A Review of Content-Based and Context-Based Recommendation Systems

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Abstract—In our work, we have presented two widely used recommendation systems. We have presented a context-aware recommender system to filter the items associated with user's interests coupled with a context-based recommender system to prescribe those items. In this study, context-aware recommender systems perceive the user's location, time, and company. The context-based recommender system retrieves patterns from World Wide Web-based on the user's past interactions and provides future news recommendations. We have presented different techniques to support media recommendations for smartphones, to create a framework for context-aware, to filter E-learning content, and to deliver convenient news to the user. To achieve this goal, we have used content-based, collaborative filtering, a hybrid recommender system, and implemented a Web ontology language (OWL). We have also used the Resource Description Framework (RDF), JAVA, machine learning, semantic mapping rules, and natural ontology languages that suggest user items related to the search. In our work, we have used E-paper to provide users with the required news. After applying the semantic reasoning approach, we have concluded that by some means, this approach works similarly as a content-based recommender system since by taking the gain of a semantic approach, we can also recommend items according to the user's interests. In a content-based recommender system, the system provides additional options or results that rely on the user's ratings, appraisals, and interests.

Keywords—Context-aware, Content-based; Recommender systems, Contextual information, Ontology, Knowledge-based Recommendation, Hybrid Recommendation system

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1 Introduction

Recommender systems are software gears and techniques which offer recommendations for users. Recommendations can be of various kinds such as music tracks, news, and movie recommendations. The recommendation system provides recommendations by keeping user interest and using contextual information into account. The abundance of available information indicates the extreme need to overcome irrelevant information [1]. The recommender system is the building block of data filtering [2]. The aim of building a recommender system is to provide maximum information required for personalized learning and interests depending on the interactive patterns of the clients [3, 4]. Contextual information is effectively used to make significant recommendations in various fields. However, still, there is a great need to resolve issues like abundant information, data redundancy, and context redundancy to generate more effective recommendations [5]. The previously proposed existing approaches do not provide a thorough solution to these problems. To address the challenges of more effective recommendations generation, we have proposed a content-based recommender system and context-aware recommender system. Context-Aware Recommender Systems (CARS) is a specific category of recommender systems that takes contextual information as an input and provides additional useful suggestions. Simultaneously, the content-based framework shows a chart of the field of recommender systems and depicts the present period of recommendation strategies that are regularly described with three essential arrangements: content-based, collective, and hybrid proposition approaches, i.e., hybrid.

Context is a versatile idea studied across distinct analysis disciplines and computing, science, linguistics, philosophy, psychology, and structure sciences. The change over the conventional data recovery approaches originates from customer profiles that possess knowledge about customers' tastes, slants, and pre-requisites. The content recovery group has contributed a few methods that are being utilized as a part of content-based recommender frameworks. Content-based strategies are constrained by the components that are explicitly connected with the items prescribed by these items. In this way, to have an adequate arrangement of elements, the content should either be in a shape that can be parsed naturally by a PC or the components should be substantially allocated. Since content-based archives are generally addressed by their most vital and essential content/phrases, content-based frameworks cannot recognize an elegantly composed article. They must be kept in touch with one, on the off chance that they happen to utilize similar terms.

The primary purpose of a recommender system is to provide users with recommendations. Other than providing significant recommendations, the recommender systems also successfully address the information overload dilemma. Most of the already existing recommender systems only target recommending the most relevant information related to the user’s search and contextual data. For example, time and place are not included in those systems. However, the currently used modern recommendation systems also include contextual information and personalization aspects into research [6].

Moreover, in various applications such as the holiday recommendation system, movie recommendation system, only users and items information is insufficient and contextual information is highly needed. For example, a travel recommender system provides suggestions for various suitable vocation packages according to different weathers.

Recommender frameworks provide customized counsel to clients about things they may be keen on. These apparatuses help individuals proficiently oversee content over-burden and lessen multifaceted nature while hunting down essential data. There are three fundamental components required to achieve personalization.

- Database to store portrayals of the accessible things,
- Profiles to model clients' inclinations and
- Proposal procedures to generate customized proposals for every person.

We have also discussed context-aware recommender systems that will provide us with the idea that contextual information can provide better recommendations. The main contributions of our work on context-aware recommender systems are:

1. We have illustrated distributions of journal paper publications per year for ontology-based recommendations from 2003-2014
2. We have investigated various information and recommendation representation techniques. We have also examined various types of context-aware learning resources. We have taken knowledge-based resources into consideration which are generated by ontology-based recommenders
3. We have also reviewed future research ideas for recommender systems

2 Recommendation Techniques / Methods

The semantic-based approach is ceaselessly being used in recommendation systems, and it has been proved as a better system for item recommendations. The currently widely used techniques are content-based, collaborative filtering, and hybrid techniques. By using any of these recommendation techniques and user preferences and appraisals, feasible information retrieval is possible. We have also used semantic-based recommendation systems. The most significant stride in the recommendation system is the extraction step. It brings about building up an archive subject guide by executing a web 2.0 administration to remove report elements. Recommendation arrangement of the examples enables educators to utilize straightforwardly the examples that offer answers for a specific issue that they face and enhances the powers. It likewise advances the input that is given by educators. It generates acceptable outcomes, enhances learning aptitudes, and opens the entryway to stimulate advancement and recommendation frameworks. In our assessment for the factual examination, we have considered factors, for instance, assorted qualities of the proposals, evaluations in types identified with the recommended programs, seeing propensities, and so on. All these factors together contribute to generating recommendations according to the client requirement. To generate efficiently related

and accurate recommendations, it is highly needed to increase information access and personalization. Figure 1 indicates the number of papers and their year of publication, which we have considered in our work.

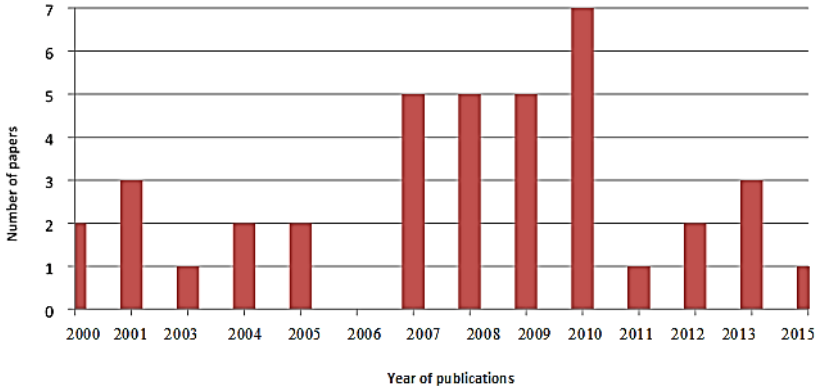

Fig. 1. Distribution of research papers W R T the year published

2.1 Semantic reasoning/semantic-based approach

The semantic-based approach is another data retrieval approach, along with content and collaborative approaches. The semantic standards are utilized to expand the concentrated learning way to recognize semantic connections among people. In particular, we have suggested a semantic model for every client who provides data about

i. Interesting and boring TV shows for the client (called: positive and negative inclinations)
ii. The primary characteristics
iii. Class of these projects in which they are characterized in the TV ontology

In past work, we researched a semantics-based way to deal with news proposals using equivalent word sets (synsets) from Word-Net [7]. The utilization of semantic Web advances to formally speak to information can give a few points of interest regarding customized suggestion frameworks: the dynamic contextualization of clients' interests in particular spaces, the assurance of between operability of framework assets, and the derivation of fragmented data about client's interests. We believe that the up-and-coming era of recommenders should concentrate on how their personalization procedures can exploit semantics and social information to enhance their proposals. Semantic suggestion frameworks are described by the joining of semantic information in their procedures with a specific end goal to enhance the proposal's quality. A conceivable approach to conquer issues of vagueness may be using an ontology, i.e., a controlled vocabulary of terms or ideas, and their semantic connections. We sometimes misuse suchlike semantic foundation information keeping

in mind the end goal to use effective surmising open doors for making client profiles because of the items these last clients obtained, more significant.

The ontological domain takes the state of the semantic system that utilized ideas of client profile interests. Adjustment of Semantic by User Preferences is the most straightforward approach. The weights would be able to set by the client. In any case, it likewise has a few downsides since client inclinations are regularly to stay unaltered. Therefore, changes take time. Semantic Web structure is utilized for building the customized news administrations. It utilized Ontology for investigation of content, for the introduction of information, for semantic inquiries.

Ontologies have turned into the foundation of the Semantic Web because of two reasons. From one viewpoint, formal conceptualizations empower deduction procedures to find new learning from the spoke to data. On alternate, ontologies encourage computerized learning sharing by permitting simple reuse amongst clients and programming specialists. Records disregarded are prepared, and critical faculties (disambiguated over Word-Net) are extricated and afterward joined to frame a semantic system. The modifying method powerfully predicts new reports on the premise of the semantic system. As the client peruses the reports, the framework fabricates the client show as a semantic system whose hubs speak to detects (not merely words) of the records asked for by the client. Semantic web innovation is that as it may, too dependent on how much creators comment on their site pages, and programmed page explanation is still in its earliest stages.

2.2 Ontology representation language

The languages used in content-based recommender systems are OWL, SWRL, RDF, and semantic mapping rules, etc. Semantic Web analysts resort to ontologies, which speak to the learning about every framework (by utilizing classes, properties, and particular examples) and by various standardized arrangements (for example, RDF, RDFS, and OWL). Semantic Web scientists fall back on ontologies, which speak to the learning about the domain of every framework (by utilizing classes, particular occurrences, and properties) by various standardized configurations (for example, RDF, RDFS, and OWL). E-learning proposal in this structure depends on SWRL, OWL, and lead-based suggestion system [8]. The word Web of Data mostly used as Semantic Web, Web 3.0, or combined Data, shows another era of advancements in charge of developing today's Web: A Web of connected data. The objective is to find new information from information utilizing standards (primarily RDF). We have proposed how Semantic Web headways and particularly ontologies can be used for upgrading functionalities of a present Java training system [9]. The outline for such an adaptable and customized mentoring framework that depends on Semantic Web instructions and developments has been displayed. The sort of a couple of ontologies has been proposed which identity with the parts of a coaching framework.

Comprehensively, our substance-based technique chooses from the OWL philosophy examples of parts and properties suitable for the customer, by considering his/her inclinations. The data has extreme constraints demonstrated in HTML, which

is intended for people to read instead of machines to translate and natural processes. We have partitioned the ontology into 2 sections for proficient store and questioning of OWL information. In this way, various levelled data of class and property is put away utilizing OWL, and occurrence data is utilized in a social database. Through them, we can obtain more efficiency. To build the ontology, we have made the facility domain and activity domain. Every domain comprises of subordinate ideas, occasions, and properties. The ontology recovery framework comprises of the crawler, the arranging module, the positioning module, and the recovery module. A crawler is used to parse the Web HTML records. The arranging module performs a characterization of parsed OWL/RDF. The positioning module selects the request made by space ontologies. Finally, the recovery module provides a client interface for recovered ontologies. For our framework, we make the ontology perception instrument and course suggestion framework utilizing Java. Specific domains can be achieved by using different ontologies languages. OWL and RDF are the most sequentially used languages that are used to build ontologies. Semantic rules are specifically designed to introduce inference rules. The ontology languages sometimes include reasoning and semantic rules that support content-based recommender systems. Also, these languages facilitate content-based systems to recommend different things to users according to their interests and profiles or rating.

The semantic standards are utilized to expand the concentrated learning way to recognize semantic connections among people. SWRL is a rising XML-based structure for building administers over OWL ontology. Amid the run building stage, clients can compose rules utilizing a Horn-like language structure, and after translating into the SWRL arrange. The SWRL standards can be altered on the Protégé OWL stage by choosing the "SWRL Tab". The inner database of our ontology is an OWL domain ontology developed by domain specialists and is questioned utilizing expanded SPARQL inquiries. Most of the semantic reasoning approach utilizes an idea-based way to enhance the client profile portrayal (client demonstrating stage) and utilize standard vocabularies and ontology language like OWL. By and large, utilizing things as labels (rather than marks) involves some fundamental favourable circumstances. Things are recognized by URIs and marked by RDFs: label or elective names: alt Label. This plan defeats existing semantic issues, for example, equivalent words, homonyms, acronyms, and diverse spelling, which current labelling frameworks endure, and by isolating the label's name from its recognizable proof. Furthermore, things may have an arrangement of further depicting RDF properties to recover similarities better.

The cross-dialect client profile is performed by the Profile Learner, which gathers the profile as a double content classifier. The latest ways to deal with Cross-Language Retrieval essentially depend on the utilization of vast corpora like Wikipedia. The approach depends on Explicit Semantic Analysis (ESA), stretching out the first model to cross-lingual recovery settings [10]. Implementation of e-paper depends on the standard OWL dialect. We manufacture charts, not a tree, and even more straightforward—second strategy: Sem-News, which gives the casing work to comprehend the news. The utilization of faculties instead of words infers that the subsequent client demonstrates more precise and autonomous from the language of

the documents perused. This is especially critical for multi-language sites ending up exceptionally regular, particularly in news locales or the electronic business domain. The preferred primary standpoint in utilizing Word-Net is that types of languages other than English are presently accessible. The fundamental focal points of interest of the semantic approach are that semantic exactness increments and that the model is free from the dialect of the news. The inquiry terms are chosen for Web look by adjusting synopsis and natural language handling methods to remove catchphrases from privately put away desktop records. There exist a few standard execution dialects for ontology advancement.

The primary propositions were RDF and RDFS, which added a formal semantic to the syntactic particulars in XML. Next, DAML and OIL emerged, which have been at long last combined and institutionalized by W3C as OWL, the most expressive language these days counting three sub-levels (Lite, DL, and Full). The language to use in the utilization of our thinking driven approach depends on the information and expressiveness necessities of the recommender framework.

2.3 Role of classification and categorization of previous researches

The main objective of classifying and categorizing previously done work is to achieve an easy clear understanding of the implementation of the content-based recommender system in various fields. The goal is to elaborate on how the content-based recommender systems have achieved better performance in the modern era. All the publications are based on content-based recommender systems. For example, the papers belong to the recommendation of news according to the user's interests, content-based recommender system in e-learning, and recommend users traveling places [11].

3 Context-Aware Recommender Systems

Context-aware recommender systems have been swiftly blooming as an effective way for relevant and useful learning retrieval according to contextual information. Recommendation techniques are classified into four different classes which include: Utility-based recommendation techniques, collaborative filtering, content-based recommendation techniques, and hybrid recommendation techniques. Each approach has its gains and losses. In our work, we have used collaborative filtering, content-based, knowledge-based, ontology-based techniques, and hybrid recommendations.

3.1 Collaborative based filtering

Collaborative filtering methods are based totally on gathering and analysing a large amount of data on user's behaviours, activities, or preferences and predicting what users will like based totally on their similarity. Some well-known e-commerce web sites propose such recommendations with success factors, based on a record of user

actions, user ratings, or correlations between different users (collaborative filtering principles) [12].

Some recommender frameworks, for example, Movielens [13], depend on collaborative filtering to customize the proposal of things. The PPG depends on a multi-operator design that encourages the mix of various client displaying methods to acknowledge the TV watcher's inclinations and the proposal of the projects to watch [14]. Since another thing has no perusing history, the separating and-personalization cannot depend on collaborative filtering (instead of different domains, for example, the proposal of books, films, and so on.), yet instead need to depend on content-based sifting, so once another thing lands to the News archive, the content-based sifting calculation can play out the essential coordinating with the clients' profiles and decide the level of importance of everything to the potential clients. Collaborative filtering recommender frameworks do this by requesting that individual's rate expressly pages and after that prescribe new pages that comparative clients have appraised very—collaborative filtering strategy matched individuals with comparable inclinations to make proposals. The favourable principle position of CF finished content is called fresh. Another method joins Content Characteristics with a Collaborative Approach. It utilizes a forecast plot like the standard collective filtering called cooperation employing content. It does not figure out the ratings that give by the clients yet considering the content profiles of every client. The fundamental fault of this approach is that the closeness of clients depends on people's relationships between content weight vectors.

The recommender systems use collaborative filtering, which is based on the taste information of the user to make automatic predictions. Collaborative filtering works on a principle that if two users have the same opinion over one matter, they are more likely to have a similar opinion on another different matter. Frameworks that utilize a keyword-based approach for content-based sifting face the issue of synonymy problem. Synonymy problems refer to the inability of the recommender system to detect the different words of the same meanings, and thus, the systems treat each word differently. The primary issue with collaborative filtering is collecting and weighing the taste information for neighbour users. If the user can achieve an immediate rating of the preferences, it can lead to accurate and precise recommendations.

3.2 Classification of publications

In Figure 2, we have classified relevant research papers that we studied in our work for ontology-based recommender systems. A total of 15 journal paper publications relevant to ontology-based recommender systems for context-aware were analyzed and classified according to the year of publication. All the 15 papers classified in this review study were published between 2003 and 2014.

A total of 10 of the papers were published between 2008 and 2014. From Figure 2, it is clear that there is significant growth in the number of publications on an ontology-based recommendation for context-aware from 2008 to 2014. Between 2003 and 2007, there is only a single relevant journal publication for each year. There is a continuous increase between the years 2008–2014.

3.3 Ontology-based recommenders in context-aware

By using ontology representation language, we can achieve knowledge about specific content. It has been proved that the ontological user profile improves recommendation accuracy and diversity. In this approach, we have used different ontology languages such as OWL, RDF, DAML, OIL, Ontology-based personalized couple clustering (OBPC), Semantic, and XML.

The Web Ontology Language is a family of representation languages, and that unit area is utilized to construct ontologies. The ontology is an accurate approach to address classification networks and classes. Mainly, it defines the knowledge associated with miscellaneous domain names. The OWL is characterized by formal linguistics, and it is concocted on an XML for objects known as the RDF. Each unit area is utilized for ontologies construction. Throughout the formation of the ontology system, we tend to utilize the domain ontology encoded with the RDF representation language.

Classification is conducted based on the domain scope ontology. We have included domain ontology and product ontology in ontologies. A domain ontology represents the concepts that are related to the realm elements of the world, for example, biology. Product ontology is used for the description of products. Zhiwen Yu et al., [15] developed a context representation model of ontology-based recommender using OWL. To ensure interoperability with third-party services and applications. For instance, Yannick et al., [12] used an ontology-based approach to express not only the interests of the user for anything described in an ontology but also the target of content for anything described in an ontology. The target mechanism was used in this paper was to support context-based recommendations and can be used to support other matching strategies. Collaborative filtering strategies infer the suitability of an item to one or more types of users. If a user has bought an item, the system can infer that other similar users could be interested in the same item. Then the recommender can be added to this item as a target, which includes properties of the buyer's profile.

3.4 Ontology-based recommendation techniques for context-aware

Ontology-based recommendation techniques are classified in Table 1. Table 1 shows that the ontology-based recommendation system and knowledge-based recommendation system are most commonly used by all the 15 recommender system users. In our survey, 11 out of the 15 recommenders used a hybrid technique isolated with collaborative filtering and content-based approach. Only 4 out of 15 ontology-based recommenders use collaborative filtering and content-based approach without isolation with the Hybrid recommender system.

Table 1. Classification of Recommendation Techniques

Reference	Hybrid	CF	CB	KB/OB	CA	FB	TA	Others
[16]	X	-	-	X	X	-	-	-
[12]	X	X	X	X	X	-	-	-
[17]	X	-	-	X	X	-	-	-
[18]	X	-	-	X	X	-	-	-
[19]	X	-	-	X	X	-	-	-
[7]	X	X	X	X	X	-	-	-
[16]	-	X	X	X	X	-	-	-
[20]	X	-	-	X	X	-	-	-
[21]	X	X	X	X	X	-	-	-
[22]	-	X	X	X	X	-	-	-
[23]	X	X	X	X	X	-	-	-
[24]	X	X	-	X	X	-	-	-
[25]	-	X	-	X	X	-	-	-
[26]	X	X	X	X	X	-	-	-

3.5 Recommended ontology-based learning resources for context-aware

Table 2 tabulates the various types of an ontology-based recommender system. It is evident that 11 out of 15 publications that we reviewed in this survey recommends personalized curricula and learning materials, paths, and goals. For instance, Giancarlo Guizzardi (2014) used the Infraware platform as a learning resource. Yannick Naudet and Sabrina Mignon (2004) recommend TV programs and LOs as learning resources, and Ana Régia Neves and Célia Ghedini Ralha (2013) and Oh Byung Kwon (2003) used artificial intelligence resource for the agent-based approach.

Table 2. Classification of ontology-based recommenders for context-aware and content base

Citation	Recommender system	Recommendation technique	Ontology Type	Ontology Representation Language	Recommended Resources
Ontology-based news recommendation	Ontology and semantic based recommender system	Content-based	Domain ontology	Semantic mapping rules	News items recommendation based on the user's interests and user profiling.
Course ontology user's knowledge necessities acquisition for behaviors with learning systems	Hybrid collaborating filtering	Collaborative based	Course ontology	Semantic rules and q/a process	To capture student's real requirements about the course and e-learning and user's knowledge.
Ontology-based architecture with recommendation strategy in java	Ontology-based recommender system	Collaborative filtering	Semantic web ontology	OWL	Ontology, tutoring system, recommendation systems

tutoring systems					
Towards the next generation of the recommender systems:	Content-based collaborative based hybrid	Collaborative filtering	Semantic ontology	Semantic mapping rules	Collaborative filtering, estimation methods, recommender systems extensions.
Travel ontology for intelligent recommendation system	Content and collaborative based	Content-based	Domain ontology	RDF and OWL	Information retrieval, HTML pages
Ontology-based image retrieval	Content based and semantic based recommender system	Content based	Task and domain ontology	Semantics-based language	Classifications, free-text descriptions, and image retrieval
Ontology-based learning content recommendation	Content recommendation	Content based	Domain ontology	Lo and axiom	Learning object, knowledgebase, recommendation, competency gap, and sequencing rules
Providing Entertainment by CB Filtering and semantic Reasoning in Intelligent Recommender systems	Content-based and semantic-based recommender system	Content and semantic	Domain ontology and generic and tv ontology	RDF and XML OWL, DAML and DARPA	Recommender systems, semantic reasoning, content-based filtering, interactive digital television.
Capturing knowledge of User Preferences (Ontologies in Recommender Systems)	Hybrid	Quickstep, multi-class	Domain ontology	Machine Learning	User Profiling
A proposed semantic Recommendation System for e-learning	Hybrid	Rule filtering	Domain ontology	Owl with swrl	Java programming language
A multi-purpose Ontology-based Approach	Content, collaborative	CSA	Domain ontology	Xml	Content filtering
A flexible and easy semantic inference methodology to reason about user preferences in knowledge-based recommender systems	Hybrid	Quickstep	Domain ontology	Owl and RDF	E-commerce and digital TV
Improving ontology- Based_ user_ profiles	Content-based	Collaborative	Ref. Ontology	Semantic rules	Web personalization, clients profiles

Exploiting the Web of data in model-based recommender systems	Model-based	Content/collaborative filtering	Domain ontology	OWL	Svm, DB-Pedia, movielens, Recall, precision
Linked open data to support content-based recommender system	Content-based	Lod-base	Domain ontology	OWL	Vector space model, DB-pedia
Multi-model ontology-based hybrid recommender in the eLearning domain	Hybrid	Content-based and rule-based	Domain ontology	Semantic mapping and OWL	Cluster-based recommender system
User modeling and Recommendation Techniques	Collaborative filtering	Collaborative based	General ontology	—	Guide user about tv programs
Taking advantage of semantics in rs	content and collaborative filtering	Hybrid	Domain ontology	OWL	Semantically upgraded reasoning and recommender systems
Semantic news Recommendation using Word-net	Content based	Content filtering	Domain ontology	Semantic mapping and owl	Semantic matching, news
Entertainment by Content-based Filtering and Semantic Reasoning in Recommender Systems	Content filtering	Content based Filtering	Domain ontology	Semantic mapping , RDF, XML, DARPA, DAML	Semantic reasoning and interactive digital television
Ontology-based curriculum content SS	Content filtering	Content based	Knowledge base ontology	OWL , SWRL and semantic Rules	Learning route, curriculum content sequencing
Exploring synergies between content-based filtering and activation in kb	Content-based and collaborative	Hybrid	Domain and user ontology	XML,OWL, DAML	Semantic reasoning and personalization
Ontological user Profiling in Recommender systems	Content-based and collaborative	Hybrid	Domain and Knowledge	X-	Artificial intelligence and user profiling
Learning Ontology User Profiles: A Semantic technique to Personalized Web Search	Content-based	Content filtering	Domain	Python programming language and natural language	User context web search and information mining
An ontology content-based filtering method	Content, collaborative	Quickstep, multiclass	Domain ontology	OWL with semantic mapping rules	User Profiles
Capturing Knowledge Of user Preference: Ontologies in recommender system	Hybrid	Quickstep, multi-class Machine learning	Domain ontology	KQML	User Profiling and machine learning

Con-Tag: A Semantic Tag Recommendation system	Content, collaborative	Semantic web	PIMO	RDF	Social software
Cross-Language Personalization through a Semantic contentbased Recommender System	Content	Quick step	Multi Word-Net Lexical ontology	Cross-language personalization	Word Sense Disambiguation, Multi Word-Net
E-Paper: A Personalized Mobile Newspaper	Hybrid	Statistical language modeling, sophisticated	Domain ontology	Ling Pipe's Language Model (LM)	User Profiles
Evaluation of an ontology-content based filtering method for a personalized newspaper	Content, collaborative	Quickstep	Domain ontology	English	User Profiles
Exploiting Semantic Product Descriptions For Recommender Systems	Hybrid	Vector space, collaborative filtering	Domain ontology	Object-oriented language	User Profiles
A Hybrid Recommender System Guided by Semantic User Profiles for Search in the Elearning Domain	Hybrid	Content-based	Domain ontology	Semantic rules	Recommender system, search engine, clustering, semantic data
A Multilayer Ontology-based Hybrid Recommendation Model	Content-based collaborative based	Hybrid	Domain	—	Hybrid recommender systems, communities of importance, ontology-based, client profiling
A Multi Purpose OB Approach for Personalized Content Filtering and Retrieval	Content-based	Content and semantic based	Domain	Semantic rules	Semantic-based, personalization, dynamic context.
A Semantic W-B Approach for Building Personalized News services	Semantic-based	Hermes	Domain ontology	OWL	Personalization
A hybrid system of pedagogical pattern recommendations based on singular value decomposition and variable data attributes.	Content, Collaborative based	Hybrid	Domain ontology	RSPP	Recommender systems; Pedagogical patterns; Singular value decomposition; Cosine Similarity

A content-collaborative recommender that exploits Word-Net based user profiles for neighborhood formation.	Hybrid	Content and CF	Domain ontology	Machine learning	User modeling, Collaborative filtering, Content-based filtering, Hybrid recommenders
Ontological content based Filtering for personalized newspapers A method and its evaluation	Hybrid	System analysis SA	Domain ontology	RDF	Personalization
Improving User Modeling with Content-Based	Content, collaborative	Word Domain Disambiguation	Domain ontology	English, Italian, Natural language processing	Word-Net
Informed recommender	Hybrid	Machine learning, text-mining	Domain ontology	Natural language	Consumer Product
Recommendations for Smart Phones	System				
Applications Of user and context-aware recommendations using ontologies	CF/CB/Hybrid	Personalization System	Domain ontology	OWL and RDF	Personalized curricula
Context-aware, Ontology-based Recommendations	Hybrid Recommender System	AMAYA recommender system	Generic and domain ontology	OWL	Personalized curricula
Context-aware recommendations on Rails	Hybrid Recommender System	Recommendation on rails, recommender construction kit	Domain ontology	OWL and Semantic	Personalized curricula
Cores: Context-aware, Ontology-based Recommender system for service	Hybrid Recommender System	Cores and kare	Domain ontology	OWL and RDF	Infraware Platform
Ontology-based Personalized and Context-aware Recommendations of News Items	CF/CB/Hybrid	Personalized recommendation models	Domain ontology	OWL	Personalized curricula
Ontology-based Matchmaking Approach for Context-aware Recommendations	CF/CB	Matchmaking, Content Based	Domain ontology	OWL and RDF	TV programs and Los
Ontology-Based Semantic Recommendation for E-learning	CF/CB	Semantic Recommendation, prototyping	Domain ontology	OWL	Learning material and prototyping
Personalized Context-aware recommendations in SMARTMUSEUM:	Hybrid Recommender System	Collaborating and content-based	Generic ontology	OWL and RDF	Learning paths & content

A Framework for Context-Aware Service Recommendation	CF/CB/Hybrid	Collaborating Filtering	Domain ontology	OWL and RDF	Learning materials
Agent-based Architecture for Context-aware and Personalized Event Recommendation	CF/CB	Context-aware recommendation system	Domain ontology	RDF and OWL	Artificial Intelligence
Recommetz: A context-aware	CF/CB/Hybrid	Recommits	Domain ontology	OWL	Learning paths & content
Knowledge-based mobile recommender					
"I know what you need to buy": context-aware multimedia-based	CF	Collaborating Filtering	Domain ontology	DAML and OIL	Artificial Intelligence
An Approach for Context-aware Service Discovery and Recommendation	CF/CB/Hybrid	Service Recommendation	Domain ontology	DAML And OIL And RDF	Learning goals
Sigtur/E-Destination: Ontology-based personalized recommendation of Tourism and Leisure Activities	CF/Hybrid	Sigtur/E-Destination system	Domain ontology	OWL	Learning paths & content
Supporting contextaware Media	Hybrid Recommender	Comer platform	Domain ontology	OWL	Learning materials

4 Content-Based Recommender Systems

Content-based recommender systems are used in information retrieval. First, terms are assigned manually, which means while assigning terms manually, a technique has to be chosen which compares these terms from the information in the client's profile, and a learning algorithm must be chosen to perform such techniques and then bring the related results to the client [27].

The thoughts of term frequency (TF) and Inverse document frequency (IDF) are used as a piece of information recuperation structures and content-based isolating frameworks (for instance, content-based recommender). They are used to choose the relative centrality of a record /article / news thing / film, et cetera. Content-based filtering is another standard method while designing recommender systems is content-based filtering. Content-based filtering methods are based on a description of the object and a profile of the person's choice. In a content-based recommender system, key phrases are used to explain the items, and a personal profile is built to suggest the kind of item this user likes. In different words, these algorithms try to recommend objects that are just like those that a user favored in the past (or is examining inside

the present). Numerous candidate items are compared with items previously rated by the user, and the best match result items are recommended. Yannick et al., [12] used a content-based algorithm to filter the best result recommended to a user.

The main advantages of a content-based recommender system include transparency, independence, and recommendations for unclassified entities. The drawbacks include serendipity, partial content analysis, and overspecialization [22].

A content-based recommender system generates recommendations provided by the user, either explicitly or by interface tapping. Considering that data, after the customer profile has been generated, it can be used to generate recommendations for the user. As the client provides more data sources or accepts activities suggestions, the engine becomes progressively precise. By using a content-based recommender system, instant results can be achieved. A content-based recommender system is much better than a collaborative system as it provides an easy implementation. We have used this system because it generated highly relevant and transparent results.

Content-based separating strategies often use content extraction and characterization systems for building client profiles and additionally for portrayals of content, i.e., item profiles. These techniques have a few weaknesses, e.g., bungle between client profile things and profile terms, prompting low execution. Content-based recommender frameworks prescribe items with comparable content to items the client has adored some time recently. Cases of the content-based proposal are Fab, which suggests site pages, and ELFI, which prescribes financing data from a database. Content-based sifting frameworks adjust their conduct to singular clients by taking in their inclinations from records that were at that point esteemed applicable. Content-based sifting manages contrasting portrayals of the content of things (archives) with portrayals of per user's interests, keeping in mind the end goal to discover things that are most applicable to every client. This represents an errand of finding the best portrayal for both the things (thing profile) and the clients (client profile). A client profile speaks to a mapping of the real client's enthusiasm to a smaller model domain, which is an estimate of the client's real certifiable interests. A client's profile and a thing's profile should share a typical portrayal (for instance: portrayal by keywords) to empower coordinating between the profiles.

The possibility of a Content-based recommender framework in an eLearning stage can be outlined as follows: We Give the addresses that the student needs to visit. The stage prescribes different addresses with content, which is like the content of the addresses saw by the student. We fabricate the learner’s ontology profile by extricating the student interests from that client's profile. Along these lines, we manufacture the ontology-based framework. Diverse content-based suggestion approaches have been utilized. Fundamentally, these methods are isolated in Heuristic-based and Model-based methodologies. The initial ones compute utility forecasts because of heuristic equations that are dependent on data recovery techniques. The content recommender framework is relying upon the level of similitude amongst things and articles that are required by the client in profile. It implies it is utilized to foresee the question, as per the client’s intrigue and if it has comparable content in another protest that is utilized to fulfil the client. These sorts of the framework have limitations too.

There are two essential excellent conditions of a content-based approach: to begin with, the model gauges, being established on resources rather than words, are more correct; second, the model is vernacular self-sufficient, allowing course in multilingual goals [28]. Content-based recommender frameworks mainly describe every shopper without matching his or her interests to different customers. They can give a rundown of content includes that clarifies why a thing has been prescribed. Such a rundown can reinforce customer trust in the suggestion and mirror the buyer's inclinations. In the content-based approach, shoppers can give some underlying data about the item to help the framework. Content-based filtering is situated considering the comparability of content (i.e., the client's profile and the records).

4.1 Ontology-based recommender system in content-based

The ontology-based recommender system is a formal representation of a knowledge domain, whose semantics is defined by its composing concepts and relationships. Ontologies can be used to express things unambiguously [19]. An ontology is a conceptual model that can be applied to describe a domain of discourse, modelling it as a set of concepts and relations. Recommender systems are founded on different ontologies for instances domain ontology, task ontology, generic ontology. Domain ontology is widely used in content-based recommender systems. Several researchers have used ontologies to discover user preferences and innovations in content-based recommender systems. For ontology construction, we create an office area and office domain. Every domain comprises of subordinate ideas, occasions, and properties. The e-learning frameworks are based on the core of the domain ontology. If we can generate ontologies that can be used as the base for various frameworks, they can support sharing, reusability, and regular phrasing. We have considered the two-rule based domain ontology display, which contains learner’s advantage based and bunch based. The mentioned framework is convenient to be implemented in several recommendation systems without keeping the activity domain into consideration. To reinforce the ideas and connections in the application domain, we require conventional and transferable vocabulary. Semantic web people group resorts to ontologies, i.e., conceptualizations that recognize common ideas and connections in an application domain.

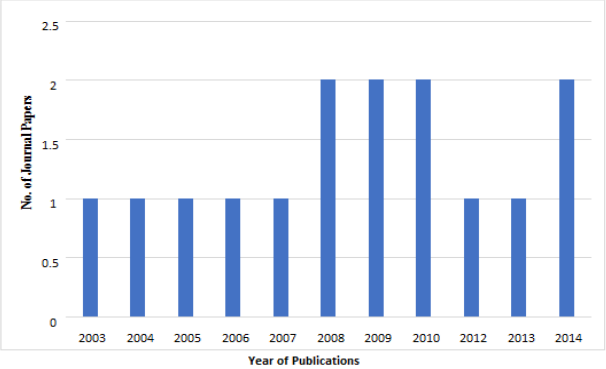

Fig. 2. Distribution of journal papers

Ontology is an emerging innovation for semantic information representation, which is associated with mastering systems. Our proposed technique models the client's profiles by reutilizing the information that is accessible in the domain ontology, named as ontology profiles. The Hermes news portal (HNP) application enables clients to discover and execute inquiries by utilizing a space ontology. The main objective is to retrieve applicable news matters. The solitary, java-based apparatus is used to utilize different semantic web innovations. Hermes assesses a semantic approach that depends on ontology ideas. The methodologies that apply domain-based inferences comprise producing deductions about the client's interests in consideration of the various levelled structure characterized by the ontology. The studies have enabled us to determine client inclinations for a few classes of TV programs that are coarser-grained than those of the general ontology. We have proposed an additional content-based technique for sifting and positioning the pertinence of items for clients, which uses a progressive ontology. The Quickstep recommender framework is displayed. Two exact investigations assess it in a genuine work setting, measuring the viability of utilizing a progressive theme ontology contrasted and an extendable level rundown. We can demonstrate that the data gave by Web 2.0 administrations in a mix with a semantic Web ontology empowers the era of applicable semantic label suggestions for archives [29].

Crossing over any barrier amongst labels and ontology, the approach portrayed the advancement of ontology in light of label uses. The utilization of an ontological content-based channel empowers personalization at each level of the ontology progression. Consequently, a client can get a customized rundown of things at the root level (i.e., the front page of the e-Paper) and at bringing down levels, as they select particular points to peruse, e.g., an arrangement of customized business-related news things are given when the client chooses to peruse the business class. There are inadequate ontological content-based profiling models available to articulate the client and content profiles in the ontology domain. All the issues related to the client's profile and related links can be resolved by utilizing the ontology.

The ontological and theoretical demonstration was equally utilized as a part of the request to distinct client profiles. For instance, the four-level ontology is utilized as a part of the Quickstep framework to recommend papers to experts by consolidating content-based and collaborative filtering methods. In the initial segment, we have planned the domain ontology that utilized the word Net. Yet, the phrasing or strategy that is utilized as a part of the word Net is entirely different and more extensive than numerous hypermedia. So, there was the issue of vagueness. In the next part, we have outlined the learner's ontology, so each learner has his own particular needs. This is removed from domain ontology and displayed as a subset ontology. We have dissected the structure of domain ontology and considered the semantic weights of the client profiles, so we have produced the domain idea space and generated assemblies of interests shared by specific users. Thus, those clients who share the same interests of a particular idea are congregated to form groups containing a higher weight of inclination. Domain ontology is considered as a crucial element in the models and systems.

Ontology-based personalization is a critical assemblage of research. It is wealthier, more exact than a keyword-based model. It gives fundamental alternatives to the rudiments of client inclinations. It utilizes ontology content analysis for introducing knowledge and for semantic inquiries. Ontology is utilized to isolate news things and enables the client to choose the points of interest. Word sense is utilized to build the precision of the arrangement of news things. Besides, it is convinced that the discovered lexical overview significantly presents the domain ontology. An ontology that is utilized as a part of the instructive example plans to tackle the issue of structure and portrayal of the particular example. The ontology provides a consummate type of portrayal and characterizing standard vocabulary. Procedures that are utilized to create ontology are dependent on the domain of ontology. The general assumption that we get from these techniques is that the lexical approach depends on the WordNet that requires more changes to gain from semantic profiles. Thus, these upgrades coordinate domain ontology that gets all the more capable information approach.

We have proposed a display of the client's data by consistently incorporating information incorporating the prompt and prior responses of the client. Also, information gathered from a prior ontology is used as a portrayal of the domain of the intrigue. In the current structure, the client setting is addressed to utilize an ontological client profile. Initially, each ontological client profile is considered as an illustration of the reference ontology. The e-Paper framework is a customer service application. On the server-side, it computes news coming ceaselessly from news suppliers and groups every news thing to subject ideas utilizing news ontology. Ontology is a conceptualization of a domain into a human-reasonable framework. Our ontological way to deal with recommender frameworks offers many favorable circumstances and a couple of advantages.

4.2 Content-based recommender

The main reason for analysis is to understand the content-based recommender system in different fields of today's area of study. In a flexible semantic inference

methodology, a proposal procedure utilizes content-based separating and a method that was about deserted years ago because of a few limitations uncertain in the best in art. In particular, our approach solves the overspecialization of the content-based suggestions that things like those the client knows. To battle the overspecialization of the explained suggestions, our system utilizes semantic derivation methods. Semantic ontologies give additional learning about the client premiums and permit the recommender framework to contrast them and the accessible information more efficiently. The proposed methodology is very sufficiently straightforward to be actualized in numerous recommender frameworks, disregarding their application domain. This activity portrays the Web assets by ontology and reasons for their semantics. Such thinking permits to derive semantic connections among the assets and find learning for improved data recovery tasks.

We have proposed a semantic recommender framework for e-learning by methods in which learners will have the capacity to discover and pick the correct learning materials reasonable to their field of premium. Semantic web innovation puts more attention on learning portrayal and administration. The primary reason for the semantic Web is to empower mechanized coordinated effort over the Internet, because of metaphysics. Philosophy is the root of the semantic Web. By utilizing philosophy, the semantic methods are provided for traditional e-learning. The ontology presents materials that are identified with our space in e-learning and semantic connection between them. To produce a recommender framework, it is essential to characterize a customized strategy and suggestion calculation. The customized content suggestion is a noteworthy efficacy for modern eLearning frameworks. The recommender framework in e-learning utilizes predefined principles to channel data and prescribe content to learners. In e-learning, content sifting prescribes considering the comparability between content for one client while collaboratively separating functions considering closeness between client profiles. Content-based and collaborative filtering separating works contemplating rating framework. There is inconsistency with the e-learning frameworks, which requires sharing and reusability. The absence of reusability and share the capacity of current information in e-learning frameworks have emerged as the most significant challenge in the modern era. Our proposed system utilizes the semantic Web and ontology since ontology empowers information to be reusable and sharable because of its auxiliary nature [30]. Along these lines, a web-based learning condition is considered as an essential part of today's training.

Most recommender frameworks utilize a straightforward twofold class approach, utilizing a client profile, and recognizing what is fascinating or not for the client. The Quickstep recommender framework utilizes a multi-class approach, permitting a profile for space ideas (inquire about paper points) to be manufactured [31]. The multi-class characterization is less exact than other double order frameworks. However, it permits particular class criticism and space information (through an “is -a progressive system”) to upgrade the profiling procedure. Two trials were led to survey observationally both the general adequacy of the Quickstep recommender framework and to evaluate the impact made by utilization of the ontology. We have utilized a philosophy to examine how area learning can help in the securing of client interests.

The reason for the two trials is to analyse a grouping of clients utilizing a content marking procedure with a grouping of clients utilizing a level rundown naming technique. Our theory for the content gathering's clean execution is that the is-a chain of command creates a rounder by adding general superclass themes if a client uses a particular subject.

The average client profiling approach for recommender frameworks is content-based, utilizing a paired model speaking to what clients find fascinating and uninteresting. This thought has prompted content-based recommender frameworks, which unpretentiously scrutinize the client's profiles on the Web and suggest new pages that relate to the client profile. With adequate positive and negative illustrations, current machine learning strategies can arrange new pages with fantastic exactness. Various machine learning techniques have already employed in the domain of healthcare [32, 33], finance [34], and surveillance [35]. Client's information pre-requisite obtaining and an investigation is imperative for a customized or client versatile learning framework. Conventional instructive methodologies are typically instructor driven, not understudy driven, because they don't adequately consider the distinction in qualities between various understudies. Keeping in mind the end goal is to upgrade understudy driven learning and guideline effectiveness. Educators ought to comprehend the understood information pre-requisite of understudies to get ready and plan their showing materials for the understudies.

We have frequently considered the rank of the learning pre-requisite instead of the correct estimation of it. This implies what a client's versatile or customized framework is most concerned with, and which components are required by an understudy. For a customized course plan in an eLearning framework, it is crucial to obtain the client’s additional information. In this framework, two methods have been proposed and executed for the essential data retrieval of the customers inside the e-learning structure about the course content. The next era of e-learning is ready with the enormous market, a market, and advancement that incorporates getting the hang of planning, exhibiting, and online support.

Moreover, everything hitting us electronically can be called e-learning. The conventional showing strategy is now demonstrating its confinements that understudies from various foundations are as yet given a similar learning substance in the meantime, and they may just enthusiasm for some portion of the entire learning content. We have examined the instrument with the learning base editorial manager. The goal of the semantic Web is to furnish conveyed data with exceedingly characterized meaning, the reason for people and machines. E-learning is an essential space that can be benefitted from semantic web advancement. Semantic web advances are a promising mechanical establishment for the coming era of e-learning frameworks [36].

In this paper, we have proposed how Semantic Web headways and particularly ontologies can improve functionalities of a present Java instructing system. The plan for such a flexible and altered content structure relies on semantic web rules and developments. The type of a few ontologies has been proposed which relate to the parts of a content-based framework. Data over-burden is winding up noticeably extreme in our present-day times of broad communications, worldwide

correspondence offices, and learning the client's capacity to recognize significant data from unessential. Like this, huge researchers have been investigating robotized sifting frameworks that provide clients with attractive and fascinating data [37]. In the most recent decade, the purposed recommender frameworks have been picking up energy as another effective method for unpredictability when hunting down essential data.

Moreover, recommenders have additionally pulled in expanding open enthusiasm, levelling the ground for new business openings in various fields, for example, web-based business and Digital TV [38]. In these areas, their principal target is to filter through substantial arrangements of data and to choose those items the clients will acknowledge, considering their past interests, history of search, and statistic data. Our reasoning-based strategy has been executed in a recommender structure for Interactive Digital Television. We have observed that the proposed framework offers precise, updated proposals that would go unnoticed in the conventional strategies.

In travel ontology for advance recommender frameworks, fly out data is expanding to offer the vacationers on the sites. Since there is a considerable amount of data given on the Web. The client gets puzzled in finding ideal data [39]. Keeping in mind the end goal is to discover the arrangement of these web issues, the possibility of the semantic Web has correspondence amongst humans and PC. The semantic Web is not just concentrating on the recovering techniques for content coordinating. Additionally, it can recover the semantic relationship of each protest utilizing the equivalent word, antonym, and hyponym connection of words.

These days, there is an extensive variety of data, for example, the vacation spots, settlement, and nearby gourmet nourishment to claim the visitor on the Web. The travel specialist assumes an imperative part in both arranging and suggesting for customized travel course. Additionally, when surfing on web administrations, end clients progressively need more effective instruments to be able to do grouping and translating the tremendous measure of heterogeneous data accessible on the Web. Be that as it may, the data has extreme impediments due to showing in HTML, which is intended for people to peruse instead of machines to translate and naturally handle. In this framework, we have proposed the smart suggestion framework in light of travel ontology. In like manner, we have utilized the data of Jeju (located in southern Korea, is renowned for a volcanic island), for instance, lodging, fascination, and so on. The proposed framework can prescribe vacationer more smart data utilizing properties and connections of travel ontology. The framework oversees discovering customized interests and plotting area of voyager on the AlMap. The Jeju travel ontology comprises of extricating of various leveled data and example data. Our framework can recover Jeju travel data more effortlessly, and we bolster Jeju travel course suggestions relying upon ontology (inclination profile and exchange profile). Likewise, it is mapping amongst representation and Almap (a sort of Digital guide) and application programming interface (API). If the client needs an incredibly delicate area. We can show precise areas from recovery utilizing this computerized outline. In this framework, we have proposed an insightful suggestion framework because of Jeju travel ontology to take care of many answers-issue. The proposed framework can prescribe the traveler more useful data utilizing properties, connections of travel ontology and help them to expect disarray of streets or attractions.

While most methodologies explore traditional data recovery procedures, e.g., closest neighbour inquiries in metric domains, accessibility, and utilization of wealthier semantic meta-data about items may additionally enhance suggestion quality essentially. Gigantic scientific categorizations for item orders are transitioning, e.g., the United Nations Standard Products and Services Classification (UNSPSC, for example, Amazon.com order scientific categorizations for books, DVDs, CDs, and clothing [40]. We have battled the overspecialized idea of customary content-based recommender frameworks. It proposed things fundamentally the same as those the client knows (principally because of the selection of syntactic coordinating methods).

The oddity is that our content-based approach defeats this impediment without considering the inclinations of different people, which was the central arrangement proposed so far in writing at the costs of presenting other extreme disadvantages. Our approach is non-sufficiently specific to be utilized as a part of a wide assortment of a domain, furthermore, recommender frameworks. The proposition has been preparatory assessed by statistics-driven tests, including genuine clients in the proposal of Digital TV content. The outcomes uncover the clients' fulfilment concerning the precision and assorted qualities of the thinking driven content-based suggestions. Moreover, in the word-based case, we considered a word list record portrayal, where each word has a score contrarily relative to the word recurrence in the news corpus. We have introduced another rendition of Site IF, a recommender framework for a Website of multilingual news. Exploring content-based archive portrayal, we have depicted a model of the client's advantages in light of word faculties rather than merely on words [41].

We have made informed recommender to address the issue of utilizing purchaser assessment about items and communicated online in freestyle content to create item suggestions. Our procedure manufactures a gathering of necessary customer item audits. The strategy for gathering audits takes after the calculations for robotized news extraction from news destinations. Once the item's feelings mining base was populated, we have utilized the content mining methods to remove valuable data from survey remarks. At this point, we will discuss the general system for mechanizing the utilization of customer audits and the structure's segments. We have utilized existing calculations, for instance, in the content mining process because we will show our approach's qualities. The framework can give the client a rundown of some of these supporters, and their past buys to clarify and make the client sure about the proposal. Research utilization of audits in a recommender framework is still in its earliest stages. To the best of our insight, this is the primary endeavour to construct a recommender framework in light of survey remarks in free shape content.

Different analysts have utilized surveys to give some clarification about an item proposal. Despite these issues, we have considered the outcomes we got to be great since we can precisely outline an expansive part of a survey into the predefined ontology. Executing this technique gives our framework a chance to utilize important printed data to make suggestions. This enables our framework to conquer the frosty begin problem, which challenges collaborative filtering procedures. Numerous personalization approaches depend on a client profile, which is an information

occasion of a client demonstrate that is caught considering the client's communication. Client profiles may incorporate statistic data and, besides, address the interests and inclinations of the client. Client profiles that are kept up after some time can be arranged into here and now what is more, long term profiles. Here and now, profiles can be used to monitor the client's later and quicker evolving interests. Long term profiles reveal client intrigues that are generally stable a time duration. A spreading enactment calculation is utilized to keep up and incrementally refresh the intrigue scores considering the client's progressing conduct. We have demonstrated that re-positioning the list items is related to the intrigue scores. The semantic proof caught in an ontological client profile empowers a versatile framework to exhibit the most important outcomes to the client. If the keywords of the client profile are not the same as those of reports, important archives may be missed. However, a specific word may have more than one value, prompting unessential archives being recovered.

4.3 Recommendation technique(S) recommenders for content-based

Table 3 presents the classification of recommendations.

Table 3. Classification of recommendation techniques

Citation	Hybrid	CF	CB	KB/OB	CA	FB	TA	Others
[42]	X	—	X	X	—	—	—	X
[43]	X	X	—	X	—	—	—	—
[9]	X	X	—	X	—	—	—	—
[39]	X	X	X	X	—	—	—	—
[11]	X	—	X	X	—	—	—	X
[36]	X	—	X	X	—	—	—	—
[44]	X	—	X	X	—	—	—	X
[31]	X	—	—	X	—	—	—	X
[8]	X	—	—	X	—	—	—	X
[45]	X	X	X	X	—	—	—	—
[38]	X	—	—	X	—	—	—	X
[37]	X	X	X	X	—	—	—	—
[46]	X	X	X	X	—	—	—	—
[40]	X	—	X	X	—	—	—	X
[47]	X	—	X	X	—	—	—	X
[14]	X	X	—	X	—	—	—	—
[48]	X	—	X	X	—	—	—	—
[44]	X	—	X	X	—	—	—	—
[49]	X	—	X	X	—	—	—	—
[41]	X	X	X	X	—	—	—	—
[50]	X	X	X	X	—	—	—	—
[27]	X	—	X	X	—	—	—	—
[51]	X	X	X	X	—	—	—	—
[31]	X	—	—	X	—	—	—	X
[52]	X	X	X	X	—	—	—	X
[10]	X	—	X	X	—	—	—	X
[53]	X	—	X	X	—	—	—	—

[54]	X	X	X	X	—	—	—	X
[29]	X	X		X	—	—	—	X
[55]	X	X	X	X	—	—	—	X
[7]	X	X	X	X	—	—	—	—
[45]	X	—	X	X	—	—	—	X
[56]	X	—	—	X	—	—	—	X
[57]	X	X	X	X	—	—	—	—
[58]	X	X	X	X	—	—	—	—
[59]	X	—	—	X	—	—	—	X
[28]	X	X	X	X	—	—	—	—
[60]	X	—	—	X	—	—	—	X

5 Hybrid Recommender System

Recent studies have established that a hybrid method, combining collaborative filtering and content-based filtering may be extra effective in a few cases. Hybrid strategies can be carried out in numerous approaches: by way of making content-based and collaborative-based predictions one at a time and after that combining them; or by adding content-based abilities to a collaborative-based approach (and vice versa); or by unifying the methods into one version [20]. It is a combination of content-based filtering and collaborative based filtering. A hybrid recommender joins content-based and CF strategies under a solitary system. Content and CF have numerous impediments and can be secured from the Hybrid arrangement of the proposal [7]. Hybrid framework joins with content and CF with one of the following methodologies:

- First, execute all techniques and afterward consolidate the outcomes
- Blend a few components of content with the shared approach
- Incorporate some CF attributes with the content approach

The strategy that we have used to outline a hybrid framework depends on a blend of collaborative and content-based that learn and dissect client profile that because of content by utilizing diverse techniques. Our hybrid data filtering approach allows appropriately gathering profile closeness between two given clients. However, the two operators have not evaluated any items in like manner.

6 Analysis of Publications

We have carried several studies on the ontology-based recommendation in context-aware from the year 2003 to 2014. For instance, [15] designed an architecture named: The CoMeR architecture to support media recommendation, adaptation, and delivery for smartphones. By using CoMeR, they have made a context-aware movie recommendation system for cell phones called ContAwareMovie. This recommendation system recommended movies based on the context information,

which used hybrid recommendation techniques and ontology-based knowledge structures in its recommendation approach.

Similarly, [12] presented a personalization system in his work, which used ontology to represent knowledge and matchmaking algorithm for multimedia content recommendations. The target mechanism was used to support the context-based recommendation. Collaborative filtering techniques were used to present and item which suit one or more type of users. Tim et al., [17] proposed a framework named: Discover, which can integrate context information in the recommendation process. Discover used hybrid recommender systems as it provides integration of many recommender techniques and context information. Christian Räck et al., [18] suggested AMAYA recommender system that could deliver convenient news articles for each user. Giancarlo et al., [19] developed a recommender system named: COReS (context-aware. Ontology-based recommender system for service recommendation), which used the abilities of the Infraware platform to support service selection by making services offered by this program more efficient, personalized, and proactive and then it will also satisfy the needs of a user in its context.

Iván et al., [7] proposed a hybrid recommender system named: News@hand, which combined content features and collaborative information to make relevant news suggestions according to the user's profile and user's contextual information. They combined the ontology-based personalization system with context-aware recommendations to give accurate suggestions. Yannick et al., [12] proposed an ontology-based matchmaking approach for context-aware recommendations. They have presented a survey of an ontology set and a matchmaking algorithm that makes accurate recommendations by keeping a given user profile and situation, interests, and associated context. Yuichi Nakamura et al., [16] proposed an ontology-based methodology for semantic recommendations.

InnarLiiv et al., [20] implemented a recommendation platform named: SMARTMUSEUM. SMARTMUSEUM recommendation platform combines a semantics-based approach and ontologies-based method with data mining and statistical techniques. They have presented the architecture and the main techniques of this system. Dong Liu et al., [21] proposed an ontology-based context model which uses RDF rectification and OWL to explain temporal characteristics and to derive high-level contexts from raw data-keeping given user's contextual information. They also improved the SAW algorithm to deal with semantics and proposed appropriate service to the user. Ana Régia et al., [22] proposed an agent-based architecture for context-aware and personalized event recommendation systems based on ontology and spreading algorithms to offer context-aware recommender systems an intelligent processing technique.

The proposed agent-based architecture was authenticated with the modelling and implementation of eAgora. Luis Omar et al., [23] proposed a recommender system named: RecomMetz, which is a context-aware mobile recommender system and is based on semantic web technologies, determines which movie showtime are to be presented to a user keeping given the location, time, and the crowd. Antonio Moreno et al., [24] implemented SigTur / E-destination for tourism and leisure interests. They used domain ontology to account for each user; the system will take as much

information about the user as possible to provide an accurate recommendation. OH ByungKwon et al., [25] developed a prototype agent-based system named: Context-aware multimedia Agent (CAMA). They focused on how the semantic Web developed a context-aware recommendation system, and to determine a way to represent multimedia-based ontology by extending ARG. Hua Xiao et al., [26] proposed a context modelling method that could handle various context types and values dynamically. They also used ontologies to enhance what a user might need. Some other ontologies are also used, which include generic ontology and reference ontology. Moreover, ontology-based representation language is widely used is OWL. Other languages that are used along with or separately from OWL include RDF representation, DAML (Agent markup language), Semantic, and OIL.

Other learning resources include artificial intelligence, prototyping and TV programs, and Los. The recommended resources that are presented in Yannick Naudet [12], Tim Hussein, Timm Linder [17], Christian Räck [18] recommended personalized curricula. In contrast, Yuichi Nakamura [16], Innar Liiv [20], Tanel Tammet [20], Zhiwen Yu [16], and Xingshe Zhou [15] recommended learning materials, paths, and goals.

7 Conclusion and Future Work

We have presented a brief review of ontology-based recommendation for context-aware. Our work discloses that the ontology-based recommendation system, combined with other recommendation techniques, is universally used to recommend context-aware resources.

Ontology domain knowledge can efficiently contribute to enhance the accuracy and quality of recommendations. However, cold-start drawbacks remain the same.

For future work, there are three context-aware recommendation system) architectural models that are contextual pre-filtering, contextual post-filtering, and contextual modelling. We will try to overcome challenges that we face in pre-filtering models that are context over-Specification that include the Sparsity problem: overly specified context may not have enough training examples for accurate prediction Generalization in which we use latent factors models or dimensionality reduction approaches to overcome this problem. We can further apply context-aware splitting approaches based on contextual pre-filtering to produce a 2D data set that incorporates context information associated with preference results. This will also lead to the sparsity problem, which we will need to overcome. We can also introduce semantics into the similarity of contexts to further alleviate the sparsity of contexts. We can also introduce factorization in contextual modelling to fit the data using various models. One of them is tensor factorization that can extend the two-dimensional matrix factorization into a multi-dimensional version of the same problem and then multi-dimensional into lower-dimensional representation. We can also implement various statistics and data mining techniques present to our data to get accurate and more specific contextual information.

The research on all the publications concluded that: in a content-based recommender system, the system will recommend users all the sites and data or information in which the user is interested or based on the client's interests or recent searches and ratings different sites. All the papers are directly relevant to e-learning and many different fields in content-based recommender systems. Using semantic-based, we can also recommend news items to the users, depending on their interests. After our research about recommender systems, we concluded that content, collaborative, and semantic are the significant and useful recommender systems to recommend users and clients according to their needs and interests.

7.1 Possible extensions

- Other essential research methods that have been investigated in recommender frameworks are writing incorporate logic, dependability, versatility, and security issues of recommender frameworks
- In the suggestion procedure, the engine analyses the things that were evaluated by the client with the things he did not rate and searches for likenesses. Those things that are, for the most part, like the decidedly evaluated ones, will be prescribed to the client. We should prescribe the user not only the things that he rated good points but also the things he searches frequently
- In this recommender system, we mostly used domain ontology in suggesting items and things according to the client's interests and likeness. We may also use task ontology instead of the domain
- We can also design content-based recommender systems in XML and jess rules, and we can also implement KB/OB recommendation techniques
- We can also apply content based on many domains to set the user profile
- Content-based fuzzy techniques can also be implemented to determine the items related to the user's interests. A fuzzy item representation technique will find similar measures
- The recommendation system can be extended in multi-criteria ratings
- More comprehensive methods can provide much better suggestions

7.2 Limitations

- To make the ontologies a challenging task and it requires a lot of skills and hard work
- There are many obstacles in content-based recommender systems, like experienced researchers, who can only work on these systems

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