An overall characterization of the project portfolio optimization problem and an approach based on evolutionary algorithms to address it

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Abstract This chapter describes the main features of project portfolio selection and formalizes a problem statement that considers these features. We provide a simple but comprehensive illustrative example that shows the usefulness of the problem statement and argue that there are no published approaches so far that deal with its whole complexity. We also provide some guidelines to build such an approach based on the use of evolutionary algorithms.

1 Introduction

Resource allocation problems are ubiquitous in business and government organizations [1] because there usually are more good project proposals than resources available to support all of them. Of course, every organization must carefully select how to distribute its resources and which projects should they support to create the best impacts on the organization's objectives. Each of these project proposals can be defined as a collection of related and interde-

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pendent activities that have common specific goals. Business organizations often engage in resource allocation activities to increase profits or improve productivity (e.g., [2, 3, 4]) while government organizations do it trying to increase the quality of life of the society (e.g., [5]). Given a set of project proposals, a project portfolio (simply portfolio hereafter) defines if each proposal is supported, or if it is not. The supported projects in the portfolio share resources during a given period, among which there may be complementarity, incompatibility or synergies produced by sharing costs and benefits derived from conducting more than one project at the same time [6]. Project portfolio selection is the activity where a subset of candidate projects that (roughly) optimizes the organization's objectives is chosen. Each of these projects has a related cost and estimated impacts on the multiple objectives of the organizations. Thus, the selection procedure is performed under a constrained multi-criteria approach where the impacts of each project are contemplated to define the overall impacts of the portfolio, in such a way that the required costs of the supported projects do not exceed the available resources.

Project portfolio selection problems share some of the following characteristics: i) considering multiple (sometimes many) and conflicting criteria [7, 8, 9], ii) modeling the decision maker (DM) preferences to select a convenient trade-off among the impacts on the criteria (e.g., [10, 11]), iii) dealing with a set of constraints related to the available resources, where the budgetary constraint is only one of them (cf. [12, 13]), iv) managing uncertainty (e.g., [14, 15, 16, 17, 18]), v) finding the best portfolio through an optimization procedure (e.g., [19, 20, 21, 11]); vi) handling synergy among projects (e.g., [4, 22]). Usually, a combination of Multicriteria Decision Aiding (MCDA) and optimization methods is used. MCDA methods are used to aggregate the impacts on the criteria by considering the decision maker preferences, and the optimization methods are used to define the portfolio that maximizes the impact(s) on the decision maker objective(s).

Project portfolio selection has been addressed from many fields [8] such as selection of infrastructure projects [10, 23, 24], selection of renewable energies [25, 26, 27], selection of products to include in a manufacturing process [28, 29], and selection of Research and Development (R&D) projects [30, 31, 32, 33]. Particularly, selection of R&D projects is a very active research area.

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