age	p_i	n_i	$I(p_i, n_i)$
<=30	2	3	0.971
31...40	4	0	0
>40	3	2	0.971

age	income	student	credit_rating	buys_computer
<=30	high	no	fair	no
<=30	high	no	excellent	no
31...40	high	no	fair	yes
>40	medium	no	fair	yes
>40	low	yes	fair	yes
>40	low	yes	excellent	no
31...40	low	yes	excellent	yes
<=30	medium	no	fair	no
<=30	low	yes	fair	yes
>40	medium	yes	fair	yes
<=30	medium	yes	excellent	yes
31...40	medium	no	excellent	yes
31...40	high	yes	fair	yes
>40	medium	no	excellent	no

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

$$Info_{age}(D) = \frac{4}{12}I(2,2) + \frac{3}{12}I(3,0) + \frac{5}{12}I(3,2)$$

$$= \frac{4}{12}(1) + \frac{3}{12}(0) + \frac{5}{12}(0.971)$$

$$= 0.5761$$

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

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

$$I(3,2) = -\frac{3}{5}\log_2\left(\frac{3}{5}\right) - \frac{2}{5}\log_2\left(\frac{2}{5}\right) = 0.971$$

$$Gain(age) = Info(D) - Info_{age}(D) = 0.9183 - 0.5761 = 0.3422$$

income	p_i	n_i
high	2	2
medium	4	1
low	2	1

$$Info_{income}(D) = \frac{4}{12}I(2,2) + \frac{5}{12}I(4,1) + \frac{3}{12}I(2,1)$$

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

$$= 0.8837$$

$$I(4,1) = -\frac{4}{5}\log_2\left(\frac{4}{5}\right) - \frac{1}{5}\log_2\left(\frac{1}{5}\right) = 0.7219$$

$$I(2,1) = -\frac{2}{3}\log_2\left(\frac{2}{3}\right) - \frac{1}{3}\log_2\left(\frac{1}{3}\right) = 0.9183$$

$$Gain(income) = Info(D) - Info_{income}(D) = 0.9183 - 0.8837 = 0.0346$$

student	p_i	n_i
Yes	5	1
No	3	3

$$Info_{student}(D) = \frac{6}{12}I(5,1) + \frac{6}{12}I(3,3)$$

$$= \frac{6}{12}(0.65) + \frac{6}{12}(1)$$

$$= 0.825$$

$$I(5,1) = -\frac{5}{6}\log_2\left(\frac{5}{6}\right) - \frac{1}{6}\log_2\left(\frac{1}{6}\right) = 0.6500$$

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

$$Gain(student) = Info(D) - Info_{student}(D) = 0.9183 - 0.825 = 0.0933$$

Credit_rating	p_i	n_i
fair	6	1
excellent	2	3

$$Info_{Credit\_rating}(D) = \frac{7}{12}I(6,1) + \frac{5}{12}I(2,3)$$

$$= \frac{7}{12}(0.5917) + \frac{5}{12}(0.9710)$$

$$= 0.7497$$

$$Gain(Credit\_rating) = Info(D) - Info_{Credit\_rating}(D) = 0.9183 - 0.7497 = 0.1686$$