Formalizing Actuarial Mathematics in the Coq Proof Assistant

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Summary

The proof assistant is a tool which implements mathematical proofs into computers using formal expressions. Many proof assistants have been developed recently, but Coq is one of the most popular ones in the world, which provides a large formal library of mathematics.

My contribution is the formalization of actuarial mathematics in Coq. Actuarial mathematics is not formalized in any proof assistant, albeit its practical indispensability. This study is the first attempt to formalize actuarial mathematics using a proof assistant.

The formal library of actuarial mathematics is named the `Actuary` package. It is open to the public in my GitHub repository `https://github.com/Yosuke-Ito-345/Actuary`. The `Actuary` package contains the theories of interest, life tables, premiums and reserves. You can also find some case studies of the practical usage of this package.

Meanwhile, the `Actuary` package covers a limited area of life insurance mathematics at present. This work is prospective for both theoretical and industrial aspects of actuarial mathematics, but more improvement is needed for business use. One of the critical problems is that calculus is not fully formalized in Coq. If probability theory is formalized in Coq, the `Actuary` package would be able to include a wider range of actuarial mathematics.

When the `Actuary` package is well developed, it can mainly be used to proofread actuarial documents and to verify programs of actuarial models. In the former case, the `Actuary` package will be a strong tool to eliminate literal errors. The latter case should be demonstrative of Coq's use, since the proof assistant can formally verify the correctness of computer programs. I would be pleased if this study makes proof assistants more popular, and look forward to meeting new contributors to the formalization of actuarial mathematics.

* The contents presented here are solely the speaker's opinions and do not reflect the views of Company.