University of Applied Sciences Northwestern Switzerland
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Master of Science
Business Information Systems

PROGRAMM-AKKREDITIERT
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Business Rules Modeling

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All starts with Terms and Facts

„The work that results in successful business rule discovery, analysis, modeling, and implementation all starts with term and fact identification and term-fact modeling.

[…] 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."
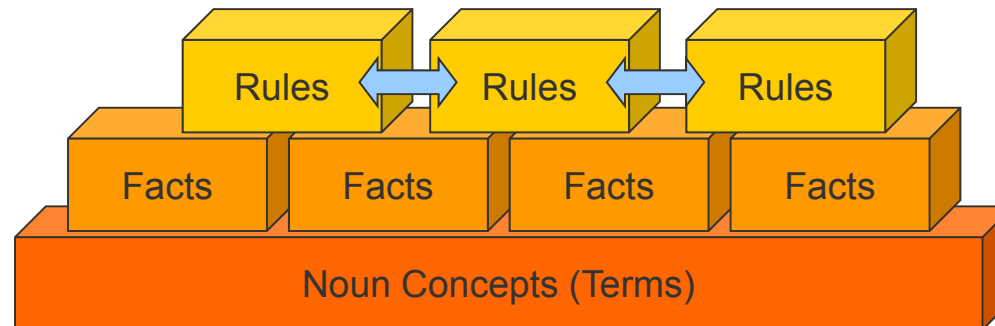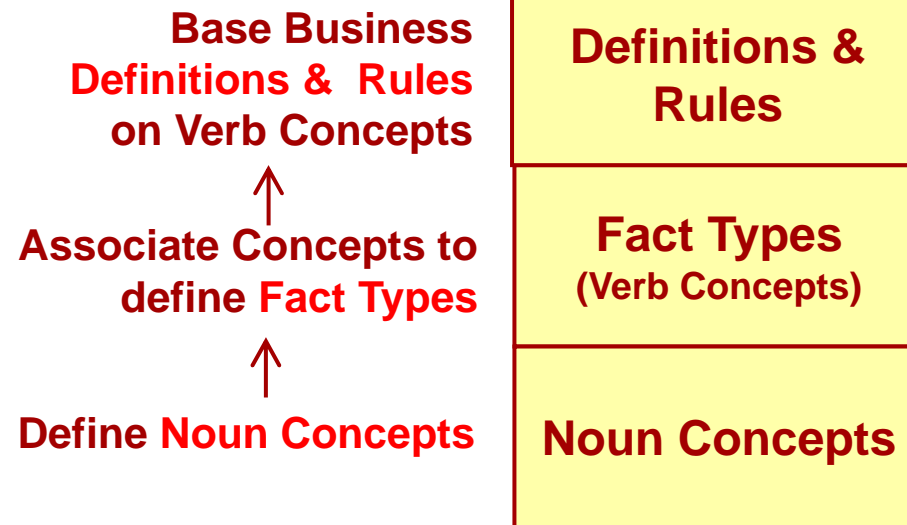

Oscar Chappel: Term–Fact Model

Quelle: Oscar Chappel: Term–Fact Modeling, the Key to Successful Rule-Based Systems.
URL: http://www.brcommunity.com/b250.php

Rules are built on Facts, Facts are built on Terms

"Rules are built on Facts. Facts are built on Terms."

**Base Business
Definitions & Rules
on Verb Concepts**

↑

**Associate Concepts to
define Fact Types**

↑

Define Noun Concepts

Definitions & Rules
Fact Types (Verb Concepts)
Noun Concepts

(Chapin et al. 2008)

SBVR - Semantics of Business Vocabulary and Business Rules
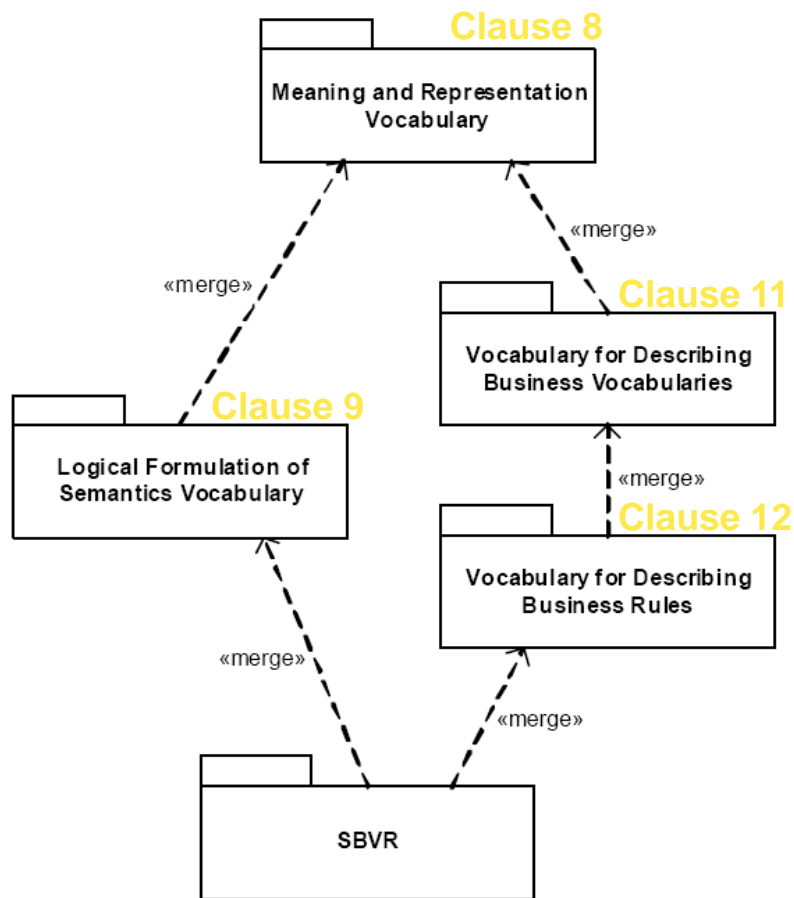
- SBVR is an OMG standard for formally describing business rules

- The SBVR consists of a large number of definitions: What is
    - a business rule
    - a rule statement?
    - level of enforcement?
    - a concept?
    - a vocabulary
    - a definition?
    - …

- SBVR also specifies the logical semantics of expressions and rules

- SBVR-compliant tools capture the meaning of business vocabularies and rules

Levels of 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 patters or decision tables, e.g.

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

Technical: Combining structured data references 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)
```

$\forall x \, \forall y \, \text{Customer}(x) \land \text{CreditAccount}(y) \land \text{Holder}(x,y) \rightarrow x>18$
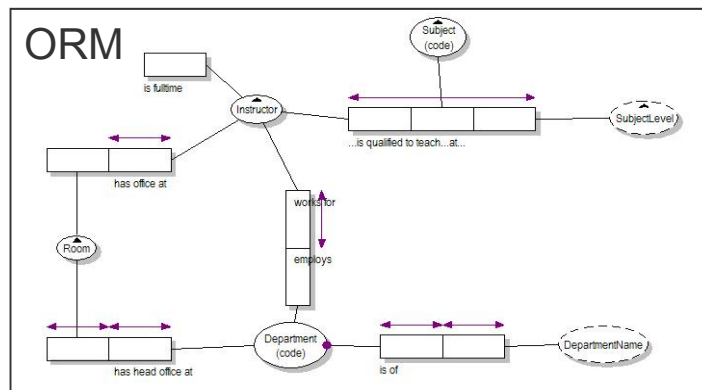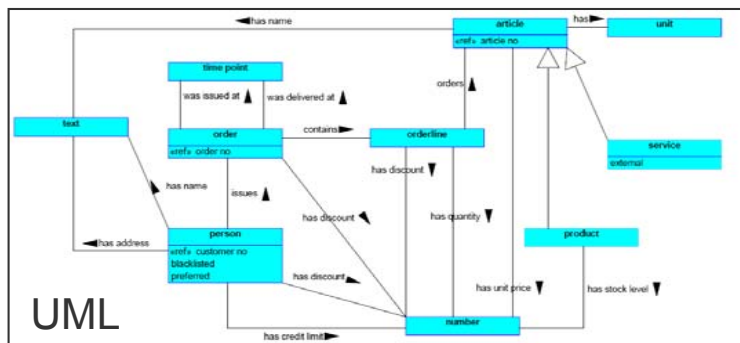
(Morgan 2002, p. 63)

Semi-Structured Notations for Business Rules

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

rental has driver

driver is qualified

UML

ORM

- SBVR is a vocabulary, not a language specification

- SBVR does not prescribe a specific language for terms, facts and rules

- Terms and facts can be represented, for example, in
    - SBVR Structured English
    - Unified Modelling Language (UML)
    - Object-Role Modeling (ORM)

- The SBVR specification itself uses SBVR Structured English to describe its vocabularies

SBVR Structured English – An Example

It is obligatory that each payment *employs* at most one credit card
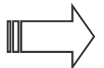
Keywords for a modality

Quantifier

Designation for a noun concept

Designation for a fact type

Quantifier

Designation for a noun concept

(Chapin & Hall 2006)

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'.

Terms and Facts According to SBVR

Terms are called noun concepts in SBVR
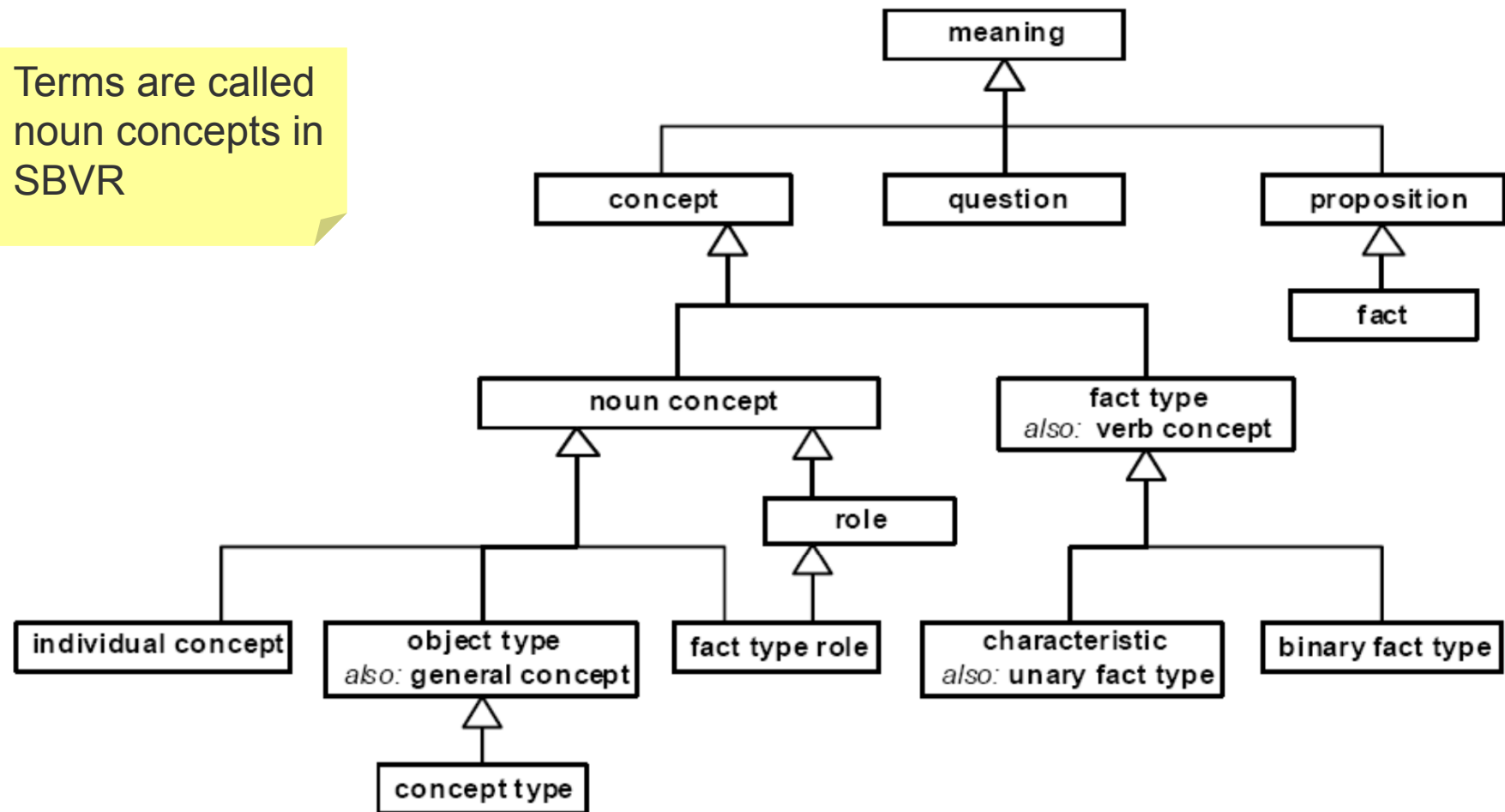
Some Definitions from SBVR

noun concept

Definition: **concept** that is the **meaning of a noun or noun phrase**

fact type

Definition: **concept** that is the **meaning of a verb phrase** that involves one or more noun concepts

Synonym: **verb concept**

meaning

Definition: what is meant by a word, sign, statement, or description; what someone intends to express or what someone understands.

concept

Definition: unit of knowledge created by a unique combination of characteristics

Source: **ISO 1087-1 (English)** (3.2.1) [concept]

General Concept: **meaning**

Terms: Noun Concepts

■ 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 paymen

■ Two noun concept definition from a dictionary

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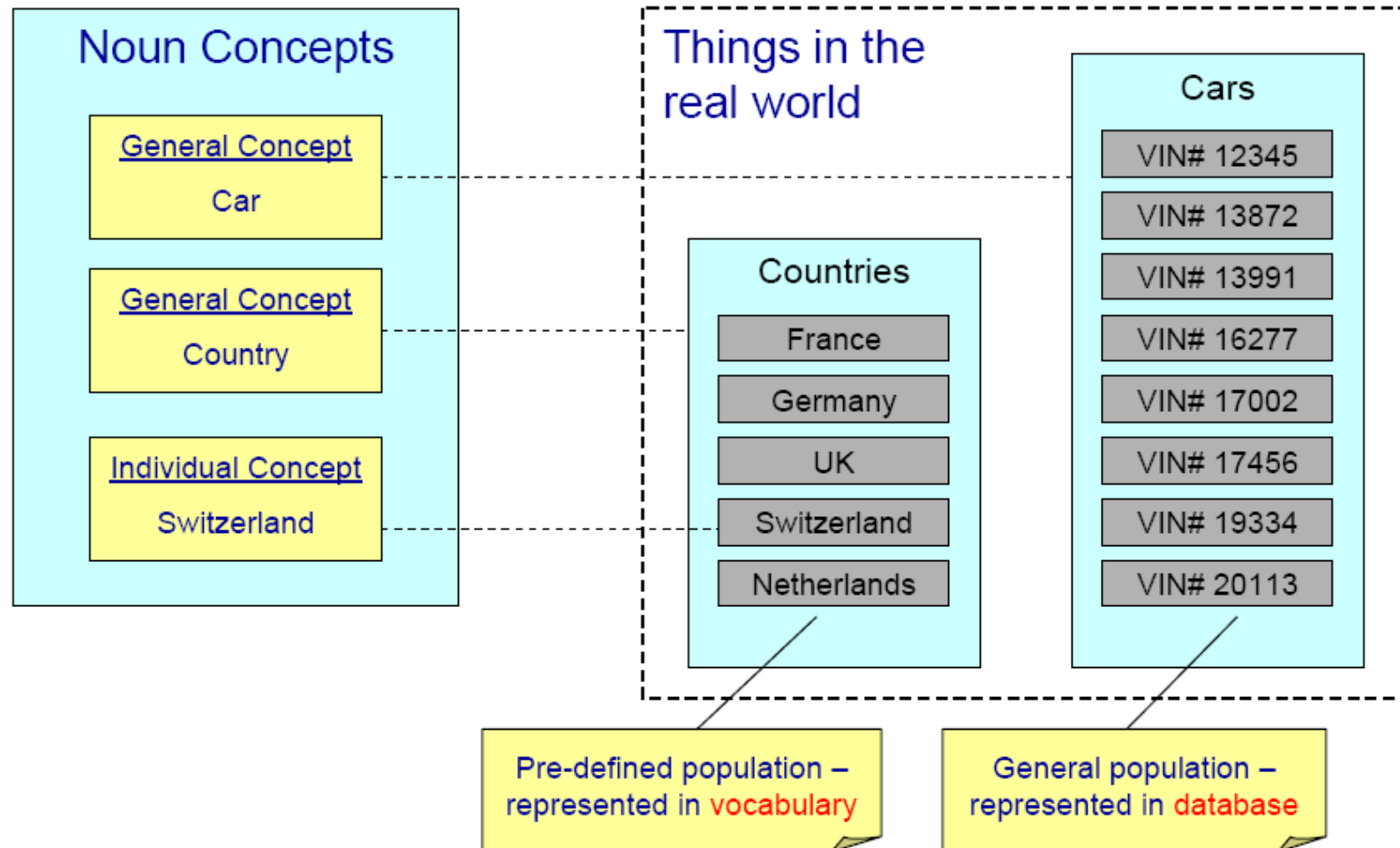> Definition: an amount paid
> — **American Heritage Dictionary of the English Language, Fourth Edition**

> **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

Noun Concepts

General Concept
Car

General Concept
Country

Individual Concept
Switzerland

Things in the real world

Countries
France
Germany
UK
Switzerland
Netherlands

Cars
VIN# 12345
VIN# 13872
VIN# 13991
VIN# 16277
VIN# 17002
VIN# 17456
VIN# 19334
VIN# 20113

Pre-defined population – represented in vocabulary

General population – represented in database

(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**

General Concept (= Object Type) and Individual Concept as defined in SBVR

object type

Definition:	noun concept that classifies things on the basis of their common properties
Source:	based on ISO 1087-1 (English) (3.2.3) ['general concept']
Synonym:	general concept
Example:	the concept 'rental car' corresponding to cars that are rented
Example:	the concept 'car', the concept 'number', the concept 'person'

individual concept

Source:	ISO 1087-1 (English) (3.2.2) ['individual concept']
Definition:	concept that corresponds to only one object [thing]
Example:	The individual concept 'California' whose one instance is an individual state in the United States of America

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**

Epressing Definitions

- One definition form (e.g. intensional) can be expressed in many languages or notations:

  - **Expressed in English**
    - The sales tax rate for a rental is the sales tax rate at the pick-up branch of the rental on the drop-off date of the rental.

  - **Expressed in French**
    - Le taux de taxe de vente pour une location de voiture est le taux de taxe de vente à l'agence de départ de la location à la date de retour de la voiture

  - **Expressed in SBVR Structured English**
    - The sales tax rate *for* a rental *is* the sales tax rate *at* the pick-up branch *of* the rental on the drop-off date *of* the rental.

  - ...

(Chapin & Hall 2006)

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

| payment | employs ▶ | personal check |

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

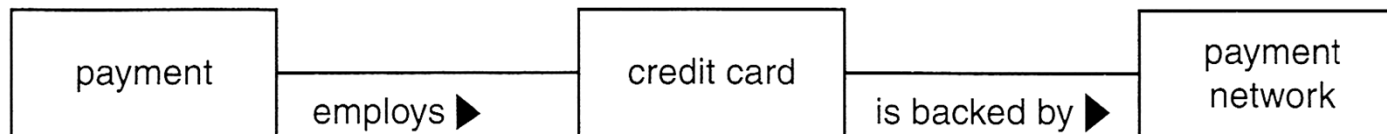■ A business rule can be build on more than one fact type

■ 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^{TM}.

payment *employs* credit card

credit card *is backed by* payment network

   ♦ Multiple Fact Types can be combined into one diagram
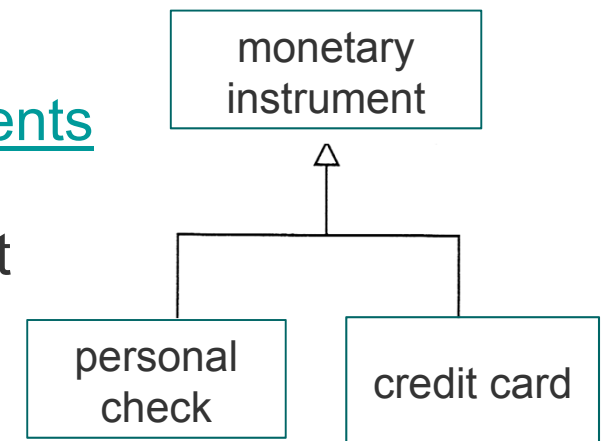
Generalizations and Specialization

■ 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

```
        ┌──────────────┐
        │  monetary    │
        │  instrument  │
        └──────────────┘
               △
        ┌──────┴──────┐
┌──────────────┐  ┌──────────────┐
│  personal    │  │  credit card │
│  check       │  │              │
└──────────────┘  └──────────────┘
```

Definition of Specialization in SBVR

$concept_1$ **specializes** $concept_2$ FL

Definition:	the $concept_1$ incorporates each characteristic that is incorporated by the $concept_2$ plus at least one differentiator
Synonymous Form:	$concept_2$ *generalizes* $concept_1$
Example:	The individual concept 'Los Angeles' specializes the concept 'city', the differentiator being that Los Angeles is one particular city in California.

Fact Type Diagrams

■ The following fact type diagram contains fact types for several rules

■ It consists of noun concepts, verbs and a specialisation
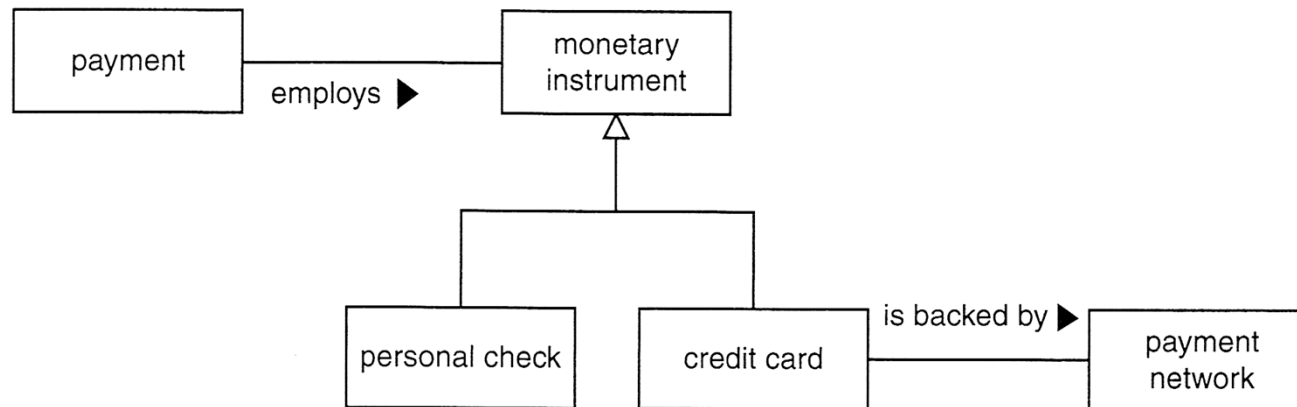
■ Note the correspondence of fact type diagrams to UML class diagrams:

♦ 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.
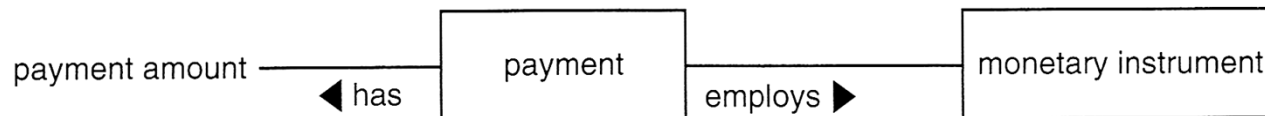
Characteristics

■ Characteristics correspond to unary fact types

♦ Unary fact type (characteristic): table *is free*

● 1 placeholder, filled by 'table'

♦ Binary fact type: table *is assigned to* guest

● two placeholders, filled by 'table' and 'guest'

(Chapin et al 2008)

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 morethan 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

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 '<u><placeholder 1></u> *has* <u><placeholder 2></u>' there is an implicit reversed form of '<u><placeholder 2></u> *is of* <u><placeholder 1></u>' 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: Definition

■ Give definitions for the following concepts:

♦ weekday

♦ working day

♦ weekend

■ Are the definitions intensional or extensional?