Ontological Representation of Design Science Research Publications

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This article describes the design of a formal ontology conceptualising publications that follow the design science research paradigm (DSR publications). This ontology serves as an extension to available standards for bibliographic descriptions in digital libraries, such as Marc21, MarcOnt, Dublin Core, etc., to describe semantics about the content of DSR publications. It should enable automatic reasoning with DSR publications. Ideally, an instantiation of this ontology should result in a machine readable summary that fulfils four Cs: comprehensive, concise, coherent, and correct. This formal ontology conceptualises the core aspects of DSR and DSR publications and is named a DSR Document Core Ontology, or DSRDCO. Because of the limited space Figure 1 depicts only the most

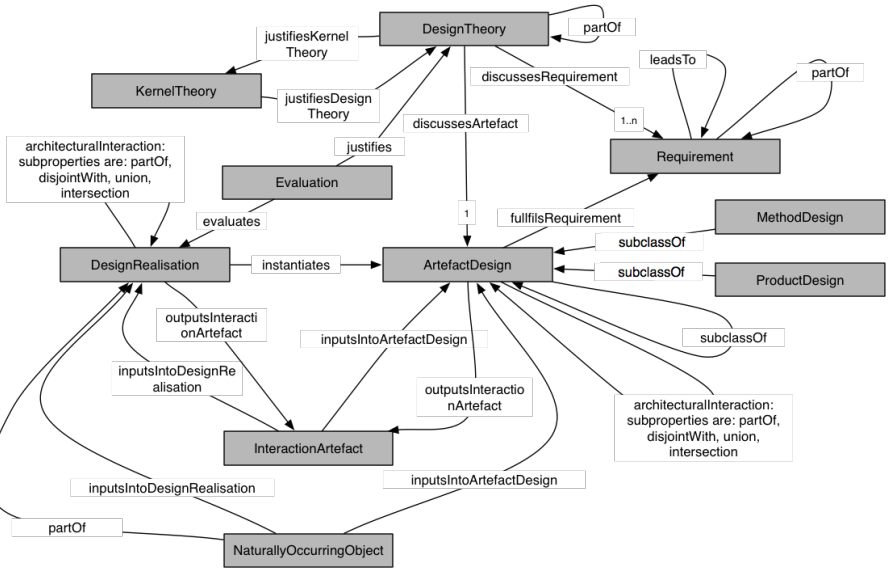

Fig. 1. Core Concepts of DSR

important core DSR concepts of the DSRDCO but the argumentation aspect in

DSR articles is only briefly outlined below. As ontology language OWL DL has been chosen for being able to use description logic to describe DSR publications. The proposed ontology has to reach a shared understanding. The concepts this ontology is comprised of are used by many proponents of DSR and will be further evaluated in an expert evaluation. Currently, a paper and pencil demonstration feasibility has been done to verify this ontology.

The DSRDCO describes a *design theory* that consists of one *artefact design* that fulfils a certain set of *requirements*. Optionally, depending on the project, *kernel theories* may be described that justify the *design theory* or are justified by the *design theory*. A *design theory* can be justified by evaluating a specific *design realisation* to see whether the *requirements* can be reached. A *design realisation* must also instantiate any components or other assertions that have been made concerning its corresponding *artefact design*. Interactions between *artefact designs* and *design realisations* are either of functional or architectural nature. The functional nature can be expressed by *interaction artefacts* that trigger a specific functionality.

A key component of a DSR article (or any scientific article) is its argumentation. Two main things have to be argued about: *artefact design* and its *requirements*. The thesis or *main claim* of a DSR paper is that the focal artefact design fulfils some requirements. The thesis and its sub-claims should be justified or supported by further claims. The main claim is supported by expressing its *theoretical significance claim*, its *practical significance claim*, and by providing evidence that the artefact design (when instantiated) fulfils the requirements through an *evaluation* argument and possibly a *basis approach*, in which the *artefact design* is based on an earlier *artefact design*. Each support is itself a claim, which can be supported (or argued against).

The ontology has been instantiated manually and its feasibility has been demonstrated using 3 DSR articles and by utilising natural language summaries as gold standard. These summaries have been further filled in into a number of cloze sentences and the cloze sentences have been mapped onto the designed ontology. An examples of such a cloze sentence looks as follows:

```
The requirement/s the artefact design named
____ (NP for <ArtefactDesign>) is designed to fulfil is/are to
____ (VP enumeration for <Requirement> (CARD >= 1))
```

A filled in example text out of one summary would be:

```
The requirements the artefact design named "Annota" is designed to fulfil
 are to "annotate and organise scientific publications on the Web", and
to "share publications with colleagues".
```

Further this example can be represented by the following ontological relations:

```
<DesignTheory> <discussesArtefactDesign> <ArtefactDesign>
<ArtefactDesign> <fulfils> <Requirement>
<DesignTheory> <discussesRequirement> <Requirement>
```

The previous steps have been repeated with all cloze sentences of the natural language summary and the resulting assertions have been transferred into an OWL ontology to see if the resulting instantiations can be represented in OWL.