 （ PD-L1），並重新獲得治療資格。

The chart below displays lung cancer, where FDA has now moved to approve chemotherapy-free treatments. There are 1.5 million lung cancer deaths annually – higher than prostate, colorectal, and breast cancers combined.

What is the forecasted cost-effectiveness of these drugs? Compared to prior standards of care, which could not increase survival, the combination of TMB and Keytruda appears to be cost-neutral for lung cancer, and cost-effective for metastatic melanoma. More clinical trials are needed to increase confidence of C-E assessments, but an anti-tumor 'memory' effect has been seen after 18 weeks of treatment in the majority of patients in one such study that may eventually limit the expenditures to roughly $70K cost (Keytruda price is ~$23K for 6 weeks).

SOA is eager to see more statistics over coming months on the cost comparison of I-O Therapy versus the current Standards of Care. However, the growing numbers of patients with decreased morbidity and mortality will bring significant outcry for coverage. Conversely, shorter treatment windows should limit outlays for insurers.

The full research report can be found here: https://www.soa.org/resources/research-reports/2019/cancergenomics/.

以下圖表顯示美國食品藥品監督管理局（FDA）已批准肺癌病人接受免化療療法。每年有一百五十萬肺癌病人死亡，這遠高於前列腺癌、結腸癌和乳癌死亡人數的總和。

這些藥物的預期成本效益如何？與先前無法增加存活率的治療標準相比，TMB 和 Keytruda 的組合似乎對肺癌有差不多的成本效益，但是對於轉移性黑色素瘤則具有良好的成本效益。在此一類研究中，大多數患者在治療 18 週後，身體會産生對抗腫瘤的"記憶"效應，最終能將支出限制在大約七万美金左右 （Keytruda 的花費是大約每六週兩萬三千美金）。不過，這需要更多的臨床試驗來增加對成本效益評估的信心。

北美精算师协会（SOA）渴望在未來幾個月內看到更多關於 I-O 療法與現時標準療法的費用比較和統計信息。不過隨著患者數量的增加而發病率和死亡率的下降，人們將會強烈要求得到保障。相反，保險公司的支出亦會因較短的治療窗口而有所控制。

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https://www.soa.org/resources/research-reports/2019/cancergenomics/.

Section 4: Cloud Computing and Machine Learning Uses in the Actuarial Profession (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 over-simplification 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復雜交互作用的風險。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，而我們需要在復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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