COMP3411/9814 Sample Exam Solutions

Q1. C Q2. D Q3. C Q4. B Q5. A Q6. D Q7. B

Q8. ONE = 182, TEN = 728 (you can try values for E one by one)

Q9. (i) (DFS) S A I D N G
(ii) (UCS) S A T I D W N O Y G
(iii) (Greedy) S T I N G
(iv) (A*Search) S T A I D O N Y G

Q10. (i) 4+0+1+1+2+2+1+3 = 14 (ii) C ($h = 13$ for this successor state and 15 for the others)

Q11. E (9) and G (3) would be pruned

Q12. (i) Prob(light) $= 0.04 + 0.16 + 0.02 + 0.63 = 0.85$
(ii) Prob(failure|rain $\vee \neg$ light) = (0.04+0.03+0.07)/(0.04+0.03+0.07+0.16+0.02+0.03) = 0.4

Q13. Entropy(root) $= -0.5(\log_2(0.5)) - 0.5(\log_2(0.5)) = 1$

Entropy(chocolate) = Entropy(banana) = 0, Entropy(vanilla) $= -\frac{1}{3}\log\frac{1}{3} - \frac{2}{3}\log\frac{2}{3} \simeq 0.9183$
Entropy(flavour) $= \frac{3}{8}(0) + \frac{2}{8}(0) + \frac{3}{8}(0.9183) \simeq 0.344$
Entropy gain for flavour $= 1 - 0.344 = 0.656$ (any number between 0.651 and 0.661 is ok)

Entropy(smarties) = 0, Entropy(peanuts) = Entropy(raisons) $\simeq 0.9183$
Entropy(ingredient) $= \frac{2}{8}(0) + \frac{3}{8}(0.9183) + \frac{3}{8}(0.9183) \simeq 0.689$
Entropy gain for ingredient $= 1 - 0.689 = 0.311$ (any number between 0.306 and 0.316 is ok)

Q14. Error(Parent) $= 1 - \frac{9+1}{14+2} = \frac{6}{16} = \frac{3}{8}$
Error(Left) $= 1 - \frac{4+1}{7+2} = \frac{4}{9}$
Error(Right) $= 1 - \frac{6+1}{7+2} = \frac{2}{9}$
Backed up Error $= \frac{7}{14}(\frac{4}{9}) + \frac{7}{14}(\frac{2}{9}) = \frac{3}{9} < \frac{3}{8}$

Therefore, the children should **not** be pruned.

Q15. There are many possible lines. The one giving maximal separation has slope $(2-1)/(2-0) = \frac{1}{2}$ and x_2-intercept $\frac{1}{2}$, which gives:

$$x_2 > 0.5\,x_1 + 0.5, \quad \text{i.e. } -0.5 - 0.5\,x_1 + x_2 > 0, \quad \text{so } w_0 = -0.5,\ w_1 = -0.5,\ w_2 = 1$$

Q16. $w_0 \to 0.5 - 1 = -0.5, \quad w_1 \to 1 - 3 = -2, \quad w_2 \to -2 - (-2) = 0$

Q17. $b_0 = -2.5,\ b_1 = 0.5,\ b_2 = 1.5,\ b_3 = 0.5$ (any number within 0.5 of these values would be ok)

Q18.

K	L	M	$K \wedge \neg M$	$L \to K \wedge \neg M$	$\neg M \wedge \neg L$	$\neg M \wedge \neg L \to K$	KB
0	0	0	0	1	1	0	0
0	0	1	0	1	0	1	1
0	1	0	0	0	0	1	0
0	1	1	0	0	0	1	0
1	0	0	1	1	1	1	1
1	0	1	0	1	0	1	1
1	1	0	1	1	0	1	1
1	1	1	0	0	0	1	0

These are the models which satisfy both sentences: {M}, {K}, {K, M}, {K, L}

Q19. D

Q20. (i) Not all swans are white.
(ii) Every clown rides a big, red bicycle.

Q21. (i) $Q^*(S_1, a_1) = 5\,/\,(1 - 0.6) = 12.5$

(ii) $Q^*(S_1, a_2) = -4 + 0.6 * 8/(1 - 0.6) = 8$

(iii) $Q^*(S_2, a_1) = 9 + 0.6 * Q^*(S_1, a_1) = 16.5$

(iv) $Q^*(S_2, a_2) = 8\,/\,(1 - 0.6) = 20$

(v) When $\gamma = 0$, we maximize the **immediate** reward, so the optimal policy is: $\pi^*(S_1) = a_1,\ \pi^*(S_2) = a_1$. We already know the optimal policy when $\gamma = 0.6$. The change from one optimal policy to the other occurs when:

$$9 + \frac{5\gamma}{1-\gamma} = \frac{8}{1-\gamma}, \quad \text{i.e. } 9(1-\gamma) + 5\gamma = 8, \quad \text{so } \gamma = 0.25$$

(vi) When $\gamma = 1$, we maximize the **average** reward, so the optimal policy is: $\pi^*(S_1) = a_2,\ \pi^*(S_2) = a_2$. In this case, the change in optimal policy occurs when

$$-4 + \frac{8\gamma}{1-\gamma} = \frac{5}{1-\gamma}, \quad \text{i.e. } -4(1-\gamma) + 8\gamma = 5, \quad \text{so } \gamma = 0.75$$