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A Competitive Co-Evolutionary Approach for the Nurse Scheduling Problem

By

Nazri, MFM (Nazri, Maizatul Farhana Mohamad) [1]; Yusoh, ZIM (Yusoh, Zeratul Izzah Mohd) [2]; Basiron, H (Basiron, Halizah) [2]; Daud, A (Daud, Azlina) [3]

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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

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and practical alternative to static fitness-based evolutionary methods for nurse scheduling, with broader applicability to healthcare scheduling and constraint optimisation problems.

Keywords

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Author Information

Corresponding Address: Nazri, Maizatul Farhana (corresponding author)
Mohamad

▼ Univ Teknikal Malaysia Melaka, Fac Informat & Commun Technol, Melaka, Malaysia

Addresses :

▼ ¹ Univ Teknikal Malaysia Melaka, Fac Informat & Commun Technol, Melaka, Malaysia

▼ ² Univ Teknikal Malaysia, Fac Artificial Intelligence & Cyber Secur, Melaka, Malaysia

▼ ³ Int Islamic Univ Malaysia, Kulliyyah Nursing, Pahang, Malaysia

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