

DyVProMo - A Lightweight Web-Based Tool for the Dynamic Visualization of Additional Information in Business Process Models

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Abstract—Business process models represent detailed information regarding the documentation, optimization, and automation of organizational processes. With an increasing level of detail, such models become rapidly complex, thus hindering their correct comprehension (i.e., both, the efficiency and accuracy of understanding decrease). Furthermore, once a process model is created, the view on it and the respective level of detail remains rigid for all stakeholders. However, a process model may contain information, which is less relevant for certain stakeholders (e.g., domain experts). Consequently, the comprehension of process models becomes more difficult, as all information in a model needs to be read. Existing modeling systems do not offer the functionality to dynamically change the level of detail of a process model according to the stakeholders' preferences. To address this issue, the work at hand presents the Dynamic Visualization of Process Models (DyVProMo), a lightweight web-based tool that enables the dynamic visualization of information in process models expressed in terms of the Business Process Model and Notation 2.0.

Index Terms—Business Process Models, BPMN 2.0, Process Model Viewer, Dynamic Visualization

I. INTRODUCTION

Business process models constitute crucial artifacts for organizations from different domains [1]. These models represent and visualize complex processes, including their activities, data, functions, and resources [2], and establish a common understanding among the involved stakeholders [3]. Furthermore, they provide means for collaboration and offer additional merits concerning process automation and optimization [4].

The Business Process Model and Notation (BPMN) 2.0 is the de facto standard for specifying comprehensible process models [5]. Aside from the basic modeling elements for the representation of processes in visual models, BPMN 2.0 provides additional elements to enrich a process model on a fine-grained level. More specifically, additional information and artifacts (e.g., annotations) may be included in a process model to enhance their level of detail, thus fostering model pragmatics [6]. Especially, novices benefit from additional details through a better process model comprehension [7]. BPMN 2.0 also enables the modeling of the data perspective fostering the implementation of processes in information systems [2]. However, such a comprehensive level of detail is not required for all stakeholders. Especially, large process models are challenging with respect to comprehension [8].

Usually, the display of process model within a tool is rather static [9]. With existing process modeling tools, changes can only be made through remodeling in the modeling tool. Consequently, with current solutions it is neither possible to dynamically hide information from the process model nor to visualize additional information (e.g., on process semantics) afterwards. As a result, the final process model in its given level of detail needs to be comprehended by all stakeholders [10]. In general, a process model should provide an adjustable level of detail, which fosters correct process model comprehension. According to [11], it is challenging to find a user-friendly and easy-to-comprehend model representation. In particular, the ability to comprehend a process model correctly is based on personal factors such as expertise in working with process models [12]. This paper introduces Dynamic Visualization of Process Models (DyVProMo), a lightweight web-based tool enabling the dynamic visualization of model information at run-time. Its process model viewer is able to change the level of detail of a process model according to users' needs. DyVProMo shall foster the comprehension of process models based on specific visualization techniques (e.g., coloring).

Section II discusses related work, whereas Section III introduces the web-based application. Finally, Section IV summarizes the paper and gives an outlook on future work.

II. RELATED WORK

[13] reviews literature dealing with the visualization of process models. No features for dynamically visualizing information in process models are discussed.

Tools, such as *proView*, rely on sophisticated algorithms for changing the view of process models (e.g., aggregating activities or abstracting process models) [14]. The *proView* framework generates personalized views based on pre-defined parameters [15]. However, the generated views are rigid, and changes cannot be made dynamically at run-time.

Proviado [16] applies a configurable XML file to customize the visualization of process models. Style adjustments as well as the assignment of specific symbols in process models can be defined. However, changes of the model visualization require changes of its XML representation.

Concerning model comprehension, [17] shows that the coloring of process models fosters their comprehension. Related to this are the results reported by [18], which presents an approach coloring the activities according to their importance.

Additional text in process models can be useful for novices regarding correct model comprehension [19]. [20], [21] apply annotations to enrich process models with details. However, a high level of detail might hinder process model comprehension for certain stakeholders, as non-relevant information is displayed as well.

Existing tools, such as *Signavio* [22] and *ARIS Express* [23] only allow for a static coloring of pools and lanes in process models.

To the best of our knowledge, there is no tool that allows the process model viewer to change the level of detail dynamically at run-time. None of the discussed approaches support the process model viewer with the dynamic highlighting (i.e., coloring) of swimlanes.

III. SYSTEM OVERVIEW

This section describes the main functions, architecture, and demonstration of DyVProMo.

A. Main Functions

DyVProMo provides the following three main functions to support an end user who is viewing a process model in the comprehension of process models:

- **Highlighting:** Process model viewers may use this function to highlight selected swimlanes or pools in a process model. One may select any number of swimlanes, even nested highlighting is supported.
- **Explanation:** This function is intended to support novices in the correct comprehension of process models. An explanation in the form of an overlay is shown for each model element that appears for the first time in the displayed process model. In the current DyVProMo version, the explanation is limited to the display of element names.
- **Visibility of BPMN Elements:** The visibility of process model details, which are displayed as annotations and data flow components, may be changed dynamically. Hereby, the sequence flow is not affected. In detail, process model information can be shown and hidden dynamically. The BPMN elements are selected and grouped based on their type.

B. Architecture

DyVProMo is implemented as a lightweight web-based software application. In particular, it is platform-independent and accessible to the general public via GitHub. DyVProMo is designed as a *React* single-page application to improve performance and response times between client and server. The basic structure of DyVProMo is created with *create-react-app*¹, which is available as a *Node.js*² package. The latter

is responsible for creating mandatory directories and files. In addition, the configuration of DyVProMo is accomplished automatically by this package. *Create-react-app* utilizes the JavaScript compiler *Babel*³ and module bundler *Webpack*⁴ to create a transpiled and bundled single file that contains the entire web-based tool. DyVProMo is hosted by a Node.js web server. Once the file and, thus, all components are successfully transferred to the client browser, no further requests become necessary for the deployed server. The web-based application runs on the client-side in a web browser. Note that offline support is provided as well. All manipulations are processed and executed on the client-side. Fig. 1 shows the individual components of DyVProMo and their interactions.

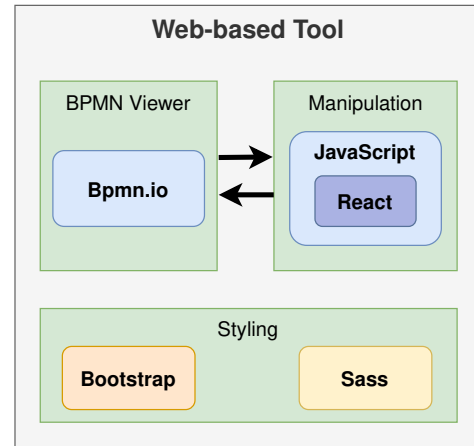


Fig. 1. System Overview

*Bpmn.io*⁵ is a configurable open-source BPMN 2.0 framework, which is responsible for rendering the BPMN 2.0 process models. For example, *Bpmn.io* enables a process model viewer to navigate and zoom inside process models. The manipulation (i.e., switching between element visibility and highlighting of swimlanes) is implemented with JavaScript. The User Interface (UI) components are realized with *React*. These UI components interact via JavaScript with the framework *Bpmn.io*. DyVProMo is mostly styled with the front-end framework *Bootstrap*⁶. Only the UI components of DyVProMo that need custom styling are designed using *Syntactically Awesome Stylesheets*⁷ (Sass).

C. Demonstration

DyVProMo⁸ is divided into two different screens. On the *home screen*, a process model viewer can upload a BPMN 2.0 process model that may contain comprehensive information (e.g., heavy use of annotations and data flows). As a prerequisite, the model must be in a valid XML format. The upload of the process model is realized either with file selection or by

³<https://babeljs.io/>

⁴<https://webpack.js.org/>

⁵<https://bpmn.io/>

⁶<https://getbootstrap.com/>

⁷<https://sass-lang.com/>

⁸Demo video of the web-based application: <https://tinyurl.com/pukhc7w>

¹<https://github.com/facebook/create-react-app>

²<https://nodejs.org/>

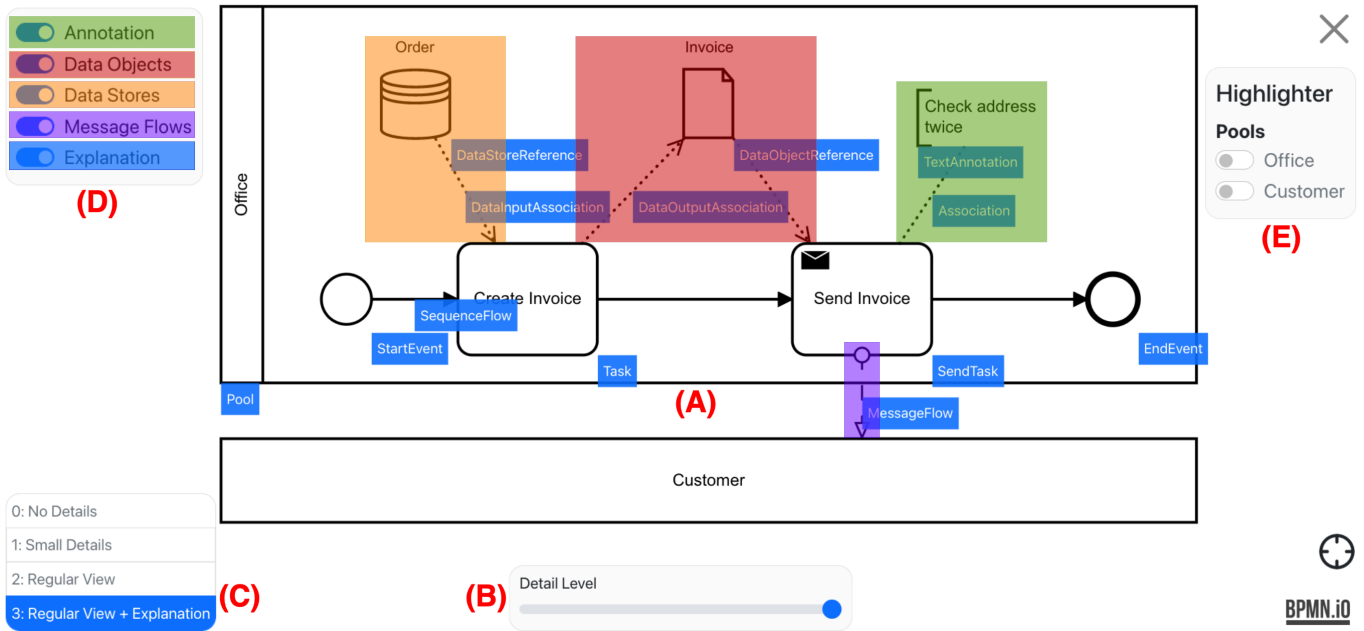


Fig. 2. Main Screen Illustrating a Process Model on the Highest Detail Level

drag and drop. After the file upload, validation and processing, the view of DyVProMo switches automatically to the *main screen*.

The core view of the web-based application is defined as the *main screen*. It is used to show and manipulate the uploaded process model. Different control elements are provided. Fig. 2 illustrates the main screen on the highest detail level. The process model (cf. Fig. 2A) is always displayed in centered mode across the entire screen. The visibility of certain process model elements can be controlled either with the provided detail slider (cf. Fig. 2B) or the more precise toggle switches (cf. Fig. 2D). For the detail slider, certain process model elements are selected and grouped based on their type. The groups are called levels. There are four predefined levels, which may be adjusted individually with the help of the detail slider. Each level change has an effect on the visibility of certain process model elements. The goal of selecting these specific elements and dividing them into four levels is to reduce the total number of elements and, thus, to increase the efficiency of understanding. At the same time, novices should be encouraged to understand the notation and process by adding information. As the UI should be easy to use and not overloaded, this limitation is made. The following list shows which process model elements are displayed in each level together with a corresponding use case.

- **Level 0:** Explanations, Annotations, Data Objects, and Data Stores are hidden. Model viewers experienced with BPMN 2.0 and the underlying process model, who are not interested in the technical view benefit from the removed additional information and data view at this level.
- **Level 1:** Explanations and Annotations are hidden, whereas Data Objects and Data Stores are displayed.

Level 1 is mainly intended to support experienced technical users when implementing the data view.

- **Level 2 (Default):** Explanations are hidden. The process model itself is displayed as modeled.
- **Level 3:** In addition to the process model, explanations referring to the used model elements are displayed. This level fosters novices with little BPMN 2.0 knowledge to understand the notation. It provides memory aids for infrequent elements to experienced users.

The current level is shown in the lower-left corner (cf. Fig. 2C), and can be derived from the position of the detail slider.

The process model viewer is able to change the level of detail with the provided toggle switches, if the predefined levels do not provide the required view. Moreover, DyVProMo supports the creation of custom views. The colored markings of Fig. 2 indicate which model elements can be displayed or hidden with the corresponding switches. Changing the level of detail of the message flow may change the control flow. Therefore, it is not considered in Levels 0-3. However, switching the visibility of message flows represents a useful feature, if there are numerous message flows intersecting activities and other elements.

The highlighting of the swimlanes can be controlled via the component in the upper right corner (cf. Fig. 2E). This control element dynamically lists all pools as well as swimlanes, and enables the process model viewer to highlight any number of swimlanes and the combination thereof with toggle switches. Highlighting enables process model viewers to find their tasks immediately. Thus, this feature is useful for viewers regardless of their role and serves to increase efficiency. In order to keep the user interface as intuitive as possible and at the same time provide potential benefits for as many model viewers as

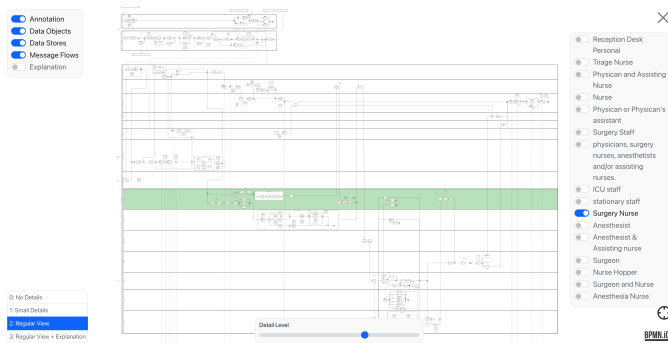


Fig. 3. Main screen in the default level with highlighted lane.

possible, highlighting is limited to swimlanes. Fig. 3 shows a complex process model in the default level with a highlighted swimlane.

In summary, the lightweight web-based characteristic of DyVProMo allows for an easy access through the browser. DyVProMo supports novices in comprehending BPMN 2.0 process models by assisting them with explanations and switchable annotations. Experts working frequently with process models can hide information to focus on relevant aspects of a process model. The optional data view is useful for users being responsible for the technical implementation of a process model in an information system. For complex process models, the highlighting of individual swimlanes is useful, as the appropriate pool or lane can be identified immediately. DyVProMo offers a wide range of visualizations for process model viewers according to their preferences. The effort for process modeling, in turn, is reduced, as different stakeholder views do not have to be explicitly modeled. Currently, changes to the process model are not persistent and, therefore, leave room for trying out and exploring.

IV. SUMMARY AND OUTLOOK

DyVProMo⁹ is a lightweight web-based tool that enables a user to dynamically change the level of detail in BPMN 2.0 process models. This primary function is realized with different components (i.e., detail slider and toggle switches), which show and hide individual BPMN 2.0 elements such as annotations, data stores, and data objects. In addition, it becomes possible to display element explanations with overlays and to highlight individual swimlanes with colors. DyVProMo supports experts and novices in correctly comprehending process models. Novices may view additional details and are supported with further explanations about the used model elements. In turn, experts may reduce or increase the level of detail to focus on relevant information needed for completing the task at hand. The component-based design of DyVProMo enables the easy enrichment of additional features. Finally, DyVProMo is platform-independent and can be used in offline mode as well.

⁹The source code of DyVProMo is provided at GitHub: <https://github.com/elmurd0r/DyVProMo>

In future work, DyVProMo will be extended with additional features to further enhance its usability. Another extension will be a persistent storage. Thus, changes of a process model may be stored and loaded. Moreover, we want to introduce specific settings to define custom levels of detail. In addition, the support of other visual process modeling notation will be the subject of future work. Finally, a first empirical study is planned in order to evaluate the usability and acceptance of the web-based application.

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