Business Process Composition.
Planning with Constraints
(Extended Abstract)

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1   Introduction

Modeling business processes is a way to describe organizational workflows which aim to achieve required goals, understood as products or services delivered to a final customer. Providing an understandable representation of a process helps to establish a common link between technical and business people. This, in turn, gives an opportunity to optimize the process structure. As a consequence, the company may achieve its business objectives in a more efficient way.

It is proved that manually created process representations usually suffer from various modeling errors, such as inconsistent connections or deadlocks [1]. Thus, automating the modeling phase could be beneficial for obtaining process models of higher quality and in a shorter time compared to manual modeling.

Business Process Composition refers to twenty Business Process Management use cases proposed by van der Aalst [2], which were defined to classify the area of research related to business processes. As there is no explicit use case related to the automated generation of process models, the "Compose model" use case has been considered. According to the cited paper, "*Use case compose model refers to the situation where different models are combined into a larger model*". In the case of the proposed method, parts of the process specification may be regarded as subprocesses or components of other models.

The concept of participatory process modeling consists in splitting the creation of the model among the participants of the process. The goal of this approach is to simplify and automate the task of collecting data and merging it into a process model. In contrast to collaborative modeling (e.g., using an interactive display board [3] or dedicated software on mobile devices [4]), the presented approach does not require the contributors to co-ordinate their actions. Figure 1 illustrates the difference between these two methodologies.

According to the main principle of the method proposed in the dissertation, process participants are given a task to prepare descriptions of activities they are responsible for. The specification of a process produced in such a way includes

input and output parameters of each activity. The generated process model needs to fulfill the data requirements, e.g. which data entities have to be available when a process instance is completed. This goal may be achieved only by a limited number of task sequences, not necessarily using all the activities included in the original specification.
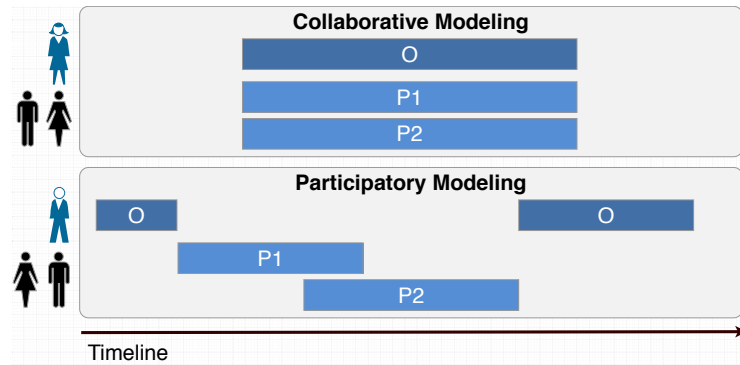

Fig. 1: The difference between collaborative and participatory process modeling (O – Process Owner, P – Process Participant).

The next step of the proposed methodology is related to Automated Planning, which is an area of research that aims to generate a chain of actions oriented at achieving desired goals. A definition of a planning problem and its solution is therefore closely related to Business Process Management, since a plan can also represent a single instance of a particular workflow. However, every business process can be executed in a limited number of ways, each of which refers to a different process instance. The upper limit of this number depends on different factors, such as the occurrence of specific events, resource availability, or other external conditions. All of these aspects can be represented by particular pieces of data and form a part of preconditions or effects for the executed activity. In other words, an activity can be executed only if a given set of constraints is satisfied. Thus, planning of a business process must be accompanied by constraints that determine the conditions needed for every activity to be executed, as well as the potential outcomes caused by this activity.

2   Scope of the Thesis and Research Results

The first part of the dissertation gives an overview of Business Process Management and its primary concepts, such as the BPM life cycle and modeling notations. It also includes a review of state-of-the-art process model generation techniques. Moreover, Automated Planning and main points of Constraint Programming together with a review of Constraint Satisfaction Problems and their applications were discussed.

The second part of the dissertation begins with a presentation of motivations and challenges related to business process composition. It also introduces the concept of *participatory process modeling*, which is the main basis for the proposed method. In addition, based on the existing solutions for the automated generation of process models [5,6,7,8], a set of requirements and constraints needed to generate a process model was collected.

As the next step, the algorithm for model composition was presented. The method uses activity descriptions provided by stakeholders of the process. These descriptions are then merged to obtain a declarative process specification, which serves as an input to a constraint solver. The Constraint Satisfaction Problem consists in finding a set of admissible workflow traces (execution plans) of the process. In the last phase of the method, the generated traces are merged into an activity graph, which is later transformed into a BPMN model. Figure 2 shows an illustrative overview of the proposed method with a distinction of its phases and the scope of the technical solution presented in the dissertation.
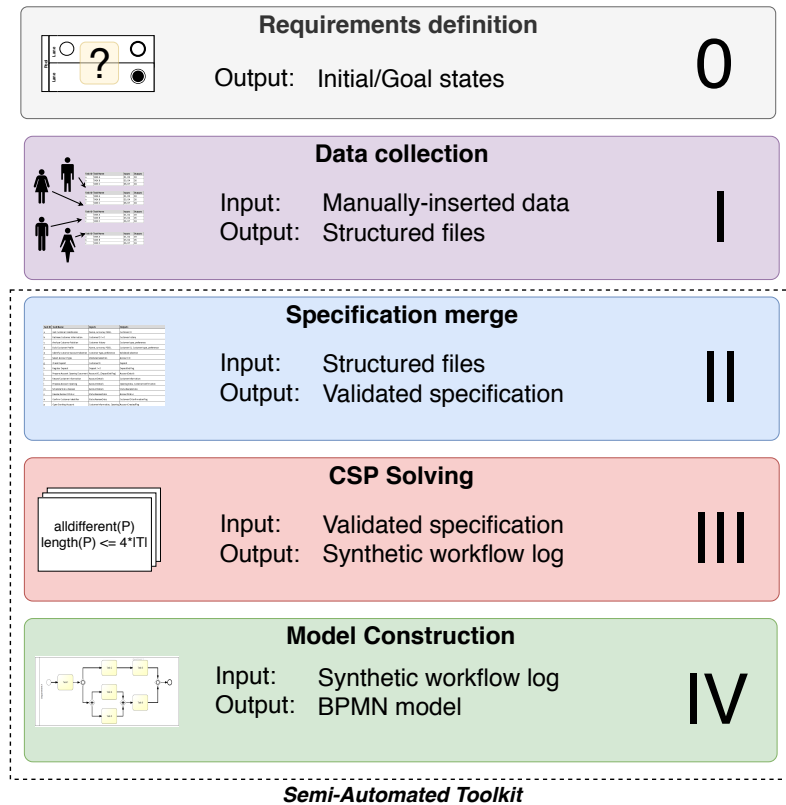

Fig. 2: Outline of the approach which consists of four main phases and a preliminary step. Based on [9].

The algorithms developed to solve the problems stated in this work served as an input to the conceptual and functional design of a process modeling software. The designed application consists of two modules: *Specification Editor* for creating declarative process specifications and *Process Composer* for process composition based on prepared specifications.

Finally, the performance of the methods presented in the dissertation was analyzed by using a dedicated methodology, as well as existing metrics for business process models. The evaluation consisted of the following steps:

– introducing a novel methodology to verify the correctness of a generated model with respect to its admissible execution sequences,
– defining the *composition accuracy* metric and verifying the proposed approach based on a set of example process models,
– conducting a survey among business and academic users to assess the applicability of the proposed declarative specification.

The results show that the proposed method of acquiring process data is efficient by being convenient also for users who are less experienced with Business Process Management. In addition, the model construction algorithm generates a prototype diagram that can be further enriched in one of the available editors.

The following results are considered the main contribution of the dissertation:

1. The taxonomy of automated process generation methods.
2. The concept of participatory process modeling.
3. The phases needed to generate BPMN models based on activity descriptions.
4. The concept of an activity graph synthesized based on a generated log.
5. The algorithm to construct a BPMN model, including the formalization of the process model and constraint-based identification of logical structures.
6. The prototype of a software system implementing the proposed approach.
7. The implementation of the Process Composer module, which is used to generate a BPMN model based on a declarative process specification.

3   Published Papers

During the development of this dissertation, several research works have been published in different journals, conferences, and workshops. The research presented in these publications served as a basis to obtain the results presented in the thesis and support its scientific quality. The published research ideas include:

– a comparative overview of process model generation techniques [10],
– the concept of business process modeling based on spreadsheets [11] and the use of spreadsheet as an interoperability standard for process modeling [12],
– the basis of the method to generate a synthetic workflow log based on an unordered list of activities [13,14],
– the concept of process model decomposition into reusable sub-diagrams [15],
– the definition of a method to evaluate generated models based on a synthetic set of workflow traces [16],
– the basic concept of BPMN model construction based on a workflow log [9,17].

References

1. Leopold, H., Mendling, J., Günther, O.: Learning from quality issues of BPMN models from industry. IEEE Software **33**(4) (2016) 26–33
2. van der Aalst, W.M.: Business Process Management: A Comprehensive Survey. ISRN Software Engineering **2013** (2013)
3. Nolte, A., Brown, R., Poppe, E., Anslow, C.: Towards collaborative modelling of business processes on large interactive touch display walls. In: 2015 International Conference on Interactive Tabletops & Surfaces, ACM (2015) 379–384
4. Kammerer, K., Kolb, J., Ronis, S., Reichert, M.: Collaborative process modeling with tablets and touch tables-a controlled experiment. In: 2015 IEEE 9th International Conference on Research Challenges in Information Science (RCIS), IEEE (2015) 31–41
5. Barba Rodriguez, I.: Constraint-based Planning and Scheduling Techniques for the Optimized Management of Business Processes. PhD thesis, Universidad de Sevilla (2011)
6. Heinrich, B., Bewernik, M.A., Henneberger, M., Krammer, A., Lautenbacher, F.: SEMPA–Ein Ansatz des Semantischen Prozessmanagements zur Planung von Prozessmodellen. Wirtschaftsinformatik **50**(6) (2008) 445–460
7. Parody, L., Gómez-López, M.T., Gasca, R.M.: Hybrid business process modeling for the optimization of outcome data. Information and Software Technology **70** (2016) 140 – 154
8. Qin, J., Fahringer, T., Prodan, R.: A novel graph based approach for automatic composition of high quality grid workflows. In: Proceedings of the 18th ACM International Symposium on High Performance Distributed Computing. HPDC '09, ACM (2009) 167–176
9. Wiśniewski, P., Kluza, K., Ligęza, A.: An Approach to Participatory Business Process Modeling: BPMN Model Generation Using Constraint Programming and Graph Composition. Appl. Sci. **8**(9) (2018) 1428
10. Wiśniewski, P., Kluza, K., Jobczyk, K., Stachura-Terlecka, B., Ligęza, A.: Overview of generation methods for business process models. In: International Conference on Knowledge Science, Engineering and Management, Springer (2019) 55–60
11. Kluza, K., Wiśniewski, P.: Spreadsheet-based business process modeling. In: 2016 Federated Conference on Computer Science and Information Systems, IEEE (2016) 1355–1358
12. Wiśniewski, P., Kluza, K., Kucharska, E., Ligęza, A.: Spreadsheets as interoperability solution for business process representation. Appl. Sci. **9**(2) (2019) 345
13. Wiśniewski, P., Kluza, K., Ligęza, A.: Towards automated process modeling based on BPMN diagram composition. In: BPM 2018 Workshop Proceedings, Cham, Springer (2018) 507–513
14. Wiśniewski, P., Kluza, K., Ślażyński, M., Ligęza, A.: Constraint-based composition of business process models. In: Business Process Management Workshops, Cham, Springer (2018) 133–141
15. Wiśniewski, P.: Decomposition of business process models into reusable sub-diagrams. In: ITM Web of Conferences. Volume 15., EDP Sciences (2017) 01002
16. Wiśniewski, P., Kluza, K., Ligęza, A., Suchenia, A.: Generation of synthetic business process traces using Constraint Programming. In: 2018 Federated Conference on Computer Science and Information Systems, IEEE (2018) 445–453
17. Wiśniewski, P., Ligęza, A.: Constraint-based identification of complex gateway structures in business process models. In: International Conference on Artificial Intelligence and Soft Computing, Springer (2018) 788–798