ORI 383 MW 12:30 – 2:00 pm
Spring 2019 ETC 4.150

# HEALTH CARE DELIVERY MODELS


PROFESSOR: J. F. Bard

OFFICE: ETC 5.126, 471-3076

OFFICE HOURS: 2:00 - 3:30 pm MW or by appointment

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PREREQUISITES: Second year or higher graduate standing

OBJECTIVES: Systems engineering tools have been used in a wide variety of applications to achieve major improvements in the quality, efficiency, safety, and delivery of services across all industrial sectors. Nevertheless, the healthcare sector as a whole has been very slow to embrace them, even though these tools have been shown to yield valuable returns to the small but growing number of health care organizations and clinicians that have applied them. During the semester, we will read a broad collection of papers in the operations research literature that discuss how quantitative techniques have been used to improve the delivery of health care at the local level. In some cases, I will present a review of the methodology being used before the discussion. Topics will include decomposition techniques for integer programs, simulation, Markov chains, and stochastic programming.

## GENERAL COURSE POLICIES

PREREQUISTIES: Second year MS student in ORIE, or MS degree in related field. Integer programming, Stochastic processes, Statistics.

COURSEWORK: Students are expected to prepare for each meeting by reading the assigned paper(s). Typically, each paper will be assigned to a student who will take the lead in the discussion, though all students in the class are responsible to understand each paper in depth. There will be one or two PowerPoint presentations each session. Students are expected to have a solid mathematical background. Knowledge of deterministic and stochastic optimization, statistics, probability, and stochastic processes will be helpful.

For each paper, each student should provide answers to the following questions.

1. What is the problem/issue being addressed?
2. What is the model/framework used?
3. What is the solution approach proposed?
4. What is the source of the data and are the data realistic or adequate?
5. What are the major results/insights generated by the model?
6. Critique the model:
   (a) When do you expect the model to perform well? Poorly?
   (b) What are some extensions/improvements that could be made in the model?
   (c) Are there any critical or questionable assumptions?

*Project*: During the semester, the students will organize in teams of 2 or 3 and undertake a project using real data. The work will involve a literature review,

model development, coding, analysis, writing a report, and group presentation during the last week of the semester. Project selection will take place during the first week of the course.

GRADING: Half the course grade will be based on attendance, weekly write-ups, and presentations. The other half will be based on the project.

DISHONESTY: University policies for academic dishonesty will be strictly followed. Students found cheating on any exam will receive a grade of "F" in the course. Homework and other assignments turned in that do not represent the student's original work will receive a grade of zero.

DISABILITIES: The University of Texas provides upon request academic adjustments for students with documented disabilities. For more information, contact the Office of the Dean of Students at 512-471-6259 (voice) or 512-410-6644 (video phone) or e-mail ssd@austin.utexas.edu or http://ddce.utexas.edu/disability/

**Topics and Papers (Assignments subject to change)**

**Health Care Planning & Control**

1. Hans, E.W., Van Houdenhoven M., Hulshof P.J.H. (2011). A framework for health care planning and control, in: Hall, R. (Ed.) *Handbook of Health Care Systems Scheduling*, Springer International Series in Operations Research & Management Science, Vol. 168. Chapter 12, 303-320.

**Staff Scheduling**

2. Bard, J.F., Shu, Z., Leykum, L. (2013). Monthly clinic assignments for internal medicine housestaff. *IIE Transactions on Healthcare Systems Engineering*, 3(4), 207-239.

4.1 Bard, J.F., Shu, Z., Morrice, D.J., Leykum, L.K. (2017). Constructing block schedules for internal medicine residents. To appear in *IIE Transactions on Healthcare Systems Engineering*.

Bard, J.F., Purnomo, H.W. (2007). Cyclic preference scheduling of nurses using a Lagrangian-based heuristic. *Journal of Scheduling*, 10(1), 5-23.

Brunner, J.O., Bard, J.F., Kolisch, R. (2009). Flexible shift scheduling of medical residents. *Health Care Management Science*, 12(3), 285-305.

**Appointment Scheduling**

3. Savin, S. (2006) Managing patient appointments in primary care. In Hall RW (ed). *Patient Flow: Reducing Delay in Healthcare Delivery*. Springer, New York, Chapter 5, pp 123-150.

4. Castaing, J., Cohn, A., Denton, B.T., Weizer, A. (2016). A stochastic programming approach to reduce patient wait times and overtime in an outpatient infusion center. *IIE Transactions on Healthcare Systems Engineering*, 6(3), 111-125.

14. Oh, H.-J., Muriel, A., Balasubramanian, H., Atkinson, K., Ptaszkiewicz, T. (2013). Guidelines for scheduling in primary care under different patient types and stochastic nurse and provider service times. *IIE Transactions on Healthcare Systems Engineering*, 3(4), 263-279.

Millhiser, W.P., Veral, E.A., Valenti, B.C. (2012). Assessing appointment systems' operational performance with policy targets. *IIE Transactions on Healthcare Systems Engineering* 2, 274-289.

**Operating Room Planning & Scheduling**

Beliën, J., Demeulemeester, E. (2007). Building cyclic master surgery schedules with leveled resulting bed occupancy, *European Journal of Operational Research*, 176(2), 1185-1204.

5. Zhang, B., Murali, P., Dessouky, M.M., Belson, D. (2009). A mixed integer programming approach for allocating operating room capacity. *Journal of the Operational Research Society*, 60(5), 663-673.

**Patient Flow & Process Improvement**

Bard, J.F., Shu, Z., Morrice, D., Wang, D., Poursani, R., Leykum, L. (2016). Improving patient flow at a family health clinic. *Health Care Management Science*, 19(2), 170-191.

6. Lane, D.C., Husemann, E (2008). System dynamics mapping of acute patient flows. *Journal of the Operational Research Society,* 59(2), 213-224.

7. Lee, E.K., Atallah, H.Y., Wright, M.D., Post, E.T., Thomas IV, C., Wu, D.T., Haley Jr, L. (2014). Transforming hospital emergency department workflow and patient care, *Interfaces*, 45(1), 58–82.

Morrice, D.J., Wang, E., Bard, J.F., Leykum, L., Noorily, S., Veerapaneni, P. (2014). A patient-centered surgical home to improve outpatient surgical processes of care and outcomes. *IIE Transactions on Healthcare Systems Engineering*, 4(3), 119-134.

8. Rohleder, T.R., Lewkonia, P., Bischak, D.P., Duffy, P., Hendijan,i R. (2011). Using simulation modeling to improve patient flow at an outpatient orthopedic clinic. *Health Care Management Science*, 14, 135-145.

**Treatment**

9. Romeijn, H.E., Ahuja, R.K., Dempsey, J.F. and Kumar, A. (2006). A new linear programming approach to radiation therapy treatment planning problems. *Operations Research*, 54(2) 201-216.

10. Underwood, D., Zhang, J., Denton, B.T., Shah, N. and Inman, B. (2012). Simulation optimization of PSA threshold based prostate cancer screening policies. *Health Care Management Science*, 15(4), 293-309.

**Emergency Department Operations**

Sinreich, D., Jabali, O., Dellaert, N.P. (2012). Reducing emergency department waiting times by adjusting work shifts considering patient visits to care providers. *IIE Transactions on Scheduling & Logistics*, 44(3), 163-180.

11. Marmor, Y.N., Golany, B., Israelit, S., Mandelbaum, A. (2012). Designing patient flow in emergency departments. *IIE Transactions on Healthcare Systems Engineering* 2(4):233-247.

**Public Health**

12. Ekici, A., Keskinocak, P. and Swann, J.L. (2014). Modeling influenza pandemic and planning food distribution. *Manufacturing & Service Operations Management*, 16(1), 11-27.

13. Kong, N., Schaefer, A.J., Hunsaker, B. and Roberts, M.S. (2010). Maximizing the efficiency of the U.S. liver allocation system through region design. *Management Science*, 56(12). 2111–2122.

**Tentative Schedule for Presentations**

**Spring 2017**

| | | |
|---|---|---|
| T | 17-Jan-17 | Course preliminaries |
| H | 19-Jan-17 | Introduction to Healthcare (Bard) |
| T | 24-Jan-17 | Introduction to Healthcare (Bard) |
| H | 26-Jan-17 | Paper 1 (Bard) |
| T | 31-Jan-17 | Paper 2 (Bard) |
| H | 2-Feb-17 | Paper 3 |
| T | 7-Feb-17 | Paper 4 |
| H | 9-Feb-17 | Paper 4.1 (Block Sched - Bard) |
| T | 14-Feb-17 | Paper 5 |
| H | 16-Feb-17 | LR Review (Bard) |
| T | 21-Feb-17 | Paper 5.1 (Cyclic LR - Bard) |
| H | 23-Feb-17 | Paper 5.1 (Cyclic LR - Bard) |
| T | 28-Feb-17 | Paper 6 |
| H | 2-Mar-17 | Paper 7 |
| T | 7-Mar-17 | Paper 8 |
| H | 9-Mar-17 | |
| T | 14-Mar-17 | Spring Break |
| H | 16-Mar-17 | |
| T | 21-Mar-17 | Paper 8.1 (FHC – Bard) |
| H | 23-Mar-17 | Paper 9 |
| T | 28-Mar-17 | Paper 8.1 (Bard) |
| H | 30-Mar-17 | Paper 10 |
| T | 4-Apr-17 | Benders Decomp (Bard) |
| H | 6-Apr-17 | Paper 11 |
| T | 11-Apr-17 | Paper 10.1 (IMRT – Bard) |
| H | 13-Apr-17 | Paper 12 |
| T | 18-Apr-17 | Paper 12.1 (APC – Bard) |
| H | 20-Apr-17 | Paper 13 |
| T | 25-Apr-17 | Paper 14 |
| H | 27-Apr-17 | |
| T | 2-May-17 | Student presentations |
| H | 4-May-17 | Student presentations |

## References

### Review Papers: Role of Operations Research in Health Care


Cardoen, B., Demeulemeester, E., Beliën, J. (2010). Operating room planning and scheduling: A literature review, *European Journal of Operational Research*, 201, 921-932.

Cayirli, T., Veral, E. (2003). Outpatient scheduling in health care: A review of literature, *Production and Operations Management*, 12(4), 519-549.

Denton, B.T., O. Alagoz, A. Holder, E.K. Lee (2011). Medical decision making: open research challenges. *IIE Transactions on Healthcare Systems Engineering*, 1, 161-167.

Green, L.V (2012). The vital role of operations analysis in improving health care delivery. *Manufacturing & Service Operations Management*, 14(4) 488-494. (There are also follow-up commentaries to this paper in the same issue of MSOM journal.)

Gupta, D., Denton, B. (2008). Appointment scheduling in health care: Challenges and opportunities, *IIE Transactions on Operations Engineering*, 40(9), 800-919.

Hall, R. (ed) (2011). *Handbook of Health Care System Scheduling*, in International Series in Operations, Research & Management Science, Vol. 168, Springer, Berlin.

Rais, A. and A. Viana. (2010). Operations research in healthcare: a survey. *International Transactions in Operations Research*, 18, 1-31


### Linear Programming Models


Bertsimas, D., V.F. Farias, and N. Trichakis (2013). Fairness, efficiency, and flexibility in organ allocation for kidney transplantation. *Operations Research*, 61(1) 73-87.

Romeijn, H.E., Ahuja, R.K., Dempsey, J.F. and Kumar, A. (2006). A new linear programming approach to radiation therapy treatment planning problems. *Operations Research*, 54(2) 201-216.


### Integer Programming Models


Bard, J.F., ,Shu, Z. and Leykum, L. (2013). Monthly clinic assignments for internal medicine housestaff. *IIE Transactions on Healthcare Systems Engineering*, 3(4), 207-239.

Bard, J.F., Y. Shao, Y., Qi, X. and Jarrah, A.I. (2014). The traveling therapist scheduling problem with fixed appointment times. IIE Transactions on Operations Engineering & Analytics, 46(7), 683-706.

Blake, J.T: and Carter, M.W. (2002): A goal programming approach to strategic resource allocation in acute care hospitals. *European Journal of Operational Research*, 140, 541-561.

Daskin, M.S. and Dean, L.K., 2004. Location of health care facilities. In Brandeau, M.L., Sainfort, F., Pierskalla, W.P. (eds) *Operations Research and Health Care. A Handbook of Methods and Applications.* Kluwer's International Series, Dordrecht, pp. 43–76.

Kong, N., Schaefer, A.J., Hunsaker, B. and Roberts, M.S. (2010). Maximizing the efficiency of the U.S. liver allocation system through region design. *Management Science*, 56(12). 2111–2122.

Taskin, Z.C., Smith, J.C., Romeijn, H.E. and Dempsey, J.F. (2010). Optimal multileaf collimator leaf sequencing in IMRT treatment planning. Operations Research, 58(3), 674-690.

Welch, J.D., Bailey, N.T.J. (1952): Appointment systems in hospital outpatient departments, *Lancet*, 259, 1105–1108.

**Facility Design and Supply Chain Models**

Daskin, M.S., Dean, L.K. (2004). Location of health care facilities. In Brandeau, M.L., Sainfort, F., Pierskalla, W.P. (eds), *Operations Research and Health Care*. *A Handbook of Methods and Applications*. Kluwer's International Series, Dordrecht, pp. 43–76.

Ekici, A., Keskinocak, P. and Swann, J.L. (2014). Modeling influenza pandemic and planning food distribution. *Manufacturing & Service Operations Management*, 16(1), 11-27.

**Stochastic (Programming) Models**

Batun, S., Denton, B.T., Huschka, T.R., Schaefer, A.J. (2011). The benefit of pooling operating rooms under uncertainty. *INFORMS Journal on Computing*, 23(2), 220-237

Cayirli, T., Veral, E., Rosen, H. (2006). Designing appointment scheduling systems for ambulatory care services, *Health Care Management Science*, 9(1), 47-58.

Chakraborty, S., Muthuraman, K., Lawley, M. (2010). Sequential clinical scheduling with patient no-shows and general service time distributions. *IIE Transactions on Operations Engineering*, 42(5), 354-366.

Kaandorp, G.C., Koole, G. (2007). Optimal outpatient appointment scheduling, *Health Care Management Science*, 10(3), 217-229.

Mancilla, C., Storer, R. (2012) A sample average approximation approach to stochastic appointment sequencing and scheduling. *IIE Transactions on Scheduling & Logistics*, 44(8), 655-670.

Muthuraman, K., Lawley, M. (2008). A stochastic overbooking model for outpatient clinical scheduling with no-shows. *IIE Transactions on Operations Engineering*, 40(9), 820-837.

Ozaltin, O.Y., Prokopyev, O.A., Schaefer, A.J. and Roberts, M.S. (2011). Optimizing the societal benefits of the annual influenza vaccine: A stochastic programming approach. *Operations Research*, 59(5), 1131-1143.

Zonderland, M.E., Boer F., Boucherie, R.J., de Roode A., van Kleef, J.W. (2009). Redesign of a university hospital preanesthesia evaluation clinic using a queuing theory approach. *Economics Education and Policy*, 109(5), 1612-1621.

**MDP and Dynamic Programming Models**

Alagoz, O., Maillart, L.M., Schaefer, A.J. and Roberts. M.S. (2007). Determining the acceptance of cadaveric livers using an implicit model of the waiting list. *Operations Research*, 55(1), 24-36.

**Simulation Models**

Bard, J.F., Shu, Z., Morrice, D., Wang, D., Poursani, R. and Leykum, L. (2016). Improving patient flow at a family health clinic. *Health Care Management Science*, 19(2), 170-191.

Tejada, J. J., Ivy, J. S., King, R. E., Wilson, J. R., Ballan, M., Kay, M. G., Diehl, K. and Yankaskas. B. C. (2013). Combined DES/SD model of breast cancer screening for older women, II: Screening-and-treatment simulation. *IIE Transactions*.

Underwood, D., Zhang, J., Denton, B.T., Shah, N. and Inman, B. (2012). Simulation optimization of PSA threshold based prostate cancer screening policies. *Health Care Management Science*, 15(4), 293-309.

Vanderby, S., Carter, M.W. (2010). An evaluation of the applicability of system dynamics to patient flow modeling. *Journal of the Operational Research Society* 61(11), 1572-1851.

Ventresca, M. and Aleman, D. (2013). Evaluation of strategies to mitigate contagion spread using social network characteristics. *Social Networks*, 35(1), 75-88.