COGS 300 — Fall 2013
Assignment 1

Solution

Question 1

Solution

(a) $P(Admitted = true|Sex = male) = 105/195 \approx 0.54$.
$P(Admitted = true|Sex = female) = 40/90 \approx 0.44$.
Males are more likely to be admitted.

(b) $P(Admitted = true|Sex = male, Dept = dept\#1) = 90/140 \approx 0.64$.
$P(Admitted = true|Sex = female, Dept = dept\#1) = 20/30 \approx 0.67$.
Females are more likely to be admitted to department *dept*#1.

(c) $P(Admitted = true|Sex = male, Dept = dept\#2) = 15/55 \approx 0.27$.
$P(Admitted = true|Sex = female, Dept = dept\#2) = 20/60 \approx 0.33$.
Females are more likely to be admitted to department *dept*#2.

(d) This is a paradox because females are more likely to be accepted into each department, but are less likely to be admitted overall. In this case, it arises because males apply more to the department that is easier to get admitted into.

(e) For a political example see
`http://www.theguardian.com/commentisfree/2013/aug/28/republicans-party-of-civil-rights`
and `http://blog.kickdex.com/post/62142295263/by-head-or-by-foot` for a soccer example
`http://www.bmj.com/content/309/6967/1480` for a medical example. For interactive tools see: `http://vudlab.com/simpsons/` or `http://blog.revolutionanalytics.com/2013/10/an-interactive-tool-to-explain-simpsons-paradox.html`.

Question 2

Solution

(a) When *Smokes* is observed to be true, *Bronchitis*, *Coughing*, *Wheezing* have their probabilities change.

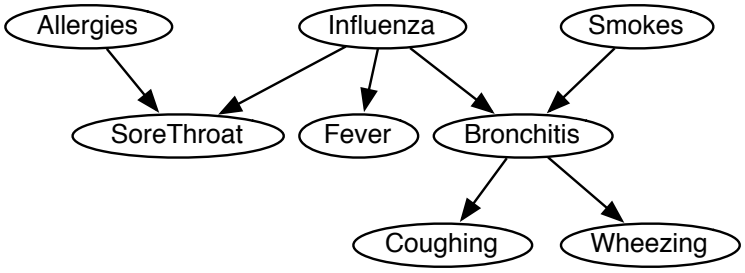
(b) When just *Fever* is observed, all of the variables except *Smokes* have their probability changed.

(c) Yes, the probability of *Fever* changes when *Wheezing* is observed to be true because wheezing provides evidence for influenza which would then affect our belief in fever.

(d) Yes, when *Wheezing* is observed to be true, observing *Fever* changes the probability of *Smokes*. Both smokes and influenza are explanations for bronchitis, which could have produced wheezing. When fever is observed, it changes the probability of influenza and so smokes is not needed (as much) to explain the wheezing.

(e) *Influenza* or *Bronchitos* could be observed so that subsequently observing *Wheezing* does not change the probability of *SoreThroat*. The reason *Wheezing* changes the probability of *SoreThroat* is that it affects the belief in *Influenza* and *Bronchitis*; if these are observed, *wheezing* doesn't affect them.

(f) Here is the resulting Bayesian network:



You need to define $P(Allergies)$ and $P(SoreThroat|Allergies, Influenza)$.

(g) *SoreThroat* needs to be observed and *Influenza* and *Bronchitis* need to be not observed. If wheezing is observed, the probability of influenza changes, and so it explains away allergies as an explanation of the sore throat.

(h) If both *SoreThroat* and one of *Bronchitis*, *Coughing* or *Wheezing* are observed, and *Influenza* is not observed, observing *Smokes* changes the probability of *Allergies*, because observing smokes affects influenza as an explanation of bronchitis, coughing or wheezing, which in turn affects the probability of allergies as an explanation of the sore throat.

Question 3

Solution a) & b) See:
`http://www.cs.ubc.ca/~poole/cogs300/2013/as1/cab.xml`
Toggle monitoring for "Cab Company", and observe the other variables.

c) One solution is:
`http://www.cs.ubc.ca/~poole/cogs300/2013/as1/cab_collision.xml`

d) One solution is:
`http://www.cs.ubc.ca/~poole/cogs300/2013/as1/cab_accident.xml`
The rate of accidents was not given and cannot be inferred from the description. I arbitrarily chose $P(accident) = 0.1$.

Note that you could have "Accident" as a parent of "Cab Company", but then it is more difficult to set the probabilities to match the story.

Question 4

Solution There are many possible correct answer for this.

Question 5

Solution See `http://wiki.ubc.ca/Course:COGS300` for solutions.

Question 6

Solution It took a couple of hours. It was probably a bit too easy for a 3rd year course, but is probably okay because we are in the middle of midterms.