

$$\text{Info}(D) = I(8,4) = -\frac{8}{12} \log_2 \left(\frac{8}{12} \right) - \frac{4}{12} \log_2 \left(\frac{4}{12} \right) = 0.9183$$

$$\text{Info}_{\text{Age}}(D) = \frac{4}{12} I(2,2) + \frac{3}{12} I(3,0) + \frac{5}{12} I(3,2)$$

$$I(2,2) = -\frac{2}{4} \log_2 \left(\frac{2}{4} \right) - \frac{2}{4} \log_2 \left(\frac{2}{4} \right) = 1$$

$$I(3,0) = -\frac{3}{3} \log_2 \left(\frac{3}{3} \right) = 0$$

$$I(3,2) = -\frac{3}{5} \log_2 \left(\frac{3}{5} \right) - \frac{2}{5} \log_2 \left(\frac{2}{5} \right) = 0.9710$$

$$\text{Info}_{\text{Age}}(D) = \frac{4}{12} (1) + \frac{3}{12} (0) + \frac{5}{12} (0.9710) = 0.5761$$

$$\text{Gain}(\text{Age}) = \text{Info}(D) - \text{Info}_{\text{Age}}(D) = 0.9183 - 0.5761 = 0.3422$$

$$\text{Info}_{\text{Income}}(D) = \frac{4}{12} I(2,2) + \frac{5}{12} I(4,1) + \frac{3}{12} I(2,1)$$

$$= \frac{4}{12} (1) + \frac{5}{12} (0.7219) + \frac{3}{12} (0.9183)$$

$$= 0.8697$$

$$\text{Gain}(\text{Income}) = \text{Info}(D) - \text{Info}_{\text{Income}}(D) = 0.9183 - 0.8697 = 0.0486$$

$$\text{Info}_{\text{Student}}(D) = \frac{6}{12} I(5,1) + \frac{6}{12} I(3,3)$$

$$I(5,1) = -\frac{5}{6} \log_2 \left(\frac{5}{6} \right) - \frac{1}{6} \log_2 \left(\frac{1}{6} \right) = 0.65$$

$$I(3,3) = -\frac{3}{6} \log_2 \left(\frac{3}{6} \right) - \frac{3}{6} \log_2 \left(\frac{3}{6} \right) = 1$$

$$\text{Info}_{\text{Student}}(D) = \frac{6}{12} (0.65) + \frac{6}{12} (1)$$

$$= 0.825$$

$$\text{Gain}(\text{Student}) = \text{Info}(D) - \text{Info}_{\text{Student}}(D)$$

$$= 0.9183 - 0.825$$

$$= 0.0933$$

$$\text{Info}_{\text{Credit Rating}}(D) = \frac{7}{12} I(6,1) + \frac{5}{12} I(2,3)$$

$$I(6,1) = -\frac{6}{7} \log_2 \left(\frac{6}{7} \right) - \frac{1}{7} \log_2 \left(\frac{1}{7} \right) = 0.5917$$

$$I(2,3) = -\frac{2}{5} \log_2 \left(\frac{2}{5} \right) - \frac{3}{5} \log_2 \left(\frac{3}{5} \right) = 0.9710$$

$$\text{Info}_{\text{Credit Rating}}(D) = \frac{7}{12} (0.5917) + \frac{5}{12} (0.9710)$$

$$= 0.7497$$

$$\text{Gain}(\text{Credit rating}) = \text{Info}(D) - \text{Info}_{\text{Credit rating}}(D)$$

$$= 0.9183 - 0.7497$$

$$= 0.1686$$

Info Gain (Age)

$$\text{Info}(D, \leq 30) = I(2,2) = -\frac{2}{4} \log_2 \left(\frac{2}{4} \right) - \frac{2}{4} \log_2 \left(\frac{2}{4} \right) = 1$$

$$I(0,2) = -\frac{0}{2} \log_2 \left(\frac{0}{2} \right) - \frac{2}{2} \log_2 \left(\frac{2}{2} \right) = 0$$

$$I(1,1) = -\frac{1}{1} \log_2 \left(\frac{1}{1} \right) - \frac{0}{1} \log_2 \left(\frac{0}{1} \right) = 0$$

$$\text{Info}_{\text{Income}}(D, \leq 30) = \frac{2}{4} I(0,2) + \frac{1}{4} I(1,0) + \frac{1}{4} I(1,1) = \frac{2}{4} (0) + \frac{1}{4} (0) + \frac{1}{4} (0) = 0$$

$$\text{Gain}(\text{Income}) = \text{Info}(D, \leq 30) - \text{Info}_{\text{Income}}(D, \leq 30) = 1 - 0 = 1$$

$$\text{Info}_{\text{Student}}(D, \leq 30) = \frac{2}{4} I(2,1) + \frac{2}{4} I(0,2) = \frac{2}{4} (1) + \frac{2}{4} (0) = 0$$

$$\text{Gain}(\text{Student}) = \text{Info}(D, \leq 30) - \text{Info}_{\text{Student}}(D, \leq 30) = 1 - 0 = 1$$

$$\text{Info}_{\text{Credit rating}} = \frac{2}{4} I(1,1) + \frac{2}{4} I(1,1) = \frac{2}{4} + \frac{2}{4} = 1$$

$$\text{Gain}(\text{Credit rating}) = \text{Info}(D, \leq 30) - \text{Info}_{\text{Credit rating}}(D, \leq 30) = 1 - 1 = 0$$

$$\text{Info}(D, > 40) = I(3,2) = -\frac{3}{5} \log_2 \left(\frac{3}{5} \right) - \frac{2}{5} \log_2 \left(\frac{2}{5} \right)$$

$$= 0.971$$

$$\text{Info}_{\text{Income}}(D, > 40) = \frac{3}{5} I(2,1) + \frac{2}{5} I(1,1)$$

$$= \frac{3}{5} (0.971) + \frac{2}{5} (1) = 0.9826$$

$$\text{Gain}(\text{Income}) = \text{Info}(D, > 40) - \text{Info}_{\text{Income}}(D, > 40)$$

$$= 0.971 - 0.9183 = 0.0527$$

$$\text{Info}_{\text{Student}}(D, > 40) = \frac{3}{5} I(2,1) + \frac{2}{5} I(1,1)$$

$$= \frac{3}{5} (0.971) + \frac{2}{5} (1)$$

$$= 0.982$$

$$\text{Gain}(\text{Student}) = \text{Info}(D, > 40) - \text{Info}_{\text{Student}}(D, > 40)$$

$$= 0.971 - 0.9183$$

$$= 0.0527$$

$$\text{Info}_{\text{Credit rating}}(D, > 40) = \frac{3}{5} I(3,0) + \frac{2}{5} I(0,2)$$

$$= \frac{3}{5} (0) + \frac{2}{5} (0) = 0$$

$$\text{Gain}(\text{Credit rating}) = \text{Info}(D, > 40) - \text{Info}_{\text{Credit rating}}(D, > 40) = 0.971 - 0 = 0.971$$

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