21-51-01

Q (a) (i) tree

(ii)

(iii)

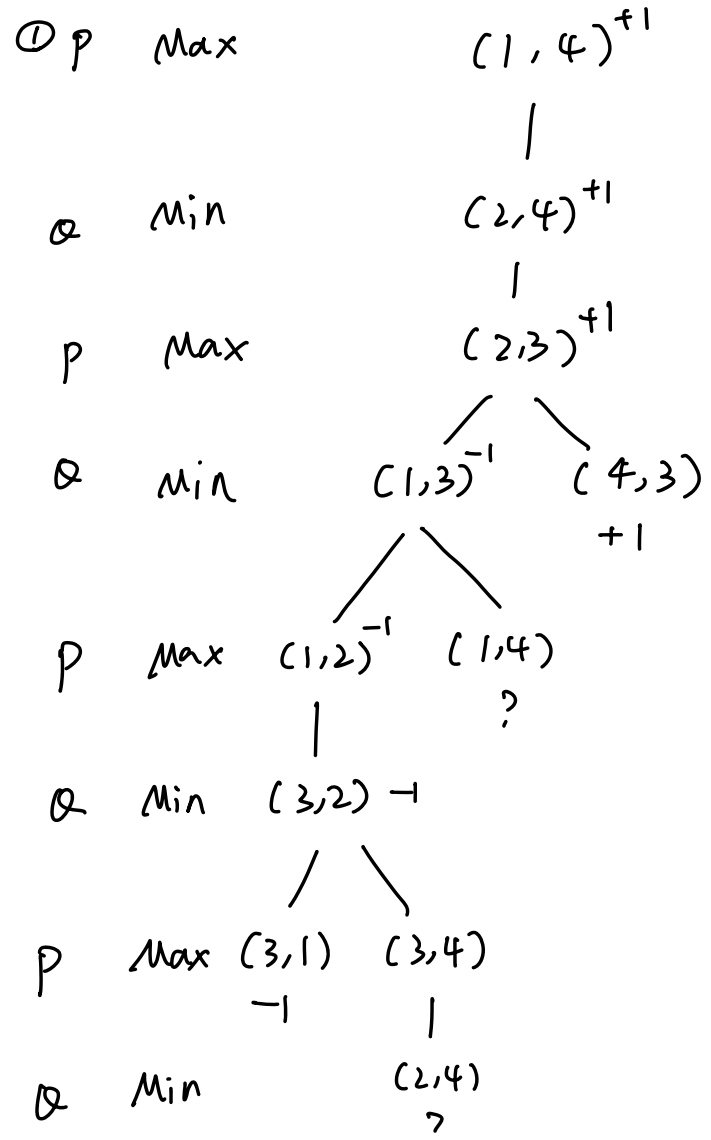
(b) (i)

(ii)

(iii)

(iv)

Solution (a) (i) State space search tree



(ii) Annotate ?

(iii) ① we do not expand "?" which prevents an infinite tree.

② ignore the "?" branch

③ If all children of node are "?" we treated it as value 0 and

propagates upward.

(b) (i) $Info(D) = -\sum_{i=0}^{m} p_i \log_2 p_i$

$= -\frac{4}{9}\log_2\frac{4}{9} - \frac{5}{9}\log_2\frac{5}{9}$

$= 0.9911$

(ii) $Info_A(D) = \sum_{j=1}^{v} \frac{|D_j|}{|D|} \times Info(D_j)$

$= \frac{4}{9} Info(D_{Yes}) + \frac{5}{9} Info(D_{no})$

$= \frac{4}{9} \times \left[-\frac{3}{4}\log_2\frac{3}{4} - \frac{1}{4}\log_2\frac{1}{4}\right] + \frac{5}{9} \times \left[-\frac{1}{5}\log_2\frac{1}{5} - \frac{4}{5}\log_2\frac{4}{5}\right]$

$= 0.7616$

$Gain(A) = Info(D) - Info_A(D) = 0.1456$

$Info_B(D) = \frac{5}{9} Info(D_{Yes}) + \frac{4}{9} Info(D_{no})$

$= \frac{5}{9}\left[-\frac{2}{5}\log_2\frac{2}{5} - \frac{3}{5}\log_2\frac{3}{5}\right] + \frac{4}{9} \times \left[-\frac{2}{4}\log_2\frac{2}{4} - \frac{2}{4}\log_2\frac{2}{4}\right]$

$= \frac{5}{9} \times 0.9710 + \frac{4}{9}$

$= 0.9839$

$Gain(B) = 0.9911 - 0.9839 = 0.0072$

(iii) ① $Gini(D) = 1 - \sum_{i=1}^{2} p_i^2$

$= 1 - (\frac{4}{9})^2 - (\frac{5}{9})^2$

$= 0.4938$

② $Gini_A(D) = \frac{|D_1|}{|D|} Gini(D_1) + \frac{|D_2|}{|D|} Gini(D_2)$

$= \frac{4}{9} Gini(D_{yes}) + \frac{5}{9} Gini(D_{no})$

$= \frac{4}{9}[1 - (\frac{3}{4})^2 - (\frac{1}{4})^2] + \frac{5}{9} \times [1 - (\frac{1}{5})^2 - (\frac{4}{5})^2]$

$= \frac{4}{9} \times \frac{3}{8} + \frac{5}{9} \times \frac{8}{25}$

$= \frac{1}{6} + \frac{8}{45}$

$= 0.3444$

③ $\Delta Gini(A) = Gini(D) - Gini_A(D)$

$= 0.1494$

④ $Gini_B(D) = \frac{|D_1|}{|D|} Gini(D_1) + \frac{|D_2|}{|D|} Gini(D_2)$

$= \frac{5}{9} Gini(D_{yes}) + \frac{4}{9} Gini(D_{no})$

$= \frac{5}{9} \times [1 - (\frac{2}{5})^2 - (\frac{3}{5})^2] + \frac{4}{9} \times [1 - (\frac{1}{2})^2 - (\frac{1}{2})^2]$

$= \frac{5}{9} \times 0.48 + \frac{4}{9} \times 0.5$

$= 0.4889$

⑤ $\Delta Gini(B) = Gini(D) - Gini_B(D)$

$= 0.0049$

(iii) ID3 selects the attribute with the highest information gain.

$$Gain(A) > Gain(B)$$

attribute A is chosen for the root node.