Nuclear reloading pattern optimization

In a nuclear reactor there are fuel rods of different ages. At the end of each fuel cycle, the oldest rods are moved to a spent fuel pool and are replaced by fresh rods. At this point, it is possible to make reallocate rods in the core leading to a combinatorial problem. This problem may be modeled as a Mixed Integer Nonlinear Problem (MINLP). The model includes dependent variables that describe physical properties such as neutron flux, burn-up, and yield. The neutron transport equations are converted to a set of algebraic equations using Green's functional theory, giving rise to a stationary description of the neutron flux in the core. The fuel burn-up is approximated by discretizing the differential equation.

More physically accurate models are solved with Meta-heuristics search methods. There for each given reloading pattern the neutron flux etc. are calculated by the numerical solution of the relevant differential equation.

There is a symmetric problem to optimize the unloading process of fuel rods. The operations to determine are the placements of rods in the spent fuel pool and to optimize the manipulations of rods in the pool by automated handling systems.

References:

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Software:

XIMAGE - Interactive Loading Pattern Design (Studsvik)

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