EPIB 676 Section 2: Advanced topics in decision-analytic modeling for health

Course syllabus, Winter 2023, McGill University

Table of contents

Course description

Advanced methods used to model health policy decisions and conduct model-based health technology assessment, both theory and technical applications. Methods covered include: Markov and microsimulation models, Bayesian model calibration and evaluation, probabilistic sensitivity analysis, value of information analysis, and equity-informative health policy analysis. Application areas include: disease screening, prevention, and treatment, public health measures, and prioritization of clinical research.

Learning objectives

By the end of the course, students should be able to:

- Develop decision analytic models to inform health policy and clinical decisions
- Understand and critically appraise published model-based decision analyses
- Create transparent reports of decision analyses that conform to open science principles

Instructor

W. Alton Russell, PhD, Assistant Professor, McGill School of Population and Global Health. alton.russell@mcgill.ca | mchi.mcgill.ca/decision-modeling-lab | Office: 2001 McGill College #1113

Class sessions & office hours

Class sessions will be held 10:05am – 11:25am on Wednesdays and Fridays at 2001 McGill College Ave in room #1203. Attendance is required.

Office hours will be held directly after class, 11:25am - 12pm Wednesday and Friday. **Starting Jan 20, OH will be in conference room 1103**. If you are not available then, please email to arrange an alternative time.

Target audience

The course is geared towards PhD students and advanced Masters students interested in conducting model-based analyses of health policies and health technologies in research. Modeling skills developed in the course will also be useful for students interested in industry and or government employment related to economic evaluation, health technology assessment, or health economics and outcomes research.

Prerequisites

The ideal preparation of this course would include (1) a course in probability, (2) a course in statistics, (3) a course on cost-effectiveness such as PPHS 528, and (4) introductory programming course. Prior experience programming in R is ideal, but solid experience in another language (understanding of nested loops, functions, and data structures) should be sufficient. Students who lack one prerequisite may need to spend extra time on some course components but should be able to succeed in the course, unless that prerequisite is programming. The course is likely not appropriate for students missing two or more prerequisites (especially if

programming is one of them). To help make an informed decision on how well-prepared you are for the course, you can attempt to complete assignment 0 early (available on Github).

Readings

Readings drawn from various sources are assigned before most class sessions as indicated in the schedule below. PDFs of the readings are available on MyCourses. Some readings are tutorials with accompanying code, which you are encouraged to download and run. To get full credit for class engagement, students should come to class prepared to discuss the readings.

Laptops and software

Students should bring a personal laptop to every class. Please reach out to the instructor if you do not have a laptop so alternative arrangements can be made. Before the first session, students should install and configure the necessary software (R, RStudio, git) using the 'Setting up your software enviroment' instructions from session 1.

Approach to learning

This course is designed to give student hands-on experience applying course concepts early and often. The course has two distinct phases:

- **Methods phase (weeks 1-7)** focuses on understanding methods and building programming skills. Class readings will include tutorials accompanied by R code, which students are encouraged to run on their own computers before class. Some classes will include running sample code on your own laptop. Six programming assignments will provide hands-on experience coding model-based decision analyses.
- **Application phase (weeks 8-13)** focuses on applying decision analytic modeling to inform health policy and clinical practice. Students will be exposed to several published model-based decision analyses through guest lectures and an assignment in which students analyze an existing open source modeling study. Students will also develop their own model-based decision analysis in a course project.

Assignments & evaluation

Class engagement (10%)

Students are expected to attend class having complete assigned readings, actively engage in discussions, and follow along with programming examples on their own laptops.

R programming assignments (42%)

A series of programming assignments will provide hands-on experience developing decision analytic models using various methods. For each assignment, students will be given a Quarto document that includes questions, instructions, and starter code. Students will complete the assignments by completing the code and answering questions.

0. Simpler models (7%)
1. Decision trees, cost-effectiveness (7%)
2. Cohort models (7%)
3. Simulation (7%)
4. Sensitivity analysis (7%)
5. Calibration, validation, and value of information (7%)

Out of fairness to your classmates, assignments will only be accepted after the deadline in exceptional circumstances. All assignments will be available more than one week before their deadline. You are encouraged to start early, work on the assignments for a short period over several days instead of all at once, and come to office hours with questions.

Open-source modeling study report (10%)

For Winter 2022 we are removing this assignment. To calculate final grades, we every other assignment will count for 10% more than was originally allocated (e.g., course project will count for 41.8%)

Students will select a published decision-analytic modeling study with open source code. Students will need to run the code on their own machine and give a class presentation about the analysis and what they learned.

Course project (38%)

The default course project entails developing a decision-analytic model an use it to inform a decision from health policy or clinical practice. Students are encouraged to analyze a decision problem related to their own research and/or engage with domain experts outside the class when applicable. Other project topics, such as developing or assessing a novel method or using modeling methods for an application that is not a decision analysis, may be approved by the instructor on a case-by-case basic. Students may work alone or in pairs.

1. Proposal (2%)
2. Class presentation (12%)
3. Written report and code (24%)

Course schedule

PDFs of all readings are available to enrolled students in MyCourses. Assignments are due at 11:59pm EST on the indicated date.

Date	Topics, Readings/tasks to be completed before class [**Tentative!**]

1/4 W

1. Course introduction

- Why do decision analysis
- Analytic perspective
- Using R and RStudio
- **Assignment 0 available (simpler models)**

(1) Follow the 'Setting up your software enviroment' instructions
(2) Read through *Reproducible Research in R session 1: Management of R projects*

1/6 F

2. Economic evaluation

- Economic evaluation
- Framing an analysis
- Quantifying health
- Discounting
- **Assignment 1 available (decision trees, cost-effectiveness)**

Ch. 1 'Introduction to health economic evaluation' from *Bayesian Methods in Health Economics (2012) by Gianluca Baio*

1/11 W

3. Probability, decision trees

- Conditional probability
- Decision trees
- Distributions, expectation, variance
- **Assignment 0 due**

Ch 9, pg 311 - 351 (you can skip 9.4.5 – 9.4.7, pg 331 - 338) 'Economic evaluation using decision-analytic modelling' from *'Methods for the Economic Evaluation of Health Care Programmes' (2014) by Drummond et. al.*

Date	Topics, Readings/tasks to be completed before class [Tentative!]

1/13 4. Cohort models I
F

- Markovian property
- Matrix operations in R
- Discrete time cohort models
- **Assignment 2 available (cohort models)**

Alarid Escudero et. al. 2022. An introductory tutorial on cohort state-transition models in R using a cost-effectiveness analysis example

1/18 5. Cohort models II
W

- Time-varying transitions
- Tolls, tunnel states
- **Assignment 1 due**

Alarid Escudero et. al. 2022. A tutorial on time-dependent cohort state-transition models in R using a cost-effectiveness analysis example

1/20 6. Modeling workflow
F

- Open science practices
- R project workflow
- Version control

Eddy et. al. 2012. Model transparency and validation: ISPOR-SMDM modeling good practices task force report

1/25 7. Microsimulation I
W

- Monte Carlo simulation
- Simulating decision trees
- Probabilistic sensitivity analysis
- **Assignment 3 available (simulation)**

Krijkamp et. al. 2018. Microsimulation modeling for health decision sciences Using R: A tutorial

Date	Topics, Readings/tasks to be completed before class [Tentative!]

1/27
F

8. Microsimulation II

- Tracking individual attributes
- Deciding on number of iterations
- Efficiency techniques (e.g., Conditional Monte Carlo)
- **Assignment 2 due**

Sections 1.4 and Ch. 2 (pg. 15 - 17, 23 - 64) from *Discrete Event Simulation for Health Technology Assessment (2016) by Caro et. al.*

2/1
W

9. Other simulation types

- Discreet event
- Agent based
- Network model

Chhatwal & He (2015). Economic evaluations with agent-based modelling: An introduction.

2/3
F

10. Uncertainty analysis

- Probabilistic sensitivity analysis
- Credible intervals
- Univariate sensitivity analysis
- Scenario analysis
- **Assignment 3 due Mon, Feb 6**

Briggs et. al. 2012. Model parameter estimation and uncertainty analysis: ISPOR-SMDM modeling good practices task force report

2/8
W

11. Value of information analysis

- For research prioritization and as sensitivity analysis
- VOI measures (EVPI, EVPPI, EVSI)
- Challenges and limitation
- **Assignment 4 available (Sensitivity analysis, VoI)**

Fenwick et. al. 2020. Value of information analysis for research decisions—an introduction: Report 1 of the ISPOR Value of Information Analysis Emerging Good Practices Task Force

Date Topics, Readings/tasks to be completed before class [Tentative!]

2/10 12. Designing & parameterizing an analysis
F

- Perspective, time horizons, comparators
- Deciding on scope & structure
- Literature-based inputs
- Patient-level data inputs
- **Project proposal assigned**
- **Assignment 4 due Mon. Feb 13**

(1) *Roberts et. al. 2012. Conceptualizing a model: a report of the ISPOR-SMDM Modeling Good Research Practices Task Force*
(2) Ch 8 (pg 209 - 236) 'Finding and summarizing the evidence' from *Decision Making in Health and Medicine (2014) by Hunink et. al.*

2/15 13. Calibration & validation
W

- Bayesian model calibration
- Model validation
- **Assignment 5 available (calibration, validation)**

Menzies et. al. 2017. Bayesian methods for calibrating health policy models: A tutorial.

2/17 14. Equity and distributional considerations
F

- Evaluation frameworks
- Data-driven modeling methods
- **Report on published study assigned**

(1) *Avanceña and Prosser (2021). Innovations in cost-effectiveness analysis that advance equity can expand its use in health policy*
(2) *Love-Koh et. al. (2019). Aggregate distributional cost-effectiveness analysis of health technologies*

2/22 15. Guest lecture: "Alcohol pricing policies and liver disease: a distributional
W   cost-effectiveness analysis" by Anton Avanceña, PhD (University of Texas Austin)

- **Project proposal due**

Paper and code on MyCourses

Date	Topics, Readings/tasks to be completed before class [**Tentative!**]

2/24
F
16. Guest lecture: "Estimating the impact of low influenza activity in 2020 on population immunity and future influenza seasons in the United States" by Kyueun Lee, PhD (University of Washington)

- **Assignment 5 due**

Manuscript, Code

2/27-
3/3
Winter reading break (no class)

3/8
W
17. Guest lecture: "Re-evaluating the health impact and cost-effectiveness of tuberculosis preventive treatment for modern HIV cohorts on antiretroviral therapy: a modelling analysis using data from Tanzania" by Jinyi Zhu, PhD (Vanderbilt University)
Manuscript, Code

3/10
F
18. Student presentations on published studies

3/15
W
19. Guest lecture: "Outbreaks of COVID-19 variants in US prisons: a mathematical modelling analysis of vaccination and reopening policies" by Theresa Ryckman (Johns Hopkins University)
Manuscript, Code to be posted on MyCourses

3/17
F
20. Guest lecture: "Improving medical decision making: Evidence and uncertainty considerations" by Natalia Kunst, PhD (Norway Directorate of Health/University of Oslo)
Manuscript1, Manuscript2, Manuscript3

3/22
W
21. Integrating machine learning and decision analysis to inform health policy
No reading assigned

3/24
F
22. Work on final projects

3/29
W
23. Guest lecture: "Scaling up target regimens for tuberculosis preventive treatment in Brazil and South Africa: An analysis of costs and cost-effectiveness" by Jonathan Campbell, PhD (McGill)
Manuscript, Code

3/31
F
24. Guest lecture: "When is mass prophylaxis cost-effective for epidemic control? A comparison of decision approaches" by Giovanni Malloy, PhD (RAND corporation)
Manuscript

Date	Topics, Readings/tasks to be completed before class [Tentative!]
4/5 W	**25. Guest lecture:** "Clinical and economic impact of molecular testing for BRAF fusion in pediatric low-grade Glioma" by Petros Pechlivanoglou (Sickkids/University of Toronto) Manuscript, Code
4/12 W	**26. Final presentations**
4/13 Th	**27. Wrap-up**
4/21 F	Final project report + code due (no class)

Academic integrity

McGill University values academic integrity. Therefore, all students must understand the meaning and consequences of cheating, plagiarism and other academic offences under the *Code of Student Conduct and Disciplinary Procedures* (see here for more details). Students found guilty of such academic offences will be given a failing grade to this course.

Language of submission

In accordance with McGill University's *Charter of Students' Rights*, students have the right to submit any written work that is to be graded in either English or French.