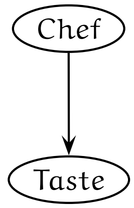
Bayesian Networks and Influence Diagrams: A Guide to Construction and Analysis

Uffe B. Kjærulff and Anders L. Madsen

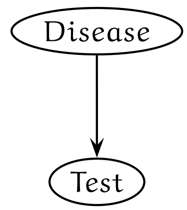
Answers to Exercises

February 13, 2009

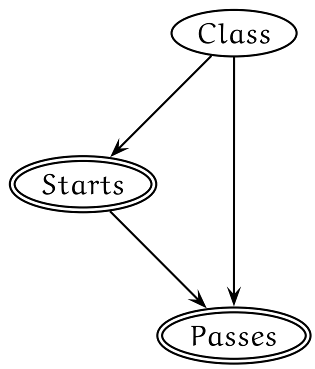
Answer to Exercise 4.1: No, the probability of Eric preparing the food is 45.45%. The structure of a Bayesian network representation is shown below.



Answer to Exercise 4.2: The probability of a randomly selected person having the disease is 1.963%. The structure of a Bayesian network representation is shown below:



Answer to Exercise 4.3: The structure of a CLG Bayesian network representation is shown below:



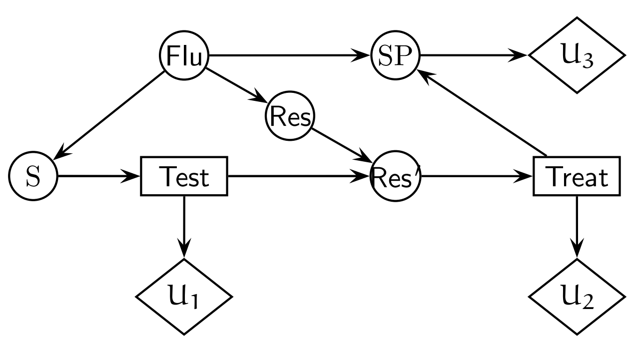
(a) The average number of students passing an exam is 50.

(b) The average number of students passing a math exam is 90.

(c) The average number of studetns taking a math class when 80 students pass is 173.33.

Answer to Exercise 4.4:

(a) The influence diagram can be structured in a few different ways depending on how you treat the test, but one approach could be:



(b) The utility functions are $U_1(\mathsf{Test}) = (-40, 0)$, $U_2(\mathsf{Treat}) = (-100, 0)$ and $U_1(\mathsf{SP}) = (1000, 0)$.

For the probabilities we have $P(\mathsf{Flu}) = (0.001, 0.999)$ together with the tables:

		Flu	
		flu	¬flu
Symp	y	0.9	0.05
	n	0.1	0.95

$P(\mathsf{Symp} \mid \mathsf{Flu})$

		Flu	
		flu	¬flu
Res	pos	0.9	0.05
	neg	0.1	0.95

$P(\mathsf{Res} \mid \mathsf{Flu})$

		Res	
		pos	neg
Test	y	(1, 0, 0)	(0, 1, 0)
	n	(0, 0, 1)	(0, 0, 1)

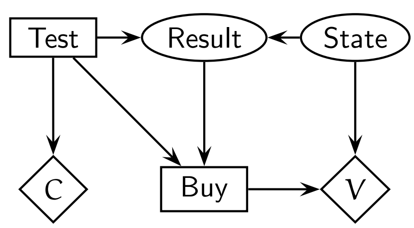
$P(\mathsf{Res}' \mid \mathsf{Test}, \mathsf{Res})$

		Flu	
		flu	¬flu
Treat	y	(0.6, 0.4)	(0, 1)
	n	(0, 1)	(0, 1)

$P(\mathsf{SP} \mid \mathsf{Flu}, \mathsf{Treat})$

Answer to Exercise 4.5:

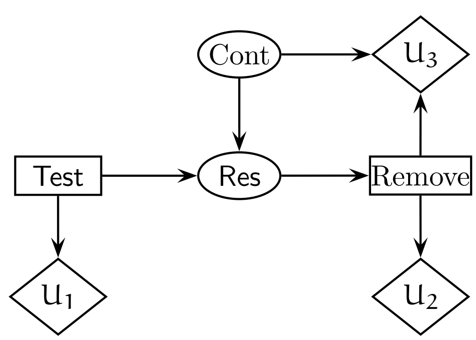
(a) The structure of an influence diagram representation is shown below:



(b) The maximum expected utility is 1545 and the optimal strategy is to perform Test_1 and buy the car unless the test shows defects.

Answer to Exercise 4.6:

(a) The structure of an influence diagram representation is shown below:



(b) The utility functions are: $U_1(\mathsf{Test}) = (-1000, 0)$, $U_2(\mathsf{Remove}) = (-30000, 0)$ and:

		Cont: y	Cont: n
Remove	y	0	0
	n	-100000	0

$U_3(\mathsf{Cont}, \mathsf{Remove})$

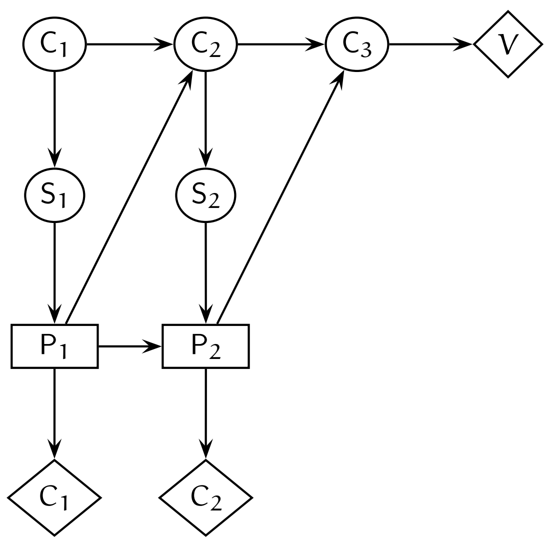
For the probabilities we have $P(\mathsf{Cont}) = (0.6, 0.4)$ and:[1]

		Cont: y	Cont: n
Test	y	$(0.9, 0.1, 0)$	$(0.01, 0.99, 0)$
	n	$(0, 0, 1)$	$(0, 0, 1)$

$P(\mathsf{Res} \mid \mathsf{Test}, \mathsf{Cont})$

Answer to Exercise 4.7:

(a) The structure of an influence diagram representation is shown below:



(b) $C_1(P_1) = (0, -10000)$, $C_2(P_2) = (0, -20000)$, $V(C_3) = (0, 100000)$, $P(C_1) = (0.01, 0.99)$ and

		C_i: fault	C_i: ok
S_i	unstable	0.99	0.001
	stable	$0, 01$	0.999

$P(S_1 \mid C_1) = P(S_2 \mid C_2)$

[1]Note that the state space for Res consists of three states: (pos, neg, nr), where nr represents no-result.

P_1	C_1	C_2 fault	C_2 ok
false	fault	1	0
false	ok	0	1
true	fault	0.05	0.95
true	ok	0	1

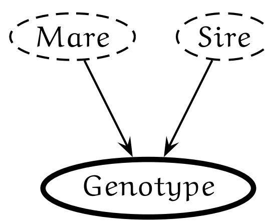
$P(C_2 \mid P_1, C_1)$

P_2	C_2	C_3 fault	C_3 ok
false	fault	1	0
false	ok	0	1
true	fault	0.01	0.99
true	ok	0	1

$P(C_3 \mid P_2, C_2)$

Answer to Exercise 4.8:

(a) The stud farm pedigree in shown in Figure 4.25 defins the structure of an object-oriented network representation. The structure of the horse class is shown below:



Each instance node in the network is an instantiation of the horse class. The interface nodes are connected according to the stud farm pedigree.

(b) The probability distribution of each horse being sick/a carrier/a non-carrier once we learn that John is sick is shown in the table below:

Horse	Sick	Carrier	Non-carrier
Cecily	0.0691	0.4073	0.5236
Ann	0.1782	0.5891	0.2327
Brian	0.1236	0.4982	0.3782
Eric	0.1382	0.5418	0.32
Gwenn	0.1782	0.5891	0.2327
Fred	0.1582	0.6018	0.24
Dorothy	0.2055	0.6346	0.16
Irene	0.2546	0.7455	0
Henry	0.3546	0.6455	0