

# EXAMINATION TIMETABLE SCHEDULING USING TABU SEARCH

A thesis submitted to the College of Arts & Sciences in partial  
fulfilment of the requirement for degree Master  
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by

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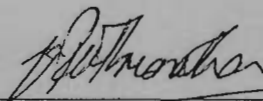
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## ABSTRACT

Examination Timetables are utilized to schedule exam-timeslots in field of Applied Science .It involved assigning times and places to suitable events by creating use of available resource. Badly designed examination timetables are not just inconvenient but proved high-priced in terms of wasting time and money. Hence, the major aim of this research is to investigate the internal method of Tabu Search in solving and improving exam-timetable problem. The research have targeted on class examination timetabling problem. Hence, Tabu search is an iterative search method. It uses a local search algorithm at every iteration to search for the finest solution in some subset of the neighborhood, which came from the finest solution obtained at the last iteration. This paper reports the powerful techniques using Tabu Search in scheduling. Examination Timetabling problem is one of the applications in scheduling. In one aspect, it deals with courses such that it executes the process time slot. These aspects are important for the examination timetabling so it can be done in a smooth way and no student can sit more than one exam in a same time slot.

**Keyword:** Tabu Search, FAS Examination Timetabling

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# CHAPTER 1

## 1.0 INTRODUCTION

The aim of this report is to discuss on the project background that was conducted at the Field Applied Science (FAS), for generating examination timetabling using Tabu Search (TS). The problem statement, the objective and the significance of the study and scope are discussed in this section.

### 1.1 Background to the study:

In achieving Malaysia's aspiration to become a developed nation by year 2020, the government has put a greater emphasis on technology-based industries as the catalyst to improve the nation's economic growth. Thus, a well trained lab our force is essential to lead and manage these high technology industries. To meet the abovementioned demand, University Utara Malaysia (UUM) has taken the initiative by officially establishing the Faculty of Information Technology.

Field of applied sciences was formally known as the School of Information Technology (SIT) before the faculty system was officially launched in September 2003. SIT was established on March 1, 1990 and was the first school to offer Information Technology programmes in Malaysia. It has since expanded its programmes from just one bachelor degree program to three bachelor degree programmes, four master programmes, PhD and collaboration programmes with local

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## References

- Abdullah Konak & Sadan Kulturel-Konak ,2005 . SIMULATION OPTIMIZATION USING TABU SEARCH: AN EMPERICAL STUDY . Proceedings of the 2005 Winter Simulation Conference M. E. Kuhl, N. M. Steiger, F. B. Armstrong, and J. A. Joines, eds.
- Alvarez, R., Crespo, E. and Tamarit, (2002) J.M. Design and implementation of a course sched- uling system using tabu search, *European Journal of Operational Research* 137, 512–523,.
- Abdennadher, S. & Marte, M. (2000). *University Course Timetabling Using Constraint Handling Rules*. Retrieved January, 2005, from <http://www.pms.informatik.uni-muenchen.de/mitarbeiter/marte/publications/Abdennadher-Marte-JAAI-2000.pdf>
- Baggio, G. Wainer, J. & Ellis, C. (2004). Applying Scheduling Techniques To Minimize The Number Of Late Jobs In Workflow Systems. *SAC '04, March 14-17, 2004, Nicosia, Cyprus. 2004 ACM Symposium on Applied Computing, pp. 1396-1403.*
- Brown, D. E. & Scherer, W. T. (1995). *Intelligent Scheduling Systems*. Kluwer Academic Publishers, 101 Philip Drive, Assinippi Park, Norwell, Massachusetts 02061, USA, ISBN 0-7923-9515-8.
- Burke, E. K. & Newall, J. P. (2002). Enhancing Timetable Solutions With Local Search. PATAT 2002 Proceedings of the 4th International Conference on the Practice and Theory of Automated Timetabling. Retrieved February, 2005, from <http://ingenieur.kahosl.be/vakgroep/IT/Patat2002/ExaminationTT/newall.pdf>
- Clark D. (1993). Exam scheduling by Tabu Search . Australian Soc. Ops Res.

Bulletin, 12, 5–9.

Cagdas Hakan Aladag & Gulsum Hocaolu, 2007. A TABU SEARCH ALGORITHM TO SOLVE A COURSE TIMETABLING PROBLEM . Hacettepe Journal of Mathematics and Statistics Volume 36 (1) (2007), 53 – 64

Carter, M. W. (2000). A Comprehensive Course Timetabling And Student Scheduling System at the University of Waterloo. PATAT 2000 Proceedings of the 3<sup>rd</sup> International Conference on the Practice and Theory of Automated Timetabling. Retrieved January, 2005,  
[frohttp://www.mie.utoronto.ca/staff/profiles/carter.html](http://www.mie.utoronto.ca/staff/profiles/carter.html)

Di Gaspero L. and Schaerf A. (2003), "Multi-neighbourhood Local Search with Application to Course Timetabling". In: Burke, E.K. and De Causmaecker, P. (eds.): Practice and Theory of Automated Timetabling IV (PATAT 2002), Lecture Notes in Computer Science 2740, Springer-Verlag 2003, pp 262--275.

De Werra D., Hertz A. -Tabu Search Techniques, (1989): A tutorial and an application to neural networks - OR Spektrum ,pp. 131-141.

EVEN, S., ITAI, A., AND SHAMIR, A. 1976. On the complexity of timetabling and multicommodity , flow problems. SIAM Journal on Computing 5, 691–703.

Enric Crespo.(1997). Department of Financial and Mathematical Economy. Universitat de Val'encia

Fang, H. L. (1992). Investigating Genetic Algorithms for Scheduling. Unpublished Thesis: MSc. University of Edinburgh.

Frank Dammeyer, and Stefan Voß ,(2005). Technische Hochschule Darmstadt, FB1/FG Operations Research, Hochschulstrasse 1, D-6100 Darmstadt, Germany

Faigle U., Kern W. (1992), Some Convergence Results for Probabilistic Tabu Search – ORSA Journal on Computing 4, pp. 32-37.

- Fox B.L 1993. -Integrating and accelerating tabu search, simulated annealing and geneticalgorithms - *Annals of Operations Research* 41, (1993) pp. 47-67.
- Filho, G. R. & Lorena, L. A. N. (2000). A Constructive Evolutionary Approach To School Timetabling. Retrieved December, 2004, from [www.lac.inpe.br/~marcos/arsig2/CGA-timet-EVOCOP.pdf](http://www.lac.inpe.br/~marcos/arsig2/CGA-timet-EVOCOP.pdf)
- Ghazali, N. H. & Ramli, R. (2004). Past Solutions Of Driver Scheduling And A Promising Path Via Genetic Algorithm. Seminar Kebangsaan Sains Pemutusan 2004, pp. 385-392.
- Glover, F. and Laguna, M. 1997. *Tabu Search*. Norwell, MA: Kluwer Academic Publishers.
- Grajcar, M. (2000). Conditional Scheduling for Embedded Systems Using Genetic List Scheduling. University of Passau. ISSS 2000, Madrid, Spain. IEEE 2000, pp. 123-128.
- Glover, F. (1986). Future Paths for Integer Programming and Links to Artificial Intelligence. *Computers and Operations Research*. Vol. 13, pp. 533-549.
- Glover, F. Kelly, J. P & Laguna, M. (1995). Genetic Algorithms and Tabu Search: Hybrids for Optimization. *Computers and Operations Research*. Vol. 22, No. 1, pp 111 – 134.
- Ghaith Mohammad Hasan Jaradat (2006), *Improving Secondary School Examination Timetabling using Genetic Algorithm*, Universiti Utara Malaysia
- Glover F. and Laguna M. (1997), "Tabu search", Boston : Kluwer Academic Publishers.
- Hertz A. (1991). Tabu search for large scale timetabling problems . *Eur . J. Opl Res.*, 54, 39–47.

- Hertz, A., Taillard, E. and Werra, D. (2005) A Tutorial on Tabu Search. Accessed on April 14: <http://www.cs.colostate.edu/whitley/CS640/hertz92tutorial.pdf>
- Hansen, P. 1986. The Steepest Ascent Mildest Descent Heuristic for Combinatorial Programming. Congress on Numerical Methods in Combinatorial Optimization, Capri, Italy.
- Hansen P 1999. -The Steepest Ascent Mildest Descent Heuristic for Combinatorial Programming - Presented at the Congress on Numerical Methods in Combinatorial Optimization, Capri, Italy, (1986) .
- Helm, T. M. Painter, S. W. & Oakes, W. R. (2002). A Comparison Of Three Optimization Methods For Scheduling Maintenance Of High Cost, Long-Lived Capital Assets. *Proceedings of the 2002 Winter Simulation Conference*, pp. 1880-1884.
- Lalescu, L. & Badica, C. (2003). Timetabling Experiments Using Genetic Algorithms. Timetabling Experiments Using Genetic Algorithms, prezentata la TAINN'03, Canakkale, Turcia, 2003. Retrieved February, 2005, from [http://software.ucv.ro/Cercetare/Inginerie\\_Software/inginerie\\_software.html](http://software.ucv.ro/Cercetare/Inginerie_Software/inginerie_software.html)
- Khaled Ahmad Eltayf ,(2007) Time table Scheduling for BIT Program. Universiti Utara Malaysia.
- Mushi ,2004 A. R. tabu search heuristic for university course timetabling problem Department of Mathematics, University of Dar es salaam, Box 35062, Tanzania
- Malek Rahoual & Rachid Saad (2006) .Solving Timetabling Problems by Hybridizing Genetic Algorithm and Tuba Search . Department informatique , University Bougara, Boumerdes Algeria .

- Melicio, F. Caldeira, J. P & Ruso, A. (2004). Two Neighbourhood Approaches To The Timetabling Problem. PATAT 2004 Proceedings of the 5<sup>th</sup> International Conference on the Practice and Theory of Automated Timetabling.
- Melicio, F. Caldeira, J. P & Ruso, A. (2004). Two Neighborhood Approaches To The Timetabling Problem. PATAT 2004 Proceedings of the 5<sup>th</sup> International Conference on the Practice and Theory of Automated Timetabling. Technische Hochschule
- Ozcan, E. & Alkan, A. (2002). Timetabling Using A Steady State Genetic Algorithm. Yeditepe University, Department of Computer Engineering, Istanbul/Turkey. Retrieved December, 2004, from <http://cse.yeditepe.edu.tr/~eozcan/research/papers/PATAT2002.pdf>
- Pham, D.T. and Karaboga, D. (2000). Intelligent Optimisation Techniques – Genetic Algorithms, Tabu Search, Simulated Annealing and Neural Networks. London: Springer-Verlag.
- Pinedo, M. (2002). Scheduling Theory, Algorithms, and Systems Second Edition, Prentice Hall, Upper Saddle River, New Jersey 07458, ISBN 0-13-028138-7.
- Ramon Alvarez-Valdes . Enric Crespo . Jose m. Tamarit (1997) a tabu search algorithm to schedule university examinations Universitat de Val' encia
- Rubio, R. G. & Munoz, D. P. (2004). A Timetable Production System Architecture For Courses And Exams. PATAT 2004 Proceedings of the 5<sup>th</sup> International Conference on the Practice and Theory of Automated Timetabling.
- Rubio, R. G. & Munoz, D. P. (2004). A Timetable Production System Architecture For Courses And Exams. PATAT 2004 Proceedings of the 5<sup>th</sup> International Conference on the Practice and Theory of Automated Timetabling.
- Reeves, C.R. (1993). Modern Heuristic Techniques for Combinatorial Problems. John Wiley & Sons, Inc.



Rossi-Doria, O. & Paechter, B. (2004). A Memetic Algorithm For University Course Timetabling. School of Computing, Napier University, Edinburgh, Scotland. Retrieved December, 2004, from [http://iridia.ulb.ac.be/~meta/newsite/downloads/co2004\\_dam.pdf](http://iridia.ulb.ac.be/~meta/newsite/downloads/co2004_dam.pdf)

Schaerf A. and Schaerf M. (1995), "Local Search Techniques for High School st Timetabling", . Proceedings of the 1 International Conference on the The Practice and Theory of Automated Timetabling (PATAT 1995), Burke E.K. and Ross P. (eds).

Sheibani, 2002. An evolutionary approach for the examination timetabling problems . University of Victoria Victoria, BC, Canada

Santos, H.G. Ochi, L. Z. & Souza, M. J. F. (2004). A Tabu Search Heuristic With Efficient Diversification Strategies For The Class/Teacher Timetabling Problem. PATAT 2004 Proceedings of the 5<sup>th</sup> International Conference on the Practice and Theory of Automated Timetabling.

Thompson J. and DowslandK. (1993). Multi-objective university examination scheduling . Working paper EBMS/1993/12.

Tariq Riaz, Yi Wang, Kuo-Bin Li (2001). Multiple Sequence Alignment Using Tabu Search. Bioinformatics Institute, 30 Biopolis Street, Singapore 138671.

Yang, Y. & Petrovic, S. (2004). A Novel Similarity Measure For Heuristic Selection In Examination. PATAT 2004 Proceedings of the 5th International Conference on the Practice and Theory of Automated Timetabling.