Sumatriptan versus caffeine for migraine

A decision tree example

Andrew J. Sims

2020-05-30

Introduction

This vignette is an example of modelling a decision tree using the `rdecision` package. It is based on the example given by Briggs[1] which itself is based on a decision tree which compared oral Sumatriptan versus oral caffeine/Ergotamine for migraine[2].

Creating the model

The following code constructs the decision tree, node by node. In the formulation used by `rdecision`, each node is a potentially recursive structure which is allowed to have zero or more child nodes; any child nodes must have already been declared before their parent node is declared. This implies that a tree should be constructed from right to left, starting with leaf nodes which have no children (leaf nodes are synonymous with pathways in Briggs' terminology, and called 'States' in `rdecision`). The final node to be constructed is the left-most decision node in the model.

```
# Time horizon
th <- as.difftime(48, units="hours")

# Model variables
sumatriptan <- 16.10
caffeine <- 1.32
ED <- 63.16
admission <- 1093

# Sumatriptan branch
state.a <- State$new("A", cost=(sumatriptan), utility=1.0, interval=th)
state.b <- State$new("B", cost=(2*sumatriptan), utility=0.9, interval=th)
state.c <- State$new("C", cost=(sumatriptan), utility=-0.3, interval=th)
state.d <- State$new("D", cost=(sumatriptan+ED), utility=0.1, interval=th)
state.e <- State$new("E", cost=(sumatriptan+ED+admission), utility=-0.3, interval=th)

c.8 <- ChanceNode$new(
  p = list(0.998, 0.002),
  children = list(state.d, state.e),
  edgelabels = list("Relief", "Hospitalization"),
  costs = list(0, 0)
)

c.4 <- ChanceNode$new(
```

```
  p = list(0.594, 0.406),
  children = list(state.a, state.b),
  edgelabels = list("No recurrence", "Recurrence relieved with 2nd dose"),
  costs = list(0, 0)
)

c.5 <- ChanceNode$new(
  p = list(0.920, 0.080),
  children = list(state.c, c.8),
  edgelabels = list("Endures attack", "ER"),
  costs = list(0, 0)
)

c.2 <- ChanceNode$new(
  p = list(0.558, 0.442),
  children = list(c.4, c.5),
  edgelabels = list("Relief", "No relief"),
  costs = list(0, 0)
)

# Caffeine/Ergotamine branch
state.f <- State$new("F", cost=(caffeine), utility=1.0, interval=th)
state.g <- State$new("G", cost=(2*caffeine), utility=0.9, interval=th)
state.h <- State$new("H", cost=(caffeine), utility=-0.3, interval=th)
state.i <- State$new("I", cost=(caffeine+ED), utility=0.1, interval=th)
state.j <- State$new("J", cost=(caffeine+ED+admission), utility=-0.3, interval=th)

c.9 <- ChanceNode$new(
  p = list(0.998, 0.002),
  children = list(state.i, state.j),
  edgelabels = list("Relief", "Hospitalization"),
  costs = list(0, 0)
)

c.6 <- ChanceNode$new(
  p = list(0.703, 0.297),
  children = list(state.f, state.g),
  edgelabels = list("No recurrence", "Recurrence relieved with 2nd dose"),
  costs = list(0, 0)
)

c.7 <- ChanceNode$new(
  p = list(0.920, 0.080),
  children = list(state.h, c.9),
  edgelabels = list("Endures attack", "ER"),
  costs = list(0, 0)
)

c.3 <- ChanceNode$new(
  p = list(0.379, 0.621),
  children = list(c.6, c.7),
  edgelabels = list("Relief", "No relief"),
  costs = list(0, 0)
```

```
)

# decision node
d.1 <- DecisionNode$new(
  children = list(c.2, c.3),
  edgelabels = list("Sumatriptan", "Caffeine/Ergotamine"),
  costs = list(0, 0)
)
```

Running the model

The method `evaluatePathways` of decision nodes computes the probability, cost and utility of traversing each root-to-leaf path in the model. In the Sumatriptan model there are eight such paths, each of which begins with the decision node and ends with a leaf node. For example, pathway A involves a traversal of nodes `d.1`, `c.2`, `c.4` and `state.a`.

Model results

The results of the scenario model, using the code from the previous sections, yields the following result:

Choice	Pathway	Probability	Cost	Expected Cost	Utility	Expected Utility
Sumatriptan	A	0.331	16.10	5.34	1.0	0.33145
Sumatriptan	B	0.227	32.20	7.29	0.9	0.20389
Sumatriptan	C	0.407	16.10	6.55	-0.3	-0.12199
Sumatriptan	D	0.035	79.26	2.80	0.1	0.00353
Sumatriptan	E	0.000	1172.26	0.08	-0.3	-0.00002
Caffeine/Ergotamine	F	0.266	1.32	0.35	1.0	0.26644
Caffeine/Ergotamine	G	0.113	2.64	0.30	0.9	0.10131
Caffeine/Ergotamine	H	0.571	1.32	0.75	-0.3	-0.17140
Caffeine/Ergotamine	I	0.050	64.48	3.20	0.1	0.00496
Caffeine/Ergotamine	J	0.000	1157.48	0.12	-0.3	-0.00003

There are, as expected, eight root-to-leaf pathways. The total probability, expected cost and expected utility for each choice can be calculated from the table above, or by invoking the `evaluateChoices` method of a decision node. This gives the following result, consistent with that reported by Evans *et al*[2].

Choice	Expected Cost	Expected Utility
Caffeine/Ergotamine	4.71	0.20128
Sumatriptan	22.06	0.41686

References

1. Briggs, A., Claxton, K. & Sculpher, M. *Decision modelling for health economic evaluation.* (Oxford University Press, 2006).

2. Evans, K. W., Boan, J. A., Evans, J. L. & Shuaib, A. Economic evaluation of oral sumatriptan compared

with oral caffeine/ergotamine for migraine. *Pharmacoeconomics* **12**, 565–577 (1997).