A SYSTEMATIC APPROACH ON MATHEMATICAL MODELS AND TECHNIQUES

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ABSTRACT

The probabilistic transition rates depend on motivation potentials governing the decisions and actions of the social agents. This schedule must be created in order to meet the university's requirements. A schedule is able to be defined as the assignment of certain people to particular intervals of time in order to accomplish a number of goals. The transition from the probability distribution to quasi-mean values leads to in general nonlinear coupled differential equations for the macro variables of the chosen social sector. The problems that can be caused by having too many soft limitations in a timetable should be minimized as much as possible by a university's course schedule. The approach applies to problems where (optimal) decisions should be found that lead to maximized benefit or yield, and/or minimized loss or disadvantage. The curriculum for the forthcoming semester is something that the teaching staff and administrative staff at a variety of educational institutions spend a significant amount of time planning each year. The activities that must be accomplished for the faculty course assignment, for instance, are laid out as linear programmers. Linear programming, which entails the creation of mathematical models or algorithms, can be used to solve the problem of the faculty course assignment. The approach is characterized in that all occurring relations are regarded as functional relationships; the model is developed in the form of a non-cyclic, directed graph of variables where the edges represent functional dependency.

Keywords: *mathematical models, non-cyclic, timetable, linear programmers, faculty course assignment, probabilistic transition.*

INTRODUCTION

Due to the massive demands during a disaster, sometimes it outstrips the available resources. However, sometimes relief goods become excessive because many international donors send relief resources to disaster-affected countries and it results in difficulties to sort out the necessary resources and distribute them timely and cost-effectively. One common use of graph colouring, also known as "the best partition of events," is the resolution of conflicts or "the best partition of events that are mutually incompatible." Allocating enough time for class and test scheduling is one example of such a problem. It is best practise to separate classes taught by the same professor from those needed to meet in the same room when arranging the timetable for classes at a college or university. A curriculum may also mandate that a student or group of students take two distinct but related subjects at the same time during a single academic semester (for example, physics and mathematics). The student or group of pupils may be required to do this. It is important to arrange classes under these conditions in order to prevent scheduling problems. Finding the fewest or most suitable amount of time slots that may be used to schedule all of the courses in a way that is compatible with the requirements is therefore one of the most difficult elements of graph colouring. The scheduling of course timetables is the subject of this study, which shows how

graph colouring may be utilised to provide an algorithm that either totally eliminates the possibility of competing schedules or, at the very least, lowers it to a manageable level. To achieve the objective of obtaining optimal solutions to issues of this kind, one technique that may be used is the identification of minimum colorings for the connected graphs. Unfortunately, it is not feasible to guarantee that this can be done in all cases in polynomial time. Since the graph colouring problem is NP-complete, there is no algorithm that can colour graph nodes optimally under a time constraint that is polynomial in the number of nodes for each graph. This implies that there is no solution to the issue at hand. This is because creating such an algorithm is actually not doable. Saturation, Recursive Largest First, Greedy, and Simulated Annealing algorithms are a few examples of graph colouring techniques that possess the NP complete condition. The Simulated Annealing method is another illustration.

LITERATURE REVIEW

Moddassir k. Nayeem (2021) Humanitarian logistics (HL) is considered one of the most significant issues of disaster operations and management. Thus, HL operation should be viable enough to function well under the uncertain and complex nature of the disaster. Many difficulties in pre-and post-disaster phases bring both human and economic losses. Therefore, it is essential to make sure that the HL operations are designed efficiently. In the last two decades, several publications have emphasized efficient HL operations and proposed several mathematical models and algorithms to increase the efficiency of HL operations and motivated the necessity of a systematic literature review. A systematic literature review is deemed pertinent due to its transparent and detailed article searching procedure. In this study, due to the importance of the mathematical optimization model, we reviewed more than one hundred articles published between 2000 and 2020 to investigate the optimization models in the field of HL.

Wasakorn (2021) The challenge of developing an automated schedule for classes within the confines of a university's limited resources is referred to as the university course timetabling problem (UCTP) Timetables that are generated manually are prone to inaccuracies and need a significant amount of effort to produce workable solutions. As a consequence of this, solutions that are both effective and rapid to implement are necessary. The complexity of the timetabling task is increased when dealing with limits connected to the faculty, such as their requirements, preferences, and availability. This can make the challenge feel even more insurmountable. As a consequence of this, the solutions that are developed by UCTP concentrate on the limits that are associated with the students, While the faculty members' limitations are restricted to their teaching schedules or preferences. This work provides a multi-objective mixed-integer programming model for a preregistration UCTP with faculty-related restrictions.

Abdoul Rjoub (2020) Manual school timetable scheduling is not only time-consuming and tedious, but it also frequently results in the assignment of the same teacher to multiple classes, the assignment of multiple teachers to the same classroom at the same slot time, or even the exercise of deliberate partialities in favour

of a particular group of teachers. All of these circumstances are bad for the following reasons, but not only those listed below: In order to help with the settlement of the customary conflicts that arise from human scheduling, this research proposes a method for the automated scheduling of school schedules. In order to get beyond the method's inherent hard and soft restrictions, hill climbing algorithms have been improved. In the majority of cases, it will be challenging to follow lax regulations, yet severe rules must be followed anyway. This approach has been used in a variety of educational contexts and has proven beneficial, although there are a number of limitations.

Abdullah Baz (2020) The university course scheduling issue determines the best course of action for a given collection of resources, such as student groups, classrooms, or laboratories, in order to meet a predetermined set of requirements. This might apply to lecturers, student groups, or classrooms. The creation of a timetable is a crucial step in making sure that all administrative and instructional aspects of an academic institution function effectively. Making a schedule can be difficult for a variety of reasons, including the availability of hours, the number of topics, and the assignments of teachers. In order to discover a solution to the problem of creating the ideal course schedule for university students, the aim of this study is to evaluate many possible optimization techniques. The analysed algorithms are designed to manage course schedules in a way that takes into consideration the requirements imposed by various institutions.

Anderson Goes (2019) This article covers the subject of school timetabling, which is the process of choosing the day and time that instructors will teach lessons at educational institutions. In order to produce and optimise Elementary and High School schedules while taking into account instructors' preferences for certain days or sequenced (twinned) lessons, a tool based on operational research (OR) methodology was developed. The following is how the document is set up. In addition to the Local Search (LS) and Iterated Local Search (ILS) techniques, a mathematical model known as Non Linear Binary Integer Programming (NLBIP) was used to solve the problem. Araucária, a city in the state of Paraná, Brazil, underwent an inquiry into a severe issue regarding the daily schedules of 14 public schools. The results show that the computational time demanded by the mathematical model is feasible under the current conditions.

The Importance of Mathematical Modeling and Difficulty in Teaching it

A community among the mathematics students, which grow bigger since the end of the 1960s, gave special importance to mathematical applications, models and modeling in mathematics teaching and learning. This importance is based on two ideas which are different but certainly compatible with each other. The first idea defended the slogan "mathematics for applications, models and modeling". According to this, primary aim and task in mathematics teaching is to stimulate mathematical activities of students of various proficiency levels by using practical activities. The second idea defends the slogan "applications, models and modeling for mathematics". That is to

say, being interested in mathematical activation in contexts that are not mathematical increases motivation of the students and feeds the formation of affective qualities, conceptual thinking and mathematical thinking power. The approach called "Realistic Mathematics Education" brought forward by Freudenthal Institute in Holland is an example for this situation.

An analytic approach to modelling competencies and sub-competencies—the bottom-up approach

The analytic definition of competence refers to the seminal work of Weinert (2001), which described it as "the cognitive abilities and skills available to individuals or learnable through them to solve specific problems, as well as the associated motivational, volitional and social readiness and abilities to use problem solutions successfully and responsibly in variable situations". Based on this definition, modelling competencies were distinguished from modelling abilities: "Modelling competencies include, in contrast to modelling abilities, not only the ability but also the willingness to work out problems, with mathematical aspects taken from reality, through mathematical modelling". Similarly, described modelling competencies as the ability and willingness to work out problems with mathematical means, including knowledge as the inevitable basis for competencies. The emphasis on knowledge as part of competence is in line with the discussion on competencies in the professional development of teachers; the most recent approach within this discussion on competence as a continuum aims to connect dispositions, including knowledge and beliefs, with situation-specific skills and classroom performance

Graph coloring approach for course timetable scheduling

The mathematician Euler was alerted to the Konigsberg Bridge's mathematical complexity in the year 1736. The creation of the Eulerian graph was motivated by this problem. Gustav Kirchhoff developed the concept of a tree, which is a linked graph devoid of cycles, during the same time period. The earliest application of a tree was to compute the currents in electrical networks or circuits; however, it was later modified to be used to count chemical molecules. Kirchhoff was a pioneer in both fields. The names "complete graph" and "bipartite graph" are attributed to A.F. Mobius, who created them in the year 1840. Thomas Guthrie is credited with being the first to recognise the well-known four-color dilemma in the year 1852. The initial research on graph colouring only concerned itself with colouring maps of planar graphs. This is so because colouring flat graphs is the simplest.

Mathematical programming tool for effective teaching assignments in non-regular time schedules

Schaerf (1999) asserts that determining who will teach a topic and when it will be taught, given a set of restrictions, is necessary for the construction of an academic calendar. This is carried out to produce a calendar. Finding a solution that makes sense is quite difficult since there are so many distinct fields, courses, professors, and ways that assignments might be integrated. Task automation, often known as automated timetabling, was motivated by the ineffectiveness of manually created schedules. Gotlieb (1963), according to, is

credited for sparking interest in automated university timetabling, which has grown steadily since then. Since then, an increasing number of studies on the topic have been published, giving various strategies for addressing these kinds of issues utilising optimum, heuristic, and meta-heuristic methods, or more recently.

A holistic approach to mathematical modelling competence—the top-down approach

The Danish KOM project first clarified the concept of modelling competence, which was embedded into an overall concept of mathematical competence consisting of eight mathematical competencies. The modelling competency was defined as one of the eight competencies, which were seen as aspects of a holistic description of mathematical competency, in the sense of Shavelson. The modelling competency was defined as follows: This competency involves, on the one hand, being able to analyze the foundations and properties of existing models and being able to assess their range and validity. Belonging to this is the ability to 'de-mathematise' (traits of) existing mathematical models; i.e. being able to decode and interpret model elements and results in terms of the real area or situation which they are supposed to model. On the other hand, competency involves being able to perform active modelling in given contexts; i.e. mathematising and applying it to situations beyond mathematics itself.

RESEARCH METHODOLOGY

A systematic review process differentiates itself from other existing review processes by its organized and categorical approach. A systematic literature review process aims to bring out the zest from the existing published studies by following a procedure of searching, collecting, and analysing the available resources. There are four steps for systematic review methodology; these are planning, searching, screening, and reporting. An unbiased screening process is very important for a good literature review. In this study, an intensive screening process is carried out where the inclusion and exclusion criteria are considered. This study focuses on the mathematical modelling technique in the field of EMF. Thus, only those papers are included that follow the mathematical modelling technique. We did not include conference papers but peer-reviewed journal articles. After applying these strategies, all coders discussed the coding schedule, with a particular focus on the discrepancies between different codes, to achieve full consensus. Study written from the perspective of commercial supply chain management are out of the scope of this literature review. Every classified area of EMF is discussed according to the nature of the model (i.e., deterministic and non-deterministic models). Finally, the current trend and the research gap are analysed.

RESULTS AND DISCUSSIONS

A method known as fuzzy programming is utilized in order to distribute all of the available classes among the teaching staff in accordance with the outlined preferences. The course assignments for the faculty members are shown in Table 1. In the same manner as described above, each and every course is delegated to a member of the faculty:

Table 1: Assigning of course (i) to faculty (j for different S value using EMF

S=0.002	S=0.003	S=0.005	S=0.010	S=0.200	S=0.300	S=0.500	S=1.000	Optimum
X_{21}	X_{21}	X_{21}	X_{21}	X_{21}	X_{21}	X_{21}	X_{21}	1
X_{41}	X_{41}	X_{41}	X_{41}	X_{41}	X_{41}	X_{41}	X_{41}	1
X_{51}	X_{51}	X_{51}	X_{51}	X_{51}	X_{51}	X_{51}	X_{51}	1
X_{62}	X_{62}	X_{62}	X_{62}	X_{62}	X_{62}	X_{62}	X_{62}	1
$X_{10.2}$	$X_{10.2}$	$X_{10.2}$	$X_{10.2}$	X_{72}	$X_{10.2}$	$X_{10.2}$	$X_{10.2}$	1
X_{73}	X_{73}	X_{73}	X_{73}	$X_{10.2}$	X_{73}	X_{73}	X_{73}	1
$X_{12.3}$	$X_{12.3}$	$X_{13.3}$	$X_{13.3}$	$X_{13.3}$	$X_{13.3}$	$X_{13.3}$	$X_{13.3}$	1
$X_{15.3}$	$X_{14.3}$	$X_{15.3}$	X_{14}	$X_{15.3}$	X_{14}	$X_{15.3}$	X_{14}	1
X_{14}	X_{14}	X_{14}	X_{34}	X_{14}	X_{34}	X_{14}	X_{34}	1
X_{34}	X_{34}	X_{34}	$X_{12.5}$	X_{34}	$X_{11.5}$	X_{34}	$X_{11.5}$	1
$X_{13.5}$	$X_{13.5}$	$X_{12.5}$	$X_{15.5}$	$X_{11.5}$	$X_{11.5}$	$X_{11.5}$	$X_{13.5}$	1
$X_{14.5}$	$X_{15.5}$	$X_{15.5}$	$X_{8.6}$	$X_{11.6}$	$X_{14.5}$	$X_{14.5}$	$X_{8.6}$	1
$X_{8.6}$	$X_{8.6}$	$X_{8.6}$	$X_{9.6}$	$X_{5.6}$	$X_{9.6}$	$X_{8.6}$	$X_{9.6}$	1
$X_{9.6}$	$X_{9.6}$	$X_{9.6}$	$X_{11.6}$	$X_{9.6}$	$X_{12.6}$	$X_{9.6}$	$X_{12.6}$	1
$X_{11.6}$	$X_{11.6}$	$X_{11.6}$	$X_{14.6}$	$X_{11.6}$	$X_{14.6}$	$X_{11.6}$	$X_{14.6}$	1

The first of a row, the first of a column X21 whose ideal value is equal to one (1) This indicates that the second course will be given to the first faculty at the aspiration level of S = 0.002.

Table 2: The computational result of the objective function at different S value using EMF

s	λ	f_1	f_2	f_3	f_4	f_5	f_6	f_7	f_8	f_9	f_{10}
0.002	0.4442	2.0	1.5	1.67	1.0	1.0	0.75	1.26	2026	29	4.3
0.003	0.4441	2.0	1.5	1.33	1.0	1.0	0.75	1.19	2026	29	4.3
0.005	0.4438	2.0	1.5	1.00	1.0	1.0	0.75	1.23	2026	29	4.2
0.010	0.4432	2.0	1.5	1.50	1.0	1.0	0.60	1.12	2026	29	4.3
0.200	0.4199	2.0	2.0	1.50	1.0	1.0	0.75	1.33	2023	29	4.3
0.300	0.4077	2.0	1.5	1.50	1.0	1.0	0.60	1.12	2026	29	4.3
0.500	0.3836	2.0	1.5	1.33	1.0	1.0	0.75	1.19	2026	29	4.2
1.000	0.3257	2.0	1.5	1.50	1.0	1.0	0.60	1.12	2026	29	4.3

The result that is obtained through the use of the fuzzy programming technique will assist the administrator in making the appropriate decision for the students when it comes to the assignment of subjects to the teaching staff.

Figure 1(a) which displays various values of λ with the exponential membership function S = 0.002, 0.003, 0.005 and 0.010. When the value of S goes up, the objective function value goes down.

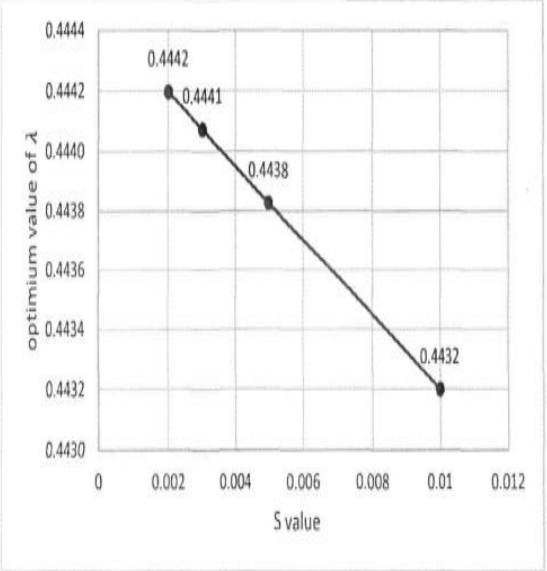

Figure 1(a): The optimum value of λ for different values of S

Figure 1(b) which displays various values of λ S = 0.2, 0.3, 0.5, and 1 for exponential membership functions, respectively. The objective function value decreases as the value of S increases.

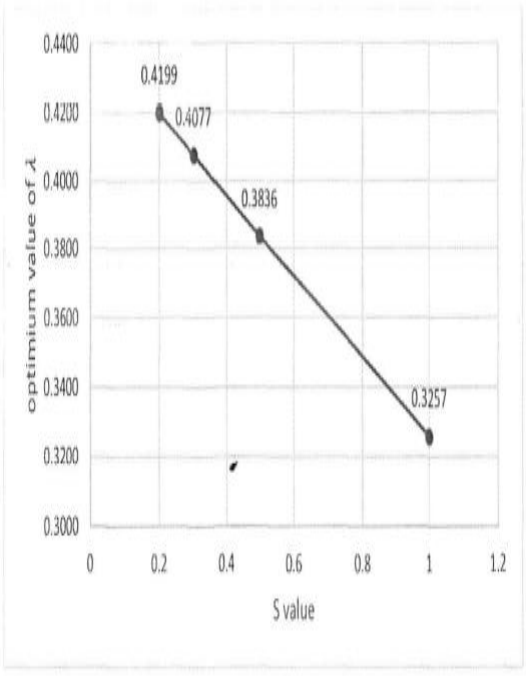

Figure 1(b): The optimum value of λ for different values of S

When we use a membership function that is linear, we only get one answer to the question of how to assign courses to the faculty. As the value of S shifts, the exponential membership function recalculates the distribution of teaching responsibilities among the faculty. These results in a new set of course assignments.

CONCLUSIONS

This study made use of a random mathematical algorithm (RMA) and a probabilistic mathematical timetabling algorithm in order to answer the problem of faculty subject assignment in educational timetabling. Both of these algorithms are mathematical (PMTA). Mathematical modelling competency could be defined as cognitive, effective, and metacognitive dimensions. However, some researchers argued that this definition seemed to be ambiguous since this definition included effective and metacognitive dimensions. This was also in line with the current investigation in measurement in modelling competency which also involved the cognitive measurement. We found that the most often employed aspect of mathematical modelling measurement in mathematics education were the cognitive component. At the same time, written examinations, projects, hands-on assessments, portfolios, contests, and questionnaires were utilized to assess modelling ability in the context of mathematics education. The results of the preference levels should be employed in the recommended method for resolving timetabling concerns in any educational institution. This will increase the likelihood of the method's success. The importance of the faculty member's course assignment to the overall success of the educational institution cannot be overstated.

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