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Towards a Reusable Evaluation Framework for Ontology based biomedical Systems Integration

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Evaluation of ontology based integrated biomedical systems is important for them to find wide adoption and reuse in distributed computing environments that facilitate information exchange and knowledge generation in biomedicine. The review reveals many approaches to information systems and ontology based evaluation with standards, none of which are generic enough for use in all situations. It also shows increased use and reliance on ontologies for biomedical integration systems to overcome the issues of semantic heterogeneity and bridging across levels of granularity in biomedical data. The wide acceptance and reuse of ontology based integration systems remains hampered by the lack of a general framework to assess these systems for quality. To address this requirement, a new flexible framework for evaluating ontology based biomedical integration systems is proposed. The proposed framework extends existing Information systems and ontology evaluation approaches. The framework is also informed by the theories of formal ontology, self organizing systems, summative and formative evaluation. It has the potential to relate ontology structure to user objectives in order to derive requirements for a flexible framework for evaluating ontology based integrated biological and clinical information systems in environments with changing user needs and increasing biomedical data.

1.0 Introduction

Biomedical integration systems bring together disparate sources of rapidly changing biological and clinical data into a transparent system to enable biologists and clinicians maximize the utilization of available information for knowledge acquisition. Ontology use has become an important approach to resolving semantic interoperability in heterogeneous information sources and creating reusable models for integrated biomedical systems. Ontology Integration is a type of ontology reuse process. It aims at building a resultant ontology by assembling, extending, specializing and adapting other ontologies (Pinto and Martins, 2000). The advantage of integration is that, from a set of small, modular, highly reusable ontologies, larger ontologies for specific purposes can be assembled (Pinto and Martins, 2000). Despite many attempts, the lack of a single satisfactory unifying ontology integration and evaluation approach to biomedical data remains (Davidson et al., 1995; Ding and Foo, 2002), creating an obstacle for ontology reuse and their wide adoption by industry (Alani and Brewster, 2006).

Ontology evaluation assesses a given ontology using a particular criterion of application to determine the best one for a given purpose (Brank et al., 2005). Evaluations are important for ontologies to be widely adopted for use in distributed computing environments where users need to assess and decide which one best fits their requirements (Pinto and Martins, 2000; Kalfoglou and Hu, 2006). Evaluation is also important for the success of ontology based knowledge technology (Gangemi et al., 2005). In ontology integration systems, evaluation is a criterion based technical judgment guiding the construction process and any refinement steps of both the integrated and resulting ontologies (Pinto and Martins, 2000). Ontologies are subjective knowledge artifacts that reflect particular interests of knowledge users as captured in the design which makes it difficult to select the right properties to use in ranking them since selection can depend on personal preferences and user requirements (Alani and Brewster, 2006), who also mention a need to investigate properties users tend to look for when judging the general quality or suitability of an ontology. Kalfoglou and Hu (2006) also suggest the need for a holistic evaluation strategy with a greater role and participation of user communities in the evaluation process.

Current ontology based approaches for integrating biological and clinical data remain independent non reusable models due to lack of a common evaluation framework with metrics for comparison to ensure quality (Kalfoglou and Schorlmer, (2003); Lambrix and Tan (2006). Comparing the effectiveness of such ontology based integration systems remains difficult and meaningless due to lack of a standard framework for evaluating them, and the use of tools that differ in function, input and outputs required (Natalya and Musen, 2002). Specialized criteria to analyze the resulting ontology following integration of knowledge and research to develop accurate evaluation metrics for ontology engineering is required (Pinto and Martins, 2000).

Existing ontology based evaluation models define standards for structuring and integrating knowledge using static relationships between concepts in a domain of discourse. The vast amounts of biological and clinical data require ontology integration systems that are able to capture and represent new structure and functions that emerge as data in the two domains increases. This study proposes a flexible reusable evaluation framework for integrated clinical and biological information that uses completeness to measure quality. General systems theory (GST) and that of self organization (from the perspective designing and building artificial systems) are adopted to explain the emergent properties of the system (Heylighen and Gershenson, 2003). The framework is also informed by the formative and summative evaluation frameworks. A Formal ontology theory perspective is adopted for structuring biological and clinical information. The novelty of this approach lies in the ability to relate ontology structure and user derived objectives in order to derive requirements for a flexible framework for evaluating ontology based integrated biological and clinical information systems in environments where biomedical of data is ever increasing and user needs changing.

This paper is organized into seven sections of introduction, information systems evaluation approaches, evaluation of ontologies, biomedical information systems integration and current work related to its evaluation, the proposed evaluation framework followed by the methodology and conclusions.

2.0 Information systems evaluation

Evaluation is used to assess and guide the result of IS development (Sun and Kantor, 2006). The evaluation cycle needs to be regularly conducted as part of the system development life cycle (Cronholm and Goldkuhl, 2003). The theory of evaluation, rooted in the twin ideas of accountability for rationale, and social enquiry for deriving the evaluation models is classified using an evaluation tree with methods, valuing and use branches (Alkin and Christie, 2004). Methods deal with knowledge construction, valuing establishes the vital role of the evaluator in valuing while use focuses on decision making (Alkin and Christie, 2004).

Evaluation approaches may be formal rational, interpretive or criteria based (Cronholm and Goldkuhl, 2003). Formal rational evaluations are largely quantitative processes concerned with the technical and economic aspects of the project. Interpretive approaches view IS as social systems with embedded information technology and aim to get a deeper understanding of what is to be evaluated, generate commitment and motivation. According to Cronholm and Goldkuhl (2003), evaluation should be performed depending on the evaluation context using three general strategies of goal based, goal free and criteria based evaluation. Goal based evaluations are formal rational and focus on intended services and outcomes of a program using quantitative or qualitative goals. Goal free evaluation is an interpretive approach preformed with limited evaluator involvement. Criteria based evaluation use selected general qualities for evaluation (Cronholm and Goldkuhl, 2003).

A framework to explain various approaches to information systems evaluation was developed by Ballantine et al., (2000). According to the framework IS evaluation is driven by purpose, process and people and is influenced by six factors of philosophy (technical and moral issues), power politics and cultural beliefs in the organization, the management style, the evaluator and resources (Ballantine et al., (2000). A matrix of these six factors gives an indication of the values and factors which underlie the use of evaluation approaches.

Avison et al., (1995) adopt a non technical contingency view in which evaluation is not an objective rational activity, but one dependent on the motives of people doing it making power and organizational issues important. They also identify impact analysis, effectiveness, economic, objectives, user satisfaction, usage, utility, standards, technical evaluation and process as approaches to IS evaluation. On the interpretive perspective to IS design and evaluation, Walsham (1993) argues that IS evaluation should consider the issues of content, social context and social process. Content considers issues of purpose for conducting the evaluation and associated factors. Social context considers the stakeholders in the situation, their needs and how to resolve conflict between those needs. Walsham (1993) also suggests that IS evaluation is a multi-stage process occurring at several points, in different ways, during the product life-cycle and it is important to consider evaluation as a learning process for all involved.

Beynon-Davis et al (2004) propose a model for IS evaluation closely linked to the development process in which they distinguish between strategic, formative, summative and post mortem analysis. Strategic evaluation is conducted as part of the planning process during project selection and feasibility study. It attempts to establish the balance of predicted costs and benefits for an intended IS. Formative evaluation is a continuous, iterative informal process aimed at providing systematic feedback to designers and implementers, influencing the process of development and the final information system (Kumar, 1990; Walsham, 1993; Remenyi and Smith, 1999). Summative evaluation usually done at the end of the project is concerned with assessing the worth of a program outcome in light of initially specified success criteria (Walsham, 1993; Kumar, 1990). Post mortem analysis is conducted if the project has to undergo total, substantial or partial abandonment (Beynon-Davis et al., 2004).

3.0 Ontology evaluation

Ontology evaluation assesses a given ontology using a particular criterion of application in order to determine which of several ontologies best suits a given purpose (Brank et al., 2005). It is important if ontologies are to be widely adopted for use in distributed computing environments (Pinto and Martins, 2000; Kalfoglou and Hu, 2006). It is important for the success of ontology based knowledge technology (Gangemi et al., 2005). In integration systems, evaluation is a criterion based technical judgment guiding the construction process and any refinement steps of both the integrated and resulting ontologies (Pinto and Martins, 2000). Ontologies may be assessed by user ratings and reviews, meeting requirements of certain evaluation tests or for general ontological properties (Alani and Brewster, 2006). Evaluation can be conducted during design and development and prior to use (Kalfoglou and Hu, 2006). Approaches to ontology evaluation are identified according to type, purpose and level of evaluation, or they qualitative, quantitative, formal and philosophical.

According to ontology type and purpose, approaches are categorized by: comparison to a golden standard, the results of using the ontology in an application, comparisons with a source of data about the domain to be covered by the ontology, human evaluation to assess how well the ontology meets a set of predefined criteria, standards and requirements (Brank et al., 2005). Secondly, depending on the level at which an ontology is evaluated, approaches are grouped into: lexical, vocabulary, or data layer that focus on concepts, instances, facts included in the ontology, and the vocabulary used to represent or identify these concepts, hierarchy or taxonomy based on the "is-a" relationship, other semantic relations besides is-a relations including measures of precision and recall, context or application level, Syntactic level, structure and architecture (Brank et al., 2005). Multicriteria is a third approach to ontology evaluation. For each criterion, the ontology is evaluated and given a numerical score. An overall score for the ontology is then computed as a weighted sum of its per-criterion scores. Multicriteria approaches support a combination of criteria from most of the levels (Brank et al., 2005).

Qualitative approaches to OE (Guarino, 1998; Gomez-Perez, 1994; Hovy, 2001) compare ontology to a gold standard but do not offer quantitative metrics for ontology evaluation. Brewster et al., (2004) propose methods to evaluate the congruence of an ontology with a given corpus in order to determine how appropriate it is for the representation of the knowledge of the domain represented by the texts. They also argue for the need to establish objective measures for ontology creation and the need for ontology ranking techniques as the number of ontologies available for reuse is continues growing.

Baker et al (2005) discuss philosophical, domain dependent and domain independent criteria for ontology evaluation. Philosophical Ontologists are concerned with evaluation for correctness of the conceptualization of knowledge in an ontology (Smith et al., 2004; Baker et al., 2005). Domain dependent evaluation is based on content and application (Baker et. al., 2005). Ontometric is an example of a tool for quantitative domain content evaluations of goal-based characteristics (Lozano-Tello and Gomez-Perez, 2004). Ontology Web Language constructs, formal and description logic are domain independent evaluations (Baker et al., 2005). In OWL construct evaluation, ontologies are ranked using a metric computed as a ratio of the frequency of class features (concepts) to properties and modifier features (roles and attributes) in its OWL sub language constructs.

In formal evaluation, the taxonomical structures of ontologies are compared with ideal predefined ones to detect inconsistencies. The OntoClean methodology relying on the notion of rigidity, unity, identity and dependence to evaluate whether specified constraints are violated within the ontology is a case of domain independent formal evaluation (Guarino and Welty, 2002). It is used during development for the formal evaluation of properties defined in an ontology using a predefined ideal taxonomical structure of metaproperties. In description logics evaluation, queries are used to interrogate the ontologies to reveal their level of complexity, suggesting their maturity and suitability to support knowledge discovery. Metrics used are: the classification hierarchies of ontologies, depth in ontologies, numbers of concepts, roles, instances, average number of child concepts and multiple inheritances (Haarslev et al., 2004).

Functional, usability and structural measures have been used to define a theoretical framework for ontology evaluation (Gangemi et al, 2005). Functional evaluation focuses on measuring how well an ontology serves its purpose (function). Usability evaluation is concerned with metadata and annotations of the ontology. Structural evaluation focuses on the structural properties of the ontology as a graph.

Issues with ontology evaluation

Ontologies are subjective knowledge artifacts in terms of time, place and cultural environment reflecting the particular interests of knowledge users as captured in the design; this makes it difficult to pinpoint the right selection of parameters or structural properties to use in ranking ontologies since selection can depend on personal preferences of use requirements (Alani and Brewster, 2006). The authors point to the need for user based experiments to find out what properties users tend to look out for when judging the general quality or suitability of an ontology. This view is also expressed by Kalfoglou and Hu (2006) who suggest the need for a holistic evaluation strategy with a greater role and participation of user communities in the evaluation process.

4.0 Biomedical information systems integration

Biomedical integration systems bring together disparate sources of biological and clinical information into one coherent and transparent system to enable biologists and clinicians discover interesting relationships between database objects to formulate and test hypothesis in order to generate knowledge (Hongzhan et al., 2004; Hernandez and Subbarao, 2002). Existing data management technology is challenged by lack of stability, evolving nature, diversity and implicit scientific context that characterize biological data (Davidson et al., 2004). New tools are required to relate genetic and clinical data (Martin-Sanchez et al., 2004). Ontology use has become an important approach for biomedical databanks integration.

Ontology Integration approaches in Biomedicine

Philosophical Ontology is the science of what is, of the kinds and structures of objects, properties, events, processes and relations in every area of reality. Broadly, it refers to the study of what might exist (Smith, 2003). Information systems ontology is an agreement about a shared, formal, explicit and partial account of a conceptualization (Gruber, 1995; Ushold and Gruniinger, 1996). It makes possible sharing and reusing of knowledge, supports interoperability between systems and allows inference to be done over them. Computer ontologies facilitate semantic interoperability in heterogeneous information sources (Jarrar et al., 2002), enabling data exchange between different models described in standard formats (Hucka, 2003). Ontology integration (OI) is the composition of many ontologies to build new ones whose respective vocabularies are usually not interpreted in the same domain of discourse (Kalfoglou and Schorlermmer, 2003). OI is a type of ontology reuse process that aims at building an ontology, by assembling, extending, specializing and adapting, other ontologies which become parts of the resulting ontology (Pinto and Martins, 2000). Its advantage is that, from a set of small, modular, highly reusable ontologies, large ontologies for specific purposes can more easily be assembled (Pinto and Martins, 2000).

Integrating biomedical information systems remains challenging largely due to problems of semantic heterogeneity and differences in levels of granularity of the data sources, and OI is a possible approach to overcome this problem. Ontology-based attempts to bridge the gap between clinical and biological information in order to achieve interoperability include ONTOFUSION (Perez-Rey et al., 2006), SEMEDA (Kohler et al., 2003), ASLER (Yugyung et al., 2006), Kumar et al., (2006) on the colon carcinoma, and that of (Sioutos et al., 2006) on cancer. The ONTOFUSION tool provides semantic level integration of genomic and clinical databases using a multiagent architecture, based on two processes: mapping and unification (Perez-Rey et al., 2006). A limitation of this approach is that the unified ontologies are too generic and the imperfections in domain ontologies are propagated into the virtual schemas (Kumar et al., 2006). It also does not bridge across levels of granularity for biomedical data. Using principles of the basic formal ontology, Kumar et al., (2006) describe a framework for integrating medical and biological information in order to draw inferences across various levels of granularity using the three sub ontologies of the Gene Ontology. Yugyung et al., (2006) describe a methodology for medical ontology integration using an incremental approach of semantic enrichment, refinement and integration (ALSER) that depends on measures of similarity between ontology models. A terminology and description logic based framework for integrating molecular and clinical cancer-related information has been described by Sioutos et al (2006). However, the approach is specific to cancer related integration issues and integrating with external sources remains a largely unresolved issue (Sioutos et al., 2006).

Evaluation of ontology integration systems - Related Work

Little work exists on evaluating the results of integrating biomedical ontologies. Pinto and Martins (2000) mention criteria for evaluating both the integrated ontology and the resulting ontology. They recommend both technical and user assessment of the candidate ontologies by domain experts and ontologists respectively using specialized criteria oriented to integration, and the selection of candidate ontologies using strict (hard) and desirable (soft) requirements. Using strict or desirable requirements, as a metric provides flexibility, as they can be adapted to integration processes that take into account particular features during the choice of one ontology.

Evaluation of the resultant ontology can be done according other criteria used for any ontology. The resultant ontology should be evaluated (verification and validation) and meet assessment criteria including completeness, conciseness, consistency, expandability and robustness (Gomez-Perez and Pazos 1995). Any ontology with an adequate design should have clarity, coherence, and extendibility, minimal encoding bias, minimal ontological commitment (Gruber, 1995). Pinto and Martins, 2000) point to the need for the resulting ontology to be consistent, non ambiguous and have both an adequate and appropriate level of detail.

Despite many approaches to biomedical data integration, there is lack of a single satisfactory strategy This lack of a single unifying approach to ontology integration is underscored by Ding Foo (2002) who point out the need to improve ontology integration using a structured approach that addresses issues of verification and consistency conditions for ontologies to be merged, the parameters to consider and the integration of ontologies with diverse relations. This lack of a unifying evaluation framework for integrated systems remains an obstacle for ontology reuse and may hinder their adoption by industry and the wider web community

(Alani and Brewster, 2006). The authors point to the need for ontology ranking techniques as the number of ontologies available for reuse continues to grow.

5.0 The proposed evaluation framework

Theoretical orientation

General systems theory (GST) and that of self organization (SOS) are adopted to explain the dynamic and emergent properties of biomedical integration systems. This study is also informed by the formative and summative evaluation frameworks. General systems theory is "elements in standing relationship, the joining and integrating of the web of relationships creates emergent properties of the whole that are not found in any analysis of the parts" (Von Bertalanffy, 1962). GST explains structure and properties of systems in terms of relationships from which new properties of wholes emerge. Some properties-of-the-whole cannot be found among those of elements, and the corresponding behavior of the whole cannot be explained in terms of the behavior of the parts.

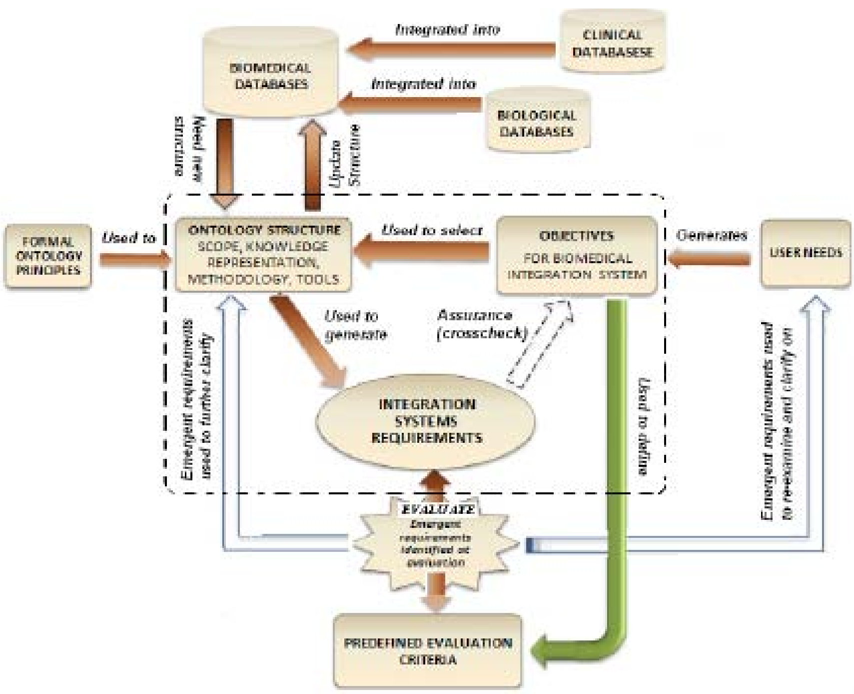
Self organization (SO) is a process in which the internal organization of a system increases in complexity without being guided or managed by an outside source and displays emergent properties. The emergent properties do not exist if the lower level is removed (Gershenson, 2006). In SOS the environment is unpredictable and the elements interact to achieve dynamically a global function or behavior (Gershenson, 2006). Engineered systems cope with the dynamic or unpredictable environment by adaptation, anticipation, robustness or a mixture of these features (Gershenson, 2006). Self-organizing systems, rather than being a type of systems, are a perspective for studying, understanding, designing, controlling, and building systems; the crucial factor being the observer, who has to describe the process at an appropriate level and aspects, and to define the purpose of the system; self-organization can therefore be everywhere, it just needs to be observed (Heylighen and Gershenson, 2003). Organization is seen as structure that has a purpose. The observer has to focus their viewpoint, set the purpose of the system to see the attractor as an organized state at the right level and in the right aspect in order to observe self-organization - a perspective that can be used for designing, building, and controlling artificial systems. A key characteristic of an artificial self-organizing system is that structure and function of the system emerge from interactions between the elements (Heylighen and Gershenson (2003). It is this perspective of self organizing systems that is adopted for this study to explain the evaluation of ontology based biomedical integration systems

Current ontology based evaluation models define standards for structuring and integrating knowledge using static relationships between concepts in a domain of discourse. The vast amounts of biological and clinical data require ontology integration structures that are able to capture and represent the dynamic nature of relationships that emerge as data in the two domains increases. Integrating such clinical and biological information leads to biomedical systems with new ontology structure and functions. The objectives for building biomedical integration systems also change with changing user needs. Change in ontology structure and user led objectives drive change in requirements for biomedical integration systems. New requirements for biomedical integration systems continuously emerge (emergent requirements). An effective evaluation process based on user needs, objectives and ontology structure has to account for and assess such dynamic relationships and emergent requirements. The proposed evaluation framework determines system quality for the biomedical integration system using effectiveness as a metric.

Conceptual framework

The framework assesses the suitability of a biomedical integration system against specified evaluation criteria in an environment of non static ontology structure and changing user needs. It seeks to determine the effectiveness of a biomedical integration system using completeness as a measure of system quality. It attempts to explain and answer key questions about (1) what do users need biological and clinical integration systems for? What are the limitations of existing systems in addressing these needs? What criteria help users to articulate these limitations? (2) For biomedical integration systems, what should be evaluated, for what purpose and which criteria should be used? (3) What is system quality in biomedical integration system? What requirements should a quality integration system conform to? What criteria help users to articulate these requirements? (4) What are the ontology structural requirements for a reusable quality biomedical integration system? How do they offer support for user needs and objectives? What criteria should be used to articulate such requirements? (5) What is the relationship between ontology based structural and user defined requirements?

The model



Dimensions of the model

The framework has dimensions of formal ontology, ontology structure, user needs, objectives, biomedical databases, integration system requirements and evaluation criteria. Clinical and biological (genomic) databases act as sources of data for the biomedical databases. Formal ontology is proposed in this model to structure such data in order to create knowledge and thereafter to update the biomedical databases. Formal ontology is used to define structural properties for a good quality integration system including the methodologies, development language and software. These have also been used in the OntoMetric evaluation method that enables selection of the most appropriate ontology for a project by comparing the importance of project objectives and the characteristics of ontologies in order to justify decisions (Lozano-Tello and Gomez, 2004).

The users and stakeholders of biomedical integration systems are biologists, medical professionals, health care workers and information systems specialists. Clinicians need to relate clinical data with insights from genetic research in order to advance knowledge about diagnosis and treatment of disease. Scientists need to test hypothesis by use of both existing clinical and genomic data. Information systems specialists need tools to structure, compare and manipulate the data. The various user needs are decomposed into objectives. The objectives as seen from the perspectives of the stakeholders are used to inform criteria for evaluating integration systems and guide the generation of ontology based biomedical integration requirements. Requirements for a quality biomedical integration system are generated by mapping those ontology based structures, functions and characteristics that help to meet the specified objectives. These are selected on the basis of ability to enable the system to conform to operational objectives. Once derived, they can be verified against the objectives

System quality, a key factor for evaluating this model is defined as "the totality of features and characteristics of a product or service that bear on its ability to satisfy stated or an implied need" (ISO 91, pp. 16). Quality is also viewed as "conformance to requirements" (Crosby, 1979, pp. 15; Garvin, 1984). This is the perspective from which quality is defined for this model. A need can be decomposed into a set of requirements upon features and characteristics of a product or service, and if all these requirements are conformed to, then that need has been satisfied. The evaluation criterion seeks to establish how well the biomedical integration system conforms to requirements. This is completeness for the system, and can be expressed as:

$$\text{Completeness} = \frac{\text{All Requirements met}}{\text{Total system requirements defined}}$$

In the model, this relationship expresses how well the ontology based structures satisfy the objective for biomedical system integration. Following evaluation, a proportion of total requirements defined are not met. These are here referred to as emergent requirements (ER) and require re-examination of user needs and /or ontology structure leading to a redefinition of the integration requirements.

ER = (Total system requirements defined - All Requirements met)

Steps for using the framework

The objectives as generated from user needs. These guide the selection of those ontology based properties that help to meet objectives. It is from these properties that integration system requirements are derived. The proposed framework has guidelines to help modelers of ontology based integrated biological and clinical information systems to build systems that meet requirements for users. They also enable modelers to meet system requirements but are not an absolute solution on their own. The steps to be followed when using this framework for evaluating ontology based biomedical integration systems are:

1. Identification and prioritization of user needs.
2. Derive objectives from user needs.
3. Generate evaluation criteria from user needs and objectives
4. Describe ontology quality characteristics for the integration system.
5. Compare and match (map) objectives to ontology quality descriptions. Rate them.
6. Generate system requirements from quality descriptions.
7. Compare requirements against the predefined evaluation criteria.
8. Generate emergent requirements. Compare them to user needs and quality descriptions to refine requirements

The novelty of this framework lies in the ability to relate ontology structure and user derived objectives in order to derive requirements for evaluating ontology based integrated biological and clinical information systems in environments where the amounts of data are ever increasing and user needs are changing.

6.0 Proposed methodology

The planned approach uses both qualitative and quantitative research methods. Qualitative methods are used to get a full understanding of user needs and quality descriptions for biomedical integration systems. Following the development of the evaluation tool, a summative evaluation of a biomedical information system involving users will be undertaken to validate the framework.

From a review of existing literature and document analysis, it will be possible to identify and describe common structures, functions, inputs, outputs that enhance quality in ontology based integrated biomedical information systems. Questionnaires and in depth interviews with stakeholders (research scientists, molecular biologists, clinicians and health care workers in research institutes, health departments and hospitals) are to be used to collect data on user needs relevant for biomedical integration systems. Objectives for integration shall be synthesized from these needs and mapped (matched) to the quality descriptions for the ontology based integrate systems. Requirements for the integrated system are to be derived from the quality descriptions.

A java based tool shall be built to validate the model with the stakeholders. UML is to be used to create a model for the tool development based on the requirements derived from the quality descriptions. Theoretical test data and selected biomedical integration systems are to be applied in the evaluation of the tool by users.

7.0 Conclusions

The paper identifies the challenges faced in evaluating ontology based biomedical integration systems. Evaluation is shown to be an important aspect of developing reusable ontology based biomedical integration systems for distributed computing environments. The paper provides the research background and approach to work in progress that aims to develop a reusable framework for evaluating integrated biomedical information systems. The theoretical, conceptual model and methodology towards such a framework are outlined. Steps for the utility of such a framework are also given.

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