Spatial risk diffusion
Predicting the propagation of risk linked to human behaviour
Digital disrupters have built thriving, operationally efficient and agile businesses by exploiting data and converting it into customer insight and mass personalization. As these companies begin entering the insurance industry, they can be expected to utilize data generated by the digitalization of our lives to maximize their risk-assessment capabilities.

The implication of digital disruption is clear: Traditional insurers cannot continue to rely on only their usual analytics methods and internal data to assess risk. Those carriers that do not embrace advanced analytics methods and external data will not be able to compete with either digital disrupters or current competitors that adopt new risk-assessment measures.

Insurers, however, can create a signal advantage for themselves—thereby improving their financials—by taking a more sophisticated approach to risk assessment. We believe that rather than assessing risk only as it relates to past events, insurers also need to understand risk as a function of customers’ individual and collective behavior and how risky behaviors are linked and influenced across different customer segments. To that end, Accenture and researchers at the Stevens Institute of Technology in Hoboken, N.J., have developed a predictive model designed to demonstrate how behavioral trends that affect risk diffuse throughout society over time.

The Spatial Risk Diffusion Model is unlike generalized linear modeling, a predictive model insurers have long employed to, for example, anticipate claims and loss severity. With meaningful certainty, the Spatial Risk Diffusion Model allows insurers to build a network of population groups by identifying the geographic, economic and social proximity of one population group to another that influences its behavior—good or bad. Linked groups in this network could be neighboring or located across the country from one another.

At the heart of this model is the notion of risk, as a social construct, adopted from theories of social constructivism, combined with network diffusion models. The premise of that construct is that societal norms, which determine the level of risk taking, are formed through social network interactions of a group. Those societal norms then influence the behavior of an individual within the same group. The theory of network propagation of risky behaviors has been supported in the past by researchers, for example in a medical study out of Harvard Medical School on the spread of obesity among friends and studies out of Harvard and the University of California—San Diego on smoking cessation. The insurance industry, however, has not applied the theory to understand the propagation of risk trends throughout the larger population.

To improve the existing theoretical foundation and to test our more expansive application of the theory and the predictive capabilities of the Spatial Risk Diffusion Model, Accenture partnered with the Stevens Institute’s Professor Babak Heydari, research assistant Mohsen Mosleh and other researchers in the Complex Evolving Networked Systems Lab. Professor Heydari suggested that network nodes can represent clusters of people located in a particular geographic area, rather than individual. This way, the model can be extended to cover a large population. Moreover, the model could still work without knowing the details of individual level relationships, as needed in the previous works.

In a nearly three-month-long project, the research team studied 12 years of National Highway Transportation Safety Administration (NHTSA) data on risky teenage driving behavior, as measured by fatal and severe non-fatal accidents. Applying the model, the researchers predicted with meaningful certainty which statewide populations of teen drivers would be led by the behavior of young drivers in other states, as well as the time needed for that behavior to propagate. For example, the model accurately predicted that the safer driving behavior of teens in North Dakota would lag behind the same behavior of teen drivers in Maine by more than a year.
The Spatial Risk Diffusion Model is unlike generalized linear modeling.
In short:
The Accenture / Stevens Institute research team applied crash and census data to its Spatial Risk Diffusion Model to determine the likelihood that driving behavior in one state would influence similar behavior in another, and the time it would take for this to happen (see diagram below).

- After reviewing 2000-2012 NHTSA data on teen driving, researchers focused on the 2008-2012 period to test the Spatial Risk Diffusion Model’s predictive capabilities. Researchers used the 2002-2006 data as a control period.

- The researchers first correlated the behavioral data for all states in the United States during the earlier four-year period, called the training-time window. They were looking for meaningful direct correlations of at least 0.60 on the Pearson’s r scale of -1.0—a perfect inverse relationship—to 1.0—a perfect direct relationship. For the meaningful correlations they found, the researchers then measured behavioral lag times.

- Researchers then examined data from the latter four-year period—or test-time window. They determined that their earlier results were highly predictive of their findings in the test-time window.

### Pair-wise cross correlations and time lags between crash data time-series of states


#### Fatal crashes (NHSTA)

#### Time series analysis

#### Population data (Census)

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Arizona lags Colorado by two years (Correlation 0.727)

Colour represents correlation
Number shows lag time in years

Highly correlated
Significantly correlated
Not significantly correlated
While the study focused on driving behavior, the behavior affecting numerous other types of insurable risk would have been equally valid study material. One such example is workers compensation. Insurers are concerned about claimants’ decisions about the length of time they will remain off work after suffering an injury. Staying off work as long as possible as opposed to returning as quickly as an injured worker is capable is driven by localized social norms in an area of collective influence. The study confirmed that this can be measured and predicted.

Other insurable risks driven by human behavior that could be assessed better with the model include employers’ liability, burglary and health, particularly health risks related to smoking and obesity.

With this behavioral forecast in hand, insurers would have a competitive edge in assessing whether they should enter, exit or remain in a geographical marketplace, as well as how they should best time any marketplace moves. In addition, where regulation allows, insurers could use the model to develop rates.

The model’s potential impact on insurers’ financials is significant. For example, consider the auto market. In the United States, teenagers’ risk attitudes are becoming more conservative by about 4 percent annually. Auto insurers could improve their loss ratios by 60 to 100 basis points by accounting for the risk diffusion effects gleaned from state-level data, Accenture’s analyses suggest. However, as we refine our analyses to a more granular zip code or county level, the loss-savings opportunity could be larger.

Insurers that apply a Spatial Risk Diffusion Model also would likely realize benefits in loss reserving. As a result of their improved risk assessments, insurers’ estimated future liabilities for those risks should be lower relative to those carriers’ relevant premium volume. Those reserve savings can flow directly to the bottom line or be allocated to measures designed to bolster the insurer’s business.
The Spatial Risk Diffusion Model also could provide tremendous support to insurers' marketing efforts and public policy campaigns.

Because the model identifies population groups that are leaders and laggards in behavior, it opens up more avenues into a market for insurers. "Not only could insurers approach their target markets directly, they also could allocate some marketing resources to regions the Spatial Risk Diffusion Model has identified as having a meaningful influence over the behavior in the target markets", notes Professor Heydari.

First steps

We believe carriers should immediately begin building the behavioral-assessment capabilities they will need to apply the spatial risk diffusion concept—within the existing insurance regulatory framework—when selecting and pricing risk.

1. Identify the data points of most value and with the highest predictive potential

Insurers have data that digital disrupters do not, and it could be even more powerful when combined with external data and new analytical techniques.

For example, as Accenture notes in its report, Digital Insurance Era: Stretch Your Boundaries, insurers already are experiencing the risk-assessment benefits of some connected risks. Auto insurers are using wireless devices in vehicles to monitor various driver behaviors, including time spent driving, acceleration and braking. In the health insurance market, Apple and Humana in the United States have partnered to allow customers to share their wellness data with Humana through the Apple HealthKit. As Accenture points out in its report, The Connected Home—New Opportunities for Property & Casualty Insurers, the same potential exists with customers who own homes in which various systems and devices can be controlled remotely with a smartphone. Besides mitigating risk by leveraging data that connected homes generate, insurers also can begin collecting data on customers' behavior. Insurers can identify the progression of risk as a function of human behavior in many other lines of coverage, too—workers compensation, burglary and health, for example.

2. Incentivize customers to share personal data that would provide additional insights about their behavior

The Accenture 2013 Consumer-Driven Innovation Survey shows that 78 percent of insurance customers globally would be willing to share personal information with their insurers in return for benefits, like lower premiums or quicker claims settlement.

3. Consider partnering opportunities

Now that the spatial risk diffusion concept has been validated and we see the merit of applying it in an insurance context, our next step is developing a full-scale model that marries granular geographic and socio-economic networks with claim data. That model would be for a specific line of coverage, such as workers compensation or auto insurance. Accenture invites insurers to contact us if they have any interest in participating in this project.
Insurers that do not look beyond their traditional data sources and analytical methods will be left behind by the industry’s digital disrupters, as well as current competitors that move out of their comfort zones and adopt modern risk assessment measures. The Spatial Risk Diffusion Model is a tool that would allow insurers to gain a competitive advantage in risk assessment. With it, insurers could see the impact that human behavior has on the progression of risk throughout society. Carriers would be able to identify which population groups influence others and how long that influence takes to propagate. With this advanced understanding of how risk progresses throughout society, insurers would improve their positioning against new market entrants, as well as current competitors, and continue to grow their business. They would become the disrupter, rather than the disrupted, in the industry.

Conclusion
About Accenture

Accenture is a global management consulting, technology services and outsourcing company, with more than 358,000 people serving clients in more than 120 countries. Combining unparalleled experience, comprehensive capabilities across all industries and business functions, and extensive research on the world’s most successful companies, Accenture collaborates with clients to help them become high-performance businesses and governments. The company generated net revenues of US$31.0 billion for the fiscal year ended Aug. 31, 2015. Its home page is www.accenture.com.

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