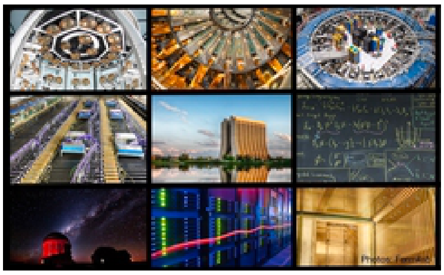

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Automated Design of Experimental Systems

Experimental system design, or the problem of developing an instrument architecture for an experiment, is a difficult optimization problem due to its high dimensionality, combination of discrete and continuous variables, and the implicit cross dependency of those variables. Conventional methods, such as genetic algorithms, are inefficient due to their ignorance of how specific sub-choices affect the overall design. For example, in the problem of optimizing an optical system for a telescope, such algorithms only consider the quality of the overall system, not the contributions of individual lens components, and therefore explore the system space inefficiently. We describe a novel technique that, through structuring the search space as a discrete tree, both takes specific design choices into account and provides the user information about which design choices matter most. We apply a combination of Monte Carlo tree search and approximate Bayesian computation to concurrently optimize the continuous and the discrete parameters of the system within the context of our tree representation. Finally, we present results that display the potential of the method in the context of symbolic regression and optical system design. Specifically, we show the algorithm's ability to find and optimize a Cooke Triplet and several solutions to various symbolic regression problems.

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