COMPARATIVE STUDY OF BIOMETRIC ALGORITHMS IN THE TIME SCHEDULING PROBLEMS

U. Priyatharsan and P. Hemija Sarawana

Department of Physical Science,
Vavuniya Campus of the University of Jaffna, Sri Lanka
tharsan1499@gmail.com

ABSTRACT
The problem of scheduling events is present in various organizations such as universities, hospitals, transport, etc. The scheduling of activities at a university has the purpose of ensuring that all students take their required courses and to utilize the resources that are available. The set of constraints that must be considered in the design of schedules involves students, lecturers and infrastructure. This paper shows that by applying Genetic Algorithms, Memetic Algorithms and Artificial Immune System generate acceptable solutions to the problem of scheduling tasks. These algorithms are applied to actual data of the Vavuniya Campus and its results are compared with those of manual works. Results of Friedman test shows that, there are difference between these three algorithms at significant level of $\alpha = 0.05$, then in the post-hoc test, Genetic algorithm is used as a control. As the results of Friedman, Friedman Aligned and Quade tests, we conclude that there is a difference between Memetic algorithm and Artificial Immune System, But there is no difference between genetic and Memetic algorithms. Finally when testing using the Wilcoxon signed-rank test between the genetic and the results of the manual works, it indicates that there is a difference of position between the distributions of results of the genetic and human work, so that, based on the results we can say that Genetic algorithm improved the results for this set of instances.

Keywords: Biometric Algorithms, Optimization, Time Scheduling Problem, Non-Parametric Tests.

INTRODUCTION

The scheduling of tasks within organizations is one of the most common and difficult problems to deal with, because it seeks to assign various activities and resources in a space of time. In the universities, it is a big deal to generate and design a schedule that meets the constraints of students, lecturers, curriculum and resources of the institution. Besides the problem of scheduling it depends on the type of course, university and education system, so there is no designed schedules that can be widely applied to all cases. In general the problem of scheduling schedules are defined from a set of events (lectures, courses, examinations), which must be assigned a set of time slots and are subject to a set of constraints.

The University scheduling is classified into 5 groups:

1. Lecturer Assignment (LA): It is the assignment of teachers to subjects.
2. Class-Lecturer Assignment (CLA): It is assigning subjects with the least time possible conflict between groups of students.
3. Course Assignment (CA): It is the allocation of subjects with the least time possible conflict between individual students.
4. Examination Assignment (EA): It is the assignment of tests to students, so that students do not apply two tests simultaneously.
5. Classroom Assignment (CRA): After assigning classes to teachers, *Class-Lecturer* assigned to classrooms.

This paper focuses on generating acceptable solutions to the problem of scheduling times, using Meta-heuristics algorithms. There are a diverse number of approaches have been used to solve the problem of scheduling times such as graph coloring, Constraint Satisfaction Programming (CSP) based methods, integer programming, linear programming, Genetic Algorithms, Meme algorithms, Tabu Search, Local search, Best-Worst ant system (BWAS) and ant colony optimization and hyper-heuristic approach.

There are a number of different NP hard problems are exist, which can be solved by various Meta-heuristics algorithms, but as Luch-Free Theorem stated there is no Meta-heuristics algorithm that outperforms all other known problems for all NP class. Due to this, in this paper nonparametric statistical tests are applied for the comparison of Genetic algorithm, Memetic algorithm and Artificial Immune System.

Data of actual instances used in this reach belong to the Department of Physical Science, Vavuniya Campus.

METHODOLOGY

Mathematical Model

The methodology describes the process of scheduling schedules as:

$$f(x) = FA(x) + FP(x) + FI(x)$$

Where:

$FA(x) =$ Number of students in conflict within x hours, (CA).

$FP(x) =$ Number of lecturers in conflict within x hours, (LA).

$FI(x) =$ Number of lecture halls and laboratories in conflict within x hours, (CRA).

This paper is restricted to take only up to $FA(x)$ which is defined as:

$$\mathrm{FA} = \sum_{j=1}^{k} \mathrm{FA}_{V_j}$$

Where:

$$\mathrm{FA}_{V_j} = \sum_{s=1}^{(M_{V_j})-1} \sum_{l=1}^{(M_{V_i})-s} (A_{j,s} \wedge A_{j,s+l})$$

With subject to

$\mathrm{FA}_{V_j} =$ Number of students in conflict within the vector V_j.

$\mathrm{V}_j =$ It is a time vector containing different subjects.

$A_{j,s} \wedge A_{j,s+l} =$ Number of students who demand the simultaneous registration of subjects $M_{j,s} \wedge M_{j,s+l}$

Non-parametric tests

Nonparametric statistical tests such as Friedman test, Friedman Aligned test, Quade test and Wilcoxon signed-rank test are applied for the comparison of the following algorithms:

(i) Genetic Algorithm
(ii) Memetic Algorithm
(iii) Artificial Immune System

RESULTS AND DISCUSSION

Sample data used for testing with the above Meta-heuristics belong to Department of Physical Science, Vavuniya Campus; these correspond to two different educational plans, belonging to the year 2009 and 2014, have approximately 42-54 classes (events) and an amount of 9-11 spaces time respectively. The configuration used at the genetic, memetic algorithms and Artificial Immune System are shown in Table 1, where we have 200,000 function calls, the initial population for each was the same. The stop criterion was the algorithms function calls.

No big difference in standard deviations for some instances between algorithms, such as the case of the instance 2, 3 and 6, since what is sought is to find algorithms that have acceptable solutions with low standard deviation, which means that the data are very close to the mean, which is indicative of reproducibility of results by Meta-heuristics algorithms used. To apply non-parametric statistical tests the Friedman test, where the median of genetic, memetic and artificial immune systems will be taken, and then apply the test and see what the algorithm has the best performance.

Table 1 shows the results of Friedman test, where h_0 = There are no differences in the performance of algorithms and h_α = There are differences between algorithms, where the P value is less in all three cases is that the α value = 0.05, so we have not enough evidence to accept h_0. Taking control as the Genetic algorithm, because it is the one with the lower rank do the post-hoc tests, worth α = 0.05.

Table 1: Ranges, statistics and p value for GA, MA and IS and Post-hoc tests on the control algorithm to Genetic Algorithm.

Algorithms	**Friedman**		**Friedman Aligned**		**Quade**	
Genetic	**1.135**		**56**		**0.965**	
Memetic	2.175		73.4		1.896	
AIS	4.000		159		4.000	
Statistic	13.95		12.32		18.67	
P value	0.0008		0.0079		6.465E-05	
	Z	**Bonferroni**	**Z**	**Bonferroni**	**Z**	**Bonferroni**
GA vs MA	1.45	0.2832	1.06	0.5723	1.43	0.2945
GA vs AIS	3.64	0.0003	6.18	1.117E-09	3.45	0.0012

Z and p values and Bonferroni correction values are shown in Table 1. As we can see in the tests even in the case of GA vs. MA in the three test p-value is less than α for which we do not have sufficient evidence to reject h_0, while in the case of GA vs AIS new values p is less than the α, thus it tells us that there is a difference in the behavior of algorithms. Therefore there is no difference in the behavior of genetic and memetic. But there is a difference between the performance of the algorithms Genetic and Artificial Intelligence System.

Next, we compare by using the Wilcoxon signed rank test and see if the results of the genetic with the results of the manual work (expert) come from populations with the same median. The results are shown in Table 2.

In applying the Wilcoxon signed-rank test (see Table 2) under the hypothesis h_0 = There are no differences in the medians vs. h_α = There are differences between the medians, where significance value was taken α = 0.05 and 8 degrees of freedom. We do not reject H_0 because 36 > 3. Therefore, we do not have statistically significant evidence at α=0.05, to show that the median difference in algorithms is not zero i.e., that there is a significant difference in after the introduction of Genetic Algorithm as compared to before. We find that there is sufficient evidence to reject h_0. Therefore, we must effectively say that the genetic algorithm improves the results obtained by the human expert.

Table 2: Wilcoxon signed-rank test between genetic and results of human expert

Instances	**Genetic**	**Manual Work**	**Absolute**	**Rank**	**Sign**
1	75	138	63	2	-
2	89	258	169	5	-
3	216	514	298	8	-
4	108	328	220	7	-
5	245	408	163	4	-
6	111	213	102	3	-
7	104	307	203	6	-
8	78	112	34	1	-
W-= 36					
W+=0			Table value W = 3(two tail test)		

CONCLUSION

Using optimization algorithms in scheduling schedules allow us to minimize the number of conflicts between the various resources of the institution such as teachers, the resources; This paper first shows a comparison between different Meta-heuristics, allowing us to find solutions that solve the problem of scheduling tasks; subsequently it determines which algorithm got better performance and a comparison with the results of the expert is done by a non-parametric statistical test. The number of conflicts in the solution proposed by the expert to design schedules was obtained; allowing a comparison between the results generated by the Meta-heuristics vs. the human expert. The results show that the genetic algorithm was outperformed, however, the statistical test of Friedman points out that there is insufficient evidence discernible between this genetic and the meme. Finally when testing using the Wilcoxon signed-rank test between the genetic and the results of the expert, it indicates that there is a difference of position between the distributions of results of the genetic and human expert, so that, based on the results we can say that Genetic algorithm improved the results for this set of instances.

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