

Day	Outlook	Temp	Humidity	Wind	Play Tennis
D1	Sunny	Hot	High	Weak	No
D2	Sunny	Hot	High	Strong	No
D3	Overcast	Hot	High	Weak	Yes
D4	Rain	Mild	High	Weak	Yes
D5	Rain	Cool	Normal	Weak	Yes
D6	Rain	Cool	Normal	Strong	No
D7	Overcast	Cool	Normal	Strong	Yes
D8	Sunny	Mild	High	Weak	No
D9	Sunny	Cool	Normal	Weak	Yes
D10	Rain	Mild	Normal	Weak	Yes
D11	Sunny	Mild	Normal	Strong	Yes
D12	Overcast	Mild	High	Strong	Yes
D13	Overcast	Hot	Normal	Weak	Yes
D14	Rain	Mild	High	Strong	No

Attribute: Outlook

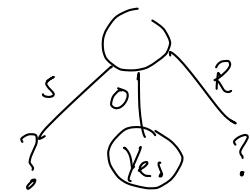
Values (Outlook) = Sunny, Overcast, Rain

$$\begin{aligned} S &= [9+, 5-] \\ S_{\text{Sunny}} &\leftarrow [2+, 3-] \\ S_{\text{Overcast}} &\leftarrow [4+, 0-] \\ S_{\text{Rain}} &\leftarrow [3+, 2-] \end{aligned}$$

$$\begin{aligned} \text{Entropy}(S) &= -\frac{9}{14} \log_2 \frac{9}{14} - \frac{5}{14} \log_2 \frac{5}{14} = 0.94 \\ \text{Entropy}(S_{\text{Sunny}}) &= -\frac{2}{5} \log_2 \frac{2}{5} - \frac{3}{5} \log_2 \frac{3}{5} = 0.971 \\ \text{Entropy}(S_{\text{Overcast}}) &= -\frac{4}{4} \log_2 \frac{4}{4} - \frac{0}{4} \log_2 \frac{0}{4} = 0 \\ \text{Entropy}(S_{\text{Rain}}) &= -\frac{3}{5} \log_2 \frac{3}{5} - \frac{2}{5} \log_2 \frac{2}{5} = 0.971 \checkmark \end{aligned}$$

$\text{Gain}(S, \text{Outlook}) = \text{Entropy}(S) - \sum_{v \in \{\text{Sunny, Overcast, Rain}\}} \frac{|S_v|}{|S|} \text{Entropy}(S_v)$

$$\begin{aligned} \text{Gain}(S, \text{Outlook}) &= \text{Entropy}(S) - \frac{5}{14} \text{Entropy}(S_{\text{Sunny}}) - \frac{4}{14} \text{Entropy}(S_{\text{Overcast}}) \\ &\quad - \frac{5}{14} \text{Entropy}(S_{\text{Rain}}) \\ \text{Gain}(S, \text{Outlook}) &= 0.94 - \frac{5}{14} 0.971 - \frac{4}{14} 0 - \frac{5}{14} 0.971 = 0.2464 \end{aligned}$$



Day	Outlook	Temp	Humidity	Wind	Play Tennis
D1	Sunny	Hot	High	Weak	No
D2	Sunny	Hot	High	Strong	No
D3	Overcast	Hot	High	Weak	Yes
D4	Rain	Mild	High	Weak	Yes
D5	Rain	Cool	Normal	Weak	Yes
D6	Rain	Cool	Normal	Strong	No
D7	Overcast	Cool	Normal	Strong	Yes
D8	Sunny	Mild	High	Weak	No
D9	Sunny	Cool	Normal	Weak	Yes
D10	Rain	Mild	Normal	Weak	Yes
D11	Sunny	Mild	Normal	Strong	Yes
D12	Overcast	Mild	High	Strong	Yes
D13	Overcast	Hot	Normal	Weak	Yes
D14	Rain	Mild	High	Strong	No

Attribute: Temp

Values (Temp) = Hot, Mild, Cool

$$\begin{aligned} S &= [9+, 5-] \\ S_{\text{Hot}} &\leftarrow [2+, 2-] \\ S_{\text{Mild}} &\leftarrow [4+, 2-] \\ S_{\text{Cool}} &\leftarrow [3+, 1-] \end{aligned}$$

$$\begin{aligned} \text{Gain}(S, \text{Temp}) &= \text{Entropy}(S) - \sum_{v \in \{\text{Hot, Mild, Cool}\}} \frac{|S_v|}{|S|} \text{Entropy}(S_v) \\ \text{Gain}(S, \text{Temp}) &= \text{Entropy}(S) - \frac{4}{14} \text{Entropy}(S_{\text{Hot}}) - \frac{6}{14} \text{Entropy}(S_{\text{Mild}}) \\ &\quad - \frac{4}{14} \text{Entropy}(S_{\text{Cool}}) = 0.9183 \end{aligned}$$

$$= 0.0289$$

Attribute: Humidity

Values (Humidity) = High, Normal

$$\begin{aligned} S &= [9+, 5-] & \text{Entropy}(S) &= -\frac{9}{14} \log_2 \frac{9}{14} - \frac{5}{14} \log_2 \frac{5}{14} = 0.94 \\ S_{\text{High}} &\leftarrow [3+, 4-] & \text{Entropy}(S_{\text{High}}) &= -\frac{3}{7} \log_2 \frac{3}{7} - \frac{4}{7} \log_2 \frac{4}{7} = 0.9852 \\ S_{\text{Normal}} &\leftarrow [6+, 1-] & \text{Entropy}(S_{\text{Normal}}) &= -\frac{6}{7} \log_2 \frac{6}{7} - \frac{1}{7} \log_2 \frac{1}{7} = 0.5916 \end{aligned}$$

$$\text{Gain}(S, \text{Humidity}) = \text{Entropy}(S) - \sum_{v \in \{\text{High, Normal}\}} \frac{|S_v|}{|S|} \text{Entropy}(S_v)$$

Gain(S, Humidity)

$$\begin{aligned} &= \text{Entropy}(S) - \frac{7}{14} \text{Entropy}(S_{\text{High}}) - \frac{7}{14} \text{Entropy}(S_{\text{Normal}}) \\ &= 0.1516 \end{aligned}$$

Attribute: Wind

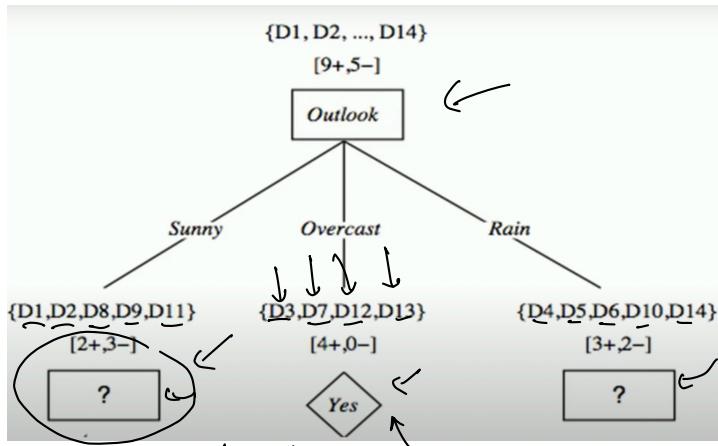
Values (Wind) = Strong, Weak

$$\begin{aligned} S &= [9+, 5-] & \text{Entropy}(S) &= -\frac{9}{14} \log_2 \frac{9}{14} - \frac{5}{14} \log_2 \frac{5}{14} = 0.94 \\ S_{\text{Strong}} &\leftarrow [3+, 3-] & \text{Entropy}(S_{\text{Strong}}) &= 1.0 \\ S_{\text{Weak}} &\leftarrow [6+, 2-] & \text{Entropy}(S_{\text{Weak}}) &= -\frac{6}{8} \log_2 \frac{6}{8} - \frac{2}{8} \log_2 \frac{2}{8} = 0.8113 \end{aligned}$$

$$\text{Gain}(S, \text{Wind}) = \text{Entropy}(S) - \sum_{v \in \{\text{Strong, Weak}\}} \frac{|S_v|}{|S|} \text{Entropy}(S_v)$$

$$\text{Gain}(S, \text{Wind}) = \text{Entropy}(S) - \frac{6}{14} \text{Entropy}(S_{\text{Strong}}) - \frac{8}{14} \text{Entropy}(S_{\text{Weak}})$$

$$= 0.0478$$



Day	Temp	Humidity	Wind	Play Tennis
D1	Hot	High	Weak	No
D2	Hot	High	Strong	No
D8	Mild	High	Weak	No
D9	Cool	Normal	Weak	Yes
D11	Mild	Normal	Strong	Yes

Attribute: Temp

Values (Temp) = Hot, Mild, Cool

$$S_{Sunny} = [2+, 3-] \quad Entropy(S_{Sunny}) = -\frac{2}{5} \log_2 \frac{2}{5} - \frac{3}{5} \log_2 \frac{3}{5} = 0.97$$

$$S_{Hot} \leftarrow [0+, 2-] \quad Entropy(S_{Hot}) = 0.0$$

$$S_{Mild} \leftarrow [1+, 1-] \quad Entropy(S_{Mild}) = 1.0$$

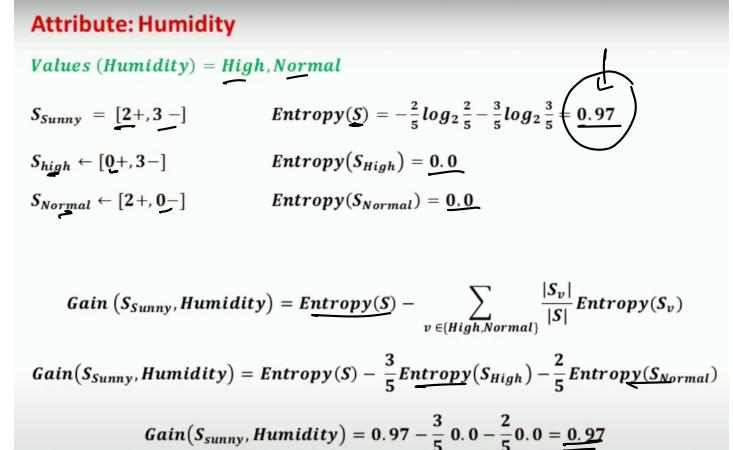
$$S_{Cool} \leftarrow [1+, 0-] \quad Entropy(S_{Cool}) = 0.0$$

$$Gain(S_{Sunny}, Temp) = Entropy(S) - \sum_{v \in \{Hot, Mild, Cool\}} \frac{|S_v|}{|S|} Entropy(S_v)$$

Gain(S_{Sunny}, Temp)

$$= Entropy(S) - \frac{2}{5} Entropy(S_{Hot}) - \frac{2}{5} Entropy(S_{Mild}) \\ - \frac{1}{5} Entropy(S_{Cool})$$

$$Gain(S_{Sunny}, Temp) = 0.97 - \frac{2}{5} 0.0 - \frac{2}{5} 1 - \frac{1}{5} 0.0 = 0.570$$



Attribute: Wind

Values (Wind) = Strong, Weak

$$S_{Sunny} = [2+, 3-] \quad Entropy(S) = -\frac{2}{5} \log_2 \frac{2}{5} - \frac{3}{5} \log_2 \frac{3}{5} = 0.97$$

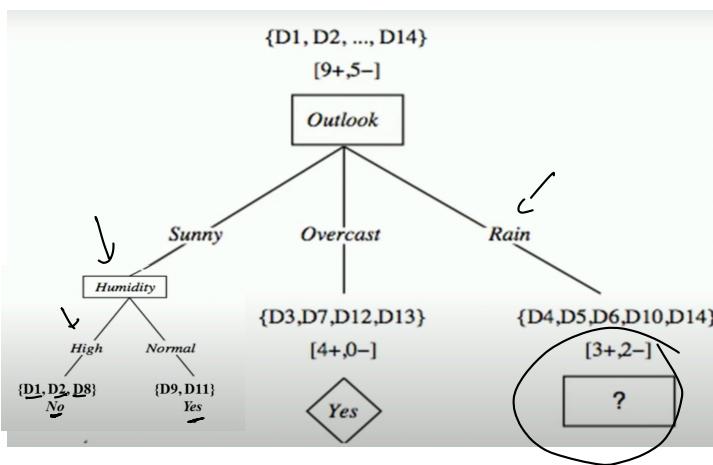
$$S_{Strong} \leftarrow [1+, 1-] \quad Entropy(S_{Strong}) = 1.0$$

$$S_{Weak} \leftarrow [1+, 2-] \quad Entropy(S_{Weak}) = -\frac{1}{3} \log_2 \frac{1}{3} - \frac{2}{3} \log_2 \frac{2}{3} = 0.9183$$

$$Gain(S_{Sunny}, Wind) = Entropy(S) - \sum_{v \in \{Strong, Weak\}} \frac{|S_v|}{|S|} Entropy(S_v)$$

$$Gain(S_{Sunny}, Wind) = Entropy(S) - \frac{2}{5} Entropy(S_{Strong}) - \frac{3}{5} Entropy(S_{Weak})$$

$$Gain(S_{Sunny}, Wind) = 0.97 - \frac{2}{5} 1.0 - \frac{3}{5} 0.918 = 0.0192$$



Day	Temp	Humidity	Wind	Play Tennis
D4	Mild	High	Weak	Yes ✓
D5	Cool	Normal	Weak	Yes ✓
D6	Cool	Normal	Strong	No ✓
D10	Mild	Normal	Weak	Yes ✓
D14	Mild	High	Strong	No ✓

Attribute: Temp

Values (Temp) = Hot, Mild, Cool

$$S_{Rain} = [3+, 2-]$$

$$\text{Entropy}(S_{Sunny}) = -\frac{3}{5} \log_2 \frac{3}{5} - \frac{2}{5} \log_2 \frac{2}{5} = 0.97$$

$$S_{Hot} \leftarrow [0+, 0-]$$

$$\text{Entropy}(S_{Hot}) = 0.0$$

$$S_{Mild} \leftarrow [2+, 1-]$$

$$\text{Entropy}(S_{Mild}) = -\frac{2}{3} \log_2 \frac{2}{3} - \frac{1}{3} \log_2 \frac{1}{3} = 0.9183$$

$$S_{Cool} \leftarrow [1+, 1-]$$

$$\text{Entropy}(S_{Cool}) = 1.0$$

$$\text{Gain}(S_{Rain}, \text{Temp}) = \text{Entropy}(S) - \sum_{v \in \{\text{Hot, Mild, Cool}\}} \frac{|S_v|}{|S|} \text{Entropy}(S_v)$$

$$\text{Gain}(S_{Rain}, \text{Temp})$$

$$= \text{Entropy}(S) - \frac{0}{5} \text{Entropy}(S_{Hot}) - \frac{3}{5} \text{Entropy}(S_{Mild})$$

$$- \frac{2}{5} \text{Entropy}(S_{Cool})$$

$$\text{Gain}(S_{Rain}, \text{Temp}) = 0.97 - \frac{0}{5} 0.0 - \frac{3}{5} 0.918 - \frac{2}{5} 1.0 = 0.0192$$

Attribute: Humidity

Values (Humidity) = High, Normal

$$S_{Rain} = [3+, 2-]$$

$$\text{Entropy}(S_{Sunny}) = -\frac{3}{5} \log_2 \frac{3}{5} - \frac{2}{5} \log_2 \frac{2}{5} = 0.97$$

$$S_{High} \leftarrow [1+, 1-]$$

$$\text{Entropy}(S_{High}) = 1.0$$

$$S_{Normal} \leftarrow [2+, 1-]$$

$$\text{Entropy}(S_{Normal}) = -\frac{2}{3} \log_2 \frac{2}{3} - \frac{1}{3} \log_2 \frac{1}{3} = 0.9183$$

$$\text{Gain}(S_{Rain}, \text{Humidity}) = \text{Entropy}(S) - \sum_{v \in \{\text{High, Normal}\}} \frac{|S_v|}{|S|} \text{Entropy}(S_v)$$

$$\text{Gain}(S_{Rain}, \text{Humidity}) = \text{Entropy}(S) - \frac{2}{5} \text{Entropy}(S_{High}) - \frac{3}{5} \text{Entropy}(S_{Normal})$$

$$\text{Gain}(S_{Rain}, \text{Humidity}) = 0.97 - \frac{2}{5} 1.0 - \frac{3}{5} 0.918 = 0.0192$$

Attribute: Wind

Values (wind) = Strong, Weak

$$S_{Rain} = [3+, 2-]$$

$$\text{Entropy}(S_{Sunny}) = -\frac{3}{5} \log_2 \frac{3}{5} - \frac{2}{5} \log_2 \frac{2}{5} = 0.97$$

$$S_{Strong} \leftarrow [0+, 2-]$$

$$\text{Entropy}(S_{Strong}) = 0.0$$

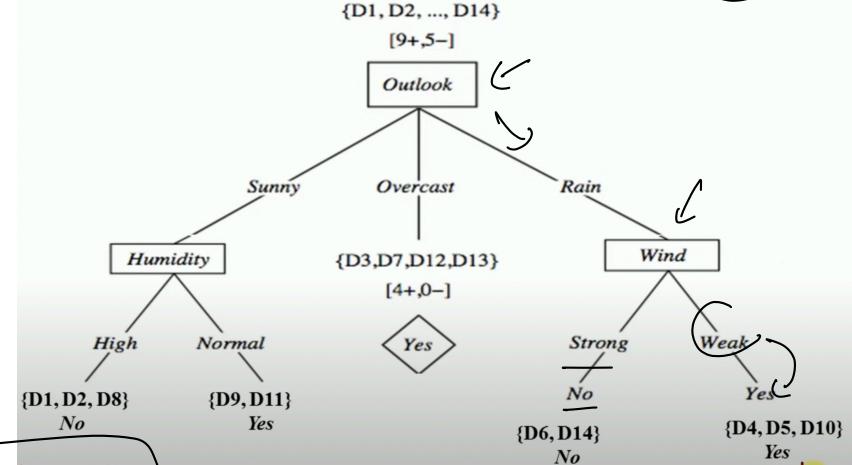
$$S_{Weak} \leftarrow [3+, 0-]$$

$$\text{Entropy}(S_{Weak}) = 0.0$$

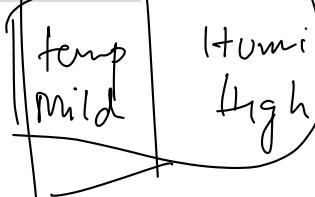
$$\text{Gain}(S_{Rain}, \text{Wind}) = \text{Entropy}(S) - \sum_{v \in \{\text{Strong, Weak}\}} \frac{|S_v|}{|S|} \text{Entropy}(S_v)$$

$$\text{Gain}(S_{Rain}, \text{Wind}) = \text{Entropy}(S) - \frac{2}{5} \text{Entropy}(S_{Strong}) - \frac{3}{5} \text{Entropy}(S_{Weak})$$

$$\text{Gain}(S_{Rain}, \text{Wind}) = 0.97 - \frac{2}{5} 0.0 - \frac{3}{5} 0.0 = 0.97$$



Outlook
Rain



temp
Mild
Humidity
High
wind
weak