

**TITLE:** Making scientific knowledge computable

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**RESEARCH PROJECT DESCRIPTION** (brief overview of background, hypothesis, methods, role of medical student, funding and relevant publications -- SHOULD NOT EXCEED ~ 250 WORDS)

Background/Hypothesis/Methods

I have several projects that seek to take biomedical scientific knowledge and make it accessible to computers. The rationale is that computers can then help humans conduct science, including the entire process from hypothesis formation, to retrieval of data and information necessary to both to prepare and execute a study design, to collection of data for the research, to the analysis of data, to the drawing of conclusions based on data, to the cataloging of the data and new knowledge so derived. A key component of this work is the development of biomedical ontologies. Ontology is the science of what exists, the fundamental nature and properties of what exists, and how various entities are interrelated. It is relevant to this task because the computer first needs to know these things before it can reason about them.

One project involves the scientific capture of information about drugs. The goals are to capture the mechanisms of action, physiological effects, therapeutic indications, metabolism, and effects on various enzymes and transporters that frequently lead to side effects and interactions with other drugs, natural products, and foods. Formal ontological representation of drugs and their characteristics is enabling comparative effectiveness research, cohort discovery, and more.

Another project addresses the fundamental nature of information itself, seeking to represent all the entities that must exist for a given record in a database to be accurate. For example, diagnoses of fractures in today's EHRs do not uniquely track each individual fracture. We are experimenting with the referent tracking paradigm to understand how much data leaves unsaid, and what are the implications.

Role of medical student

Students will spend 2-3 weeks learning both theory and practical skills in ontology and referent tracking. The remainder of the time will be spent constructing ontological artifacts, referent tracking templates, and testing them with data and queries. Students are encouraged to co-author manuscripts about the results of this work.

Funding

Some of the projects are funded by grants from the Florida Department of Health's James and Esther King Biomedical Research Program and the Patient Centered Outcomes Research Institute.

Publications

1. Hogan WR. To what entities does an ICD-9-CM code refer? A realist approach. In, Proceedings of Bio-Ontologies 2010, "Semantic Applications in Life Sciences." 2010:60-63. <http://www.bio-ontologies.org.uk/programme/Bio-Ontologies-2010-Handout-Formatted.pdf>

2. Hogan WR, Garimalla S, Tariq SA. Representing the reality underlying demographic data. Proceedings of the International Conference on Biomedical Ontology (July 28-30, 2011, Buffalo, NY):147-152. Available at: <http://ceur-ws.org/Vol-833/paper20.pdf>.
3. Hogan WR, Hanna J, Joseph E, Brochhausen M. Towards a consistent and scientifically accurate drug ontology. International Conference on Biomedical Ontology 2013 (July 8-9, 2013, Montreal, Canada). Available at: [http://ceur-ws.org/Vol-1060/icbo2013\\_submission\\_40.pdf](http://ceur-ws.org/Vol-1060/icbo2013_submission_40.pdf)
4. Hanna J, Joseph E, Brochhausen M, Hogan WR. Building a drug ontology based on RxNorm and other sources. Journal of Biomedical Semantics, 2013 Dec;4:44. doi:10.1186/2041-1480-4-44. Available at: <http://www.jbiomedsem.com/content/4/1/44/abstract>. PMID: PMC3931349.
5. Brochhausen M, Schneider J, Malone D, Empey PE, Hogan WR, Boyce RD. Towards a foundational representation of potential drug-drug interaction knowledge. In Proceedings of the First International Workshop on Drug-drug Interaction Knowledge Representation (DIKR 2014). October, 2014, Houston, Texas. Available at: <http://ceur-ws.org/Vol-1309/paper2.pdf>
6. Ceusters W, Hogan W. An ontological analysis of diagnostic assertions in electronic healthcare records. Proceedings of the 6<sup>th</sup> International Conference on Biomedical Ontology. July 27-30, 2015, Lisbon, Portugal. Available in: <http://icbo2015.fc.ul.pt/ICBO2015Proceedings.pdf>
7. Hanna J, Bian J, Hogan WR. An accurate and precise representation of drug ingredients. 4th International Workshop on Vaccine and Drug Ontology Studies (VDOS-2015), held in conjunction with the 6th International Conference on Biomedical Ontology. July 27, 2015, Lisbon, Portugal.