**Monte Carlo Simulation**

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**Introduction**

This exercise focused on the use of the Monte Carlo simulation to estimate with confidence. The benefit of using a Monte Carlo simulation is to make projections for the future based on historical data and with significant accuracy. The IIHS data was evaluated to determine the maximum annual loss to a person’s vehicle if they are at fault (*Insurance Losses by Make and Model*, n.d.). The code was executed in R with Appendix A noting the code used for all calculations. As new data is gathered, using this code to update the results would be possible with an upload of the more recent data.

**Average Loss Frequency**

The average loss frequency was calculated by calculating a Poisson distribution. As noted by Girling (2013), the Poisson distribution simplifies the modeling of frequency of an event and it best works when there are no significant fluctuations from one point of measurement to another. In the code, the Poisson distribution was calculated with inputs of the number of values to return and the vector of means of collision events in a year (*R: The Poisson Distribution*., n.d.). For the IIHS data, the value was 34, indicating the average loss frequency.

**Average Loss Severity**

The average loss severity looked at the data for the collision amount. Calculations for the mean, the standard deviation, the mean log-normal distribution (or mu), and the standard deviation (or sigma) of the log-normal distribution. Samples based on the calculated mu and sigma values. The average loss severity for the IIHS data was 105.3043.

**Maximum Total Loss**

The Monte Carlo simulation is a way to project data based on the historical data collected. The process combines the frequency and severity distributions in order to do so (Girling, 2013). Once the frequency distribution and severity distribution are determined, as was done in this exercise, these values were multiplied. Doing so over many iterations increases the confidence level.

The maximum total loss was identified as the largest value in iterations of multiplying the Poisson sample and log-normal distribution sample. Through five iterations, the values were: 3262.26, 3219.706, 2952.151, 2834.987, and 2033.963. The largest value in these iterations was 3262.26. This seems to correlate with the average yearly collision losses calculated from the complete data set, where the average values ranged from 2735.436 to 3051.064. It would be expected this value would be larger than any in that list. To be more reliable, significantly more iterations would need to be completed.

**Monte Carlo Extrapolation Process**

According to the Girling (2013) text, the 99.9 percentile confidence level can be achieved with their example using the Monte Carlo simulation through compiling a list of 1,000 iterations. That list is then sorted from smallest to largest. The largest of the values is the max expected loss in any year. The process to find the number of iterations for any data set is outlined by Liu (n.d.). The process involves identifying the mean, sample standard deviation, and z-statistic.

Applications for this can be seen across numerous fields, from business to medical and many other situations where long-term projects need be made. Over the past few years there has been great interest in predicting the spread of Covid-19. There have been several articles published with projections for the way the virus would spread. Research from Maltezos & Georgakopoulou (2021) attempts to show the spread dynamics of the virus using the Monte Carlo simulation. Epidemiologically the Monte Carlo simulation can be a very helpful tool.

**Appendix A.**

Code for all calculations completed.

**Text

Description automatically generated**

**Appendix B.**

Code and outputs for all calculations completed.

**Text

Description automatically generated**

**Appendix c.**

Histogram of distribution of max total loss for author’s own visualization purposes with assistance for code from post by Rendyk (2021).

Chart, histogram

Description automatically generated

**References**

Girling, P. (2013). *Operational Risk Management: A Complete Guide to a Successful Operational Risk Framework* (1st ed.). Wiley.

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Rendyk. (2021, April 19). *How to Perform Monte Carlo Simulation?* Analytics Vidhya. Retrieved October 16, 2022, from https://www.analyticsvidhya.com/blog/2021/04/how-to-perform-monte-carlo-simulation/