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COMPOUND POISSION PROCESS AND LAUNCH ACTIVITY

Abstract

The number of space objects is expected to increase rapidly over the coming decades due to mega-constellation plans. A significant rise in space object launches will also lead to a higher collision risk. To accurately assess risks to the space environment, it is essential to simulate the launch process using a more suitable stochastic model. This paper introduces the compound Poisson process for that purpose and explains its underlying mathematical principles. The model includes two key parameters: jump frequency and jump size. These parameters can be adjusted flexibly to better reflect real-world launch conditions.

Compared to traditional uniform or Poisson processes, the compound Poisson process better captures the increasingly centralized launch periods. Based on a collision probability model, different evolutionary processes can result in varying numbers of collisions, even when the total number of space objects remains the same. This paper demonstrates that the traditional launch model underestimates long-term collision frequency, explains why the compound Poisson process leads to improvements, and provides examples to validate these enhancements using the MIT Orbital Capacity Assessment Tool Monte Carlo (MOCAT-MC) model.

The findings can be applied to improve the accuracy of space environment models and enhance calculation algorithms for space mission ratings. Additionally, this work contributes to the determination of orbital capacity.