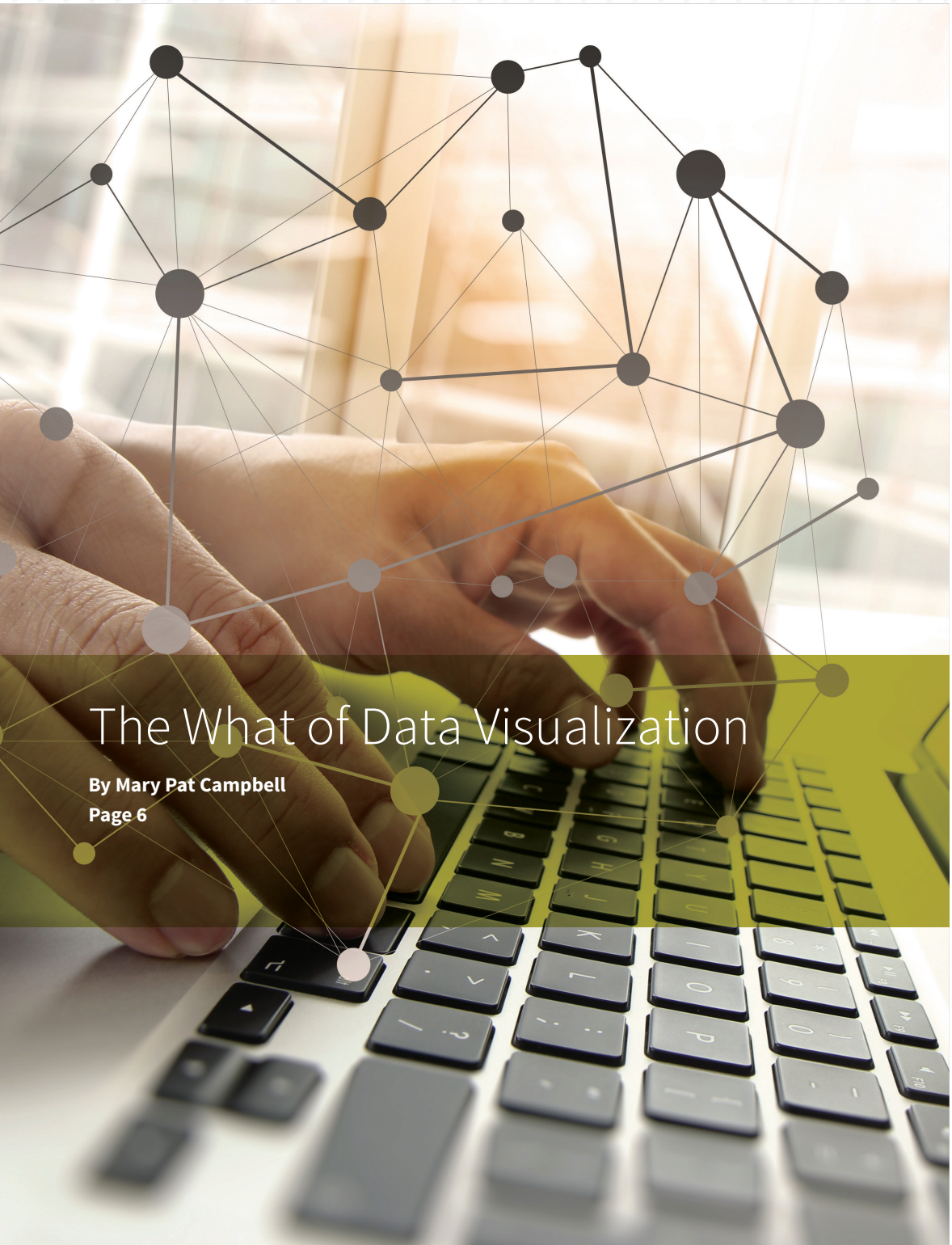
SOCIETY OF ACTUARIES
TECHNOLOGY SECTION

CompAct

ISSUE NUMBER 59 • OCTOBER 2017



The What of Data Visualization

By Mary Pat Campbell

Page 6

CompAct

Issue Number 59 • October 2017

Published twice a year by the Technology Section of the Society of Actuaries.

475 N. Martingale Road, Suite 600
Schaumburg, Ill 60173-2226
Phone: 847.706.3500 Fax: 847.706.3599
www.soa.org

This newsletter is free to section members. Current issues are available on the SOA website (*www.soa.org*).

To join the section, SOA members and non-members can locate a membership form on the Technology Section webpage at *http://www.soa.org/sections/technology/technology-landing/*.

Publication Schedule
Publication Month: April 2018
Articles Due: Feb. 6, 2018

2017 SECTION LEADERSHIP

Letter from the Editors

By Mark Africa and Sean Hayward

Welcome fellow members of the Society of Actuaries Technology Section to the second edition of *CompAct* in 2017. The feedback we received on the switch to a paper issue was positive across the board, and we received a lot of strong feedback on the quality of our articles in the last issue. The one area where some members did provide some constructive feedback was around the number of articles, to which we as editors say, we fully agree! We would love more articles, both because it helps educate our section members, and selfishly because as editors, we both love reading and hearing different ideas and perspectives from our talented section members. So, while we definitely hear and understand the feedback for more articles, we need to turn that request back to you, our readers. We encourage you to take a bit of time and put together an article, and if you have interest in writing, but need help with a topic, or to flesh out an idea, myself, Mark or any of the other technology section council members are always happy to help, just ask!

With respect to article submissions, there are two initiatives that we'd like to draw attention to. First, is the SOA volunteer database. This is a place where all SOA members can go to look for areas where they can volunteer to help the profession, and one key area of recruitment on that site is for newsletter authors. More information on this can be found under the volunteer section at *engage.soa.org*.

More specific to the technology section, there is an active call for essays that Paul Ramirez will discuss in more detail in his letter from the chair.

As always, Mark and I welcome feedback on *CompAct* from all of our members, both related to content as well as the changes to our delivery mechanism and timing. We encourage any of you to reach out to either of us with ideas for potential articles, or if you have an interest in authoring an article. We can be reached at *mark.africa@aig.com* or *sean.hayward@fisglobal.com*.

In this latest issue of *CompAct*, in addition to Paul's letter from the chair, we have four articles. One is a continuation of a recurring series, and we have three new contributors.

THE WHAT OF DATA VISUALIZATION

One of our most dedicated authors, Mary Pat Campbell, continues her series on data visualization with an insightful discussion on the software available to help with data visualization. She covers a number of different categories of tools, with discussion around some of the benefits of each category of software.

ACTUARIAL SYSTEMS ON THE PUBLIC CLOUD

Focusing on a quickly expanding area of interest for actuaries, new contributor Yash Titus of FIS has written a useful article on the applicability and considerations for making use of the public cloud for your actuarial modeling needs.

EFFECTIVE COMMUNICATION OF STOCHASTIC RESULTS

Continuing with the data visualization theme, John Hegstrom from ARC covers one of the more challenging topics in actuarial modeling these days, understanding and effectively communicating stochastic results in a way that allows meaningful conclusions to be drawn from them. His article covers a wide range of options and considerations for how these results can be handled in a way that allows insightful and independent conclusions to be drawn.

HORSES FOR COURSES

Van Beach from Milliman revisits the age-old debate between open and closed actuarial software platforms, and makes the argument that this discussion isn't nearly as binary as it used to be. Best practice these days is to blend aspects of both paradigms in a way that gives actuaries the flexibility they need, without sacrificing the controls and governances demanded of modern actuarial platforms. ■

Mark Africa, ASA, MAAA, is an IT actuary at AIG. He can be reached at *mark.africa@aig.com*.

Sean Hayward, CFA, FSA, MAAA, is a software development actuary with FIS. He can be reached at *sean.hayward@fisglobal.com*.

Chairperson's Corner

By Paul Ramirez

The goal of the Technology Section per our mission statement is to "promote the exchange of information concerning technology as it relates to the work of actuaries" as well as "facilitating the adoption of new technology."

Earlier this year, our section council held our first in-person meeting; it was well attended by the council and was instrumental in setting our direction for the upcoming year. Among the topics we discussed was how to better serve our section members. The role that technology plays in the actuarial career is at an inflection point; the pace at which technological changes and developments are occurring seems to be increasing every year. Predictive analytics is driving much of this change. R and Python are increasingly being used by actuaries. Actuaries are starting to work with Hadoop, Pig, and Hive. Cloud computing is becoming more and more prevalent, while artificial intelligence and automation are affecting all areas of insurance. FinTech and InsurTech companies are emerging and providing new competitive threats to insurance companies and actuaries.

Although some actuaries may be familiar with these technologies, many actuaries are probably completely unfamiliar with them. To help fill in these gaps, the Technology Section is sponsoring a Call for Essays on Cutting Edge Technology. By the time this article is published, the submission deadline will have passed, but we plan on publishing the submitted essays in early 2018.

Another initiative of the Technology Section in 2017 is to revamp the Tools for Actuaries website (*http://toolsforactuaries.org*). This website has been around for some years but is lightly trafficked. In the short run, we are working with the SOA to broaden the set of tools that can be uploaded to this site. We hope that in the future actuaries will be using this site to share tools that they find valuable, including R scripts, Python scripts, Excel tools, VBA scripts, and so many more. We will be hosting a contest later this year to award a cash prize to the actuary who uploads the best technology tool. See the Technology Section homepage for more details! In the long run, the Technology Section is partnering with the SOA to provide a tool repository that can provide capabilities such as rating, commenting, and revision tracking.

Last, we are committed to continuing to deliver value to our membership through our well-received newsletter and webcasts. In response to feedback from section members, we switched formats from an electronic newsletter to a paper newsletter, and we reduced the frequency from quarterly to semiannually. Our webcasts in the last few years have been very well attended, and we are focused in the upcoming years on delivering diverse topics that are valuable to actuaries. Feedback on recent changes has been positive, but we continue to welcome more constructive comments from our audience. We recognize that technology does not stand still and neither should our section, as we continue to strive to provide value to members.

If you are not a member of the Technology Section, I encourage you to join. Technology is a critical part of our jobs as actuaries, and its importance will only grow in the future. If you are interested in volunteering, there are various ways to get involved: you can write an article, join as a friend of the section, or run for a section council position. The Technology Section is a great community of actuaries; don't miss out! ■

Paul Ramirez, FSA, MAAA, is a health actuary at Allstate Benefits. He can be reached at *paul.ramirez@allstate.com*.

The What of Data Visualization

By Mary Pat Campbell

This is a fourth part of a continuing series on data visualization (aka dataviz):

- The Why of data visualization—questions to ask when visualizing numerical information
- The Who of data visualization—major figures and books in advocating data visualization best practices
- The Where of data visualization—websites to polish your data visualization game
- The What of data visualization—software to implement data visualization
- The How of data visualization—specific data visualization techniques to consider in actuarial practice.

(The when of data visualization being NOW, of course.)

For this article, I'm going to concentrate on software and resources involved with that software for data visualization, focusing on widely available and widely used languages or applications.

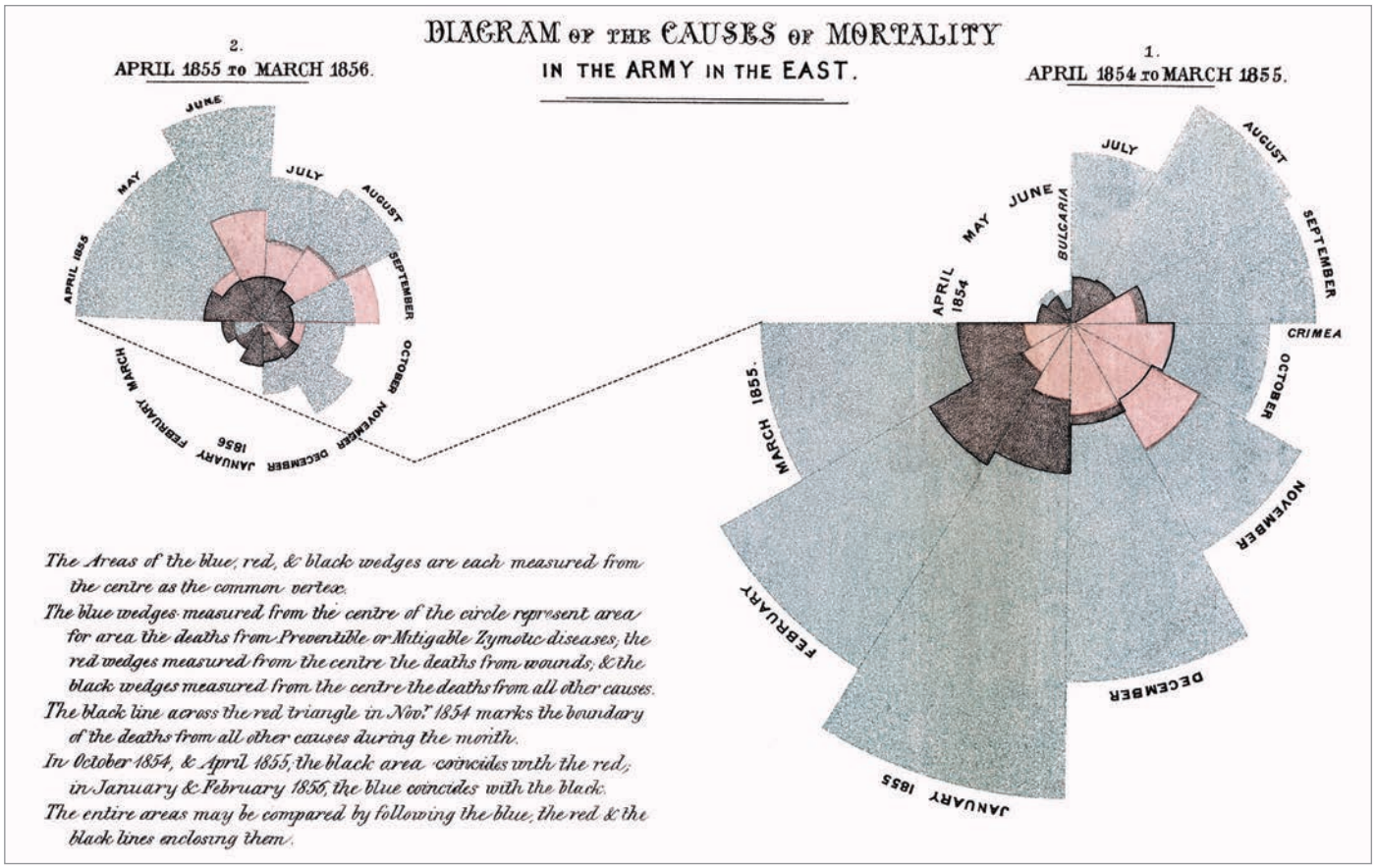
I will consider the choices on the following dimensions:

Dimension	Description
Learning Curve	How easy is it to get up to speed to use for visualizations?
Ease of Use	Once you've gotten up to speed, how easy is it to use?
Default Choices	How many default graphs are there to use? Do they span what you need to graph?
Flexibility	How much can you change in the visualizations?
Aesthetics	How pretty are the graphs?
Interactivity	Are there elements of interactivity for the data consumer (as opposed to the visualization creator)?

CONSIDER OLD TECHNOLOGY FIRST

But before I dive into an overview of some of the tools at our disposal, I want to advocate for a very old, familiar technology to begin with: pencil and paper.

In "The Who of Data Visualization," I mentioned Edward Tufte, who has a veritable suite of books and examples of fabulous (and some decidedly awful) visualizations—and many of the best examples he has were hand-drawn.



I recently came across this graphic from Florence Nightingale, on mortality rates in British war hospitals during the Crimean War.

Miss Nightingale drew several graphs, by hand, to demonstrate mortality rates among the British soldiers, which became part of her masterwork *Notes on Matters Affecting Health, Efficiency, and Hospital Administration in the British Army*, published in 1858. In addition to this radial-oriented graph—oriented to give the feel of a cycle for a year—she had other graphs in the finished book that were area graphs or simple bar charts, in addition to tables of numbers.

At the 1900 World Fair in Paris, W. E. B. Du Bois and his sociology students at Atlanta University (now known as Clark Atlanta University) created 60 charts to show how African American life had changed in the prior 200 years. The charts were hand-drawn and hand-colored, many being familiar bar and line charts, but some taking interesting shapes as Dr. Du Bois was not tied to any particular framework for displaying his data.

One of the issues with the technology-driven aspect of our jobs is that often we are crammed into the defaults or the structures endemic in our tools, and we go with the menu of what is easily available, rather than thinking about what we want to see or what we want to show. We forget that pencil and paper are open to us as well.

The main distinction between these historical hand-drawn charts and our own is the level of precision our software can graph with and uniformity of elements such as shading, line width, and text. We can be sure, by golly, that our graphs will be accurate to the nearest pixel or the fineness of our printers.

But can our data users actually perceive the difference? And one may consider the aesthetics not much of an improvement.

The whole point of data visualization is to provide *humans* with insight about a set of data, taking advantage of our huge analysis apparatus naturally built into our visual cortexes. We may be using the visualization to tell a story (as both Miss Nightingale and Dr. Du Bois were doing), or we may be using the visualization to see if there are discernable patterns in our data. But if distinctions can't be seen, the point of visualization is completely missed.

I'm not saying we should be publishing hand-drawn charts, but that if we have a complex set of data we want to visualize, the

first step may be to grab a marker and step up to the whiteboard, or to get a pen and some paper from the recycle bin. Don't hit the software as your first choice.

To see a story of a modern data graphic designer going through a process that started out with a sketch, check out the article "Sketching with Data Opens the Mind's Eye" by Giorgia Lupi, originally published on the National Geographic Data Points blog (links to this and a longer version of the article can be found at the end of this article.) In addition, links to MIss Nightingale's and Dr. Du Bois's charts can be found in the resource list—check them out!

EXCEL

Yes, yes, I know. But don't count Excel out for data visualization. Excel gets a bad reputation for awful default graph settings (and chart types that nobody should ever use [cough] pie charts [cough]), but let us consider the following: How complicated do we really need our graphs to be? As noted above, in the era of hand-drawn charts, we will see many familiar designs.

Much of the data visualization we need to do may be looking at particular slices of data as bar/column graphs, line graphs, or scatter plots. Excel can do all of those easily and, more to the point, has a relatively easy interface if you want to change the formatting of a single data point to help it stand out. Excel may be one of the easier tools to use simply due to our own familiarity.

But also due to our own familiarity, we may be used to using Excel in a specific way.

I want to highlight two types of visualizations built into Excel, which I find very useful for working in my calculations directly. I'm often creating large tables of data, and I would like to eyeball the results.

One method is using built-in Conditional Formatting. An example is seen below:

Return	0%										
		Contrib Increase									
		0%	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%
Benefit Increase	0%	2024	2025	2027	>2040	>2040	>2040	>2040	>2040	>2040	>2040	>2040
	1%	2023	2024	2024	2026	>2040	>2040	>2040	>2040	>2040	>2040	>2040
	2%	2022	2023	2023	2024	2025	>2040	>2040	>2040	>2040	>2040	>2040
	3%	2022	2022	2023	2023	2024	2025	>2040	>2040	>2040	>2040	>2040
	4%	2021	2022	2022	2022	2023	2023	2024	2028	>2040	>2040	>2040
	5%	2021	2021	2021	2022	2022	2023	2023	2024	2026	>2040	>2040
	6%	2021	2021	2021	2021	2022	2022	2022	2023	2024	2025	>2040
	7%	2021	2021	2021	2021	2021	2021	2022	2022	2023	2023	2025
	8%	2020	2020	2021	2021	2021	2021	2021	2022	2022	2022	2023
	9%	2020	2020	2020	2020	2021	2021	2021	2021	2021	2022	2022
	10%	2020	2020	2020	2020	2020	2021	2021	2021	2021	2021	2022

Another in-cell visualization is sparklines:

Funded Ratio Trend	Row Labels
	Chicago Municipal Employees
	Chicago Teachers
	Connecticut Municipal
	Connecticut SERS
	Illinois Municipal
	Illinois Teachers
	Wisconsin Retirement System

I find that many people are unaware of these as built-in visualization techniques for Excel, and the boon of these techniques in particular is that they are useful if you're working within data and want to see simple visualizations while you see what changes.

In this article, I am not talking about how to do any of these, but now that you know these exist, you can search for the resources to work through examples.

Dimension	Description
Learning Curve	Fairly simple for basic charts; even for the most complicated built-in techniques, there are not of things needed to learn.
Ease of Use	Using menus and options, fairly easy; if you need to automate with VBA, less easy, but still not too onerous
Default Choices	Covers major graph types, but provides too many bad options (3-d effects, pie charts, etc.)
Flexibility	Can manipulate axes, change fonts, etc.; difficult to change beyond basic chart types
Aesthetics	Aesthetics are meh; default graph styles have issues with color choices
Interactivity	Interactivity is limited for user; there are ways to use VBA to make things more interactive, but it's not natural to the program

GOOGLE DOCS—SHEETS

This one is harder to talk about, because as I was writing this, Google had an announcement on what it was doing with Sheets:

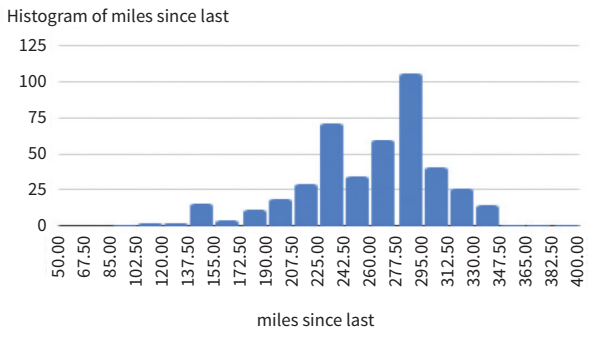
> Explore in Sheets, powered by machine learning, helps teams gain insights from data, instantly. Simply ask questions—in words, not formulas—to quickly analyze your

> data. For example, you can ask "what is the distribution of products sold?" or "what are average sales on Sundays?" and Explore will help you find the answers.
>
> Now, we're using the same powerful technology in Explore to make visualizing data even more effortless. If you don't see the chart you need, just ask. Instead of manually building charts, ask Explore to do it by typing in "histogram of 2017 customer ratings" or "bar chart for ice cream sales." Less time spent building charts means more time acting on new insights. (Gundrum, June 1, 2017)

First off, I wasn't even aware of Explore as an option in Sheets, which I've mainly used for some very simple spreadsheets I've created over the years. Explore is hidden in a diamond-ish icon in the lower right of the sheet, which opens up. The problem is that there really isn't a huge amount of flexibility with this tool, because the type of data I'm looking at tends to differ from whatever Google trained their Explore tool on.

This has been my frustration with Google Sheets in general: the suite of Google document-creating and -sharing tools has been geared toward people who don't want or need a lot of features—that is, the great majority of people currently using Microsoft Office. A huge amount of flexibility isn't available in terms of what the visualization creator can control: there are very few chart types to choose among, and the amount of editing you can do on items such as axes and fonts is also limited.

That said, I tried out the Explore tool with one of my longer-running Google Sheets: a tracker of my gasoline usage, costs, and mileage. I drive about 35,000 miles per year, so you can imagine I keep a close eye on this expense. I had created my own graphs with moving averages of cost per gallon and the like, but here are some graphs the Explore tool created for me automatically:



Ranges from 96 (October 5, 2015) to 394 (April 30, 2016), but most values are around 260, plus or minus 33.

Not only did it create a histogram for me, it also gave me some "analysis" in words.

Alas, most of the graphs automatically created were useless.

Dimension	Description
Learning Curve	Even simpler than Excel
Ease of Use	Very easy to create graphs
Default Choices	Has been expanding chart types, has main ones used; one not built into Excel is Geo Maps, which will do choropleths
Flexibility	Limited flexibility in controlling aspects of the graph, once the graph type has been chosen
Aesthetics	You are forced into particular aesthetics and can't adjust
Interactivity	Limited

R

R itself is an interpreted language developed by statistical-minded people, with 10 years of development. Various environments have been developed for it, to make it a bit more user-friendly, and people create packages of code to be used with the base R language and syntax. I use RStudio myself, and other tools are out there to make results easier to deal with.

The main issue users may have is that R itself is mostly command-line driven, meaning one must type in all the parameters being used. If you want to adjust aspects of the graphs, you may get annoyed at having to look up, for example, what the different parameters are.

The good aspect, though, is that if you're looking for data visualizations to help you analyze your data (as opposed to telling a good story), many people have already coded that for you, so graphs are automatically generated for you when you do specific analyses. For example, if you plot the results from a multiple linear regression, it will generate plots testing goodness of fit, such as a normal Q-Q plot, which checks that the residuals are normally distributed.

R is not intended to be user-friendly. It's intended to be tech-friendly, and a very large number of tools have been developed for people who concentrate on data analysis. The main library of R functions for graphing that I see people use are in ggplot2.

Dimension	Description
Learning Curve	Can be quite steep
Ease of Use	If adjusting a lot of aspects, can be difficult
Default Choices	Packages available for making all sorts of graphs, but you essentially have to look them up
Flexibility	A lot of flexibility in controlling the graphs, but this is a trade-off with how much you need to learn to manipulate these elements
Aesthetics	The default aesthetics are spartan and can get quite ugly
Interactivity	Limited

PYTHON

Python is a fairly widely used programming language. It is not optimized for data analysis, in its core language, but like with R, people develop modules to expand Python's capabilities. There are many "data science" types using Python now, with modules such as pandas, numpy, matplotlib, and Seaborn that are used for data crunching and visualization.

Much of what I wrote for R can be written for Python—indeed, many people use both. I find that the R people came mainly from the academic side, but because Python is fairly easy to pick up, some invade from that side. There's a package to run Python from R . . . and vice versa. R is more used for standalone data analysis, and Python when you need to work with apps or other external users.

There are ways to import/export data from Excel to these as well.

Dimension	Description
Learning Curve	Python itself is fairly simple, but getting into data science applications can be quite difficult
Ease of Use	It is easy to debug Python code, but you still need to learn specific code
Default Choices	There are packages for making all sorts of graphs, but you essentially have to look them up
Flexibility	A lot of flexibility in controlling the graphs—but this is a trade-off with how much you need to learn to manipulate these elements
Aesthetics	Many packages to help make pretty graphs
Interactivity	Can be interactive—but you need to find proper modules to use

TABLEAU

Tableau is an "oooh, pretty" type of software, with multiple versions, and the pricing has been in flux as of late. That said, there is a free version to play with, the downside being everything you do with it must be public, and the options on the free, public version are more limited than the full software. I have not tried a paid version, so my comments relate to the public version.

Dimension	Description
Learning Curve	Easy to get started, with lots of support: sample data sets, videos, and exercises
Ease of Use	Extensive point-and-click interface; intended to be easy for general public to use.
Default Choices	Lots of choices, and uses defaults based on structure and content of the data; has geographic graphs as a choice
Flexibility	There can be flexibility, but to keep it simple, limits on what you can adjust in the public tool
Aesthetics	It's the prettiest in the land—nice color palettes
Interactivity	Built to be interactive, very easy to embed into websites

TRYING TO HIT A MOVING TARGET

The above evaluations of different choices are not exhaustive. Given that data science is very hot right now, and that several not terribly numerate people are attempting to ride this wave, more and more easy-to-use tools are being developed. As I noted, as I was writing about Google Sheets, I noticed that they just announced new features.

The problem is that we're now in a world of software-as-a-service. One doesn't buy a static piece of software, but you have a subscription to using a platform (like Microsoft Office or Tableau), or you're part of a coding community where the packages keep getting updated.

This article is more to let you know some of the available tools. I tend to use multiple tools, depending on my task. I do much of my for-publication visualizations in Excel (or, rather, graphs embedded in PowerPoint) because I am part of a publication team, and this is dependent on the tools I use. I can generate graphics to use in other formats, but because of limitations of adjustments and wanting to meet certain production standards, I keep this sort of production to a minimum.

I am primarily using tools like R and Python to do visualization for analysis beyond Excel's (or Google Sheets') capabilities. I use Google Sheets for simple graphs I embed in my blog. I have rarely used Tableau, though I did use it once, to embed an interactive graph on my blog. It didn't play well with my blogging software, so I didn't do that again.

At the end of it all, I tend to go back to my pencil and paper, trying to do some doodles to think things through. Some visualizations I'm still working on . . . and maybe that perfect tool will be just around the corner for me. ■

Mary Pat Campbell, FSA, MAAA, is a vice president, Insurance Research at Conning in Hartford, Conn. She can be reached at *marypat.campbell@gmail.com*.

RESOURCES

Giamo, Cara. "Florence Nightingale Was Born 197 Years Ago, and Her Infographics Were Better than Most of the Internet's." *Atlas Obscura*, May 12, 2017, *http://www.atlasobscura.com/articles/florence-nightingale-infographic*. Date accessed, May 16, 2017.

Gundrum, Daniel. "Visualize Data Instantly with Machine Learning in Google Sheets." G-Suite, June 1, 2017, *https://www.blog.google/products/g-suite/visualize-data-instantly-machine-learning-google-sheets/*. Date accessed, June 7, 2017.

Lupi, Giorgia. "Sketching with Data Opens the Mind's Eye." National Geographic Data Points blog, July 10, 2015, *http://news.nationalgeographic.com/2015/07/2015704-datapoints-sketching-data/*. Date accessed, June 7, 2017.

Lupi, Giorgia. "Sketching with Data Opens the Mind's Eye." Accurat studio blog on *Medium.com*, Feb. 19, 2016, *https://medium.com/accurat-studio/sketching-with-data-opens-the-mind-s-eye-92d78554565*. Date accessed, June 7, 2017.

Meier, Allison. "W. E. B. Du Bois's Modernist Data Visualizations of Black Life." Hyperallergic, July 4, 2016, *https://hyperallergic.com/306559/w-e-b-du-boiss-modernist-data-visualizations-of-black-life/*. Date accessed, Feb. 9, 2017.

Miller, Meg. "W. E. B. Du Bois Was a Master of the Hand-Drawn Infographic." *Co.Design*, Febr. 9, 2017, *https://www.fastcodesign.com/3068020/web-dubois-was-a-master-of-the-hand-drawn-infographic*. Date accessed, Feb. 9, 2017.

Nightingale, Florence. *Notes on Matters Affecting Health, Efficiency, and Hospital Administration in the British Army.* London: Harrison and Sons, 1858. *https://archive.org/details/b20387118.*

Simonite, Tom. "Google Sprinkles AI on Its Spreadsheets to Automate Away Some Office Work." MIT Technology Review, June 2, 2017, *https://www.technologyreview.com/s/608023/google-sprinkles-ai-on-its-spreadsheets-to-automate-away-some-office-work/*. Date accessed, June 7, 2017.

Willems, Karlijn. "Choosing R or Python for Data Analysis? An Infographic." DataCamp, May 12, 2015, *https://www.datacamp.com/community/tutorials/r-or-python-for-data-analysis*. Date accessed, June 7, 2017.

A Global Qualification

Certified Actuarial Analyst (CAA)

Benefit from enhanced technical and analytical skills

With the mathematical skills and ability to communicate financial concepts, manipulate and analyze data sets, CAAs are essential members of your actuarial team.

The CAA is offered by CAA Global, a joint venture of the Institute and Faculty of Actuaries and the Society of Actuaries.

Learn more at CAA-Global.org and continue building to the future.

Leveraging the Public Cloud to Run Actuarial Risk Modeling Software

By Yash Titus

Actuarial and IT teams have been challenged over the past few years by goals that are contradictory in nature. On one side, from a business perspective, there is a need for more processing power to meet new regulatory obligations or the need to reduce the time to produce reports. And, on the other side, IT teams are constantly under pressure to do more with the same budget or reduce cost further. The public cloud and the ability to procure infrastructure quickly and rent large processing capacity for short periods have provided an effective answer to ensure both business and IT goals are met.

PUBLIC CLOUD AND THE FIT

The public cloud is resulting in a change in basic assumptions, enabling actuarial teams to focus on their models and calculations without having to work around or be restricted by the available calculation capacity.

Public cloud vendors, because of their size and scale, are able to keep costs low and offer attractive pay-as-you-go models. The cloud model makes it very cost effective, especially for applications that require large processing capacity comprising expensive servers and have usage patterns that have peaks and troughs.

Actuarial systems fit well into the cloud due to their need for a large amount of capacity to complete month-end/quarter-end and annual reporting requirements (additional 3× to 5× calculation capacity needs during peak periods) while often requiring much lower capacity on average for the rest of the year.

This provides the insurance company several benefits compared to a static solution within a conventional datacenter:

1. Pay for the additional capacity only when required, compared with needing to provision for peak capacity. This allows you to do more with the same budget or reduce costs for comparable capacity.

2. Flexibility: Ability to quickly provision up and then ramp down to meet business needs. It is not unusual in a conventional datacenter to take weeks to fulfill any requests for new hardware or storage requested against minutes, hours or a few days on the public cloud based on the type of requests.

3. The public cloud solution also eliminates the need for large capital expenditure allocation every three to five years to replace aging hardware.

As insurance companies think more about leveraging the public cloud to meet their actuarial processing needs, companies also need to budget time to plan upfront and consider several factors prior to making the move to ensure they achieve the best possible results.

The first step is to prioritize the needs from an actuarial processing perspective. This will allow the company to plan for what is needed initially against what may be required 18 to 24 months down the road. There is no need to plan everything upfront due to the flexibility of the public cloud.

Many definitions are found on the internet of what the public cloud is; in essence, it is a set of resources/technologies (servers, storage, etc.) and services provided by a third-party public cloud provider. The cloud provider manages the underlying hardware, and the company that wishes to leverage the infrastructure will need to implement, host and support their applications on the public cloud.

Since the public cloud vendor provides you the necessary hardware required to host the actuarial applications, you need to think about whether you want to rent the infrastructure and build, host and support the actuarial environment yourself (I like to say it is analogous to buying the parts of the car and building the car yourself), or whether you want to sign up with a vendor managed Services or Software as a Service (SaaS) offering

(analogous to buying a car from a reputable brand and focusing on driving the car rather than focusing on building and ongoing maintenance of the car). To clarify the difference between SaaS solution and a managed services solution, a SaaS solution is a multi-tenant solution at the application level where the vendor is providing the software on a subscription model and offers a single fee to cover software license, maintenance, support and infrastructure costs. The vendor also usually does not customize the environment for individual customers, and services such as upgrades are as per the vendor schedule. In a managed services solution, while the vendor may have shared resources to manage the environment, the individual environments are built as per customer requirements and the customer may have more flexibility to schedule services like upgrades even if they are included as part of the service. The license and maintenance fees are usually separate from the fees to host and manage the environment for the customer.

The choice whether you decide to provision and support your actuarial systems yourself or rely on a vendor managed services or SaaS solution should be based on your overall IT and actuarial priorities, goals and risk appetite. Managing the actuarial system on your own may look attractive initially, and although the cost may seem higher for a vendor managed services or SaaS solution on first look, a detailed TCO is likely to show that this may be the better solution for you when you weigh all the costs and risks associated with both options.

Most of the leading actuarial risk modeling systems have adopted their solutions for the public cloud and offer various license models and deployment models to support it. Most of them have a solution on Amazon Web Services and/or Microsoft Azure, which are the two leading public cloud providers as per Gartner's "Magic Quadrant" as of June 2017.

As you consider which option and approach is best for you, a few factors to think about in more detail are listed next.

PERFORMANCE AND USABILITY OF YOUR ACTUARIAL SOFTWARE ON THE CLOUD ENVIRONMENT

The underlying architectures for the cloud providers are different and hence it is important to know how the actuarial software that you currently use or are planning to choose performs on a particular cloud platform.

If you decide to do it yourself, then you will need to spend time and do, for instance, technical proof of concepts to get a deeper understanding of the various services available, server instance types, storage types and what works best with your actuarial software. When considering production environments, there is even more to consider to manage and support the environment and make it secure (e.g., antivirus, firewalls configuration, monitoring, encryption).

A related point to consider is the availability of resources that understand both the public cloud and the actuarial systems that they are supporting on the public cloud. Keyman risk is something that needs to be considered when supporting with your own IT team because demand for resources proficient with cloud technologies combined with knowledge of business applications is very high and hence should be accounted for in your TCO comparison.

If you choose to take a managed services or SaaS solution from the actuarial systems vendor, then the responsibility to optimize the solution on the public cloud lies with the vendor. While choosing a vendor managed services or SaaS solution, you need to ensure that the vendor is managing the engagement via strong service levels offered at the system level because you should be concerned with whether the application is available for use rather than just infrastructure availability. The common service levels that you should look for from the vendor are around incident response and resolution as well as system availability. You should also check that the vendor is offering hard service level agreements (SLAs) with associated service credit penalties rather than soft target service levels with no penalties attached for a miss of an SLA.

SECURITY

Security is another key factor that always comes up when moving to a cloud solution. Leading cloud providers like AWS and Azure take security very seriously and take many steps to make their offering as secure as possible. The view and perception of IT and security teams within insurance companies have also evolved over the past 12 to 18 months, and there is a common acceptance that the security measures on the public cloud are comparable to, if not better than, solutions offered on the private cloud. If you take a vendor managed services or SaaS solution, those vendors may take additional steps to secure the environment in conjunction with the cloud provider. Managed services and SaaS vendors usually have additional SOC 2 Type 2 or equivalent certifications, which are in addition to all the certifications that the cloud provider maintains.

DATA

What data to transfer to the cloud and how frequently you transfer data is another key consideration while moving to the cloud. Moving to the cloud is a good time to do some housekeeping so that you are transferring only data that are useful and required. Cloud vendors offer different storage options, and although you may need more expensive options to support actuarial runs in production, it may be possible to store infrequently used data on lower cost storage options. Cloud providers generally don't have data transfer costs to transfer data into the cloud environment, but usually have some costs to transfer data out of the cloud environment. It is best to transfer the required data upfront, complete the processing on the cloud, and then pull

> If you go with a vendor managed services for SaaS solution, it will be easier to budget costs. . .

only the required results from the cloud so that you can feed other systems.

Finally, it is important to be able to estimate and budget the cost of the solution initially to support your business case and, once on the cloud, to be able to track and monitor your costs against budget. Although flexibility and having unit pricing provide a lot of flexibility, estimating total costs and budget can be tricky because the cost varies based on your usage of the various services and resources that you leverage from the cloud provider. The costs can vary greatly based on your design of the infrastructure and your usage patterns.

If you are planning to move and support yourself, you need to work out effective ways to validate the costs and track your budget. It is not very easy initially: the reporting provided by the cloud vendor provides details only at the infrastructure level and will not give actuarial teams a complete picture, because it does not provide them details as to which teams did how many runs, how much time each run took what resource used, and so on. You will need to think about how you will generate additional custom reports to meet your requirements, and the degree of difficulty and cost to create reports will vary based on access provided by the actuarial software vendor and cloud vendor.

You will also need to consider the costs to support the environment and the continuous investment required to keep abreast with cloud technologies and security requirements to get to the TCO.

If you go with a vendor managed services or SaaS solution, it will be easier to budget costs because they will abstract some of the details and provide you a cost that includes a number of the underlying individual cost elements. Some of the vendors may also provide additional reports that give you more details about, for example, the number of runs and which department or users have performed the runs, which will further help you budget and allocate costs internally to the appropriate teams or departments.

The one thing to keep in mind is to leave some flexibility in your budget for additional usage fees: usually once the actuarial teams fully understand the power and flexibility of the solution, which takes about three to six months, they tend to get new ideas on ways to further leverage the environment because the constraints of processing power and capacity have been largely reduced.

There is no doubt that for actuarial processing operations, the public cloud is a great fit. However, you need to plan upfront so that you choose the best option for you. ■

Yash Titus is a vice president with FIS. He can be contacted at *yash.titus@fisglobal.com*.

Effective Communication of Stochastic Model Results

By John Hegstrom

One of the challenges facing financial modelers is how best to display a distribution of results. The goal is to convey the necessary information without making the recipient work too hard to understand it. Also, the viewer should be able to come to his or her own conclusion without being led to a specific outcome. Blending art with science helps develop an effective graphical presentation of a distribution of results. A fixed deferred annuity product with a market value adjustment was chosen as a test case for developing graphical displays of results. The results distribution consists of the present value of distributable earnings at issue from a group of new contracts. One thousand economic scenarios were run to produce the distribution of results. In addition, four product variations were compared.

There are many options for presentation of the results. At one extreme, a point estimate of the mean of the distribution could be communicated as a single number. At the other extreme, a complete table of results by economic scenario could be provided. Clearly, neither of these extremes would be appropriate for decision making. Several alternatives will be explored. The intention is to convey the nature of complex results in a simple-to-understand format.

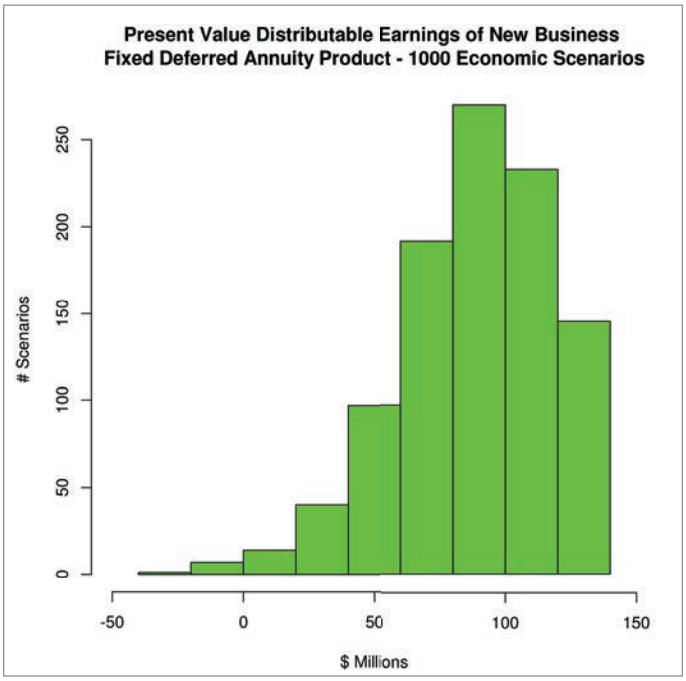
UNDERSTAND YOUR AUDIENCE

Understanding your audience is the first step in effective visual communication. Busy executives do not want to be overwhelmed with too much data in a graph or chart. On the other hand, they need enough information to make effective decisions. Technical audiences will want the ability to extract more details. Avoid jargon or acronyms that your audience may not understand. Know in advance if any of your audience is visually impaired with color blindness or other conditions, and make adjustments as necessary.

TYPES OF GRAPHS

There are a number of approaches to take when presenting graphical results. Following are some of these options, along with a brief description and example of each.

Figure 1
Histogram



Histogram

One of the most common approaches to display a distribution of results is a histogram. Figure 1 shows a basic histogram of the results from the base annuity product run.

Note that there are choices of bin size, coloring, scale and annotations, among others. The choice of bin size is important. If the bins are too large, important details about the distribution will be left out. If the bins are too small, the big picture will be obscured by the noise. Colors can have meaning or just aesthetic appeal. Annotations can provide valuable supplemental information to aid the viewer. One of the drawbacks of a histogram is that it is difficult to display multiple distributions side by side effectively.

Density Plot

Another graph related to the histogram is the density plot. Kernel density estimation (KDE) estimates the probability density function based on sample data. The curve will have the same shape as a histogram but will be a smooth representation of the data. Figure 2 shows a density plot (green line) overlaid on the previous histogram.

The density plot provides a good representation of the data. However, there are some parameters that need to be set, such as the smoothing kernel distribution and bandwidth. Most statistical packages do a good job of selecting optimal parameters, but the data should be compared to a histogram for reasonability.

Figure 2
Density Plot

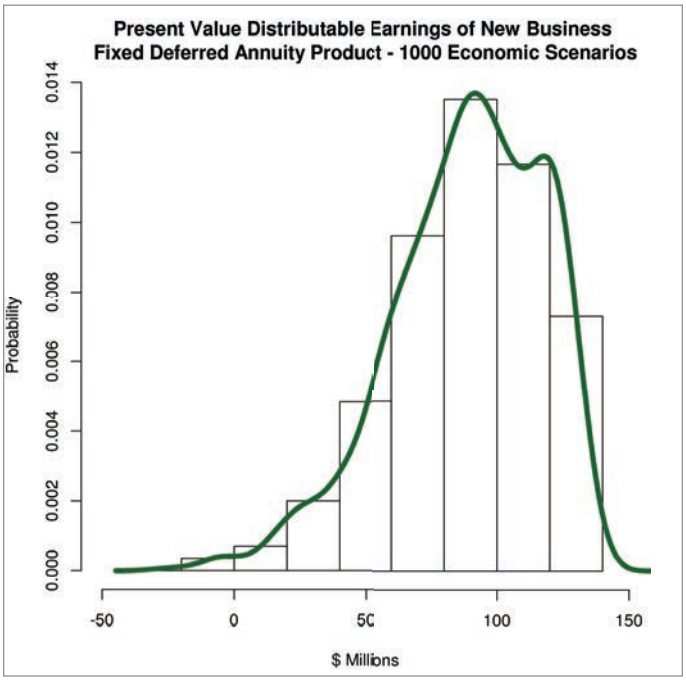


Figure 3
Strip Chart with Jitter

Several density plots can be overlaid using different colors to compare different sets of results. However, this can be confusing if different plots are somewhat similar.

Strip Chart With Jitter

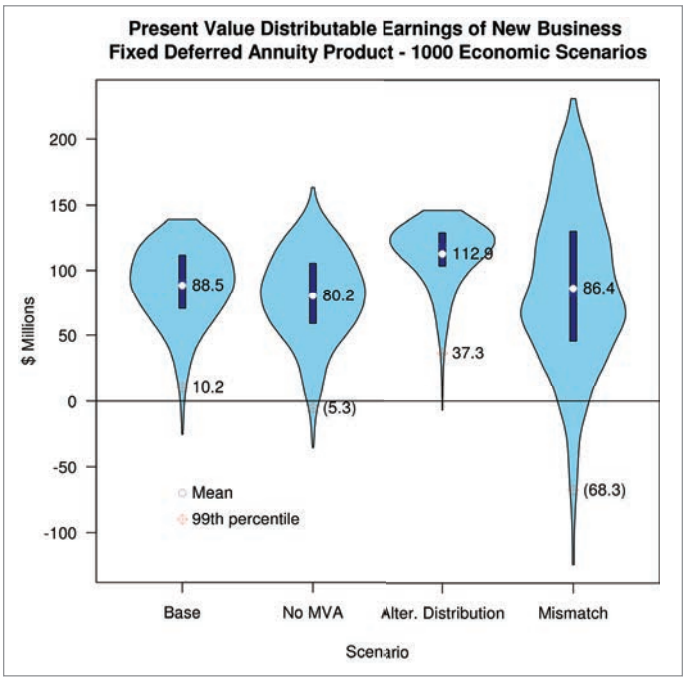
A strip chart can be created showing the distribution of data points. Normally, a strip chart shows data in one dimension. However, by adding jitter, which is controlled random noise, it becomes easier to see the distributional pattern. In addition, color can be added to the data points to provide valuable information, as in Figure 3.

In this strip chart, the data points are colored based on the relative level of interest rates over the modeling period. This provides valuable information to the viewer on an important factor that is driving results. The jittering takes place along the *x*-axis, providing some space between points. Strip charts can be shown with comparable data sets side by side, if desired.

Violin Plot

Violin plots are basically density plots shown in a symmetric fashion, allowing side-by-side visualization of comparable data. In addition, they typically show the quartiles and median of the data. The modified violin plot in Figure 4 shows the results of several variations of the product and the corresponding results distributions.

Figure 4
Violin Plot



The violin plot has been modified from the standard violin plot template in a few ways. First, the mean is shown instead of the

median, as the mean of the distribution has special significance as a probability weighted expected value, assuming that the economic scenarios are equally probable. Second, only the middle 50 percent of the data is indicated by the dark blue shapes; the standard whiskers have been removed for the sake of clarity. Third, the 99th percentile of the data is indicated by the red symbol and a label. This risk measure could easily be set to other measures, such as a conditional tail expectation (CTE) level or a value at risk (VaR) amount.

This modified violin plot has the advantage of being able to easily display results side by side, show the shape of the results distribution and show the key metrics as well. It is a valuable chart for presenting results to decision makers. Figure 4 leads to the conclusion that the alternative distribution strategy (lower excess lapse rates) offers a superior risk/reward profile and should be pursued if viable. Another conclusion is that stretching the asset duration to pick up yield does not pay off in this instance and increases risk.

ASOP 41

Graphs can be considered a part of actuarial communications and a component of an actuarial report under Actuarial Standard of Practice (ASOP) 41. It is necessary to follow ASOP 41 when creating, presenting and distributing graphs, if it applies. ASOP 41 lays down requirements as to form, content and disclosures. Proper disclosure of methodology and assumptions is required. It is important to disclose that the distributions shown are just estimates and don't encompass all possibilities.

CONCLUSION

With today's computing power, large numbers of scenarios can be run. The resulting avalanche of results data needs to be analyzed and communicated in an efficient and effective manner. There are many powerful tools, such as violin plots and strip charts (with jitter), that can be successfully used to analyze and communicate results.

The visual displays in this article were created using the freely available R software package. The annuity product used in the examples resembles real-world products but is fictitious. ■

John Hegstrom, FSA, MAA, is a consulting actuary with Actuarial Resources Corporation. He can be reached at *john.hegstrom@arcval.com*.

Horses for Courses

By Van Beach

Complexity is a challenge in the insurance industry. Products, regulations, and the underlying risks of insurance are difficult to quantify, manage, and explain. Actuarial modeling has felt the tension created by complexity very keenly. Some examples are the following:

- Reserve and capital paradigms have shifted between formulaic and principle-based, vastly increasing the volume of calculations, data, and analyses.
- The range of applications for modeling has expanded tremendously over the last 10 years, putting increased strain on modeling systems.
- Actuarial model processes for data, assumptions, and reporting have become more complex and intensive.
- Relatively new concepts such as modeling efficiency approaches (e.g., cluster modeling) have become part of the modeling process.
- The infrastructure needed to support actuarial calculations has moved from (a) desktop processing to (b) on-premise grids to (c) cloud computing.
- Product designs and the associated methodologies and approaches for managing risks have diverged and become more proprietary as companies pursue competitive advantage.

Further, all of this needs to be governed. It is not an option, but a reality, for all companies. Modeling has changed and evolved rapidly, and it has left models and processes at many companies deficient. It is a complex challenge, and many companies struggle.

Companies intuitively know that change is required, but knowing what and how to change—even knowing the right questions to ask—is itself a challenge. In the attempt to address complexity, many of the debates have been reduced to oversimplified dichotomies:

- Open versus closed code,
- Single versus multiple systems and
- Desktop versus cloud platforms.

Of these, the open versus closed debate is the most longstanding and has the most fundamental impact on the complexity issues noted above. This article will explore the context of the debate, along with the pros and cons of each approach, and will conclude with a viewpoint on the "right" approach.

WHAT IS THE OPEN VERSUS CLOSED DEBATE IN THE CONTEXT OF ACTUARIAL MODELING?

In an actuarial modeling context, the open versus closed debate refers to the actuarial code required to support a model:

- An open code approach allows the user to view and modify the calculation of an actuarial model directly by adding, deleting, or changing business rules. The vendor typically provides standard code, but the user can augment the standard code with proprietary logic.
- The user cannot view or change the business rules under a closed code approach. Instead, the code is maintained by the software vendor. The user can change only the input parameters to the system. Code is reviewed indirectly through examples or documentation.

The open versus closed debate is not limited to actuarial modeling. It is pervasive in software engineering, and proponents are almost fanatical in their defense of both approaches.

WHERE HAS THE INDUSTRY BEEN ON THIS ISSUE?

Actuarial modeling found its roots in a closed code environment on mainframe computers. The introduction of desktop PCs changed the game, when the power to create and innovate was shifted to the end user. New software vendors and actuarial modeling products entered the market, and options now included the following:

- Vendor systems with entirely closed actuarial logic,
- Closed vendor systems with insertion points or formula tables to enable customized logic to augment the core,
- For the savvy modeler with programming skills, models that could be built from scratch using powerful desktop programming language packages—the truly open code solution and
- Systems built with closed frameworks around flexible scripting languages providing a blend of open and closed code.

The modeling market evolved, providing options across the full range from entirely closed to entirely open. As market needs evolved—driven by product innovations, new risk management approaches, and new regulations—and companies gained experience with the pros and cons of open and closed systems, companies' preferences have evolved and shifted as well. At some points the scale tilted toward open approaches, at other times favoring closed approaches.

WHAT ARE THE PROS AND CONS? ACTUARIAL MODELING CONTEXT

As noted above, industry preferences have evolved as market requirements have evolved, but the debate is still ongoing. The pros and cons of open and closed approaches to actuarial modeling are not as simple as writing a list. Understanding the benefits and disadvantages of open versus closed approaches

first requires an exploration of several key interdependent concepts, including the following:

- The universe of actuarial modeling calculations,
- Actuarial modeling applications and the need for flexibility and control,
- Required level of precision and
- Continuous change in products, regulations, risks, and modeling approaches.

Each of these concepts will impact key considerations such as speed, ease of use, scalability, quality, and cost, and they are discussed below.

The Universe of Actuarial Modeling Calculations

Actuarial model calculations are substantial because they should encompass all material product, asset, company, economic, regulatory, and risk characteristics. They may include the following:

- Lives in-force, reflecting interdependent decrements such as mortality, morbidity, voluntary surrenders, and lapses;
- Product features and policy mechanics (e.g., account value crediting, dividend payments, or mode of care benefit maximums);
- Guarantees such as minimum cash values, death benefits, or withdrawal values;
- Commissions, expenses, and other company cash flow items
- Asset characteristics;
- Reserve regulations, both formulaic and principle-based;
- Capital requirements, both formulaic and principle-based;
- Investment strategies;
- Future business issued;
- Economic impacts, including policyholder behavior and interest-crediting methodologies;
- Accounting structures;
- Taxes;
- Distribution of profits and
- Management behavior and reactions.

Although the general categories of calculations are common, it is critical to understand the heterogeneous nature of the logic; that is, two companies that issue the same products to the same market in the same jurisdiction could require substantially different logic to account for company-specific requirements across any one of the categories noted above. Further, considering a global market where regulations and products differ across nearly every jurisdiction, the universe of actuarial logic expands even more. Good design should reuse common components and calculations, but even when optimized, the full breadth of calculations is staggering.

But while the universe of calculations is staggering, what is required for a given company for a given application is just a subset. From a systems standpoint, a specific application for a given company needs only the applicable logic. For the focused purpose, the other options and features are just clutter. So by providing a comprehensive solution to a wider range of clients, the system becomes more complex for all users. Thus, there is an inherent tension between comprehensiveness and tractability.

Actuarial Modeling Applications, Flexibility, and Control

Actuarial models can be broadly classified into three categories:

- Pricing,
- Valuation and
- Projections.

Although the core aspects of the model may be the same, the processes and control requirements around these three functions differ greatly.

When working with a model in a pricing context, flexibility is important to test different product designs, benefit structures, risk management approaches, and the like. The ability to explore, understand, and creatively adjust nearly all aspects of the actuarial model is desirable.

With a valuation model, changes are made with much more control. Examples include projections to support FAS 97 GAAP, Principle-Based Reserves, Solvency II, IFRS, and other model-based regulations. Hedging analysis would also have characteristics similar to valuation with regard to the need for high levels of control and productionization. For these applications, each model change has the potential to impact a reported financial result or a critical financial measure, and therefore these applications have a very low tolerance for mistakes. In this environment, control and governance are key.

The middle ground of "projection" applications can show aspects of each. Cash flow testing, ERM and economic capital projections, duration matching, and many other applications are generating results under increasingly rigorous controls, yet there is typically more iteration and "what-if" analyses than for valuation applications.

In short, the requirements for the style of usage of models differs significantly across applications, ranging from flexible to highly controlled.

Required Level of Precision versus Speed

By definition, a model does not produce a "correct" result. A model is a representation of reality, used to analyze potential future outcomes. The level of detail necessary in a model to capture the relevant characteristics of the vast array of products, regulations, risk management approaches, modeling methodologies, and other things again varies by many factors and is not heterogeneous.

The granularity and detail of calculations also has a direct relationship with the time required to complete a model projection. As the precision of the model increases, so does the time required for the model to execute. Model runtime is a critical factor impacting the usefulness of a model, so finding the right balance of precision and speed is another area of inherent tension in model design.

Continuous Change in Products, Regulations, Risks, and Modeling Approaches

Development of a model is never finished. New products, new regulations, and new modeling approaches produce evolving and changing models. Some changes, such as new products, are driven by internal demands and will reflect company preferences. Other changes, such as new regulations, are external and often subject to interpretation, especially as the regulation intersects with company-specific designs. Companies must address how model changes will be implemented and managed. The design, process, and timing of the implementation are as often critical as the change itself.

WHAT ARE THE PROS AND CONS?

With the context in mind, let's look at some of the pros and cons of each approach:

Closed: Pros

- The vendor likely has experts and specialized expertise to develop, implement, and optimize the functionality it provides. With complete control and knowledge of the system, it can likely implement a given feature faster and with better quality than a modeler.
- The code is also the responsibility of the vendor, so the expertise to develop and maintain the code does not need to be maintained by the modeler.
- The code is common for all modelers, so there is the potential for greater review and more efficient system support.
- Code consistency is ensured because all the code is guaranteed to be the same.
- The code can be optimized by the vendor and, if done well, will not impact the model results.
- Every modeler gets the benefit of new logic introduced through system upgrades.
- System upgrades, including logic, can be more seamless and streamlined.
- The modeler can rely on the vendor to provide the code they need when they need it.

> The binary open versus closed debate greatly oversimplifies the reality of actuarial modeling options.

Closed: Cons

- The closed system may simply not be able to do what a company needs it to.
- Every modeler gets the weight and complexity of new logic and features, making the model increasingly intractable.
- As the system grows to accommodate more features and functions, the complexity increases.
- Similarly, runtime will likely degrade as the system grows.
- The timeline for new features, options, methodologies, and the like is at the discretion of the vendor. The modeler is taking on the business risk that the vendor will provide the code they need when they need it.
- Proprietary products and methods may be exposed to others once implemented.
- Debugging is more challenging since the code can be analyzed only indirectly.
- Creativity is limited since only data can be changed.

Open: Pros

- The system can be optimized for the modeler's needs. Features can be added, changed, hidden, or removed.
- Data and code complexity can be greatly reduced by introducing targeted changes.
- The modeler can optimize the performance of the model.
- Code can be written that aligns perfectly with the company's view of products, regulations, and risk management, improving tractability.
- Proprietary code is guaranteed to remain proprietary.
- Debugging and understanding calculations is more rapid since the code can be viewed directly.

- The modeler can make changes according to his or her timeline.
- Flexibility exists to lock down (essentially, "close") elements of the calculations once they have been finalized.

Open: Cons

- Poorly implemented code can result in poor performance, incorrect results, or unnecessary complexity.
- Expertise in managing code needs to exist within the company or be purchased from outside sources.
- Knowledge of the code must be maintained within the company.
- Code needs to be maintained, and changes must be documented and governed.
- If coding changes are allowed to proliferate across a company, the effort required to maintain consistency within the company will grow, and reconciliation will become increasingly challenging.
- Upgrading the logic is typically not seamless and requires extra effort to implement and test.
- Standard logic provided by the vendor will typically be limited to common features and approaches, not the entire universe of calculations.

IS THERE A RIGHT ANSWER?

Exploring the "right" answer requires that we go back to the discussion of concepts that frame the open versus closed debate. First, the reality of the breadth of actuarial calculations is an important consideration. A closed system will take on that entire burden. An open system will leave some of this burden with the modeler. At what point does the closed system reach a tipping point where the sheer volume of code and calculations becomes overly burdensome? Or does the closed approach naturally lead to systems that are targeted for more specific applications or jurisdictions where the calculations can be tailored and focused (hedging, for example)? Can an open system hit the sweet spot of providing core calculations and leaving only the truly custom components to the modeler? Will an open system fall victim to the temptation of trying to provide too many features? Or too few features leaving too much customization for the client to meet all their needs?

Also, code is only part of the challenge. Data are equally as difficult to manage, and data errors are just as costly as code errors. Data requirements are necessarily greater with closed systems. This is especially true for closed systems as they become more comprehensive. With closed code, additional parameters and inputs are necessary to provide the required options and functionality. Often with an open system, a simple line of code can eliminate the need for multiple tables, inputs, and other data. As discussed earlier, the universe of potential actuarial calculations is staggering. Data can be staggering as well. Both must

be considered, and the best answer may be to find a balance between both, meaning that flexible code is part of the solution to reducing data complexity.

What about quality of code and maintenance burden? A closed system addresses that challenge and limits proliferation of code by locking it away. That is one solution—albeit an extreme one. It is sometimes viewed positively because companies have felt the pain from poorly managed open environments. This attitude is more common among companies that have been using open systems for the last decade during which modeling was an ad hoc exercise and products and modeling approaches were still evolving. Over time, model governance best practices emerged (partly in response to the inherent provided creativity), and many companies incorporated vendor standard code; however, not everyone took the time for this exercise. The lesson is that power and flexibility must be actively managed.

Change is a given, so models, data, and code need to evolve. Regardless of whether a system is open or closed, the model and data need to be governed. As discussed above, data governance is equally as critical and complex as code governance. With regard to code, a closed system again will be solely responsible to address this requirement, often with direction from clients' companies. For many this is a significant benefit because code development is a specialized skill that companies do not want to maintain. However, once a company does, in fact, recognize that model development, including both code and data, is a specialized skill and does not expect all their modelers to be developers, the landscape changes. Centralizing and optimizing model development and change is a key evolution in how companies organize their modeling function. With limited and controlled access to the code, data, and configurations, changes can be governed effectively. With an open model, clients have an option to develop and innovate logic at their own pace, using vendor-provided code as appropriate and available. As noted above, vendor-provided code will take more effort to incorporate into

an open system, but with a centralized modeling function, that burden is greatly reduced.

An open system can be closed. A closed system cannot be opened. A closed system provides a narrow range of flexibility at the closed end of the spectrum. An open system provides a range of options from closed to open, giving responsibility to manage that flexibility to the user. It is quite likely that the right answer is to not choose a single point on the spectrum, but rather use the appropriate approach for the given company and application, which is an option available to open systems but not available to closed systems.

CONCLUSION

Each system has an approach for meeting the needs of its modeling customers. Some companies preach the benefits of closed code. Others promote the benefits of flexible, open code.

The binary open versus closed debate greatly oversimplifies the reality of actuarial modeling options. Nearly all vendor systems reflect a blend of open and closed components:

- Systems purporting to be entirely closed offer formula tables and insertion points.
- Systems that are perceived as open are built with underlying frameworks and architectures that lock away certain fundamental modeling calculations and have varying levels of access to modify calculations.

Each system reflects its preferred approach to blending open and closed capabilities. As tools evolve to better manage and govern code, open systems have the potential to be governed with confidence and assume many of the positive aspects of closed systems. Because of the various blends of features, each system will need to be evaluated with a keen eye toward understanding how flexibility and control are provide via open and closed aspects of their system approach. Remember, though, that an open system can be closed. A closed system cannot be opened.

There is no "right" answer for every company and every situation. The discussion of the context for actuarial modeling is critical—these realities directly impact whether the flexibility of an open system or the control of a closed system is the best choice for a given company. But it is interesting again to observe that even within a company, different functions likely prefer vastly different approaches (i.e., pricing prefers open versus valuation that prefers closed).

So choose the horse for your particular course. Or choose to have a stable of horses all trained to excel at each and every race that is important to you.

If this article sounds familiar, it is because an article with the same title was written by Phil Gold in the January 2007 CompAct. Many of the discussions from 2007 are revisited here. ■

Van Beach, FSA, MAAA, leads the professional services organization within the Life Technology Solutions (LTS) practice for Milliman. He can be contacted at *van.beach@milliman.com*.

SOA Explorer Tool

Find Actuaries Around the Globe

The SOA Explorer Tool is a global map showing locations of fellow SOA members and their employers, as well as actuarial universities and clubs.

Explorer.SOA.org

SOCIETY OF ACTUARIES®

SOCIETY OF ACTUARIES®

475 N. Martingale Road, Suite 600
Schaumburg, Illinois 60173
p: 847.706.3500 f: 847.706.3599
w: www.soa.org

NONPROFIT
ORGANIZATION
U.S. POSTAGE
PAID
SAINT JOSEPH, MI
PERMIT NO. 263