Indice

Capitolo 1

Problem Settings

In this chapter we present firstly the question that leads our research and the motivations which sustain it. Next we extend in Section x the requirements posed by the research question and the issues it involves. In the end we provide the technical formalization of those requirements and why our work must cover them, which issue they solves and which limitation we have to face to.

1.1 Overview

Stream Reasoning research filed wonders to achieve a tight integration of known reasoning systems and DSMS. An RDF Stream Processing Engine, shortly RSP Engine, is the abstraction that realizes this integration and can exploit reasoning techniques upon rapid changing information [?, ?, ?]. Consequently it is able to manage rapidly changing worlds at the semantic level and answer typical Semantic Web complex queries. The Stream Reasoning community is working on the standardization of a protocol to talk with RSP Engines, which actually can be implemented applying a number of RSP techniques. Their number is increasing together with the need of shared practices and tools to perform analyses and evaluations. As stated in Chapter 2, benchmarking RSP Engines is possible thanks to the proposed RDF streams, continuous queries, and performance measurements. The critics on these works have showed their limits and further developments partially went beyond [?]. However we noted that the community still lacks the formalization of a comparative approach for the research on RSP Engines and not least an infrastructure that allows the its rigorous application.

In this thesis we propose $\mathcal{H}$eaven, a framework that tries to solve the Stream Reasoning need of a Systematic Comparative Approach on RSP Engine evaluation.

1.2   Why Comparative?

The comparative research approach is typical of the Social Science, where the complexity of the subject go beyond the possible observable models. RSPEngine are complex system too, as can be seenin Chapter 6, is difficult to analyse them even in case of simple, well defined architectures. This emphasises the importance to be able to conduct comparative research based on controlled experimental conditions and, thus, the need for a open source16 framework like Heaven.

1.3   Requirements

We developed $\mathcal{H}$eaven in order to simplify and support Systematic Comparative Research Approach on RSP engines. To this extent we need to answer the following questions:

Q.1 How can the behaviour of system be evaluated?

Q.2 What makes this evaluation rigorous?

Q.3 How can this rigorous evaluation be automated?

A proper answer to Question Q.1 can be stated exploiting the traditional definition of *experiment*: a test under controlled conditions that is made to demonstrate a known truth or examine the validity of an hypothesis. Going deeply, we answer Q.2 bringing about the notions of *reproducibility*, *repeatability*, and *comparability* of experiments. The concepts we identified make easy to answer Q.3 formalising the technical requirements for $\mathcal{H}$eaven.

Reproducibility is related to the variation in measurements made on a subject under changing conditions. The concept of experiment gather this conditions. $\mathcal{H}$eaven must allow its users to define it in details:

R.1 it must be *test data independent*, thus allowing users to chose relevant RDF data streams and ontologies from their domain of interest.

R.2 it must be *query independent*, thus allowing users to register relevant queries from their domains of interest.

R.3 it must be *engine independent*, thus allowing users to put an RSP engine on the test stand by the means of easy to implement software interfaces, e.g., it should adopt an event-base architecture as normally done by RSP engines and present events to RSP engine in a simple to parse RDF serialisation.

R.4 it must include a *basic set of performance measurements* [?] including **Latency** – defined as the delay between the injection of an event in the RSP engine and its response to it –, **Memory Usage** – defined as the difference

between total system memory and free memory –, and **Completeness &
Soundness** of query-answering results.

R.5 it should enable users to extend the test stand adding their own software
sensors in order to other performance measurements

In terms of software engineering the list of requirements above demands an
Extendable Design [R6], i.e., the possibility to replace theoretically each module
with one with the same interfaces, but different behaviour, without affecting
architecture stability.

Repeatability of measurements regards the variation in repeat measurements
made on the same subject under identical conditions. $\mathcal{H}$eaven must not affect
the RSP engine evaluation to grant it. This from a practical point of view poses
two requirements to the test stand:

R.7 it must not be running when the RSP engine is under execution.

R.8 it must have reduced (and possibly constant) memory footprint.

The comparative research is case-oriented. It allows the systematic analysis
of complex cases, exploiting comparable metrics. The complex cases are seen
as configurations, a combination of known properties, upon which is possible
to identify parallelism or state contrasts. A Systematic Comparative Research
Approach (SCRA) requires both the definition of *Metrics that allow comparison*
and the standardization of *Evaluation conditions*. $\mathcal{H}$eaven must support the
collection of the performance measurements as custom metrics [R.9]; again the
concept of experiment is required as a formalization for the execution setting.
The next step consists in providing *Tools for qualitative analysis*, which allow
visualisation of the results [R.10].

Last but not least, to simplify SCRA is important to identify *Initial terms
of comparison*, a.k.a. baselines, which must be simple while maintaining an ex-
perimental validity. $\mathcal{H}$eaven contains specific modules to fulfil this requests. We
exploit them to support the consequent need of *Examples of successful analysis
and evaluations*, which can be seen as guidelines. Chapter 7 of this thesis present
a set of experimental evaluations which show deeply the potential of $\mathcal{H}$eaven .