University of Houston Clear Lake

College of Science and Engineering

Sring 2018
Course Syllabus

Course number: SENG 5336

Course Title: Healthcare Systems Analytics and Optimization

Course Description

Healthcare delivery presents numerous systems analysis problems including diagnosis, forecasting, scheduling, and optimization. The course provides students the skills to develop rigorous analytical solutions to health care problems. Students will apply statistical methods including Bayesian belief networks and Dempster-Shafer theory, linear and nonlinear optimization techniques including simplex and greedy-based algorithms, and Monte Carlo modeling. Students will be exposed to several real-world projects for health care. Students will learn about current problems in healthcare systems.

Desired Learning Outcomes

Students will understand and apply systems analysis, modeling, and optimization techniques to healthcare problems. At the completion of the course, the students will:

- Understand key concepts and techniques in systems engineering to be applied to health care delivery
- Understand healthcare applications of Bayesian belief networks for diagnosis and prediction
- Understand and apply Dempster-Shafer theory to augment healthcare decision making
- Understand and apply scheduling optimization techniques to optimize patient care and resource utilization
- Apply Monte Carlo modeling techniques to health care applications
- Develop static schedules for patient appointments, health care provider staffing, and so on
- Understand current problems in healthcare delivery systems and apply systems analysis and optimization to propose feasible solutions

Topics

- Bayesian belief network applications to diagnosis
- Dempster-Shafer diagnosis support
- Monte Carlo modeling of health care delivery systems

- Overview of scheduling problems
- Heuristic methods in large-scale scheduling
- Triage algorithms

Prerequisites

SENG 5232 Concurrent Engineering and SENG foundation courses

Text: No text

Course Schedule

*Note that the following schedule can be changed to suit the needs of the class at instructor's discretion.

Weeks	Contents
Week 1	**Overview of healthcare systems analytics and optimization** **Read** • Kopach-Konrad R. et al. Applying systems engineering principles in improving health care delivery, *Journal of General Internal Medicine,* 22.3 (2007): 431-437. • Rais, Abdur, and Ana Viana. "Operations research in healthcare: a survey." *International Transactions in Operational Research* 18.1 (2011): 1-31.
Week 2	**Decision support systems for diagnosis** **Read** • Hamilton, P. W., et al. "Expert system support using Bayesian belief networks in the diagnosis of fine needle aspiration biopsy specimens of the breast." *Journal of clinical pathology* 47.4 (1994): 329-336. • Cios, Krzysztof J., et al. "An expert system for diagnosis of coronary artery stenosis based on 201TI scintigrams using the Dempster-Shafer theory of evidence." *Computer Applications in the Biosciences: CABIOS* 6.4 (1990): 333-342.
Week 3	**Forecasting** Read Wharam, J. Frank, and Jonathan P. Weiner. "The promise and peril of healthcare forecasting." *The American Journal of Managed Care* 18.3 (2012): e82-5. Behkami, Nima A., and Tugrul U. Daim. "Research forecasting for health information technology (HIT), using technology intelligence." *Technological Forecasting and Social Change* 79.3 (2012): 498-508.
Week 4	**Data Mining** • Koh, Hian Chye, and Gerald Tan. "Data mining applications in healthcare." *Journal of Healthcare Information Management* 19.2 (2011): 65. • Silver, Michael, et al. "Case study: how to apply data mining techniques in a healthcare data warehouse." *Journal of healthcare information management* 15.2 (2001): 155-164.
	Monte Carlo modeling Read

Week 5	• Lin, Yuting, et al. "Comparing gold nano-particle enhanced radiotherapy with protons, megavoltage photons and kilovoltage photons: a Monte Carlo simulation." *Physics in Medicine and Biology* 59.24 (2014): 7675. • Beggs, Clive B., Simon J. Shepherd, and Kevin G. Kerr. "How does healthcare worker hand hygiene behaviour impact upon the transmission of MRSA between patients?: an analysis using a Monte Carlo model." *BMC infectious diseases* 9.1 (2009): 64.
Week 6	**Simulation** • Jun, J. B., Sheldon H. Jacobson, and J. R. Swisher. "Application of discrete-event simulation in health care clinics: A survey." *Journal of the Operational Research Society* 50.2 (1999): 109-123. • Jacobson, Sheldon H., Shane N. Hall, and James R. Swisher. "Discrete-event simulation of health care systems." *Patient flow: Reducing delay in healthcare delivery*. Springer US, 2006. 211-252.
Week 7	Optimization Earnshaw, Stephanie R., et al. "A linear programming model for allocating HIV prevention funds with state agencies: a pilot study." *Health care management science* 10.3 (2007): 239-252.
Weeks 8	**Heuristic methods** Liu, Ran, et al. "Heuristic algorithms for a vehicle routing problem with simultaneous delivery and pickup and time windows in home health care." *European Journal of Operational Research* 230.3 (2013): 475-486.
Weeks 9	Statistical modeling • Parachoor, Satheesh Babu, Eric Rosow, and John D. Enderle. "Knowledge management system for benchmarking performance indicators using statistical process control (SPC) and Virtual Instrumentation (VI)." *Biomedical Sciences Instrumentation* 39 (2002): 175-178. • Wright, Ian H., et al. "Statistical Modeling to Predict Elective Surgery TimeComparison with a Computer Scheduling System and Surgeon-provided Estimates." *The Journal of the American Society of Anesthesiologists* 85.6 (1996): 1235-1245.
Week 10	• **Decision analysis** • **Pauker Stephen Kassirer Decision Analysis**
Week 11	**Markov decision process** • Schaefer, Andrew J., et al. "Modeling medical treatment using Markov decision processes." *Operations Research and Health Care*. Springer US, 2005. 593-612. Yaesoubi, Reza, and Ted Cohen. "Generalized Markov models of infectious disease spread: A novel framework for developing dynamic health policies." *European Journal of Operational Research* 215.3 (2011): 679-687.
Week 12	• Capacity planning • Green Linda Capacity planning and management in hospitals • Ridge JC Jones SK Nielsen MS Shahani AK 1998 capacity planning for intensive care units, EJOR
Week 13	**Patient Scheduling** Read

	• Liang, Bohui, and Ayten Turkcan. "Acuity-based nurse assignment and patient scheduling in oncology clinics." *Health Care Management Science* 19.3 (2016): 207-226. • Robinson, Lawrence W., and Rachel R. Chen. "Scheduling doctors' appointments: optimal and empirically-based heuristic policies." *IIE Transactions* 35.3 (2003): 295-307.
Week 14	• **Staffing** • **Staff scheduling in health care systems** • **Optimizing nursing human resource planning in British Columbia**
Week 15	**Final Team Project Presentation and paper due**