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WORKFORCE PLANNING WITH GENETIC ALGORITHMS IN A UNIVERSITY DEPARTMENT

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ABSTRACT
The main motivation that the workforce planning is a system that enables a right occupation choice, the planning and defining of a workforce with attributes, experience and attitude that can guarantee the fulfillment of the right education program and selection of a right number of employees. Workforce planning has a large application range and its application in production and service sectors has been examined. While solving the problem, various scientific techniques, intuitional methods and mathematical models have been used in order to get the best results. In this study a genetic algorithm solution method is used for an application in the education field. In this application, the examination topic is proper instructor assignment for classes. The aim is to get the maximum benefit by making the proper assignment planning under certain conditions. Therefore, using the constraints a utility function has been formed and attempted to be maximized.
Keywords: Workforce planning, Heuristic method, Genetic algorithms.

1. INTRODUCTION

The task of providing the right number of employees at the right time is commonly known as workforce planning. There have been many studies about workforce in literature. Workforce planning has practically been applied to almost every sector. Some of these sectors are production, service, aeronautics and transportation. Planning has been made to reduce workforce costs and gain competitive advantage while considering the certain problem or situation. In the workforce planning solution, various optimization techniques and intuitive techniques have been used.

2. WORKFORCE PLANNING WITH GENETIC ALGORITHMS

In the literature there are many solution algorithms for the workforce planning problem. X. Cai and K. N. Li [1] are formulated the staff scheduling problem as a multi-criteria optimization model, where the primary objective is to minimize the total cost for assigning staff to meet the manpower demands over time, the secondary objective is to seek a solution with the maximum surplus of staff among the solutions with almost same level of assigning cost, and the tertiary objective is to reduce the variation of staff surplus over different scheduling periods. This is a new model to handle the staff scheduling problem, which is motivated by the operational requirements in some local service organizations. A new genetic algorithm is proposed to solve the problem. The proposed genetic algorithm (GA) differs from traditional GA's in the following components: (1) it performs its parent selection by using a ranking scheme that considers successively the three criteria; (2) it uses a multi-point crossover operator based on the hamming distance between schedules; and (3) it adopts a heuristic to resolve the problem of infeasibility created by crossover operations [1]. The model used on the solution of the staff scheduling is one that simultaneously addresses multiple criteria prioritized in a hierarchical structure, manpower demands requiring different skilled workers, and workforce of different and multiple skills.

Uwe Aickelin and Kathryn A. Dowsland [2] applied a Genetic Algorithms approach to a manpower-scheduling problem arose at a major UK hospital. The work described in their paper has two objectives. The first is to develop a fast, flexible solution approach to a nurse rostering problem and second, to add to the body of knowledge on solving constrained problems using genetic algorithms.

3. IMPLEMENTATION OF SCHEDULING PROBLEM INTO EDUCATION FIELD

This survey focuses on the implementation of scheduling problem into education field. The aim in this application is to assign a proper number of instructors to classes under certain constraints. In this study, a general industrial engineering curriculum has been constructed by considering industrial engineering curriculums of 5 Turkish universities. The defined fall semester industrial engineering courses are shown in the Table 1.

Table 1. A sample 4-year Industrial Engineering Program for Fall Semester

INDUSTRIAL ENGINEERING COURSES (FALL SEMESTER)

	Course Code	Course Name
1st year	116	Calculus I
	118	Physics I
	147	Int. to Industrial Engineering
	126	Int. to Computers and Programming
	146	Technical Drawing
	141	Critical Thinking
2nd year	210	Production & Management Proc.
	239	Int. to Business Man.
	223	Engineering Elements I
	237	Principles of Economics I
	221	Linear Algebra
	225	Probability Theory
3rd year	301	OR I (Linear Progr.)
	307	Engineering Stat.II
	328	Methods Engineering
	329	Engineering Economy & Cost Analy.
	331	Financial Engineering
	342	Information Systems Management
4th year	405	Project Management
	432	Quality Management
	413	Facilities Design & Planning
	414	Computer Integrated Manufacturing
	444	Selected Topics in Ind. Eng. I
	436	Supply Chain Management

An application is prepared for the Bahçeşehir University, Industrial Engineering Department. Firstly, courses are given codes and classified according to the required instructor skills and abilities. The courses are broken down into three categories as within-the-field courses, field-related courses and

out-of-field courses. Later on, the instructors are given proper codes and the course matching is done. The following constraints are considered while assigning courses to the instructors: the course load of the instructors, time frame (daily) (morning, afternoon, evening), course classification and the frequency of courses.

Using these constraints, a fitness value function is formed and attempted to be maximized. A Genetic algorithm is used during problem solving as the intuitive optimization technique. Using the genetic algorithm technique, a decent solution is attempted to be found. Generally, iteration is determined by the user. The algorithm is ended by determining the best solution or the number of population as determined by the user. Genetic algorithm procedures have been used during problem solving. Firstly, coincidentally 6 chromosomes is used to form the first population. Secondly, for every chromosome a fitness value is calculated. The function of the fitness value for the chromosome is shown in Table 2. The highest 4 of these fitness values are selected. Next, the basic operators of genetic algorithms, crossover and mutation operations are done consecutively. A sample of a chromosome and its fitness value are shown in Table 3. The selected 4 chromosomes are defined as the parents. 2 of the parents with the highest fitness values are exposed to crossover operation with each other. It is aimed to produce better solutions with this operation. Then, 2 off-springs are produced. To avoid the repetition of possible gene alterations, mutation operation is applied.

Table 2. The function of the fitness value for the chromosome.

F(X) = Course Load(CL) + Time Segment on a Daily Basis(TSDB) + Area Courses(AC) + Consecutive Days of Giving Lecture(CDGL)

F(X) = CL + TSDB + AC + CDGL

Table 3. A sample of a chromosome and its fitness value

COURSE CODES FOR CHROMOSOME 1

301	405	239	413	141	328	329	147	342	210	436	414	432
331	147	307	225	223	146	307	116	221	225	118		

TIME SEGMENT FOR CHROMOSOME 1

1	10	2	8	3	9	15	8	14	6	9	12	2
8	9	12	15	1	7	13	2	8	14	5		

INSTRUCTOR CODES FOR CHROMOSOME 1

2	2	3	2	3	2	3	3	3	1

FITNESS VALUE = 184

Lastly, having calculated the fitness values of the 4 off-springs and considering the first 6 chromosomes, out of the 10 possible solutions, the most suitable 6 have been selected for the new population. By doing so, the new population is formed and the solution is attempted to be improved. The algorithm, following the new population, continues iteratively. Thus, the best solution for the problem is attempted to be determined.

4. CONCLUSION

This paper presents an alternative algorithm for solving a staff-scheduling problem in a university. The aim of the study is to find possible solutions to problem by using genetic algorithms. In order to solve these complex problems by genetic algorithms, a computer program like Matlab or Minitab is necessary for forming more population number and improves alternative solutions.

5. REFERENCES:

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