Course Title: Principles of Referent Tracking in Biomedical Informatics

	Department of Health Outcomes and Biomedical Informatics College of Medicine
Course Subject Code:	GMS
Course Number:	7866
Type of Instruction:	LEC
Class Number:	to be assigned
Semester:	Spring 2019

1. *Course Information*

- Date(s)/Time(s): Monday Periods 3 and 4 9:35 – 11:30
  Wednesday Period 3 9:35 – 10:25
- Delivery Mode: Traditional
- Number of Credits: 3
- Instructors

Course director and lecturer:

William R. Hogan, MD
CTRB 3241
2004 Mowry Rd. Gainesville, FL 32610
352-294-4197
hoganwr@ufl.edu

Office hours: By appointment only

2. *Course Objectives*

By the end of this course, students will be able to:

1. Describe the principles of ontological realism
2. Apply the principles of ontological realism to problems in information management
3. Describe the principles of referent tracking
4. Conduct referent-tracking-based analyses of situations and extant datasets to identify ambiguities, develop any new necessary ontology, and make data maximally explicit
5. Explain how referent tracking makes data maximally explicit and self-explanatory

3. *Course Description*

- Summary: This course provides an in-depth exploration of the purpose, scope, technical structure, and uses of the methodology of Referent Tracking. This methodology serves the design of information systems that are maximally *self-explanatory* and *explicit* in terms of the data they manage and *self-aware* in terms of their interactions with other systems and users thereof. The course includes theoretical lectures, group discussions, and guided exercises, the latter aimed to help integrate all aspects of Referent Tracking into prototype applications useful for the students' PhD thesis work or other relevant research endeavors.

- Course outline: This course will offer students an in-depth, both theoretical and practical, review of Referent Tracking (RT), a novel paradigm for entry and retrieval of data in information systems in general and in Electronic Health Record (EHR) systems in particular. Its aim is to provide students with deep insight into the principles and methods needed to design systems that have the potential to achieve automated semantic interoperability with other information systems.

  The course comprises lectures on RT theory, guided group exercises, and a course pilot project. The course will begin with a presentation of the problems created by traditional database designs and the major strategies for solving them. It will then provide the information students need to design a pilot RT system to support the creation, curation, evolution, and quality control of data collections they might have to use in their PhD or other research work. The first group of lectures covers how the ontological basis of the theory is able to prevent, detect, and—where possible—remediate the ambiguities and hidden

assumptions typically found in traditional information systems. The following lectures will focus on the discords in traditional information systems between changes in reality, changes in our understanding of reality, and changes in information systems intended to represent reality and our understanding thereof. In these lectures, it will be shown how RT systems can more clearly represent entities over time both for what is the case and what is believed to be the case, thus enabling advanced forms of quality assurance in information systems. The final lectures will cover in detail how dealing with, or ignoring, various types of changes can make or break systems for automated reporting, prediction, and decision support. The last class will be used for the presentation and in-depth discussion of the students' projects.

- Course project:
  During the course, the students will develop in parallel with the classes a skeleton of a referent tracking system (RTS) for data collections they are working with, or intend do so, in the context of their PhD thesis or other research-related endeavor. The functions of this RTS will be:
  1. to represent in a uniform and ontologically principled way:
     1.1. certain variables (or data types) within these data collections,
     1.2. the portions of reality they are (intended to be) about, and
     1.3. the possible relationships between 1.1 and 1.2;
  2. to track possible changes in the data collections and the resulting changes in the RTS itself,
  3. to track quality changes in the data collections and the RTS,
  4. to support automatic decision support or advanced analytics within the covered research domain.

  Depending on the students' educational background, this skeleton may take the form of a formal specification for such a system or a prototype implementation demonstrating the functionalities of a referent tracking system for their domain, limited to what will be focused on in this course. Whatever output chosen, the various assignments of this course are designed to make such development possible in a stepwise fashion, with requirements for the successful completion of these assignments being focused on the documentation or description of these efforts. At the end of the course, the students will combine their documentation into either a vision paper for future research, or the background, preliminary results, and methodology sections for an early career grant proposal within the context of their PhD thesis.

- Course prerequisites:
  - GMS6850 (Foundations of Biomedical Informatics) or equivalent,
  - GMS6803 (Data Science and Clinical Research) or equivalent,
  - GMS6804 (Translational Bioinformatics) or equivalent, and
  - GMS6805 (Introduction to Applied Ontology) or equivalent.

4. Student Learning Outcomes (SLO)

Abbreviations used in the table:

- PCT: 'post-class test'
- PCA: 'post-class assignment'
- PD: 'participation in discussion'

Course Learning Outcomes; students will be able to:	BMI PhD Program Outcomes / Competencies	Instructional Method(s)	Assessment Method(s)
(1) Determine the extent to which data points in biomedical databases and information systems adequately and accurately identify and describe the entities in reality they are about	• Key informatics concepts, models, and theories • Methods of data representation, manipulation, storage, analysis, and mining in healthcare and biomedical research databases	• Lectures • Group discussion • Guided exercise	• Reading test • PCA • PD • Final exam
(2) Judge the value of operational medical data in providing evidence for better treatment paradigms	• The purpose, scope, structures, and uses of electronic health record (EHR) systems • Human healthcare decision sciences, decision support tools, knowledge modeling, and quality/safety measures	• Lecture	• Reading test • PCA
(3) Criticize the limitations of biomedical coding and classification systems for diagnoses, procedures, and billing.	• Biomedical ontology theories, standards, and development methods	• Lectures • Group discussion	• Reading test • PD • PCA • PCT • Final exam

(4) Evaluate the potential of Ontological Realism for improving electronic healthcare record data.	• Ontological Realism and the Basic Formal Ontology (BFO)	• Lecture • Guided exercise • Group discussion	• Reading test • PD • PCT • PCA
(5) Formulate the deficiencies of data- and knowledge bases in specific areas of biomedical research in terms of violations of basic referent tracking principles.	• The ability to organize and write a clear and complete thesis including […] the data and research methods used • Technical approaches to acquiring, modeling, representing, and managing healthcare and biomedical research knowledge	• Lecture • Guided exercise	• PCA • Final exam
(6) Discuss the commonalities in data representation deficiencies in non-overlapping research areas	• Describe the characteristics of the data to be collected and the data analysis methods to be used	• Lecture	• PCA
(7) Formulate requirement specifications for problem-oriented referent tracking systems	• Ability to make effective use of biomedical information systems, architectures, and networks • The ability to organize and write a clear and complete thesis including […] the data and research methods used	• Lecture	• PCA • PCT • Final exam
(8) Compare biomedical information system designs	• Technical approaches to healthcare and biomedical knowledge management • Current and potential new areas of biomedical ontology research and development	• Lecture • Group discussion	• PCT • PD
(9) Develop accurate documentation for research and development projects	• The ability to prepare a detailed research proposal and to defend the proposal in discussion with other researchers	• Group discussion • Lecture • Guided exercise	• Reading test • PCA • Student presentation
(10) Distinguish the various sorts of changes that might render information systems inaccurate	• The principles for change management and upgrades to biomedical ontologies and information systems	• Lecture • Group discussion	• PD • PCT • PCA
(11) Propose adequate change management mechanisms to keep information system in sync with the reality they represent	• The principles for change management and upgrades to biomedical ontologies and information systems	• Lecture • Group discussion	• PD • PCT • PCA • Final exam
(12) Develop rules for automated decision support in biomedical information systems	• The ability to build CDS applications • Logical principles for building structured representations of data and knowledge • Human healthcare decision sciences, decision support tools, knowledge modeling, and quality/safety measures	• Lecture	• PCA • Final exam
(13) Create information system components that are maximally explicit and self-explanatory	• Modeling, representing and maintaining biomedical data and knowledge • Innovative design concepts for information management systems	• Lecture • Guided exercise	• PCT • PCA

5. Course Requirements

- Students are required to read 23 papers and electronic publications as listed in the course materials below, some only partially where indicated.
- The content of most papers will be explained and elaborated on in the lectures. Other papers contain necessary background information that will be assumed to be 'known' prior to the lecture. Such papers – their titles are marked in bold font in section 9 and the dates at which they will happen are listed in section 5 – will be the topic of a pre-lecture reading test to assess the student's preparedness for the class. Students arriving too late in the class might not be able to participate in the test of that class. Students who gave prior notice of valid reasons for not being able to attend a class may negotiate to take the test another time.
- At the end of some classes, students will be tested about what they learned since the first class, or the previous post-class test. The dates are listed in section 5. Students who gave prior notice of valid reasons for not being able to attend a class may

negotiate another form of assessment for the topic covered, or use the results of the post-class assignment to also count for the post-class test.

- All assignments are due at 5PM of the due dates listed in section 5 and must be submitted to the course Canvas site. Assignments submitted late will be subject to a 10% deduction in the assessment unless the student has negotiated an alternative deadline prior to the stated deadline.
- Students must participate in a final exam during the official final exam period after the course.

6. Grading Policy

Grading follows standard graduate policies (see the UF Graduate Catalog at http://gradcatalog.ufl.edu/content.php?catoid=5&navoid=1054#grades).

Learning assessments will be graded based on rubric criteria and weighted according to the break-down in the following table.

week designator	date	required reading test	participation in discussion	post-class test	assignment	due date, 5 PM	final exam
W1	07-Jan	20			5	11-Jan	
W2	14-Jan	15			5	18-Jan	
W3*	23-Jan	15			5	01-Feb	
W4	04-Feb			25	5	08-Feb	
W5	11-Feb			25			
W6	18-Feb				10	22-Feb	
W7	25-Feb	15	50		5	01-Mar	
W8†	11-Mar		50		10	15-Mar	
W9	18-Mar	15			10	22-Mar	
W10	25-Mar			25	5	29-Mar	
W11	01-Apr			25	10	05-Apr	
W12	08-Apr				15	12-Apr	
W13	15-Apr	20			5	19-Apr	
W14	22-Apr				10		
Final Exam	29-Apr						100
sum		100	100	100	100		100
weight		**15**	**5**	**20**	**30**		**30**

* Note that W3 covers 3 class periods: Wed 1/23, Mon 1/28, and Wed 1/30. Monday 1/21 is a University holiday.
† Note that Spring Break occurs between W7 and W8, and thus W8 date is two weeks after W7 date instead of one week.

Grading scale:

Grade	Grade points	Percentage
A	4.0	95.0% -100.00%
A-	3.67	90.0% - 94.9%
B+	3.33	87.0% - 89.9%
B	3.00	83.0% - 86.9%
B-	2.67	80.0% - 82.9%
C+	2.33	77.0% - 79.9%
C	2.00	73.0% - 76.9%
C-	1.67	70.0% - 72.9%
D+	1.33	67.0% - 69.9%
D	1.00	63.0% - 66.9%
D-	0.67	60.0% - 62.9%
E	0	59.9% or below

7. ACADEMIC INTEGRITY

UNIVERSITY POLICY ON ACADEMIC MISCONDUCT: Academic honesty and integrity are fundamental values of the University community. Students should be sure that they understand the UF Student Honor Code at http://www.dso.ufl.edu/students.php. You are expected and required to comply with the University's academic honesty policy (University of Florida Rules 6C1-4.017 Student

Affairs: Academic Honesty Guidelines, available at http://regulations.ufl.edu/chapter4/4017.pdf). Cheating, plagiarism, and other forms of academic dishonesty will not be tolerated. Note that misrepresentation of the truth for academic gain (e.g., misrepresenting your personal circumstances to get special consideration) constitutes cheating under the University of Florida Academic Honesty Guidelines.

8. ACCESSIBILITY RESOURCES

UNIVERSITY POLICY ON ACCOMMODATING STUDENTS WITH DISABILITIES: Students with disabilities requesting accommodations should first register with the Disability Resource Center (352-392-8565, www.dso.ufl.edu/drc/) by providing appropriate documentation. Once registered, students will receive an accommodation letter which must be presented to the instructor when requesting accommodations. Students with disabilities should follow this procedure as early as possible in the semester.

9. Course Organization / Schedule

- Reference: https://catalog.ufl.edu/UGRD/dates-deadlines/pdfs/calendar1819.pdf
- Papers marked with bold titles in the '**Required readings prior to lecture**' sections below are subject to pre-reading tests.

W1	**Dates:** Jan 7, 9	**SLO:** 1, 2, 3
Topics Covered		**Required readings prior to lecture**
Lecture: 1) Ambiguities and hidden assumptions in traditional and prevailing data and information modeling paradigms; 2) explicit representation of entities implicitly referred to when associating ICD codes with a patient-diagnosis.		1. Hersh WR Weiner MG Embi PJ et al.. **Caveats for the use of operational electronic health record data in comparative effectiveness research.** Med Care 2013; 51 (8 Suppl 3):S30–7. 2. Ceusters W, Blaisure J. **A Realism-Based View on Counts in OMOP's Common Data Model**. Studies in Health Technology and Informatics 2017;237:55-62. 3. Ceusters W, Smith B. **What do Identifiers in HL7 Identify? An Essay in the Ontology of Identity**. In: Okada M and Smith B (eds.) Interdisciplinary Ontology; Proceedings of the Second Interdisciplinary Ontology Meeting (InterOntology 2009), Tokyo, Japan, February 28 - March 1, 2009;:77-86.
Assignment due: Jan 11		**Assignment assessment**
Select from within a domain of your research interests (ideally within the scope of your PhD thesis) a database, dataset, data dictionary, or one or more papers describing in detail the structure and content of such data collection. Identify therein 5 distinct variables or combinations thereof for which the provided descriptions are suggestive for some violation of, or ambiguity with respect to, the principles adhered to in the Basic Formal Ontology, or any other ontology which uses it as basis. Explain in terms of these principles why that is the case, how the problems could have been avoided and what might perhaps be done to minimize the effects after the facts. One page maximum.		• Degree to which each of the 5 reported problems are indeed problems (10%) • Degree to which the identified problems are sufficiently distinct (20%) • Correctness of the argumentation why they are problems (50%) • Proposals for prevention (10%) • Proposals for remediation after the facts (10%)

W2	**Dates:** Jan 14,16	**SLO:** 4, 5
Topics Covered		**Required readings prior to lecture**
1) Lecture: Ontological basis of referent tracking; 2) Guided exercise: applying the basics of referent tracking to some of the problems in the research areas reported on by the students through the post-lecture assignment of W1.		4. Ceusters W, Smith B. **Strategies for Referent Tracking in Electronic Health Records.** J Biomed Inform. 2006 Jun;39(3):362-78. 5. Hogan WR, Garimalla S, Tariq SA, Ceusters W. **Representing local identifiers in a referent-tracking system.** In Proceedings of the International Conference on Biomedical Ontology (July 28-30, 2011, Buffalo, NY):252-254. 6. Rudnicki R, Ceusters W, Manzoor S, Smith B. What Particulars are referred to in EHR Data? A Case Study in Integrating Referent Tracking into an Electronic Health Record Application. In Teich JM, Suermondt J, Hripcsak C. (eds.), American Medical Informatics Association 2007 Annual Symposium Proceedings, Biomedical and Health Informatics: From Foundations to Applications to Policy, Chicago IL, 2007;:630-634.
Assignment due: Jan 18		**Assignment assessment**
Select from the five problems identified in the assignment of W1 two that have not been specifically addressed in lecture W2 and that require both a different (1) approach to prevent and (2) solution to remediate after the facts. Using the method explained in the lecture, draft formal specifications for each of the two issues. No page limit.		• Degree to which each of the two selected issues are distinct from each other (10%) • Degree to which all provided descriptions and arguments in the submitted document are relevant (10%) • Adequacy and clarity of the specifications for each selected issue (20% each)

W3	**Dates:** Jan 23, 28, 31	**SLO:** 6, 7
Topics Covered		**Required readings prior to lecture**

Lecture: 1) Example applications of referent tracking in a variety of domains 2) Problems occurring when local identifiers are not guaranteed to be globally and singularly unique 3) Drafting requirements specifications for referent tracking applications	7. 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. 8. Ceusters W, Smith B. Referent Tracking for Treatment Optimization in Schizophrenic Patients. Journal of Web Semantics 4(3) 2006:229-36; Special issue on semantic web for the life sciences. 9. Ceusters W, Smith B. Referent Tracking for Corporate Memories. In: Rittgen P. (ed.) Handbook of Ontologies for Business Interaction. Hershey, New York and London: Information Science Reference, 2007, 34-46. 10. Manzoor S, Ceusters W, Smith B. Referent Tracking for Command and Control Messaging Systems. Ontology for the Intelligence Community 2009 (OIC-2009), Fairfax Virginia, October 21-22, 2009.
Assignment due: Feb 1	**Assignment assessment**
Review the five reported problems selected for assignment W1. Using the examples used and principles explained in lecture W3, draft the requirements specifications for a referent tracking system that will solve most – if not all, but at least covering the five reported problems – representation issues identified thus far. Outline limitations of the requirements, if any. One page maximum.	• Clarity and completeness of the requirements specifications (70%) • Argumentation for the limitations or absence thereof (30%)

W4	**Dates:** Feb 4, 6	**SLO:** 7, 8
Topics Covered		**Required readings prior to lecture**
Lecture: Building referent tracking systems		11. Manzoor S, Ceusters W, Rudnicki R. Implementation of a Referent Tracking System. International Journal of Healthcare Information Systems and Informatics 2007;2(4):41-58. 12. Ceusters W, Buekens F, De Moor G, Bernauer J, De Keyser L, Surjan G. TSMI: a CEN/TC251 Standard for time specific problems in healthcare informatics and telematics. International Journal of Medical Informatics 1997;46:87-101.
Assignment due: Feb 8		**Assignment assessment**
Use your previous assignment submissions to write what could be the introduction to the methodology section for a paper or grant proposal about the application of referent tracking to relevant elements in your PhD thesis or in your research domain of interest. This section must summarize the referent tracking principles discussed thus far and describe the relevancy of them for the research work you are or wish to be engaged in. Half page maximum.		• Scholarly style of the prose (20%) • Adequate summary of the referent tracking (RT) principles (20%) • Relevancy to your research work (30%) • Degree to which the section does not require further reading to be understandable by non-experts in RT (30%)

W5	**Dates:** Feb 11, 12*	**SLO:** 3, 4, 5, 10
Topics Covered		**Required readings prior to lecture**
Lecture: Representing negative findings, adverse events and adverse event reports		13. Ceusters W, Capolupo M, De Moor G, Devlies J, Smith B. An Evolutionary Approach to Realism-Based Adverse Event Representations. Methods of Information in Medicine, 2011;50(1):62-73. 14. Ceusters W, Elkin P, Smith B. Negative Findings in Electronic Health Records and Biomedical Ontologies: A Realist Approach. International Journal of Medical Informatics 2007;76:326-333.
Assignment none		

* Wednesday class rescheduled to Tuesday 2/12 at 1p to accommodate student/instructor conflicts

W6	**Dates:** Feb 18, 19*	**SLO:** 4, 10, 11
Topics Covered		**Required readings prior to lecture**
Lecture: Tracking distinct types of changes: changes in reality, changes in knowledge about reality, changes in information systems		15. Ceusters W, Manzoor S. How to track absolutely everything? In: Obrst L, Janssen T, Ceusters W (eds.) Ontologies and Semantic Technologies for the Intelligence Community. Frontiers in Artificial Intelligence and Applications. IOS Press Amsterdam, 2010;:13-36.
Assignment due: Feb 22		**Assignment assessment**

Identify in the context of your previous assignment submissions the circumstances which might lead to changes of the sorts discussed in the lecture. Describe each type of change using a coherent template of referent tracking tuples. Propose for each type of change an algorithm able to identify such change in source data and to represent them faithfully in the system on the basis of reasonable assumptions. Motivate why these assumptions are reasonable. For some type of changes full preciseness in representation can perhaps not be achieved. Whenever that is the case, select the solution which minimizes the possibility for unfaithfulness. No page limit.	• Correct identification of types of changes that might occur within the students' research topic (20%) • Adequate construction of templates (30%) • Adequateness of proposed algorithms (40%) • Motivations for assumptions (10%)

* Wednesday class rescheduled to Tuesday 2/19 at 2p to accommodate student/instructor conflicts

W7	**Dates:** Feb 25, 27	**SLO:** 3, 4, 10, 11
Topics Covered		**Required readings prior to lecture**
1) Lecture: Tracking quality changes in representation systems. 2) Group discussion: Adequate algorithms for dealing with discords between information systems and reality.		16. Ceusters w, Bona J. **Analyzing SNOMED CT's Historical Data: Pitfalls and Possibilities.** In: American Medical Informatics Association 2016 Annual Symposium Proceedings, Chicago IL, November 12-16, 2016;361-370. 17. Ceusters W. Applying Evolutionary Terminology Auditing to the Gene Ontology. Journal of Biomedical Informatics 2009;42:518–529. 18. Ceusters W. Dealing with Mistakes in a Referent Tracking System. In: Hornsby KS (eds.) Proceedings of Ontology for the Intelligence Community 2007 (OIC-2007), Columbia MA, 28-29 November 2007;:5-8.

Assignment due: Mar 1	**Assignment assessment**
Correct your W6 assignment according to the feedback I gave you. Show all relevant IUI assignments, PtoU tuples, PtoP tuples, PtoLackU tuples, and D tuples. For example, if you are correcting a PtoU tuple, show the PtoU tuple being corrected. If you only handled one type of change (e.g., change in reality), develop a scenario / circumstance that embodies at least one more type of change (e.g., change in belief or change in relevance). Represent new scenarios / circumstances using adequate A, PtoU, PtoP, PtoLackU, and D tuples. Be careful to ensure that the relations and types you are using are compatible.	• Scenarios / circumstances show more than one type of change (20%) • Adequate construction of templates (30%) • Adequateness of error correction, belief updating, and capture of changes in relevance (30%) • Quality of supporting documentation (20%)

W8	**Dates:** Mar 11, 12*	**SLO:** 8, 9, 10, 11
Topics Covered		**Required readings prior to lecture**
Group discussion: the submitted assignments of W7 will be discussed and corrected where needed. Students will compare alternatives and discuss opportunities for improvements of their own work. The submissions thus far will further be evaluated to assess their appropriateness for a research paper and/or (part of) a grant proposal.		none

Assignment due: Mar 15	**Assignment assessment**
Students will assemble all the assignments W1-W7 together into one document and make it coherent, knitting together all the pieces into one whole. Use a standard paper format: Introduction (plus or minus Background if you wish), Methods, Results, Discussion, Conclusions. Students will slot the prior assignments under the headings, and then work on making it cohesive as a whole. The Introduction does not have to be publication-ready in terms of reviewing past work, but nevertheless should identify the key prior work (with at least some citations) on which it builds. The students will incorporate edits based on instructor feedback provided on past assignments. Students will incorporate written, paragraph-based scenarios created for past assignments in the Methods section. Students will include problems they identified in pre-existing artifacts and their consequences in the Results section, as well as issues in detecting certain types of change from those artifacts as they currently exist. The other part of the Results section will be the students' proposed referent tracking solution to the issues described. The Discussion section should include any conclusions reached thus far, but does not need to be complete.	• All prior work is included (10%) • Degree to which the pieces are well-integrated into a coherent whole (30%) • Quality of writing (20%) • Degree to which Results section clearly shows the limitations and problems of the pre-existing artifacts under consideration, including but not limited to their insufficiencies in tracking changes in knowledge and reality (20%) • Degree to which Results section outlines in detail a referent tracking solution to the problems identified in the pre-existing artifact(s), including but not limited to tracking changes in belief and reality and relevance (20%)

* Wednesday class rescheduled to Tuesday 3/12 at 2p to accommodate student/instructor conflicts

W9	**Dates:** Mar 18, 20	**SLO:** 9, 12
Topics Covered		**Required readings prior to lecture**
Lecture: Implementing automatic decision support based on referent tracking statements		19. Hogan WR and Ceusters W. **Diagnosis, misdiagnosis, lucky guess, hearsay, and more: an ontological analysis**. Journal of Biomedical Semantics 2016;7(54). 20. Ceusters W, Capolupo M, Devlies J. D4.3 – RAPS Application ontology (Version 1). Background materials and methodology used to develop Application Ontologies for Risks against Patient Safety, January 11, 2009, 53p. Chapters 5 and 6.
Assignment due: Mar 22		**Assignment assessment**
Each student will select from within his research domain a specific problem to be tracked in the referent tracking system and write using templates built out of referent tracking assertions a set of decision support rules that will guide the referent tracking system in fine-tuning the temporal dependencies between the entities it is tracking.		• Size and/or complexity of the selected problem (20%) • Adequate construction of templates (30%) • Adequateness of proposed algorithms taking into account the assumptions selected in W6 (30%) • Quality of supporting documentation (20%)

W10	**Dates:** Mar 25, 27	**SLO:** 13
Topics Covered		**Required readings prior to lecture**
Lecture: Referent tracking as a tool to build self-explanatory databases and self-aware information systems		21. Ceusters W, Hsu CY, Smith B. Clinical Data Wrangling using Ontological Realism and Referent Tracking. International Conference on Biomedical Ontologies, ICBO 2014, Houston, Texas, Oct 6-9, 2014; CEUR Workshop Proceedings 2014;1237:27-32.
Assignment due: Mar 29		**Assignment assessment**
Students will identify within their research domain an area requiring de novo data collection. They will define the variables using the principles of ontological realism and describe dependencies amongst them using referent tracking assertions over arbitrary particulars. They will create the ontology component required to design after the following lecture (W11) a self-explanatory data collection sheet for the intended data collection.		• Number of variables and complexity of relationships amongst them (20%) • Adequate construction of templates (30%) • Adequateness of proposed algorithms taking into account the assumptions selected in W6 (30%) • Quality of supporting documentation (20%)

W11	**Dates:** Apr 1, 3	**SLO:** 1, 5, 9, 13
Topics Covered		**Required readings prior to lecture**
Guided exercise: designing a formal representation for a self-explanatory data collection sheet		22. Ceusters W. An Ontology for Pain and related disability, Mental health and Quality of Life (OPMQoL). Final Report for grant R01DE021917 from the National Institute of Dental and Craniofacial Research, NIH), September 27, 2014, 141p. Chapters 9 and 15.
Assignment due: Apr 5		**Assignment assessment**
Students will create a self-explanatory data collection sheet for their intended data collection. They will document this by writing a new section to their paper and/or proposal section explaining how they will render their data collections maximally self-explanatory and explicit.		• Completeness of the self-explanatory data collection sheet • Clarity of the documentation • Suitability of their prose for an appropriate section of a research paper or grant proposal.

W12	**Dates:** Apr 8, 9*	**SLO:** 1, 8, 9
Topics Covered		**Required readings prior to lecture**
Group discussion: towards a harmonized referent tracking system for biomedical research		none
Assignment due: Apr 12		**Assignment assessment**

In groups of maximally 6 collaborators, students will compare and discuss their individual work thus far. They will produce together one specification document for a harmonized referent tracking system able to deal with all representation issues identified in the selected research domains covered by the students. They may work in any combination on different sections of the document, but each section must be annotated with the names of the contributors; what is considered 'contributing' may be freely determined by the students in agreement, perhaps even different for each section. Where relevant, sections may be derived from documents produced earlier in this course, yet the document to be developed here needs to be coherent.	Each section will be assessed for clarity and appropriateness. Students who contributed to a section will all receive the same score (expressed as a percentage) for that section. Students that didn't contribute to a section will receive the difference between 100 and the percentage for that section. The weight of a section with respect to the entire document will be determined by the sum of the assigned scores for the students normalized to 100%. A student's score for the document will then be the sum of his weighted scores for the section.

* Wednesday class rescheduled to Tuesday 4/9 at 2p to accommodate student/instructor conflicts

W13	**Date:** Apr 15, 17	**SLO:** 9
Topics Covered		**Required readings prior to lecture**
Self-study: using the principles of referent tracking for writing unambiguous papers and grant proposals.		23. Ceusters W, Michelotti A, Raphael KG, Durham J, Ohrbach R. **Perspectives on Next Steps in Classification of Orofacial Pain – Part 1: Role of Ontology**. Journal of Oral Rehabilitation 2015;42(12):926-41.
Assignment **due: Apr 19**		**Assignment assessment**
Students will finish their paper / grant proposal sections and prepare a presentation to be delivered during the last class.		• Clarity of prose (70%) • Appropriateness for grant proposal sections or scientific paper (30%)

W14	**Dates:** Apr 22, 24	**SLO:** 9
Topics Covered		**Required readings prior to lecture**
Student presentations.		none
Assignment		**Assignment assessment**
the presentation itself		• Clarity and appropriateness of slides (30%) • Verbal presentation (30%) • Adequateness of answers to questions or issues raised (40%)

W15	**Date:** Apr 29	
Topics Covered		**Required readings prior to lecture**
Everything discussed in the class		All papers and slides used during the course
Final Exam		**Assessment**
The final exam will be held in the class room. It will be composed of questions and exercises covering the complete content of the course. Students may bring their laptop to the exam pre-loaded with any documentation they consider useful to consult during the text, whether or not used during the course. However, wifi services must be disabled and use of cell phones is not allowed, this to ensure that students will do the test individually.		• scoring mechanism will be different for each exercise or question, but clearly explained.

10. Course Materials

This course requires reading the following 23 papers and research reports, all of which are publicly available

a) Papers which are subject of a reading test:

- Ceusters W, Blaisure J. A Realism-Based View on Counts in OMOP's Common Data Model. Studies in Health Technology and Informatics 2017;237:55-62. http://www.referent-tracking.com/RTU/files/pHealth2017-Ceusters-Blaisure-resubmission/1.0/pHealth2017-Ceusters-Blaisure-resubmission.pdf
- Ceusters w, Bona J. Analyzing SNOMED CT's Historical Data: Pitfalls and Possibilities. In: American Medical Informatics Association 2016 Annual Symposium Proceedings, Chicago IL, November 12-16, 2016;361-370. https://www.ncbi.nlm.nih.gov/pubmed/28269831

- Ceusters W, Michelotti A, Raphael KG, Durham J, Ohrbach R. Perspectives on Next Steps in Classification of Orofacial Pain - Part 1: Role of Ontology. Journal of Oral Rehabilitation 2015;42(12):926-41. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4741295/
- Ceusters W, Smith B. Strategies for Referent Tracking in Electronic Health Records. J Biomed Inform. 2006 Jun;39(3):362-78. https://www.ncbi.nlm.nih.gov/pubmed/16198639
- Ceusters W, Smith B. What do Identifiers in HL7 Identify? An Essay in the Ontology of Identity. In: Okada M and Smith B (eds.) Interdisciplinary Ontology; Proceedings of the Second Interdisciplinary Ontology Meeting (InterOntology 2009), Tokyo, Japan, February 28 - March 1, 2009;:77-86. http://ontology.buffalo.edu/HL7/HL7_identifiers.pdf
- Hersh WR Weiner MG Embi PJ et al.. Caveats for the use of operational electronic health record data in comparative effectiveness research. Med Care 2013; 51 (8 Suppl 3):S30-7. https://www.ncbi.nlm.nih.gov/pubmed/23774517
- Hogan WR and Ceusters W. Diagnosis, misdiagnosis, lucky guess, hearsay, and more: an ontological analysis. Journal of Biomedical Semantics 2016;7(54). https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5025551/
- 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. http://ceur-ws.org/Vol-833/paper20.pdf
- Hogan WR, Garimalla S, Tariq SA, Ceusters W. Representing local identifiers in a referent-tracking system. In Proceedings of the International Conference on Biomedical Ontology (July 28-30, 2011, Buffalo, NY):252-254. http://ceur-ws.org/Vol-833/paper39.pdf

b) Papers further elaborated on in the lectures and group discussions:

- Ceusters W. Applying Evolutionary Terminology Auditing to the Gene Ontology. Journal of Biomedical Informatics 2009;42:518-529. https://www.ncbi.nlm.nih.gov/pubmed/19162233
- Ceusters W. An Ontology for Pain and related disability, Mental health and Quality of Life (OPMQoL). Final Report for grant R01DE021917 from the National Institute of Dental and Craniofacial Research, NIH), September 27, 2014, 141p. Chapters 9 and 15. http://www.referent-tracking.com/RTU/files/R01DE21917-FinalReportWithAppendix/1.0/R01DE21917-FinalReportWithAppendix.pdf
- Ceusters W. Dealing with Mistakes in a Referent Tracking System. In: Hornsby KS (eds.) Proceedings of Ontology for the Intelligence Community 2007 (OIC-2007), Columbia MA, 28-29 November 2007;:5-8. http://www.referent-tracking.com/RTU/files/OIC2007CeustersRevised/1.0/OIC2007CeustersRevised.pdf
- Ceusters W, Buekens F, De Moor G, Bernauer J, De Keyser L, Surjan G. TSMI: a CEN/TC251 Standard for time specific problems in healthcare informatics and telematics. International Journal of Medical Informatics 1997;46:87-101. https://www.ncbi.nlm.nih.gov/pubmed/9315498
- Ceusters W, Capolupo M, Devlies J. D4.3 - RAPS Application ontology (Version 1). Background materials and methodology used to develop Application Ontologies for Risks against Patient Safety, January 11, 2009, 53p. Chapters 5 and 6. http://www.referent-tracking.com/RTU/files/ReMINE-D4-3/1.0/ReMINE-D4-3.pdf
- Ceusters W, Capolupo M, De Moor G, Devlies J, Smith B. An Evolutionary Approach to Realism-Based Adverse Event Representations. Methods of Information in Medicine, 2011;50(1):62-73. https://www.ncbi.nlm.nih.gov/pubmed/21057717
- Ceusters W, Elkin P, Smith B. Negative Findings in Electronic Health Records and Biomedical Ontologies: A Realist Approach. International Journal of Medical Informatics 2007;76:326-333. https://www.ncbi.nlm.nih.gov/pubmed/17369081
- Ceusters W, Hsu CY, Smith B. Clinical Data Wrangling using Ontological Realism and Referent Tracking. International Conference on Biomedical Ontologies, ICBO 2014, Houston, Texas, Oct 6-9, 2014; CEUR Workshop Proceedings 2014;1237:27-32. http://ceur-ws.org/Vol-1327/icbo2014_paper_29.pdf
- Ceusters W, Manzoor S. How to track absolutely everything? In: Obrst L, Janssen T, Ceusters W (eds.) Ontologies and Semantic Technologies for the Intelligence Community. Frontiers in Artificial Intelligence and Applications. IOS Press Amsterdam, 2010;:13-36. http://www.referent-tracking.com/RTU/files/CeustersICbookRevised/1.0/CeustersICbookRevised.pdf
- Ceusters W, Smith B. Referent Tracking for Treatment Optimization in Schizophrenic Patients. Journal of Web Semantics 4(3) 2006:229-36; Special issue on semantic web for the life sciences. http://www.referent-tracking.com/RTU/files/CEUSTERS_IPAP_LSCI/1.0/CEUSTERS_IPAP_LSCI.pdf

- Ceusters W, Smith B. Referent Tracking for Corporate Memories. In: Rittgen P. (ed.) Handbook of Ontologies for Business Interaction. Hershey, New York and London: Information Science Reference, 2007, 34-46. http://www.referent-tracking.com/RTU/files/EnterpriseOnt-Ceustersrev/1.0/EnterpriseOnt-Ceustersrev.pdf
- Manzoor S, Ceusters W, Rudnicki R. Implementation of a Referent Tracking System. International Journal of Healthcare Information Systems and Informatics 2007;2(4):41-58. http://www.referent-tracking.com/RTU/files/manzoorfinaldraft/1.0/manzoorfinaldraft.pdf
- Manzoor S, Ceusters W, Smith B. Referent Tracking for Command and Control Messaging Systems. Ontology for the Intelligence Community 2009 (OIC-2009), Fairfax Virginia, October 21-22, 2009. http://www.referent-tracking.com/RTU/files/ManzoorOIC2009final/1.0/ManzoorOIC2009final.pdf
- Rudnicki R, Ceusters W, Manzoor S, Smith B. What Particulars are referred to in EHR Data? A Case Study in Integrating Referent Tracking into an Electronic Health Record Application. In Teich JM, Suermondt J, Hripcsak C. (eds.), American Medical Informatics Association 2007 Annual Symposium Proceedings, Biomedical and Health Informatics: From Foundations to Applications to Policy, Chicago IL, 2007;:630-634. https://www.ncbi.nlm.nih.gov/pubmed/18693912

11. Attendance Policy

ATTENDANCE POLICY: Class attendance is mandatory. Excused absences follow the criteria of the UF Graduate Catalogue (e.g., illness, serious family emergency, military obligations, religious holidays), and should be communicated to the instructor prior to the missed class day when possible. UF rules require attendance during the first two course sessions. Missing more than three scheduled sessions will result in a failure. Regardless of attendance, students are responsible for all material presented in class and meeting the scheduled due dates for class assignments. Finally, students should read the assigned readings prior to the class meetings, and be prepared to discuss the material for each session.

12. Classroom Decorum

Students are expected to arrive in due time for each class. Most lectures will start with a pre-lecture test to assess the student's level of preparation for the class. This test contributes to the final grading. Use of cell phones and laptops is allowed for the purposes of the class, such as in group exercises and literature search, but not for private reasons.