國立聯合大學

經營管理學系碩士班

碩士論文

課程排課問題之研究

—科目對開和教師合開

Modeling a Course Scheduling Problem Involving Multiple Courses at the Same Time and Multiple Instructors in one Course

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摘要

大學課程安排屬於時間安排(Timetabling)問題之一，因其求解計算困難而歸類於NP-complete，亦即目前尚未能找到具有效率的求解演算法。所謂課程排課問題乃是找出所有科目的可行授課時段，且滿足資源限制（例如可用教室等）及遵循既定規模（例如教師的時段偏好和上課日數等）。所以排課問題除了具有計算複雜度課題，多面向的需求衝突亦是挑戰。何況每所學校各有特別專屬的目標與限制，尤其是在教務方針與實務運作規則。因此，不太可能存在一個適用於所有教育機構的通用型課程排課模式。但即使某些限制因個別案例而定，仍有一些基本限制是通用於每個排課問題。故雖然每一個案例均是建構出不同的變異模式，但基本上都可以藉由過去的研究文獻，選擇最核心的模式再加以擴展。

本研究目的是找尋「科目-教師-教室-時段」的週課表，其能最佳化教師偏好及符合各種限制條件。我們提出一個二元整數規劃模型，不僅滿足一般的排課要求（例如科目安排於唯一的教室與時段），並能符合科目對開及教師合開的需求（此挑戰性在於如何使用數學公式表達）。所謂科目對開即為多門選修課程在同一時段開設，讓學生擇一修課；教師合開指多位教師必須在同一時段中排入合開的科目，以便教師輪流授課。我們並用定理證明所提模型能滿足科目對開和教師合開的要求。

為驗證模式可行性，我們應用所提排課模型於某大學學系的排課實例，共有 70 門科目、26 位教師、12 間教室及 60 個時段。我們採用 AMPL 語言建構具有 19577 個二元變數和 3047 條限制式的數學規劃模型，並使用 NEOS 雲端伺服器在 0.25 秒完成求解計算。實作結果指出本模式所求得之課表是行政人員認同且具可行性，因此數學模式確實快速獲得令人滿意的課表；反觀傳統的手動排課通常費時耗力，尤其在資料更動頻繁的情況。透過本研究的數學模式能達到自動排課的效果，即便因應資料變更，亦能立刻更訂課表，而人工排課就得耗時重排。

關鍵詞：時間安排問題、課程排課、二元整數規劃

ABSTRACT

The course scheding problem is a timetabling problem, which is computationally difficult and known to be NP-complete. In the course scheduling problem, the aim is to find feasible time slots for a number of courses that require limited resources, such as available classrooms, and follow some established policies such as instructors' preferences. However, every school has its own special objectives and constraints, especially in terms of academic policies or practical rules. Therefore, it is impossible to establish a general course scheduling model that is applicable for all educational institutions. However, there are some general restrictions which should be satisfied in every course scheduling problem.

The objective of this study is to obtain a timetable of courses-instructors-classrooms-times over a week period, optimizing instructors' preferences and satisfying a set of constraints of various types. We propose a binary integer wodel that is not only suitable for general restrictions such as each course assigned to only one classroom and time slot, but also for the following two specific cases: (1) Multiple courses at the same time - a special set with multiple courses should be taught at the same time, (2) Multiple instructors per course - a course associated with multiple instructors is to be scheduled.

The proposed model is applied to the case of a university department with 70 courses, 26 instructors, 12 classrooms and 60 time slots. The corresponding mathematical program with 19577 binary variables and 3047 constraints is built using the AMPL modeling language and solved in the cloud using the free NEOS server within 0.25 second. Empirical results show that the optimel timetable of the proposed model is reasonable for clerks as well as feasible for practice. The mathematical modeling quickly provides a satisfied solution, whereas traditional manual scheduling usually takes a lot of manpower and time, especially when the data are frequently changed.

Keywords： Timetabling Problems, Course Scheduling, Binary Integer Programming