2017 IEEE 15th Intl Conf on Dependable, Autonomic and Secure Computing, 15th Intl Conf on Pervasive Intelligence and Computing, 3rd Intl Conf on Big Data Intelligence and Computing and Cyber Science and Technology Congress

Electronic Lecture Time-table Scheduler using Genetic Algorithm

Jumoke Soyemi
Department of Computer Science
Federal Polytechnic, Ilaro
Ilaro, Nigeria
Jumoke.soyemi@federalpolyilaro.edu.ng

John Akinode
Department of Computer Science
Federal Polytechnic, Ilaro
Ilaro, Nigeria
john.akinode@federalpolyilaro.edu.ng

Samson Oloruntoba
Department of Computer Science
Federal Polytechnic, Ilaro
Ilaro, Nigeria
samson.oloruntoba@federalpolyilaro.edu.ng

***Abstract*— Lecture time-tabling preparation has always been known as a typical scheduling problem that is time consuming, energy sapping and often leading to general apathy and waste of resources. Planning time-table every session or semester is among the most complex and error-prone task carried out in higher institutions of learning. Therefore, the need to adopt an electronic system as opposed to the manual process cannot be over-emphasized. Several other administrative sectors of most institutions have been automated, but lecture time-tabling is still done manually because of its inherent problems. Planning lecture time-table demands enormous attention and effort from any institution because of its constraint satisfaction problem. The Federal Polytechnic Ilaro, the case study in this research operates a Manual time tabling system (MTTS) that is done centrally, which makes it more difficult in getting a flawless lecture scheduling. This study developed an electronic lecture time-table scheduler (ELTS) using Genetic algorithm to provide convenience in fixing classes and reduction in the risk of omission and clashes of courses, halls and lecturers. Questionnaire was also prepared and administered to sample the opinions of staff, students and committee members involved in the manual process. Difference in mean response on the two response variables of ELTS and MTTS was tested using Paired Sample T-test technique. The result from the analysis corroborates the fact that the new ELTS will be the best method in tackling the lapses experienced by the old system.**

Keywords— Lecture time table, Manual time-tabling system, Electronic lecture Time-table scheduler, Genetic Algorithm

I. INTRODUCTION

Lecture time-tabling system is a system that schedules lecture time and available resources in order to maximize such resources [1],[2]. It is one the most important yet time consuming task done periodically in any academic institution of learning. Therefore lecture time table should be carefully assigned into appropriate timeslot for students, lecturers and lecture halls based on constraints [3]. The manual lecture time-tabling in our case study is done centrally and not on school (faculty) basis or departmental basis as obtained in several other institutions. This method is employed in order to manage the limited resources optimally in term of lecture halls. Data are collected from various departments in each school for the preparation. The timetable process is in three phases namely: Data collection from departments, where each department will supply the various courses which will include the course title, course code, contact hour (lectures and practical), course unit and the lecturer to take them. The second phase is the analysis of the provided data where the data supplied by the departments are analyzed with the available space [hall sizes]. The last phase is the Lecture time scheduling. Based on the analysis in the second phase, the lecture time-table is produced with three outputs vis-à-vis: Hall time-table [omnibus/main control], Departmental Input and Lecturers time-table [control II]. In scheduling the lecture time table, the following constraints must be taken into consideration; No student can attend more than one lecture at a time, No lecturer can teach more than one course per time and lecture hall cannot be assigned to more than one particular course at a time.

The problem of time-table scheduling is an optimization problem, a non-polynomial hard (NP hard) problem which implies that, there are no exact algorithms to solve the problem. Although, there are several techniques employed in literature for solving NP hard problem such as Evolutionary Algorithms (EA), Generic Algorithms (GA), Heuristic Algorithms (HA), and others, this study adopted the Genetic Algorithm approach to solve the problem at hand in our case study.

The scope of work is limited to space allocation for lectures and merging of similar courses for a particular lecturer.

II. LITERATURE REVIEW

A. Lecture Time-Table Scheduling Problem

The manual lecture time-table scheduling requires considerable time and effort with a lot of paperwork. The process involves assigning courses, lecturers and resources such as lecture halls to timeslots subject to constraints [1], [4]. The committee saddled with the responsibility of manual time-tabling generation are usually faced with numerous challenges ranging from erroneous computation, clashes in lecture halls, omission of courses just to mention a few. It has been noted that space management in educational institutions is more critical compared to other institutions [5]. Therefore,

978-1-5386-1956-8/17 $31.00 © 2017 IEEE
DOI 10.1109/DASC-PICom-DataCom-CyberSciTec.2017.124

management of space and facilities within an organization is paramount and must be dealt with efficiently. A study by Ibrahim *et al*. noted that the space management for institute of higher learning is very critical and therefore, space and facilities management must be the main agenda and such agenda should be managed efficiently [6].

According to Burke *et al*., the problem of timetabling is the problem of assigning the various resources to the meetings in a consistent manner [7]. Timetable involves a set of incident E = {e1, e2,.…en} meeting a set of time to the said incident T = {t1, t2, …..ts}. The set of places where the incident occurred P = {p1, p2..,.pm} and a set of agents to conduct the incident A = {a1, a2, ….an} for example, lecturers.

The formal definition for timetable according to Zaeem *et al.,* is given in details in the event that the following resources and time slot exist as follows:

A set of lecturers {t1, t2…tn}
A set of courses {c1, c2,….cm}
A set of lecture-halls {r1, r2,…..rq}
A set of time {p1, p2, ….ps}

This attempts to arrange classes suitable to the lecture-halls such that no lecturer will be allocated in two classes at the same time [8]. This approach in scheduling timetable may solve several constrictions such as courses that have various time, joint courses, the distribution of courses in a week and lecture halls required.

With the increase in the number of student population, new programmes being mounted and additional lecture halls, an electronic lecture time-table scheduler is required to cater for this increase. Most of the time-tabling problems belong to the class of NP-hard problems, as no deterministic polynomial algorithm exists. Timetable is defined as the total schedule of specific lectures attended by a group of students in an institution and the lecturer at a specific time. It also requires specific resources such as lecture halls and so on [8].

Computational methods used to solve time-tabling include Tabu Search, Simulated Annealing, Evolutionary Algorithms and Artificial Intelligence [9]. Quite a number of papers employed generic algorithm for electronic time-table scheduling [10]. A study by [11] noted that Evolutionary Algorithm and Generic Algorithm only outperform methods such as hill-climbing when dealing with complex or resource starved time table problems. Professional software currently available for ELTS lacks the generality required by different institutions [10].

B. Hard and Soft Constraints

Time table constraints are grouped into hard and soft constraints. Hard constraints are those constraints that needed to be satisfied. In our case, some of such constraints are;

- ✓ Students can only be allocated to one class at a time
- ✓ Lecturers can only be allocated to one class at a time
- ✓ Venues can only be allocated for one class at a time
- ✓ Courses with same course title, code, content and same lecturers should be merged and fix in the hall with same capacity as the class size
- ✓ Practical for ICT-related courses must be allocated between 8am-2pm

The Soft constraints are desired requirements that do not necessarily had to be fulfilled. Although, it should be noted that sometimes, it might be important to satisfy soft constraints. Some of the soft constraints in our study include;

- ✓ Lecturers should not go for more than 4 hours at a stretch
- ✓ Students should have some free periods between lectures
- ✓ Certain courses are to be taken in particular period.
- ✓ Certain periods within the week are to be free for all lecturers and students.

C. Genetic Algorithm

Genetic algorithm is a technique that is able to get an appropriate solution to search problems when the search space is complex and large. It has become the most preferred optimization technique of choice because it often succeeds in getting the best optimal solution as opposed to other common optimization algorithms. The algorithm employed biological method and genetic programming to solve problem. One of the advantages of GA is that they can explore solution space a multiple directions at once [12, 13]. The Genetic algorithm is described in figure 1 below; [14]

Produce the initial population of individuals
Evaluate the fitness of every individual
While termination condition not satisfied do
{
Select individual for reproduction
Recombine between individuals
Mutate individuals
Evaluate new solutions for fitness of modified individuals
generate a new population
end while
}

Figure 1. Description of Genetic Algorithm [14]

The flow diagram of the described algorithm above is depicted figure 2 below;

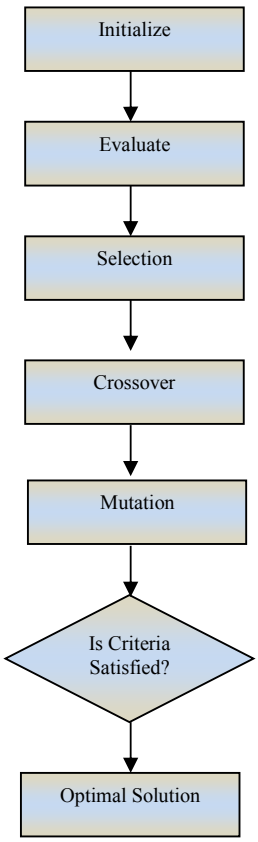


Figure 2. Flow diagram of Genetic Algorithm

The genetic algorithm is made up of an iterative process, evolving an operational set of individuals (known as population) towards an objective function. This algorithm mimics the process of natural selection and is therefore considered a good method of solving this type of complex optimization problem of lecture time-table scheduling. The algorithm searches through the problem space defined by all possible encodings of solutions. Evaluation is performed to check the fitness of each solution in current population while selection picks individual for survival based on probability function of fitness. Crossover is a means of exchanging genetic materials, providing rules, features of machine learning, search or optimizing problem. Mutation has to do with change in gene composition of chromosome modification for single individuals.

III. SYSTEM DESIGN

The proposed model was built using the genetic algorithm after analyzing the manual process of time table scheduling; this is represented in figure 3. The first step in developing the software was to gather the required input from the committee involved in manual time table preparation. Data obtained include the number of lectures, venues and their capacities, student capacity per course, name of lecturers, courses and the units with hours of lectures and practical involved.

Java was the programming language used for the development of the front end and Microsoft SQL Server was employed for designing the back end. Window 7 operating system is the minimum operating system required to run the application. Also Adobe PDF reader or any other PDF reading software was used. The design of different forms required for user interaction was done and the interface was developed to be user friendly. The development of a model that represents the structure of the database and the interaction of the application with the database was carried out. For the Controller, we designed the logic and the implementation of different processes for the application system and then integrated the developed modules into a single unit - the software package. The application developed was then tested and validated for efficiency and flow of operation.

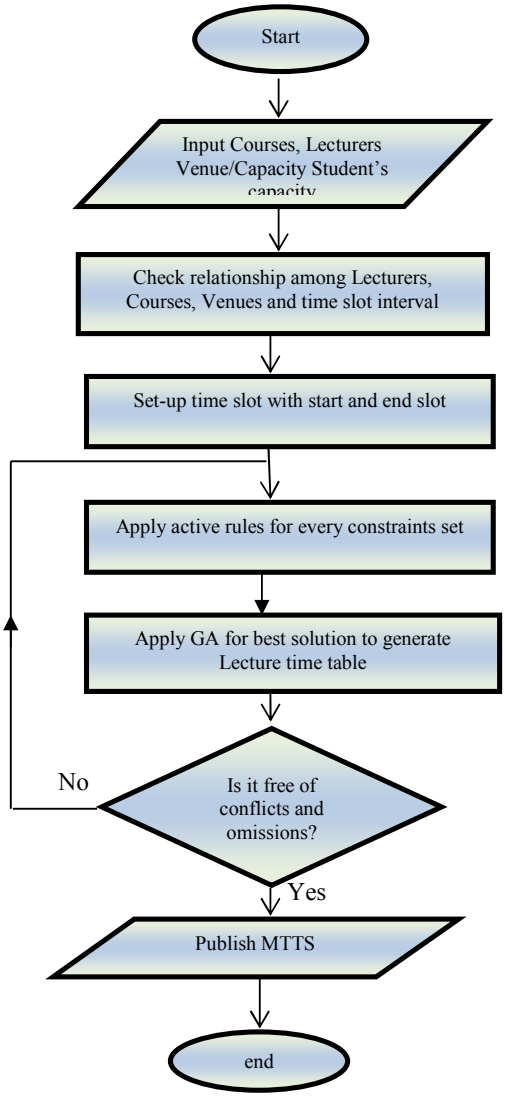


Figure 3. Proposed Algorithm Flowchart for ELTS

IV. SYSTEM IMPLEMENTATION AND STATISTICAL ANALYSIS

A. Software Implementation

Several constraints were taken into consideration in the software implementation. All the aforementioned hard constraints were put to use among which are; No student can attend more than one lecture at a time, No lecturer can teach more than one course per time and lecture hall cannot be assigned to more than one particular course at a time. In addition courses with same course code, title and at the same class level can be merged together to maximize space utilization. Figures 4, 5 and 6 are snapshots of generation of Time-table module, download module and module for the result of the ELTS generated and downloaded in PDF format.

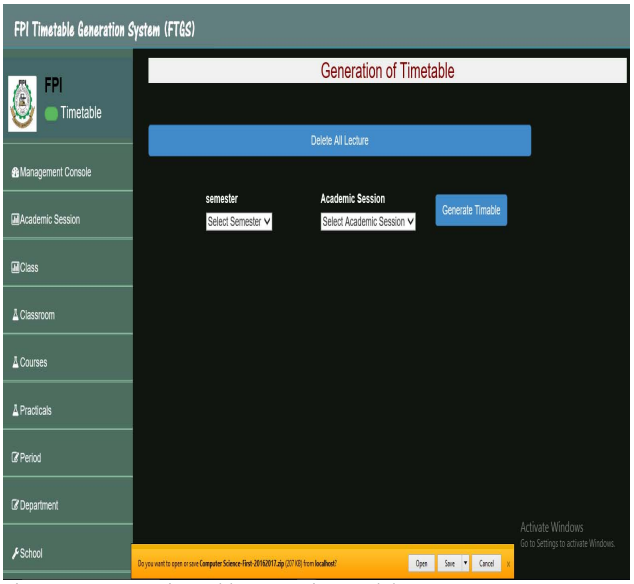


Figure 4. Lecturer Time table Generation Module

Figure 4 is the module where the actual time table is generated by the software after applying all the constraints stated earlier.

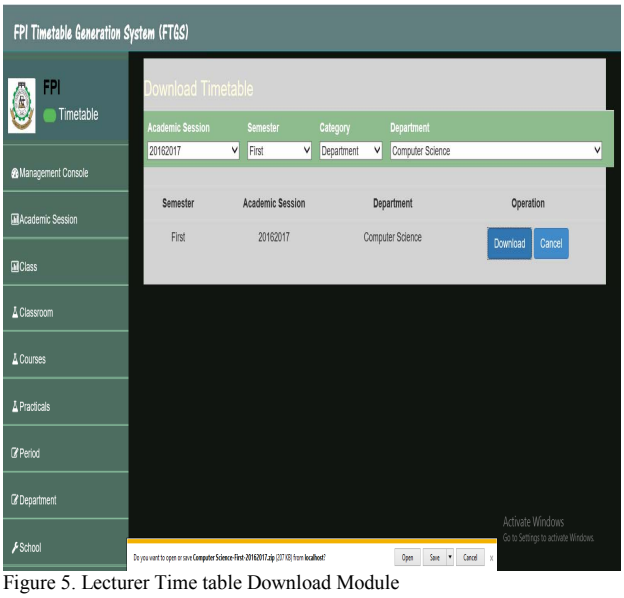
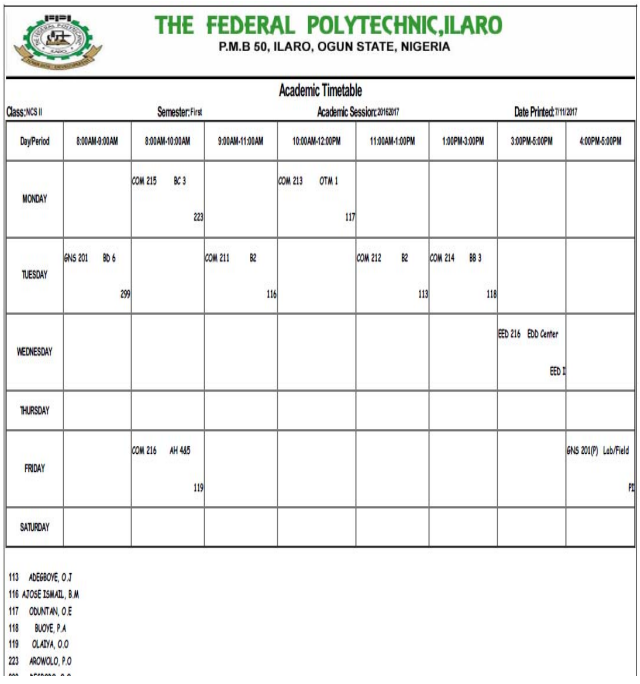


Figure 5. Lecturer Time table Download Module

Figure 5 is the module where the generated time table could be downloaded by specifying whether it should downloaded based on departmental basis, school basis or for the whole institution. The Tab 'Academic session' selects the session to be downloaded. 'Semester tab' is where to specify either first or second semester and 'class tab' selects the department and the class level such as CSI - which means Computer Science department 100 level, MSII – means Mathematics and Statistics department 200 level and so on.

.



THE FEDERAL POLYTECHNIC,ILARO

P.M.B 50, ILARO, OGUN STATE, NIGERIA

Academic Timetable

Class:NCS II Semester:First Academic Session:20162017 Date Printed:7/11/2017

Day/Period	8:00AM-9:00AM	9:00AM-10:00AM	9:00AM-11:00AM	10:00AM-12:00PM	11:00AM-1:00PM	1:00PM-3:00PM	3:00PM-5:00PM	4:00PM-5:00PM
MONDAY		COM 215 BC 3 223		COM 213 OTM 1 117				
TUESDAY	GNS 201 BD 6 299		COM 211 B2 116		COM 212 B2 113	COM 214 BB 3 118		
WEDNESDAY							EED 216 EDD Center EED 1	
THURSDAY								
FRIDAY		COM 216 AH 485 119						GNS 201(P) Lab/Field P1
SATURDAY								

113 ADEGBOYE, O.J
116 AZOSE ISMAIL, B.M
117 ODUNTAN, O.E
118 BLOYE, P.A
119 OLADIYA, O.O
223 AROWOLO, P.O

Figure 6. Generated and Downloaded Lecture time Table in PDF format

Figure 6 is a PDF sample of software generated and downloaded table showing allocations of courses to lecturers and lecture halls. This figure also displays a list of lecturers to teach various courses and the code given to such lecturers for identification.

.

B. Statistical Analysis of ELTS Adoption

This study is aimed at the adoption of electronic lecture time-table scheduler as against the Manual process operated in majority of all Nigeria Tertiary Institutions of learning. Two hundred and fifteen (215) questionnaires were administered to the respondents which comprises of the time-tabling committee members, the lecturers, and the students, out of which two hundred (about 93%) were returned. Opinion of respondents' towards their perception on the two systems based on time consumption, efficiency, convenience and overall performance were analyzed on a likert scale of three thereby resulting in the test of degree of relationship and formulation of hypothesis on the average response of both variables under the same condition of response using Paired Sample T-test for decision making process..

Hypothesis

H_0: There is no significant difference in the average response of Automated and Manual time tabling scheduling in Higher Institution (H_0: $\mu_1 - \mu_2 = 0$)

H_1: There is significant difference in the average response of Automated and Manual time tabling scheduling in Higher Institution (H_1: $\mu_1 - \mu_2 \neq 0$)

Test Statistic: $Z = \frac{(\bar{x}_1 - \bar{x}_2) - (\mu_1 - \mu_2)}{\sigma_{\bar{x}_1 - \bar{x}_2}}$

Critical value: $Z_{1-\alpha/2}$

Decision: Reject H_0 if $|Z| > Z_{1-\alpha/2}$. Otherwise, accept Ho.

For convenience sake, Statistical Package for Social Sciences (SPSS) was used in the statistical analysis of the research study.

TABLE I. PAIRED SAMPLES CORRELATIONS

		N	Correlation	Sig.
Pair 1	ELTS total response & MTTS total response	200	.825	.000

TABLE II. PAIRED SAMPLES TEST

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	SD	Std. Error Mean	95% C.I of the Difference Lower	Upper			
$\mu_1 - \mu_2 = 0$	.88000	.49682	.03513	.81072	.94928	25.049	199	.000

Pair 1

ELTS mean response 4.4850, SD = 0.78284, SE mean = 0.05536

MTTS mean response 3.6050, SD = 0.87338, SE mean = 0.06176

N = 200

Source: SPSS Output, version 2017

μ_1 = ELTS total average response

μ_2 = MTTS total average response

Paired sample correlation in table 1 for the 200 respondents on their opinion pertaining to electronic lecture time-table scheduler and Manual Time Tabling Scheduling revealed a strong positive relationship (r = 0.825) under study. This indicates that Manual processing system of time tabling influenced the adoption of its electronic method counterpart in terms of time consumption, convenience, efficiency and its overall performance when adopted.

Table 2 depicts the paired sample test of the total response on the adoption of ELTS against its manual process counterpart for difference in mean response. Analysis revealed that there are 4.485 and 3.605 mean response of respondents' perception on ELTS and MTTS on delivery based on time, convenience, efficiency and overall performance under study. However, we also failed to accept the null hypothesis of no significance difference in the average response of electronic and Manual time tabling scheduling in Higher Institution with student T-statistic of 25.049 df=199 and an associated P-value 0.000<0.05. The mean difference of 0.880 weighted on ELTS showed that electronic lecture Time-table development is the best solution to fix time constraints, convenience and overall performance as it is vetted more on its average response respectively. This can be evidenced in figure 7 below.

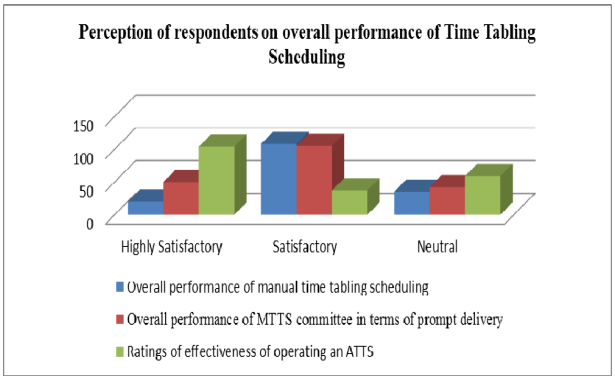


Figure 7. Chart showing perception of respondents on overall performance of Time Tabling Scheduling

Based on the empirical analysis of this study, it is significant enough to conclude that ELTS is appropriate and will be the best method to adopt in tackling the lapses of its manual process counterpart in this modern dispensation as evidenced by the opinion of the respondents.

V. CONCLUSION

At the end of the software development, an electronic lecture time-table scheduler was generated to overcome the

shortcoming of manual time tabling system. This electronic system will simplify the manual process, ensure optimum allocation of resources and reduce the risk of omission of courses and clashes of halls and lecturers. The application software developed can be adapted and customized in other institutions of learning to ease the burden of the manual process. Also based on the statistical analysis of this study, electronic lecture time-table scheduler will be the best method to be adopted to ameliorate the issues associated with the manual process. This study therefore recommends the full deployment of this prototype and its implementation which will ease the burden of the manual process of time-tabling system and improve the academic activities within the institution.

ACKNOWLEDGMENT

This research was sponsored by Tertiary and Education Trust Fund (TETFUND). Also to the Federal Polytechnic, Ilaro Research and Development Centre (R&DC) that presented the work.

REFERENCES

[1] E.K. Burke and S. Petrovic, "Recent research directions in automated timetabling," European Journal of Operational Research, vol. 140 issue 2 pp. 266-280. , 2002

[2] A. Chowdhary P. Kakde S. Dhoke S. Ingle R. Rushiya and D. Gawande, "Timetable generation system". International Journal of Computer Science and Mobile Computing, vol.3 issue 2, 2014.

[3] M.I. Bayo and O. M. Izah, "Towards the Implementation of Electronic Lecture Timetable System at Ambrose Alli University," Applied Science Research Journal, vol. 1, pp. 27-37, 2014.

[4] X. Zhou and M. Zhong, "Single-track train timetabling with guaranteed optimality: Branch-and-bound algorithms with enhanced lower bounds Transportation Research Part B", Methodological, vol.41, issue 3, pp. 320-341, 2007.

[5] L. Tay and J.T. Ooi, "Facilities management: a Jack of all trades?", Facilities, vol. 10, pp. 357-363.

[6] I. Ibrahim W.Z. Yusuff and N.S. Sidi, "Space Charging Model: Cost analysis on classrooms in higher education institutions" Procedia-Social and Behavioral Sciences, vol. 28, pp. 246-252, 2011.

[7] E. Burke D. Elliman and R. Weare "The automation of the timetabling process in higher education", Journal of Educational Technology Systems, *vol.* 23, issue 4, pp. 353-362, 1995.

[8] A. Zaeem, A. Aamir and A. Ahmed, "Automated Timetable Generator" International Journal for Innovative Research in Science and Technology, vol. 1, issue 11, pp. 118-121, 2015.

[9] D. de Werra, "Some combinatorial models for course scheduling, Practice and Theory of Automated Timetabling, pp.296-308, 1996

[10] E. Burke, "Practice and Theory of Automated Timetabling", In: Proceedings of 1st International Conference, Edinburgh, UK, August 29-September 1, 1995.

[11] L. Bambrick, "Lecture Timetabling Using Genetic Algorithms", Department of Electrical and Computer Engineering, The University of Queensland, 1997, pp.29

[12] Ansari A and Bojewar S., "Genetic Algorithm to generate the automatic time-table – An overview", International Journal of Recent and Innovation Trends in Computing and Communication, vol. 2, issue 11, pp. 3480 – 3483, 2014.

[13] N. R. Jenning, Coordination Techniques for Distributed Artificial Intelligence, University of London Mile End Rd.London E1 4NS UK, 1995.

[14] R.S. Sutar, R.S. Bichkar, "University Timetabling based on Hard Constraints using Genetic Algorithm", International Journal of Computer Applications, vol. 42, issue 15, pp.3-5 2012.