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Engineering, Built Environment and IT
Department of Computer Science

COS 314

Tutorial/Practical 7

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Questions

1. Classify the following as either inductive learning or deductive learning. Justify your selection.
   (a) Bruno is a brown dog, every brown dog I have seen barks loudly, all brown dogs bark loudly. (2)
   Sol: inductive ....moves from specific to general
   (b) Humans cannot breathe underwater, you are human, you cannot breathe under water. (2)
   Sol: inductive ....moves from general to specific
   (c) Baby lillie started crawling at 6 months, all observed babies crawl at 6 months, all babies crawl at 6 months. (2)
   Sol: inductive ....moves from specific to general
2. If you are given the task to optimise an artificial neural network using grammatical evolution answer the following questions.
   (a) What would each variable length genotype represent. (2)
   Sol: a complete design of the ANN
   (b) What would the grammar constitute of? (2)
   Sol: components of the ANN, weights, momentum, learning rate
   (c) What would be your fitness function. (2)
   Sol: Output from the ANN
   (d) What type of crossover would not be suitable for GE without modification. (2)
   Sol: 2-point crossover
3. Figure 1 depicts 4 points A,B,C and D linked by trails used by artificial ants.

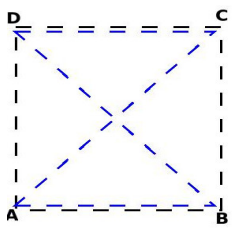

Figure 1:

$$\text{Cost Matrix}= \begin{bmatrix} & A & B & C & D \\ A & 0 & 3 & 4 & 2 \\ B & 3 & 0 & 2 & 3 \\ C & 4 & 2 & 0 & 2 \\ D & 2 & 3 & 2 & 0 \end{bmatrix}$$

$$\text{Pheromone} = \begin{bmatrix} & A & B & C & D \\ A & 0 & 2 & 2 & 2 \\ B & 2 & 0 & 2 & 2 \\ C & 2 & 2 & 0 & 2 \\ D & 2 & 2 & 2 & 0 \end{bmatrix}$$

Given the cost matrix (e.g C_{AB} = A -> B = 3), the pheromone matrix (e.g A -> B = 2), α =1, β =1 and the heuristic $\eta = 1/C_{ij}$ answer the questions that follow

(a) Determine the probabilities an ant at **C** would consider to select the next path. (3)
Sol: P_{CD} = (2*1/2)/(2*1/4 + 2*1/2+ 2*1/2) = 0.4, P_{CB} = (2*1/2)/(2*1/4 + 2*1/2+ 2*1/2) = 0.4, P_{CA} = (2*1/4)/(2*1/4 + 2*1/2 +2*1/2) = 0.2
P_{CD} = 40%, P_{CB} = 40% and P_{CA} = 20%

(b) Determine the most likely path an ant at **D** would choose (3)
Sol: P_{DC} = (2*1/2)/(2*1/2 + 2*1/2 + 2*1/3) = 0.375, P_{DA} = (2*1/2)/(2*1/2 + 2*1/2 + 2*1/3) = 0.375, P_{DB} = (2*1/3)/(2*1/2 + 2*1/2 +2*1/3) = 0.25
P_{DC} = 37.5%, P_{DA} = 37.5% and P_{DB} = 25%

(c) How would you use tournament selection of size 2 to select the path selected by an ant in (b) assuming the probabilities are fitness values. (2)
Sol: Randomly select 2 of the probabilities and select the one with the highest value. If they both have the same probability randomly select one of the two.

4. Given that the neural network depicted in Figure 2 uses backpropagation , the following activation function = $1/(1 + e^{-n})$ and a learning rate of 0.6. Starting with the following values answer the questions that follow.

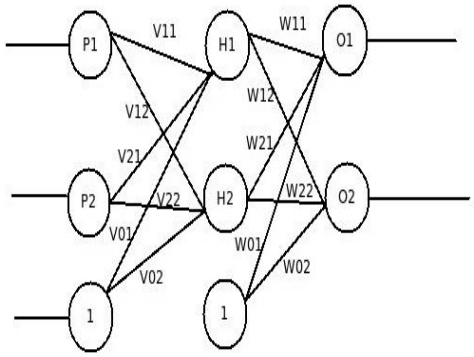

Figure 2:

V_{01} = 0.26,V_{02} = -0.15,V_{11} = 0.3,V_{12} = 0.5, V_{21} = -0.25,V_{22} = 0.5, W_{11} = 0.15,W_{12} = 0.35, W_{21} = -0.05, W_{22} = 0.55, W_{01} = 0.12, W_{02} = 0.13. The desired outputs are t_1 = 0.2 and t_2 = 0.8.

(a) Evaluate the values of H_1, H_2 ,O_1 and O_2in the forward pass for the following inputs (8)
P_1 = 0.68 and P_2 = 0.35 .
Sol:
$H_1 = 1/(1 + e^{-0.377}) = 0.593$ (2),
$H_2 = 1/(1 + e^{-0.365}) = 0.59$ (2)
$O_1 = 1/(1 + e^{-0.179}) = 0.545$ (2)
$O_2 = 1/(1 + e^{-0.366}) = 0.59$ (2)

(b) Calculate δ_1 and δ_2 for the inputs in (a). (2)
Sol:
δ_1 = (0.2 - 0.545)(0.545(1-0.545))= -0.09
δ_2 = (0.8 - 0.59)(0.59(1-0.59))= 0.05

(c) Update weight W_{11} (2)

Sol: ΔW_{11} = 0.6*-0.09*0.593 = 0.042696