Classification : ทำนายกลุ่มของข้อมูล

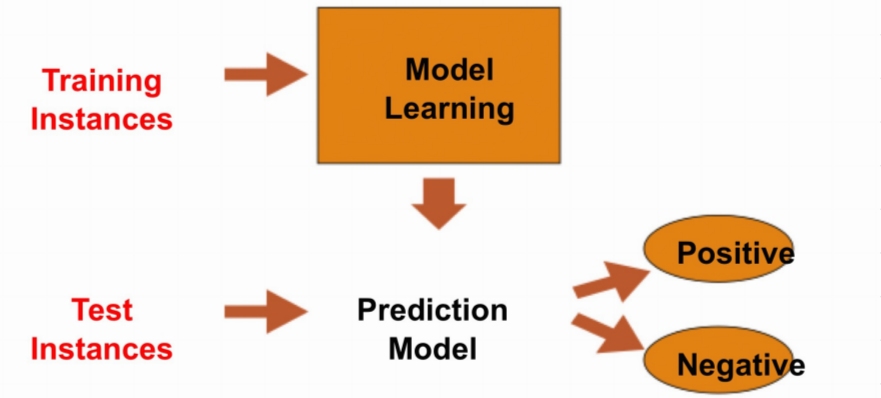
- สร้างเส้นแบ่ง ที่สามารถจัดกลุ่มข้อมูล
- set of sample used for model construction training set
- New data is classified based on the models built from training set
- Predict Categorical class labels (discrete / nominal)

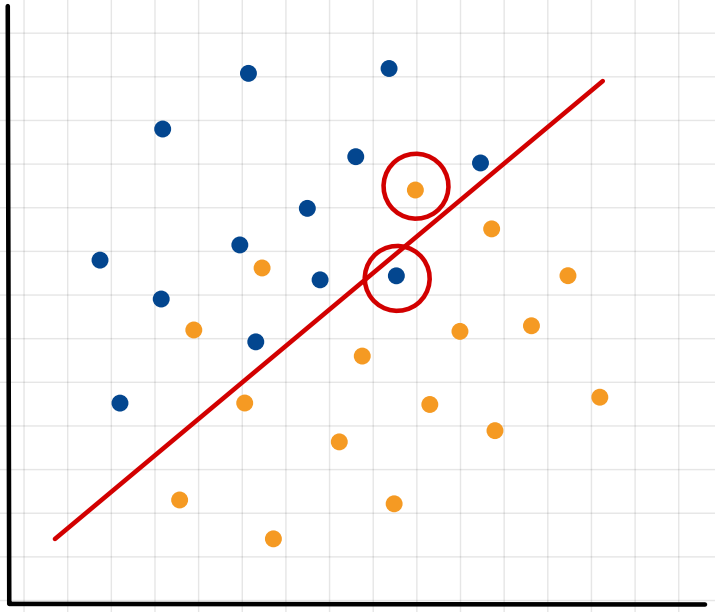
เส้นแบ่งที่ดีที่สุดใน
การจัดกลุ่มข้อมูล

จะเห็นว่า ยังคงมี data points บางตัวที่ไม่เป๊ะตามเส้น แต่
This is prediction there will be some discrepancy

Training Data with class label:

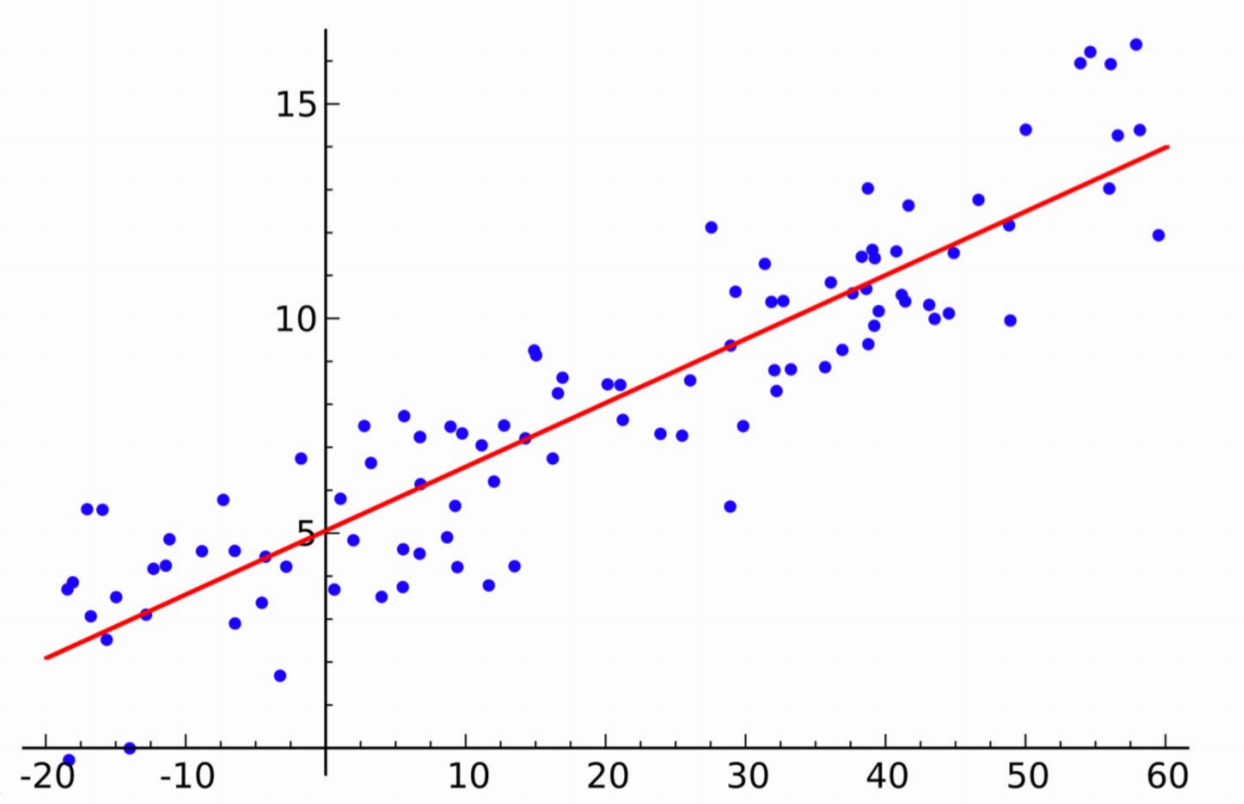
age	income	student	credit_rating	buys_computer
<=30	high	no	fair	no
<=30	high	no	excellent	no
31...40	high	no	fair	yes
>40	medium	no	fair	yes
>40	low	yes	fair	yes
>40	low	yes	excellent	no
31...40	low	yes	excellent	yes
<=30	medium	no	fair	no
<=30	low	yes	fair	yes
>40	medium	yes	fair	yes
<=30	medium	yes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





Numeric prediction : ทำนายค่าของข้อมูล

- สร้างโมเดล หรือฟังก์ชัน ที่ใช้ทำนายค่าของข้อมูล (predict unksnown / missing values)
- ซึ่งก็คือ Regression Model นั่นแหละ สมการที่สำคัญ y = a + bx1 + bx2 + ... + e
- หาเส้น / ระนาบ ที่ดีที่สุด ที่ตัดผ่านจุดของข้อมูลมากที่สุด : f(x)



Decision Tree : predict class label

Information Theory : Entropy ใช้ในการทำ attributes selection measure

- เลือก the highest information gain
- มีสูตร

- Expected information (entropy) needed to classify a tuple in D:

$$Info(D) = -\sum_{i=1}^{m} p_i \log_2(p_i)$$

- Information needed (after using A to split D into v partitions) to classify D:

$$Info_A(D) = \sum_{j=1}^{v} \frac{|D_j|}{|D|} \times Info(D_j)$$

- Information gained by branching on attribute A

$$Gain(A) = Info(D) - Info_A(D)$$

RID	Age	Income	Student	Credit rating	Class: buys computer
1	Youth	High	No	Fair	No
2	Youth	High	No	Excellent	No
3	Middle_aged	High	No	Fair	Yes
4	Senior	Medium	No	Fair	Yes
5	Senior	Low	Yes	Fair	Yes
6	Senior	Low	Yes	Excellent	No
7	Middle_aged	Low	Yes	Excellent	yes
8	Youth	Medium	No	Fair	No
9	Youth	Low	Yes	Fair	Yes
10	Senior	Medium	Yes	Fair	Yes
11	Youth	Medium	Yes	Excellent	Yes
12	Middle_aged	Medium	No	Excellent	Yes
13	Middle_aged	High	Yes	Fair	Yes
14	Senior	Mdium	No	Excellent	no

Step 1 : หา expected info ที่จะ classify ก่อน

จากตัวอย่าง class label: buys computer มีค่าคำตอบอยู่ 2 แบบ

- class P : buys computer = 'yes' 9 อัน
- class N : buys computer = 'no' 5 อัน

จากสูตร จะได้

$$Info(D) = -\frac{9}{14}\log_2\left(\frac{9}{14}\right) - \frac{5}{14}\log_2\left(\frac{5}{14}\right) = 0.940$$

RID	Age	Income	Student	Credit rating	Class: buys computer
1	Youth	High	No	Fair	No
2	Youth	High	No	Excellent	No
3	Middle_aged	High	No	Fair	Yes
4	Senior	Medium	No	Fair	Yes
5	Senior	Low	Yes	Fair	Yes
6	Senior	Low	Yes	Excellent	No
7	Middle_aged	Low	Yes	Excellent	yes
8	Youth	Medium	No	Fair	No
9	Youth	Low	Yes	Fair	Yes
10	Senior	Medium	Yes	Fair	Yes
11	Youth	Medium	Yes	Excellent	Yes
12	Middle_aged	Medium	No	Excellent	Yes
13	Middle_aged	High	Yes	Fair	Yes
14	Senior	Mdium	No	Excellent	no

Step 2: หา info ของแต่ละ attribute

- Age

	P (yes)	N (no)	
Youth (<=30)	2	3	5/14
Middle (31...40)	4	0	4/14
Senior (>40)	3	2	5/14

$$Info_{age}(D) = \frac{5}{14} \times \left(-\frac{2}{5}\log_2\frac{2}{5} - \frac{3}{5}\log_2\frac{3}{5}\right)$$

$$= + \frac{4}{14} \times \left(-\frac{4}{4}\log_2\frac{4}{4}\right) + \frac{5}{14} \times \left(-\frac{3}{5}\log_2\frac{3}{5} - \frac{2}{5}\log_2\frac{2}{5}\right)$$

$$= 0.694 \text{ bits.}$$

Step 3 : หา information gained ของ แต่ละ attributes

Hence, the gain in information from such a partitioning would be

Gain(age) = Info(D) - $Info_{Age}$ (D)

= 0.940 – 0.694 = 0.246 bits

RID	Age	Income	Student	Credit rating	Class: buys computer
1	Youth	High	No	Fair	No
2	Youth	High	No	Excellent	No
3	Middle_aged	High	No	Fair	Yes
4	Senior	Medium	No	Fair	Yes
5	Senior	Low	Yes	Fair	Yes
6	Senior	Low	Yes	Excellent	No
7	Middle_aged	Low	Yes	Excellent	yes
8	Youth	Medium	No	Fair	No
9	Youth	Low	Yes	Fair	Yes
10	Senior	Medium	Yes	Fair	Yes
11	Youth	Medium	Yes	Excellent	Yes
12	Middle_aged	Medium	No	Excellent	Yes
13	Middle_aged	High	Yes	Fair	Yes
14	Senior	Mdium	No	Excellent	no

Step 2: หา info ของแต่ละ attribute

- Income

	P (yes)	N (no)	
High	2	2	4/14
Medium	4	2	6/14
Low	3	1	4/14

$$Info_{Income}(D) = \frac{4}{14} \times \left(-\frac{2}{4}\log_2\frac{2}{4} - \frac{2}{4}\log_2\frac{2}{4}\right)$$

$$= + \frac{6}{14} \times \left(-\frac{4}{6}\log_2\frac{4}{6} - \frac{2}{6}\log_2\frac{2}{6}\right)$$

$$+ \frac{4}{14} \times \left(-\frac{3}{4}\log_2\frac{3}{4} - \frac{1}{4}\log_2\frac{1}{4}\right)$$

$$= 0.911 \text{ bits.}$$

Step 3 : หา information gained ของ แต่ละ attributes

Hence, the gain in information from such a partitioning would be

$Gain(Income) = Info(D) - Info_{Income}(D)$

$= 0.940 - 0.911 = 0.029$ bits

RID	Age	Income	Student	Credit rating	Class: buys computer
1	Youth	High	No	Fair	No
2	Youth	High	No	Excellent	No
3	Middle_aged	High	No	Fair	Yes
4	Senior	Medium	No	Fair	Yes
5	Senior	Low	Yes	Fair	Yes
6	Senior	Low	Yes	Excellent	No
7	Middle_aged	Low	Yes	Excellent	yes
8	Youth	Medium	No	Fair	No
9	Youth	Low	Yes	Fair	Yes
10	Senior	Medium	Yes	Fair	Yes
11	Youth	Medium	Yes	Excellent	Yes
12	Middle_aged	Medium	No	Excellent	Yes
13	Middle_aged	High	Yes	Fair	Yes
14	Senior	Mdium	No	Excellent	no

Step 2: หา info ของแต่ละ attribute

- Student

	P (yes)	N (no)	
Yes	6	1	7/14
No	3	4	7/14

$$Info_{Student}(D) = \frac{7}{14} \times \left(-\frac{6}{7}\log_2\frac{6}{7} - \frac{1}{7}\log_2\frac{1}{7}\right)$$

$$+ \frac{7}{14} \times \left(-\frac{3}{7}\log_2\frac{3}{7} - \frac{4}{7}\log_2\frac{4}{7}\right)$$

= 0.788

Step 3 : หา information gained ของ แต่ละ attributes

Hence, the gain in information from such a partitioning would be

Gain(Student) = Info(D) - $Info_{Student}(D)$

= 0.940 – 0.788 = 0.151 bits

RID	Age	Income	Student	Credit rating	Class: buys computer
1	Youth	High	No	Fair	No
2	Youth	High	No	Excellent	No
3	Middle_aged	High	No	Fair	Yes
4	Senior	Medium	No	Fair	Yes
5	Senior	Low	Yes	Fair	Yes
6	Senior	Low	Yes	Excellent	No
7	Middle_aged	Low	Yes	Excellent	yes
8	Youth	Medium	No	Fair	No
9	Youth	Low	Yes	Fair	Yes
10	Senior	Medium	Yes	Fair	Yes
11	Youth	Medium	Yes	Excellent	Yes
12	Middle_aged	Medium	No	Excellent	Yes
13	Middle_aged	High	Yes	Fair	Yes
14	Senior	Mdium	No	Excellent	no

Step 2: หา info ของแต่ละ attribute

- credit

	P (yes)	N (no)	
Fair	6	2	8/14
Excellent	3	3	6/14

$$Info_{Credit}(D) = \frac{8}{14} \times \left(-\frac{6}{8}\log_2\frac{6}{8} - \frac{2}{8}\log_2\frac{2}{8}\right)$$

$$+ \frac{6}{14} \times \left(-\frac{3}{6}\log_2\frac{3}{6} - \frac{3}{6}\log_2\frac{3}{6}\right)$$

$= 0.892$

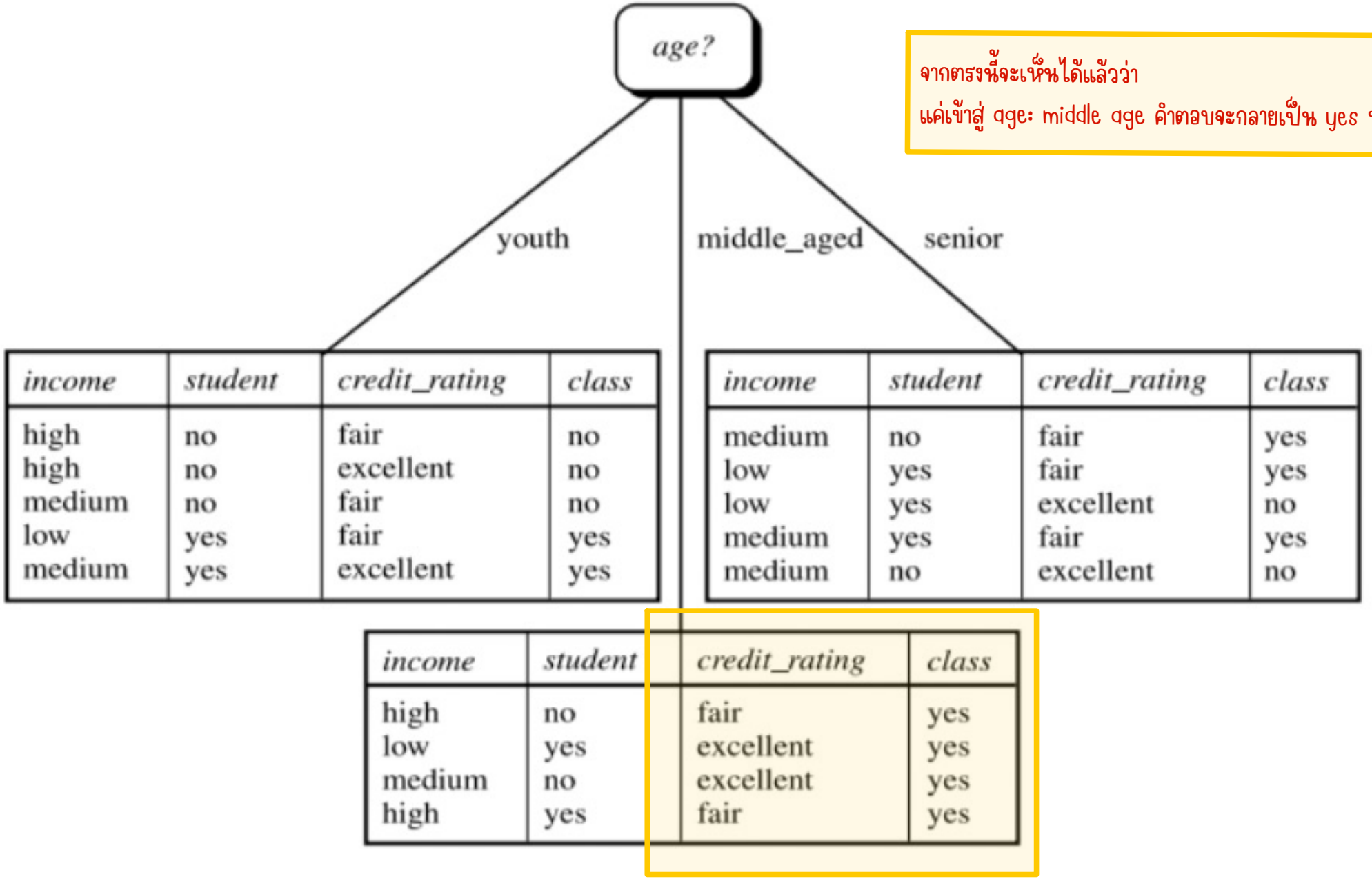
Step 3 : หา information gained ของ แต่ละ attributes

Hence, the gain in information from such a partitioning would be

Gain(Credit) = Info(D) - $Info_{Credit}$ (D)

= 0.940 – 0.892 = 0.048 bits

มาถึงตรงนี้ เราจะได้ Root Node : Age เพราะ มี highest information gain



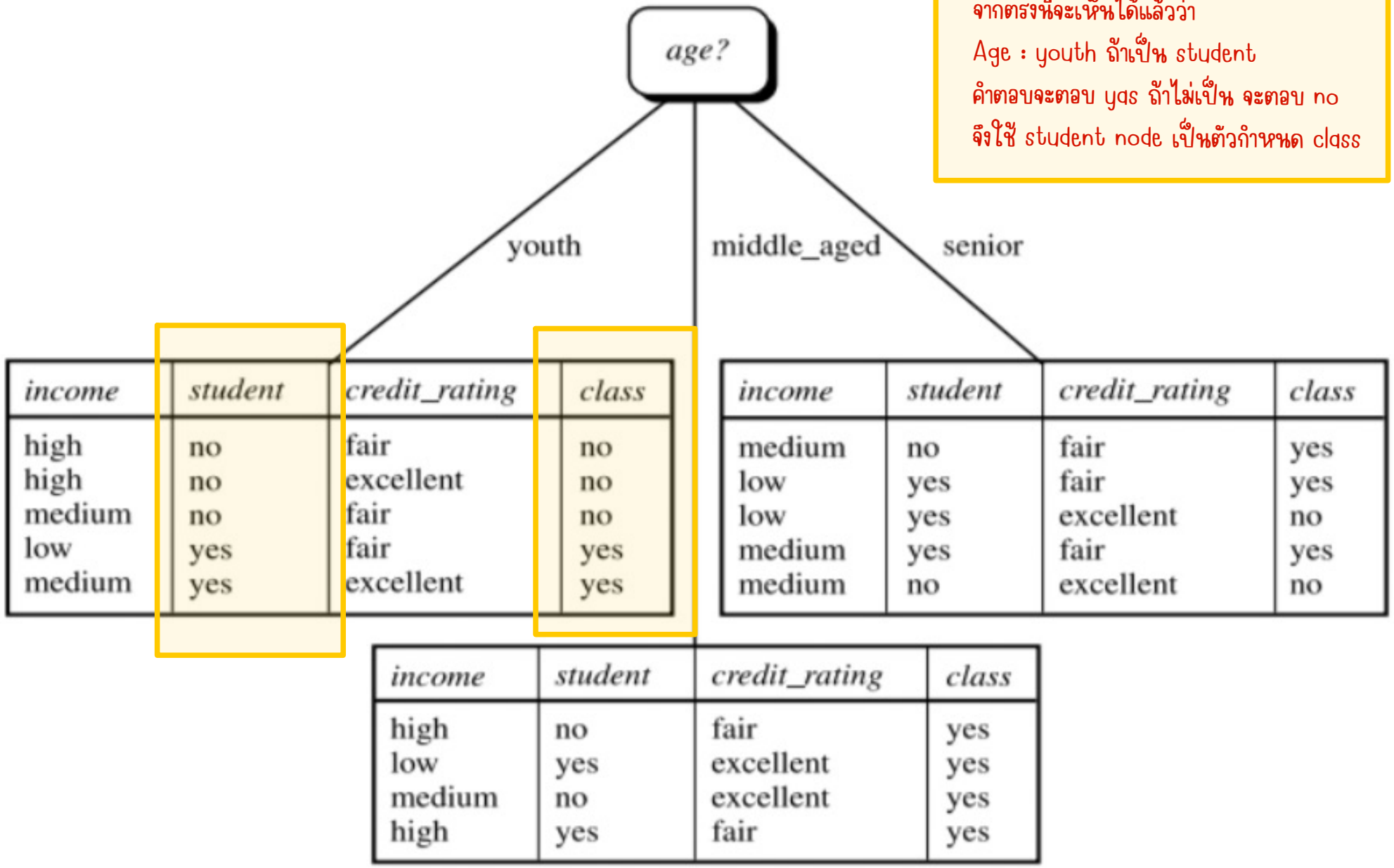
income	*student*	*credit_rating*	*class*
high	no	fair	no
high	no	excellent	no
medium	no	fair	no
low	yes	fair	yes
medium	yes	excellent	yes

income	*student*	*credit_rating*	*class*
medium	no	fair	yes
low	yes	fair	yes
low	yes	excellent	no
medium	yes	fair	yes
medium	no	excellent	no

income	*student*	*credit_rating*	*class*
high	no	fair	yes
low	yes	excellent	yes
medium	no	excellent	yes
high	yes	fair	yes

จากตรงนี้จะเห็นได้แล้วว่า
แค่เข้าสู่ age: middle age คำตอบจะกลายเป็น yes ทั้งหมด

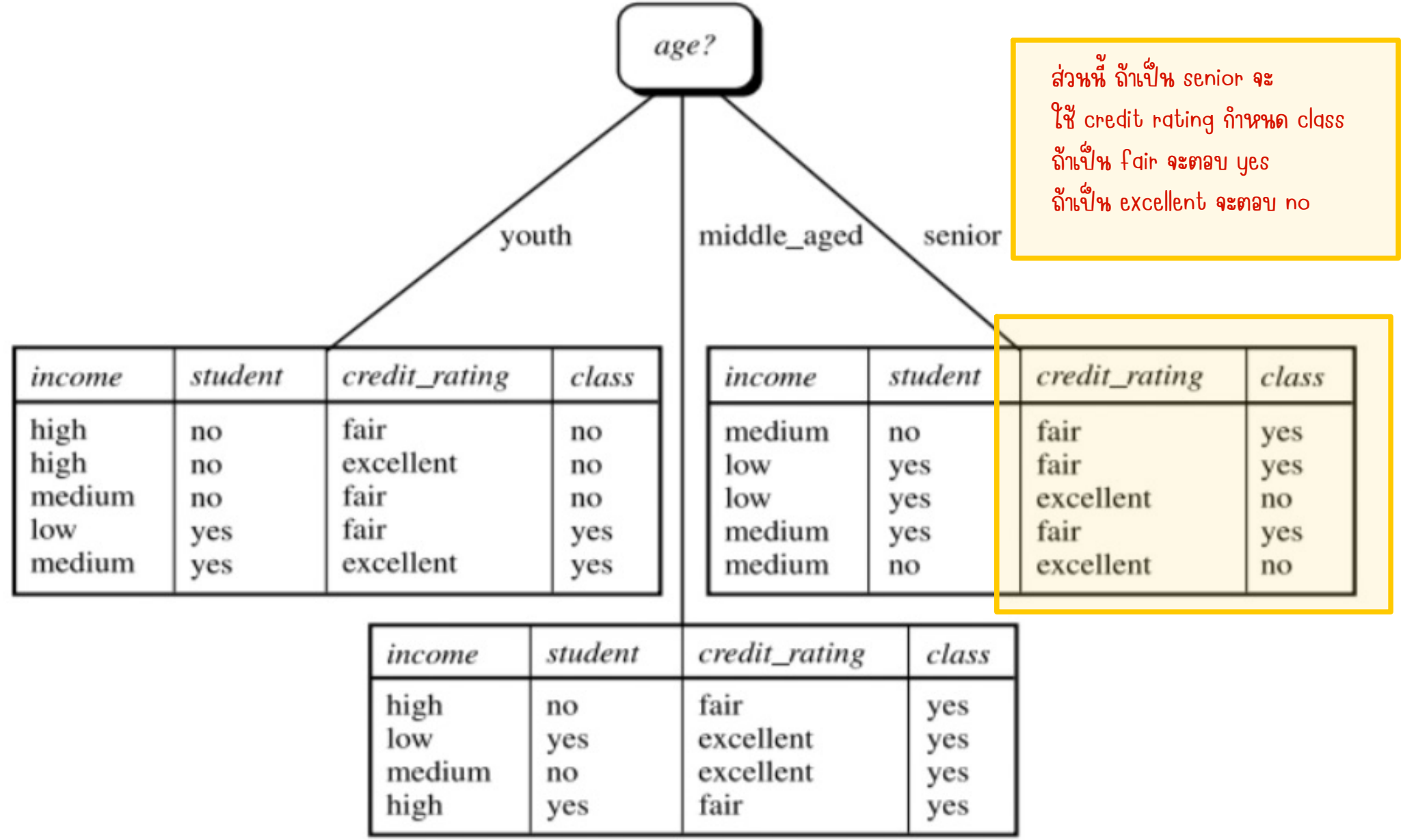
จากตรงนี้จะเห็นได้แล้วว่า
Age : youth ถ้าเป็น student
คำตอบจะตอบ yes ถ้าไม่เป็น จะตอบ no
จึงใช้ student node เป็นตัวกำหนด class



income	*student*	*credit_rating*	*class*
high	no	fair	no
high	no	excellent	no
medium	no	fair	no
low	yes	fair	yes
medium	yes	excellent	yes

income	*student*	*credit_rating*	*class*
medium	no	fair	yes
low	yes	fair	yes
low	yes	excellent	no
medium	yes	fair	yes
medium	no	excellent	no

income	*student*	*credit_rating*	*class*
high	no	fair	yes
low	yes	excellent	yes
medium	no	excellent	yes
high	yes	fair	yes



income	*student*	*credit_rating*	*class*
high	no	fair	no
high	no	excellent	no
medium	no	fair	no
low	yes	fair	yes
medium	yes	excellent	yes

income	*student*	*credit_rating*	*class*
high	no	fair	yes
low	yes	excellent	yes
medium	no	excellent	yes
high	yes	fair	yes

income	*student*	*credit_rating*	*class*
medium	no	fair	yes
low	yes	fair	yes
low	yes	excellent	no
medium	yes	fair	yes
medium	no	excellent	no

ส่วนนี้ ถ้าเป็น senior จะ
ใช้ credit rating กำหนด class
ถ้าเป็น fair จะตอบ yes
ถ้าเป็น excellent จะตอบ no

สุดท้าย จะทำให้ได้ Decision tree ดังนี้

- **Resulting tree:**