Business Rules – Modeling Business Rules

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SBVR - Semantics for Business 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
Notations for Business Rules

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

Decision table:

<table>
<thead>
<tr>
<th>Conditions</th>
<th>Rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>Printer does not print</td>
<td>Y Y Y Y N N N N</td>
</tr>
<tr>
<td>A red light is flashing</td>
<td>Y Y N N Y N N N</td>
</tr>
<tr>
<td>Printer is unrecognized</td>
<td>Y N N Y N Y N N</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Actions</th>
<th>Rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>Check the power cable</td>
<td>X</td>
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<tr>
<td>Check the printer-computer cable</td>
<td>X</td>
</tr>
<tr>
<td>Ensure printer software is installed</td>
<td>X</td>
</tr>
<tr>
<td>Check the printer ink</td>
<td>X</td>
</tr>
<tr>
<td>Check for paper jam</td>
<td>X</td>
</tr>
</tbody>
</table>

Decision tree:
Levels of Business Rules Expression

- For expressing rules there is a trade-off between accessibility 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.
  - **Technical**: Combining structured data references and operators, e.g.
    
    ```
    CreditAccount
    self.customer.age >= 18
    ```
  - **Formal**: statements conforming to a more closely defined syntax with particular mathematical/logical properties, e.g.
    
    ```latex
    \{X, Y, (customer X) (creditAccount Y) (holder X,Y) \\
    \rightarrow (ge (age X) 18) \\
    \forall x \forall y Customer(x) \land CreditAccount(y) \land Holder(x,y) \rightarrow age(x)>18
    ```

(Morgan 2002, p. 63)
All starts with Terms and Facts

„... successful business rule discovery, analysis, modeling, and implementation 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 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."

Examples

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

Base Business Definitions & Rules on Verb Concepts

Associate Concepts to define Fact Types

Define Noun Concepts

Definitions & Rules

Fact Types (Verb Concepts)

Terms (Noun Concepts)

(Chapin et al. 2008)
Terms and Facts According to SBVR

Terms are called noun concepts in SBVR

Diagram:

- concept
- question
- proposition
- fact

Noun concept:
- role
- individual concept
- object type
  - also: general concept
- fact type role
- characteristic
  - also: unary fact type
- binary fact type

Fact type:
- also: verb concept

Meaning:
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

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 based on ISO 1087-1 (English) (3.2.3) ['general concept']

**Source:**

**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 delimitation characteristics

- **extensional definition**: a description of a concept by enumerating all of its 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**
Expressing 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

- **Potential Rule**: It is obligatory that a payment employ a personal check.
  
  **Interpretation**: For that odd restaurant that requires all payments be made in personal checks.

- **Potential Rule**: It is permitted that a payment employ a personal check only if the personal check is drawn on a local bank.
  
  **Interpretation**: A personal check is acceptable if another condition holds: the check is local.

- **Potential Rule**: It is obligatory that a customer be photographed if the customer makes a payment and the payment employs a personal check.
  
  **Interpretation**: For the careful restaurant that wants to collect forensic evidence from customers who might bounce checks.
Multiple Fact Types

- A business rule can be built on more than one fact type

- Example:
  - The rule VISA Only is built on two fact types
  
  **VISA Only:** It is permitted that a payment employs 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
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)

  \[
  \text{credit card} \overset{\text{specializes}}{\rightarrow} \text{monetary instruments}
  \]

  or it relates an individual and a general concept

  \[
  \text{Washington D.C.} \overset{\text{specializes}}{\rightarrow} \text{city}
  \]

- The fact type *generalizes* is the inverse relation

  \[
  \text{monetary instruments} \overset{\text{generalizes}}{\rightarrow} \text{credit card}
  \]
Definition of Specialization in SBVR

\( \text{concept}_1 \text{ specializes } \text{concept}_2 \)

Definition: the \( \text{concept}_1 \) incorporates each characteristic that is incorporated by the \( \text{concept}_2 \) plus at least one differentiator

Synonymous Form: \( \text{concept}_2 \text{ generalizes } \text{concept}_1 \)

Example: The \text{individual concept} ‘Los Angeles’ specializes the \text{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 specific verb „has“ to indicate properties and to distinguish them from other associations.
Characteristics

- Characteristics correspond to unary fact types
  - Unary fact type (characteristic): \textit{table is free}
    - 1 placeholder, filled by ‘table’
  - Binary fact type: \textit{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 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

- Business rules are in practice written as sentences instead of diagrams
- There are some special forms of business rules that can be represented as diagrams
  - Decision Trees
  - Decision Tables
- We will also see some components of business rules, in particular fact type diagrams
**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:**
  - **Logical Rules:** The effects represent possible decision values.
- 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

### Printer troubleshooter

<table>
<thead>
<tr>
<th>Conditions</th>
<th>Rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>Printer does not print</td>
<td>Y Y Y Y N N N N N</td>
</tr>
<tr>
<td>A red light is flashing</td>
<td>Y Y N N Y Y N N N</td>
</tr>
<tr>
<td>Printer is unrecognised</td>
<td>Y N Y N Y N Y N N</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Actions</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Check the power cable</td>
<td>X</td>
</tr>
<tr>
<td>Check the printer-computer cable</td>
<td>X X</td>
</tr>
<tr>
<td>Ensure printer software is installed</td>
<td>X X X X X</td>
</tr>
<tr>
<td>Check/replace ink</td>
<td>X X</td>
</tr>
<tr>
<td>Check for paper jam</td>
<td>X X</td>
</tr>
</tbody>
</table>

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This decision table represents condition-action-rules
Example: Decision Table for Health Insurance

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

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

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
Representing a Decision Tree in VisiRule

**Table 1. Simple set of rules.**

<table>
<thead>
<tr>
<th>Condition</th>
<th>Rule</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full time = yes</td>
<td>and Over4yrs = yes</td>
<td>Grant Loan</td>
</tr>
<tr>
<td>Full time = yes</td>
<td>and Over4yrs = no</td>
<td>Unclear</td>
</tr>
<tr>
<td>Full time = no</td>
<td>and Over4yrs = yes</td>
<td>Unclear</td>
</tr>
<tr>
<td>Full time = no</td>
<td>and Over4yrs = no</td>
<td>No Loan</td>
</tr>
</tbody>
</table>

**Diagram:**
- Start
- Full time: Do you work full time?
  - Yes: Over4years: Is the contract more than 4 years?
    - Yes: Grant Loan
    - No: Unclear
  - No: Over4years: Is the contract more than 4 years?
    - Yes: Unclear
    - No: No Loan