A Competitive Co-Evolutionary Approach for the Nurse Scheduling Problem

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Abstract

The Nurse Scheduling Problem (NSP) is a constrained combinatorial optimisation problem that plays a critical role in healthcare scheduling and constraint optimisation. Traditional evolutionary approaches often rely on static fitness evaluation, which struggles to balance feasibility and solution

quality under complex real-world constraints. This study proposes a competitive co-evolutionary algorithm for the NSP that introduces adaptive adversarial evaluation, where candidate schedules are assessed under dynamic competitive pressure to expose structural weaknesses and guide evolution more effectively. The proposed competitive NSP is evaluated on a 20-nurse, one week scheduling instance and compared against a classical Genetic Algorithm (GA) under identical conditions for 30 independent runs. Experimental results show that the competitive NSP achieves a mean best penalty of 447.28, compared to 651.30 for the classical GA, corresponding to an average improvement of approximately 31%. The competitive approach further exhibits smoother convergence behaviour across generations, indicating stronger optimisation dynamics and improved robustness. These findings demonstrate that competitive co-evolution provides an effective and practical alternative to static fitness-based evolutionary methods for nurse scheduling, with broader applicability to healthcare scheduling and constraint optimisation problems.

Author keywords

adversarial evaluation; competitive co-evolution; constraint optimisation; evolutionary algorithms; healthcare scheduling; Nurse Scheduling Problem

Indexed keywords

Engineering controlled terms

Combinatorial optimization; Constrained optimization; Genetic algorithms; Information systems; Scheduling algorithms

Engineering uncontrolled terms

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