Extended Clinical Discourse Representation Structure for Controlled Natural Language Clinical Decision Support Systems

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ABSTRACT

To support an end to end Question and Answering system to help the clinical practitioners in a cardiovascular healthcare environment, an extended discourse representation structure CIDERS is introduced. This extension of the well-known DRT (Discourse Representation Theory) structures, go beyond single text representation extending them to embrace the general clinical history of a given patient. Introduced is a proposed and developed ontology framework, Ontology for General Clinical Practice, enhancing the currently available state-of-the-art ontologies for medical science and for the cardiovascular specialty. It’s shown the scientific and philosophical reasons of its present dual structure with a deeply expressive (SHOIN) terminological base (TBox) and a highly computable (EL++) assertions knowledge base (ABox).

Keywords: CDSS, Clinical QA, Controlled Natural Language, Description Logic, Discourse Representation Structure, Knowledge Acquisition Bottleneck, OGCP, Ontology, OWL

INTRODUCTION

This paper describes an aspect extracted from the work undertaken by the authors when developing a Clinical Decision Support System for the Cardiovascular Healthcare environment based in state-of-the-art Artificial Intelligence techniques.

It was originated by the cooperation among the different authors in the accomplishment of the first one PhD degree in Computer Science and namely in Clinical Knowledge representation for reasoning and acquisition based in NLP (Natural Language Processing).

We found that the problem known as “Knowledge Acquisition Bottleneck” (Wong et al., 2012) is currently the major obstacle for development of adequate representations of medical
knowledge computable representations, namely ontologies in the specific domain and in particular in the healthcare sub domain. Trying to devise a valid solution to that problem in order to enable clinical automatic reasoning either in a local, distributed or Semantic Web fashion, different subproblems had to be addressed and solutions found are proposed and summarized in “Our Solution” section.

The particular solution illustrated here is the extension of the usual DRS (Discourse Representation Structure) that usually handles single texts and our proposal that we named CIDERS (Clinical Integrated Discourse Enhanced Representation Structure) has the extended capability of representing the whole discourse of a patient’s clinical history.

First of all we introduce the scientific question of overcoming the KAB problem in the next section and explain why it is so hard to overcome.

Next the solution proposed is detailed in its various problems, and pragmatic approaches taken for the problem’s different facets.

The fourth section briefly explains the rationale behind CIDERS and why it may be as a natural extension of the application of ACE tools in our work.

In the fifth section, we present the results obtained so far and explain the promising applicability to different clinical realities with expectable similar results.

Finally in the last section some conclusions are drawn and summarized from the various sections of the present paper.

Nomenclature

ACE: Attempto Controlled English
AI: Artificial Intelligence
CAT: Computer Aided Translation
CIDERS: Clinical Integrated Discourse Extended Representation Structure
CNL: Controlled Natural Language
CORE: Clinical Observations Recording and Encoding
CPR: Computer Based Patient Record Ontology
CQA: Clinical Question Answering
DO: Disease Ontology
DR: Discourse Reasoning
DRS: Discourse Representation Structure
EHR: Electronic Health Record
FOL: First Order Logic
GS: Gold Standard
IE: Information Extraction
KAB: Knowledge Acquisition Bottleneck
KR: Knowledge Representation
NLP: Natural Language Processing
OGCP: Ontology for General Clinical Practice
OGMS: Ontology for General Medical Science
OWL2: Web Ontology Language Version 2
SNOMED-CT: Systematized Nomenclature of Medicine - Clinical Terms
SOAP: Subjective, Objective, Assessment, Plan
TM: Translation Memories
WS: Web Services
WSD: Word Sense Disambiguation
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