Triple Stores

What is a triple store?

- A specialized database for RDF triples
- Can ingest RDF in a variety of formats
- Supports a query language
  - SPARQL is the W3C recommendation
  - Other RDF query languages exist (e.g., RDQL)
  - Might or might not do inferencing
  - Most query languages don't handle inserts
- Triple stored in memory in a persistent backend
- Persistence provided by a relational DBMS (e.g., mySQL) or a custom DB for efficiency.

Architectures

- Based on their implementation, can be divided into several broad categories *: In-memory, Native store, Non-native store*
- In Memory : RDF Graph is stored as triples in main – memory
- Native store: Persistent storage systems with their own implementation of databases. E,g., JENA TDB, Sesame Native, Virtuoso, AllegroGraph, Oracle 11g
- Non-Native store: Persistent storage systems set-up to run on third party DBs. Eg. Jena SDB using mysql or postgres

Architecture trade-offs

- In memory is fastest, obviously, but load time has to be factored in
- Native stores are fast, scalable, and popular now
- Non-native stores may be better if you have a lot of updates and/or need good concurrency control
- See the W3C page on large triple stores for some data on scaling for many stores

Large triple stores

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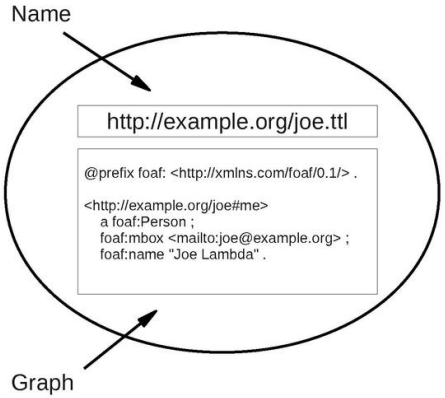
Quads, Quints and Named Graphs



- Many triple stores support quads for named graphs
- A named graph is just an RDF with a URI name often called the *context*
- Such a triple store divides its data a default graph and zero or more additional named graphs
- SPARQL has support for named graphs
- De facto standards exist for representing quad data, e.g., n-quads and TriG (a turtle/N3 variant)
- AllegroGraph stores quints (S,P,O,C,ID), the ID can be used to attach metadata to a triple

Example: Jena Framework

- An open software Java system originally developed by HP (2002-2009)
  - http://incubator.apache.org/jena/
- Moved to Apache when HP Labs discontinued its Semantic Web research program ~2009
- Good tutorials
  - http://incubator.apache.org/jena/getting_started/
- Has internal reasoners and can work with DIG compliant reasoners or Pellet.
- Supports a Native API and SPARQL
- Joseki is an add-on that provides a SPARQL endpoint via an HTTP interface

Jena Features

- API for reading, processing and writing RDF data in XML, N-triples and Turtle formats;
- Ontology API for handling OWL and RDFS ontologies;
- Rule-based inference engine for reasoning with RDF and OWL data sources;
- Stores to allow large numbers of RDF triples to be efficiently stored on disk;
- Query engine compliant with the latest SPARQL specification
- Servers to allow RDF data to be published to other applications using a variety of protocols, including SPARQL

Example: Sesame

- Sesame is an open source RDF framework with support for RDFS inferencing and querying
- http://www.openrdf.org/
- Implemented in Java
- Query languages: SeRQL, RQL, RDQL
- Triples can be stored in memory, on disk, or in a RDBMS

Example: Stardog

- http://stardog.com/ by Clark and Parsia
- Pure Java RDF database (“quad store”)
- Designed to be lightweight and very fast for in memory stores
- Performance for complex SPARQL queries
- Reasoning support via Pellet for OWL DL and query rewriting for OWL 2 QL, EL & RL
- Command line interface and JAVA API

Issues

- Can we build efficient triple stores around conventional RDBMS technology?
- What are the performance issues?
  - Load time?
  - Interfencing?
- How well does is scale?

Performance

- A lot of work has been done on benchmarking triples stores
- There are several standard benchmark sets
- Two key things are measured include
  - Time to load and index triples
  - Time to answer various kinds of SPARQL queries
- See, for example, recent (2011) data from the Berlin SPARQL Benchmarks which studied 4store, BigData, BigOwlim, TDB and Virtuoso.

Load Time

SUT	100M	200M
4store	26:42*	1:12:04*
BigData	1:03:47	3:24:25
BigOwlim	**17:22**	**38:36**
TDB	1:14:48	2:45:13
Virtuoso	1:49:26**	3:59:38**

* The N-Triples version of the dataset was used.

** The dataset was split into 100 respectively 200 Turtle fiiles and loaded with the DB.DBA.TTLP function consecutively.

Queries per hour

6.1.1 QMpH: Explore use case

The complete query mix is given here.

	100m	200m
4store	5589	4593
BigData	2428	1795
BigOwlim	3534	1795
TDB	2274	1443
Virtuoso	**7352**	**4669**

A much more detailed view of the results for the Explore use case is given under Detailed Results For The Explore

6.1.2 QMpH: Explore and Update use case

The Explore and Update query mix consists of the Update query mix (queries 1 and 2) and the Explore query mix (

	100m
4store	**5311**
BigOwlim	2809
TDB	680