

# Challenge Feb-2018

## Tax Decision Table

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	<b>IF This year's filing</b>	1	2	3	4	5	6	7	8	9	10	11	12	
2	Doc Code being processed is 7,8 or 28	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	
3	Taxable Income < 50,000	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	
4	Interest Income < 400	-	N	N	N	N	-	-	-	-	Y	Y	Y	
5	Taxable Pension = 0	-	-	-	-	-	N	N	Y	Y	Y	Y	Y	
6	Under 65 Years Old	-	Y	N	N	Y	N	N	N	N	Y	Y	Y	
7	AGI < 25,000	-	-	N	Y	-	N	Y	N	Y	-	-	-	
8	Doc Code being processed is a 28	-	-	-	-	-	-	-	-	-	Y	N	N	
9	Zip Code OK (not SC, APO or LL)	-	-	-	-	-	-	-	-	-	-	Y	-	
10	<b>THEN</b>													
	Next Year send the taxpayer the following forms and schedules:										Y	Y		
11	1040EZ Telefile (MFR 15)												Y	
	Next Year send the taxpayer the following forms and schedules:													
12	1040EZ (MFR 13)													
	Next Year send the taxpayer the following forms and schedules:	Y	Y	Y		Y	Y		Y					
13	1040A, with Sch 1,2 (MFR 02)													
	Next Year send the taxpayer the following forms and schedules:				Y			Y		Y				
14	1040A with Sch R (MFR 14)													

To make the given decision table correct and complete, I've used a tool called TFAT; there are still software testers in the Netherlands who are familiar with it. The first result of this tool gives:

	0001	0003	0004	0009	0013	0017	0033	0065	0129
Doc code is 7, 8 or 28	Y	Y	Y	Y	Y	Y	Y	Y	N
Taxable income < 50000	Y	Y	Y	Y	Y	Y	Y	N	-
Interest income < 400	Y	Y	Y	-	-	Y	N	-	-
Taxable pension = 0	Y	Y	Y	-	-	N	-	-	-
Age < 65	Y	Y	Y	N	N	Y	Y	-	-
AGI < 25000	-	-	-	Y	N	-	-	-	-
Doc code is 28	Y	N	N	-	-	-	-	-	-
Zip Code OK	-	Y	N	-	-	-	-	-	-
MFR15	X	X	-	-	-	-	-	-	-
MFR13	-	-	X	-	-	-	-	-	-
MFR02	-	-	-	-	X	-	X	X	-
MFR14	-	-	-	X	-	-	-	-	-

Now we can see immediately that there are two columns/rules where the action-part is missing, namely columns 0017 and 0129; for those rules we have to add an explicit "do nothing"- action. A second severe problem with this table is that it is not readable and comprehensible for human readers. To (partially!) overcome this problem, I inserted rules 0017 and 0033 just next to rule 0004. The resulting table has been captured in an own tool with the work title DT5GL; I'm still working on it with Python 3.6.0.

Implementation of the decision table in DT5GL:

Table 0: Taxform

If:	0  1  2  3  4  5  6  7  8
'Doccode being processed is 7,8 or 28'	Y  Y  Y  Y  Y  Y  Y  Y  N
Taxable_income < 50000	Y  Y  Y  Y  Y  Y  Y  N  -
Interest_income < 400	Y  Y  Y  Y  N  -  -  -  -
Taxable_pension = 0	Y  Y  Y  N  -  -  -  -  -
Age < 65	Y  Y  Y  Y  Y  N  N  -  -
Agi < 25000	-  -  -  -  -  Y  N  -  -
Doc_code = 28	Y  N  N  -  -  -  -  -  -
'Zipcode ok (not APO, SC or LL)'	-  Y  N  -  -  -  -  -  -

Then:	
Formcode is MFR15	X  X
Formcode is MFR13	X
Formcode is MFR02	X    X  X
Formcode is MFR14	X
Formcode is None	X          X
# .....	

Attribute: Taxable\_income  
 Askable\_using: "What is the Taxable\_income?"  
 Attribute: Interest\_income  
 Askable\_using: "What is the Interest\_income?"  
 Attribute: Taxable\_pension  
 Askable\_using: "What is the Taxable\_pension?"  
 Attribute: Age  
 Askable\_using: "What is the Age?"  
 Attribute: Agi  
 Askable\_using: "What is the Agi?"

GoalAttribute: Formcode  
 Case: MFR02  
 Print: "Taxform to send is MFR02"  
 Case: MFR13  
 Print: "Taxform to send is MFR13"  
 Case: MFR14  
 Print: "Taxform to send is MFR14"  
 Case: MFR15  
 Print: "Taxform to send is MFR15"  
 Case: None  
 Print: "No Taxform to send"  
 # .....

Table 1: Doccode being processed is 7,8 or 28

If:	0  1  2  3
Doc_code = 7	Y  N  N  N
Doc_code = 8	-  Y  N  N
Doc_code = 28	-  -  Y  N
Then:	
'Doccode being processed is 7,8 or 28'	X  X  X

# .....

Attribute: Doc\_code  
 Askable\_using: "What is the doccode being processed (7,8 or 28 expected)?"

Table 2: Zipcode ok (not APO, SC or LL)

If:	0  1  2  3
Zip_code is APO	Y  N  N  N
Zip_code is SC	-  Y  N  N
Zip_code is LL	-  -  Y  N
Then:	
'Zipcode ok (not APO, SC or LL)'	X

# .....

Attribute: Zip\_code  
 Askable\_using: "What is the zipcode?"

# .....

Instead of using a nice Pythonlike condition as “doc\_code in {7,8,28}” or “zip\_code in {APO, SC, LL} (it is on my todo-list), I make use of **condition subtables** with the same result. Of course the idea of condition subtables optimal works in combination with a goaldriven/backward chaining-reasoning strategy!

A typical consult with this tool (with clearly the style of an “expert system” for rapid prototyping) looks like this (where I gave the answers for rule 2 to obtain a MFR13-formcode):

With Trace=False:

```
PS C:\Users\Administrator\onedrive\pprogs\english> python uc.py
File to read...: taxformv1.txt

"What is the doccode being processed (7,8 or 28 expected)?"
> 8

"What is the Taxable_income?"
> 49000

"What is the Interest_income?"
> 399

"What is the Taxable_pension?"
> 0

"What is the Age?"
> 64

"What is the zipcode?"
1. APO
2. SC
3. LL
4. Otherwise
> 3

"Taxform to send is MFR13"

PS C:\Users\Administrator\onedrive\pprogs\english>
```

The same consult, but now with Trace=True gives the following result:

```
PS C:\Users\Administrator\onedrive\pprogs\english> python uc.py
File to read...: taxformv1.txt

Prove (Formcode is MFR15)
  >> Conditions Table 0 Rule 0:
  Prove ('Doccode being processed is 7,8 or 28')
    >> Conditions Table 1 Rule 0:
    "What is the doccode being processed (7,8 or 28 expected)?"
    > 8

    >> Failed...
    >> Conditions Table 1 Rule 1:
    >> Succeed...
  Succeed
  "What is the Taxable_income?"
  > 49000

  "What is the Interest_income?"
  > 399

  "What is the Taxable_pension?"
  > 0

  "What is the Age?"
  > 64

  >> Failed...
  >> Conditions Table 0 Rule 1:
  Prove ('Zipcode ok (not APO, SC or LL)')
    >> Conditions Table 2 Rule 3:
    "What is the zipcode?"
    1. APO
    2. SC
    3. LL
    4. Otherwise
    > 3

    >> Failed...
  Failed..
  >> Failed...
Failed
Prove (Formcode is MFR13)
  >> Conditions Table 0 Rule 2:
  >> Succeed...
  "Taxform to send is MFR13"

Succeed
PS C:\Users\Administrator\onedrive\pprogs\english>
```

Implementation of the decision table in DT5GL: more readable/comprehensive version:

The solution I gave, namely:

```

Table 0: Taxform
If:
'Doccode being processed is 7,8 or 28'
Taxable_income < 50000
Interest_income < 400
Taxable_pension = 0
Age < 65
Agi < 25000
Doc_code = 28
'Zipcode ok (not APO, SC or LL)'
Then:
Formcode is MFR15
Formcode is MFR13
Formcode is MFR02
Formcode is MFR14
Formcode is None
# .....

```

	0	1	2	3	4	5	6	7	8
'Doccode being processed is 7,8 or 28'	Y	Y	Y	Y	Y	Y	Y	Y	N
Taxable_income < 50000	Y	Y	Y	Y	Y	Y	Y	N	-
Interest_income < 400	Y	Y	Y	Y	N	-	-	-	-
Taxable_pension = 0	Y	Y	Y	N	-	-	-	-	-
Age < 65	Y	Y	Y	Y	Y	N	N	-	-
Agi < 25000	-	-	-	-	-	Y	N	-	-
Doc_code = 28	Y	N	N	-	-	-	-	-	-
'Zipcode ok (not APO, SC or LL)'	-	Y	N	-	-	-	-	-	-
Formcode is MFR15	X	X							
Formcode is MFR13			X						
Formcode is MFR02					X		X	X	
Formcode is MFR14						X			
Formcode is None				X					X

is not optimal for readability and comprehensibility!

The table is (in my opinion) much more readable when the conditions “Age < 65” and “Agi < 25000” are switched with the two above (with Notepad++ really a simple operation):

```

Table 0: Taxform
If:
'Doccode being processed is 7,8 or 28'
Taxable income < 50000
Age < 65
Agi < 25000
Interest_income < 400
Taxable_pension = 0
Doc_code = 28
'Zipcode ok (not APO, SC or LL)'
Then:
Formcode is MFR15
Formcode is MFR13
Formcode is MFR02
Formcode is MFR14
Formcode is None
# .....

```

	0	1	2	3	4	5	6	7	8
'Doccode being processed is 7,8 or 28'	Y	Y	Y	Y	Y	Y	Y	Y	N
Taxable income < 50000	Y	Y	Y	Y	Y	Y	Y	N	-
Age < 65	Y	Y	Y	Y	Y	N	N	-	-
Agi < 25000	-	-	-	-	-	Y	N	-	-
Interest_income < 400	Y	Y	Y	Y	N	-	-	-	-
Taxable_pension = 0	Y	Y	Y	N	-	-	-	-	-
Doc_code = 28	Y	N	N	-	-	-	-	-	-
'Zipcode ok (not APO, SC or LL)'	-	Y	N	-	-	-	-	-	-
Formcode is MFR15	X	X							
Formcode is MFR13			X						
Formcode is MFR02					X		X	X	
Formcode is MFR14						X			
Formcode is None				X					X

And TFAT does agree on this:

	0001	0003	0004	0005	0009	0033	0049	0065	0129
Doc code is 7, 8 or 28	Y	Y	Y	Y	Y	Y	Y	Y	N
Taxable income < 50000	Y	Y	Y	Y	Y	Y	Y	N	-
Age < 65	Y	Y	Y	Y	Y	N	N	-	-
AGI < 25000	-	-	-	-	-	Y	N	-	-
Interest income < 400	Y	Y	Y	Y	N	-	-	-	-
Taxable pension = 0	Y	Y	Y	N	-	-	-	-	-
Doc code is 28	Y	N	N	-	-	-	-	-	-
Zip Code OK	-	Y	N	-	-	-	-	-	-
MFR15	X	X	-	-	-	-	-	-	-
MFR13	-	-	X	-	-	-	-	-	-
MFR02	-	-	-	-	X	-	X	X	-
MFR14	-	-	-	-	-	X	-	-	-
do nothing	-	-	-	X	-	-	-	-	X