CAS RESEARCH PAPER

THE FIRST ANNUAL CAS ACTUARIAL TECHNOLOGY SURVEY

CASUALTY ACTUARIAL SOCIETY

The First Annual CAS Actuarial Technology Survey

Actuaries are clever people who have impressive mathematical skills and experience. However, they cannot generate results without assistance from technology. A wide range of software tools allow actuaries to carry out calculations on large and small data sets; to store, extract, and transform information; and to generate output that may be shared with their stakeholders. Actuaries use these tools to implement a broad range of techniques, from classic methods such as chain-ladder reserving to more recently established predictive analytics methods like decision trees or deep learning.

But how is all of this being done? In the summer of 2021, the Casualty Actuarial Society (CAS) conducted the first of what we hope will be an annual survey on technology used by actuaries. A total of 1,294 responses were received from members and from candidates still sitting for exams. We asked respondents about which tools they use, their self-reported proficiency levels, the barriers they experience, which techniques they apply, and in which areas they would like to improve.

This paper will walk through results in detail. Key observations can be summarized as follows:

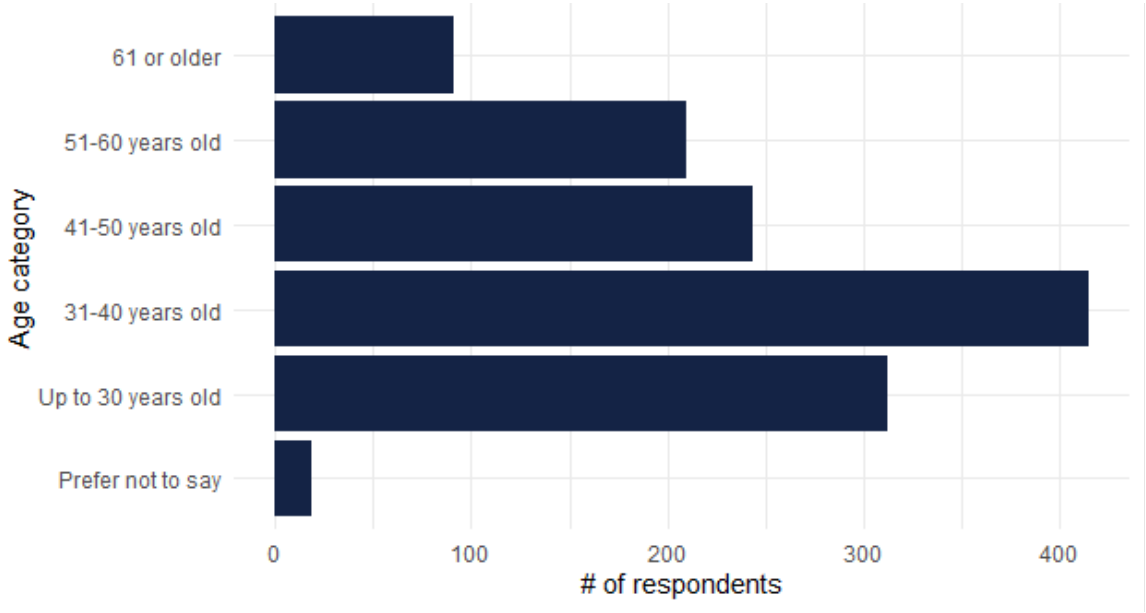
- Excel continues to be actuaries' most widely used software tool, with more than 94.3% of respondents reporting that they use it at least once a day.
- With that understood, most actuaries (92.3%) use more than one tool.
- Actuaries want to increase their proficiency in R (47.2%), Python (39.1%), SQL (30.8%), and Excel (26.0%).
- No tool had more than 50% of respondents indicating that they wanted to increase their proficiency.
- Time is the greatest barrier to learning new technology. (80.5% of respondents felt so.)
- Newer analysis methods such as tree-based algorithms and artificial intelligence (AI) are not widely used (16.5% and 7.0%, respectively).

1 Demographics

The survey asked questions about age, designation, type of employer and other demographics. Although these data may give a general sense of what a typical respondent may look like, survey participants showed a wide range of characteristics (Figure 1.1).

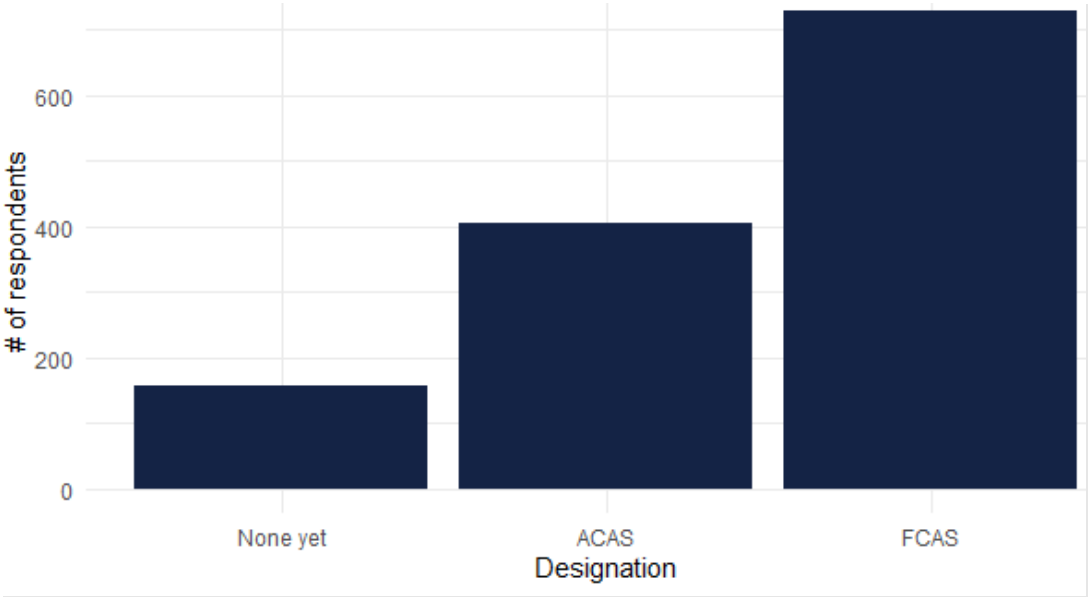
A plurality of respondents are in their 30s, but the second largest group is those 30 and younger. The number of respondents older than 40 decreased for older groups.

Figure 1.1.1 Age of Respondents (Non-responses removed)



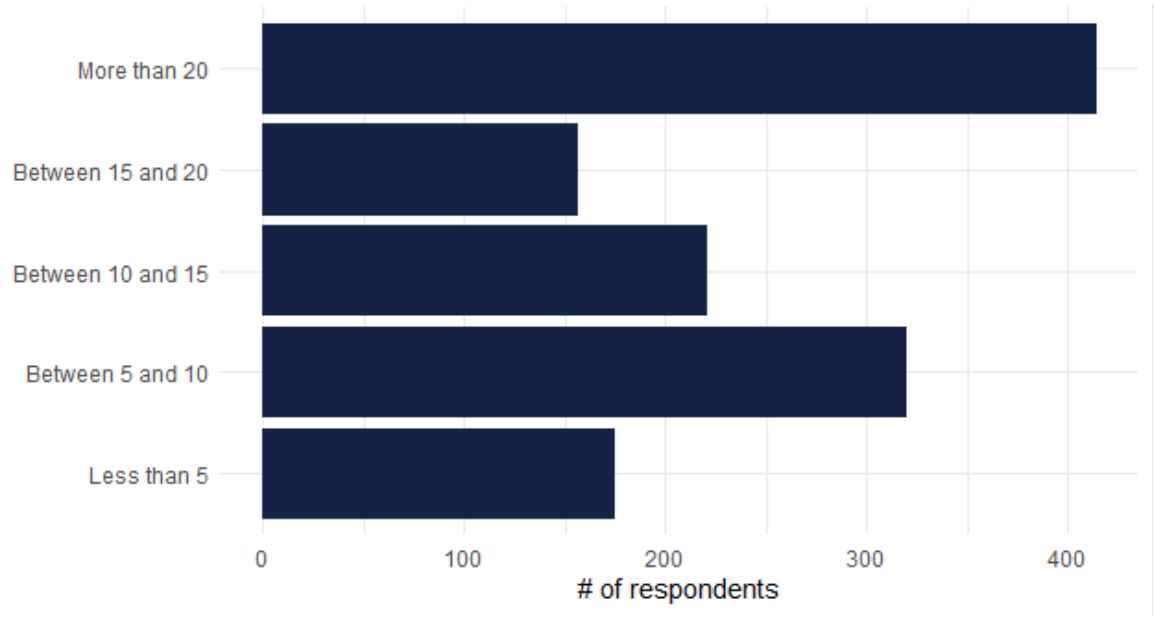
Respondents are overwhelmingly Fellows (Figure 1.2). This is not surprising, since Fellows may be most motivated to respond, having already shown engagement to the CAS through their commitment to the exam process. We are happy to see that some of our candidates took time to share their experiences and thoughts, and we hope their participation increases in future surveys.

Figure 1.2 Designation of Respondents



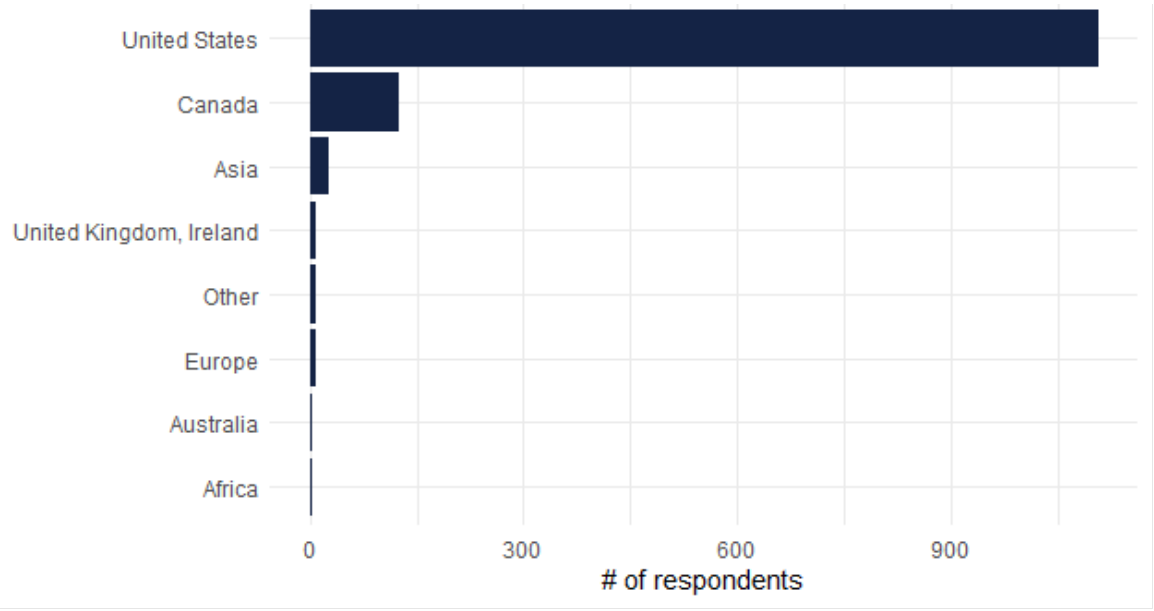
Most of the respondents have been practicing for more than 20 years, but there was a meaningful volume of response from actuaries closer to the start of their careers (Figure 1.3).

Figure 1.3 Years of Experience (Non-responses removed)



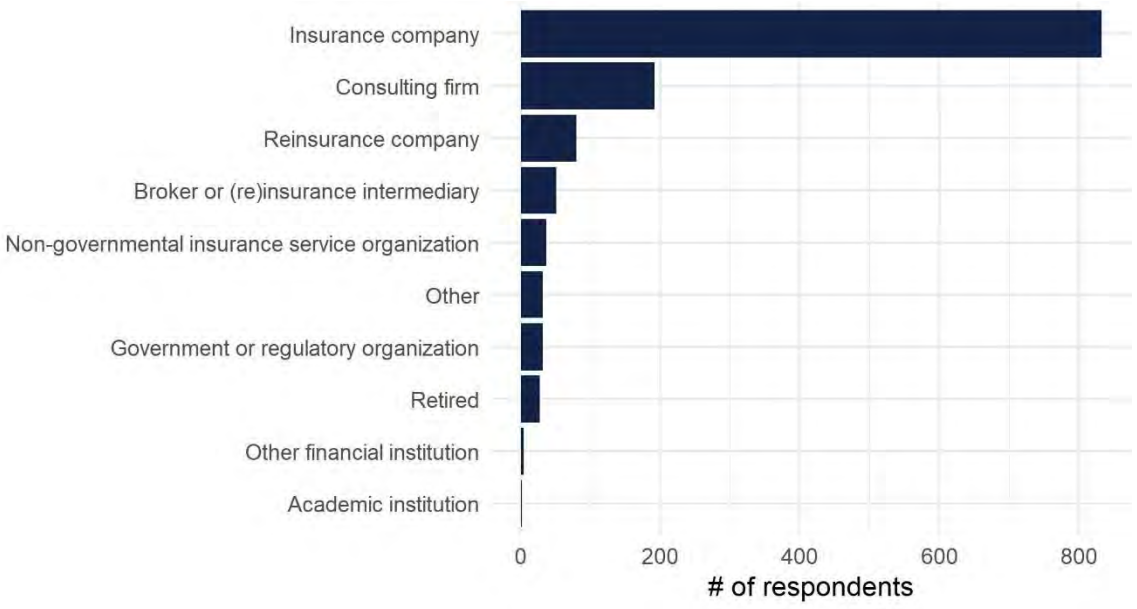
Consistent with overall CAS member numbers, most survey participants are based in the United States, but we were pleased to receive responses from around the world (Figure 1.4). Respondents choosing "Other" are largely made up of actuaries practicing in Bermuda.

Figure 1.4 Location of respondent (Non-responses removed)



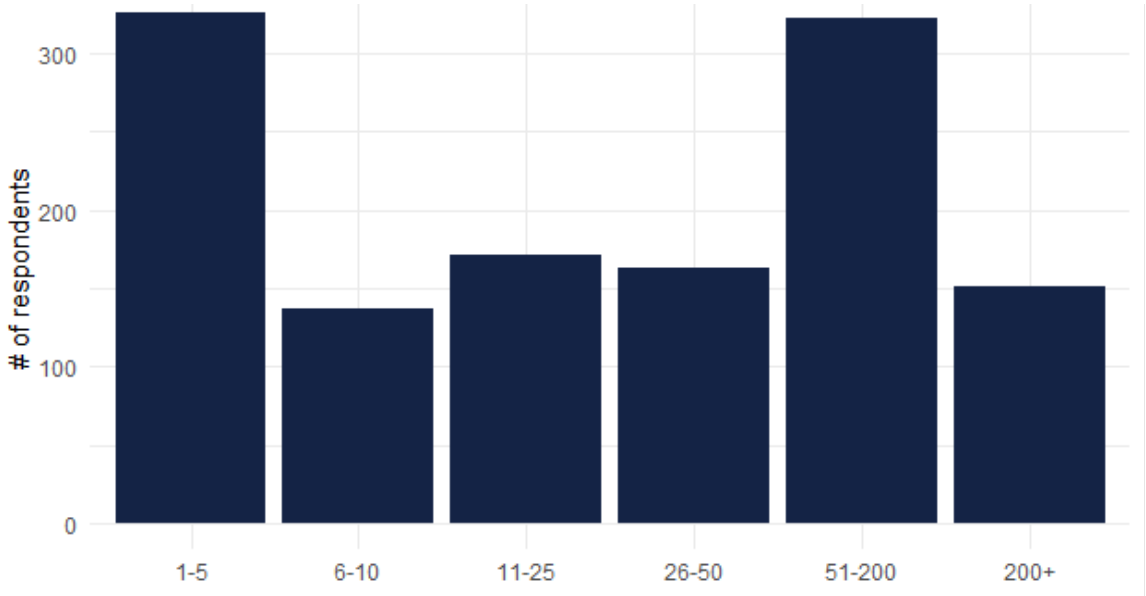
It should be no surprise that most respondents work for insurance companies (Figure 1.5). Consulting firms are a distant second place.

Figure 1.5 Type of company of respondent (Non-responses removed)



The size of respondents' actuarial departments varied widely, with a notably bimodal distribution (Figure 1.6). Respondents are just as likely to work for a company with five or fewer actuaries as to be employed by an organization with 51–200 actuaries.

Figure 1.6 Number of actuaries at respondents' organizations (Non-responses removed)



2 Tools

Our survey begins by asking what tools actuaries are using and with what frequency, including:

- R
- Excel
- Other spreadsheet tools such as Google Sheets
- SAS
- Python
- Data visualization tools such as Tableau
- MATLAB/Octave (in the displays below, we refer to this option as "MATLAB" for short)
- Business intelligence dashboarding tools such as Power BI
- SQL

We acknowledge that this list is not – and cannot be – exhaustive. To gain additional context, we asked respondents for suggestions about other tools could be included. The 10 most common are shown in Figure 2.0.

Figure 2.0 Other tools commonly used

Software	Number of mentions
Emblem	48
ResQ	46
Igloo	30
Alteryx	29
Access	25
Arius	23
Radar	19
VBA	18
MetaRisk	14
Julia	13

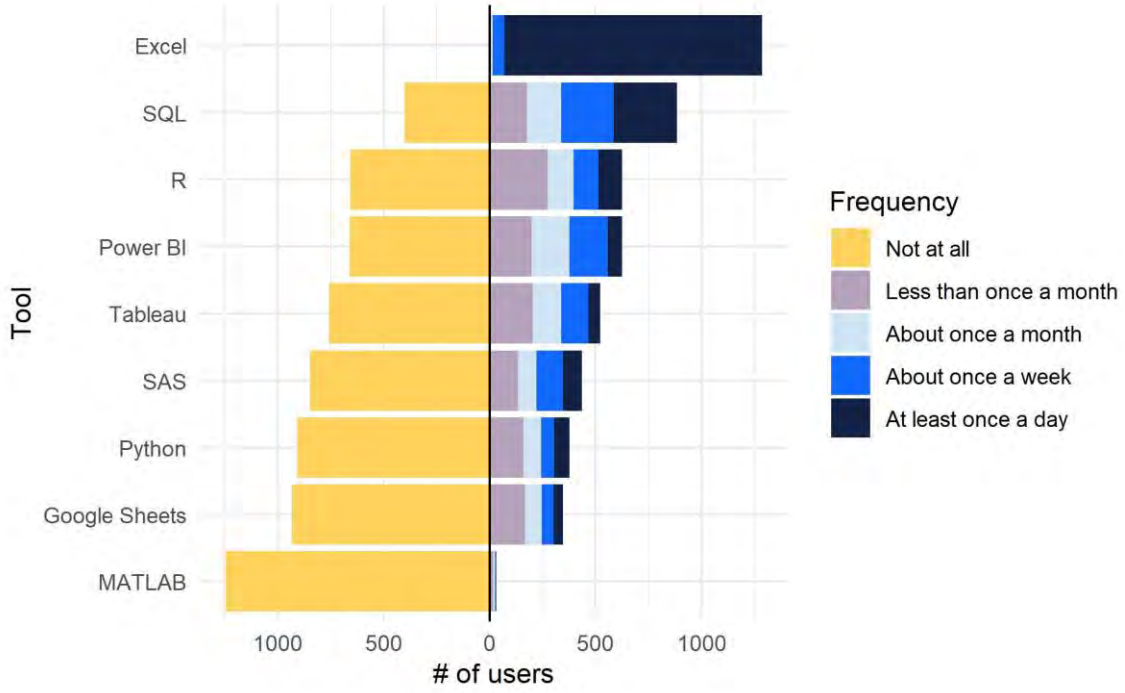
We had assumed that VBA would come under the general heading of Excel and that a database management program like Access would be included under SQL. We will ensure that this is made explicit in future surveys. Many of the other suggestions, including Arius

and MetaRisk, are written with an actuarial end user in mind. We recognize that these tools have a large user base, and we would like to know more about where and how they are being used. However, producing an inventory of all such tools on the market is inherently challenging. In future surveys, we may add appropriate examples of third-party actuarial software as well as an option to indicate specific products.

2.1 Frequency of use

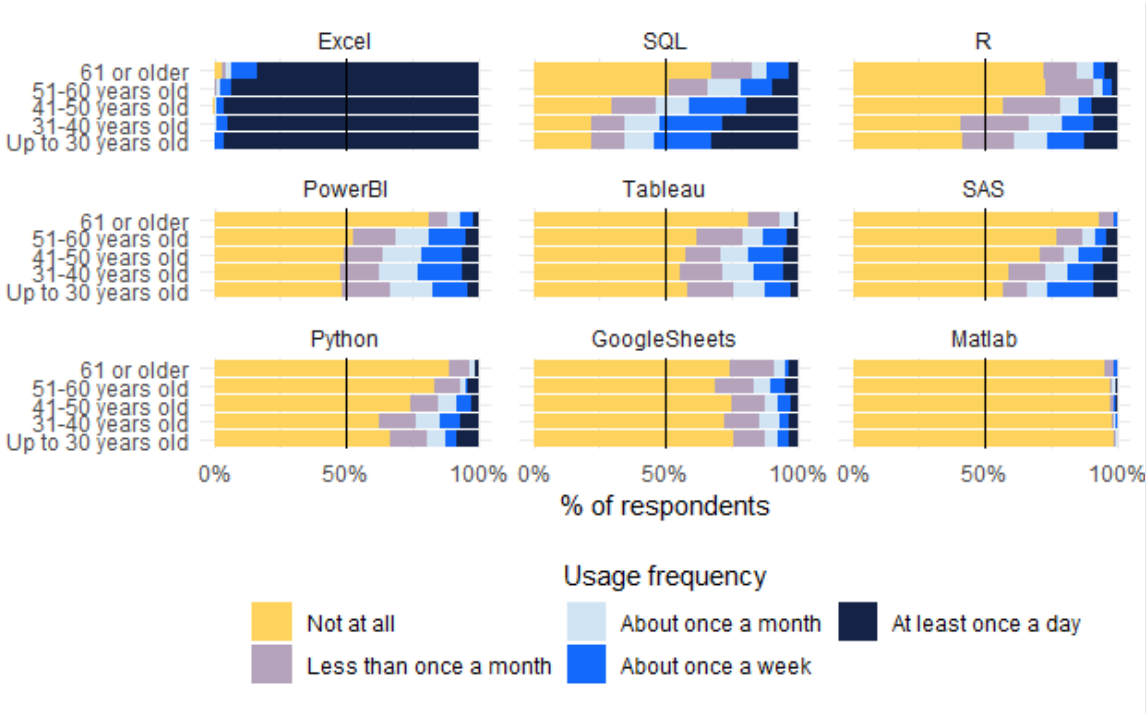
In terms of the frequency of use for various tools, Figure 2.1.1 shows a result that is unlikely to surprise anyone. With results arranged in ascending order by the number of respondents who marked "Not at all," Excel comes out as the most frequently used tool, with only four respondents indicating that they do not use Excel at all. Moving down the list, SQL appears at number two, though with a substantially increased number of "Not at all" responses. Notably, SAS has more users than Python.

Figure 2.1.1 Tools' frequency of use



We may ask whether these trends are a function of respondents' ages or designations. Figure 2.1.2 shows the relative portions of usage frequency by tool and age. Note that the scale of the axis has changed from a count of responses to a percentage of the total within each age and designation category. (See Figure 2.2.1 for the total number of respondents within each category.) A vertical line has been drawn at 50 percent.

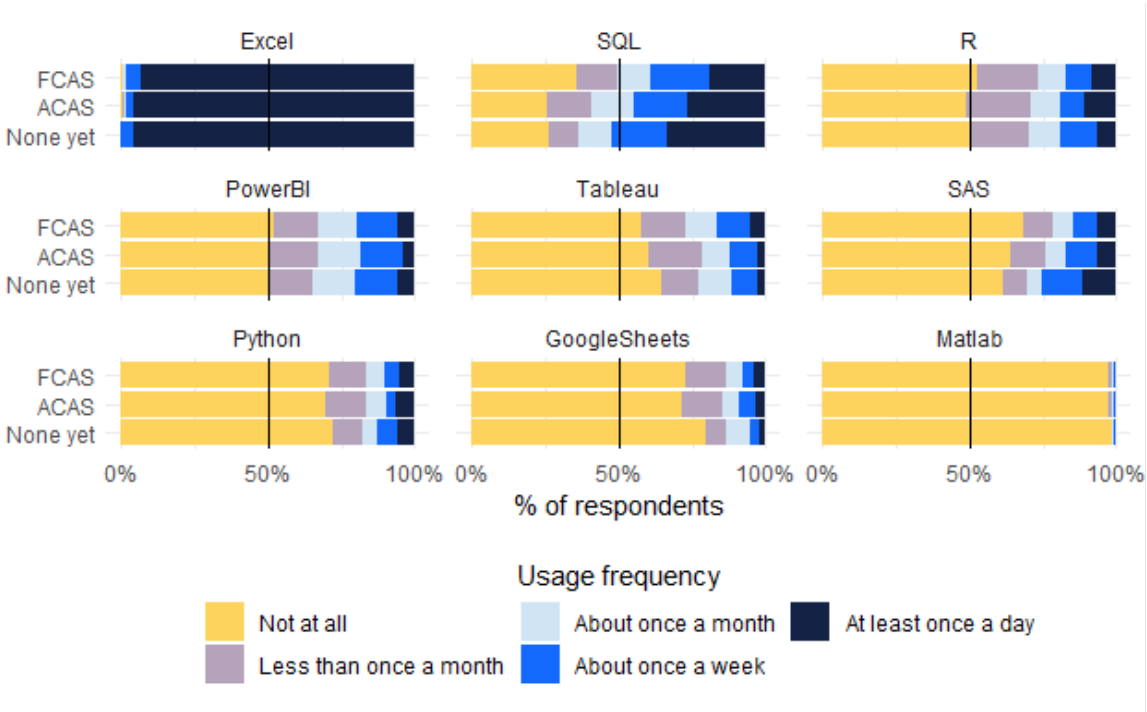
Figure 2.1.2 Frequency of use by tool and respondent age



We see a clear distinction based on age for SQL, SAS, R, and, to some extent, Python. This may be a function of the specific tasks that actuaries are called to perform at varying stages of their career. Notably, although MATLAB is not widely used, it is the only scripting tool with more frequent use among older actuaries.

The results for designation are parallel with those of age, although the patterns are less stark (Figure 2.1.3).

Figure 2.1.3 Frequency of use by tool and respondent designation



2.2 Use of multiple tools

Although virtually every respondent uses Excel from time to time, Excel is not the only tool that they use. True, there were 98 respondents who marked "Not at all" for every non-Excel tool (Figure 2.1.1). However, roughly two-thirds of respondents reported some level of use of other tools (Figure 2.2.1). The percentage of respondents who reported using several tools decreases when considering only tools that they used at least once a week.

Figure 2.2.1 Respondents' use of other tools

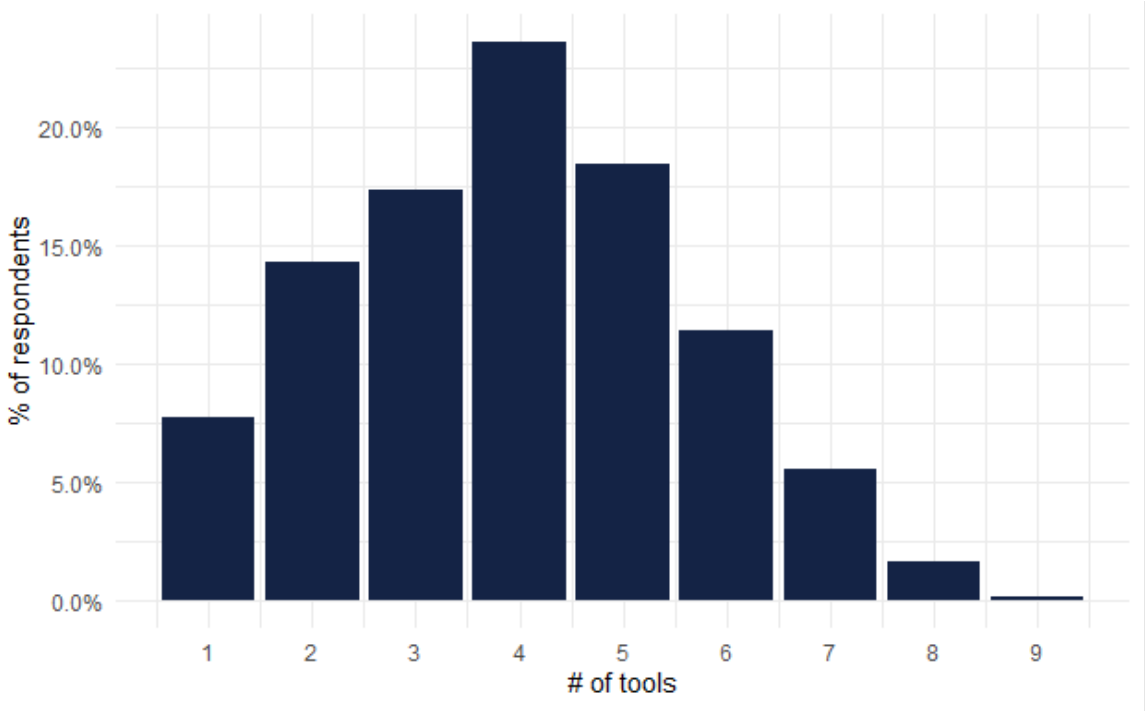
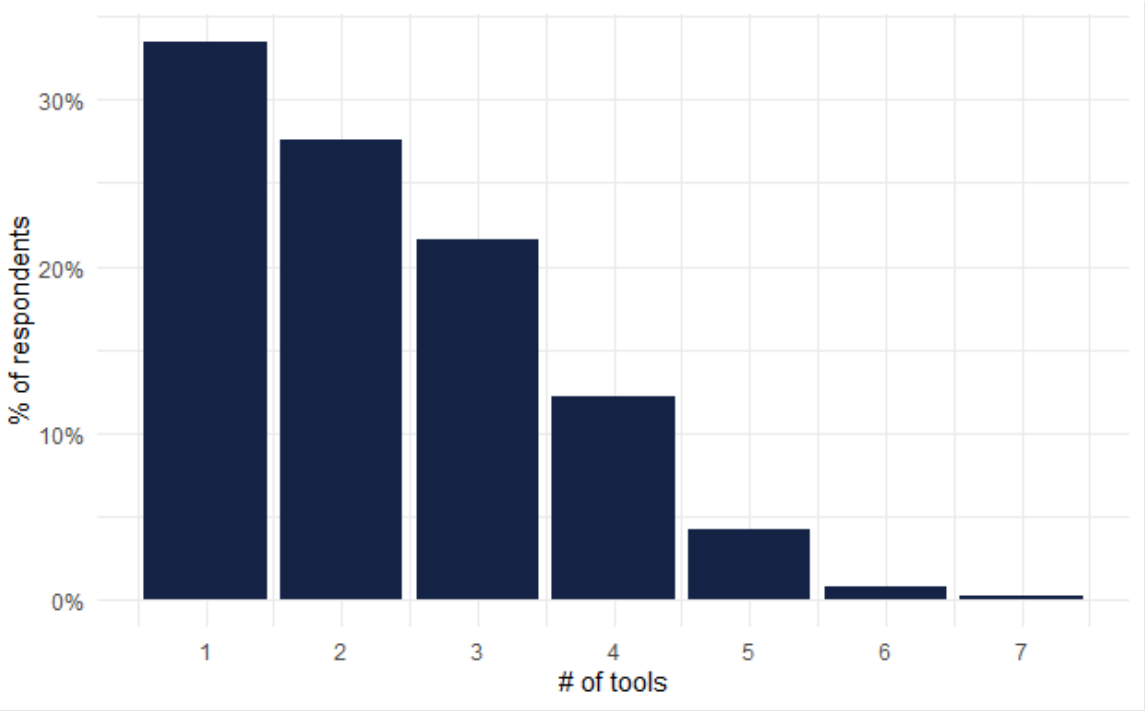


Figure 2.2.2 Frequency of respondents' use of multiple tools

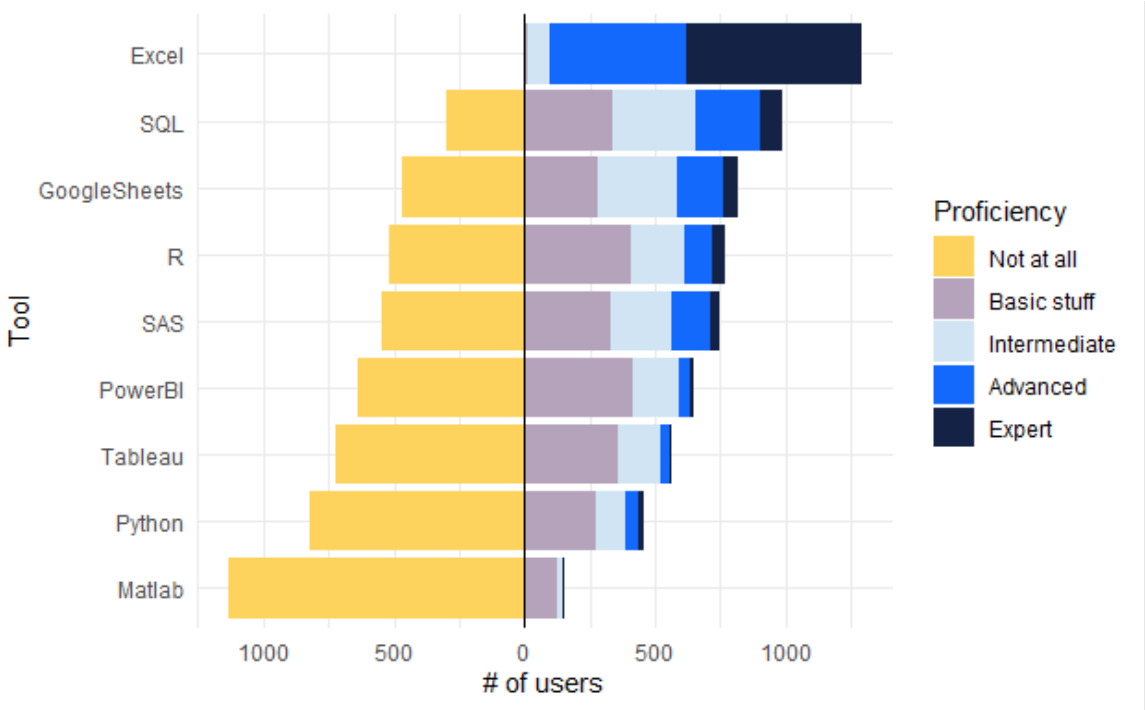


We may surmise that even if respondents can use a variety of tools, most of their work can be performed using only one or two. We should also note that maintaining fluency in multiple tools is difficult and may not be necessary for day-to-day tasks.

3 Proficiency

In addition to asking users how frequently they used particular tools, we also asked how they would regard their own proficiency. This is necessarily subjective, but it is revealing all the same; two things may be noted. First, even though they may use a particular tool at least once a day, many respondents do not regard themselves as experts, perhaps reflecting some level of modesty. Second, actuaries may consider themselves to be relatively proficient for tools that they are not presently using. This could reflect the fact that the respondent has mastered an older tool (such as MATLAB or SAS) that they no longer use. Alternately, they could be skilled in using a newer tool (such as Python or R) that their organization does not support. This year's survey does not include questions that can directly answer the reasons behind respondents' choices.

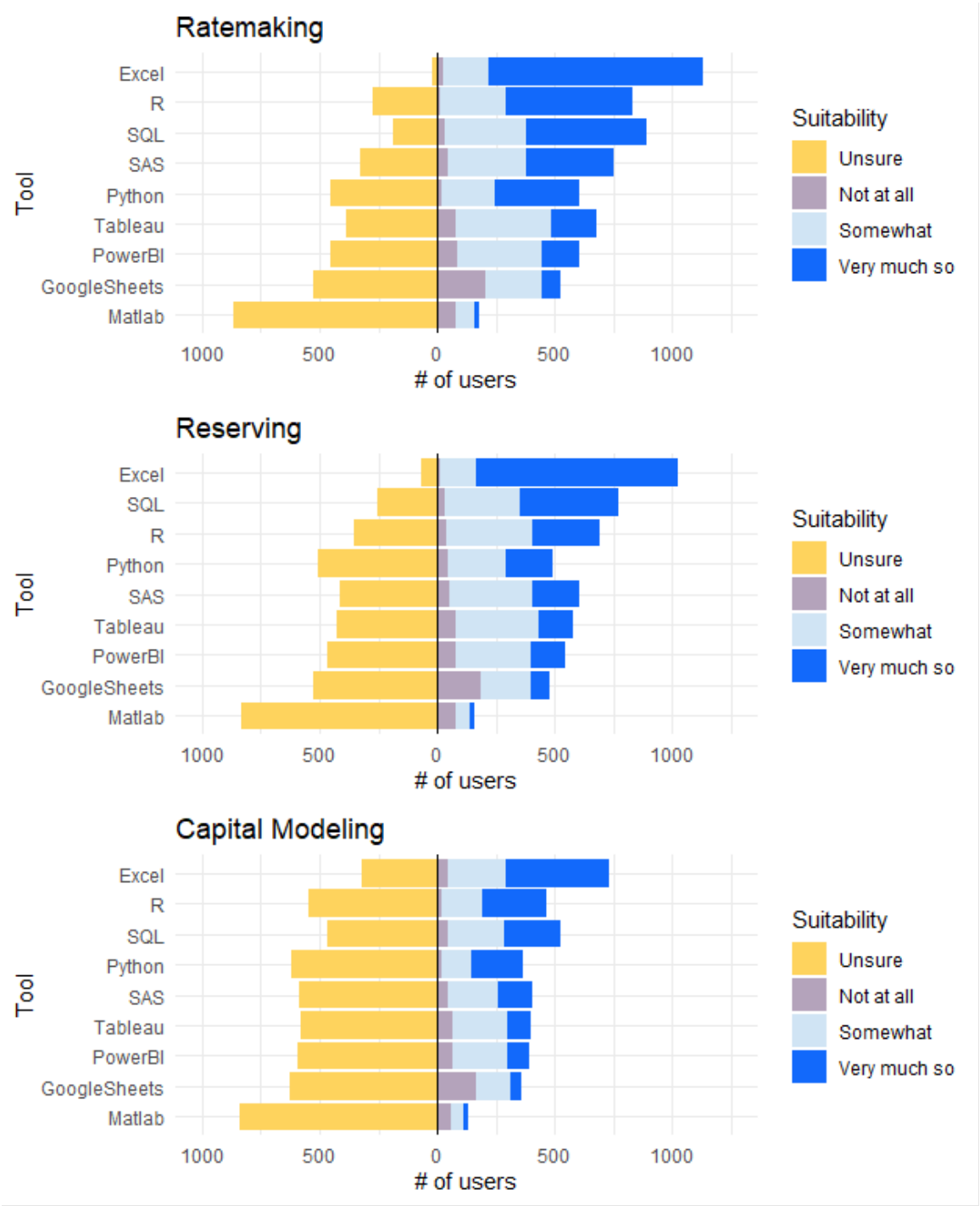
Figure 3.1 Proficiency levels of respondents



4 Suitability

With the caveat that the survey does not capture all the tools that actuaries are using, we wanted to gauge the suitability of various tools in performing the core actuarial tasks of ratemaking, reserving and capital modeling. In Figure 4.1, the tools have been arranged in descending order by the number of users reporting the tool to be "very much" suited to the practice area.

Figure 4.1. Suitability ratings of all tools across actuarial practice areas



Overall, we find that suitability aligns with usage. The scripting tools SAS and Python received higher ratings in suitability relative to their frequency of use. For all tasks, Google Sheets has the highest number of respondents marking it as not at all suitable, yet it still has its defenders.

Interestingly, the level of certainty about the suitability of some tools appears to vary by practice area. In particular, the certainty decreases from ratemaking to reserving to capital modeling. Figure 4.1 shows the suitability ratings totaled across all tools, with practice areas compared against one another.

In Figure 4.2, users who gave no response were not included. Inferring that a failure to mark an answer is equivalent to a response of "Unsure," Figure 4.3 groups blank and "Unsure" responses together. The overall conclusion is unchanged.

Figure 4.2 Suitability by practice area (non-responses removed)

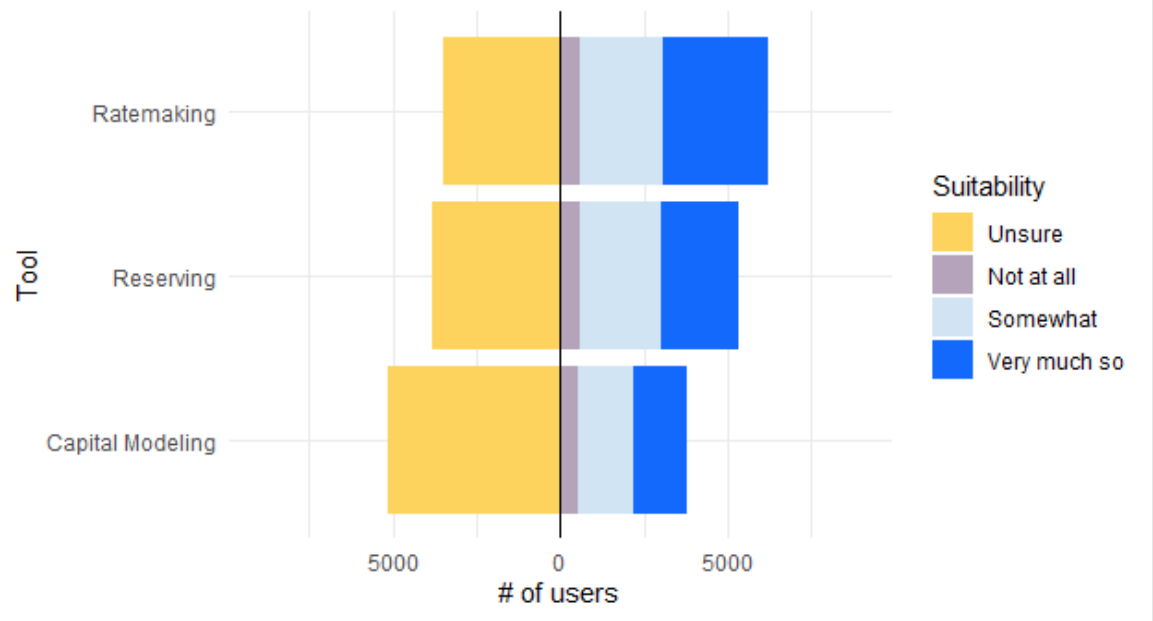
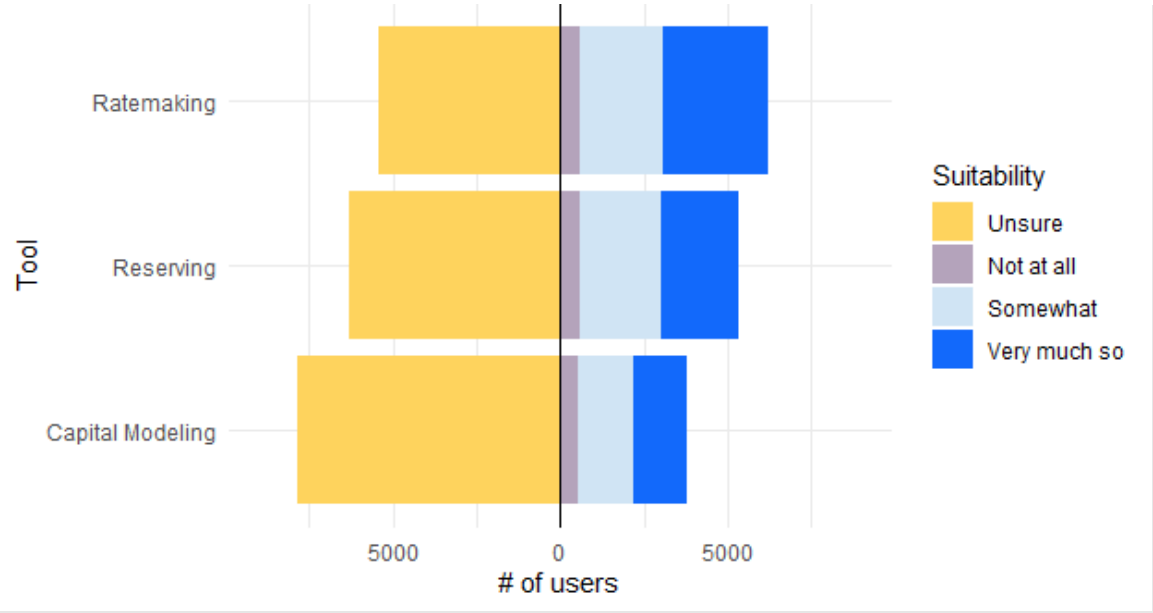
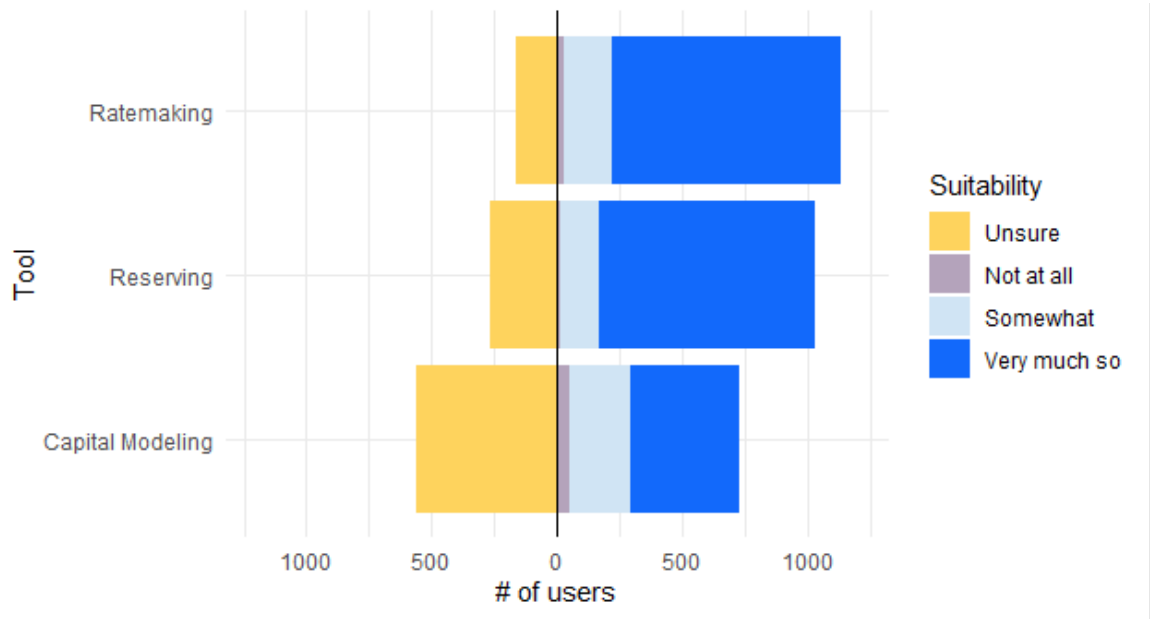


Figure 4.3 Suitability by practice area (non-responses grouped with "Unsure")



These varying levels of uncertainty may stem from the inclusion of tools that the respondent does not use regularly. However, Figure 2.1.1's focus exclusively on Excel shows that the general pattern holds, with roughly 50 percent of respondents saying that they are not sure or that Excel is not at all appropriate for capital modeling.

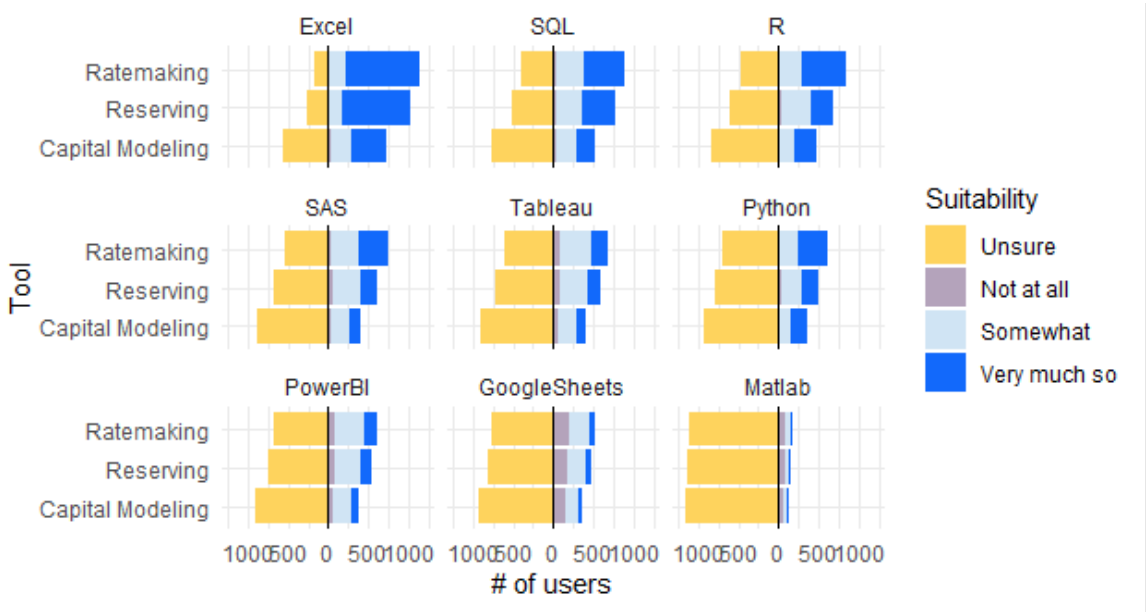
Figure 4.4 Suitability by practice area for Excel (non-responses grouped with "Unsure")



There is greater uncertainty among the other tools. Figure 4.5 shows results for all tools, in order of the total responses across all practice areas that ranked a tool as somewhat or very suitable. Interestingly, in this analysis, SQL comes in second after Excel. SQL's primary use is data acquisition and aggregation, not predictive analytics. Admittedly, this may reflect a potential weakness in the survey since respondents are likely to acknowledge SQL's utility as part of the analytics pipeline. However, it may reveal that a nontrivial amount of work encompasses the construction of bespoke queries for ad hoc data analysis.

Notably, R and Python showed their largest (though admittedly small) number of "Not at all" suitability rankings for reserving. This is somewhat surprising given that both languages include chain-ladder packages written specifically to deal with property and casualty loss reserving.

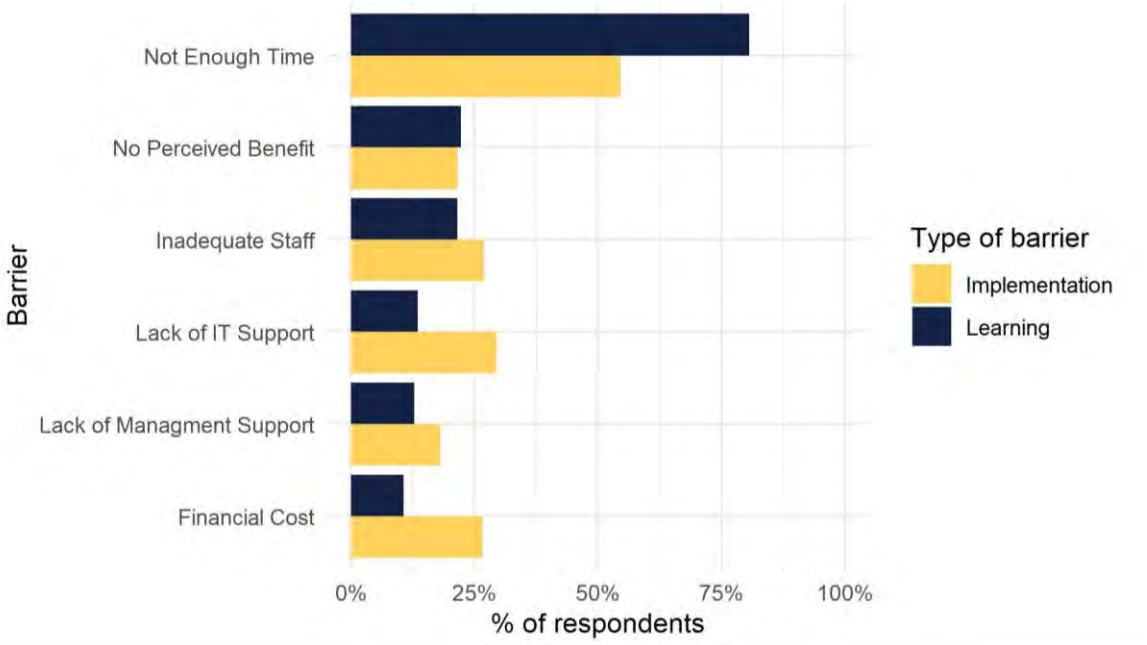
Figure 4.5 Suitability by practice area for all tools (non-responses grouped with "Unsure")



5 Barriers

Excel is an entrenched element of the technology stack at many companies. Even when a solution like R, Python, or Octave carries no financial cost, actuaries may not move to learn and implement them. We asked respondents what barriers they find, both to learning new tools and implementing them. The results are shown in Figure 5.0.

Figure 5.0 Barriers to learning and implementation of tools as reported by respondents



No one who struggles with their workload will be surprised to see that more than three out of four respondents listed time as a barrier to learning new tools. This was also the number one barrier to implementation, though the percentage is lower at just over 50%.

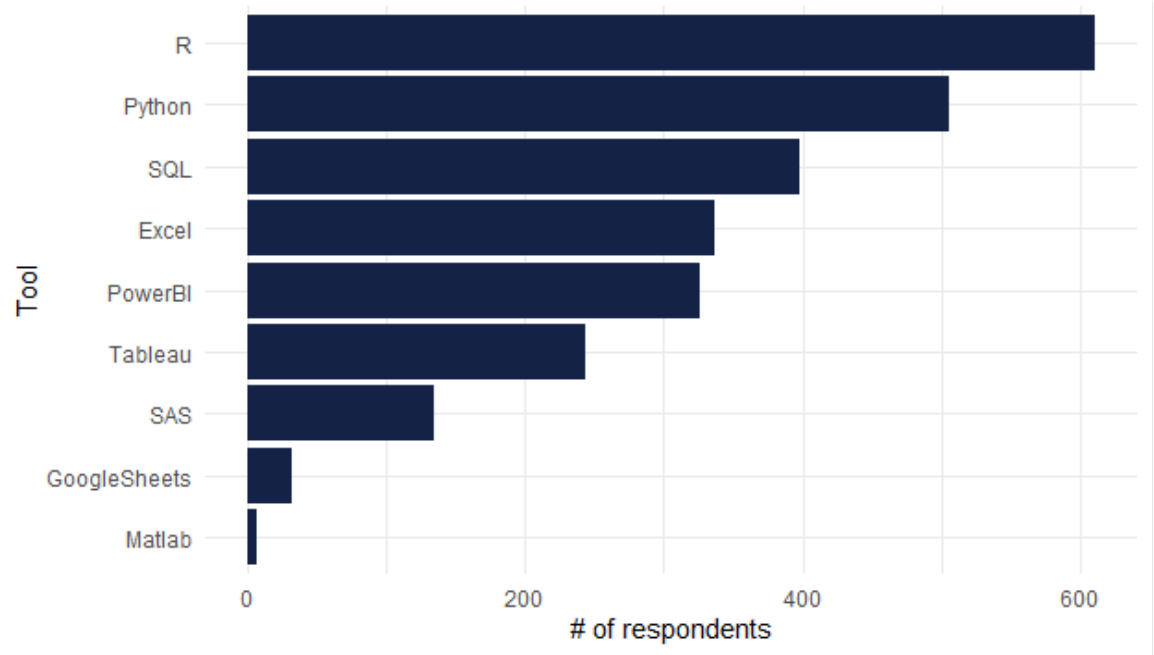
For learning, the other barriers are below 25% each and little stands out. It may be reassuring to managers that cost does not seem to be an issue, nor is a lack of management support something which is seen an impediment for most respondents.

On the implementation side, the number two barrier is a lack of IT support. Though the numbers are not terribly high – a bit more than 25% – the figures for cost and staffing are also higher than the learning barriers. Additionally, those implementation barriers are all higher than the perceived benefit. Given that, there may be operational questions within some organizations. Are there actuaries who could embrace leading edge technologies if only IT were supportive? Is there an opportunity to invest in employees' time to clear the learning and implementation hurdle?

6 Interest in increasing proficiency

Despite these potential barriers, many respondents indicated an intent to increase proficiency in some of the tools listed (Figure 6.1). R and Python – both scripting tools – had the highest numbers of respondents expressing interest in increasing proficiency, followed by SQL. It is interesting to note that Excel placed fourth, just ahead of the point-and-click Power BI and Tableau.

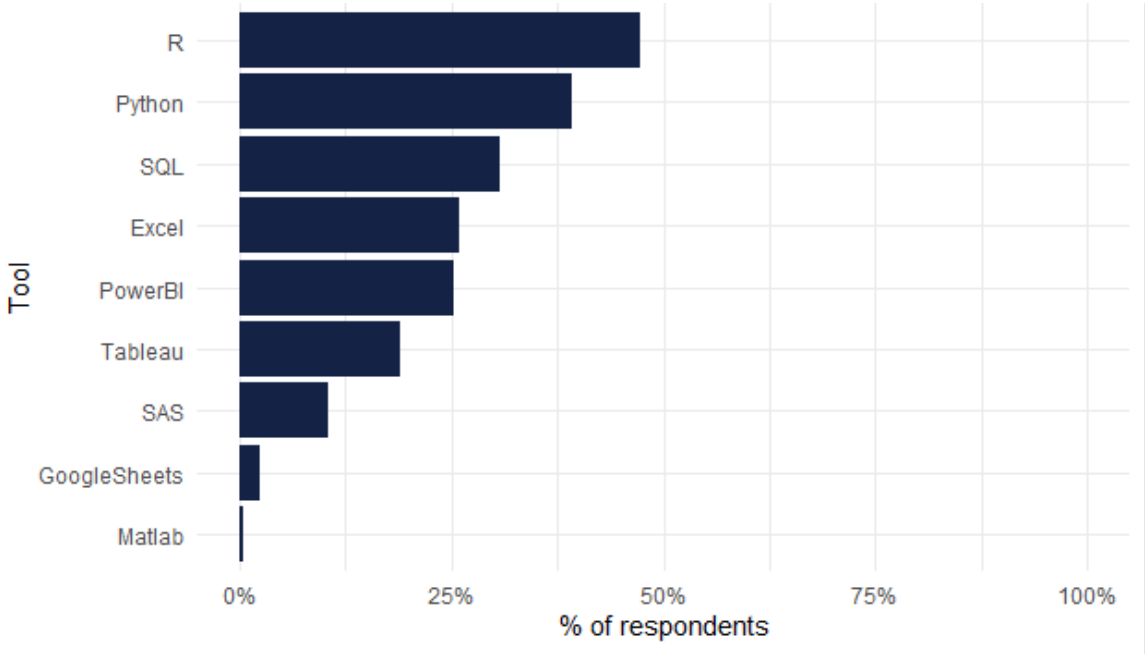
Figure 6.1 Respondents interested in increasing their proficiency



These results suggest a meaningful appetite for improvement, with a large number of actuaries expressing interest in increasing their skills in various tools – more than 600 for R

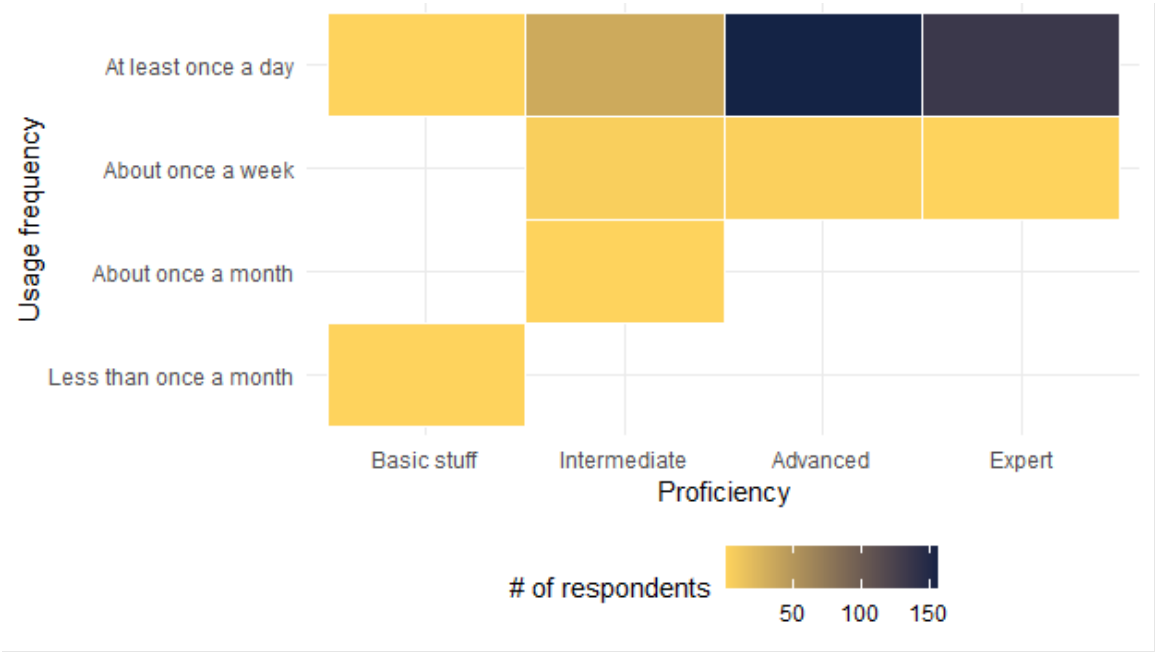
and more than 500 for Python. However, the picture changes when viewed in the context of the entire survey population (Figure 6.2). No tool has more than 50% of all respondents indicating that they want to increase their proficiency. Does this low percentage present an opportunity for an actuary to differentiate themselves, or is it reflective of the technical and market realities of how actuaries are deployed in insurance enterprises? The answer to that question is, of course, a moving target and will vary between actuaries and from one company to another.

Figure 6.2 Respondents interested in increasing their proficiency



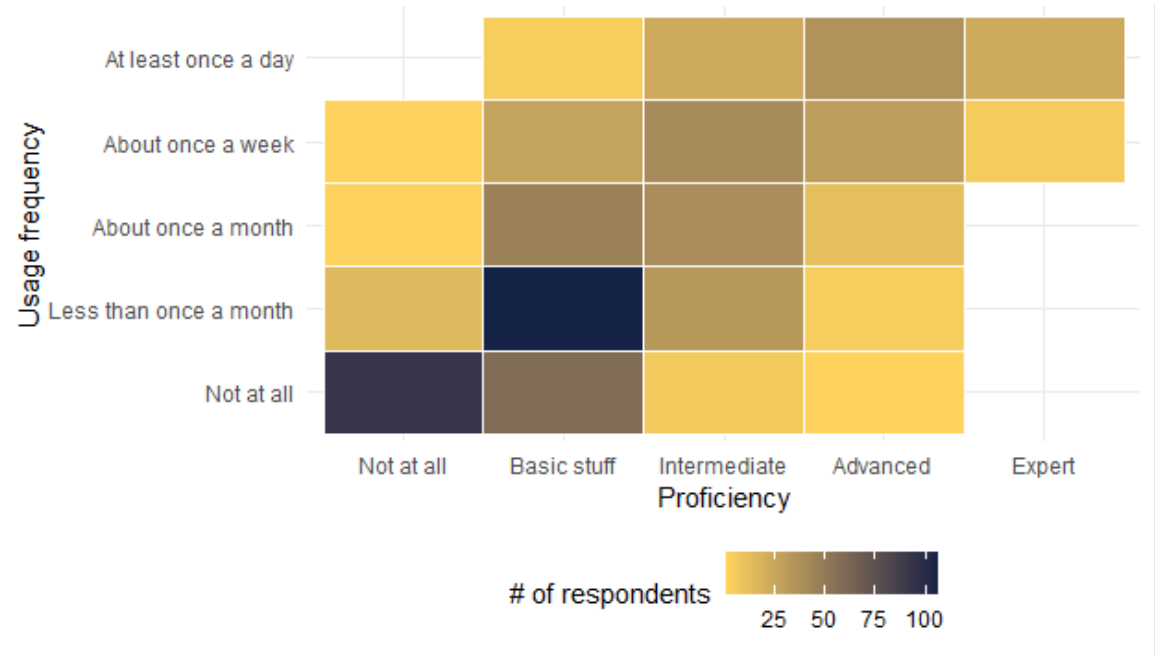
Given its ubiquity, Excel's relatively high placement in terms of respondents' interest in increasing proficiency is noteworthy. The data would suggest that this is a result of some users engaging with Excel often but not regarding themselves as sufficiently proficient. Most of those who intend to continue to improve their facility use Excel at least once a day, or once a week, with the top three bins (the rightmost blocks of the top row) using it daily (Figure 6.3). Of those, 20% of users who would deem themselves experts and who use Excel at least once a day want to get better. The percentages are higher for users who regard their skills as less than expert.

Figure 6.3 Number of respondents who want to increase their proficiency in Excel



What does this look like for R, Python, or SQL – the top three tools in terms of respondents' interest in increased proficiency? The results for R are shown in Figure 6.4 and the picture is quite different. The largest segments of responses come from actuaries who are using R less regularly and whose proficiency is a bit lower. This suggests that these respondents have an appetite for broadening their skills rather than gaining deeper knowledge of a tool that they have already mastered.

Figure 6.4 Number of respondents wanting to increase their proficiency in R



For Python, the picture is similar, though with a slightly larger number of respondents at the bottom left, representing those who are not presently using Python and who regard themselves as being "not at all" proficient (Figure 6.5). Why would they want to invest in learning a tool that they are not presently using? We may infer any number of reasons, not least of which could be that these respondents are presently in a "chicken and egg" situation: They may feel that Python would be beneficial, but until they reach a basic level of understanding, they are not in a position to introduce it to their work. It will be interesting to see how this figure changes in subsequent surveys.

Turning to SQL, the view more closely resembles the situation for Excel (Figure 6.6). Even respondents who are reasonably adept with SQL want to continue to improve.

Figure 6.5 Number of respondents wanting to increase their proficiency in Python

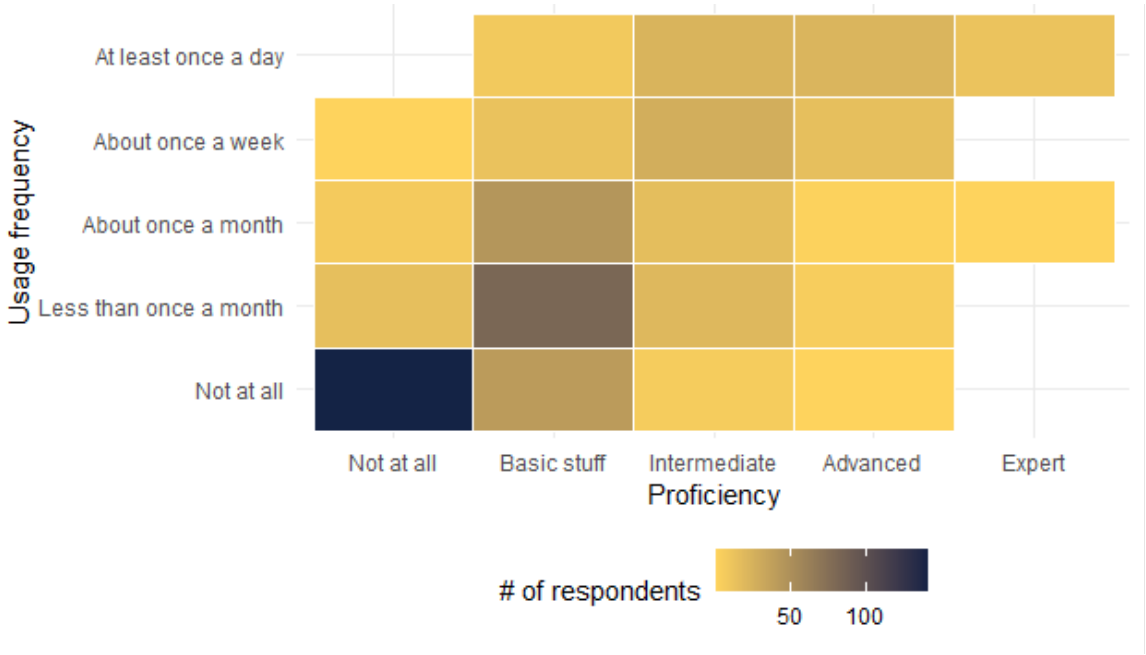
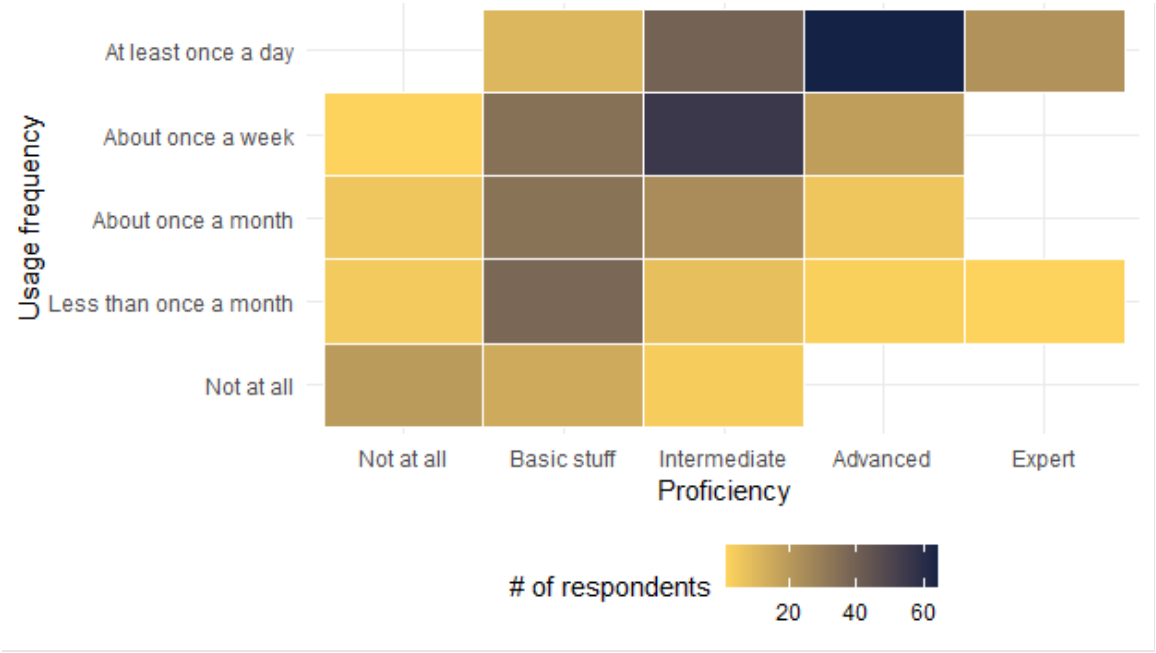


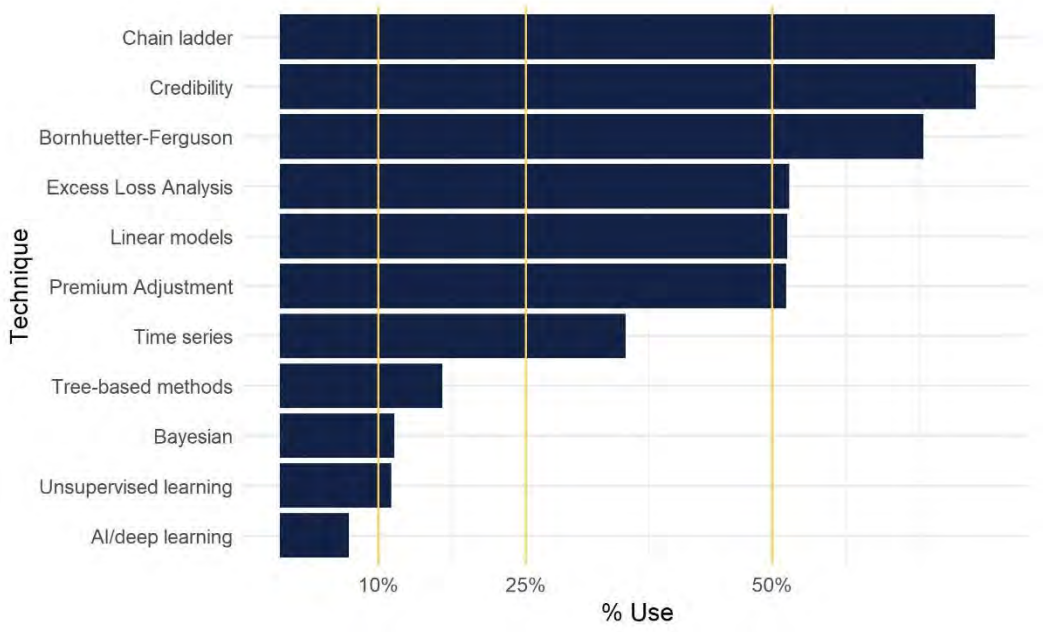
Figure 6.6 Number of respondents wanting to increase their proficiency in SQL



7 Techniques

Finally, Figure 7.0 gives an overview of the use of some classic actuarial techniques alongside a few that have gained use in the past decade or so. Lines are drawn at 10%, 25% and 50%. Notably, fewer than a quarter of respondents use tree-based methods and barely more than 10% use Bayesian techniques or unsupervised learning methods. Despite all the recent talk about AI and deep learning, fewer than 10% of survey respondents use these methods at all.

Figure 7.0 Percentage of respondents' use of actuarial techniques



8 Comments

64 of the respondents chose to add comments. Here are a few that we found particularly interesting:

- "Analytic techniques leveraged can vary greatly by role, sometimes creating a perceived barrier to posting to a new role (don't know the tool, so unqualified for the job)."
- "Careful about inference from question about 'which methods we currently use should be.' This is far too tied to the past, and those methods are changing rapidly."
- "My direct-report analysts (22–27 years old) have been becoming frustrated with management's inability to keep up with technology. And since management doesn't want to devalue themselves, [they fall] back on cost/expense as excuse/reason to prevent us from learning more programming for automation."
- "The biggest challenge I have in learning other tools is lack of time. I see uses for R (for example), but my workload and deliverable timelines usually mean that I can abuse Excel more efficiently than climbing the learning curve for R."

9 Conclusion

We are under no illusion that the information presented here can be considered the final word on how actuaries are using technology now, nor on how things may change going forward. Nevertheless, we find some results that substantiate conventional wisdom, along with some data which raises some provocative areas for discussion.

Some questions remain: Can we expect the profession to continue to be relevant, given such an emphasis on a single tool like Excel? Has this hampered the adoption of leading-edge predictive modeling and machine learning techniques? Alternately, are actuaries capably performing their vital functions in ways that are well served by a straightforward and pragmatic technology stack? Are there cultural elements that impede adoption of newer tools and techniques? To what extent does this constitute a generational divide?

This survey does not purport to give definitive answers to these or other questions. We hope, however, that it will inform future conversations and surveys that attempt to answer them.

Finally, this paper should not be construed as a monologue. If you have thoughts about the results – suggestions of opportunities for new continuing education offerings, tweaks to the syllabus, or new research projects – please let us know. Feel free to send an e-mail to CAS Research Actuary Brian Fannin, at bfannin@casact.org.