

# Decision Analytics in a Sustainability Optimization Problem

## Extended Abstract

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### ABSTRACT

In many real-life applications with underlying constraints there are several parameters to configure. Solving such problems involves finding configurations that satisfy the constraints associated to the problem. In addition, many times there are certain criteria to optimize. Many configurations are incompatible and only few are the best (optimal solutions). Then, we can model an optimisation problem and apply algorithms that facilitate decision making leading to an optimal solution. Some areas that generally involve optimisation problems are: telecommunications, transportation, logistics, supply chain management, energy efficiency, environmental sustainability, and many others. Specifically, in this extended abstract, a case study of an environmental sustainability problem will be explained: forestry harvesting.

### CCS CONCEPTS

• **Mathematics of computing** → **Mixed discrete-continuous optimization**;

#### ACM Reference format:

Laura Climent, Adejuyigbe O. Fajemisin, and Steven D. Prestwich. 2017. Decision Analytics in a Sustainability Optimization Problem. In *Proceedings of womENCourage, Barcelona, Spain, September 2017*, 2 pages. <https://doi.org/10.1145/nnnnnnn.nnnnnnn>

## 1 ENVIRONMENTAL SUSTAINABILITY

In Environmental sustainability, the key idea is to sustain the global ecosystem that maintains human life. Then, a common problem in such field is to minimise the use of resources from the ecosystem when extracting certain products from such resources. As an example of optimization applied to environmental sustainability, we will analyse the forestry harvesting problem, which is characterized by:

- Forests are subdivided into sections called ‘blocks’. Each block is composed by many trees of different sizes.
- Harvesting Machines (HM) are designed to cut log pieces of certain dimensions from the full logs, according to certain ‘cutting patterns’.
- Customers specify the number of log pieces of certain dimensions that they wish to purchase.

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womENCourage, September 2017, Barcelona, Spain  
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ACM ISBN 978-x-xxxx-xxxx-x/YY/MM...\$15.00  
<https://doi.org/10.1145/nnnnnnn.nnnnnnn>

- The cutting of the logs leads to waste of valuable resources when the number of log pieces of certain type exceed the customers’ demands (since the pieces cannot be sold and become damaged over time).
- **Goal:** Select the blocks that should be harvested and select a single cutting pattern to apply to each of them so that the customers’ demands are satisfied and the minimum number of trees is harvested.

## 2 DECISION ANALYTICS IN ACTION

We propose a combined Cutting-Stock and Vehicle-Routing Problem and we model it as Mixed-Integer Linear Program (MILP). The combined objectives minimise the value of the blocks harvested, as well as the cost of the route through the forest, while harvesting dynamically. Previous related work was presented in [1].

Figure 1 shows the result obtained by our approach in a forest with 26 blocks. Note that only 6 blocks were harvested and the customer’s demands were satisfied. Our technique generally outperforms a popular metaheuristic used in this industry. Specially, when the cut-off times are low. For example, for high demands and low cut-off times, the metaheuristic is often not able to provide a solution even by harvesting the whole forest. While our approach provides good solutions for such low cut-off times (for the example in Figure 1, in less than 2 min.). Note that harvesting unnecessary blocks implies the waste of thousands of trees and economic losses.

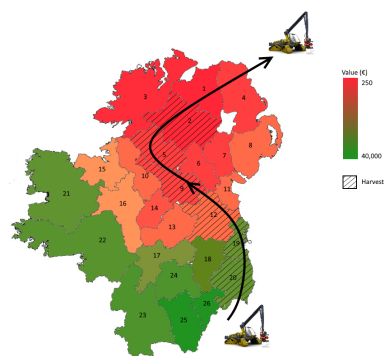


Figure 1: Example of a solution: harving machines path.

## REFERENCES

- [1] Steven D. Prestwich, Adejuyigbe O. Fajemisin, Laura Climent, and Barry O’Sullivan. 2015. Solving a Hard Cutting Stock Problem by Machine Learning and Optimisation. In *Proceedings of the European Conference on Machine Learning and Principles and Practice of Knowledge Discovery in Databases (ECML PKDD)*.