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Automatic Menu Planning of Cafeterias Serving a la Carte Menu

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Abstract

Many companies in Japan operate cafeterias in universities, offices, factories, and other locations. Cafeterias offer a wide variety of menu items, including set menus, rice bowls, and noodles. Japanese cafeterias have a variety of styles to serve food. In particular, a la carte menu is preferred by many users. In the a la carte menu, dishes such as the staple meal, main dish and soup are sold as individual items, rather than as a set meal. The menu allows customers to freely select dishes according to their tastes, quantities, and economics. Therefore, customers can be very satisfied. In the a la carte menu, it is important to combine dishes of various tastes and prices and to use ingredients with different textures when preparing a menu for a day. If there are similar dishes and the number of choices is small, the number of visitors to the cafeteria may decrease, which will lead to a decrease in sales. In addition, when preparing a menu for several days, it is necessary to consider constraints such as frequency of service, cooking methods, and budget. It is very difficult to manually find combinations of dishes that satisfy many of these constraints. In addition, the menu contents vary depending on the menu planner, making it difficult to continue creating high-quality menus over a long period of time. Therefore, there is a need for an automatic menu planning model to improve operational efficiency.The purpose of this study is to propose a menu planning model that considers the characteristics of a la carte menu based on mathematical optimization. We regard menu planning as "finding the optimal combination of dishes that satisfies various constraints in the field for multiple periods from several sets of dishes". Then, we formulate a menu planning model for a la carte menu as a "combinatorial optimization problem" in mathematical optimization. In this study, we took into account constraints on dish categories, frequency of serving some ingredients, and cost. To demonstrate the usefulness of the proposed model, numerical experiments are conducted using actual data from a cafeteria that serves a la carte menu. The cafeteria serves approximately 25 dishes per day, including staples, main dishes, and side dishes. The menu creator manually prepares menu lists for multiple periods over a long period of time.Numerical experiments using the mathematical optimization solver Gurobi Optimizer produced a menu for one month. The menu consisted of six dishes that is composed of staple meals and main dishes. The results of the numerical experiments were evaluated by menu planners of the cafeterias. They regarded the menu created by the proposed model as a menu that can be served in the field. The time required to output a menu was less than one minute. Compared to manual menu creation, the time required was significantly reduced.

Keywords
Menu planning, Mathematical optimization, Combinatorial optimization, A la carte menu.

Biographies

Shuntaro Yamazaki is with Department of Industrial Engineering and Management, Graduate School of Engineering, Kanagawa University. His research involves creating menu of a la carte based on mathematical optimization. He entered Kanagawa University in 2019 and joined the Management Systems and Engineering Laboratory in 2021. After he received his undergraduate degree in Industrial Engineering and Management in 2023, he entered the graduate school of Kanagawa University.

Hideki Katagiri is a Professor of Department of Industrial Engineering and Management at Kanagawa University, Japan. He earned his B.E., M.E. and Ph.D. in Engineering at Osaka University in 1995, 1997 and 2000, respectively. He was the Chair of IEEE SMC Hiroshima Section Chapter (2008-2010) and a Visiting Scholar at the University of Chicago Booth School of Business (2014-2015). He was a Visiting Professor of Hiroshima University (2016-2020). His research and teaching activities are in the areas of operations research and soft computing, especially, multi-objective optimization under uncertainty and data analysis using machine learning techniques. He is the author or co-author of more than 100 refereed journal papers and several co-authored or co-edited books in English.