TriAD: A Distributed Shared-Nothing RDF Engine based on Asynchronous Message Passing

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Motivation

RDF is ubiquitous…

- Many organizations now support and publish RDF data
  Eg. DBpedia (400M), YAGO2 (130M), Freebase,…

How to scale and yet be efficient..?

.. in managing and querying RDF data

Our Approach: TriAD RDF store

- Scalability – main-memory backed distributed setting
- Efficiency – 1. Asynchronous query processing
  2. Join-ahead pruning

Problems with Current Approaches

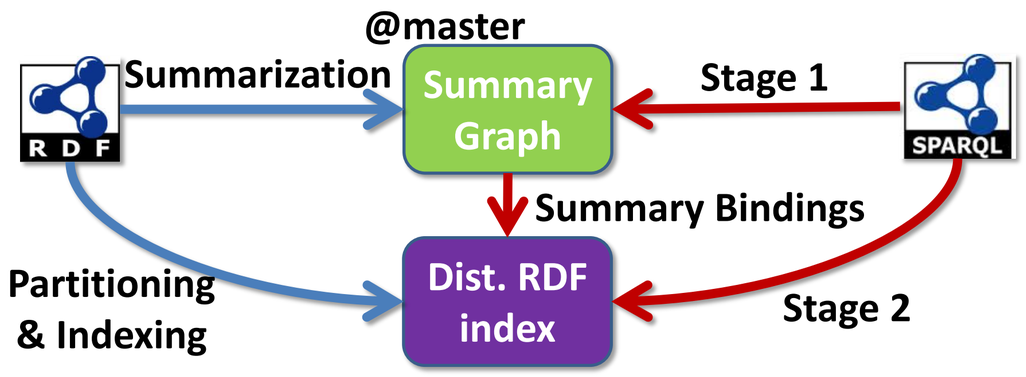
Problem 1: Synchronous processing of joins

Hadoop-based systems process joins using iterative & synchronous MapReduce jobs

Problem 2: Pruning dangling triples

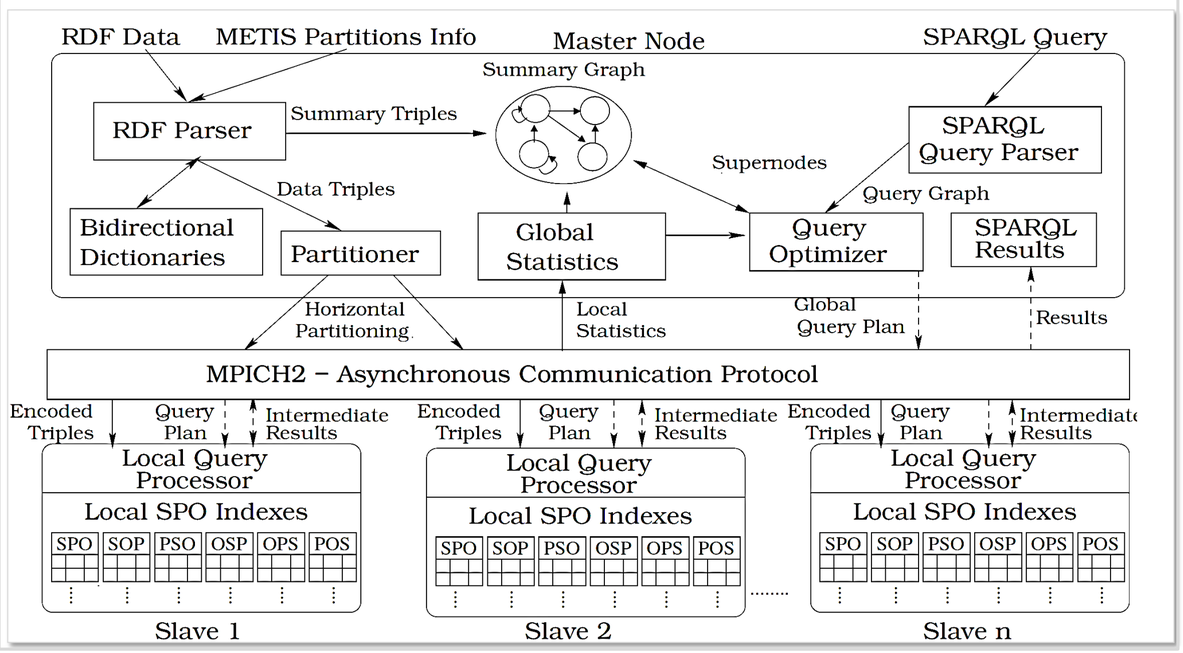
- Dangling triples are the triples that appear in intermediate relations but not part of final joins
- Approaches: Graph exploration, Sideways Information Passing (SIP)
- Graph exploration – works well for selective queries
  SIP – needs synchronization among join operators

Our Approach (in a nut shell)



- Summary index (via summary bindings) is used for pruning dangling triples **(join-ahead pruning)**
- Asynchronous distributed query execution over RDF index

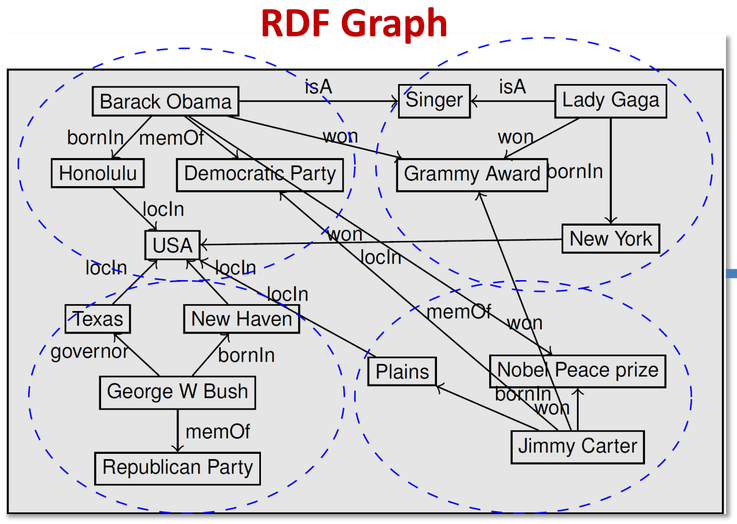
TriAD Architecture



Graph Summarization & Query Processing Workflow

Graph summarization

RDF Graph



Cost function for optimal partitions

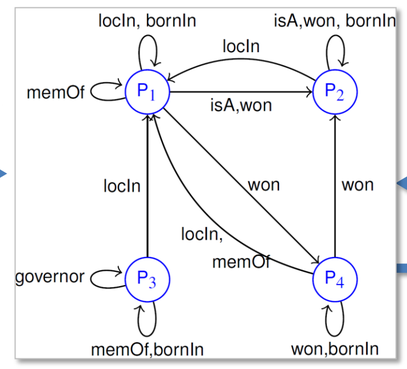
$$c_{Q,n} := c_S + c_{P,n} = \frac{d|V_S|}{|E_D|} \cdot c_D + \frac{\lambda}{|V_S|} \cdot \frac{c_D}{n}$$

Optimal summary size

$$|V_S| := \sqrt{\frac{\lambda |E_D|}{d\, n}}$$

λ - tuning parameter

Summary Graph



Stage 1: Join-ahead pruning (of dangling triples)

SPARQL Query

```
SELECT ?person ?city ?prize WHERE{
?person <bornIn> ?city .
?city <locatedIn> USA .
?person <won> ?prize.
?prize <hasName> ?name  }
```

Graph Exploration

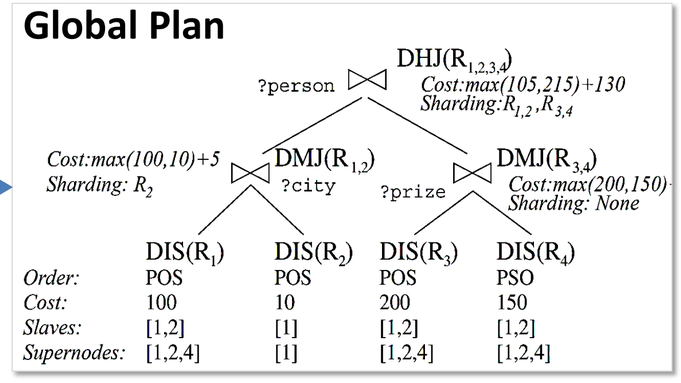
Bindings

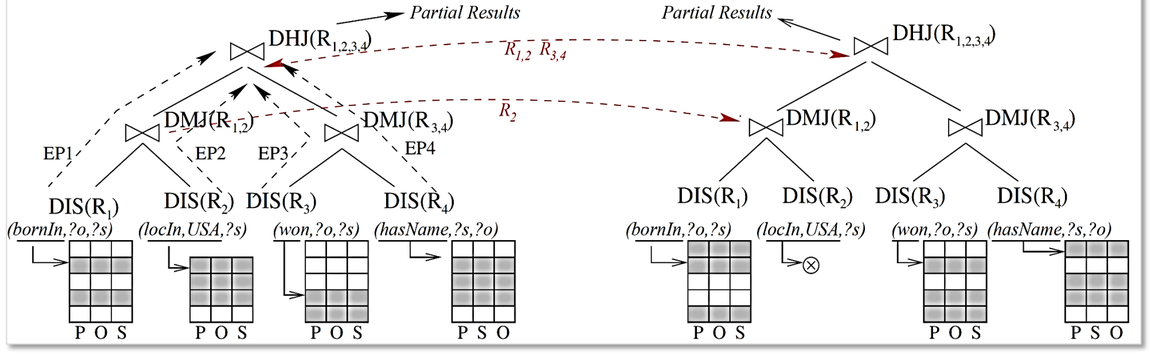
```
?person: P1, P2, P4
?city: P1, P2, P4
?prize: P2, P4
```

Stage 2: Distributed & asynchronous query execution

Bindings

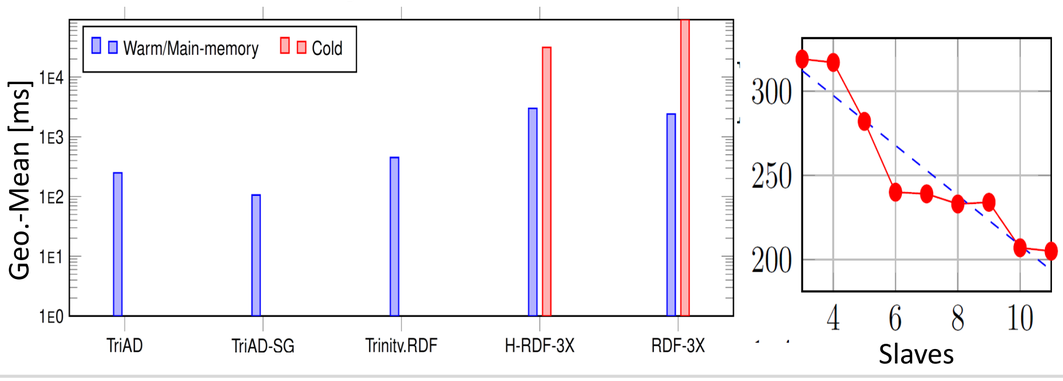
Global Plan



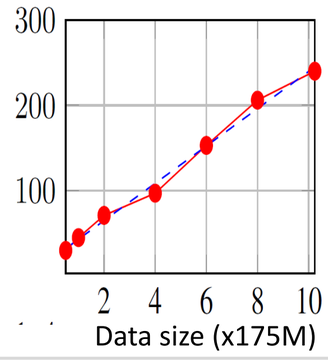


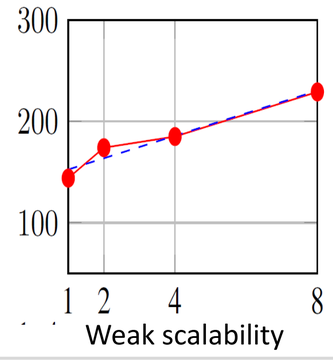
Evaluation

Query Performance

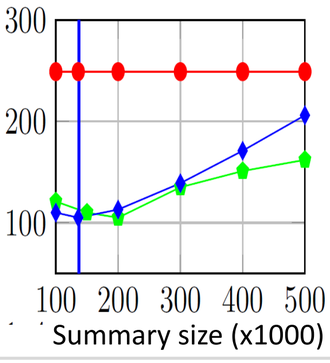


Scalability





Summary sizes



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