"STUDY OF SEMANTIC WEB BAS`ED E-RECRUITMENT SYSTEM : REVIEW"

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Abstract: Data retrieval of existing online recruitment systems on the basis of exact match finding techniques of user's stored profiles and the recruiter's requirement is an addressable issue nowadays. Despite of eligibility criteria all the exact details of an applicant does not match the recruiter's online form leading to zero results. Several Ontologies have been popular in the field of knowledge management and knowledge sharing, especially after the evolution of the Semantic Web. Ontology defines the terms and concepts (meaning) used to describe and represent an area of knowledge. The aim of this research is to review the existing Ontologies developed for e – recruitment. In this paper I have done a review and analysis of semantic web based e – recruitment systems with their different concepts undertaken for their development. It involves study of different job portals for domain terminology, different semantic technology used so far for similar purpose, development of Ontology, Development and testing of SPARQL queries for accurate searching, Deployment over the Internet to conduct practical search. I have explained the e-recruitment process and methods listing them through several sections and drawn the conclusion.

Keywords: Semantic web, e-recruitment, Ontology, literature survey

1. INTRODUCTION

E-recruitment

Recruiting suitable candidates online for the vacant jobs with the help of recruitment websites using different online resources is known as e- recruitment. It is the general practice of using different Web-based resources for searching, matching, checking, reviewing, interviewing and hiring new applicants (job seekers) in an efficient and effective way.

Benefits of E-Recruitment

- Free form filling and flexible recruitment process in comparison to physical recruitment process.
- Reducing cost of advertisement and marketing.
- Does not involve any intermediaries.
- Job seeker can apply in any part of the world and explore the entire world job vacancies at any time 24 x 7.
- The Recruiting Company and the Job applicant, both shall have the benefit of meeting each other online through the job portal developed. The Recruiting Company post their job requirements online and the suitable candidate can fill in his profile for the vacancy.
- Costs less time in hiring the suitable candidate for the job.
- Hiring the Right match for the Right job through E-Recruitment, by matching the applicants resume with the job profile.
- The recruitment process becomes more efficient and easy to record details of the applicant.
- Nowadays Monster.com, Naukri.com, indeed.com, GoogleforJobs are few online recruitment websites providing multiple forms to suit the candidates eligibility criteria with the hiring firms requirement on WWW.

Limitations of E-Recruitment

- Data retrieval in the current e- recruitment process is based on the exact match of the job and the applicant's details.
- Still companies cannot rely fully on Internet for hiring suitable candidates.
- Meeting in person is also an important aspect to know and understand the job applicant.
- In many parts of India still Internet has not gained much popularity since internet penetration and awareness among people is much less.

2. ONTOLOGY

Ontology is defined as formal naming specification of shared conceptualization exploring the interrelationship between entities which actually exist in the source domain. In brief, it is a study of different things that exist and the existing entities in the world. It is derived from the Greek word onto (being) and logia (written or spoken discourse). It is a branch of metaphysics , the study of first principles or the essence of things.

Ontology has different definitions in different fields. In Artificial Intelligence, it is the "the specification of conceptualizations, used to help programs and humans share knowledge." According to Tom Gruber, an AI specialist at Stanford University. In IT field, it is defined as formal naming specification of shared concepts like entities, attributes, events and their relationship to enable creation of a agreed vocabulary of terms for information exchange. After the evolution of Semantic Web ontologies have been popular in the field of knowledge management and knowledge. Any area of knowledge can be easily defined by the Ontology which defines its terms and concepts (meaning). It has four basic components namely concepts, relationship, instances and axioms.
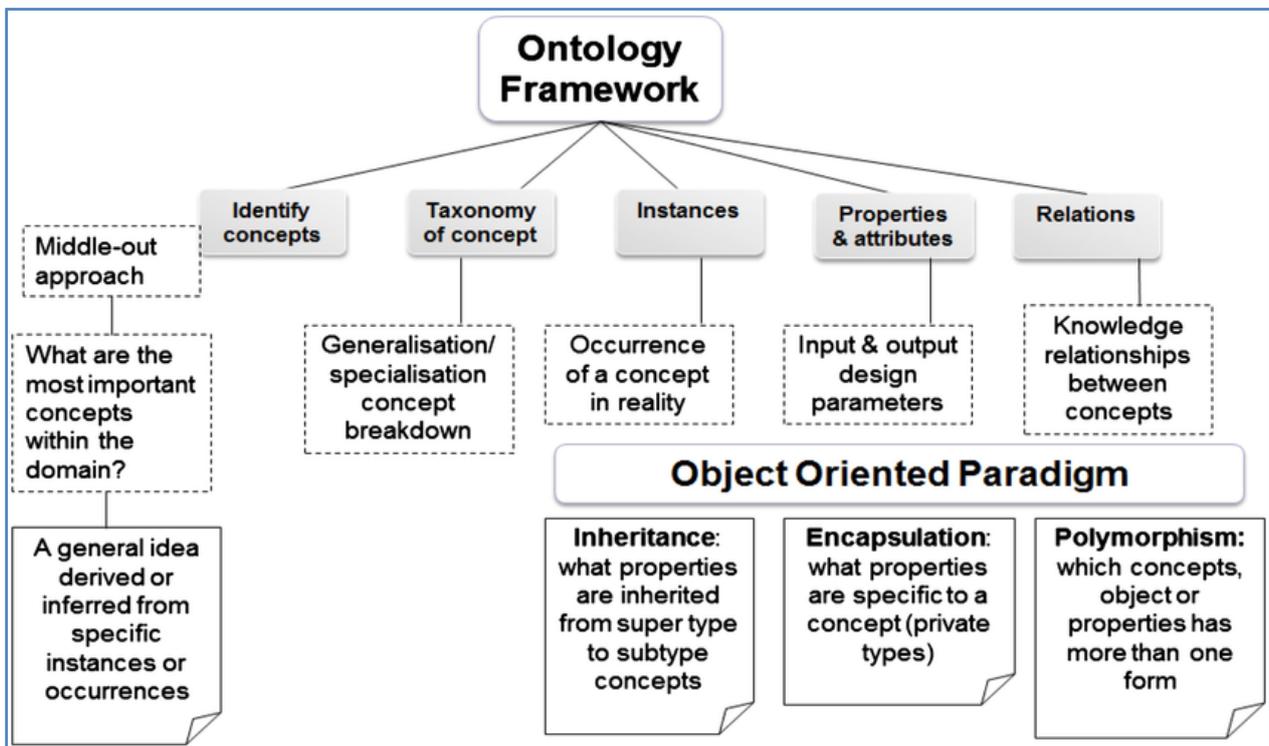
Figure 1: OOP paradigm in ontology development for KBE system [9].

Ontology building tools[13]

1) Protégé 3.4 is a knowledge based ontology editor providing graphical user interface. It provides better flexibility and enables the construction of domain ontologies.
2) IsaViz is a visual environment for browsing and authoring RDF models as graphs.
3) Apollo is a user-friendly knowledge modelling tool. The modelling is based around the basic primitives, such as classes, instances, functions, relations among application.
4) SWOOP is a Web-based OWL ontology editor and browser. SWOOP contains OWL validation and offers various OWL presentation syntax views.

3. SEMANTIC WEB

The World Wide Web Consortium (W3C) promoted common formats for data on the World Wide Web. It aims at converting the current web of unstructured documents into a "web of data". It builds on the W3C's Resource Description Framework (RDF). The architecture of semantic web is illustrated in the figure below. The first layer, URI and Unicode, follows the important features of the existing WWW. Unicode is a standard of encoding international character sets and it allows all different languages to be used in one standard form.

Uniform Resource Identifier (URI) is a string of a standard format that allows unique identification of resources. A subset of URI is Uniform Resource Locator (URL), which contains access mechanism and a (network) location of a document - such as http://www.example.org/. It offers solution, capturing and exploiting the meaning of terms to transform the Web, from a platform that focuses on presenting information, to a platform that focuses on understanding and reasoning with information. "The Semantic Web is an extension of the current web in which information is given well-defined meaning, better enabling computers and people to work in cooperation" [12].
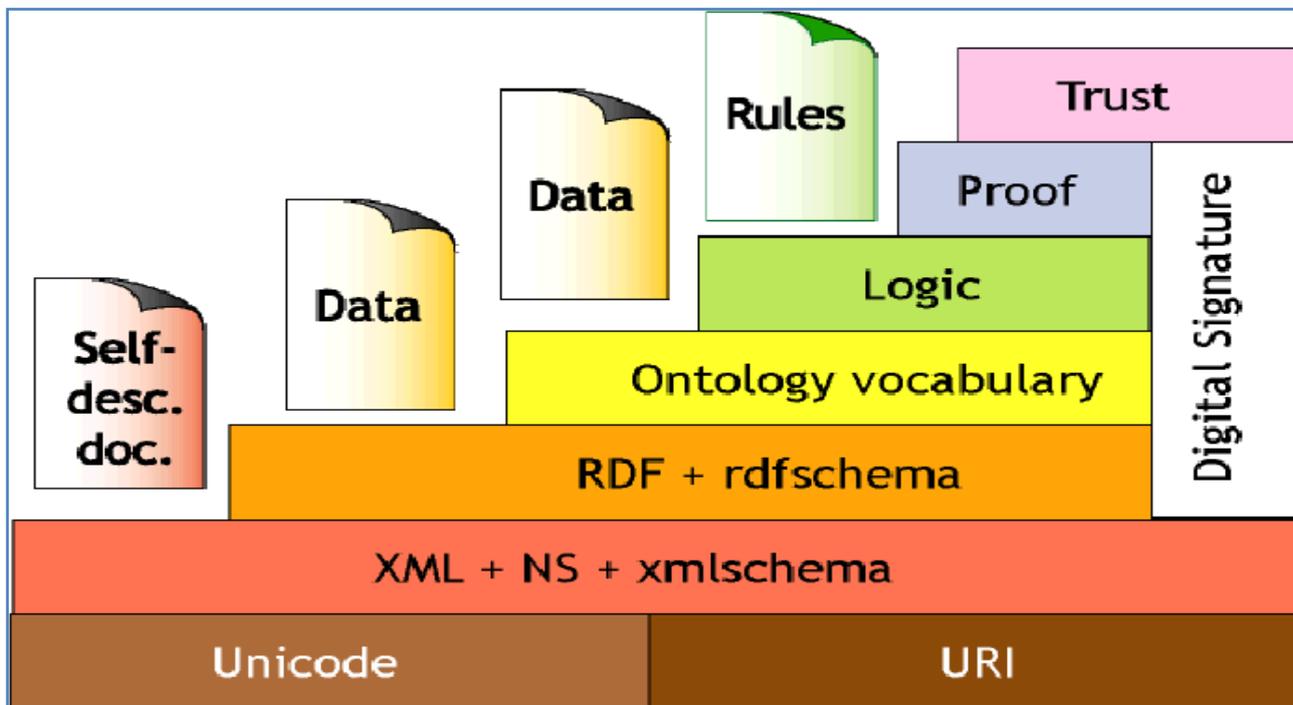
-- Tim Berners-Lee

Figure 2.Semantic web layers (Fgure by Tim Berners-Lee, http://www.w3c.org/2000/Talks/1206-xml2k-tbl/slide10-0.html[10]

XML

Extensible Markup Language (XML) layer with XML namespace and XML schema definitions makes sure that it follows a common syntax for terms used in the semantic web. It is a general purpose markup language for documents containing structured information. It contains elements that can be nested and that may have attributes and content. It allows specifying different markup vocabularies in one XML document.

i) Resource Description Framework (RDF).

A Resource Description Framework (RDF) is a data representation format. It represents resource information in a graph form**.** It was basically intended for representing metadata about WWW resources, such as the title, author, and modification date of a Web page. It can also be used for storing any other data. It is based on triples subject-predicate-object that form graph of data. All data in the semantic web use RDF as the primary representation language.

ii) Web Ontology Language (OWL)

A language derived from description logics which offer more detailed ontology constructs over RDFS is OWL. It is syntactically embedded into RDF, so like RDFS, it provides additional standardized vocabulary. RDFS and OWL have semantics defined which can be used for reasoning within ontologies and knowledge bases described using these languages. To provide rules beyond the constructs available from these languages, rule languages are being standardized for the semantic web as well.

iii) Simple Protocol and RDF Query Language (SPARQL)

SPARQL, a Simple Protocol and RDF Query Language are used for querying RDF data, RDFS and OWL ontologies. It is an SQL-like language that can be used for querying ontologies, but uses RDF triples and resources for both matching part of the query and for returning results of the query. It is also a protocol for working with RDF data.

IV. Comparison of WWW and Semantic Web

Today's Scenario: The Syntactic Web: A syntactic web is a place where computers do the presentation easy and people do the linking and interpreting, which is actually a tough work. [Hendler & Miller 02]. The Syntactic Web the following difficulties are observed namely..

- Locating information in data repositories
- Travel enquiries
- Prices of goods and services
- Complex queries involving background knowledge
- To book an Hotel not too far away from city and place is calm and cool and weather is pleasant

Why we need to add Semantics?

Ontologies are used to specify the meaning of annotations. Ontologies provide a vocabulary of terms. It derives new terms by combining existing ones. Meaning (Semantics) of such terms is formally specified and to specify relationships between terms in multiple ontologies. Let's understand the concept using a Travel example [11].

A person searched for the word "child-friendly hotel at the beach in Northern Germany" in Google. He found a website with the review of a hotel in Dubai. It was located as it contained the words "beach", "Germany", and "children". Upon closer inspection he noticed, however, that Germany was the country of origin of the customer who wrote the review, and his profile said "children: none"– hence the match for "children". A search engine just checks for matches of words. It is called a "Syntactic Web "as it searches for the results on the basis of matching of characters without understanding its meanings. Semantic Web tries to go a step further. A semantic application for hotel search could deal with the customer's request "child-friendly hotel at the beach in Northern Germany" in the following manner:

- Linguistic analysis of the search query, for example, "Hotel" is a noun, "child-friendly" is an adjective and "with swimming at the beach" and "Northern Germany" is adverbial particles.
- Synonym used, for example, "family-friendly" is something similar to "child-friendly".
- Reasoning, as Northern Germany is a part of Germany, adjoins both North and Baltic Sea, seas have beaches etc.

- Matching is done here by finding hotels that match closely with the description.

In contrast to the Syntactic Web, any application of the Semantic Web would understand the search keywords similar to human beings and draws conclusions.
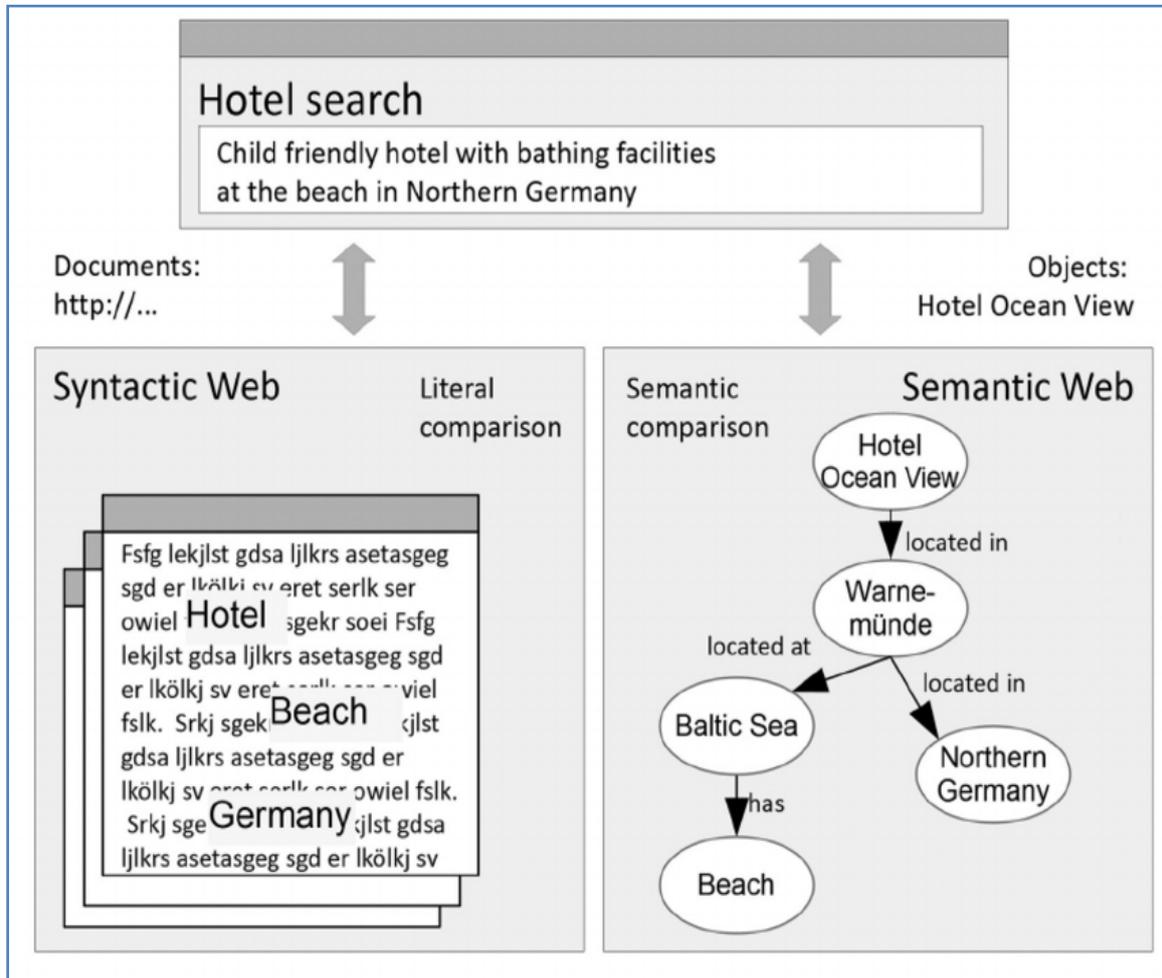

Figure 3.Comparing "Syntactic Web "and "Semantic Web"[11].

4. E-RECRUITMENT SCENARIO

For building ontology we first identified the sub-domains of the application setting like skills, professions types, etc. and several useful knowledge sources covering them. Certain applications may need more complex Ontologies depending on the requirements and the goals of the applications. A usual recruitment process seen from the organization's viewpoint can be divided into four phases:
1. Requirements analysis
2. Publishing the job posting
3. Receiving and pre-selecting applications
4. Final recruitment decision.
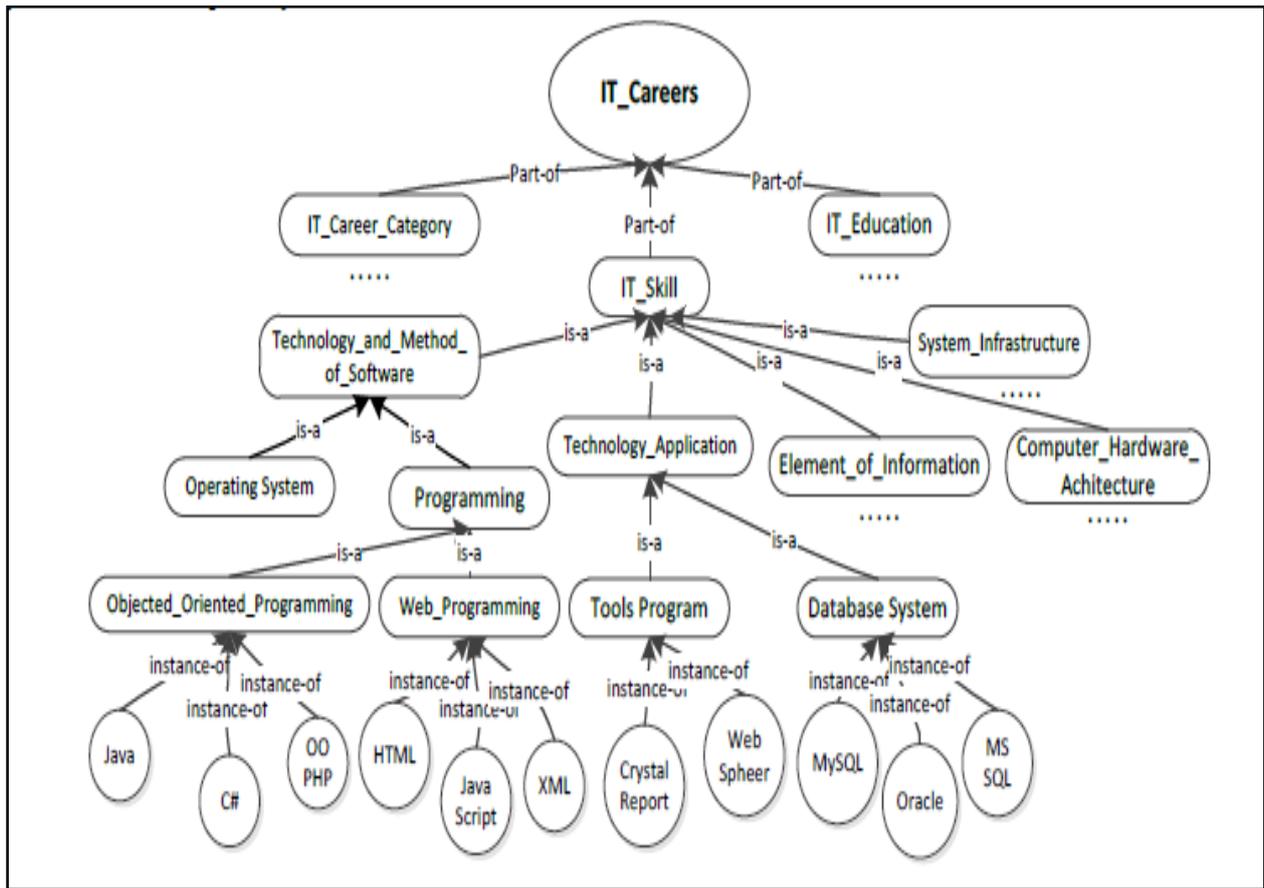The below figure describes the recruitment process for IT Domain

Figure 4 . Ontology FlowChart for IT Carrier recruitment [12]

5. LITERATURE REVIEW

Sr. No.	Author	Title	Name of Journal / Research paper	Year	Technique and Conclusion	Limitation and Future Work
1	Mihaela-Irina ENĂCHES CU	A Prototype for an e-Recruitment Platform using Semantic Web Technologies	Informatica Economică vol. 20, no. 4/2016	2016	-To use ontology in developing a job recommender system, this helps to automatically match job offers with the candidates' profiles and vice-versa. -proposed a Java based architecture to implement the e-Recruitment platform. -To convert the users' input into RDF description, RDF2Go and RDFBeans APIs are employed.	- Compatibility ratio based matching of Applicants profile and Job advertisement[1]. -To include personality traits of candidate in matching process. - Research should be extended in other domains along with IT
2	Sheng-Wei Huang1, Chia-Ho Yu1, Ce-Kuen Shieh1, Ming-Fong Tsai2*	Efficient and Scalable SPARQL Query Processing with Transformed Table	IEEE Wireless Communications and Networking Conference (WCNC) - Workshop - Next Generation WiFi Technology	2015	-Map Reduce programming model and NoSQL database system such as HBase are well-known solutions for large scale data processing. In some queries, finding matched triple patterns is a time-consuming job using SPARQL Designed another table with different storage schema called Transformed Table to reduce the time cost for read operation.	-looking for other solutions for optimizing TripleStore queries to make it a useful tools for both Semantic Web and Linked Open Data communities[2].
3	Sisay Chala Madjid Fathi	Job Seeker to Vacancy Matching using Social Network	2017 IEEE International Conference on Industrial Technology	2017	-To identify methods that measure the skills, expertise and experience of a job seeker and to check importance of using social networking data as input to user modeling that determines the	-Implementation of a prototype and its evaluation should be done to test its effectiveness while

		Analysis	(ICIT)		strength of skills to be used for recommending matching job vacancies. -Development of vacancy recommendation through.. i) job vacancy modeling through data from occupational standards ii) job seeker modeling through skill, qualification and experience data from the job seeker's self-assessment as well as evaluation by connections of individuals; and iii) Matching the job vacancy to the job seeker.	matching it with job vacancies with actual usage by job seeker. -It is important to consider qualifications and certifications in the analysis process. - To conduct experiments on varied use cases to measure its actual usability in the real world[3].
4	Sisay Chala Scott Harrison Madjid Fathi	Knowledge Extraction from Online Vacancies for Effective Job Matching	2017 IEEE 30th Canadian Conference on Electrical and Computer Engineering (CCECE)	2017	-Skills are categorized as Required skills and Desired skills. - The job requirements are categorized for vacancies with the objective of matching job seekers with these criteria, and determining whether or not a job seeker satisfies mandatory and optional skill requirements. -Used technologies to perform the analysis and matching like i) web mining -to scrap data online, ii)natural language processing to represent the textual data and iii) Machine learning – to extract, and present the analysis result. iv) Research shows how plain keyword-based vacancy-to-jobseeker matching without taking into account these two types of criteria may result in improper matching.	- A prototype implementation and its evaluation need to be done to test its effectiveness when used in matching job seekers with job vacancies. - It is imperative to also perform natural language processing to extract the required and desired skills when a vacancy has not explicitly categorized them[4].
5	Paolo Montuschi, Valentina Gatteschi, Fabrizio Lamberti, Andrea Sanna, and Claudio Demartini,	Job Recruitment and Job Seeking Processes: How Technology can help.	IEEE Computer Society IT Professional	2014	Computer-supported job matchmaking has been explored using different methods 1) Supervised methods – a) Decision trees, Neural n/ws 2) Unsupervised- a) Antcolony method b) Cluster Analysis 3) Genetic Algorithm 4) S/W Agents 5) Semantic Approaches	-Research should be done to reduce the user and expert's dependency by developing automatic strategies for a integration of matchmaking platform with existing profiles, résumés, and job advertisement repositories. - Additional research and implementations can be targeted 1)to add more flexibility by identifying suitable approaches for fully exploiting existing standards and classifications, 2) define and implement validation methodologies to evaluate and check the effectiveness and performance of

						automatic job matchmaking techniques[5].
6	Alaba T. Owoseni a, Olatunbosun Olabode b, B. A. Ojokoh a,b,*	Enhanced E-recruitment using Semantic Retrieval of Modeled Serialized Documents	I.J. Mathematical Sciences and Computing, 2017, 1, 1-16 Published Online January 2017 in MECS (http://www.mecs-press.net) DOI: 10.5815/ijmsc.2017.01.01	2017	This paper presents a 3-tier system that models serialized documents of the applicants" worth and they are analyzed using document retrieval and natural language processing techniques for a human-like assessment. Its presentation tier was developed using java server pages and middle tier functionalities using web service technology. The data tier models résumés that have been tokenized and tagged using Brill Algorithm with my sequel. Within the middle tier, indexing was achieved using an inverted index whose terms are noun phrases extracted from résumés that have been tokenized and tagged using Brill Algorithm.	Retrieving data through Natural Language Processing intensive knowledge about it is required and is time consuming, which can be challenge for a new researcher. [8]
7	Aliva M. Pradhan Aparna S. Varde	Ontology based meta knowledge extraction with Semantic Web tools for ubiquitous computing Sign In or Purchase	Ubiquitous Computing, Electronics & Mobile Communication Conference (UEMCON), IEEE Annual	2016	-Extracted data from Wikiepedia deployed to extract meta knowledge with the following tasks: (1) annotate and extract Wikipedia contents (2) create RDF metadata using the annotations.(3) query metadata from the RDF files to obtain the required knowledge. Our general purpose is to link documents to Wikipedia fed to DBpedia / Cyc for extracting the shared lightweight ontology and utilize it for SPARQL querying of documents encompassing meta knowledge. -In our approach and experiments we focus on academic scenarios. This knowledge extraction process is useful in developing AI tools and mobile apps where semantics is critical. - Provides efficient and accurate Web access for knowledge extraction on many platforms like desktop computers and mobile devices.	-An app can be developed for a specific university that incorporates the retrieval of useful data with semantics encompassing meta knowledge -Development of AI tools where semantics is very important. -Development and use of domain-specific KBs in the area of social media mining to capture intuitive reasoning of domain experts while mining opinions from online repositories[6].
8	Malgorzata Mochol1, Holger Wache2, Lyndon J. B. Nixon1	Improving the recruitment process through ontology-based querying	SEBIZ'06 - 1st International Workshop on Applications and Business Aspects of the Semantic Web	2006	Research focuses on concepts.. 1) Recruitment Nowadays 2) e-Recruitment Use Case 3) Requirements Analysis 4) Semantic Web-based Prototype 5) Extension of the Semantic Web-based Prototype 6) Job postings and offerings are annotated with metadata 7) Ability to search with complex and precise queries	-Complex queries have to be relaxed. - Sliders like skill, experiences, Function and age are not always appropriate for representing relaxation. -Rewriting rules more human-oriented. Combination of both is most promising[7]

In addition to the research shown section [3] of Literature Review, the below figure no.5focuses on the study of the research on the development of vacancy recommendation that involves i) job vacancy modeling through data from occupational standards,

ii) Searching job through skill, qualification and experience data from the job seeker's individual-assessment along with evaluation of their social connections; and iii) Matching the job seeker requirement to the job vacancy requirement.
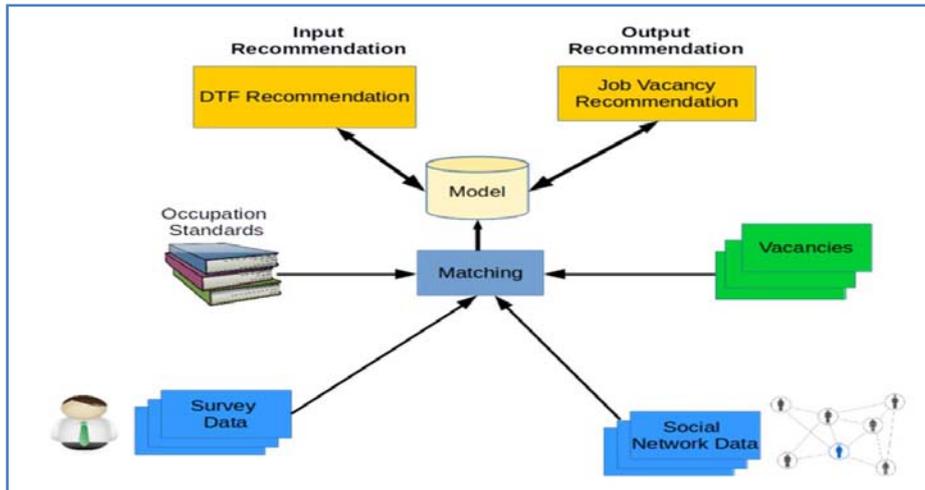
Figure 5. Components of Context-Aware Vacancy Recommendation [3]

In addition to the research shown section [5] of Literature Review, the below figure no 6. shows development of semantic match making process should occur in three steps. The first step should include a standard common language model which defines standards for representing job recruitment information and job seeking contexts in the semantic format. The second step targets annotation, where information provided by users (in job advertisements and résumés) is "augmented" with meta-data retrieved from the first step's taxonomical and ontological model. The third step describes the algorithms for calculating the distance in terms of its semantics between concepts and actually computing the match. At this stage, the relations among concepts used for the annotation of résumés and job offers are checked for its weigh to find similarities among the skill and knowledge possessed and required. The final conclusion can be drawn on the basis of matchmaking algorithm used, and the quality of defined model and annotations accuracy.
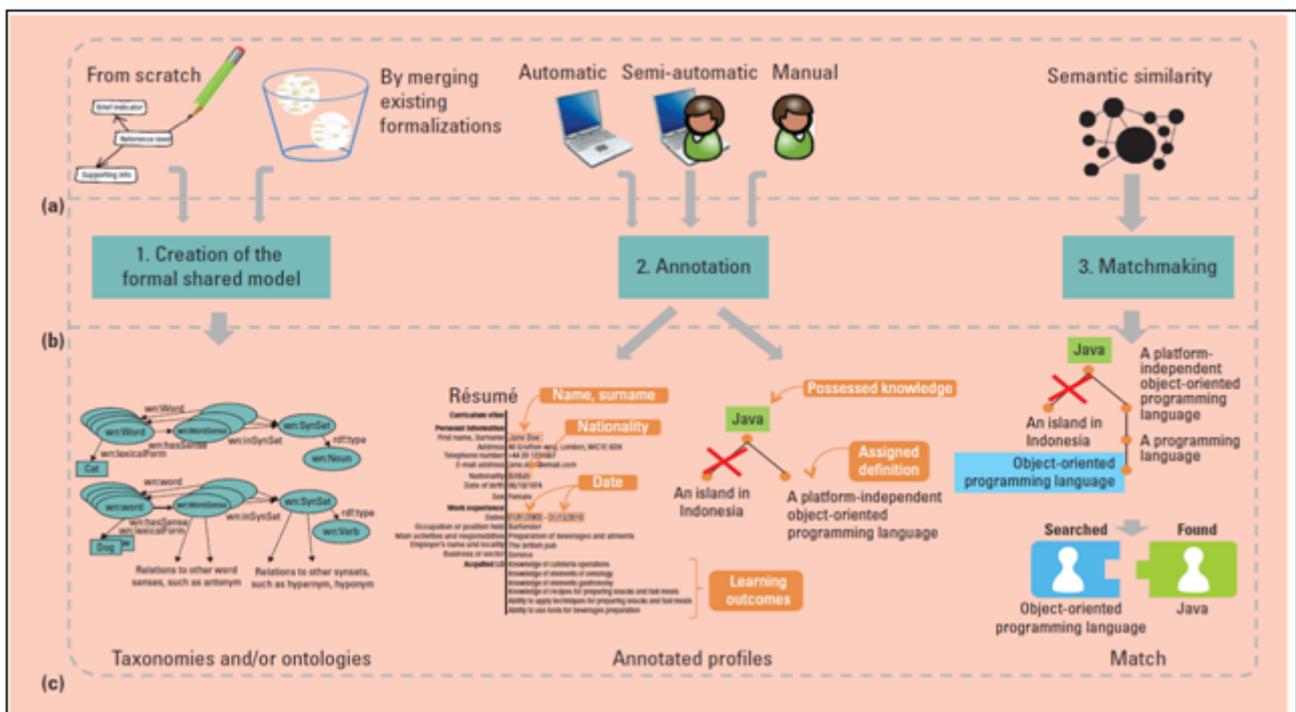

Figure 6. Development of a semantic job matchmaking system [6].

6. CONCLUSION AND FUTURE WORK

In this paper, we reviewed different Ontologies that are used for development of e-Recruitment systems online and defined its architecture along with different technologies. There are many research papers that discusses about the different ontological framework to provide online recruitment using semantic web, increasing and improving the skill analysis, skill measurement and recruitment process. Also research has been done showing collecting data from the social networking sites and filtering them and connecting them with the e-recruitment sites enabling easy data fetching and improving job recommendations. Also it focused on the different types of skill set of job seeker

namely desired skills and required skills and enabled a better platform for allocating right job to the right person. This study explores many future works for promoting e-recruitment using semantic web connecting social networking sites and employees data stored in Human Resource departments of companies. Mainly a prototype could be developed improving e-recruitment efficiency and effectiveness. Secondly, physical certificates can also help to validate the applicant's data analysis and lastly, various experiments should be conducted to prove the actual implementation and usability in today's semantic network.

7. ACKNOWLEDGMENT

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