The Methodology for Software Development to Support Decision Making Processes

Grzegorz Kołaczek, Paweł Świątek, Krzysztof Juszczyszyn, Adam Grzech and Arkadiusz Sławek

Abstract The paper describes an original software development Methodology and its supporting online tools (the Process Optimization Platform) which allow efficient identification of optimization problems in transport organizations and fast development of a prototype solution. The result of applying the Methodology and the Platform in the context of an organization is a prototype of a decision support system, which can be evaluated with a sample of live data representing actual problems of the organization. This enables the organization to easily assess potential business benefits and quality of the solution before engaging in full software development process related to the implementation of decision support system. The benefits brought by the application of cloud computing solutions while implementing and applying the proposed set of methods and tools have been presented.

Keywords Resource optimization · Decision making · Software development

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1 Introduction

The Methodology of the Process Optimization Platform focuses on identification, analysis, planning and optimization of enterprise resource management processes in domain-specific information systems. The first part of the paper describes characteristics of basic elements associated with the proposed Methodology. Goals of identification and description of activities in the domain of transport have been described, as well as usage of systematic knowledge in the form of dictionaries and repositories of data gathered from previously conducted studies. The second part of the paper includes details of four classes of use-cases, so-called "Methodology paths" [1, 2].

Main features characterizing the developed Methodology and distinguishing the proposed approach from other solutions are [3]:

- agile approach—involving the provision of methods and tools to make rapid and accurate identification of the relevant decision-making processes for the organization,
- accumulation of knowledge—the knowledge derived from previously solved problems is collected and made available for future systematic analysis of organizations,
- use of service-oriented architecture—use of the SOA paradigm provides ability to streamline the implementation phase and facilitate the integration of newly developed software solutions and organizations' legacy information systems.

2 The Methodology

The Methodology proposes a complete procedure to be followed by development teams. It defines a series of steps, from the very beginning of business analysis, through the structured specification of an optimization problem, to the final delivery of a prototype solution—a software implementation of an algorithm solving the identified optimization problem. The Methodology also defines a set of structures and software elements which are required while following the procedure defined by the Methodology [4–6]. These elements are as follows:

- a tool to assist work of an analyst,
- a method of identification of optimization needs,
- a collection of dictionaries and corresponding development tools,
- a repository of tasks decision models,
- a method of selecting or generating algorithms solving optimization problems,
- a repository of algorithms solving optimization problems.

From its early beginnings the Methodology shares the same principles and ideas which lay behind service oriented and agile computing—sharing resources to achieve coherence and economies of scale, similar to a utility over a network. The convergence between the Methodology and service oriented architecture appears clearly when we consider the common aim which is maximizing effectiveness of shared resources. In case of the Methodology resources are defined by:

- software tools to facilitate business analysis process which can be simultaneously shared by multiple users and applied in different context of organization needs,
- aggregation of domain knowledge gathered during previous analyses,
- aggregation of the algorithms solving various optimization problems identified in organizations,
- service orientation, so that different tools and components supporting problem identification, description and software development process can be exchanged and combined to build new functionalities.

In addition to the advantages of utilizing dedicated online services to support identification and analysis of optimization problems, an important benefit to the Methodology comes from building cloud based computation environments. The ability of diffusion and concurrent computations combined with flexibility of resource management and on-demand availability offered by cloud oriented environments brings a straightforward improvement to the sophisticated computation methods required by models and algorithms forming the final solutions of identified optimization problems.

3 Main Elements Defining the Methodology

The aim of processes defined by the Methodology (Fig. 1) in addition to identifying organization's optimization needs is to prepare a prototype solution. Depending on analyzed context, preparation of a prototype requires selection of one of four possible paths defined by the proposed Methodology.

3.1 Finding Solutions

The first path defined by the Methodology—"Finding Solutions"—is followed if an adequate solution of decision making task already exists and is available in one of the Process Optimization Platform repositories. It means that for a given organization and its identified optimization problem, a solution algorithm can be found in

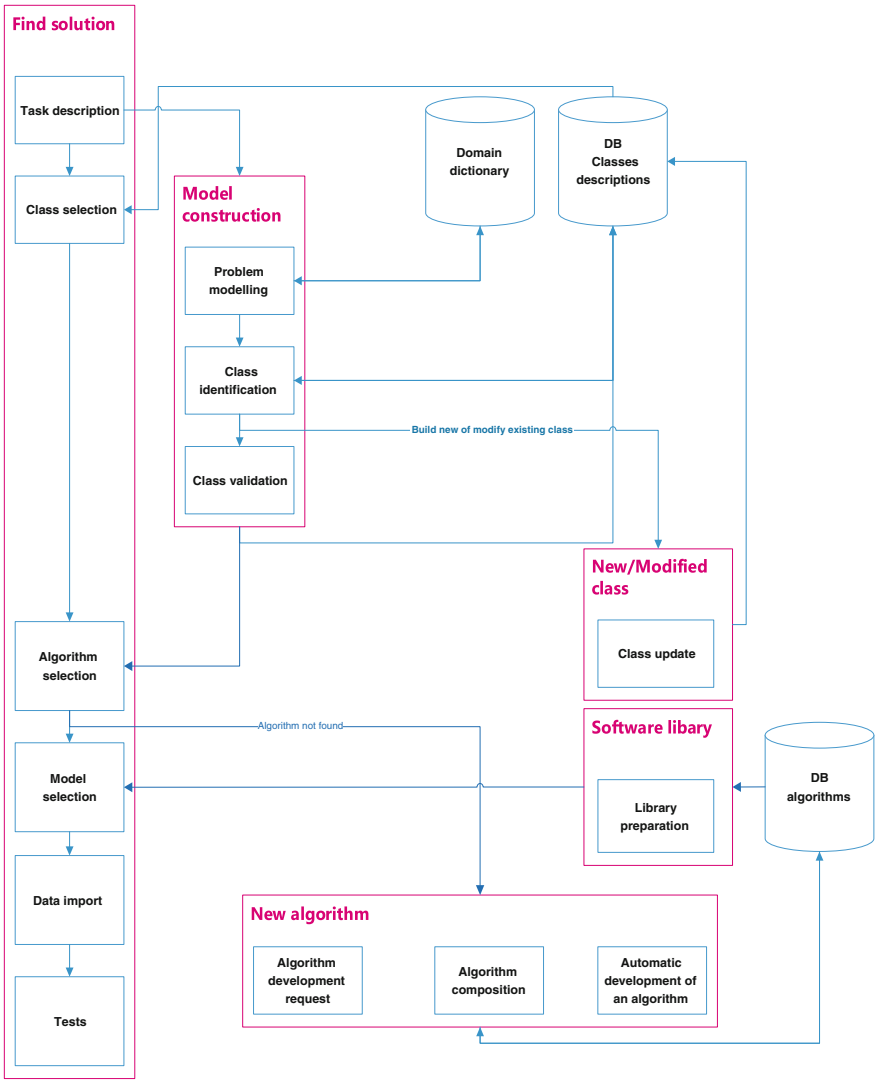

Fig. 1 The methodology

the Platform repository and matched based on the similarity of the current problem to one of previously analyzed cases. In this scenario, we assume that the matched algorithm can be re-used in the preparation process of prototype solution for the given organization. In this path of the Methodology all decisions regarding the choice of the model and the algorithm class are undertaken independently by an appropriate system analyst (Fig. 2).

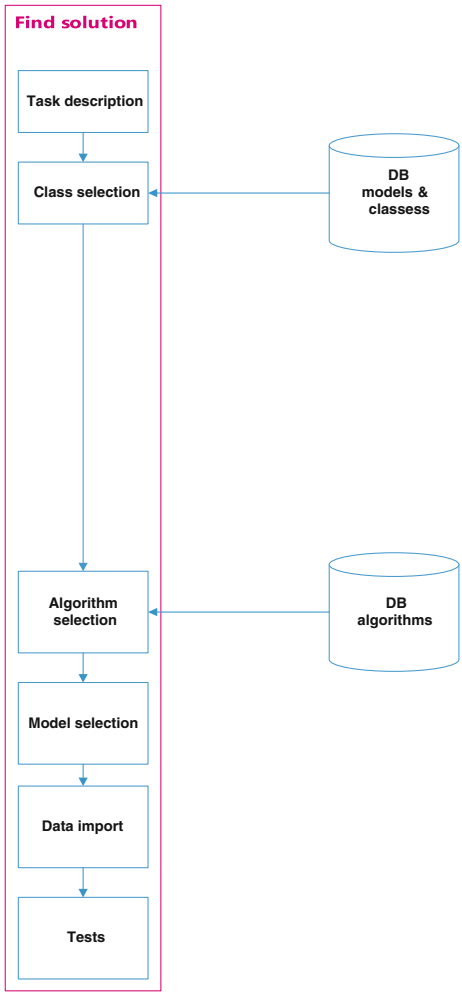

Fig. 2 Path 1: finding solutions

3.2 Path 2: Model Construction

The second path in the Methodology—"Model construction"—is followed when an analyst builds a description of an organization using online Platform modeling tools (Fig. 3). The Process Optimization Platform comprises online tools dedicated to support the structured process of gathering and organizing knowledge about an organization, its decision making processes and occurring optimization problems. The Platform, supplied with a set of tools, allows for interactive use of domain knowledge accumulated in its repositories and domain dictionaries. The goal of organization modeling process is to enable automation of task model definition and aided selection of relevant classes for the defined optimization tasks. As the

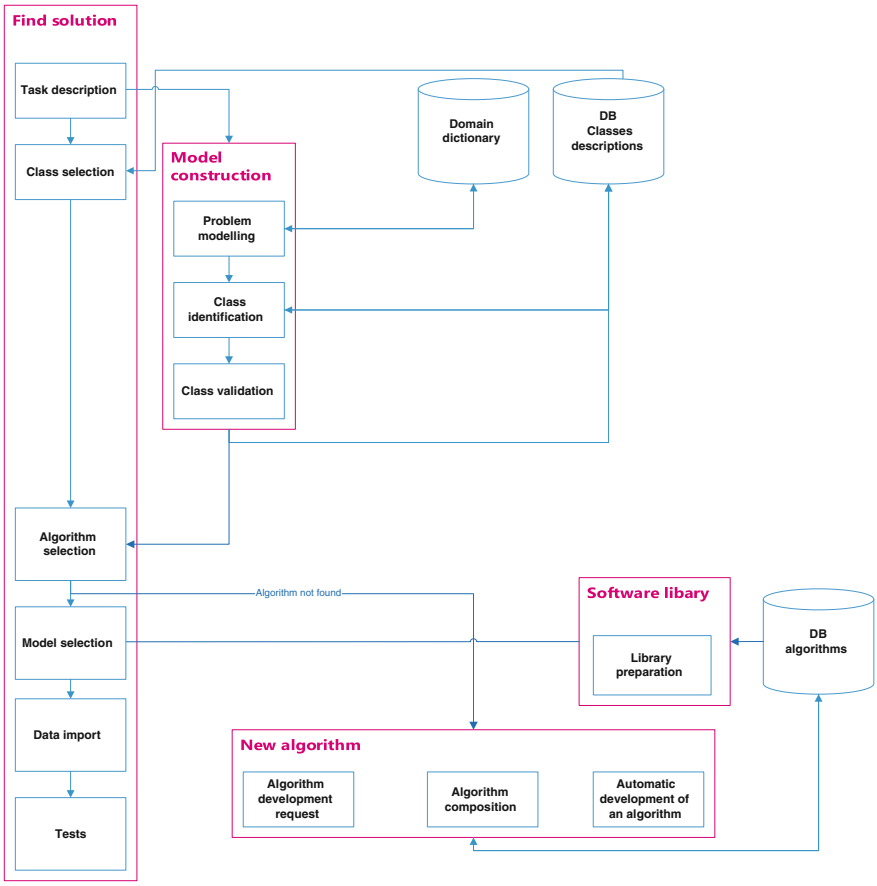

Fig. 3 Path 2: model construction

Platform repositories maintain relations between gathered solution algorithms and optimization task classes, selecting a proper class enables instant discovery of matching solution algorithms and further—generation of a prototype. Path 2 describes scenarios in which, like in the case of Path 1, there are appropriate models, class definitions and algorithms already available in the repositories of the online Platform.

3.3 Path 3: Modification of a Class

The third path in the Methodology—"Modification of a class"—is selected if an analyst using the modeling tools provided by the online Platform states that available types and classes of tasks are not sufficient to properly reflect the

optimization problem of the analyzed organization and it is not possible to precisely define the optimization task (Fig. 4). The lack of a class which would directly define the analyzed optimization process occurs when the optimization problem encountered differs from any of previously analyzed cases but some general similarities can be found. Although there is no class definitions in the Platform repository ready to be used directly, classes related to the same domain do exist. Therefore, in the Path 3 of the Methodology, there is a need to update the definition of an available class to match the analyzed optimization problem and a need to build new solution algorithm. According to the general concept of the Platform, a new solution algorithm can be made available as a result of one of three activities. The first possible scenario is when a new algorithm is implemented by a specialist and uploaded to the Platform repository. It is important, that while a specialist is preparing an implementation of a solution algorithm he/she uses the detailed guidance provided by the Platform and the model of the organization built with the

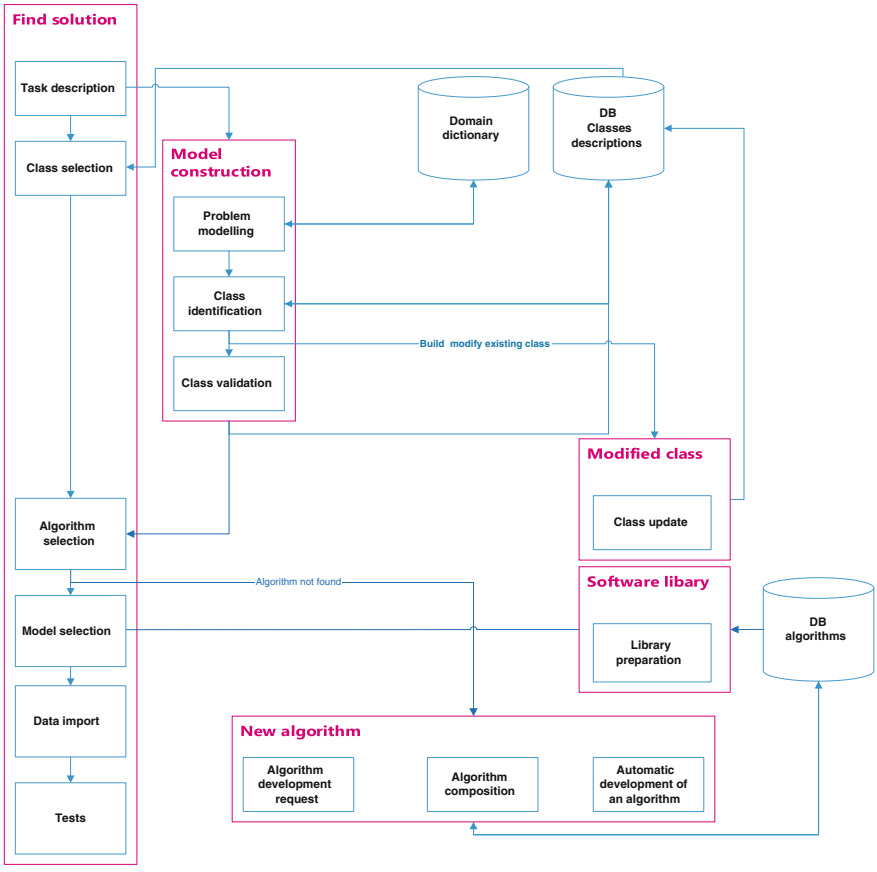

Fig. 4 Path 3: modification of a class

Platform tools. The second method to deliver a solution algorithm is related to the so-called manual composition algorithm. It means that a software engineer configures and publishes a composite service which fulfills all requirements defined during earlier stages of analysis. In the third variant a solution algorithm is composed and provided automatically by mechanisms implemented in the Platform.

3.4 Path 4: Defining a New Class

The fourth path of the Methodology—"Defining a new algorithm"—describes a class of scenarios in which, like it was in the case of the Path 3, the analysis identified a new, previously not described problem of organization's optimization needs (Fig. 5). In this case however, unlike in the Path 3, there are no classes available or

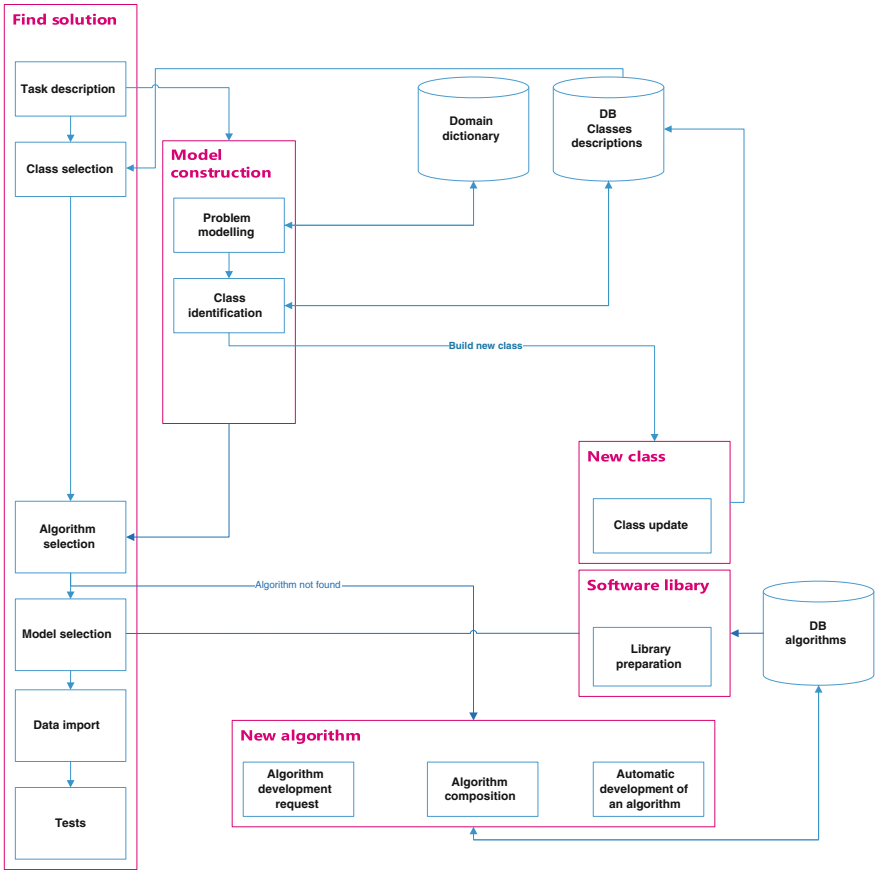

Fig. 5 Path 4: defining a new algorithm

none of the classes can be modified to match the identified problem. Therefore, the primary action that must be taken in the context of this path, is to add a new class of optimization problems to the Platform repository, matching the definition of the analyzed task. Also, in addition to extending the task class repository, there is a need to provide a new algorithm solving the new optimization problem. The algorithm is made available on a similar basis as described in the case of Path 3, i.e. the algorithm can be prepared by an expert, can be made available as a result of the so-called manual composition, or also in certain cases it is possible to automatically compose an algorithm using the techniques and methods available with the Platform.

4 Conclusions

The Methodology proposes a complete procedure to be followed by development teams. It defines a series of steps, from the very beginning of business analysis, through the structured specification of an optimization problem, to the final delivery of a prototype solution—a software implementation of an algorithm solving the identified optimization problem. To the best authors' knowledge the Methodology and the Platform are the first available solution which delivers holistic support for specialized software development for supporting decision making processes in business organizations. The Methodology also defines a set of structures and software elements which are required while following the procedure defined by the Methodology.

The key benefits offered by using the proposed Methodology in the production of software for the analysis, planning and optimization of resource management processes of the organization are:

- quicker development, implementation and adaptation of the system by the possibility of using libraries of standard and specialized processes and algorithms dedicated to the areas of transport management,
- reduction in the system implementation costs by simplifying and speeding up the analysis of the requirements for the development or adaptation of the system,
- optimization of organization's management processes and utilization of resources by selecting appropriate optimization methods dedicated to specific customer requirements,
- integration of optimization modules and functionality of monolithic and legacy systems through the use of service-oriented paradigm (Service Oriented Architecture).

The Methodology has been developed and evaluated in the context of the optimization needs of transportation organizations. However, it is possible to benefit from the Methodology and the Platform also in many other areas of business activities. The future works include e.g. application of developed tools and methods to support production process and warehouse management in small and medium-sized enterprises.

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