View metadata, citation and similar papers at core.ac.uk

brought to you by CORE

provided by Universiti Utara Malaysia: UUM eTheses

EXAMINATION TIMETABLING USING GENETIC ALGORITHM CASE STUDY: KUiTTHO

by

Mohd Zaki Bin Mohd Salikon

EXAMINATION TIMETABLING USING GENETIC ALGORITHM CASE STUDY: KUiTTHO

A Thesis submitted to the Graduate School in partial fulfilment of the requirements for the degree Master of Science (Intelligent System), Universiti Utara Malaysia

by
Mohd Zaki Bin Mohd Salikon

© Mohd Zaki Bin Mohd Salikon, April 2005. All rights reserved.

JABATAN HAL EHWAL AKADEMIK
(*Department of Academic Affairs*)
Universiti Utara Malaysia

PERAKUAN KERJA KERTAS PROJEK
(Certificate of Project Paper)

Saya, yang bertandatangan, memperakukan bahawa
(I, the undersigned, certify that)

MOHD. ZAKI BIN MOHD. SALIKON

calon untuk Ijazah
(candidate for the degree of) **MSc. (Int. Sys)**

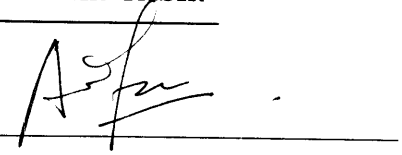
telah mengemukakan kertas projek yang bertajuk
(has presented his/ her project paper of the following title)

EXAMINATION TIMETABLING USING GENETIC ALGORITHM
CASE STUDY: KUiTTHO

seperti yang tercatat di muka surat tajuk dan kulit kertas projek
(as it appears on the title page and front cover of project paper)

bahawa kertas projek tersebut boleh diterima dari segi bentuk serta kandungan dan meliputi bidang ilmu dengan memuaskan.
(that the project paper acceptable in form and content, and that a satisfactory knowledge of the filed is covered by the project paper).

Nama Penyelia Utama
(Name of Main Supervisor): **MR. AZMAN YASIN**

Tandatangan
(Signature) : 

Tarikh
(Date) : 9/4/08.

PERMISSION TO USE

In presenting this thesis in partial fulfilment of the requirements for a postgraduate degree from Universiti Utara Malaysia, I agree that the University Library may make it freely available for inspection. I further agree that permission for copying of this thesis in any manner, in whole or in part, for scholarly purposes may be granted by my supervisor in his absence, by the Dean of the Faculty of Information Technology. It is understood that any copying or publication or use of this thesis or parts thereof for financial gain should not be allowed without my written permission. It is also understood that due recognition shall be given to me and to Universiti Utara Malaysia for any scholarly use which may be made of any material from my thesis.

Requests for permission to copy or to make other use of materials in this thesis, in whole or in part, should be addressed to

Dean of Faculty of Information Technology
Universiti Utara Malaysia
06010 UUM Sintok
Kedah Darul Aman

ABSTRAK

Algoritma Genetik merupakan salah satu kaedah yang popular dalam penyelesaian pengoptimuman. Ia telah diiplementasikan dalam pelbagai aplikasi seperti penjadualan. Aliran AG menggunakan proses pemilihan, persilangan dan mutasi terhadap populasi dari kromosom. Kertas ini membincangkan teknik yang berkesan menggunakan Algoritma Genetik untuk aplikasi penjadualan. Masalah jadual peperiksaan adalah satu daripada aplikasi dalam penjadualan. Pada satu aspek, ia bertujuan untuk mengatur slot masa pelajar yang ingin menduduki peperiksaan. Faktor ini penting bagi melicinkan perjalanan peperiksaan agar tiada pelajar yang menduduki lebih dari satu peperiksaan dalam slot masa yang sama. Di samping itu, beban subjek juga ditentukan kepada kurang dari tiga peperiksaan secara berturutan. Permasalahan penjadualan peperiksaan di Kolej Universiti Teknologi Tun Hussein Onn (KUiTTHO) diperkenalkan dan prototaip sistem telah dibangunkan menggunakan bahasa pengaturcaraan Java. Prototaip yang dicadangkan mempunyai pelbagai penyelesaian yang munasabah terhadap pengguna.

ABSTRACT

Genetic Algorithm (GA) is one of the most popular optimization solutions. It has been implemented in various applications such as scheduling. The flows of GA are using selection, crossover and mutation operators applied to populations of chromosomes. This paper reports the powerful techniques using GA in scheduling. Examination timetabling problem is one of the applications in scheduling. In one aspect, it deals with students such that it fulfils the process time slot. These aspects are important for the examination can be done in a smooth way and no students can sit more than one exam in a same time slot. The other constraint is the student workload should be arranged less than three exams in a row. The examination timetabling problem at Kolej Universiti Teknologi Tun Hussein Onn (KUiTTHO) is introduced and the prototype has been developed using Java language. The prototype suggested several feasible solutions to the user.

ACKNOWLEDGEMENTS

Praise be to Allah S.W.T, Most Gracious, Most Merciful whose blessing and guidance have helped me through entire project works. Peace be upon our Prophet Muhammad S.A.W, who has given light to mankind. My most sincere appreciation goes to my beloved mother, Tharina Bt Abdullah for their patience, prayers and understanding over the entire period of my study. Besides to my family who always there to giving me love and encourage me along the way.

Firstly, special thanks to my supervisor, Mr. Azman Bin Yasin for his idea, suggestion, support, important additions of material and supervision during the project development and in the preparation of this thesis. I am also grateful to Mr. Nurnasran Bin Puteh who contributed their time during the study.

To all my reviewers (Intelligent System) lecturers, thanks for the guidance and advice that you have given. These include Mr. Azizi Bin Aziz, Assoc. Prof. Dr. Norita Bt Norwawi, Mr. Wan Hussain Bin Wan Ishak and others.

I also wish to thank the graduate Intelligent System batch November 2004 who have supported me for the completion of this project as well as my friends Nor Rafidah, Norlia and Wan Faridah Hanum for their encouragement.

Finally, to my beloved best friends, Syaharudin, Farhan, Adrisham, Mandy, Warakorn, Fakhrul, Ahmad, Ishak, Rashid, Lim and all the individuals who share my laughter, sadness and motivations.

DEDICATION

To my mother Tharina Bt Abdullah,
for his love, patience and support.

TABLE OF CONTENTS

		Page
ABSTRAK (BAHASA MELAYU)		i
ABSTRACT (ENGLISH)		ii
ACKNOWLEDGEMENTS		iii
DEDICATION		iv
LIST OF TABLES		vii
LIST OF FIGURES		viii
LIST OF ABBREVIATIONS		ix
CHAPTER 1: INTRODUCTION		
1.1	Background Study	1
1.2	Problem Statement	4
1.3	Objective	5
1.4	Significance of Study	5
1.5	Scope	6
1.6	Thesis Overview	6
CHAPTER 2: LITERATURE REVIEW		
2.1	Introduction	7
2.2	Applications of GAs in Scheduling Problem	8
2.3	Timetabling Problem Solving Approach	10
2.4	Applications of GA in Timetabling Problem	14
2.5	Other Application in Timetabling Problem	16
2.6	Applications of GA in Examination Timetabling Problem	18
2.7	Other Application in Examination Timetabling Problem	20
CHAPTER 3: METHODOLOGY		
3.1	Introduction	23
3.2	Problem Identification	24
3.3	Theory Building	26
	3.3.1 Initialization	29
	3.3.2 Fitness Evaluation	31
	3.3.3 Reproduction	31
3.4	System Development	35
3.5	Experimentation	40
3.6	Summary	41

CHAPTER 4: FINDINGS AND RESULTS
4.1 Introduction 42
4.2 Acceptable Solutions 42
4.3 Effects of Parameters Variations 44
4.4 Summary 49

CHAPTER 5: CONCLUSIONS AND RECOMMENDATIONS
5.1 Introduction 50
5.2 Project Review 50
5.3 Experimentation Results 51
5.4 Limitation 51
5.5 Contribution 51
5.6 Future Research 52
5.7 Conclusion 52
5.8 Summary 53

REFERENCES 54

APPENDIX A: EXAMINATION TIMETABLING SYSTEM USER MANUAL
APPENDIX B: Chromosome in T1 to T25

LIST OF TABLES

Table 3.1	Actual timeslots allocation	26
Table 3.2	Penalty values	30
Table 3.3	Prototype development environment	36
Table 4.1	Default parameters setting	43
Table 4.2	Results from T1 to T15	45
Table 4.3	Results from T12, T16 to T19	46
Table 4.4	Results from T12, T20 to T23	48

LIST OF FIGURES

Figure 3.1 Methodology approach for examination timetabling 23

Figure 3.2 Outline of Genetic Algorithm 27

Figure 3.3 A GA for timetabling framework 28

Figure 3.4 Representation of Gene, Chromosome and Population 29

Figure 3.5 Actual chromosome in KUiTTHO timetabling problem 30

Figure 3.6 Single point crossover 33

Figure 3.7 Mutation 34

Figure 3.8 ETS architecture 35

Figure 3.9 KUiTTHO raw data 37

Figure 3.10 Subject Table (Fields: Code and Name) 38

Figure 3.11 Student Table (Fields: Matric and Name) 39

Figure 3.12 SubjectTaken Table
(Fields: Matric, Name, Subject, Subject Name, Sem) 40

Figure 4.1 The acceptable timetable with default setting 43

Figure 4.2 Report of the acceptable timetable 44

Figure 4.3 Graph for different of crossover rate and mutation rate 46

Figure 4.4 Graph for different of population size 47

Figure 4.5 Graph for different of slot size 49

LIST OF ABBREVIATIONS

ACS	Ant Colony System
BSc. IT	Bachelor of Science Information Technology
CBR	Case Base Reasoning
EPP	exam proximity problem
ETS	Examination Timetabling System
FIFO	First In First Out
FTMM	Fakulti Teknologi Maklumat Dan Multimedia
GA	Genetic Algorithm
GDA	Great Deluge Algorithm
GUI	graphic user interface
HC	Hill Climbing
IS	Information System
JSDK 1.3.1_05	Java Software Development Kit version 1.3.1_05
KUiTTHO	Kolej Universiti Teknologi Tun Hussein Onn
MA	Memetic Algorithm
NP	Nondeterministic Polynomial
ODBC	Open Database Connectivity
PMRP	Point to Multipoint Routing Problem
TEDI	Timetabling Tool for Educational Institutions
UPJJ	Unit Pendidikan Jarak Jauh
UUM	Universiti Utara Malaysia

CHAPTER 1

INTRODUCTION

The aim of this paper is to discuss on the project background that mainly involves in examination timetabling using Genetic Algorithm (GA). The problem statement, the objective and the significance of the study and scope will be discussed in this section.

1.1 Background Study

Scheduling problems is a difficult task in the artificial intelligence. It deals with the allocation of limited resources to tasks over time (Pinedo, 2002). The process is to optimize one or more objectives. The measurement methods which is known as computationally NP (Nondeterministic Polynomial) is the most difficult parts that the researchers faced on the scheduling problems which is lacking with the elements of the polynomial time algorithm.

The contents of the thesis is for internal user only

REFERENCES

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

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

Erben, W. & Song, P. Y. (2003). *A Hybrid Grouping Genetic Algorithm For Examination Timetabling.* Department of Computer Science, FH Konstanz – University of Applied Science, Konstanz, Germany. Retrieved December, 2004, from www.asap.cs.nott.ac.uk/patat/patat04/487.pdf

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

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

Galiasso, P. & Wainwright, R. L. (2001). A Hybrid Genetic Algorithm For The Point To Multipoint Routing Problem With Single Split Paths. *Mathematical and Computer Sciences Department, The University of Tulsa, USA. SAC 2001, Las Vegas, NV. 2001 ACM, pp. 327-332.*

Ghani, T. A. Khader, A. T. & Budiarto, R. (2004). Optimizing Examination Timetabling using A Hybrid Evolution Strategies. *2nd International Conference on Autonomous Robots and Agents, December 13-15 2004 Palmerston North, New Zealand.*

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.*

Grajcar, M. (2000). Conditional Scheduling for Embedded Systems Using Genetic List Scheduling. University of Passau. *ISSS 2000, Madrid, Spain. IEEE 2000, pp. 123-128.*

Gy'ori, S. Petres, Z. & Varkonyi-Koczy, A. R. (2001). Genetic Algorithms in Timetabling. A New Approach. *MFT Periodika 2001-07. Hungarian Society of IFSA, Hungary, 2001.* Retrieved February, 2005, from http://www.mft.hu/hallg/200107.pdf

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

Melicio, F. Caldeira, J. P & Ruso, A. (2004). Two Neighbourhood Approaches To The Timetabling Problem. *PATAT 2004 Proceedings of the 5th International Conference on the Practice and Theory of Automated Timetabling.*

Merlot, L. T. Boland, N. Hughes, B. D. & Stuckey, P.J. (2002). A Hybrid Algorithm For The Examination Timetabling Problem. *PATAT 2002 Proceedings of the 4th International Conference on the Practice and Theory of Automated Timetabling.*

Michalewicz, Z. (1999). *Genetic Algorithms + Data Structures = Evolution Programs; Third, Revised and Extended Edition.* New York, New York: Springer-Verlag.

Mitchell, M. (1999). *An Introduction to Genetic Algorithms*, MIT Press, Cambridge, Massachusetts, London, England, ISBN 0-262-13316-4 (HB), 0-262-63185-7 (PB).

Mukherjee, S. N. (2001). *Timetabling Using Cellular Genetic Algorithms With Adaptive Mutation Operators.* Unpublished Thesis: Final year dissertation, University of York.

Muller, T. (2002). *Some Novel Approaches To Lecture Timetabling.* Charles University, Faculty of Mathematics and Physics, Czech Republic. Retrieved December, 2004, from http://kti.mff.cuni.cz/~muller/lt02_na.pdf

Nunamaker, Jr. J. F. Chen, M. & Purdin, T. D. M. (1991). System Development In Information Systems Research. *Journal of Management Information Systems/Winter 1990-91, Vol. 7, No. 3, pp. 89-106.*

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

Ozcan, E. & Alkan, A. (2003). *Memetic Algorithms For Timetabling.* Yeditepe University, Department of Computer Engineering, Istanbul/Turkey. Retrieved December, 2004, from http://cse.yeditepe.edu.tr/~eozcan/research/papers/CEC03.pdf

Pinedo, M. (2002). *Scheduling Theory, Algorithms, and Systems Second Edition,* Prentice Hall, Upper Saddle River, New Jersey 07458, ISBN 0-13-028138-7.

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

Rubio, R. G. & Munoz, D. P. (2004). A Timetable Production System Architecture For Courses And Exams. *PATAT 2004 Proceedings of the 5th International Conference on the Practice and Theory of Automated Timetabling.*

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 5th International Conference on the Practice and Theory of Automated Timetabling.*

Sheibani, K. (2002). An Evolutionary Approach For The Examination Timetabling Problems. *PATAT 2002 Proceedings of the 4th International Conference on the Practice and Theory of Automated Timetabling.*

Wong, T. Cote, P. & Sabourin, R. (2004). A Hybrid MOEA For The Capacitated Exam Proximity Problem. *IEEE Congress On Evolutionary Computation (CEC 2004), Portland, Oregon, June 20-23, pp. 1495-1501, 2004.*

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.*

Yasin, A. Puteh, N. & Tahir, H. (2002). Examination Timetabling With Genetic Algorithms. *Jurnal Tek. Maklumat & Sains Kuantitatif, UiTM, Jilid 4, Bil (1), pp. 11-24.*