

Operations Research in practice : two case studies in workforce and manufacturing

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1 Introduction

DecisionBrain¹ is a software company that specializes in providing optimization solutions primarily in the fields of production planning, workforce management and logistics. Decision-Brain offers modular, custom planning, scheduling and logistics optimization software solutions to solve multi-objective problems with complex constraints. In this presentation, we will illustrate two case studies corresponding to two different business problems. The first is about a workforce solution that optimizes tactical planning and operational scheduling. The second talks about a manufacturing solution that optimizes a production planning problem.

2 First use case : route inspections

The first use case is a combined strategic and tactical workforce scheduling application for an auditing company that is in charge of inspecting route cleanliness in a major city in a tropical country. Poor route cleaning might result in public health hazard because of potential outbreaks of dengue and other mosquito-carried diseases. Audits are performed by inspectors and in the audit plans, each inspector has two target audit routes per day. The planned routes have a given frequency (e.g. some routes need to be cleaned every day, some every other day, every week or every few months).

This application comprises a medium-term (strategic) planning module that spans over 9 months and defines a high-level plan for all the officers and all the audits, that takes into consideration all the audits and their priorities and balances the workload over the officers. The objectives of this module are :

- minimize the travel time
- prioritize the important audits

The module takes into consideration the officers preferred sectors to set the monthly targets and makes sure that all the cleaning routes will be inspected at least once every 9 months

The second module of the application takes the medium-term plan as input and computes a monthly schedule for each inspector, defining which jobs will be performed on which day by each officer. The main objectives are the following :

- minimize the travel time
- maximize the service level (i.e., meeting the targets set on the 9-months plan)

The problem belongs to the class of combined workforce routing and scheduling problems (see [1]).

1. <https://www.decisionbrain.com/>

3 Second use case : a textile manufacturer

The second use case is a mid-term lot-sizing problem for a textile manufacturer. Lot-sizing problems aim at determining a production or distribution plan that satisfies demands over a planning horizon discretized into periods ([2], [3]), minimizing the total production, inventory and setup costs. Lot-sizing problems are very common in manufacturing and logistics and are usually *NP-hard*. In our use case, each production process consists in the combination of a style (t-shirt, pants...) and a color that is produced at a plant and then immediately shipped to distribution centers all around the world. The batches that are optimized are then split into the different available sizes (S, M, L...) in order to satisfy the demands over an horizon of 18 months. The resulting production planning problem is highly complex because production occurs by fixed batch sizes of style-color, which then need to be disaggregated in order to satisfy demands that are defined by sizes. The problem contains many capacity constraints. For instance a subset of plants can have a monthly minimum and a maximum capacity usage, and minimum ordering constraints can apply to some of the style-colors. The resulting lot-sizing problem uses a lexicographic approach with the following objectives :

- Respect of the minimum capacity use at the plants
- A maximization of the demand satisfaction
- Respect of the safety stocks for each style-color
- A minimization of the inventory at each period
- A minimization of the total production costs

The complete optimization process has two runs, where the second run distribute the over-production that was caused by the minimum resource capacity and the minimum lot-size constraints during the first run.

4 Conclusions

DecisionBrain's solutions are based on DB Gene, its development platform that enables rapid prototyping and deployment of optimization-based applications. DB Gene is based on state-of-the-art technologies and made of standard components. It provides out-of-the-box web user interface components, data and scenario management services, user access and profiling components, and a tasks server that can manage several computation processes in parallel, on-premise, or in the Cloud.

We estimated that on applications such as the two use cases presented above, DB Gene reduced development time and costs by at least 70%. Indeed, the scenario management that is made possible using the platform allowed to easily manage the input and outputs, and consequently the analysis of the input data and the optimization results was greatly simplified. Additionally, the data analysis was made even easier using the web user interface and its visualization features.

Références

- [1] J Arturo Castillo-Salazar, Dario Landa-Silva, and Rong Qu. Workforce scheduling and routing problems : literature survey and computational study. *Annals of Operations Research*, 239(1) :39–67, 2016.
- [2] Ford W. Harris. How Many Parts to Make at Once. *Factory, The Magazine of Management*, 10(2) :135–136, 1913.
- [3] Yves Pochet and Laurence A. Wolsey. *Production planning by mixed integer programming*. Springer series in operations research and financial engineering. Springer, New York ; Berlin, 2006.