Semantic Interoperability for Decision Support Using Case Formalism and Controlled Vocabulary

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Semantics

• Humans possess articulate speech denied to other creatures
• Doctors try to say just the right thing without saying either too much or too little
• Description influences communicating and processing of medical information
• Problem: How to create descriptions that we can use with a computer?
Interoperability

• Functional (ability to exchange information)
• Semantic (ability to use the exchanged information)
Semantic Interoperability Challenge

- At the semantic level, a message must convey meaning that can be interpreted.
- At the pragmatic level, a message must correspond in some way to the structure and the rules of the world.
- Medical cognition -- Knowledge of the way people process information is crucial to the successful use of information systems.
Semantic Interoperability Application
Three communities of practice
1. Medical Education
2. Clinical Care
3. Health Informatics
Use teaching cases and electronic health records to populate a case base
Use case base as a testbed for semantic interoperability
Semantic Interoperability Solution

• Terminology system for meanings
• Ontology to deal with the semantic proximity of different concepts and the different ways to code a concept (e.g., medical, financial, quality assurance)
• Health Level 7 (HL7) for context
  – Health care activity occurs within a context of who, whom, when, where, how, and why
Terminology system

• A thesaurus stimulates the usage of standardized terminology.
• We start with the UMLS Metathesaurus
• A controlled vocabulary is a restricted set of preferred terms and has two goals:
  – Standardization
  – Communication
Nomenclature

• Codes are assigned to concepts
• Combine codes for complex concepts
• Useful in producing standardized reports, such as discharge letters
• Nomenclatures used in electronic health records include:
  – SNOMED
  – MEDCIN
SNOMED International and CT

- SNOMED International – part of UMLS
- SNOMED CT – emerging as the single global terminology standard in UK & USA
- SNOMED Ontology is expressed in Description Logics
- CLUE Browser for SNOMED CT
SNOMED CT

Concept
Diagram for Metformin
MEDCIN
Aims to support the clinical thought process using a Concept Hierarchy with Six Categories
1. Symptoms
2. History
3. Physical Findings
4. Tests
5. Diagnoses, Syndromes & Conditions
6. Therapy and Management

Co-HOSTED BY:
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Text Corpus

REFERENCES Med II CURRICULUM
• Diabetes: An Instant Reference
• Tutor Guide for COPS Cases

REFERENCE from Food Drug & Administration
• Pharmaceutical Company’s Drug Labeling

CASES
• COPS Cases
• Clinical Reasoning Exam
Terminology Standardization

- Concepts are expressed in Narrative.
- Natural Language Processing by UMLS MetaMap Transfer program
- Map from text in narrative to UMLS concepts and preferred terms.
- Representation for UMLS preferred term is sought in SNOMED and MEDCIN

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Ontology-Based MetaData

- UMLS Ontology for Semantic Types and Semantic Relations
- Health Level 7 (HL7) Ontology for action-oriented information structure (what, who, whom, when, where, how and why)
- HL7 Document Ontology for Structures of Clinical Information in Patient Records
Structure Standardization

Three layers of structures for clinical info:
1. Documents and sections
2. Clinical statements
3. Systematic details within statements (e.g., drug prescriptions)
Semantic Interoperability

**Semantics**

- Nomenclature for medical information description
- UMLS as switching language between terminologies
- Ontologies for concept definition and relationships

**Pragmatics**

- Explicit constructs versus free-text narrative
- Archetypes facilitate homogeneous browsing of clinical information organized and represented according to miscellaneous criteria
Idea of <<archetype>>

A well-formed statement that defines the requirements on the content of attributes and coding systems, e.g.,

*Kind-of-habit* (e.g., *alcohol*, *smoking*)

*Is* a life feature

*Has quantity* number

*Has units* unit of measurement

*Has duration* time interval

*Has stop-time* date, time interval
Clinical Statements

• Convey context

• “Blood urea, creatinine, and electrolytes (sodium; potassium; chloride; bicarbonate) as well as total protein, albumin, serum calcium, and phosphate should be measured on a yearly basis for all type 2 DM patients and post pubertal type 1 DM patients”

Operable Clinical Cases

• Electronic health records (EHR) are real-life cases that depict both a clinical situation and an associated solution

• Leverage EHRs as a source of diagnostic-quality operable clinical cases

• EHRs possess knowledge about what clinical activities were done and in what context

• Case representation needs terminological, numerical and ontological standardization
Results

• Extracted clinical concepts from narrative text
• Semantic interoperability among electronic health resources requires attention to:
  – terminology system (UMLS, MEDCIN, SNOMED) for semantics
  – medical information descriptions for pragmatics
• Archetypes and HL7 Templates are a Work-in-Progress
Putting It All Together

• Development of an Information Flow Model and Interdisciplinary Teaching Resource
• Work-in-Progress Website http://www.healthinformatics.ca/dme
• Evaluation Plan – to be determined
• Intent is to build a curriculum resource for medical and health informatics education
References

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