**Course outline**

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| **Objective & Expectations** | * Learning objectives   + Understand how R can be used to perform model-based cost-effectiveness analysis with existing packages;   + Develop own models in R by modifying existing code for commonly used model types;   + Understand how using R can improve reproducibility and transparency of model-based cost-effectiveness analysis * Agenda * Class setup   + Slides   + Exercises with R (R-cloud) | 5 min |
| **Introduction** | * Criteria that economic models should strive to meet   + Clinical realism   + Quantifying decision uncertainty   + Transparency and reproducibility   + Reusability and adaptability * Structural uncertainty * Limitations of excel * Overview of R; why R * Initiatives of R for decision-modeling | 10 min |
| **(Basic) model taxonomy** | * Simple Markov cohort models (homogeneous) * Partitioned survival models * Time-varying state-transition models   + Time-varying Markov models (non-homogeneous)   + Semi-Markov individual-level models * Discrete and continuous time approaches * Cohort vs individual simulation | 15 min |
| **Simple Markov cohort models**  **(part 1)** | * Time-homogeneous Markov cohort model; state transition rates do not change over time. * HIV Simple Markov model   + Health states and transition diagram & description   + Health states and transition diagram & input parameters (TP, utility, costs)   + Health states and transition diagram & matrix   + R code matrix   + R code state occupancy over time   + R code compute expected outcomes   + R code ICER * Incorporating Probabilistic sensitivity analysis | 20 min |
| ***Exercise 1: simple Markov cohort model*** | * *Review and run R code* * *Modify code (update TM, utility, costs, time horizon, discount rate)* * *Review and run R code incorporating PSA* * *Modify uncertainty transition probabilities and relative treatment effect* | *25 min* |
| **Simple Markov cohort models**  **(part 2)** | * Hesim   + Types of models in hesim   + Structure: Disease model; Utility model; and cost models   + Parameterization, simulation, decision analysis * Markov cohort model in hesim (present R code) | 20 min |
| ***Exercise 2: Simple Markov cohort model with PSA*** | * *Run hesim R code for Markov cohort model with PSA* * *Modify distributions for PSA* | *25 min* |
| **Break** |  | 15 min |
| **Partitioned survival models** | * The standard 3-state model (stable disease, progressed disease, death) * State occupancy probabilities estimated using progression-free survival (PFS) and overall survival (OS) curves * Present R code | 15 min |
| ***Exercise 3: Partitioned survival model*** | * *Review and run R hesim code* * *Modify time-to-event distributions; structural uncertainty/ extrapolations* | *20 min* |
| **Time-varying state-transition models** | * Time-varying cohort models   + Transition rates will be allowed to vary over time; “clock-forward” multi-state model in which transition rates depend on time since treatment initiation. * Equivalency between partitioned survival models and time-inhomogeneous Markov cohort models * Semi-Markov individual-level models * Transition rates vary over time and depend on time since entering an intermediate health state. | 15 min |
| ***Demonstration: individual level continuous time state-transition model*** | * *hesim* * *4-state models?* * *Interactive; modify models based on audience input* | *15 min* |
| **Decision analysis** | * Representations of decision uncertainty * cost-effectiveness plane * cost-effectiveness acceptability curves * cost-effectiveness acceptability frontiers * value of information analysis | 15 min |
| ***Exercise 5: Decision uncertainty*** | * *Review and run hesim R code* * *Add code related to decision-analysis for ICTSTM model* | *20 min* |
| **Summary** |  | 5 min |