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Dear Ms. Royston,

I am writing to submit a proposal in response to the Casualty Actuarial Society's "Call for Monographs: Credibility in P&C Actuarial Science." As mentioned in the call, there have been recent advances in both predictive modeling and analytics and practicing actuaries have made use of these techniques to significant effect in improving the insurance industry. But most of the techniques that actuaries use in analyzing the data they come across rely on the assumption that the observations are "independent and identically distributed." The world is certainly more complicated than that, and we need to embrace methods of analysis that get us closer to the rich complexity that we see in our data sets.

One avenue to capture a richer world is to move away from independent observations; that is, instead of viewing our data as a random sample from a population, we must realize that in many instances we are sampling observations that come from distinct clusters within a population. This clustered data, so ubiquitous around us, stands at the center of the theory of mixed models and of applications of credibility theory.

Unfortunately, the statistical training of actuaries has not focused its attention on the theory of mixed models and thus most practicing actuaries are not familiar with these techniques and their connections to credibility theory. In the actuarial literature there are many applications of mixed models. But these papers are difficult to appreciate and understand for the mainstream practicing actuary. The gap between their current statistical training and the level needed in these papers is just too big.

I propose to you a monograph to close this gap. The working title is "Practical Mixed Models for Actuaries" and I envision it as providing a path from ordinary regression through the general linear model and longitudinal models to mixed models. I want to include enough theory so that practicing actuaries can confidently apply the methods and effectively collaborate with statisticians; but not so much, that they would lose interest in the topic. And rather than learn about the theory first and then use it in applications, I believe that a mixed approach that blends them together will provide the best path into this area. Also, from a pedagogical perspective, if the readers are not actively engaged in the problems and the discussion, then they will not be able to internalize the material and make it their own. Hence, I will incorporate working computer code that illustrates and reinforces the concepts and the theory and have exercises sprinkled throughout the text.

The literature and applications of mixed models is vast and there are many topics and paths one can take. I believe that an introduction to this area would proceed from ordinary least squares to the general linear model, and into longitudinal models and the hierarchical linear model. Longitudinal models are essential in making the connection with several credibility models and the hierarchical linear model provides an excellent entry point for understanding the random effects of mixed models. Then we can explore the generalized linear mixed model and its applications. These are the main topics but for a practitioner to apply these techniques they need to be complemented with a thorough understanding of grouped data, appropriate exploratory data analysis tools, fitting methods, and diagnostic techniques.

A proposed rough outline:

1. Quick review of ordinary least squares
2. Review of credibility models
3. Introduction to longitudinal models and their connections to credibility models
4. Understanding of grouped data and exploratory data analysis techniques
5. Hierarchical models, linear mixed models, and generalized linear mixed models
6. Hands-on fitting techniques and diagnostic tools and methods
7. Applications and simulations to illustrate techniques, concepts, and methods (throughout all of the above topics)

Regarding my qualifications to undertake this project, I worked as an actuary in the insurance industry for about 20 years before switching to academia three years ago. During those years I incorporated more advanced statistical techniques into our pricing and reserving processes. I was a member of the group that wrote *A Practitioner's Guide to Generalized Linear Models*. This publication was used by the CAS as a study note for one of their examinations. I have also contributed a chapter on using GLMs in pricing for the book **Predictive Modeling Applications in Actuarial Science** (Vol. 2) edited by Frees, Meyers, and Derrig. Other publications are available on the accompanying resume.

My background as a practicing actuary tells me that some theory is important. But it is better to provide worked examples that illustrate the theory and opportunities to actively apply the concepts, rather than to focus on developing the theory in detail. Most practitioners will not be developing software fitting procedures to estimate these models. They will be using pre-existing software. Therefore, my approach to this monograph would be more pragmatic and hands-on for the reader.

Should you have any questions about this proposal, please do not hesitate to contact me. I'm looking forward to your response.

Best regards,

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