

## Bayesian Models CSE458 Exercise 2

### An Oil Drilling Problem

The following problem is based on a famous problem in H. Raiffa, *Decision Analysis: Introductory Lectures on Choices under Uncertainty*, Addison-Wesley, 1968.

*An oil wildcatter must decide whether to drill or don't drill. The cost of drilling is uncertain. It could be \$4,000,000 with probability 0.2, \$5,000,000 with probability 0.7 and \$7,000,000 with probability 0.1. Also, the oilcatter is uncertain whether the hole is **dry**, **wet**, or **soaking**. His payoffs are given in Table 1.*

State	Drill	Don't Drill
<b>Dry</b>	\$0	\$0
<b>Wet</b>	\$12,000,000	\$0
<b>Soaking</b>	\$270,000,000	\$0

**Table 1**

*At a cost of \$100,000 the wildcatter could take standard seismic soundings which will help determine the underlying geological structure of the site. The soundings will disclose whether the terrain below has **no structure**, or an **open structure**, or a **closed structure**. Table 2 provides the joint probabilities of the structure of the terrain and the true state of the hole.*

True State	Seismic outcome		
	No Structure	Open Structure	Closed Structure
<b>Dry</b>	0.30	0.15	0.05
<b>Wet</b>	0.09	0.12	0.09
<b>Soaking</b>	0.02	0.08	0.10

**Table 2**

*The oilcatter could also use an experimental device which will give an indication of the subsurface structure, but with occasional errors.*

*This experiment costs only \$30,000 and Table 3 provides the conditional probabilities of the structure indicated from the experiment given the true underlying structure.*

<b>Underlying Structure</b>	<b>Structure indicated by experiment</b>		
	<b>No Structure</b>	<b>Open Structure</b>	<b>Closed Structure</b>
<b>No Structure</b>	<i>0.90</i>	<i>0.10</i>	<i>0.00</i>
<b>Open Structure</b>	<i>0.20</i>	<i>0.70</i>	<i>0.10</i>
<b>Closed Structure</b>	<i>0.10</i>	<i>0.30</i>	<i>0.60</i>

**Table 3**

1. Using a decision flow diagram decide what the wildcatter should do.
2. Suppose the wildcatter uses the following utility function:

$$u(x) = 1 - e^{-x/2,000,000}.$$

Now what should the wildcatter do?