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E-Medical Diagnosis using Semantic Web

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Abstract: Generally for the diagnosis of a patient, we tend to reach out to our nearest doctor's clinic or hospital. In the case of emergencies, we tend to panic and lose precious time because of various factors such traffic, calling problems, etc. In this paper, we are going to propose a system wherein the layman user can help in the medical diagnosis of the patient where we could buy some time. This system will use the concept of Semantic Web for data integration, whereby data from various hospitals and in various formats can be integrated into one, for resource discovery and classification to provide better symptoms specific search engine capabilities, for cataloguing for describing the content and the content relationships available. We aim to bring the data from different sources into a single format using Relation Description Format (RDF) via common ontologies and make the available data interoperable and using mining techniques to obtain significant results. According to the proposed architecture, SPARQL (SPARQL Protocol and RDF Query Language) will be used for querying with the main application server.

Keywords: Semantic Web, RDF, Ontology, OWL, SPARQL, E-Medical Diagnosis.

I. INTRODUCTION

The medical diagnosis is a process which begins with the patient, physically present at the doctor's clinic or hospital and ends with the start of the treatment.

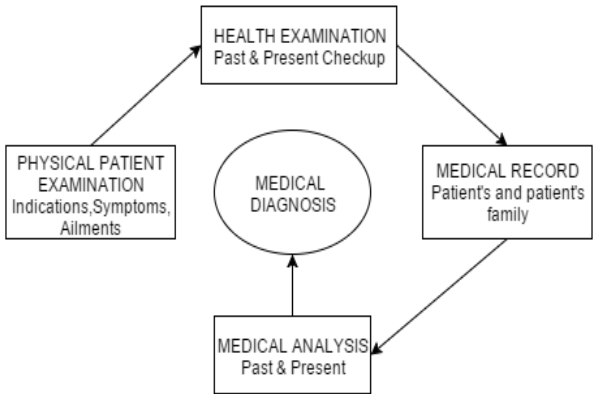

Figure 1 – Traditional Medical Diagnosis

Figure 1 shows the flow of traditional medical diagnosis. Firstly, the patient has to be physically present at the doctor's clinic for examination. The doctor then looks up the patient's medical history and on the basis of this record along with the signs and symptoms concludes with his/her medical analysis. The doctor proceeds with the treatment and deals with the patient by suggesting the necessary measures.

The main drawbacks of this process can at times be very time-consuming and can lead to a delay in the time factor during emergency cases. There can be many factors that aid to the flaws of the system such as vehicular traffic, where the patient can be delayed with his/her diagnosis because of the peak hours, telephonic congestion can be another factor where the patient's family cannot contact the emergency services provided by the hospitals/clinics. The distance between the patient's residence and the clinic/hospital so we want to buy time for the victim. This could cause a state of panic and could be fatal.

We are proposing a system that would help reduce these drawbacks to a great extent. Our proposed system will collect data from various different hospitals and clinics regarding the diagnosis of the previous history of patients. We will integrate all the data in one single format using semantic web, RDFs and ontologies. Using SPARQL, the system will help the layman to query the data and get the appropriate results of the diagnosis.

II. E-MEDICAL DIAGNOSIS

Nowadays e-medical information systems have been on a rise. With the latest ascendancy in the interest of medical diagnosis using the internet. In E-medical diagnosis usually the patient provides the doctor with the symptoms and signs. There are various steps that e-medical diagnosis has been under process which is through medical information systems where the patient gets to research conditions, check symptoms with the help of symptom checker ,access drug information, get first aid essentials and check local health listings from the most trusted people in health information.

Table 1 – Difference between the Traditional Medical Diagnosis and E-Medical Diagnosis

Dimension	Traditional Diagnosis	E-Medical Diagnosis
Access	Physical presence required	Anytime, anywhere access
Time	Time consuming	Quick access to results
Availability	Uncertain	Available at all times.
Knowledge	Single source	Multiple sources with enhanced and integrated data
Domain	Specific doctors for different types of diseases	Generalized access wherein all types of diagnosis is possible

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Adaptivity	Static: Content remains in their original form	Dynamic: Content changes constantly through user input, experiences, new practices and previous records.
Performance	Irregular	Highly accurate as the data is integrated from multiple sources.

III. PROPOSED SYSTEM

We propose a system that would be optimum and efficient and easy to handle. The system plans to be for the use of laymen. The user will provide his input with a specific topic on the application. The application will then generate SPARQL queries for the purpose of its interaction with the OWL ontologies and RDF datasets.

- **Data Acquisition**

At first we would take the information from various hospitals and clinics. Decompose all the information then acquired into finer grained media segments, which form the ingredients for deriving Information Extraction (IE) models and patterns. Media segments are then appended or annotated, that is, extra information that can be accessed through some form of foreign source. A model which can extract information from the decomposed and tagged media needs to be made with the help of domain experts.[1]

- **Data Integration**

The Resource Description Framework (RDF) which is designed as a metadata model. It has come to be used as a general method for theoretical description or modelling of information that is enforced in web resources, using Triple stores which consist of the subject, the predicate and the relationship between the subject and object. [2]Ontology is defined as, "the terms used to describe and represent an area of knowledge". Ontologies contain application specific definitions of fundamental concepts in the domain and the relationships among them.Ontology have given us a wide range of descriptions levels OWL is a Web Ontology language. OWL has richer terminology and better articulated as with OWL, it is easier to specify attributes and use of logical operators like the union of classes. A set of mappings between OWL ontologies is defined in order to integrate the access to the federated resources. [3]

- **Data Querying**

The queries of the application users are asserted in SPARQL by OWL ontology. The mappings from OWL ontologies are used to transform the original SPARQL query, through reworking, to a set of SPARQL queries that are used to approach the organized RDF data sources.[4]

- **Application System and User**

The proposed application system will have an intuitive User Interface (UI) which will be used to retrieve the medical diagnosis suggestions using the observed symptoms which will be fed to the system. In order to carry out this process, the system will use this input to generate SPARQL queries.

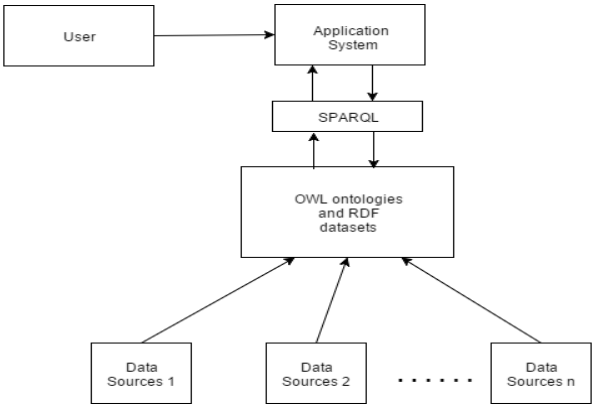

Figure 2 – System Architecture

IV. BENEFITS OF PROPOSED SYSTEM

E-Medical diagnosis has definite benefits over traditional Medical diagnosis. While the most obvious is the flexibility, there are also others that are equally significant.

Better health care: Improving all aspects of patient care, including safety, effectiveness, patient-centeredness, communication, education, timeliness, efficiency, and equity.

Integrated precise medical information: Accurate, complete and up-to-date information about medical records from different sources into one standard format. Better clinical decision making by integrating patient information from multiple sources.

Home safety: If an accident or emergency medical condition occurs at your place, one can quickly act using our proposed system and know how to deal with the situation before an ambulance arrives. Thus buying some time for the victim.

Better understanding and communication: It will help to effectively communicate with professionals with vital information about the patient's condition and what measures have been executed as of now. It will also help in better understanding of the medical terms and the potential treatment conveyed by the doctor later.

Any moment, any place, anyone: This system can be used by any user with no or some medical knowledge. This system will be accessible 24 *7 because of world-wide-web and high-speed computer networks. With the increasing use of mobile portable devices, it possible to access the system from any location.

All in one: Usually a patient would visit different specialist doctors at different places for respective medical conditions but with online capabilities of E-Medical diagnosis, all the specializations are present in one single repository for diagnosis and no need for separate visits.

Faster search: All the data is integrated using RDF and ontologies, thus the search of the desired results using the various observed symptoms is much quicker as compared to paper/book based search.

Uniformity of Content: The information delivered can be consistent to all users, therefore reducing the possibility for misinterpretations.

Regularly Updated Data Repository: With multiple sources for data acquisition, as and when new data is

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added at the source, all will be updated accordingly in the data centre in astandardized format, thus keeping up with latest discoveries and knowledge in the medical field.

Cost Effective: In cases of minor medical conditions such as cold, headache, etc. cost of visiting a doctor can be saved as the system will diagnose the problem and provide the appropriate treatment.

Buying time in cases of emergency: The proposed system will help in alleviating the suffering of the patient by suggesting appropriate measures before interacting with aspecialist doctor, thereby buying some time to receive desired treatment in time. [7]

V. SEMANTIC WEB

Semantic web is an addition of the current Web that provides an easier way to discover, share, reiterate and integrate information. It is based on machine-readable information and builds on XML technology's capacity to determine personalized tagging schemes and RDF's malleable path to represent data. The Semantic Web gives us familiar formats for the interchange of data (as on the Web there is only an exchange of documents). It also provides a simple language for measuring how information is related to actual objects, letting a user or a system to start off in a particular database, and then move through a limitless set of databases which are not connected physically but by being the same thing. [5]

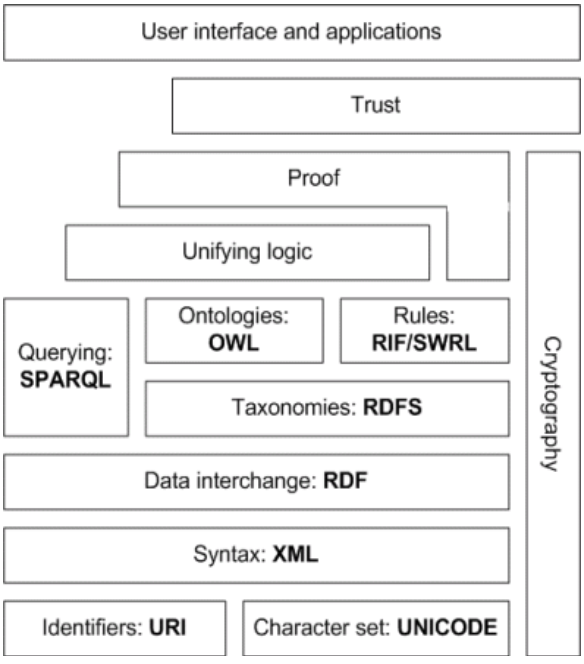

Figure 3 – Semantic web stack [10]

According to the industrial point of view, the Semantic Web consists primarily of the following fundamental standards:

RDF (Resource Description Framework): It is used as the data modelling language for the Semantic Web. All Semantic Web information is gathered and expressed in the RDF.

SPARQL (SPARQL Protocol and RDF Query Language): It is the query language of the Semantic Web. It is especially constructed to query data across different systems.

OWL (Web Ontology Language): It is the schema language, or knowledge representation (KR) language, of the Semantic Web. OWL helps us declare approaches so that these approaches can be recycled as often as possible. The definition of these approaches means that each approach is attentively defined so that it can be elected and bring together in various mixtures with different approaches as required for the various applications and functions.

Although there are various standards referenced by Semantic Web, these are the basic three.

VI. INTEGRATING E-MEDICAL DIAGNOSIS AND SEMANTIC WEB

Semantic web suitable to scientific domains that contain a large amount data that is present in the public domain and has to be integrated. It is better for data integration and sharing, even for resources developed independently or broadly distributed across the web. Although medical databases and information management systems are common, healthcare knowledge, which is important for medical diagnosis and treatment, is rarely integrated into software systems supporting healthcare processes [Buranarach et al. 2009]. The semantic web is a concept that involves incorporating descriptions into data to make the data reusable and enable applications to be built that can take advantage of this describable collection of data. It features a common framework for data to be shared and reused across application, enterprise, and community boundaries.

The various data from different sources such as hospitals/clinics is integrated into one format and suitable ontologies are formed. Our proposed system will be using various ontologies such as disease symptoms ontology. In this type of ontology, we would be using the data obtained in formof disease and symptoms relations using OWL. Similarly, there is also patient related information, mentioned in medical documents, which is also essential for diagnosis. This will also be represented as OWL ontologies.[11]

The Web Ontology Language (OWL) is a Semantic Web language designed to represent rich and complex knowledge about things, groups of things, and relations between things. OWL is a computational logic-based language such that knowledge expressed in OWL can be exploited by computer programs, e.g., to verify the consistency of that knowledge or to make implicit knowledge explicit. OWL documents, known as ontologies, can be published in the World Wide Web and may refer to or be referred from other OWL ontologies. OWL is part of the W3C's Semantic Web technology stack, which includes RDF, SPARQL, etc.

A query engine which has the ability to retrieve specific information (queries) from the OWL ontologies and RDF datasets will be developed which uses SPARQL. Thereby query engine would return desired results to the user. [6]

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Key property of the Semantic Web architecture (common-shared-meaning, machine-understandable metadata), enabled by a set of suitable agents seems to be powerful enough to satisfy the e-Medical Diagnosis requirements: fast, just-in-time and relevant results. Medical information is semantically annotated and newly discovered knowledge maybe upgraded into the original. According to his/her preferences, user can find remedies and conduct medical diagnosis very easily. In Table 2 a summary view of the possibility to use the Semantic Web for realizing the e-medical diagnosis requirements is presented.

Table 2 – Benefits of using semantic web as a technology for e-medical diagnosis [8] [12]

Requirements	Semantic Web
Access	User can describe the symptoms observed, previous knowledge and can perform semantic querying for suitable diagnostic results. Access to knowledge can be expanded by semantically defined navigation
Adaptivity	Semantic enables the use of knowledge provided in various form by semantic annotation of contents.
Availability	Similar to the world wide web. Available at all time via high-speed networks.
Knowledge	Medical knowledge is distributed on the web and various hospital server, but they are linked to a commonly agreed ontology. This enables the construction of user specific results by semantic querying.
Performance	Performance of semantic web application over relational database-backed web app can be improved using SPARQL query caching.
Authority	The semantic will be as decentralised as possible. This enables an effective co-operative content management.

VII. CONCLUSION

Semantic web is a developing technology and the emerging Semantic Web Methods have resulted in applications that are real world scenarios and provide us with a cumulative value to the end users when compared with traditional solutions. Semantic web is aimed at web-based knowledge and services that would be comprehensible and recyclable by both humans and computers. "Making data machine-recognizable" is a popular explanation for the Semantic Web. Medical diagnosis is very vague and complex situation at hand as it involves life-saving situations and with the help of Semantic Web in internet applications we can make the medical diagnosis an easier task. Semantic web has its application in medical diagnosis with benefits such as faster and better search in a much more efficient manner, integration of data, knowledge management and composition of complex systems.

VIII. FUTURE SCOPE

This concept of Semantic Web in E-Medical Diagnosis can be further expanded in the sector of e-learning and e-training for amateur nurses and doctors. The Semantic Web can offer more flexibility in e-learning and e-training systems through theuse of new emergent Semantic Web technologies. Along with this, we are also planning to study various Ontology languages and Metadata requirements for the e-Medical Diagnosis and the representation of knowledge using ontology.

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