Bayesian Networks and Influence Diagrams: A Guide to Construction and Analysis

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Answers to Exercises

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Answer to Exercise 10.1: We assume $\mathsf{P}(\mathsf{Rain} = \mathsf{no}) = \mathsf{P}(\mathsf{Sprinkler} = \mathsf{no}) = 0.9$.

(a) $\varepsilon = \{\mathsf{Holmes'\ lawn} = \mathsf{wet}, \mathsf{Gibbon's\ lawn} = \mathsf{dry}, \mathsf{Watson's\ lawn} = \mathsf{dry}\}$.

(b) We compute normalized likelihoods of the hypothesis given each subset of the evidence

Gibbon's lawn = dry	Holmes' lawn = wet	Watson's lawn = dry	Sprinkler = yes
			1
		+	1
	+		5.05
	+	+	9.88
+			1
+		+	1
+	+		9.88
+	+	+	10.0

(c) We compute Bayes' factor for each subset of the evidence

Gibbon's lawn = dry	Holmes' lawn = wet	Watson's lawn = dry	Sprinkler = yes
			1
		+	81.1
	+		0.92
	+	+	73.66
+			81.1
+		+	7290.1
+	+		73.66
+	+	+	6620.69

(d) We perform a what-if analysis on each evidence node

Evidence change	P(Sprinkler = yes)
Gibbon's lawn = wet	0.89
Holmes' lawn = dry	0.01
Watson's lawn = wet	0.89

(e) For each finding ε_X, we compute $\mathsf{P}(\mathsf{Sprinkler} = \mathsf{yes})$, $\mathsf{P}(\mathsf{Sprinkler} = \mathsf{yes} | \varepsilon \setminus \{\varepsilon_X\})$ and $\mathsf{P}(\mathsf{Sprinkler} = \mathsf{yes} | \varepsilon)$

Finding	P(Sprinkler = yes)	P(Sprinkler = yes | ε \ {ε_X})	P(Sprinkler = yes | ε)
Gibbon's lawn = dry	0.1	0.9879	0.9999
Holmes' lawn = wet	0.1	0.1	0.9999
Watson's lawn = dry	0.1	0.9879	0.9999

Answer to Exercise 10.2:

(a) $\varepsilon = \{\mathsf{Smoker} = \mathsf{yes}, \mathsf{Asia} = \mathsf{yes}, \mathsf{Dyspnea} = \mathsf{yes}\}$.

(b) We compute normalized likelihoods of the hypothesis given each subset of the evidence

Smoker = yes	Asia = yes	Dyspnoa = yes	Bronchitis = yes
			1
		+	1.85
	+		1
	+	+	1.80
+			1.33
+		+	1.96
+	+		1.33
+	+	+	1.93

(c) We compute Bayes' factor for each subset of the evidence

Smoker = yes	Asia = yes	Dyspnoa = yes	Bronchitis = yes
			1
		+	0.99
	+		1
	+	+	1.0
+			0.73
+		+	0.73
+	+		0.73
+	+	+	0.73

(d) We perform a what-if analysis on each evidence node

Evidence change	P(Bronchitis = yes)
Smoker = no	0.72
Asia = no	0.88
Dyspnoa = no	0.26

(e) For each finding ε_X, we compute P(Bronchitis = yes), P(Bronchitis = yes$|\,\varepsilon \setminus \{\varepsilon_X\}$) and P(Bronchitis = yes$|\,\varepsilon$)

Finding	P(Bronchitis = yes)	P(Bronchitis = yes$|\,\varepsilon \setminus \{\varepsilon_X\}$)	P(Bronchitis = yes$|\,\varepsilon$)
Smoker = yes	0.45	0.81	0.87
Asia = yes	0.45	0.88	0.87
Dyspnoa = yes	0.45	0.60	0.87

Answer to Exercise 10.3:

(a) P(Disease = true|Test = true) = 0.0196.

(b) $f(t) = \frac{19.6*t}{18.6*t+0.98}$.

(c) $f'(t_0) = 19.3$.

(d) $(-\infty, 0.046)$.

Answer to Exercise 10.4:

(a) $f(t) = \frac{-1.086*t+1.099}{-0.986*t+1.099}$ computed for initial value P(Rain = yes) = 0.1.

(b) $f'(t_0) = -0.135$.

(c) $f(t) = \frac{0.112*t}{-0.986*t+1.099}$ computed for initial value P(Rain = yes) = 0.1.

(d) $(-\infty, 0.81667)$ computed for initial value P(Rain = yes) = 0.1.