สมาชิก

643020063-4	นางสาวเพ็ญพิชชา วรรณ์ชูมาตร์
643020513-9	นายภัทรธร ก้อนมณี
643020515-5	นายรัชชานนท์ ทิพย์พิมานพร
643020519-7	นางสาววริศรา ปันลา
643020521-0	นายวุฒิชัย คำนา
643020526-0	นางสาวอนัญญา พูลสวัสดิ์
643021271-2	นางสาววิลันดา ทาระมาตย์

(1) $Info(D) = I(175, 149)$

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

$Info_{a_9}(D)$
$$= \frac{144}{324} I(11,133) + \frac{180}{324} I(138,42)$$
$$= \frac{144}{324}\left[-\frac{11}{144}\log_2\frac{11}{144} + \left(-\frac{133}{144}\log_2\frac{133}{144}\right)\right] + \frac{180}{324}\left[-\frac{138}{180}\log_2\frac{138}{180} + \left(-\frac{42}{180}\log_2\frac{42}{180}\right)\right]$$
$$= 0.173033 + 0.435421$$
$$= 0.608454$$

$Info_{a_{10}}(D)$
$$= \frac{184}{324} I(135,49) + \frac{140}{324} I(40,100)$$
$$= \frac{184}{324}\left[-\frac{135}{184}\log_2\frac{135}{184} + \left(-\frac{49}{184}\log_2\frac{49}{184}\right)\right] + \frac{140}{324}\left[-\frac{40}{140}\log_2\frac{40}{140} + \left(-\frac{100}{140}\log_2\frac{100}{140}\right)\right]$$
$$= 0.47483 + 0.372953$$
$$= 0.84778$$

$Info_{a_{12}}(D)$
$$= \frac{172}{324} I(90,82) + \frac{152}{324} I(85,67)$$
$$= \frac{172}{324}\left[-\frac{90}{172}\log_2\frac{90}{172} + \left(-\frac{82}{172}\log_2\frac{82}{172}\right)\right] + \frac{152}{324}\left[-\frac{85}{152}\log_2\frac{85}{152} + \left(-\frac{67}{152}\log_2\frac{67}{152}\right)\right]$$
$$= 0.530036 + 0.464375$$
$$= 0.99422$$

$Info_{a_{13}}(D)$
$$= \frac{290}{324} I(154,136) + \frac{6}{324} I(2,4) + \frac{28}{324} I(19,9)$$
$$= \frac{290}{324}\left[-\frac{154}{290}\log_2\frac{154}{290} + \left(-\frac{136}{290}\log_2\frac{136}{290}\right)\right] + \frac{6}{324}\left[-\frac{2}{6}\log_2\frac{2}{6} + \left(-\frac{4}{6}\log_2\frac{4}{6}\right)\right]$$
$$+ \frac{28}{324}\left[-\frac{19}{28}\log_2\frac{19}{28} + \left(-\frac{9}{28}\log_2\frac{9}{28}\right)\right]$$
$$= 0.892573 + 0.0170055 + 0.078290$$
$$= 0.98787$$

$Info_{a_{13}}(D)$ ↓ ที่แบ่งเป็น 1,(2,3)
$$= \frac{290}{324} I(154,136) + \frac{34}{324} I(21,13)$$
$$= \frac{290}{324}\left[-\frac{154}{290}\log_2\frac{154}{290} + \left(-\frac{136}{290}\log_2\frac{136}{290}\right)\right] + \frac{34}{324}\left[-\frac{21}{34}\log_2\frac{21}{34} + \left(-\frac{13}{34}\log_2\frac{13}{34}\right)\right]$$
$$= 0.892573 + 0.100706$$
$$= 0.993281$$

$Info_{a_{13}}(D)$ ↓ ที่แบ่งเป็น 1,(2,3)
$$= \frac{296}{324} I(156,140) + \frac{28}{324} I(19,9)$$
$$= \frac{296}{324}\left[-\frac{156}{296}\log_2\frac{156}{296} + \left(-\frac{140}{296}\log_2\frac{140}{296}\right)\right] + \frac{28}{324}\left[-\frac{19}{28}\log_2\frac{19}{28} + \left(-\frac{9}{28}\log_2\frac{9}{28}\right)\right]$$
$$= 0.911654 + 0.0782901$$
$$= 0.969944$$

(2)

Gain(a_9) = 0.99535 - 0.60845 = **0.3869**

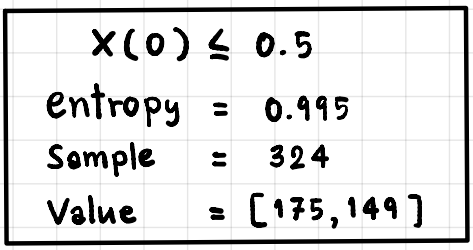
Gain(a_{10}) = 0.99535 - 0.84778 = 0.14757

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

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

Gain(a_{13}) → 1,(2,3) = 0.99535 - 0.993281 = 0.002069

→ (1,2),3 = 0.99535 - 0.989944 = 0.005406



3

กรณี $a_9 = 0$ หรือ $a_9 \le 0.5$

$$Info(D) = I(133,11)$$

$$= \left[-\frac{133}{144}\log_2\frac{133}{144}\right] + \left[-\frac{11}{144}\log_2\frac{11}{144}\right]$$

$$= 0.28344 + 0.105885$$

$$= 0.389325$$

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

$$= \frac{115}{144}\left[-\frac{104}{115}\log_2\frac{104}{115} + \left(-\frac{11}{115}\log_2\frac{11}{115}\right)\right] + \frac{29}{144}\left[-\frac{29}{29}\log_2\frac{29}{29} + \left(-\frac{0}{29}\log_2\frac{0}{29}\right)\right]$$

(0 และ หาค่าไม่ได้)

$$= 0.363416$$

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

$$= \frac{82}{144}\left[-\frac{76}{82}\log_2\frac{76}{82} + \left(-\frac{6}{82}\log_2\frac{6}{82}\right)\right] + \frac{62}{144}\left[-\frac{57}{62}\log_2\frac{57}{62} + \left(-\frac{5}{62}\log_2\frac{5}{62}\right)\right]$$

$$= 0.215048 + 0.174149$$

$$= 0.389197$$

$Info_{a_{13}}(D)$ แบ่งเป็น 1,(2,3)

$$= \frac{121}{144}I(117,4) + \frac{23}{144}I(16,7)$$

$$= \frac{121}{144}\left[-\frac{117}{121}\log_2\frac{117}{121} + \left(-\frac{4}{121}\log_2\frac{4}{121}\right)\right] + \frac{23}{144}\left[-\frac{16}{23}\log_2\frac{16}{23} + \left(-\frac{7}{23}\log_2\frac{7}{23}\right)\right]$$

$$= 0.17604 + 0.1416$$

$$= 0.31764$$

$Info_{a_{13}}(D)$ แบ่งเป็น (1,2),3

$$= \frac{127}{144}I(119,8) + \frac{17}{144}I(14,3)$$

$$= \frac{127}{144}\left[-\frac{119}{127}\log_2\frac{119}{127} + \left(-\frac{8}{127}\log_2\frac{8}{127}\right)\right] + \frac{17}{144}\left[-\frac{14}{17}\log_2\frac{14}{17} + \left(-\frac{3}{17}\log_2\frac{3}{17}\right)\right]$$

$$= 0.299164 + 0.0793682$$

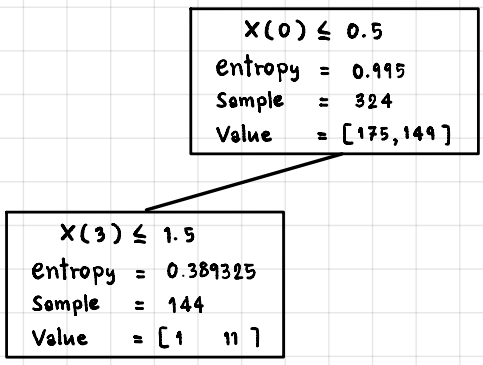
$$= 0.378532$$

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

$Gain(a_{12}) = 0.389325 - 0.383197 = 0.000128$

$Gain(a_{13}) \rightarrow = 0.389325 - 0.31764 = \boxed{0.071685}$ → กรณี a_{13} ที่แบ่งเป็นกรณี 1,(2,3)

$Gain(a_{13}) \searrow = 0.389325 - 0.378532 = 0.010793$



(4)

กรณี $a_9 = 1$
หรือ $a_9 \geq 0.5$

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

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

$$= 0.489892 + 0.293885$$

$$= 0.783777$$

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

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

$$= 0.380482 + 0.287449$$

$$= 0.667931$$

$$\text{Info}_{a_{12}}(D) = \frac{90}{160} I(14,76) + \frac{90}{180} I(28,62)$$

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

$$= 0.311785 + 0.447226$$

$$= 0.759011$$

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

↓ แบ่งเป็น (1,3)

$$= \frac{169}{180}\left[-\frac{37}{169}\log_2\frac{37}{169} + \left(-\frac{132}{169}\log_2\frac{132}{169}\right)\right] + \frac{11}{180}\left[-\frac{5}{11}\log_2\frac{5}{11} + \left(-\frac{6}{11}\log_2\frac{6}{11}\right)\right]$$

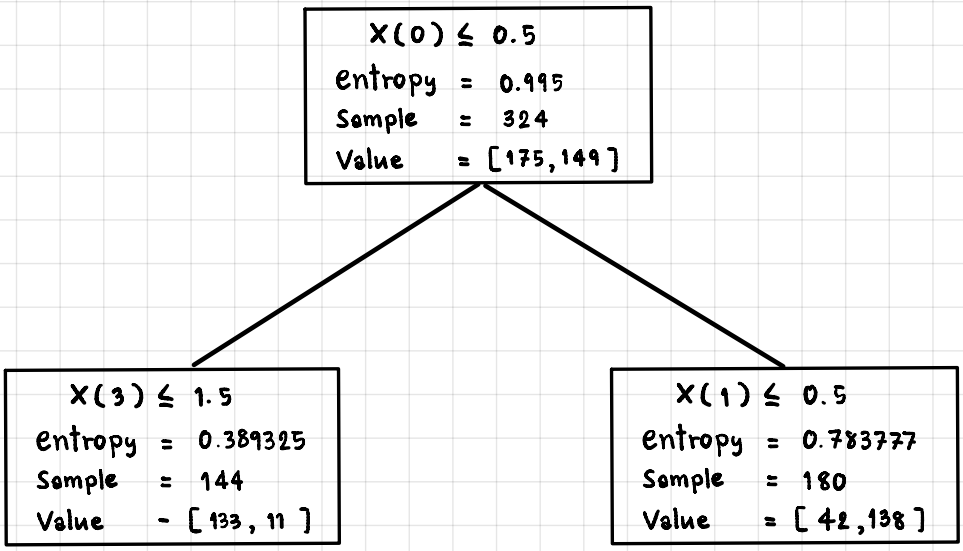
$$= 0.711882 + 0.0607463$$

$$= 0.7726283$$

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

$$\text{Gain}(a_{12}) = 0.783777 - 0.759011 = 0.0024766$$

$$\text{Gain}(a_{13}) = 0.783777 - 0.7726283 = 0.0111487$$



5

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

$$Info(D) = I(117,4)$$

$$= \left[-\frac{117}{121}\log_2\frac{117}{121}\right] + \left[-\frac{4}{121}\log_2\frac{4}{121}\right]$$
$$= 0.0468953 + 0.162607$$
$$= 0.2095023 \text{ //}$$

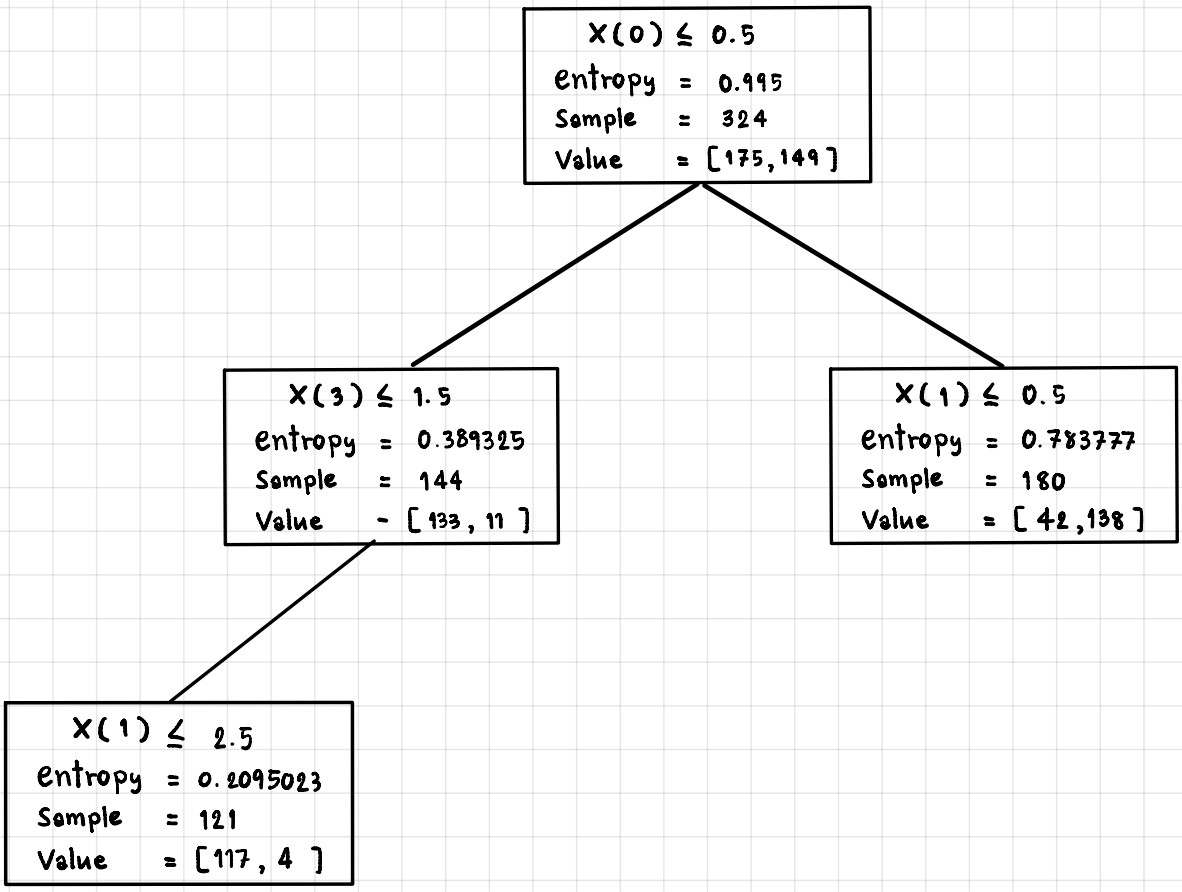
$$Info_{a_{10}}(D) = \frac{92}{121}I(88,4) + \frac{29}{121}I(29,0)$$
$$= \frac{92}{121}\left[-\frac{88}{92}\log_2\frac{88}{92} + \left(-\frac{4}{92}\log_2\frac{4}{92}\right)\right] + \frac{29}{121}\left[-\frac{29}{29}\log_2\frac{29}{29} + \left(-\frac{0}{29}\log_2\frac{0}{29}\right)\right]$$

0 หรือไม่ได้

$$= 0.19618 \text{ //}$$

$$Info_{a_{12}}(D) = \frac{72}{121}I(69,3) + \frac{49}{121}I(48,1)$$
$$= \frac{72}{121}\left[-\frac{69}{72}\log_2\frac{69}{72} + \left(-\frac{3}{72}\log_2\frac{3}{72}\right)\right] + \frac{49}{121}\left[-\frac{48}{49}\log_2\frac{48}{49} + \left(-\frac{1}{49}\log_2\frac{1}{49}\right)\right]$$
$$= 0.14869 + 0.0582032$$
$$= 0.2068932 \text{ //}$$

$Gain(a_{10}) = 0.2095023 - 0.19618 = \boxed{0.0133223}$
$Gain(a_{12}) = 0.2095023 - 0.2068932 = 0.0026091$



b

กรณี $a_9 = 0$ แล้ว $a_{13} = 2, 3$
หรือ $a_9 \leq 0.5$ แล้ว $a_{13} \geq 1.5$

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

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

$$= 0.364217 + 0.522324$$

$$= 0.886541 //$$

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

$$= \frac{23}{23}\left[-\frac{16}{23}\log_2\frac{16}{23} + \left(-\frac{7}{23}\log_2\frac{7}{23}\right)\right]$$

$$= 0.886541 //$$

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

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

$$= 0.38317 + 0.503321$$

$$= 0.88649 //$$

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

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

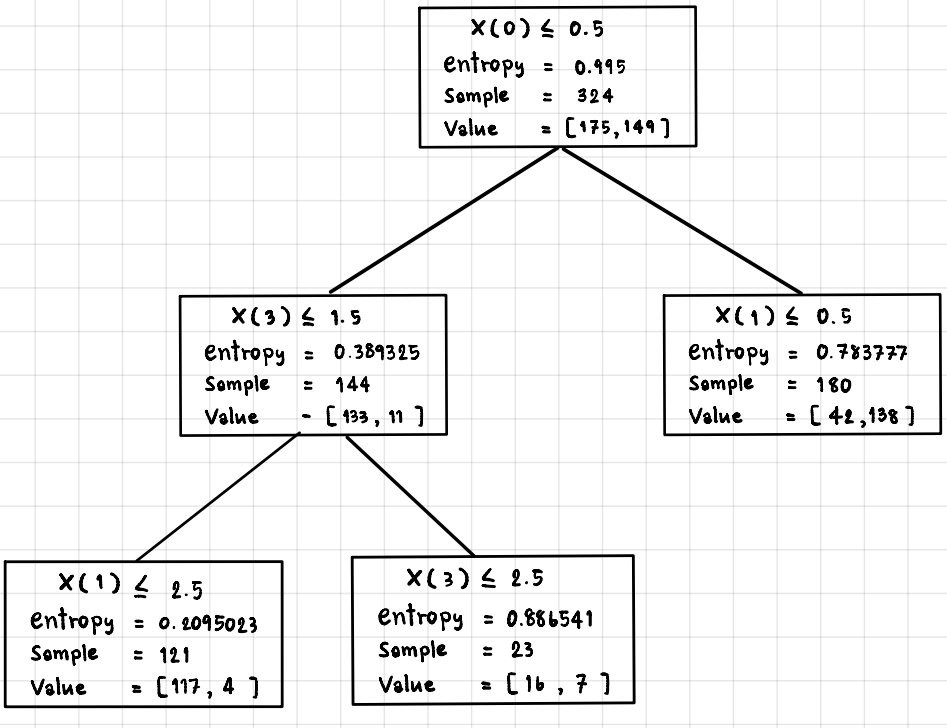
$$= 0.239555 + 0.496914$$

$$= 0.736469 //$$

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

$$\text{Gain}(a_{12}) = 0.886541 - 0.88641 = 0.000051$$

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



(7)

กรณี $a_9 = 1$ แล้ว $a_{10} = 0$
หรือ $a_9 \geq 0.5$ แล้ว $a_{10} \leq 0.5$

$$Info(D) = I(31,38)$$

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

$$= 0.992563$$

$$Info_{a_{12}}(D) = \frac{31}{69}I(10,21) + \frac{38}{69}I(21,17)$$

$$= \frac{31}{69}\left[-\frac{10}{31}\log_2\frac{10}{31} + \left(-\frac{21}{31}\log_2\frac{21}{31}\right)\right] + \frac{38}{69}\left[-\frac{21}{38}\log_2\frac{21}{38} + \left(-\frac{17}{38}\log_2\frac{17}{38}\right)\right]$$

$$= 0.407567 + 0.546314$$

$$= 0.953881$$

$$Info_{a_{13}}(D) = \frac{58}{69}I(26,32) + \frac{11}{69}I(5,6)$$

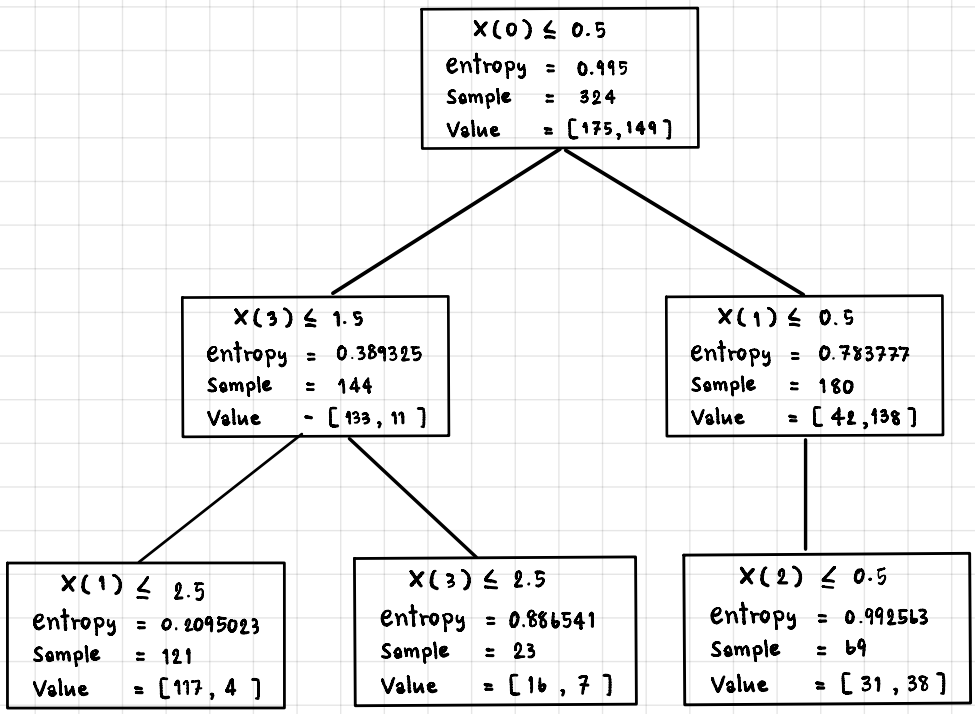
$$= \frac{58}{69}\left[-\frac{26}{58}\log_2\frac{26}{58} + \left(-\frac{32}{58}\log_2\frac{32}{58}\right)\right] + \frac{11}{69}\left[-\frac{5}{11}\log_2\frac{5}{11} + \left(-\frac{6}{11}\log_2\frac{6}{11}\right)\right]$$

$$= 0.83408 + 0.158469$$

$$= 0.992549$$

$$Gain(a_{12}) = 0.992563 - 0.953881 = \boxed{0.038682}$$

$$Gain(a_{13}) = 0.992563 - 0.992549 = 0.000014$$



8

กรณี $a_9 = 1$ แล: $a_{10} = 1$
หรือ $a_9 \geq 0.5$ แล: $a_{10} \geq 0.5$

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

$$= \left[-\frac{11}{111} \log_2 \frac{11}{111} \right] + \left[-\frac{100}{111} \log_2 \frac{100}{111} \right]$$

$$= 0.330494 + 0.135639$$

$$= 0.466133 //$$

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

$$= \frac{59}{111} \left[-\frac{4}{59} \log_2 \frac{4}{59} + \left(-\frac{5}{59} \log_2 \frac{5}{59} \right) \right] + \frac{52}{111} \left[-\frac{45}{52} \log_2 \frac{45}{52} + \left(-\frac{7}{52} \log_2 \frac{7}{52} \right) \right]$$

$$= 0.1901 + 0.267009$$

$$= 0.457109 //$$

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

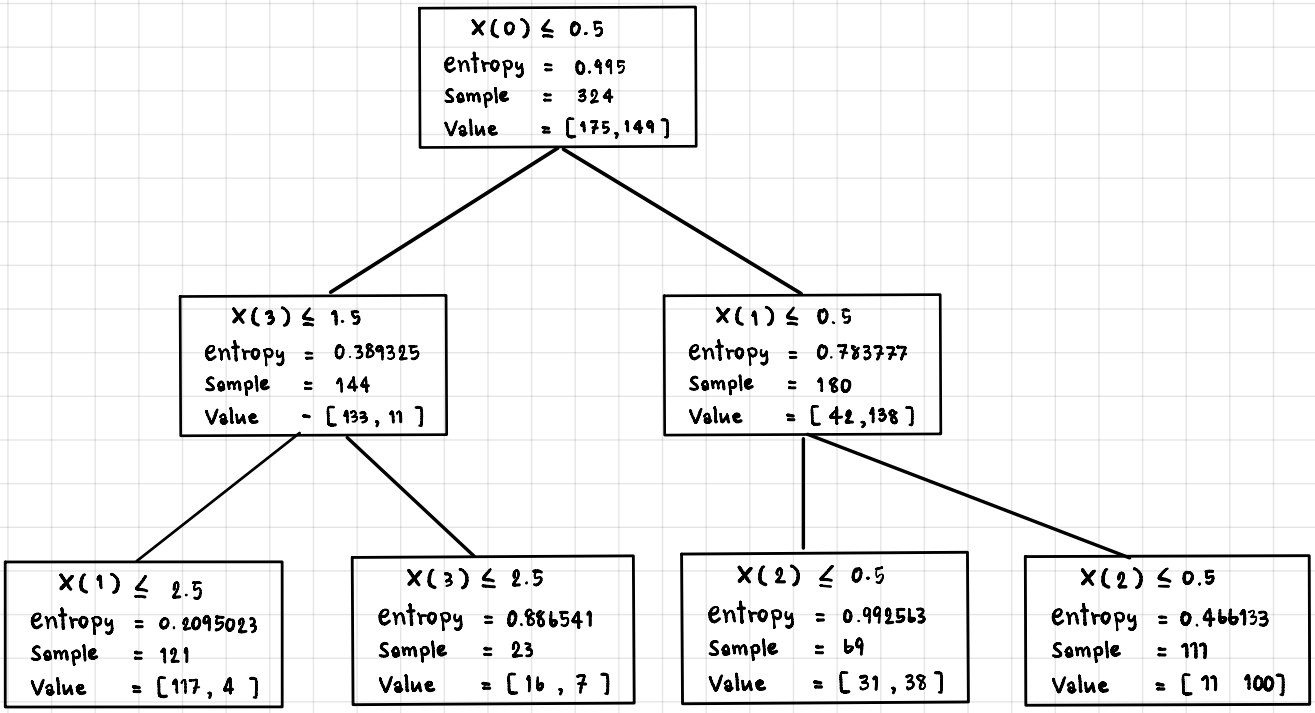
$$= \frac{111}{111} \left[-\frac{11}{111} \log_2 \frac{11}{111} + \left(-\frac{100}{111} \log_2 \frac{100}{111} \right) \right]$$

$$= 0.330494 + 0.135639$$

$$= 0.466133 //$$

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

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



9

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

$$Info(D) = I(88,4)$$

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

$$= 0.258019 //$$

→ สิ้นสุดแล้วเนื่องจากใช้ feature, column, dimention, attribute คนเดียว

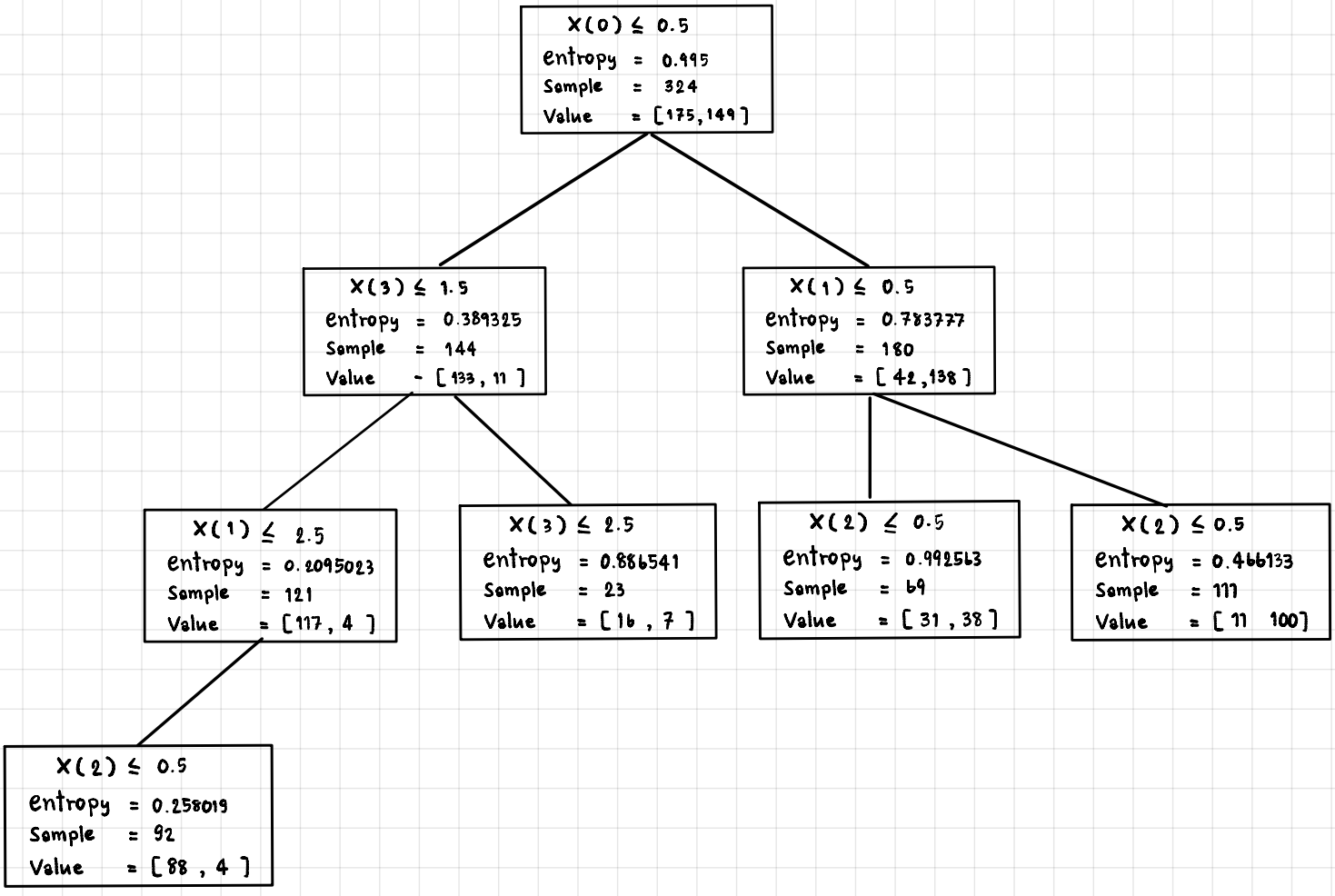
$$Info_{a_{12}}(D) = \frac{57}{92} I(54,3) + \frac{35}{92} I(34,1)$$

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

$$= 0.184303 + 0.0712083$$

$$= 0.2555113 //$$

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



10

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

$$Info(D) = I(15,14)$$

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

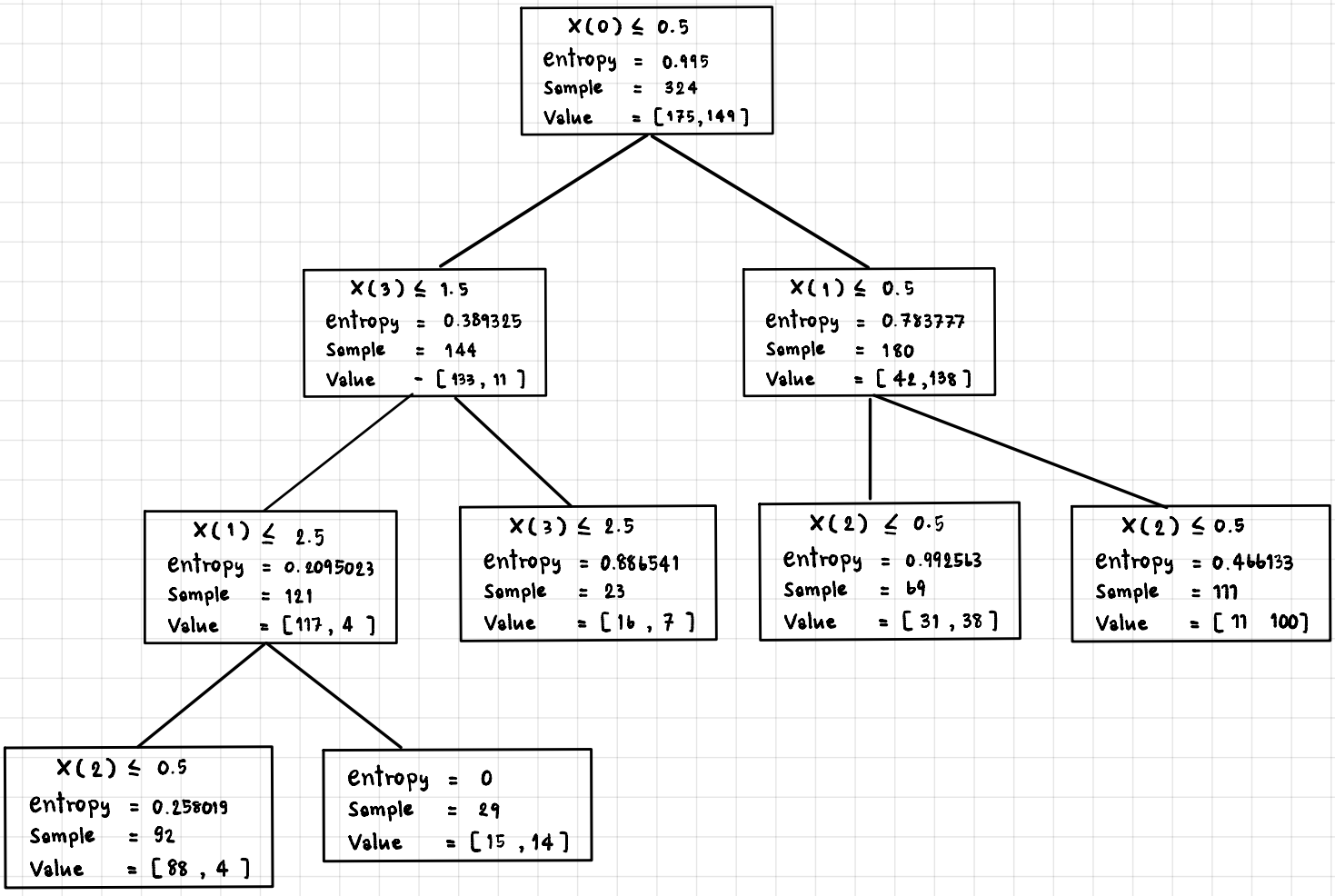
$$= 0.999142$$

$$Info_{a_{12}}(D) = I(15,14)$$

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

$$= 0.999142$$

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



(11)

กรณี $a_9 = 0$ แล: $a_{13} = (2,3)$ แต่ $a_{13} = (1,2)$
หรือ $a_9 \leq 0.5$ แล: $a_{13} \geq 1.5$ แต่ $a_{13} \leq 2.5$

$$Info(D) = I(2,4)$$

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

$$= 0.918296$$

$$Info_{a_{12}}(D) = \frac{5}{6}I(2,3) + \frac{1}{6}I(0,1)$$

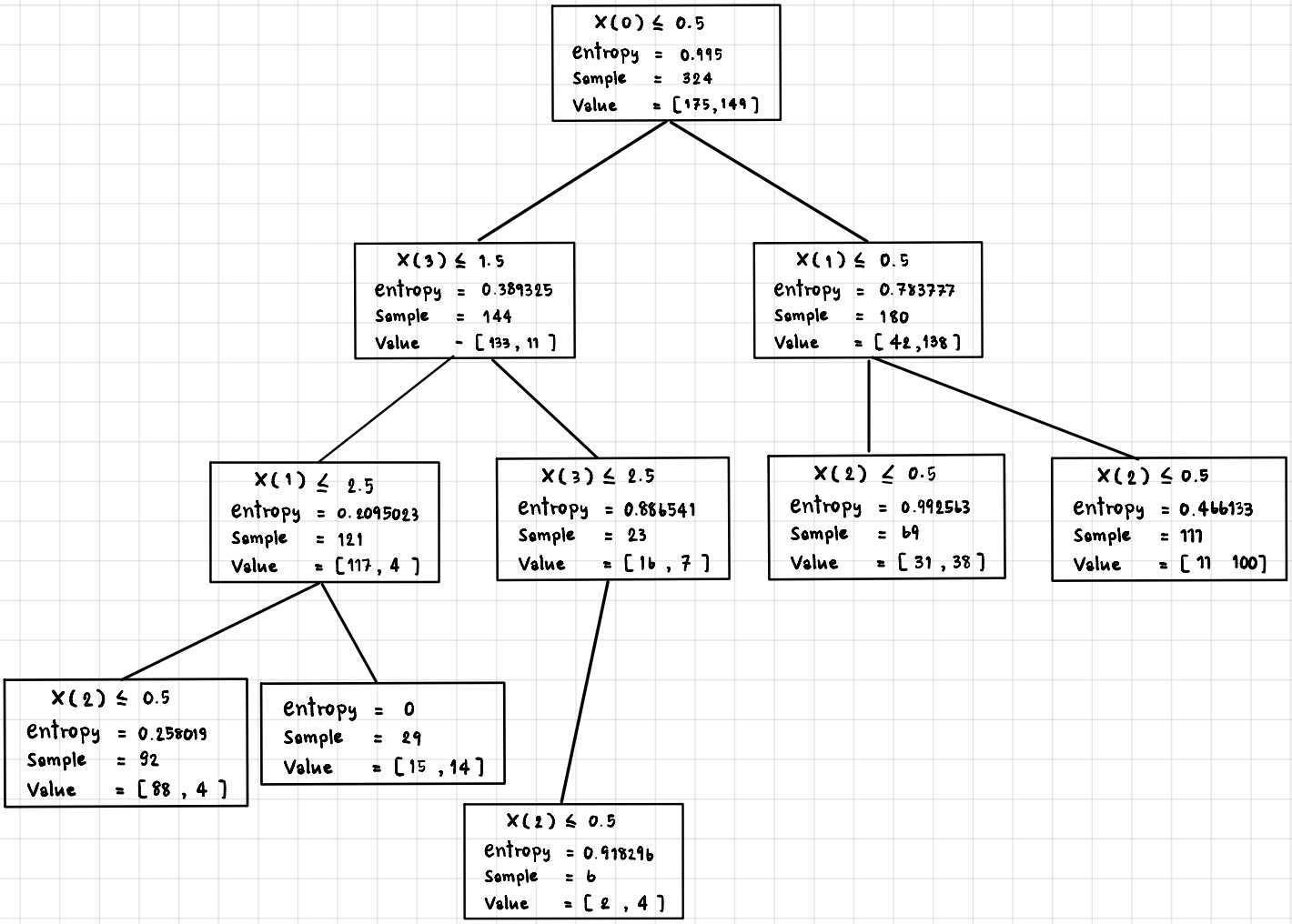
$$= \frac{5}{6}\left[-\frac{2}{5}\log_2\frac{2}{5} + \left(-\frac{3}{5}\log_2\frac{3}{5}\right)\right] + \frac{1}{6}\left[-\frac{0}{1}\log_2\frac{0}{1} + \left(-\frac{1}{1}\log_2\frac{1}{1}\right)\right]$$

0.97095

ทศนิยมไม่ได้ 0

$$= 0.809126$$

$$Gain(a_{12}) = 0.918296 - 0.809126 = \boxed{0.10917}$$



12 กรณี $a_9 = 0$, $a_{13} = (2,3)$ และ $a_{13} = 3$
หรือ $a_9 \leq 0.5$, $a_{13} \geqslant 1.5$ และ $a_{13} \geqslant 2.5$

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

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

$$= 0.672295 \text{ //}$$

สิ้นสุดแล้ว

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

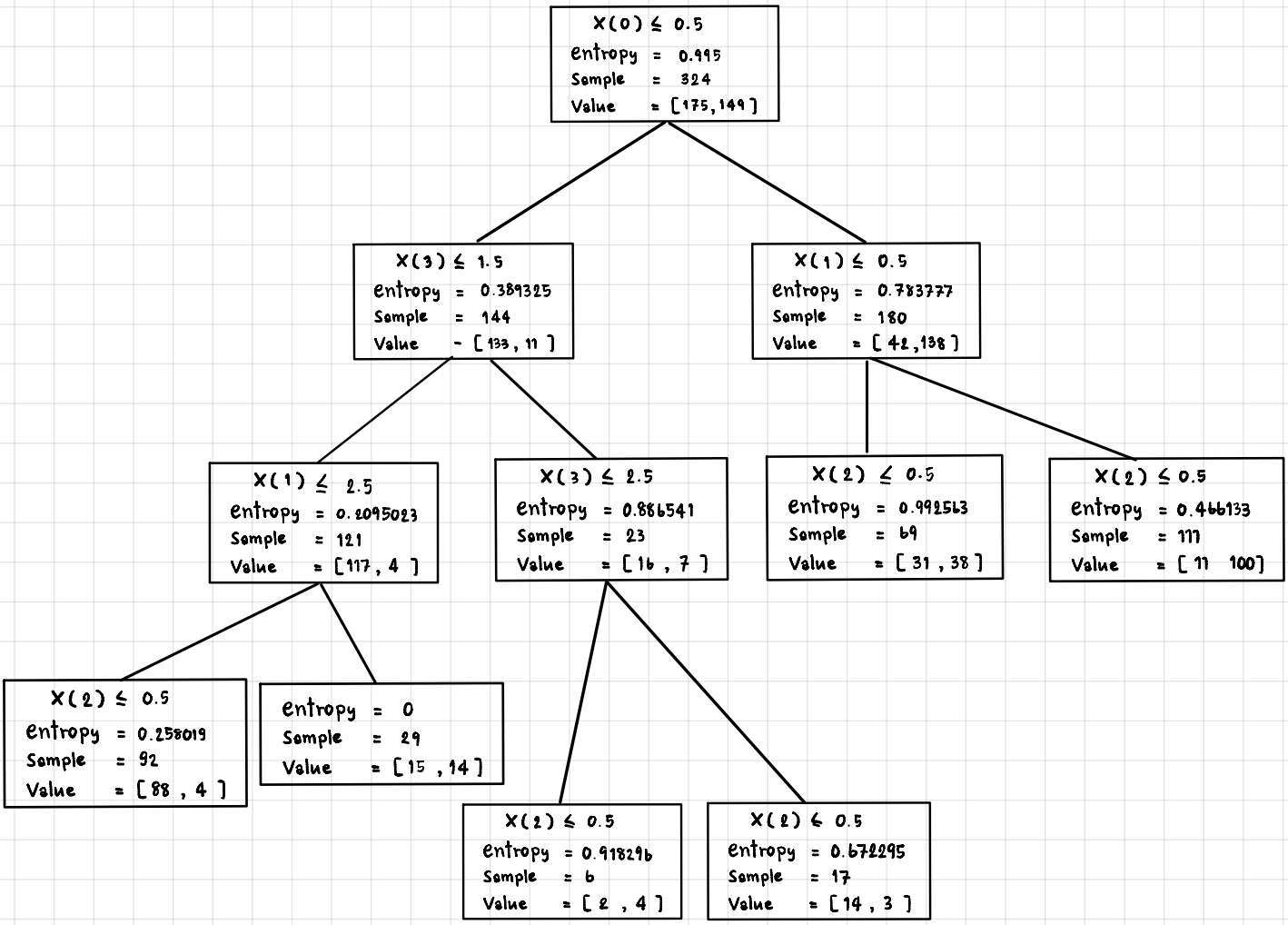
$$= \frac{5}{17}\left[-\frac{5}{5}\log_2\frac{5}{5} + \left(-\frac{0}{5}\log_2\frac{0}{5}\right)\right] + \frac{12}{17}\left[-\frac{9}{12}\log_2\frac{9}{12} + \left(-\frac{3}{12}\log_2\frac{3}{12}\right)\right]$$

(0 แต่ทำไม่ได้)

$$= 0.572667 \text{ //}$$

(0.811278)

$$\text{Gain}(a_{12}) = 0.672295 - 0.57667 = 0.099628$$



13

กรณี $a_9 = 1$, $a_{10} = 0$, $a_{12} = 0$
หรือ $a_9 \geq 0.5$, $a_{10} \leq 0.5$, $a_{12} \leq 0.5$

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

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

$$= 0.526538 + 0.380628$$

$$= 0.907166$$

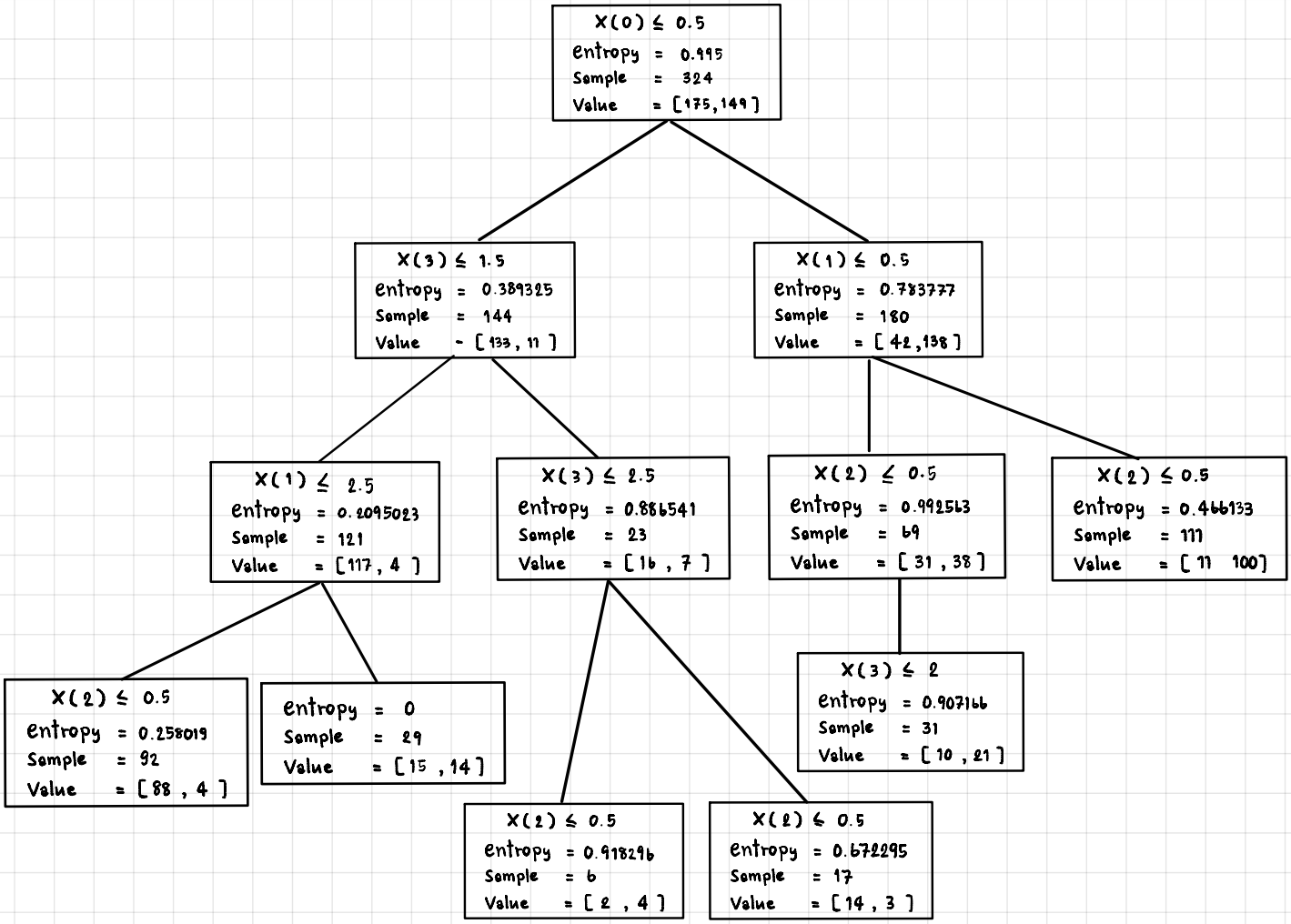
$$\text{Info}_{a_{13}}(D) = \frac{24}{31} I(9,15) + \frac{7}{31} I(1,6)$$

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

$$= 0.738917 + 0.133604$$

$$= 0.872521$$

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



14

กรณี $a_9 = 1$, $a_{10} = 0$, $a_{12} = 1$
หรือ $a_9 \geq 0.5$, $a_{10} \leq 0.5$, $a_{12} \geq 0.5$

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

$$= \left[-\frac{21}{38} \log_2 \frac{21}{38} \right] + \left[-\frac{17}{38} \log_2 \frac{17}{38} \right]$$

$$= 0.472837 + 0.519155$$

$$= 0.991992 \text{ //}$$

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

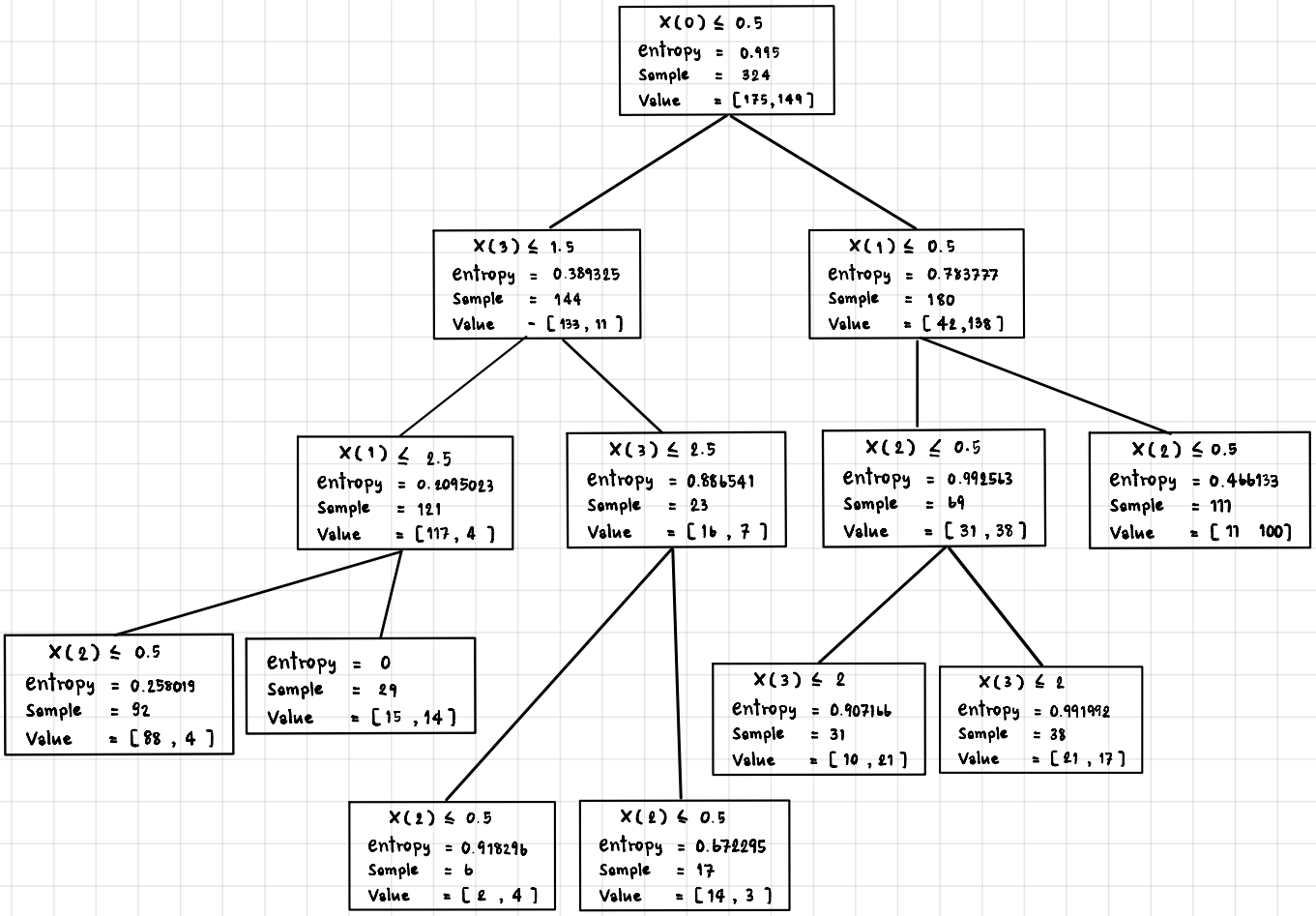
$$= \frac{34}{38} \left[-\frac{17}{34} \log_2 \frac{17}{34} + \left(-\frac{17}{34} \log_2 \frac{17}{34} \right) \right] + \frac{4}{36} \left[-\frac{4}{4} \log_2 \frac{4}{4} + \left(-\frac{0}{4} \log_2 \frac{0}{4} \right) \right]$$

(0 ; หาค่าไม่ได้)

$$= \frac{34}{38} \times (0.5 + 0.5)$$

$$= 0.894737 \text{ //}$$

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



15

กรณี $a_9 = 1$, $a_{10} = 1$, $a_{12} = 0$
หรือ $a_9 \geq 0.5$, $a_{10} \geq 0.5$, $a_{12} \leq 0.5$

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

$$= \left[-\frac{4}{59} \log_2 \frac{4}{59} \right] + \left[-\frac{55}{59} \log_2 \frac{55}{59} \right]$$

$$= 0.26323 + 0.0944167$$

$$= 0.3576467$$

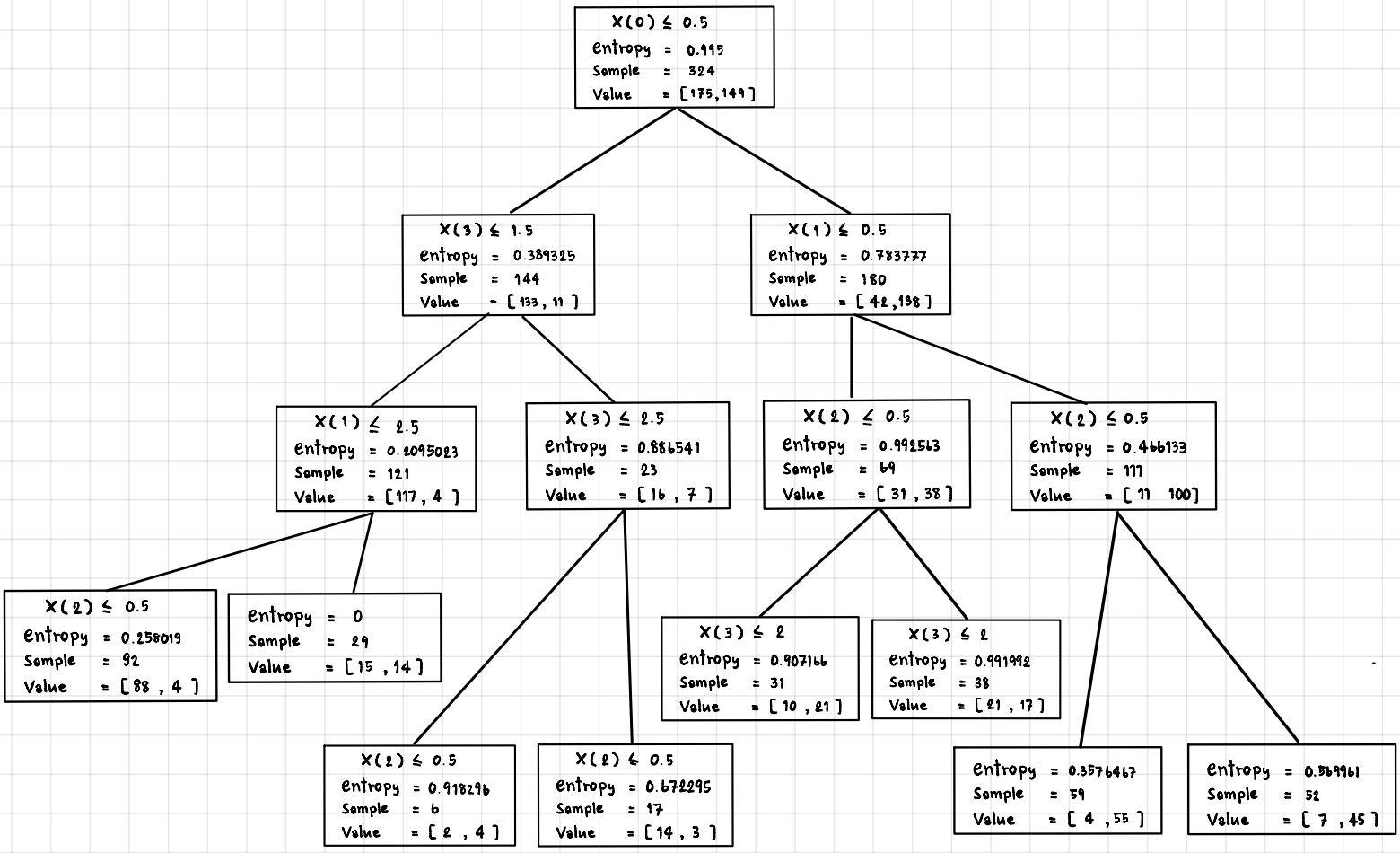
→ ไม่มีแบ่งต่อ เพราะ feature $x(3)$ หรือ a_{13} มีค่าเป็นไปได้ค่าเดียวคือ 1

กรณี $a_9 = 1$, $a_{10} = 1$, $a_{12} = 1$
หรือ $a_9 \geq 0.5$, $a_{10} \geq 0.5$, $a_{12} \geq 0.5$

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

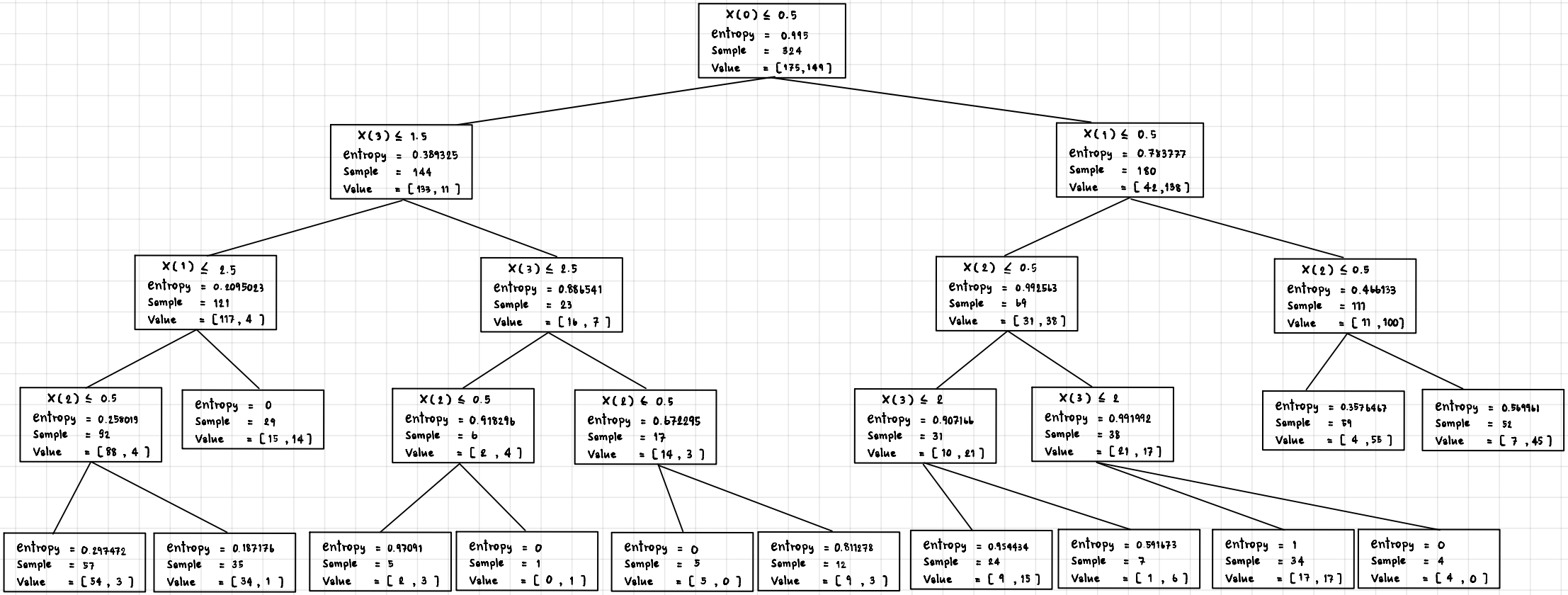
$$= \left[-\frac{7}{52} \log_2 \frac{7}{52} \right] + \left[-\frac{45}{52} \log_2 \frac{45}{52} \right]$$

$$= 0.569961$$

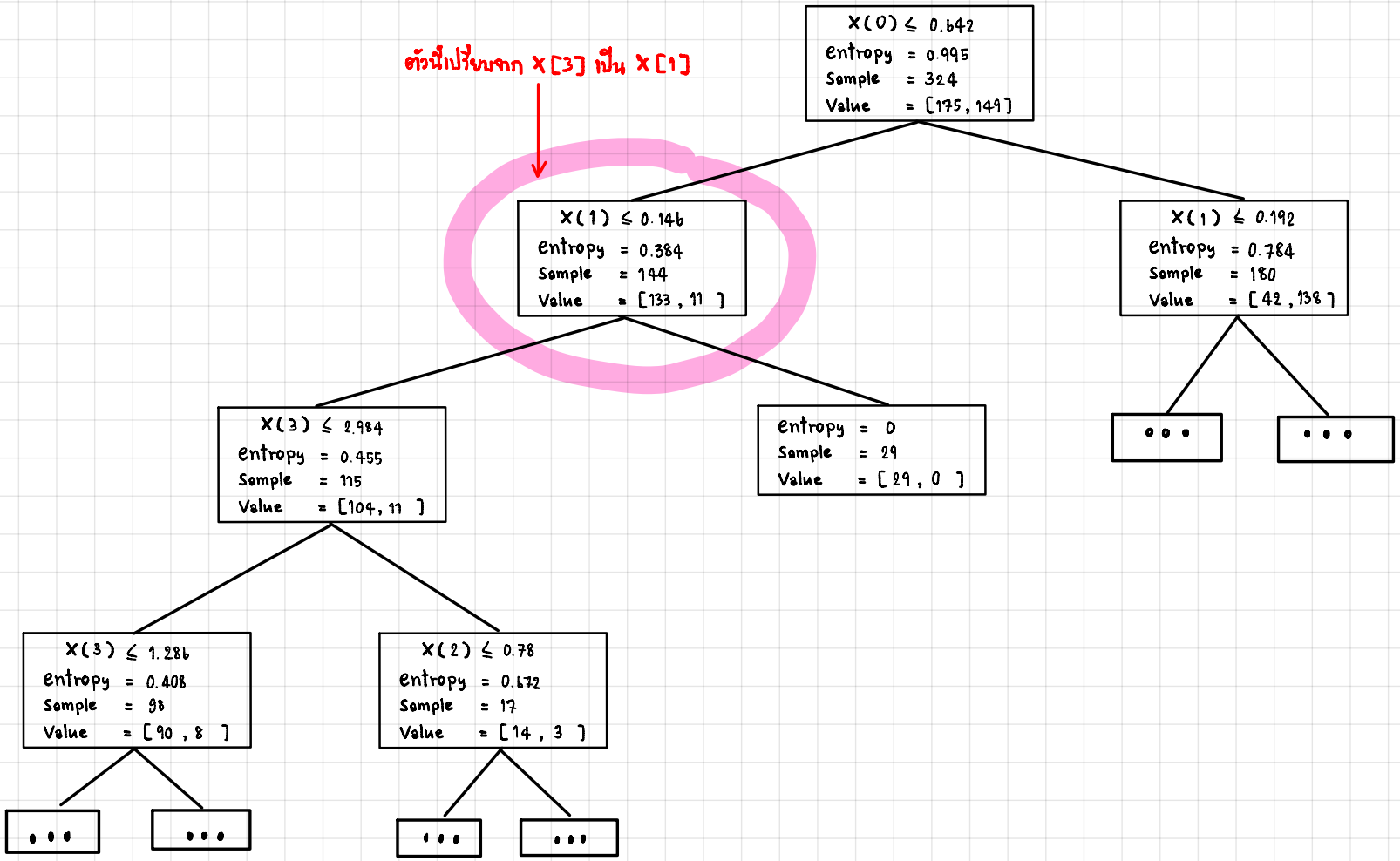


16

Best and Min samples split



กรณี random แบบที่ 2



18 random ต้นไม้ที่เป็นไปได้

กรณี $a_9 \le 0.299$ แล้ว $a_{10} \le 0.744$
หรือ $a_9 = 0$ แล้ว $a_{10} = 0$

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

$$= \left[-\frac{104}{115}\log_2\frac{104}{115}\right] + \left[-\frac{11}{115}\log_2\frac{11}{115}\right]$$

$$= 0.131176 + 0.323884$$

$$= 0.45506 //$$

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

$$= \frac{67}{115}\left[-\frac{61}{67}\log_2\frac{61}{67} + \left(-\frac{6}{67}\log_2\frac{6}{67}\right)\right] + \frac{48}{115}\left[-\frac{43}{48}\log_2\frac{43}{48} + \left(-\frac{5}{48}\log_2\frac{5}{48}\right)\right]$$

$$= 0.25342 + 0.20121$$

$$= 0.45463 //$$

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

↓ กรณี (1,(2,3))

$$= \frac{92}{115}\left[-\frac{88}{92}\log_2\frac{88}{92} + \left(-\frac{4}{92}\log_2\frac{4}{92}\right)\right] + \frac{23}{115}\left[-\frac{16}{23}\log_2\frac{16}{23} + \left(-\frac{7}{23}\log_2\frac{7}{23}\right)\right]$$

$$= 0.206415 + 0.177311$$

$$= 0.383726 //$$

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

↓ กรณี ((1,2),3)

$$= \frac{98}{115}\left[-\frac{90}{98}\log_2\frac{90}{98} + \left(-\frac{8}{98}\log_2\frac{8}{98}\right)\right] + \frac{17}{115}\left[-\frac{14}{17}\log_2\frac{14}{17} + \left(-\frac{3}{17}\log_2\frac{3}{17}\right)\right]$$

$$= 0.347607 + 0.0993827$$

$$= 0.4469897$$

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

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

$\text{Gain}(a_{13})$ → $= 0.45506 - 0.4469897 = 0.0080703$ → กรณี ((1,2),3)

19

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

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

$$= \left[-\frac{90}{98} \log_2 \frac{90}{98} \right] + \left[-\frac{8}{98} \log_2 \frac{8}{98} \right]$$

$$= 0.112828 + 0.295078$$

$$= 0.407906 \text{ //}$$

$$\text{Info}_{a_{12}}(D) = \frac{62}{98} I(56, 6) + \frac{36}{98} I(34, 2)$$

$$= \frac{62}{98}\left[-\frac{56}{62} \log_2 \frac{56}{62} + \left(-\frac{6}{62} \log_2 \frac{6}{62} \right) \right] + \frac{36}{98}\left[-\frac{34}{36} \log_2 \frac{34}{36} + \left(-\frac{2}{36} \log_2 \frac{2}{36} \right) \right]$$

$$= 0.290189 + 0.11371$$

$$= 0.403899$$

$$\text{Info}_{a_{13}}(D) = \frac{92}{98} I(88, 4) + \frac{6}{98} I(2, 4)$$

↓ กรณี (1,2)

$$= \frac{92}{98}\left[-\frac{88}{92} \log_2 \frac{88}{92} + \left(-\frac{4}{92} \log_2 \frac{4}{92} \right) \right] + \frac{6}{98}\left[-\frac{2}{6} \log_2 \frac{2}{6} + \left(-\frac{4}{6} \log_2 \frac{4}{6} \right) \right]$$

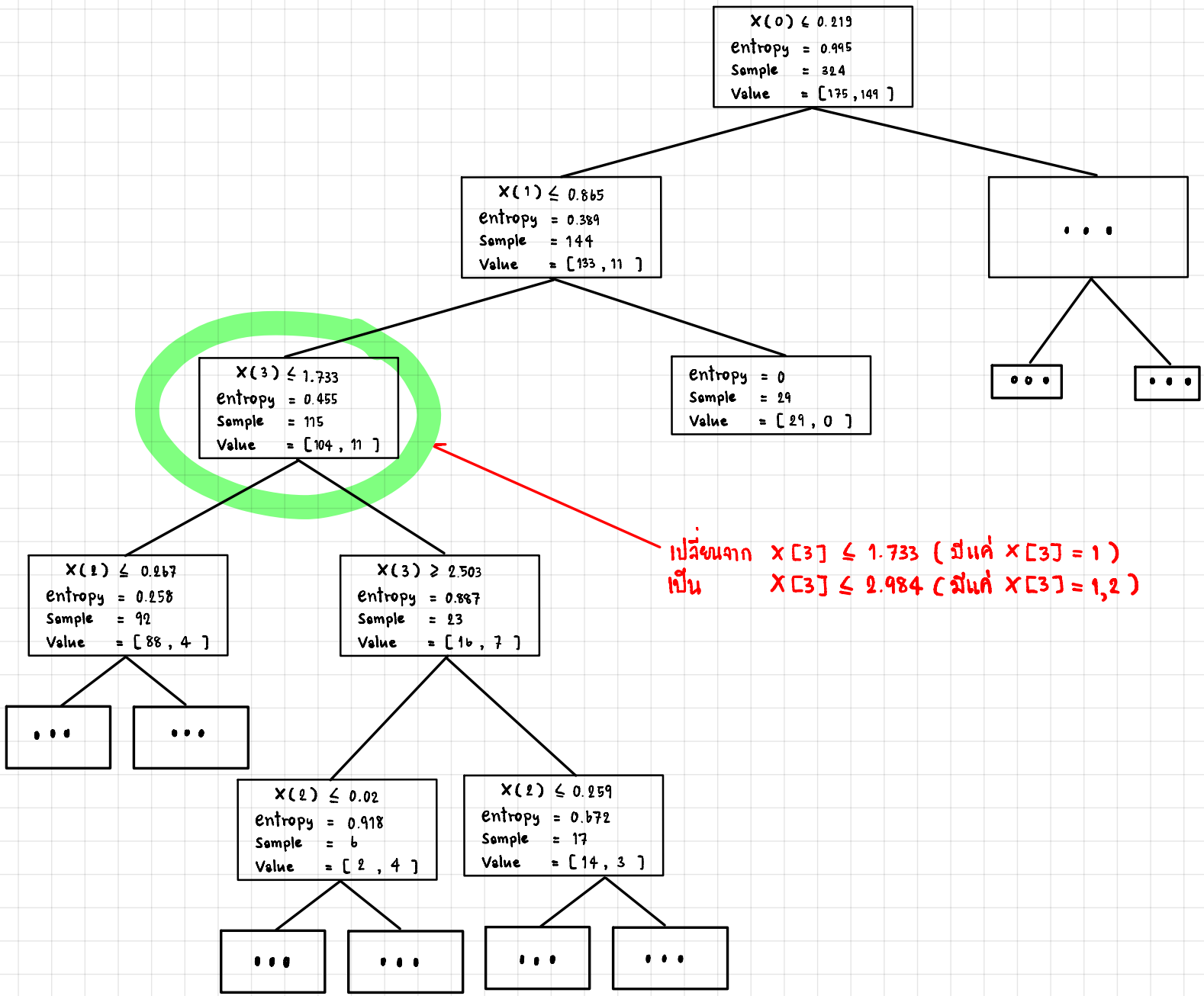
$$= 0.242222 + 0.0562222$$

$$= 0.2984442$$

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

$$\text{Gain}(a_{13}) = 0.407906 - 0.298442 = \boxed{0.109464}$$

กรณี random แบบที่ 3



เปลี่ยนจาก $X[3] \leq 1.733$ (มีแค่ $X[3] = 1$)
เป็น $X[3] \leq 2.984$ (มีแค่ $X[3] = 1, 2$)

(21) กรณี $a_9 = 0$, $a_{10} = 0$, $a_{13} = 2$ หรือ 3
หรือ $a_9 \leq 0.74$, $a_{10} \leq 0.072$, $a_{13} \geq 1.389$

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

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

$$= 0.364217 + 0.522324$$

$$= 0.886541 //$$

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

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

$$= 0.38317 + 0.503322$$

$$= 0.886492 //$$

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

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

$$= 0.239555 + 0.496914$$

$$= 0.736469 //$$

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

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