SOCIETY OF ACTUARIES

Innovation and Technology

Cloud Computing Report Summary

Simplified Chinese (云计算和机器学习在精算行业中的应用)

October 2020

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

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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链接，从而更轻松地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 over-simplification 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:

请点开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.

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.

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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.

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