Business Rules – Modeling Business Rules

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SBVR - Semantics for Busines Vocabulary and Business Rules

- The Semantics of Business Vocabulary and Business Rules (SBVR) is an adopted standard OMG
- It is intended to be the basis for formal and detailed natural language declarative description of a business.
- The SBVR defines the vocabulary and rules for documenting the semantics of business vocabularies, business facts, and business rules
- SBVR is based on separation between symbols and their meaning, thus allowing multilingual development

Levels of Business Rules Expression

- For expressing rules there is a trade-off between acessibility of business meaning and desirable automation
- Rules can be expressed on various levels:

Informal and semi-formal: *natural language* statements within a limited range of patterns or *decision tables*, e.g.

It is obligatory that a credit account customer is at least 18 years old

Printer troubleshooter

		Rules						
Conditions	Printer does not print	Y	Y	Y	N	N	N	N
	A red light is flashing	Y	Y	N	N	Y	N	N
	Printer is unrecognised	Y	N	Y	N	Y	N	N
Actions	Check the power cable			X				
	Check the printer-computer cable	X		X				
	Ensure printer software is installed	X		X		X		X
	Check/replace ink	X	X			X	X	
	Check for paper jam		X		X			

Technical: Combining structured data and operators, e.g.

```
CreditAccout
  self.customer.age >= 18
```

Formal: statements conforming a more closely defined syntax with particular mathematical/logical properties, e.g.

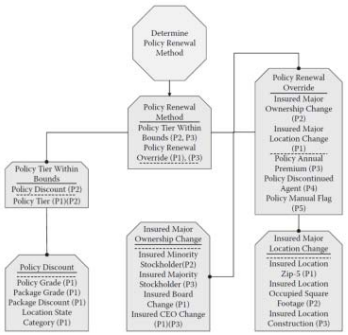
```
{X, Y, (customer X) (creditAccount Y) (holder X,Y)
  ==> (ge (age X) 18)
```

$\forall x \, \forall y \; \text{Customer}(x) \wedge \text{CreditAccount}(y) \wedge \text{Holder}(x,y) \rightarrow \text{age}(x) > 18$

(Morgan 2002, p. 63)

Notations for Business Rules

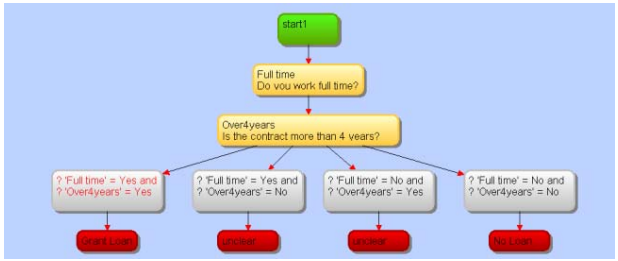
Decision table:



Printer troubleshooter

		Rules							
Conditions	Printer does not print	Y	Y	Y	Y	N	N	N	N
	A red light is flashing	Y	Y	N	N	Y	Y	N	N
	Printer is unrecognised	Y	N	Y	N	Y	N	Y	N
Actions	Check the power cable			X					
	Check the printer-computer cable	X		X					
	Ensure printer software is installed	X		X		X		X	
	Check/replace ink	X	X			X	X		
	Check for paper jam		X		X				

Decision tree:



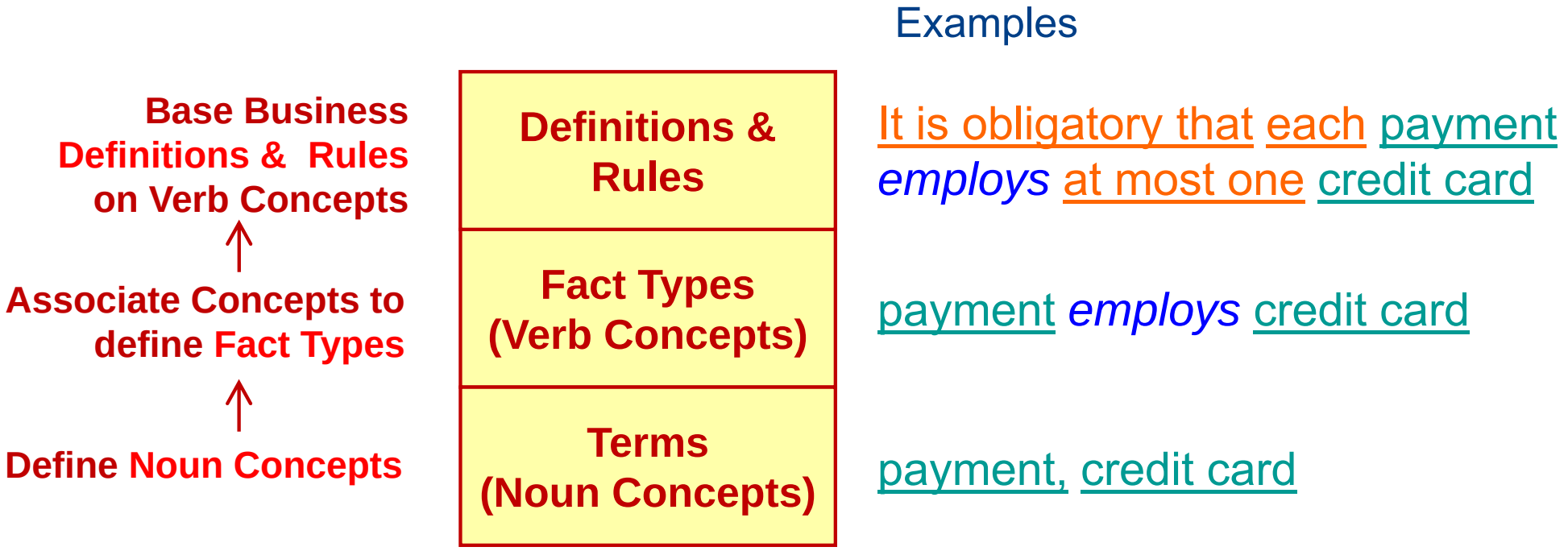
It is obligatory that each driver *of a* rental *is qualified.*

rental *has* driver

driver *is qualified*

- Rules can be represented, for example, in
  - Decision Tables
  - Decision Trees
  - SBVR Structured English/Rule Speak
- Terms and Fact Types can be represented in
  - SBVR Structured English
  - Fact Type Models
- SBVR is a vocabulary, not a language specification. The SBVR specification itself uses SBVR Structured English to describe its vocabularies

Rules are built on Facts, Facts are built on Terms

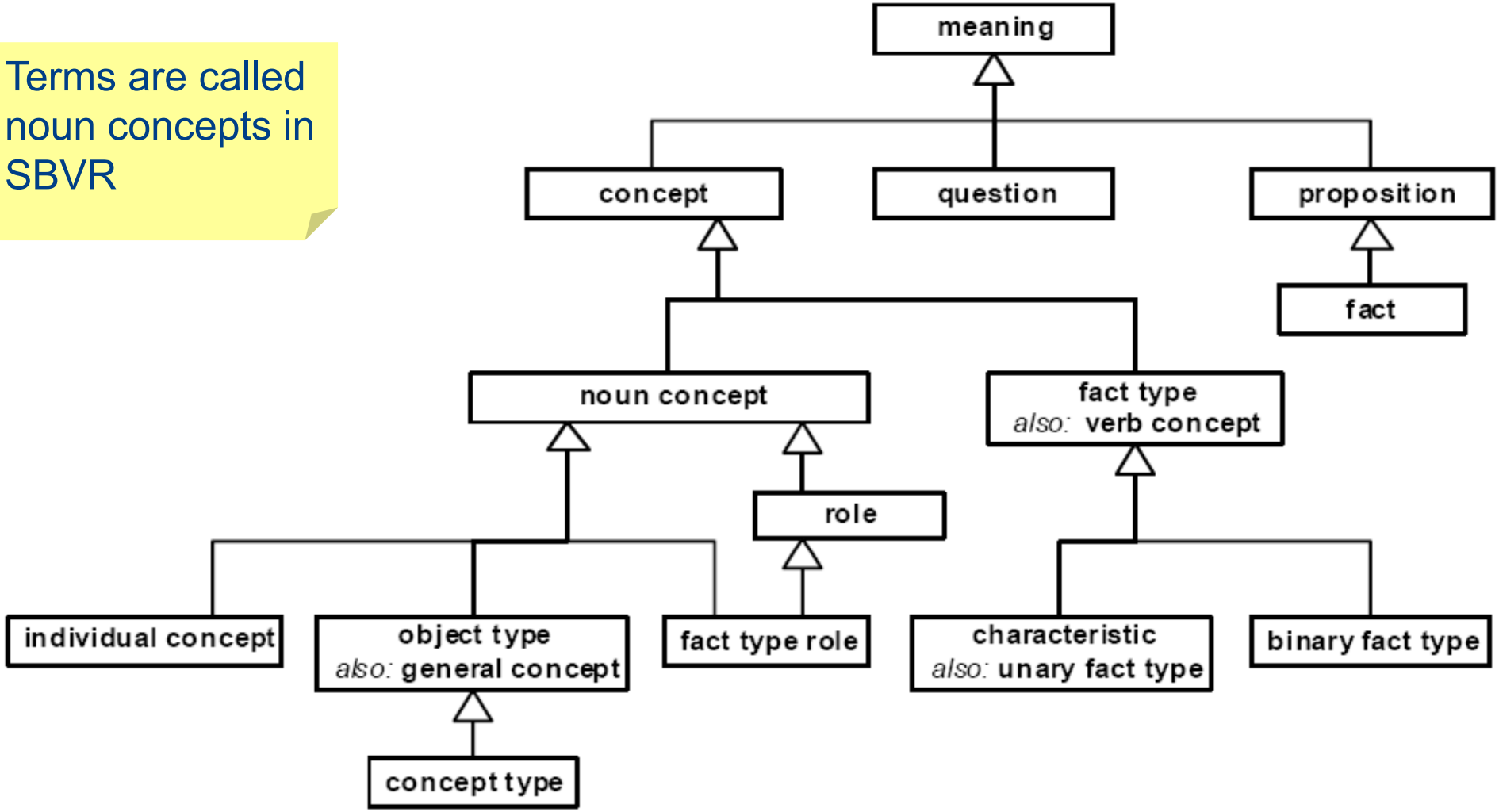


- Business terms are words and phrases that have meaning to business people in the context where those terms are used.
- Facts are combinations of business terms that describe what business people know about their business.“

(Chapin et al. 2008)

Terms and Facts According to SBVR

Terms are called noun concepts in SBVR



Terms: Noun Concepts

- A business rule – even if expressed as an English sentence – is more formally stated than most sentences in everyday life.
- Just like any sentence, business rules contain nouns
  - words or word phrases describing persons, places, things, or abstract ideas
- The meaning of a noun is called a *noun concept*
- Every noun concept used in a rule must be defined in a business rule model
  - If a term is a common term, the definition can be taken from a dictionary
  - For specific terms you can create your own definitions

Noun Concepts - Examples

- Definition of a Noun concept

> ***cash payment***
> *Definition:* ***payment*** *that employs* ***cash***

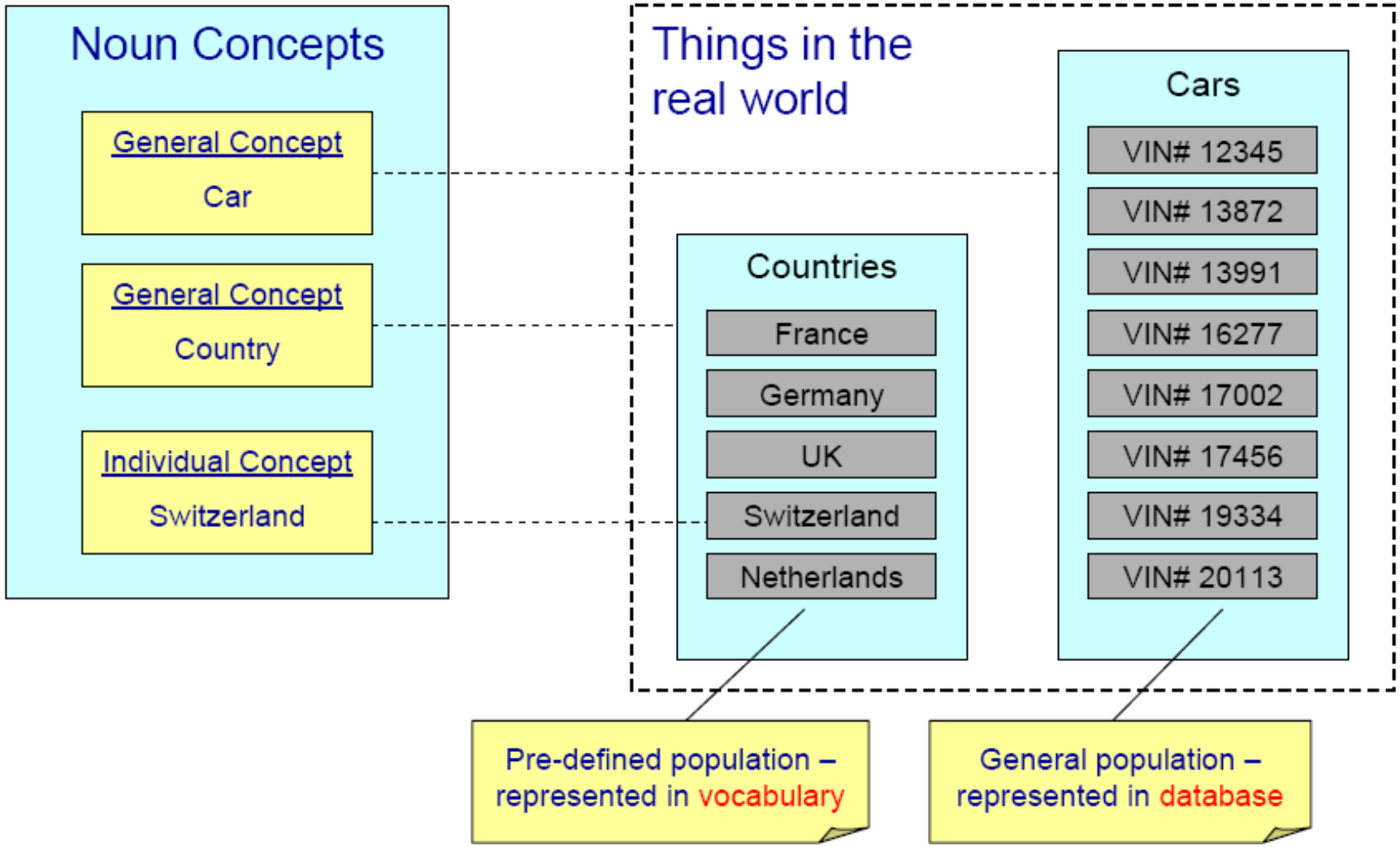
  - A cash payment is a specialisation; any payment that employs cash is a cash payment

- Two noun concept definition from a dictionary

> ***payment***
> *Definition: an amount paid*
> — American Heritage Dictionary of the English Language, Fourth Edition

> ***cash***
> *Definition: money in the form of bills or coins; currency*
> — American Heritage Dictionary of the English Language, Fourth Edition

Noun Concepts: General and Individual



(Chapin & Hall 2006)

General and Individual Noun Concepts

Examples:

- The '**general concept**' that denotes the set of cities in which Cora Group has restaurants

operating cities

Definition: **cities** in which **Cora Group** has restaurants
Concept Type: **general concept**

- The '**individual concept**' that denotes the city Washington D.C.

Washington D.C.

Concept Type: **individual concept**
Definition: The capital city of the **USA**
General Concept: **city**

Intensional and Extensional Definitions

- In general there are two types of definitions
  - **intensional definition**: a definition which describes the intension of a concept by stating the superordinate concept and the delimination characteristics
  - **extensional definition**: a description of a concept by enumerating all of ist subordinate concepts
- Example: These are an intensional and an extensional definition of the restaurants of Cora Group

Cora restaurant

Definition: restaurant which belongs to Cora Group

Definition: one of restaurants **Nola**, **Portia**, **Viola**, **Zona** and **Adelina**

Noun Concepts and Structural Rules

- A noun concept can be detailed with a structural rule
- Structural Rules cannot be violated and thus can be used as definitions
- Example: The following rule can be regarded as a definition of the noun concept „separated party“: A separated party must be seated at two or more tables, otherwise it is not a separated party

Parties 1: It is necessary that a separated party is seated at two or more tables

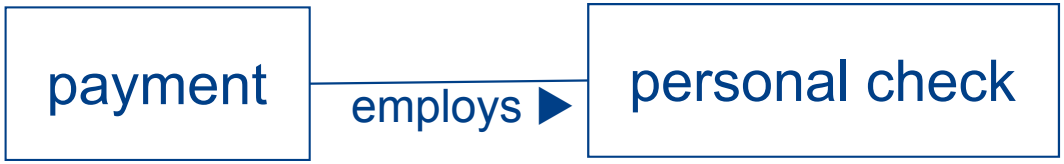
Fact Types

- A Fact Type is the meaning of a verb phrase that involves one or more noun concepts
- Fact types characterize the way noun concepts may be related.
- Example:
  - The following fact type says that any rule that includes the noun concept payment and the noun concept personal check can relate those two noun concepts via the verb employs

    payment *employs* personal check
- Fact types can be visualized as fact-type diagrams

Fact Types and Rules

The same fact type can be used in many rules



Potential Rule	Interpretation
It is obligatory that a payment employ a personal check.	For that odd restaurant that requires all payments be made in personal checks.
It is permitted that a payment employ a personal check only if the personal check is drawn on a local back.	A personal check is acceptable if another condition holds: the check is local.
It is obligatory that a customer be photographed if the customer makes a payment and the payment employs a personal check.	For the careful restaurant that wants to collect forensic evidence from customers who might bounce checks.

Multiple Fact Types

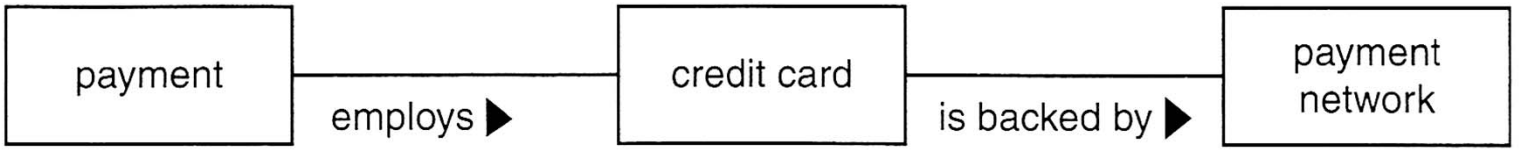
- A business rule can be build on more than one fact type
- Example:
  - The rule VISA Only is build on two fact types

VISA Only: It is permitted that a payment employ a credit card only if the credit card is backed by VISA™.

payment *employs* credit card

credit card *is backed by* payment network

  - Multiple Fact Types can be combined into one diagram



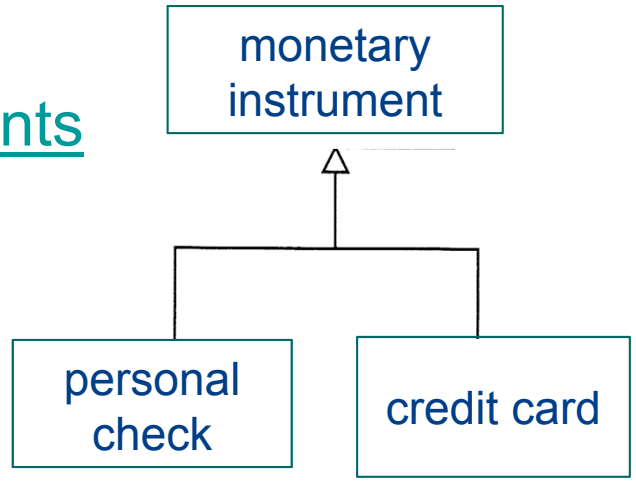
Generalization and Specialization

- The relation *specializes* is a predefined fact type in SBVR to define a generalisation hierarchy.
- It either relates two general concept which is equivalent to the generalization in UML (meaning subclass of)

  credit card *specializes* monetary instruments

  or it relates an individual and a general concept

  Washington D.C. *specializes* city

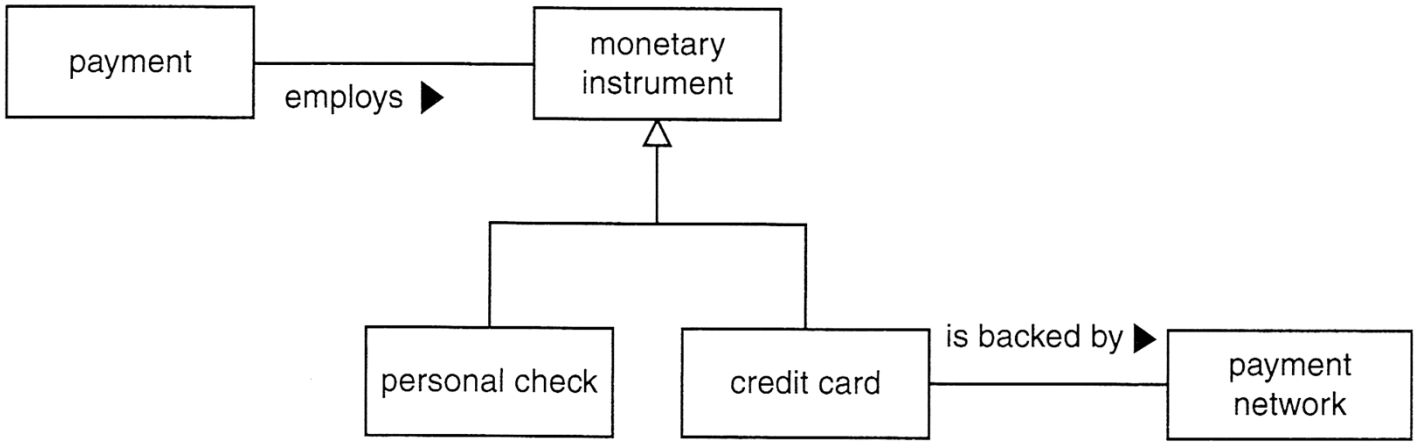


- The fact type *generalizes* is the inverse relation

  monetary instruments *generalizes* credit card

Fact Type Diagrams

- The following fact type diagram contains fact types for several rules
- It consists of noun concepts, verbs and a specialisation



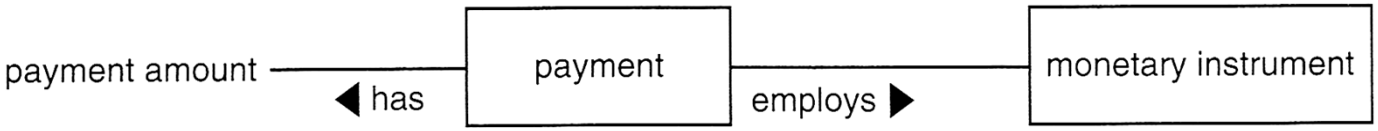
- Note the correspondence of fact type diagrams to UML class diagrams:
  - noun concepts correspond to classes
  - verbs correspond to associations

Fact Type Properties

- Consider the following rule:

> **One Monetary Instrument:** It is prohibited that a payment employ more than one monetary instrument if the amount of the payment is less than $50.

- This rules is build on two fact types
  - payment employs monetary instrument
  - payment has payment amount
- A payment amount is special: it is a property of a payment: Without a payment there is no payment amount.
- It could be a convention, to use a specifc verb „has“ to indicate properties and to distinguish them from other associations.



Fact Type Consistency

- Business rules should be easy to understand and written precisely – avoiding misinterpretation as far as possible.
- Therefore the business rules of an organisation should use a coherent set of fact types
- For example, no two different verbs should be used to name the same association between noun concepts
- Also, fact types can also be defined, too, in a business rules model.

Defining a Business Rule

- Start with a fact type, e.g.

  payment *employs* credit card

- Apply an obligation or necessity to it, e.g.

  it is obligatory that payment *employs* credit card.

- Add qualifications, quantifications and conditions, if necessary, e.g.

  It is obligatory that each payment *employs* at most one credit card

Defining a Business Rule

This procedure is applied also for complex rules with more than one fact type

- Start with the fact types, e.g.

  payment *employs* credit card

  credit card *is backed by* payment network

  VISA *specializes* payment network

- Apply modality keyword, e.g.

  It is permitted that payment *employs* credit card,
  credit card *is backed by* payment network

- Add qualifications, quantifications, conditions, and instantiate, etc.

  It is permitted that a payment *employs* a credit card only if the
  credit card *is backed by* VISA

Graphical Rule Modeling

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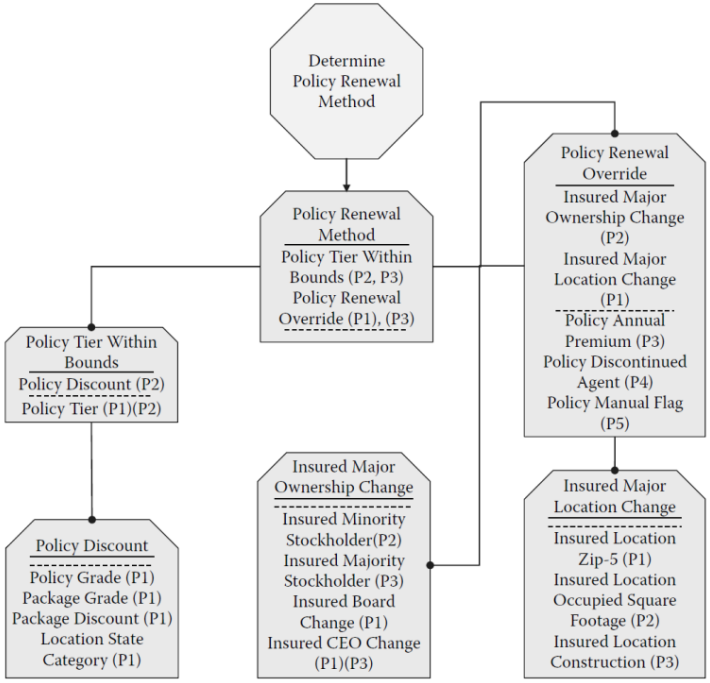
Graphical Rule Modeling

- There are some special forms of business rules that can be represented as diagrams
  - Decision Models
  - Decision Trees
  - Decision Tables

Decision Model Elements

A Decision Model has two different kinds of diagrams:

Decision Model Diagram



Rule Family Table

Conditions						*Conclusion*	
Person Student Loans		Person Business Loans		Person Customer Status		Person Miscellaneous Loans Assessment	
Is	Yes			Is not	Current customer	Is	Medium Risk
		Is	Yes	Is not	Current customer	Is	High Risk
Is	Yes			Is	Current customer	Is	Low Risk
		Is	Yes	Is	Current customer	Is	Medium Risk

Decision Tables

- A decision table is a compact form to represent a whole set of rules
- A decision table can represent condition-action rules and also logical rules
  - Condition-Action rules:

Conditions	Condition alternatives
Actions	Action entries

  - Logical Rules: The effects represent possible decision values

Conditions	Condition alternatives
Effects	Effect entries

- The second column represents a set of rules: one column for each combination of possible values for condition
- All rules (conditions and actions/effects) are formulated with terms and fact types

Decision Table for Printer Diagnosis

each column represents one rule

Printer troubleshooter

		Rules							
Conditions	Printer does not print	Y	Y	Y	Y	N	N	N	N
	A red light is flashing	Y	Y	N	N	Y	Y	N	N
	Printer is unrecognised	Y	N	Y	N	Y	N	Y	N
Actions	Check the power cable			X					
	Check the printer-computer cable	X		X					
	Ensure printer software is installed	X		X		X		X	
	Check/replace ink	X	X			X	X		
	Check for paper jam		X		X				

This decision table represents condition-action-rules

Example: Decision Table for Health Insurance

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

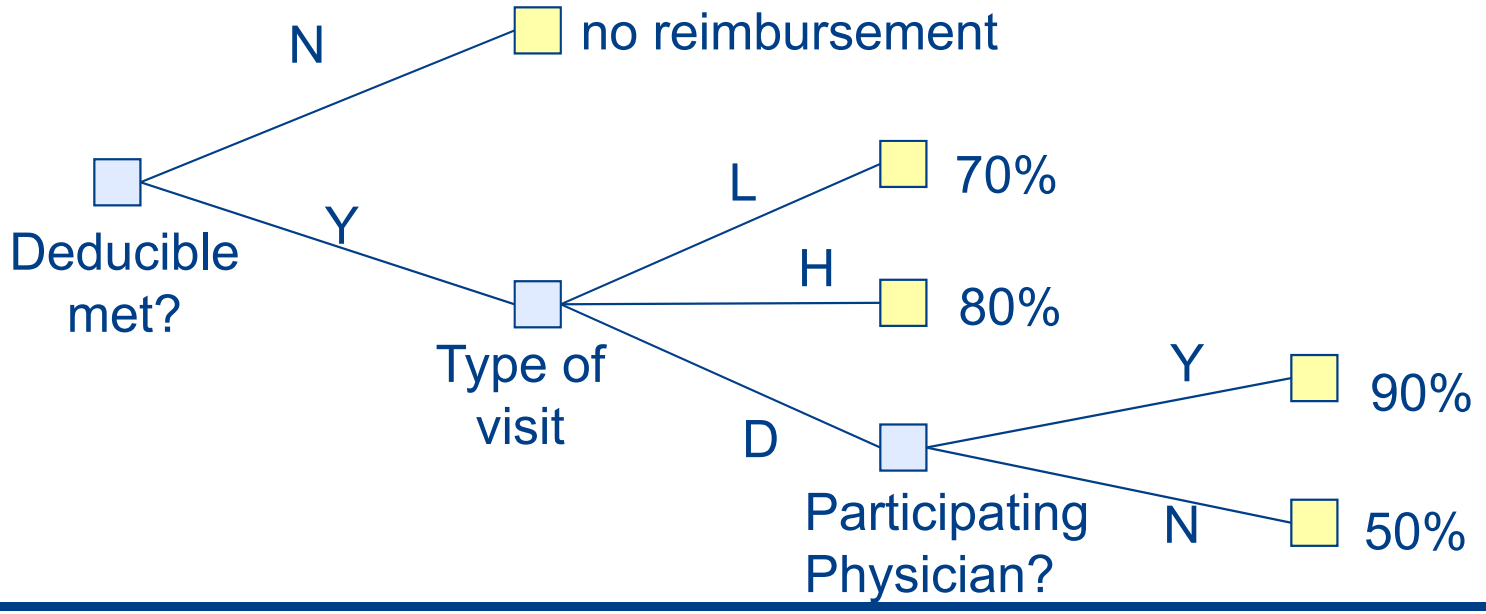
Conditions	1	2	3	4	5	6	7	8	9	10	11	12
Deductible met?	Y	Y	Y	Y	Y	Y	N	N	N	N	N	N
Type of visit	D	D	H	H	L	L	D	D	H	H	L	L
Participating Physician?	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N
Effects												
Reimburse has amount 50%		X										
Reimburse has amount 70%						X						
Reimburse has amount 80%				X								
Reimburse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

each column represents one rule

http://web.sxu.edu/rogers/sys/decision_tables.html

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



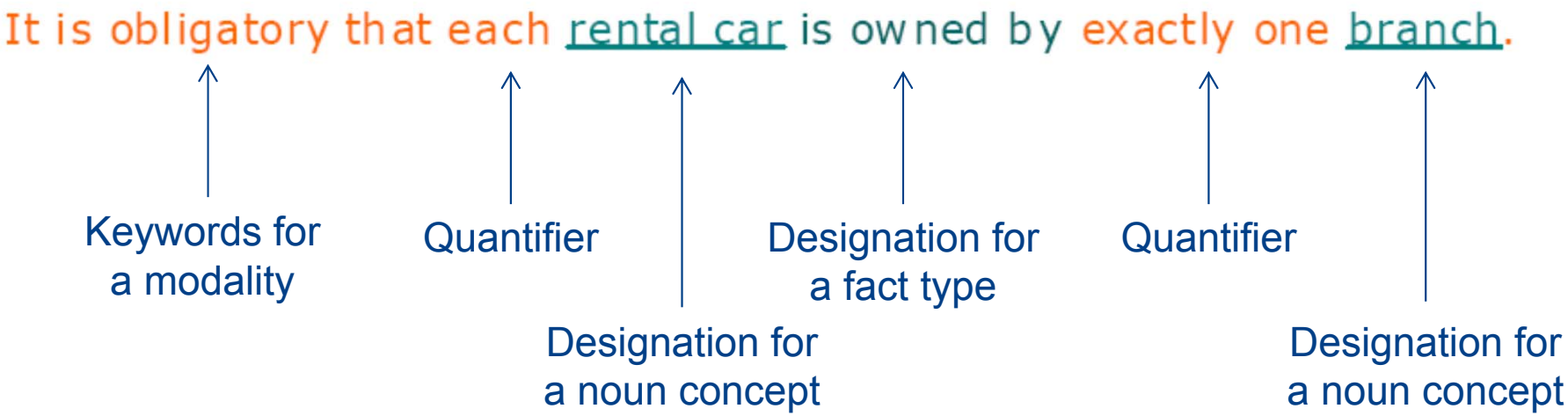
SBVR – Structured English Notation

SBVR Structured English Notation

There are four font styles with formal meaning:

term	The 'term' font is used for a designation for a noun concept (other than an individual concept), e.g. rental car, branch
Name	The 'name' font is used for a designation of an individual concept — a name. Names tend to be proper nouns, e.g. California, 25
verb	The 'verb' font is used for designations for verb concepts — usually a verb, preposition or combination thereof. Such a designation is defined in the context of a form of expression, e.g. local area *owns* rental car, rental *has* pick-up branch
keyword	The 'keyword' font is used for linguistic symbols used to construct statements – the words that can be combined with other designations to form statements and definitions, e.g., 'each' and 'it is required that'.
	Quotation marks are also in the 'keyword' font. Single quotation marks are used (among other purposes) to mention a concept – to refer to the concept itself rather than to the things it denotes. In this case, a quoted designation or form of expression is preceded by the word 'concept' or by a term for a kind of concept, e.g. the concept 'walk-in rental' *is* a category *of* the concept 'rental'.

SBVR Structured English – An Example



(Chapin & Hall 2006)

SBVR Structured English – Modal Operations

it is obligatory that *p*	obligation formulation
it is prohibited that *p*	obligation formulation embedding a logical negation
it is necessary that *p*	necessity formulation
it is impossible that *p*	necessity formulation embedding a logical negation
it is possible that *p*	possibility formulation
it is permitted that *p*	permissibility formulation

The following key words are used within expressions having a verb to form verb complexes that add a modal operation.

… must …	obligation formulation
… must not …	obligation formulation embedding a logical negation
… always …	necessity formulation
… never …	necessity formulation embedding a logical negation
… may …	permissibility formulation

SBVR Structured English- Quantification

each	universal quantification
some	existential quantification
at least one	existential quantification
at least n	at-least-n quantification
at most one	at-most-one quantification
at most n	at-most-n quantification
exactly one	exactly-one quantification
exactly n	exactly-n quantification
at least n and at most m	numeric range quantification
more than one	at-least-n quantification with $n = 2$

SBVR Structured English – Logical Operations

it is not the case that p	logical negation
p and q	conjunction
p or q	disjunction
p or q but not both	exclusive disjunction
if p then q	implication
q if p	implication
p if and only if q	equivalence (see exception explained under Modal Operations below)
not both p and q	nand formulation
neither p nor q	nor formulation
p whether or not q	whether-or-not formulation

SBVR Structured English – Modal Operations

The key word phrase "only if" is used in combination with some of the key words and phrases shown above to invert a modality.

… may … only if *p*	is equivalent to	… must not … if not *p*
it is permitted that *q* only if *p*	is equivalent to	it is obligatory that not *q* if not *p*
it is possible that *q* only if *p*	is equivalent to	it is necessary that not *q* if not *p*

For example, the following two statements have the same meaning.

A car may be rented only if the car is available.

A car must not be rented if the car is not available.

The key word "only" can also be used before a preposition in combination with "may" to invert a modality. The noun phrase after the preposition is then understood as a negated restriction as shown in these two equivalent statements:

A car may be rented only to a licensed driver.

A car must not be rented to a person that is not a licensed driver.

Because of the use of "only" in stating modal operations, the pattern "*p* if and only if *q*" for equivalence is not used if *p* involves a modal operation.

SBVR Structured English – Other Keywords

the	1. used with a designation to make a pronominal reference to a previous use of the same designation. This is formally a binding to a variable of a quantification. 2. introduction of a name of an individual thing or of a definite description
a, an	universal or existential quantification, depending on context based on English rules
another	(used with a term that has been previously used in the same statement) existential quantification plus a condition that the referent thing is not the same thing as the referent of the previous use of the term
a given	universal quantification pushed outside of a logical formulation where 'a given' is used such that it represents one thing at a time – this is used to avoid ambiguity where the 'a' by itself could otherwise be interpreted as an existential quantification. Within a definition, 'a given' introduces an auxiliary variable into the closed projection that formalizes the definition.
that	1. when preceding a designation for a noun concept, this is a binding to a variable (as with 'the') 2. when after a designation for a noun concept and before a designation for a fact type, this is used to introduce a restriction on things denoted by the previous designation based on facts about them 3. when followed by a propositional statement, this used to introduce nominalization of the proposition or objectification, depending on whether the expected result is a proposition or an actuality. See C.1.5.
who	the same as the second use of 'that' but used for a person
is of	The common preposition "*of*" is used as a shorthand for "that *is of*." For any sentential form that takes the general form of '<placeholder 1> *has* <placeholder 2>' there is an implicit reversed form of '<placeholder 2> *is of* <placeholder 1>' that has the same meaning.
what	used to introduce a variable in a projection as well as indicate that a projection is being formulated to be considered by a question or answer nominalization. See C.1.5 below.

Exercise: Definitions

- Give definitions for the following concepts:
  - weekday
  - working day
  - weekend
- Are the definitions intensional or extensional?