Multi-objective decision-making for dietary assessment and advice

thesis by J.C. van Lemmen-Gerdessen

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General Foulkesweg 1a, Wageningen

Unhealthy diets contribute substantially to the worldwide burden of non-communicable diseases, such as cardiovascular diseases, cancers, and diabetes. Globally, non-communicable diseases are the leading cause of death, and numbers are still rising, which makes healthy diets a global priority. In Nutrition Research, two fields are particularly relevant for formulating healthier diets: dietary assessment, which assesses food and nutrient intake in order to investigate the relation between diet and disease, and dietary advice, which translates food and nutrient recommendations into realistic food choices. Both fields face complex decision problems: which foods to include in dietary assessment or advice in order to pursue the multiple objectives of the researcher or fulfil the requirements of the consumer. This thesis connects the disciplines of Nutrition Research and Operations Research in order to contribute to formulating healthier diets.

In the context of dietary assessment, the thesis proposes a MILP model for the selection of food items for food frequency questionnaires (a crucial tool in dietary assessment) that speeds up the selection process and increases standardisation, transparency, and reproducibility. An extension of this model gives rise to a 0-1 fractional programming problem with more than 200 fractional terms, of which in every feasible solution only a subset is actually defined. The thesis shows how this problem can be reformulated in order to eliminate the undefined fractional terms. The resulting MILP model can solved with standard software.

In the context of dietary advice, the thesis proposes a diet model in which food and nutrient requirements are formulated via fuzzy sets. With this model, the impact of various achievement functions is demonstrated. The preference structures modelled via these achievement functions represent various ways in which multiple nutritional characteristics of a diet can be aggregated into an overall indicator for diet quality. Furthermore, for OR the thesis provides new insights into a novel preference structure from literature, that combines equity and utilitarianism in a single model.

Finally, the thesis presents conclusions of the research and a general discussion, which discusses, amongst others, the main modelling choices encountered when using MODM methods for optimising diet quality.

Summarising, this thesis explores the use of MODM approaches to improve decision-making for dietary assessment and advice. It provides opportunities for better decision-making in research on dietary assessment and advice, and it contributes to model building and solving in OR. Considering the added value for Nutrition Research and the new models and solutions generated, we conclude that the combination of both fields has resulted in synergy between Nutrition Research and OR.