Temporal Enrichment and Querying of Ontology-Compliant Data

Jing Ao, Zehui Cheng, Rada Chirkova and Phokion G. Kolaitis

NC STATE UNIVERSITY

UC SANTA CRUZ

Temporal Data

- **Temporal semantics**
  - Valid time in the real world

- **Many application domains**
  - Weather
  - Biological records
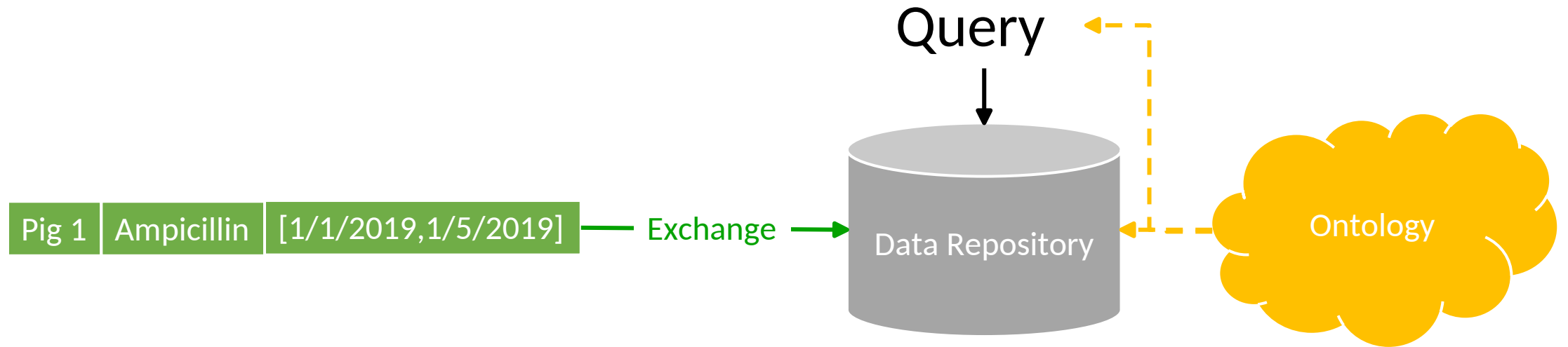 - …

User Expectation

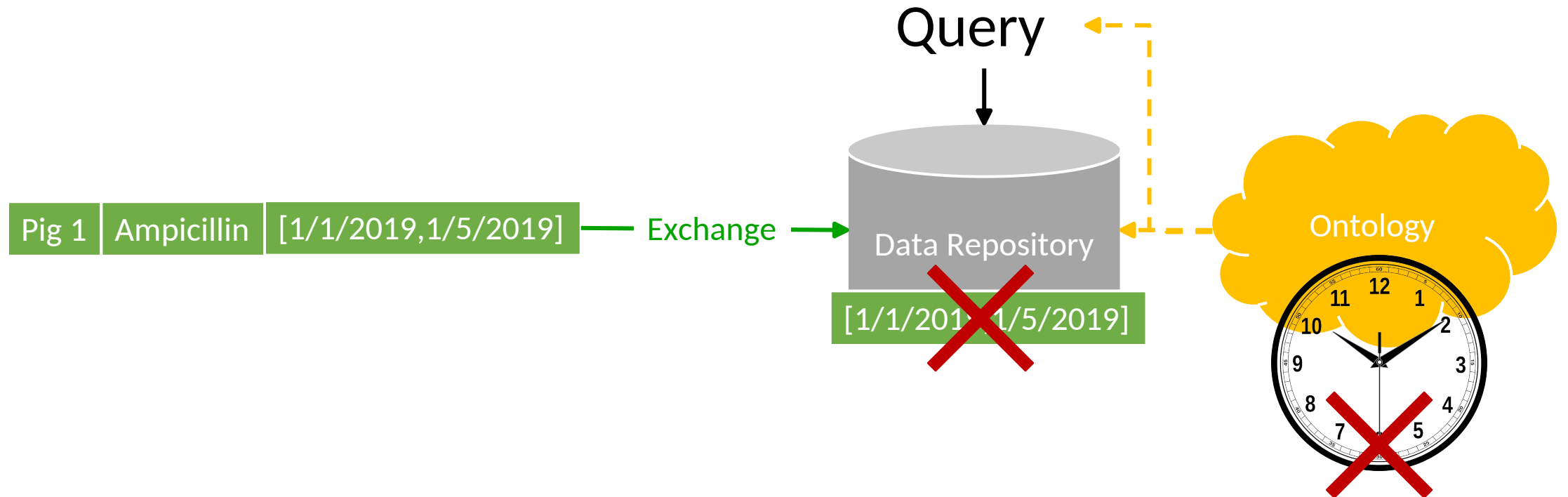*Obtain answers to* *temporal queries* *over temporal data from different sources*

e.g., "Any connection between occurrences of special weather events and bacteria outbreak?"

Standard Solution

Limitations

Our Work

Given time-agnostic target ontology, data-exchange rules

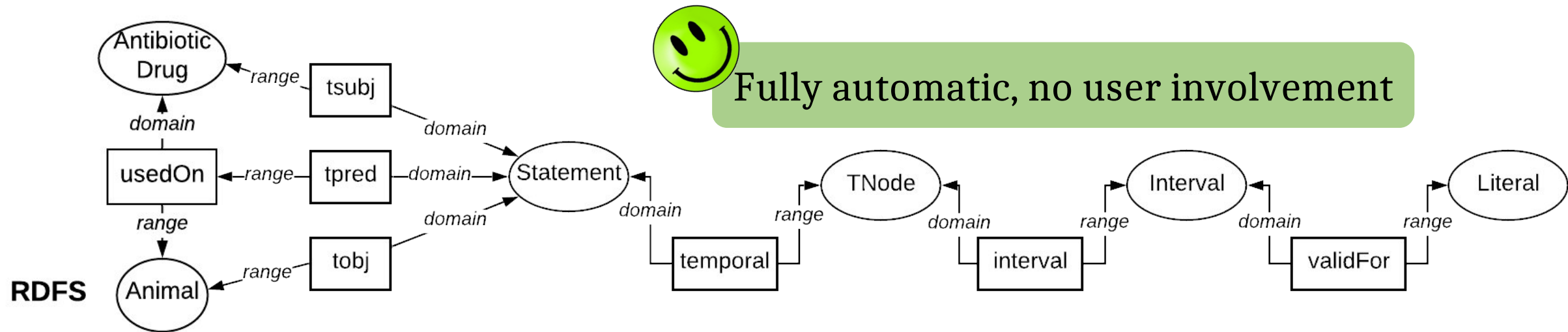***Automatically preserve* *source temporal information at the target***

Our focus:
- Interval-based temporal information
- Relational-to-RDF(S) exchange setting

Temporally-Enriched Data Exchange

- Step 1: Temporal enrichment
  - Targets parts of time-agnostic ontologies and exchange rules

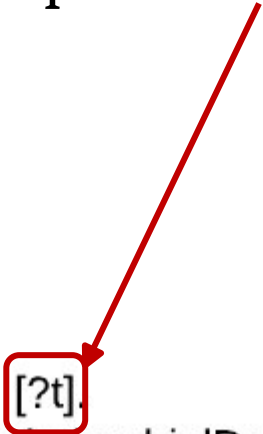Fully automatic, no user involvement

- Step 2: Apply enriched rules to exchange

Getting Correct Temporal-Query Answers

- Step 1: Temporal querying UI
  - Annotate SPARQL triple patterns with temporal variables [8]

```
SELECT ?d ?f ?t
WHERE
{
    ?d      amr:usedOn    ?a      [?t].
    ?d      rdf:type          amr:AntimicrobialDrug.
    ?t      during  "[2019-01-01,2019-12-31]".
    ?a      amr:livesIn      ?f.
}
```

Getting Correct Temporal-Query Answers

- Step 2: Reformulate UI-based queries into SPARQL
  - Expand annotation into triple patterns respecting enriched ontology structure

```
SELECT ?d ?f ?t
WHERE
{
    ?d      amr:usedOn          ?a.
    ?s      temporal:tsubj      ?d.
    ?s      temporal:tpred      amr:usedOn.
    ?s      temporal:tobj       ?a.
    ?s      temporal:temporal   ?tn.
    ?tn     temporal:interval   ?i.
    ?i      temporal:validFor   ?t.
    ?d      rdf:type            amr:AntibioticDrug.
    ?a      amr:livesIn         ?f.
    FILTER(
    intialDate(?t)>"2019-01-01"^^xsd:dateTime
    AND
    finalDate(?t)<"2019-12-31"^^xsd:dateTime).
}
```

Experimental Settings

- Evaluate
  - Degree of preservation of source temporal information at the target
  - Degree of correctness of target temporal-query answers

- Baseline
  - Relational-to-relational temporal data exchange and query answering
  Correctness supported by [12]: Golshanara, L., Chomicki, J.: Temporal data exchange. Inf. Systems 87 (2020).

- Data domains: *Antimicrobial Resistance [NCSU CVM]* and
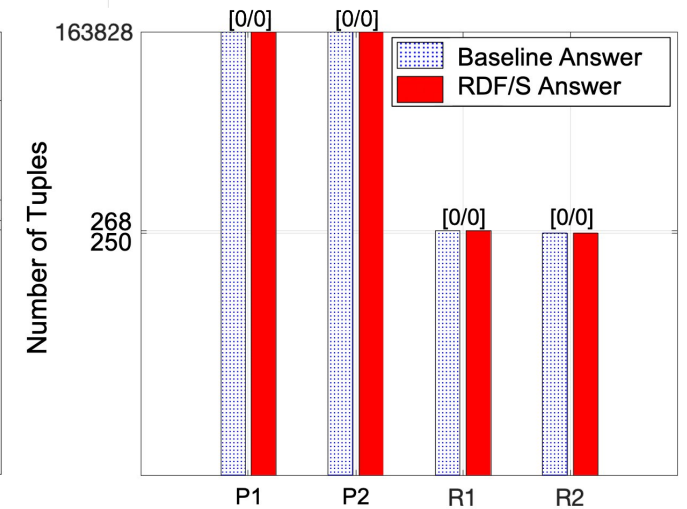
  Business [TPC-BiH]

Experimental Results
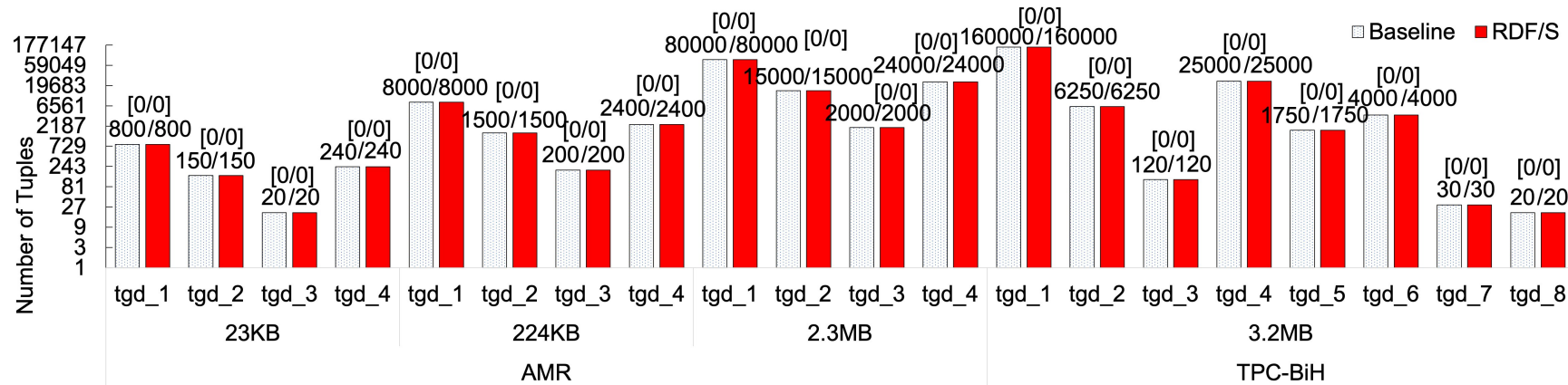
- **All identical ([0/0]) results to baseline**
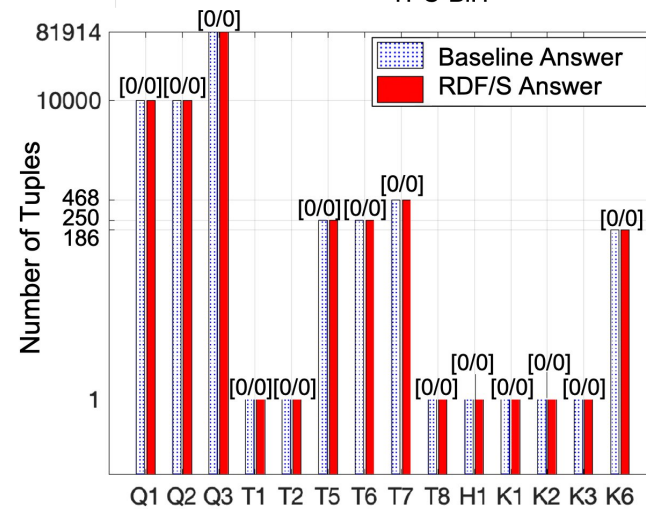
(a)

(b)

Conclusion

- Problem
  - Relational-to-RDF(S) temporal data exchange and query answering

- Proposed approach
  - Temporal enrichment of ontologies and exchange rules
  - Declarative temporal-query answering framework

- Experiments
  - Promising solution

Thank you!