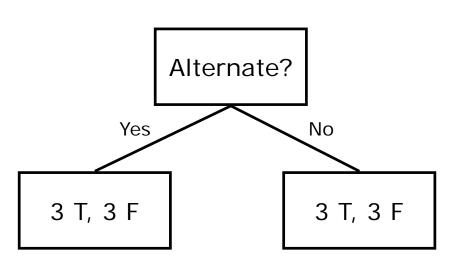
Example					At	tributes	3				Target
	Alt	Bar	Fri	Hun	Pat	Price	Rain	Res	Type	Est	WillWait
X_1	T	F	F	T	Some	\$\$\$	F	T	French	0–10	Т
X_2	T	F	F	Τ	Full	\$	F	F	Thai	30–60	F
X_3	F	T	F	F	Some	\$	F	F	Burger	0–10	Τ
X_4	T	F	T	Τ	Full	\$	F	F	Thai	10–30	Τ
X_5	T	F	T	F	Full	\$\$\$	F	T	French	>60	F
X_6	F	T	F	Τ	Some	<i>\$\$</i>	Τ	T	Italian	0–10	Τ
X_7	F	T	F	F	None	\$	Τ	F	Burger	0–10	F
X_8	F	F	F	Τ	Some	<i>\$\$</i>	T	Τ	Thai	0–10	Τ
X_9	F	T	T	F	Full	\$	Τ	F	Burger	>60	F
X_{10}	T	T	T	Τ	Full	\$\$\$	F	Τ	Italian	10–30	F
X_{11}	F	F	F	F	None	\$	F	F	Thai	0–10	F
X_{12}	T	T	T	T	Full	\$	F	F	Burger	30–60	T

T = True, F = False
Entropy =
$$-\binom{6}{12}\log_2\binom{6}{12} - \binom{6}{12}\log_2\binom{6}{12} = 1$$

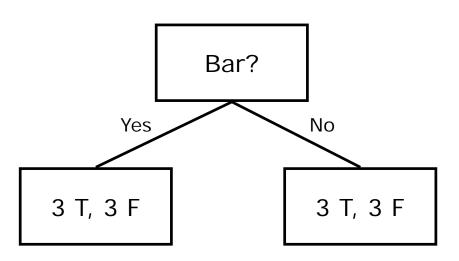
6 True, 6 False



Example					At	tributes	3				Target
1	Alt	Bar	Fri	Hun	Pat	Price	Rain	Res	Type	Est	WillWait
X_1	T	F	F	T	Some	\$\$\$	F	T	French	0–10	T
X_2	T	F	F	T	Full	\$	F	F	Thai	30–60	F
X_3	F	Τ	F	F	Some	\$	F	F	Burger	0–10	T
X_4	T	F	T	T	Full	\$	F	F	Thai	10–30	T
X_5	T	F	T	F	Full	\$\$\$	F	T	French	>60	F
X_6	F	Τ	F	T	Some	\$\$	T	T	Italian	0–10	T
X_7	F	Τ	F	F	None	\$	T	F	Burger	0–10	F
X_8	F	F	F	Τ	Some	\$\$	T	T	Thai	0–10	Τ
X_9	F	Τ	T	F	Full	\$	T	F	Burger	>60	F
X_{10}	T	Τ	T	T	Full	\$\$\$	F	T	Italian	10–30	F
X_{11}	F	F	F	F	None	\$	F	F	Thai	0–10	F
X_{12}	T	Τ	T	T	Full	\$	F	F	Burger	30–60	T

Remainder(Alternate) =
$$\frac{6}{12} \left[-\binom{3}{6} \log_2 \binom{3}{6} - \binom{3}{6} \log_2 \binom{3}{6} \right] + \frac{6}{12} \left[-\binom{3}{6} \log_2 \binom{3}{6} - \binom{3}{6} \log_2 \binom{3}{6} \right] = 1$$

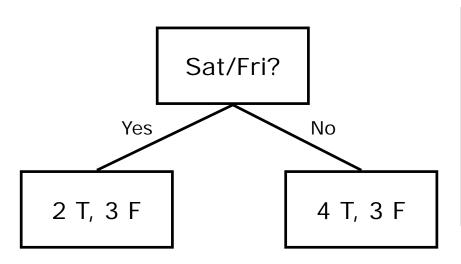
Gain(Alternate) = 1 - 1 = 0



Example					At	tributes	3				Target
	Alt	Bar	Fri	Hun	Pat	Price	Rain	Res	Type	Est	WillWait
X_1	T	F	F	Τ	Some	\$\$\$	F	T	French	0–10	Т
X_2	Τ	F	F	Τ	Full	\$	F	F	Thai	30–60	F
X_3	F	Τ	F	F	Some	\$	F	F	Burger	0–10	T
X_4	T	F	Τ	Τ	Full	\$	F	F	Thai	10-30	T
X_5	Τ	F	Τ	F	Full	\$\$\$	F	T	French	>60	F
X_6	F	Т	F	T	Some	\$\$	T	T	Italian	0-10	T
X_7	F	T	F	F	None	\$	T	F	Burger	0–10	F
X_8	F	F	F	T	Some	\$\$	T	T	Thai	0–10	T
X_9	F	T	Τ	F	Full	\$	T	F	Burger	>60	F
X_{10}	T	T	Τ	T	Full	\$\$\$	F	T	Italian	10–30	F
X_{11}	F	F	F	F	None	\$	F	F	Thai	0–10	F
X_{12}	T	Т	Τ	T	Full	\$	F	F	Burger	30–60	T

Remainder(bar) =
$$\frac{6}{12} \left[-\frac{3}{6} \log_2 \left(\frac{3}{6} \right) - \left(\frac{3}{6} \right) \log_2 \left(\frac{3}{6} \right) \right] + \frac{6}{12} \left[-\frac{3}{6} \log_2 \left(\frac{3}{6} \right) - \left(\frac{3}{6} \right) \log_2 \left(\frac{3}{6} \right) \right] = 1$$

Gain(Bar) = 1 - 1 = 0

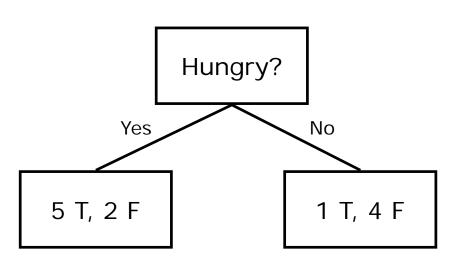


Example					At	tributes	3				Target
Litearipre	Alt	Bar	Fri	Hun	Pat	Price	Rain	Res	Type	Est	WillWait
X_1	T	F	F	T	Some	\$\$\$	F	T	French	0–10	T
X_2	T	F	F	Τ	Full	\$	F	F	Thai	30–60	F
X_3	F	Τ	F	F	Some	\$	F	F	Burger	0–10	T
X_4	T	F	T	Τ	Full	\$	F	F	Thai	10-30	T
X_5	T	F	T	F	Full	\$\$\$	F	T	French	>60	F
X_6	F	Τ	F	Τ	Some	\$\$	Τ	T	Italian	0–10	T
X_7	F	Τ	F	F	None	\$	Τ	F	Burger	0–10	F
X_8	F	F	F	Τ	Some	\$\$	Τ	T	Thai	0–10	T
X_9	F	T	T	F	Full	\$	T	F	Burger	>60	F
X_{10}	T	T	T	T	Full	\$\$\$	F	T	ltalian	10-30	F
X_{11}	F	F	F	F	None	\$	F	F	Thai	0–10	F
X_{12}	T	T	T	Τ	Full	\$	F	F	Burger	30–60	T

Remainder(Sat / Fri) =
$$\frac{5}{12} \left[-\binom{2}{5} \log_2 \binom{2}{5} - \binom{3}{5} \log_2 \binom{3}{5} \right]$$

+ $\frac{7}{12} \left[-\binom{4}{7} \log_2 \binom{4}{7} - \binom{3}{7} \log_2 \binom{3}{7} \right] = 0.9793$

Gain(Sat/Fri) = 1 - 0.9793 = 0.0207

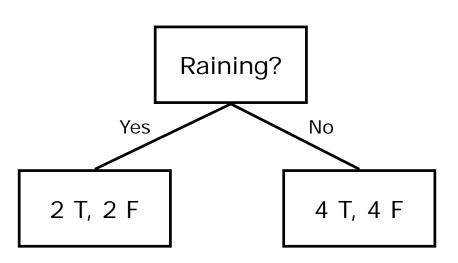


Example					At	tributes	3				Target
Larrest Ipre	Alt	Bar	Fri	Hun	Pat	Price	Rain	Res	Type	Est	WillWait
X_1	T	F	F	T	Some	\$\$\$	F	T	French	0–10	T
X_2	T	F	F	T	Full	\$	F	F	Thai	30–60	F
X_3	F	Τ	F	F	Some	\$	F	F	Burger	0–10	T
X_4	T	F	T	T	Full	\$	F	F	Thai	10-30	T
X_5	Τ	F	Т	F	Full	\$\$\$	F	T	French	>60	F
X_6	F	Т	F	T	Some	\$\$	T	T	Italian	0–10	T
X_7	F	T	F	F	None	\$	T	F	Burger	0–10	F
X_8	F	F	F	T	Some	\$\$	T	T	Thai	0–10	T
X_9	F	T	T	F	Full	\$	T	F	Burger	>60	F
X_{10}	T	T	T	T	Full	\$\$\$	F	T	Italian	10-30	F
X_{11}	F	F	F	F	None	\$	F	F	Thai	0–10	F
X_{12}	T	T	T	T	Full	\$	F	F	Burger	30–60	T

Remainder(Hungry) =
$$\frac{7}{12} \left[-\binom{5}{7} \log_2 \binom{5}{7} - \binom{2}{7} \log_2 \binom{2}{7} \right]$$

 $+ \frac{5}{12} \left[-\binom{1}{5} \log_2 \binom{1}{5} - \binom{4}{5} \log_2 \binom{4}{5} \right] = 0.8043$

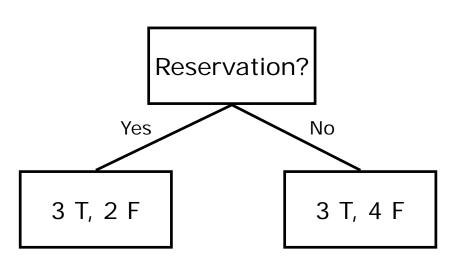
Gain(Hungry) = 1 - 0.8043 = 0.1957



Example					At	tributes	8				Target
1	Alt	Bar	Fri	Hun	Pat	Price	Rain	Res	Type	Est	WillWait
X_1	Τ	F	F	Τ	Some	\$\$\$	F	Τ	French	0–10	T
X_2	Τ	F	F	Τ	Full	\$	F	F	Thai	30–60	F
X_3	F	T	F	F	Some	\$	F	F	Burger	0–10	T
X_4	T	F	T	Τ	Full	\$	F	F	Thai	10-30	T
X_5	Τ	F	T	F	Full	\$\$\$	F	Τ	French	>60	F
X_6	F	T	F	T	Some	\$\$	T	Τ	Italian	0–10	T
X_7	F	T	F	F	None	\$	T	F	Burger	0–10	F
X_8	F	F	F	T	Some	<i>\$\$</i>	T	Τ	Thai	0–10	T
X_9	F	T	T	F	Full	\$	T	F	Burger	>60	F
X_{10}	T	Τ	Τ	Τ	Full	\$\$\$	F	Τ	ltalian	10–30	F
X_{11}	F	F	F	F	None	\$	F	F	Thai	0–10	F
X_{12}	Τ	T	T	T	Full	\$	F	F	Burger	30–60	T

Remainder(Raining) =
$$\frac{4}{12} \left[-\frac{2}{4} \log_2 \left(\frac{2}{4} \right) - \frac{2}{4} \log_2 \left(\frac{2}{4} \right) \right] + \frac{8}{12} \left[-\frac{4}{8} \log_2 \left(\frac{4}{8} \right) - \frac{4}{8} \log_2 \left(\frac{4}{8} \right) \right] = 1$$

Gain(Raining) = 1 - 1 = 0

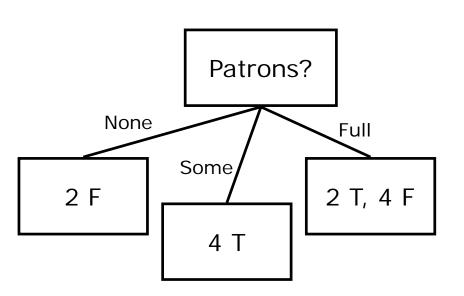


Example					At	tributes	3				Target
Linteditiple	Alt	Bar	Fri	Hun	Pat	Price	Rain	Res	Type	Est	WillWait
X_1	T	F	F	T	Some	\$\$\$	F	T	French	0–10	T
X_2	T	F	F	Τ	Full	\$	F	F	Thai	30–60	F
X_3	F	T	F	F	Some	\$	F	F	Burger	0–10	T
X_4	T	F	Τ	Τ	Full	\$	F	F	Thai	10-30	T
X_5	T	F	T	F	Full	\$\$\$	F	Τ	French	>60	F
X_6	F	T	F	T	Some	\$\$	T	Т	Italian	0–10	T
X_7	F	T	F	F	None	\$	T	F	Burger	0–10	F
X_8	F	F	F	T	Some	\$\$	T	Τ	Thai	0–10	T
X_9	F	Τ	Τ	F	Full	\$	T	F	Burger	>60	F
X_{10}	T	T	T	T	Full	\$\$\$	F	T	ltalian	10–30	F
X_{11}	F	F	F	F	None	\$	F	F	Thai	0–10	F
X_{12}	T	T	T	T	Full	\$	F	F	Burger	30–60	T

Remainder(Re servation) =
$$\frac{5}{12} \left[-\binom{3}{5} \log_2 \binom{3}{5} - \binom{2}{5} \log_2 \binom{2}{5} \right]$$

+ $\frac{7}{12} \left[-\binom{3}{7} \log_2 \binom{3}{7} - \binom{4}{7} \log_2 \binom{4}{7} \right] = 0.9793$

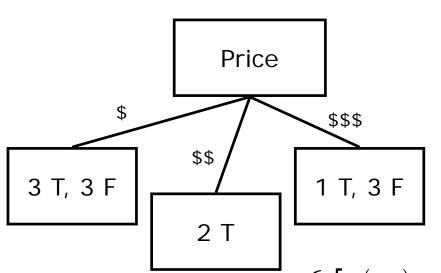
Gain(Reservation) = 1 - 0.9793 = 0.0207



Example					At	ttributes	3				Target
	Alt	Bar	Fri	Hun	Pat	Price	Rain	Res	Type	Est	WillWait
X_1	T	F	F	T	Some	\$\$\$	F	T	French	0–10	T
X_2	T	F	F	Τ	Full	\$	F	F	Thai	30–60	F
X_3	F	Τ	F	F	Some	\$	F	F	Burger	0–10	T
X_4	T	F	T	T	Full	\$	F	F	Thai	10-30	T
X_5	T	F	T	F	Full	\$\$\$	F	T	French	>60	F
X_6	F	T	F	T	Some	\$\$	T	T	Italian	0–10	T
X_7	F	T	F	F	None	\$	T	F	Burger	0–10	F
X_8	F	F	F	T	Some	\$\$	T	T	Thai	0–10	T
X_9	F	T	T	F	Full	\$	T	F	Burger	>60	F
X_{10}	T	T	T	T	Full	\$\$\$	F	T	Italian	10–30	F
X_{11}	F	F	F	F	None	\$	F	F	Thai	0–10	F
X_{12}	T	T	T	T	Full	\$	F	F	Burger	30–60	T

$$\begin{aligned} & \text{Remainder}(Patron) = \frac{2}{12} \left[-\binom{0}{2} \log_2 \binom{0}{2} - \binom{2}{2} \log_2 \binom{2}{2} \right] \\ & + \frac{4}{12} \left[-\binom{4}{4} \log_2 \binom{4}{4} - \binom{0}{4} \log_2 \binom{0}{4} \right] + \frac{6}{12} \left[-\binom{2}{6} \log_2 \binom{2}{6} - \binom{4}{6} \log_2 \binom{4}{6} \right] \\ & = 0.459 \end{aligned}$$

Gain(Patron) = 1 - 0.459 = 0.541



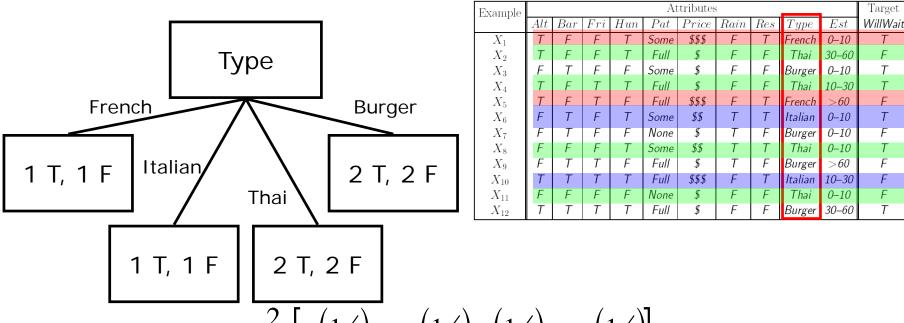
Example					A	ttributes	3				Target
Lixemple	Alt	Bar	Fri	Hun	Pat	Price	Rain	Res	Type	Est	WillWait
X_1	T	F	F	T	Some	\$\$\$	F	T	French	0-10	T
X_2	T	F	F	Τ	Full	\$	F	F	Thai	30–60	F
X_3	F	T	F	F	Some	\$	F	F	Burger	0–10	T
X_4	T	F	T	Τ	Full	\$	F	F	Thai	10-30	T
X_5	T	F	T	F	Full	\$\$\$	F	T	French	>60	F
X_6	F	T	F	T	Some	\$\$	Τ	T	Italian	0–10	T
X_7	F	T	F	F	None	\$	T	F	Burger	0–10	F
X_8	F	F	F	T	Some	\$\$	Τ	T	Thai	0–10	T
X_9	F	Τ	Τ	F	Full	\$	Τ	F	Burger	>60	F
X_{10}	T	T	T	T	Full	\$\$\$	F	T	Italian	10-30	F
X_{11}	F	F	F	F	None	\$	F	F	Thai	0–10	F
X_{12}	T	T	T	T	Full	\$	F	F	Burger	30–60	T

Remainder(Price) =
$$\frac{6}{12} \left[-\left(\frac{3}{6}\right) \log_2\left(\frac{3}{6}\right) - \left(\frac{3}{6}\right) \log_2\left(\frac{3}{6}\right) \right]$$

$$+\frac{2}{12}\left[-\frac{2}{2}\log_2(\frac{2}{2})-\frac{0}{2}\log_2(\frac{0}{2})\right]$$

$$+\frac{4}{12}\left[-\frac{1}{4}\log_2\left(\frac{1}{4}\right)-\frac{3}{4}\log_2\left(\frac{3}{4}\right)\right]=0.7704$$

Gain(Remainder) = 1 - 0.7704 = 0.2296

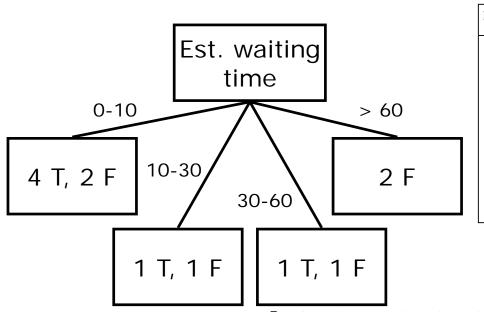


Remainder(Type) =
$$\frac{2}{12} \left[-\left(\frac{1}{2}\right) \log_2\left(\frac{1}{2}\right) - \left(\frac{1}{2}\right) \log_2\left(\frac{1}{2}\right) \right]$$

$$+\frac{2}{12}\left[-\frac{1}{2}\log_2(\frac{1}{2})-\frac{1}{2}\log_2(\frac{1}{2})\right]$$

$$+\frac{4}{12}\left[-\frac{2}{4}\log_2\left(\frac{2}{4}\right)-\frac{2}{4}\log_2\left(\frac{2}{4}\right)\right]+\frac{4}{12}\left[-\frac{2}{4}\log_2\left(\frac{2}{4}\right)-\frac{2}{4}\log_2\left(\frac{2}{4}\right)\right]=1$$

Gain(Type) =
$$1 - 1 = 0$$



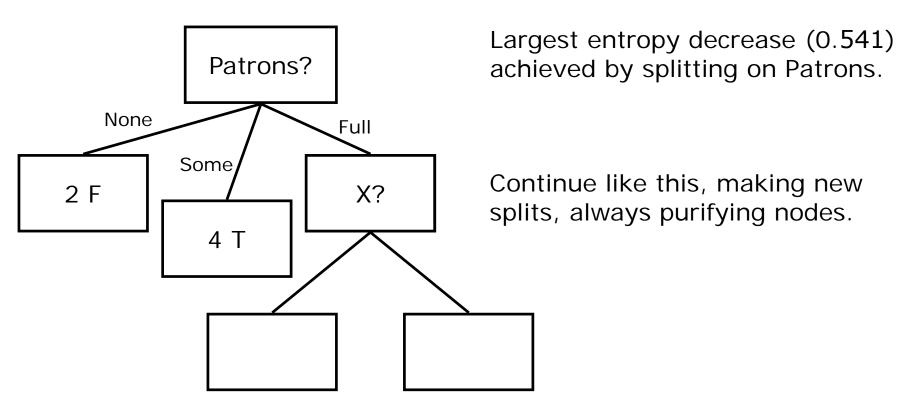
	I	Attributes											
Example											Target		
	Alt	Bar	Fri	Hun	Pat	Price	Rain	Res	Type	Est	WillWait		
X_1	T	F	F	T	Some	\$\$\$	F	Τ	French	0–10	Τ		
X_2	T	F	F	T	Full	\$	F	F	Thai	30–60	F		
X_3	F	T	F	F	Some	\$	F	F	Burger	0–10	Τ		
X_4	T	F	T	Τ	Full	\$	F	F	Thai	10–30	T		
X_5	T	F	T	F	Full	\$\$\$	F	T	French	>60	F		
X_6	F	T	F	Τ	Some	\$\$	T	T	Italian	0–10	Τ		
X_7	F	T	F	F	None	\$	T	F	Burger	0–10	F		
X_8	F	F	F	T	Some	\$\$	T	T	Thai	0–10	Τ		
X_9	F	T	T	F	Full	\$	T	F	Burger	>60	F		
X_{10}	T	T	T	T	Full	\$\$\$	F	T	ltalian	10–30	F		
X_{11}	F	F	F	F	None	\$	F	F	Thai	0–10	F		
X_{12}	T	T	T	T	Full	\$	F	F	Burger	30–60	T		

Remainder(Wait) =
$$\frac{6}{12} \left[-\left(\frac{4}{6}\right) \log_2\left(\frac{4}{6}\right) - \left(\frac{2}{6}\right) \log_2\left(\frac{2}{6}\right) \right]$$

$$+\frac{2}{12}\left[-\frac{1}{2}\log_2\left(\frac{1}{2}\right)-\frac{1}{2}\log_2\left(\frac{1}{2}\right)\right]$$

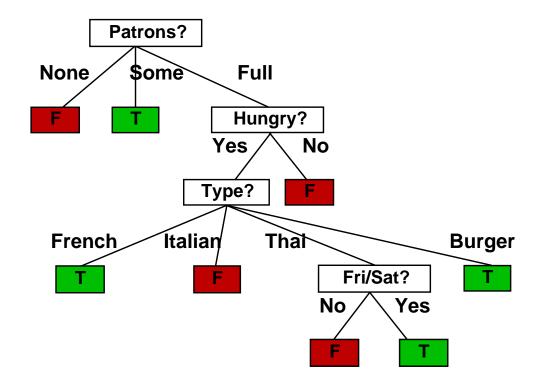
$$+\frac{2}{12}\left[-\binom{1}{2}\log_2\binom{1}{2}-\binom{1}{2}\log_2\binom{1}{2}\right]+\frac{2}{12}\left[-\binom{0}{2}\log_2\binom{0}{2}-\binom{2}{2}\log_2\binom{2}{2}\right]=0.7925$$

Gain(Wait) = 1 - 0.7925 = 0.2075



Example contd.

Decision tree learned from the 12 examples:



Substantially simpler than "true" tree—a more complex hypothesis isn't justified by small amount of data