

Chinese Report Summaries





Chinese Report Summaries

ORIGINAL AUTHORS

BEHAVIOR SCIENCE

RISK & REGULATORY CONSULTING

BIG DATA & THE FUTURE ACTUARY

MADDOCK DOUGLAS

CANCER GENOMICS

BREAKTHROUGH DEVELOPMENT CO.

CLOUD COMPUTING

MILLIMAN

TRANSLATORS

Yihong Lu
Translation Consultant
LEAD Insurance Consulting

Tinny Tsun, FSA, FCIA

Yuan Yuan, FSA, MAAA
Consultant
Ernst & Young

SPONSOR

Actuarial Innovation & Technology
Steering Committee

Caveat and Disclaimer

The opinions expressed and conclusions reached by the authors are their own and do not represent any official position or opinion of the Society of Actuaries or its members. The Society of Actuaries makes no representation or warranty to the accuracy of the information.

Copyright © 2020 by the Society of Actuaries. All rights reserved.

The Chinese version is Simplified Chinese

CONTENTS

Section 1: Behavior Science Report Summary (行为科学报告摘要) 4

Section 2: Big Data and the Future Actuary Report Summary (大数据与精算的未来报告摘要)..... 7

 2.1 Using Non-Traditional Data in Traditional Ways (以传统方式使用非传统数据) 7

 2.2 Using Non-Traditional Data in Non-Traditional Ways (以非传统方式使用非传统数据)..... 8

 2.3 Becoming an Actuary of the Future (精算师职业的未来) 9

Section 3: Cancer Genomics Report Summary (癌症基因报告摘要) 10

Section 4: Cloud Computing and Machine Learning Uses in the Actuarial Profession (云计算和机器学习在精算行业中的应用) 12

 4.1 How the insurance industry and actuarial profession are impacted by the cloud (云计算如何改变保险行业和精算业)..... 12

 4.2 Impact on the actuarial profession (对精算师的影响) 12

 4.3 The use of the cloud in financial modeling and actuarial processes (云计算在金融建模和精算流程中的应用) 13

 4.4 Considerations when using the cloud (使用云计算的注意事项) 14

 4.5 Use of artificial intelligence and machine learning by actuaries (人工智能和机器学习对精算师的用途) 14

 4.6 Common machine learning algorithms and tools (机器学习常用算法及工具) 15

 4.7 Considerations for model selection & results interpretations (选择模型和分析结果的注意事项) 15

Section 4: Acknowledgments 17

About The Society of Actuaries 18

Chinese Report Summaries

Section 1: Behavior Science Report Summary (行为科学报告摘要)

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.

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.

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.

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

行为科学报告旨在提供行为经济学 (BE) 的总体认识，并鼓励读者对该主题进行其他研究。该研究报告是由 RRC 于 2019 年 6 月完成。RRC 是一家为监管机构服务的保险咨询公司，并已为 SOA 进行了一系列的研究。

BE 是一种将心理洞察力应用于人类行为，以解释和推动经济决策的经济分析方法。BE 融合了对心理学和经济学的见解，并对一些不符合个人利益最大化的行为提供了合理的解释。BE 提供了一个框架以理解人们何时以及如何犯错，亦可在特定情况下预测系统性错误或偏见的再次发生。

大脑可被视为一种互动系统。一个重要的观点是大脑是民主的，也就是说，没有领先的决策者。虽然每个人的行为是以尽可能提高幸福感为目标，但是要达到这个目标则需要大脑不同区域的贡献。BE 试图将心理学家对人类行为的理解整合到经济分析中。

来自 BE 的经验可促使人们朝着更明智的决策和更健康的生活发展。BE 对保险业有很多好处，包括更好地教育申请人，让他们了解如实告知的益处，这可以改善承保流程和结果，令提交的申请更为可靠，从而缩短承保的时间。另一个好处便是可以通过改善购买流程为更多的消费者提供更多

obtain underwriting approval. An added benefit is the 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.

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.

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.

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.

的人寿保险，并使购买流程更具个性化和相关性。

BE 也有潜在的弊端，BE 需要投入大量的资源，如果做得不好便有可能对客户体验带来负面影响。尽管客户体验很重要，我们需要在降低死亡率和发病率的风险和改善客户体验之间取得平衡。

该报告回顾了几种可用于指导产品设计、建模和承保的 BE 技术。这项研究的重点是人寿保险的承保，而正在进行的许多研究都是为了测试如何利用 BE 来改善申请人的信息披露。当前的保险申请过程鼓励快速思考，导致人们在保险申请中提供不太准确的信息。

该研究回顾了有关行业的现有文献，并利用 RRC 编制的问卷调查表对 13 位专家小组成员进行了访谈，初步总结了行业观点。小组成员分别来自保险、再保险和咨询公司的成员。

报告中考虑的 BE 技术包括框架、轻推、认知辅助、社会规范、可用性启发法、锚定、信使效应、管理惯性、流利性、选择架构、前哨效应、缩放、悬停效应、心理操纵和前景理论。这些 BE 技术是根据一系列可以改善承保过程的方法来进行评估的。报告中还简要讨论了监管方面的考虑。监管部门通常最为关注的，便是任何关于承保申请的变更。该报告还评估了这些技术在改善产品营销和分销、改善顾问行为以及提供客户售后参与互动的能力。

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.

总之，该报告概述了如何将 BE 应用于现有保险客户的购买经验，还为读者提供了其他资源以进一步了解 BE。

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

请点击以下网址查阅完整的研究报告 □

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

Section 2: Big Data and the Future Actuary Report Summary (大数据与精算的未来报告摘要)

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.’

对大型非传统数据的运用已经、正在且即将影响各行各业，并推动产生一些新的行业。在保险业中，使用大数据意味着保险公司与客户之间的关系正变得日益复杂和亲密。从积极的一面来看，这会鼓励保险公司进行创新并为客户持续创造价值。但同时，也引发了隐私、透明度，以及数据使用的尺度界限等问题。

2.1 USING NON-TRADITIONAL DATA IN TRADITIONAL WAYS (以传统方式使用非传统数据)

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.

在更传统的保险流程中，大数据可以在各个层面鼓励创新。新的利基产品可以做到用低廉的价格针对一小部分消费者。AI 可以简化承保流程并提高准确度。无人机录像可以判定受自然灾害风险更大的地区。大数据应用的可能性似乎是无限的。

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.**

对于保险业的许多既有数据而言，形式正在发生变化。无论是数据的复杂性、可访问性，还是数据的收集和分析方式，完全取决于数据本身以及收集数据的人员以及公司。经历着这种转变的数据包括**人口统计、财务、政府、气候、医疗、机动车记录、公共记录和远程信息处理。**

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.

与此同时，业界还将获得一些相对较新的数据，尤其是表观遗传学数据和数字化行为数据。**表观遗传学数据**是指与“细胞年龄”有关的信息。它可以预测一个人可能活多久，是否有可能避免常见疾病等。对于保

险业而言，**数字化行为数据**则可能是最有价值的。这包括可穿戴设备、应用程序，以及不断记录用户行为、习惯、位置和健康状况的网络平台。这些数据可应用于风险定价、预防欺诈、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.

非传统大数据也同时给保险公司带来了巨大的责任。保险公司应该特别警惕某些通过机器学习而继承了带有社会歧视或偏见的预测算法。尽管此方面已有重大进展，但目前仍没有公认的方法来确保 **AI 和机器学习** 在没有任何偏见的情况下运行。在承保、定价和理赔过程中基于种族、宗教或国籍进行歧视是非法的，这使得保险行业整合新技术变得非常棘手。

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.

从积极的方面来看，大数据为保险公司提供了无尽的与客户互动的机会。以客户需求为中心的企业通常在竞争时处于上风，而保险行业如今拥有工具和技术来支持大数据的发展。意识到大数据的潜力并采取行动的保险公司可以不断创造价值，帮助客户过上更健康、幸福、富有的生活。

2.2 USING NON-TRADITIONAL DATA IN NON-TRADITIONAL WAYS (以非传统方式使用非传统数据)

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:

除了使用非传统数据来改善与创新既有的行业惯例和流程外，精算师和保险公司还可以利用许多新方式来突破传统界限。其中中心思想是，保险业正经历从“发现和补救”至更主动的“预测和预防”模式的变革。保险业可通过以下几种方式积极致力于这一转变：

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. **健康管理计划**：保险公司为客户创造价值的最直观的方法就是健康管理计划，它提供了专业指导和激励措施，可以使消费者的身心健康得到改善。
2. **慢性病患者管理计划**：医疗机构与保险公司可以合作为患有慢性疾病的客户制定管理计划。
3. **互惠式模型**：这种保险形式可以将客户行为与健康管理直接联系起来，通过日常指导和奖励来鼓励客户养成健康的生活方式。
4. **先使用后付费模式**：这种模式通过无缝衔接的保险产品为客户提供有形和无形的价值与保障。
5. **利用物联网互联互通**
6. **承保新的风险**

2.3 BECOMING AN ACTUARY OF THE FUTURE (精算师职业的未来)

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.

大数据不仅改变保险业，还改变了精算师职业的意义。未来的精算师将是数学家、数据科学家、数字战略家、程序员和设计思想家的结合体，精算师将整合所有这些技能以充分利用新技术和跨行业合作的成果。新的数据源将提供大量的结构化和非结构化数据，具有编程技能的精算师从而可以开发高效处理海量数据的算法。

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.

与过去不同，未来的精算师会将客户视为导向。随着保险业更加积极主动地向“以客户为中心”转型，保险产品和项目将与客户在各个层面展开互动，全程以卓越服务为客户创造价值并提升体验。精算师正是推动这一变革的中坚力量。

请点击以下网址查阅完整的研究报告：

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 (癌症基因报告摘要)

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.

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%.

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.

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.

自 2017 年起，晚期致命癌症（包括肺癌和扩散的肿瘤）的治疗发生了重大的变化。治疗方案已由传统的手法如手术、电疗和化疗变成用肿瘤基因治疗和免疫治疗这两种更有效的疗法。

这对于保险业有着越来越显著的影响。对于五年存活率低于百分之五十的癌症，这种疗法能帮大约百分之三十的病人降低发病率和死亡率，而对于其他癌症也日渐有效。

肿瘤科医生的新武器便是一种由 Keytruda® (Merck) 主导的抗体，这种抗体能释放之前被隔绝的免疫系统，从而识别并破坏的癌细胞。总括而言，这类型的药物叫做免疫肿瘤治疗 (I-O) 或称为抑制剂检查。不过，过度释放免疫系统会导致副作用或对身体有更坏的影响。至少有一种肿瘤基因测试 TMB (肿瘤突变负荷)，保证对符合资格接受免疫肿瘤治疗 (I-O) 的病人减低危险。TMB (肿瘤突变负荷) 不需要知道基因的详情，只需要计算在活体组织检查中抽取的肿瘤细胞突变数。细胞突变数量超过 15 的病人一般都符合接受免疫肿瘤治疗 (I-O) 的资格。如果细胞突变数量较少，病人也可以接受另一种救治方法 – 基因靶测试 (PD-L1)，并重新获得治疗资格。

以下图表显示美国食品药品监督管理局 (FDA) 已批准肺癌病人接受免化疗疗法。每年有一百五十万肺癌病人死亡，这远高于前列腺癌、结肠癌和乳癌死亡人数的总和。


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).

这些药物的预期成本效益如何？与先前无法增加存活率的治疗标准相比，TMB 和 Keytruda 的组合似乎对肺癌有差不多的成本效益，但是对于转移性黑色素瘤则具有良好的成本效益。在此一类研究中，大多数患者在治疗 18 周后，身体会产生对抗肿瘤的“记忆”效应，最终能将支出限制在大约七万美金左右（Keytruda 的花费是大约每六周两万三千美金）。不过，这需要更多的临床试验来增加对成本效益评估的信心。

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.

北美精算师协会（SOA）渴望在未来几个月内看到更多关于 I-O 疗法与现时标准疗法的费用比较和统计信息。不过随着患者数量的增加而发病率和死亡率的下降，人们将会强烈要求得到保障。相反，保险公司的支出亦会因较短的治疗窗口而有所控制。

The full research report can be found here:
<https://www.soa.org/resources/research-reports/2019/cancer-genomics/>.

请点击以  查看更多关于 I-O 疗法与现时标准疗法的费用比较和统计信息。
<https://www.soa.org/resources/research-reports/2019/cancer-genomics/>.

Section 4: Cloud Computing and Machine Learning Uses in the Actuarial Profession (云计算和机器学习在精算行业中的应用)

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.

如今保险公司在一种快速且持续的技术和消费者转型环境中运营着。在过去的几十年中，多种技术取得了巨大的发展，其中之一就是云计算。

4.1 HOW THE INSURANCE INDUSTRY AND ACTUARIAL PROFESSION ARE IMPACTED BY THE CLOUD (云计算如何改变保险行业和精算业)

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.

随着保险公司为了探索与客户互动的新方式而加大投资，保险科技日益受资本追捧。例如，保险公司需要拓展更先进的动态定价功能，才能为喜爱数字化和全方位渠道以及全天候客户服务的千禧一代和 Z 世代提供即时且个性化的报价。云计算所提供的敏捷性和容量使新的保险业务模式得以引入。

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).

精算师对于云计算的使用并不罕见，大多数的云用户期望云计算能够为他们的工作带来积极的影响。最常见的用途是利用云资源进行更快的计算（即分布式计算）。

4.2 IMPACT ON THE ACTUARIAL PROFESSION (对精算师的影响)

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.

得益于广泛使用的健康跟踪应用程序和其他数据密集型技术，保险公司现在可以对海量数据进行更多分析挖掘。建模师如今开始采用大数据技术，例如预测分析，并将其与保险、统计和经济学方面的专门处理相结合。

4.3 THE USE OF THE CLOUD IN FINANCIAL MODELING AND ACTUARIAL PROCESSES (云计算在金融建模和精算流程中的应用)

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.

近年来我们目睹了全球范围内日益复杂的精算财务报告准则，例如 Actuarial Guideline 43 (美国精算准则第 43 号) 和 C-3 Phase II (美国风险基础资本市场风险)、Solvency II (欧洲偿付能力监管标准 II) 和 IFRS 17 (国际财务报告准则第 17 号)，而它们通常涉及更复杂的建模。为应对不断变化的法规监管要求，云计算为精算师提供了一种新的数据存储模式，减少了运算时间，且简化了流程。

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.

云通过其大容量、连通性和高效处理的能力，改变了收集数据的方式。云几乎没有存储限制，因为它可以按需扩展，并随时提供额外的容量。云端还装有应用程序接口，以简化与多个第三方供应商和公共异构数据库的连接，从而更轻松地利利用外部数据丰富内部信息。云提供商不断对数据分析功能进行开发和迭代，使得保险公司可以将其用于数据处理。

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.

云能够高效地进行随机嵌套模型或确定加随机混合模型的计算，在缩短运算时间方面拥有巨大优势。有时，精算师需要简化模型以提高效率，尤其是对于嵌套随机模型或随机确定模型。使用云则可避免模型的过度简化，且保持合理的运行时间。

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.

云计算可以支持自动化报告的生成，而这通过将财务报表模型迁移至云端来实现。利用强大的行业内业务分析工具，用户可以将调整后的模型输出直接导入至可视化报告模板。任何授权用户都可以随时使用网页上的动态概要面板来替代现在基于微软 Office 的静态报告模板。

4.4 CONSIDERATIONS WHEN USING THE CLOUD (使用云计算的注意事项)

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.

保险公司有两个管理方面的考虑因素：数据管理和模型管理。保险公司在更新数据和模型管理框架时需要考虑云技术的应用。使用云提供商时，需要对其安全控制措施高度信任，并且需要考虑到可能意想不到的隐私问题。理想情况下，公司可成立一个专门的跨部门云端模型管理委员会。此外，云端和线下的模型管理标准都应一致并互补。

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.

在考虑采用的云计算部署模式时，精算师必须考虑使用云计算的确切用途和需求。关键因素包括预算、安全性和合规要求、硬件和虚拟服务器、故障转移控制、服务等级协议、云资源利用率和连贯性、云环境中使用的数据、内部 IT 资源和技术支持、有多少部门将利用云以及这些计算过程的相似性、以及利用私有云可以实现的自动化程度。

4.5 USE OF ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING BY ACTUARIES (人工智能和机器学习对精算师的用途)

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) 可定义为使机器从经验中学习并执行人类的行为，而机器学习是人工智能的一个分支，它允许机器、程序或算法从数据中学习并改进。当前，由于大数据、不断改进的算法以及更大的存储和计算能力，人工智能和机器学习正蓬勃发展。

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.

对于精算师而言，机器学习的最常见用途包括定价、理赔、业务管理、风险、承保、估值和疾病管理。这份研究报告阐述了四个案例研究，以深入体现精算师如何在日常工作中运用机器学习。机器学习算法可以有效地分析大量的高精度数据。人们相信，人工智能将在未来的决策过程中扮演越来越重要的角色。

4.6 COMMON MACHINE LEARNING ALGORITHMS AND TOOLS (机器学习常用算法及工具)

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.

机器学习领域包括两种学习方法：监督学习和无监督学习。监督学习的目标是找到一个最适合既定数据的模型，以便在给定新的输入值时输出预测值。无监督学习则是在没有标签的数据里发现潜在结构的一种训练方式。监督学习包括分类回归树 (CART) 和随机森林算法，通常用于定价分析、创建准备金算法以及评估具有复杂交互作用的风险。一种常见的无监督学习算法是 K-均值 (k-means) 算法，在销售中经常使用来识别风险，以进行理赔管理和流程优化。R 和 Python 是用于进行机器学习分析的常用编程语言。它们提供的多种软件包允许各式群体轻松实现机器学习。

4.7 CONSIDERATIONS FOR MODEL SELECTION & RESULTS INTERPRETATIONS (选择模型和分析结果的注意事项)

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.

当我们选择模型时，有许多算法可供考虑，而我们需要在复杂性和可解释性之间谨慎权衡。在实施新的机器学习算法时，至关重要的是要了解其背后的理论，以便了解工作原理，在什么情况下合适以及对于给定情况合适的参数范围。与此同时，需要仔细分析结果以了解模型背后隐藏的信息。

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.

总体而言，云技术可深刻影响精算师的多种实践领域，包括但不限于产品定价、评估准备金、风险管理、经验分析和精算假设。为了从云计算以及粒计算所提供的机会中受益，精算师将需要成为数据和技术专家或对这些专题足够熟悉，以有效地为雇主提供所需的解决方案和技能。

The full research report can be found here:

请点击以下网址查阅完整的研究报告:

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

Section 4: Acknowledgments

The SOA's deepest gratitude goes to those without whose efforts this project could not have come to fruition, especially Yun Gwen Weng, FSA, CERA, FCIA, who organized and oversaw all steps of the process.

These papers were translated from English by SOA members Yuan Yuan, FSA, MAAA and Tinny Tsun, FSA, FCIA, along with Yihong Lu, a translation consultant.

Yuan Yuan works in the Financial Services practice at Ernst & Young LLP where she is a manager in the Insurance and Actuarial Advisory Services team. She can be reached at yuan.yuan@ey.com.

Tinny Tsun is an actuary with almost 20 years of diverse work experience in Toronto, Beijing and Hong Kong. She can be reached at Tinny.tsun@gmail.com.

Yihong Lu is a translation consultant at LEAD Insurance Consulting. She can be reached at <https://leadinsuranceconsulting.com>.

At the Society of Actuaries:

Korrel Crawford, Senior Research Administrator

Mervyn Kopinsky, FSA, EA, MAAA, Experience Studies Actuary

Jingxin (Jessie) Li, FSA, Lead China Representative

About The Society of Actuaries

With roots dating back to 1889, the [Society of Actuaries](#) (SOA) is the world's largest actuarial professional organization with more than 31,000 members. Through research and education, the SOA's mission is to advance actuarial knowledge and to enhance the ability of actuaries to provide expert advice and relevant solutions for financial, business and societal challenges. The SOA's vision is for actuaries to be the leading professionals in the measurement and management of risk.

The SOA supports actuaries and advances knowledge through research and education. As part of its work, the SOA seeks to inform public policy development and public understanding through research. The SOA aspires to be a trusted source of objective, data-driven research and analysis with an actuarial perspective for its members, industry, policymakers and the public. This distinct perspective comes from the SOA as an association of actuaries, who have a rigorous formal education and direct experience as practitioners as they perform applied research. The SOA also welcomes the opportunity to partner with other organizations in our work where appropriate.

The SOA has a history of working with public policymakers and regulators in developing historical experience studies and projection techniques as well as individual reports on health care, retirement and other topics. The SOA's research is intended to aid the work of policymakers and regulators and follow certain core principles:

Objectivity: The SOA's research informs and provides analysis that can be relied upon by other individuals or organizations involved in public policy discussions. The SOA does not take advocacy positions or lobby specific policy proposals.

Quality: The SOA aspires to the highest ethical and quality standards in all of its research and analysis. Our research process is overseen by experienced actuaries and nonactuaries from a range of industry sectors and organizations. A rigorous peer-review process ensures the quality and integrity of our work.

Relevance: The SOA provides timely research on public policy issues. Our research advances actuarial knowledge while providing critical insights on key policy issues, and thereby provides value to stakeholders and decision makers.

Quantification: The SOA leverages the diverse skill sets of actuaries to provide research and findings that are driven by the best available data and methods. Actuaries use detailed modeling to analyze financial risk and provide distinct insight and quantification. Further, actuarial standards require transparency and the disclosure of the assumptions and analytic approach underlying the work.

Society of Actuaries
475 N. Martingale Road, Suite 600
Schaumburg, Illinois 60173
www.SOA.org