Creating an Actuarial Option for Students is Within your Reach

Susan Staples

Introduction

There has been a clear trend in recent years towards an emphasis on career opportunities at colleges and universities in the US. According to a 2019 *US News & World Report* article, "Prospective students and parents increasingly assess schools for how well they help undergrads gear up for the job market," and "over 85% of college freshmen reported that getting a 'better job' was a very important factor in their decision to go to college, compared with about 72% a decade earlier" [1]. Accordingly, that magazine, as well as *The Princeton Review*, now has metrics to rank the career placement of alumni and career centers of schools.

For classically trained mathematicians such as myself, designing or modifying a mathematics curriculum that can accommodate such a shift in emphasis may seem bewildering and daunting, at least at the outset. In this article, I briefly describe the implementation of a concentration in actuarial science within a thoroughly mainstream mathematics curriculum. Such an adaptation requires the addition of less than a handful of new courses and therefore preserves the overall tenor of the original curriculum. At the same time, an actuarial concentration prepares students for a possible career that currently enjoys wide availability, good earning potential, high levels of job satisfaction, and favorable market projections. In addition, the few new courses offer instructors the opportunity to develop applications that enliven many of the calculus and probability topics which students often find boring or of little value. Above all, I will attempt to demonstrate that such a concentration is already within reach for most schools. In fact, the industry itself provides many useful resources that schools may tap into, which I will discuss also.

Actuarial Science and Career Opportunities

Actuaries do not make their living by consulting moldy, hundred-year-old mortality tables. They study and quantify risk by building and analyzing mathematical models, and are at work in many sectors of the economy, with employers from insurance companies, financial institutions, consulting firms, the retirement industry, and government agencies. Actuarial jobs are routinely listed among those with excellent earning potential and high levels of job satisfaction. Moreover, the Bureau of Labor Statistics predicts that "employment of actuaries will be 20% higher in 2028 than it was in 2018, a job growth rate that is much faster than the 5% average among all occupations" [2].

The development of an actuary's career, which proceeds from the first credentialed status of "associate" and later to the status of a "fellow" of an actuarial society, can be a lengthy process. Completion of the associate level includes seven exams, while the fellow level consists of a total of 10 or 11 exams depending on the accreditation track pursued. However, the passing of the first two exams, usually referred to as Exam P (for probability) and Exam FM (for financial mathematics), is sufficient in most cases to launch a career. I will discuss the mathematics involved in these two preliminary exams below. Further information related to the actuarial societies will be provided in the resources section.

Mathematics Courses in a Basic Actuarial Curriculum

Statistics, probability, and interest theory courses are central to the design of an introductory actuarial curriculum. The aforementioned Exam P and Exam FM are concerned with the last two of these mathematical areas; coverage of the topics in these two exams form the core mathematics of an introductory actuarial program. A well-designed actuarial degree plan also includes classes in economics, finance, and accounting in addition to the key mathematics courses.

Most departments of mathematics already have a first class on probability that covers both discrete and continuous settings. Depending on the scope and depth of the existing probability class in the curriculum, either one probability class alone or a two-semester sequence in probability would treat all the necessary topics in probability. For this reason, I will focus my comments on interest theory, which likely needs to be added to the existing mathematics curriculum. Again, some departments cover the interest theory syllabus in a one-semester three or four credit class, while others may use two quarters or two semesters to complete the curriculum. (See the resources section for more information on the course syllabi.)

Interest theory is a standard part of financial mathematics, and a course on the subject usually assumes a background of two semesters of single-variable calculus. The AMS/MAA Textbooks series publishes one of the most popular textbooks on interest theory: *Mathematical Interest Theory* by Vaaler, Harper, and Daniel. A significant number of financial models and algorithms are developed in such a course and mastery of these models and their associated formulas is necessary for Exam FM. Problems are multistep in set up, exacting in detail, and often involve clever observations. Of course, these clever observations themselves can be classified and learned with practice. The flavor of teaching interest theory may be likened to that of teaching second semester calculus, especially integration techniques, sequences, and series.

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Not only do interest theory problems provide applications of calculus to finance, but they also offer opportunities for students to hone their problem-solving skills on integration, and sequences and series. Here are a few illustrative examples. An early concept discussed in the course is the notion of the effective rate of interest over a time period. The effective rate of interest is constant in the setting of compound interest as well as four other classical models. However, the effective rate of interest is a function that varies with time in a number of other standard models, including simple interest. Launching from an understanding of the effective rate of interest and taking an appropriate limit, a notion akin to an instantaneous rate of interest called the force of interest arises. Integral calculus is employed to build a model for how money accumulates in settings where the force of interest is not constant. Many other models and examples throughout the course depend on sequence and series techniques to solve problems. Students are often surprised to learn that there are practical uses for series and that these examples move far beyond a mere determination of whether or not a series diverges or converges. A later topic in the course relies on utilizing Taylor series to determine how to build a portfolio that is so-called "immunized" or protected against fluctuations in interest rates. Careful analysis of the second-degree Taylor polynomial fit generated by the immunization model leads to a remarkable result! In special settings the prescribed fit protects the portfolio for all interest rate fluctuations and not merely for small changes in rates. With this model the details that undergird the theory of convergence of Taylor series come to life in an interesting application.

Resources

There are two actuarial societies in the United States, the Society of Actuaries, SOA (`https://www.soa.org/`), and the Casualty Actuarial Society, CAS (`https://www.casact.org`). Both the SOA and CAS offer support to faculty members in developing an actuarial curriculum. Specific curricular goals including syllabi and suggested texts for these courses are provided by the SOA at `https://www.soa.org/education/exam-req/edu-asa-req/`. The syllabi featured on the website are remarkably detailed, containing information from outlines of overall objectives all the way down to individual section numbers of recommended textbooks. These tips can be very useful, particularly for a new program. The websites also publish old exams and exam study materials. The problems on the exams are challenging for students and national passing rates are low. Therefore, I recommend that instructors familiarize themselves with these exam materials, especially as they develop a new program.

The actuarial field also features a number of organizations that support students and enhance diversity initiatives. The CAS welcomes student members to join CAS Student Central (`https://www.casstudentcentral.org/`) and the SOA facilitates the Candidate Connect community for aspiring actuaries (`https://www.soa.org/future-actuaries/soa-candidate-connect-features/`). Several other groups offer scholarship and mentoring opportunities focused on increasing diversity in the actuarial field. The International Association of Black Actuaries (`https://www.blackactuaries.org/`), the Organization of Latino Actuaries (`https://www.latinoactuaries.org/`), and the Gamma Iota Sigma Solutions for Authenticity Inclusion and Diversity (`https://www.gammaiotasigma.org/gammasaid/`) are three such resources. To put in perspective the level of underrepresentation of minorities in the actuarial field here are some quick estimates. A representative from IABA offers a rough approximation that historically 1% of credentialed actuaries are Black, and representatives from OLA provide the estimate that over the last ten years about 2% of new members to the CAS or SOA are Latinx. Most actuaries enter the profession after an undergraduate degree and continue their studies on the job instead of pursuing graduate school. Thus, an actuarial career provides a more affordable entry point into a high-profile profession for many first-generation college students.

If starting an actuarial option at your university has piqued your interest, the SOA provides a checklist of requirements for a program to be formally listed as a University or College with an Actuarial Program (UCAP) (`https://www.soa.org/institutions/`). The community of actuarial educators welcomes newcomers and the UCAP listing includes a contact person for each actuarial program. You can also meet other actuarial educators online in the MAA Connect Actuarial Educators group. Faculty members creating an actuarial program can also find support from two programs sponsored by the societies: the CAS University Liaison Program and the SOA University Support Actuary Program.

Concluding Remarks

Directing the TCU actuarial program for twenty years has been a most rewarding experience for me. Dozens of talented TCU graduates have well-established careers in the actuarial industry and a few have gone on to graduate studies in related areas. At our annual actuarial career fair, a number of alumni actively recruit our students. I wish the same success to you, if you venture down the road to create an actuarial option at your own institution.

References

[1] `https://www.usnews.com/education/best-colleges/articles/2019-09-09/how-colleges-help-students-gear-up-for-jobs` (September 9, 2019)

[2] `https://www.usnews.com/education/best-colleges/articles/reasons-to-study-actuarial-science-and-how-to-become-an-actuary` (August 31, 2020)

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Credits

Author photo is courtesy of TCU.

Trust Your Instincts When Opportunity Arises

Noah Giansiracusa

At several key points in my education and career I've felt a tension between what I thought I should be doing and what I really wanted to be doing professionally—but a lesson I've learned over and over is that what you should be doing professionally is whatever you really want to be doing. I'll try to convince you of this notion throughout this column, but whether you should follow this advice perhaps depends on whether you want a conventional career or are open to a potential career adventure.

Without exception, whenever I have thrown caution to the wind and followed my passions rather than following more traditional paths, I believe I have come out of it more successful, not to mention happier, than I would have otherwise. The first couple of times this happened I thought it was just serendipity, that the random thing I did against my better judgment somehow, by pure chance, turned out to be professionally beneficial beyond anything I could have anticipated. But it's happened so many times now that I don't think it's simply luck. Here are some overarching reasons why I now believe your career will grow more by trusting your instincts and following your passions than by just doing what you think the profession expects of you:

1. You will be more motivated to work hard, and the product of your work will likely be more creative and inspired, if you are working on something you are passionate about.
2. Your applications (for jobs, promotions, grants, etc.) will stand out more and be more memorable if your career path doesn't look identical to everyone else's.
3. Networking is one of the most important activities you can do at any career stage, and unusual opportunities almost always end up introducing you to people you otherwise would not have met.

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I think the easiest way to convince you of this is simply to walk you through various junctures in my life where I did what I wanted to even though at the time I thought this was the "wrong" thing to do.

After one year of grad school I wasn't sure if it, or math more generally, was really for me. Over that first summer rather than studying for exams or doing a directed reading with a potential adviser, as I "should" have done, I decided to test the waters outside of academia and lay the first steps for a possible escape route. I looked for an internship, and ultimately found one that appealed to me on a variety of levels—a public policy fellowship at the National Academies in DC—and went for it even though mathematically this would set me back a whole summer. As grad school progressed I became more interested in math and open to academia, so when graduation came around I put this idea of a career in public policy out of mind and did the usual thing of applying for postdocs. To my surprise, I landed one that was far more prestigious than anything I ever expected or felt I had a chance at. To be quite honest, I was puzzled by why I got it.

A year into that postdoc, in a conversation with my mentor, Bernd Sturmfels, over pizza and beer he encouraged me to try doing some applied and interdisciplinary math, but I pushed back and said I only have a limited time as a postdoc to establish myself professionally so feel I should keep focusing on the pure math I had done in grad school that got me this postdoc. Sturmfels then said, bluntly, that he read dozens and dozens of applications from algebraic geometers that all looked the same, competent and excited to share the latest theorem they had proven, but the reason he selected my application over the others wasn't because my thesis was better than theirs (it wasn't!) nor that I was a stronger mathematician overall (I certainly wasn't!), it was because in grad school I had spent a summer doing a public policy fellowship in DC and that showed him that I was willing to take chances professionally and think outside the box and connect with people in other fields.

I was shocked when he told me this, that the activity I thought set me back in math was actually what set me apart from other mathematicians. This casual comment that my postdoc mentor almost certainly doesn't remember making has been one of the most influential insights of my career—whether consciously or not, it has been at the heart of almost every professional decision I have made since that moment. (I don't think I've ever told you this before, Bernd, so now is my chance: thank you for your wisdom and candor.)

Later in my postdoc, my research was hitting some snags—progress was grinding to a halt and relationships with collaborators were starting to fray. I felt that I should persevere and push through this rough patch, but I was having trouble getting myself to do so. Meanwhile, an