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Visualizing and Clustering Workflows in the Fire Fighting Domain

Workflows are used nowadays in different areas of application. Emergency services are one of these areas where explicitly defined workflows help to increase traceability, control, efficiency, and quality of rescue missions. In this thesis, we introduce a generic workflow model for describing fire fighting operations in different scenarios. Based on this model we also describe heuristics for calculating the similarity of workflows which can be used for searching and clustering.

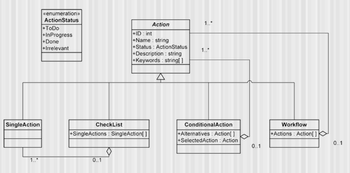
Clustering · Workflows · Fire Fighting · Similarity Measurement

Introduction

Currently, business process models are reliable means for describing business activities along with their temporal and logical relationships contained in workflows of business processes which are required to be executed in order to achieve certain business goals. Explicit definition of workflows helps in increasing traceability, control, efficiency, clarity, and quality. However, task description using process models is not restricted to the business process modeling
area. In contrast, many concrete areas of application adopt the notion of task description using process models. Emergency services is one of these concrete areas as detailed process definitions help in reducing the risk of human errors which consequently helps in saving human lives and to improve effectiveness.

In the area of emergency services, the main goals that the fire fighters have to achieve are saving life, property and the environment. Time is considered an important factor during rescue missions, as saving time consequently leads to saving lives and properties.

In this thesis, we focus on the scenario of a decentralized fire fighting organization. In this organization, hierarchical workflows (i.e. workflows consisting of actions, transitions, and sub-workflows) are used to describe actions to be executed in different kinds of emergency situations. As the circumstances differ from one emergency situation to another, most defined workflows have to take into account the specific characteristics of each concrete emergency scenario. Therefore, individual workflows are a priori defined by many users taking into account the difficulty of generalization. The idea behind a priori definition of workflows is to save the fire fighters' time during rescue missions and to reduce the danger of human errors. The fire fighters' commanders will exert less effort in thinking about which actions have to be executed in which sequence, as they will have access to various workflows that describe multiple rescue scenarios through a tablet personal computer connected to a remote database.



For keeping a large number of workflows manageable, two strategies may be applied:

1. Performing a fuzzy search on all existing workflows
2. Grouping related workflows together using clustering algorithms

By performing a fuzzy search, the user will have the opportunity to check already defined workflows and refer to them while creating a new workflow. By using clustering algorithms, related workflows in terms of containment of similar tasks will be grouped together, workflows that can act as representatives for their groups/clusters will be identified, and a posteriori simplification or standardization can be performed.

As a base for searching and clustering, we introduce a generalized object oriented workflow model. Based on the work of Jung and Bae, we describe several heuristics for calculating the similarity of workflows on the semantic (actions) level as well as on the structural (transitions) level. Furthermore, we develop a new method of combining various similarity measures at a time. This new approach allows us to take advantage of the individual characteristics of arious similarity measures and combine them together in order to produce a new similarity measure that helps in achieving satisfying clustering results.

In order to ensure the suitability of this approach and the fairness of evaluation, we cluster automatically generated sets of workflows using various already existing clustering algorithms (k-Means, DBSCAN, and Expectation Maximization) and compare the clustering results.

Furthermore, we developed two graphical user interfaces for:

1. Creating and editing workflows
2. Viewing and processing already defined workflows

The editor allows the fire fighter commander to define his imagination/visualization of various workflows that have to be carried out in multiple rescue missions. It also allows the fire fighters' commander to edit a previously defined workflow either by adding new actions, removing actions or modifying already existing actions. The viewer allows the fire fighters' commander to view the predefined workflows and change the status of each action during the emergency situation. It also allows the fire fighter to enrich the workflow with more information by annotating actions using symbols, images, or comments.