Practical 11: Computing the EVPI using nested Monte Carlo simulations

Thursday, 23 June 2022

Lecture 11 PDF version

Examples

Maternal screening for HIV:

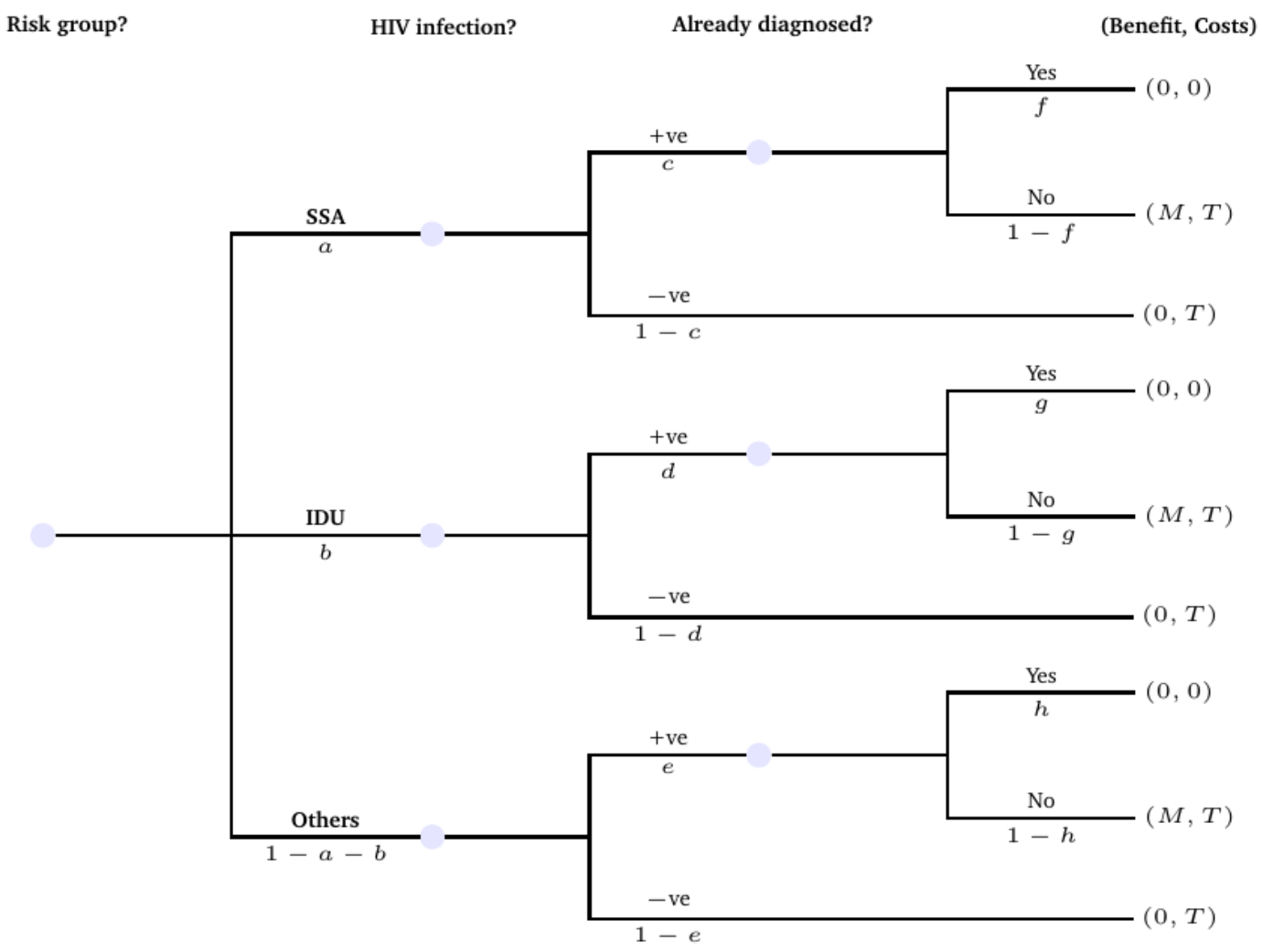
Ades AE, Cliffe S. Markov Chain Monte Carlo estimation of a multi-parameter decision model: consistency of evidence and the accurate assessment of uncertainty. *Medical Decision Making*. 2002; **22**:359-371.

Wound infection:

Cooper NJ, Sutton AJ, Abrams KR. Decision analytical economic modeling within a Bayesian framework: Application to prophylactic antibiotics use for caesarean section. *Statistical Methods in Medical Research*. 2002; **11**: 491-512.

HIV Example: Maternal screening for HIV

Ades and Cliffe (2002) conducted a multi-parameter evidence synthesis to compare universal screening of pregnant women for HIV with a strategy that targets high risk groups. The decision tree for the HIV example (used also in the lecture) is shown below. Incremental costs and benefits for universal screening compared with targeted screening of high risk groups is summarised in the decision tree below.



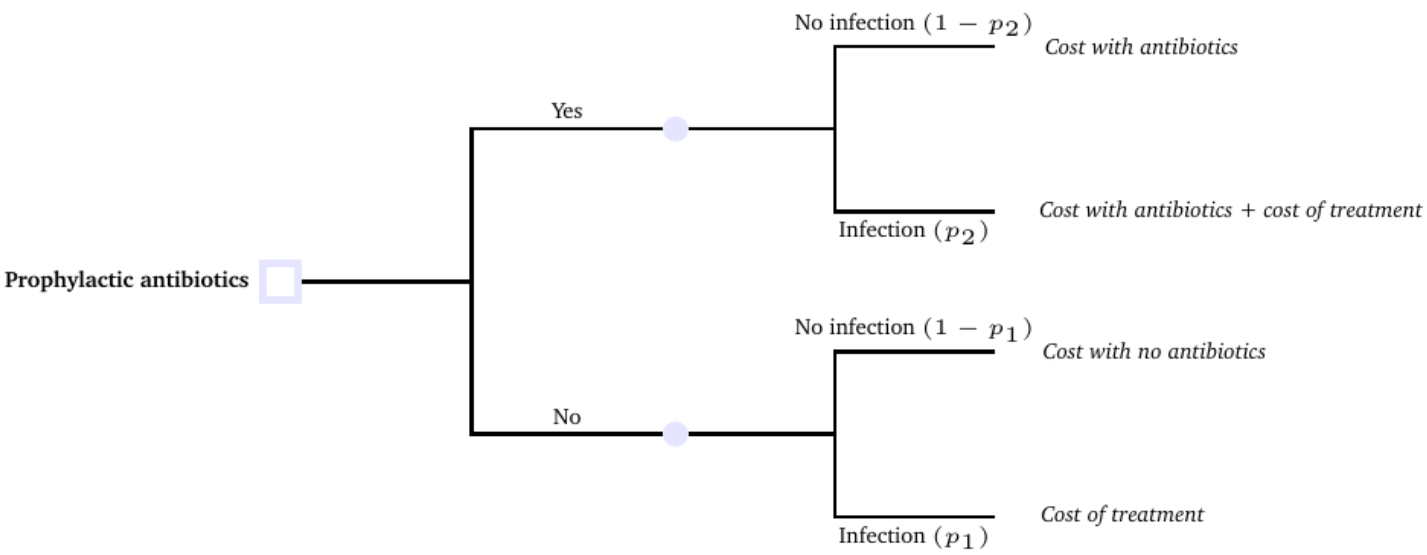
The test cost is $T = £3$, which is assumed fixed and known. The population size of pregnant women is 105,000 per year. All other parameters a, b, e, h, and M have been estimated, and we have PSA simulations available for them (from MCMC).

1. Write out the net-benefit function, and check it agrees with the formula given in the lecture.
2. Open the file `hiv.R` and follow the script to read the PSA samples in and then compute the EVPI. *NB: Make sure you specify the correct path to the folder in which you have saved this file!*
3. Following the script, compute the Expected Net Benefit and the probability that universal screening is indeed cost-effective.

4. Following the script, check convergence of the EVPI, by computing it repeatedly for increasing sample sizes. Plotting your simulations against iteration number, we would expect the EVPI to settle down. Are you happy convergence has been achieved? How precise would you want to be? What would you do if you are convergence not adequate?
5. Finally, use directly `BCEA` to compute the EVPI — again, the script can help you identify the relevant~commands).

Wound Infection following Caesarean Section

Cooper et al (2002) presented the decision model shown below to assess the cost-effectiveness of using prophylactic antibiotics to prevent wound infections following Caesarean section.



The probability of a wound infection without antibiotics was based on a meta-analysis giving the log-odds of infection, ψ. The probability of a wound infection with antibiotics was based on a meta-analysis giving the log-odds ratio, ϕ, so that:

$$p(t) = \begin{cases} \dfrac{e^{\phi+\psi}}{1+e^{\phi+\psi}} & t = 2 \text{ (antibiotics)} \\ \dfrac{e^{\psi}}{1+e^{\psi}} & t = 1 \text{ (no antibiotics)}. \end{cases}$$

The parameters Qwi and $Qnwi$ indicate respectively the QALYs with and without infection. Similarly, the costs are indicated as Cwi and $Cnwi$ with or without infection. The drug cost is $Cdrug_t$, with $Cdrug_1 = 0$. The net benefit can be then written as

$$\text{NB}_t(\boldsymbol{\theta}) = k\left[p(t)Qwi + (1-p(t))Qnwi\right] - \left[p(t)Cwi + (1-p(t))Cnwi + Cdrug(t)\right].$$

The file `wounds.txt` contains 150,000 PSA simulations for all the model parameters

$$\boldsymbol{\theta} = (Qwi, Qnwi, Cwi, Cnwi, \boldsymbol{Cdrug}, \phi, \psi).$$

1. Follow the script contained in the file `wounds.R` to read the PSA in, compute the effects and costs under both options.
2. Follow the script and use `BCEA` to compute the expected net-benefit, probability that antibiotics are cost-effective, and 1-year EVPI per woman, for a range of willingness to pay values from £ 1,000 to £ 40,000 (use `?bcea` to help you with syntax). What are the values when $k =$ £ 20,000?
3. Use the `BCEA` commands `ceac.plot` and `evi.plot` to produce a CEAC and a plot of EVPI over different values of the willingness to pay. Comment on what these graphs show.
4. There were 166,081 cesearean sections in England and Wales in 2013-14. Assuming this is constant over time, compute the population EVPI for a 10-year lifetime of technology (discounted to 7.7217). What is the population EVPI when $k =$ £ 20,000?
5. **Advanced:** Code the EVPI yourself for $k =$ £ 20,000, so that you can check convergence. Check the results agree with those from `BCEA`. *Hint 1: You have already computed effects and costs, so easy to compute net-benefit. Hint 2: After computing net-benefit, follow the code used for the HIV example.*