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Research Directions in Semantic Web on Healthcare

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Abstract
This paper presents various dimentionality of research on semantic web in healthcare. Semantic web is an extension of web imbued with meaning, it discover documents on the web and also from a description. There are varieties of applications in semantic web on healthcare. This extensive survey identifies and discusses various prevalent research directions on semantic web in healthcare such as EHR, Ontologies in healthcare, Rule based healthcare systems etc .
Keywords: *Semantic web, Ontologies, healthcare, EHR.*

Introduction

Semantic web is an enhancement from syntactic web in which information is given based on its meaning. It is having data as well as documents on the web so that machine can process, transform, assemble and even act on the data in a useful way. It provides a common framework that allows data to be shared and reused across heterogeneous application enterprises. It is based on RDF which integrates variety of applications using XML for syntax and URI for naming.

This paper surveys the research field on Semantic web defined for the purpose of this paper as health system that utilizing semantic techniques. The survey is based on reading and exploring some 30 different papers to semantic web that addresses the health care domain. The material has gathered based on a keyword search for semantic and healthcare in various publication databases and is meant to be a sufficient representative of the variety of semantic web papers related to healthcare.

There are many research issues concerning semantic web on healthcare are EHR, Interoperability, Clinical decision support system, Rule based healthcare system, Clinical Pathway and use of Ontologies in healthcare.

Need for semantic web on health care:

Health is a life and death implication so that we should give more attention to that. Health care systems need continuity of care through timely and secure sharing of information. Health care systems need to manipulate semantically rich and highly structured clinical data in a distributed environment. This can be achieved through semantic web. Semantic web provides more knowledge translation that is increased possibilities to steer patients to related information relevant to the health and steer patient stream to best quality providers and identify the trusted information.

Semantic web is amplifying many of the existing challenges and offer new opportunities. Semantic web is an extension of current web with machine processable evaluation and trust data.

Research directions

From the corpus of research utilized in this survey four distinct research directions emerged. These the categories sometimes do not differ much in methodology, they seem sufficiently separate and coherent with regards to research goals, to be an accurate clustering of the research space. The four areas are described in an elaborate manner.

EHR

This paper [24] develop a protocol in an distributed environment that provides continuity of care by using control numbers and explain about the requirements needed for locating and accessing clinical records across country borders in association with data protection. But if universal accepted standards arise in the future it possibly render the protocol so how long it can be applied is not yet known.

Similarly in a distributed environment, an integrated platform that investigates clinical process and describe about how the health care, SOA and web services are related to each other. The paper also describes the need of semantics and identified the EPRS requirements. But the integration issues are not covered, (Ex: Security) there is no mapping derived between other standards (HL7, CEN) and some service oriented features are not covered [30].

This paper [31] describes about the security issues in HL7 EHR, address the use of semantics and define how much information is needed to achieve semantic discovery. The paper also describes the security holes presented in HL7. But there is no semantic policy decision point and enforcement point, no multiple lower level ontologies to test HL7.

This paper [1] provides a semi automated EHR that explain about how to record the medically significant events during surgery in a real-time environment with the use of stream processing engine. The system also use radio frequency identification to identify the medicines used during surgery. But the system cannot account the time to carried out the medical event. The system does not deal with supply tracking and there is no video clip of the surgery in order to the physicians to evaluate their skills.

The telemonitoring home medical devices used for the on demand uniform tele-monitoring services. The data are gathered from multiple devices. The architecture deals with EHR and also maintains patient's privacy and end-user authentication. But the architecture does not deal with patient's awareness and there is no decision support system to check the incoming reports [35].

Interoperability issues

This paper [7] narrates about the semantic interoperability activities during 2007 and explains about real-time public health issues, which identifies the neglected issues and the requirements needed for digital health record.

This paper [10] provides a health report concern levels of interoperability, goals for EHR and what are all the areas needed for research and investment. The paper also explains about medium, long term actions in semantic web on healthcare.

This paper [19] provides the testing on EHR interoperability by the use of ontologies. The test is conducted by different approaches but there is no guaranty provided to what extent ontologies contribute to the success of semantic interoperability.

This paper [25] presents a study on 20 FP5 & FP6 health projects results the efforts of standardization and its assessments. It identifies the current trends related to semantic interoperability and significance of research institutes. But the international standards are not taken into account.

In Italy a HL7 aECG format is developed for the purpose of EHR Interoperability.[26] it provide the methods for the conversion from open ECG or other format. The paper also describe about how to reuse existing ECG devices. But there is no approach to solve the compatibility problems that is large amount ECG data makes the service to be complex and too heavy for transmission.

The NTUA – ICCS Organisation provide a road map for Interoperability of E – health systems in Bulgaria. It includes national health initiative, implementation with further activities and also specifies the current practices in Bulgaria related to EHR [6].

By the combination of web services & semantic web technologies build a ambient intelligent medical devices. This device provides semantic Interoperability with legacy hospital information system. It acts as a bridge between the transmissions of one standard to another [34].

Clinical Decision Support Systems

In an intelligent health monitoring with decision support system the patient monitoring tasks is based on agent technology. It provide home based training, specify the medical and technical point of views, but the system does not preserve the patient's privacy rights [4].

This paper [5] describes about Clinical practice guidelines that are developed by creating computer interpretable guideline models with the use of ontologies. It provides guideline for hypertension management, drawing comparisons with other, related guidelines and segmenting complex task into different levels. The guidelines are integrated into the clinical practices of a healthcare setup. But every guideline tool represents the context in form of preconditions so that the rules are not formalized.

In intelligent healthcare CDSS and Ontologies are used, for the purpose of semantically analyze user's health data. The system [15] is developed for emergency management services. So users can use services at anytime, anywhere and also maintain privacy. The system returns responses to the users and care provider.

This paper [13] proposes architecture (Medical database Adapter) for mapping medical decision support system to multiple clinical databases. By the use of three heuristics (choice of vocabulary, choice of key term, choice of measurement unit) mapping three KB's of medical decision support system to three DB's. The system addresses about the reuse of decision support application and its KB's. But the system does not provide a 1:1 mapping between KB's within MDSS and to DB's, dangling pointers

occur in both cases. The mapping approach is specific to a set of predefined KB's only.

This paper [18] presents a machine processable approach that addresses the semantics of clinical guideline interfaces for the purpose of executing clinical guideline. This can be achieved via integrating EHR and web service technologies. It explains about how to share guidelines among different organizations. But the system does not provide query based interaction.

It [27] develops a simulation framework for the purpose of achieving content layer interoperability between online clinical cases and medical guidelines, that provide a higher interaction between EHR and evidence based medicine.

Clinical Pathway

This paper [9] presents a sempath prototype to achieve real-time adaptation of healthcare. This prototype consists of rule set execution. After the execution of the rule set, the next step of the treatment is defined. But the protocol does not provide priority modeling for resources and activity management. The protocol does not deal with simultaneous clinical path execution.

This paper [37] presents ontology based clinical pathway that handle decision of different types of variances that occur during treatments execution time. By the use of fuzzy event, condition, action and typed fuzzy Petri net, the different variances are analyzed and handled.

This paper [33] presents a report about clinical pathway background, definition, functionality and applicability. It provides a link between the establishment of guidelines and their use.

It [3] develops an ontology based approach for computerizing clinical pathway. This describes about the integration of multiple localized clinical pathway to unified disease for prostate cancer management system.

Ontologies in Healthcare

The ontology based framework is developed for the counseling on personal health by including personal health records. This framework uses ontology to match personal health data with medical treatments, maintain a data transmission between patients and system. Every dynamic change is observed to trigger alerts [8].

In the M – health platform shared and common features are extracted, registered and manipulated. It also provides health services, which has key features that are reusability, adaptability. Ontologies are used to make the platform more evaluable but the platform, does not define diverse mobile E – health applications [11].

In a ubiquitous computing environment [14] provides context aware framework ontology. In this rules were used to convert low level context to high level context, for the purpose of providing personalized healthcare services to users at any time and any where. Intelligent service deduction and knowledge inference technology is used to recognize a situation and provide customized healthcare services. But the system seems to be complex in competence management in companies with less formal training.

It [17] describes about the inconsistency tolerant approach that is used to merge two healthcare ontologies SNOMED CT and ICNP. By the use of this merging the different perspectives can be maintained without loosing meaningful information. But there is no efficient technique for merging large ontologies and does not provide reasoning with multiple views.

E – Neuro science data addresses the integration problem by the use of oracle RDF data model technology. The data are extracted from brain plus and swan. The system provide relational to RDF migration. But the system does not provide user friendly query interface and there is no native support for OWL [21].

This paper [22] presents a nutritional advice for diabetic patients with the help of food ontology. This ontology is tested to share knowledge between the different stake holders in the pipes project for diabetic control.

In intensive care unit, medical ontology is used to register health problems. The healthcare system that combines frame based representation, description logic and RDF is used to store patient information. It can be further analyzed using DL – based reasoner. But the system cannot concentrate with scalability and the system cannot differentiate which kind of queries need DL based reasoning or RDF based querying [32].

This paper [23] proposes an ontology based knowledge framework that provide personalized healthcare by retrieving all necessary knowledge such as patient care, insurance policies, drug prescriptions etc. The developed ontology allows the users and physicians to manage and even create context aware new medical workflows without the intervention of IT people. But the system does not use any semantic rule engines for knowledge retrieval and reasoning.

This paper [16] proposes a methodology for sharing knowledge in healthcare using ontologies. The knowledge is extracted with the use of deductive databases and ontologies. It describes about how to integrate heterogeneous information and to answer complex queries in a real world environment.

Rule based healthcare systems

This paper [2] presents rule based information extraction from medical documentation. It uses an IE grammar that addresses ambiguous keywords, negation, coordination etc. The extracted information is then grouped and structured into more complex templates. The IE method is also used to gather most important facts and select the group of patients that require special attention. But the system is a time consuming approach.

It [28] describes about dynamic modification of workflows. At the time of exception occurs, the system identifies the affected workflow region and the corresponding control flow is adjusted dynamically. Rules are used to detect semantic exceptions and decide about which activities are dropped or added. But the system does not handle additional activities such as side effects by specific drug.

This paper [36] develops a protocol that handles exceptions and the corresponding workflow is adapted dynamically with the use of guidelines. It provides a rule based exception detection method.

Others

In health monitoring E – inclusion technologies were used, for the purpose of receiving treatment and care immediately. In this data streams coming from smart sensors that are attached to the patients are processed with real-time constraints. The actual processing resources are dynamically adapted by the data stream processing. Disconnections and reconnections have to be handled transparently to the user [20].

With the use of E – inclusion technology the system detect the most suitable service based on the context of their user and provide how the cascom system combines with agent technology, semantic web and peer-to-peer technologies. Normally the system is documented in real-world settings. But there is no infrastructure defined to support health monitoring and E – inclusion [29].

This paper [12] provides a health information portal based on shared metadata schema, ontologies. This portal provides up-to-date health information, meaningful searching and browsing services. To solve various problems on health information portals, the semantic web technologies were used. But the portal does not deal with personalization services (ex: push e-mail). There is no registry of health services to interlink with information resources.

Conclusion

The extensive surveys in this field facilitate us to identify the core area of research such as EHR and Rule based systems. The EHR directs continuity of care and helps the physicians to capture the complete clinical history of a patient at anytime and anywhere. This survey will be helpful to the research in education, healthcare and semantic web technologies.

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