Challenge June-2018
Credit Card Application

A solution with DT5GL by Jack Jansonius – 16 Sept 2018

All details for this challenge can be found [here](#).

<u>Decision variable overview:</u>

```
Credit_Card
    Applicant_Demographic_Suitability
        Applicant_Years_of_Age
        Applicant_Card_Type
        'Applicant is existing customer'
            Product_holdings_number
        Applicant_Student_Creditcard_Demographic_Suitability
            Current_account_Type
        Applicant_Private_Creditcard_Demographic_Suitability
            Sole_Annual_Income
            Outstanding_Mortgage
            Saving_and_Investment_balance

    Applicant_Creditcard_Eligibility
        Applicant_Card_Type
        Applicant_Credit_Score
            Score_on_payments
                Number_of_payments
            Score_on_bankruptcy
                'Applicant has declared bankruptcy'
            Score_on_current_account_bank_years
                current_account_bank_years
            Score_on_available_credit_used%
                Amount_of_available_credit_used%
        Applicant_Balance_Transfer_CreditCard_Eligibility
            Sole_Annual_Income
            Residential_Status
            'CreditCard previously applied in last 6 month'
            Number_of_years_address_history
```

This overview is typical for a goal-oriented approach: a stepwise refinement of goals.

<u>Implementation of the decision tables in DT5GL:</u>

```
Table 0: credit card application
If:                                                      | 0| 1| 2|
Applicant_Demographic_Suitability is Suitable            | Y| Y| N|
Applicant_Creditcard_Eligibility is Eligible             | Y| N| -|
Then:
Credit_Card is Accepted                                  | X|  |  |
Credit_Card is Rejected                                  |  | X| X|
# .......

GoalAttribute: Credit_Card
Case: Accepted
Print: "Credit card is accepted"
Case: Rejected
Print: "Credit card is rejected"
```

```
rTable 1: Applicant Demographic Suitability
If:                                                         | 0| 1| 2|
Applicant_Years_of_Age < 18                                 | N| N| N|
Applicant_Card_Type is Student                              | Y| N| N|
Applicant_Card_Type is Private                              | -| Y| N|
Applicant_Card_Type is Balance-Transfer                     | -| -| Y|
'Applicant is existing customer'                            | Y| Y| -|
Applicant_Student_Creditcard_Demographic_Suitability is Suitable  | Y| -| -|
Applicant_Private_Creditcard_Demographic_Suitability is Suitable  | -| Y| -|
Then:
Applicant_Demographic_Suitability is Suitable               | X| X| X|
# .......


Attribute: Applicant_Years_of_Age
Askable_using: "What is the years of age of the applicant?"
Attribute: Applicant_Card_Type
Askable_using: "What is the desired cardtype?"


rTable 2: Existing customer?
If:                                                         | 0|
Product_holdings_number > 0                                 | Y|
Then:
'Applicant is existing customer'                            | X|
# .......

Attribute: Product_holdings_number
Askable_using: "What is the number of products held?"


rTable 3: Applicant Student Creditcard Demographic Suitability
If:                                                         | 0|
Current_account_Type is Student                             | Y|
Then:
Applicant_Student_Creditcard_Demographic_Suitability is Suitable  | X|
# .......

Attribute: Current_account_Type
Askable_using: "What is the current account type?"


Table 4: Applicant_Private_Creditcard_Demographic_Suitability
If:                                                         | 0| 1| 2| 3|
Sole_Annual_Income   < 100000                               | Y| Y| Y| N|
Outstanding_Mortgage < 300000                               | Y| Y| N| -|
Saving_and_Investment_balance < 100000                      | Y| N| -| -|
Then:
Applicant_Private_Creditcard_Demographic_Suitability is Suitable  |  | X| X| X|
# .......

Attribute: Sole_Annual_Income
Askable_using: "What is the sole anual income (>=100000 expected)"
Attribute: Outstanding_Mortgage
Askable_using: "What is the outstanding mortgage (>=300000 expected)"
Attribute: Saving_and_Investment_balance
Askable_using: "What is the saving and investment balance (>=100000 expected)"
```

```
rTable 5: Applicant Creditcard Eligibility
If:                                                | 0| 1| 2|
Applicant_Card_Type is Student                     | Y| N| N|
Applicant_Card_Type is Private                     | -| Y| N|
Applicant_Card_Type is Balance-Transfer            | -| -| Y|
Applicant_Credit_Score >= 500                      | Y| -| -|
Applicant_Credit_Score >= 750                      | -| Y| Y|
Applicant_Balance_Transfer_CreditCard is Eligible  | -| -| Y|
Then:
Applicant_Creditcard_Eligibility is Eligible       | X| X| X|
# .......


# Instead of the full table; see the notes on this version:
#
# Table 5: Applicant Creditcard Eligibility
# If:                                                | 0| 1| 2| 3| 4| 5| 6| 7|
# Applicant_Card_Type is Student                     | Y| Y| N| N| N| N| N| N|
# Applicant_Card_Type is Private                     | -| -| Y| Y| N| N| N| N|
# Applicant_Card_Type is Balance-Transfer            | -| -| -| -| Y| Y| Y| N|
# Applicant_Credit_Score >= 500                      | Y| N| -| -| -| -| -| -|
# Applicant_Credit_Score >= 750                      | -| -| Y| N| Y| Y| N| -|
# Applicant_Balance_Transfer_CreditCard is Eligible  | -| -| -| -| Y| N| -| -|
# Then:
# Applicant_Creditcard_Eligibility is Eligible       | X|  | X|  | X|  |  |  |


rTable 6: Applicant Balance Transfer CreditCard
If:                                                | 0|
Sole_Annual_Income > 10000                         | Y|
Residential_Status is UK_resident                  | Y|
'CreditCard previously applied in last 6 month'    | N|
Number_of_years_address_history >= 3               | Y|
Then:
Applicant_Balance_Transfer_CreditCard is Eligible  | X|
# .......

Proposition: 'CreditCard previously applied in last 6 month'
Askable_using: "**?"
Attribute: Residential_Status
Askable_using: "What is the residential status of the applicant?"
Attribute: Number_of_years_address_history
Askable_using: "What is the number of years with a adress history (3 or more
expected)?"
```

```
Attribute: Applicant_Credit_Score
Summation_of: Score_on_payments + Score_on_bankruptcy +
Score_on_current_account_bank_years + Score_on_available_credit_used%
```

Table 7: Score on payments

If:	0	1	2	3
Number_of_payments = 0	Y	N	N	N
Number_of_payments <= 3	−	Y	N	N
Number_of_payments <= 6	−	−	Y	N
Then:				
Score_on_payments = 250	X			
Score_on_payments = 100		X		
Score_on_payments = 50			X	
Score_on_payments = 0				X

```
# .......
```

```
Attribute: Number_of_payments
Askable_using: "What is the number of default payments in the last 12 months
(0,..3,..6,..)?"
```

Table 8: Score on bankruptcy

If:	0	1
'Applicant has declared bankruptcy'	Y	N
Then:		
Score_on_bankruptcy = 0	X	
Score_on_bankruptcy = 250		X

```
# .......
```

```
Proposition: 'Applicant has declared bankruptcy'
Askable_using: "**?"
```

Table 9: Score on current account bank years

If:	0	1	2
current_account_bank_years = 0	Y	N	N
current_account_bank_years <= 3	−	Y	N
Then:			
Score_on_current_account_bank_years = 50	X		
Score_on_current_account_bank_years = 150		X	
Score_on_current_account_bank_years = 250			X

```
# .......
```

```
Attribute: current_account_bank_years
Askable_using: "Years with current account bank (0,..3,..)?"
```

Table 10: Score on available credit used percentage

If:	0	1	2	3
Amount_of_available_credit_used% < 25	Y	N	N	N
Amount_of_available_credit_used% < 50	−	Y	N	N
Amount_of_available_credit_used% < 75	−	−	Y	N
Then:				
Score_on_available_credit_used% = 200	X			
Score_on_available_credit_used% = 249		X		
Score_on_available_credit_used% = 150			X	
Score_on_available_credit_used% = 0				X

```
# .......
```

```
Attribute: Amount_of_available_credit_used%
Askable_using: "Amount of available credit used percentage
(0..24,..49,..74,..100)?"
```

Some notes on this version of DT5GL.

To meet up with the requirements of this challenge I had to introduce a new construction in DT5GL, namely:

```
Attribute: Applicant_Credit_Score
Summation_of: Score_on_payments + Score_on_bankruptcy +
Score_on_current_account_bank_years + Score_on_available_credit_used%
```

Also interesting is the notion of 'reduced table' with the keyword 'rTable'.
The use of 'rTable' instead of 'Table' simply disables the check on completeness, what leads to more compact decisions tables. Example:

```
rTable 1: Applicant Demographic Suitability
If:                                                              | 0| 1| 2|
Applicant_Years_of_Age < 18                                     | N| N| N|
Applicant_Card_Type is Student                                  | Y| N| N|
Applicant_Card_Type is Private                                  | -| Y| N|
Applicant_Card_Type is Balance-Transfer                         | -| -| Y|
'Applicant is existing customer'                                | Y| Y| -|
Applicant_Student_Creditcard_Demographic_Suitability is Suitable | Y| -| -|
Applicant_Private_Creditcard_Demographic_Suitability is Suitable | -| Y| -|
Then:
Applicant_Demographic_Suitability is Suitable                   | X| X| X|
# .......
```

is the reduced version of:

```
Table 1: Applicant Demographic Suitability
If:                                                              | 0| 1| 2| 3| 4| 5| 6| 7| 8|
Applicant_Years_of_Age < 18                                     | Y| N| N| N| N| N| N| N| N|
Applicant_Card_Type is Student                                  | -| Y| Y| Y| N| N| N| N| N|
Applicant_Card_Type is Private                                  | -| -| -| -| Y| Y| Y| N| N|
Applicant_Card_Type is Balance-Transfer                         | -| -| -| -| -| -| -| Y| N|
'Applicant is existing customer'                                | -| Y| Y| N| Y| Y| N| -| -|
Applicant_Student_Creditcard_Demographic_Suitability is Suitable | -| Y| N| -| -| -| -| -| -|
Applicant_Private_Creditcard_Demographic_Suitability is Suitable | -| -| -| -| Y| N| -| -| -|
Then:
Applicant_Demographic_Suitability is Suitable                   |  | X|  |  | X|  |  | X|  |
...
Weights for completeness                                        |64| 8| 8|16| 4| 4| 8| 8| 8|
```

Every dash "-" in a column stands for a factor 2, so 2 dashes in a column gives a weight of 4 (2*2), 3 dashes a weight of 8 (2*2*2), 4 dashes a weigth of 16 (2*2*2*2), and so forth.. With this weights, the completeness of the table can be checked: for every condition in the table the number of weigthed Y's must be equal to the number of weigthed N's.

The full table will pass this check; the reduced table will give an error when using "Table":
Decisiontable 1 is not correct.
For condition 1 the number of Y's differs from the number of N's.
Number of Y's: 0
Number of N's: 20

In my opinion it is highly recommended to keep the full version with the reduced version in regards to future changes; see table 5 for another example. On the other hand, many people find it difficult to make complete decision tables, so maybe the use of reduced tables solely is not a problem at all.

Various testruns

1. Age=17 ➔ rejected

```
"What is the years of age of the applicant?"
> 17
"Credit card is rejected"
```

Credit Cardtype=Student

2. Age=18, not existing customer ➔ rejected

```
"What is the years of age of the applicant?"
> 18
"What is the desired cardtype?"
1. Student
2. Private
3. Balance-Transfer
4. Otherwise
> 1

"What is the number of products held?"
> 0
"Credit card is rejected"
```

3. Age=18, existing customer, current account type <> Student ➔ rejected

```
"What is the years of age of the applicant?"
> 18
"What is the desired cardtype?"
1. Student
2. Private
3. Balance-Transfer
4. Otherwise
> 1
"What is the number of products held?"
> 1
"What is the current account type?"
1. Student
2. Otherwise
> 2
"Credit card is rejected"
```

4. Age=18, existing customer, current account type=Student, Application Credit Score<500
➔ rejected

```
"What is the years of age of the applicant?"
> 18
"What is the desired cardtype?"
1. Student
2. Private
3. Balance-Transfer
4. Otherwise
> 1
"What is the number of products held?"
> 2
"What is the current account type?"
1. Student
2. Otherwise
> 1
"What is the number of default payments in the last 12 months (0,..3,..6,..)?"
> 7
'Applicant has declared bankruptcy' (y/n)? *> y
"Years with current account bank (0,..3,..)?"
> 4
"Amount of available credit used percentage (0..24,..49,..74,..100)?"
> 49
"Credit card is rejected"
```


5. Age=18, existing customer, current account type=Student, Application Credit Score>=500
➔ accepted

```
"What is the years of age of the applicant?"
> 18
"What is the desired cardtype?"
1. Student
2. Private
3. Balance-Transfer
4. Otherwise
> 1
"What is the number of products held?"
> 2
"What is the current account type?"
1. Student
2. Otherwise
> 1
"What is the number of default payments in the last 12 months (0,..3,..6,..)?"
> 0
'Applicant has declared bankruptcy' (y/n)? *> y
"Years with current account bank (0,..3,..)?"
> 0
"Amount of available credit used percentage (0..24,..49,..74,..100)?"
> 24
"Credit card is accepted"
```

<u>Credit Cardtype=Private</u>

6. Age=18, existing customer, Sole_Annual_Income<100000,
Outstanding_Mortgage<300000,Saving_and_Investment_balance<100000 ➔ rejected

```
"What is the years of age of the applicant?"
> 18
"What is the desired cardtype?"
1. Student
2. Private
3. Balance-Transfer
4. Otherwise
> 2
"What is the number of products held?"
> 2
"What is the sole anual income"
> 99000
"What is the outstanding mortgage"
> 299000
"What is the saving and investment balance"
> 99000
"Credit card is rejected"
```

7. Age=18, existing customer, Sole_Annual_Income>=100000,
Applicant_Credit_Score >= 750 ➔ accepted

```
"What is the years of age of the applicant?"
> 18
"What is the desired cardtype?"
1. Student
2. Private
3. Balance-Transfer
4. Otherwise
> 2
"What is the number of products held?"
> 2
"What is the sole anual income"
> 100000
"What is the number of default payments in the last 12 months (0,..3,..6,..)?"
> 0
'Applicant has declared bankruptcy' (y/n)? *> n
"Years with current account bank (0,..3,..)?"
> 4
"Amount of available credit used percentage (0..24,..49,..74,..100)?"
> 88
"Credit card is accepted"
```

<u>Credit Cardtype= Balance-Transfer</u>

8. Age=18, Applicant_Credit_Score < 750 ➔ rejected

```
"What is the years of age of the applicant?"
> 18
"What is the desired cardtype?"
1. Student
2. Private
3. Balance-Transfer
4. Otherwise
> 3
"What is the number of default payments in the last 12 months (0,..3,..6,..)?"
> 0
'Applicant has declared bankruptcy' (y/n)? *> y
"Years with current account bank (0,..3,..)?"
> 4
"Amount of available credit used percentage (0..24,..49,..74,..100)?"
> 49
"Credit card is rejected"
```

9. Age=18, Applicant_Credit_Score >= 750,
Sole_Annual_Income > 10000, Residential_Status is UK_resident,
 'CreditCard previously applied in last 6 month' = False,
Number_of_years_address_history >= 3 ➔ accepted

```
"What is the years of age of the applicant?"
> 18
"What is the desired cardtype?"
1. Student
2. Private
3. Balance-Transfer
4. Otherwise
> 3
"What is the number of default payments in the last 12 months (0,..3,..6,..)?"
> 0
'Applicant has declared bankruptcy' (y/n)? *> n
"Years with current account bank (0,..3,..)?"
> 4
"Amount of available credit used percentage (0..24,..49,..74,..100)?"
> 88
"What is the sole anual income"
> 10001
"What is the residential status of the applicant?"
1. UK_resident
2. Otherwise
> 1
'CreditCard previously applied in last 6 month' (y/n)? *> n
"What is the number of years with a adress history (3 or more expected)?"
> 3
"Credit card is accepted"
```

Demo Goal-driven/Backward-chaining reasoning with condition subtables.

Credit Cardtype=Private
7. Age=18, existing customer, Sole_Annual_Income>=100000,
Applicant_Credit_Score >= 750 ➔ accepted

```
Prove (Credit_Card is Accepted)
    >> Conditions Table 0 Rule 0:
    Prove (Applicant_Demographic_Suitability is Suitable)
        >> Conditions Table 1 Rule 0:
        "What is the years of age of the applicant?"
        > 18
        "What is the desired cardtype?"
        1. Student
        2. Private
        3. Balance-Transfer
        4. Otherwise
        > 2
        >> Failed...
        >> Conditions Table 1 Rule 1:
        Prove ('Applicant is existing customer')
            >> Conditions Table 2 Rule 0:
            "What is the number of products held?"
            > 2
            >> Succeed...
        Succeed
        Prove (Applicant_Private_Creditcard_Demographic_Suitability is Suitable)
            >> Conditions Table 4 Rule 1:
            "What is the sole anual income"
            > 100000
            >> Failed...
            >> Conditions Table 4 Rule 2:
            >> Failed...
            >> Conditions Table 4 Rule 3:
            >> Succeed...
        Succeed
        >> Succeed...
    Succeed
```

Prove (Credit_Card is Accepted)

```
    Prove (Applicant_Creditcard_Eligibility is Eligible)
        >> Conditions Table 5 Rule 0:
        >> Failed...
        >> Conditions Table 5 Rule 1:
        Prove (Applicant_Credit_Score >= 750)
            >> Conditions Table 7 Rule 0:
            "What is the number of default payments in the last 12 months
            (0,..3,..6,..)?"
            > 0
            >> Succeed...
                Derived value for Score_on_payments is: 250
            >> Conditions Table 8 Rule 0:
            'Applicant has declared bankruptcy' (y/n)? *> n
            >> Failed...
            >> Conditions Table 8 Rule 1:
            >> Succeed...
                Derived value for Score_on_bankruptcy is: 250
            >> Conditions Table 9 Rule 0:
            "Years with current account bank (0,..3,..)?"
            > 4
            >> Failed...
            >> Conditions Table 9 Rule 1:
            >> Failed...
            >> Conditions Table 9 Rule 2:
            >> Succeed...
                Derived value for Score_on_current_account_bank_years is: 250
            >> Conditions Table 10 Rule 0:
            "Amount of available credit used percentage (0..24,..49,..74,..100)?"
            > 88
            >> Failed...
            >> Conditions Table 10 Rule 1:
            >> Failed...
            >> Conditions Table 10 Rule 2:
            >> Failed...
            >> Conditions Table 10 Rule 3:
            >> Succeed...
                Derived value for Score_on_available_credit_used% is: 0
            Derived value for Applicant_Credit_Score is: 750
        Succeed
        >> Succeed...
    Succeed
    >> Succeed...
"Credit card is accepted"
Succeed
```