

$x_1 \quad x_2 \quad x_3 \quad x_4$

yes      no

age	$p_i$	$n_i$	$I(p_i, n_i)$
$\leq 30$	2	2	1
$31 \dots 40$	3	0	0
$> 40$	3	2	0.971

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

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

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

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

$$\begin{aligned} \text{Info}_{\text{age}}(D) &= \frac{4}{12} I(2,2) + \frac{3}{12} I(4,0) + \frac{5}{12} I(3,2) \\ &= \frac{4}{12}(1) + \frac{3}{12}(0) + \frac{5}{12}(0.971) = 0.7979 \end{aligned}$$

$$\text{Gain}_{\text{age}} = \text{Info}(D) - \text{Info}_{\text{age}}(D) = 0.9183 - 0.7979 = 0.1204$$

income	$p_i$	$n_i$	$I(p_i, n_i)$
high	2	2	1
medium	4	1	0.7919
low	2	1	0.9182

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

$$I(4,1) = -\frac{4}{5} \log_2 \left(\frac{4}{5}\right) - \frac{1}{5} \log_2 \left(\frac{1}{5}\right) = 0.7919$$

$$I(2,1) = -\frac{2}{3} \log_2 \left(\frac{2}{3}\right) - \frac{1}{3} \log_2 \left(\frac{1}{3}\right) = 0.9182$$

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

$$\approx \frac{4}{12}(1) + \frac{5}{12}(0.7919) + \frac{3}{12}(0.9182) = 0.8637$$

$$\text{Gain}_{\text{income}} = \text{Info}(D) - \text{Info}_{\text{income}} = 0.9183 - 0.8637 = 0.0546$$

Student	$p_i$	$n_i$	$I(p_i, n_i)$
yes	5	1	0.65
no	3	3	1

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

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

$$\text{Info}_{\text{student}}(D) = \frac{6}{12} I(5,1) + \frac{6}{12} I(3,3) = \frac{6}{12}(0.65) + \frac{6}{12}(1) = 0.895$$

$$\text{Gain}_{\text{student}} = \text{Info}(D) - \text{Info}_{\text{student}} = 0.9183 - 0.895 = 0.0233$$

Credit_rating	$P_i$	$n_i$	$I(P_i, n_i)$
fair	6	1	0.5917
excellent	9	3	0.9710

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

$$I(9,3) = -\frac{9}{12} \log_2 \left(\frac{9}{12}\right) - \frac{3}{12} \log_2 \left(\frac{3}{12}\right) \approx 0.9710$$

$$\text{Info}_{\text{credit\_rating}}(D) = \frac{7}{12}(0.5917) + \frac{5}{12}(0.9710) \approx 0.7497$$

$$\text{Gain}(\text{credit\_rating}) = \text{Info}(D) - \text{Info}_{\text{credit\_rating}}(D) = 0.9183 - 0.7497 \approx 0.1686$$

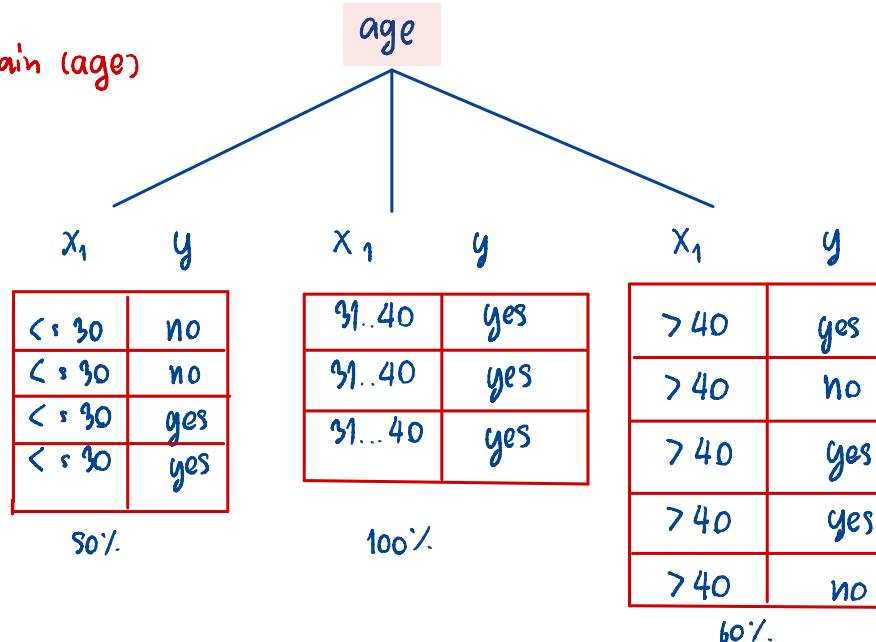
$$\text{Gain}(\text{age}) \approx 0.1804$$

$$\text{Gain}(\text{credit\_rating}) \approx 0.1686$$

$$\text{Gain}(\text{student}) \approx 0.0933$$

$$\text{Gain}(\text{income}) \approx 0.0846$$

Gain(age)



$X_1$	$X_2$	$X_3$	$X_4$	
age	income	student	credit rating	buys computer
<=30	high	no	fair	no
<=30	high	no	excellent	no
<=30	low	yes	fair	yes
<=30	medium	yes	excellent	yes

$$\text{Info}(D \leq 30) = I(9,9) = -\frac{9}{4} \log_2 \left(\frac{9}{4}\right) - \frac{9}{4} \log_2 \left(\frac{9}{4}\right) \approx 1$$

income	$P_i$	$n_i$	$I(P_i, n_i)$
high	0	9	0
medium	1	0	0
low	1	0	0

$$I(0,9) = -\frac{0}{9} \log_2 \left(\frac{0}{9}\right) - \frac{9}{9} \log_2 \left(\frac{9}{9}\right) \approx 0$$

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

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

$$\text{Info}_{\text{income}}(D \leq 30) = \frac{9}{4} I(0,9) + \frac{1}{4} I(1,0) + \frac{1}{4} I(1,0) = \frac{9}{4}(0) + \frac{1}{4}(0) + \frac{1}{4}(0) = 0$$

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

student	$P_i$	$n_i$	$I(P_i, n_i)$
yes	9	0	0
no	0	9	0

$$I(9,0) = -\frac{9}{9} \log_2 \left(\frac{9}{9}\right) - \frac{0}{9} \log_2 \left(\frac{0}{9}\right) \approx 0$$

$$I(0,9) = -\frac{0}{9} \log_2 \left(\frac{0}{9}\right) - \frac{9}{9} \log_2 \left(\frac{9}{9}\right) \approx 0$$

$$\text{Info}_{\text{student}}(D \leq 30) = \frac{9}{4} I(9,0) + \frac{9}{4} I(0,9) = \frac{9}{4}(0) + \frac{9}{4}(0) = 0$$

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

credit_rating	$P_i$	$n_i$	$I(P_i, n_i)$
fair	1	1	1
excellent	1	1	1

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

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

Info credit\_rating ( $D \leq 90$ ) =  $\frac{2}{4}(1) + \frac{2}{4}(1) = 1$

$$\text{Gain}(\text{credit\_rating}) = \text{Info}(D \leq 90) - \text{Info}_{\text{credit\_rating}}(D \leq 90) = 1 - 1 = 0$$

$$\text{Gian}(income) = 1$$

$$\text{Gian}(student) = 1$$

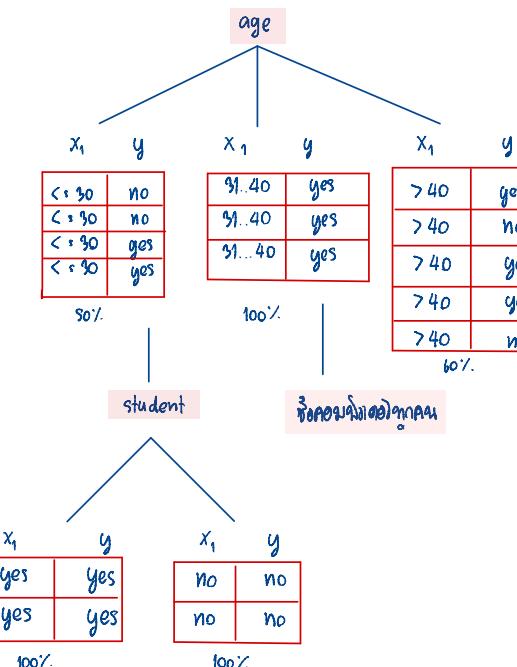
$$\text{Gian}(credit\_rating) = 0$$

ເພື່ອກຳນົດ  $\text{Gian}(income)$  ໂດຍ  $\text{Gian}(student)$  ມີຄວາມຖັນໄດ້ ພະຍາຍາດ  
ກຳນົດມາດຕະກຳລົງທະບຽນ ຕື່ມັງກອງຕະຫຼາດ

age	income	student	credit_rating	buys_computer
31...40	high	no	fair	yes
31...40	medium	no	excellent	yes
31...40	high	yes	fair	yes

$$\text{Info}(D \leq 31...40) = I(3,0) = -\frac{3}{0} \log_2 \left(\frac{3}{0}\right) - \frac{0}{3} \log_2 \left(\frac{0}{3}\right) = 0$$

$$\text{Info}(D \leq 31...40) = 0 \quad \text{ເນື້ອໃນກຳນົດ ສົມຜົນກຳນົດ}$$



age	income	student	credit_rating	buys_computer
>40	medium	no	fair	yes
>40	low	yes	fair	yes
>40	low	yes	excellent	no
>40	medium	yes	fair	yes
>40	medium	no	excellent	no

$$\text{Info}(D > 40) = I(3,2) = -\frac{3}{5} \log_2 \left(\frac{3}{5}\right) - \frac{2}{5} \log_2 \left(\frac{2}{5}\right) = 0.9183$$

income	$P_i$	$n_i$	$I(P_i, n_i)$
medium	2	1	0.9183
low	1	1	1

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

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

$$\text{Info}_{\text{income}}(D > 40) = \frac{3}{5}(9,1) + \frac{2}{5}(1,1) = \frac{3}{5}(0.9183) + \frac{2}{5}(1) = 0.951$$

$$\text{Gain}(\text{income}) = \text{Info}(D > 40) - \text{Info}_{\text{income}}(D > 40) = 0.971 - 0.951 = 0.02$$

student	$P_i$	$n_i$	$I(P_i, n_i)$
yes	9	1	0.9183
no	1	1	1

$$I(9,1) = -\frac{9}{10} \log_2 \left(\frac{9}{10}\right) - \frac{1}{10} \log_2 \left(\frac{1}{10}\right) = 0.9183$$

$$I(1,1) = -\frac{1}{9} \log_2 \left(\frac{1}{9}\right) - \frac{1}{9} \log_2 \left(\frac{1}{9}\right) = 1$$

$$\text{Info}_{\text{student}}(D > 40) = \frac{3}{5}(9,1) + \frac{2}{5}(1,1) = \frac{3}{5}(0.9183) + \frac{2}{5}(1) = 0.951$$

$$\text{Gain}(\text{student}) = \text{Info}(D > 40) - \text{Info}_{\text{student}}(D > 40) = 0.971 - 0.951 = 0.02$$

credit_rating	$P_i$	$n_i$	$I(P_i, n_i)$
fair	3	0	0
excellent	2	0	0

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

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

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

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

when credit\_rating is fair Gain(credit\_rating) is 0.971

