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Student-Company Assignment: Simulation Approach

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Abstract: Student-Company Assignment is defined as a multi-criteria problem involving the allocation of students to companies according to various criteria. Universities offering workplace experience courses in their undergraduate programs send their students to companies. During this assignment process, allocating suitable students to suitable companies can be a challenging task, as company demands are limited, and certain companies are more preference after by many students. This study proposes a simulation approach to solve the problem. In the first stage of the study, various criteria for students and companies were identified. These criteria include the total number of students, the total number of companies, student preferences, company demands for students, language skills of students, academic grade point averages of students, subject-specific skills of students, language skills demand of companies, and subject-specific skills demand of companies. In the second stage of the study, student-company matching is performed considering these criteria. The SIMIO program was used to model and simulate this process. The contribution of this study to the literature can be summarized as a simulation approach to the student-company assignment problem. The proposed approach was applied to a university offering workplace experience and the results showed an improvement in terms of performance parameters compared to the existing situation.

Keywords: Simulation, Student-company assignment problem, matching problem

Introduction

Personnel selection is a crucial process that involves identifying and assigning individuals with the necessary qualifications and competencies to succeed in a particular job role. The matter of personnel selection is of paramount significance, exerting a profound impact not only within educational systems but also across diverse domains. The foremost objective in staff selection lies in the precise alignment of adept personnel with their most suitable job roles, a task that necessitates a comprehensive assessment of the distinctive attributes among staff members. In a parallel vein, student selection constitutes an assignment or matching quandary contingent upon the capabilities and performance of the students. It is customary in the majority of universities and educational institutions for students to engage in workplace training courses. This pedagogical model grants students invaluable hands-on experience in tackling real-world challenges, equipping them with practical skills prior to embarking on their professional careers, as aptly elucidated by (Cavdur et al., 2019). The placement of students in corporate environments to fulfill course requirements underscores the importance of discerning and harmonizing each student's unique strengths with the specific demands of the pre-selected companies.

The literature contains numerous studies on the student selection process. A significant portion of these studies revolves around what is commonly referred to as the "student matching problem." This issue was first introduced by (Gale & Shapley, 1962) and primarily aimed to investigate the matching process during college admissions. Over time, this problem has been extended to various contexts, including marriage, college admissions, one-to-one matching, and labor market assignments.

The algorithm used for these matching scenarios typically follows a series of rounds. In the initial round, all candidates are matched with agents, and the best possible candidate is assigned to each agent. In subsequent rounds, rejected candidates are sequentially matched with their next most preferred agents. This iterative process continues through each round, allowing for optimal matching outcomes. The matching algorithm has found applications in diverse fields, such as marriage assignments (Choo & Siow, 2006), teacher assignments (Boyd et al., 2013), school choice (Agarwal & Somaini, 2018), and job positioning (Kelso & Crawford, 1982). Alongside the matching algorithm, studies employing assignment models have also been explored. Some of these models involve developing preference systems to minimize the number of unassignable student groups while allocating projects to students (Teo & Ho, 1998). These solutions generate feasible outcomes based on specific evaluation criteria but do not necessarily yield optimal assignments. Furthermore, alternative approaches like goal programming (Wang & Li, 1993), genetic algorithms (Chu & Beasley, 1997), analytic hierarchy processes (Tine & Filip, 2011), knapsack problem (Cohen et al., 2006), and artificial neural networks (Drigas et al., 2004) have been applied to address the student matching problem. Notably, a variety of techniques, including integer programming, genetic algorithms, tabu search, particle swarm optimization, and others, are utilized for student project assignment. Nevertheless, it's important to note that a comprehensive comparison of these techniques is beyond the scope of the present study. It is important to note that the student matching problem is a complex and dynamic issue, and researchers continue to explore and propose new models, algorithms, and mechanisms to address it in different settings.

This study entails the application of a two-sided matching algorithm within a simulation model, wherein one side represents students, and the other, companies. The mutual goal of students and companies is to establish the most suitable candidate matches. To illustrate this, a university setting is used as an example, and specific conditions for company allocation are delineated. Furthermore, the proposed model exhibits a sufficient level of generality to be applicable to various other scenarios. Given that the demand for students by companies is typically constrained, a selection process becomes imperative for the purpose of aligning students with companies. This selection process comprises two fundamental stages. The first stage entails the identification of students' skills and preferences, along with the collection of company demands. The subsequent stage focuses on the actual matching of students with companies. Within the skills assessment phase, students' competencies in foreign languages, computer science, economics, entrepreneurship, business, marketing, law, and finance are taken into consideration. Subsequently, student preferences, especially with respect to company preferences, which are one of the pivotal criteria in placement, are factored in. In conjunction with this, the demands and capacities of companies are weighed, and the matching of students and companies is established based on a predetermined number of preferences. It is essential to account for student preferences as it ensures that students are assigned to companies aligned with their interests. In terms of fairness, it is particularly critical that students are matched with companies commensurate with their skill sets. However, this is not always feasible in cases where potential students lack the necessary skills for assignment to specific companies. Presently, the process involves faculty members identifying companies and randomly assigning students, offering the advantage of simplicity and a lack of need for extensive planning. Nevertheless, it falls short in considering the preferences of both students and companies. This approach is applied for the second, third, and fourth years of a four-year university program, leading to challenges such as time constraints, labor inefficiencies, and the assignment of students to companies that may not be the best fit. To address this, we propose a simulation-based approach to resolve the assignment problem, which takes into account both student preferences and abilities. In the initial stage, student’s skills and preference rankings are input into the system. Subsequently, the assignment process is executed based on the student’s skill preferences of the companies. The primary objective in this assignment problem is to place the student in their first preference, while the secondary goal is to maximize company capacity utilization and assign suitable students. This study has been applied to a real-world problem and has effectively facilitated appropriate matching, thereby mitigating the issues associated with the existing system.

Method

The data for this problem comprises a roster of companies and students, each accompanied by concise descriptions. Included in the data are the preferences and skills of students regarding companies, as well as the specific demands that companies have for students. Prior to the implementation of our solution approach, a preprocessing step is carried out to arrange the data pertaining to students' preferences, skills, and companies' demands. The organized data serve as inputs for our simulation model, where the matching process between students and companies is executed. As illustrated in Figure 1, each student is expected to possess skills in foreign languages, computer science, economics, entrepreneurship, business, marketing, law, and finance. Based on this dataset, the matching process is devised. The initial phase of the process involves the allocation of students to companies in alignment with their stated preferences. During this allocation, the criteria

corresponding to company requirements are taken into careful consideration. Among the students with skills demanded by a specific company, those with the highest score are assigned to the specified capacity of the company. If the capacity remains unfilled based on the first preference, the company's demand is met by proceeding sequentially to the second and third preferences. Candidates who cannot be matched with their first, second, and third preferences are ultimately assigned in accordance with their skills, prioritizing those with the highest scores, assuming there is an available capacity. The primary objective of the model is to maximize the number of students who are assigned to their first-preference companies while concurrently fulfilling the requirements of the companies.

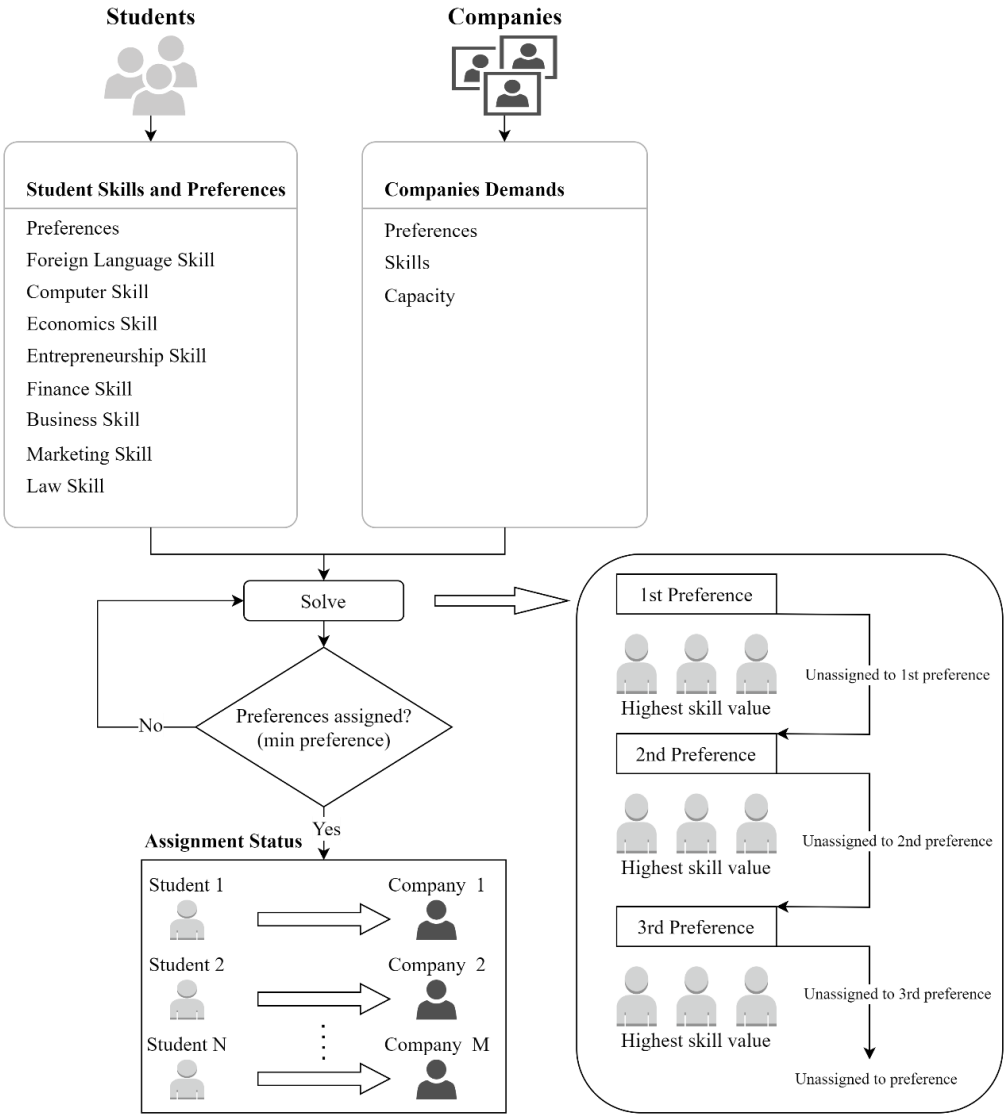

Figure 1. General solution approach

Performance Measures

In this study, the performance measure considered is the assignment of each student to their first preference, while also ensuring that the demand of each company is met. This means that the objective is to match each student with their most preferred company and ensure that all companies are able to fill their available positions. The performance measure of the model was calculated using the following formula. This formula is designed to capture the success of the matching process in terms of meeting student preferences and company demand.

$$\frac{1}{N}\sum_{n=1}^{N}\frac{1}{Pj} \qquad (1)$$

where P_j students' order of preference, N, number of students. In the mentioned study, the preferences assigned to each student are calculated using Equation 1, and the performance of the model is measured based on this calculation.

Results and Discussion

The main data source for the study is an electronic database obtained from a university that offers workplace training. The database contains course grade information about the students. It also contains the company preference list of the students. The total number of courses taken by the students in the 4-year undergraduate program is 146 and these courses are clustered under 8 categories. To calculate the grades for each student in a specific category, the scores from the courses within the respective cluster are averaged. For example, if there are 19 courses categorized under the business cluster, the average score of these courses represents the student's business skill (Table 1.). This approach allows for a comprehensive assessment of the students' skills and performance within each category. The averaged scores provide a measure of their competence and proficiency in specific areas, which is then utilized in the matching or selection process. The use of this electronic database and the averaging method for calculating scores provide a valuable source of information for evaluating the students' capabilities and incorporating them into the selection process based on their preferences and skills in different clusters. The table shows the average scores of 50 students for language, business, entrepreneurship, economics, marketing, law, finance, law, and computer skills.

Table 1. Students skills

Students	Student Skills							
	Language	Business	Entrepreneurship	Economics	Marketing	Law	Finance	Computer
Student 1	English	3,5	3,2	3,9	2,5	1,2	2,7	2,9
Student 2	French	1,5	2,1	2,5	1,7	1,9	3,2	3,1
Student 3	Turkish	2,4	3,8	1,2	3,3	2,2	2,6	2,6
Student 4	Russian	2,6	2,9	3,8	3,9	3,3	2,1	3,6
Student 5	German	1,8	2,6	2,8	1,8	2,1	2,4	1,3
Student 6	Arabic	3,2	1,3	1,6	2,6	2,4	2,8	2,3
Student 7	Spanish	1,3	1,9	1,8	2,2	1,5	1,9	2,5
:	:	:	:	:	:	:	:	:
Student 50	German	1,2	0,3	2,0	3,2	3,1	2,2	3,4

In the study, companies have their respective student demands and capacities, which means that each company has its specific requirements for the number of students it wants to hire and the maximum number of students it can accommodate. The student capabilities and demands of each company may vary (Table 2.). This table includes details such as the specific skills or qualifications sought by each company in the students they want to hire, as well as the number of students they are looking to recruit. Each student and company data constitute the input data of the simulation. These student capabilities and company demand data are vital input for the simulation process in the study. The simulation employs algorithm that take into account these input data to match the students with the companies, considering both the preferences of the students and the demands of the companies. This input data helps in facilitating a more effective and accurate allocation of students to companies, considering the varying demands and capacities of each company involved in the study.

Table 2. Companies skills and demands

Companies	Company Skills and Demand							
	Language	Business	Entrepreneurship	Economics	Marketing	Law	Finance	Computer
C 1	English	2			1			
C 2	French					1		2
C 3	Turkish		1				2	3
C 4	Russian	1			2	1	1	1
C 5	German		2		2	1		
C 6	Arabic	1	1	3			1	1
C 7	Spanish			2		2		
:	:	:	:	:	:	:	:	:
C 10	French				2			1

Table 3 shows the number of students assigned to the first, second and third preferences. Specifically, the table displays the number of students who were assigned to their first, second, and third preferences, as well as the number of students who were unable to be assigned to any of their preferred companies. According to the information provided, out of the total number of students, 41 were successfully assigned to their first preference.

Additionally, 2 students were assigned to their second preference, and 1 student was assigned to their third preference. 6 students could not be assigned to their preferences and were assigned to companies with the remaining capacity according to the point ranking. To visualize the distribution of these assignments, Figure 2 likely shows a graphical representation of the student-company assignments.

Table 3. Solution of simulation

Students	Student Preference			Student Assignment	Number of students assigned to 1st preference	Number of students assigned to 2nd preference	Number of students assigned to 3rd preference	Un-assigned to preference
	1st	2nd	3rd					
Student 1	C1	C5	C3	C1				
Student 2	C4	C3	C1	C4				
Student 3	C4	C2	C3	C4				
Student 4	C3	C5	C2	C3				
Student 5	C3	C1	C4	C3	41	2	1	6
Student 6	C3	C2	C1	C3				
Student 7	C1	C5	C3	C8				
:	:	:	:	:				
Student 50	C5	C7	C8	C5				

Overall, Table 3 provides an overview of the distribution of students to their preferred companies, including the number of successful assignments, the number of students assigned as per their second and third preferences, and the number of students who were unable to be assigned to their preferences and instead assigned according to the remaining capacity and point ranking. The performance of the model was calculated using equation 1 and was found to be 84.7%. The model was run with 100 replications. With this result, we can say that our model gives good results.

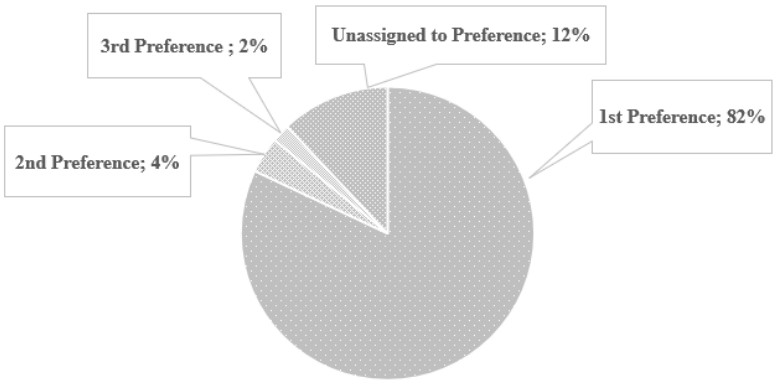

Figure 2. Distribution of assignments

Conclusion

This paper presents a simulation model for the student-company allocation problem where both students and companies have preferences. The main model is summarized as follows: Initially, priority is given to the students' preferences for companies. Each student has three fixed preferences. Once the students are grouped based on their first preference, they are further sorted according to their skills. Considering the companies' demands, the student with the highest aptitude score among those with the desired aptitude is assigned to the company. The primary aim at this stage is to maximize the number of students assigned to their first preference. The algorithm terminates when the companies' demand is fulfilled. For companies whose demand cannot be met in the first preferences, second preferences are taken into account and reassignments are made. Finally, if there are still unmatched students when third preferences are considered and company capacity is available, students are allocated to the company with the highest skill level regardless of their preferences. The results show that an effective solution can be produced by eliminating the matching uncertainty of both students and companies. Considering the performance output of 84.7% achieved through the simulation approach, it can be inferred that the mutual needs in student-company matching are largely addressed.

Recommendations

Research can be conducted on different universities that provide workplace training by taking into account the group ability average of students who go to companies.

Scientific Ethics Declaration

The authors declare that the scientific ethical and legal responsibility of this article published in EPSTEM journal belongs to the authors.

Acknowledgements or Notes

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