*DMN & Decision Modeling
- Stand van zaken -

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Research and teaching:
- Business rules, processes and information systems
- Decision models & tables
- AI, Business intelligence & Analytics
- Information & Knowledge Management

IBM Faculty Award
Belgian Francqui Chair 2009 at FUNDP

- ING Research Chair on Metadata Analytics
- Bpost bank Research Chair Actionable Analytics
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- IBM Fund Intelligent Business Decision Making
- Microsoft Research Chair on Intelligent Environments
- PricewaterhouseCoopers Chair on E-Business

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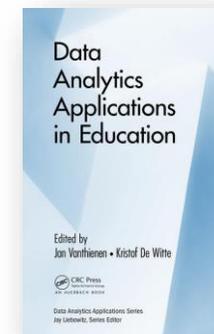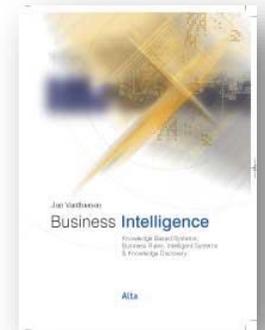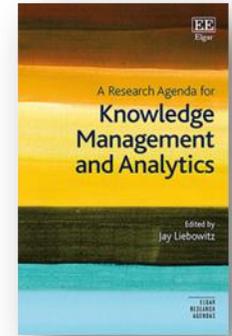
Contents

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   - Applications & tooling
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   - Decision mining
   - Smart execution

Manage processes

- **Organizations have to model and manage their business processes for the day-to-day operations**

- **Automating business processes is necessary to increase speed and throughput**

- But what about:
  - Knowledge-intensive processes
  - Decisions in processes
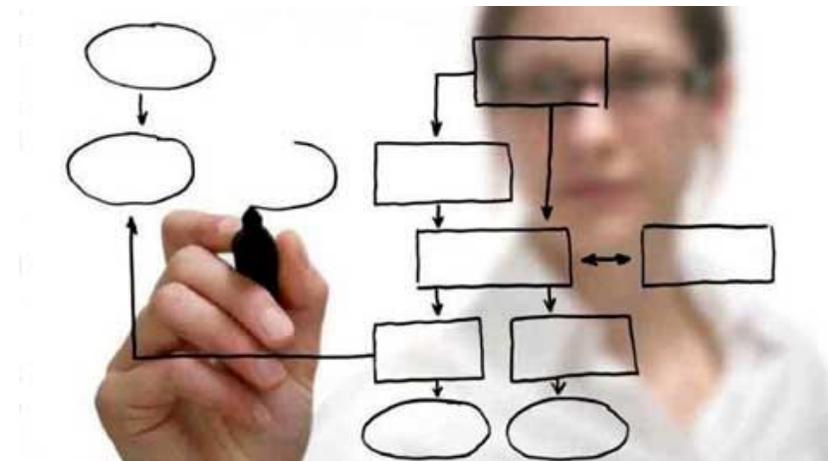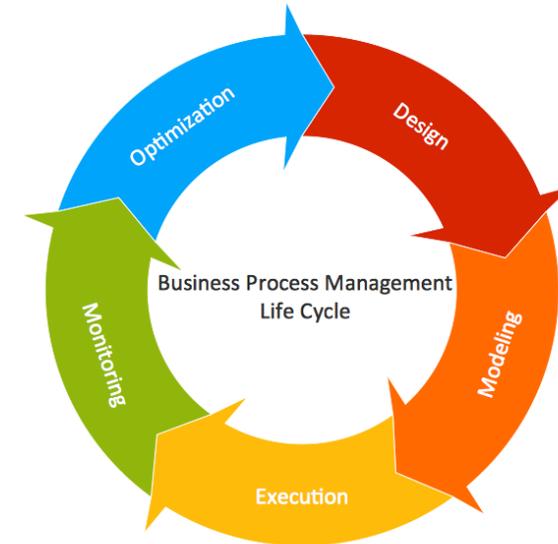
Decisions as a business concern

Because

- More and more business operations are being automated,

- and business has to react immediately, e.g. in online applications,

- and a human is often not involved anymore
  at the moment of transaction

It is important that

- Systems, processes and decisions are crafted correctly
  and remain correct after updates

A decision is defined as 'the act of determining an output value from a number of input values (data), using decision logic (models), defining how the output is determined from the inputs.
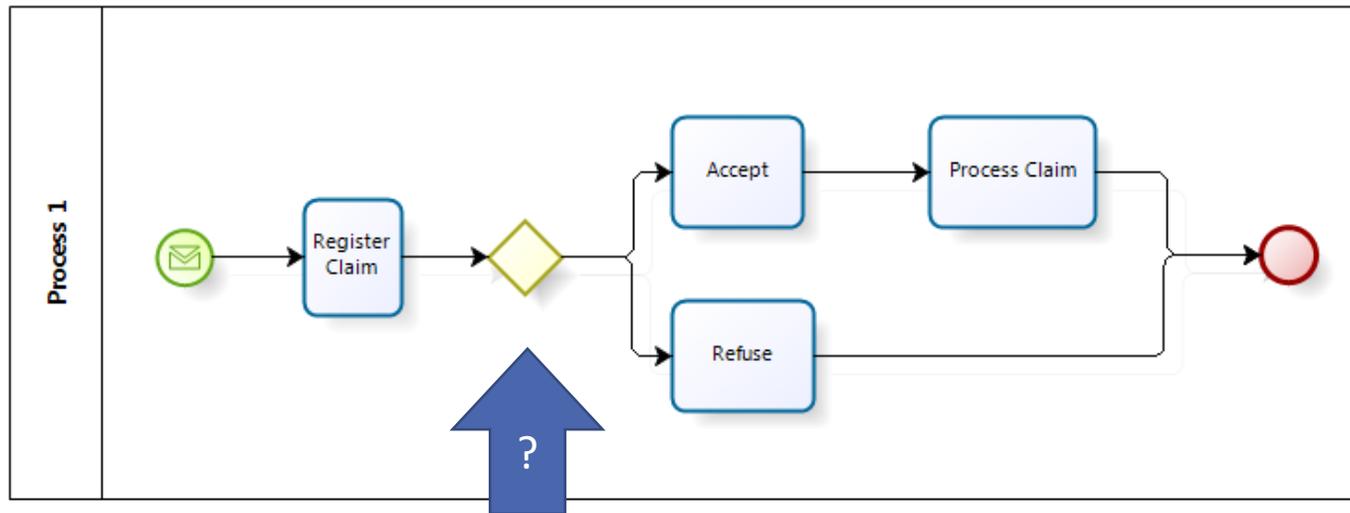
Only BPMN?

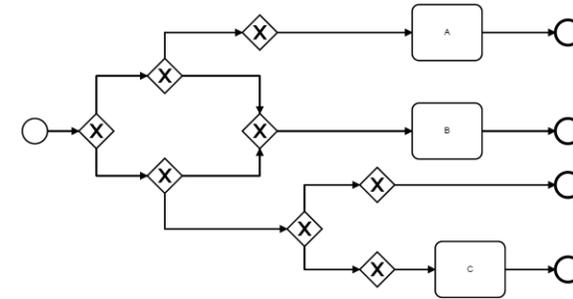- **If all you have is a hammer, everything looks like a nail**

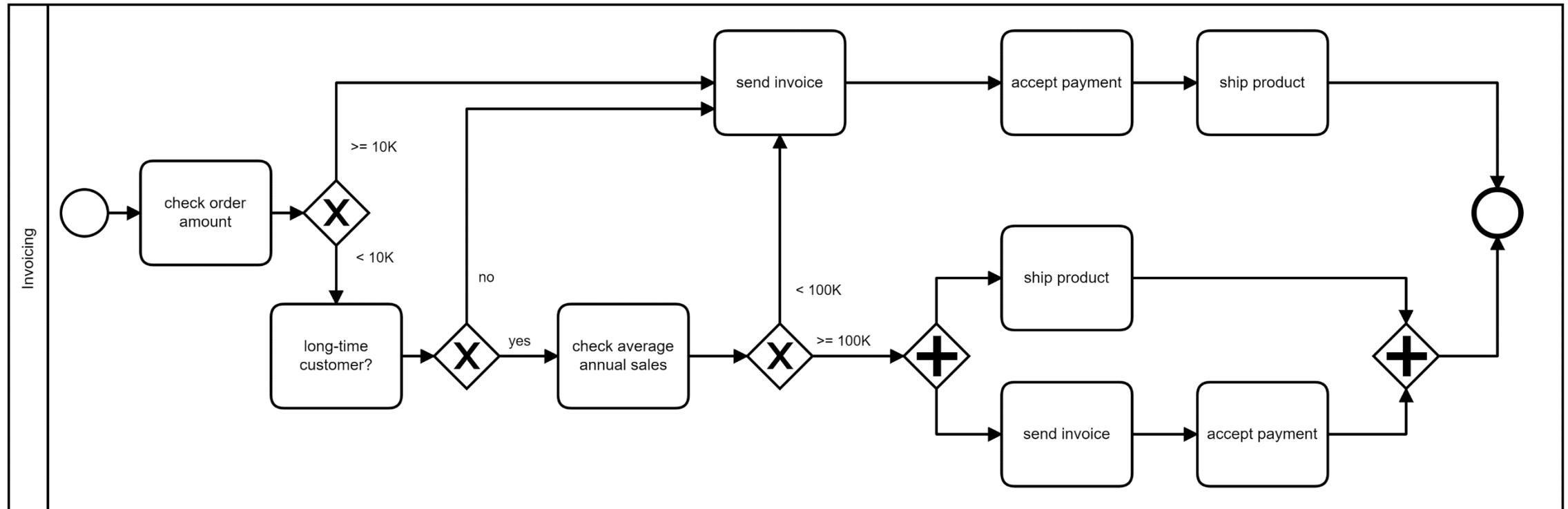# Concern : Decisions

Where are the decisions?

- The gateway is not the decision

- Decisions should not be hardcoded in process paths

- When to accept/refuse a claim
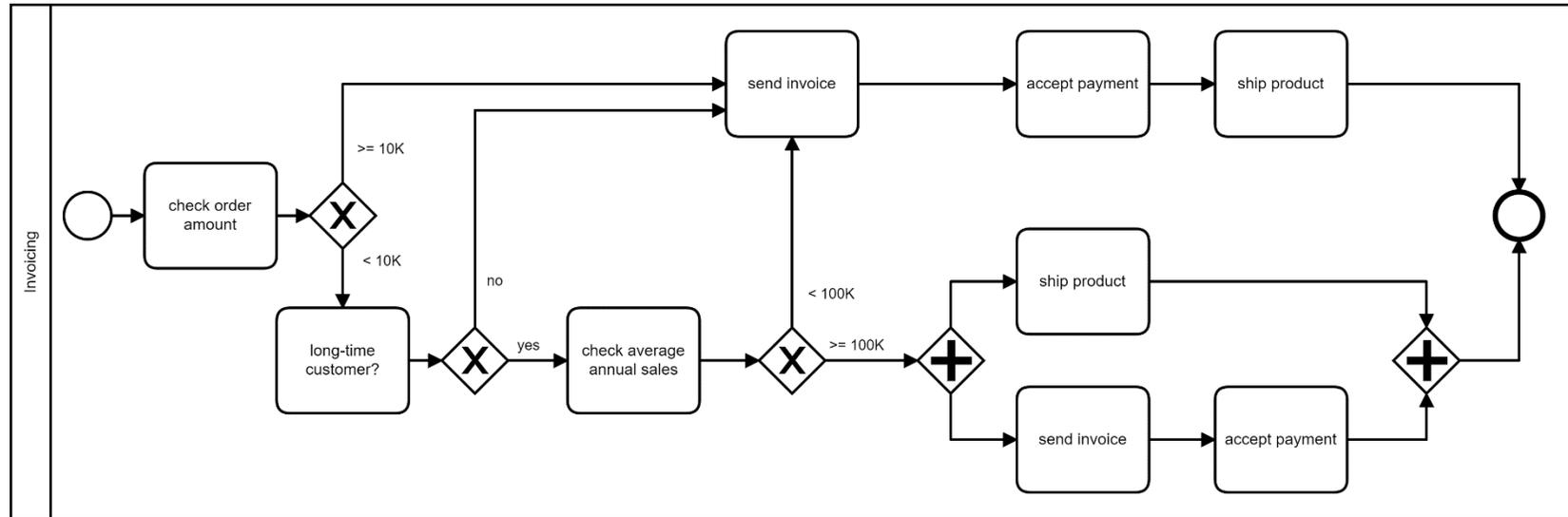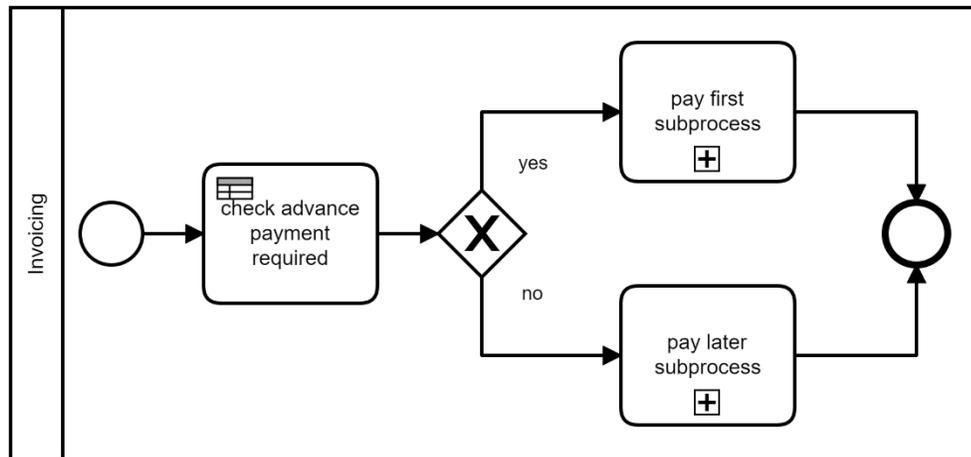
An example

What is really the issue here?

Sometimes we expect payment before we ship (to be on the safe side)
and sometimes we ship and send the invoice in parallel (only for good customers)

The real decision therefore is:

Do we require advance payment?

That seems to depend on order amount, customer history and average annual customer sales

The simpler process
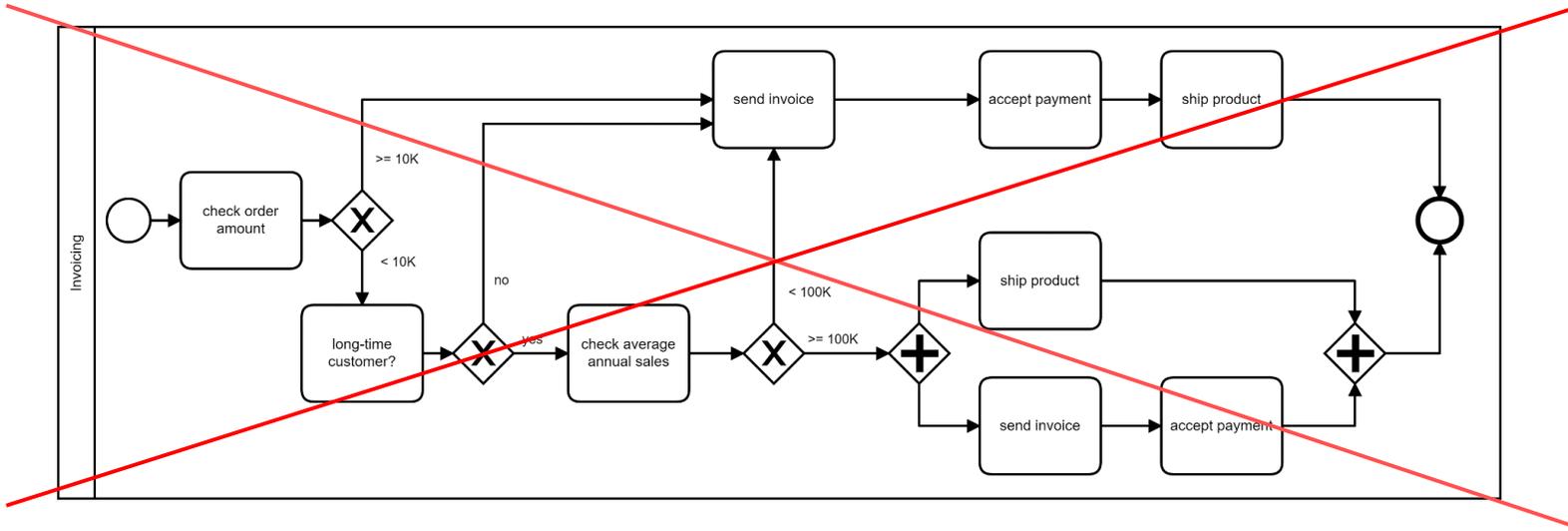
Prepayment is not required for loyal customers when the OrderAmount is small (<10K)

A loyal customer is defined as such if their AnnualSales is high (>=100K) and their Customeryears is more than 5

Decision modeling with DMN

The process and the decision
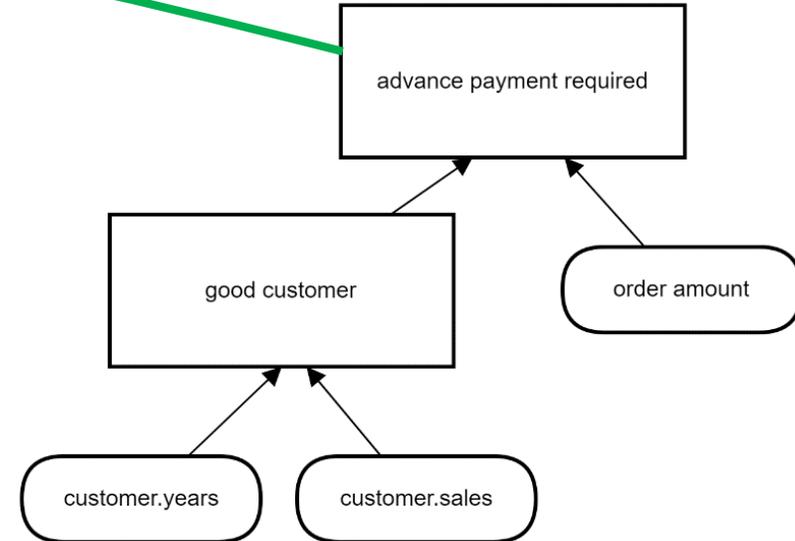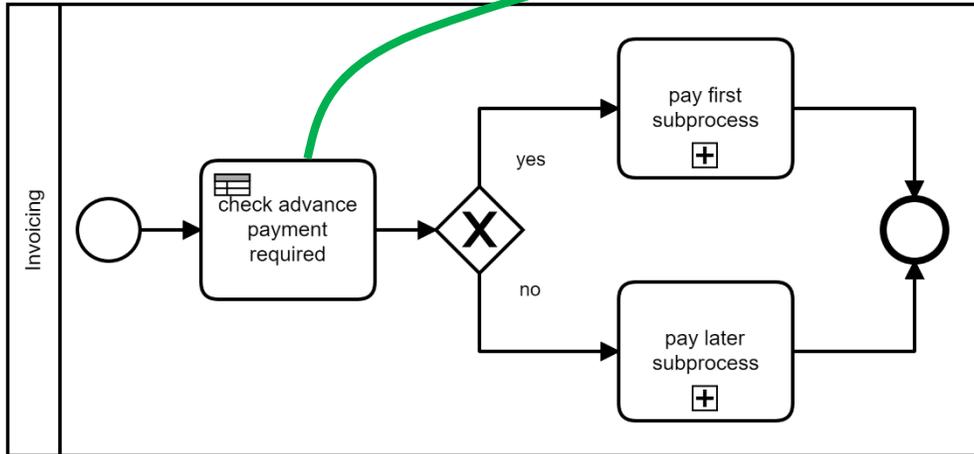
Why separate decisions and processes?
- Processes can be stable and simpler
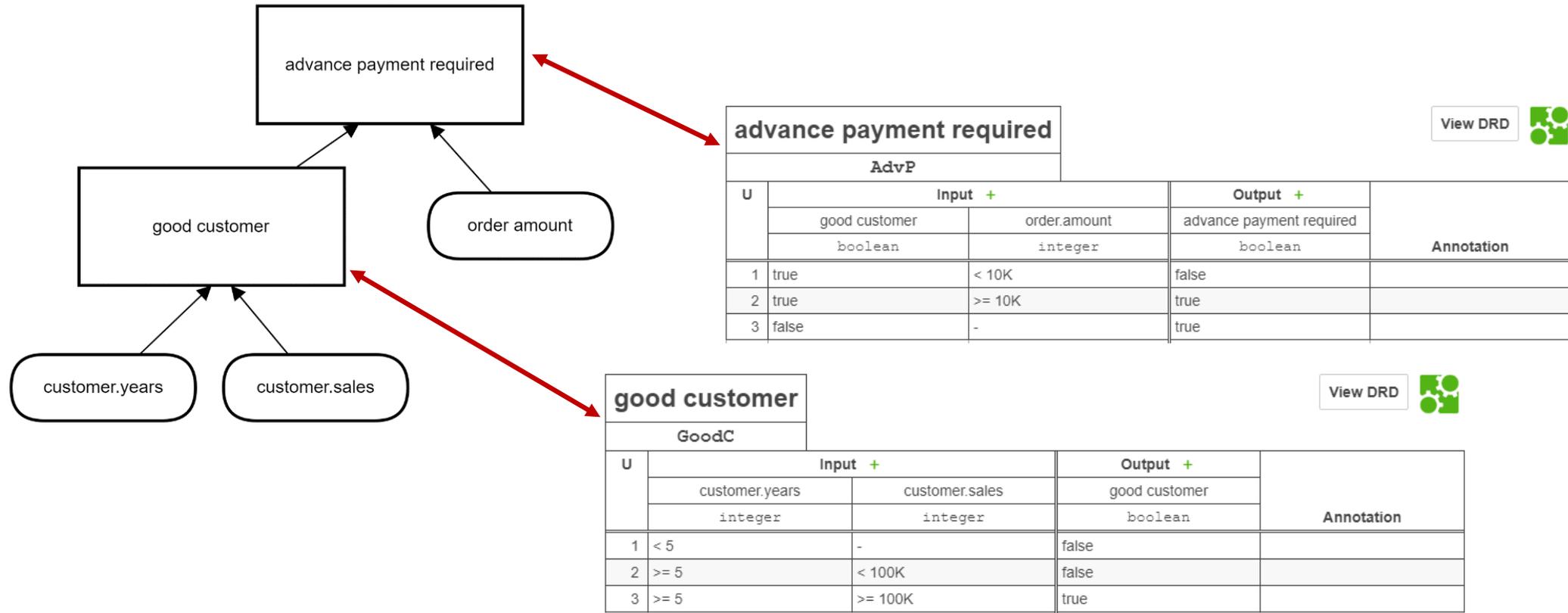- Decisions have improved visibility and can be reused
- Decision logic can be maintained separately
- Different stakeholders, separation of concerns

The decision logic

Decision

Business knowledge

Input data

advance payment required

good customer

order amount

customer.years

customer.sales

advance payment required

View DRD

	AdvP			
U	Input +		Output +	
	good customer	order.amount	advance payment required	Annotation
	boolean	integer	boolean	
1	true	< 10K	false	
2	true	>= 10K	true	
3	false	-	true	

good customer

View DRD

	GoodC			
U	Input +		Output +	
	customer.years	customer.sales	good customer	Annotation
	integer	integer	boolean	
1	< 5	-	false	
2	>= 5	< 100K	false	
3	>= 5	>= 100K	true	

DMN

- **Decision Model & Notation (DMN)**

- **DMN 1.0 published by Object Management Group (OMG) in 2015**

- **Now OMG DMN 1.4 (2022)**

- DMN is an executable notation for the precise specification of business decisions and rules by the business. It is designed to work alongside BPMN (or CMMN) providing a mechanism to model decision making.

- **Typical applications: decisions in finance, insurance, healthcare, legal, …**

Decision management

Why would we only care about the (big) data or the processes?
Decisions are important for business

- **What is the decision?**
    - eligibility, price, insurance, theft rating, customer offer, retention, supplier selection, hire, credit, …
- **Who owns the decision?**
- **Who makes the decision every day?**
- **What triggers the decision?**
- **How can we improve the decision?**
- **What is required to make this decision?**
    - Information requirements
    - Knowledge sources (regulations, analytics, expertise)
    - Other decisions
    - Decision logic

Modeling decisions: a new standard

Decision(s) (logic) need to be modeled
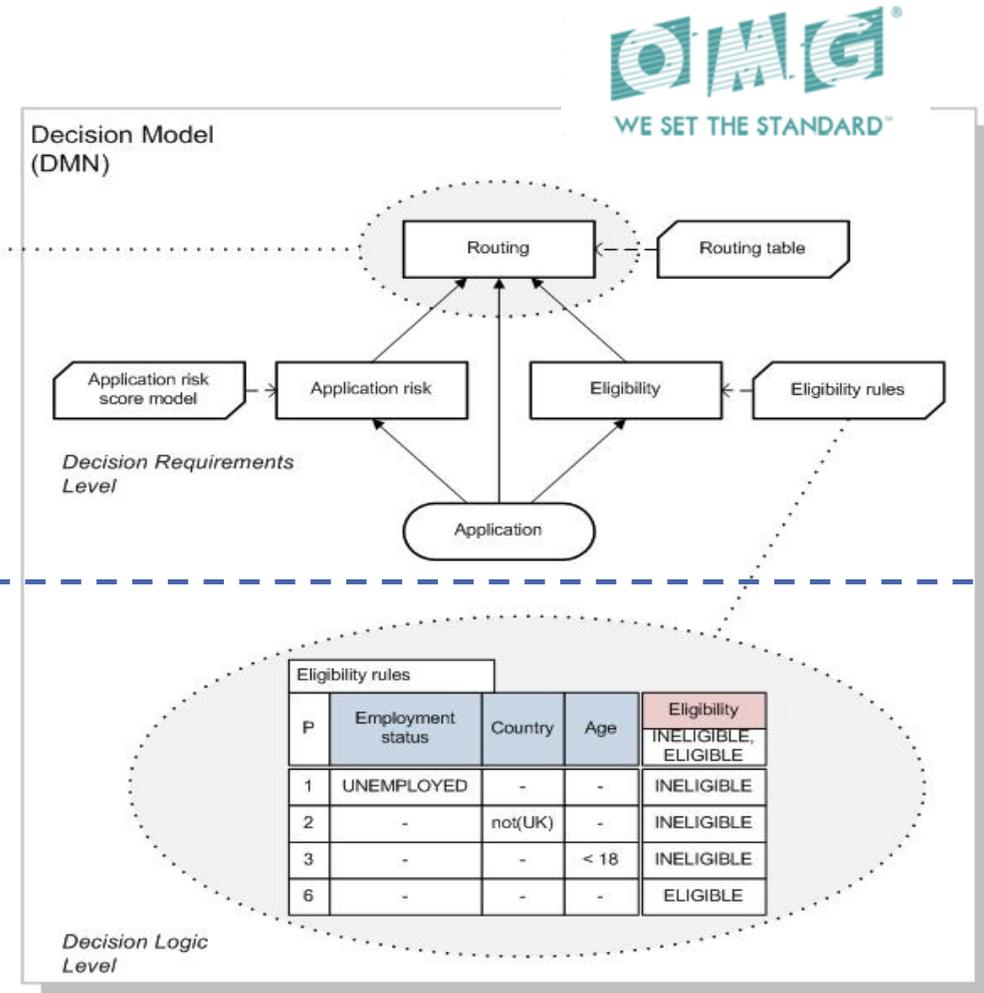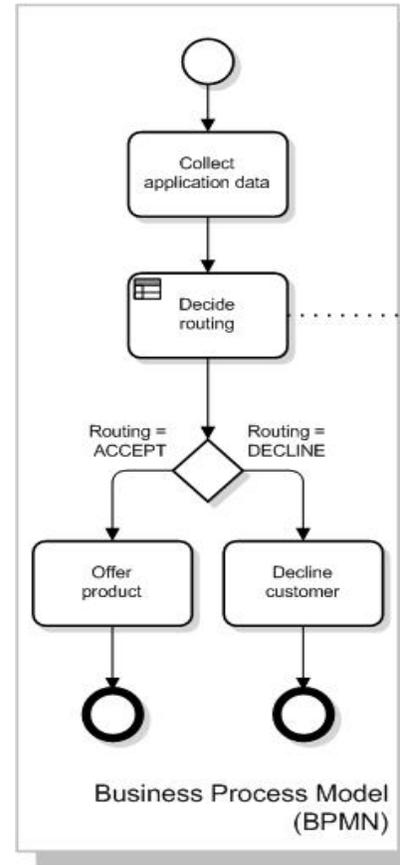
A standard for processes (BPMN)
is not enough

- **What is the decision?**
  - Eligibility, rating, retention, offer, selection, hire, credit, …
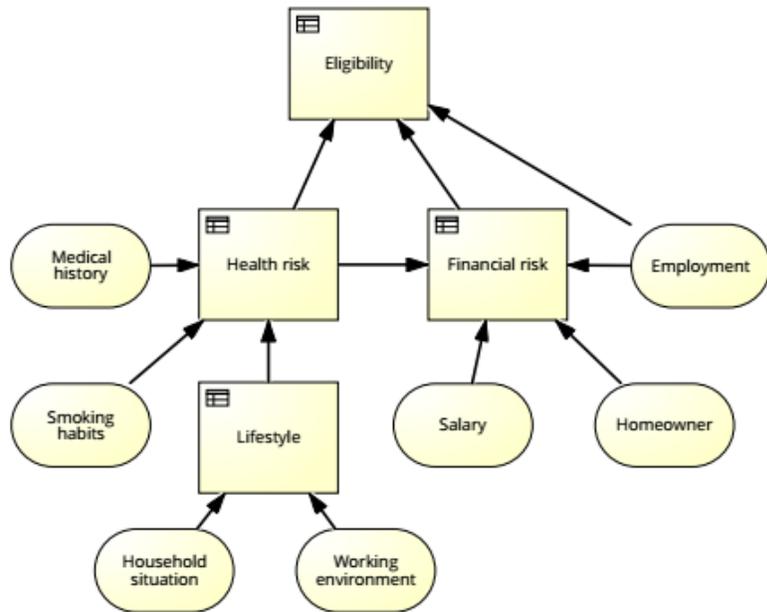- **What is required to make this decision?**
  - Information
  - Knowledge sources (regulations, analytics, expertise)
  - Other decisions
  - Decision logic

Intended for business people who specify and monitor the decisions, and for implementers
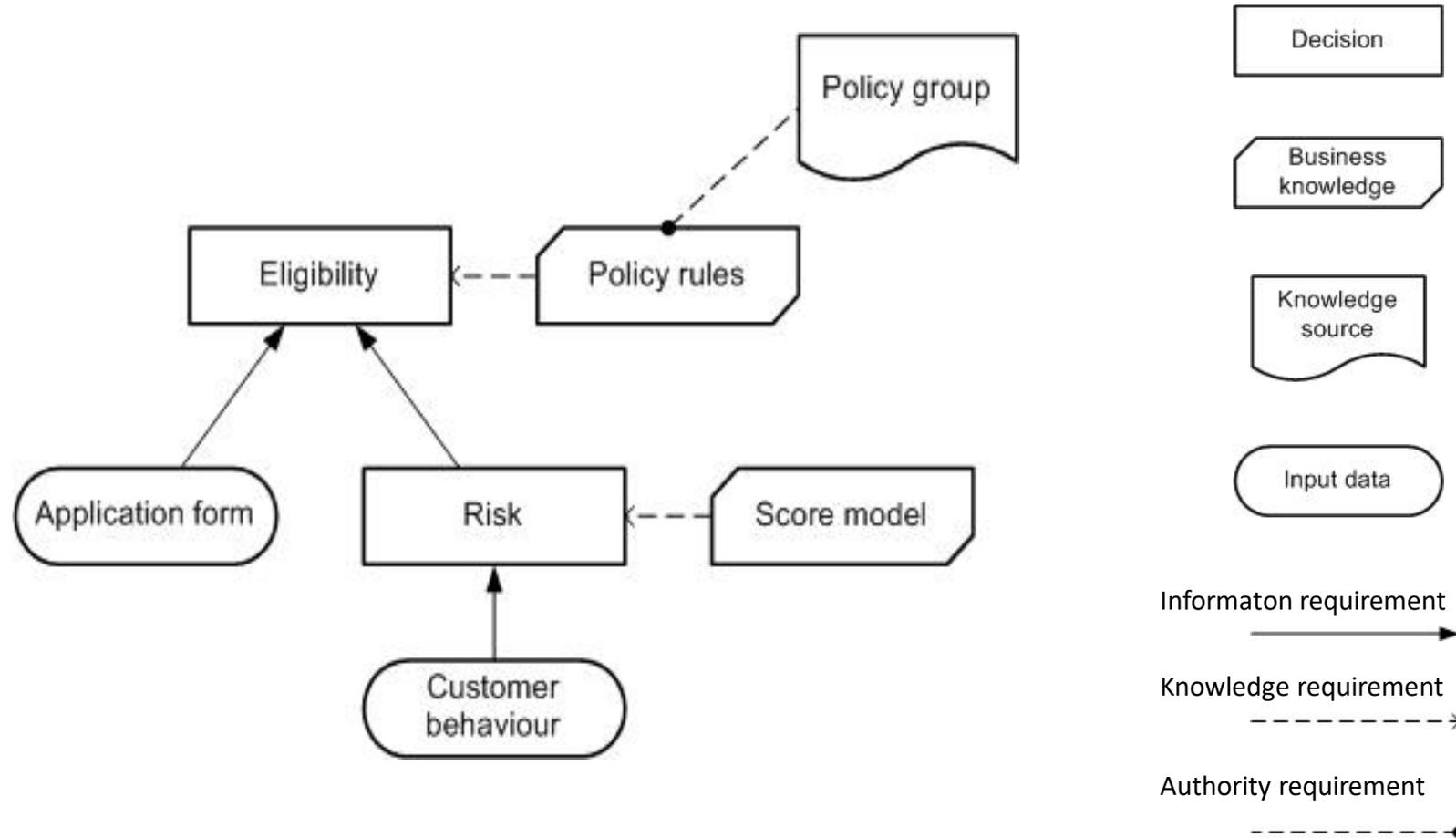
How to model decisions?

1. Decisions requirements

2. Decision logic

Decision requirement diagram for the credit eligibility decision

Applicant Risk Rating			
U	Applicant Age	Medical History	Applicant Risk Rating
1	> 60	good	Medium
2	> 60	bad	High
3	[25..60]	-	Medium
4	< 25	good	Low
5	< 25	bad	Medium

Decision Requirements Graph

Decision table

To Quit or not to Quit

If I don't get a raise of at least 10 percent, I will find a job somewhere else. But if I get promoted, then I will expect my own office or I'll quit, unless the work is going to be more interesting; in which case, I'll stay with just a 10 percent raise.

Quit or not quit -QUI-

Promotion ?	Y	Y	Y	Y	N	N
Own office ?	Y	N	N	N	–	–
Raise of ≥ 10 % ?	–	Y	Y	N	Y	N
More interesting work ?	–	Y	N	–	–	–
Quit	–	–	×	×	–	×
Stay	×	×	–	–	×	–

❖ **Good** decision table models are a proven technique to represent decision rules

*Consistency, completeness and correctness **by design***
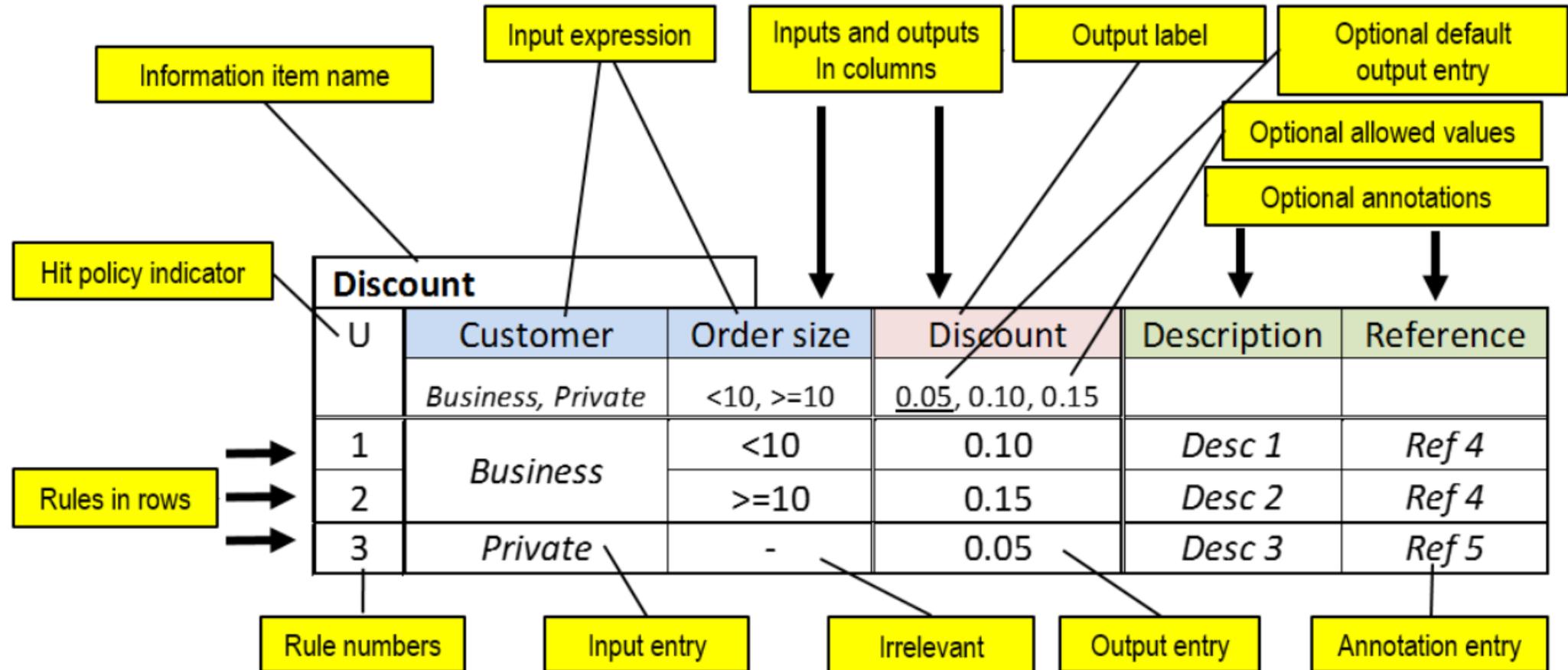
DMN decision table

Figure 8.2: Decision table example (horizontal orientation: rules as rows)

Decision table formats

Applicant Risk Rating

Applicant Age	Medical History	Applicant Risk Rating
> 60	good	Medium
> 60	bad	High
[25..60]	-	Medium
< 25	good	Low
< 25	bad	Medium

Rules in rows

Applicant Risk Rating

Applicant Age	< 25		[25..60]	> 60	
Medical History	good	bad	-	good	bad
Applicant Risk Rating	Low	Medium	Medium	Medium	High

Applicant Risk Rating

Applicant Age	< 25		[25..60]	> 60	
Medical History	good	bad	-	good	bad
Low	X	-	-	-	-
Medium	-	X	X	X	-
High	-	-	-	-	X

Rules in columns

Applicant Risk Rating		Medical History	
		good	bad
Applicant Age	< 25	Low	Medium
	[25..60]	Medium	Medium
	> 60	Medium	High

Crosstab

Example: Insurance premiums

Decision requirements level
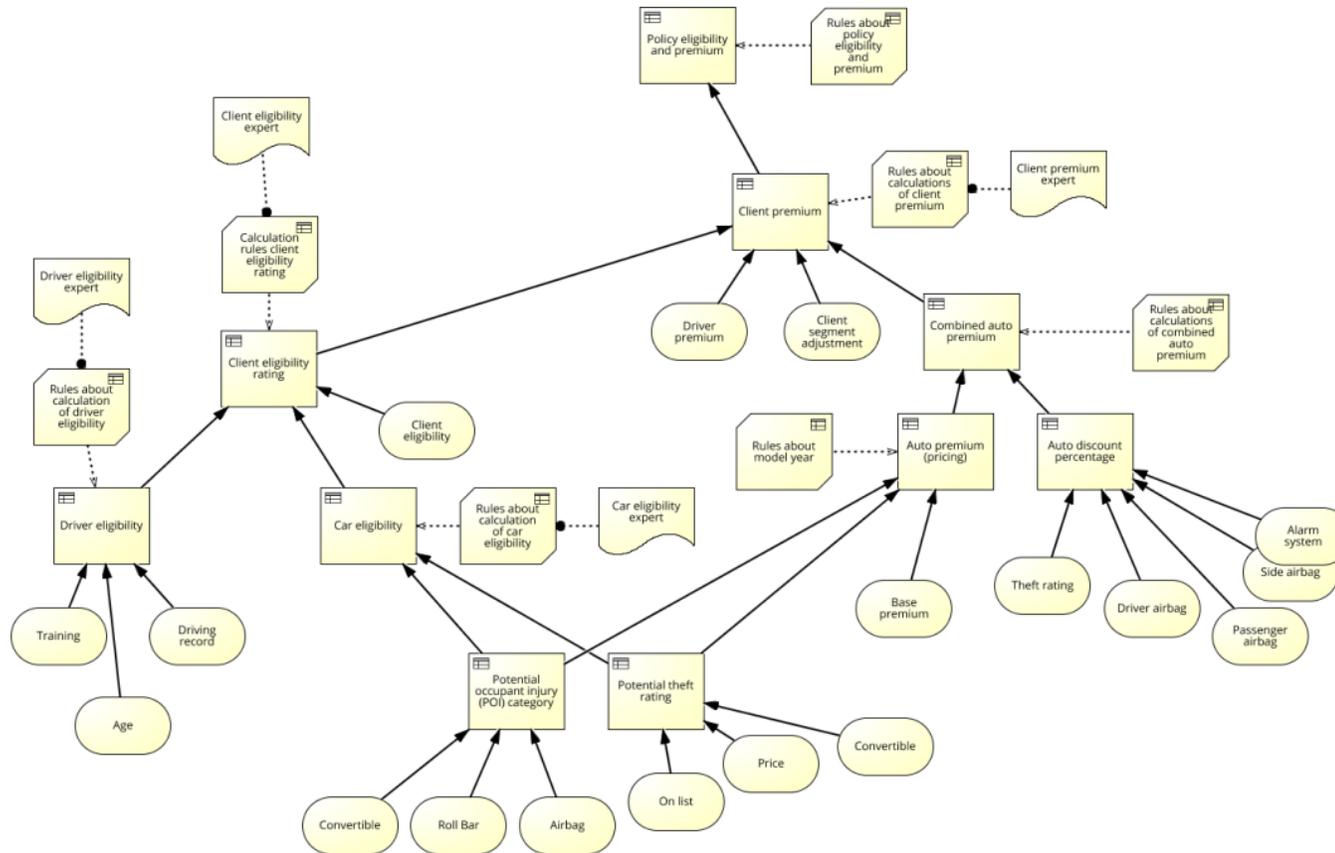
The **Client Premium** is based on
- The client segment adjustment (based on client data)
- The combined auto premium (based on car data)
- The driver premium (based on driver information)

The **Potential Theft (PT) Category** is subject to the following rules (in decreasing priority)

- If the car is a convertible, then its potential theft rating is high.
- If the car's price is greater than $40.000, then its potential theft rating is high.
- If the car model is on the list of 'High Theft Probability Auto', then its potential theft rating is high.
- If all of the following are true, , then its potential theft rating is moderate:
  - The car's price is between $22.000 and $40.000.
  - The car model is not on the list of 'High theft potential Probability Auto'.
- If all of the following are true, the car's potential theft rating is low:
  - …

Decision logic level

U	On list		Price		Convertible		Theft Rating
	{YES,NO}		{<22 000,22 000-40 000,>…		{YES,NO}		{High,Medium,Low}
1	=	YES		-		-	High
2	=	NO	=	<22 000	=	YES	High
3	=	NO	=	<22 000	=	NO	Low
4	=	NO	=	22 000-40 000	=	YES	High
5	=	NO	=	22 000-40 000	=	NO	Medium
6	=	NO	=	>40 000		-	High

Issues DMN solves

- ***Separating decisions and processes***
  - Using a standard modeling notation.

- ***Decision table types***
  - Recognize, and unambiguously exchange.

- ***Decision modeling methodology***
  - Keep the insights of the past and avoid confusion.

- ***Separating decision structure and decision logic***
  - *A*llows to model decision relations, even if not all logic is in tables.

- ***Standard notation for exchange and implementation***
  - Strict notation and simple expression language (FEEL).
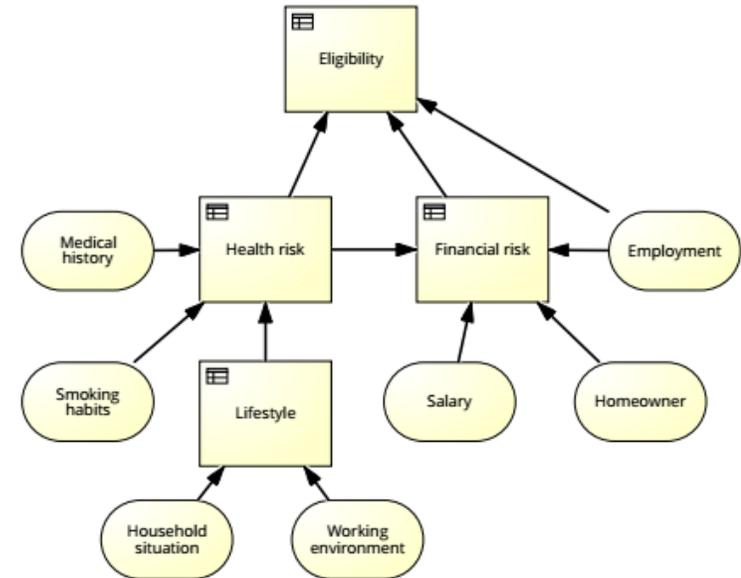
Decision requirement diagram for the credit eligibility decision

Application areas & Tools
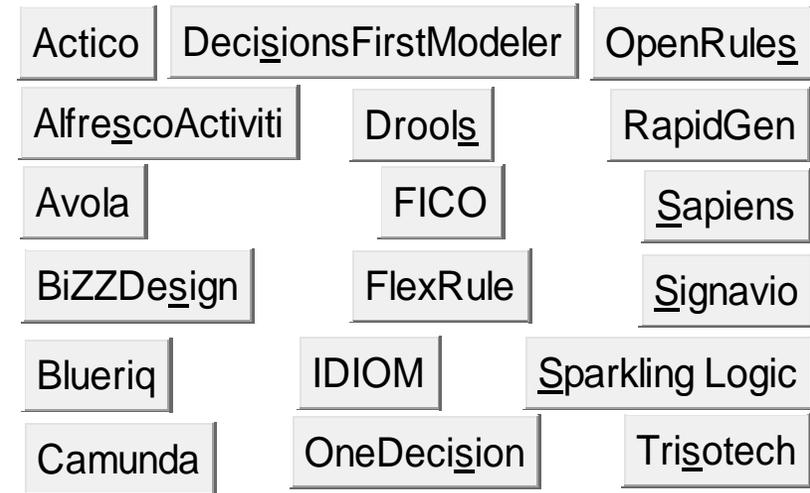
- **Decisions, decisions, decisions**
  - Decisions in process modeling
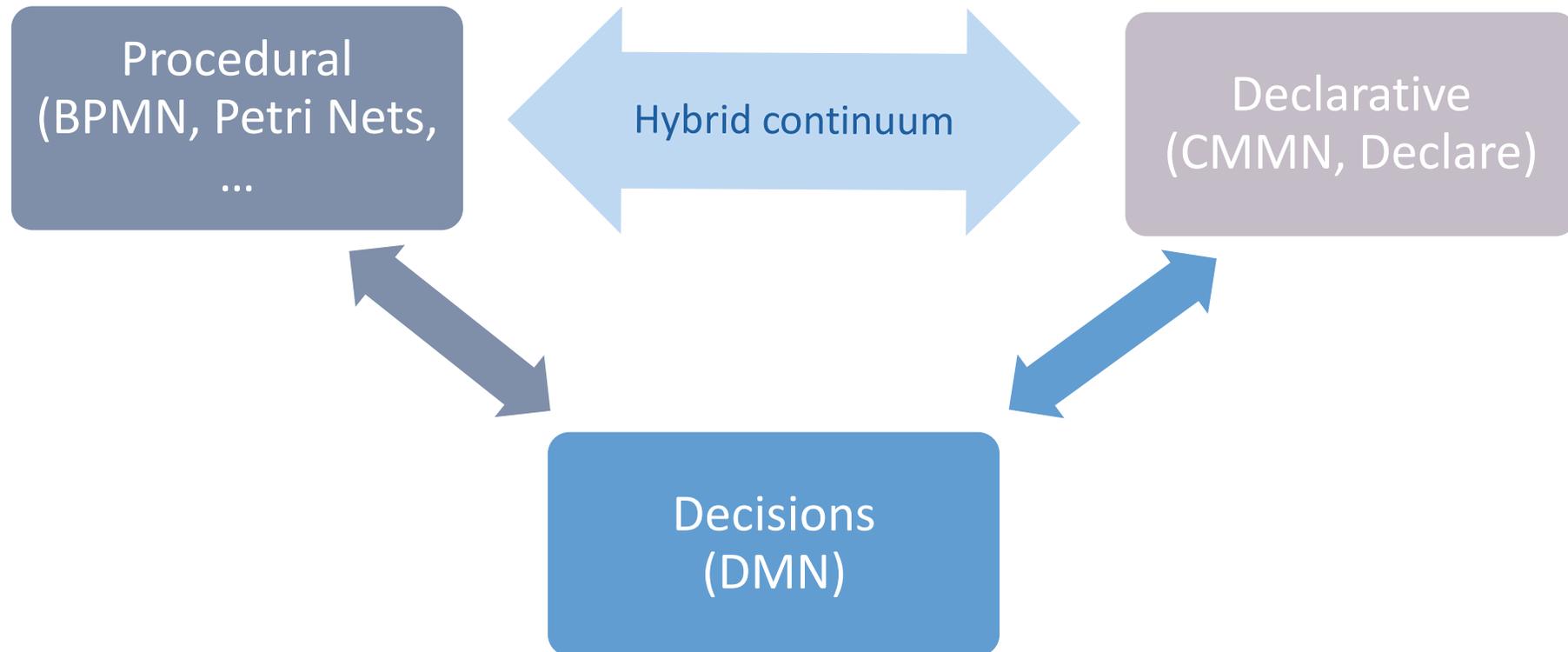 - Process variability

- **'Simple' operational decisions**
  - Eligibility, credit, churn, social security, finance, insurance, healthcare, security, definitions, …
  - Regulations, legislation

- **Enumerating and evaluating alternatives, constraints, options**
 - Combinatorial optimizations
  - Scheduling and resource allocation

Actico	DecisionsFirstModeler	OpenRules
AlfrescoActiviti	Drools	RapidGen
Avola	FICO	Sapiens
BiZZDesign	FlexRule	Signavio
Blueriq	IDIOM	Sparkling Logic
Camunda	OneDecision	Trisotech

Modeling paradigms

Recent developments

Recent developments

1. **New in DMN 1.4**
2. **DMN and analytics**
3. **DMN + BPMN**
   - Consistent integration
4. **Decision modeling methodology**
   - Decision or process first
   - Top-down or bottom-up
5. **Decision mining**
6. **DMN Extraction from text**
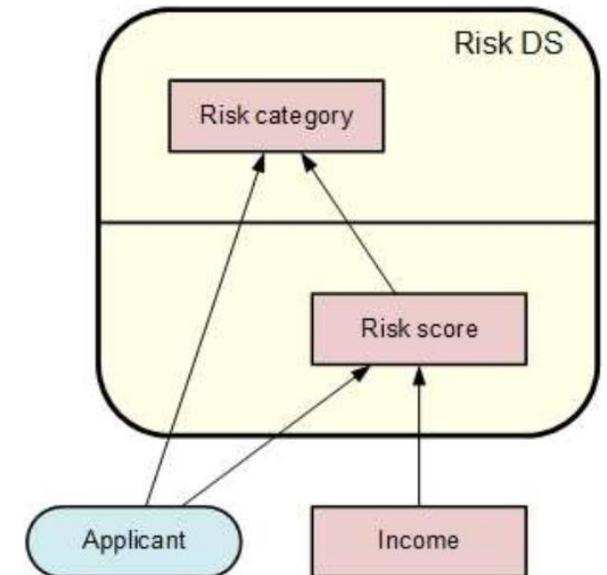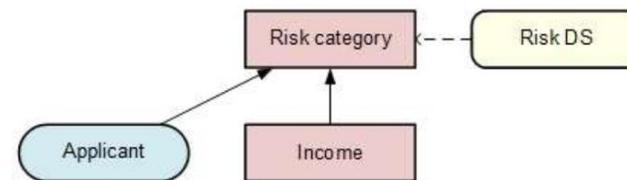7. **Smart execution**
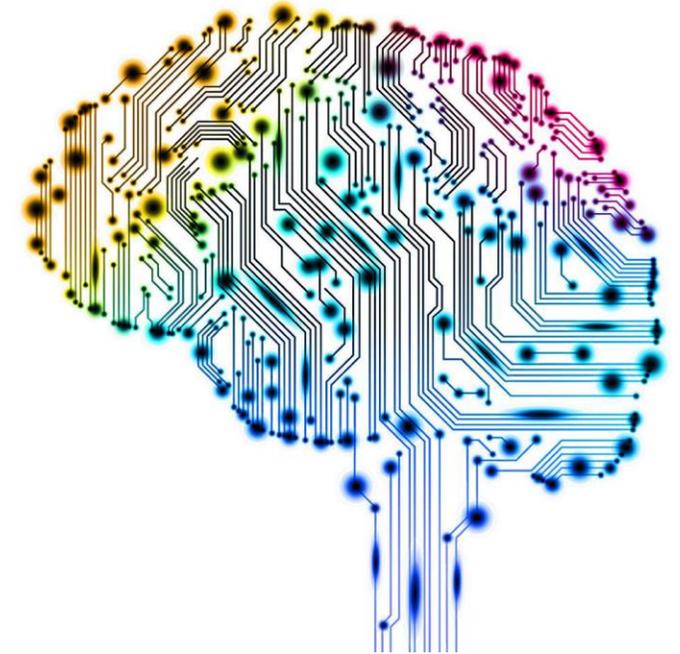
New in DMN

- **1.0 (2015)**

- **1.1 (2016)**
  - Notation of decision services
  - Refinement of XML interchange
  - Many corrections

- **1.2 (2019)**
  - Invokable decision services
  - Ellipsis notation (…) for undisplayed requirements
  - Decision table annotations
  - Loops in FEEL
  - Mathematical functions in FEEL
  - Diagram layout interchange

New in DMN

- **1.3 (2021)**
  - Visual grouping of DRD elements
  - Temporal reasoning in FEEL
  - Context FEEL functions
  - Typing improvements
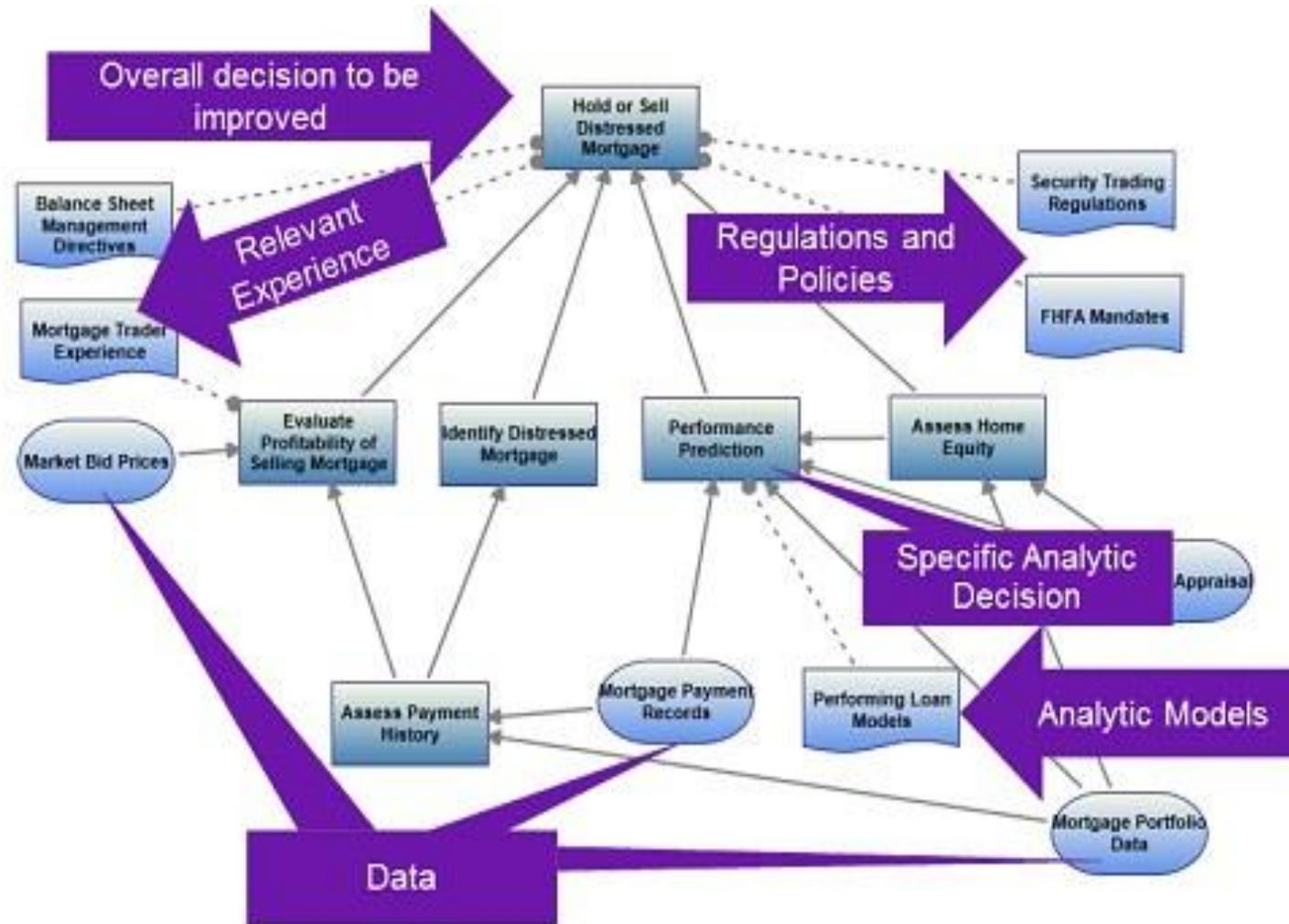
New in DMN

- **1.4 (2022)**
  - New FEEL functions (now, today, context, rounding)
  - New boxed expressions allow to reuse
    business-friendly constructs such as decision tables
    - Conditional
    - Iterator
    - Filter
  - Collection marker on decisions: the output of the decision is a collection

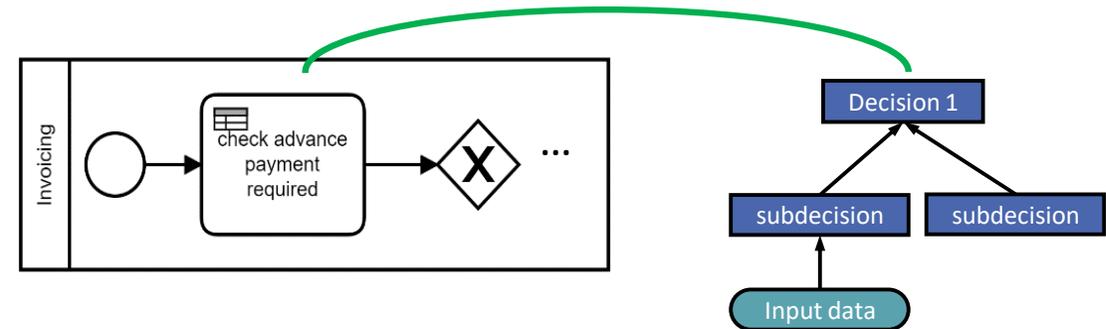**Figure 6-10: Decision and Input Data showing collection marker**

DMN and Analytics requirements

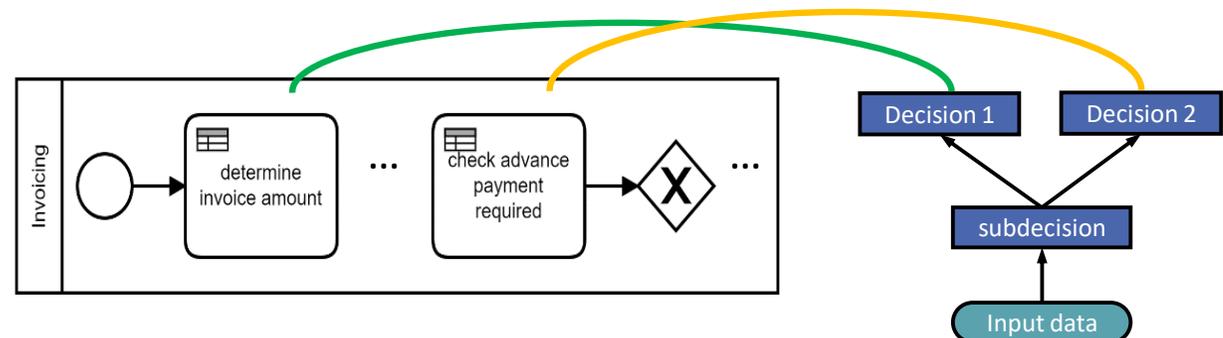Source: Decision Management Solutions, 2015

Consistent DMN + BPMN integration (1)

- **One decision model for one decision activity**

- **One decision model for multiple decision activities**
  - If two (top) decisions share a lot of required elements, they are commonly depicted in one decision model

Consistent DMN + BPMN integration (2)

- **Only repeat subdecisions of a decision model in the process model**
  - if subdecisions that contain an intermediate result are relevant for the process execution (messages, exceptions, additional activities)
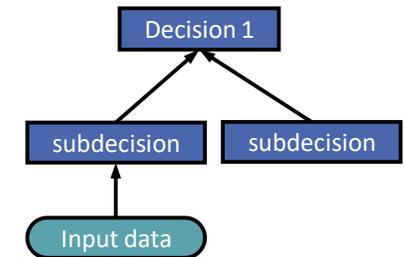 - But: the hierarchy has to be maintained
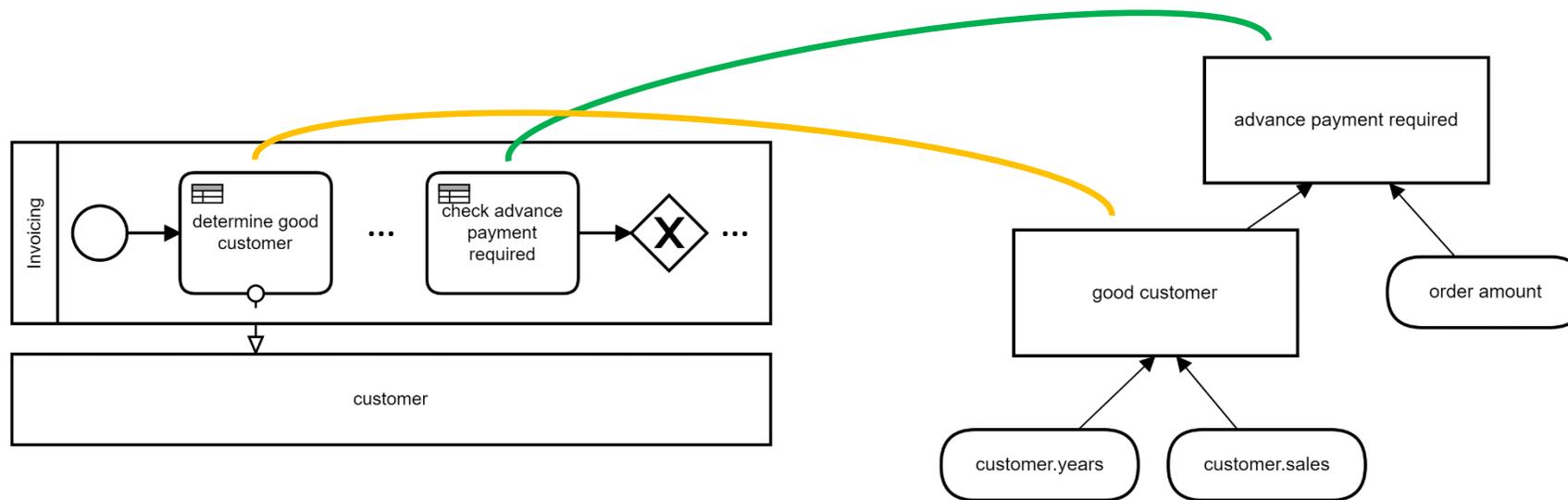
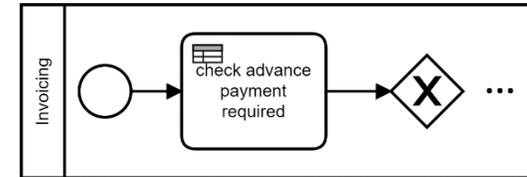(Consistent Integration of Decision (DMN) and Process (BPMN) Models, Laurent Janssens, Ekaterina Bazhenova, Johannes De Smedt, Jan Vanthienen, and Marc Denecker, CaiSE forum, 2016)
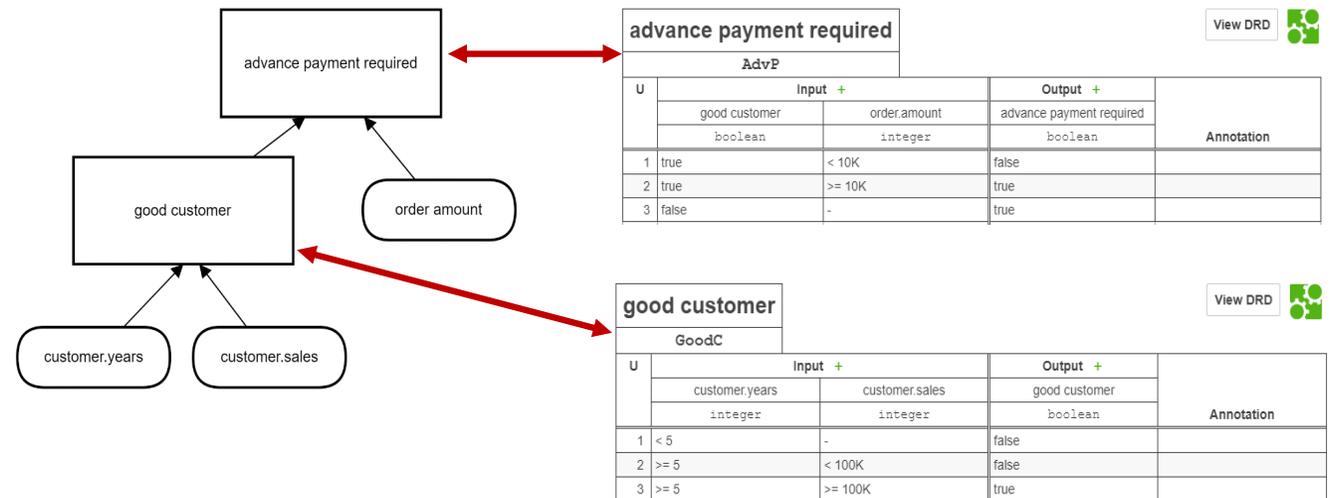
Decision modeling methodology

- **Process first or decisions first?**
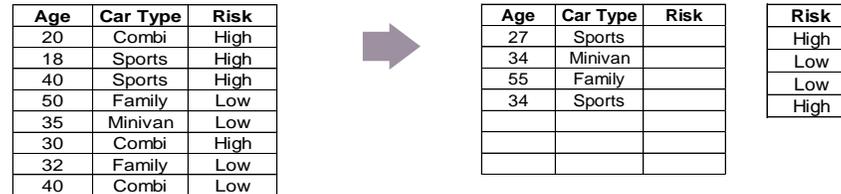 - Is it a knowledge-intensive process?

- **Modeling decisions:**
  - Top-down or bottom-up?
  - With or without the detailed logic?
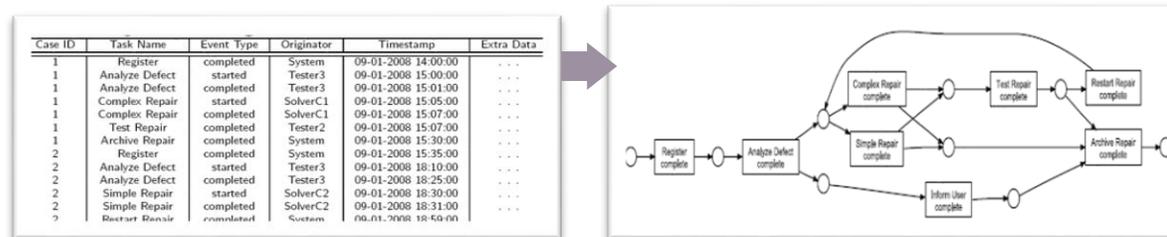 - Or starting from the tables?

Integrated decision mining

- **Data mining**

Age	Car Type	Risk
20	Combi	High
18	Sports	High
40	Sports	High
50	Family	Low
35	Minivan	Low
30	Combi	High
32	Family	Low
40	Combi	Low

Age	Car Type	Risk
27	Sports	
34	Minivan	
55	Family	
34	Sports	

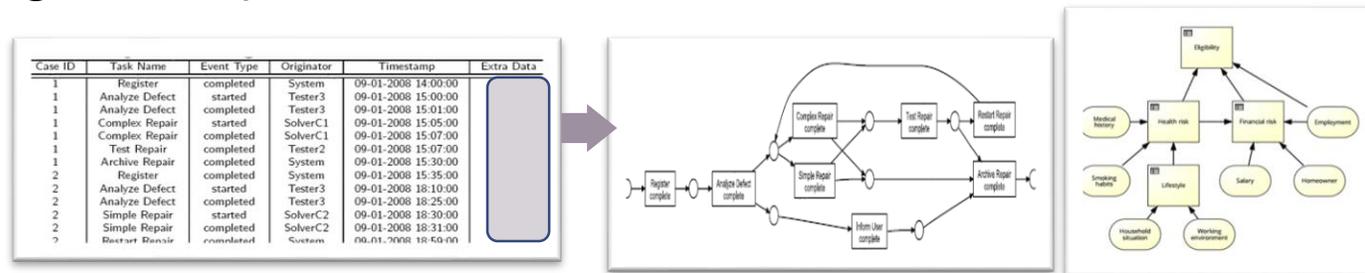| Risk |
|---|
| High |
| Low |
| Low |
| High |

- **Process mining (including event timestamps)**

- **Integrated mining (including decisions)**

(De Smedt, J., vanden Broucke, S., Obregon, J., Kim, A., Jung, J.-Y., & Vanthienen, J. (2017). Decision Mining in a Broader Context: An Overview of the Current Landscape and Future Directions. *Business Process Management Workshops—BPM 2016, Revised Papers* (Vol. 281, pp. 197–207))

DMN Extraction from Text

TEXT :

1. Decision Dependencies

- *"The health risk level of a patient should be assessed from the obesity level, waist circumference and the sex of the patient. Furthermore, the degree of obesity should be determined from the BMI value and sex of the patient. Patient's height and weight are considered to calculate his BMI value."*

2. Decision Logic

- *"When the patient's sex is a male and his BMI value is in between 25 and 29.9, then his obesity level is normal."*
- *"If patient' sex is female and BMI value is above 25.0 and less than 30, then obesity level is overweight . Where as, If BMI value is 30.0 or higher, obesity level falls within the obese I range."*

DRD:
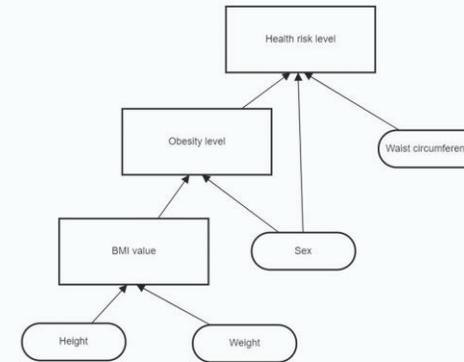
Rules:

	Inputs		Outputs
5	[25..29.9]	"Male"	"Normal"
6	[25..29.9]	"Female"	"Overweight"
7	[30..34.9]	-	"Obese I"

BMI Guidelines: https://www.nhlbi.nih.gov/files/docs/guidelines/ob_gdlns.pdf

*Clinical Guidelines on the Identification, Evaluation, and Treatment of Overweight and Obesity in Adults

Smart execution

- **Currently a process model/decision model serves one purpose:**

- **The basic decision/process:**
  - John Doe is 50 and has 30 years of service, process John's case
  - A customer puts in an claim/order/loan request, how to handle this?
  - Given all the necessary data, what is the output?

- **We process the case, but why do we need other systems, processes, people**
  - to give advice, support, explanation?
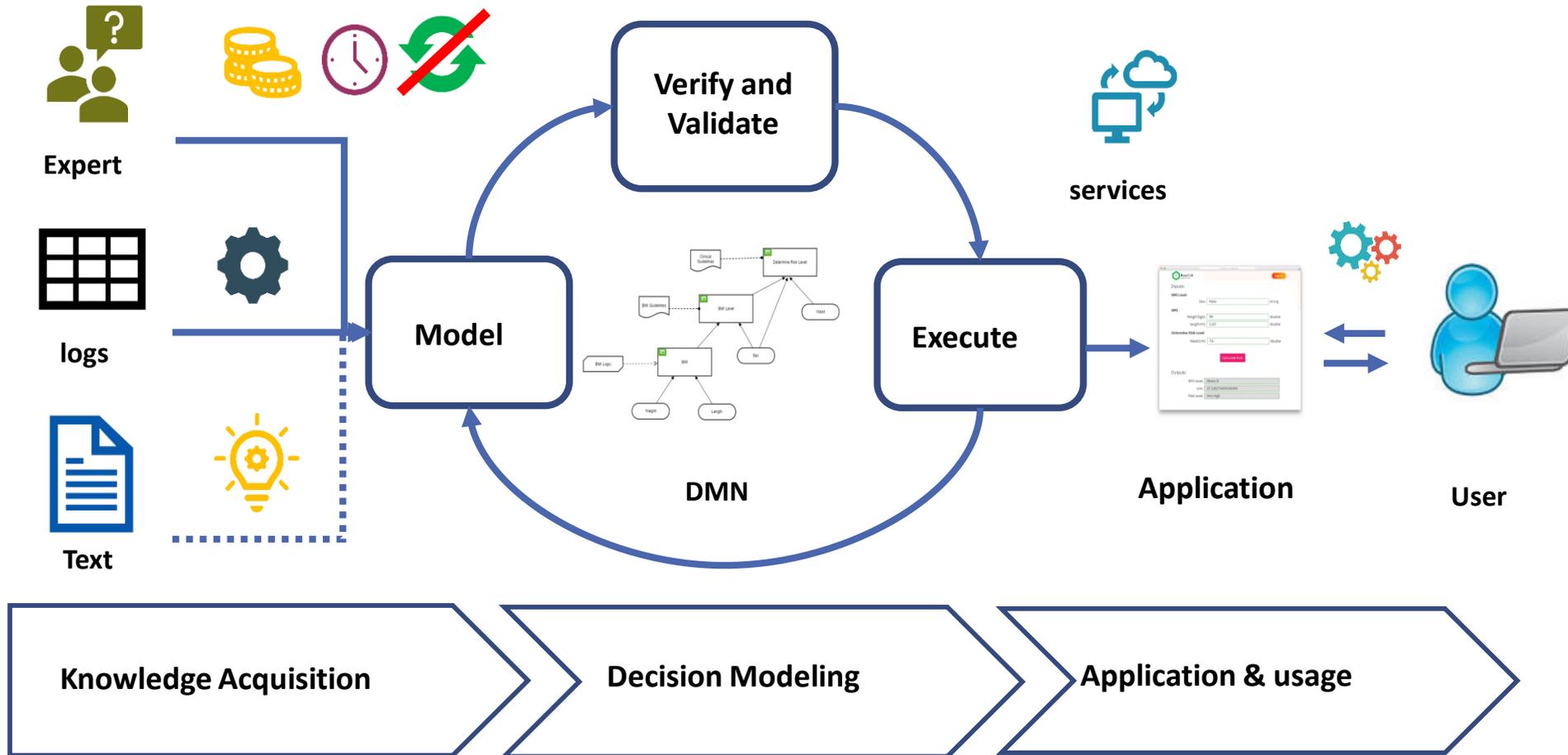 - to analyze and optimize?

There is more than the basic decision/process

- **Why** do I get this result?

- **What if** some input data would be different?

- What can I already decide with these **incomplete data**?

- Goal seeking: What do I have to change to obtain that result?
- **Optimization**: How do I get the maximum?

- **Decision Analysis**: Are there some strange assignments in giving this result? Who finally gets which result?

- **Decision Maintenance**: What if the policy changes?
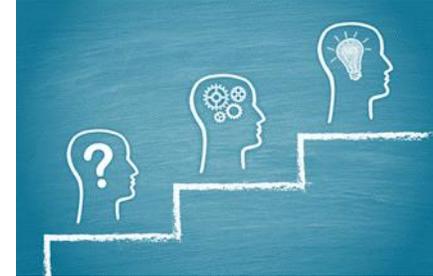
(Dasseville, I., Janssens, L., Janssens, G., Vanthienen, J., & Denecker, M. (2016). Combining DMN and the knowledge base paradigm for flexible decision enactment. *CEUR Workshop Proceedings, 1620*)

Business Decision Management from A to Z

Expert

logs

Text

Verify and Validate

services

Model

DMN

Execute

Application

User

Knowledge Acquisition

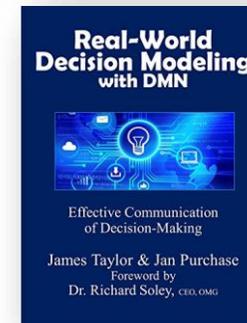Decision Modeling

Application & usage

More information

- Figl, K., Mendling, J., Tokdemir, G., Vanthienen, J.: What we know and what we do not know about DMN. *Enterprise Modelling and Information Systems Architectures* 13: 2:1-16 (2018).

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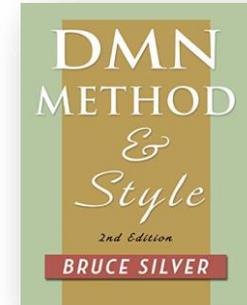
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