

สมาชิก

643020063-4	นางสาวเพ็ญพิชชา วรณ์ชุมาร์
643020513-9	นายภัทรธร ก้อนมณี
643020515-5	นายรัชชานนท์ ทิพย์พิมานพร
643020519-7	นางสาววิศรา ปันลา
643020521-0	นายวุฒิชัย คำนา
643020526-0	นางสาวอนันญา พูลสวัสดิ์
643021271-2	นางสาววิลันดา ทารามาตร্য

1

$$\text{Info}(D) = I(175, 149)$$

$$\begin{aligned}
 &= \left[-\frac{175}{324} \log_2 \frac{175}{324} \right] + \left[-\frac{149}{324} \log_2 \frac{149}{324} \right] \\
 &= 0.479975 + 0.515375 \\
 &= 0.99535
 \end{aligned}$$

$$\text{Info}_{a_9}(D) = \frac{144}{324} I(11, 133) + \frac{180}{324} I(138, 42)$$

$$\begin{aligned}
 &= \frac{144}{324} \left[-\frac{11}{144} \log_2 \frac{11}{144} + \left(-\frac{133}{144} \log_2 \frac{133}{144} \right) \right] + \frac{180}{324} \left[-\frac{138}{180} \log_2 \frac{138}{180} + \left(-\frac{42}{180} \log_2 \frac{42}{180} \right) \right] \\
 &= 0.173033 + 0.435421 \\
 &= 0.608454 //
 \end{aligned}$$

$$\text{Info}_{a_{10}}(D) = \frac{184}{324} I(135, 49) + \frac{140}{324} I(40, 100)$$

$$\begin{aligned}
 &= \frac{184}{324} \left[-\frac{135}{184} \log_2 \frac{135}{184} + \left(-\frac{49}{184} \log_2 \frac{49}{184} \right) \right] + \frac{140}{324} \left[-\frac{40}{140} \log_2 \frac{40}{140} + \left(-\frac{100}{140} \log_2 \frac{100}{140} \right) \right] \\
 &= 0.47483 + 0.372953 \\
 &= 0.84778 //
 \end{aligned}$$

$$\text{Info}_{a_{12}}(D) = \frac{172}{324} I(90, 82) + \frac{152}{324} I(85, 67)$$

$$\begin{aligned}
 &= \frac{172}{324} \left[-\frac{90}{172} \log_2 \frac{90}{172} + \left(-\frac{82}{172} \log_2 \frac{82}{172} \right) \right] + \frac{152}{324} \left[-\frac{85}{152} \log_2 \frac{85}{152} + \left(-\frac{67}{152} \log_2 \frac{67}{152} \right) \right] \\
 &= 0.530036 + 0.464375 \\
 &= 0.99422 //
 \end{aligned}$$

$$\text{Info}_{a_{13}}(D) = \frac{290}{324} I(154, 136) + \frac{6}{324} I(2, 4) + \frac{28}{324} I(19, 9)$$

$$\begin{aligned}
 &= \frac{290}{324} \left[-\frac{154}{290} \log_2 \frac{154}{290} + \left(-\frac{136}{290} \log_2 \frac{136}{290} \right) \right] + \frac{6}{324} \left[-\frac{2}{6} \log_2 \frac{2}{6} + \left(-\frac{4}{6} \log_2 \frac{4}{6} \right) \right] \\
 &\quad + \frac{28}{324} \left[-\frac{19}{28} \log_2 \frac{19}{28} + \left(-\frac{9}{28} \log_2 \frac{9}{28} \right) \right] \\
 &= 0.892573 + 0.0170055 + 0.078290 \\
 &= 0.98787 //
 \end{aligned}$$

$$\text{Info}_{a_{13}}(D) = \frac{290}{324} I(154, 136) + \frac{34}{324} I(21, 13)$$

↓

$$\begin{aligned}
 &\text{กี่เม่งฟีน } 1, (2, 3) \\
 &= \frac{290}{324} \left[-\frac{154}{290} \log_2 \frac{154}{290} + \left(-\frac{136}{290} \log_2 \frac{136}{290} \right) \right] + \frac{34}{324} \left[-\frac{21}{34} \log_2 \frac{21}{34} + \left(-\frac{13}{34} \log_2 \frac{13}{34} \right) \right] \\
 &= 0.892573 + 0.100706 \\
 &= 0.993281 //
 \end{aligned}$$

$$\text{Info}_{a_{13}}(D) = \frac{296}{324} I(156, 140) + \frac{28}{324} I(19, 9)$$

↓

$$\begin{aligned}
 &\text{กี่เม่งฟีน } 1, (2, 3) \\
 &= \frac{296}{324} \left[-\frac{156}{296} \log_2 \frac{156}{296} + \left(-\frac{140}{296} \log_2 \frac{140}{296} \right) \right] + \frac{28}{324} \left[-\frac{19}{28} \log_2 \frac{19}{28} + \left(-\frac{9}{28} \log_2 \frac{9}{28} \right) \right] \\
 &= 0.911654 + 0.0782901 \\
 &= 0.969944 //
 \end{aligned}$$

2

$$\text{Gain}(a_9) = 0.99535 - 0.60845 = 0.3869$$

$$\text{Gain}(a_{10}) = 0.99535 - 0.84778 = 0.14757$$

$$\text{Gain}(a_{12}) = 0.99535 - 0.99442 = 0.00093$$

$$\text{Gain}(a_{13}) = 0.99535 - 0.98787 = 0.00748$$

$$\text{Gain}(a_{13}) \begin{cases} \rightarrow 1, (2,3) = 0.99535 - 0.993281 = 0.002069 \\ \rightarrow (1,2), 3 = 0.99535 - 0.989944 = 0.005406 \end{cases}$$

$$X(0) \leq 0.5$$

$$\text{Entropy} = 0.995$$

$$\text{Sample} = 324$$

$$\text{Value} = [175, 149]$$

กรณี $a_9 = 0$
ให้ $a_9 \leq 0.5$

$$\text{Info}(D) = I(133, 11)$$

$$\begin{aligned}
 &= \left[-\frac{133}{144} \log_2 \frac{133}{144} \right] + \left[-\frac{11}{144} \log_2 \frac{11}{144} \right] \\
 &= 0.28344 + 0.105885 \\
 &= 0.389325 //
 \end{aligned}$$

$$\text{Info}_{a_{10}}(D) = \frac{115}{144} I(104, 11) + \frac{29}{144} I(29, 0)$$

$$\begin{aligned}
 &= \frac{115}{144} \left[-\frac{104}{115} \log_2 \frac{104}{115} + \left(-\frac{11}{115} \log_2 \frac{11}{115} \right) \right] + \frac{29}{144} \left[-\frac{29}{29} \log_2 \frac{29}{29} + \left(-\frac{0}{29} \log_2 \frac{0}{29} \right) \right] \\
 &= 0.363416 //
 \end{aligned}$$

หาก $a_{10} \leq 0$

$$\text{Info}_{a_{12}}(D) = \frac{82}{144} I(76, 6) + \frac{62}{144} I(57, 5)$$

$$\begin{aligned}
 &= \frac{82}{144} \left[-\frac{76}{82} \log_2 \frac{76}{82} + \left(-\frac{6}{82} \log_2 \frac{6}{82} \right) \right] + \frac{62}{144} \left[-\frac{57}{62} \log_2 \frac{57}{62} + \left(-\frac{5}{62} \log_2 \frac{5}{62} \right) \right] \\
 &= 0.215048 + 0.174149 \\
 &= 0.389197 //
 \end{aligned}$$

$$\text{Info}_{a_{13}}(D) = \frac{121}{144} I(117, 4) + \frac{23}{144} I(16, 7)$$

$$\begin{aligned}
 &\text{ลงเอยเป็น } 1, (2, 3) \\
 &= \frac{121}{144} \left[-\frac{117}{121} \log_2 \frac{117}{121} + \left(-\frac{4}{121} \log_2 \frac{4}{121} \right) \right] + \frac{23}{144} \left[-\frac{16}{23} \log_2 \frac{16}{23} + \left(-\frac{7}{23} \log_2 \frac{7}{23} \right) \right] \\
 &= 0.17604 + 0.1416 \\
 &= 0.31764 //
 \end{aligned}$$

$$\text{Info}_{a_{13}}(D) = \frac{127}{144} I(119, 8) + \frac{17}{144} I(14, 3)$$

$$\begin{aligned}
 &\text{ลงเอยเป็น } (1, 2), 3 \\
 &= \frac{127}{144} \left[-\frac{119}{127} \log_2 \frac{119}{127} + \left(-\frac{8}{127} \log_2 \frac{8}{127} \right) \right] + \frac{17}{144} \left[-\frac{14}{17} \log_2 \frac{14}{17} + \left(-\frac{3}{17} \log_2 \frac{3}{17} \right) \right] \\
 &= 0.299164 + 0.0793682 \\
 &= 0.378532 //
 \end{aligned}$$

$$\text{Gain}(a_{10}) = 0.389325 - 0.363416 = 0.025909$$

$$\text{Gain}(a_{12}) = 0.389325 - 0.389197 = 0.000128$$

$$\begin{aligned}
 \text{Gain}(a_{13}) &\rightarrow = 0.389325 - 0.31764 = 0.071685 \rightarrow \text{กรณี } a_{13} \text{ ก็ลงเอยเป็นกรณี } 1, (2, 3) \\
 &\quad = 0.389325 - 0.378532 = 0.010793
 \end{aligned}$$

$X(0) \leq 0.5$
Entropy = 0.995
Sample = 324
Value = [175, 149]

$X(3) \leq 1.5$
Entropy = 0.389325
Sample = 144
Value = [1 11]

4

$$\text{กรณี } \theta_9 = 1 \\ \text{หรือ } \theta_9 \geq 0.5$$

$$\text{Info}(D) = I(42, 138)$$

$$= \left[-\frac{42}{180} \log_2 \frac{42}{180} \right] + \left[-\frac{138}{180} \log_2 \frac{138}{180} \right] \\ = 0.489892 + 0.293885 \\ = 0.783777 //$$

$$\text{Info}_{a_{10}}(D) = \frac{69}{180} I(31, 38) + \frac{111}{180} I(11, 100)$$

$$= \frac{69}{180} \left[-\frac{31}{69} \log_2 \frac{31}{69} + \left(-\frac{38}{69} \log_2 \frac{38}{69} \right) \right] + \frac{111}{180} \left[-\frac{11}{111} \log_2 \frac{11}{111} + \left(-\frac{100}{111} \log_2 \frac{100}{111} \right) \right] \\ = 0.380482 + 0.287449 \\ = 0.667931 //$$

$$\text{Info}_{a_{12}}(D) = \frac{90}{180} I(14, 76) + \frac{90}{180} I(28, 62)$$

$$= \frac{90}{180} \left[-\frac{14}{90} \log_2 \frac{14}{90} + \left(-\frac{76}{90} \log_2 \frac{76}{90} \right) \right] + \frac{90}{180} \left[-\frac{28}{90} \log_2 \frac{28}{90} + \left(-\frac{62}{90} \log_2 \frac{62}{90} \right) \right] \\ = 0.311785 + 0.447226 \\ = 0.759011 //$$

$$\text{Info}_{a_{13}}(D) = \frac{169}{180} I(37, 132) + \frac{11}{180} I(5, 6)$$

↓

$$\text{ไม่ใช่ } (1, 3) \\ = \frac{169}{180} \left[-\frac{37}{169} \log_2 \frac{37}{169} + \left(-\frac{132}{169} \log_2 \frac{132}{169} \right) \right] + \frac{11}{180} \left[-\frac{5}{11} \log_2 \frac{5}{11} + \left(-\frac{6}{11} \log_2 \frac{6}{11} \right) \right] \\ = 0.711882 + 0.0607463 \\ = 0.7726283 //$$

$$\text{Gain}(a_{10}) = 0.783777 - 0.667931 = 0.115846$$

$$\text{Gain}(a_{12}) = 0.783777 - 0.759011 = 0.024766$$

$$\text{Gain}(a_{13}) = 0.783777 - 0.7726283 = 0.011487$$

$x(0) \leq 0.5$
entropy = 0.995
Sample = 324
Value = [175, 149]

$x(3) \leq 1.5$
entropy = 0.389325
Sample = 144
Value = [133, 11]

$x(1) \leq 0.5$
entropy = 0.783777
Sample = 180
Value = [42, 138]

5

กรณี $a_9 = 0$ หมายความว่า $a_{13} = 1$
 หรือ $a_9 \leq 0.5$ หมายความว่า $a_{13} \leq 1.5$

$$\text{Info}(D) = I(117, 4)$$

$$\begin{aligned} &= \left[-\frac{117}{121} \log_2 \frac{117}{121} \right] + \left[-\frac{4}{121} \log_2 \frac{4}{121} \right] \\ &= 0.0468953 + 0.162607 \\ &= 0.2095023 \end{aligned}$$

$$\text{Info}_{a_{10}}(D) = \frac{92}{121} I(88, 4) + \frac{29}{121} I(29, 0)$$

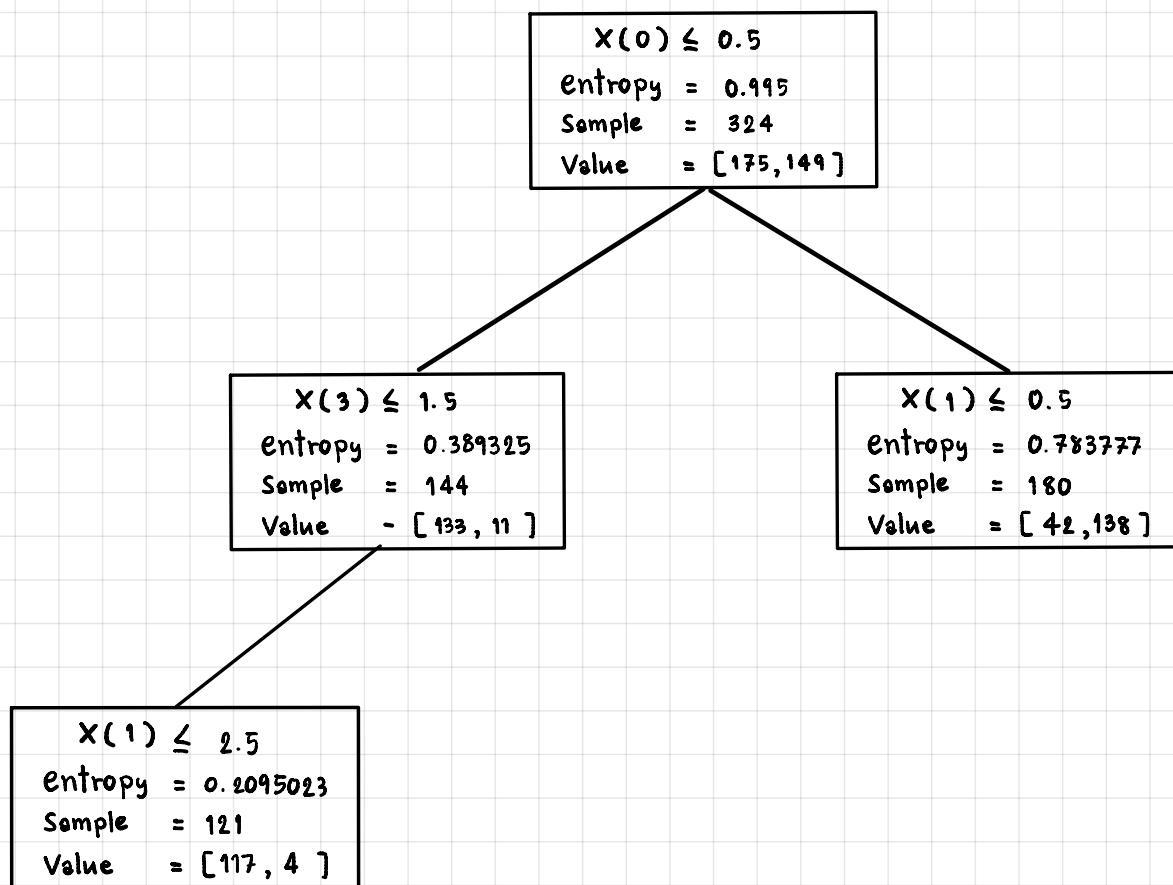
$$\begin{aligned} &= \frac{92}{121} \left[-\frac{88}{92} \log_2 \frac{88}{92} + \left(-\frac{4}{92} \log_2 \frac{4}{92} \right) \right] + \frac{29}{121} \left[-\frac{29}{29} \log_2 \frac{29}{29} + \left(-\frac{0}{29} \log_2 \frac{0}{29} \right) \right] \\ &= 0.19618 \end{aligned}$$

$$\text{Info}_{a_{12}}(D) = \frac{72}{121} I(69, 3) + \frac{49}{121} I(48, 1)$$

$$\begin{aligned} &= \frac{72}{121} \left[-\frac{69}{72} \log_2 \frac{69}{72} + \left(-\frac{3}{72} \log_2 \frac{3}{72} \right) \right] + \frac{49}{121} \left[-\frac{48}{49} \log_2 \frac{48}{49} + \left(-\frac{1}{49} \log_2 \frac{1}{49} \right) \right] \\ &= 0.14869 + 0.0582032 \\ &= 0.2068932 \end{aligned}$$

$$\text{Gain}(a_{10}) = 0.2095023 - 0.19618 = 0.0133223$$

$$\text{Gain}(a_{12}) = 0.2095023 - 0.2068932 = 0.0026091$$



b

กรณี $\partial_9 = 0$ ให้ $\partial_{13} = 2, 3$
 กรณี $\partial_9 \leq 0.5$ ให้ $\partial_{13} \geq 1.5$

$$\text{Info}(D) = I(16, 7)$$

$$\begin{aligned} &= \left[-\frac{16}{23} \log_2 \frac{16}{23} \right] + \left[-\frac{7}{23} \log_2 \frac{7}{23} \right] \\ &= 0.364217 + 0.522324 \\ &= 0.886541 // \end{aligned}$$

$$\text{Info}_{\partial_{10}}(D) = \frac{23}{23} I(16, 7)$$

$$\begin{aligned} &= \frac{23}{23} \left[-\frac{16}{23} \log_2 \frac{16}{23} + \left(-\frac{7}{23} \log_2 \frac{7}{23} \right) \right] \\ &= 0.886541 // \end{aligned}$$

$$\text{Info}_{\partial_{12}}(D) = \frac{10}{23} I(7, 3) + \frac{13}{23} I(9, 4)$$

$$\begin{aligned} &= \frac{10}{23} \left[-\frac{7}{10} \log_2 \frac{7}{10} + \left(-\frac{3}{10} \log_2 \frac{3}{10} \right) \right] + \frac{13}{23} \left[-\frac{9}{13} \log_2 \frac{9}{13} + \left(-\frac{4}{13} \log_2 \frac{4}{13} \right) \right] \\ &= 0.38317 + 0.503321 \\ &= 0.88649 // \end{aligned}$$

$$\text{Info}_{\partial_{13}}(D) = \frac{6}{23} I(2, 4) + \frac{17}{23} I(14, 3)$$

$$\begin{aligned} &= \frac{6}{23} \left[-\frac{2}{6} \log_2 \frac{2}{6} + \left(-\frac{4}{6} \log_2 \frac{4}{6} \right) \right] + \frac{17}{23} \left[-\frac{14}{17} \log_2 \frac{14}{17} + \left(-\frac{3}{17} \log_2 \frac{3}{17} \right) \right] \\ &= 0.239555 + 0.496914 \\ &= 0.736469 // \end{aligned}$$

$$\text{Gain}(\partial_{10}) = 0.886541 - 0.886541 = 0$$

$$\text{Gain}(\partial_{12}) = 0.886541 - 0.88649 = 0.000051$$

$$\text{Gain}(\partial_{13}) = 0.886541 - 0.736469 = 0.150072$$

$X(0) \leq 0.5$
entropy = 0.995
Sample = 324
Value = [175, 149]

$X(3) \leq 1.5$
entropy = 0.389325
Sample = 144
Value = [193, 11]

$X(1) \leq 0.5$
entropy = 0.783777
Sample = 180
Value = [42, 138]

$X(1) \leq 2.5$
entropy = 0.2095023
Sample = 121
Value = [117, 4]

$X(3) \leq 2.5$
entropy = 0.886541
Sample = 23
Value = [16, 7]

$$\text{กรณี } \hat{a}_9 = 1 \text{ แล้ว } \hat{a}_{10} = 0 \\ \text{ที่ } \hat{a}_9 \geq 0.5 \text{ แล้ว } \hat{a}_{10} \leq 0.5$$

$$\text{Info}(D) = I(31, 38)$$

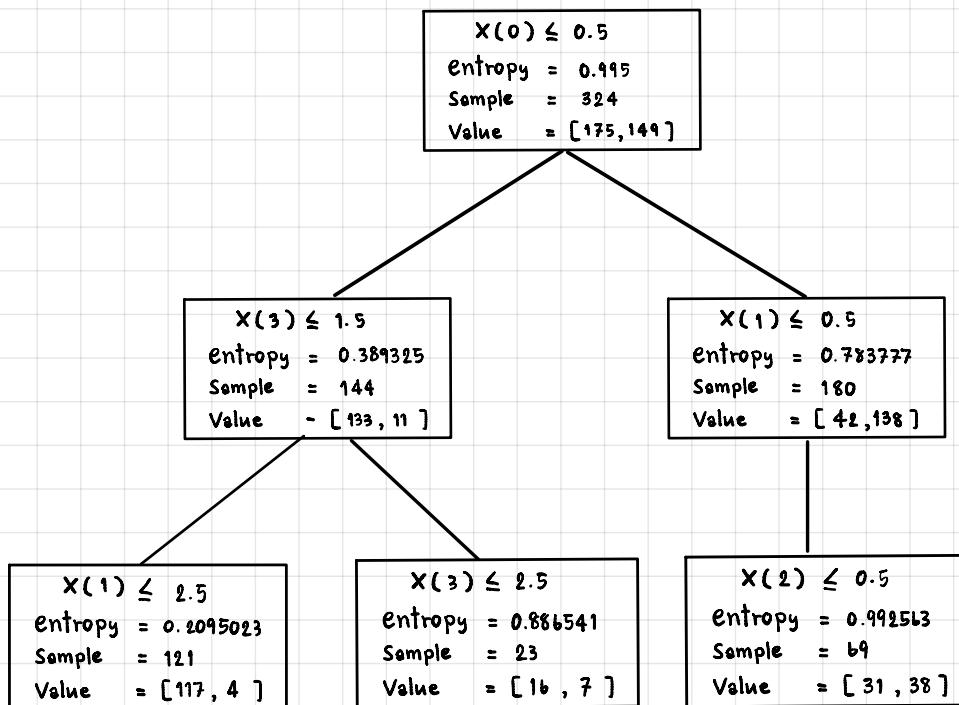
$$= \left[-\frac{31}{69} \log_2 \frac{31}{69} \right] + \left[-\frac{38}{69} \log_2 \frac{38}{69} \right] \\ = 0.992563 //$$

$$\begin{aligned} \text{Info}_{\hat{a}_{12}}(D) &= \frac{31}{69} I(10, 21) + \frac{38}{69} I(21, 17) \\ &= \frac{31}{69} \left[-\frac{10}{31} \log_2 \frac{10}{31} + \left(-\frac{21}{31} \log_2 \frac{21}{31} \right) \right] + \frac{38}{69} \left[-\frac{21}{38} \log_2 \frac{21}{38} + \left(-\frac{17}{38} \log_2 \frac{17}{38} \right) \right] \\ &= 0.407567 + 0.546314 \\ &= 0.953881 // \end{aligned}$$

$$\begin{aligned} \text{Info}_{\hat{a}_{13}}(D) &= \frac{58}{69} I(26, 32) + \frac{11}{69} I(5, 6) \\ &= \frac{58}{69} \left[-\frac{26}{58} \log_2 \frac{26}{58} + \left(-\frac{32}{58} \log_2 \frac{32}{58} \right) \right] + \frac{11}{69} \left[-\frac{5}{11} \log_2 \frac{5}{11} + \left(-\frac{6}{11} \log_2 \frac{6}{11} \right) \right] \\ &= 0.83408 + 0.158469 \\ &= 0.992549 // \end{aligned}$$

$$\text{Gain}(\hat{a}_{12}) = 0.992563 - 0.953881 = 0.038682$$

$$\text{Gain}(\hat{a}_{13}) = 0.992563 - 0.992549 = 0.000014$$



กรณี $\hat{a}_9 = 1$ หรือ $\hat{a}_{10} = 1$
ให้ $\hat{a}_9 \geq 0.5$ หรือ $\hat{a}_{10} \geq 0.5$

$$\text{Info}(D) = I(11, 100)$$

$$\begin{aligned} &= \left[-\frac{11}{111} \log_2 \frac{11}{111} \right] + \left[-\frac{100}{111} \log_2 \frac{100}{111} \right] \\ &= 0.330494 + 0.135639 \\ &= 0.466133 // \end{aligned}$$

$$\text{Info}_{a_{12}}(D) = \frac{59}{111} I(4, 5) + \frac{52}{111} I(45, 7)$$

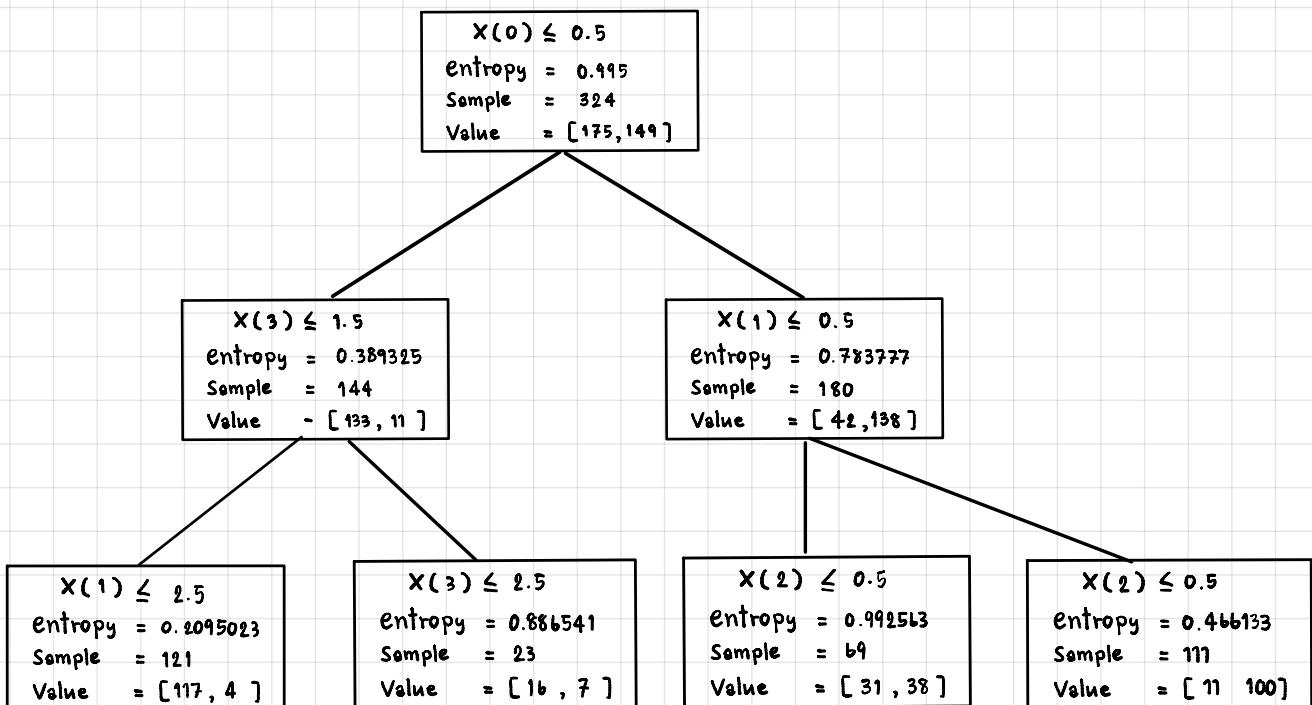
$$\begin{aligned} &= \frac{59}{111} \left[-\frac{4}{59} \log_2 \frac{4}{59} + \left(-\frac{5}{59} \log_2 \frac{5}{59} \right) \right] + \frac{52}{111} \left[-\frac{45}{52} \log_2 \frac{45}{52} + \left(-\frac{7}{52} \log_2 \frac{7}{52} \right) \right] \\ &= 0.1901 + 0.267009 \\ &= 0.457109 // \end{aligned}$$

$$\text{Info}_{a_{13}}(D) = \frac{111}{111} I(11, 100)$$

$$\begin{aligned} &= \frac{111}{111} \left[-\frac{11}{111} \log_2 \frac{11}{111} + \left(-\frac{100}{111} \log_2 \frac{100}{111} \right) \right] \\ &= 0.330494 + 0.135639 \\ &= 0.466133 // \end{aligned}$$

$$\text{Gain}(a_{12}) = 0.466133 - 0.457109 = 0.009024$$

$$\text{Gain}(a_{13}) = 0.466133 - 0.466133 = 0$$



9

กรณี $a_9 = 0$, $a_{13} = 1$, $a_{10} = 0$
กรณี $a_9 \leq 0.5$, $a_{13} \leq 1.5$, $a_{10} \leq 0.5$

$$\text{Info}(D) = I(88, 4)$$

$$= \left[-\frac{88}{92} \log_2 \frac{88}{92} \right] + \left[-\frac{4}{92} \log_2 \frac{4}{92} \right]$$

$$= 0.258019 //$$

$$\text{Info}_{a_9}(D) = \frac{57}{92} I(54, 3) + \frac{35}{92} I(34, 1)$$

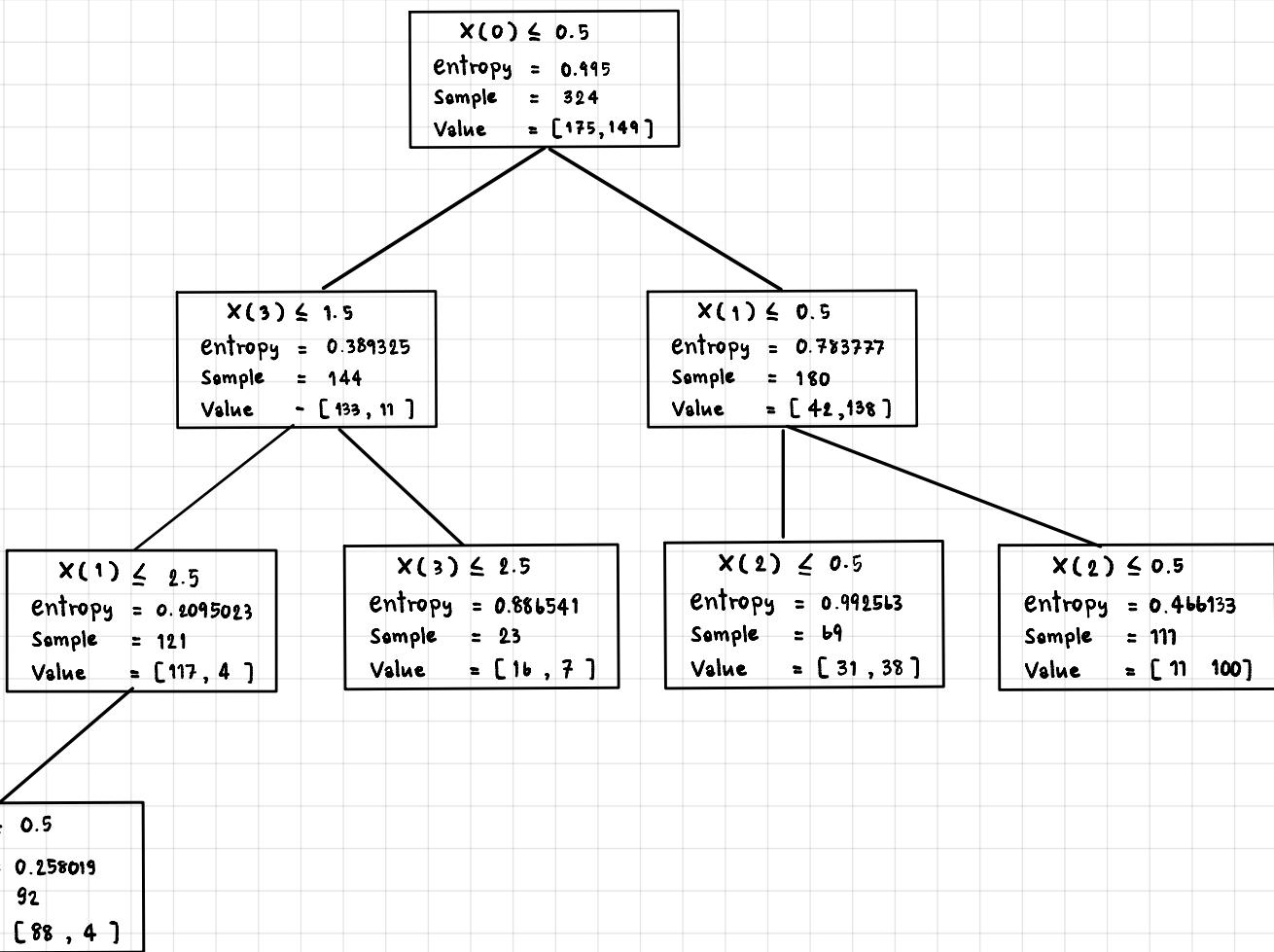
$$= \frac{57}{92} \left[-\frac{54}{57} \log_2 \frac{54}{57} + \left(-\frac{3}{57} \log_2 \frac{3}{57} \right) \right] + \frac{35}{92} \left[-\frac{34}{35} \log_2 \frac{34}{35} + \left(-\frac{1}{35} \log_2 \frac{1}{35} \right) \right]$$

$$= 0.184303 + 0.0712083$$

$$= 0.2555113 //$$

สิ่งสุดท้ายที่องานให้ feature, column, dimension, attribute คุณลักษณะ

$$\text{Gain}(a_{12}) = 0.258019 - 0.2555113 = 0.0025077$$



10

$$\text{గణి} \quad a_9 = 0, \quad a_{13} = 1, \quad a_{10} = 1 \\ \text{గాళి} \quad a_9 \leq 0.5, \quad a_{13} \leq 1.5, \quad a_{10} \geq 0.5$$

$$\text{Info}(D) = I(15, 14)$$

$$= \left[-\frac{15}{29} \log_2 \frac{15}{29} \right] + \left[-\frac{14}{29} \log_2 \frac{14}{29} \right]$$

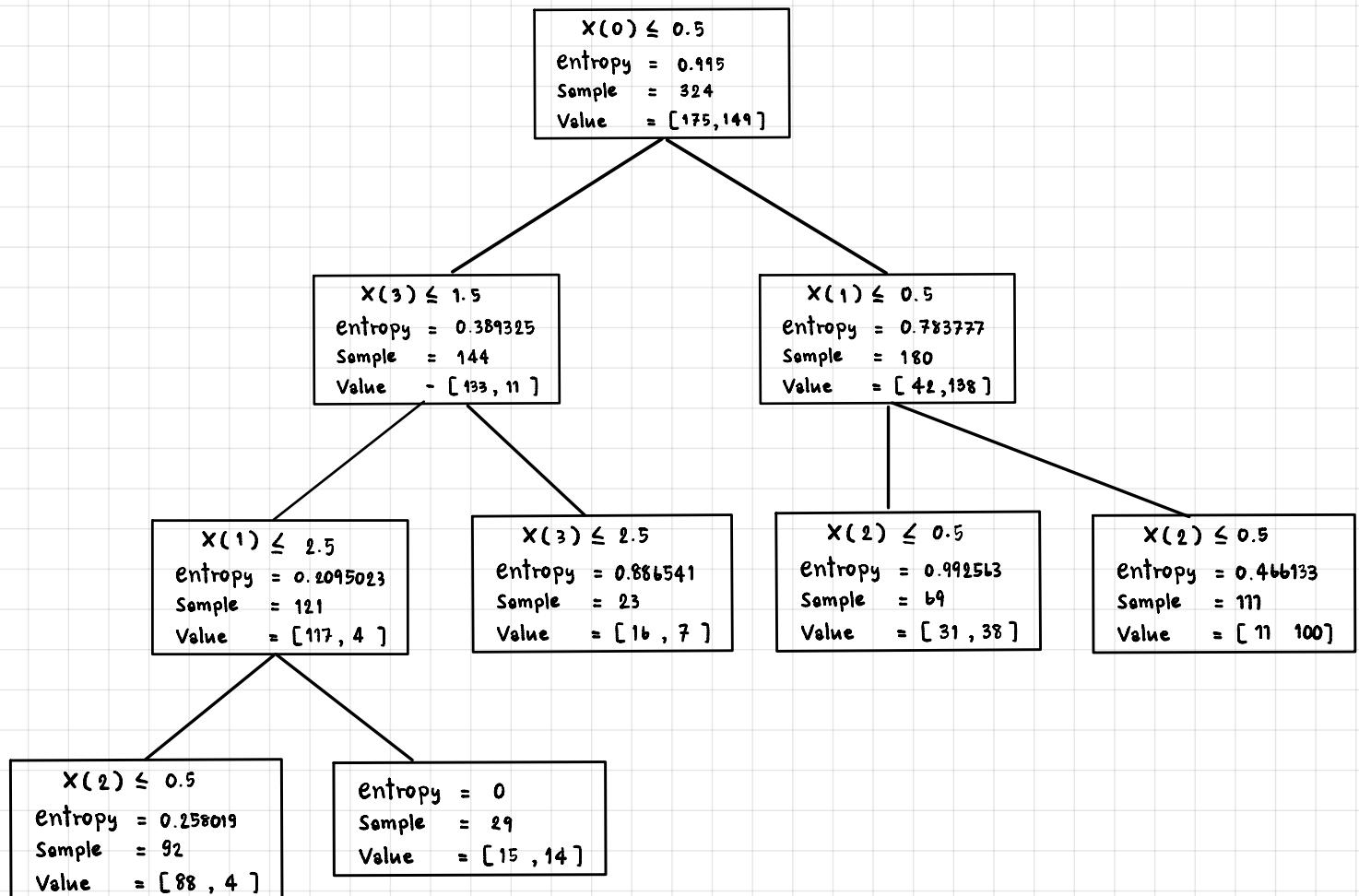
$$= 0.999142 \approx$$

$$\text{Info}_{a_{12}}(D) = I(15, 14)$$

$$= \left[-\frac{15}{29} \log_2 \frac{15}{29} \right] + \left[-\frac{14}{29} \log_2 \frac{14}{29} \right]$$

$$= 0.999142 \approx$$

$$\text{Gain}(a_{12}) = 0.999142 - 0.999142 = 0$$



11

กรณี $\partial g = 0$ หมายความว่า $\partial_{13} = (2,3)$ หมายความว่า $\partial_{13} = 2$
 และ $\partial g \leq 0.5$ หมายความว่า $\partial_{13} \geq 1.5$ หมายความว่า $\partial_{13} \leq 2.5$

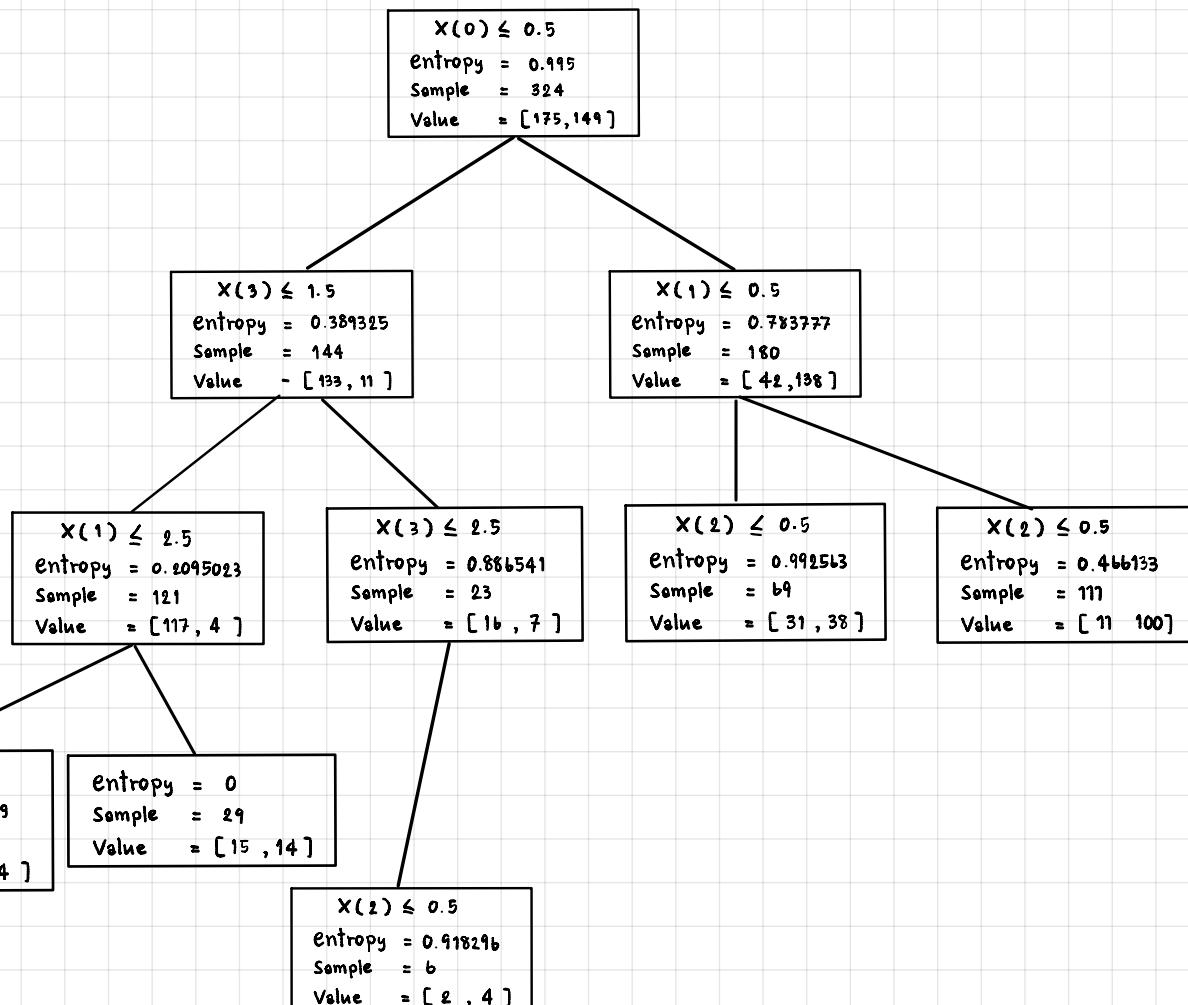
$$\text{Info}(D) = I(2,4)$$

$$= \left[-\frac{2}{6} \log_2 \frac{2}{6} \right] + \left[-\frac{4}{6} \log_2 \frac{4}{6} \right]$$

$$= 0.918296 \approx$$

$$\begin{aligned}\text{Info}_{\partial_{12}}(D) &= \frac{5}{6} I(2,3) + \frac{1}{6} I(0,1) \\ &= \frac{5}{6} \left[-\frac{2}{5} \log_2 \frac{2}{5} + \left(-\frac{3}{5} \log_2 \frac{3}{5} \right) \right] + \frac{1}{6} \left[-\frac{0}{1} \log_2 \frac{0}{1} + \left(-\frac{1}{1} \log_2 \frac{1}{1} \right) \right] \\ &= 0.809126 \approx\end{aligned}$$

$$\text{Gain}(\partial_{12}) = 0.918296 - 0.809126 = 0.10917$$



12

กรณี $a_9 = 0$, $a_{13} = (2, 3)$ 乃是 $a_{13} = 3$
 หรือ $a_9 \leq 0.5$; $a_{13} \geq 1.5$ 乃是 $a_{13} \geq 2.5$

$$\text{Info}(D) = I(14, 3)$$

$$= \left[-\frac{14}{17} \log_2 \frac{14}{17} \right] + \left[-\frac{3}{17} \log_2 \frac{3}{17} \right]$$

$$= 0.672295 //$$

ดันสูงแล้ว

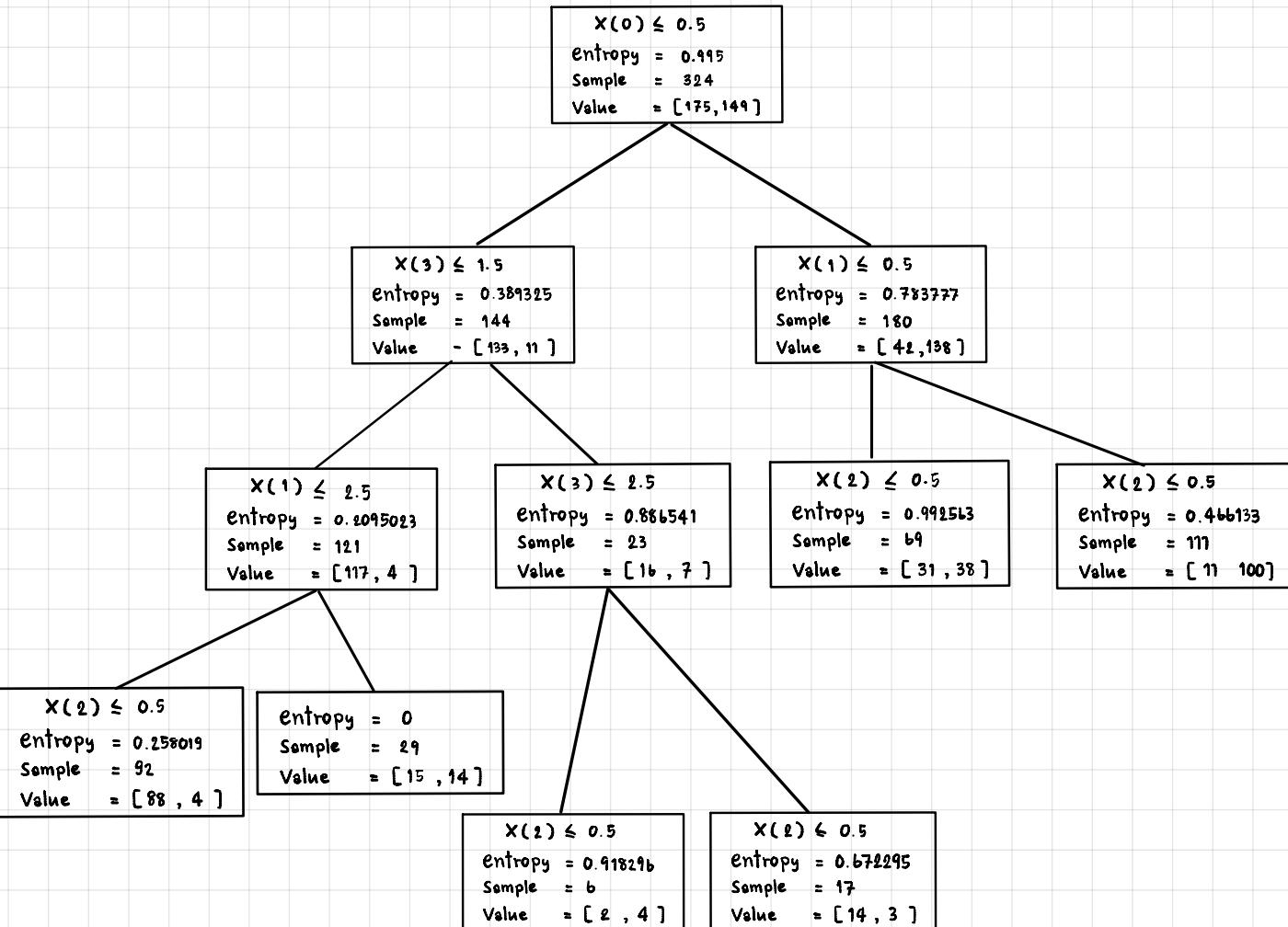
$$\text{Info}_{a_{12}}(D) = \frac{5}{17} I(5, 0) + \frac{12}{17} I(9, 3)$$

$$= \frac{5}{17} \left[-\frac{5}{5} \log_2 \frac{5}{5} + \left(-\frac{0}{5} \log_2 \frac{0}{5} \right) \right] + \frac{12}{17} \left[-\frac{9}{12} \log_2 \frac{9}{12} + \left(-\frac{3}{12} \log_2 \frac{3}{12} \right) \right]$$

$$= 0.572667 //$$

$$0.811278$$

$$\text{Gain}(a_{12}) = 0.672295 - 0.572667 = 0.099628$$



13

$$\text{กรณี } \partial_9 = 1, \partial_{10} = 0, \partial_{12} = 0 \\ \text{หรือ } \partial_9 \geq 0.5, \partial_{10} \leq 0.5, \partial_{12} \leq 0.5$$

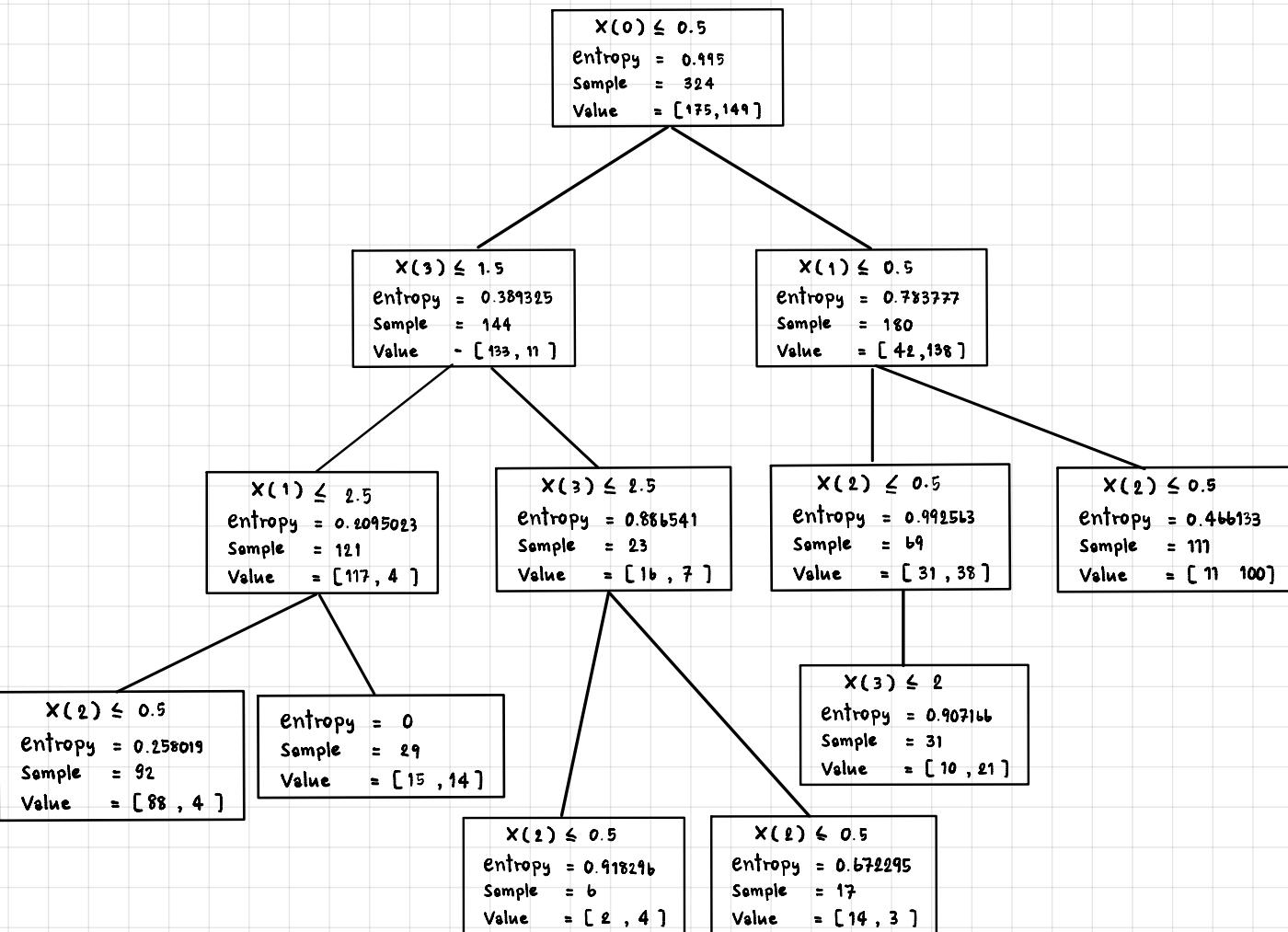
$$\text{Info}(D) = I(10, 21)$$

$$= \left[-\frac{10}{31} \log_2 \frac{10}{31} \right] + \left[-\frac{21}{31} \log_2 \frac{21}{31} \right] \\ = 0.526538 + 0.380628 \\ = 0.907166 //$$

$$\text{Info } \partial_{13}(D) = \frac{24}{31} I(9, 15) + \frac{7}{31} I(1, 6)$$

$$= \frac{24}{31} \left[-\frac{9}{24} \log_2 \frac{9}{24} + \left(-\frac{15}{24} \log_2 \frac{15}{24} \right) \right] + \frac{7}{31} \left[-\frac{1}{7} \log_2 \frac{1}{7} + \left(-\frac{6}{7} \log_2 \frac{6}{7} \right) \right] \\ = 0.738917 + 0.133604 \\ = 0.872521 //$$

$$\text{Gain } (\partial_{13}) = 0.907166 - 0.872521 = 0.034645$$



14

กรณี $\hat{a}_9 = 1, \hat{a}_{10} = 0, \hat{a}_{12} = 1$
กรณี $\hat{a}_9 \geq 0.5, \hat{a}_{10} \leq 0.5, \hat{a}_{12} \geq 0.5$

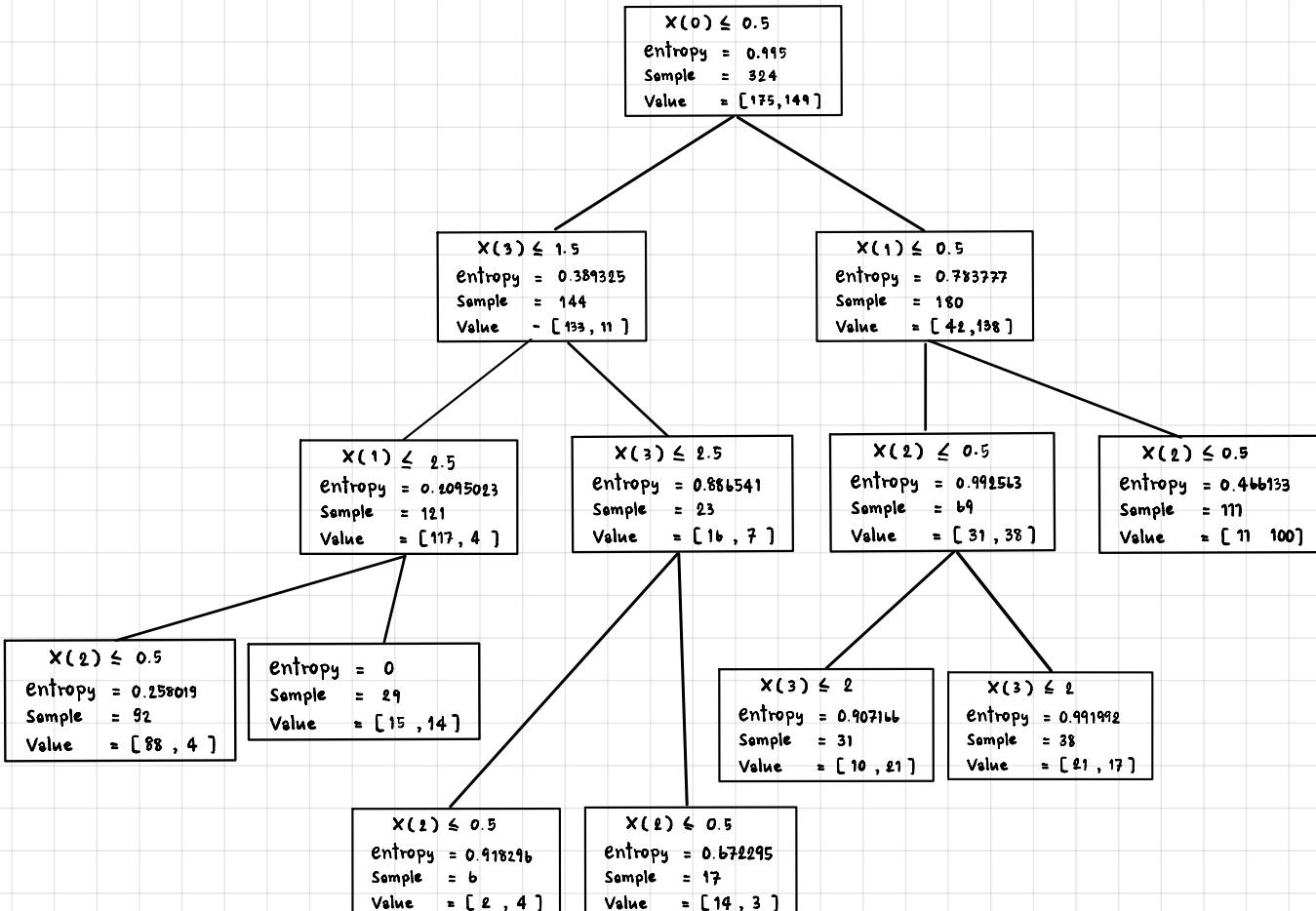
$$\text{Info}(D) = I(21, 17)$$

$$\begin{aligned}
 &= \left[-\frac{21}{38} \log_2 \frac{21}{38} \right] + \left[-\frac{17}{38} \log_2 \frac{17}{38} \right] \\
 &= 0.472837 + 0.519155 \\
 &= 0.991992 //
 \end{aligned}$$

$$\text{Info } a_{13}(D) = \frac{34}{38} I(17, 17) + \frac{4}{36} I(4, 0)$$

$$\begin{aligned}
 &= \frac{34}{38} \left[-\frac{17}{34} \log_2 \frac{17}{34} + \left(-\frac{17}{34} \log_2 \frac{17}{34} \right) \right] + \frac{4}{36} \left[-\frac{4}{4} \log_2 \frac{4}{4} + \left(-\frac{0}{4} \log_2 \frac{0}{4} \right) \right] \\
 &= \frac{34}{38} \times (0.5 + 0.5) \\
 &= 0.894737 //
 \end{aligned}$$

$$\text{Gain}(a_{13}) = 0.991992 - 0.894737 = 0.0972552$$



กรณี $\theta_9 = 1$, $\theta_{10} = 1$, $\theta_{12} = 0$
หรือ $\theta_9 \geq 0.5$, $\theta_{10} \geq 0.5$, $\theta_{12} \leq 0.5$

$$\text{Info}(D) = I(4, 55)$$

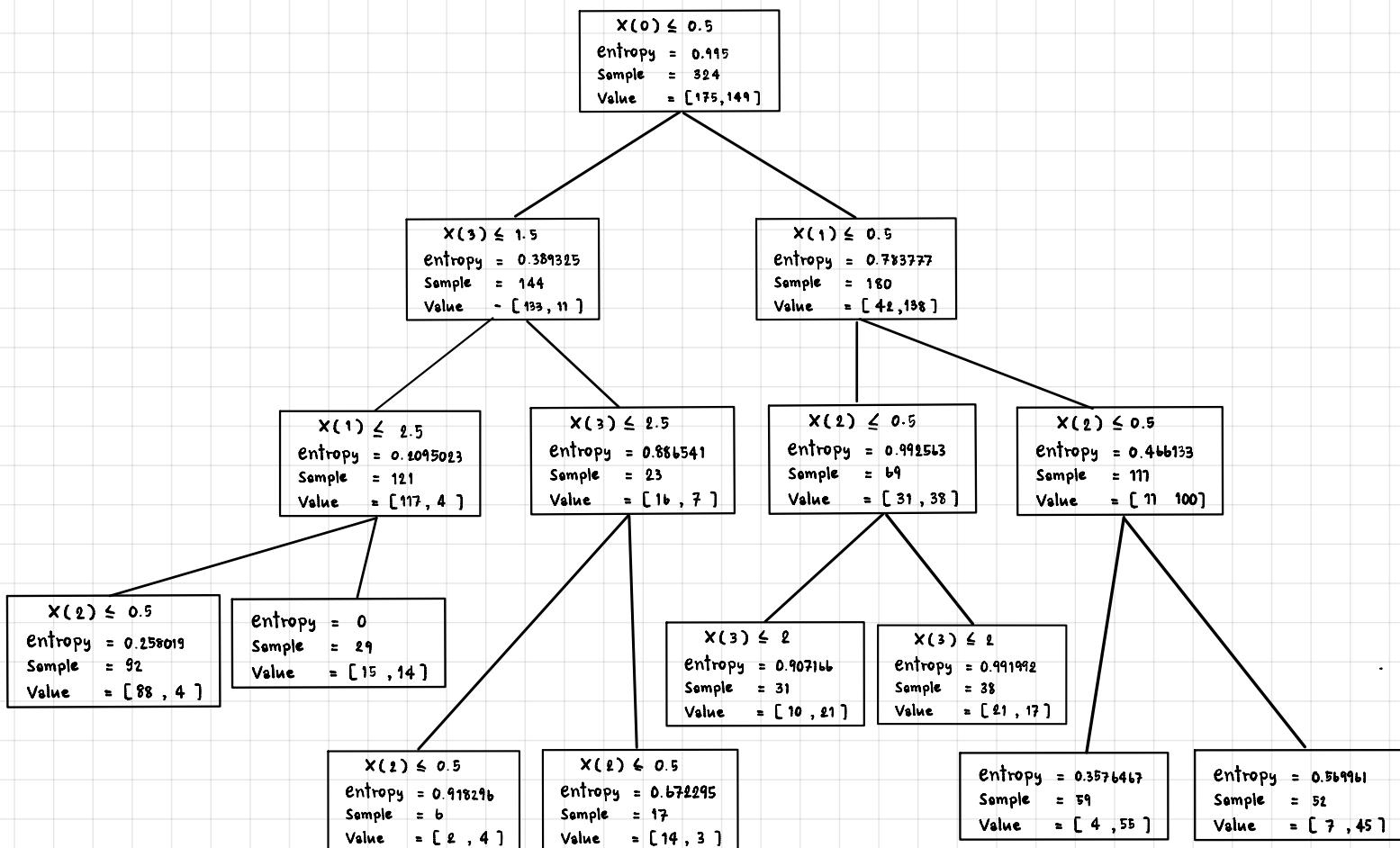
$$\begin{aligned} &= \left[-\frac{4}{59} \log_2 \frac{4}{59} \right] + \left[-\frac{55}{59} \log_2 \frac{55}{59} \right] \\ &= 0.26323 + 0.0944167 \\ &= 0.3576467 \end{aligned}$$

กรณี $\theta_9 = 1$, $\theta_{10} = 1$, $\theta_{12} = 1$
หรือ $\theta_9 \geq 0.5$, $\theta_{10} \geq 0.5$, $\theta_{12} \geq 0.5$

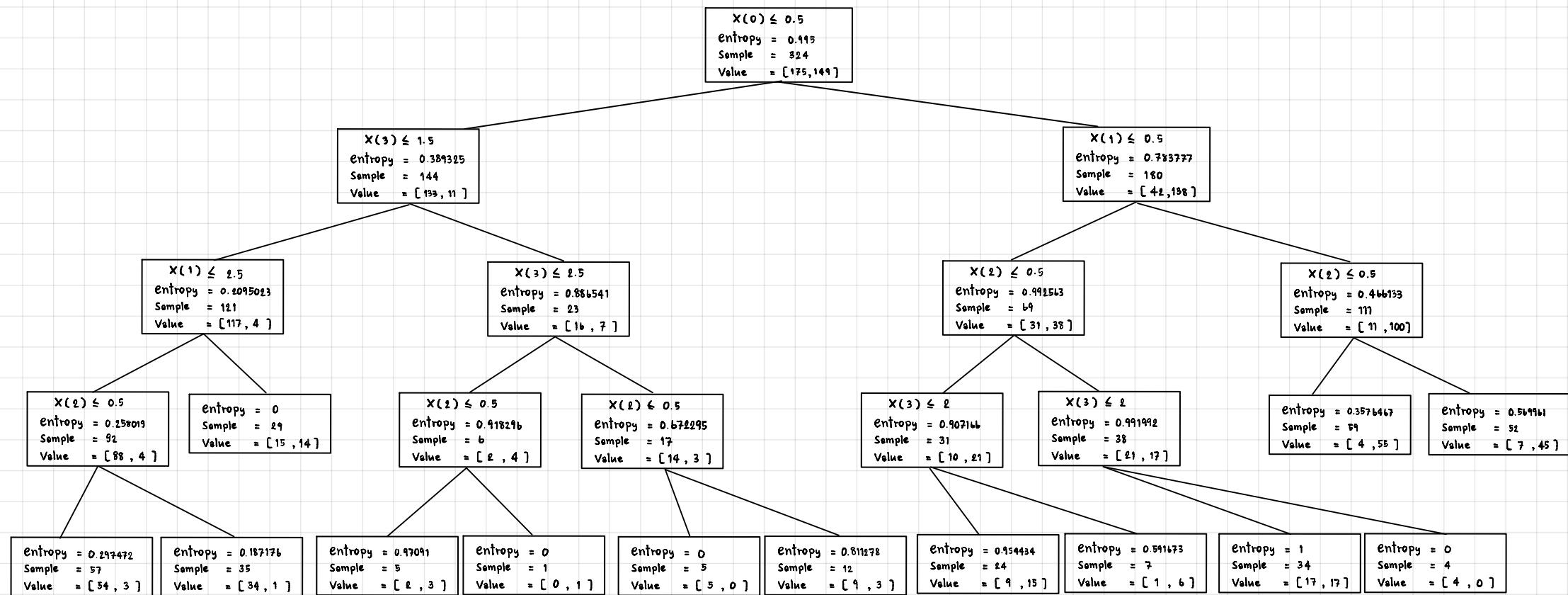
$$\text{Info}(D) = I(7, 45)$$

$$\begin{aligned} &= \left[-\frac{7}{52} \log_2 \frac{7}{52} \right] + \left[-\frac{45}{52} \log_2 \frac{45}{52} \right] \\ &= 0.569961 \end{aligned}$$

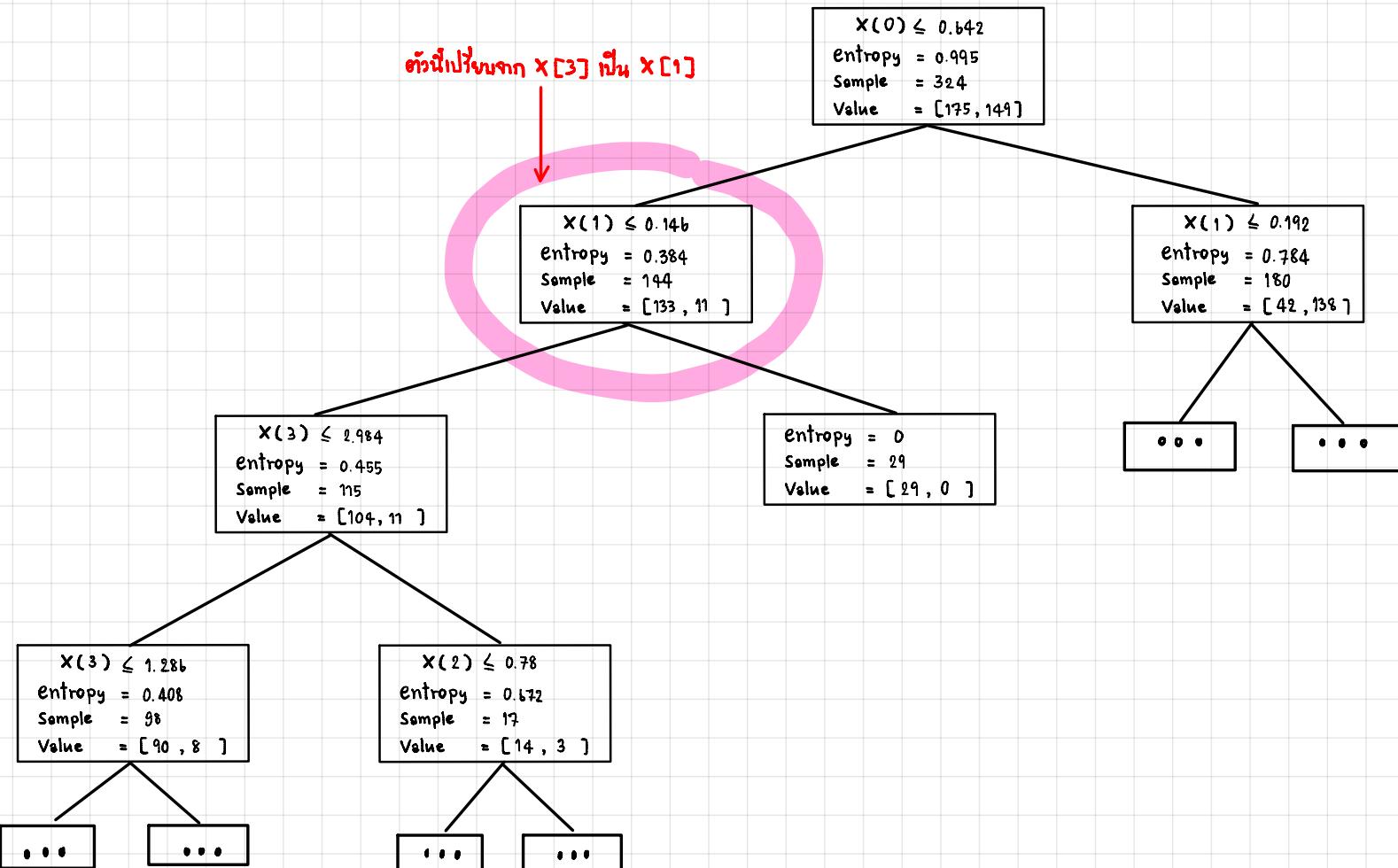
เมื่อ feature $x(3)$ หรือ θ_{13}
มีค่าเป็นไปได้ต่ำมาก คือ 1



Best and Min samples split



กราฟ random แบบที่ 2



random ห้ามที่เป็นไปได้

$$\begin{aligned} \text{กรณี } \alpha_9 &\leq 0.299 \text{ และ } \alpha_{10} \leq 0.744 \\ \text{หรือ } \alpha_9 &= 0 \quad \text{และ } \alpha_{10} = 0 \end{aligned}$$

$$\text{Info}(D) = I(104, 11)$$

$$\begin{aligned} &= \left[-\frac{104}{115} \log_2 \frac{104}{115} \right] + \left[-\frac{11}{115} \log_2 \frac{11}{115} \right] \\ &= 0.131176 + 0.323884 \\ &= 0.45506 // \end{aligned}$$

$$\text{Info } \alpha_{12}(D) = \frac{67}{115} I(61, 6) + \frac{48}{115} I(43, 5)$$

$$\begin{aligned} &= \frac{67}{115} \left[-\frac{61}{67} \log_2 \frac{61}{67} + \left(-\frac{6}{67} \log_2 \frac{6}{67} \right) \right] + \frac{48}{115} \left[-\frac{43}{48} \log_2 \frac{43}{48} + \left(-\frac{5}{48} \log_2 \frac{5}{48} \right) \right] \\ &= 0.25342 + 0.20121 \\ &= 0.45463 // \end{aligned}$$

$$\text{Info } \alpha_{13}(D) \downarrow = \frac{92}{115} I(88, 4) + \frac{23}{115} I(16, 7)$$

$$\begin{aligned} \text{กรณี } (1, (2,3)) &= \frac{92}{115} \left[-\frac{88}{92} \log_2 \frac{88}{92} + \left(-\frac{4}{92} \log_2 \frac{4}{92} \right) \right] + \frac{23}{115} \left[-\frac{16}{23} \log_2 \frac{16}{23} + \left(-\frac{7}{23} \log_2 \frac{7}{23} \right) \right] \\ &= 0.206415 + 0.177311 \\ &= 0.383726 // \end{aligned}$$

$$\text{Info } \alpha_{13}(D) \downarrow = \frac{98}{115} I(90, 8) + \frac{17}{115} I(14, 3)$$

$$\begin{aligned} \text{กรณี } ((1,2),3) &= \frac{98}{115} \left[-\frac{90}{98} \log_2 \frac{90}{98} + \left(-\frac{8}{98} \log_2 \frac{8}{98} \right) \right] + \frac{17}{115} \left[-\frac{14}{17} \log_2 \frac{14}{17} + \left(-\frac{3}{17} \log_2 \frac{3}{17} \right) \right] \\ &= 0.347607 + 0.0993827 \\ &= 0.4469897 \end{aligned}$$

$$\text{Gain } (\alpha_{12}) = 0.45506 - 0.45463 = 0.00043$$

$$\text{Gain } (\alpha_{13}) \xrightarrow{\text{กรณี } (1, (2,3))} = 0.45506 - 0.383726 = 0.0678$$

$$\xrightarrow{\text{กรณี } ((1,2),3)} = 0.45506 - 0.4469897 = 0.0080703$$

19

กรณี $a_9 = 0$, $a_{10} = 0$, $a_{13} = 1$ หรือ 2
แล้ว $a_9 = 0.74$, $a_{10} \leq 0.072$, $a_{13} \leq 2.984$

$$\text{Info}(D) = I(90, 8)$$

$$\begin{aligned} &= \left[-\frac{90}{98} \log_2 \frac{90}{98} \right] + \left[-\frac{8}{98} \log_2 \frac{8}{98} \right] \\ &= 0.112828 + 0.295078 \\ &= 0.407906 // \end{aligned}$$

$$\text{Info } a_{12}(D) = \frac{b_2}{98} I(56, 6) + \frac{36}{98} I(34, 2)$$

$$\begin{aligned} &= \frac{b_2}{98} \left[-\frac{56}{b_2} \log_2 \frac{56}{b_2} + \left(-\frac{b}{b_2} \log_2 \frac{b}{b_2} \right) \right] + \frac{36}{98} \left[-\frac{34}{36} \log_2 \frac{34}{36} + \left(-\frac{2}{36} \log_2 \frac{2}{36} \right) \right] \\ &= 0.290189 + 0.11371 \\ &= 0.403899 \end{aligned}$$

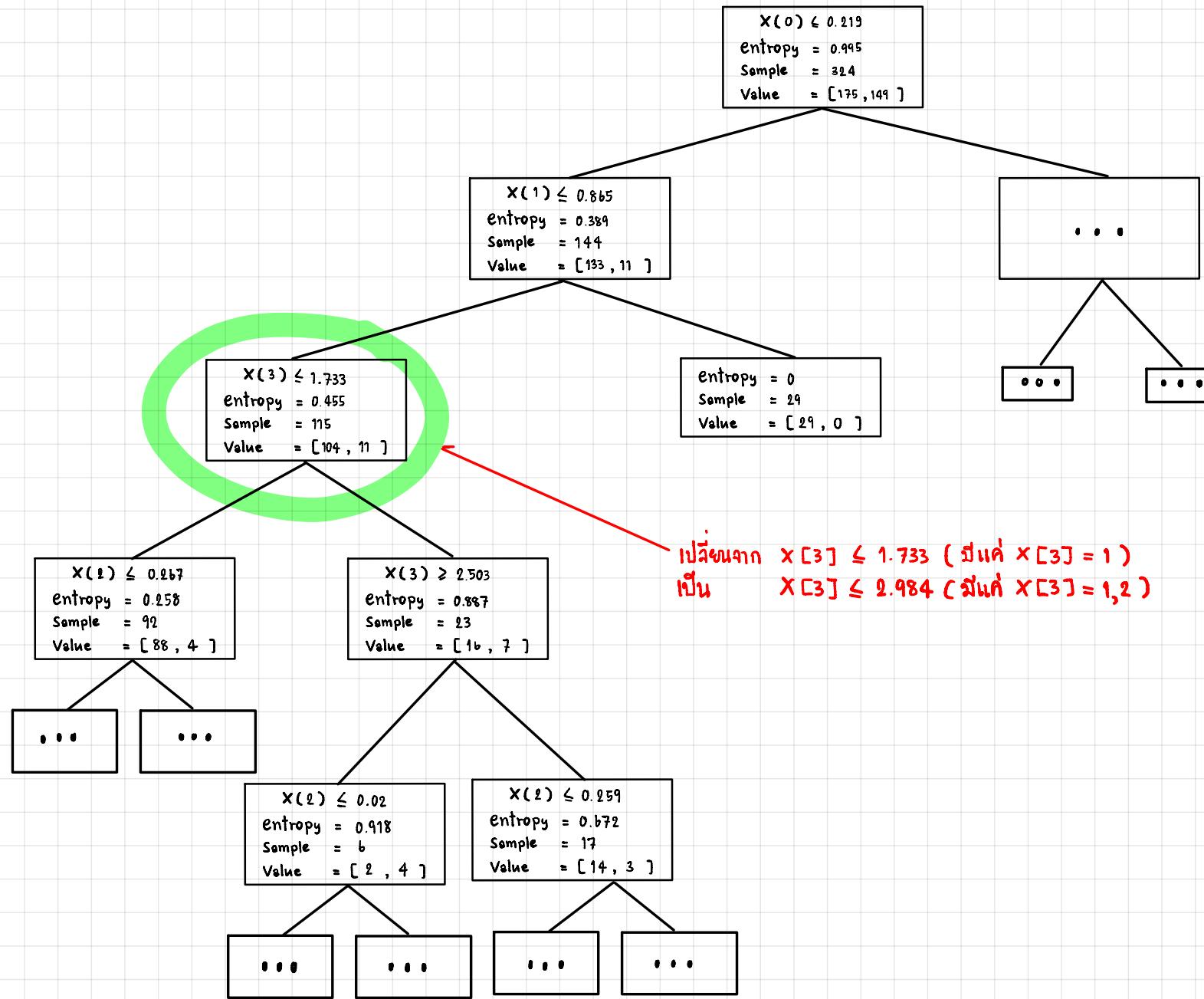
$$\text{Info } a_{13}(D) = \frac{92}{98} I(88, 4) + \frac{b}{98} I(2, 4)$$

$$\begin{aligned} \downarrow \text{กรณี } (1, 2) &= \frac{92}{98} \left[-\frac{88}{92} \log_2 \frac{88}{92} + \left(-\frac{4}{92} \log_2 \frac{4}{92} \right) \right] + \frac{b}{98} \left[-\frac{2}{b} \log_2 \frac{2}{b} + \left(-\frac{4}{b} \log_2 \frac{4}{b} \right) \right] \\ &= 0.242222 + 0.0562222 \\ &= 0.2984442 \end{aligned}$$

$$\text{Gain}(a_{12}) = 0.407906 - 0.403899 = 0.004007$$

$$\text{Gain}(a_{13}) = 0.407906 - 0.2984442 = 0.109464$$

กรณี random เน้นก้าว 3



$$\text{กรณี } a_9 = 0, a_{10} = 0, a_{13} = 2 \text{ นั่น } \\ \text{ถ้า } a_9 \leq 0.74, a_{10} \leq 0.072, a_{13} \geq 1.389$$

$$\text{Info}(D) = I(16, 7)$$

$$= \left[-\frac{16}{23} \log_2 \frac{16}{23} \right] + \left[-\frac{7}{23} \log_2 \frac{7}{23} \right] \\ = 0.364217 + 0.522324 \\ = 0.886541 //$$

$$\text{Info } a_{12}(D) = \frac{10}{23} I(7, 3) + \frac{13}{23} I(9, 4)$$

$$= \frac{10}{23} \left[-\frac{7}{10} \log_2 \frac{7}{10} + \left(-\frac{3}{10} \log_2 \frac{3}{10} \right) \right] + \frac{13}{23} \left[-\frac{9}{13} \log_2 \frac{9}{13} + \left(-\frac{4}{13} \log_2 \frac{4}{13} \right) \right] \\ = 0.38317 + 0.503322 \\ = 0.886492 //$$

$$\text{Info } a_{13}(D) = \frac{6}{23} I(2, 4) + \frac{17}{23} I(14, 3)$$

$$= \frac{6}{23} \left[-\frac{2}{6} \log_2 \frac{2}{6} + \left(-\frac{4}{6} \log_2 \frac{4}{6} \right) \right] + \frac{17}{23} \left[-\frac{14}{17} \log_2 \frac{14}{17} + \left(-\frac{3}{17} \log_2 \frac{3}{17} \right) \right] \\ = 0.239555 + 0.496914 \\ = 0.736469 //$$

$$\text{Gain}(a_{12}) = 0.886541 - 0.886492 = 0.000049$$

$$\text{Gain}(a_{13}) = 0.886541 - 0.736469 = 0.150072$$