

# CAS 757/eHEALTH 757

## Modern Software Technology for eHealth

### Winter 2014 Course Outline

#### Updates

- (Jan 6) Reading list for the course seminar is updated.
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#### Instructor

TBA

Email:

Web:

Office:

#### Times

The regular schedule for the course lectures is Wednesdays, 1900 – 2200. Office hours: Wednesdays 1800-1900 (please also email to make an appointment)

#### Location

ITB 222

#### Description

This course exposes the graduate students in software engineering, computer science, or related programs to the challenges in the field of electronic health (eHealth). The course introduces a collection of modern architectures and technologies that are recommended by standardization organizations to build the infrastructure that meets the emerging demands in the growing network of health care systems. Topics include: standard health care and data and service representations; clinical terminology systems; web services and service oriented architecture; decision support systems; data mining techniques on clinical data; data and knowledge interoperability; security and privacy techniques, and health care application development environments.

#### Course Objectives

A wide range of information technologies such as business intelligence and analytics, collaboration and social (and mobile) software, expert systems, natural language processing, visualization and imaging systems, coupled with the traditional transactional information systems and workflow management systems are being utilized to support work in current health care. This course describes some of the information technology challenges in the field of eHealth and prepares students to face the problems from two perspectives: (1) from the health care system perspective the course will help student understand hospital processes, system architecture, and the core components of current healthcare systems, (2) from the computer science perspective the course will provide opportunities to learn and apply modeling and analytical techniques from the software engineering discipline for system analysis and design in the context of eHealth.

#### Course Website

<http://www.cas.mcmaster.ca/~cas757/>

#### Prerequisites

Familiarity with a programming language (preferably object-oriented) and relational databases is required. Some exceptions may apply if you are not well familiar with a programming language but you are prepared to formulate a design problem, analyze requirements, and evaluate the design (please email the instructor for permission).

#### Organization

Class sessions will include lectures by the instructor, student seminars, intra-class activities, and guest lecturers.

#### Grading Scheme

Seminar and participation (individual)	20%
Assignment (individual)	15%
Project Proposal (individual)	15%
Project (group)	50%

#### Course Seminar

Each student is expected to present and lead class discussion on assigned readings related to the objectives of the course. The student will summarize and present the main contributions of the readings in 10 minutes using presentation slides or any other approved media. The student will conclude the presentation with raising questions and leading class discussion for 5 minutes. Everyone in the class is expected to have read all the required readings before class. A written report is not required but the presentation slides (including the discussion questions) need to be sent to the instructor 24 hours before the presentation. The dates are distributed throughout the semester. The reading list will become available after the first lecture and students will have to sign up for selected readings before the beginning of the second lecture (Jan 15). Students will be randomly selected if some spots are not filled in. Four seminars (at most) will be scheduled for each day (two items with prefix A and two with prefix B).

The seminar is worth 20% of the course marks. 15% will be assigned to the depth and breadth of the individual's seminar presentation and 5% to the individual's participation in the class discussion while the other students are presenting.

#### Design Project

Each student will carry out a design project of his or her choice (subject to the instructor's approval) in the context of eHealth for this class. Initially, everyone will work

individually. Each student will hand in a written design project proposal and present it to the class (Feb. 5). The proposal document is limited to 4 pages (including references) and must be formatted according to the IEEE conference proceeding template ([http://www.ieee.org/conferences\\_events/conferences/publishing/templates.html](http://www.ieee.org/conferences_events/conferences/publishing/templates.html)). Each student has 5 minutes to pitch his/her proposal to the class. After all project proposals have been turned in and presented to the class, individuals should choose to merge into 2-3 member teams (doing project individually is only allowed by the permission of the instructor). The team then identifies the requirements for the design problem, creates a design concept and implements it as a prototype, and evaluates the prototype. The team will describe their work-in-progress (preferably covering the first iteration of the design) in a 2-page document (IEEE format) and present their progress to the class (Mar. 5). Finally the work carried out in the project will then be described in a poster to be showcased on April 5 and reported as a scientific paper. The written report is limited to 10 pages (IEEE format) and should describe the motivation, the problem space, the solution space and how the prototype is being evaluated. The written report may include an appendix containing supporting materials that will help the reader evaluate your work.

The project proposal document and presentation (individual) are worth 15% of the course marks. The progress report and presentation are worth 10%, the prototype and final report are worth 30%, and the poster presentation is worth 10% of the course marks.

### Assignment

The theme of the assignment is the reflection of the Software Engineering modeling techniques (taught throughout the lectures) on analysis of a design problem. Each student will work on her/his project proposal as the design problem and describe the problem this time using one of the modeling techniques (e.g. goal or agent oriented modeling, process modeling, object modeling). The student will report the limitations and the advantages of using the modeling technique.

The assignment is worth 15% of the course marks.

### References

The topics discussed in the following books will be substantially covered in lectures. Other sources will also be consulted. The following books and most readings are available online via McMaster digital library. For off-campus access, you will need to login through proxy with macid.

[BEN12] Benson, Tim. *Principles of health interoperability HL7 and SNOMED*. Springer, 2012.

<http://catalogue.mcmaster.ca/catalogue/Record/1966059> <http://link.springer.com.libaccess.lib.mcmaster.ca/book/10.1007%2F978-1-4471-2801-4>

[SHO14] Shortliffé, Edward H and Cimino James J. *Biomedical Informatics, Computer Applications in Health Care and Biomedicine*, Springer-Verlag London 2014.

<http://catalogue.mcmaster.ca/catalogue/Record/1582781> <http://link.springer.com.libaccess.lib.mcmaster.ca/book/10.1007%2F0-387-36278-9>

(Note that this is the 2006 edition. Efforts is underway to make the 2014 edition available)

### Instructor's Note

The instructor and the university reserve the right to modify elements of the course during the term. The university may change the dates and deadlines for any or all courses in extreme circumstances. If either type of modification becomes necessary, reasonable notice and communication with the students will be given with explanation and the opportunity to comment on changes. It is the responsibility of the student to check their McMaster email and course websites during the term and to note any changes.

### Academic Integrity

Academic dishonesty will not be tolerated. Please read the Code of Behaviour on Academic matters: [http://www.mcmaster.ca/senate/academic/ac\\_integrity.htm](http://www.mcmaster.ca/senate/academic/ac_integrity.htm)

### Accessibility

Students with accessibility needs may receive accommodations for completing assignments and exams. Please contact the [Centre for Student Development](#) for advice and for arranging assistance. Please contact the instructor to facilitate the process.

### Summary of Course Contents and Schedule

*Schedule and contents are tentative and may be adjusted as we make our way through the course and based on the students' survey in the first lecture. Additional readings may be assigned.*

Week	Date	Topic	Readings	Assigned readings for student presentations	Presenter	Notes
1	Jan 8	- Course overview - Challenges of Health Information Technologies and Medical Science - An introduction to EHR	Ch. 1 & 2 [BEN12] Ch. 1&12 [SHO14]			
2	Jan 15	- Software Engineering for Healthcare and Biomedicine - Health Data modeling	Ch. 6 [SHO14] Ch. 4 [BEN12] (UML)  Kifer, M., Bernstein, A. J., & Lewis, P. M. (2005). <i>Database Systems: An Application-oriented Approach: Introductory Version</i> . Pearson/Addison Wesley. (Ch. 4, Ch.6, Ch8 (JDBC & ODBC)) (This book might be replaced with an eBook on Databases accessible via McMaster digital library)	A1: Hickey, A. M., & Davis, A. M. (2003, September). Elicitation technique selection: how do experts do it?. In <i>Requirements Engineering Conference</i> , A2: Zowghi, D., & Coulin, C. (2005). Requirements elicitation: A survey of techniques, approaches, and tools. In <i>Engineering and managing software requirements</i> (pp. 19-46). Springer Berlin Heidelberg. B1: Hersh, W. (2008). Health and biomedical informatics: opportunities and challenges for a twenty-first century profession and its education. <i>Yearb Med Inform</i> , 157-164. B2: Wu, S., Chaudhry, B., Wang, J., Maglione, M., Mojica, W., Roth, E., ... & Shekelle, P. G. (2006). Systematic review: impact of health information technology on quality, efficiency, and costs of medical care. <i>Annals of internal medicine</i> , 144(10), 742-752.		Seminar topic selection due
3	Jan 22	- Biomedical Data: Acquisition, Storage, and use - Health process	Ch.2 [SHO14] Ch. 3 & 4 [BEN12] (BPMN)  White, Stephen A. (2004) <a href="#">Introduction to BPMN</a> . IBM	A1: Alt, R., & Puschmann, T. (2005). Developing customer process orientation: the case of Pharma Corp. <i>Business Process Management Journal</i> , 11(4), 297-315. A2: Benyoucef, M., Kuziemyk, C., Rad, A. A., & Elsabbahi, A.		Project topic selection due

		modeling	Supplementary: S1: Kimmel, P. (2005) UML Demystified – A Self-Teaching Guide. McGraw-Hill/Osborne S2 (Reference): OMG (2011) <a href="#">Business Process Model</a> and Notation (BPMN) Version 2.0	(2011). Modeling healthcare processes as service orchestrations and choreographies. <i>Business Process Management Journal</i> , 17(4), 568-597. A3: Reichert, M. (2011). What BPM technology can do for healthcare process support?. In <i>Artificial Intelligence in Medicine</i> (pp. 2-13). Springer Berlin Heidelberg. B1: Mandl, K. D., Szolovits, P., and Kohane, I. S. Public standards and patients' control: how to keep electronic medical records accessible but private. <i>Bmj</i> 2001 322(7281); 283-7 B2: Isem, D., Moreno, A., Sanchez, D., Hajnal, A., Pedone, G., & Varga, L. Z. (2011). Agent-based execution of personalised home care treatments. <i>Applied Intelligence</i> , 34(2), 155-180.	
4	Jan 29	- Healthcare processes; service architecture and core healthcare systems - HL7 healthcare messaging standard - Health IS Requirements Engineering (social modeling)	Ch. 5 & 13 [SHO14] Ch. 6 & 8 [BEN12] Yu, E. <a href="#">Social Modeling and i*</a> . In: Conceptual Modeling: Foundations and Applications - Essays in Honor of John Mylopoulos. A. T. Borgida, V. Chaudhri, P. Giorgini, E. S. Yu (eds). LNCS volume 5600. Springer, 2009. pp. 99-121. Supplementary: S1: <a href="#">HL7 V3.0</a> . S2: Canada health Infoway (2006), <a href="#">EHRs Blue Print</a> (Ch. 4)	A1: Cherbakov, L., Galambos, G., Harishankar, R., Kalyana, S., & Rackham, G. (2005). Impact of service orientation at the business level. <i>IBM Systems Journal</i> , 44(4), 653-668. 2003. A2: Jones, S., & Maiden, N. A. (2005). RESCUE: An integrated method for specifying requirements for complex socio-technical systems. <i>Requirements Engineering for Socio-Technical Systems</i> , 245-265. A3: Allee, V. (2002). <a href="#">A value network approach for measuring and modeling intangibles</a> . White paper presented at the Transparent Enterprise Conference, Madrid. B1: Winter, A., Brigl, B., & Wendt, T. (2003). Modeling hospital information systems (part 1): the revised three-layer graph-based meta model 3LGM2. <i>Methods of Information in Medicine-Methodik der Information in der Medizin</i> , 42(5), 544-551. B2: Dolin, R. H., Alschuler, L., Boyer, S., Beebe, C., Behlen, F. M., Biron, P. V., & Shvo, A. S. (2006). HL7 clinical document architecture, release 2. <i>Journal of the American Medical Informatics Association</i> , 13(1), 30-39.	
5	Feb 5	Project proposals presentation			Project proposal due
6	Feb 12	- Clinical Terminologies, SNOMED CT - An introduction to Ontologies and Semantic Web	Ch. 7 [SHO14] Ch. 15 & 16 [BEN12] Shadbolt, N., Hall, W., & Berners-Lee, T. (2006). The semantic web revisited. <i>Intelligent Systems, IEEE</i> , 21(3), 96-101. Berners-Lee, T., Hendler, J., & Lassila, O. (2001). The semantic web. <i>Scientific american</i> , 284(5), 28-37. Supplementary: S1: <a href="#">The Unified Medical Language System (UMLS) Project</a> S2: Decker, S., Melnik, S., Van Harmelen, F., Fensel, D., Klein, M., Broekstra, J., ... & Horrocks, I. (2000). The semantic web: The roles of XML and RDF. <i>Internet Computing, IEEE</i> , 4(5), 63-73. S3 <a href="#">Protege guide</a> (use it as a reference): Horridge, M. (2009). A Practical Guide To Building OWL Ontologies Using Protege 4 and CO-ODE Tools Edition 1. 2. <i>The University Of Manchester</i> .	A1: Noy, N. F., & McGuinness, D. L. (2001). Ontology development 101: A guide to creating your first ontology. A2: Sowa, J. F. (2001). Building, sharing, and merging ontologies. <i>web site: http://www.jfsowa.com/ontology/ontoshar.htm (last modified 01/18/2009)</i> B1: Shankar, R. D., Martins, S. B., O'connor, M. J., Parrish, D. B., & Das, A. K. (2006). Towards semantic interoperability in a clinical trials management system. In <i>The Semantic Web-ISWC 2006</i> (pp. 901-912). Springer Berlin Heidelberg. B2: A student will present any two papers from the following <a href="#">three papers</a> : (1) Dameron, O., Roques, E., Rubin, D., Marquet, G., & Burgun, A. (2006, July). Grading lung tumors using OWL-DL based reasoning. In <i>Presentation Abstracts</i> (p. 69) (2) Ogren, P. V. (2006, July). Knowtator: a plug-in for creating training and evaluation data sets for biomedical natural language systems. In <i>Proceedings of the 9th International Protege Conference</i> (pp. 73-76). (3) Diez, A., Cortes, A., BET, R. G., Castells, P., Diez, F., & Fuentes, A. V. (2006, July). A VICENA, ontology for the design of executable clinical practice guidelines. In <i>Presentation Abstracts</i> (p. 65).	Project team membership due
7	Feb 26	- Semantic interoperability of clinical data - An introduction to Database integration	Ch. 13 & 14 [SHO14] Ch. 2 & 17 [BEN12] Mead, C. N. (2006). Data Interchange Standards in Healthcare IT-Computable Semantic Interoperability: Now Possible but Still Difficult. Do We Really Need a Better Mousetrap?. <i>Journal of Healthcare Information Management</i> , 20(1), 71. Supplementary: S1: Lenzerini, M. (2002, June). Data integration: A theoretical perspective. In <i>Proceedings of the twenty-first ACM SIGMOD-SIGACT-SIGART symposium on Principles of database systems</i> (pp. 233-246). ACM.	A1: Halevy, A. Y., Ashish, N., Bitton, D., Carey, M., Draper, D., Pollock, J., ... & Sikka, V. (2005, June). Enterprise information integration: successes, challenges and controversies. In <i>Proc. of the ACM SIGMOD</i> (pp. 778-787). A2: Barry Smith et al. (2007) The OBO Foundry: coordinated evolution of ontologies to support biomedical data integration. <i>Nature Biotechnology</i> 25, 1251 – 1255 B1: Orgun, B., & Vu, J. (2006). HL7 ontology and mobile agents for interoperability in heterogeneous medical information systems. <i>Computers in Biology and Medicine</i> , 36(7), 817-836. B2: Searls, D. B. (2005). Data integration: challenges for drug discovery. <i>Nature Reviews Drug Discovery</i> , 4(1), 45-58.	Assignment due
8	Mar 5	- Clinical decision support systems - Evidence based medicine - OLAP, data mining concepts and techniques	Ch. 3, 21 & 22 [SHO14] S1: Kifer, M., Bernstein, A. J., & Lewis, P. M. (2005). <i>Database Systems: An Application-oriented Approach: Introductory Version</i> . Pearson/Addison Wesley. (Ch. 5 (only 5.2.5) and Ch. 17) (This book might be replaced with an eBook on Databases accessible via McMaster digital library)	A1: Davis, Dave, Mike Evans, Alex Jadad, et al. (2003) The case for knowledge translation: shortening the journey from evidence to effect. <i>British Medical Journal</i> . 2003 (327) 33-35 A2: Kitson, Alison, and Sharon E. Straus (2010) The knowledge-to-action cycle: identifying the gaps. <i>Can. Med. Assoc. J.</i> , Feb 2010; 182: E73 - E77 B1: Chignell, M., Roubahman, M., Kealey, R., Yu, E., Samavi, R.,	

			Supplementary:  S1: Sayad S., (2012). An Introduction to Data Mining. <a href="http://www.saedsayad.com/">http://www.saedsayad.com/</a>  S2: Prather, J. C., Lobach, D. F., Goodwin, L. K., Hales, J. W., Hage, M. L., & Hammond, W. E. (1997). Medical data mining: knowledge discovery in a clinical data warehouse. In <i>Proceedings of the AMIA Annual Fall Symposium</i> (p. 101). American Medical Informatics Association.	& Sieminowski, T. (2013). Development of Non-Confidential Patient Types for Use in Emergency Medicine Clinical Decision Support.  B2: Rebuge, A., & Ferreira, D. R. (2012). Business process analysis in healthcare environments: A methodology based on process mining. <i>Information Systems</i> , 37(2), 99-116.  B3: OpenClinical - <a href="#">Methods and tools for representing computerised clinical guidelines.</a>		
9	Mar 12	Project progress presentation				Progress report due
10	Mar 19	- Patient-centered care systems - Consumer Health Informatics and Personal Health Records	Ch. 15 & 17 [SHO14]  Supplementary:  S1: Halamka, J. D., Mandl, K. D., & Tang, P. C. (2008). Early experiences with personal health records. <i>Journal of the American Medical Informatics Association</i> , 15(1), 1-7.  S2: Tang, P. C., Ash, J. S., Bates, D. W., Overhage, J. M., & Sands, D. Z. (2006). Personal health records: definitions, benefits, and strategies for overcoming barriers to adoption. <i>Journal of the American Medical Informatics Association</i> , 13(2), 121-126.  S3: Detmer, D., Bloomrosen, M., Raymond, B., & Tang, P. (2008). Integrated personal health records: transformative tools for consumer-centric care. <i>BMC medical informatics and decision making</i> , 8(1), 45.	A1: Bosch, J. (2009, August). From software product lines to software ecosystems. In <i>Proceedings of the 13th International Software Product Line Conference</i> (pp. 111-119). Carnegie Mellon University.  A2: Seichter, D., Dhungana, D., Pleuss, A., & Hauptmann, B. (2010, August). Knowledge management in software ecosystems: software artefacts as first-class citizens. In <i>Proceedings of the Fourth European Conference on Software Architecture: Companion Volume</i> (pp. 119-126). ACM  B1: Weitzman, E. R., Adida, B., Kelemen, S., & Mandl, K. D. Sharing data for public health research by members of an international online diabetes social network. <i>PLoS one</i> 2011 6(4); e19256  B2: Weitzman, E. R., Kaci, L., Quinn, M., & Mandl, K. D. Helping high-risk youth move through high-risk periods: personally controlled health records for improving social and health care transitions. <i>Journal of Diabetes Science and Technology</i> 2011 5(1); 47-54		
11	Mar 26	- eHealth security models - eHealth privacy models	Ch. 10 & 27 [SHO14] Ch. 5 [BEN12]  Sweeney, L. (2002). k-anonymity: A model for protecting privacy. <i>International Journal of Uncertainty, Fuzziness and Knowledge-Based Systems</i> , 10(05), 557-570.  Supplementary:  S1: <a href="#">UTD Anonymization ToolBox</a>  S2: Malin, B., & Sweeney, L. (2004). How (not) to protect genomic data privacy in a distributed network: using trail re-identification to evaluate and design anonymity protection systems. <i>Journal of biomedical informatics</i> , 37(3), 179-192.  S3: Rothstein, M. A. (2010). Is deidentification sufficient to protect health privacy in research?. <i>The American Journal of Bioethics</i> , 10(9), 3-11.  S4: Canada health Infoway (2006), Electronic Health Record Infrastructure (EHRI) <a href="#">Privacy and Security Conceptual Architecture</a> . (Ch. 7 P&S services).	A1: Rothstein, M. A. (2010). Is deidentification sufficient to protect health privacy in research?. <i>The American Journal of Bioethics</i> , 10(9), 3-11.  A2: Lodderstedt, T., Basin, D., & Doser, J. (2002). SecureUML: A UML-based modeling language for model-driven security. In <i>UML'02—The Unified Modeling Language</i> (pp. 426-441). Springer Berlin Heidelberg.  A3: Samavi, R., & Topaloglu, T. (2008). Designing privacy-aware personal health record systems. In <i>Advances in Conceptual Modeling—Challenges and Opportunities</i> (pp. 12-21). Springer Berlin Heidelberg.  B1: MD+A Health Solutions. Privacy Impact Assessment, ConnectingGTA University Health Network, 2012. (Section 3.4 Consent)  B2: Cavoukian, A., & Alvarez, R. C. (2012, March 11). <a href="#">Embedding Privacy into the Design of EHRs to Enable Multiple Functionalities—Win/Win.</a>  B3: FairWarning (2011), UK: <a href="#">How Privacy Considerations Drive Patient Decisions and Impact Patient Care Outcomes.</a>  B4: An industry-standard approach to security and privacy of health data: Intel, (2011), <a href="#">Health Information at Risk: Successful Strategies for Healthcare Security and Privacy</a>		
12	Apr 2	- The future of informatics in biomedicine - Role of software technologies in future eHealth	Ch. 26 & 28 [SHO14]  Supplementary:  Garde, S., Knaup, P., Hovenga, E. J., & Heard, S. (2007). Towards Semantic Interoperability for Electronic Health Records--Domain Knowledge Governance for open EHR Archetypes. <i>Methods of information in medicine</i> , 46(3), 332-343	A1: <i>Biomedical semantic indexing and question answering (QA)</i> : <a href="http://nlp.uned.es/clef-qa/">http://nlp.uned.es/clef-qa/</a> (using the theme described in this challenge, the student should describe the state of the art in his/her seminar)  A2: Microsoft (2010), <a href="#">Answering the Health ICT Challenge: An Optimized Infrastructure.</a>  B1: Haux R. (2010). Medical informatics: past, present, future. <i>international journal of medical informatics</i> , 79(9), 599-610.  B2: Avancha, S., Baxi, A., & Kotz, D. (2012). Privacy in mobile technology for personal healthcare. <i>ACM Computing Surveys (CSUR)</i> , 45(1), 3.		
13	Apr 9	Project Poster Session				Project final report/poster due