

SEEM 3430 Tutorial 3

Decision Tables & Basic Decision Trees

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Content

- Decision Tables
- Basic Decision Trees
- Exercise

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- **Decision Tables**
- Basic Decision Trees
- Exercise

Overview

- A diagram of all the logic and possible outcomes associated with a particular process
 - Conditions
 - Condition Alternatives
 - Actions

Conditions	Condition Alternatives
Actions	Action Entries

Overview

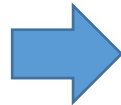
- Conditions and Condition alternatives
 - Represent the specific rule when making a decision
- Actions
 - Represent all possible courses of action associated with a given set of conditions

Why decision table?

Structured English Process Description

```

IF Driver_Age < 25 THEN
  IF Accident_Free = "N" THEN
    Surcharge = 0.20
  ENDIF
ELSE
  IF Driver_Gender = "F" THEN
    Surcharge = 0.10
  ENDIF
ELSE
  IF Driver_Educ = "N" THEN
    Surcharge = 0.15
  ENDIF
ELSE
  IF College = "N" THEN
    Surcharge = 0.12
  ENDIF
ELSE
  IF HS_GPA < 3.25 THEN
    Surcharge = 0.10
  ENDIF
ELSE
  IF HS_GPA >= 3.25 THEN
    Surcharge = 0.07
  ENDIF
ELSE
  IF Accident_Free = "Y" THEN
    Surcharge = 0.00
  ENDIF
ELSE
  IF Accident_Free = "N" THEN
    Surcharge = 0.07
  ENDIF
ENDIF
  
```



Driver Age	25 yrs +	25 yrs +	< 25 yrs	< 25 yrs	< 25 yrs	< 25 yrs	< 25 yrs	< 25 yrs
Accident Free	Y	N	N	Y	Y	Y	Y	Y
Driver Gender	-	-	-	Female	Male	Male	Male	Male
Driver's Education	-	-	-	-	N	Y	Y	Y
College (attending /completed)	-	-	-	-	-	N	Y	Y
High School GPA	-	-	-	-	-	-	< 3.25	3.25+
20% surcharge			X					
15% surcharge					X			
12% surcharge						X		
10% surcharge				X			X	
7% surcharge		X						X
No surcharge	X							

Why decision table?

- Model complicated programming logic.
- Make it easy to see that all possible combinations of conditions have been considered.

Developing decision tables

You need to determine the maximum size of the table, eliminate any impossible situations, inconsistencies, or redundancies, and simplify the table as much as possible.

Step 1

Determine the number of conditions that may affect the decision.

- Combine rows that overlap, for example, conditions that are mutually exclusive.
- The number of conditions becomes the number of rows in the top half of the decision table.

Conditions	Condition Alternatives
Actions	Action Entries

Mutually exclusive conditions

- Gender
 - Male and Female
- Education
 - High school, Bachelor, Master and Doctor etc.

Mutually exclusive conditions should be combined to be one condition with multiple alternatives

Step 2

- Determine the number of possible actions that can be taken.
 - This becomes the number of rows in the lower half of the decision table.

Conditions	Condition Alternatives
Actions	Action Entries

Step 3

- Determine the number of condition alternatives for each condition.
 - In the simplest form of decision table, there would be two alternatives (Y or N) for each condition.
 - In an extended-entry table, there may be many alternatives for each condition.

Conditions	Condition Alternatives
Actions	Action Entries

Step 4

- Calculate the maximum number of columns in the decision table by multiplying the number of alternatives for each condition.
 - If there are four conditions and two alternatives for each of them, there will be $2^4 = 16$ possibilities

Conditions	Condition Alternatives
Actions	Action Entries

Step 5

- Fill in the condition alternatives. Start with the first condition and divide the number of columns by the number of alternatives for that condition.

Condition 1	Y	Y	Y	Y	Y	Y	Y	Y	N	N	N	N	N	N	N	N
Condition 2	Y	Y	Y	Y	N	N	N	N	Y	Y	Y	Y	N	N	N	N
Condition 3	Y	Y	N	N	Y	Y	N	N	Y	Y	N	N	Y	Y	N	N
Condition 4	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N

Step 6~9

6. Complete the table by inserting an X where rules suggest certain actions.
7. Combine rules where it is apparent that an alternative does not make a difference in the outcome
8. Check the table for any impossible situations, contradictions, redundancies.
9. Rearrange the conditions and actions (or even rules) to make the decision table more understandable.

An example

A store wishes to program a decision on non-cash receipts for goods into their intelligent tills.

Conditions

1. Transaction under £50
2. Pays by cheque with cheque card (guarantee £50)
3. Pays by credit card

Possible actions

1. Ring up sale
2. Check credit card from local database
3. Call a supervisor
4. Automatic check of credit card company database

Initial the decision table

Under £50	Y	Y	Y	Y	N	N	N	N
Pays by cheque	Y	Y	N	N	Y	Y	N	N
Pays by credit card	Y	N	Y	N	Y	N	Y	N
Ring up sale								
Check from local database								
Call Supervisor								
Check credit card database								

Some of the condition rules are invalid (Marked as red and blue)

- Customer cannot pay by cheque AND pay by credit card or not pay by either method

Delete invalid condition rules

Under £50	Y	Y	Y	Y	N	N	N	N
Pays by cheque	Y	Y	N	N	Y	Y	N	N
Pays by credit card	Y	N	Y	N	Y	N	Y	N
Ring up sale								
Check from local database								
Call Supervisor								
Check credit card database								



Under £50	Y	Y	N	N
Pays by cheque	Y	N	Y	N
Pays by credit card	N	Y	N	Y
Ring up sale				
Check from local database				
Call Supervisor				
Check credit card database				

Indicate the actions

Under £50	Y	Y	N	N
Pays by cheque	Y	N	Y	N
Pays by credit card	N	Y	N	Y
Ring up sale				
Check from local database				
Call Supervisor				
Check credit card database				



Under £50	Y	Y	N	N
Pays by cheque	Y	N	Y	N
Pays by credit card	N	Y	N	Y
Ring up sale	X			
Check from local database		X		
Call Supervisor			X	
Check credit card database				X

Check for completeness

- What if the customer has not shopped there before? Reconstructing the table!

Adding a new condition to the existing table

Under £50	Y	Y	Y	Y	N	N	N	N
Pays by cheque	Y	Y	N	N	Y	Y	N	N
Pays by credit card	N	N	Y	Y	N	N	Y	Y
<u>Unknown customer</u>	<u>Y</u>	<u>N</u>	<u>Y</u>	<u>N</u>	<u>Y</u>	<u>N</u>	<u>Y</u>	<u>N</u>
Ring up sale								
Check from local database								
Call Supervisor								
Check credit card database								

- The action list remain the same, clean the action entries
- The number of condition rules increases by a multiple of 2 (number of alternatives for the new condition).

Indicate the actions

Under £50	Y	Y	Y	Y	N	N	N	N
Pays by cheque	Y	Y	N	N	Y	Y	N	N
Pays by credit card	N	N	Y	Y	N	N	Y	Y
Unknown customer	Y	N	Y	N	Y	N	Y	N
Ring up sale		X						
Check from local database				X				
Call Supervisor	X				X	X		
Check credit card database			X				X	X

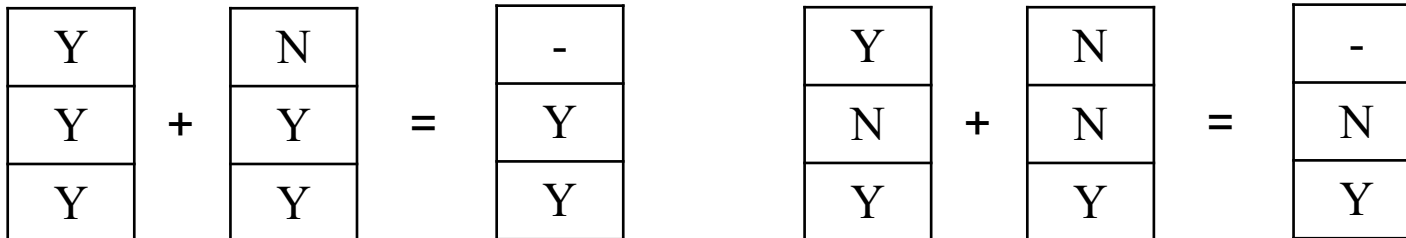
Delete mutually exclusive conditions

Under £50	Y	Y	Y	Y	N	N	N	N
Pays by cheque	Y	Y	N	N	Y	Y	N	N
Pays by credit card	-	-	-	-	-	-	-	-
Unknown customer	Y	N	Y	N	Y	N	Y	N
Ring up sale		X						
Check from local database				X				
Call Supervisor	X				X	X		
Check credit card database			X				X	X

- The dash in the Pays by credit card row indicates that it does not matter about the condition rule since if a customer pays by cheque they will not pay by credit card and vice versa (mutually exclusive).

Combine possible situations according to actions

Under £50	Y	Y	Y	Y	N	N	N	N
Pays by cheque	Y	Y	N	N	Y	Y	N	N
Pays by credit card	-	-	-	-	-	-	-	-
Unknown customer	Y	N	Y	N	Y	N	Y	N
Ring up sale		X						
Check from local database				X				
Call Supervisor	X				X	X		
Check credit card database			X				X	X

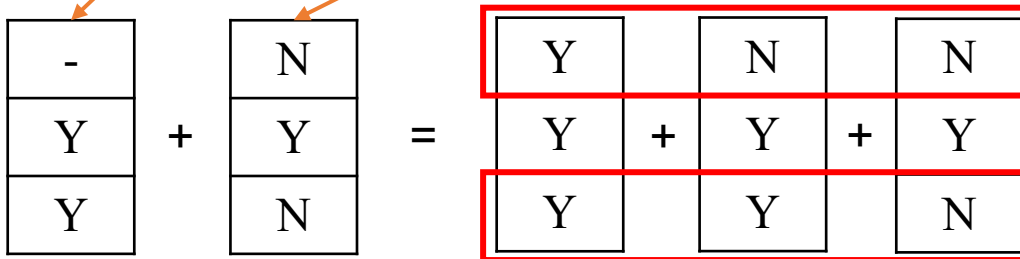


Remove the redundant

Under £50	-	Y	-	Y	N	N
Pays by cheque	Y	Y	N	N	Y	N
Pays by credit card	-	-	-	-	-	-
Unknown customer	Y	N	Y	N	N	N
Ring up sale		X				
Check from local database				X		
Call Supervisor	X				X	
Check credit card database			X			X

Combine identical actions

Under £50	-	Y	-	Y	N	N
Pays by cheque	Y	Y	N	N	Y	N
Pays by credit card	-	-	-	-	-	-
Unknown customer	Y	N	Y	N	N	N
Ring up sale		X				
Check from local database				X		
Call Supervisor	X				X	
Check credit card database			X			X



Can not merge !!!

Final Version

Under £50	-	Y	-	Y	N	N
Pays by cheque	Y	Y	N	N	Y	N
Unknown customer	Y	N	Y	N	N	N
Ring up sale		X				
Check from local database				X		
Call Supervisor	X				X	
Check credit card database			X			X

Exercise 1

When a burglar alarm sounds, if it is in one of students' houses where alarm sounds every week, ignore it. Otherwise have a look outside and if the house looks not broken into and there is nobody moving inside it, ignore the alarm. Otherwise call police.

(Answer will be released on the course website)

Exercise 2

- A marketing company wishes to construct a decision table to decide how to treat clients according to three characteristics: Gender, City Dweller, and age group: A (under 30), B (between 30 and 60), C (over 60). The company has four products (W, X, Y and Z) to test market. Product W will appeal to female city dwellers. Product X will appeal to young females. Product Y will appeal to Male middle aged shoppers who do not live in cities. Product Z will appeal to all but older females.

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What is Decision Tree

A decision tree shows the sequence and the structure of a decision problem.

It is a visual way to represent the same information that appears in a decision table.

3 Elements of a Decision Tree

- Decisions
- Uncertainties/Change Event
- Payoffs(Get/Pays)

Example

Should I bring an umbrella with me today?

- Decision = whether to bring the umbrella or leave it behind
- Uncertainty = whether it is going to rain
- Payoffs(Get/Pays) = happiness or a measure of satisfaction

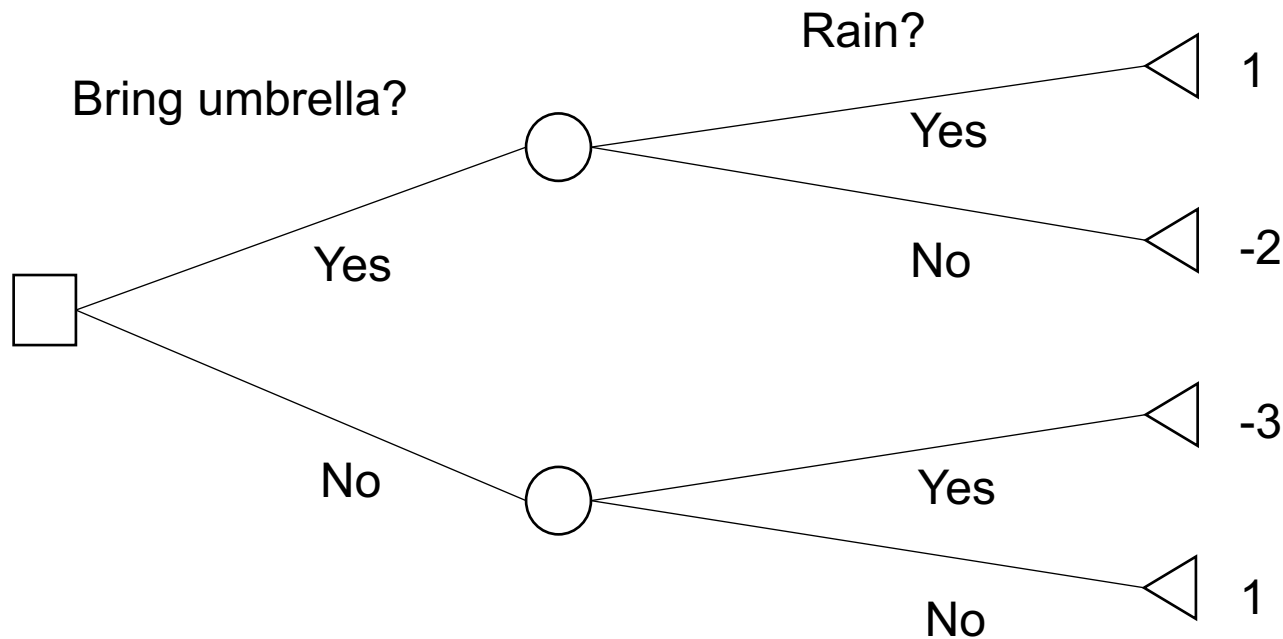
Example

Should I bring an umbrella with me today?

Choices	Events and Results	
	Rain	No Rain
Umbrella	Real comfort (1)	Mild discomfort (-2)
No Umbrella	Disaster (-3)	Real comfort (1)

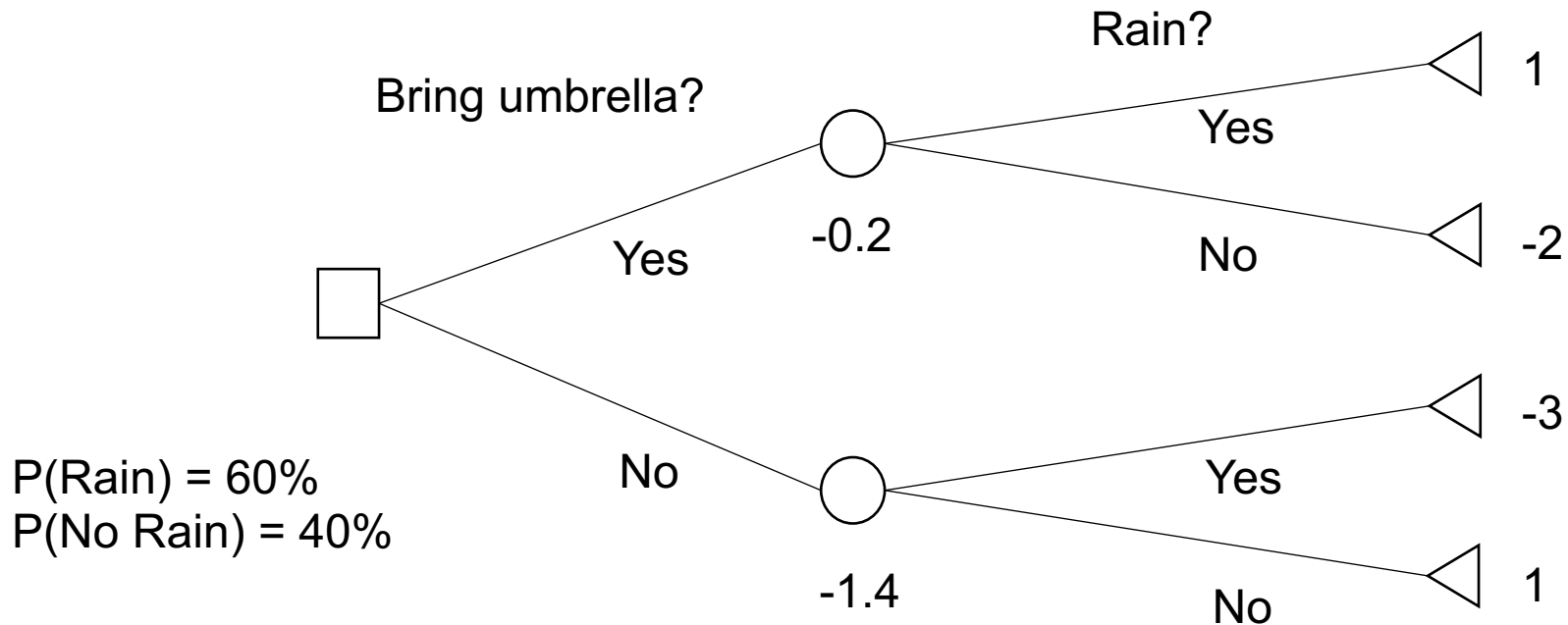
Example

Choices	Events and Results	
	Rain	No Rain
Umbrella	Real comfort (1)	Mild discomfort (-2)
No Umbrella	Disaster (-3)	Real comfort (1)



Example

Choices	Events and Results	
	Rain	No Rain
Umbrella	Real comfort (1)	Mild discomfort (-2)
No Umbrella	Disaster (-3)	Real comfort (1)



Exercise 3

If the customer account is billed using a fixed rate method, a minimum monthly charge is assessed for consumption of less than 100 kwh. Otherwise, apply a schedule A rate structure. However, if the account is billed using a variable rate method, a schedule A rate structure will apply to consumption below 100 kwh, with additional consumption billed according to schedule B.

(Answer will be released on the course website)

Exercise 4

Whether or not the chemical tracking system should accept a request for a new chemical from an individual depends on four factors, which showed in the following decision table.

Requirement Number					
Condition	1	2	3	4	5
User is authorized	F	T	T	T	T
Chemical is available	-	F	T	T	T
Chemical is hazardous	-	-	F	T	T
Requester is trained	-	-	-	F	T
Action					
Accept request			X		X
Reject request	X	X		X	

References

1. http://en.wikipedia.org/wiki/Decision_table
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3. <https://www.youtube.com/watch?v=MMHQ2gUMoNA>
4. <https://medium.com/datadriveninvestor/its-only-logical-decision-tables-and-decision-trees-12a8b52243ea>
5. <https://hbr.org/1964/07/decision-trees-for-decision-making>
6. <http://cs.furman.edu/~pbatchelor/csc105/MyPPT/Intro%20Decision%20Analysis.pptx>

Q&A
Thanks!