Labeled k-partite Graph for Statement Annotation in the Web of Data

Abstract—The Web of Data introduces issues in storing, representing, managing, and querying the massive amount of data with additional information i.e., meta-knowledge. These issues exist because when introducing meta-knowledge 1) the graph size, the number of statements, and the query response time increase, and 2) some redundancies are created. We propose a new approach called Labeled k-partite Graph data model (LKG) to overcome some of these issues. Our approach uses MSPARQL as a query language, an extension of SPARQL. Experiments were conducted using the SPARQL Performance Benchmark (SP^2 Bench) dataset (without meta-knowledge) and the Bio-medical Knowledge Repository (BKR) dataset, Gov-track dataset (with meta-knowledge). For the former dataset, the LKG approach is compared with the RDF directed labeled graph, and for the latter, LKG is compared with the state-of-the-art approaches: Singleton Property, RDF Reification, Named Graph and PaCE. The experiments analyzed the meta-knowledge representation in terms of number of edges, number of statements, storage space and redundancy creation. The results show that the LKG model performs better in terms of query response time, query length, and in terms of meta-knowledge representation, which gives an advantage over storage management, graph data management and faster information retrieval.

Appendix A
Queries for Experiment 2: The SP^2 bench queries in LKG format

Q1 **Return the year of publication of Journal 1 (1940).**
SELECT ?yr WHERE { ?journal http://www.w3.org/1999/02/22-rdf-syntax-ns#type http://localhost/vocabulary/bench/Journal ?i. ?journal http://purl.org/dc/elements/1.1/title "Journal 1 (1940)" ?i1 . ?journal http://purl.org/dc/terms/issued ?yr ?i2 . }

Q2 **Find all articles of type "Journal" and the year they were issued.**
SELECT ?journal ?yr WHERE{ ?journal http://www.w3.org/1999/02/22-rdf-syntax-ns#type http://localhost/vocabulary/bench/Journal ?i . ?journal http://purl.org/dc/terms/issued ?yr ?i1 . }

Q3 **Select all articles with property http://swrc.ontoware.org/ontology#isbn.**
SELECT ?article WHERE{ ?article http://www.w3.org/1999/02/22-rdf-syntax-ns#type http://localhost/vocabulary/bench/Article ?i1 . ?article http://swrc.ontoware.org/ontology#isbn ?value ?i2 . }

Q4 **Find all the details of journal34/1983.**
SELECT ?predicate ?object WHERE { http://localhost/publications/journals/Journal34/1983 ?predicate ?object ?i .}

Q5 **Select all articles with property http://swrc.ontoware.org/ontology#pages.**
SELECT ?article WHERE{ ?article http://www.w3.org/1999/02/22-rdf-syntax-ns#type http://localhost/vocabulary/bench/Article ?i1 . ?article http://swrc.ontoware.org/ontology#pages ?value ?i2 . }

Appendix B
Queries for Experiment 4: Queries in LKG format for BKR dataset

Q4 **Find the triple whose source is: <http://mor.nlm.nih.gov/bkr/PUBMED_10979521-INST>.**
select ?s ?p ?o where { ?s ?p ?o ?i . ?i <http://knoesis.wright.edu/provenir/derives_from> <http://mor.nlm.nih.gov/bkr/PUBMED_10979521-INST> ?i1.}

Q5 **Find the source of the triple: <http://mor.nlm.nih.gov/umls/META_C0012963> <http://mor.nlm.nih.gov/umls/SEMNET_STIMULATES> <http://mor.nlm.nih.gov/umls/META_C0598981>.**
select ?pmid where { <http://mor.nlm.nih.gov/umls/META_C0012963> <http://mor.nlm.nih.gov/umls/SEMNET_STIMULATES> <http://mor.nlm.nih.gov/umls/META_C0598981> ?i. ?i <http://knoesis.wright.edu/provenir/derives_from> ?pmid ?i1 .}

Q6 **Insert a new source: <http://mor.nlm.nih.gov/umls/PUBMED_876587587-INST> into the triple: <http://mor.nlm.nih.gov/umls/META_C0012963> <http://mor.nlm.nih.gov/umls/SEMNET_STIMULATES> <http://mor.nlm.nih.gov/umls/META_C0598981>.**
insert {?i <http://knoesis.wright.edu/provenir/derives_from> <http://mor.nlm.nih.gov/umls/PUBMED_876587587-INST> .} where { <http://mor.nlm.nih.gov/umls/META_C0012963> <http://mor.nlm.nih.gov/umls/SEMNET_STIMULATES> <http://mor.nlm.nih.gov/umls/META_C0598981> ?i .}

SELECT ?article WHERE{ ?article http://www.w3.org/1999/02/22-rdf-syntax-ns#type http://localhost/vocabulary/bench/Article ?i1 . ?article http://swrc.ontoware.org/ontology#pages ?value ?i2 . }