EXEMPLAR: An Experimental Information Repository for Software Engineering Research

Jose Antonio Parejo, Sergio Segura, Pablo Fernandez, and Antonio Ruiz Cortés

University of Sevilla, Spain
ETSII. Avda. de la Reina Mercedes s/n, 41012, Sevilla.
`japarejo@us.es`

Abstract. The number and variety of experiments carried in software engineering research is growing, leading to a increasing need of replication and review. In order to support such needs the information about experiments should be provided as lab-packs comprising of: a description of the experiment, the materials used and data generated during the conduction, and the results of the analyzes performed on such data. However, this information is often scattered, poorly structured, and even unavailable, implying a tedious process of search and gathering. EXEMPLAR is an online platform for managing experimental information, that allows the uploading and publication of experimental lab packs, and an efficient search. The platform also supports the use of formal languages for providing experimental descriptions (e.g. SEDL). In so doing, EXEMPLAR enables the automated analysis of lab-packs, in order to detect common validity threats and missing information which could hinder replicability.

Keywords: empirical research, experiments, experimental replicability, experimental repositories

1 Introduction

In science, the quality of an experiment is determined primarily by two factors: its degree of validity and its replicability. According to [1], "*The use of precise, repeatable experiments is the hallmark of a mature scientific or engineering discipline*".

EXEMPLAR (EXpErimets Management PLAtfoRm) is an online repository of experimental information that aims at supporting the creation of high quality experiments. EXEMPLAR focuses on easing the publication of lab-packs, supporting efficient search, and assuring the quality of experimental information through the automated detection of common validity threats and missing information (based on the analysis of experimental descriptions when provided in formal languages such as SEDL [2] and on the analysis of lab-packs contents). In the next section the main features of EXEMPLAR are described. The repository is available for public access at http://exemplar.us.es.

2 EXEMPLAR features

2.1 Experimental information repository

EXEMPLAR is essentially an online repository of experimental information that provides: i) support for uploading and controlling the availability of experimental information, through the creation of workspaces that can contain several labpacks; and ii) support for searching experiments based on keywords, several classification taxonomies, and on the indexation of the contents of the labpacks. Those features are described in detail below.

Information Organization: Workspaces, labpacks and access control. In EXEMPLAR, each registered user has its own personal space with a maximum quota (currently limited to 1Gb). In such personal space, users can create an unlimited number of workspaces, for which they can control access. Currently workspaces are either public (meaning availability to anyone in read-only mode) or private, but authors plan to implement workspace sharing among users in read-write mode as future work. Each workspace contains an unlimited number of lab-packs. Each lab-pack contains the information of a single experiment, structured as an unlimited number of files and nested folders. The workspaces and labpacks management interface of EXEMPLAR is shown in figure 1 (left side).
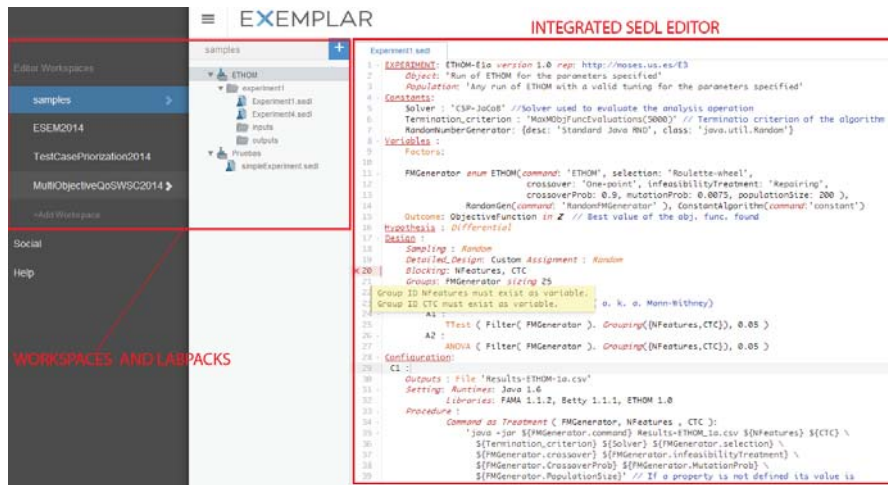

Fig. 1. EXEMPLAR interface for workspace and lab-packs management

Search and Indexation. EXEMPLAR supports two different search mechanisms. On the one hand, users can search labpacks based on their tags or classification according to standard taxonomies (for software engineering experiments we support the SWEBOK taxonomy of areas [1]). On the other hand,

users can perform full text searches on the indexed contents of the labpacks. Figure 2 shows the search page of EXEMPLAR.

Fig. 2. Experimental information search in EXEMPLAR

2.2 Support for experimental description and lab-packs layout

Apart from its capabilities as information repository, EXEMPLAR supports the creation formal descriptions of experiments based on SEDL [2], and it provides a default lab-pack directory layout for inducing a tidy structure on lab-packs contents.

Formal experimental descriptions with SEDL. Formal description of experimental information in EXEMPLAR is supported through an integrated SEDL editor. SEDL (Scientific Experiment Description Language) is a generic language to describe experiments in a precise, unambiguous and tool-independent way. SEDL documents include the information that any experimental description should provide regardless of the application domain: objects, subjects, population, variables, hypothesis, treatments and analysis to be performed. A detailed description of the syntax of SEDL along with several examples are provided in [2]. Figure 1 shows that integrated editor support **syntax coloring**, **sections code folding**, **auto-save** and **error highlighting as you type**.

Layout of experimental information (according to SEA). Experimental reproducibility requires not only providing a comprehensive and detailed description, but also providing all the input and output data of the experiment,and any experimental artifact used for its conduction, such as survey forms, data gathering spreadsheets, etc. The role of those elements in the experiment should have an impact on their location on the lab-pack, in order to ease its use. Thus, a generic default layout for the elements of lab-packs named SEA (Scientific Experiments direcory lAyout) is described in detail in [2, appendix E]. EXEMPLAR supports the creation of SEA-compliant lab-packs, providing advices on where the uploaded files should be located depending on the specific extension and role for such workspaces (identified by asking users).

2.3 Automated analysis of experimental information

The killer feature of EXEMPLAR is its support for the automated analysis of experimental information. This feature enables the detection of: i) common validity threats in the experiments, and ii) inconsistencies between SEDL experimental descriptions and the actual contents of the lab-pack.

Automated detection of common validity threats. Currently, EXEMPLAR supports three operations that can detect common validity threats identified in the literature:

Multiple Comparison: This operations checks if a single comparison statistical test is being used to perform multiple comparisons, leading to a statistical analysis validity threat [3].

Small sampling: This operation checks if the sample size of the experiment is sufficient for a safe application of the statistical tests specified for the analysis in its SEDL description, leading to a statistical analysis validity threat [3]. Currently, this operation checks a minimum sample size of 30 observations in null hypothesis statistical tests are applied.

Inconsistent Variable Measurement: This operation checks if the values of the experimental variables contained in the inputs and output datasets provided, are consistent with the corresponding domains specified in the SEDL description. Depending on the type of data inconsistency (missing value, value out of variable domain), and dataset role (input or output), this inconsistency can be symptomatic of a specific validity threat [2]. Authors plan to implement the whole catalog of analysis operations described in [2] as future work.

Automated detection of missing experimental information in lab-packs. EXEMPLAR supports the checking of the consistencies between inputs, and outputs specified in SEDL experimental descriptions and the actual contents of the corresponding lab-pack. In this sense the repository can remind users to upload forgotten files, or find errors in the inputoutput files specification of SEDL descriptions.

Acknowledgments

References

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