An interactive tool for supporting university timetabling

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Introduction

University Course Timetabling Problem *(UCTTP) is a combinatorial optimization problem that consists of allocating* *__events__, __rooms__, __lecturers__, and __students__ to weekly schedules while meeting certain __constraints__ (Figure 1). This research focuses on* ***Curriculum-Based Course Timetabling*** *(CB-CTT), a variant of UCTTP that focuses on course scheduling.*

Due to the size and complexity of the problem, obtaining an optimal solution in usable time is typically infeasible. However, using ***heuristic algorithms****, it is possible to get approximate and good-quality solutions effectively.*

FCUP's timetabling building process *is __time-consuming__, __not automated__, and __suboptimal__. In general, the currently available tools focus primarily on visualizing timetables or on basic conflict detection without offering optimized solutions.*

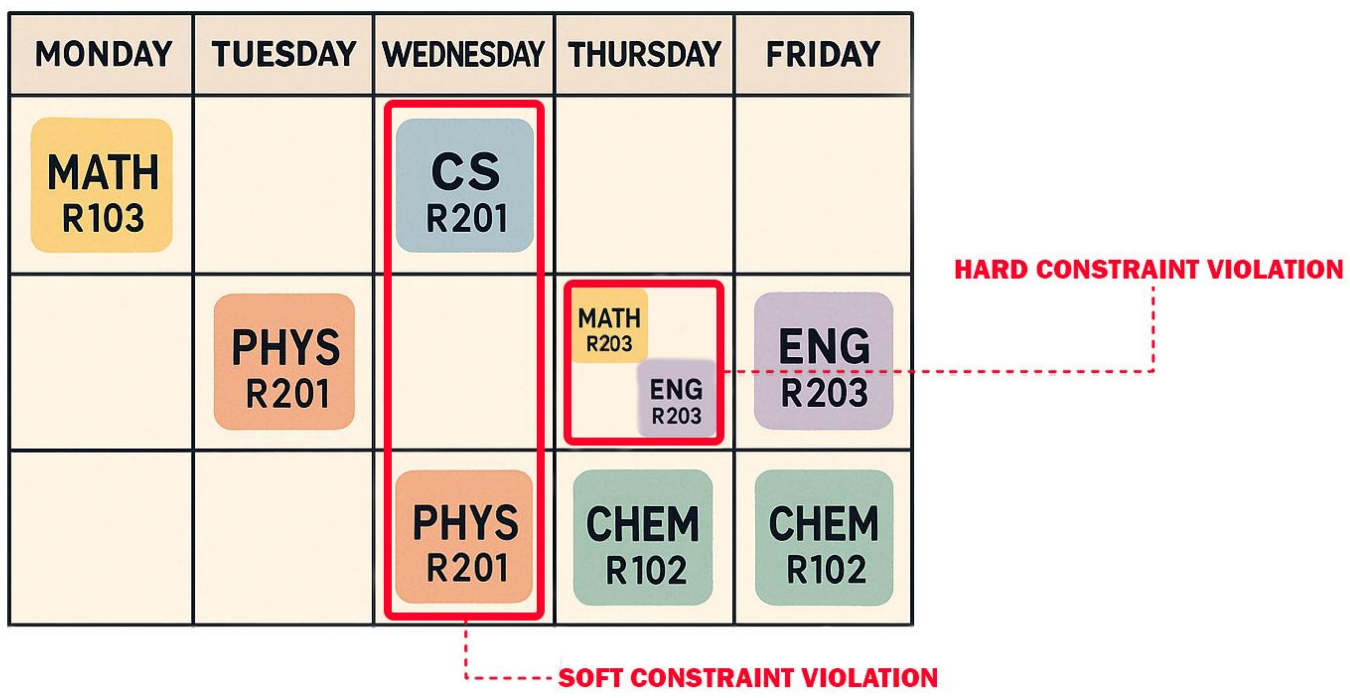

Figure 1 – *Hard and Soft constraints.*

Aim

- *Enhance the* ***efficiency*** *and* ***quality*** *of FCUP's timetabling.*
- *Provide step-by-step interactive* ***recommendations****.*
- *Detect potential* ***conflicts****.*
- *Integrate these functionalities into a timetable visualization* ***interface*** *that was previously developed using reactive programming.*

Methodology

Monte Carlo Tree Search *(MCTS) chosen due to its effectiveness in games and optimization problems, as well as its ability to navigate large search spaces effectively (Figure 2). Although it has shown positive results in various areas, in the context of CB-CTT there are no studies that use MCTS.*

Hill Climbing *(HC) used in simulation phase for local optimization but only if a feasible and improved solution is found.*

Additionally, a ***diving strategy*** *is under investigation to enhance MCTS. Instead of restarting from the root each iteration, the algorithm follow and deepen promising paths, aiming to improve the convergence speed and solution quality.*

Performance is evaluated using the ***benchmark datasets*** *from* ***ITC-2007 track 3*** [1].

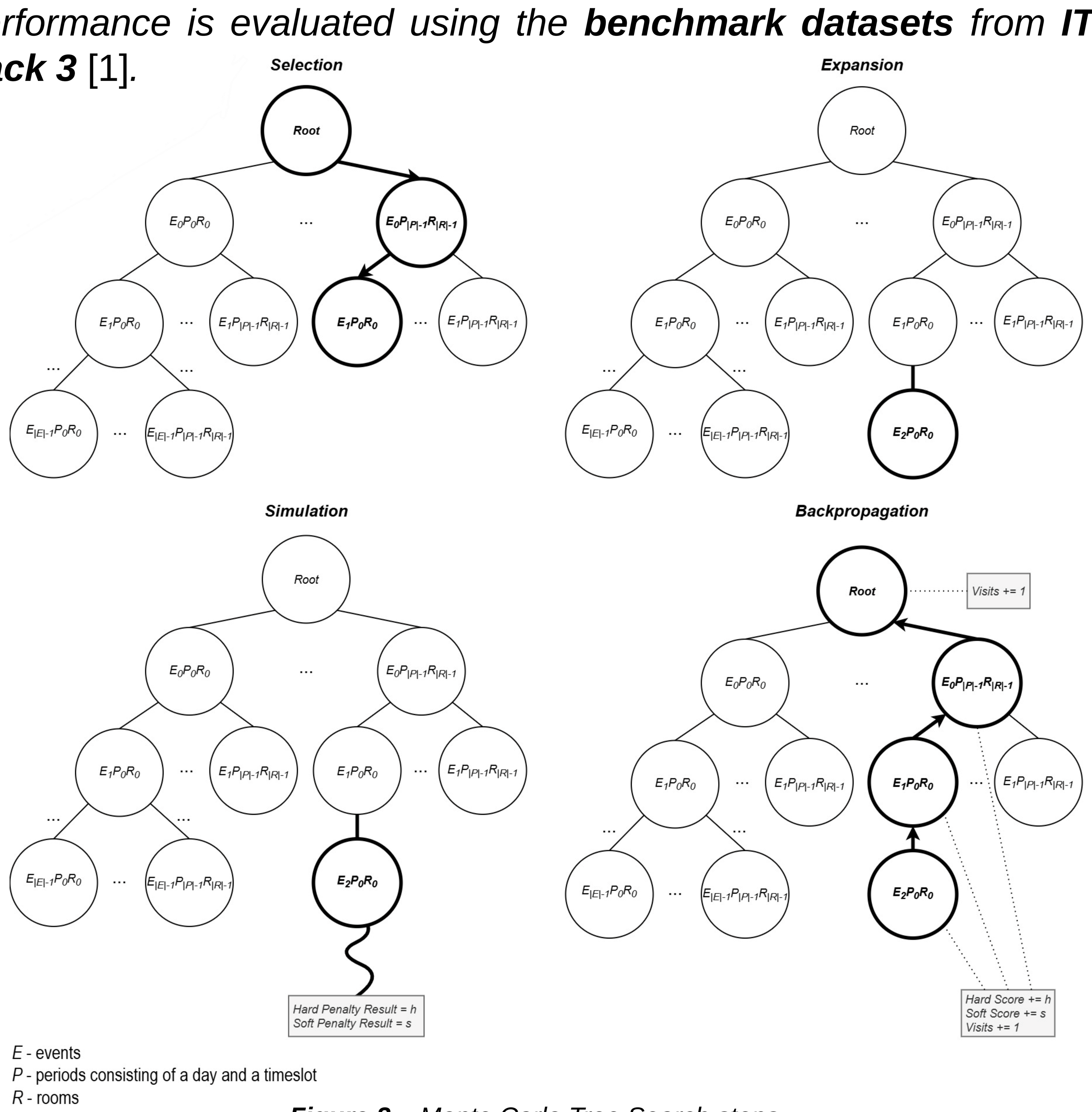

Figure 2 – *Monte Carlo Tree Search steps.*

Preliminary Results

Tested ***C*** *values (0.1 to 1000) in the* ***UCT formula*** *and in a* ***modified version*** *incorporating accumulated rewards for exploitation.*

All tests so far have consistently produced ***feasible solutions****, in the challenging ITC-2007 set of benchmark instances.*

In 10-minute runs with different fixed seeds, ***C showed minimal impact on results****, indicating a weaker-than-expected influence on node selection.*

Diving strategy *is still under development, but early results (Figure 3) are encouraging, though not yet competitive with state-of-the-art solutions.*

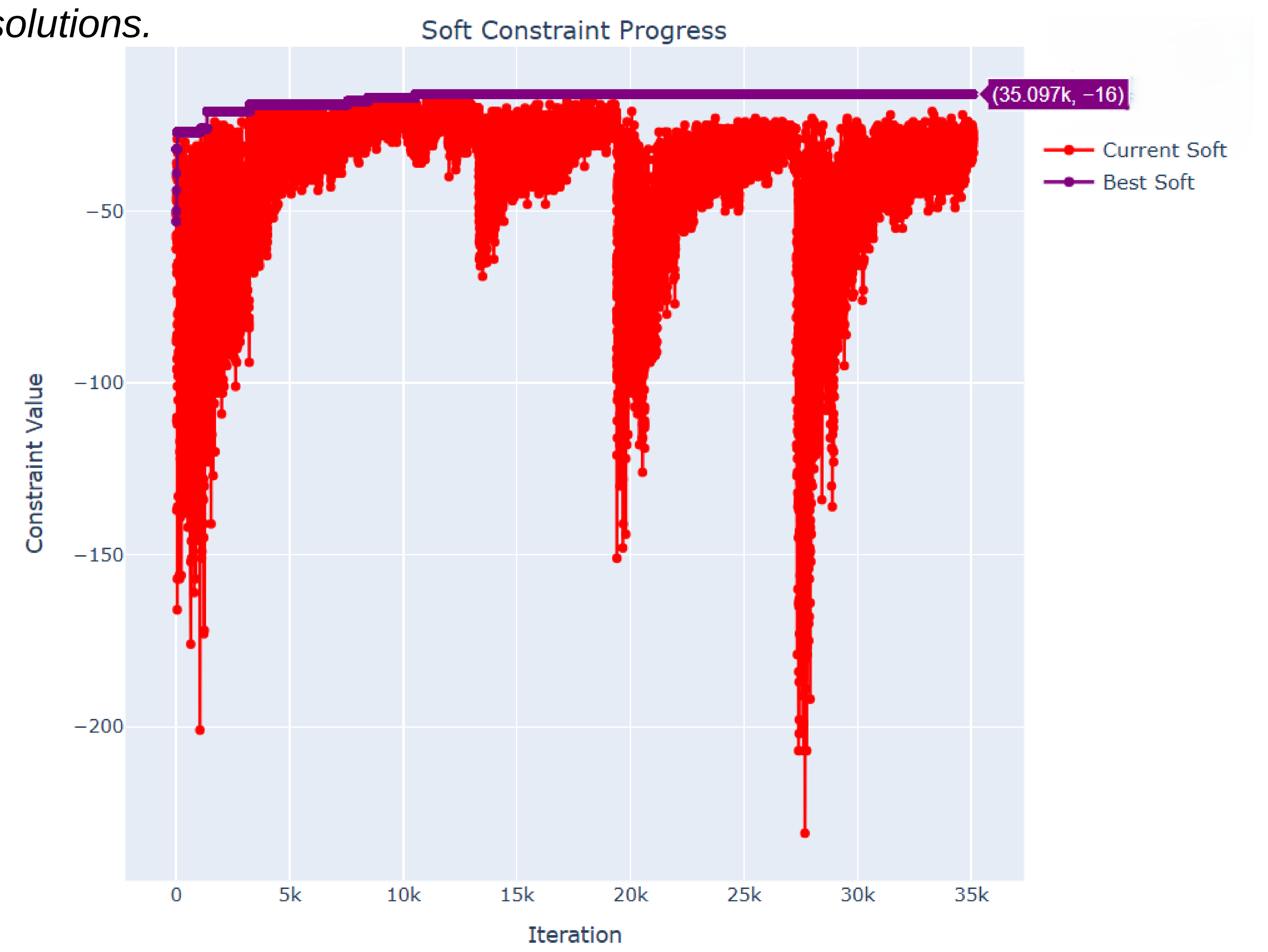

Figure 3 – *Soft constraint progress using the diving approach on the comp01 instance from ITC-2007.*

Conclusion

The proposed system presents a ***novel*** *application of MCTS to UCTTP, combined with HC for local improvements. By leveraging interactive recommendations and conflict detection, the tool provides a more effective and adaptive scheduling process for FCUP and can be extended to other institutions and help in other studies.*

Future work will focus on the ***diving strategy****,* ***refining the heuristic functions*** *and* ***improving computational performance****.*

References

[1] International Timetabling Competition --- eeecs.qub.ac.uk. https://www.eeecs.qub.ac.uk/itc2007/Login/SecretPage.php
[2] R. Lewis, "A survey of metaheuristic-based techniques for university timetabling problems," OR Spectrum, vol. 30, no. 1, pp. 167–190, Jan. 2008. Available: https://doi.org/10.1007/s00291-007-0097-0
[2] S. Abdipoor, R. Yaakob, S. L. Goh, and S. Abdullah, "Meta-heuristic approaches for the university course timetabling problem," Intelligent Systems with Applications, vol. 19, p. 200253, Sep. 2023. Available: https://linkinghub.elsevier.com/retrieve/pii/S2667305323000789
[3] H. Babaei, J. Karimpour, and A. Hadidi, "A survey of approaches for university course timetabling problem," Computers & Industrial Engineering, vol. 86, pp.43–59, Aug. 2015. Available: https://linkinghub.elsevier.com/retrieve/pii/S0360835214003714
[4] M. C. Chen, S. N. Sze, S. L. Goh, N. R. Sabar, and G. Kendall, "A survey of university course timetabling problem: Perspectives, trends and opportunities," IEEE Access, vol. 9, pp. 106 515–106 529, 2021, conference Name: IEEE Access. Available: https://ieeexplore.ieee.org/document/9499056/?arnumber=9499056
[5] T. Müller, "Itc2007 solver description: a hybrid approach," Annals of Operations Research, vol. 172, no. 1, pp. 429–446, Nov. 2009. Available: http://link.springer.com/10.1007/s10479-009-0644-y
[6] S. L. Goh, "An investigation of monte carlo tree search and local search for course timetabling problems,", pp. 76–105, Jul. 2017. Available: https://eprints.nottingham.ac.uk/43558/

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Introduction

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Aim

- *text*
- *text*
- *text*

Methodology

text

Results

text

Conclusion

text

References

text

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