Decision Tables

The Business Process Viewpoint on Companies

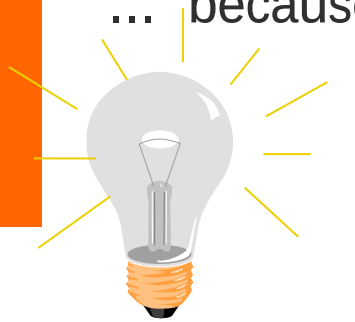
A Business Process is ...

... not only a logical flow of activities,which are executed by people and Systems in order to achieve a specific goal ...

... but...

... the *Know-How Platform* of the enterprise ...

... because...



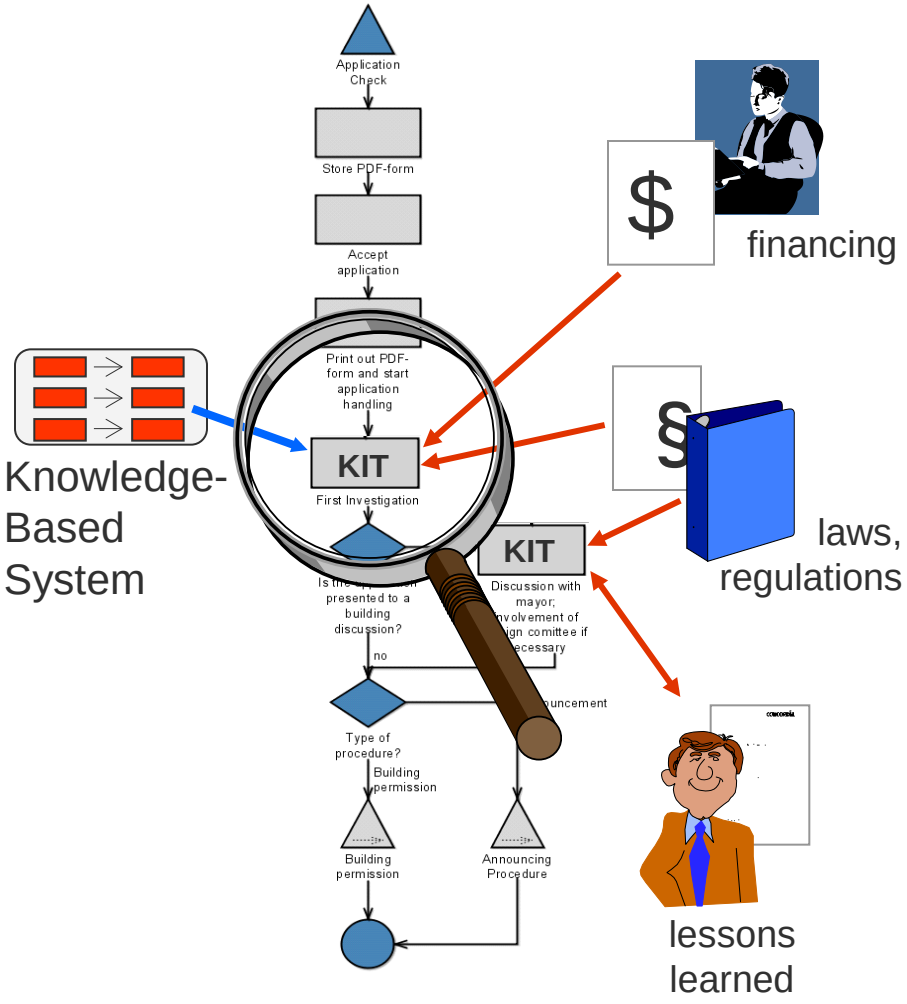
... core processes are based on core competences

... knowledge is generated and used in business processes

...

knowledge is relevant, if it is needed in business processes

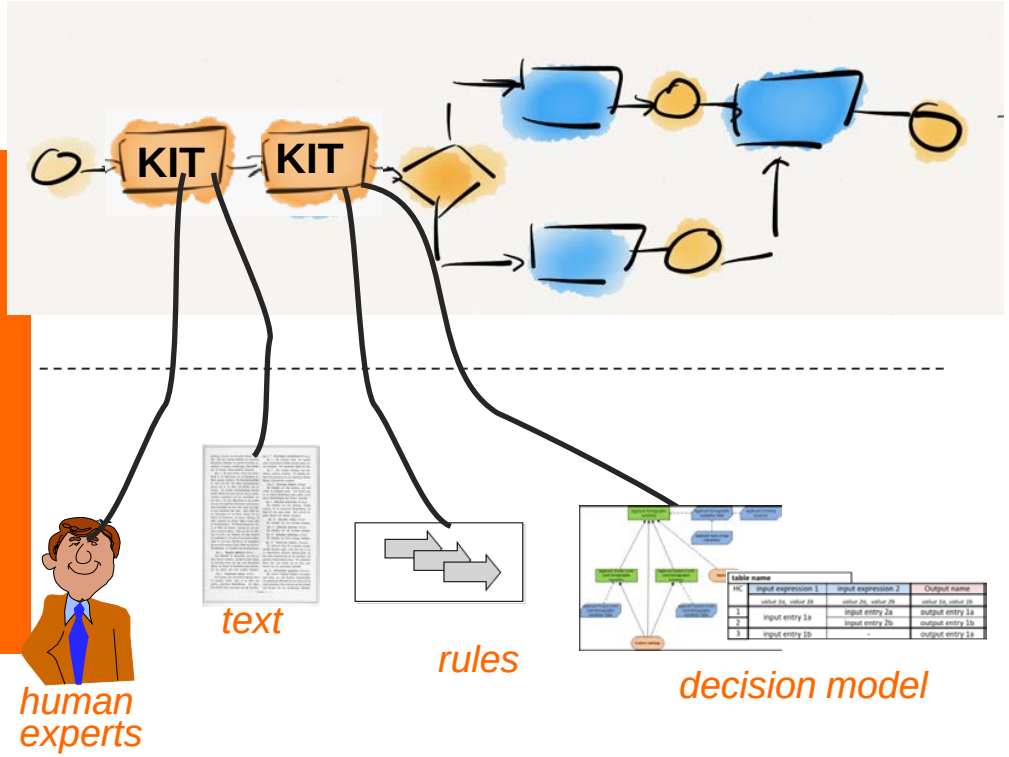
Knowledge Support of Processes



- Structured processes can contain knowledge work
- Support of Knowledge-Intensive Tasks (KIT) by …
  - … Identifying knowledgable people
    - Assign the task to employee with appropriate skills
  - … Intelligent Information Provision
    - Find documentation
  - … Knowledge-Based System (expert system) for
    - Decision making
    - Planning
    - Diagnosis
    - Problem solving

Distinguishing Process Logic and Business Logic

Process Logic

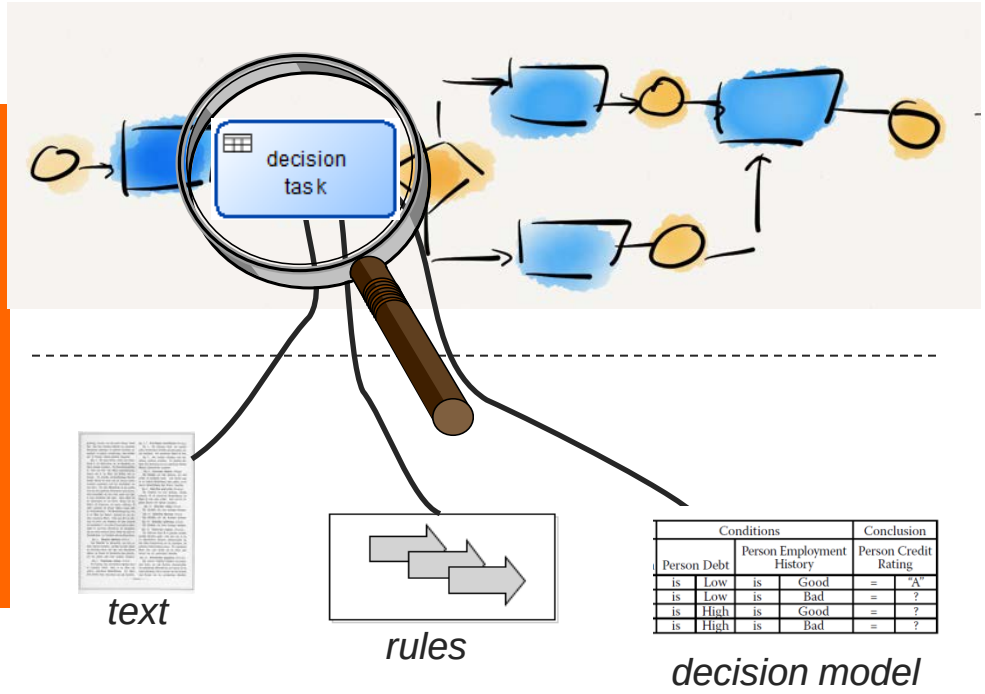


- The process model contains the process logic
- Business logic can be assigned to tasks in the process model:
  - knowledge-intensive tasks
- The business logic can occur in different forms
  - implicit in head of people
  - as text (e.g. guidelines)
  - as business rules
  - as decision model
  - coded in an application

Business Logic

Decision-Aware Process Models: Managing Process Logic and Decision Logic Separately

Process Logic



Business Logic / Decision Logic

- The process model contains the process logic → **procedural**
- Decision logic is externalized from decision tasks and represented in a different kind of model → **declarative**
- Separating business decisions from business process tasks
  - simplifies the business process model
  - allows to manage business logic in a declarative form

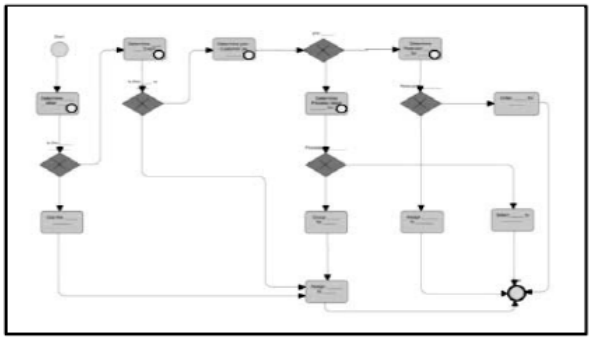
Distinguishing a Procedural Task from a Declarative Decision

- A procedural solution specifies how, in a step-by-step manner, something is to be done.
  - A business process model is a procedural solution because it prescribes a set of tasks that are carried out in a particular sequence.
- A declarative solution only specifies what needs to be done, with no details as to how, in a step-by-step manner, it is to be carried out, because sequence is irrelevant to arriving at the correct result.
  - A Decision Table is a declarative solution because it is a set of unordered business logic, not a set of ordered tasks.

(von Halle & Goldberg 2010, p. 67)

Procedural versus Declarative

A procedural solution specifies how, in a step by step manner, something is to be done



HOW

process logic

Business process is a procedural solution of tasks to be performed in precise sequential order. The "How" of a unit of work.

A declarative solution is what needs to be done, with no details as to the methods to be used (no sequential information).

Conditions				Conclusion	
Person Debt		Person Employment History		Person Credit Rating	
is	Low	is	Good	=	"A"
is	Low	is	Bad	=	"B"
is	High	is	Good	=	"B"
is	High	is	Bad	=	"C"

WHAT

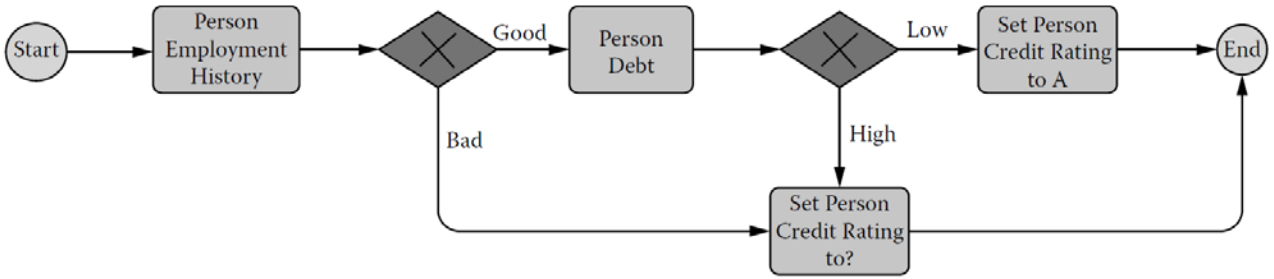
business logic

A declarative solution occurs when sequence is irrelevant to the result. The "What" of a unit of work.

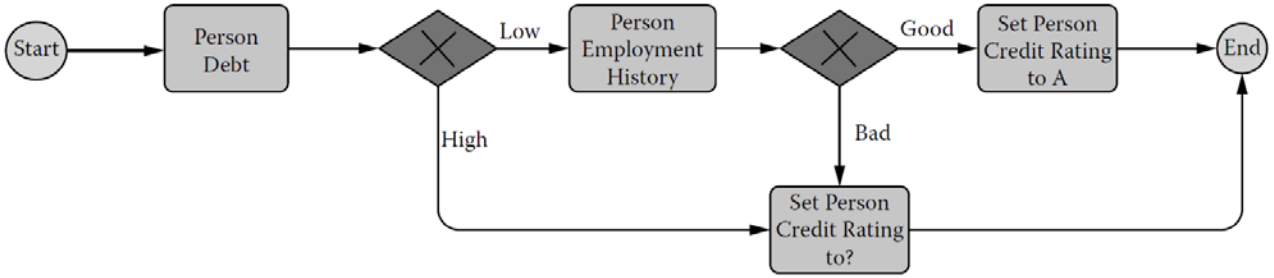
(von Halle & Goldberg 2010, p. 67)

Example 1: Declarative vs. Procedural Solutions

Option 1

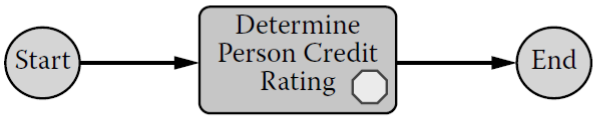


Option 2



Procedural

Option 3



Process Model

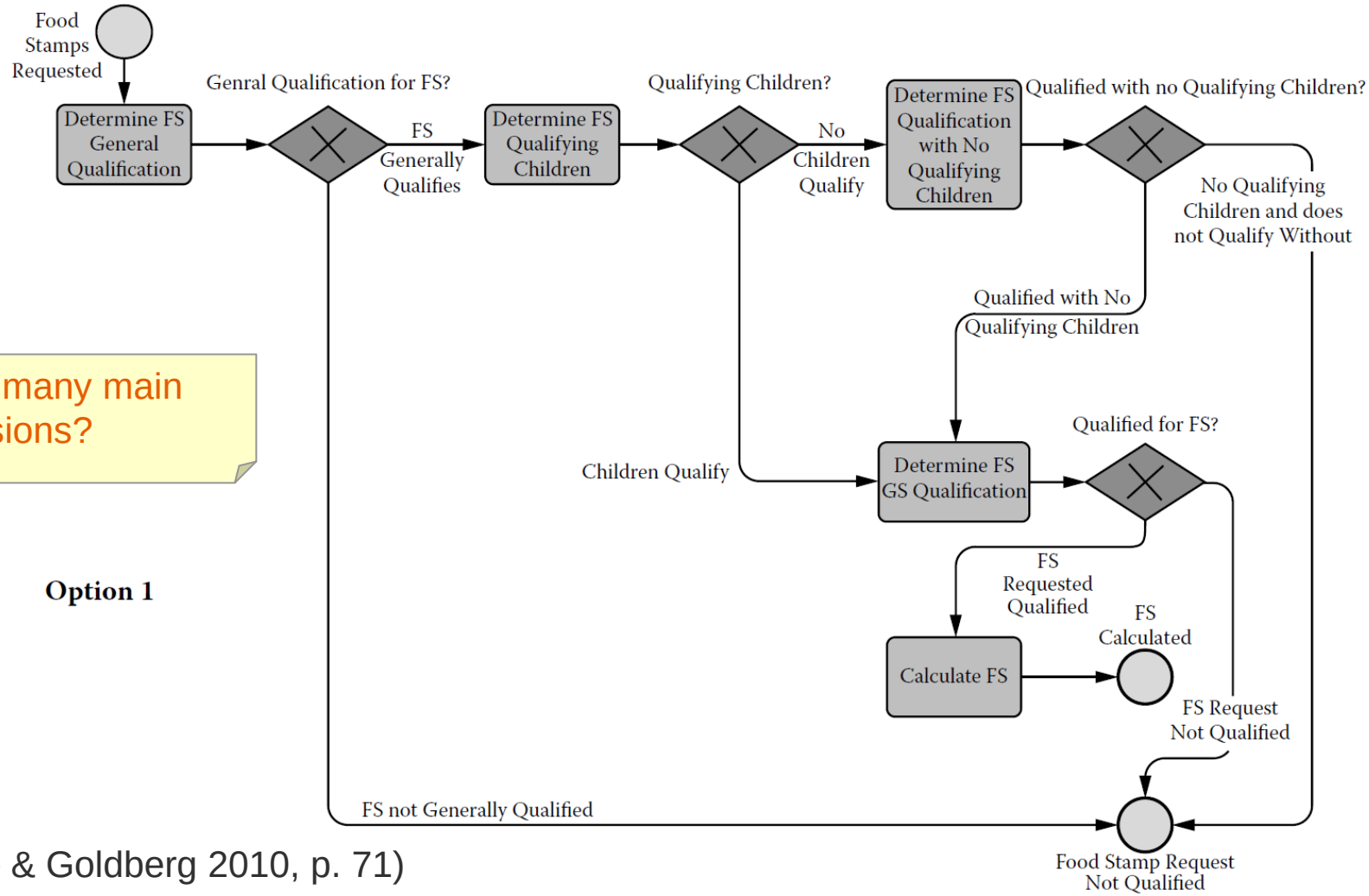
	Conditions				Conclusion	
Rule Pattern	Person Debt		Person Employment History		Person Credit Rating	
1	is	Low	is	Good	=	"A"
1	is	Low	is	Bad	=	?
1	is	High	is	Good	=	?
1	is	High	is	Bad	=	?

Decision Table

Declarative

(von Halle & Goldberg 2010, p. 69)

Example 2: Business Logic contained in a Process Model

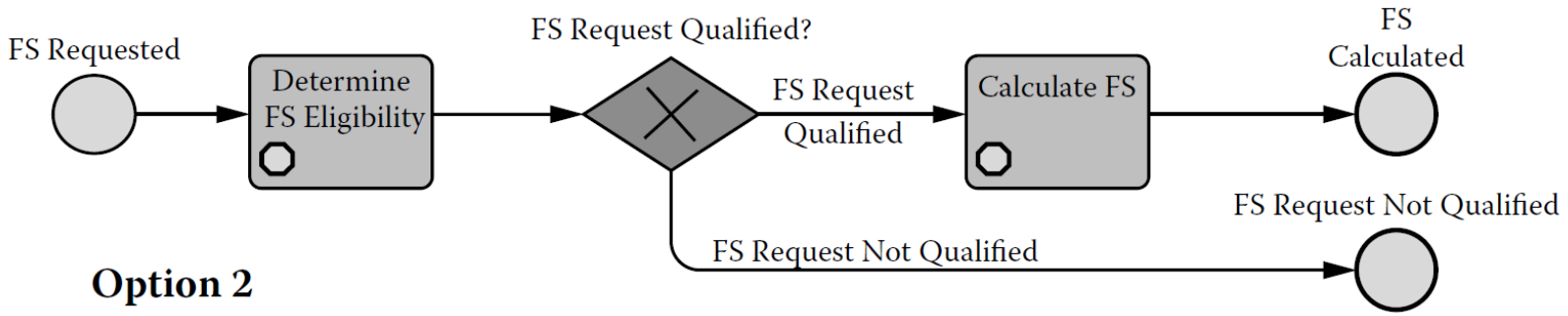


How many main decisions?

Option 1

(von Halle & Goldberg 2010, p. 71)

Managing Business Logic separately

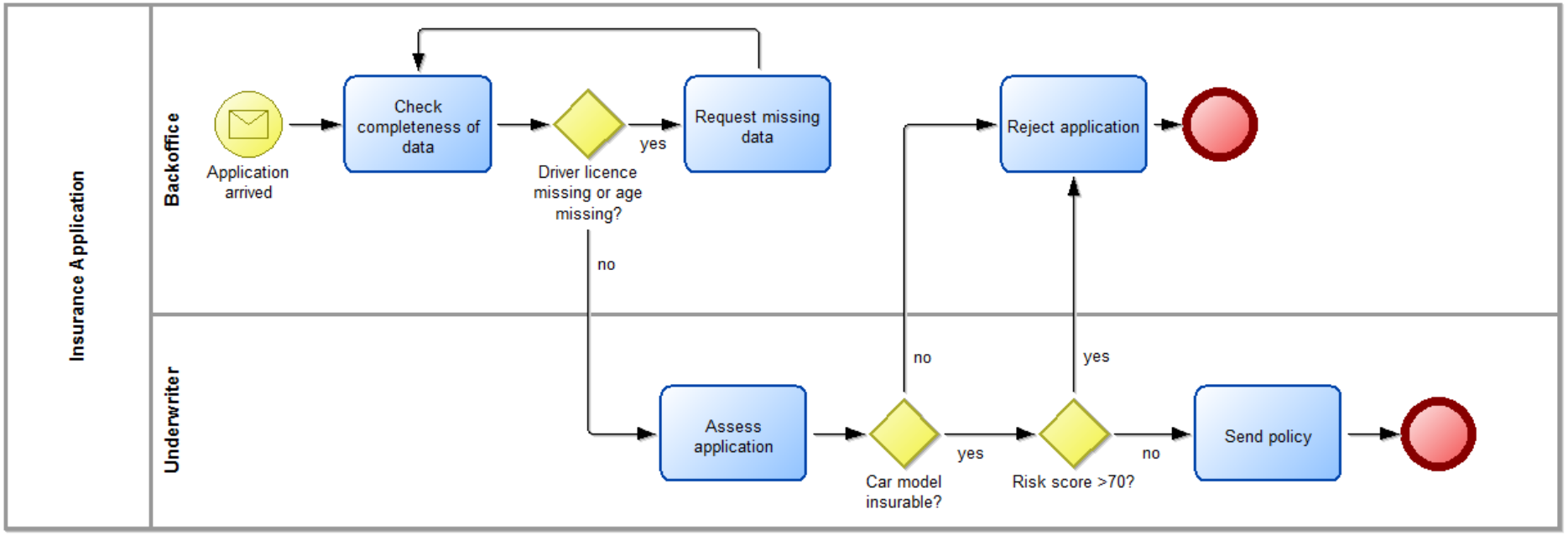


- This solution has two tasks with their Decision Models.
- The Decision Models can be viewed, managed, and executed as one whole set of business logic
- The process model is simplified. The decision logic is a black box evaluating conditions and reaching a conclusion.
- Business Logic can be reused
  - the whole decision model
  - Individual decision tables/rules

(von Halle & Goldberg 2010, p. 71f)

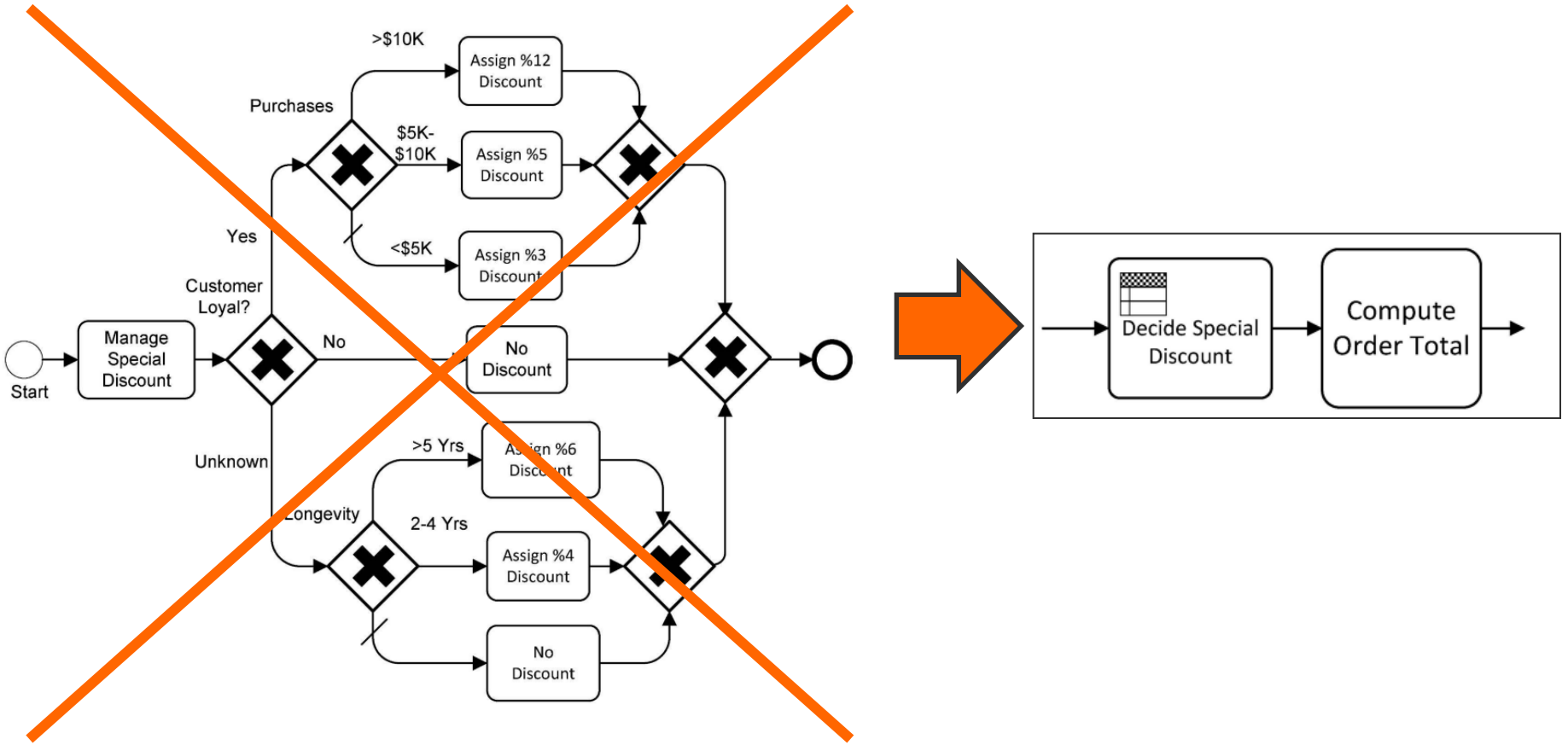
Exercise: Process Logic and Business Logic

This process model mixes business logic and process logic



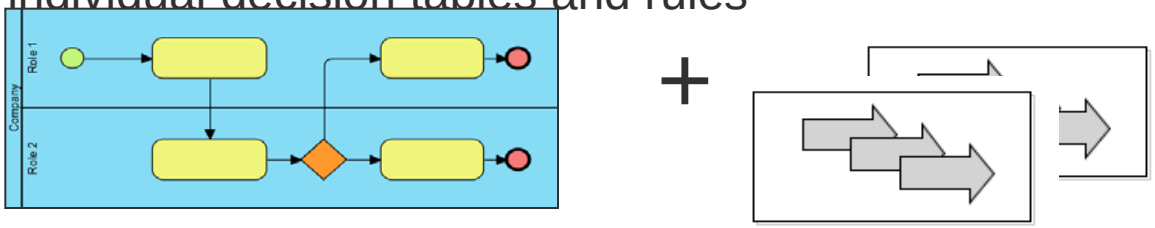
- How many decisions are made in this process?
- What business logic can you identify in this process model?
- What tasks are knowledge-intensive resp. decision tasks?
- What would you improve?

Example 3: Collapsing gateways for a complex discount decision into a decision



Advantages of separating Business Logic from Business Process Model

- Allows a much simpler business process model
  - If a business process is too complicated, a reason might be that business rules are embedded in the flow
- Makes changes to business process and business logic easier
  - Permits changes in the Decision Model without changing the business process model and vice versa
- Business Logic can be automated
  - Rule-based systems, fuzzy logic, ...
- Business Logic can be reused in several processes
  - the whole decision model
  - individual decision tables and rules



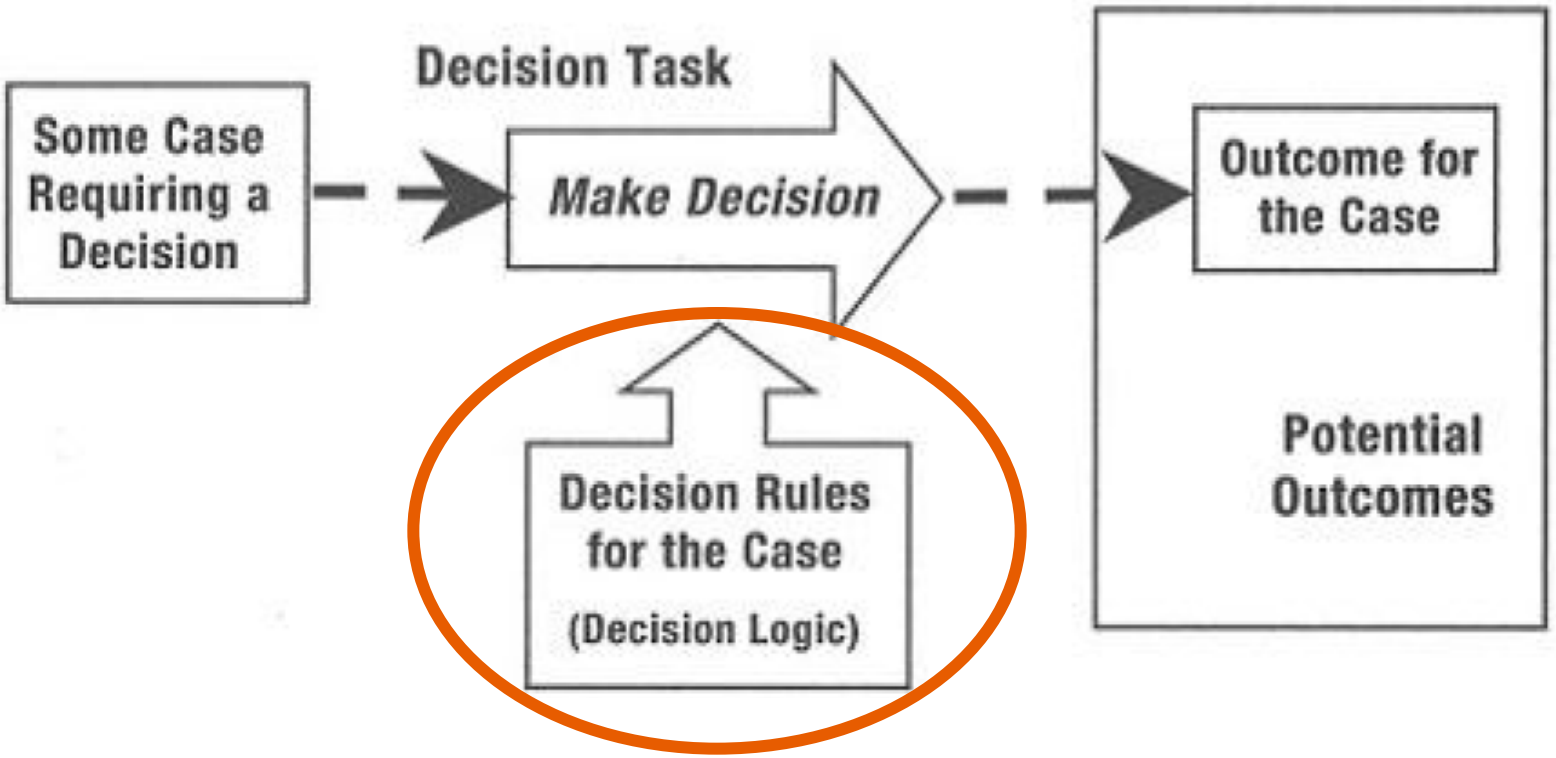
OBJECT MANAGEMENT GROUP

Decision Model and Notation

Beta1

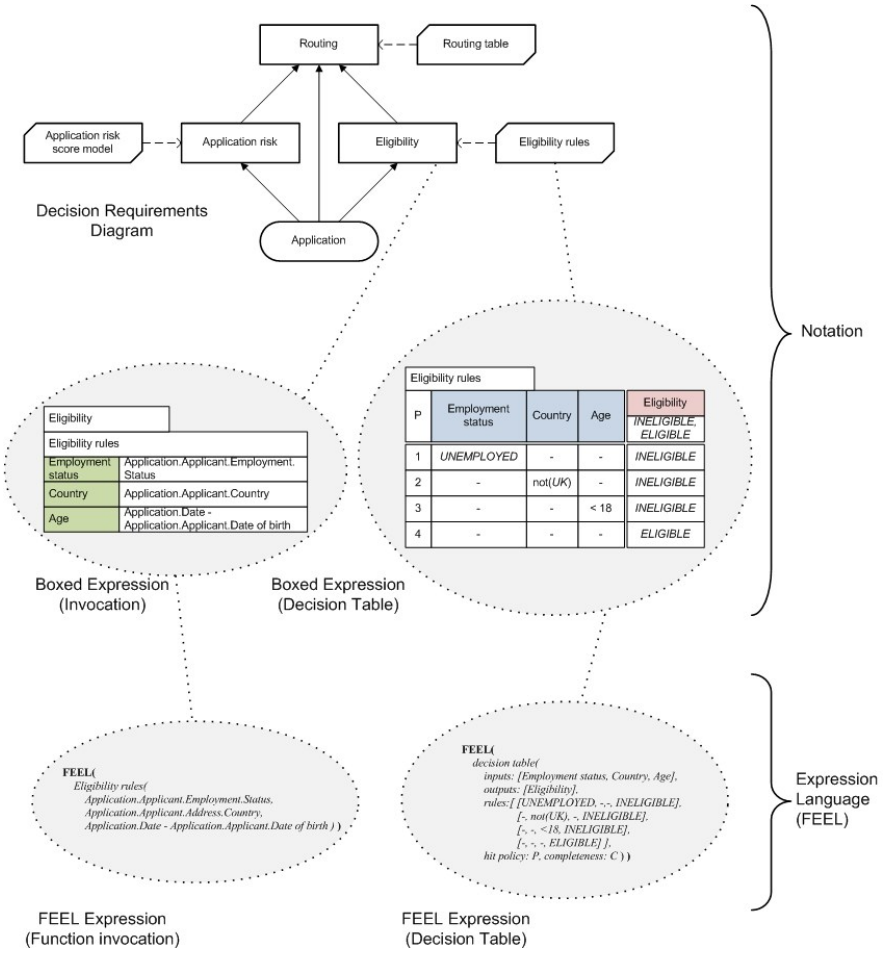
DECISION MODEL AND NOTATION (DMN)

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 1.0
- 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
  - (optionaly) automated

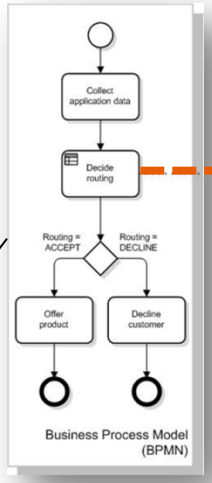
Main Concepts of DMN

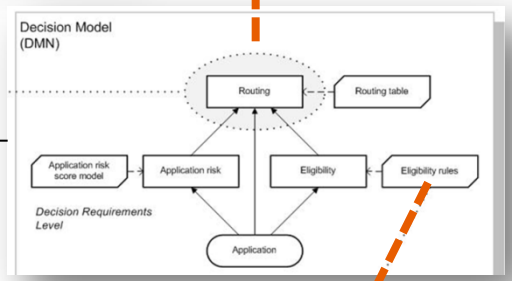
More details

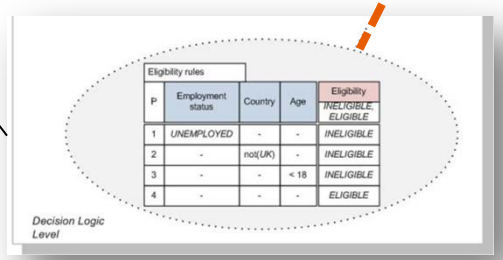
Business Process

Decision Requirements

Decision Logic





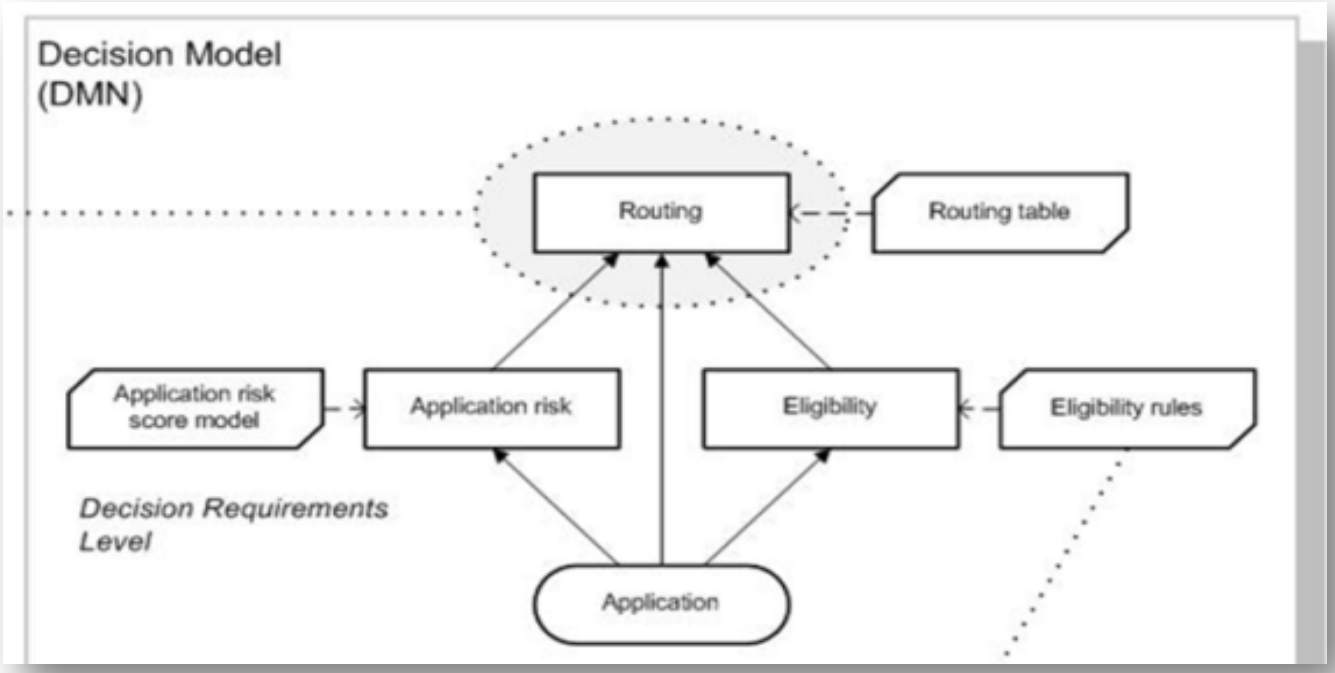


(Coenen 2013)

Main concepts – Decision Requirements Level

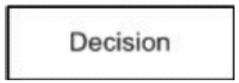
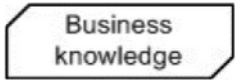
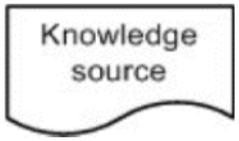
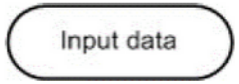
- Business concepts only
- Business decisions
- Areas of business knowledge
- Sources of business knowledge

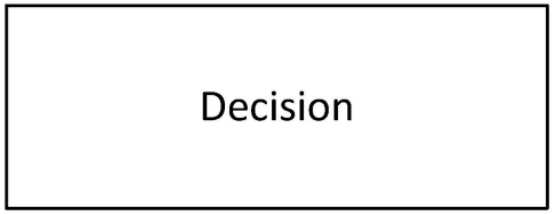
Decision Requirements



(Coenen 2013)

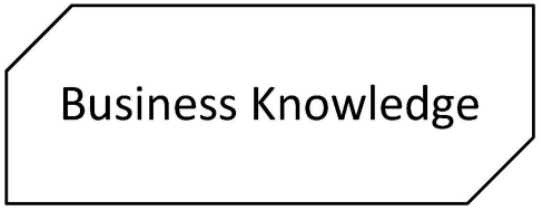
Constructs of a Decision Requirements Model

Construct	DMN Notation	Description
ELEMENTS		
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.
REQUIREMENTS		
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.



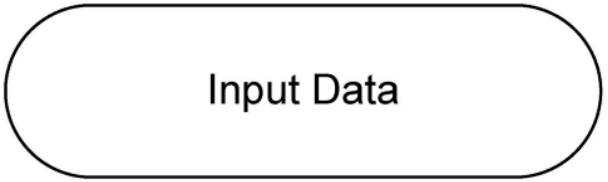
Decision

- A decision determines an output from a number of inputs by applying some 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 often will simply provide input to other decisions.
- Two properties should be captured for every decision:
  - Question: A natural language statement that represents the decision in the form of a question. This should be specific and detailed.
  - Allowed Answers: A natural language description of the possible answers to this question.
- For action-oriented decisions, the allowed answers represent the responses that the process must handle when the decision model is invoked by a business rule task.



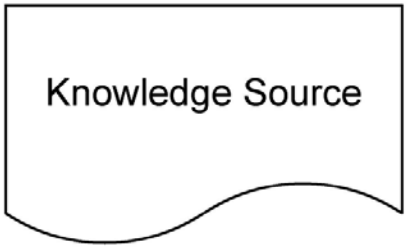
Business Knowledge Models

- Business knowledge models represent functions that encapsulate reusable decision making logic. The logic they encapsulate might be a set of business rules, a decision tree, a decision table, or an analytic model.
- The specifics of knowledge representation involved need not be displayed on the diagram but could be.
- The decision logic that can be specified in a business knowledge model can also be linked directly to a decision, but encapsulating it in a business knowledge model allows it to be reused, parameterized and displayed on a Decision Requirements Diagram



Input Data

- Decisions require inputs, and many of these are input data, which is data that is input to the decision making from outside the decision context.
- Input data elements typically represent business entities that are being used in the decision making, such as Policy or Customer. However, sometimes they can represent any information element at any level of detail.
- Each input data element can be described in terms of a hierarchical information model that specifies exactly what information elements comprise the input data.



Knowledge Source

- Knowledge sources represent the source of know-how for making a decision. This could be regulations or policies about how a decision must be made, best practices or expertise on how it should be made, or even analytic knowledge on how it might be made more accurate.
- 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

Elements and Allowed Relationships of the Requirements Graph

Decision 1 is **used as input** for decision 2

Decision **depends on** Knowledge Source

Business Knowledge **invokes** a Decision

Business Knowledge 1 **invokes** Business Knowledge 2

Input data is **used as input** for decision

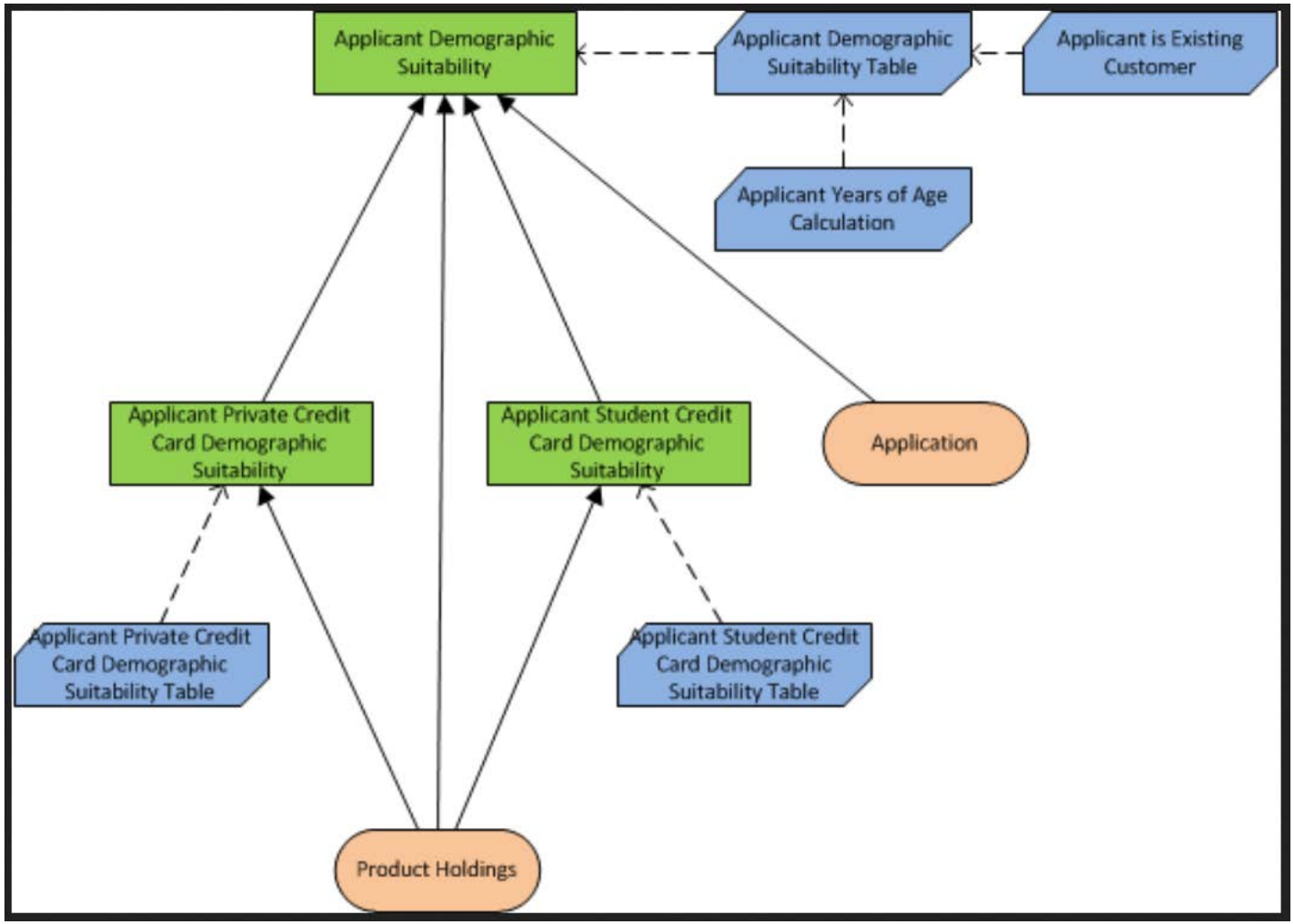
Input data **depends on** Knowledge Source

Knowledge Source **depends on** Decision

Knowledge Source **depends on** Business Knowledge

Knowledge Source1 **depends on** Knowledge Source2

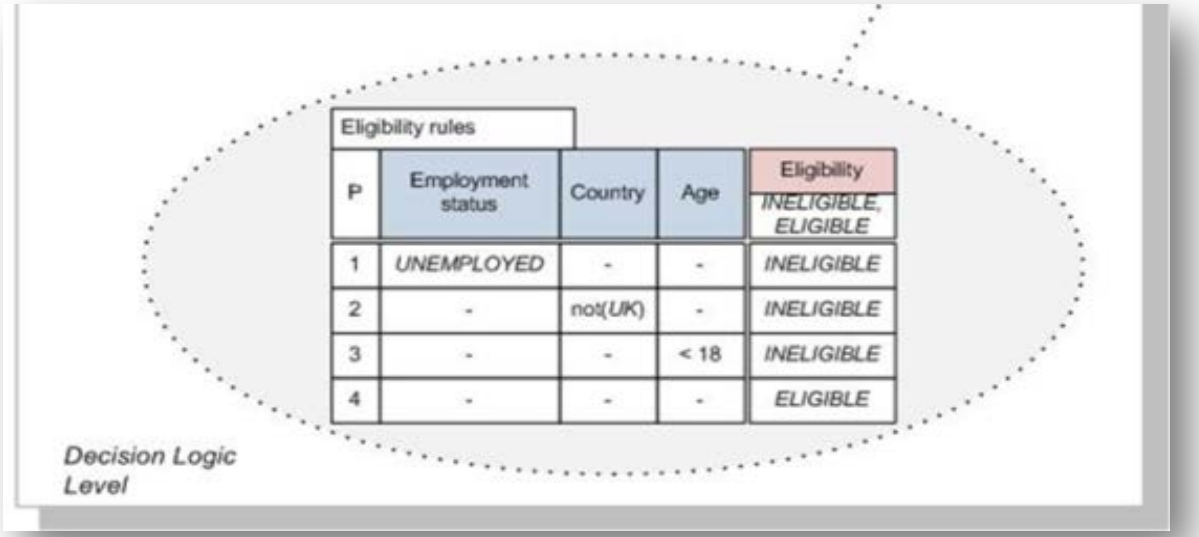
(Coenen 2013)


Applicant Demographic Suitability
Applicant Demographic Suitability Table
Applicant is Existing Customer
Applicant Years of Age Calculation
Applicant Private Credit Card Demographic Suitability
Applicant Student Credit Card Demographic Suitability
Application
Applicant Private Credit Card Demographic Suitability Table
Applicant Student Credit Card Demographic Suitability Table
Product Holdings

Main concepts – Decision Logic

- Greater detail
- Business rules
- Calculations
- Automated
- Display

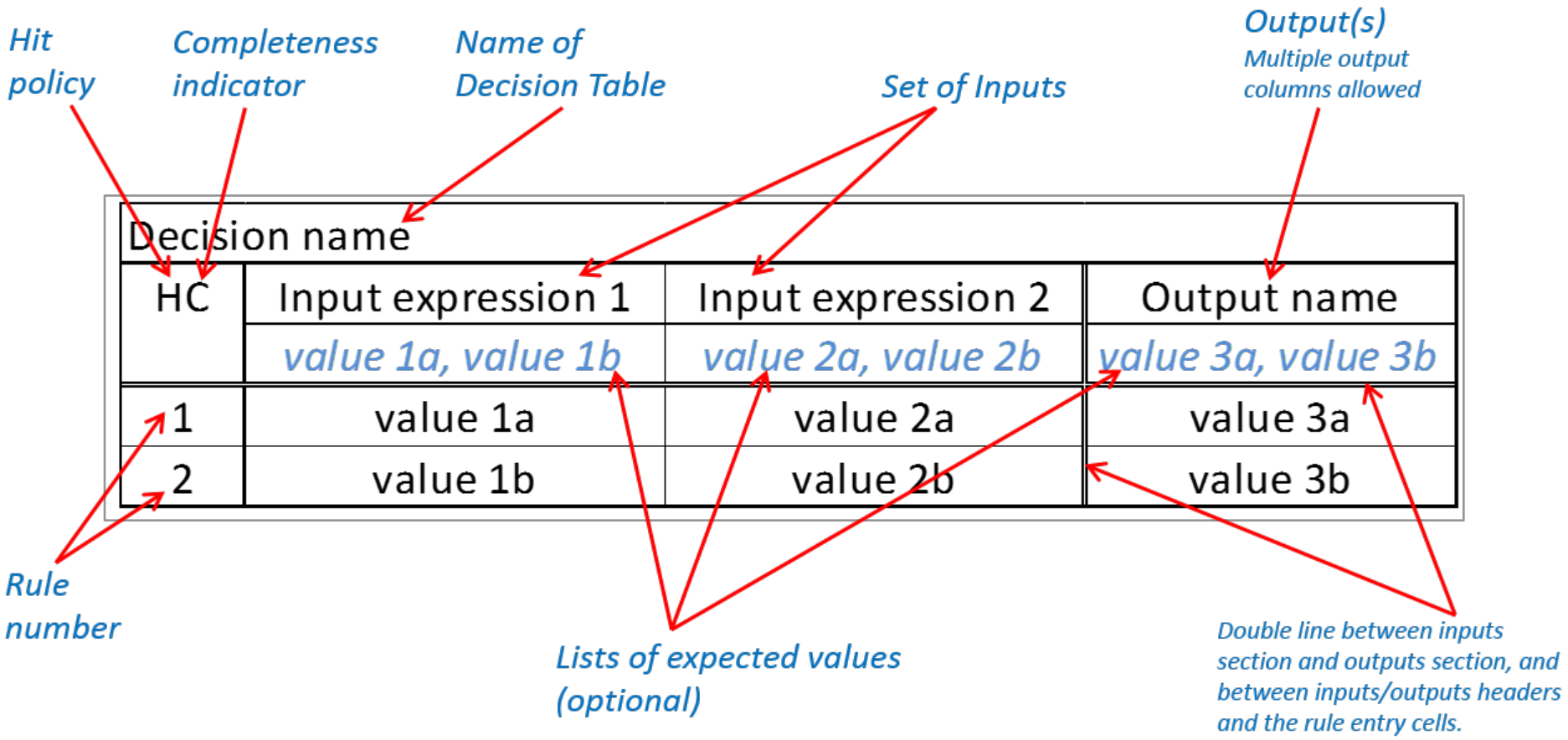
Decision Logic



(Coenen 2013)

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

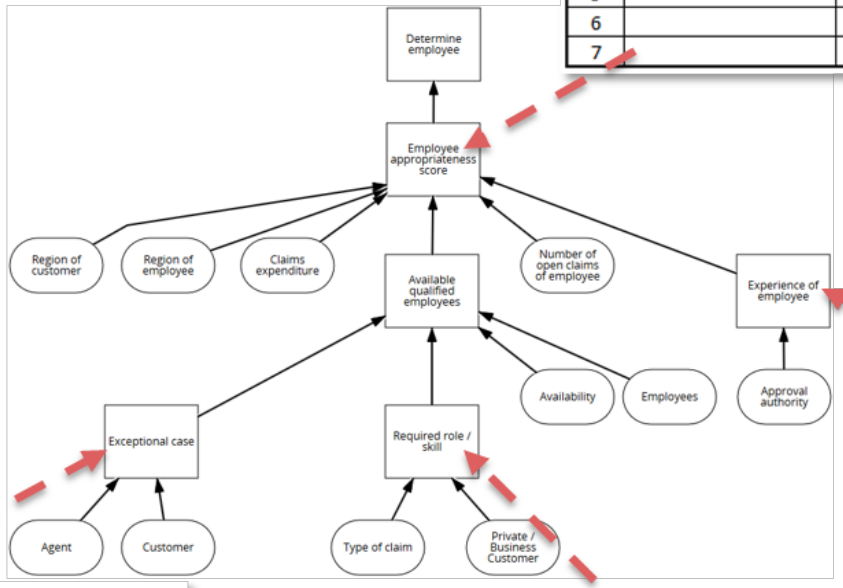
Structure of a Decision Table in DMN



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

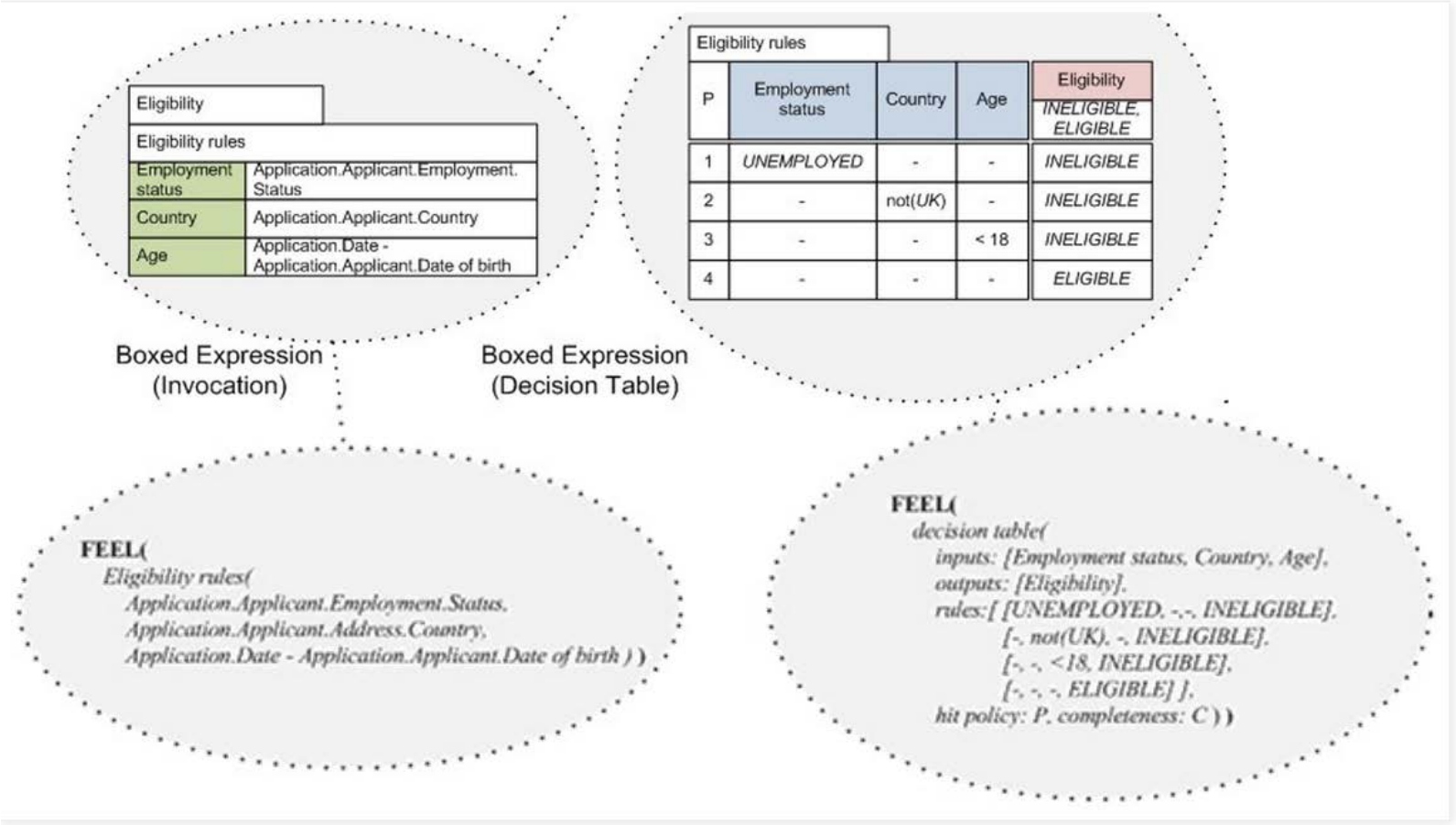
	Agent Id	Customer Frame Contract Id	Required Role	Special Employee
1	4711		Special Customer Task Force Berlin	
2		0815	Special Customer Task Force Berlin	
3		camunda		Mr. Important
4	...	...	...	...

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	...	...	...	

FEEL = Friendly Enough Expression Language

FEEL is a script language for decision tables



Orientation of Rules in a DMN Decision Table

Rules as Rows:

table name			
HC	input expression 1	input expression 2	Output name
	value 1a, value 1b	*value 2a, value 2b*	*value 1a, value 1b*
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	*value 1a, value 1b*	input entry 1a		input entry 1b
input expression 2	*value 2a, value 2b*	input entry 2a	input entry 2b	-
Output name	*value 1a, value 1b*	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

Decision Tables – Reducing Combinations

- If effects for a several combinations are the same, the combinations can be combined, reducing the number of rules
- Example:
  - If Cause 1 is „Y“ and Cause 2 is „N“, the the effect does not depend on the values of Cause 3
  - In this case, the value of Cause 3 does not need to be taken into account

		Combinations							
Causes	**Values**	1	2	3	4	5	6	7	8
Cause 1	*Y, N*	Y	Y	Y	Y	N	N	N	N
Cause 2	*Y, N*	Y	Y	N	N	Y	Y	N	N
Cause 3	*Y, N*	Y	N	Y	N	Y	N	Y	N
Effects									
Effect 1		X		X	X	X		X	X
Effect 2			X			X	X		X

		Combinations						
Causes	**Values**	1	2	3	4	5	6	7
Cause 1	*Y, N*	Y	Y	Y	N	N	N	N
Cause 2	*Y, N*	Y	Y	N	Y	Y	N	N
Cause 3	*Y, N*	Y	N	-	Y	N	Y	N
Effects								
Effect 1		X		X	X		X	X
Effect 2			X		X	X		X

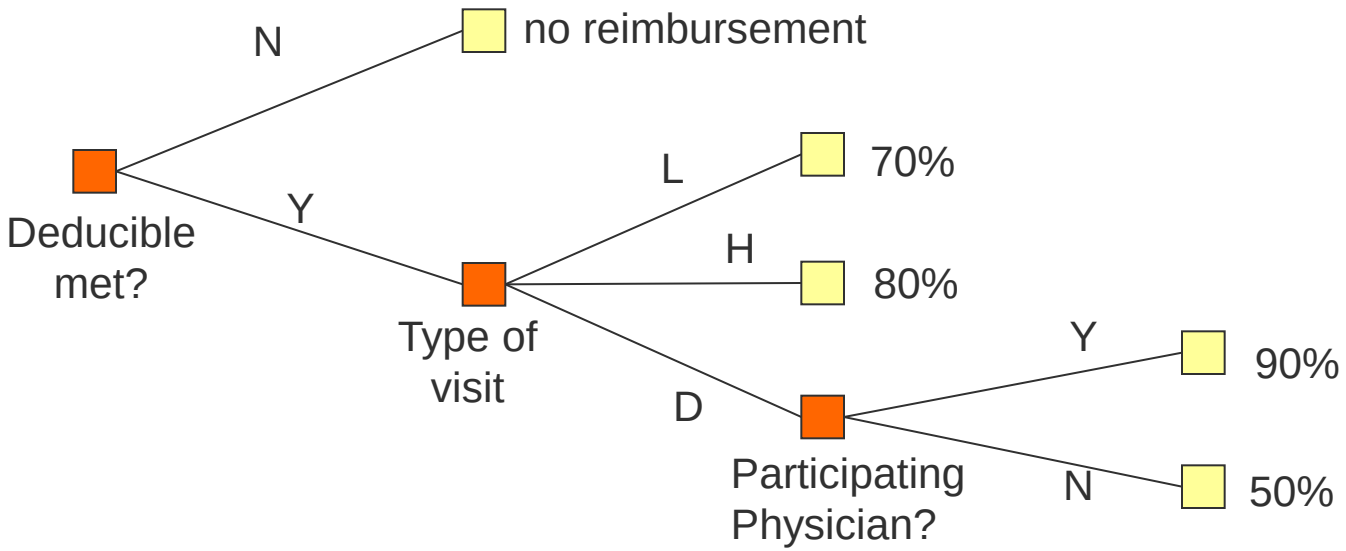
Exercise: Reduce decision table

- The following decision table represents rules for reimbursing expenses by health insurance
- Reimbursement depends on three conditions:
  - whether decuctible 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 doctor is a Participating Physician
- The decision table is complete showing all combinations of decisions. Reduce the table to only the really needed number of rules

Conditions	1	2	3	4	5	6	7	8	9	10	11	12
1. Deductible met?	Y	Y	Y	Y	Y	Y	N	N	N	N	N	N
2. Type of visit	D	D	H	H	L	L	D	D	H	H	L	L
3. Participating Physician?	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N
Effects												
1. Reimburse 50%		X										
2. Reimburse 70%						X						
3. Reimburse 80%				X								
4. Reimburse 90%	X											
5. No reimbursement							X	X		X		X
6. Impossible or N/A			X		X				X		X	

Decision Trees

- Decision trees are a graphical representation of rules
  - Each inner node corresponds to a decision
  - Each edge represents an alternative value for the decision
  - The leaf nodes represent actions or effects



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 *catch-remainder* rule. **This type of policy is hard to validate manually and must be used with care.**

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.

Admission Process to the Msc Business Information Systems.

- The process starts when we receive the application from a candidate. First the study assistant prepares the eligibility check of the candidate.
- *The dean of study decides, whether the candidate is eligible. Candidates without a bachelor degree from an accredited university are rejected.*
- The interview team validates the eligibility of the candidate.
- Then the admission commission decides whether the candidate is accepted. *The candidate is accepted if she/he has a bachelor degree in Information Systems, Information Technology or Business Administration with at least good grade from an accredited university.*
- *For accepted candidates the administration determines the tuition fee: Swiss and European citizens pay CHF 700. The same is for Non-European students who are residents of Switzerland. Residentship in Switzerland means that the person has residence permit C. Non-European students who are not residents of Switzerland pay CHF 7500.*

Exercise:

- **Task 1:**
  - Decision Analysis: What are the key decisions that arise during this process?
  - What are knowledge-intensive tasks?
  - Model the process flow accordingly
- **Task 2:**
  - Develop Decision Models for
    - the eligibility of the candidate
    - acceptance of the candidate
    - the tuition fee.

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