D-Sight:
A New Decision Making Software to Address Multi-Criteria Problems

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ABSTRACT

PROMETHEE and GAIA belong to the family of multi-criteria outranking methods. A key aspect of their successful application to real problems relies on the existence of user-friendly software implementing these approaches. Following PROMCALC and DECISION LAB 2000, D-Sight is the third generation of PROMETHEE and GAIA based applications. It offers multiple interactive and visual tools that help the decision maker to better understand and manage his multi-criteria problem. The aim of this paper is to provide a description of D-Sight by presenting its main characteristics. An illustrative case study about the outsourcing of IT infrastructure and application development is detailed.

Keywords: Decision Making Software, Geometrical Analysis for Interactive Aid (GAIA), Multi-Criteria Decision Aid, Preference Ranking Organization METHOD for Enrichment Evaluations (PROMETHEE), Project Portfolio Management

1. INTRODUCTION

Multi-criteria decision aid (MCDA) addresses problems where choices, alternatives, items, etc are evaluated on several conflicting criteria. The aim is to help a decision maker to structure and to better understand his problem by providing him valuable information about the consequences of his choices, the synergies and redundancies between criteria, the influence of parameters, the comparison of action profiles, … The approaches developed in the MCDA community can be divided in three major categories: interactive, multi-attribute and outranking methods (Vincke, 1989).

PROMETHEE (Preference Ranking Organization METHOD for Enrichment Evaluations) (Brans & Vincke, 1985) and GAIA (Geometrical Analysis for Interactive Aid) (Mareschal & Brans, 1998) belong to the family of outranking methods. Since the original presentation of the PROMETHEE I and II rankings by Brans (1982), a number of extensions have been proposed such as a complementary geometrical analysis approach called GAIA (Mareschal & Brans, 1998), tools for sensitivity analysis
(Mareschal, 1988) or a procedure for group decision support (Macharis, Brans, & Mareschal, 1998). We refer the interested reader to Brans and Mareschal (2005) for a state of the art of these developments.

Recently, Behzadian et al. (2010) have realized a comprehensive literature review of the applications of PROMETHEE to various fields such as finance, health care, logistics and transportation, chemistry, environmental management, … (they listed more than 200 papers published in 100 journals). From our point of view, a key factor of this success relies on the existence of efficient and user-friendly software. Following PROMCALC (Brans & Mareschal, 1994) and DECISION LAB 2000, D-Sight constitutes the third generation of PROMETHEE based applications. It has been developed by Quantin Hayez at the CoDE-SMG laboratory under a grant of the Walloon Region supervised by Prof. Yves De Smet. The main intention underlying this project was to develop an application based on interactive visual tools. Now that the resulting product has reached a certain level of maturity, the aim of this paper is to offer a complete description of the software.

D-Sight implements classic functionalities such as the PROMETHEE I and II rankings, the GAIA visualization tool, sensitivity analysis (including for instance the walking weights or the decision maker’s brain) and a Group Decision Support System (GDSS). Compared to previous software, several functional improvements have been proposed in addition to a modern user interface: a new visualization format for the PROMETHEE I ranking called the “Diamond,” a plugin system allowing the customization of the software, a module for automatic updates, the explicit projections in the GAIA plane, new GAIA visualization options (Hayez, Mareschal, & De Smet, 2009; Mareschal & De Smet, 2009), a multiple levels hierarchy of criteria, a functionality dedicated to the elicitation of weights, … D-Sight is available since February 2010. Up to now, it is regularly used by several universities and research centers all over the world for teaching and research purposes (Macharis, Bernardini, De Smet, & Hayez, 2010). In addition, D-Sight is used in private companies as well. Some of those collaborations led to the publication of different case studies (see http://www.d-sight.com/academic).

The paper is organized as follows: a brief description of PROMETHEE and GAIA is provided in Section 2 followed by a short MCDA software review in Section 3. Then, the main characteristics, the architecture of D-Sight and the plugin system are presented in Section 4. Finally an illustrative case study is detailed in Section 5 in order to highlight the added value of using D-Sight. Therefore, we will consider the case of a production company that is looking to outsource both IT infrastructure and application development.

2. MODEL

In this section, we provide a brief description of PROMETHEE and GAIA. As already stressed, we invite the interested reader to consult (Brans & Mareschal, 2005) for a detailed presentation of the methods and their extensions.

Let \( A = \{a_1, \ldots, a_n\} \) be a set of \( n \) alternatives and \( F = \{f_1, \ldots, f_q\} \) be a set of \( q \) criteria. Without loss of generality we will assume that these criteria have to be maximized. In what follows, we will also use the terms: actions, alternatives, items, projects … to describe the object of the decision.

At first, we will focus ourselves on the PROMETHEE prescriptive approach. Basically, this one can be divided in four main steps:

**Step 1:** Pair-wise comparisons of alternatives for every criterion.

For every couple of alternatives \((a_i, a_j)\), we compute the evaluation difference for each criterion \( f_k \):

\[
d_k(a_i, a_j) = f_k(a_i) - f_k(a_j)
\]

(1)
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