Artificial Intelligence
CSC 361

Tutorial#7

You have a friend who sometimes stay in in the weekend and sometimes go out. You have observed your friend's behavior over 12 different weekends.

On each of these weekends you have noted the weather (Sunny, Windy or Rainy), whether his parents visit (Yes or No),

whether he has drawn cash from an ATM machine (Yes or No),

and whether he has an exam during the coming week (Yes or No).

You have built the following data table:

Example	Weather	Parent's visit	Exam	Cash	Decision
1	Sunny	No	No	Yes	Go out
2	Sunny	Yes	No	Yes	Stay in
3	Rainy	No	Yes	No	Stay in
4	Sunny	No	Yes	Yes	Stay in
5	Sunny	No	No	Yes	Go out
6	Windy	No	No	No	Stay in
7	Windy	No	No	Yes	Go out
8	Sunny	No	No	No	Go out
9	Rainy	No	No	Yes	Stay in
10	Sunny	No	No	Yes	Stay in
11	Rainy	Yes	No	Yes	Stay in
12	Sunny	No	No	Yes	Go out

Use ID3 to build a decision tree from the data.

$\sum - p_i \log_2 p_i = -\frac{2}{4}\log\frac{2}{4} - \frac{2}{4}\log\frac{2}{4} = 1$

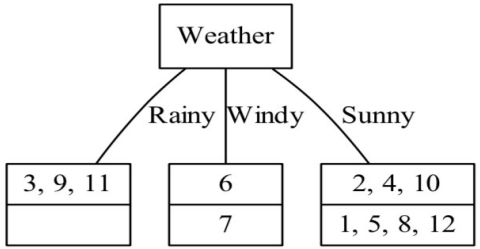
$= 0$

We start by choosing the first attribute to test. For this, we compute the remainder for each attribute and pick the one with the **minimum** remainder: $= 0.47$

$$Remainder\,(A) = \sum_{k=1}^{d} \frac{p_k + n_k}{p + n} B\left(\frac{p_k}{p_k + n_k}\right)$$

Reminder (Weath

$$Remainder(A) = \sum_{k=1}^{d} \frac{p_k + n_k}{p + n} B\left(\frac{p_k}{p_k + n_k}\right)$$



Stay in
Go Out

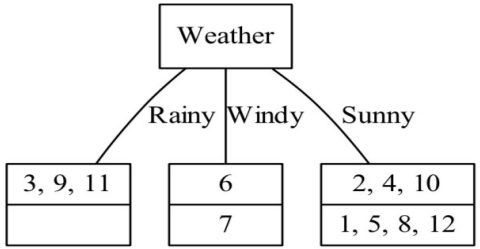
Reminder (Weather)

Reminder (Weather)

Reminder (Weather)

Reminder (Weath

$$Remainder(A) = \sum_{k=1}^{d} \frac{p_k + n_k}{p + n} B\left(\frac{p_k}{p_k + n_k}\right)$$



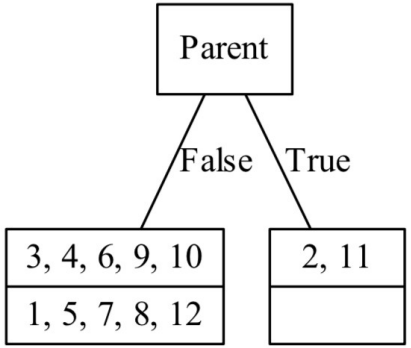
Stay in
Go Out

Reminder (Weather)
=

Reminder (Weather)
=

Reminder (Weather)
=0.74

Reminder (Parent)



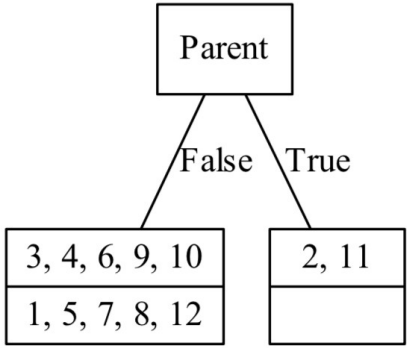
Stay in
Go Out

Reminder (Parent)
=

Reminder (Parent)
=

Reminder (Parent)
=

Reminder (Parent)



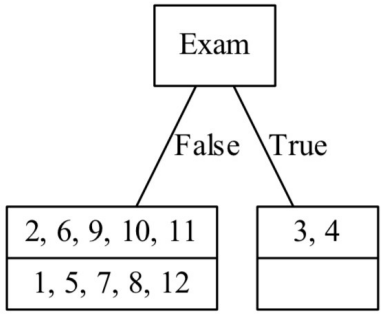
Stay in
Go Out

Reminder (Parent)
=

Reminder (Parent)
=

Reminder (Parent)
=0.83

Reminder (Exam)



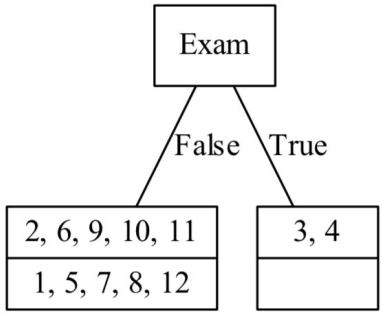
Stay in
Go Out

Reminder (Exam)
=

Reminder (Exam)
=

Reminder (Exam)
=0.83

Reminder (Exam)



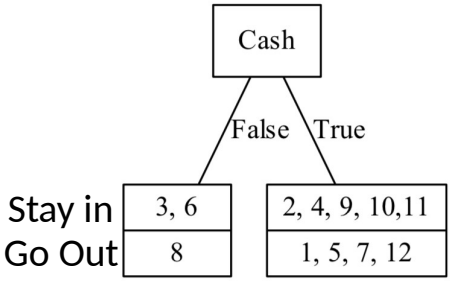
Stay in
Go Out

Reminder (Exam)
=

Reminder (Exam)
=

Reminder (Exam)
=0.83

Reminder (Cash)

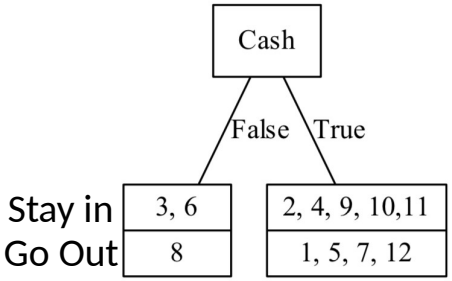


Reminder (Cash)
=

Reminder (Cash)
=

Reminder (Cash)
=0.97

Reminder (Cash)



Reminder (Cash)
=

Reminder (Cash)
=

Reminder (Cash)
=0.97

$H(\text{weather} = \text{Sunny}) = \begin{bmatrix} \text{stay} \\ 3 \\ 90 \\ 4 \end{bmatrix} = \frac{-3}{7}\log\frac{3}{7} - \frac{4}{7}\log\frac{4}{7} = 0.985$ خبابية

كل ما زاد

$H(\text{P.V}(w = S)) \begin{cases} x \\ n \end{cases}$

Reminder (Weather)
=0.74

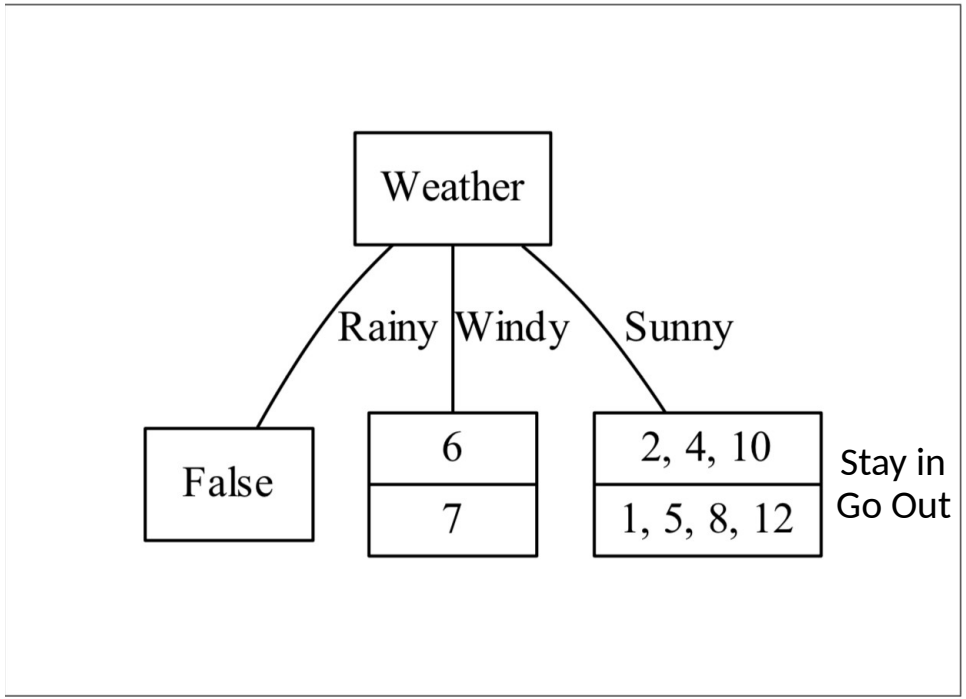
Reminder (Parent)
=0.83

Reminder (Exam)
=0.83

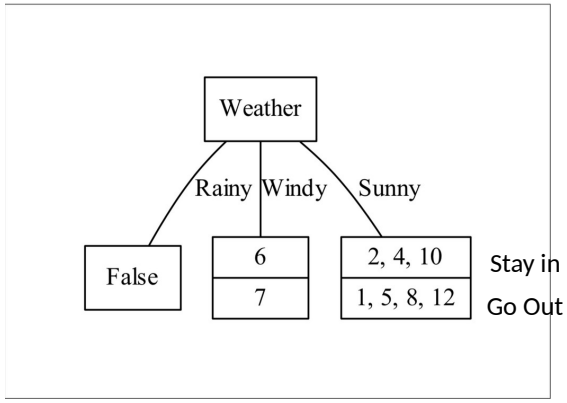
Reminder (Cash)
=0.97

The most important attribute is then **Weather**. Therefore, we split the examples according to the values of this attribute.
For the value Rainy, all the examples have the same classification, so we can put the resulting node as a decision node.

Now, we repeat the same procedure recursively for the node corresponding to the value Windy:



Example	Weather	Parent's visit	Exam	Cash	Decision
1	Sunny	No	No	Yes	Go out
2	Sunny	Yes	No	Yes	Stay in
3	Rainy	No	Yes	No	Stay in
4	Sunny	No	Yes	Yes	Stay in
5	Sunny	No	No	Yes	Go out
6	Windy	No	No	No	Stay in
7	Windy	No	No	Yes	Go out
8	Sunny	No	No	No	Go out
9	Rainy	No	No	Yes	Stay in
10	Sunny	No	No	Yes	Stay in
11	Rainy	Yes	No	Yes	Stay in
12	Sunny	No	No	Yes	Go out



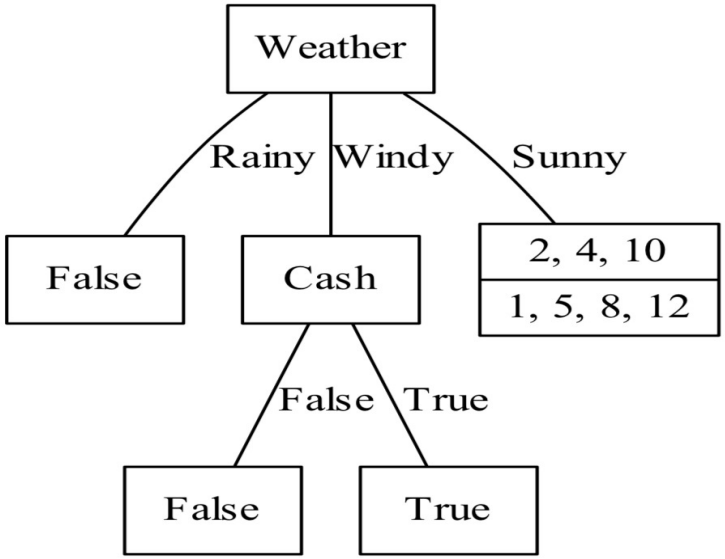
Reminder (Parent) = = 1

Reminder (Exam) = = 1

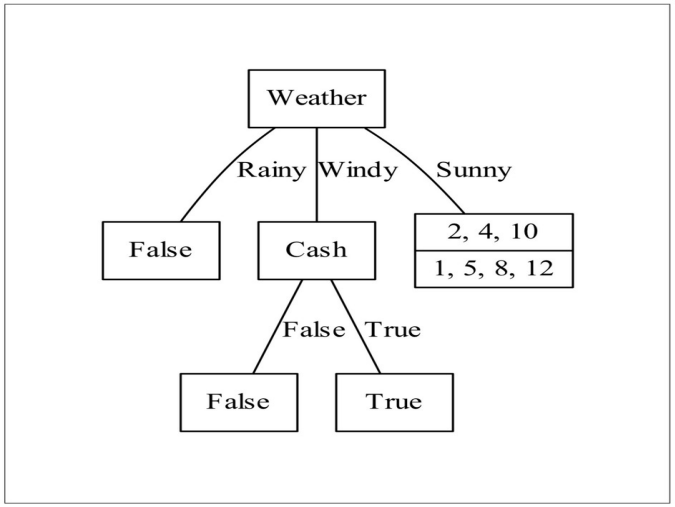
Reminder (cash) = += 0

We then choose **Cash** and the tree becomes:

Now, we repeat the same procedure recursively for the node corresponding to the value Sunny:



Example	Weather	Parent's visit	Exam	Cash	Decision
1	Sunny	No	No	Yes	Go out
2	Sunny	Yes	No	Yes	Stay in
3	Rainy	No	Yes	No	Stay in
4	Sunny	No	Yes	Yes	Stay in
5	Sunny	No	No	Yes	Go out
6	Windy	No	No	No	Stay in
7	Windy	No	No	Yes	Go out
8	Sunny	No	No	No	Go out
9	Rainy	No	No	Yes	Stay in
10	Sunny	No	No	Yes	Stay in
11	Rainy	Yes	No	Yes	Stay in
12	Sunny	No	No	Yes	Go out



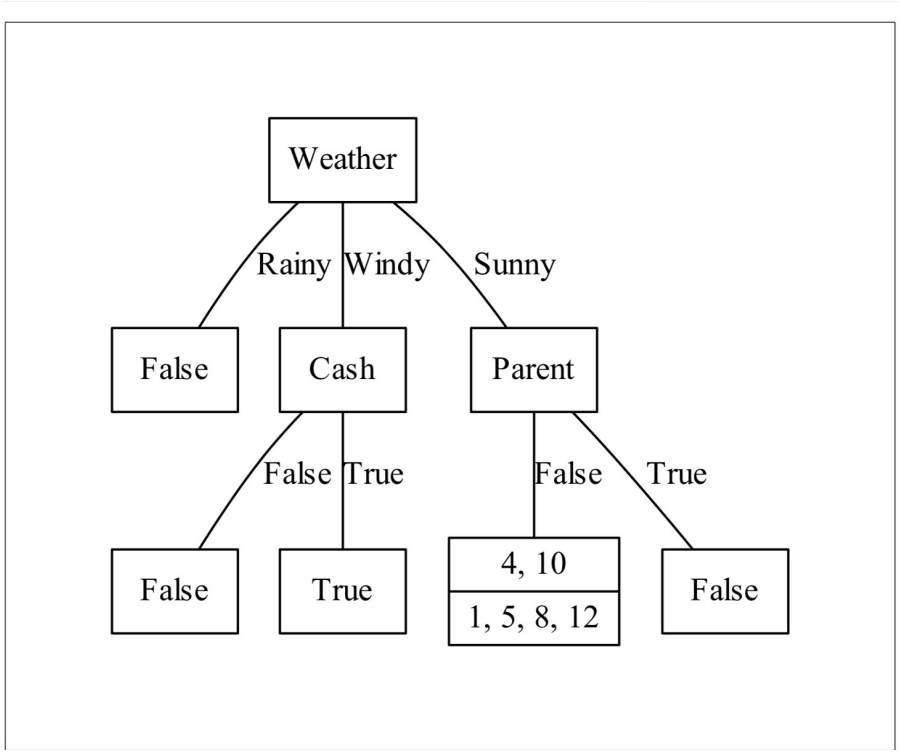
Reminder (Parent) = = 0.78

Reminder (Exam) = = 0.78

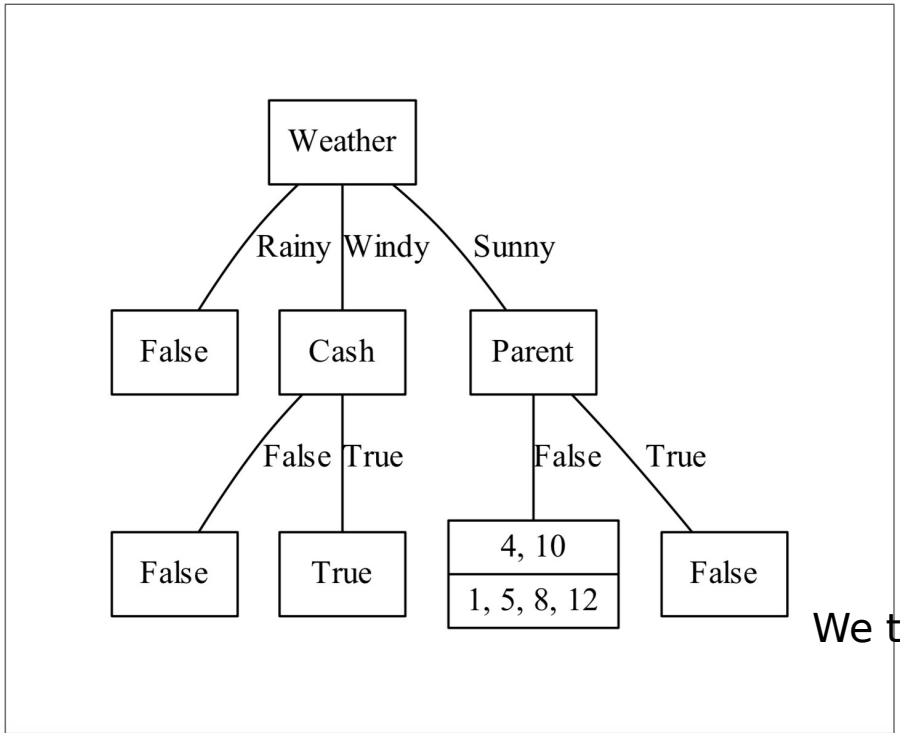
Reminder (Cash) = += 0.85

Parent and Exam are equally important and we can choose either one. We choose **Parent**:

Now, we repeat the same procedure recursively for the node corresponding to the value Sunny and parent =false:



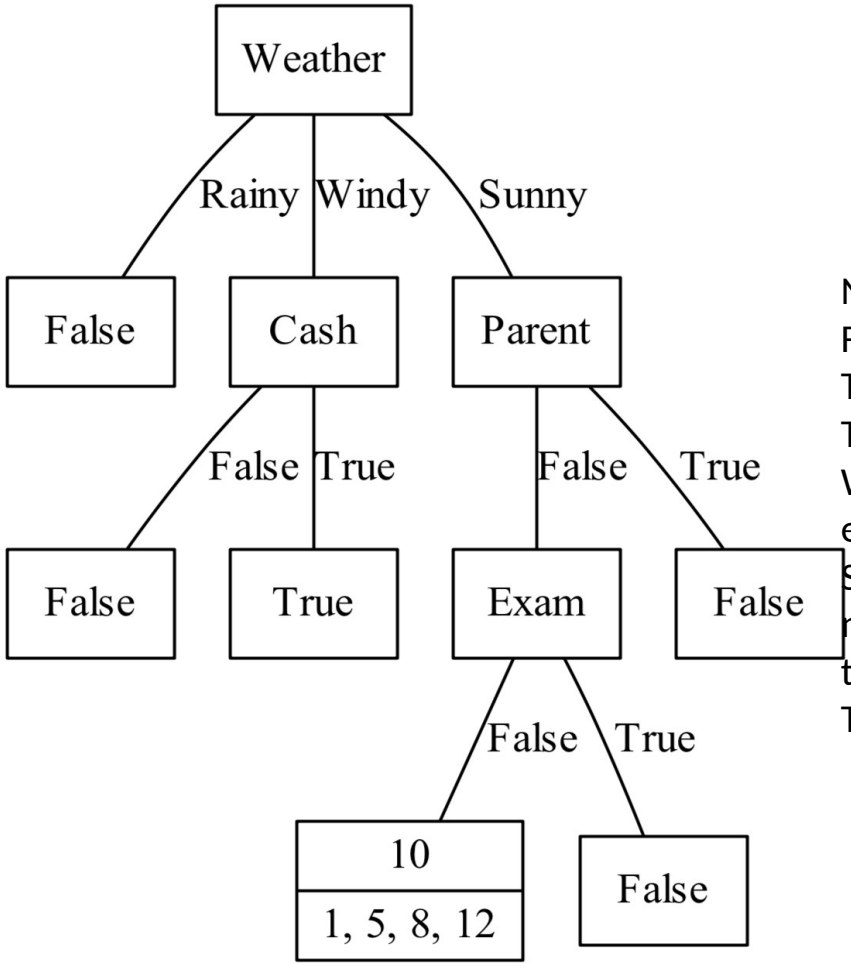
Example	Weather	Parent's visit	Exam	Cash	Decision
1	Sunny	No	No	Yes	Go out
2	Sunny	Yes	No	Yes	Stay in
3	Rainy	No	Yes	No	Stay in
4	Sunny	No	Yes	Yes	Stay in
5	Sunny	No	No	Yes	Go out
6	Windy	No	No	No	Stay in
7	Windy	No	No	Yes	Go out
8	Sunny	No	No	No	Go out
9	Rainy	No	No	Yes	Stay in
10	Sunny	No	No	Yes	Stay in
11	Rainy	Yes	No	Yes	Stay in
12	Sunny	No	No	Yes	Go out



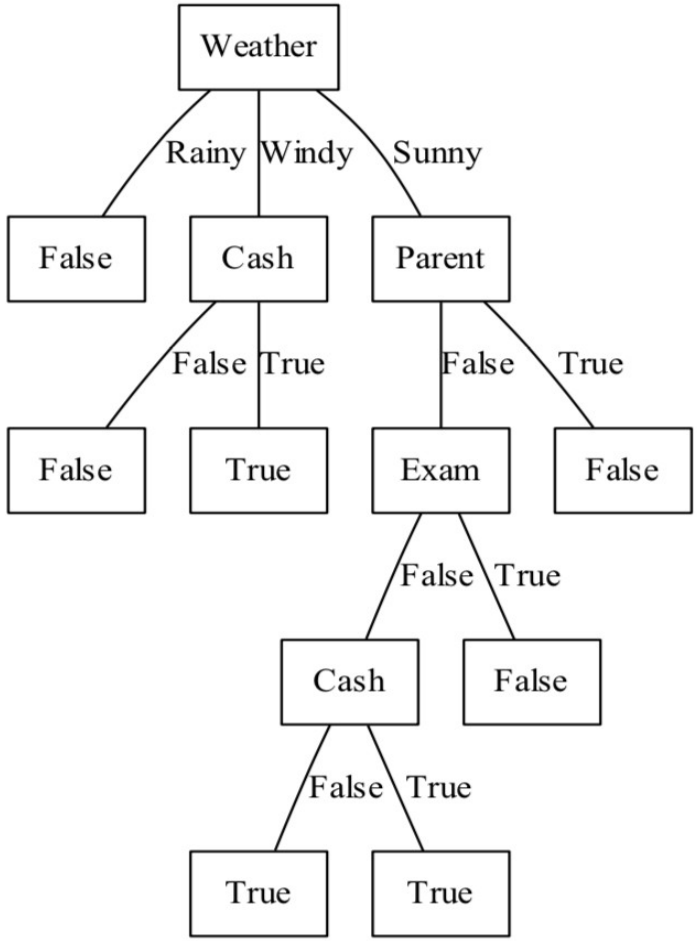
Reminder (Exam) = = 0.60

Reminder (Cash) = += 0.81

We then choose Exam and the tree becomes:



Now, we have one attribute left, which is Cash. When Cash = False, we have one example, and it is positive.
Thus, the node is made into a decision node with the value True.
When Cash = True, we have both positive and negative examples left.
Since we do not have any more attributes to test, this is due to noise in the data. We make the decision at the node by taking the majority classification, which gives True.
The final decision tree is as follows:


Weather
Rainy
Windy
Sunny
False
Cash
Parent
False
True
False
True
False
True
Exam
False
False
True
Cash
False
False
True
True
True