Course Title: Principles of Referent Tracking

	Department of Biomedical Informatics Jacobs School of Medicine and Biomedical Sciences
Course Subject Code:	BMI
Course Number:	714
Type of Instruction:	SEM
Class Number:	24684
Semester:	Spring 2018

1. *Course Information*

- Date(s)/Time(s): Tuesdays, 9-11.30AM
- Delivery Mode: Traditional
- Number of Credits: 3
- Instructors

Course director: Werner Ceusters, MD (contact: 77 Goodell street, 5th floor, on appointment only through wceusters@gmail.com)

Lecturer: Werner Ceusters

2. *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.

- 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 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 allowing 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. 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 their 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:
  Either
  a) any 5xx or 6xx **database** course, or
  b) in absence of such course:
  (1) BMI503 (Systems, Databases, & Other Software Development Methods for Biomedical Informaticians) or equivalent course in computer science, and
  (2) BMI504 (Statistical Data Analysis, and Research Methods for Biomedical Informaticians) or equivalent course in mathematics or statistics, and either
  (3a) BMI508 (Biomedical Ontology) cross-listed PHI548 or equivalent course in ontology tailored to a specific domain, or
  (3b) BMI708 (Advanced topics in biomedical ontology).

3. Student Learning Outcomes (SLO)

Abbreviations used in the table:

- Wn where 0 < n < 15: 'Week number n' as described in section 9 'Course Organization / Schedule'
- 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 to 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, information 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, information and knowledge • Innovative design concepts for information management systems	• Lecture • Guided exercise	• PCT • PCA

4. 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 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 send by email to the course director. Assignments delivered too late will be subject to a 10% deduction in the assessment unless prior to the stated deadline an alternative one has been negotiated.
- Students must participate in a final exam during the official final exam period after the course.

5. ***Grading Policy***

Grading follows standard graduate policies (http://grad.buffalo.edu/Academics/Policies-Procedures/Grading-Procedures.html)
An interim grade of Incomplete (I) may be assigned if the student has not completed all requirements for the course. An interim grade of 'I' shall not be assigned to a student who did not attend the course. The default grade accompanying an interim grade of 'I' shall be 'U' and will be displayed on the UB record as 'IU.' The default Unsatisfactory (U) grade shall become the permanent course grade of record if the 'IU' is not changed through formal notice by the instructor upon the student's completion of the course.
Assignment of an interim 'IU' is at the discretion of the instructor. A grade of 'IU' can be assigned only if successful completion of unfulfilled course requirements can result in a final grade better than the default 'U' grade. The student should have a passing average in the requirements already completed. The instructor shall provide the student specification, in writing, of the requirements to be fulfilled.
Learning assessments will be graded based on rubric criteria and weighted according to the break-down in the following table.

Week	Date	Required reading test	participation in discussion	post-class test	assignment	Due date, 5 PM	Final test
W1	30-Jan	20			5	4-Feb	
W2	6-Feb	15			5	11-Feb	
W3	13-Feb	15			5	18-Feb	
W4	20-Feb			25	5	26-Feb	
W5	27-Feb			25			
W6	6-Mar			25	10	10-Mar	
W7	13-Mar	15	50		5	26-Mar	
W8	27-Mar		50		10	2-Apr	
W9	3-Apr	15			10	9-Apr	
W10	10-Apr			25	5	16-Apr	
W11	17-Apr				10	12-May	
W12	24-Apr				15	12-May	
W13	1-May	20			5	12-May	
W14	8-May				10		
Final Exam	15-May						100
sum		100	100	100	100		100
weight		**15**	**5**	**20**	**30**		**30**

Final Grades:

Grade	Quality Points	Percentage
A	4.0	93.0% -100.00%
A-	3.67	90.0% - 92.9%
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	60.0% - 66.9%
F	0	59.9% or below

6. ***ACADEMIC INTEGRITY***

Academic integrity is a fundamental university value. Through the honest completion of academic work, students sustain the integrity of the university while facilitating the university's imperative for the transmission of knowledge and culture based upon the generation of new and innovative ideas. See http://grad.buffalo.edu/Academics/Policies-Procedures/Academic-Integrity.html.
Students may collaborate for the assignments in which case the submitted materials should be clearly labeled as such, with the names of all collaborating students. In case students who collaborate cannot come to a consensus for certain parts of the work, alternate

solutions proposed by individual students should be clearly marked as such. Grading of individual students will take into account such alternatives.

7. ACCESSIBILITY RESOURCES

If you have any disability which requires reasonable accommodations to enable you to participate in this course, please contact the Office of Accessibility Resources, 25 Capen Hall, 645-2608, and also the instructor of this course .. The office will provide you with information and review appropriate arrangements for reasonable accommodations. http://www.student-affairs.buffalo.edu/ods/

8. COURSE FEES

Standard UB tuition and fees. No extra costs.

9. Course Organization / Schedule

- Reference: http://registrar.buffalo.edu/calendars/academic/
- Papers marked with bold titles in the '**Required readings prior to lecture**' sections below are subject to pre-reading tests.

W1	**Date:** January 30	**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: Feb 4		**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	**Date:** February 6	**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: Feb 11		**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	**Date:** February 13	**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 18		**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	**Date:** February 20	**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 26		**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	**Date:** February 27	**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		

W6	**Date:** March 6	**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: March 10		**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%)

W7	**Date:** March 13	**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: March 26		**Assignment assessment**
Some of the changes of the sort addressed in the assignment of W6 lead to changes in the quality of the data collections with respect to their faithfulness to reality. Students will propose methodologies to document and track within their proposed referent tracking system changes in the quality of the data collections and, as a consequence, in the referent tracking system itself. These methodologies need to be documented by means of coherent templates of referent tracking tuples and appropriate algorithms.		• Correct identification of the types of quality changes that might occur within the students' data collections (20%) • Adequate construction of templates (30%) • Adequateness of proposed algorithms taking into account the assumptions selected in W6 (30%) • Quality of supporting documentation (20%)

W8	**Date:** March 27	**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: April 2		**Assignment assessment**
Students will correct and improve what they submitted in response to W7 based on what was discussed in W8. In addition, they will use the materials to expand the earlier submitted methodology section, and, where appropriate, the research plan of a research proposal.		• Adequateness of the correction of the W7 assignment (50%) • Quality of paper/grant proposal section (50%)

W9	**Date:** April 3	**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: April 9		**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	**Date:** April 10	**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: April 16		**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	**Date:** April 17	**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: May 12		**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	**Date:** April 24	**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: May 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.

W13	**Date:** May 1	**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: May 12		**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	**Date:** May 8	**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:** May 15	
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, or through the UB Libraries:

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
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11. Attendance Policy

Students are expected to attend ***all*** lectures, team exercises and group discussions. For religious observances, university sanctioned events, athletic commitments and family/work obligations/emergencies, absences may be granted upon request prior to the class but can have an effect on the finally obtained grade (see grading policy).
For course cancellation/emergency planning, see the university website for cancellations/delays due to weather or other unforeseen events (http://emergency.buffalo.edu/campus-weather-alerts.html)

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.