

Evolutionary discovery of OWL SubClassOf axioms

Research axis of the 3IA: Fundamental AI

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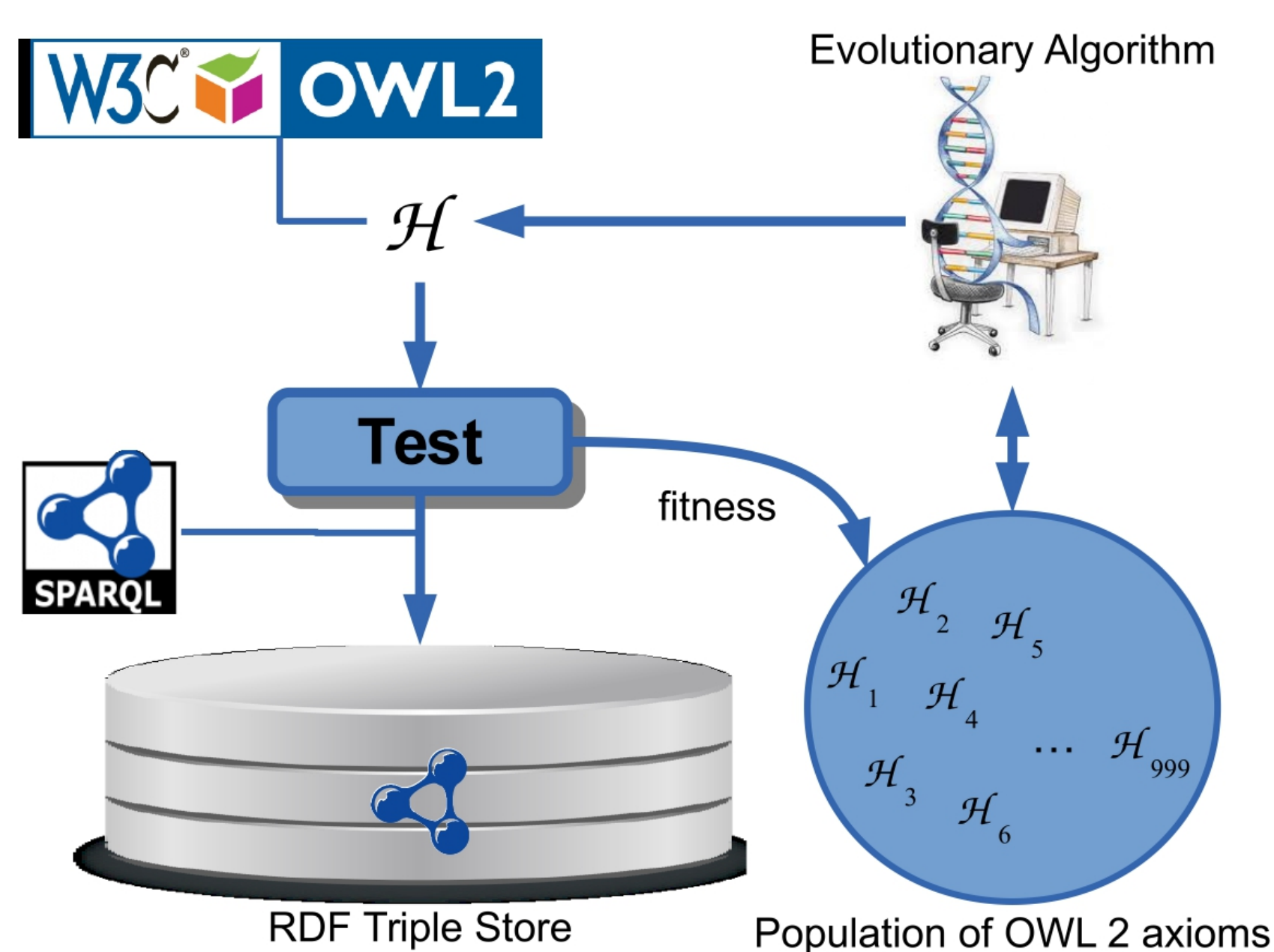


Abstract

We consider a possibilistic 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_ϕ the cardinality of ϕ ,

- Number of confirmations v_ϕ^+ :

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

- Number of exceptions v_ϕ^- :

```
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]

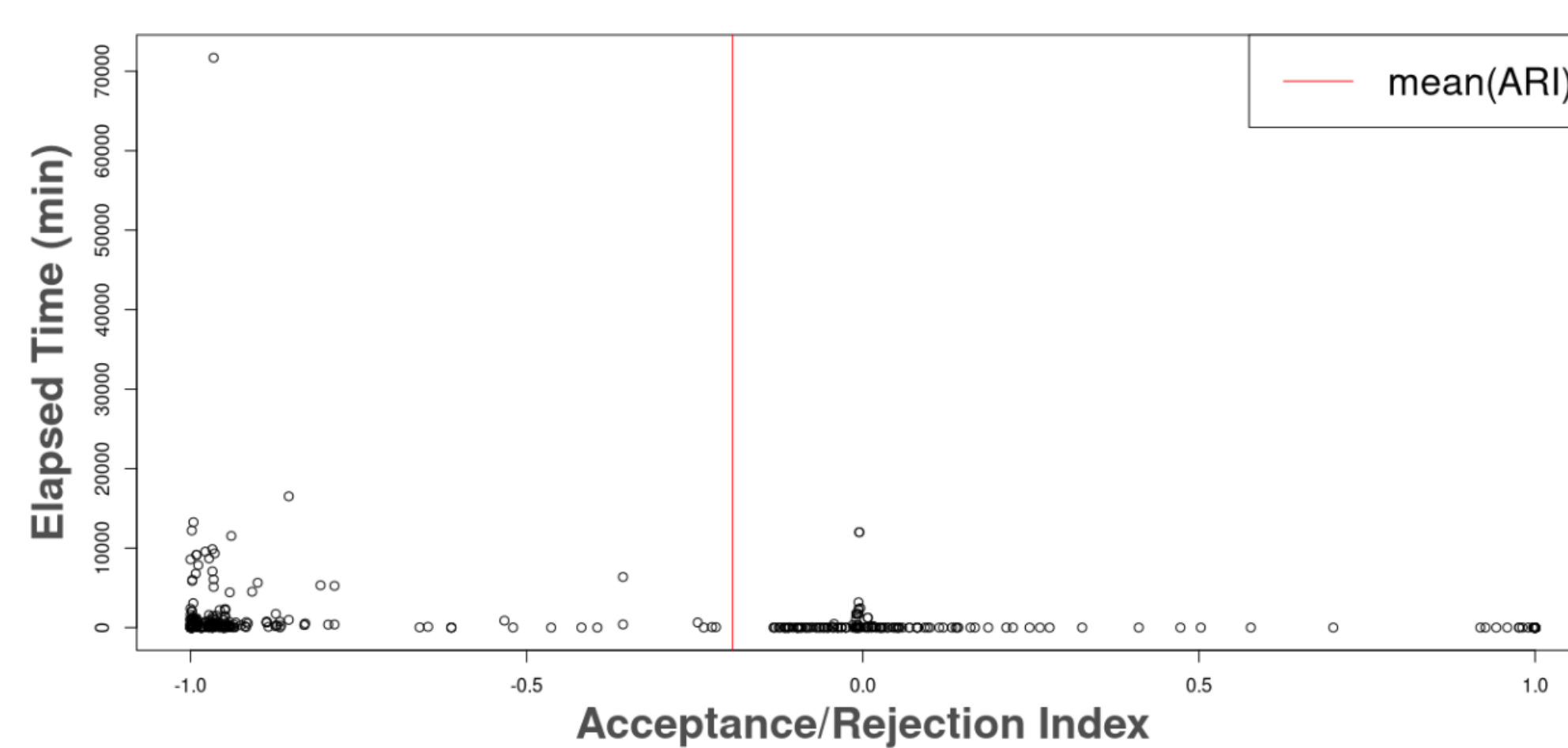
BNF Grammar structure to generate well-formed candidate SubClassOf axioms involving complex class expressions through an evolutionary approach. We consider **3 class expressions** to build these candidates: ObjectSomeValuesFrom; ObjectAllValuesFrom and ObjectIntersectionOf.

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

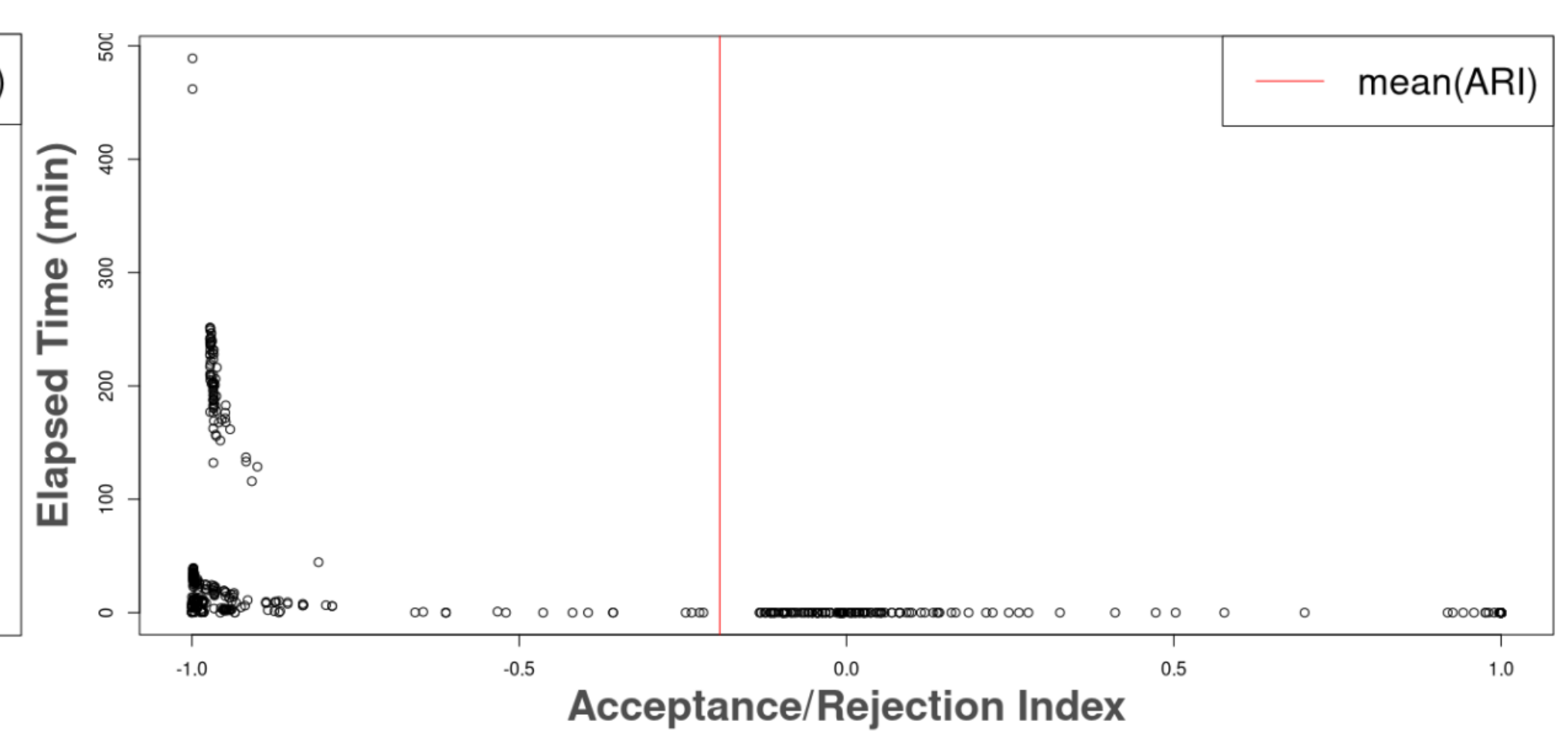
Number of individuals	Number of axioms	
	with training dataset	with full dataset
100	476	358
200	525	525
500	1911	1888

2. Optimizing SubClassOf Axioms assessment [5]

- a multi-threading system to parallelize axiom assessment.
- a heuristic to avoid redundant computation.
- an optimization for SPARQL query chunking.

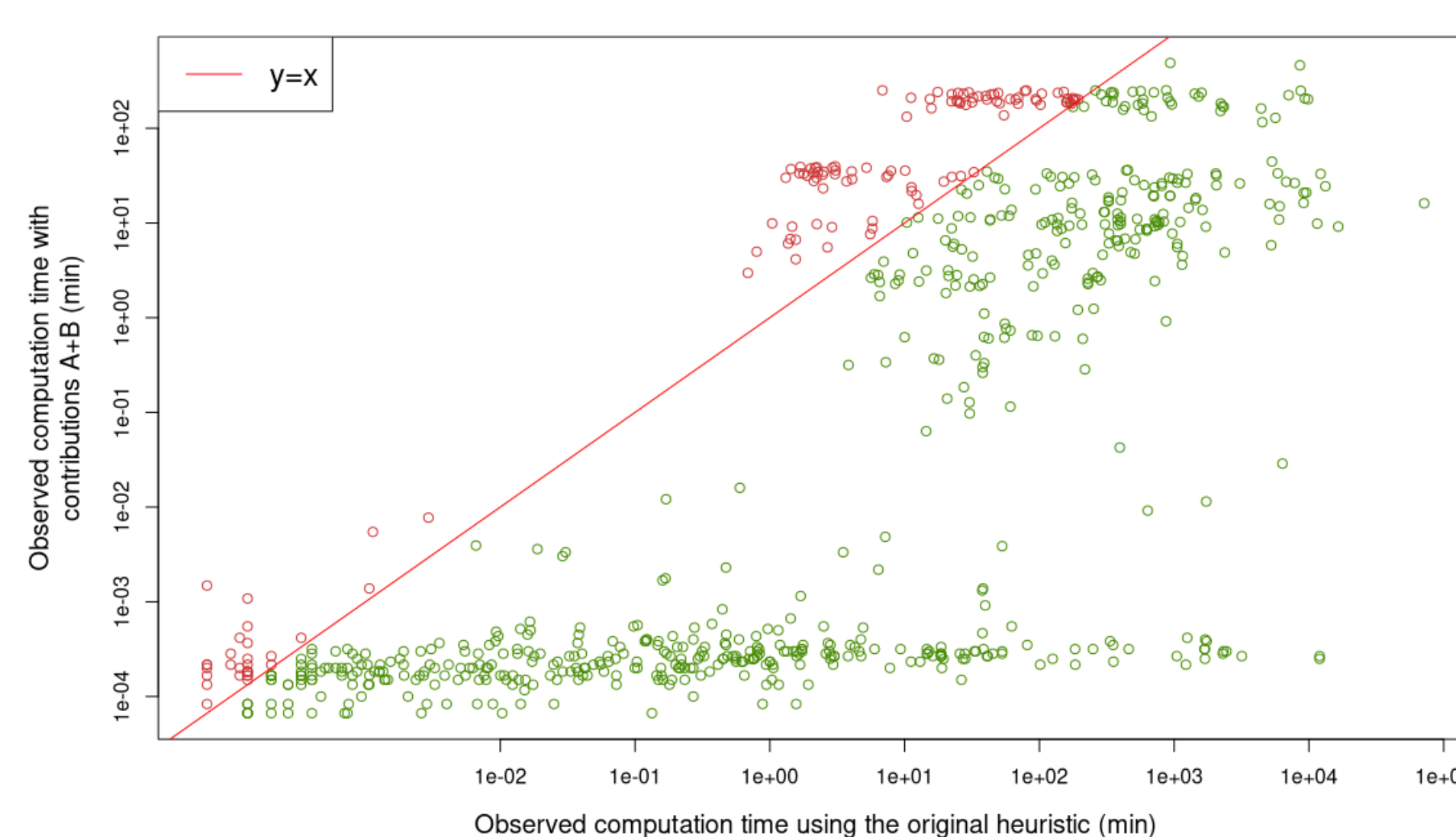


(a) Original heuristic

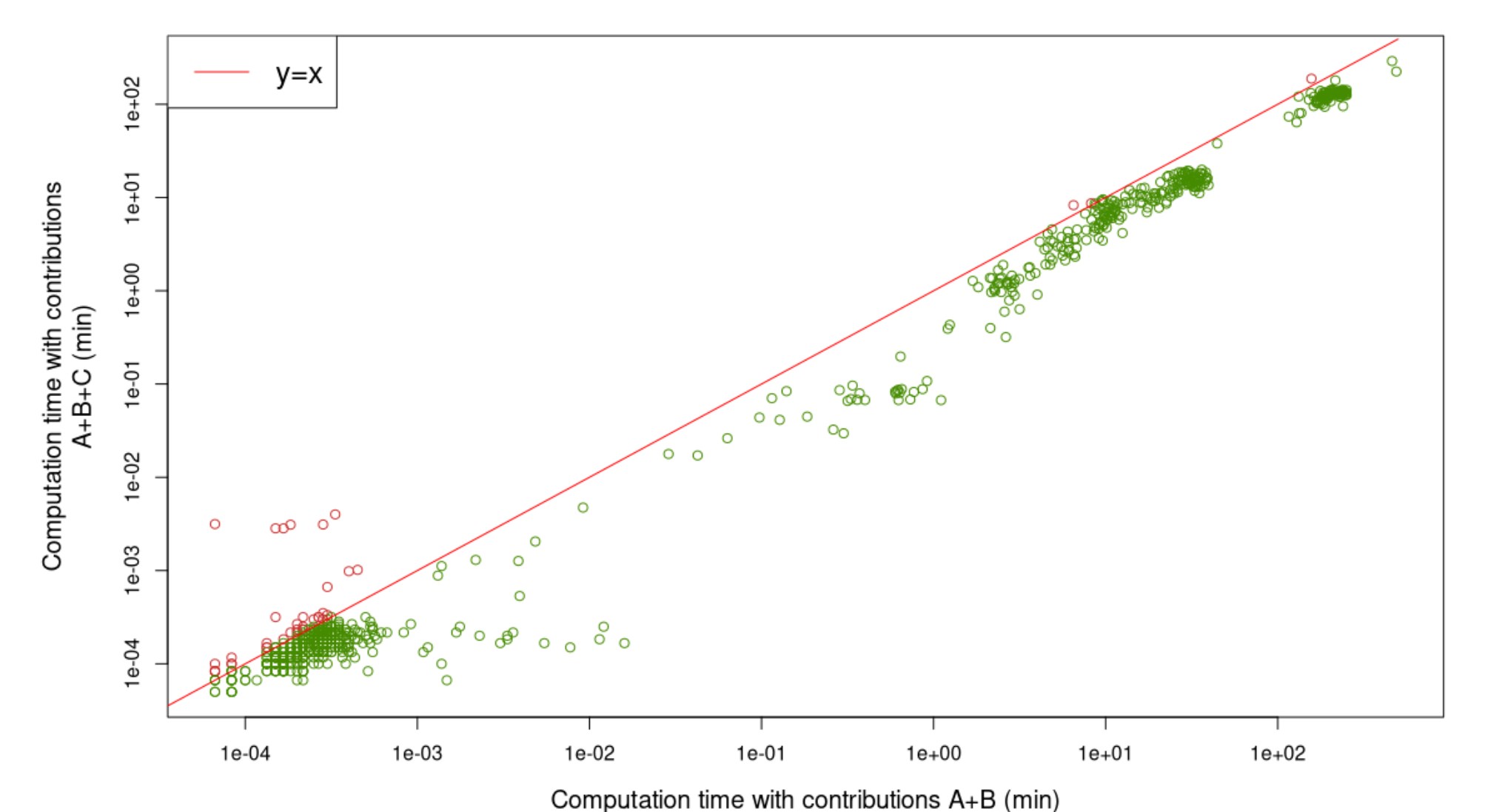


(b) Results obtained with contributions A+B

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



(a) Contrib. A+B against the original heuristic



(b) Contrib. A+B+C against Contrib. A+B

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

References

- [1] Andrea G. B. Tettamanzi, Thu Huong Nguyen, and Rémi Felin. Rdfmining project. <https://github.com/RemiFELIN/RDFMining>.
- [2] Thu Huong Nguyen and Andrea G. B. Tettamanzi. Grammatical Evolution to Mine OWL Disjointness Axioms Involving Complex Concept Expressions. In *CEC 2020 - IEEE Congress on Evolutionary Computation*, pages 1–8, Glasgow, United Kingdom, July 2020. IEEE.
- [3] Andrea G. B. Tettamanzi, Catherine Faron-Zucker, and Fabien Gandon. Testing owl axioms against rdf facts: A possibilistic approach. In *EKAW*, volume 8876 of *Lecture Notes in Computer Science*, pages 519–530. Springer, 2014.
- [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.
- [5] Rémi Felin, Olivier Corby, Catherine Faron, and Andrea G. B. Tettamanzi. Optimizing the computation of a possibilistic heuristic to test owl subclassof axioms against rdf data. Niagara Falls, Canada, November 2022. IEEE/WIC/ACM International Conference on Web Intelligence.