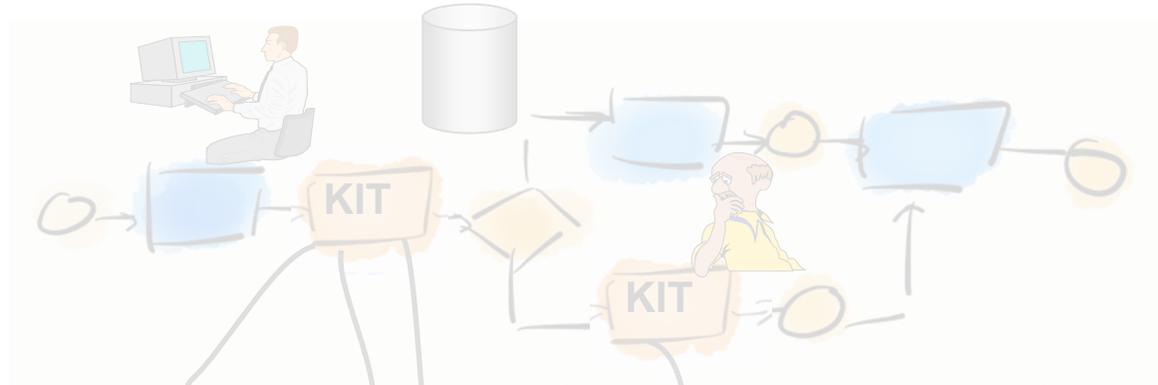
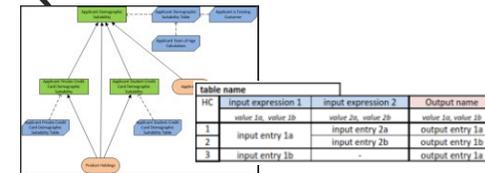
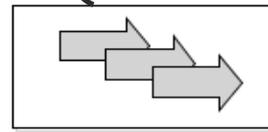


# Decision Tables

Process Logic



Business Logic



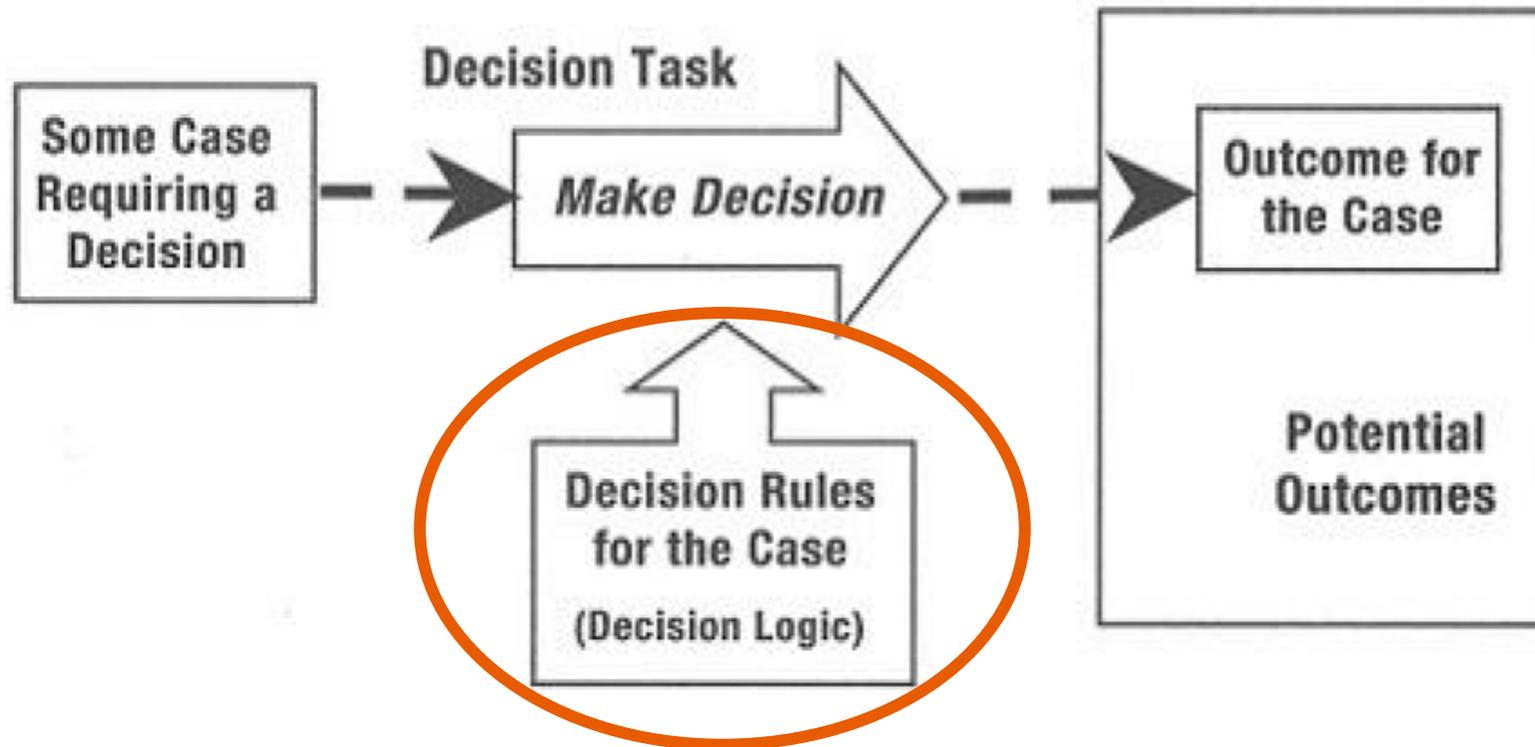
decision model

Decision Model and Notation

*Beta1*

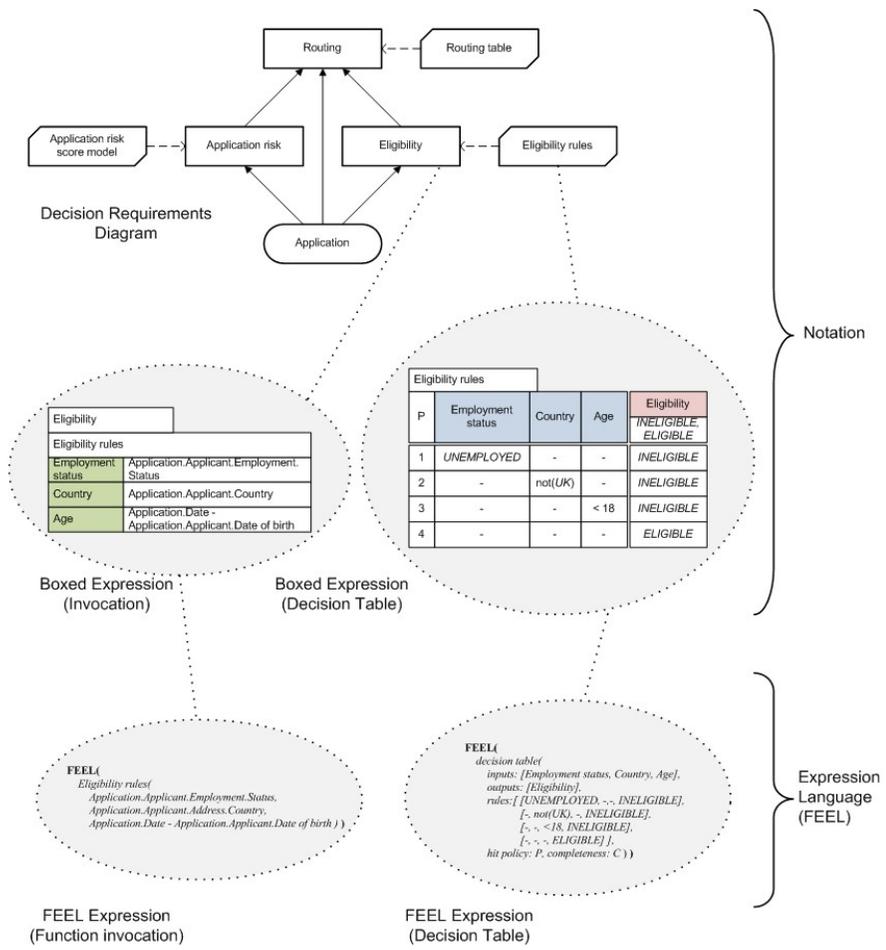
# DECISION MODEL AND NOTATION (DMN)

# Decision Logic and Decision Task



(Ross 2011, p. 152f)

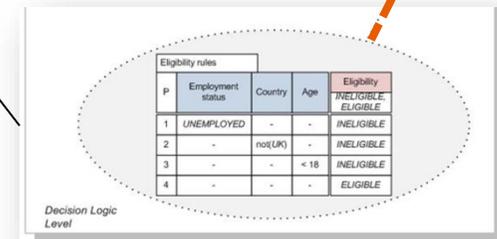
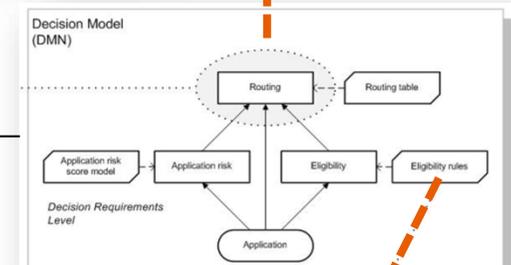
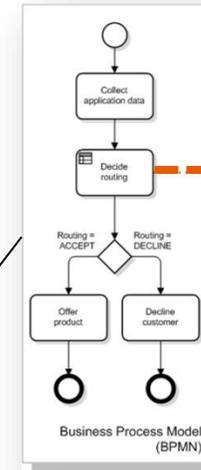
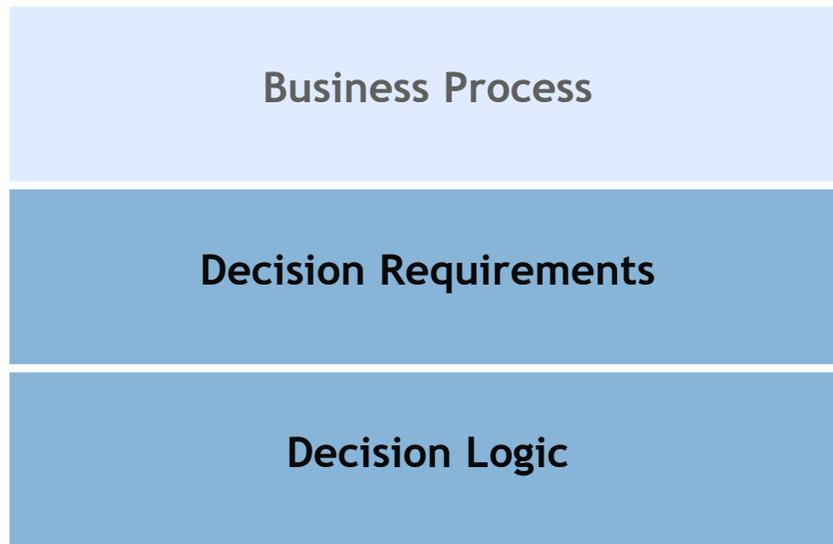
# Decision Model and Notation (DMN)



- The Decision Model and Notation is a new standard from the OMG
- It is currently published in its version 1.2
- Purpose of DMN: provide the constructs that are needed to model decision, so that organizational decision-making can be
  - ◆ readily depicted in diagrams
  - ◆ accurately defined by business analysts
  - ◆ (optionally) automated

# Main Concepts of DMN

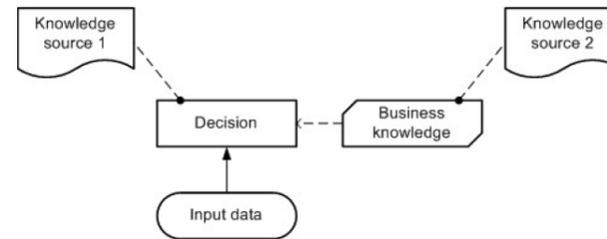
More details



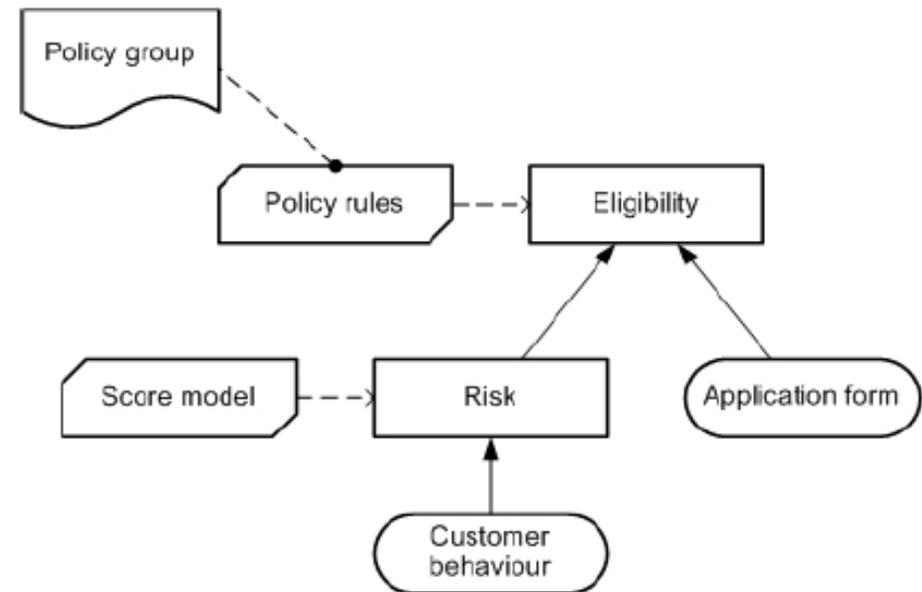
(Coenen 2013)

# Main concepts – Decision Requirements Level

- Business decisions
- Business knowledge
- Sources of business knowledge
- Input Data

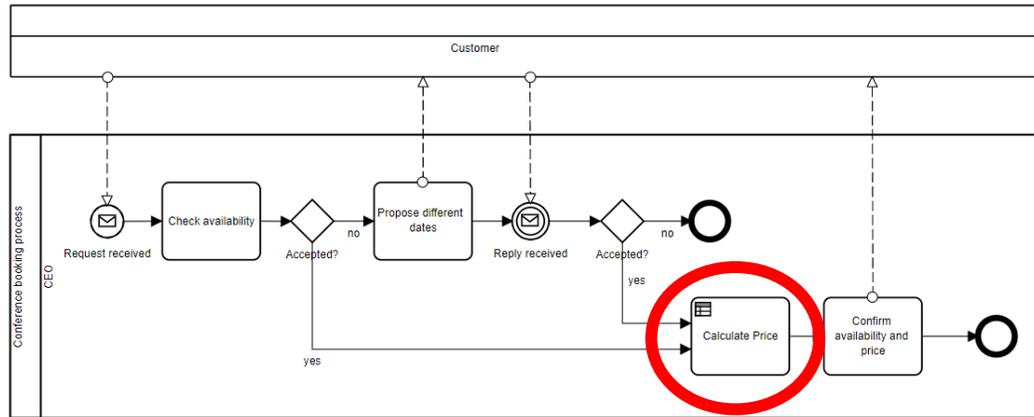


## Decision Requirements

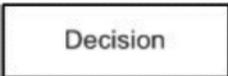
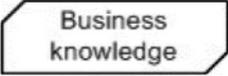
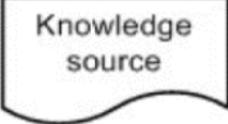
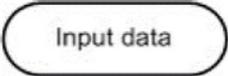


(Coenen 2013)

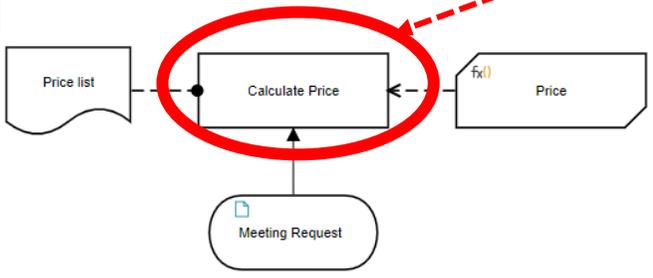
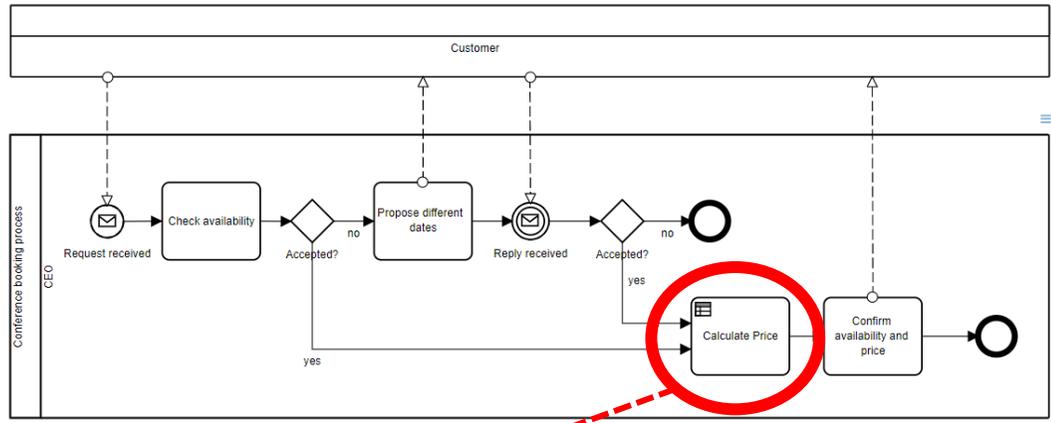
# Decision Aware Representation of Booking Process with Price Calculation



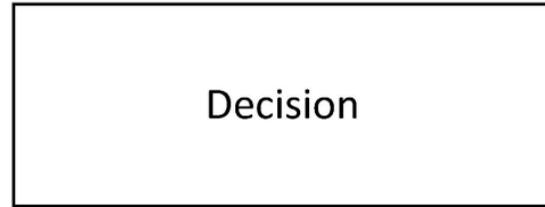
# Constructs of a Decision Requirements Model

Construct	DMN Notation	Description
<b>ELEMENTS</b>		
Decision		The act of determining an output from a number of inputs, using decision logic which may reference one or more business knowledge models.
Business Knowledge Model		A function encapsulating business knowledge, in the form of business rules, decision table or analytic model. Some of the tool may not support this element. In such case the decision logic is directly linked to the Decision rather than the business knowledge model.
Knowledge Source		The authority for a business knowledge model or decision.
Input Data		Information used as an input by one or more decisions. It also denotes the parameters of a Business Knowledge Model.
<b>REQUIREMENTS</b>		
Information Requirement		Information - input data or decision output - required for a decision.
Knowledge Requirement		The invocation of a business knowledge model.
Authority Requirement		Showing the knowledge source of an element or the dependency of a knowledge source on input data.

# Decision Aware Representation of Booking Process with Price Calculation



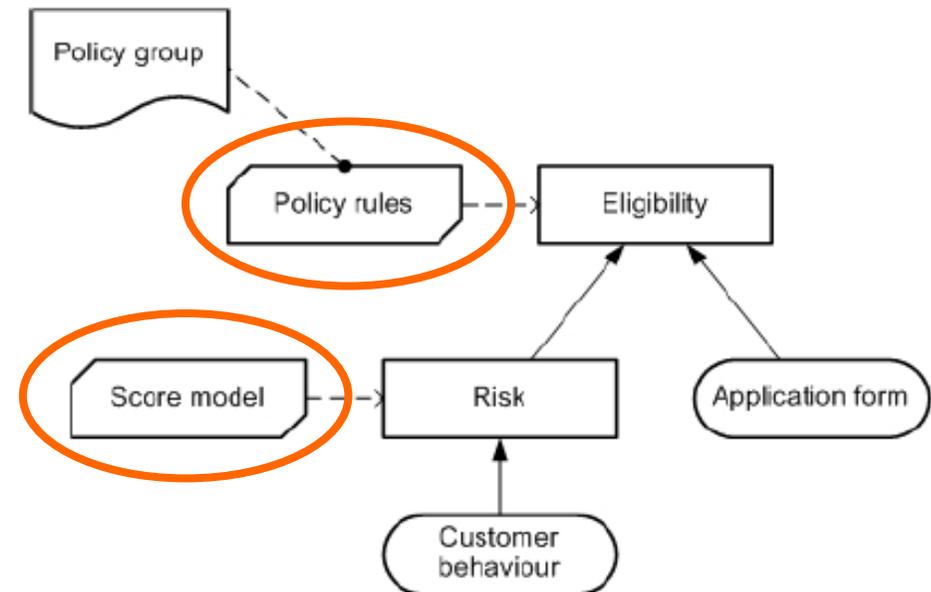
# Decision

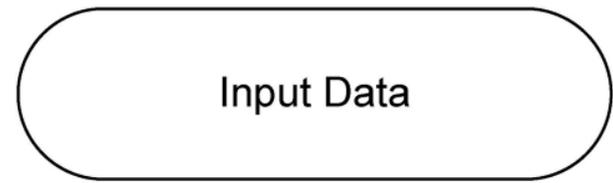


- A decision determines an output from a number of inputs by applying some decision logic.
- Two properties should be captured for every decision:
  - ◆ Question: A specific and detailed natural language statement that represents the decision in the form of a question.
  - ◆ Allowed Answers: A natural language description of the potential outcomes.
- Decisions can have reference to Decision Logic
- Decisions can be decomposed into sub-decisions.
  - ◆ Top level decisions can be thought of as selecting an answer from a range of possible answers.
  - ◆ Lower level decisions provide input to higher-level decisions.

# Business Knowledge Models

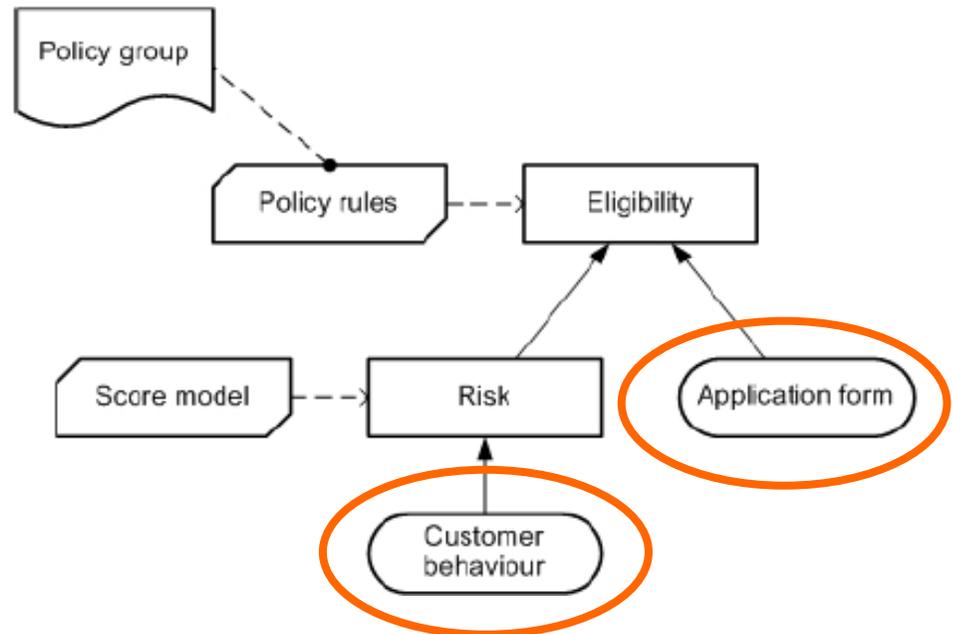
- Business knowledge models represent reusable decision logic.
- The decision logic might be
  - ◆ a decision table,
  - ◆ a decision tree,
  - ◆ a set of business rules,
  - ◆ an analytic model.

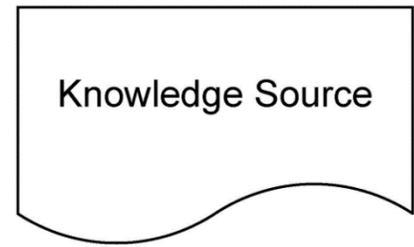




# Input Data

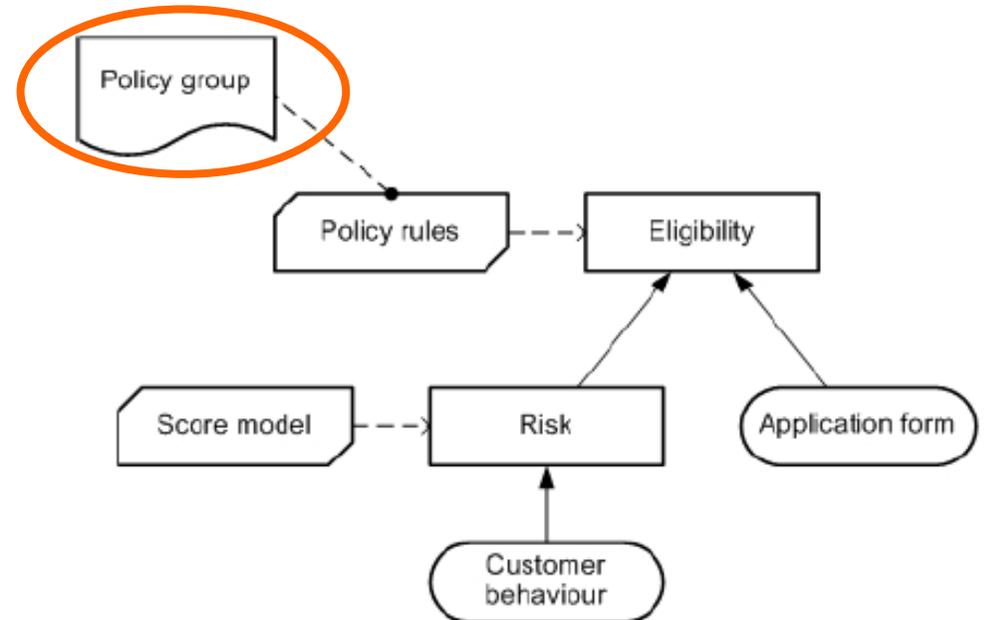
- Decisions require are input data.
- Input data elements typically represent business entities that are being used in the decision making, such as Application Form or Customer Data.





# Knowledge Source

- Knowledge sources represent the source of know-how for making a decision. This could be regulations or policies, best practices or expertise on how a decision should be made.
- Knowledge sources are the authorities for a decision and typically refer to some external document or source that contains detailed guidance



# DRD Requirements



Shows that Input Data or Decision output is required as an input by another Decision



Shows that a Business Knowledge Model is invoked by a Decision or another Business Knowledge Model



Shows the dependency of a DRD Element on a Knowledge Source

# Main concepts – Decision Logic

Detailed criteria for decision making

- Business rules
- Calculations
- Decision Tables
- Scripts

Decision Logic

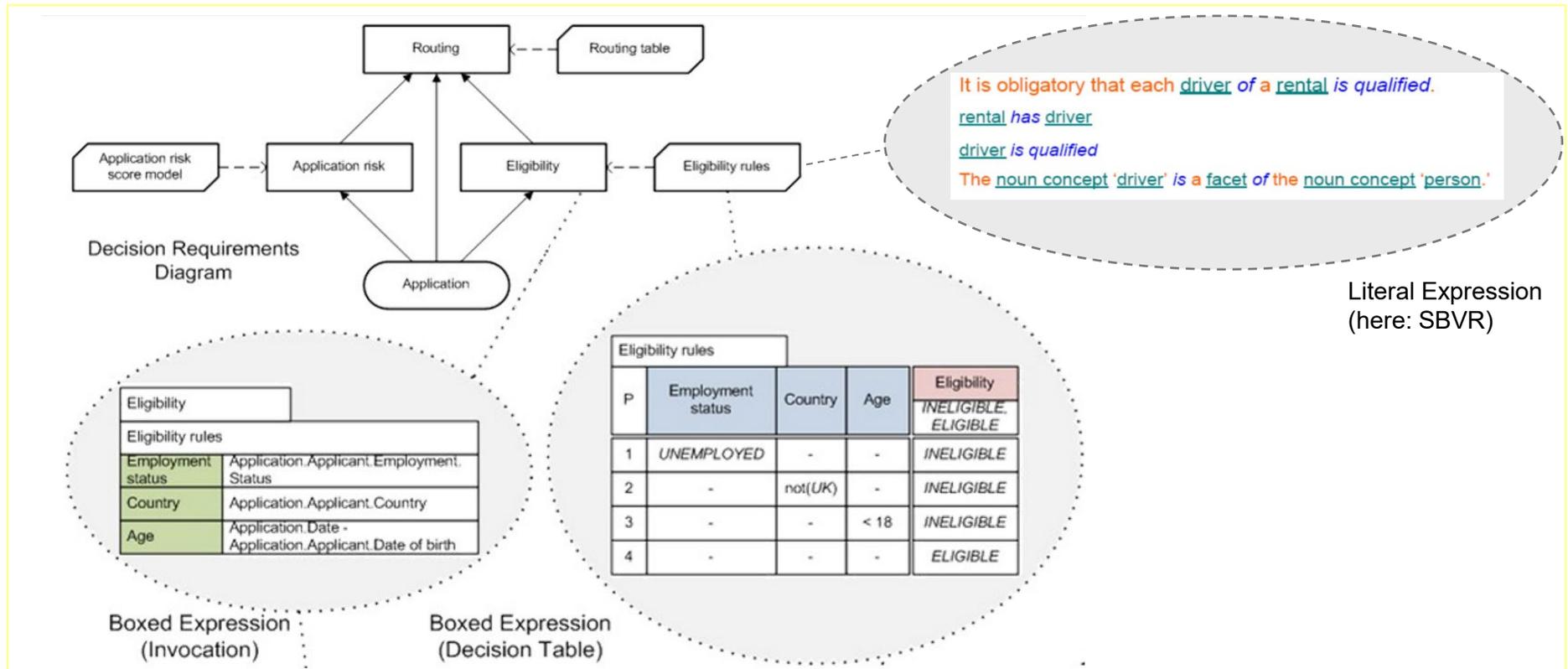
The diagram illustrates a decision logic level. It features a table titled "Eligibility rules" with four columns: "P", "Employment status", "Country", and "Age". A fifth column, "Eligibility", is highlighted in pink and contains the possible outcomes: "INELIGIBLE" and "ELIGIBLE". The table lists four rules (1-4) with their corresponding values for the first four columns and the resulting eligibility status. The entire table is enclosed in a dotted oval, and the text "Decision Logic Level" is written below it.

Eligibility rules				
P	Employment status	Country	Age	Eligibility
1	UNEMPLOYED	-	-	INELIGIBLE
2	-	not(UK)	-	INELIGIBLE
3	-	-	< 18	INELIGIBLE
4	-	-	-	ELIGIBLE

Decision Logic Level

# Linking Requirements Diagram with Decision Logic

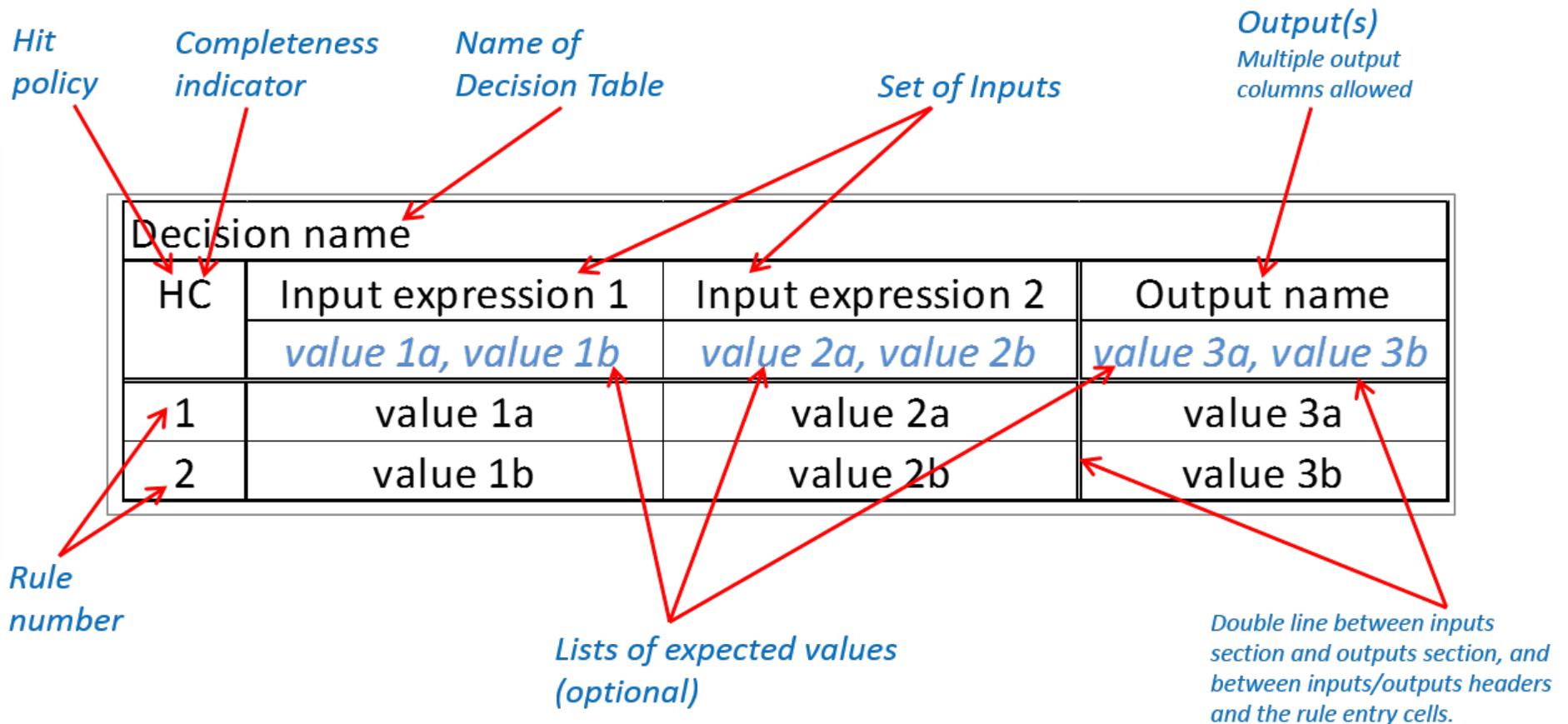
- The notation for decision logic in DMN is a
  - Decision Table
  - Invocation
  - Literal expression (business rule)
- Decision logic can be assigned to Decision or Business Knowledge elements





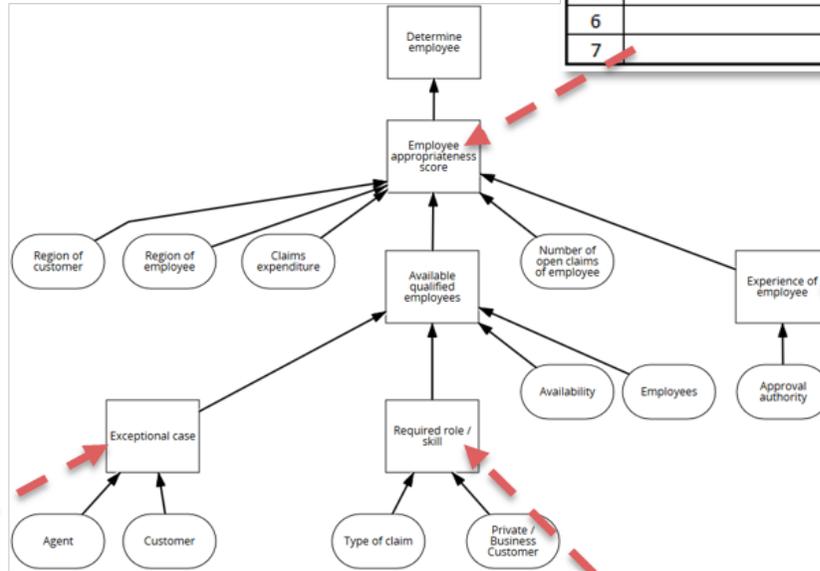
*"I'm here because my boss said we should use more decisions tables for our project. What types of decision tables do you sell?"*

# Structure of a Decision Table in DMN



# Decision Tables

Employee appropriateness score					
C	Region of employee = Region of customer	Claims Expenditure (estimated)	Experience of employee	Number of open claims of employee	Score
	yes/no	Number	low/medium/high	Number	Number
1	yes				100
2		[1000..10000]	low		-100
3		> 10000	low		-1000
4		> 10000	medium		-100
5				[10..20]	-100
6				[20..30]	-500
7				> 30	-1000



Experience of Employee		
	Approval Authority	Experience
1	< 1000	low
2	[1000..10000]	medium
3	> 10000	high

Exceptional Case				
	Agent Id	Customer Frame Contract Id	Required Role	Special Employee
1	4711		Special Customer Task Force Berlin	
2		0815	Special Customer Task Force Berlin	
3		camunda		Mr. Important
4	...	...	...	...

Required Skill / Role				
	Type of Claim	Private/Business Customer?	Required Role	Required Skill
1	Third Party Liability	Private	Service Center	
2	Third Party Liability	Business	Service Center	Business Law Qualification
3	Accident	Private	Service Center	
4	Accident	Business	Business Accident Team	
5	...	...	...	

## Decision Tables – Reducing Combinations

- If effects for several combinations are the same, the combinations can be combined, reducing the number of rules
- Example:
  - ◆ If Cause 1 is „yes“, the effect does not depend on the value of Cause 2
  - ◆ In this case, the value of Cause 2 does not need to be taken into account

effect			
	Cause1	Cause 2	Effect
	<i>yes, no</i>	<i>yes, no</i>	<i>E1, E2, E3</i>
1	yes	yes	E1
2	yes	no	E1
3	no	yes	E2
4	no	no	E3

effect			
	Cause1	Cause 2	Effect
	<i>yes, no</i>	<i>yes, no</i>	<i>true, false</i>
1	yes	-	E1
2	no	yes	E2
3	no	no	E3

## Exercise: Reduce decision table

- The following decision table represents rules for reimbursing expenses by health insurance
- Reimbursement depends on three conditions:
  - ◆ whether deductible is already met,
  - ◆ whether the patient visited the doctor's office (D), a hospital (H) or a lab (L) and
  - ◆ whether – in case of a visit at the doctor's office – the physician is present

- The decision table is complete showing all combinations of decisions. Reduce the table to only the really needed number of rules

Reimbursement				
	Deductible met	Type of visit	Physician present	Reimbursement
	<i>yes, no</i>	<i>D, H, L</i>	<i>yes, no</i>	<i>integer</i>
1	yes	D	yes	90
2	yes	D	no	50
3	yes	H	yes	80
4	yes	H	no	80
5	yes	L	yes	70
6	yes	L	no	70
7	no	D	yes	0
8	no	D	no	0
9	no	H	yes	0
10	no	H	no	0
11	no	L	yes	0
12	no	L	no	0

# Reduced Decision Table for Health Insurance

Reimbursement depends on whether deductible is already met, whether the patient visited the doctor 's office (D), a hospital (H) or a lab (L) and whether the Doctor in the doctor 's office is a Participating Physician

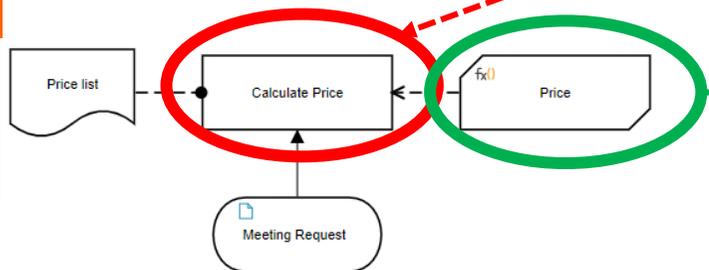
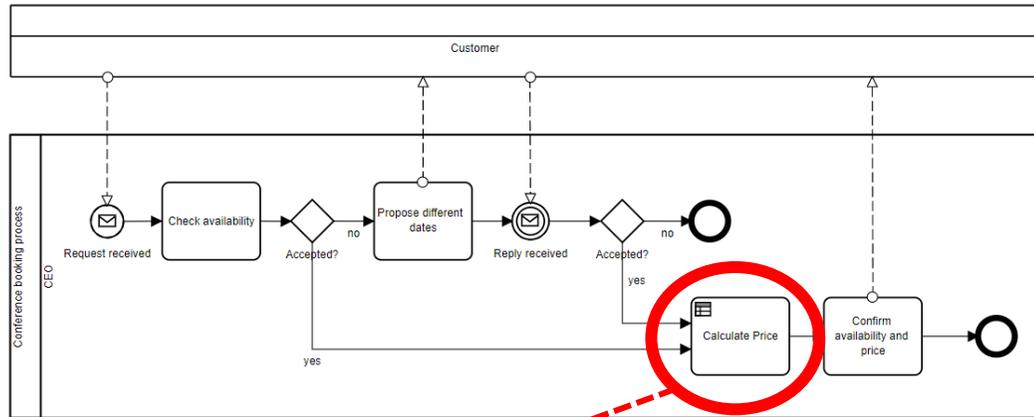
Reimbursement				
	Deductable met	Type of visit	Physician present	Reimbursement
	<i>yes, no</i>	<i>D, H, L</i>	<i>yes, no</i>	<i>integer</i>
1	yes	D	yes	90
2	yes	D	no	50
3	yes	H	-	80
4	yes	L	-	70
5	no	-	-	0

- A Hospital visit and a Lab visit have the same reimbursement, independent of a participating physician.

- If the deductible is not met, no reimbursement is given, independent of the other conditions

[http://web.sxu.edu/rogers/sys/decision\\_tables.html](http://web.sxu.edu/rogers/sys/decision_tables.html)

# Decision Aware Representation of Booking Process with Price Calculation



	Type of Room	Number of People	Price
U	Text "Meeting Room", "Conference Room"	Number	Number
1	"Meeting Room"	-	500
2	"Conference Room"	<=30	800
3	"Conference Room"	>30	1200

# Input Data and Decision Table

- The data types of the decision must match the input data
- This decision table fits for the input data: appropriate data types
  - ◆ Enumeration
  - ◆ Number

Meeting Request

Type of Room

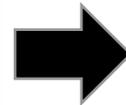
Meeting Room

Conference Room

Number of People

Your answer

Submit



	Type of Room	Number of People	Price
U	<i>Text</i> "Meeting Room", "Conference Room"	<i>Number</i>	<i>Number</i>
1	"Meeting Room"	-	500
2	"Conference Room"	$\leq 30$	800
3	"Conference Room"	$> 30$	1200

# Input Data and Decision Table

- These decision tables do **not** fit for the input data
  - ◆ Input for Number of People is a number
  - ◆ In decision tables the types for Number of People are different

### Meeting Request

---

Type of Room

Meeting Room

Conference Room

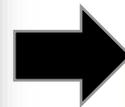
---

Number of People

Your answer

U	Type of Room	Number of People	Price
	<i>Text</i> "Meeting Room", "Conference Room"	<i>Text</i> "<=30", ">30"	<i>Number</i>
1	"Meeting Room"	-	500
2	"Conference Room"	"<=30"	800
3	"Conference Room"	">30"	1200

Enumeration (text)  
'<=30' '>30'



U	Type of Room	Number of People	Price
	<i>Text</i> "Meeting Room", "Conference Room"	<i>Boolean</i> >30	<i>Number</i>
1	"Meeting Room"	-	500
2	"Conference Room"	true	800
3	"Conference Room"	false	1200

Boolean  
But: Who made the check whether the number is >30 or not?

## Hit Policies (1)

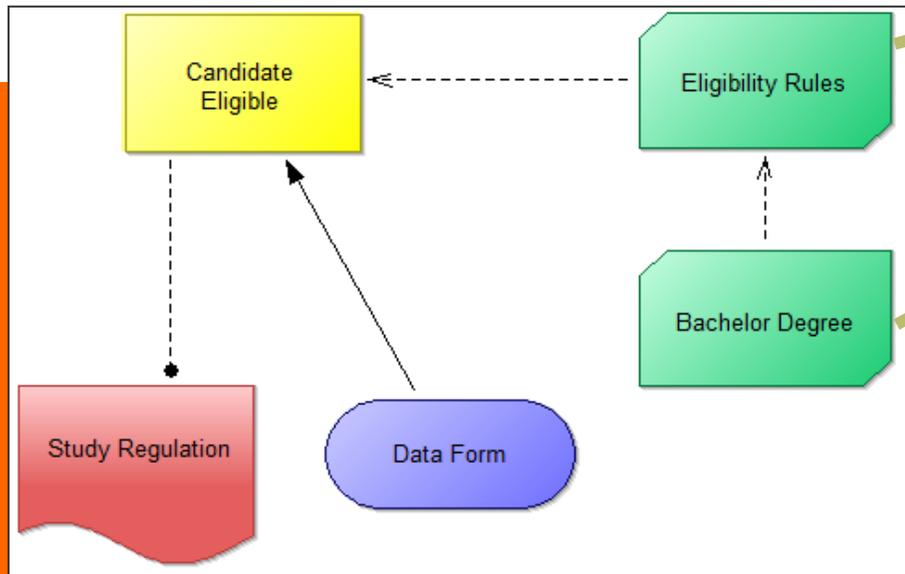
- The hit policy specifies what the result of the decision table is, if there are multiple matches for a given set of inputs.
- The hit policy indication is mandatory and is summarized using a single character in a particular decision table cell.

### Single Hit Policies:

Hit Policy	Description
Unique	This is the default policy. All rules are exclusive and only a single rule is matched.
Any	Multiple matching rules, all matching rules with the same output. Any of these outputs can be used.
Priority	Multiple matching rules with different outputs. Returns the matching rule with the highest output priority which is specified in an ordered list of values, e.g. the list of expected output values.
First	Multiple matching rules with different outputs. First hit by rule order is returned. Once there is a hit, the evaluation stops (and ignore the rest of the rules). The matching has a dependency on the order of the rules. The last rule is often the <i>catch-remainder</i> rule. <b>This type of policy is hard to validate manually and must be used with care.</b>

# Subdecisions: Result of one decision is input to another decision

Decision Requirements Diagram



Decision Tables

Eligibility			
A	Degree valid	University Registered	eligible
	<i>yes, no</i>	<i>yes, no, unclear</i>	<i>yes, no</i>
1	yes	yes	yes
2	no	-	no
3	-	no	no
4	-	unclear	no

Degree valid		
A	Bachelor Degree	Degree valid
	<i>IS, BA, IT, other</i>	<i>yes, no</i>
1	IS	yes
2	BA	yes
3	IT	yes
4	other	no

# Hit Policies (2)

## Multiple Hits Policies for Single Output

Hit Policy	Description
No order	Returns all hits in a unique list in arbitrary order.
Output order	Returns all hits in decreasing priority order. Output priorities are specified in an ordered list of values.
Rule order	Returns all hits in rule order, i.e. dependency on the order of the rules.

## Aggregation for Multiple Hits Policy

Aggregation	Description
Collect	The result of the decision table is the list of all the outputs, ordered or unordered per the hit policy.
Sum	The result of the decision table is the sum of all the outputs.
Min	The result of the decision table is the smallest value of all the outputs.
Max	The result of the decision table is the largest value of all the outputs.
Count	The result of the decision table is the number of outputs.
Average	The result of the decision table is the average value of all the outputs, defined as the sum divided by the count.

# Example for Multiple Hit Policy

## Collect – Sum

Apply all possible rules and sum up the values. This gives the overall price of room and extras

### Meeting Request

---

Type of Room

Meeting Room

Conference Room

---

Number of People

Your answer

---

Extras

Beamer

Flipchart

Whiteboard



C+	Type of Room	Number of People	Extras	Price
	<i>Text</i> "Conference Room", "Meeting Room"	<i>Number</i>	<i>Text</i> "Beamer", "Flipchart", "Whiteboard"	<i>Number</i>
1	"Conference Room"	<=30	-	800
2	"Conference Room"	>30	-	1200
3	"Meeting Room"	-	-	500
4	-	-	"Beamer"	60
5	-	-	"Flipchart"	30
6	-	-	"Whiteboard"	40

# Orientation of Rules in a DMN Decision Table

Rules as Rows:

table name			
HC	input expression 1	input expression 2	Output name
	<i>value 1a, value 1b</i>	<i>value 2a, value 2b</i>	<i>value 1a, value 1b</i>
1	input entry 1a	input entry 2a	output entry 1a
2		input entry 2b	output entry 1b
3	input entry 1b	-	output entry 1a

Rules as Columns:

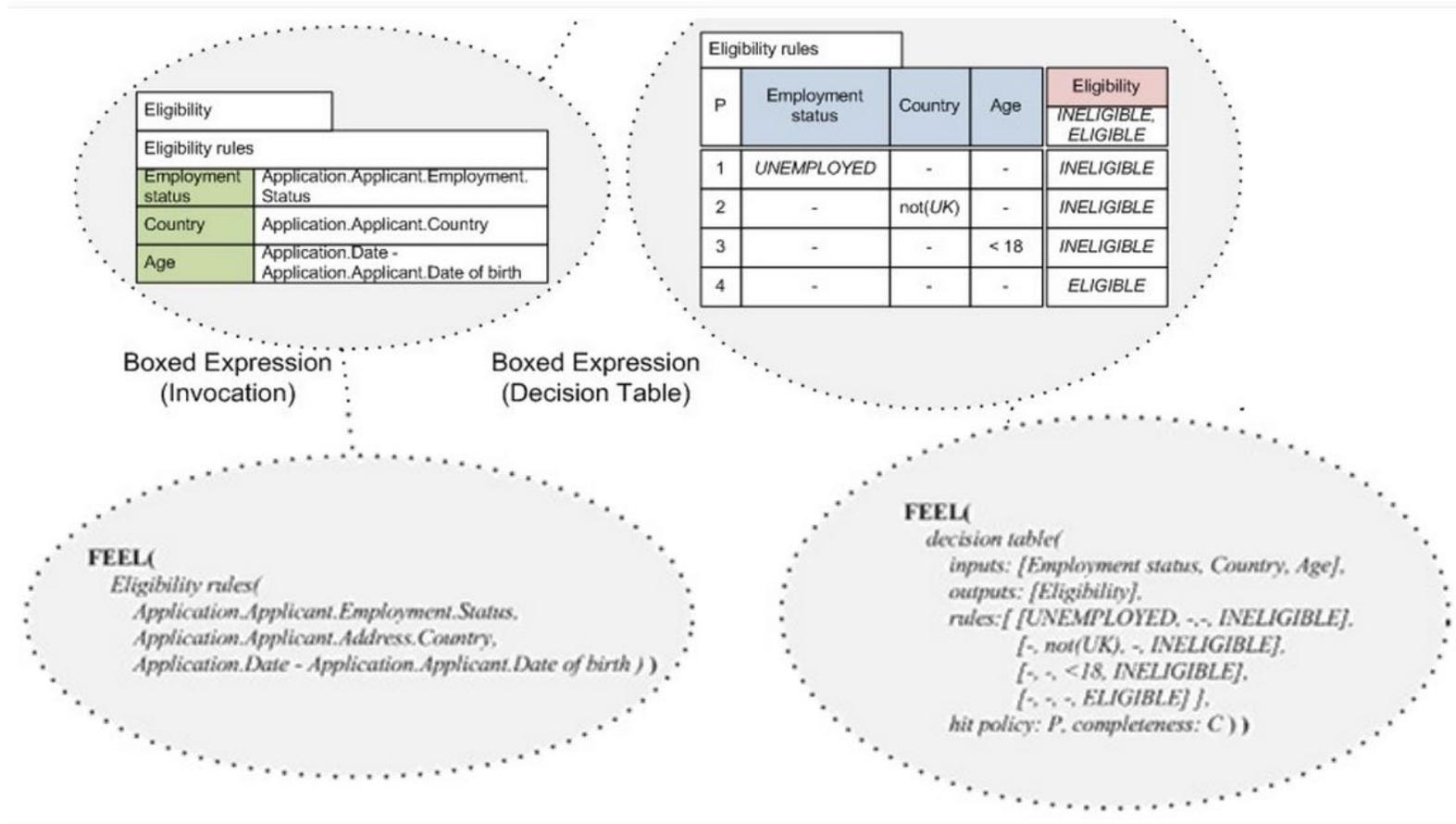
table name				
input expression 1	<i>value 1a, value 1b</i>	input entry 1a		input entry 1b
input expression 2	<i>value 2a, value 2b</i>	input entry 2a	input entry 2b	-
Output name	<i>value 1a, value 1b</i>	output entry 1a	output entry 1b	output entry 1a
HC		1	2	3

Rules as Crosstabs:

table name			
Output name		input expression 1	
		input entry 1a	input entry 1b
input expression 2	input entry 2a	output entry 1a	output entry 1a
	input entry 2b	output entry 1b	output entry 1a

# FEEL = Friendly Enough Expression Language

FEEL is a script language for decision tables



# Literatur

- BPM Professional, 2014, Introduction to Decision Model & Notation (DMN), <http://blog.maxconsilium.com/2014/09/introduction-to-decision-model-notation.html>
- Ross, R. G., & Lam, G. S. W. (2011). *Building Business Solutions: Business Analysis with Business Rules*. Business Rule Solutions Inc.
- Alcedo Coenen (2013). Decision Model & Notation (DMN) 1.0 – a new OMG Standard. <http://de.slideshare.net/alcedocoenen/intro-dmn-10>
- OMG (2016). Decision Model and Notation 1.1, <http://www.omg.org/spec/DMN/>