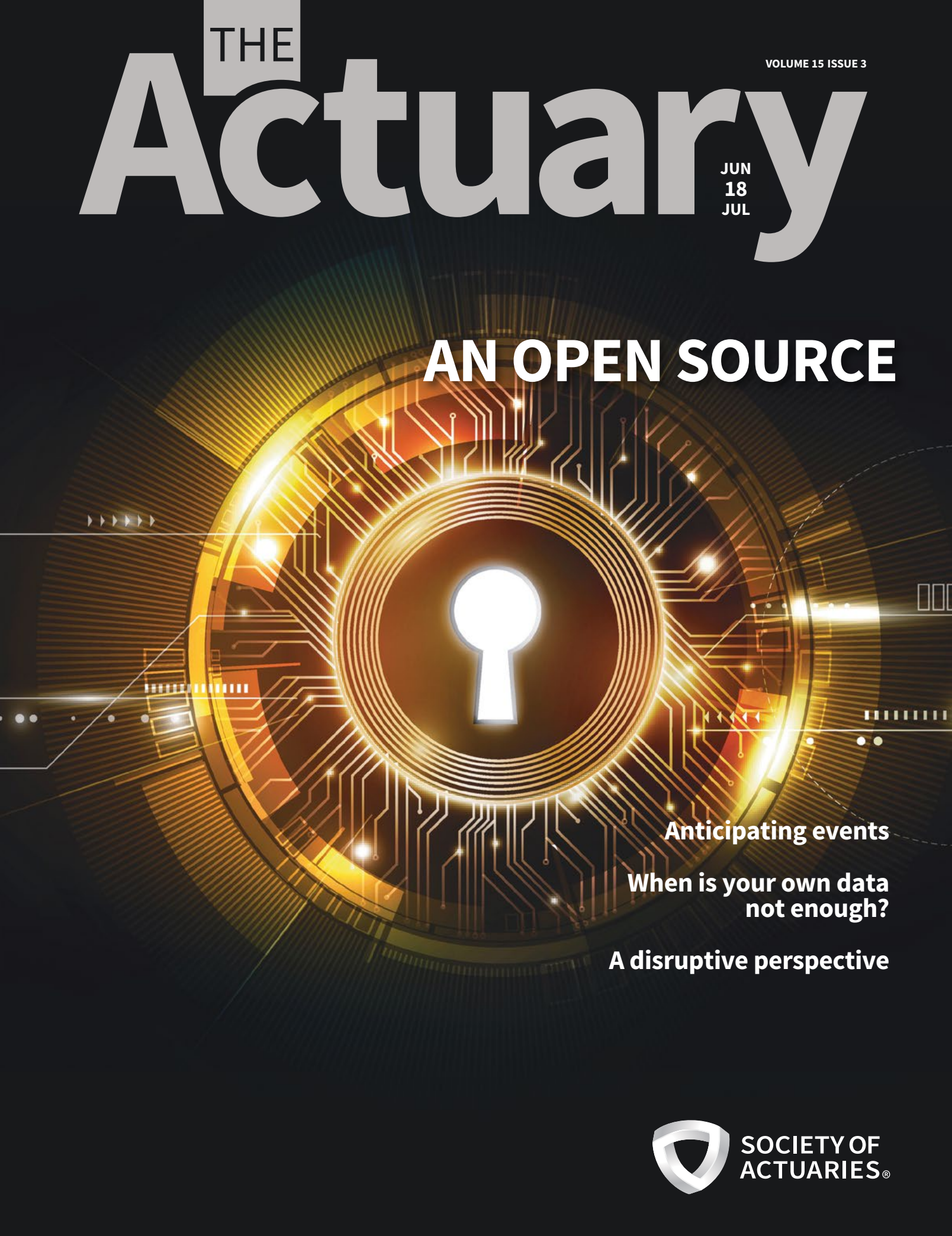
THE Actuary

VOLUME 15 ISSUE 3

JUN 18 JUL

AN OPEN SOURCE



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Maintaining Our Relevance

For our profession, relevance remains an overarching issue. We need to demonstrate our value to employers and clients, both now and in the future.

What does it mean to be relevant? The word "relevant" is defined as "having significance on the matter at hand." I often refer to it as not standing still. As business professionals, we need to keep up-to-date on current issues.

During the 2017 Society of Actuaries (SOA) Annual Meeting & Exhibit shortly after taking the office of SOA president, I addressed the membership on the importance of the profession staying relevant.

I keep these words in mind wherever I go and with everything I do as president. We carry our prestigious designations with us. Our actions and strategic advice speak volumes about the meaningful work we do. For our profession, relevance remains an overarching issue. We need to demonstrate our value to employers and clients, both now and in the future.

To help our members achieve this objective, the SOA looks to its 2017–2021 Strategic Plan to guide the decision-making process. We look at the world around us, and we consider how our members and our organization can make a difference to the public and to employers.

For example, globalization trends are a fact of life, both in business and in the profession. The SOA's International Committee is responding to this challenge by working with our local committees in China, Asia and Latin America to enhance the reputation of the profession and by providing support to members. At the same time, we continue to serve the profession in North America through quality education, research, meetings and collaboration with key stakeholders. Yes, we are a global organization, but we also act locally.

As part of the Strategic Plan, we also look to members to help identify new challenges and trends. The SOA recently created a form for you (and other stakeholders) to help us identify emerging issues. This Environmental Observation form allows you to highlight important trends (whether risks or opportunities) that may impact actuaries and the profession. We need your eyes and ears to help us identify what's on the horizon and to respond accordingly. Fill out this form whenever you see a trending topic, and—by the way—you can even earn volunteer recognition through your participation!

Today we are faced with new challenges—from emerging technologies, such as artificial intelligence and automation, to predictive analytics. We strengthen our relevance by

PHOTO: HYON SMITH

MIKE LOMBARDI, FSA, CERA, FCIA, MAAA, is president of the Society of Actuaries. He can be reached at ***mlombardi@soa.org***. Find him on LinkedIn at *bit.ly/MLombardiSOA*.

learning and applying new approaches. The SOA is committed to working with its members to determine how best to sharpen skills in these new areas and to harness new actuarial methods and tools.

In many of our major meetings, online resources and research projects, the SOA offers content on predictive modeling and analytics. It is up to you to take advantage of these new techniques. Sign up for professional development. Download the latest papers. Engage in a conversation in-person or online with peers on these topics. Most important, learn!

In terms of volunteering, you can help make a difference by participating in research, education, webcasts, meetings and professional interest sections. Consider signing up for volunteer opportunities—by giving back to the profession, you can improve your own skills and also help us move forward.

In conclusion, I encourage you to rise to the challenges ahead. We need to work together to embrace the changing world, with its many risks and opportunities, and let's help evolve new technologies and ideas. Let's remain open to new ideas. You strengthen our profession by maintaining your skills and learning. We learn and grow in our knowledge together. Let's give others reasons to continue seeing us as business leaders, valued problem-solvers and talented communicators of complex ideas.

Thank you. ■

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The Future of Insurance Is Predictive

BY DOROTHY L. ANDREWS

Using big data and machine learning algorithms can transform the governance, marketing, underwriting, issuance, analysis and management of insurance.

THE PHRASE "BIG BROTHER" REMINDS MANY OF US OF A POPULAR REALITY TELEVISION SHOW where members of a household are constantly being watched and recorded. I suspect we rarely remember this phrase in connection with a work of fiction titled *1984*, which was written by George Orwell in 1949. In the dystopian society depicted in the novel, citizens are observed and influenced through the government's (aka "Big Brother's") use of media and technology tools. Today, most people have an adverse reaction to the notion of being watched by the government, yet they readily consent to the sharing of personal information for the "right" to post details of their lives on social media networks for all to see.

Technology is mediating our lives, and we are becoming more disconnected from each other as we become increasingly connected to the world around us through our "Black Mirror"[1] devices. They connect us to our families, work and the world at large, causing our reality to mirror Orwell's fictional world. Heaven forbid these devices are misplaced, broken or stolen, disrupting what has become a basic need for both digital immigrants and digital natives alike.

Media psychology is an emerging discipline that studies the differences between how digital immigrants and digital natives respond to media and technology. It is becoming important for insurers to recognize and understand these differences as the nature of the engagement between insurers and consumers changes from one mediated by agents to one mediated by technology. We are living in the age of the mobile app

Continued on page 10

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Continued from page 8

through our black mirror devices, requiring less human contact in our daily transactions. Future sales of life insurance will be to the next generations who want their insurance on-demand, inexpensive, customized and deliverable through a mobile app.

Traditional life insurance policy issuance and underwriting reflects none of these attributes. Depending on age, gender, smoking status, policy size, state of health and pre-existing conditions, the insurer incurs significant costs to cover tests on bodily fluids, attending physician statements, medical testing and examinations, cognitive testing, and analysis of nonmedical data such as financial data, motor vehicle records and credit reporting data. The collection, examination and assessment of all this information take time and still may lead to an adverse decision for the applicant or insurance at prohibitive rates. The latest innovation in insurance technology, often referred to as InsurTech, is rapidly removing the obstacles that make acquiring insurance a lengthy and cost-prohibitive process for those with certain conditions and unresponsive to consumer demands for customization.

InsurTech firms employ external big data to data traditionally collected by insurers to develop risk profiles more reflective of individual lifestyles and behaviors. Statistically predictive algorithms are proving just as effective at classifying risks as traditional methods at a fraction of the cost and time. The result is more responsiveness to consumer demands for an increasingly accelerated, customized and budget-friendly experience.

Machine learning algorithms are part and parcel of actuarial analysis tools for increasing the understanding and management of insurance risks. Credit data has long been used in property and casualty insurance to understand the propensity that an insured is likely to have a claim. It is now being used in life insurance predictive modeling to understand lifestyle behaviors of insureds and assess the credibility of health information that is self-reported on insurance applications. Credit scores and other predictive variables aid in the determination of which medical tests are necessary to facilitate risk classification. Fewer medical tests results in immediate cost savings to the insurer, and those cost savings can be passed to the consumers demanding them.

This issue of *The Actuary* is a monograph on how using big data and machine learning algorithms can transform the governance, marketing, underwriting, issuance, analysis and management of insurance. Most of the new tools in the actuary's toolkit are open source and in need of a model governance framework (Alahakone and Andrews, page 14). Using the tools of market segmentation (Diede, page 20) is the first step toward better understanding the complex needs of consumers and the best deployment of analytics to gain the greatest competitive advantage (Vohra and Hutchinson, page 24). The acquisition, quality and strategic use of data (Paris, page 28) is the foundation for machine learning models. It drives the results and informs decision-making through the application of statistically reliable algorithms and actuarial judgment (Larson, Leemhuis and Niemerg, page 34; Granieri, Heck and Tafoya, page 42). Improving data generating processes using distributed ledger technology (DLT) is the next frontier insurers will need to settle (Carruthers, Bai and Shirra, page 48). DLT can improve the reliability of data used at every level of the insurance organization, especially data used in predictive machine learning algorithms.

The future of insurance is clearly predictive. There are many pathways actuaries can pursue to acquire data science skills. Actuaries are best positioned to become data scientists for the insurance industry, given the depth and breadth of their insurance subject-matter expertise. The combination of expertise, mathematical and statistical aptitude, and computer hacking skills is the ubiquitous definition of a data scientist. The SOA has developed a certificate program designed to help actuaries complete their transition to become one.

Please use this issue of *The Actuary* to guide your journey to become a data scientist and help steer your company to a prosperous future state of health in an ever-changing, technology-mediated world. ■

Reference

[1] Cellphones, tablets, virtual reality, augmented reality and computers; *Black Mirror* is a British science-fiction anthology television series that examines modern society, particularly with regard to the unanticipated consequences of new technologies. It can be viewed on Netflix.

ABOUT THE WRITER

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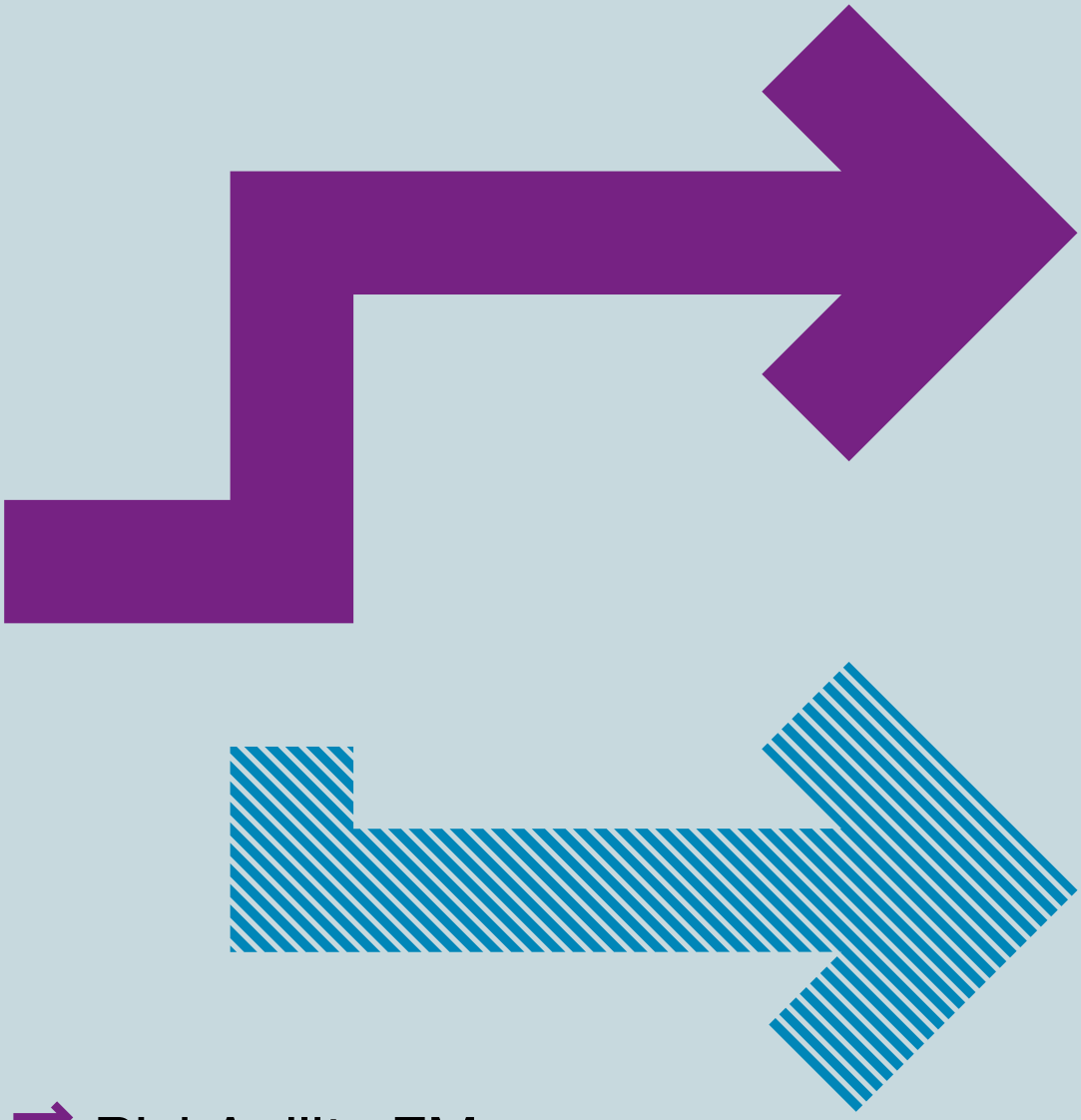

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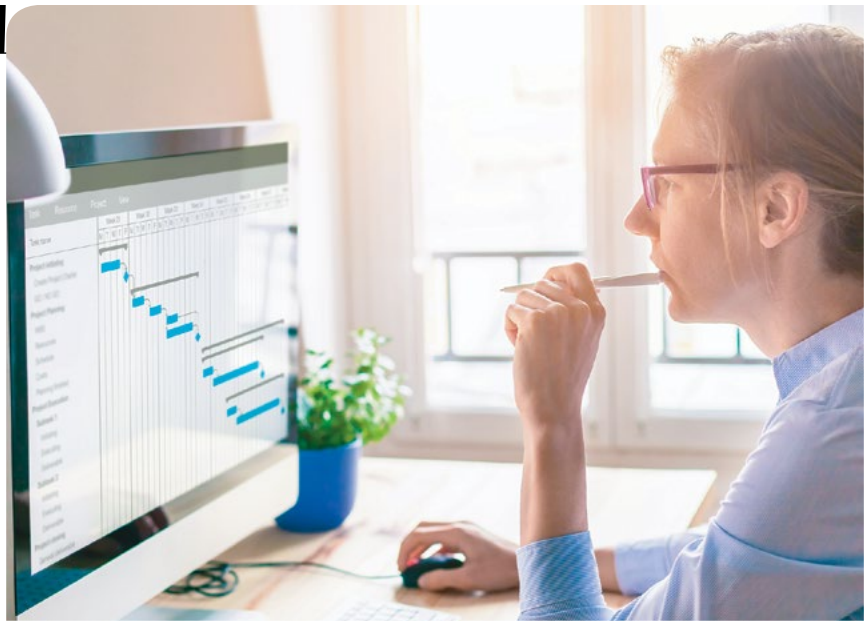
Modeling Section Update



The Society of Actuaries (SOA) Modeling Section offers members continuing education, research opportunities, networking and other support that relates to creating and using models. If you code, provide input, use, review or rely on actuarial models, the section may be helpful to you.

2018 represents the fifth year for the Modeling Section. When I volunteered as webcast coordinator for the section in 2015, I quickly learned we could raise more money for the section with a webcast if we partnered with a larger, more established section. If we partnered with a big section, we needed to share the pie, but the pie was triple (or larger) in size. A good sign for the Modeling Section today is that we have grown large enough that other sections are reaching out to us to partner with them on webcasts.

Being a member of the Modeling Section has a range of benefits and will bring you closer to all of the activities our volunteers perform.

The section leadership works to create continuing education content of interest to our members. The section (along with help from the SOA) recently completed a survey of members. The top five topics our members are interested in are:

- Model validation
- Assumption-setting and experience studies
- Emerging modeling techniques (including artificial intelligence and state-based modeling)
- Modeling software approaches
- Model efficiency

The section leadership will work toward creating materials for our members on these topics.

The section sponsors continuing education sessions at the Life & Annuity Symposium (LAS), Valuation Actuary Symposium and SOA Annual Meeting & Exhibit. The LAS this year was May 7–8 in Baltimore, and we sponsored sessions on centralized versus decentralized models and model efficiency.

Our members receive our semiannual newsletter, *The Modeling Platform*, and Modeling Section e-newsletters. The section also sponsors and publishes original research of interest to our members. Our members have the opportunity to influence and/or sponsor research topics related to modeling.

Additionally, we sponsor and co-sponsor educational webcasts. Our 2018 topics include model governance, model validation and economic scenario generators. Section members receive discounts on webcasts and may listen to and view recordings of past webcasts that are more than one year old for free.

Section members have networking opportunities and receive discounts on section networking events. They also receive members-only access to LinkedIn discussions.

If you are not already a member, please consider joining our section to enjoy these benefits.

> *If you code, provide input, use, review or rely on actuarial models, the Modeling Section may be helpful to you.*

ABOUT THE WRITER

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International Program in Actuarial Sciences in Bogotá

The Society of Actuaries (SOA) sponsored the first International Program in Actuarial Sciences in May in Bogotá, Colombia. The SOA Latin America Committee collaborated with the Casualty Actuarial Society (CAS) to organize the successful event.

The seminar was offered by Colombia's *Instituto Nacional de Seguros* (INS-Fasecolda). More than 80 participants from eight areas of Latin America attended, including business professionals from El Salvador, Paraguay, Panama, Honduras, Ecuador and Bolivia. The program was designed for actuaries, auditors, vice presidents and finance managers from the insurance, reinsurance and finance industries.

"We are very pleased to add specialized actuarial topics to our course offerings with renowned speakers from the SOA and CAS," noted INS Executive Director José Fernando Zarta.

SOA past president Ed Robbins, FSA, MAAA, attended the event. Other volunteers included SOA members Carlos Arocha, FSA; Luis Maldonado, FSA, MAAA; and Alan Ramirez, ASA, CERA.

bit.ly/INS-Programa-Internacional

SOA Past President Ed Robbins, FSA, MAAA, kicks off the seminar with a session on Mortality Tables.

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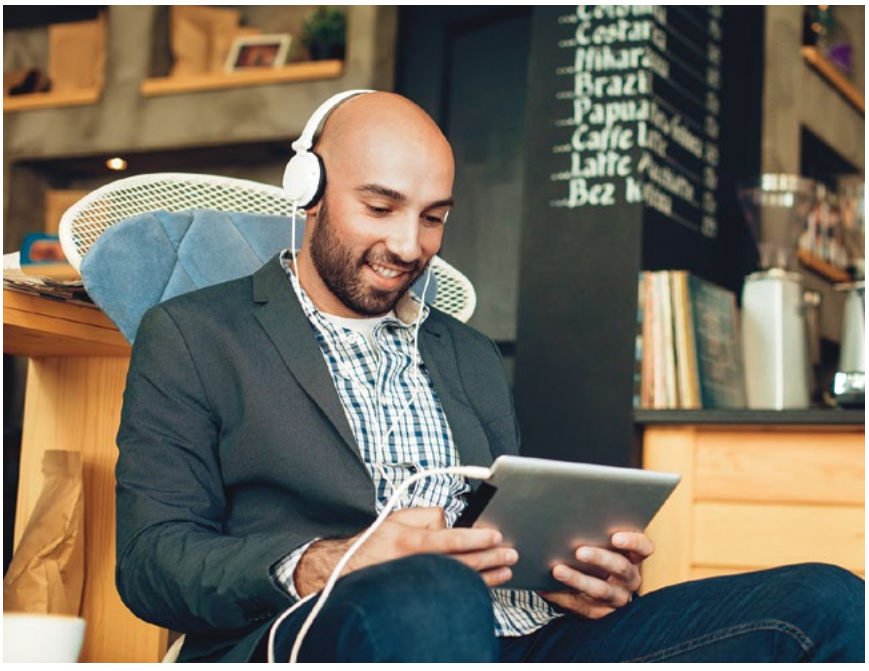

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See the *U.S. News & World Report* article on Medicare and retirement planning, referencing the SOA's retirement risks research.

bit.ly/Out-of-Pocket

AN OPEN SOURCE

Model governance in an open-source world

BY ROHAN N. ALAHAKONE AND DOROTHY L. ANDREWS

In the most recent exposure draft of the Modeling Actuarial Standard, a model is defined as "A representation of relationships among variables, entities or events using statistical, financial, economic, mathematical, or scientific concepts and equations."

Many companies struggle with the decision to adopt open-source versus closed-source systems for modeling. Models are used to price products, project future profits and determine how much capital to hold, providing important financials for financial reporting as well as management decision-making and predictive modeling. An error in a model or the modeling process can lead to huge losses, penalties, loss of reputation and even financial failure.

The banking industry has mature and regulated governance processes around its models. The insurance industry has a renewed impetus to advance a mature model governance framework due to recent awareness and new valuation regulations emphasizing model governance to reduce model risk. Model risk is an important consideration when choosing between open- or closed-source systems. A common belief in the industry is that closed-source systems pose less model risk than open-source systems, and coding flexibility is sacrificed. We believe this notion is flawed. The perceived model risk of open-source systems can be successfully minimized by imposing an appropriate governance framework over the modeling process to mitigate model risk without sacrificing the coding flexibility of an open-source system.

The purpose of this article is to provide the reader with the major pros and cons of open versus closed systems to inform on decision-making when choosing between the two systems under a complete model governance framework.

Key Pros and Cons

Figure 1 summarizes the major pros and cons of closed versus open systems. The two systems are distinguished by a few key features: vendor control of code, transparency, cost, flexibility and training. The more closed the system, the less transparent and the higher the cost to make code enhancements, the more planning required to ensure enhancements are ready when needed and the more oversight needed to ensure enhancements reflect specifications. The more open the system, the more transparency of its inner workings, flexibility to make changes and the lower the cost, but the higher the need for security to prevent unintended changes to the code, an often-cited concern. However, an effective model governance framework can mitigate risks of both types of systems. It is important to note open-source codes such as R and Python are now common actuarial tools that also require a model governance framework as much as valuation and profit projection software tools.

Figure 1 Pros and Cons of Open- and Closed-Source Systems

Closed-Source Systems	
Pros	**Cons**
» Built-in audit trails » Built-in version control » Source tested for computation efficiency » Code changes maintained and controlled by vendor » Code tested by vendor for accuracy and correctness	» High acquisition and renewal costs » Customizations and validation add-on costs » Limited access to source code » Vendor dependency for source changes and customizations require time that must be planned for » Limited transparency may delay detection of errors

Open-Source Systems	
Pros	**Cons**
» Flexibility to make changes » Quicker turnaround time making changes » Likely less expensive as vendor is not responsible for customization » Unhampered creativity and innovation » Unlimited transparency	» Lack of audit trails » In-house testing required » Inefficient source for computations » Staff need training in programming » Unauthorized programming changes » Need to standardize coding styles for conformity

Purpose of Model Governance

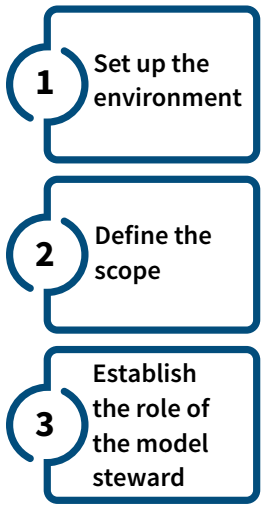
The purpose of model governance is to reduce model risk. This can be achieved by instituting strict processes and controls around model components such as source code, assumptions, data and results. Any changes to these model components must be subject to management approval. The production environment must limit access to model components to designated persons. It is important to note that both closed- and open-source systems require model governance to reduce model risk.

In a 1996 Goldman Sachs Quantitative Strategies Research Note, which is still highly relevant today, Goldman Sachs defined model risk as "the risk of loss by using a model to make financial decisions" and identified several forms of model risk.[1]

They identified seven types of model risk:

1. Inapplicable model
2. Incorrect model
3. Correct model, incorrect solution
4. Correct model, inappropriate use
5. Badly approximated model
6. Software and hardware bugs
7. Unstable data

Initial steps in setting up a model governance framework



OPEN SOURCE VERSUS CLOSED SOURCE

Source refers to computer software code. Open-source software is a type of computer software where its source code can be made available with a license. The copyright holder provides the rights to study, change and distribute the software to anyone and for any purpose. Open-source software may be developed in a collaborative public manner.

Closed source, on the other hand, is defined as software whose source code is not published. The source code is not shared with the public to view or change. It is also known as proprietary software.

The research note provides more details about each type of model risk. However, the meaning of each type of risk should be fairly intuitive. The paper also goes into considerable detail enumerating the signs a model may be incorrect. For example, the modeler may not have considered important factors in the design of the model, or the model may be correct only under ideal conditions, which rarely present themselves.

Design and Implementation of a Successful Model Governance Framework

The model governance framework is a structured set of protocols that govern the use of modeling tools and provide guidance for the use of those tools. The initial steps in setting up a framework are to set up the environment, define the scope and establish the role of the model steward. The next three sections provide some initial guidance to define these three areas.

Setting the Environment

The implementation and preservation of a governance framework requires unwavering corporate commitment and a virtuous risk management culture. A newly formed governance process needs a lot of care and commitment for its processes and rules to be established and followed. As with any new infrastructure, there will be those resistant to change and governance. Therefore, it is important to enlighten all affected parties about the purpose and importance of the new framework. It will also be beneficial to involve all potentially affected parties in the development of the new framework and its processes. People tend to support structures they helped develop and implement. A risk management culture needs to be woven into the larger operating DNA of the department and company at large.

Defining the Scope

The ultimate scope will include all models that functionally impact the company. However, at the onset of implementing

a governance process, it would be wise to select a few key models to subject to the new framework. The new framework will invariably require adjustments to address unique processing components and inefficiencies, and to avoid redundancies. Once the governance framework is sufficiently perfected it is ready for additional scope.

A majority of these functional processes include:

» Assumption-setting
» Data transfer
» Model enhancements
» Model validation
» Model corrections
» Archival of models
» Model results usage
» Management approval
» Software upgrades/conversions
» Peer review

Establishing the Function of the Model Steward

The primary responsibility of the model steward is to make sure the instituted model governance framework processes and controls are followed. The steward may not be appreciated at first by the model developers and users, and the model users and developers will have pain points as the rules are enforced. Some of the early pain points experienced may be:

» Protocol prevents making changes on-the-fly
» Perception that management no longer trusts capabilities of users and developers
» Increase in meetings, write-ups and analysis rather than making model code changes
» Too much time spent on documentation

As time goes by and governance processes are fine-tuned with the help of the model steward, developers and users will realize the framework is effective in reducing model risk. The role of the model steward is defined in the next section of this article.

The primary responsibility of the model steward is to make sure the instituted model governance framework processes and controls are followed.

Roles in a Model Governance Framework

There are different roles in a model governance framework focused on code changes. The model governance framework is a stage for a play, and the success of the play depends on the brilliance of the actors in the starring roles identified in this section.

Model Approvers

The model approvers are tasked with the responsibility of approving changes to model code and model assumptions. They are senior managers who own the assumption-setting and reporting processes. All changes to models must be warranted, peer reviewed, documented and analyzed before being presented for approval. It may be optimal to have more than one group of model approvers, depending on their expertise and the nature of the change. For example, it may be necessary to have a group approve changes to model code that is distinct from the group that approves model assumptions.

Model Developers

Model developers are authorized to change model code and assumptions. Their expertise is in the source code and product knowledge. All code changes are completed per coding standards. The impacts to model results are quantified, validated, analyzed, independently tested and peer reviewed, and documented. The model developers are a center of excellence in the company. They work on model changes at the request of sponsors and will often present their work to the model approvers for approval.

Model Users

Model users are those who use the model results for reporting and analysis purposes. They are responsible for valuation, pricing, generally accepted accounting principles (GAAP) reporting, embedded value reporting, forecasting and so on, as well as for the accuracy of the results produced by

the models. They work closely with the model developers. Model users submit the majority of the requests for changes to models and are often heavily involved in the peer review of the work products before they are installed to production.

Gatekeeper

The gatekeeper is the guardian of the production models. The gatekeeper works closely with the model steward to make sure that only approved model changes enter the production zone. A predominant aspect of this role is the archiving of older production versions before replacing them with the latest version from the staging zone, and making sure the new versions perform as specified. The gatekeeper ensures the correct model is installed to the production environment.

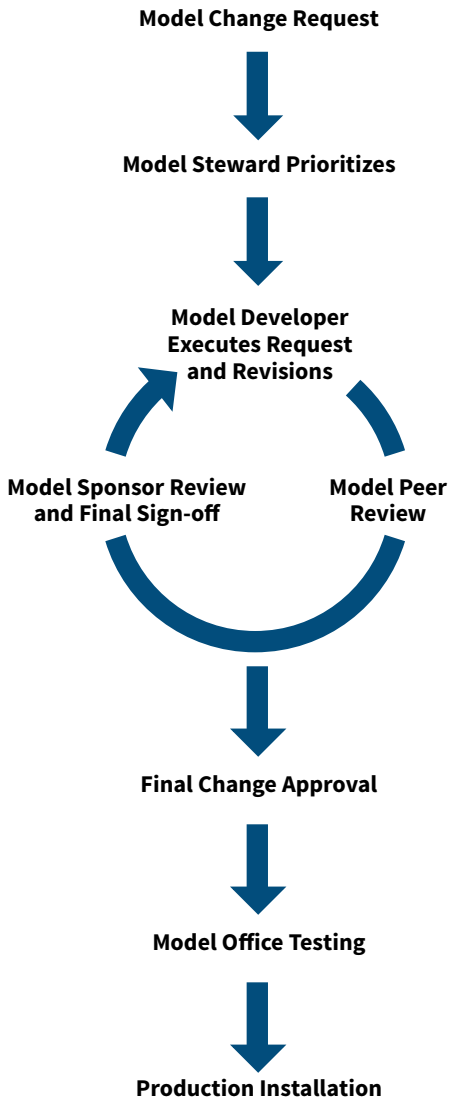
Model Steward

The model steward stars in the leading role, making sure everyone adheres to the model governance framework. The major responsibilities of the model steward include making sure the model change control process works smoothly by facilitating approver meetings, scheduling and maintaining a list of all model change requests, prioritizing model change requests and working with all parties to ensure an optimal solution is reached for each request. The model steward is expected to have a good appreciation and understanding of the open-source software. Project management skills are a must for this role.

Sponsors of Model Change

The sponsors of model changes are usually senior management responsible for financial reporting areas such as valuation, GAAP or pricing. They work with the model steward to schedule requested changes to models. The sponsors are tasked with making sure their requested model changes are implemented accurately as specified.

Figure 2 Model Change Process Flow Diagram



The Acts of the Play

Figure 2 depicts a model change control process for making changes to system code under a model governance framework. The process becomes iterative once a change request is submitted to allow for continual peer review until the modeled change is functionally correct per the change request specifications. The act descriptions provide additional high-level narratives for the execution of each step in the change control process. It is expected that organizations create and maintain detailed implementation catalogs for each act.

- **Act 1.** A model change in the form of an enhancement or an assumption change is identified and enters the model change control process.
- **Act 2.** The model change is assigned a developer and reviewer by the model steward.
- **Act 3.** The model developer works on the requested model change and, along with a sponsor, presents the model change for approval.
- **Act 4.** The approved changes are brought into production by the model steward and gatekeeper.

The Props

Props support the execution of each act and serve to document the process of moving a requested change through the process to completion.

Formal Processes, Rules and Standards

The implementation of each requested model change needs to follow the process illustrated in Figure 2. Once the rules are set in place, skipping a step in the sequence is not allowed. The amount of rigor built into each act is deliberate for defining and instituting minimum standards for the following areas:

- **Coding.** As per the coding standards in place.
- **Peer review.** Appropriate rigor based on the nature of the change.
- **Analysis.** Appropriate rigor based on the complexity of the change.
- **Validation.** Level of tolerance specific to metric.
- **Documentation.** Level of documentation based on its purpose.

Separation of Duties

Actors should only play one part in the process to prevent dilution of and conflicts with standards in implementing other roles. Allowing actors to reenter the process at different entry points defies the very purpose of a model governance framework—independent validation of work products. Therefore, roles and responsibilities need to be defined carefully and clearly. They need to be formally documented and followed at all times.

Information Technology

IT is a key component for the success of a model governance framework. All of the defined roles will need to interact with the IT department to make sure:

- Everyone has the correct access and restrictions to directories and networks.
- Renewal of software licenses and software updates work smoothly and on time.
- There are IT professionals dedicated to the framework and software.
- Disaster recovery and backup processes are set in place.
- IT process controls are in place to audit all work performed.

Final Act

The successful implementation of a model governance framework will have these benefits:

- Model developers will have the satisfaction of working on model changes in a controlled environment. They will learn to abide by the framework in place to perform their role effectively, creating excitement and satisfaction for all.
- The model steward will continually improve controls and processes with the advance of actuarial and regulatory practice. With roles clearly defined, all actors will play their parts more effectively and with a greater commitment to the model governance framework.
- The organization will benefit from a significant mitigation of model risk, resulting in an increased level of confidence in the models by senior management and pride of ownership among the modeling community. The mitigation of risk effected by such a framework will eliminate a number of the cons between open- and closed-source systems to permit an on-par evaluation of the capabilities of each, and, hence, the cost-benefits of each to an organization.

The design and implementation of governance frameworks will differ from organization to organization. Governance frameworks should be designed around existing frameworks, culture and personalities unique to the organization. If senior management has the desire and commitment to implement a successful model governance process, they should certainly seek guidance from experienced professionals. ■

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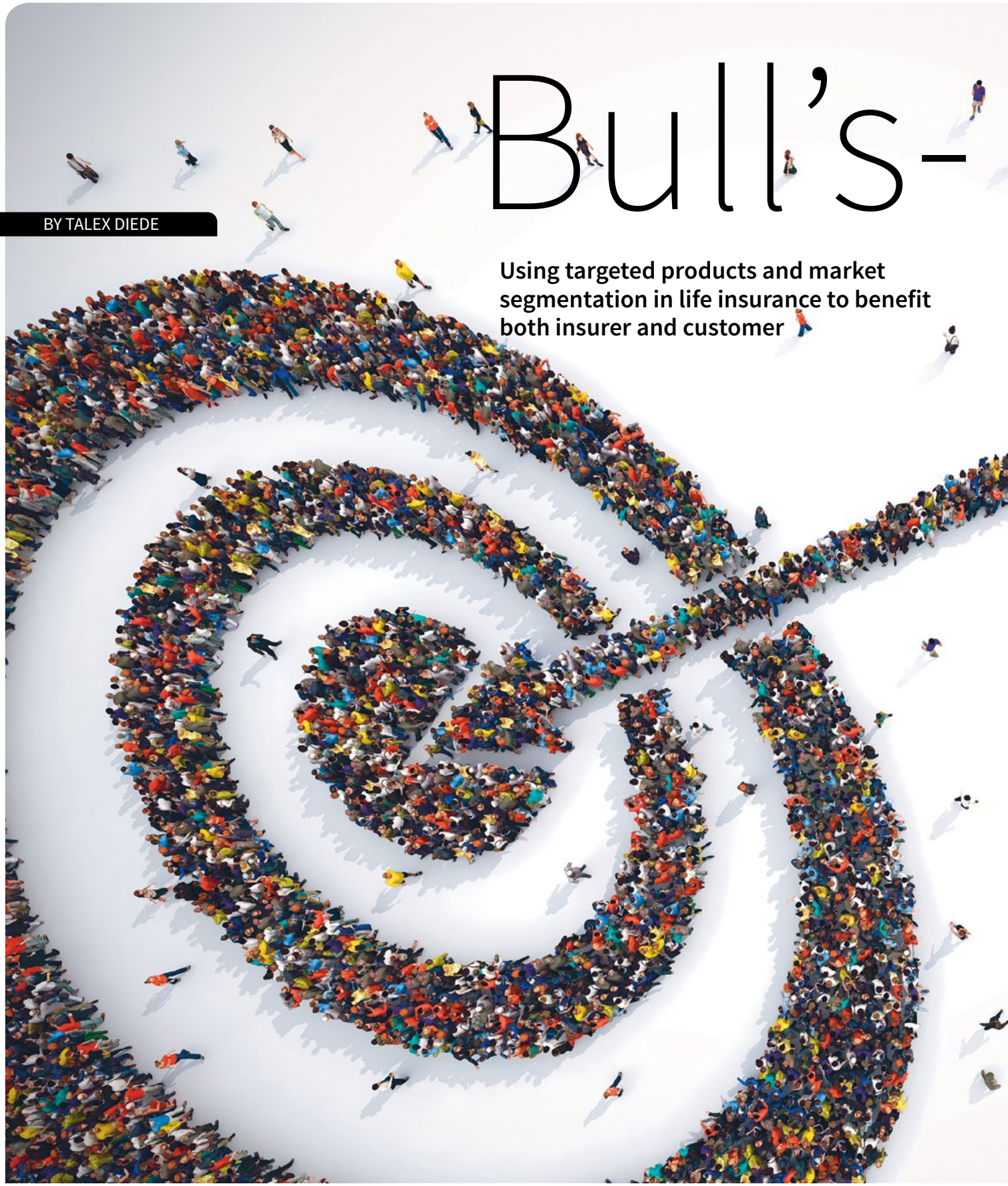
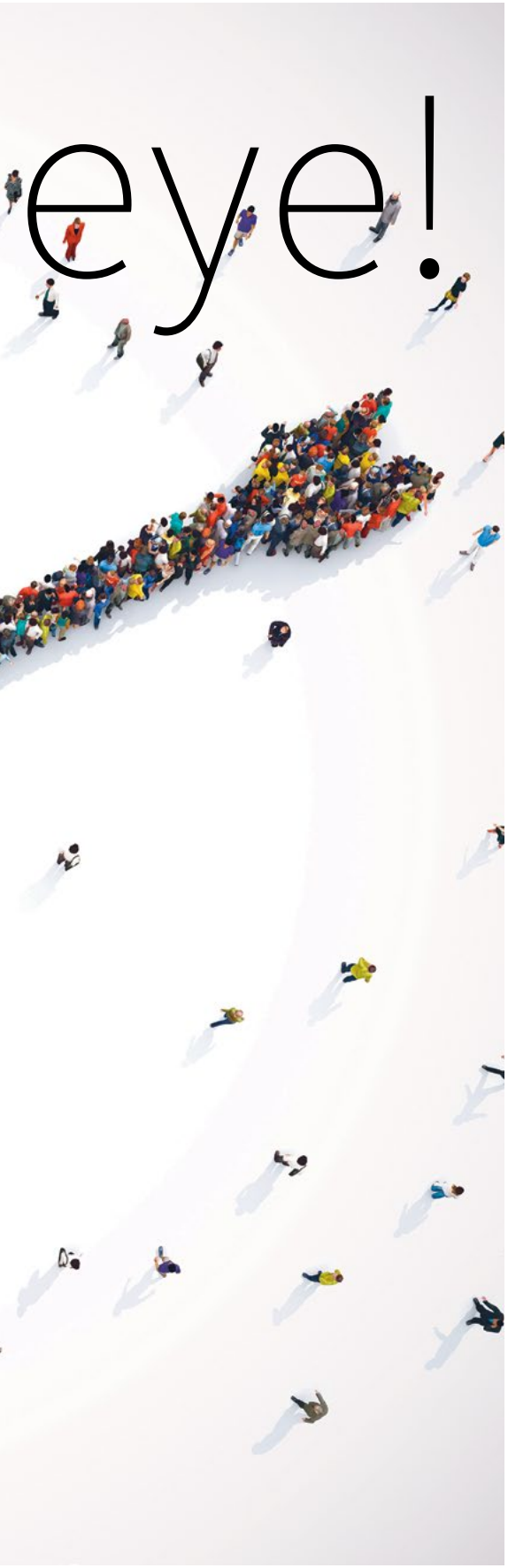
Bull's-

BY TALEX DIEDE

Using targeted products and market segmentation in life insurance to benefit both insurer and customer





Market segmentation is by no means a new topic, or even a particularly innovative one. Rather, segmentation has been considered a key marketing concept and focus of marketing research since the early 1960s.[1] It is readily apparent that markets are heterogeneous, making it nearly impossible to develop a single product that will have mass appeal across all consumers. Even if such a product is created, or a product is able to be widely marketed, it is likely that different consumers will have different motives or uses for the product in question.

This diversity of consumers has motivated marketers of products to strive to identify segments, or profiles, to help them either build a more tailored product or market an existing product to more targeted subsets of consumers. This targeted marketing and product development is starting to be applied in the life insurance industry, where, to date, there are relatively few products that all tend to be widely sold using the same marketing techniques. By adapting other industries' uses of segmentation, we can develop better targeted products and/or better identify the customer base for which a particular product will be most valuable.

Market segmentation has the potential to benefit both the insurer and the insured. Insurers can increase sales efficiency by targeting subsets of the population for marketing and distribution of particular products, and consumers can get products that are more tailored to fit their particular needs. By offering tailored products that satisfy the needs of the customer, insurers can look forward to increased customer satisfaction and retention. Better understanding the needs of the insurance consumer can be a win-win prospect, and segmentation can help get us there.

Segmentation at Work

Before delving into segmentation in the life insurance industry, we can take hints from uses of segmentation that have been pervasive across many industries. In the 1920s, General Motors overtook Ford in vehicle sales by producing "a car for every purse and purpose"—a famous example of a market segmentation strategy. More recently, the credit card industry has segmented customers based on their past credit behaviors to send targeted solicitation messages, products and benefits.

Moving closer to the insurance industry, there are examples of segmentation already at work. For example, auto insurance companies have evolved to serve niche markets—for example, USAA serves the military and their families, and Progressive serves high-risk drivers. By serving these specific markets, a company can increase sales efficiency and customer satisfaction as it markets to its selected segment,

and it can provide offerings specific to those customers' needs.

The life insurance industry has also already seen a version of segmentation. Clustering previously has been brought to the forefront of actuarial modeling, specifically being used for inforce compression. This idea is, at its core, the same as market segmentation. The clustering procedure takes a group—inforce policies in this case—and uses characteristics about the policies to create groups of like policies. A single record that characterizes the policies included represents each segment. This allows for projections to be run on a smaller number of records without loss of accuracy. The purpose of this clustering is to reduce run time for time-consuming projections, but we can take similar algorithmic approaches on the customer-facing side of the business.

Better understanding of customers' motives can help insurers design products that are more targeted and better suited to specific customer needs.

Bringing Segmentation to the Life Insurance Industry

As the life insurance industry accumulates more data on its policies and policyholders, we, too, can better understand and target our customers. The existing experience data collected by the insurance company is used regularly to set assumptions related to policyholder behavior. And, more and more, the life industry's growing mass of data is being used to set more precise assumptions for those policyholder behaviors by employing predictive modeling techniques.

Predictive modeling with policy-related characteristics is the first step in advancing assumption-setting to better differentiate policyholder behavior, but it is still relatively blind to the person behind the policy. This is where big data comes into play. Through the acquisition of additional data on policyholders available from third-party data vendors, we can move beyond predicting behaviors and begin to understand the motives behind them. Better understanding of the customer in this way can help insurers design products that are more targeted and better suited to specific customer needs. For example, customers with immediate liquidity needs are more likely to place value on the ability to get money out now than they are on a product feature that may provide them with more money down the road.

The first step in this process, as with any predictive analytics project, is to gather data. Insurers can start by gathering internal data such as policy values, policy experience, policyholder demographics and distribution data. The next step is to acquire as much additional data as possible to enrich the internal data, ideally information that will give a sense of a policyholder's overall financial situation. This may include occupational, consumer marketing, mortgage, credit data[2] and other types of information. Major types of segmentation variables include:

- Geographic (population density, climate)
- Demographic (age, family size, life stage, gender, income, education)
- Psychographic (lifestyle, personality)
- Behavioral (purchases, transactions, customer tenure)

This data can be used to create policyholder segments using any number of clustering algorithms.

The policyholder segments we create identify policyholders who are likely to behave in similar ways due to shared circumstances and motivations. To be useful, the segments must be:

- **Measurable.** The size, purchasing power and characteristics of the segments can be measured.
- **Substantial.** The segments are large and profitable enough to serve.
- **Accessible.** The segments can be effectively reached and served.
- **Differentiable.** The segments are conceptually distinguishable and behave differently.
- **Actionable.** The segments can be attracting/served effectively.[3]

For example, a segment with low credit scores and/or high loan-to-value ratios on their mortgages implies liquidity needs that are likely to influence the decisions they make regarding their policies. Predictive models can then be fit to each policyholder segment to predict the behaviors of interest. We expect to see differences among the models for each segment, which will give us insight into how each segment makes decisions.

With an enhanced understanding of how each segment makes decisions, we can understand a lot more about these customers and their needs, and thus form better assumptions about their future behavior. Taking this a step further, these predictive model assumptions can be used in cash flow projections to determine the profitability of each segment. The calculated profitability can be used to determine segments to which the product should be marketed in order to improve bottom-line profitability.

Beyond enhancing the profitability impact that can be made, the enhanced behavior understandings can be used to develop new products that can better target the needs of a given segment. For example, if the analysis identifies a segment of policyholders who are exhibiting what would be considered inefficient behavior, this information can be used to target them with a new or different product that would better fit their perceived needs.

Most life insurance companies historically have faced a key problem in the inability to distinguish policyholders who are likely to behave quite differently from one another. This has led to overall inefficiencies and challenges in the marketing and development of new products. Market segmentation has been used in many other industries already to help alleviate those inefficiencies. Segmentation can be used simultaneously to improve company profitability as well as provide better value to customers based on their unique needs.

We see segmentation as the next step for product development and marketing in life insurance, but it's worth noting that this is unlikely to be the ultimate state. As data and technology continue to evolve, we should continue to look forward, beyond where we are now, to where we are likely to move down the road.

The Future Beyond Segmentation

The ultimate level of segmentation leads to segments of one—individual customized products and offers. Products such as "Design your own Converse" sneakers currently incorporate "mass customization" of product features, but "segments of one" are seen more commonly today in marketing. In the era of big data, we have already started to see many companies make moves in data analytics that extend beyond market segmentation. They are no longer targeting markets solely based on groups of people, but rather they are targeting people as individuals. For example, Amazon uses individual customer purchase history to recommend products for future purchase. Looking at another recognized name in data analytics, Netflix performs similar analyses at the individual level to recommend movies or shows users may enjoy based on past viewing history and ratings.

Another, perhaps infamous, example comes from Target, which saw a backlash over coupons for baby and maternity items that were sent to a teenage girl. The girl's father was furious, but later returned to apologize after discovering that his high school daughter was indeed pregnant. Target had analyzed other customers' buying behaviors and was able to determine patterns of purchase behavior, at the individual level, that could identify customers who were likely pregnant. Target's algorithm matched the expected purchase pattern to the teenage girl in question, and she was sent the coupons that were aimed at a pregnant audience.[4]

The ability to move beyond segmentation and into individual marketing and recommendations is heavily dependent on data size. Companies such as Amazon, Netflix and Target have frequent customer transactions and a wealth of data already collected; the life insurance industry is slower to generate as much data internally, but it can supplement its own data with external sources to move down the same path.

Using market segmentation, the life insurance industry can take advantage of available internal data and external data sources to better serve customers' needs. As more data becomes available, both internally and externally, and as we as an industry continue to become even more sophisticated using that data, we will follow in the footsteps of other industries and move toward serving the segments of one. ■

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BY GAURAV VOHRA AND KEVIN HUTCHINSON

On Your Mark

Restoring the competitive advantage of analytics by integrating data foundation and data science

At leading insurers, data does not just support the business—it drives it. Leaders at these organizations recognize data is a strategic asset that can drive competitive advantage and aid in the quest for customers and top-flight talent. At the same time, data consumers—from internal users to external customers—are more comfortable than ever working with data, and they push the enterprise to deliver impactful data quickly and in an immediately actionable format.

Faced with evolved consumer expectations and an explosion of information, many insurers struggle with operating under this new paradigm. Hampered by aging infrastructure, outdated approaches and a reactive culture, it is a challenge for them to progress at the pace necessary for today's disruptive environment. Years of underinvestment in modern technology, methodologies and processes have weakened their data foundation to the point that the savviest consumers—like actuaries and data scientists—conduct mission-critical analysis in independent, nonintegrated silos.

To become more data-led, insurers should coordinate and integrate investments in both data foundation and data science programs to deliver more frequent data insights and fundamentally influence the strategy of the business.

The Challenges of Executing Traditional Reporting and Analytics Programs

Traditional reporting and analytics initiatives typically follow one of two paths: data foundation or data science. Data foundation programs, usually driven by information technology (IT), include investments in building or improving data structures, and delivering regulatory, compliance, operational or management reports. Data science programs, led by actuaries and data scientists, focus on using predictive and probabilistic approaches centered on a specific use case. Both paths advance the journey to becoming a data-driven insurer, but each suffers from distinct challenges that hamper the ability to maximize program investments.

Both data foundation and data science challenges have compounded to severely depress the business benefits of delivering traditional approaches to improving data.

Data foundation programs struggle to deliver value quickly because fragmented data architecture makes the program difficult to scale and move at a faster pace. This challenge manifests at the start of initiatives because data sourcing and standardizing is the most challenging exercise and there is a severe lack of understanding of the existing solutions that have evolved over decades, with the knowledge residing with a select few. This hampers the opportunities for IT and business users to form integrated, diversified teams that can deliver results quickly. Instead, the underlying data complexities force projects to follow a narrow scope and traditional delivery methodologies—business users create data sourcing requirements to pass off to IT to develop and implement.

The complexity of data foundations causes problems post-delivery because few users in the organization fully understand the data, which leads to conclusions drawn using incomplete or incorrect information. This reduces the trust users have in the data, which leads to the creation of siloed data stores not integrated into the foundation, exacerbating the complexity.

Another challenge with complex data foundations is that issues are frequently uncovered later in the delivery life cycle, which increases project durations and leads to long, multiyear roadmaps. Some of these programs try to deliver perfect data and, as a result, try and "boil the ocean," grouping many different challenges under one umbrella. These programs are difficult to administer and maintain, which can lead to diminished momentum and dwindling executive support.

Data science programs also struggle to execute effectively, and the central challenge facing these programs is operational sustainability. Difficulties procuring quality data for the foundation result in significant efforts to acquire and cleanse data. This

approach erodes project value as highly-skilled employees spend hours on repetitive, redundant activities rather than analysis. Once this cleanup is complete and the data is ready for analysis, it is frequently stored in a silo outside of the enterprise foundation, making it difficult or impossible to access by other users or integrate into existing business processes. Lastly, insights generated by these programs are rarely fed back to the data foundation or integrated into business processes, which limits their ability to drive incremental and sustainable business value.

According to a survey of more than 2,000 managers conducted by *MIT Sloan Management Review* and SAS Institute: "The percentage of companies that report obtaining a competitive advantage with analytics has declined significantly over the past two years. Increased market adoption of analytics levels the playing field and makes it more difficult for companies to keep their edge."[1]

Restoring Competitive Advantage Through Better Analytics Investments

To return to a more profitable model for investment, insurers need to combine data foundation and data science into a holistic set of capabilities. An integrated approach allows each pillar to concentrate on driving specific value while contributing to a comprehensive approach that delivers repeatable insights.

For the data foundation, the focus should be on developing a platform that enables self-service and exploration while delivering information that provides insights into business profitability. For example, many insurance companies have a combination of active and legacy source systems with convoluted data pathways and overlapping data repositories. In the past, the most common remedy was to invest in heavy data modeling projects to build complex data warehouses to deliver a set of predetermined reports. Driving this approach was an older generation of tools that could not handle the volume and processing power required for more advanced predictive analysis. But newer technologies—like big data platforms and cloud-based infrastructure—have drastically reduced the cost and time for data retrieval. Data foundation projects can now focus on making flatter, less normalized structures—like data lakes and operational data stores—that allow business users, rather than IT, to define how to consume the data. Alongside these architectural improvements, projects can enable advanced data management approaches, like automated data mastering and cleansing routines powered by artificial intelligence (AI), which can help drive quicker, more accurate insights and allow for a culture of self-service. This innovation in technology enables integration of data foundation and data science capabilities on an integrated platform.

Increasing the value of data science investments requires increasing the breadth, depth and diversity of internal and external sources available to actuaries and data scientists through modern data analysis tools allowing them to generate insights quickly. This helps support statistically driven approaches—like predictive modeling and scenario analysis—which can use uncleansed data to deliver insights. But to fully accelerate value capture of data science investments, obtained insights need to be integrated back into the data foundation through institutionalized and repeatable processes to which a high quality data foundation is critical. This process helps these insights take advantage of next-generation technologies like robotic process automation (RPA) and cognitive engagement that improve results over time.

Operationalizing Data Foundation and Data Science Initiatives

Integrated data foundation and data science initiatives should be executed within a common operating model for analytics. Shifting to more agile, integrated approaches will be radically different for some insurers, so care is needed to reduce the disruption to current processes and help put the right people in the right roles. It is critical that leadership from both business and IT champion the effort and implement the project from a joint perspective.

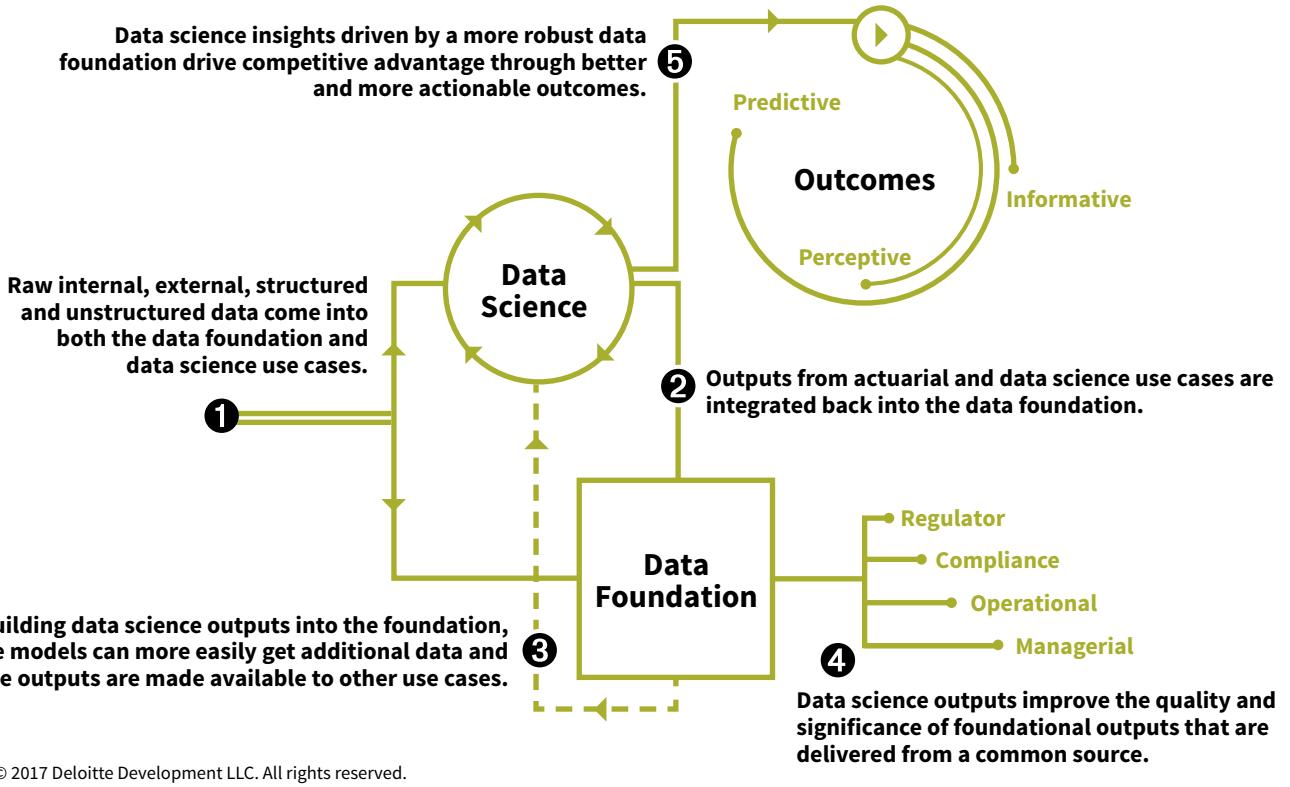
Instantiating an integrated operating model will help fund future improvement to data foundation and data science initiatives. With traditional approaches it is difficult to secure funding for needed data foundation work because of the large costs frequently involved and the difficulties of being able to tie back that investment to discrete business benefits. Data science programs operating in silos also struggle for support because demonstrating how anticipated insights can be shared across the enterprise is opaque and indirect. Integrating the outcomes from data science use cases back into the data foundation, a causal relationship is created and a self-referential loop of investments and benefits can power future initiatives. See Figure 1.

Getting There: Building the Wins for the Program

While it can be difficult to enact these changes, the imperatives for insurers are clear. To help build a future-focused analytics function, three key themes are critical:

1. **Define program integrations from the start.** Before executing any projects, clearly define the scope and understand how it will enable both the data foundation

Figure 1 Integrating Data Science and Foundation for Competitive Advantage



and data science together. Encourage program leads to continually work toward simplifying foundational complexity, and eliminate analysis executed in nonintegrated platforms. Consider using interactive, participant-driven workshops and labs to secure buy-in and help build messages that sustain momentum.

2. **Improve the pace of change.** Employ agile methodologies that deliver incremental value in short, defined periods that demonstrate progress and build excitement. This will better maintain momentum and give more periods for reflection on delivering business value.
3. **Track investment of required resources.** Secure and maintain leadership support for integrated data programs. Use a continually updated stakeholder matrix to capture the program champions and identify who needs to be engaged more directly. Lean on the program champions to identify and make available their top resources to support programs with dedicated hours and budget.

As other industries have demonstrated, there is an early mover advantage awaiting insurers that find ways to increase their data savviness. According to Gartner's "Hype Cycle for Digital Insurance,"[2] fewer than 5 percent of insurers are well positioned to leverage full benefits from data science. Working now to integrate a robust data foundation and impactful data science programs into a common operating model for analytics can provide a powerful competitive advantage. User demand for data shows no signs of slowing, so starting the journey now can help put insurers on a path to future success. ■

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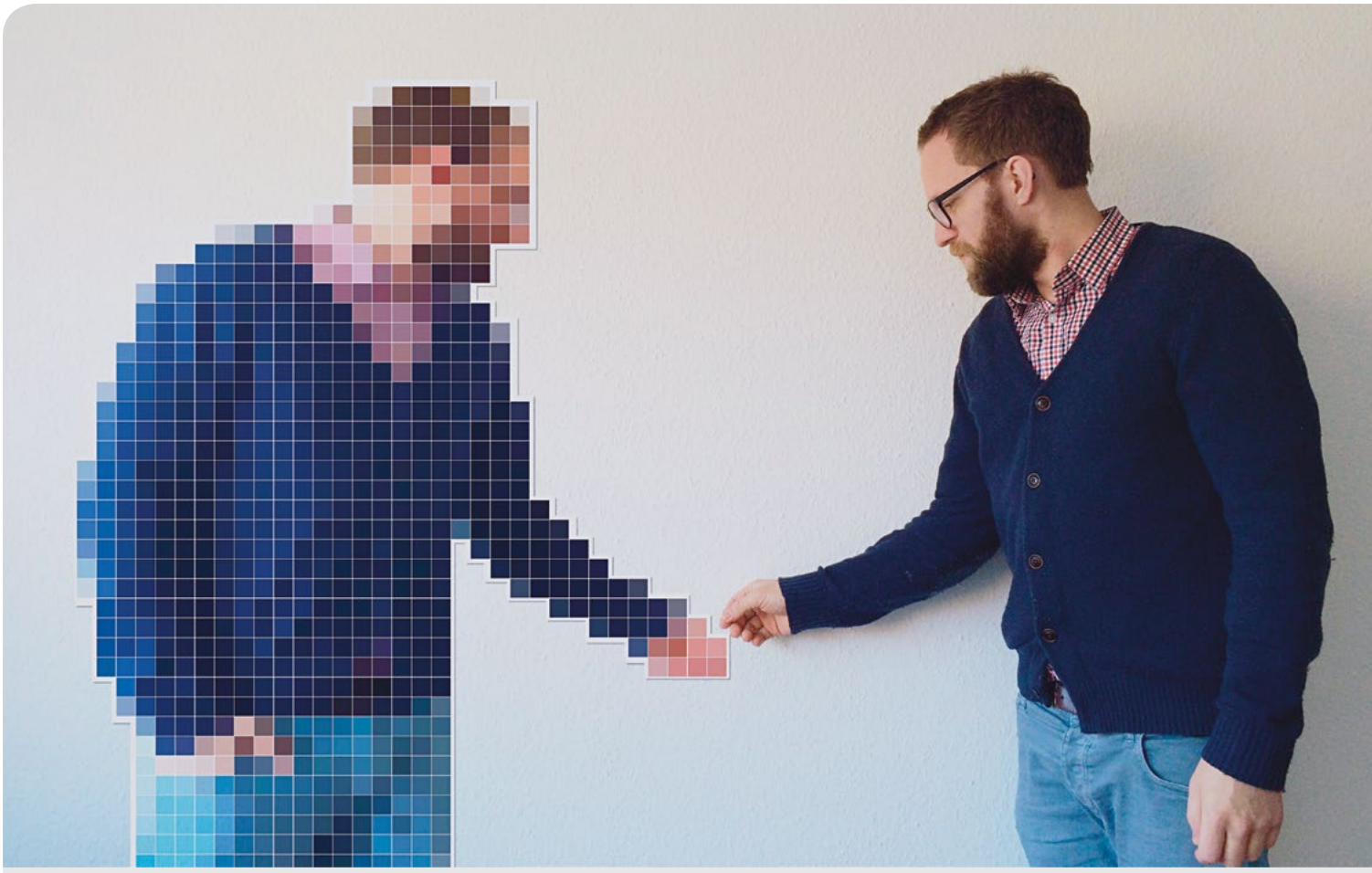


When Is Your Own Data Not Enough?

How using external data can strengthen results

BY TIMOTHY PARIS

> ***It is a capital mistake to theorize before one has data.***
>
> —Sir Arthur Conan Doyle

My career started with a data blind spot. I originally did not want to be an actuary, and I did not know that analyzing data could be a career choice. Fortunately, and in spite of myself, after finishing my undergraduate degree in mathematics, I got my first job as an actuarial student at a startup insurance company. I was its only actuarial student, supporting its one actuary.

The price of light is less than the cost of darkness.

—Arthur C. Nielsen

As often happens in startups, this gave me the opportunity to build my skills from scratch and then do virtually every actuarial function in the company within a short period of time. In these early years, while I learned a great deal about the insurance industry and what it meant to be an actuary, what I came to realize is how much actuarial work required me to quickly gather, scrub and analyze various data, and communicate results that would inform important business decisions.

Think in shades, rather than black and white. Failure to acknowledge relevant data does not make it go away.

I also came to realize that I was mainly working only with my company's own data, simply because there was essentially no external or industry-level data for a company like mine blazing a new market. This theme seemed to follow me, or vice versa, as I persisted in my actuarial career in the individual retirement savings and income market, which has grown to become a multi-trillion-dollar market.[1] With such growth comes a trove of experience data, and perhaps some wisdom. Combined with the incredible power of modern analytical tools, this leads hopefully to fewer data blind spots.

So that is the quick run-down of how I got here, writing this article, with way more experience data than I ever imagined, personally and professionally. My aim is to share some important things that I have learned along the way about how to analyze and use data in actuarial work and how more data tends to dramatically improve results. I will then illustrate some of this learning using industry experience data from the variable annuity market. Throughout, my focus will be on guiding principles rather than numerical precision or technical wizardry.

Common Scenarios When Data May Not Be Enough

Actuaries have had centuries of training in data analysis, much under the heading of "credibility theory," the details of which are beyond our scope here. If you are reading this, you probably know them anyway, so hopefully we can agree that the basic purpose is to balance the use of company- or product-specific data with broader data from other companies or the industry at large. Even so, there are situations where this can be difficult:

- **Innovation.** Like me early in my career, we sometimes find ourselves in situations where there is ostensibly no data yet. For example, new product types or expansion to new jurisdictions. What to do? Be as conservative as possible, then cross your fingers? Rely on expert judgment? These and other methods may be useful, but it is often beneficial to look beyond the narrowly defined problem to other similar markets or products where there is extensive data, then analyze that rigorously to help inform the expert judgment and other methods that will inevitably be needed. Think in shades, rather than black and white. Failure to acknowledge relevant data does not make it go away.
- **New world.** Systemic shocks or large secular changes—such as precipitous stock market drops, negative interest rates, regulatory changes, genetic testing or the internet of things—can make it very tempting for actuaries to zealously exercise their expert judgment, dismiss prior data as irrelevant and start anew. This can be a big mistake. While the exact numbers or formulations may change, deeper underlying relationships in the data typically persist and offer wisdom. There are reasons why we still study the Dutch tulip mania of the 1600s, the stock market crash of 1929 and mortality data that predates 21st century health care.

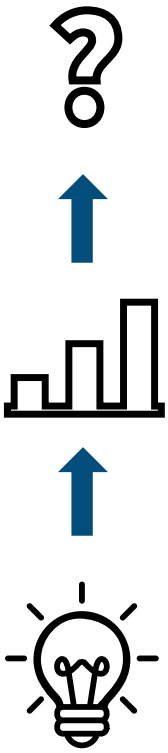
» **Limitations with your own data.** This is the gravity well and focus of traditional credibility theory—the data for your company or product may not be large, seasoned or varied enough to reliably tell the whole story, even when you think you know the main plot elements. For example, if your fixed indexed annuity block with lifetime income guarantees has not yet reached the end of the surrender charge period, then you would probably be unwise to ignore corresponding experience from the larger and more seasoned variable annuity market with similar features. Relevant data is out there. Invest in the quality of your actuarial work and in your company's risk management—get the data and use it intelligently, which will be much more than rules of thumb from traditional credibility theory based on simplified assumptions.

In summary, gathering and analyzing data are extremely important no matter the circumstance. At times, more or less professional judgment may be required, and external data can be helpful to stakeholders in corroborating your judgment. There may be a range of reasonable answers, but judgment without data is not one of them.

Ask the Difficult Questions

In the course of analyzing experience data for individual companies and across industries for many years, I have compiled this list of questions that actuaries would be well-served to ask in any data analytics work:

» **Data breadth.** Have you gathered all data that could reasonably be expected to be relevant? Is it precisely relevant for the matter at hand, or is some judgment required? How granular is the data? How far back should it go? Are there outliers that should be noted or discounted?
» **Data quality.** Is the data scrubbed and fit for purpose? Have you reconciled it to control totals?



» **Range.** Are you plodding forward one-dimensionally, "unlocking" from one version of assumptions to the next, or do you have a sense of the range of outcomes and actual-to-expected ratios relative to your assumptions? Can you separate random fluctuations from changes in underlying trends?
» **Confirmation bias.** "No material change" is often the path of least resistance, especially when analyzing aggregate data across many years. Look closely at the time series and its composition, and analyze the data with a variety of people and techniques, in order to avoid missing important changes.

» **Whither the future.** To what extent might future events trigger a departure from historical data trends? How likely are they, and to what extent can you quantify them when you develop assumption models for the future?
» **Capacity.** Do you have the human and technological capacity to do the necessary analysis? Are your constraints related to people, talent, data or computational power?
» **Time.** Even with all of the above, do you have the time and prioritization to deliver meaningful and actionable analysis quickly enough to be useful?

Of course, I cannot answer these questions for you. But I have found these to be critical to the performance of the high-quality data analysis, calibration and assumption-setting required for great actuarial work.

Human capacity is needed for data analytics work.

Analysis needs to be delivered relatively quickly to be useful.

Actuaries Are Poised to Answer the Difficult Questions

As we are frequently reminded, the amount of data, its availability and our power to analyze it are in increasing abundance. And actuaries are not alone in the business of analyzing data, whether related to our traditional insurance domains or otherwise. But we do have many advantages that others simply do not have, and these advantages help us to answer difficult data questions where others falter.

> *Invite your data science team to ask questions and assume any system, rule or way of doing things is open to further consideration.*
>
> —Damian Mingle

» **Science + Art + Code.** At its best, complex data analysis tends to require much more than just data, statistics and computer code. Subject-matter expertise is vital, as it guides us in asking the right sorts of questions, rejecting the wrong sorts of answers and applying the artistic *je ne sais quoi*. Combine that with another code, our *Code of Professional Conduct*,[2] and we have a very powerful value proposition.
» **Professional standards of practice and other guidance.** We have been doing data analytics for a very long time, and through this, professional standards have emerged. To name a few, we have the Credibility ASOP, Data Quality ASOP, Setting Assumptions ASOP exposure draft, PBR implementation guidance and a whole section of our professional society devoted to Predictive Analytics and Futurism.[3] Actuaries are not lone rangers or a loose confederacy. We are well-trained professionals united by shared and publicly documented high standards.
» **Putting the answers to work.** Actuarial science is an applied science. Great data, great analytical techniques and great answers mean very little if they are not implemented in a practical manner. Our profession has a long and well-documented track record of success in doing this with (pun intended) high credibility.

Altogether, while data analytics as a field unto itself has only emerged fairly recently, and we as actuaries are certainly increasing our focus on it, it has always been one of our essential elements. Within our traditional insurance domains and well beyond, we are uniquely positioned to continue to lead and excel in providing essential and practical data analytics services to our companies and clients.

Illustration: Variable Annuity Policyholder Behavior

Variable annuity policyholder behavior provides an excellent illustration of the

If the statistics are boring, you've got the wrong numbers.

—Edward Tufte

principles presented due to its critical importance to the financial risk of the products, the array of factors that are influential and their changes through time and market circumstances, and the increasing sophistication of analytical processes that actuaries have brought to bear to analyze this data. A robust exposition is beyond scope here, so I will focus on a few key aspects.

Arguably the most important variable annuity innovation of the last 20 years is the guaranteed lifetime withdrawal benefit (GLWB), which has been one of the key drivers of hundreds of billions of dollars in sales.[4] This feature provides the policyholder with a lifetime income benefit in the event that the account value of the variable annuity is reduced to zero, subject to certain conditions. The ultimate cost for companies to provide this benefit depends on many factors, including the amount of the benefit, the performance of the investment funds within the variable annuity, and policyholder behavior including lapse and income utilization before the account value is reduced to zero. With respect to policyholder behavior, each company should ask itself the basic question—is my own data enough?

Generalized linear models (GLMs) such as *logistic regression models* have become important tools for actuaries trying to answer this question. (See "Model Background" sidebar for more details.)

An actuary working at a company with a representative block of variable annuities with GLWB uses R software to fit a logistic regression model to its own policyholder income utilization data. The resultant model indicates that the following factors are highly predictive of income utilization behavior:

- Attained age
- Tax status
- Policy size
- Prior income utilization
- Interaction terms that capture nonlinearities in the above relationships

For each of these factors, the model output includes a corresponding coefficient estimate and standard error term. Unfortunately, the intrinsic limitations due to the size and composition of this company's block mean that the standard error terms for some of these coefficients are relatively large (about 10 percent), meaning this model does not provide a high degree of fit to the historical data. This is naturally disconcerting to the actuary.

The actuary also uses a fivefold cross-validation to test the predictive power of the model against data held out from the model calibration. The resultant actual-to-expected error ratios for the five "folds" average 1.5 percent. This seems vaguely encouraging to the actuary, but she does not feel like it is enough, for her or her company's stakeholders. She would be much more comfortable putting forth a model with better fit to the historical data and higher predictive power. But how?

The answer is by using the exact same methodology, but applying it to a block of data 40 times larger that corresponds to similar products across the industry. Obviously, this requires access to the industry-level data, but it also requires subject-matter expertise and professional judgment in selecting the similar products

MODEL BACKGROUND

As the name implies, a generalized linear model (GLM) is a more flexible generalization of the traditional regression models that have been used for centuries to fit linear models to data. They effectively allow for response variables that have non-normal error distributions.

A logistic regression model is used for binary response variables (e.g., surrender the policy or not, live or die). By way of a linear "log of odds" function, it allows for easy calculation of the estimated probabilities for the values of the response variable.[1]

Reference

[1] Frees, Edward W., Richard A. Derrig, and Glenn Meyers, eds. 2016. *Predictive Modeling Applications in Actuarial Science*. New York: Cambridge University Press.

***n*-fold cross-validation** is a sampling technique where the data is randomly partitioned into *n* equal "folds." In turn, *n* times (*n–1*) of the folds are used to calibrate a candidate model that is tested against the *1* fold held out.[5]

and appropriate time period. Using this larger industry data set, the resultant standard error terms are about 20 times smaller (about 0.5 percent), indicating a much better fit to the historical data. And the predictive power metric—the average actual-to-expected error ratios—has improved by a factor of five, to 0.3 percent.

With the dramatically improved model fit and predictive power metrics, along with the sensibility of the model factors themselves based on her subject-matter expertise, the actuary is now quantitatively and qualitatively comfortable. She will put forth this model, or perhaps a customized blend of the company- and industry-based models, for her company's use in product pricing, hedging and risk management, and reserves and capital, and she will plan to review and update it periodically as more company- and industry-level data emerges. *This* is enough.

Looking Forward

So for me, and all of us, we now have a lot more data than when I started. And this gives us a much more solid foundation, for annuities and any other products, to use our unique combination of analytical skills, *Code of Professional Conduct* and standards, and practical mindset to deliver excellent work so that our companies and clients continue to grow and thrive. I believe that this is necessary and sufficient—exactly enough—as our legacy for the next generation of actuaries. ■

> *Listening to the data is important … but so is experience and intuition. After all, what is intuition at its best but large amounts of data of all kinds filtered through a human brain rather than a math model?*
>
> —Steve Lohr

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SOA.org/about/governance/about-code-of-professional-conduct

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[5] James, Gareth, Daniela Witten, Trevor Hastie, and Robert Tibshirani. 2013. *An Introduction to Statistical Learning: With Applications in R*. New York: Springer.

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Anticipating Events

Using member-level predictive models to calculate IBNR reserves

BY ANDERS LARSON, JACK LEEMHUIS AND MICHAEL NIEMERG

Predictive models have the potential to transform many aspects of traditional actuarial practice and change the way actuaries manage and think about risk. One common actuarial task where modern predictive models are not commonly used is the calculation of incurred but not reported (IBNR) reserves. Rather, IBNR has historically been calculated for pools of members using aggregate methods that utilize high-level assumptions without any sophisticated consideration of the risk factors of the individual members within the pool. However, by incorporating these risk factors into a predictive model, there is the potential to develop an informative alternative to the traditional actuarial approach. In this article, we'll consider how a predictive model might be built to estimate IBNR at the member level. To demonstrate its efficacy, we'll consider a case study from the group health care market.

IBNR Defined

Let's first define what IBNR is. Essentially, IBNR is an estimate of the amount of claim dollars outstanding for events that have *already* happened but have not yet been reported to the risk-bearing entity.[1] For instance, if you break your arm and go to the emergency room, you will generate a claim on that date. Until you (or your provider) report that claim, your insurance company does not know about it. However, your insurance company is still liable for the claim. In fact, the risk-bearing entity is responsible for all incurred and unreported claims like this across its pool, and so it must set funds aside in its financial statements for the estimated amount of these payments. The challenge here is obvious: Because the insurance company doesn't even know that you've gone to the hospital, the IBNR reserves held on its financial statement will always need to be estimated.

Traditional actuarial methods for IBNR estimation have many flavors, but they have largely revolved around aggregate estimations for entire pools of members. One traditional actuarial method, which we'll refer to as the completion factor method, looks at the claims already received and estimates what percentage of incurred claims are believed to already be reported. This value is our completion factor. With an estimate of the total incurred claim cost, then the calculation of IBNR is as straightforward as subtracting the claims already reported from the total incurred claim costs, as shown in Figure 1 on page 36. All the science and art of this method of IBNR estimation revolve around deriving good estimates for how complete the claims are for a given month.

Figure 1 Application of Completion Factor Method to Estimate IBNR

	A	B	C = A / B	D = C–A
Incurred Month	Claims Reported to Date	Assumed Completion Factor	Estimated Final Incurred Claims	IBNR
December 2017	$1,000,000	40.0%	$2,500,000	$1,500,000
November 2017	$1,200,000	60.0%	$2,000,000	$800,000
October 2017	$900,000	90.0%	$1,000,000	$100,000
September 2017	$1,000,000	100.0%	$1,000,000	$0

An alternative actuarial approach, which we'll refer to as the projection method, is to estimate the average incurred claim cost per member with no consideration of the amount of claims already reported. This is typically done by using the average incurred claim costs per member from a time period that is assumed to be 100 percent complete (or close to complete).[2] With an estimate of the total incurred claim cost per member in hand, we merely need to take the difference between this value and the average amount of the claims already reported per member to get the IBNR expressed on a per-member basis. Multiplying this value by the total number of members in the pool gives us our final IBNR estimate.

The projection method is a common approach for very recent months, and it relies on the assumption that the claims that have been reported to date in those recent months are not a good predictor of total incurred claims. The completion factor method is more common in months where the claim payments are assumed to be more mature.

Why Use Predictive Models at the Member Level?

Traditional methods like the previous example are technically predictive models, but they treat all individual risks the same. The benefit of such an approach is its simplicity and tractability. However, the underlying assumption that every person in the pool has the same historical payment pattern and propensity to have incurred and unreported claims seems unlikely.

An alternative to these traditional methods is to use predictive models at the member level. One of the strengths of predictive models is their ability to take high-dimensional data sets within which to segment and attribute risk more accurately, while appropriately handling any complex relationships between our prediction and the variables the model uses to make that prediction. Instead of relying upon aggregate completion patterns, predictive models can estimate IBNR for each member directly. These member-level IBNR predictions can then be summed together into an aggregate reserve amount for an entire employer group or pool of business.

Why use predictive analytics in this fashion? The biggest potential gain is in the accuracy of the estimate. IBNR can fluctuate wildly, particularly for small groups or payers with unstable payment patterns, and any additional pickup in predictive power can be helpful in estimation. An additional drawback of traditional methods is that it can often be difficult to develop IBNR estimates for different subpopulations. For instance, suppose you work at a small insurance company and you are interested in reviewing the incurred claims by month, including IBNR, for individually insured members ages 55 to 64 in a particular geographic region. Using a traditional approach, there would be two options:

1. **Develop an IBNR estimate based on payment patterns observed specifically for this cohort.** This involves additional effort, and the credibility of the estimates could be a concern if the population is small.
2. **Apply completion factors developed from a larger pool of members.** This approach is simpler, but it can also be problematic if the underlying payment pattern for this cohort is different from the larger pool.

Predictive analytics methods applied at the member level can solve this challenge by leveraging the credibility of the entire pool of members while accurately reflecting the risk characteristics embedded within any slice of the data. By producing estimates for each individual member, the estimates can be aggregated to any desired level.

The added sophistication of member-level predictive models is not free. Generally, estimating IBNR using aggregate methods can be done in a spreadsheet application after doing some data preprocessing in a language of your choice. The minimum data requirements for the completion factor method are simply a summary of claims paid for each combination of incurred month and reported month in the historical period (known as a lag triangle). Building predictive models at the member level is more demanding. First, you need to capture all the data elements required for your predictive model that perhaps you weren't capturing at

the individual level before (demographics, geography, risk scores, etc.). Second, you need to manipulate this larger data set into a format that can be fed into modeling software. Once the data is ready, you need to actually be scoring all these members on a platform capable of making predictions using a predictive model before finally aggregating and interpreting results.

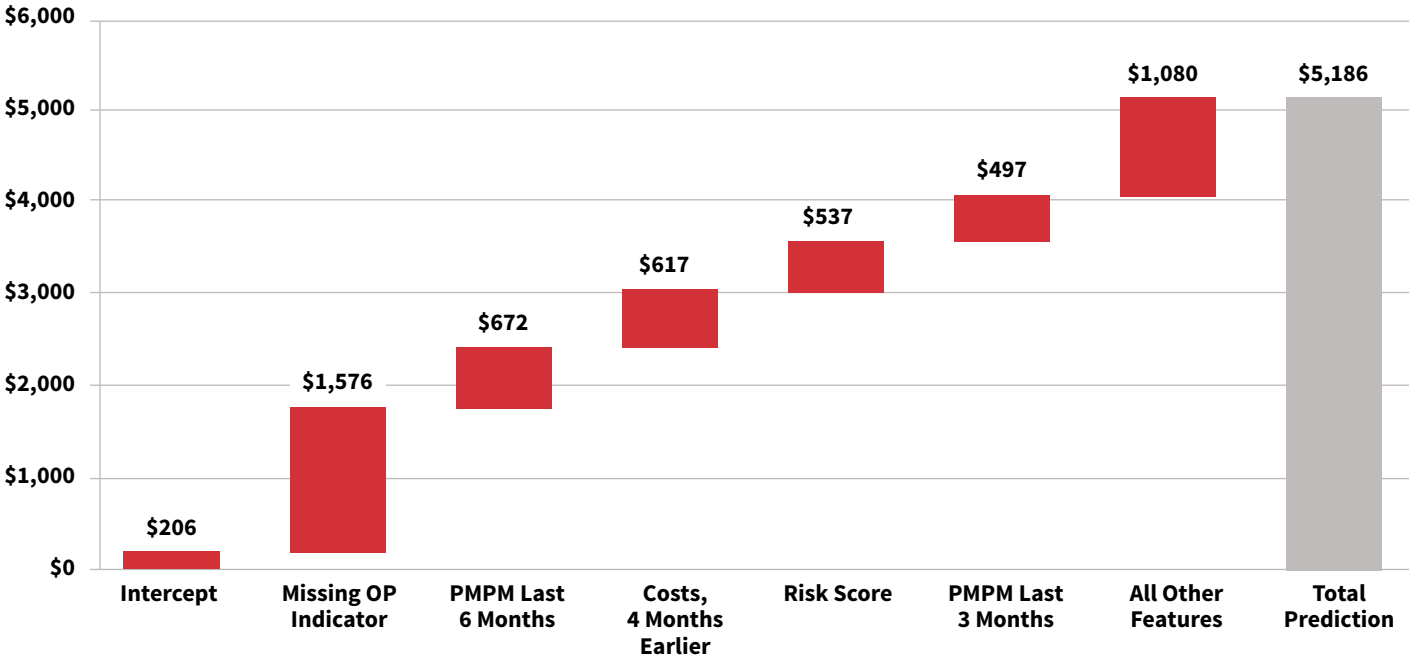
Case Study: Our Model Building Approach

To assess the potential benefits of using predictive analytics to calculate IBNR at the member level, we performed an illustrative case study from a large, multiple-payer data set for 10 different employer groups ranging in size from approximately 400 to 7,000 members. In our evaluation, we looked at the performance of two popular machine learning methods: penalized regression and gradient boosting decision trees.[3]

We built separate models for each incurred month. For instance, one model was strictly focused on predicting IBNR in the most recent month, while a separate model was focused on predicting IBNR in the previous month. To train the models, we included a rich variety of features, including historical payment information (by incurred month and paid month), as well as demographic and clinical information such as age, gender and risk score. We also included some "leading indicator" features that helped the model identify potential large payments that had been incurred. For instance, one of these features indicated that a member had incurred a professional claim at an inpatient or outpatient facility during a given month, yet no facility claim had been reported for that month. During a hospital visit, there are typically separate bills from the facility and from the physician (or physicians). The physician (professional) bill is often processed more quickly and is generally much less expensive than the facility bill. The presence of *only* the professional bill is a strong indicator that there is a large claim that is yet to be reported.

For many modern machine learning algorithms, the relationships between features and predicted values can be complex. The waterfall chart in Figure 2 is a representation of the prediction development for a single member's IBNR estimate for the most recent month, using a gradient boosting machine. For this member, the model started with a baseline estimate of $206, but this increased by approximately $1,576 as a result of the member having a "missing outpatient claim" (as described earlier). Other features pushed the prediction even higher, including high monthly costs over the past six months and a high risk score. Ultimately, the model predicted an IBNR of $5,186 for this member.

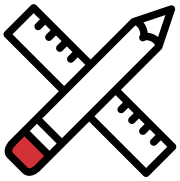
Figure 2 Illustration of Predicted IBNR for Individual Member, Gradient Boosting Machine



Case Study: How Accurate Were Our Models?

To keep our case study simple, our models only predicted claims that were incurred within the three months prior to the valuation date because these months constitute the bulk of the reserve. To evaluate the accuracy of our models, we split the data into two sets: a training set and the testing set. The model was built on the training set while the testing set was withheld for model evaluation and to ensure we weren't overfitting.

To estimate overall performance, we compared the 10 group-level models for each algorithm to two traditional methods. We then compared the predicted results to the actual IBNR for each method or model, and we calculated the aggregate error across all groups, the average absolute percentage error for each group, and the standard deviation of the percentage error across the groups. These values can be seen in Figure 3. Overall, the gradient boosting decision tree model and the penalized regression model estimated the overall IBNR more accurately and had less variation than the traditional methods. These results suggest that predictive models have the potential to increase the accuracy of reserve estimates. We also found that the member-level predictions from the predictive models generally had a 30 percent to 50 percent correlation with actual results, compared with 20 percent to 30 percent when applying the group-level completion factors to individual members. The member-level correlation statistics are more complicated to aggregate across groups and lag months, so we excluded them from Figure 3.



One of the most important considerations in building a predictive model is which variables to include.

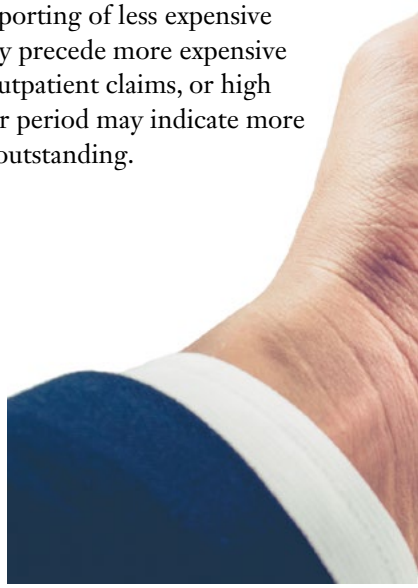
Considerations

Using predictive analytics for the estimation of IBNR does not mean that actuarial judgment is no longer needed. Beyond the expertise needed in crafting the models themselves, adjustments to IBNR should still be made outside the model or as offsets within the modeling process. These adjustments can include handling new entrants without historical data, claim trends, or any staffing or technological considerations that could impact the backlog of claims.

One of the most important considerations in building a predictive model is which variables to include. Most of the increases in predictive power will not come from more powerful or refined techniques, but rather from more carefully considered and richer input data. For health care, some more obvious variables to consider (when available) are age, gender, plan design and geography of the member. In addition, the temporal nature of IBNR makes the timing of when things happen a key consideration. In designing variables for the model, this should be exploited where possible. For instance, the reporting of less expensive drug claims may precede more expensive inpatient and outpatient claims, or high claims in a prior period may indicate more claims are still outstanding.

Figure 3 Error Metrics for Traditional Methods and Predictive Models

Traditional Methods	Aggregate Percentage Error	Average Absolute Percentage Error	Standard Deviation
Completion Factor	–3.6%	42.8%	72%
Projection Method	8.3%	43.2%	47%
Predictive Models			
Gradient Boosting Decision Tree	1.4%	24.8%	29%
Penalized Regression	–0.1%	27.1%	34%



Given enough feature creation and enough volume of data, a well-crafted predictive model should be able to discern the most pertinent relationships. As an example of some possible relationships a predictive model might uncover, consider Figure 4. In the first table, we see two variables and their joint impact on the IBNR within our case study (for simplicity we are only considering the amount of unreported claims in the month prior to the valuation date and paid within the next month, which we denote L0). The first variable is the member's average monthly claims over the past year. The other variable is the "missing inpatient" indicator discussed earlier. Similarly, in the second table in Figure 4, we see another joint relationship that can stratify risk. This time the relationship is between the claims already paid in L0 and the risk score of the member.

The values shown in each cell represent the average *observed* IBNR for the most recent incurred month in our training data. As we can see in each chart, these variables are all strongly correlated with IBNR, but together we can stratify the risk more accurately than we can in isolation.

Before involving predictive models in your reserving process, many practical considerations are involved. The first and foremost should be a good understanding of the problem you are hoping to solve. While we mention two possible benefits to using predictive models—increased accuracy of the estimates and more accurate IBNR attribution to individual members within the pool—these benefits may not hold in all cases, depending on the availability of data and the line of business. For a list of potential considerations, see Figure 5.

Figure 4 Average IBNR in Lag 0 by Certain Key Features

	Missing IP Indicator	
Prior Year's Claims PMPM	Yes	No
$0–$200	$12,612	$92
$200–$400	$10,152	$316
$400–$600	$15,103	$391
$600–$800	$14,302	$473
$800–$1,000	$17,017	$530
$1,000–$10,000,000	$19,831	$1,545

	Risk Score			
Claims Paid in L0	0–0.5	0.5–1.0	1.0–2.0	2.0+
$0–$1,000	$98	$157	$217	$757
$1,000–$2,500	$1,591	$1,595	$2,408	$5,374
$2,500–$10,000	$2,170	$2,492	$2,029	$8,361
$10,000–$10,000,000	$2,231	$2,934	$4,954	$16,225

Figure 5 Practical Considerations Before Using Predictive Models for IBNR

- How will you define success for the endeavor?
- What kind and quality of data do you have?
- Will you need access to new data fields not currently used in the reserving process?
- Do you have access to modeling software?
- Do you have the expertise to create and deploy a predictive model?
- Can you obtain the data and generate predictions fast enough to meet valuation timelines?
- Can the results be explained to auditors and key stakeholders?

One thing to keep in mind is that member-level predictive models need not completely replace traditional actuarial methods to be valuable. In fact, the completion factor method and the projection method described are often blended in practice. IBNR estimates created by member-level predictive models can be similarly blended with any traditional approach. They could also be used not for the results directly, but instead as a way to help understand the drivers of changing IBNR values. Regardless, until enough comfort and sophistication with predictive models is established, the most prudent course of action for any actuary is to do rigorous back-testing and results monitoring before replacing any traditional methods.

Conclusion

Overall, our findings indicate that using predictive models for IBNR estimation is promising. However, our analysis is not definitive; given the volatility in IBNR estimates and the sample size we tested, further research is warranted before concluding that predictive modeling techniques are superior to traditional methods. However, predictive analytics methods need not completely supplant traditional IBNR methods to be valuable. Instead, and more likely, the two approaches can supplement and complement each other.

What our analysis does suggest is that this is a productive endeavor to explore. By incorporating predictive models into traditional actuarial methods we might not find the crystal ball that we seek, but with the steady incremental improvements it allows us, we can help advance actuarial practice. ■

References

[1] This differs slightly from incurred but not paid (IBNP) reserves, which would also include claims that have been reported but not yet paid. Throughout this article we use the term IBNR, although the same approach could be applied to IBNP reserves.

[2] Actuaries often make additional adjustments to this historical cost, including applying an assumed trend and adjusting for seasonality or the number of working days per month.

[3] James, Gareth, Daniela Witten, Trevor Hastie, and Robert Tibshirani. 2013. *An Introduction to Statistical Learning: With Applications in R*. New York: Springer.

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SOCIETY OF ACTUARIES®

BY VINCENT J. GRANIERI, GREGORY P. HECK AND ROGER TAFOYA

A Disruptive Perspective

The confluence of actuarial science, underwriting, IT and predictive analytics

Disruptive technologies make it an exciting and potentially threatening time to be in the life insurance industry. Life insurance underwriting programs are affected by consumer demands for higher efficiencies, less invasive requirements and quicker turnaround times. Integrating new data sources with traditional requirements and utilizing the latest predictive modeling techniques are prerequisites for future success. Building automated underwriting systems that leverage three disciplines—actuaries, underwriters and IT personnel—are worthy endeavors, but, traditionally, these groups typically work in silos rather than collaborating in cross-functional teams. How can we best integrate these vital functions to produce a better product?

It's not just about doing it better, but faster, all while transforming the customer experience. Today's technology allows for faster access to more relevant information, which strikes at the core of underwriting data sources. This new data is useful in underwriting the life insurance risk, but how do we integrate it with the existing underwriting process? Further, our customers demand faster decisions with less invasive processing, as illustrated by the success of accelerated underwriting programs. We question whether the traditional underwriting process can survive these disruptive forces.

What happens when the irresistible forces of increased data and shorter decision-making windows meet up with an immovable object, the underwriting process? Conventional underwriting methods are dominated by specialized training and significant judgment that is as much an art as it is a science. It's possible that, in our quest for automation and speed, we risk losing the traditional benefits of the underwriting process.

We need to meet these challenges with a disruptive underwriting process that combines efforts and shares somewhat disparate, but equally valid, perspectives. The result envisioned is a prioritized underwriting system that focuses on the outcome—life expectancy—instead of the inputs—risk classification. The path created is just one of many possible routes. This article is a description of the general process and goals rather than detailed documentation of each step in the process.

Successful predictive modeling of the life insurance risk requires three knowledge areas: clinical underwriting knowledge, programming knowledge and actuarial knowledge. Clinical underwriting knowledge is critical in collecting input data, sifting through pages of medical records to extract and normalize all the conditions documented for the subjects in the study. Programming knowledge and data organization develop systems to store and validate data the underwriters find. All the conditions and data collected by the underwriters need a home, which is provided by an IT team of database experts and programmers. The underwriters and the IT team work together to develop the triggers that would indicate discrepancies in the medical records, which, if triggered, prompt the underwriter examining the case to further investigate for errors or potential fraud. Actuarial knowledge provides the analytical review of the work completed with underwriting and programming knowledge. While the computers automate calculations, produce stunning visualizations of the data and learn the best-fitting models, the actuaries make sense of it all.

The Data

Data on insured populations is a critically needed asset. The data covers both demographic and health conditions information. Data from other relevant populations, such as the general U.S. population, college-educated subjects and nursing home populations, is needed to measure how the mortality of new populations converge to the mortality of existing populations. The challenge is to define the speed of convergence as a function of age in actuarial modeling.

For data on deaths, we utilize the Social Security Death Master File (SSDMF) and supplement it with obituary search services that help bridge any gaps in the file. This two-stage approach is necessary due to changes in the SSDMF implemented in November 2011, which eliminated approximately 1 million deaths per year from it due to a new interpretation of the law that concluded state death records could not be used as source material for the SSDMF. Life data is supplemented with health data to determine the likelihood an insured has a certain underwriting condition given the existence of a prescription drug and/or ICD codes. For example, if an insured has a prescription drug history that includes Metformin, the odds are overwhelming that he or she suffers from diabetes.

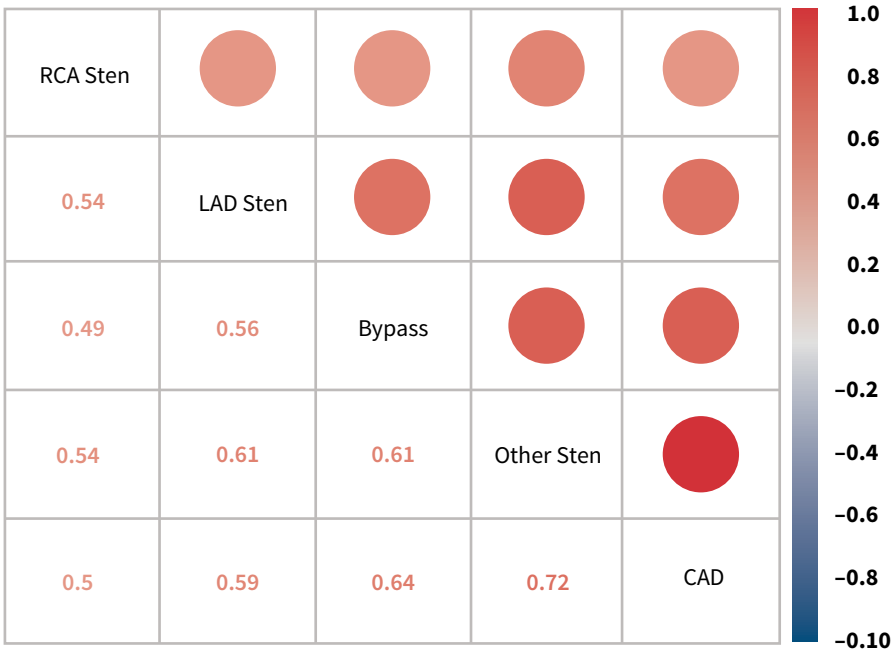
The Process

It is both a blessing and a curse that our key predictive analytics tool, the Cox proportional hazards model, which is used to ascertain risk levels, is ambivalent about the mortality distribution underlying the data. A base mortality table is needed to begin the process. The Cox model can be used to define base mortality tables by gender and smoking status. It is also possible to substitute other tables, but it is important to address disparate results from the use of different tables. (See sidebar on page 46 for more on the Cox model.)

Consistent underwriting guidelines are important in identifying current health state using medical records that contain both quantitative data and subjective information. Cataloging quantitative results, such as A1C levels, eGFR measurements, ICD codes, prescription information, vitals or ejection fractions, is extremely valuable in providing unbiased results as well as determining appropriate thresholds for normalization. Pinpointing the onset of health conditions is crucial to mapping out the longitudinal history needed to understand the increase or decrease in mortality over time.

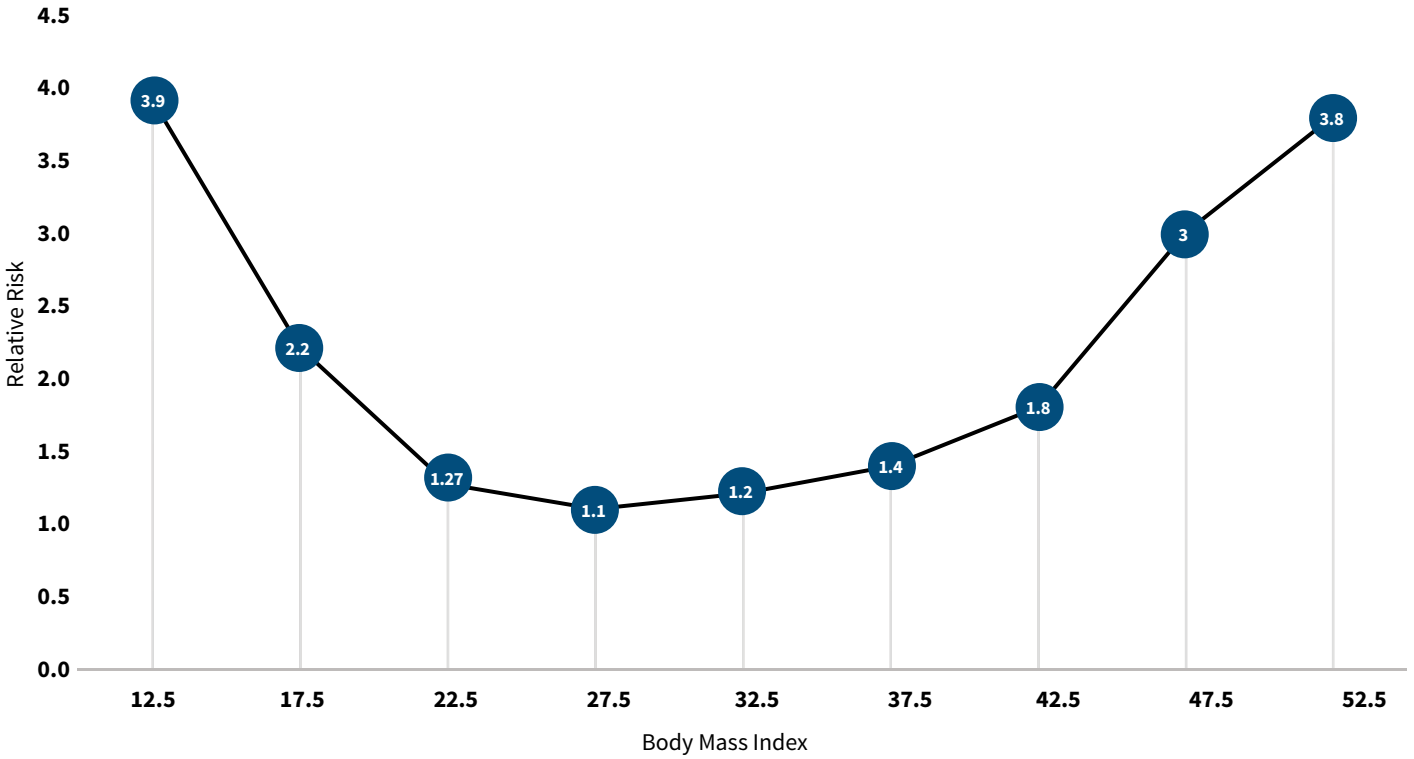
Traditional underwriting relies on the application of a mortality debit/credit system to place individuals in

Figure 1 Positive Correlation Among Potential Explanatory Variables



Source: Compiled from research conducted by Predictive Resources LLC.

Figure 2 Mortality Risk Associated With Body Mass Index



Source: Compiled from research conducted by Predictive Resources LLC.

appropriate risk classes. The new underwriting paradigm accesses data sources and information not previously used in traditional underwriting and not previously available. Using models and sophisticated algorithms to ingest and digest big data allows us to evaluate new attributes about individual risks that may affect their longevity, focusing underwriting efforts on outcomes rather than inputs. Creating impairment-specific mortality allows for more effective risk classification, which results in better pricing and product development. Leveraging underwriting skills is critical in identifying comorbidity and collinearity among conditions to improve life expectancy estimates.

In addition, this outcomes-based underwriting system shares its theoretical underpinnings with essentially all current medical research, allowing for easy incorporation of the latest findings into the underwriting model.

Challenges in the Brave New World

It will not be all smooth sailing using this new, more data-driven approach. Extreme care is needed to properly interpret potential results. Models may not be readily usable for many reasons.

One reason could be that independent variables may not be truly independent; they may be correlated, confounding the results. For example, a variable that indicates the presence of coronary artery disease is highly correlated to others indicating stenosis of the coronary arteries (see Figure 1). When this happens, the Cox model is unable to properly assign risk to each variable and produces spurious results. (Please see Granieri's article, "Predictive Modeling Techniques—A Case Study in Resolving Correlated Explanatory Variables," in the June 2017 Predictive Analytics and Futurism Section Newsletter, for a more detailed discussion of this topic at *bit.ly/June2017-Issue15*.) The models replicate known relationships with a high degree of accuracy. They accurately associate shortened life expectancies with smoking and indicate a lengthening of life expectancies with exercise. The value of the models and algorithms is in detecting associations in big data that were not previously known. For example, most people know that being overweight is bad for one's health, but what many don't realize is that being 10 points below the ideal body mass index (BMI) is worse than being 10 points above the ideal BMI, a result detected using machine learning (see Figure 2).

A second reason is some results may run counter to intuition and require more inspection before adoption. For example, a result that finds someone with a family history of cancer slightly longer in life expectancy than someone with no family history of cancer, all else being equal. It is up to all three disciplines (actuarial, underwriting and IT) to determine if these results are legitimate from their perspective.

Conclusion

In summary, the new data-driven predictive underwriting paradigm provides the greatest opportunity to thrive in an industry that is affected by some of the same forces that are disruptive in many others. Underwriters, actuaries and IT specialists using predictive modeling tools can join forces in a new and better alliance. As for the challenges that remain, let the words of Loren Eisely be our guide to an improved future in underwriting risks: "The journey is difficult, immense, at times impossible, yet that will not deter some of us from attempting it." ■

COX PROPORTIONAL HAZARD MODEL

The Cox proportional hazard model was introduced in 1972 as a method to examine the relationship between survival (mortality) and one or more independent variables. Its advantages include the ability to handle data that is right-censored, and it can utilize many underwritings on the same life. It does not require knowledge of the underlying (base) survival curve.

THE FIVE Vs OF BIG DATA

❶ VOLUME

The amount of data continues to grow at an exponential rate.

❷ VELOCITY

The speed at which data is available can be "real-time."

❸ VARIETY

Due to the many sources from which data is extracted, the data is in many forms.

❹ VERACITY

The reliability of the data is not uniform.

❺ VALUE

The resulting contribution of the data to an application can be in a range from highly negative to extremely positive, and all points in between.

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Distributed ledger technology in life and health insurance

BY MELISSA CARRUTHERS, LOUISA BAI AND RUSSELL SHIRRA

In recent years, the insurance industry has faced renewed challenges from increased competition, compressed margins, increased regulatory scrutiny, disruptive technologies and rapidly shifting customer expectations. In response, insurers are actively exploring new ways to achieve operational efficiencies, reduce their cost structure and drastically improve the customer experience. While forward-looking life and health (L&H) insurers are actively embracing emerging technologies such as artificial intelligence (AI) and robotic process automation in conjunction with the internet of things and big data, there is buzz in the air around the new kid on the "block"—distributed ledger technology (DLT), or blockchain—in response to these challenges.

DLT 101: An Introduction

DLT, at its heart, is a method of collectively maintaining a record on an immutable, distributed ledger.[1] In contrast to existing systems, it does not rely on intermediaries (e.g., banks) to create and uphold trust. Instead, the ledger is "distributed" or shared among many different parties. Membership in the distributed ledger can be open to all (a public network), or only open to select parties (a permissioned network).

Transactions on the DLT can generally be classified into three key steps.

1. Select parties exchange a unit of value representing money, medical records, customer information or anything else that can be digitally described.
2. All participants in the system use predetermined rules to determine that the transaction is valid (e.g., ensuring it makes sense in the context of previous transactions, authenticating parties' identities).
3. Once participants validate a transaction, it is permanently added to the "chain" of transactions that form the ledger as a new "block."

Critically, once entered, information on the ledger can never be erased or altered. Any given DLT therefore gives a verifiable record of every transaction that has taken place and can be trusted implicitly.

This powerful technology provides four unique and transformative capabilities that have a wide-ranging impact across industries.

1. **Transparency and auditability.** All data added to the chain is immutable, and can be viewed by all members (although some implementations allow for privacy). This makes it a lasting record upon which all network participants can rely.
2. **Trust.** All data blocks on a chain are interconnected and mutually dependent, making the entry of fraudulent data essentially impossible. That, in tandem with the distributed validation of transactions, makes it possible for all participants to trust one another.
3. **Disintermediation.** Transparency and trust together enable direct peer-to-peer transactions, allowing DLT to displace traditional intermediaries such as payment service providers.
4. **Automation and smart contracts.** Through smart contracts, which are defined as a predetermined set of rules that can be thought of as a series of "if" statements, the DLT can also actively trigger transactions when predetermined conditions are met. These can automate routine payments and are especially applicable to industries like insurance where policies clearly define the conditions that trigger a payout.

The underlying key to success with DLT is a high degree of collaboration among trusted parties. The strength of a network, such as a distributed ledger, lies in the number of its members. This presents an interesting opportunity for an industry so

heavily dependent on the integration and transfer of digital assets among parties in its ecosystem (i.e., reinsurers, vendors, regulators, providers).

Global Insurance Applications of DLT

Rising Global Interest

In recent years, the global financial services industry has been extensively exploring the applications of DLT.[2] Banks, especially, prize it for its ability to detect and reduce fraud, and its role in streamlining operations while better and more securely meeting customers' needs.

Among insurers, DLT is still in its adolescence. Public skepticism largely associated with the hype around cryptocurrency, regulatory concerns and a general lack of awareness or understanding have weighed on insurers' minds and prevented enthusiastic adoption of this technology. However, given the quickly evolving industry dynamics, the global insurance industry is seeing a rapid uptake in both interest and activity. Successful efforts to realize this technology's potential require not only the right capabilities, but a sufficiently large network. In order to gain these prerequisites for success, many companies with scale are going it alone, while even more prefer to work with consortia.

The Power of Collaboration

For a few large global players, going it alone is a viable option. They have the scale to make headway with their own solution and are willing to build, buy or create partnerships with DLT startups to gain the required capabilities. For example, global insurer and asset manager Allianz is assessing the viability of deploying smart contracts across its multiple global entities. Rather than transferring assets between disparate departments and subsidiaries, it hopes to do so by automatically triggering actions through the use of smart contracts when certain conditions are met.[3] This would reduce the administrative burden on employees and allow the enterprise to make internal transactions more quickly and inexpensively.

The power of distributed ledger technology is truly enabled when engaged with a broader network.

However, the power of DLT is truly enabled when engaged with a broader network. For that reason, most players are opting to be part of a consortium, which typically includes industry representatives, governments, vendors and regulators. These groups support the development of decentralized business platforms and applications, allowing all members to transact and contract with one another on the DLT. Some prominent consortia, such as Enterprise Ethereum Alliance, R3 and Hyperledger, provide open-source platforms to enable cross-industry applications of this technology.

One of the largest is R3, a New York–based company that leads a consortium of more than 70 large financial institutions in efforts to develop a distributed ledger applicable to the broader financial system. Its code was made open source in 2016 and is designed to quickly and easily scale to serve global financial markets' needs. R3's members, and the financial space more broadly, are poised to benefit from the decreased transaction costs and increased security the platform can provide.

Consortia are becoming a strong force in the insurance space. Many insurance companies have joined the DLT Insurance Industry Initiative (B3i), a European joint venture that market-tested a DLT reinsurance prototype and is expanding its focus to include commercial and primary insurance, including L&H applications. More important, it is laying the groundwork for future collaboration and standardization across key players and parties within the insurance ecosystem. This effort is crucial to eventually integrating the multiple DLTs that are in development across industry value chains. Establishing common standards will dramatically amplify this technology's ability to drive operational efficiencies and a seamless customer experience. Through B3i, network participants are actively

pursuing cutting-edge technology to address insurance-specific, industrywide pain points.

RiskBlock Alliance—a partnership between The Institutes, a risk management and insurance knowledge group focused on the property and casualty (P&C) industry, and LIMRA—is another group dedicated to accelerating the insurance industry's adoption of DLT.[4] This consortium includes more than 30 insurers in the United States and has already developed a DLT-based auto insurance solution alongside several use cases. By bringing insurers together to discuss the strategy, architectural requirements, standards and governance around DLT, it enables the industrywide collaboration vital to unlocking this technology's benefits. Lucky for the L&H industry, after a successful track record of P&C use cases, the partnership plans to focus its next DLT application on annuities.

The desire to embrace DLT in insurance may be off to a slow start, but it is quickly gaining momentum. As consortia, governments and organizations begin to collaborate and develop a better understanding of the applications of DLT, viable DLT companies, proofs of concept and lessons learned will increasingly emerge.

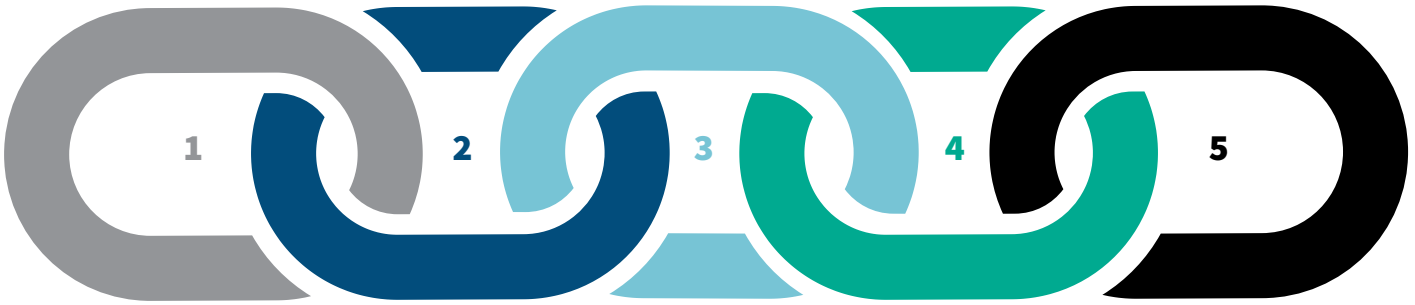
By bringing insurers together to discuss the strategy, architectural requirements, standards and governance around DLT, it enables the industrywide collaboration vital to unlocking this technology's benefits.

DLT in Life and Health Insurance

The Suitability of DLT

Like most technologies, DLT is by no means the right solution—or even a viable solution—to all challenges faced by the L&H insurance industry. However, based on the foundational elements of DLT, there are several requirements (i.e., suitability criteria) that, when met in part or in full, indicate DLT may be an effective solution for a particular business issue. Some DLT problems may possess only a few of these characteristics, and their relative importance may vary by context and organization, but these five criteria can be useful in assessing the suitability of DLT as a solution across the L&H value chain (see Figure 1).

Figure 1 Criteria for Assessing the Suitability of Distributed Ledger Technology



Shared/transfer of Data
Blockchain is a technology for **shared databases**—there is a need for a structured repository of information.

Opportunity for Disintermediation
Blockchain removes the need for **trusted intermediaries**—no gatekeeper is required to verify transactions and authenticate the source.

Multiple Writers
Blockchain is a technology for **databases with multiple writers**—multiple entities generating transactions that modify the database.

Absence of Trust
Blockchain is a technology for multiple **non-trusting writers**—there needs to be a level of mistrust among the entities writing to the database.

Transaction Dependency
Blockchain provides value when there is **interaction** among the transactions created by the writers, meaning the transactions depend on one another.

The Need for a New Solution

Leveraging these criteria, several pain points faced by L&H insurers are thought to be especially amenable to resolution through DLT:[5,6]

1. **Inefficient exchange of information.** The frequent flow of data among customers, third parties, vendors, reinsurers and regulators is often slow and difficult to integrate, requiring time-consuming manual intervention or complex processes to facilitate.
2. **Vulnerability to fraud.** Verifying policy application and claims information is often prohibitively costly, leaving insurers open to otherwise avoidable losses.
3. **Fragmented data.** Lacking a single source of truth and with data silos spread across organizations, many insurers struggle to gain a complete picture of their business.
4. **Manual processing.** Inhibited by legacy systems, a large portion of insurers still require costly and inefficient manual processes. Labor-intensive processes and an inability to automatically approve simple applications and claims limit opportunities for back-office efficiencies.
5. **Burdensome customer experiences.** Policyholders are frequently subjected to inefficient processes, long wait times and customer experiences unacceptable in comparison to those offered by other industries.

Combined, these inherent challenges within traditional L&H insurance business models limit an insurer's capacity to combat increasing operational costs and adversely affects its ability to ultimately improve the overall customer experience. The need has never been greater to identify an appropriate solution to address these friction points, and only by gaining a deeper understanding of the foundational elements of DLT will the industry identify whether or not it has the transformative potential other industries are buzzing about.

Potential Use Cases

While implementation remains in its infancy, several insurers and consortia are building out use cases to better understand the risks and benefits of DLT as a solution. In an attempt to bring this technology to life in the context of L&H, three use cases are illustrated. They depict the potential future state processes, including the network participants and the key activities affected as a result of leveraging DLT.

Use Case 1: Group Health Claims Payment

Driven by the sheer volume of data transfer, high-cost manual processes and the dependency on trusted partners, the first use case focuses on health claim payments, leveraging DLT to exchange data with trusted health care providers beginning with policy issuance.

Key activities include:

1. The plan sponsor uses DLT to issue a request for proposal (RFP) to insurers, including quote details and required member data; data flows from plan to sponsor to insurers.
2. The insurer receives the data from the plan sponsor via DLT and generates a quote.
3. If the quote is accepted, the plan sponsor and insurer bind the policy with a DLT-enabled smart contract that contains coverage details, plus terms and conditions; data flows from insurer to plan sponsor.
4. When either an employee or health service provider submits a claim, they do so on the blockchain, automatically triggering claims processing via smart contract; data flows from employee or health service provider to insurer.
5. The smart contract looks up the source of the claim in a directory of trusted service providers, automatically paying if the provider is in this directory; data flows from insurer to service provider.
6. If the claim does not come from a trusted service provider, it is routed for manual review (per predefined claim amount limit thresholds) and paid after approval; data flows to claims reviewers.

Key benefits include:

- **Reduced fraud.** Automatic verification of member data and trusted providers eliminates opportunities to mislead.

- **Efficient data exchange.** All data is integrated via DLT, and most of it flows automatically.
- **Automated claims processing.** DLT enables a sharp reduction in manual labor required to investigate and approve claims.
- **Enhanced customer experience.** Customers receive payment faster and with no paperwork required.

Use Case 2: Sales and Underwriting

The second use case applies DLT to the life insurance sales and underwriting process, which remains heavily dependent on the data exchange amongst several parties. This application of DLT has the potential to change the traditional business model by disintermediating the adviser in the initial data exchange process and requires the collaboration of health care providers as well as policyholder consent.

Key activities include:

1. The customer requests a quote by providing necessary information through the blockchain; data flows to insurers, who are automatically notified.
2. The insurer obtains health information through third parties such as health care providers and physicians also connected through the ledger; data flows from third parties to the insurer.
3. The insurer matches the customer with a risk profile, generates policy details, and offers a quote directly to them; data flows from insurer to customer.
4. Once the customer accepts the quote, the DLT generates a smart contract reflecting the policy's terms, and reinsurance policies where applicable; data flows from customer to insurer and reinsurer.

Key benefits include:

- **Reduced fraud.** Insurers can obtain data directly from third parties, rather than relying on the customer.
- **Enhanced customer experience.** The customer need not manually provide data or submit to burdensome exams (e.g., blood tests).
- **Automated diligence and underwriting.** Insurers can quickly and automatically verify information and generate an appropriate price.
- **Efficient information exchange.** Integrating entire health ecosystems on the blockchain allows insurers, customers and third parties to seamlessly communicate.

Use Case 3: Life Claim Processing

The third use case applies DLT to the life insurance claims process, recognizing that this is a highly manual process for a majority of carriers today despite a large volume lacking the need for complex adjudication.

Key activities include:

1. A hospital uploads death information on a distributed ledger to which the insurer has access, automatically triggering a smart contract that confirms details (e.g., validity, beneficiary, payment amount) and pays out simple claims; data flows from hospital to insurer.
2. If the life insurance policy is complex and requires manual review, the smart contract automatically escalates it to a claims team; data flows to this team.
3. If a fraud investigation is required, a special investigation unit is brought in to request additional documentation from family members; data flows to the investigators.
4. Upon the claim's approval, payment is made automatically to the beneficiaries with no requirement to apply for it; data flows to beneficiaries.

Key benefits include:

- **Reduced fraud.** Automatic escalation to investigative teams as needed provides a safeguard, preventing fraud.
- **Efficient exchange of information.** Linking hospitals and insurers via DLT allows carriers to respond instantaneously to covered events.
- **Automated claim processing.** Insurers drive efficiency by straight-through-processing simple, commonly occurring claims.

» **Enhanced customer experience.** Removing the need to apply means the customer will be paid faster and with less effort required.

Considering DLT

The innovative nature, complexity and, to some extent, the pure stigma associated with DLT has deterred many L&H insurers from entertaining the possibility of its applications within their operations. However, given the pace at which the industry is forced to react to the shifting market dynamics, there is no reason to leave any stone unturned.

Getting Started

As you begin to consider potential technology-enabled solutions within your organization, consider:

» **Enhancing your understanding of DLT.** Gain a foundational understanding of the key elements and benefits of DLT through online resources, expertise within your organization or subject-matter experts within your ecosystem.
» **Engaging in ideation sessions.** Host internal or external ideation sessions with representatives from varying lines of business and across the value chain (i.e., regulators, vendors, underwriting, claims) to identify an initial list of industrywide or organization-specific priority pain points to be addressed.
» **Assessing the suitability of DLT.** Using the suitability criteria identified in this article, assess whether blockchain may be a suitable solution for the initial list of pain points, and as a group prioritize those you believe to be an appropriate use case or proof of concept.
» **Joining a consortium.** Enhance your collaboration efforts within your insurance ecosystem and leverage the existing partnership network, capabilities and proofs of concept already developed by consortia.

Ultimately, consortium-driven distributed ledgers can accelerate and enhance the potential benefits of DLT. They provide the opportunity to engage various industry stakeholders (e.g., peers, regulators) to share capabilities and expertise; promote valuable discussion, learning and facilitate the ideation process; and aid in shared costs and risks among members. After all, a technology that at its root is shared and distributed across different players in the network should have a shared and distributed approach to development. A hurdle for carriers to overcome will be the level of collaboration required among competitors. However, industrywide problems require industrywide solutions, and these organizations are uniquely positioned to bring together disparate parties in pursuit of mutual benefits.

Opportunities Ahead

As L&H players race to find an appropriate solution for challenges inherent in traditional operations, they should not overlook the potential applications of DLT. By partnering with peers, competitors, regulators and other members of the insurance ecosystem, insurers have the opportunity to resolve a wide range of longstanding, cross-industry pain points and position themselves for future growth and profitability. ■

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Problem Solver

Q&A with Patrick Getzen, FSA, MAAA, SVP and chief data and analytics officer at Blue Cross NC

How did being a chief actuary prepare you for your role in data analytics?
My experience as an actuary serves as a good foundation for the role of chief data and analytics officer. As chief actuary, my job is to use disparate sources of data to make predictions. That can be claims data, membership data, information about care management, provider contracts and more. The other part of the foundation is my experience in our business. When you add my familiarity with things like operations, customer service and digital marketing to my experience as chief actuary, I think the data and analytics role is a good fit.

Tell me about the diversity of your team. Data scientists? Actuaries? Others? What are the skills and abilities of your team?
It's a team with broad and diverse skills and experience—it includes analysts, data scientists and engineers. We also have some "translators" to bridge the analytical and business worlds. Our work requires technical skills to help us move in a rapidly changing industry, but more than that, it requires problem-solving skills. We have a great foundation with the data and analytics professionals already in the company. As a team, they're really strong at taking the data and translating it into actionable information for the company. We are looking to add to their ranks.

What unique characteristics do these individuals bring to the table, especially with regard to the insurance domain?
In our business, we need people who know how to solve problems. We also value curiosity, strong collaboration and people who are excited to leverage data and analytics to make a difference in the lives of our customers. That's what this team has. They bring an energy and understanding of how fast our industry is changing and the new technology, new sources of data and analytical tools that are available to them. These are the kinds of people with whom we want to work. Traditionally, as actuaries, we have job descriptions that are too rigid. We're transitioning to job descriptions that are based on being able to solve problems.

Were there any hurdles to overcome during the transition to a position focusing on data analytics?
Understanding the data side of the business—how to store data, maintain it and protect it. There are a lot of complexities to it. Beyond that, I'm really focused on getting the people side of it right. Creating a new group dedicated to analytics represents a lot of change, so there are change management elements that are important. When people are in an uncomfortable setting, they tend to hunker down. Understanding the personal side of change and

PHOTO: CHARLES HARRIS

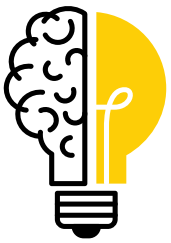
I like to work with people who are curious and want to learn more. It's all about being a lifelong learner.

proactively working through the change process is key.

Technology changes at a rapid pace—how do you keep your team abreast of all the advancements?
I'm not alone in this, but I try to immerse myself in all the information that's out there. I try to spend some time with tech companies, and I have been fortunate to have been able to have regular conversations with venture capitalists as well as technology companies in Silicon Valley. I constantly learn from them and share insights with my teams. The problems we're trying to solve in health care are, in some ways, similar to problems other industries face, such as lowering costs, improving quality and creating a better customer experience.

As you look at the role of actuaries evolving, where do you see the biggest opportunities?
Actuaries specialize in being good risk managers. The great news for actuaries and others with this skill set is that the risk management space is growing rapidly in many industries. For our industry today, there are risk management challenges like data security, particularly as we handle larger volumes of protected information. There's a growth opportunity for actuaries to apply their skills in new ways and to more industries. They can bring a structural thought process to many areas of business. For our company, I see a big opportunity for actuaries in helping to create and manage new payment models where we're paying providers for quality outcomes and providers are taking on more risk.

How did you create your own opportunities?
I started at Blue Cross NC as an actuarial assistant in 1996. Although I have considered other opportunities, I've been very fortunate to work for a company that allows me to bring a perspective beyond actuarial science to our business. I've been involved in business development, provider negotiations and other aspects of our business. At Blue Cross NC, we try to make sure employees have opportunities to apply their skills and interests while at the same time meeting a need for the company.



There's always a need for more people with critical thinking skills who understand business and technology. Actuaries are well-positioned to bring these skills.

What would you say to someone who is in their early to mid-career? What kinds of skills are needed?
I would advise anyone to focus on analytical and problem-solving skills. There's always a need for more people with critical thinking skills who understand business and technology. Actuaries are well-positioned to bring these skills. I would say there's one other trait, and that's curiosity. I like to work with people who are curious and want to learn more. There are all kinds of opportunities to get more training and education—it's all about being a lifelong learner.

What about your work brings you the most joy?
There are really two things. First, solving important problems for a company that has a mission-driven focus. We have the opportunity to drive more insight than ever as we try to solve some big problems. When we solve those problems, like improving quality and reducing cost, we know we're making a difference for our customers and our health care system. Second, I'm always excited about the people side of the business. I really like working with smart, committed, passionate people from whom I can learn and work alongside to solve these big problems.

Industry disruptors: How will InsurTech evolve the role of the actuary?
We're seeing more and more disruptors in health care. I think it may play out a little differently than what we saw in financial services with FinTech startups. In health care, we're seeing more vertical integration

Like other professions, some aspects of the role actuaries play can be automated. But there's no replacing the analytical and critical thinking skills actuaries bring to the table.

among incumbents—CVS buying Aetna, for example—but there's certainly room for InsurTech startups to bring innovation and technology to the market. Innovation and disruption are good things. Like other professions, some aspects of the role actuaries play can be automated. But there's no replacing the analytical and critical thinking skills actuaries bring to the table.

How did you make the jump from chief actuary to predictive/data analytics?
I had some discussions with our new CEO, Patrick Conway, about the possibility of taking on a new role in an area of need for the company. I actually started by identifying the business challenges we were trying to solve and worked backward to identify the opportunity for a specific role in data and analytics. Patrick understood and liked the idea.

What is your definition of success?
The one thing I don't want to lose sight of—and you can call it a definition of success—is personal happiness and satisfaction. This doesn't always happen by accident. You have to think about it. My daughter's definition of success is to have good grades and get into a good college, so I challenged her a little bit. After she thought about it, she decided her real goal is to go into a line of work that will positively impact people's health. Doing well in school then becomes a step, not an outcome, and what really will make her happy is to achieve that goal of improving people's health. That's how I think about success—starting with the goal in mind, and working backward to see how I'm going to achieve it. ■

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PHOTO: CHARLES HARRIS

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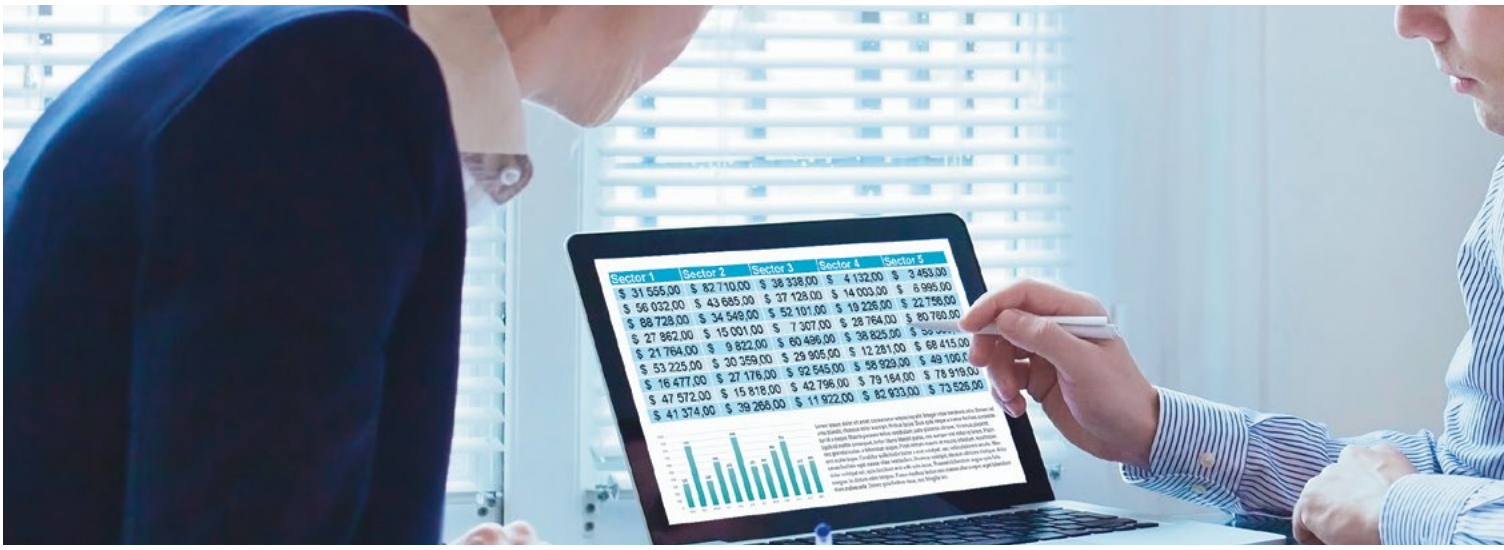

Firearm Risk: An Insurance

BY KRISTEN MOORE AND CRAIG REYNOLDS

Gun violence in America exacts a significant toll on our society in both human and economic terms. The economic cost of firearms directly impacts the financial outcomes of insurers and taxpayers. We deliberately do not take a stand on policy issues related to firearms. Rather, we focus on the associated insurance risks, share known data and call for further research.

The death rate for firearms is material, largely not considered in insurance underwriting and larger than at least one factor that is considered in insurance underwriting.

Firearms are the third leading cause of injury-related death, just behind automobiles. From 2010–2015, on average, there were about 33,500 firearm fatalities per year, which is 97.6 percent of the number of automobile fatalities. In addition, during the same period, there were about 80,000 nonfatal gunshot wounds per year.[1] Between 2006 and 2014, the average annual cost of initial inpatient hospitalizations for gunshot wounds was $734.6 million.[2]

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$734.6 million
is the annual cost of initial inpatient hospitalizations for gunshot wounds.

Given the frequency and costs, we would expect to see actuaries actively evaluating firearm risks. However, we found only one related article in an actuarial journal, which estimated the reduction in life expectancy and the increase in life insurance premiums in the United States due to firearm violence.[3]

Multiple studies have concluded that a firearm in the home is a risk factor for suicide, domestic violence homicide and accidental shootings, and that higher levels of gun prevalence are positively associated with higher homicide rates.[4,5,6,7,8,9]

For life insurance, risky avocations such as scuba diving are often considered in the underwriting process, though firearm ownership generally is not. Our analysis of publicly available data shows that the firearm death rate per million gun owners exceeds that of scuba participants per million divers.

For homeowners insurance, risky features in the home such as swimming pools, trampolines and aggressive breed dogs are generally considered in the

Perspective

underwriting process, while firearm ownership is not. It is natural to ask whether the risk of a firearm in the home is comparable to the risk of these other household features.

Actuaries can provide high-quality, objective, relevant, quantitative research that can be used by our stakeholders as input for recommendations and decisions on this key societal issue. Toward that end, we propose three important avenues for future research.

1. Actuaries should examine the frequency and severity of firearm-related claims across lines of insurance business in order to analyze insurers' exposure to firearm risk.
2. Actuaries should follow the claims of gunshot survivors longitudinally to quantify the total health care cost of treating gunshot wounds.
3. Actuaries should examine whether a mortality differential exists between members of gun-owning households and the general and insured population.

Actuaries have unique skills in measuring and managing risk. We are experts in mortality analysis. We are skilled in data analytics and model building. And we can analyze the problem objectively. As a profession, we must employ our skills and talents to help address the economic, mortality and morbidity impact of gun violence.

ABOUT THE WRITERS

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Enhanced Assessment Methods Coming to a Test Center Near You

BY STUART KLUGMAN AND MARTHA SIKARAS

One experience that binds Society of Actuaries (SOA) members together is surviving the exam process. As changes in learning methods (e.g., online e-Learning modules) and testing methods (e.g., computer-based tests with immediate results) occur, each generation's pathway is unique.

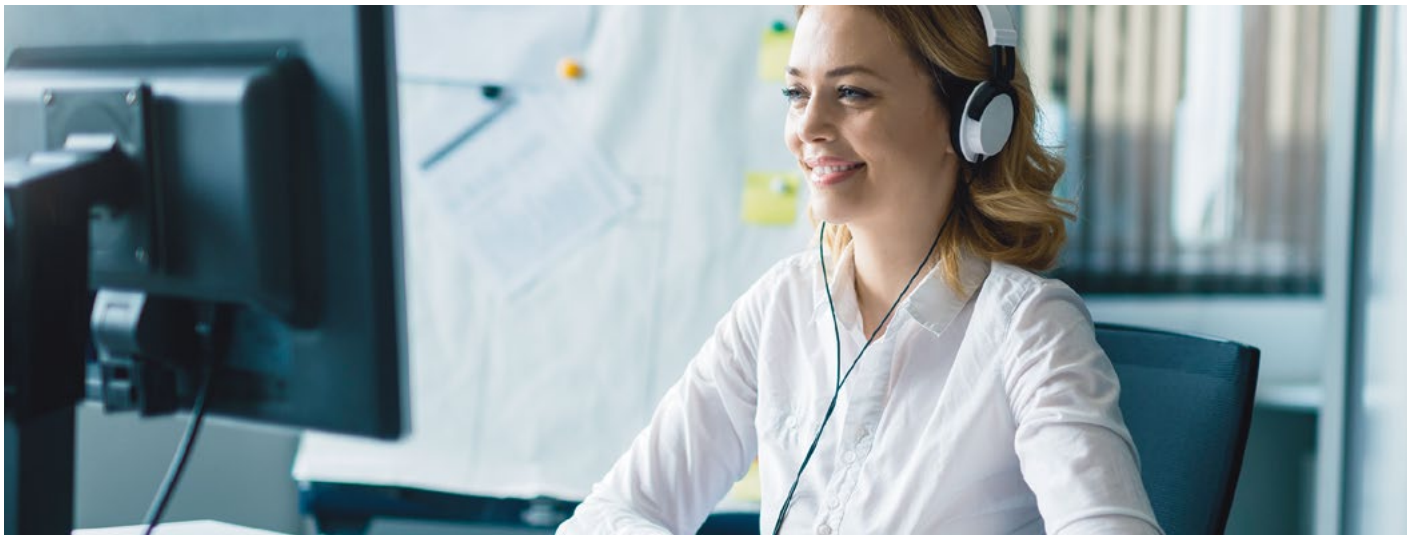
Throughout, the SOA has been committed to continuous improvement. The next step is to upgrade our testing environment. To be properly assessed, candidates should have the same tools in front of them that they use at their job. That means computer tools (such as spreadsheets and programs for statistical analysis) and the ability to write reports using a word processor. In turn, this will allow us to ask more complex questions that get closer to real-work situations. In December, the first phase will be introduced—assessment of predictive analytics via a proctored project with access to software. In this article, we explain the need for the change, provide details regarding the assessment and offer some thoughts as to what might come next as we expand this platform to other exams.

In 2016, the SOA Board of Directors approved a proposal to make significant changes to our associateship education. Along with achieving a better balance in coverage of long-term and short-term insurance, there was demand from employers to significantly upgrade education in predictive analytics. This presented a challenge in that being able to work with big data is more than reciting the details of the major models and techniques. It is about visualizing complex data, dimension reduction and feature selection, understanding the bias/variance trade-off, and communicating results. With model building requiring a sequence of complex and interrelated decisions, multiple-choice or short written-answer questions with the assistance of a scientific calculator are clearly insufficient.

A Two-Step Process

To ensure that predictive analytics is properly learned and assessed, the Board approved a two-step process. Candidates must first pass (or have waiver credit via the transition rules) the new Statistics for Risk Modeling Exam. This is a multiple-choice exam to be first offered in September 2018 and then every four months thereafter. It is offered in the same computer-based environment as other preliminary exams. Multiple-choice questions work here because the goal of this exam is to ensure that candidates are familiar with the basic concepts of the major analytics techniques (the generalized linear model, regression-based time series, decision trees, principal components analysis and clustering) as well as model selection and assessment techniques such as cross-validation.

The second step is the Predictive Analytics (PA) Exam. This exam will be first offered on Dec. 13, 2018. The latest information about the exam is available at *bit.ly/SOA-ExamPA*. At the time of this writing (May 2018), this is what we know:



- The project will be a realistic analytics assignment where candidates are presented with a data set and a business problem. A report that presents and supports the solution provided is to be prepared. Enough direction will be provided to ensure that the five-hour time limit is reasonable. For example, a problem might be amenable to solution by a generalized linear model or by a regression tree. Candidates might be asked to only investigate a regression tree solution and then write about why a generalized linear model may or may not be a better approach.
- Candidates will take the exam at a Prometric test center. This is the same network of centers used for our computer-based preliminary examinations. Candidates will have the same experience with regard to registration, check-in and security as they have for their earlier exams. The exceptional security protocols used by Prometric ensure that we have met the Board's desire that this assessment be proctored using the highest standards of supervision.
- Candidates will work in a Windows-like environment in which they will have access to Microsoft Word and Excel, a PDF reader (to provide access to those documents the exam committee deems useful for candidates) and RStudio for performing their analyses. Their deliverables will be a Word file with their report and a file with their R code. Candidates will have the option to upload additional files in support of their work.
- The R statistical computing environment is open source and features hundreds of routines, known as packages. Because more than one package can perform a particular task, we will ensure that candidates will know in advance which packages will be installed on the Prometric computers for their use in completing their analysis.
- Candidates may bring calculators of the same approved models used for other exams.
- Candidates will also be provided scratch paper as well as a hard copy of the project statement to use while at the test center.
- Candidates will have five hours to complete their project. It is anticipated that the timer may be stopped for up to 15 minutes for restroom/snack breaks. As with any SOA exam, additional time may be used for these purposes, but the timer will be running.
- Candidates will have e-Learning support designed to enhance their Exam SRM studies and to set expectations for what their predictive analytics project will be like—and the SOA's expectations with regard to a successful submission.

RELATED LINK

ASA Curriculum Changes
bit.ly/SOA-CC

» Grading of the assessment will follow protocols used for fellowship exams. Graders will have a guide that clearly lays out expectations and how points will be assigned. Papers near the proposed pass mark will be independently graded by a second grader, and the two graders will reconcile any differences. More information can be found in the Guide to SOA Written Exams (*bit.ly/SOA-Exam-Guide*).

By taking this approach, the SOA will be better able to properly assess which candidates have mastered the fundamental skills related to using predictive analytics to solve real (or, given the time constraint, realistic) problems.

Other Applications for the New Approach

While this platform was designed specifically for the PA Exam, it will open up opportunities to improve existing exams in the future. For example, the Long-term Actuarial Mathematics Exam (the fall 2018 successor to Models for Life Contingencies) is currently a mixture of multiple choice and written answer administered by paper and pencil. If moved to the new platform we are using for predictive analytics, candidates could type rather than write their answers, ensuring that their communications are what they intend. They would also have access to Excel as a calculation tool. Some fellowship exams could be delivered in a similar manner. The profession and employers benefit because we can ask questions that are more relevant to actuarial practice. Solutions to the questions can then be based on tools representative of those used by candidates in their jobs and workplaces. Volunteers benefit because they won't need to strain to decipher handwriting. Everyone benefits with a more secure method of delivering papers from the test center to the SOA, and then to graders.

We are enthusiastic about this new approach to assessing candidates and look forward to the improvements that will flow from it in the future. ■

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Inside Pension Research

Q&A with Lisa Schilling

The Society of Actuaries (SOA) continues to develop and update a variety of research on pension plans. These studies and reports cover private and public plans, including single employer and multiemployer plans. Lisa Schilling, FSA, EA, FCA, MAAA, retirement research actuary at the SOA, provides insights on the latest pension research.

What types of multiemployer research findings has the SOA released?

Schilling: The SOA has released several studies on U.S. multiemployer pension plans, including on contribution indices, stress metrics and employer withdrawals among pension plans. For example, the contribution indices are metrics for measuring whether pension plan contributions paid down unfunded liabilities or met other benchmarks, such as regulatory requirements. The employer withdrawals research is a longitudinal study on the prevalence and impact of employer withdrawals. On average during 2009–2015, 1.2 percent of all participating employers withdrew annually, affecting 18 percent of plans and 63 percent of participants. The SOA also annually released stress metrics on previous benefit cost (PBC) and previous benefit cost ratio (PBCR) of multiemployer pension plans.

The SOA also provides summaries of key financial statistics from publicly available information for several multiemployer pension plans. The source of these statistics is the Form 5500 that plans file with the U.S. Department of Labor each year. These multiemployer pension plans include:

- Major League Baseball (MLB) Players Pension Plan stats
- National Football League (NFL) Players' Pension Plan stats
- National Basketball Association (NBA) Players' Pension Plan stats
- National Hockey League (NHL) Players' Retirement Benefit Plan stats
- Entertainment Industry Pension Plan Funded Status Comparison
- American Federation of Musicians and Employers' Pension Fund stats
- American Federation of Television and Radio Artists (AFTRA) Retirement Plan stats
- Screen Actors Guild - Producers Pension Plan stats
- Directors Guild of America - Producer Pension Plan stats
- Producers - Writers Guild of America Pension Plan stats
- Motion Picture Industry Pension Plan stats

Visit *SOA.org/Research* for the latest updates on new research opportunities, data requests, experience studies and completed research projects.

What were the findings from the latest report on insolvencies with pension plans?

Schilling: The May 2018 study "U.S. Multiemployer Pension Plan Pending Insolvencies" explores the impact of insolvency on these 115 "Critical and Declining" plans, their participants and contributing employers. The study examines projected insolvencies and their impact on retirees and related subject matter, as well as sensitivity to investment returns. The study found that optimistic investment returns have limited impact on insolvency among the plans primarily because their net cash flow positions tend to be severely negative. The projections show a steady increase in the number of insolvent plans. By 2028, 50 plans are projected to become insolvent, increasing to 91 by 2033 and 107 by 2038. The 50 plans projected to become insolvent by 2028 are projected to cover roughly 545,000 participants with about 2,700 contributing employers. The 107 plans projected to exhaust assets by 2038 are projected to cover about 875,000 participants with more than 11,000 contributing employers.

Optimistic investment returns have limited impact on insolvency among the plans primarily because their net cash flow positions tend to be severely negative.

What studies are there on single employer pension plans?

Schilling: Earlier this year, the SOA developed a longitudinal study of single employer plan contribution indices in the United States. Contribution indices are metrics for measuring whether pension plan contributions paid down unfunded liabilities or met other benchmarks, such as regulatory requirements. About 11 percent of plans had an unfunded liability for 2015. Preliminary results for 2016 show an increase in unfunded liabilities—roughly 27 percent of plans had unfunded liabilities.

What other tools or resources are available?

Schilling: The SOA developed the Annuity Factor Calculator to calculate an annuity factor utilizing user-selected annuity forms, interest rates, mortality tables and projection scales commonly used for defined benefit pension plans in the United States and Canada. ■

RELATED LINKS

Pension Research Reports
bit.ly/SOA-Pension-Research

Multiemployer Pension Plan Pending Insolvencies
bit.ly/2018Pending

Multiemployer Pension Plan Stats
bit.ly/MEPlanStats

Annuity Factor Calculator
afc.SOA.org

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The 2018 Society of Actuaries (SOA) Annual Meeting & Exhibit is the largest SOA professional development event, and this year it will take place Oct. 14–17 in Nashville, Tennessee.

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2018 Valuation Actuary Symposium

The 2018 SOA Valuation Actuary Symposium will be Aug. 27–28 in Washington, D.C. The symposium covers a range of content relevant to the finance, health and life industries. Attend to increase your acumen on the latest topics in valuation and financial reporting.

Sign up by July 31 and save $300 off the registration price!

SOA.org/ValAct

Contest

Through Kaggle, Actuaries Help Solve Complex Business Problems

Give an actuary a large data set and a problem to solve, and he or she is likely to feel a little giddy. This is the actuary's bread and butter. Manipulating and analyzing data are part of an actuary's day-to-day routine, and for many, it's the part they most enjoy. That's why actuaries are so well suited to participate in Kaggle competitions.

In a Kaggle competition, participants have the opportunity to contribute to major research initiatives—for example, improving prediction models for cervical cancer, detecting and classifying fish to aid in conservation—as well as less serious topics, such as identifying humpback whales by their tailfins or identifying horror authors through excerpts of their writing. Often, predictive analytics has a starring role in solving these challenges.

The Society of Actuaries (SOA) began the Kaggle Involvement Program to increase the awareness and credibility of actuaries as predictive modelers. In 2017, 15 SOA members and five candidates placed in the top percentiles for their challenges. "The competitions are filled with hundreds of teams, cutting-edge technology and industrial titans. With results like these, it's clear that actuaries don't need to explain why we're the predictive analytics experts industries are looking for—we can prove it," says SOA President Mike Lombardi, FSA, CERA, FCIA, MAAA.

Moshe Radinsky, ASA, FCA, MAAA, is a principal and chief actuary in Mercer's New York office and leads the Health and Benefits Technology Solutions practice. His team finished in the top 25 percent in the "Intel & Mobile ODT Cervical Cancer Screening" challenge. "When I saw the announcement from the SOA about the Kaggle competition, I had two reactions," he says. "The first was that I was happy to see the SOA recognizing the importance of data science and embracing a platform, even though it was nonactuarial, that would help actuaries learn skills that are important and will continue to become more important to actuaries. Second, the competition was structured so that attaining rewards was achievable for those willing to invest the effort in learning these skills."

CHALLENGE

Each Kaggle competition is sponsored by organizations with names like Google, IEEE, NOAA and Intel, and many come with a hefty cash reward for those who finish at or near the top of the competition. As part of the SOA's Kaggle Involvement Program, an additional cash prize is available for eligible participants who become a Kaggle Competitions Master or finish at a top percentile of their competition.

For more information on the SOA's 2018 Kaggle Involvement Program, visit *bit.ly/SOAkaggle*.

In 2017, Sarah Prusinski, ASA, MAAA, a consultant with Milliman's PRM Analytics, took part in the challenge titled "Planet: Understanding the Amazon from Space." The goal of this challenge was to label satellite images with atmospheric conditions and classifications of land use in order to help better understand deforestation. This was not the first Kaggle competition Prusinski had competed in—she regularly participates with coworkers. But this one was different, she says.

"The SOA's Kaggle Involvement Program definitely helped enhance my experience in the competition. For the Kaggle competitions I participated in at work, it was more laid-back and less focused on winning. Due to this program, I had the motivation to see the project through from start to finish, and I put in the numerous hours needed to perform highly and better understand the features of the modeling software used."

Participants can enter as individuals or as part of a team. To qualify for the SOA Kaggle Involvement Program, both SOA members and candidates can participate. However, candidates must have an official SOA member on their team.

"The teamwork aspect was great," says Charles Cadman, FSA, CERA, MAAA, whose team finished in the top 10 percent for "Planet: Understanding the Amazon from Space." "I couldn't have done this on my own in so little time, and I contributed a piece of code that might have pushed the team over the 10 percent threshold."

While the financial awards are motivating, they aren't the only reward for participants. With Kaggle, competitors have the opportunity to learn new skills, hone current skills and apply it all to a real-world problem with demonstrable results. Companies benefit from the collective knowledge, and actuaries benefit from a broader understanding of data science and predictive analytics.

"I would highly recommend that any interested actuary consider participating in a Kaggle competition … You will gain firsthand experience, learn a lot and become well informed about both the potential and the limitations of machine learning and data science," Radinsky says.

Prusinski agrees. "I would definitely recommend other actuaries participate in programs like this, and with Kaggle in general. Predictive analytics is rapidly growing and becoming more and more a part of our daily lives. Actuaries are already equipped with the skill base in order to be part of the change and form what predictive analytics [is] used for, and it can help change the services we can provide to the marketplace."

SHOWCASE YOUR DATA ANALYTICS SKILLS IN THE SOA'S 2018 KAGGLE INVOLVEMENT PROGRAM

Both individuals and groups are welcome to participate in the Kaggle Involvement Program. To compete as an individual, you must be a member of the SOA. Groups can include active candidates, and at least half of the group members must be FSAs or ASAs.

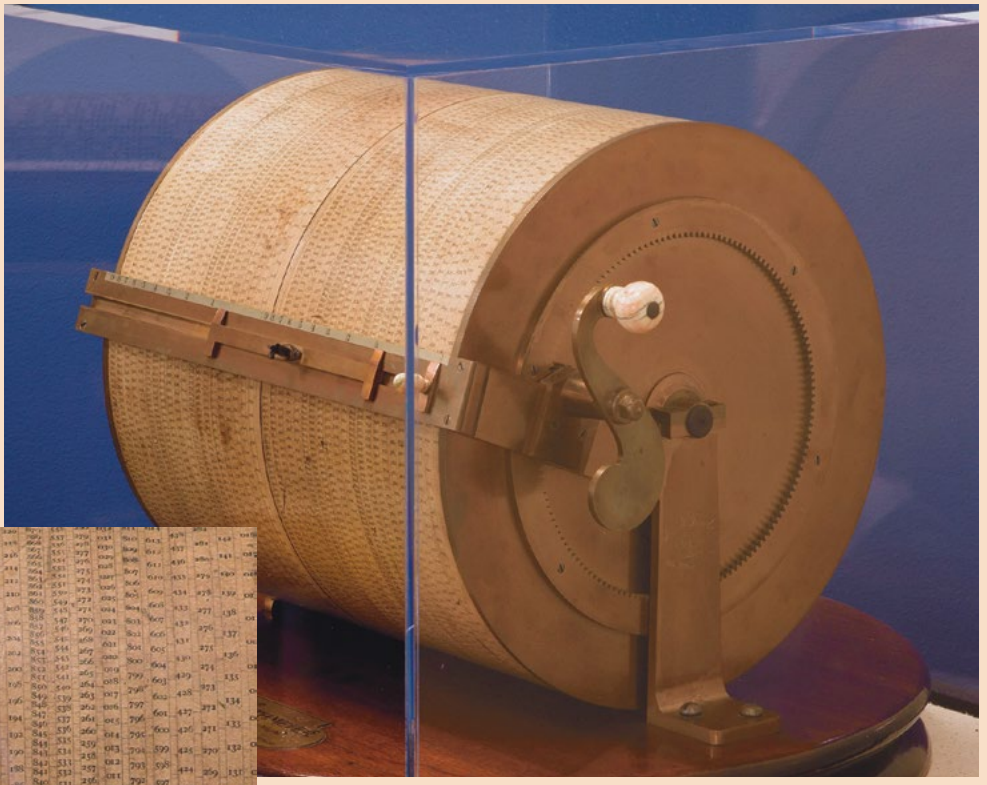
Compete for SOA awards, including US$2,500 for eligible individuals/teams who place in the top 10 percent on the private leaderboard, and US$5,000 for eligible individuals who become a Kaggle Competitions Master.

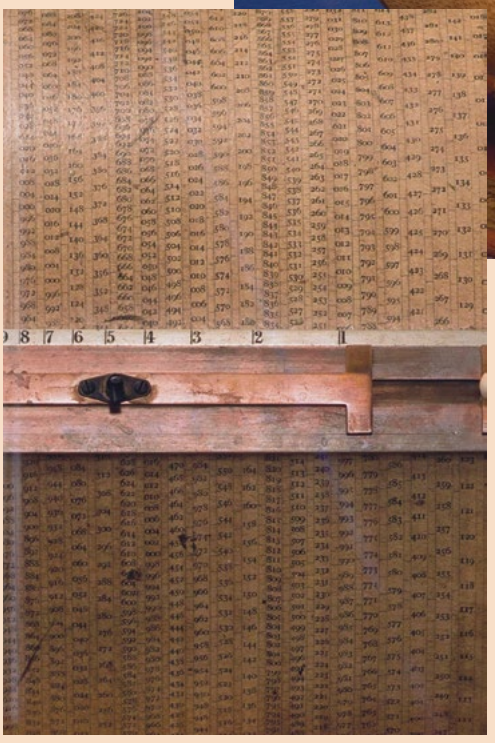
The program closes Dec. 31, 2018. Actual prize-winners will be determined based on final rankings.

Visit *bit.ly/SOAkaggle* for official rules and how to enter.

Timeless

THE PAST, PRESENT AND FUTURE OF THE SOA





1869 Elizur Wright (1804–1885) was a pioneer in establishing sound actuarial practices. It is said he built the arithmeter (shown on this page) with his own hands to expedite the thousands of calculations made necessary by the landmark legislation that he had drafted. The legislation required the Massachusetts Insurance Department to compute net level premium reserves on all policies in force in domestic and out-of-state life companies.

According to historians, at least three arithmeters still exist. One of these treasured artifacts resides at the Society of Actuaries (SOA) headquarters in Schaumburg, Illinois. The arithmeter has been described as the historical starting point of the mechanization of the American life insurance business.

Send us information about SOA historical artifacts that will enlighten everyone about our organization's past, and serve as a springboard for future growth, as the actuarial profession continues to inspire and evolve. Write to *theactuary@soa.org* and share.

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