

# A Rule-Based Soft Constraint Conflict Detection Framework for Academic Timetables

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## Abstract

Time-table slot selection is an important administrative task in educational institutions where conflicts may occur due to resource limitations, faculty availability, and class capacity restrictions. Traditional scheduling approaches mainly address hard constraints to ensure feasibility, while soft constraints such as workload balance, avoidance of consecutive lectures, and time slot preferences are often overlooked. This paper proposes a rule-based soft constraint conflict detection system that evaluates existing timetables using predefined IF-THEN rules. The system identifies violations of soft constraints and classifies them into severity levels. Rather than generating an optimized timetable, the framework acts as a decision-support tool by highlighting inefficient scheduling patterns. Experimental evaluation demonstrates the effectiveness of the proposed approach in detecting violations and categorizing them based on severity, making it suitable for small to medium-sized academic institutions.

Keywords— Academic Timetabling; Soft Constraints; Rule-Based System; Conflict Detection; Decision Support

## I. Introduction

Timetable scheduling is an important administrative problem in higher education institutions as it affects faculty workload distribution and student learning experience. Academic timetables are governed by hard constraints such as faculty availability, room capacity, and student group clash avoidance. However, soft constraints such as workload balance and preferred time slots significantly influence timetable quality.

## II. Literature Review

Previous research in academic timetabling has focused primarily on constraint satisfaction and optimization approaches such as genetic algorithms, simulated annealing, and particle swarm optimization. While effective, these methods are computationally intensive and often lack interpretability. Soft constraint modeling using weighted CSP and fuzzy logic has improved flexibility but increased system complexity.

## III. Proposed Methodology

The proposed system evaluates an existing timetable after hard constraints are satisfied. It defines soft constraints such as consecutive lecture overload, uneven workload distribution, undesirable time slots, and student fatigue. A rule-based IF-THEN framework detects violations and assigns severity levels (low, medium, high). The algorithm operates in linear time relative to timetable size.

## IV. Experimental Results

The system was tested on departmental timetable data. Results indicate that consecutive lecture overload and student fatigue generated the highest severity conflicts. The classification of conflicts into severity levels assists administrators in prioritizing corrective actions effectively.

## V. Discussion and Limitations

The framework is interpretable and lightweight, making it suitable for small institutions. However, its effectiveness depends on well-defined soft constraint rules and appropriate threshold selection. The system does not automatically generate

optimized timetables but functions as a decision-support tool.

## **VI. Conclusion and Future Work**

The rule-based soft constraint conflict detection framework effectively evaluates academic timetables and classifies violations by severity. Future work may integrate optimization modules and dynamic threshold adjustment to enhance system adaptability.

## **References**

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