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

DRAFT Course syllabus, Winter 2023, McGill University

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

Target audience

The course is targeted 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 some positions in industry and with governmental agencies.

Meetings

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

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

Office hours: 11:25am - 12pm Wednesday and Friday (directly after class) in my office (#1113, 11th floor) or by appointment.

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) some programming experience (we will use R). 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 to be very 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 complete assignment 0 (available on Github) and reach out to the instructor.

Readings

There is no textbook for this course. Readings drawn from various sources will be assigned before many class sessions; they will be posted on the course website. Some readings are tutorials with accompanying code, which students should run and analyse before class when indicated. 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. Students should install and configure the necessary software (R, RStudio, git) before the first class 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:

- **Phase 1 (weeks 1-6)** 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. Five programming assignments will provide hands-on experience coding model-based analyses.
- **Phase 2 (weeks 6-13)** focuses on applying decision analytic modeling to inform health policy and clinical practice. Students will be exposed to several published model-based decision analyses, largely 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 through 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 Quarto document that includes questions, instructions, and starter code. Students will complete the assignments by completing starter code and answering questions.

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

Open-source modeling study report (10%)

Students will select a published decision-analytic modeling study with open source code (and data, if applicable). Students will need to run the code on their own machine and give a class presentation about the model and analysis.

Course project (38%)

Using methods they learn in lecture and through the problem sets, 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 [Still under development. Course topics and readings subject to change]

Date	Content, *Readings/tasks to be completed before class* Tentative!
1/4 W	**Course introduction** • Why do decision analysis • Analytic perspective • R basics • **Assignment 0 available (simpler models)** Follow the 'Setting up your software enviroment' instructions

Date	**Content,** *Readings/tasks to be completed before class* Tentative!
1/6 F	**Economic evaluation** • Economic evaluation • Framing an analysis • Quantifying health • Discounting • **Assignment 1 available (decision trees, cost-effectiveness)** (1) *Ch. 1 'Introduction to health economic evaluation' from Bayesian Methods in Health Economics (2012) by Gianluca Baio* (2) OPTIONAL *Sanders et. al. 2016. Recommendations for Conduct, Methodological Practices, and Reporting of Cost-effectiveness Analyses.*
1/11 W	**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) from *'Economic evaluation using decision-analytic modelling' from 'Methods for the Economic Evaluation of Health Care Programmes' (2014) by Drummond et. al.*
1/13 F	**Cohort models I** • Markovian property • Matrix operations in R • Discrete time cohort models • **Assignment 2 available (cohort models)** *DARTH cohort tutorial intro*
1/18 W	**Cohort models II** • Time-varying transitions • Tolls, tunnel states • **Assignment 1 due** *DARTH cohort tutorial advanced*

Date	**Content,** *Readings/tasks to be completed before class* Tentative!
1/20 F	**Microsimulation I** • Monte Carlo simulation • Simulating decision trees • Probabilistic sensitivity analysis • **Assignment 3 available (simulation)** *Reading*
1/25 W	**Microsimulation II** • Tracking individual attributes • Deciding on number of iterations • Efficiency techniques (e.g., Conditional Monte Carlo) • **Assignment 2 due** *Reading*
1/27 F	**Other simulation types** • Discreet event • Agent based • Network model 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	**Designing & parameterizing an analysis** • Perspective, time horizons, comparators • Deciding on scope & structure • Literature-based inputs • Patient-level data inputs *Roberts et. al. 2012. Conceptualizing a model: a report of the ISPOR-SMDM Modeling Good Research Practices Task Force*

Date	**Content,** *Readings/tasks to be completed before class* Tentative!
2/3 F	**Uncertainty analysis** • Probabilistic sensitivity analysis • Credible intervals • Univariate sensitivity analysis • Scenario analysis • **Assignment 3 due** • **Assignment 4 available (Sensitivity analysis, value of information)** *Briggs et. al. 2012. Model parameter estimation and uncertainty analysis: ISPOR-SMDM modeling good practices task force report*
2/8 W	**Value of information** • EVPI, EVPPI • EVSI *Reading from ISPOR tutorial* *Code from SMDM session Anna Heath and Jeremy GF*
2/10 F	**Modeling workflow** • Model selection • Parameterization • R project workflow • **Project proposal assigned** (1) *Reproducible Research in R Chapter 4: Management of R projects* (2) *Eddy et. al. 2012. Model transparency and validation: ISPOR-SMDM modeling good practices task force report*
2/15 W	**Calibration & validation** • Bayesian model calibration • Model validation • **Assignment 4 due** • **Assignment 5 available (calibration)** *Menzies et. al. 2017. Bayesian methods for calibrating health policy models: A tutorial.*

Date	**Content,** *Readings/tasks to be completed before class* Tentative!
2/17 F	**Equity and distributional considerations** • Evaluation frameworks • Data-driven modeling methods • **Report on published study assigned**
2/22 W	**Applied analysis presentation 1 - Assignment 5 due** *Read paper*
2/24 F	**Applied analysis presentation 2 - Project proposal due** *Read paper*
2/27-3/3	*Winter reading break (no class)*
3/8 W	**Applied analysis presentation 3** *Read paper*
3/10 F	**Student presentations on published studies**
3/15 W	**Applied analysis presentation 4** *Read paper*
3/17 F	**Applied analysis presentation 5** *Read paper*
3/22 W	**Work on final projects**
3/24 F	**Applied analysis presentation 6** *Read paper*
3/29 W	**Applied analysis presentation 7** *Read paper*
3/31 F	**Work on final projects**
4/5 W	**Applied analysis presentation 8** *Read paper*
4/12 W	**Final presentations**
4/13 Th	**Wrap-up**

Date	**Content,** *Readings/tasks to be completed before class* Tentative!
4/21 F	Final project report + code due (no class)