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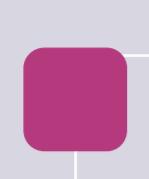
LiRoT: A lightweight incremental reasoner for the Web of Things

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CoSWoT

- Platform for the WoT
- Use Semantic Web technologies (ontologies, reasoning)
- Constrained and heterogeneous devices
- Decentralized architecture
- Applications in smart building and agriculture

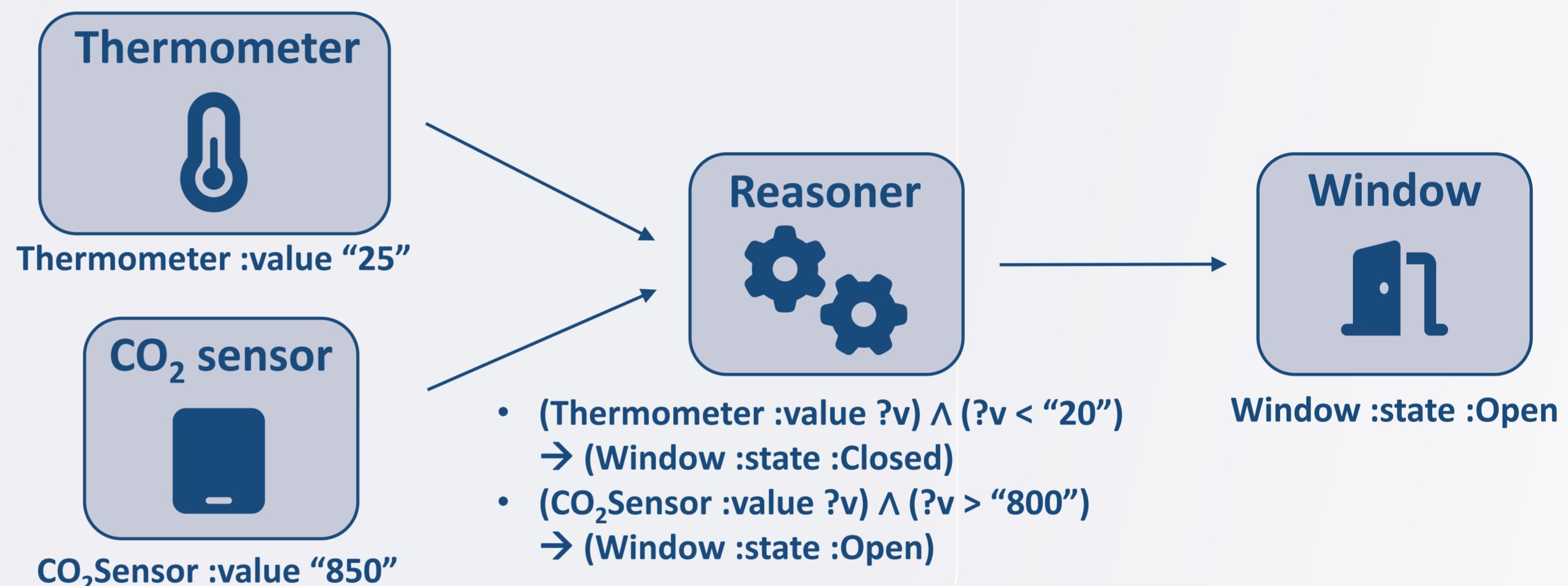


Rule-based reasoning

- RDF data is stored in triples (e.g. coswot:Room1Thermometer1 rdf:type sosa:Sensor)
- Generic rules (multiple conditions with variables) are applied to explicit triples to derive new information (implicit triples). Example of a rule:

$$(\exists v \text{ owl:someValuesFrom } w) \wedge (\exists v \text{ owl:onProperty } p) \wedge (\exists u \text{ } p \text{ } x) \rightarrow (\exists u \text{ rdf:type } v)$$

Running example



Challenges and hypotheses

- Traditional reasoners are built for desktop computers or servers
- Targeted platforms are more constrained (desktop computer: \approx 10GB RAM vs. ESP32: 320KB SRAM)

→ Reduce reasoning memory footprint

- Small datasets (\approx 1000 explicit facts)
Dynamic data → incremental reasoning



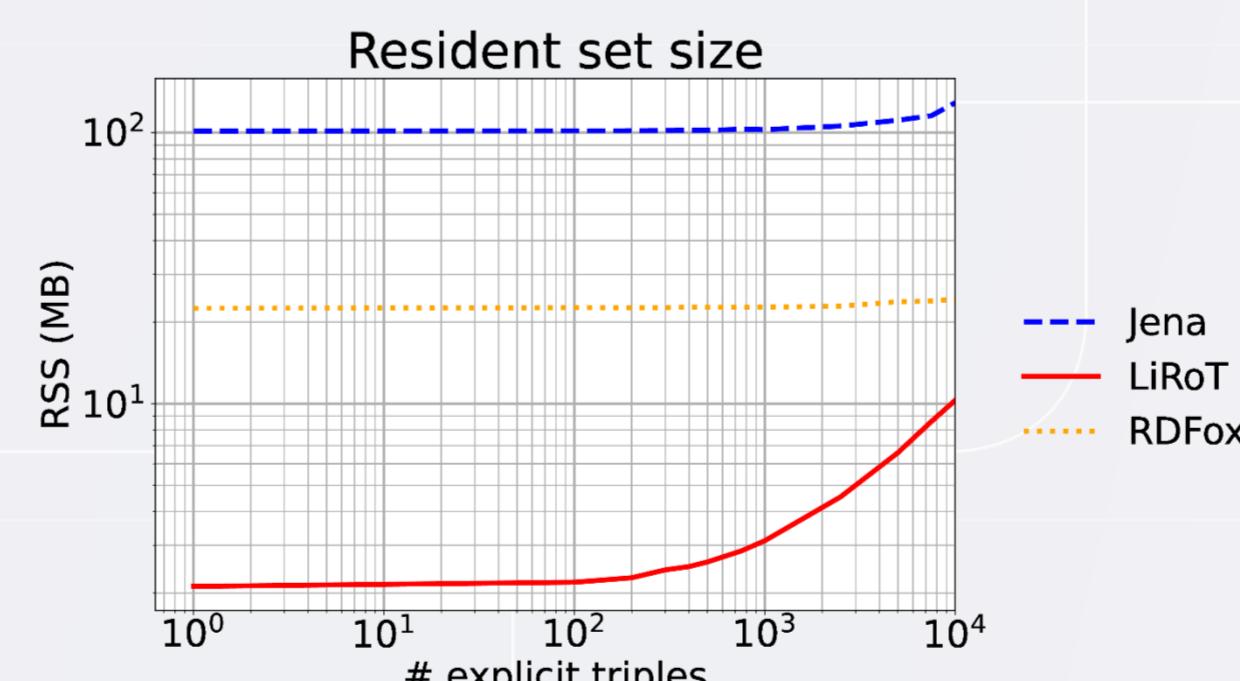
Proposed approach: LiRoT

- LiRoT [Bento22]: Lightweight incremental reasoner based on the RETE algorithm [Forgy89]
- Adapt the Backward/Forward algorithm to optimize incremental maintenance
- Custom Memory optimizations
 - Merge memory spaces for nodes that have equivalent conditions
 - Index terms to avoid duplicates
 - Encode data in CBOR (ongoing work)
- Open-source implementation in C
- For desktop and Arduino platforms

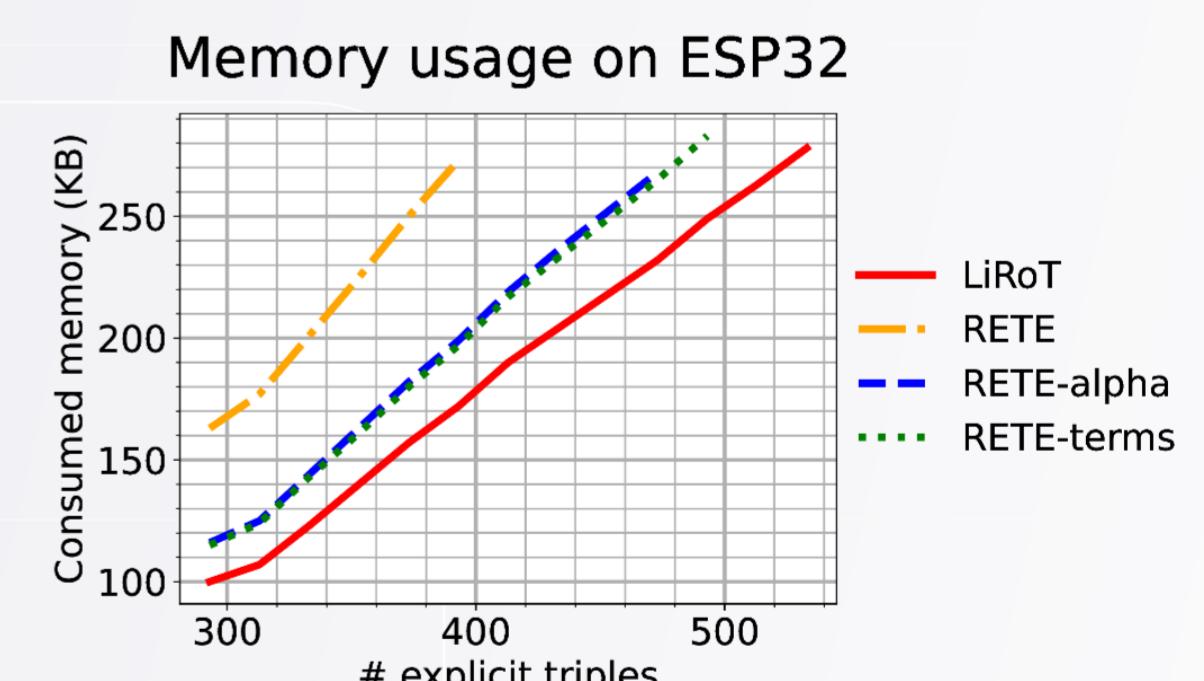


<https://gitlab.com/coswot/lirot>

Experiments



Comparison between LiRoT, Apache Jena and RDFox on desktop



Comparison between different optimizations on ESP32 platform

- LiRoT uses 46-91% less memory than RDFox and 91-98% less than Apache Jena
- LiRoT has similar or better performance than RDFox for datasets of 500-1000 explicit facts, depending on the task and ruleset, and is generally faster than Jena
- Incremental maintenance requires memory overhead, but improves performance

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