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Multi-Objective Optimization of APR-1400 Core Reload Pattern using Metaheuristic Algorithm

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Optimizing the reload pattern of a nuclear reactor core, such as that of the APR-1400, is a complex and computationally intensive task due to the high dimensionality and non-linearity of the search space. These problems are characterized by numerous local minima, making it challenging to locate the global optimum using conventional deterministic methods. Metaheuristic algorithms like Simulated Annealing (SA) offer a promising alternative by probabilistically exploring the solution space. SA mimics the physical annealing process in metallurgy: it begins with a high "temperature" that encourages broad exploration, including the acceptance of suboptimal solutions, and gradually reduces the temperature to refine the search around promising areas.

In reactor core optimization, achieving a balance between competing objectives, economic performance (e.g., maximizing cycle length) and safety constraints (e.g., minimizing power peaking factor), further increases the problem complexity. Although SA provides flexibility and adaptability, its effectiveness can be hindered by the presence of deep local minima, which can trap the search process and prevent convergence to the global optimum. In this preliminary work, an SA framework is tailored for the Apr-1400 core reload problem to assess its feasibility.

Technical Track

Reactor Physics

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