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Student Project Allocation for Monitoring Duplication

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***Abstract*— Here is a paper that will cover the Student Project Allocation (SPA) problem presuppose to distributing a set of projects to freshman "Directed Studies in Mathematics" journey at the" Department of Mathematics" of the Institute of Hong Kong. Out of a set of the projects, every student will indicates there liking list over their appropriate projects, while the Department wants to make the most allotments, with its fondness over the individual student as group by their GPA's. We are going to apply "Pre-emptive Goal Programming" to a multi- criteria SPA model for allotments of these projects to the students with "Decision Support System "implementation. The arithmetic outcome will accompany the complete effectiveness and potency of this approach.**

Opener of the scholar Student Project Allocation is: Pre-emptive goal Programming and Decision Support System (DSS)

1. INTRODUCTION

In order to provide a student associate early expertise on freelance study, with the chance to do little arithmetic project about to analysis, the Department of arithmetic at the University of Port offers associate UG course "Directed Studies in Mathematics." For this course, the code is predicted to try to do around one hundred hours of freelance work and attend conferences and seminars. And by the tip of the course, the code would hand thesis and will offer a speech as acceptable. For every year, the arithmetic lecturers prepare a listing of the project briefs for the arithmetic majors, World Health Organization rank their eligible comes so as of their preferences. Every project is supervised by one supervisor and is allotted to at least one or 2 students inside the Department, betting on the quality of the project. The Department's preferences area unit to create the utmost doable range of acceptable allotments comes to students with sensible educational performance, or high grade- points averages (GPA's). Allocation of projects to the students as a part of a course is incredibly similar to institutes with totally different criteria and particular conditions. It initials seems because the classical Hospital /Residents downside (HR) within the 1980s, that was to distribute graduating medical students, or residents, to their initial hospital posts. The rule in found a stable matching of residents to hospitals, that was resident-optimal, within which every resident may acquire the hospital of his/her highest preference among all the stable matching. The matter of allocating students to projects supported liking lists and ability constraints the alleged, 'Student Project Allocation (SPA) problem' — then followed as a generalization of 60 minutes. Anon and on the structured allocation and automatic assessment approach, it was projected systematic approach to final- year comes in an engineering science college boy course at Nan yang Technological University in Singapore. To apportion comes, a computer virus (Assign project that is coded in the language C) tried to not solely minimize the quantity of unassigned student teams. However, additionally take into consideration student fondness over the projects.

However, the model failed to allow prospective supervisors' preferences. Apart from the rule obtained a possible however not really optimum solution and therefore, the program may endure twenty- four hours for an oversized scale details to achieve an answer. Development techniques, like number programming employed in and genetic rule adopted in is applied for the SPA downside. And last (in 2007 and 2008), the optimum and approximation algorithms for SPA issues are studied with stress on stable matching and quality problems. The SPA downside of the kind delineates during this paper takes into consideration student preferences over projects and supervisor/departmental preferences over students. Hence, it's naturally being multi-objective, and that we solve this case of multi-criteria comes allocation downside instance by our Goal Programming (GP) model for the SPA downside developed in the remainder of this paper is structured as follows. In section two, the first statistics of projects choice, and its initial process area unit mentioned. Then, section three shortly reviews the Goal Programming formulation for our multi- criteria SPA (MC- SPA) model. The comparison and analysis of the Goal Programming resolution with 2 alternative heuristic solutions, one derived manually by the Department, and therefore, the alternative obtained from a greedy rule, area unit mentioned in section four. Section five, presents a DSS implementation approach for this MC- SPA resolution automation on computer program

2. INPUT DATA

2.1 Original data:

For the educational year 2008- 2009, there are 13 projects in total for the course: Directed Studies in Mathematics; and twenty- five students have deposited their liked lists of projects for subsets of these projects over the internet before the point in time. The projects time limit is from one to thirteen. And for all 13, aside from the fifth and eighth which might a piece grasp 2 students, a project will solely be allotted to at least one student. The authentic statistics as well as the twenty five students' decision sand their average GPA's measure given in (Fig. 1), during which every row constitutes one student's hierarchic decisions and his/her measure. Therefore, for every column of decisions, the amount is j underneath its alternative contributes that the student's its preference is that the fourth project. From the table, we will notice that the students' picks tend to vary. One student selects solely one project however others might specify all.

2.2 Initial data processing:

Since the fifth and eighth projects will every handle 2 students where as all alternative projects solely have capability for one student, we tend to treat the fifth project as 2 new totally different projects and rename them project five and project fourteen, with capability for one student every one. If a student selects the first project five, he/she is treated as choosing each project five and project fourteen. Similarly, the first project eight is doubled and labeled because the eighth and also the fifteenth. one single time, this pre-processing, there square measure currently fifteen are collectively, mark from one to fifteen, within projects five and fourteen, and projects eight and fifteen separately severally identical. Then these "new" fifteen projects are assigned to students on a person to person basis.

student	Choices													Year GPA
	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	
1	1	6	8	9										2.95
2	2	9	1											2.53
3	1	4												2.54
4	10	5	11											3.56
5	2	4	11	3	6	5								3.40
6	9	6	10											3.04
7	7	11	2	5	6	13	3							2.91
8	2	8	7	5	10	11	9	6						2.75
9	8	3	13											2.18
10	9	11	13	4										3.19
11	10	7	11	8	2	5								3.23
12	6	11	10	5	7	9	13	3	1	4	12	2	8	3.48
13	7	12												3.83
14	13													3.77
15	11	3	8	13										2.90
16	8													2.56
17	4	8	13	5	3	9								3.14
18	8	3	4											1.49
19	8	9	6	1	3	7	10	4	11	5	2	12	13	1.52
20	13	3	8											2.24
21	5	3	6	8	4	13								1.97
22	13	3	8	1	4	2								1.87
23	8	5	3											1.71
24	13	4	8	1	3	6	10	5						1.25
25	12	9	13											3.32

Figure 1: The original data of the SPA problem. (Shaded entries: Department's solution)

Students' decisions as shown in the (Fig. 1) represents their preference distribution on the projects. So as to quantify and compare ranks all inclusive, the assumed Analytical Hierarchy method (AHP) elementary Scale [11] of 1, 3, 5, . is taken on. That is, if a student takes a project as his/her initial alternative, then the priority value of this alternative is 1; as second alternative, the priority value is 3; as third alternative, the priority value is five, so on... for the most of fifteen projects. If a student doesn't opt a project, we tend to outline the priority value to be zero. Hence, the hierarchy of the students' alternative list has been change to numerical values, which may be used and differentiate within the next higher cognitive process procedure. As for the Department's preference, it bases on the students' GPA's; with normal vary from one to four points. Let Gi represent student i's GPA; so = five −Gi is thus outlined to be a non- negative parameter representing student i's GPA priority value.

After the on top of processing procedure, the input data for the SPA problem is as shown in (Fig. 2), within which every row represents one student's alternative and his/her GPA. The twenty five students' selections make use of depicted by a twenty five × fifteen matrix with entry Pi, j representing the priority value of student i over project j victimisation the AHP elementary scale.

student	Projects															Year GPA
	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th	
1	1	0	0	0	0	3	0	5	7	0	0	0	0	0	5	2.95
2	5	1	0	0	0	0	0	0	3	0	0	0	0	0	0	2.53
3	1	0	0	3	0	0	0	0	0	0	0	0	0	0	0	2.54
4	0	0	0	0	3	0	0	0	0	1	5	0	0	3	0	3.56
5	0	1	7	3	11	9	0	0	0	0	5	0	0	11	0	3.40
6	0	0	0	0	0	3	0	0	1	5	0	0	0	0	0	3.04
7	0	5	13	0	7	9	1	0	0	0	3	0	11	7	0	2.91
8	0	1	0	0	7	15	5	3	13	9	11	0	0	7	3	2.75
9	0	0	3	0	0	0	0	1	0	0	0	0	5	0	1	2.18
10	0	0	0	7	0	0	0	0	1	0	3	0	5	0	0	3.19
11	0	9	0	0	11	0	3	7	0	1	5	0	0	11	7	3.23
12	17	23	15	19	7	1	9	25	11	5	3	21	13	7	25	3.48
13	0	0	0	0	0	0	1	0	0	0	0	3	0	0	0	3.83
14	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	3.77
15	0	0	3	0	0	0	0	5	0	0	1	0	7	0	5	2.90
16	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	2.56
17	0	0	9	1	7	0	0	3	11	0	0	0	5	7	3	3.14
18	0	0	3	5	0	0	0	1	0	0	0	0	0	0	1	1.49
19	7	21	9	15	19	5	11	1	3	13	17	23	25	19	1	1.52
20	0	0	3	0	0	0	0	5	0	0	0	0	1	0	5	2.24
21	0	0	3	9	1	5	0	7	0	0	0	0	11	1	7	1.97
22	7	11	3	9	0	0	0	5	0	0	0	0	1	0	5	1.87
23	0	0	5	0	3	0	0	1	0	0	0	0	0	3	1	1.71
24	7	0	9	3	15	11	0	5	0	13	0	0	1	15	5	1.25
25	0	0	0	0	0	0	0	0	3	0	0	1	5	0	0	3.32

Figure 2: Input data for SPA problem after initial processing. (Shaded entries: GP solution)

3. GOAL PROGRAMMING FORMULATION

Here during this section, we tend to concisely review a GP formulation for multi- criteria student projects allocation model, or MC- SPA model for brief. The foremost gracefulness of this Student Project Allocation problem is its being multi- objective.

That is, we tend to try and maximise the quantity of the projects that are allotted, and satisfying the maximum amount as accessible to both the students' and the Department's preferences. For the matter of allocating M projects and N students, the pre-emptive goal programming model is being developed as follows-

Goal 1: Max $Z1 = \sum_{i=1}^{N} \sum_{j=1}^{M} x_{i,j}$ Goal 2: Min $Z2 = \sum_{i=1}^{N} \sum_{j=1}^{M} P_{i,j} x_{i,j}$ Goal 3: Min $Z3 = \sum_{i=1}^{N} \sum_{j=1}^{M} S_{i,j} x_{i,j}$

Constraints: $\sum_{i=1}^{N} x_{i,j} \leq 1, \forall j$

$\sum_{j=1}^{M} x_{i,j} \leq 1, \forall i$ $x_{i,j} \leq P_{i,j}, \forall i, j$

$x_{i,j} = 0$ or $1, \forall i, j$

This model has three stratified goals to attain:

- First is to assign most projects to students is of primary importance and is maximised initial.
- Next, make use of the target worth obtained from the primary goal, it tries to optimise the overall satisfaction level of students' preferences.
- Then later, minimize the total of criterion choices of scholars allotted with projects.

It introduces binary decision variables, j, i = 1, 2, . . . , N; j = 1, 2, . . . , M, that is equivalent to one if student i is allotted project j and else zero. P is N ×M coefficient matrix that is showing the priority prices in between all the pairs of the scholar sand projects during the time of this formulation, and S is modelled a lot of typically as an N × M coefficient matrix showing the priority prices in between the scholar sand the supervisors(beyond simply criterion choices of the students)

4. NUMERICAL RESULTS

In this we will going to apply GP to the MC- SPA model represented within the previous section to the course choice information. The model is enforced in LINGO 10.0 for Windows 8, running on an Intel Celeron duo processor based mostly computer. It takes few seconds it may be less than one second to resolve any goal. The target operation worth for goal one is fifteen, which suggests all the fifteen projects may be allotted to students. Making use of this target worth for optimizing Goal two to minimize the total of priority prices of allotted projects provides a worth of nineteen during this case, below the constraint all the fifteen project sought to be distributed to students. This averages to 1.27 among the fifteen students. Then, by making use of the target perform worth of nineteen from the second goal and fifteen from the primary goal, optimizing Goal three produces the ultimate SPA resolution. The elaborated assignments of projects to students are indicated by the shaded cell entries as shown in the (Fig. 2). As additionally summarised in row one as shown in the (Fig.3) all the allotted projects are among the students' initial 2 selections. This compares all right with the opposite 2 heuristic solutions with details to be provided later. In fact, the result shows that almost ninety % (87%) of scholars are allotted their initial selections, and solely 2 students are allotted the projects of their second selections, whereas the typical criterion of scholars of these allotted projects is 3.048, with their individual GPA's starting from 1.97 to 3.83.

No. (percentage) of Projects Allocated	Student Preference						Avg. GPA	Min GPA
	1st	2nd	3rd	4th	5th	6th		
GP Model	13 (87%)	2 (13%)	0	0	0	0	3.048	1.97
Department's Manual Solution	7 (47%)	7 (47%)	0	0	0	1 (7%)	3.084	2.18
Greedy Algorithm	11 (73%)	2 (13%)	1 (7%)	1 (7%)	0	0	3.131	1.97

Figure 3: Numerical results of three methods

Second row as shown in the (Fig. 3) represents manual solution given by the Department. This distribution plan also successfully allocates all the 15 projects to students with nearly half (7) of the students obtaining their first choices, over ninety percent (93%) of them (7+7=14) receiving their first and second choices and only one of the projects is assigned to a student as his/her 6th choice. The detailed assignments of projects to students are indicated by the shaded cell entries as shown in the (Fig. 1). And for the third row, it is another distribution plan derived from a greedy algorithm, which treats the Department's GPA preference much more important than the students' preferences. The greedy algorithm is described as follows. First of all, it will sort all the 25 students according to their GPA's from the highest to lowest. The first student is assigned of his/her first choice. Consider the next assigning of the second student of his/her first choice if the project is still available for assignment, otherwise of his/her second choice. Then consider the third student, and assign him/her the first unassigned project that he/she prefers the most and so on. During this processing, if a student being considered has all his/her selections already assigned, he/she is skipped over and we have moved on to consider the next one below him/her. Although it is a greedy approach, for this problem instance, it solves the SPA problem not too badly. Eleven out of fifteen students (73%) are assigned projects of their first choices, and the rest of 4 projects are allocated to students at least as of their 4th choice. The average GPA has an expectedly high value of 3.131, but also accompanied by a low minimum GPA of 1.97.

As from the (Fig. 3), we have noticed that the numerical results that are obtained from the GP dominate the other two in satisfying students' preferences, since all projects are assigned to the students of their first or second choices, with nearly 90% of them first choices. As compared with the manual solution given by the Department, although the average GPA of the GP solution is slightly lower, the distribution plan itself is far better in meeting the overall students' preferences. Hence, the GP solution is deemed to be rather better than the Department's manual solution. As for the dominance between the results of the GP model and the "greedy algorithm", the former totally dominates in meeting students' preferences, but its average GPA of students being assigned projects slower than that derived from the greedy algorithm, since the greedy algorithm allocates projects sequentially from the student with the highest GPA to the one with the lowest.

Besides, if we consider allocatment of the projects again among only 15 students which are opted by the Department already, that is those 15 are being assigned by the projects decided by the Department's manual solution, by the GP model to this restricted subset of students (being the first 15, cf. the shaded entries in Fig. 1), the allocation plan can indeed be improved as shown in (Fig. 4). This re-allocation has the number of students obtaining their first choices increased by one. No student gets his/her 6th choice, with a more equitable distribution.

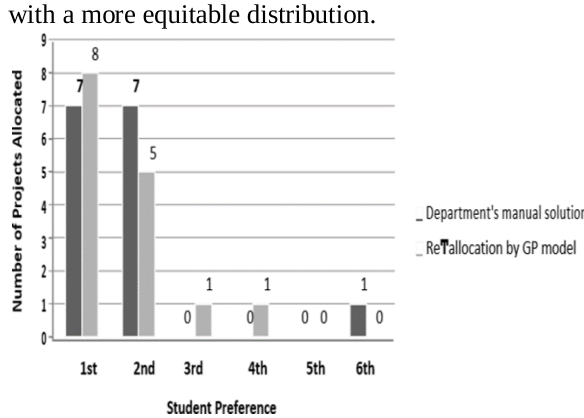

Figure 4: Distribution plans given by the Department and re- allocated by the GP model.

Moreover, to examine the trade- off effects between the last 2 goals of the GP model, that's between minimising the students' choices over projects and minimising the Department's total priority prices over students, the non- dominated front- tier of the typical GPA of scholars being assigned projects v/s the overall priority prices of assigned projects is planned, as shown in the (Fig. 5).

Since the target total priority price is being relaxed, the typical GPA of scholars allotted project is improved and out streach its most attainable of 3.202. Nodes on the frontier correspond to the 5 non-dominated allocation plans, Example, the MC- SPA GP answer marked by the spherical dot in (Fig. 5). The choice maker will adopt a final distribution set up in keeping with his/her own assessment. The manual solutions given by the Department and also the greedy algorithmic rule, yet because the re-allocation arrange by GP, are so verified in (Fig.5) to be mathematically dominated solutions.

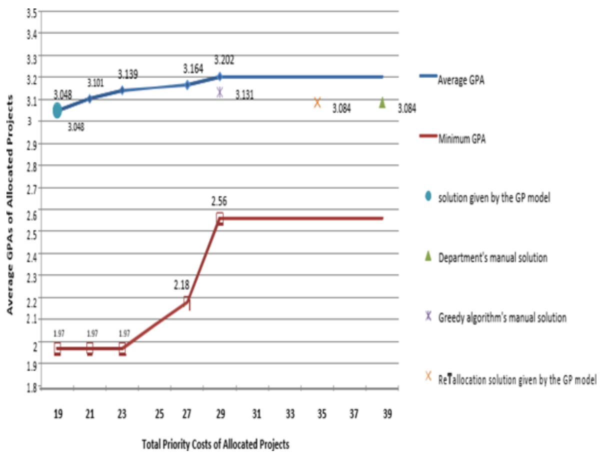

Figure 5: The efficient frontier between the total priority cost and the average GPA of allocated projects derived from the GP model.

5. DSS IMPLEMENTATION OF MC- SPA GP MODEL

To facilitate booming applications, the GP code of the MC- SPA model is improved into a choice network (DSS), group action the GP model asan optimiser engine with its front- end interface and back- end communicator integrated within the same stand out computer program, into that the input file records is placed and outputs of distribution plans may be economical frontier plots displayed.

In our case, the DSS is being developed as an Excel-based system to come up with allocation plans mechanically by giving the input data of students' choice data and their GPA's. The computer files are going to be processed and passed to a LINGO problem solver to search out solutions that are based on the pre-emptive GP model. The DSS can capture the answer into the stand out computer program moreover because the economical frontier as consisting of individual non- dominated solutions. The easy computer program based mostly interface provides the last word flexibility for users to create changes to the first downside data and to perform what- if analysis.

6. CONCLUSION

In the given Research Paper, we have a tendency to apply a Pre-emptive GP formulation to resolve a multi- criteria SPA problem obligatory by the Department of Maths of the University of Port. The MC- SPA GP model is enforced in LINGO 10.0 and computationally resolved with efficiency on a desktop computer that technically stems from the advantage of its signalment drawback network structure with its entirely uni-modul coefficient matrix. Com- pared with the physical solutions given by the Department and also the greedy formula, the GP model has created good and efficient distribution set up of all projects being allotted to students with best priority prices and highest potential GPA's. With the implementation of its DSS, we have a tendency to extremely expect that the approach may be used for future courses or project picks in an exceedingly easy and effective manner.

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