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Shop on: Ontology for E-shopping

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ABSTRACT: Online stores are available 24x7, do not require travelling, provide a variety of items and services at a single store which is easy to access and look up. All these features have let these e-shops gained popularity from late 90's. Since then many attempts have been made to improve the experience of shoppers with the online shopping sites. Inspired by the Tim Berners Lee's vision of Semantic Web to make searching on the web easy and efficient, in this paper, an ontology for online-shopping has been created by using Protégé in-order to add new features in the shopping sites and answer the complex queries of the users making their life of shopping easier and happier.

KEYWORDS: Ontology, Online Shopping, Protégé, RDF, SPARQL.

I. INTRODUCTION

Online shopping is a form of trading by the use of internet which helps users to buy goods or services from a seller using web browser. Michael Aldrich invented e-shopping in 1979 [1]. With the advancement in internet and web technologies, experience of e-shoppers improved day by day. Most of online shopping applications till today have relational databases as their data servers which were proposed by E. Codd in 1970[2]. With a lot of progress made in the field of knowledge management, there are various types of databases available like NoSQL[7] databases, graph databases to suit particular requirement settings. When Tim Berners Lee [8] introduced his vision of web in which machines can also understand and exchange the data on the web, RDF (Resource Description Framework)[4] databases were introduced. RDF data model has the ability to express the semantics of data (expressed in terms of uniquely identifiable resources) and to make it sharable on the web. RDF technology is used to create an ontology which is a formal description of concepts of a particular domain. Just like database schema describes the structure of database, relationship between tables and how the data is stored in tables, in the same way ontologies describe the resources in terms of the concepts to which they belong, what is the relationship between concepts, what are the properties each concept have, thereby creating a graph which link resources to concepts and concepts to each other through properties/relationships.

In general, an ontology consists of collection of concepts and relationships between these concepts [10]. These terms describe the domain of ontology. For example in ontology for online shopping setting, brands, clothing, shoes and jewellery are some concepts. Most of the typical ontologies are hierarchical in nature. *RDF Schema* is a description language for describing properties and classes of RDF resources and hierarchies of such properties and classes [9]. Each relationship is expressed as an RDF triple. A part of ontology for online shopping domain has been shown in fig 1. The relationship shown in fig1 will be stored as <BlackT-shirt><IsOfBrand><Puma>. RDF database can be queried using SPARQL [3]. SPARQL Protocol And RDF Query Language is based on matching graph patterns against RDF graphs. Using any of the subject or object, the other one can be queried by using SPARQL.

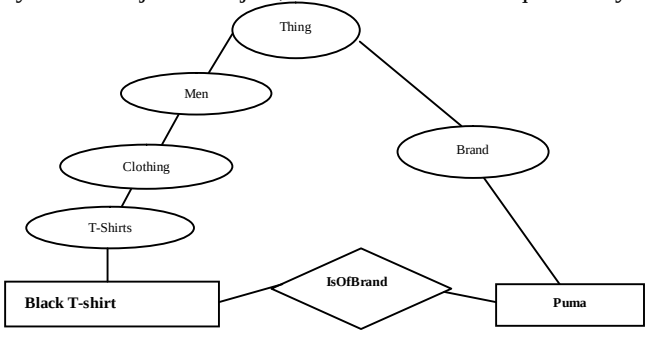

Fig.1 Example Ontology

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In this paper, an ontology for online shopping domain has been created using protégé. The proposed ontology has been loaded with instances and performance has been evaluated by executing complex SPARQL queries on it. The organization of this paper is as follows: In section II, advantages of representing data as ontologies over relational databases are discussed. In section III, the model and statistics of the proposed ontology are given. In section IV, common and complex queries of users are discussed and how they are handled by the proposed method is shown. In section V, paper is concluded by discussing the contributions and future scope.

II. WHY ONTOLOGY?

In this section, advantages of storing data as RDF rather than as relational tables have been discussed. Following are various advantages of ontologies over RDBMSs:

- There is no overhead of normalization in ontologies as it is in relational databases in order to get rid of redundancies and inconsistencies [6].

- New instances can be easily added without worrying about data integrity. Relational databases for online store are frequently updated and if they are poorly planned and unnormalized, they suffer from update and insert anomalies and therefore it is not always easy to update such databases. Moreover, adding new data in relational databases need to undergo certain integrity/constraints checking. But in case of ontologies new instances can be simply added without worrying about data integrity.

- Reasoners with ontologies can be used to derive new information from the both the schema and tuple information: In case of ontologies for shopping domain, products can be recommended to customers by defining simple rues based on information from what they have already bought. For example if a user has bought some t-shirts which are of color black and from puma, black colored trousers and shoes from puma can be recommended to the user .

- Ontologies are reusable, sharable and are more expressive in terms of semantics than RDBMSs [6].

III. PROPOSED ONTOLOGY

The ontology for online shopping is created using Protégé [5]. The main elements of ontology are Concepts, Properties, Instances and Rules which are described briefly in this section.

A. *Design:*

The design of the ontology contains concepts of shopping domain like Books, Stationery, Men, Women, Brand, Home and Furnishing etc. These concepts have further sub-concepts to cover the in-depth knowledge in shopping domain. Object properties and data properties are defined to link the data and describe the attributes of each concept. Instances of concepts are also defined to test the reliability of the design as far as complexity of users' queries is concerned. To design this ontology following steps have been followed:

Step 1: Identify the concepts in the shopping domain.
Step 2: Identify the object properties.
Step 3: Identify the data properties.
Step 4: Adding individuals by creating instances of concepts defined in step 1.

The ontograph view of the created ontology is shown in the fig 2:

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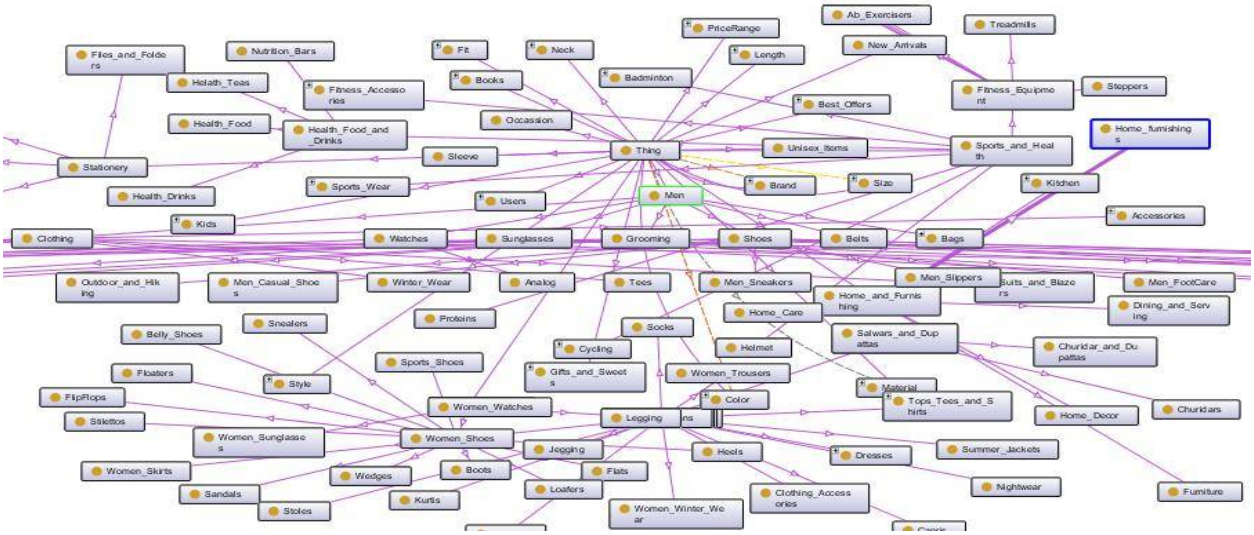

Fig.2. Shopping Ontology Graph

B. *Concepts:*

The proposed ontology contains 289 classes which covers the concepts of shopping domain. The hierarchy of the concepts is shown in the fig 3:

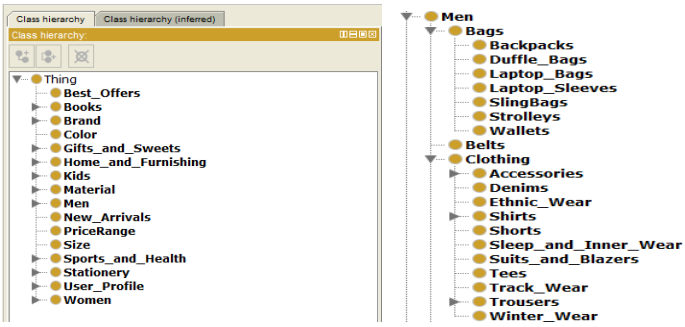

Fig.3. Hierarchy of Concepts

C. *Properties:*

- Object Properties: There are 17 object properties which are defined in this ontology to provide linking to other concepts in ontology.
- Data Properties: 15 data properties are defined to describe attributes of each concept.

The properties also have sub-properties for example in fig.4 Product_Info property have subproperties like hasdimensions, Product_Weight etc.

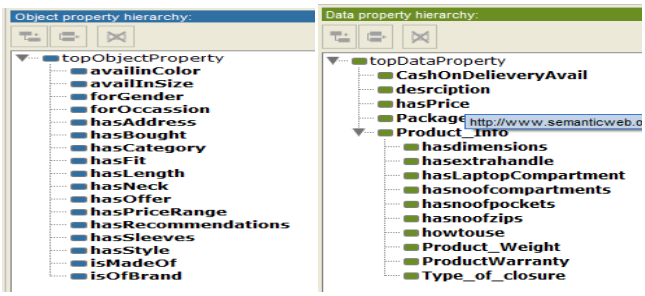

Fig 4. Object Properties and Data Properties

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D. *Instances:*

There are around 382 instances which are used to further query and find results from the created knowledge. Some of the instances are shown in the fig 5.

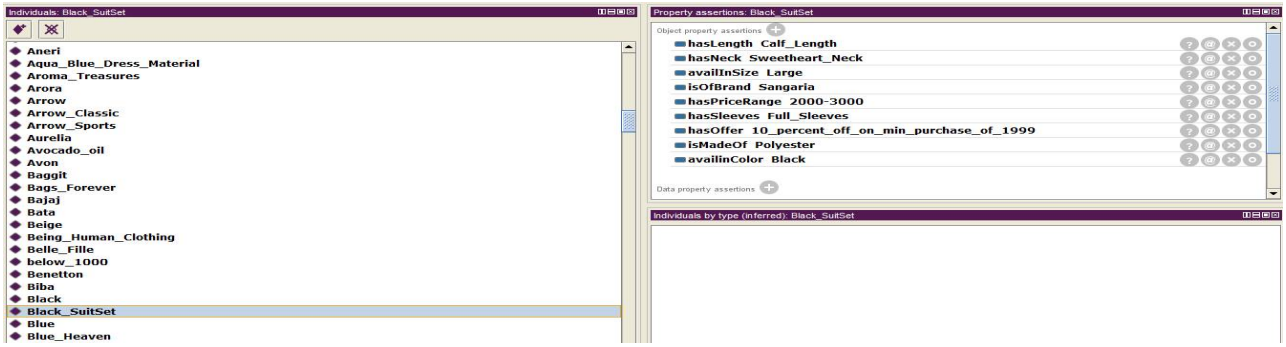

Fig.5 Instances and the property assertions

E. *Rules:*

Ontologies have the assistance of reasoners whenever it is required to derive new information. To derive new information from existing data and schema information, description logic rules need to be applied. The rules can be defined as shown below in the fig 6:

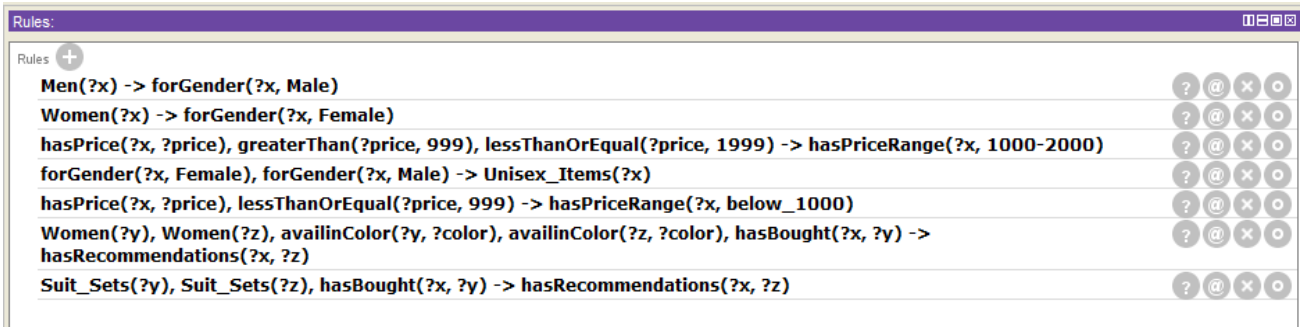

Fig.6 DL Rules

IV. SHOPPER QUERIES AND RESULTS

In this section it has been shown that both common and complex user queries can be handled efficiently by the proposed framework. The table1 shows queries in natural language and the corresponding SPARQL queries and also the results that appeared when they were executed on SPARQL tab in Protégé.

Table.1. User queries and results

S.No	User Query	SPARQL Query and Result
1.	What are products of Brand are available?	SPARQL query: PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> PREFIX owl: <http://www.w3.org/2002/07/owl#> PREFIX xsd: <http://www.w3.org/2001/XMLSchema#> PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#> PREFIX x: <http://www.semanticweb.org/kanchan/ontologies/2016/1/untitled-ontology-49#> SELECT ?product WHERE { ?product x:isOfBrand x:Sparkle_Street} product Alloy_Bracelet Alloy_Necklace Result shows products of Sparkle Street brand available in the store are queried for.

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2	What is the price range of this category?	SPARQL query: PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> PREFIX owl: <http://www.w3.org/2002/07/owl#> PREFIX xsd: <http://www.w3.org/2001/XMLSchema#> PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#> PREFIX x: <http://www.semanticweb.org/kanchan/ontologies/2016/1/untitled-ontology-49#> SELECT DISTINCT ?pricerange WHERE { ?y x:hasPriceRange ?pricerange . ?y rdf:type ?z . ?z rdfs:subClassOf x:Bags } pricerange below_1000 1000-2000 3000-4000 2000-3000 Results show the price ranges of the available bags for men.
3	What are best offers available on this product?	SPARQL query: PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> PREFIX owl: <http://www.w3.org/2002/07/owl#> PREFIX xsd: <http://www.w3.org/2001/XMLSchema#> PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#> PREFIX x: <http://www.semanticweb.org/kanchan/ontologies/2016/1/untitled-ontology-49#> SELECT ?offer WHERE { x:Pearl_Edp x:hasOffer ?offer} offer 30_percent_off Result shows the offer available on product Pearl_Edp
4	What colours of this product are available?	SPARQL query: PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> PREFIX owl: <http://www.w3.org/2002/07/owl#> PREFIX xsd: <http://www.w3.org/2001/XMLSchema#> PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#> PREFIX x: <http://www.semanticweb.org/kanchan/ontologies/2016/1/untitled-ontology-49#> SELECT DISTINCT ?color WHERE { ?x rdf:type x:Necklaces . ?x x:availinColor ?color} color Red Golden Result shows the available colours of necklaces
5	What is the price range of this Brand for this product?	SPARQL query: PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> PREFIX owl: <http://www.w3.org/2002/07/owl#> PREFIX xsd: <http://www.w3.org/2001/XMLSchema#> PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#> PREFIX x:<http://www.semanticweb.org/kanchan/ontologies/2016/1/untitled-ontology-49#> SELECT ?pricerange WHERE { ?product x:isOfBrand x:Sangaria . ?product x:hasPriceRange ?pricerange } pricerange 1000-2000 2000-3000 below_1000 Result shows the price range of available products of brand Sangaria

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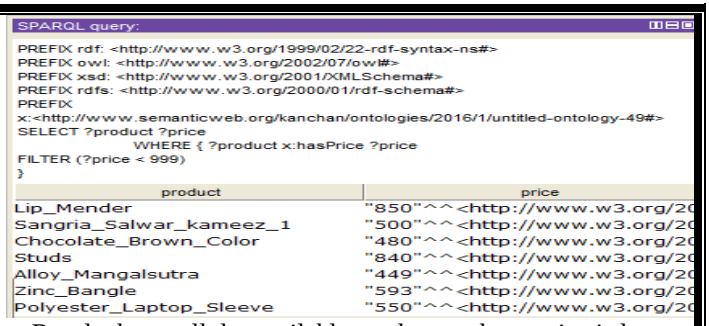
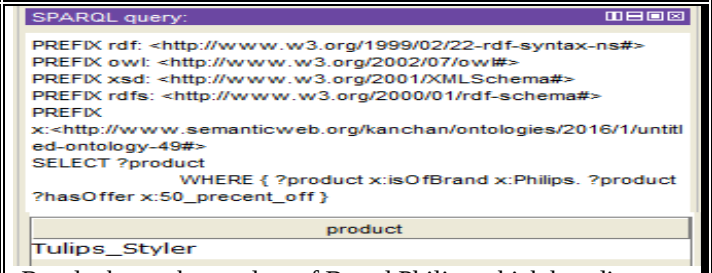
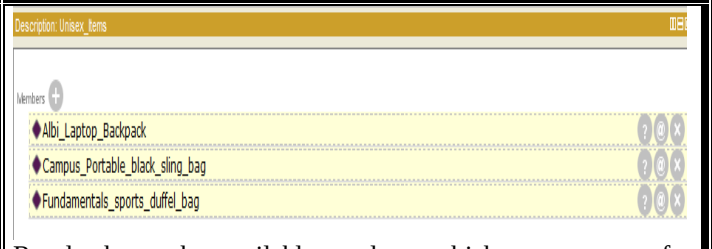
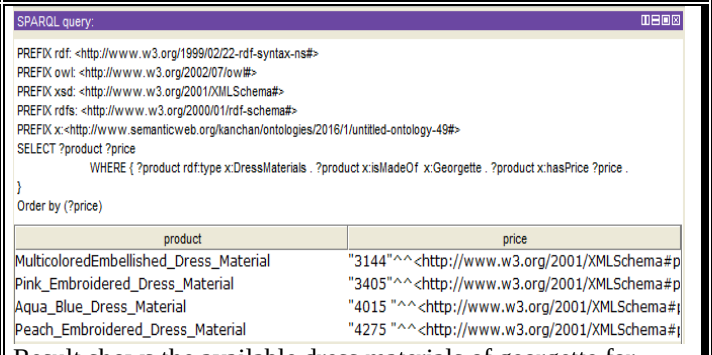
6	Display all the product below Rs999	 Result shows all the available products whose price is less than Rs. 999
7	Display all the products of the brand with discount of 50%	 Result shows the product of Brand Philips which has discount of 50%
8.	What are the unisex products available in the store?	 Result shows the available products which are common for men and women(implemented using DL rules)
9.	What are the dress materials of a particular cloth type?	 Result shows the available dress materials of georgette for women along with their prices

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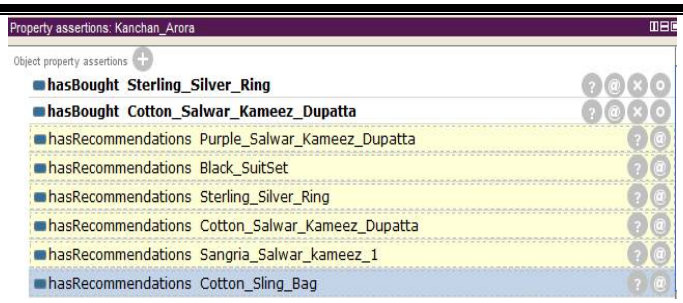
10	What are the recommended products?	 Result shows the recommendations of user
11	What are the dresses available for women for party occasion?	SPARQL query: PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> PREFIX owl: <http://www.w3.org/2002/07/owl#> PREFIX xsd: <http://www.w3.org/2001/XMLSchema#> PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#> PREFIX x:<http://www.semanticweb.org/kanchan/ontologies/2016/1/untitled-ontology-49#> SELECT ?product ?color WHERE { ?product rdf:type x:Dresses . ?product x:forOccassion x:Party . ?product x:availinColor ?color } product | color Solid_Shift_Dress | Black Solid_Skater_Dress | Maroon Solid_Maxi_Dress | Red Solid_Bodycon_Dress | Purple Results shows the women dresses with their colour available for party occasion
12.	Show the suit sets along with their best price of this brand in sorted order.	SPARQL query: PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> PREFIX owl: <http://www.w3.org/2002/07/owl#> PREFIX xsd: <http://www.w3.org/2001/XMLSchema#> PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#> PREFIX x:<http://www.semanticweb.org/kanchan/ontologies/2016/1/untitled-ontology-49#> SELECT ?suitset ?price WHERE { ?suitset rdf:type x:Suit_Sets . ?suitset x:isOfBrand x:Sangaria . ?suitset x:hasPrice ?price } ORDER BY DESC(?price) suitset | price Sangria_Salwar_kameez_1 | "500"^^<http://www.w3.org/200 Purple_Salwar_Kameez_Dupatta | "1200 "^^<http://www.w3.org/2(Result shows the suit sets available from brand Sangaria in sorted order of their price
13.	Show the brands with their discount in sorted order	SPARQL query: PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> PREFIX owl: <http://www.w3.org/2002/07/owl#> PREFIX xsd: <http://www.w3.org/2001/XMLSchema#> PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#> PREFIX x:<http://www.semanticweb.org/kanchan/ontologies/2016/1/untitled-ontology-49#> SELECT ?brand ?discount WHERE { ?brand rdf:type ?y . ?y rdfs:subClassOf x:Brand . ?product x:isOfBrand ?brand . ?product x:hasOffer ?discount } ORDER BY DESC(?discount) brand | discount Puma | 50_precent_off Philips | 50_precent_off Victoria | 50_precent_off Mascara_Blanco | 30_percent_off Vitasta | 30_percent_off Colour_Me | 30_percent_off Mascara_Blanco | 30_percent_off Indiyra | 30_percent_off Forest_Essentials | 10_percent_off_on_min_purchase_of_1999 Sangaria | 10_percent_off_on_min_purchase_of_1999 Sangaria | 10_percent_off_on_min_purchase_of_1999 Loreal_Paris | 10_percent_off_on_min_purchase_of_1999 Puma | 10_percent_off_on_min_purchase_of_1999 Result shows the brands whose products are available in the store with offered discount in descending order

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14.	What is the laptop bag made of leather available for men?	SPARQL query: PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> PREFIX owl: <http://www.w3.org/2002/07/owl#> PREFIX xsd: <http://www.w3.org/2001/XMLSchema#> PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#> PREFIX x: <http://www.semanticweb.org/kanchan/ontologies/2016/1/untitled-ontology-49#> SELECT ?bags WHERE { ?bags rdf:type ?y . ?y rdfs:subClassOf x:Bags . ?bags x:isMadeOf x:Leather } bags Leather_Laptop_Bag Results shows the available men laptop bags which are made of leather
15.	What brand bags are available?	SPARQL query: PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> PREFIX owl: <http://www.w3.org/2002/07/owl#> PREFIX xsd: <http://www.w3.org/2001/XMLSchema#> PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#> PREFIX x: <http://www.semanticweb.org/kanchan/ontologies/2016/1/untitled-ontology-49#> SELECT DISTINCT ?brand WHERE { ?x rdf:type ?y . ?y rdfs:subClassOf x:Bags . ?x x:isOfBrand ?brand} brand The_House_of_tara Nike Puma Adidas Celio Samsonite Gauge_Machine Result shows the brands whose bags are available in store
16.	What are the combinations of kurtas, eye creams and mangalsutras available under this offer?	SPARQL query: PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> PREFIX owl: <http://www.w3.org/2002/07/owl#> PREFIX xsd: <http://www.w3.org/2001/XMLSchema#> PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#> PREFIX x: <http://www.semanticweb.org/kanchan/ontologies/2016/1/untitled-ontology-49#> SELECT ?product1 ?product2 ?product3 WHERE { ?product1 x:hasOffer x:10_percent_off_on_min_purchase_of_1999 . ?product2 x:hasOffer x:10_percent_off_on_min_purchase_of_1999 . ?product3 x:hasOffer x:10_percent_off_on_min_purchase_of_1999 . ?product1 rdf:type x:Kurtas . ?product1 x:hasPrice ?price1. ?product2 rdf:type x:Eye_Care . ?product1 x:hasPrice ?price2 . ?product3 rdf:type x:Manglasutra . ?product1 x:hasPrice ?price3 . FILTER (?price1+?price2+?price3<=1999) } product1 product2 product3 Sangria_Salwar_kame Intensive_Eye_Cream_Silver_Mangalsutra Result shows the combinations of kurtas, creams and mangalsutras which have discount of 10 percent and whose price in total is less than 1999

It is evident from Table 1, all the shopper queries can be easily articulated as SPARQL queries which when fired to the proposed ontology give desired answers. It can also be noticed that if relational tables are used some queries may involve multiple table joins which would make the queries complex and inefficient in terms of both space and time.

V. CONCLUSION AND FUTURE WORK

In this paper an ontology framework for the online shopping domain has been proposed. Database for online stores is almost daily updated therefore if instead of RDBMS, ontology is used in this domain then modifications can be easy and efficient. Items can be also recommended easily by applying simple rules. New feature of recommending combination of products under a certain offer which prevents users from making combinations by browsing extensively the available items that lie under the price of offer has been proposed which as per my knowledge has not been introduced yet. As it can also be seen that even complex natural language user queries can be easily expressed as SPARQL queries and when they are delegated to the proposed ontology framework desired results have been produced. Automatic conversion of user needs to SPARQL queries is left as future work of this study.

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