Towards Meta-reasoning for Ontologies: A Roadmap

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Ontologies

- Describes abstract concepts & complex relationships
- Widely used in many domains & applications: data integration in biomedical research
- Ontology languages (OWL DL, OWL 2 DL, etc.)
  - Based on expressive ***Description Logics***: precise syntax & semantics

Ontology reasoning

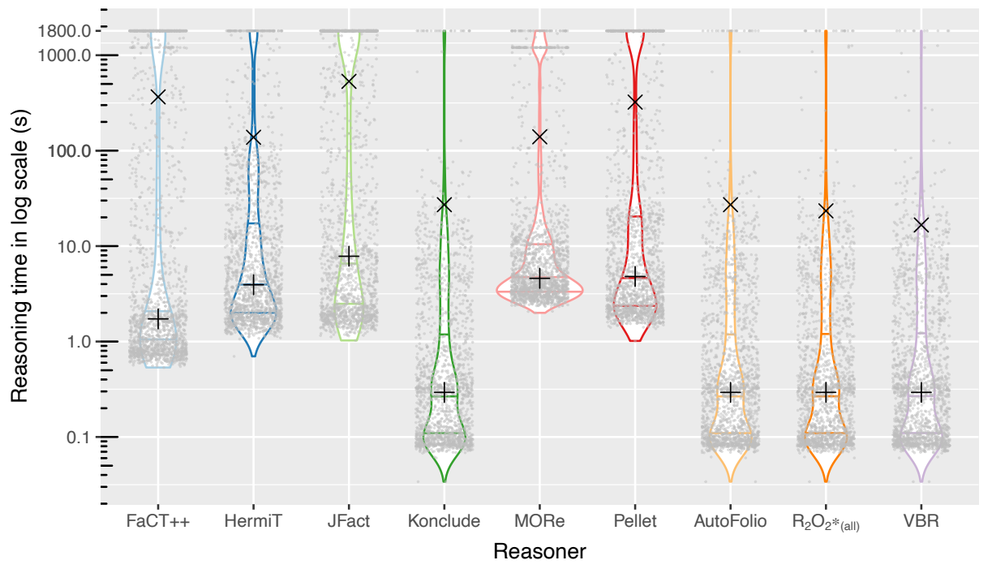
- Ensures logical consistency of ontologies & infers implicit facts
- Many reasoning algorithms & reasoners developed over years
  - (Hyper)tableaux, resolution, etc.
- Theoretically **complex**: NExpTime-complete for OWL DL & 2NExpTime-complete for OWL 2 DL

Reasoning is *hard*

- Empirically **hard**: non-trivial to identify the most efficient reasoner for an ontology
- On the other hand: a group of reasoners is robust: highly likely one reasoner performs well for any given ontology

$R_2O_2^*$: performance evaluation

- 1,760 ontologies, 6 SOTA reasoners & AutoFolio (SOTA algorithm selection model)
- $R_2O_2^*$ achieves best corpus-average



$R_2O_2^*$: a meta-reasoning framework

- **Predicts** the most efficient from a *portfolio* of state-of-the-art reasoners
- Through **learning**: (1) a regression model of reasoning time for each reasoner & (2) rankers to rank by predicted efficiency
- From a large **corpus** of ontologies: (1) ontology hardness descriptions (syntactic & structural metrics) & (2) collected running time of reasoner executions

Future directions

- **Representation learning** of ontology constructs
- **Reasoner** characteristics
  - Not just ontology characteristics
- Inefficiency **repair**
  - Identify & fix performance hotspots
- **ABox** reasoning support
- **Benchmark** ontology generation