

## MA410 Artificial Intelligence - Probability Problem Sheet

- The probability that it will rain is 0.5. Given the rule "If it rains, Alice won't go into college otherwise there's a 50/50 chance she'll go into college".
  - What is the probability on a particular day that Alice will go into college?
  - Suppose there is no chance Alice will go into college on a Saturday or Sunday. What is the probability she will go in on a random day?
- The probability that John is lucky is 0.5 and the probability he studies is 0.2 (assume independence). Given that John studies, the chance that he studies hard is 0.7. Suppose you are given the rule:

*if John is lucky and studies / or he studies hard then  
he will pass his exam - otherwise he won't.*

  - What is the probability that John passes his exam?
  - If instead, John had a 5% chance *otherwise* of passing, what would be the probability John passes his exam?
- A machine is either working, has a small fault or has a major fault. The chances of these disjoint events are 0.7, 0.2, 0.1 respectively. Suppose a robot can fully repair a machine with probability 0.6 if it has a small fault, and with probability 0.2 if it has a major fault.
  - Draw a Bayesian Network with states *Faultless*, *Small* and *Major*.
  - Suppose a machine was fixed by a robot. What is the probability that the machine had a fault which was (i) small, (ii) major.
  - If a machine visited by a robot is now working. What is the probability it had (i) no fault, (ii) a small fault, (iii) a major fault?
- Suppose that a computer is infected with a virus with probability 0.1. If it has a virus, the probability it has a worm is 0.4 and a trojan is 0.5. An anti-virus program is found to remove a trojan only with probability 0.9 and a worm with probability 0.85, all other viruses can't be removed. Suppose trojan and worm are independent.
  - What is the probability of a worm and a trojan given the computer was infected?
  - Draw a Bayesian Network Diagram with states *Infected*, *Worm*, *Trojan*, *Faultless*.
  - If a computer was fixed by the anti-virus software, what is the probability it had a (i) worm only, (ii) trojan only, (iii) a worm and a trojan?
- Refer to Question 4 above. Suppose that the probabilities for trojan, worm are respectively 0.6 & 0.4 and these events are disjoint.
  - Draw a Bayesian Network Diagram as in 4(b).
  - If the anti-virus software worked, what is the chance it had (i) a worm, (ii) a trojan?
  - If computer is found virus-free, what is the chance it had (i) a worm, (ii) a trojan?
- Given the events and probabilities: S: sprinkler system goes on, R: it rains, W: grass wet  
 $P(R) = .5$ ,  $P(S|R) = .01$ ,  $P(S|\bar{R}) = .9$ ,  $P(W|R \cap \bar{S}) = .95$ ,  $P(W|S \cap \bar{R}) = .88$ ,  $P(\bar{W}|\bar{R} \cup \bar{S}) = 1$ .
  - Draw a Bayes' network comprising of three states *sprinkler*, *rain* and *grass wet*.
  - Find (i)  $P(R | S)$ , (ii)  $P(R | W)$ , (iii)  $P(S | W)$ , (iv)  $P(R \cap S | W)$ , (v)  $P(R \cup S | W)$ .
- A robot is programmed to detect art forgeries by using the latest AI computer vision technologies. It will detect forgeries correctly in 90% of cases and wrongly class a genuine painting as a forgery in 0.1% of cases. An art dealer inspects two paintings and works out the probabilities are 0.5, 0.3 and 0.2 that 0, 1 or 2 of them, respectively, are forgeries.
  - Draw an appropriate Bayes' network diagram.
  - If one of them is a forgery, what is the chance the other is also a forgery?
  - The robot detects one painting as a forgery. What is the chance it will detect the other as a forgery?