論文 / 著書情報
Article / Book Information

題目(和文)	クリーク分割問題に対する整数計画アプローチにおける冗長性
Title(English)	Redundancy in Integer Programming Approach for the Clique Partitioning Problem
著者(和文)	鮭川矩義
Author(English)	Noriyoshi Sukegawa
出典(和文)	学位:博士（工学）, 学位授与機関:東京工業大学, 報告番号:甲第9892号, 授与年月日:2015年3月26日, 学位の種別:課程博士, 審査員:水野　眞治,宮川　雅巳,鈴木　定省,中田　和秀,松井　知己
Citation(English)	Degree:, Conferring organization: Tokyo Institute of Technology, Report number:甲第9892号, Conferred date:2015/3/26, Degree Type:Course doctor, Examiner:,,,,
学位種別(和文)	博士論文
Category(English)	Doctoral Thesis
種別(和文)	論文要旨
Type(English)	Summary

（博士課程）
Doctoral Program

論 文 要 旨

THESIS SUMMARY

専攻： Department of	経営工学 専攻	申請学位（専攻分野）： Academic Degree Requested	博士 （ 工学 ） Doctor of
学生氏名： Student's Name	鮭川 矩義	指導教員（主）： Academic Advisor(main)	水野 眞治
		指導教員（副）： Academic Advisor(sub)	

要旨（英文 800 語程度）
Thesis Summary（approx.800 English Words ）

The clique partitioning problem, which is the focus of this thesis, is a fundamental combinatorial optimization problem that gives a useful model for clustering tasks. A large number of real world applications include qualitative data analysis, flight gate scheduling, and community detection. However, in addition to its theoretical hardness, NP-hardness, its standard formulation, which is defined to be a simple integer linear programming problem, is known to require huge computational resources. This property has been pointed out as the main difficulty, and prevents us from efficiently solving the clique partitioning problem in practice. In this thesis, we focus on a specific redundancy in the formulation. Specifically, the redundancy referees to the variables and constraints that can be deleted from the formulation. Therefore, detecting and removing redundancies can contribute to problem size reduction and efficient computation. The aim of this thesis is to study on practical methodologies for detecting and removing the redundancy of the clique partitioning problem, through its standard integer programming formulation, in terms of both algorithmic and theoretical aspects. Extensive numerical experiments demonstrated a usefulness of our methodologies, especially for real-world problems. This thesis is organized by the following six chapters.

Chapter 1 and 2 are devoted to the basis points for this thesis. In Chapter 1, titled "Introduction", we first briefly review the existing studies on the clique partitioning problem, with emphasis on its importance for qualitative data analysis. Then, we state the positioning and importance of this study. The background is the recent dramatic improvement on the performances of the software for solving integer programming problems. Although the software is now very powerful, further techniques, such as preprocessing and reformulation, are needed, especially for huge and complex problems arising from real world. This status stimulates the approaches discussed in Chapter 3 and 4, which are the main part of this thesis. In Chapter 2, titled "problem", we give the formal definition of the clique partitioning problem and the standard formulation as an integer linear programming problem. Based on these definitions, we explain our intuition for the redundancy, which will be discussed in the remainder of this thesis. The redundancy of variables and constraints are discussed in Chapter 3 and 4, respectively.

Then, in Chapter 3 and 4, we show the main results of this study. In Chapter 3, titled "Preprocessing", a practical preprocessing algorithm for detecting the redundancy in variables is proposed. To this end, the well-known existing method, called the pegging test, is strengthened by using the problem structure, transitivity. We conceptually and experimentally demonstrate that this transitivity property is excellent with redundancy detection. Numerical results show that our preprocessing algorithm substantially reduces the problem size based on the redundancy detected, and the reduced problems are solved efficiently by the software, Gurobi Optimizer. There is a clear advantage compared to a naïve one that directly applies Gurobi Optimizer. Furthermore, in order to ease the computational burden arising from the numerous constraints, we propose a further relaxation on the Lagrangian relaxation, which is employed as the basis of the pegging test. In Chapter 4, titled "Reformulation", we propose a reformulation that nicely removes the redundancy in constraints. This results follows from a theoretical characterization of the redundancy in constraints. There, again, we utilize the structural property of the clique partitioning problem, that is, transitivity. Most of the existing approaches consider to solve many auxiliary problems to detect non-redundant constraints. In contrast, we give simple sufficient conditions for the constraints to be redundant, which enables us to dispense with cumbersome sequential procedures employed in the existing approaches. Although our approaches are simple, the computation time by the software can be substantially reduced. Also, to see the versatility of our approach, we also address the linear ordering problem, which also possesses the transitivity property. Finally, in Chapter 5, titled "Hardness Results", we mention the known results on the theoretical complexity of the clique partitioning problem, and give a proof for the NP-hardness of a special case, which is referred to as the maximum edge clique partitioning problem. The aim of this chapter is simply give a counterexample, an error, in the existing proof and propose an alternative one.

Chapter 6, titled "Conclusion" sums up this thesis, and discusses the possible future works.

備考 ： 論文要旨は、和文 2000 字と英文 300 語を 1 部ずつ提出するか、もしくは英文 800 語を 1 部提出してください。
Note : Thesis Summary should be submitted in either a copy of 2000 Japanese Characters and 300 Words (English) or 1copy of 800 Words (English).