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

Course syllabus, Winter 2023, McGill University

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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, optimization, 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, prioritization of clinical research, and policies to avert drug overdose deaths.

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

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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, in Alton's office (#1113, 11th floor). 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) an introductory programming course. Prior experience programming in R may reduce the time needed to complete assignments, but experience in another language 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. In particular, students may find assignments time-consuming if they have not had an introductory programming course. 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 many 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 should 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 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%)

Open-source modeling study report (10%)

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 by downloading and running the code.

Course project (38%)

Students will develop 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. 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.

Date	Topics, Readings/tasks to be completed before class [Tentative!]
1/4 W	**1. Course introduction** • Why do decision analysis • Analytic perspective • R workflow • **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 F	**4. Cohort models I** • 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 W	**5. Cohort models II** • 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 F	**6. Microsimulation I** • 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*
1/25 W	**7. 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.*

Date	Topics, Readings/tasks to be completed before class [Tentative!]
1/27 F	**8. Other simulation types** • Discreet event • Agent based • Network model *Chhatwal & He (2015). Economic evaluations with agent-based modelling: An introduction.*
2/1 W	**9. Uncertainty analysis** • Probabilistic sensitivity analysis • Credible intervals • Univariate sensitivity analysis • Scenario analysis • **Assignment 3 due** • **Assignment 4 available (Sensitivity analysis)** *Briggs et. al. 2012. Model parameter estimation and uncertainty analysis: ISPOR-SMDM modeling good practices task force report*
2/3 f	**10. Designing & parameterizing an analysis** • Perspective, time horizons, comparators • Deciding on scope & structure • Literature-based inputs • Patient-level data inputs • **Project proposal assigned** (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.*

Date	Topics, Readings/tasks to be completed before class [Tentative!]
2/8 W	**11. Modeling workflow** • Model selection • Parameterization • R project workflow *Eddy et. al. 2012. Model transparency and validation: ISPOR-SMDM modeling good practices task force report*
2/10 F	**12. Calibration & validation** • Bayesian model calibration • Model validation • **Assignment 4 due** *Menzies et. al. 2017. Bayesian methods for calibrating health policy models: A tutorial.*
2/15 W	**13. Informing health intervention research** • Value of information (VoI) analysis • VOI measures (EVPI, EVPPI, EVSI) • Challenges and limitation • **Assignment 5 available (calibration, validation, and 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
2/17 F	**14. Equity and distributional considerations** • 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*

Date	Topics, Readings/tasks to be completed before class [Tentative!]
2/22 W	**15. Guest lecture:** Topic TBD by Anton Avanceña, PhD (University of Texas Austin) • **Assignment 5 due** *Read paper*
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) Manuscript
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 (Vandebilt University) Manuscript, Code
3/10 F	**18. Student presentations on published studies**
3/15 W	**19. Applied analysis presentation 4** *Read paper*
3/17 F	**20. Applied analysis presentation 5** *Read paper*
3/22 W	**21. Work on final projects**
3/24 F	**22. Applied analysis presentation 6** *Read paper*
3/29 W	**23. Guest lecture:** TBD by Giovanni Malloy, PhD (RAND corporation) *Read paper*
3/31 F	**24. Work on final projects**
4/5 W	**25. Applied analysis presentation 8** *Read paper*

Date	Topics, Readings/tasks to be completed before class [Tentative!]
4/12 W	**26. Final presentations**
4/13 Th	**27. Wrap-up**
4/21 F	Final project report + code due (no class)