Session 7: Health Care Operations

Chair: Harwin de Vries

Caroline Jagtenberg (Vrije Universiteit Amsterdam) - Modeling Emergency Medical Service Volunteer Response

Out of hospital cardiac arrest requires immediate treatment and patient survival can be improved by combining traditional ambulance response with the dispatch of volunteers alerted via an app. How many volunteers are needed, and from where should they be recruited? We model the presence of volunteers throughout a region as a Poisson point process. We compute the response-time distribution and, using known survival functions from literature, infer survival rates. Survival rates depend on the way volunteers are spread across a city, but it is challenging to estimate this distribution because of data-privacy issues. We consider both plausible volunteer location distributions and also an optimized volunteer location distribution that maximizes survival rates. All of the optimization problems are highly tractable. We include a case study for Auckland, New Zealand, where we show how the optimal allocation of volunteers over the region varies, depending on the number of available volunteers as well as the choice of objective function. We also show how ambulance locations affect the optimal distribution of volunteers. The optimal allocation of volunteers over the region provides guidance for recruitment of volunteers, both in terms of the number of volunteers needed to substantially increase survival rates and in city locations where additional recruitment would be most beneficial.

Denise Tönissen (Vrije Universiteit Amsterdam) - Using 3D-printing in disaster response: The two-stage stochastic 3D-printing knapsack problem

In this presentation, we will shed light on when to pack and use 3D-printers in disaster response operations. For that, we introduce a new type of problem, which we call the two-stage stochastic 3D-printing knapsack problem. We provide a two-stage stochastic programming formulation for this problem, for which both the first and the second stage are NP-hard integer linear programs. We reformulate this formulation to an equivalent integer linear program, which can be efficiently solved by standard solvers. Our numerical results illustrate that for most situations using a 3D-printer is beneficial. Only in extreme circumstances, where the quality of printed items is extremely low, the size of the 3D-printer is extremely large compared to the knapsack size, when there is no time to print the items, or when demand for items is low, packing no 3D-printers is the best option.

Harwin de Vries (Rotterdam School of Management) - Site Visit Frequency Policies for Mobile Family Planning Services

Improving access to family planning services is key to achieving many of the United Nations sustainable development goals. To scale up access in remote areas and urban slums, many developing countries deploy mobile family planning teams that visit “outreach sites” several times per year. Visit frequencies have a significant effect on the total number of clients served and hence the impact of the outreach program. Using a large dataset of visits in Madagascar, Uganda, and Zimbabwe, our study models the relationship between the number of clients seen during a visit and the time since the last visit and uses this model to analyze the characteristics of optimal frequencies. We use the latter to develop simple frequency policies for practical use, prove bounds on the worst-case optimality gap, and test the impact of the policies with a simulation model. Our main finding is that despite the complexity of the frequency optimization problem, simple policies yield near-optimal results. This holds even when few data are available and when the relationship between client volume and the time since the last visit is misspecified or substantially biased. The simulation for Uganda shows a potential increase in client numbers of between 7% and 10%, which corresponds to more than 12,000 additional families to whom family planning services could be provided. Our results can assist policymakers in determining when to start data-driven frequency determination and which policies to implement.