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Predicting the Next Big Impact: Modelling the Rate of Massive Meteorite Strikes

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Abstract

Meteorites are solid pieces of debris from an astronomical object such as a comet, asteroid, or meteoroid that originates in outer space and survives its passage through the atmosphere to reach the surface of a planet. Although rare, a collision between massive astronomical objects, known as an impact event, can have measurable effects, and physical and biospheric consequences. In this work, we investigate the distributional trend of heavy meteorites that strike the earth and determine if any probability distributions can serve as effective predictive models. NASA meteorite data from 1980 to 2012 were imported into R after pre-processing. Pre-processing activities involved the following: removal of missing data, irrelevant features to meteorite mass or the year of meteorite impact. Statistical analysis was then restricted to meteorites at or above the 98th percentile of mass. It was found that while the distribution of mass for all meteorites is lognormal, the distribution for the top 2% is severely right-skewed, indicating that an extreme-value distribution could be used to model them. Furthermore, the rate of impact for these massive meteorites can be modelled with a zero-inflated negative binomial distribution.

Keywords: extreme-value distribution, lognormal distribution, NASA meteorites data, skewness, zero-inflated negative binomial distribution