



## Evolutionary Discovery of OWL SubClassOf Axioms

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### ► To cite this version:

Rémi Felin, Catherine Faron, Andrea G B Tettamanzi. Evolutionary Discovery of OWL SubClassOf Axioms. 3IA Annual Scientific Meeting, Nov 2022, Sophia-antipolis, France. 2022. hal-04411795

HAL Id: hal-04411795

<https://inria.hal.science/hal-04411795>

Submitted on 23 Jan 2024

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# Evolutionary discovery of OWL SubClassOf axioms

Research axis of the 3IA: Fundamental AI



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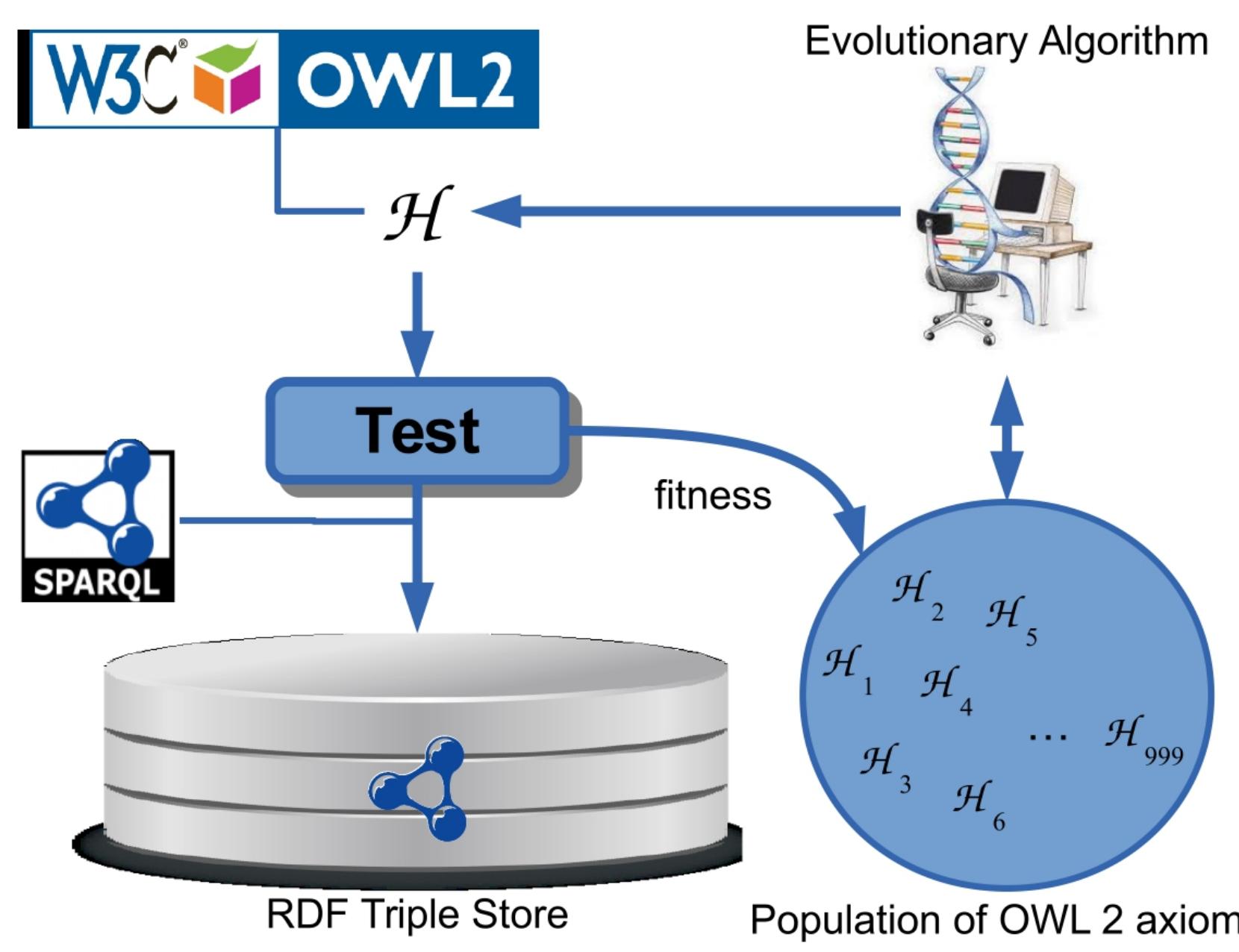


## Abstract

We consider a probabilistic framework and an evolutionary approach for ontology enrichment with OWL axioms. This poster presents 1) an extension of OWL SubClassOf axioms mining, where candidate axioms are composed of complex class and 2) an optimization of the OWL SubClassOf axioms assessment heuristic. The results highlight 1) promising first results on the complex SubClassOf axioms mining and 2) that our proposal significantly outperforms the original algorithm, enabling a significant reduction in computation time (CPU). The source code of the project is available here [1]

### Overall approach [3][2]

Approach based on Grammatical Evolution [2]



Approach based on the Possibility Theory [3]  
For an axiom  $\phi = C \sqsubseteq D$  and  $v_\phi$  the cardinality of  $\phi$ ,

- Number of confirmations  $v_\phi^+$ :

```
SELECT (COUNT(DISTINCT ?x) AS ?n) WHERE {
?x a <C>, <D> .
}
```

- Number of exceptions  $v_\phi^-$ :

```
SELECT (COUNT(DISTINCT ?x) AS ?n) WHERE {
?x a <C>, ?t .
FILTER NOT EXISTS { ?y a ?t, <D> . }
}
```

- Possibility and necessity degrees:

$$\Pi(\phi) = 1 - \sqrt{1 - \left( \frac{v_\phi^+ - v_\phi^-}{v_\phi} \right)^2},$$

$$N(\phi) = \begin{cases} \sqrt{1 - \left( \frac{v_\phi^+ - v_\phi^-}{v_\phi} \right)^2}, & \text{if } \Pi(\phi) = 1, \\ 0, & \text{otherwise.} \end{cases}$$

- Acceptance/Rejection Index:

$$ARI(\phi) = N(\phi) + \Pi(\phi) - 1 \in [-1, 1].$$

### 1. Mining axioms involving complex class expressions [4]

BNF Grammar structure to generate well-formed candidate SubClassOf axioms involving complex class expressions through an evolutionary approach. We consider **3 class expressions** to build these candidates: ObjectSomeValuesFrom; ObjectAllValuesFrom and ObjectIntersectionOf.

- A large set of candidate axioms with  $\Pi(\phi) > 0$
- Need to optimise the assessment process.

| Number of individuals | Number of axioms      |                   |
|-----------------------|-----------------------|-------------------|
|                       | with training dataset | with full dataset |
| 100                   | 476                   | 358               |
| 200                   | 525                   | 525               |
| 500                   | 1911                  | 1888              |

### 2. Optimizing SubClassOf Axioms assessment [5]

A) a multi-threading system to parallelize axiom assessment.

B) a heuristic to avoid redundant computation.

C) an optimization for SPARQL query chunking.

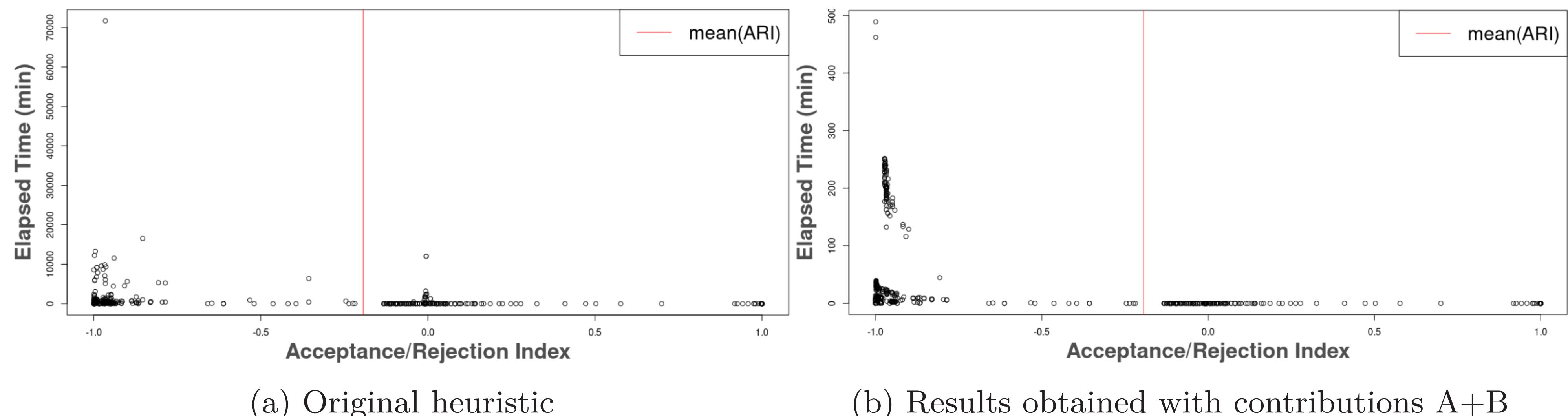


Figure 1: Comparison of computation time (CPU) (axis are logarithmic).

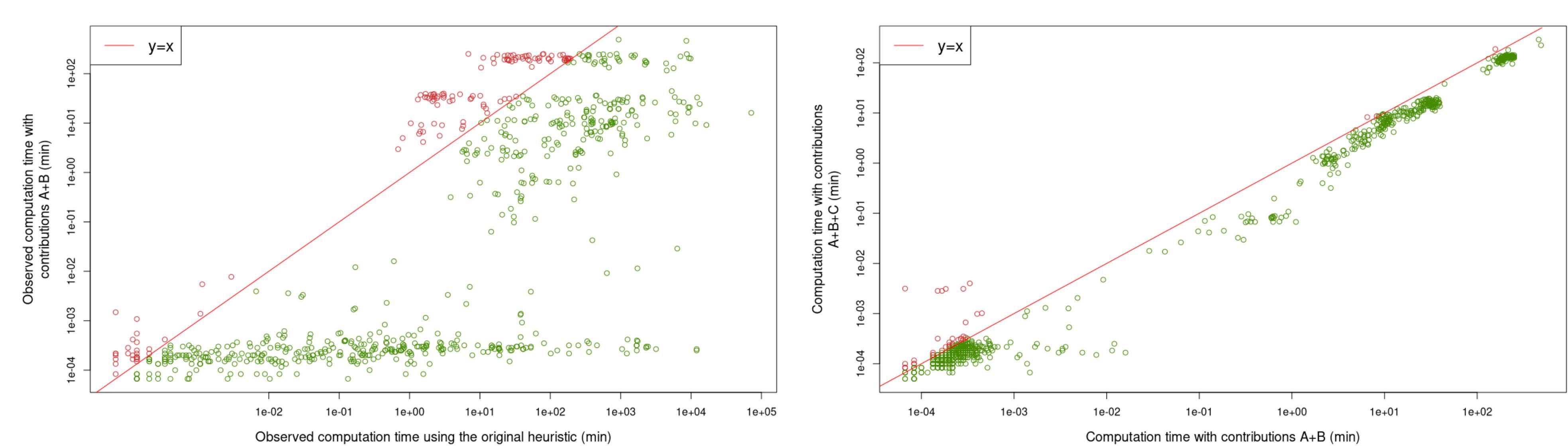


Figure 2: Comparison of computation time (CPU) (axis are logarithmic).

## References

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- [4] Rémi Felin and Andrea G. B. Tettamanzi. Using grammar-based genetic programming for mining subsumption axioms involving complex class expressions. Melbourne, Australia, December 2021. IEEE/WIC/ACM International Conference on Web Intelligence.
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