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Improving Science Yield for NASA Swift with Automated Planning Technologies.

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The Swift Gamma-Ray Burst Explorer is a uniquely capable mission, with three on-board instruments and rapid slewing capabilities. It often serves as a fast-response space observatory for everything from gravitational-wave counterpart searches to cometary science. Swift averages 125 different observations per day, and is consistently over-subscribed, responding to about one-hundred Target of Oportunity (ToO) requests per month from the general astrophysics community, as well as co-pointing and follow-up agreements with many other observatories. Since launch in 2004, the demands put on the spacecraft have grown consistently in terms of number and type of targets as well as schedule complexity. To facilitate this growth, various scheduling tools and helper technologies have been built by the Swift team to continue improving the scientific yield of the Swift mission. In this study, we examine various approaches to the automation of observation schedules for the Swift spacecraft, comparing the efficiency and quality of these tools to each other and to the output of well-trained human Science Planners. Because of the computational complexity of the scheduling task, no automation tool has been able to produce a plan of equal or higher quality than that produced by a well-trained human, given the necessary time constraints. We detail here several approaches towards achieving this goal of surpassing human quality schedules using classical optimization and algorithmic techniques, as well as machine learning and recurrent neural network (RNN) methods. We then quantify the increased scientific yield and benefit to the wider astrophysics community that would result from the further development and adoption of these technologies.

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