Semantics and Business Rules

Overview of the Tutorial

Presented at

Semantics Technology Conference
March 6-9, 2006 — San Jose, California

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Two OMG Specifications

• Semantics of Business Vocabulary and Business Rules (SBVR)
  – A metamodel for developing semantic models of business vocabularies and business rules
  – Adopted by the Object Management Group (OMG) in September 2005
  – Scheduled for finalization as an OMG specification in September 2006

• The Business Motivation Model (BMM)
  – A simple metamodel supporting corporate governance
  – Developed by the Business Rules Group, published in 2000
  – Adopted by the OMG in December 2005
  – Scheduled for finalization as an OMG specification in June 2006
What this tutorial is about

- Part I -- Introduction to “Semantics of Business Vocabulary and Business Rules” (SBVR)
  - SBVR ↔ Information System Modeling
  - Overview of SBVR
  - SBVR Architecture
  - Context for Meaning
  - Business Vocabulary (vs. Business Rules)
  - Integration by Vocabulary Adoption
  - Business Rules: Building on Business Vocabulary
  - Formal Logics

- Part II
  - Introduction to “The Business Motivation Model” (BMM)
  - The BMM modeled in SBVR
  - Extending the BMM to support specialized requirements for:
    - Regulatory Compliance
    - Vertical domains of regulatory (finance, health care, privacy …)
Semantics and Business Rules

SBVR ↔ Information System Modeling

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How Business Modeling Relates to Information System Modeling

About the ‘Business’ and ‘Business’ Things’

Business Modeling

Two-Way Negotiation

Business Requirements

External Design

Requirements Satisfied

Information System Modeling

About ‘Recorded Information’ and the ‘Information System’

Business Semantics

Model Systems

- ABOUT the Business
- FOR Business purposes
- FROM a Business perspective
- IN the actual language used by Business staff
- BY the Business

Business Customer IT Supplier
Talks about real business things

SBVR

... other Business Model topics:
- business policy
- business process
- organization & responsibilities
- geography & logistics

Two-Way Negotiation

Business Semantics of
- Data ‘Containers’
- Processing Logic

Business Requirements

MOF XMI using SBVR XSD

External Design

Requirements Satisfied

Business Customer

IT Supplier

Talks about buckets that hold data & processing logic

Information System Model

... other Information System Model topics:
- services / methods
- network
- user interface
- etc.
How Rules Standards Relate to Business & Information System Modeling

Semantics of Business Vocabulary & Business Rules
(Business Language Resources)

Talks about real business things

Two-Way Negotiation

Business Requirements
MOF XMI using SBVR XSD

External Design
Requirements Satisfied

Metamodels that built on:
- UML
- Production Rules
- OCL
- RDBMS Triggers
- W3C RIF

Talks about buckets that hold data & processing logic

Business Model

Information System Model

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Hotel Booking Example

1. Please send this form to the hotel before: Monday 25 April 2005
2. The special conference rate applies only for reservations made with this hotel reservation form, for dates from Monday 6 June to Friday 10 June 2005.
3. Reservations can only be confirmed with a credit card number with valid expiry date.
4. In order to avoid late cancellation charges, cancellations must be done in writing by 4pm (16.00 hrs.) twenty-four hours prior to arrival. In case of a no-show or a failed written cancellation, the first night’s accommodation will be charged.
5. When you cancel by phone, the hotel will give you a cancellation number as confirmation of your cancellation.
6. If you check out prior to the booked departure date, the hotel will be entitled to charge you for one extra room night.
7. The number of rooms held for conference participants is limited. There is no guarantee of price or availability. After Monday 25 April 2005, remaining rooms will be released and the conference rate is not valid anymore.
8. Make the following reservation:
   - Standard room for single use at €220,00 per night
   - Supplement for double occupancy €35,00
   - Non-Smoking room (upon availability)

See “Supplemental Slides” for full Hotel Case Study
Semantics and Business Rules

Overview of SBVR

Presented at

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SBVR Business Vocabulary+Rules: What does it Contain?

SBVR Business Vocabulary+Rules

= Business Glossary
  (Noun Concepts, Definitions & Primary Terms)
  (+)
  Taxonomy
  (General/Specific + Whole/Part Hierarchical Relationships)
  +
  Thesaurus
  (Synonyms, Acronyms, Abbreviations, etc. + Multilingual)
  (Instances of Concepts e.g. Business Events & Business Entities)
  (Verb Concepts {Business Facts; Relations among Concepts})
  +
  Ontology
  (Relations among Instances of Concepts)
  (Definitional Rules)
  (Definitions, Relationships & Rules specified in formal logic)
  +
  Business Rules
  (Rules Governing Business Actions)
Overview of SBVR

**Business Community**

- Business Community with sub-communities that may use different natural languages and specialized vocabularies

**Community**

- Business Community with sub-communities that may use different natural languages and specialized vocabularies

**Business Meaning**

- Concepts, Facts & Rules (Unique, Discrete Meaning)

**Forms of Meaning**

- Forms of Concepts, Facts & Rules (different ways of saying the same thing)

**Forms of Meaning**

- Formulated as Concepts, Facts & Rules

**Content**

- Business Vocabulary: Clause 8, 11

- Business Rules: Clause 12

**Business Expression**

- Expression of Forms of Concepts, Facts & Rules in a Business Language

**Formal Logic**

- Semantic Formulations
- Formal Logic Grounding

**Structure of Meaning**

- Clause 9

**Formal Interpretation**

- Clause 10
## SBVR Audiences

<table>
<thead>
<tr>
<th>Audience</th>
<th>Role</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business people in general</td>
<td>Create the business content (e.g. EU-Rent) in a BV+R</td>
</tr>
<tr>
<td>BV+R integrators/ administrators</td>
<td>Integrate and quality assure the business content in a BV+R</td>
</tr>
<tr>
<td>Information system designers</td>
<td>Design information systems that talk and work according to the business content in a BV+R</td>
</tr>
<tr>
<td>BV+R business tool designers</td>
<td>Design BV+R tools for business people to use to define, store and manage business content</td>
</tr>
<tr>
<td>Infrastructure designers for BV+R business tools</td>
<td>Design tools to support interchange of business content in a BV+R among business communities within and between organizations</td>
</tr>
<tr>
<td>Linguists, semanticists and logicians</td>
<td>Provide the semantic and logical foundation for all BV+R</td>
</tr>
</tbody>
</table>

*BV+R: “SBVR Business Vocabulary + Rules”*
Semantics and Business Rules

Context for Meaning

Presented at

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Business Context: Community

Community

Business Community with sub-communities that may use different natural languages and specialized vocabularies

Business Meaning

Concepts, Facts & Rules (Unique, Discrete Meaning)

Forms of Meaning

Forms of Concepts, Facts & Rules (different ways of saying the same thing)

Formal Logic

Semantic Formulations + Formal Logic Grounding

Context

Clause 11

defines

uses

formulated as

expressed as

underpins

underpins

underpins

Expression of Forms of Concepts, Facts & Rules in a Business Language
Communities and Vocabularies

- Community
  - Subcommunity
  - Semantic Community
    - Shares understanding of concepts
    - Body of shared meanings
    - Contains body of shared concepts
  - Concept
  - Speech Community
    - Targets
    - Uses
    - Owns
    - Incorporates
  - Vocabulary
  - Language
    - Is expressed in symbol
Semantic Community

- **Definition:** *community* whose unifying characteristic is a shared understanding (perception) of the things that they have to deal with

- A semantic community defines the scope of an SBVR Business Vocabulary+Rules:
  - what concepts (both noun concepts and verb concepts) are to be included
  - what business rules it needs to build on them

- Usually, the most important semantic community is the organization for which you are building the SBVR Business Vocabulary+Rules, e.g. EU-Rent.
  - You will often have to consider other semantic communities that do or could share some of the vocabulary, e.g. the car rental industry, national trade associations, EU-Rent customers

- When you define rules, you do it from the perspective of the owning semantic community

- Two kinds of business Semantic Communities:
  - **Collaborative Community**
    - e.g. A department, cross-function programme team, a internal service
  - **Community of Practice**
    - e.g. project managers, operational excellence champions, departmental budget managers

- Two scopes for Semantic Communities:
  - Internal to an organization
  - Among parts of different organizations
Speech Community

**speech community**

Definition: *community* whose unifying characteristic is the *vocabulary* that it uses.

Example: The EU-Rent German Community shares the German-based vocabulary of symbols used in EU-Rent’s business. The symbols include German words for EU-Rent’s concepts plus symbols adopted from other languages.

- A speech community is a subcommunity of a semantic community. It has the same “body of shared meanings”, but expresses them in a particular, shared vocabulary.

Necessity: Each *speech community* is of exactly one *semantic community*.
Vocabulary

• A vocabulary is drawn from one shared language, which may be:
  – A natural language, such as English, German, Dutch
  – Specialised terminology such as that used by lawyers or engineers
  – A constructed language such as the UML (or SBVR Structured English)

• Each vocabulary expresses only one Body of Shared Meanings

• A vocabulary includes
  – terms and names for the noun concepts
  – ‘readings’ for the verb concepts

• SBVR users are strongly encouraged to limit the amount of internally managed vocabulary, and:
  – use everyday natural language as much as possible, backed up with a standard dictionary
  – adopt as much as possible from authoritative sources, such as ISO standards and industry standard glossaries.
Symbolization

- **signifier**: regulates its usage of
  - **speech community**: 1
    - 1 is owned by
  - **representation**:
    - uses
  - **concept**: 0..1
    - is understood anywhere within [symbol context]

- **symbol**:
  - **term**
  - **icon**
  - **fact symbol**

- **name**
SBVR Structured English Notation

SBVR Structured English is defined using styled fonts in MS Word.

**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. Ford, San Jose

**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’.
UML Notation Adapted for SBVR

Business Semantics
Model Systems

RuleSpeak™ Notation

- A rental may be open only if an estimated rental charge is provisionally charged to the credit card of the renter of the rental.

- The rental charge of a rental is always calculated in the business currency of the rental.

- The rental charge of a rental must be converted to the currency of a price conversion requested by the renter of the rental.

  - Note: RuleSpeak does not recommend the “If ...then...” syntax for operative business rules.


- A cash rental always honors its lowest rental price.
Semantics and Business Rules

SBVR Architecture

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Semantics and Business Rules

*SBVR Architecture: How Rules are Built*

Presented at

[Image of conference logo]

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SBVR supports realisation of the ‘Business Rules Mantra’:

“Rules are built on Facts. Facts are built on Terms.”

… to describe businesses, not the IT systems that serve them

… in language understandable by business people
A rental **may be open only if an estimated rental charge is provisionally charged to the credit card of the renter of the rental.**
## Business Rules are built on Verb Concepts

### Supporting Verb Concepts

<table>
<thead>
<tr>
<th>Verb Concepts</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>rental</strong> <strong>has</strong> <strong>estimated rental charge</strong></td>
</tr>
<tr>
<td><strong>estimated rental price</strong> <strong>is provisionally charged to</strong> <strong>credit card</strong></td>
</tr>
<tr>
<td><strong>renter</strong> <strong>has</strong> <strong>credit card</strong></td>
</tr>
<tr>
<td><strong>rental</strong> <strong>has</strong> <strong>renter</strong></td>
</tr>
</tbody>
</table>

### Related Factual Connections

<table>
<thead>
<tr>
<th>Factual Connections</th>
</tr>
</thead>
<tbody>
<tr>
<td>’being open’ is a characteristic of the <strong>concept</strong> ’rental’</td>
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</table>
Verb Concepts are built on Noun Concepts expressed by Terms

**rental**

Definition: contract with renter specifying use of a car of a car group for a rental period and a rental movement.

Dictionary Basis: contract for use of a rental car by a renter for an agreed period under the rental company’s terms and conditions for rental. [CRISG]

**credit card**

Dictionary Basis: MWU, 1: a small card (as one issued by hotels, restaurants, stores, or petroleum companies) authorizing the person or company named or its agent to charge goods or services.

**estimated rental charge**

Definition: rental charge estimated at start of rental.

**renter**

Source: CRISG [“renter”]

Concept Type: role

Definition: person contractually responsible for a rental

Synonym: customer (car rental responsibility)

Synonym: primary driver
Semantics and Business Rules

*SBVR Architecture: Meaning vs. Form vs. Expression*

Presented at

[Logo of Semantic Technology Conference]

March 6-9, 2006 — San Jose, California

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Separating Vocabulary & Rules

SBVR Business Vocabulary+Rules

Business Vocabulary

- Noun Concepts
- Verb Concepts

Business Rules
Separating Meaning, Form & Expression

SBVR Business Vocabulary+Rules

Business Vocabulary

Unique, Discrete Vocabulary
(Noun & Verb Concepts)
Meaning

Business Rules

Unique, Discrete Rule
Meaning
Single Discrete Meanings

• Provides to focus for shared understanding of meanings by a community regardless of:
  – Language
  – Grammar syntax or graphic notation
  – Terms (character strings, icons, etc used to refer to meanings)
  – Form in which the meaning is stated

• Enables each discrete meaning to be recorded non-redundantly e.g.
  – $C=A+B$, $A=C-B$ and $B=C-A$ are all entered once as a single discrete meaning

• Enables all statements of meaning to be tied directly or indirectly back to a single discrete meaning

• Supports semantic integration
### SBVR Business Vocabulary+Rules

#### Business Vocabulary

- **Unique, Discrete Vocabulary**
  - (Noun & Verb Concepts)
  - **Meaning**

- **Unique, Discrete Rule**
  - **Meaning**

- **Form(s)** for each Discrete Vocabulary Meaning

#### Business Rules

- **Unique, Discrete Rule**
  - **Meaning**

- **Form(s)** for each Discrete Rule Meaning

---

**Separating Meaning, Form & Expression**

---

*Business Semantics*
Single Discrete Meaning ↔ ‘Forms of Meaning’

• C=A+B, A=C-B and B=C-A are each a different form of the same single discrete meaning

• What ‘Forms of Meaning’ add to a Single Discrete Meaning
  – Different ways to say the same thing independent of:
    • Natural Language used
    • Notation, graphics or syntax used
    • A particular speech community’s vocabulary

• What a Single Discrete Meaning adds to multiple ‘Forms of Meaning’
  – Ability to know that different ‘Forms of Meaning’ mean the same thing
  – Ability to automatically translate from one ‘Form of Meaning’ to another
## SBVR Business Vocabulary+Rules

### Business Vocabulary
- Unique, Discrete Vocabulary
  (Noun & Verb Concepts)
- **Meaning**
- Unique, Discrete Vocabulary
  (Noun & Verb Concepts)
- **Form(s)**
  for each Discrete Vocabulary
  Meaning
- Language/Notation & Community-specific
  **Expression(s)**
  for each Discrete Vocabulary Form

### Business Rules
- Unique, Discrete Rule
- **Meaning**
- Unique, Discrete Rule
  **Form(s)**
  for each Discrete Rule Meaning
- Language/Notation & Community-specific
  **Expression(s)**
  for each Discrete Rule Form

### Separating Meaning, Form & Expression
‘Form of Meaning’ ↔
Expressions in a Language / Notation

- Example language and optional notation combinations:
  - English
  - French
  - English + SBVR Structured English
  - ORM + English
  - ORM + French

- What ‘Expressions in a Language/Notation’ add to a ‘Form of Meaning’
  - The particular terms and names used by a given Speech Community
  - A natural or artificial language used by the Speech Community
  - A graphics notation

- What a ‘Form of Meaning’ adds to multiple ‘Expressions in a Language/Notation’
  - Ability to know that different ‘Expressions in a Language/Notation’ have the same ‘Form of Meaning’ (and through ‘Form of Meaning’ the same of different discrete meanings)
  - Ability to automatically translate from one ‘Expressions in a Language/Notation’ to another using
    - a common ‘Form of Meaning’ or
    - the ability to also translate between different forms of meaning.
Semantics and Business Rules

SBVR Architecture: Propositional Content + Performatives

Presented at

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Propositional Content + Performative

- Propositional Content:
  - a mental picture of a possible state of the world that is expressed in some communication (for example, expressible by arranging certain words: Hat in Box)
  - is INDEPENDENT of how you use it!
    - Statement: Hat in Box – The hat is in the box.
    - Command: Hat in Box – Let the hat be in the box!
    - Question: Hat in Box – Is the hat in the box?
    - Stipulation: Hat in Box – The hat must be in the box.

- Example SBVR Propositional Content:
  - customer wants kind of car

- SBVR supports these kinds of Performatives
  - Assertion (Statement)
    - (It is taken to be true that) customer wants kind of car
      - NOTE: The ‘it is taken to be true that’ is implied from the formal logic grounding of the whole of SBVR
  - Stipulation (Rule)
    - It is obligatory that customer wants kind of car if the customer places an order
  - Question
    - What kind of car the customer wants? … from within the rule:
      - An agent must ask each new customer what kind of car the customer wants.
Semantics and Business Rules

Business Vocabulary (vs. Business Rules)

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Business Vocabulary: Business Meaning of Concepts

Community
- Business Community with sub-communities that may use different natural languages and specialized vocabularies

Business Meaning
- Concepts, Facts & Rules (Unique, Discrete Meaning)

Forms of Meaning
- Forms of Concepts, Facts & Rules (different ways of saying the same thing)

Business Expression
- Expression of Forms of Concepts, Facts & Rules in a Business Language

Formal Logic
- Semantic Formulations + Formal Logic Grounding

Content
- Business Vocabulary: Clause 8, 11

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**Noun Concept** (Discrete Meaning -- ISO 1087-1)

**rental car**
- **Source:**
- **Definition:**
- **Synonym:**

MWU (1/1d) ["car"], CRISG ("rental car")
vehicle owned by EU-Rent and rented to its customers

**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

**Business Semantics**

**Model Systems**
Noun Concepts (Discrete Meaning) -- (represented by Terms, Names & Definitions)

• The ‘noun concept’ that denotes the set of cars EU Rent has for renting to customers:
  – DEFINITION:
    • vehicle owned by EU-Rent and rented to its customers
  – TERM:
    • Rental car
    • car

• The ‘noun concept’ that denotes all the specific agreements EU Rent makes with customers to rent cars:
  – DEFINITION:
    • contract with renter specifying use of a car of a car group for a rental period and a car movement
  – TERM:
    • rental
**Verb Concepts** (Discrete Meaning) --
*(represented by ‘Fact Symbols’)*

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Business Vocabulary: Forms of Meaning

Community
- Business Community with sub-communities that may use different natural languages and specialized vocabularies

Content
- Business Vocabulary: Clause 8, 11
- Formulated as

Forms of Meaning
- Forms of Concepts, Facts & Rules (different ways of saying the same thing)

Business Expression
- Expression of Forms of Concepts, Facts & Rules in a Business Language

Business Meaning
- Concepts, Facts & Rules (Unique, Discrete Meaning)

Formal Logic
- Semantic Formulations + Formal Logic Grounding

Different Ways of Saying the Same Thing

defines

uses

formulated as

expressed as

underpins

underpins
Multiple Definition Forms for One Noun Concept (Discrete Meaning)

• The Definition of one Concept
  • E.g. 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.

  can be structured in many ‘Forms of Meaning’:
  – Intensional Form
    • E.g. sales tax rate for a rental: sales tax rate at the pick-up branch of the rental on the drop-off date of the rental.
  – Extensional Form
    • E.g. 1%, 2.5%, 4%, 7%

• The meaning of a concept is structured (formulated) into a ‘Form of Meaning’ by using a Semantic Formulation
  – One Semantic Formulation for each Form of Meaning
    (see section explaining Semantic Formulations)
Multiple Verb Concept Forms for One Verb Concept (Discrete Meaning)

- **One Verb Concept** (e.g. Associative Verb Concept)
  - E.g. Drivers licenses have expiration dates can be put together in many forms:
    - **Sentential Forms**
      - driver's license expires on date *(semantics in verb)*
      - driver's license has expiration date *(semantics in role name)*
    - **Noun Forms**
      - driver's license expiring on date
      - driver's license having expiration date
    - **Multiple orderings**
      - **Sentential Form**
        - driver's license expires on date *(active)*
        - date is expiration of driver’s license *(passive)*
      - **Noun Form**
        - expiration date of driver's license
        - driver's license having expiration date
Business Vocabulary: Business Expression

Community
- Business Community with sub-communities that may use different natural languages and specialized vocabularies

Business Meaning
- Concepts, Facts & Rules (Unique, Discrete Meaning)

Forms of Meaning
- Forms of Concepts, Facts & Rules (different ways of saying the same thing)

Formal Logic
- Semantic Formulations + Formal Logic Grounding

Content
- Expression of Forms of Concepts, Facts & Rules in a Business Language

Business Vocabulary: Clause 8, 11
Multiple Definition Statements
Expressing One Definition Form

- One Definition Form (e.g. Intensional)
  - 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.

  can be expressed in many language, notation & speech community combinations:

  - 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.

  - Expressed in ORM (“ActiveQuery” notation)
    - (see next slide)
Expressed in ORM
(“ActiveQuery” notation)

Outline View

- **Rental Sales Tax Rate**
  - 1 Sates Tax Rate
    - (definitely) is determined at 2 Pickup Branch from Date1 to Date2
      - (definitely) provides 3 Rental
        - (definitely) is for use of 4 Rented Car
          - (definitely) is returned on 5 DateTime ( >= Date1 and <= Date2 )

Verbalization View

List each sates tax rate, pickup branch, rental, rented car, and date time
where for some date1 and date2:
- sates tax rate is determined at pickup branch from date1 to date2,
- pickup branch provides rental that is for use of rented car that is returned on date time that is greater than or equal to Date1,
- and date time is less than or equal to Date2.
Multiple Fact Symbols
Expressing One Verb Concept Form

• One Verb Concept Form (e.g. Sentential Form)
  – driver's license expires on date

can be expressed in many language, notation & speech community combinations:

  – Expressed in English
    • driver's license expires on date

  – Expressed in French
    • le permis de conducteur expire la date

  – Expressed in SBVR Structured English
    • driver's license expires on date

  – Expressed in ORM (“Object Role Modeling” notation)
Semantics and Business Rules

Integration by Vocabulary Adoption

Presented at

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Owned & Adopted Concepts

• Adoption is important:
  – Reduces work in maintaining business vocabulary
  – Supports communication with organizations that have interests in common
  – Creates consistency across vocabularies

• Vocabulary adoption is about adopting ‘symbols’ (signifiers associated with meanings)

• Concepts are adopted two ways:
  – By reference – via an adopted vocabulary, e.g. rental, rental car (from ‘Car Rental Industry Standard Glossary’)
  – By name – Individual concept, e.g. Switzerland

• When an “owner” vocabulary is revised,
  – all the “users” of the vocabulary have to be considered –
    • this is a good thing!


SBVR provides strong support for adoption
Vocabulary Adoption

• EU-Rent English Vocabulary - built using SBVR contains:
  – The symbols EU-Rent has assigned as term and fact symbols, and has assumed responsibility for maintaining; e.g.
    • bad experience: damage to car or moving traffic offence or unauthorized late return or car not returned to EU-Rent or …
    • barred driver: driver who has at least three bad experiences on rentals
  – Adopted vocabularies:
    • Car Rental Industry Standard Glossary [fictitious]
      – Note: the EU-Rent German speech community has adopted equivalent “Glossar für Autovermietungsgeschäft” [also fictitious] – consistency issue to be managed
    • ISO Dictionary of International Symbols – adopted across all languages [does not exist yet]
    • Merriam-Webster Unabridged Dictionary – default vocabulary for English
Semantics and Business Rules

Business Rules:
Building on Business Vocabulary

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Business Rules

• (Surprisingly) small part of SBVR
  – Business Vocabulary is much bigger (and reusable for other aspects of business modelling)

• Two kinds of business rule:
  – Operational: govern what the business does
    • “It is obligatory that …”
    • “It is permitted that …” (and its negation, “It is forbidden that …”)
  – Structural: true by definition
    • “It is necessary that …”
    • “It is possible that …” (and its negation, “It is impossible that …”)

• Intended for people:
  – Can be broken
  – Need enforcement

• Actionable, but not necessarily automatable
Enforcement

• Operative business rules can be broken, and need to be enforced

• Enforcement action is outside SBVR’s scope. It will be resolved in integration with other OMG business modelling specifications

• SBVR does include enforcement level – how strictly the rule will be enforced. This is quite independent of what the enforcement action is.

• Examples are:
  – Strictly enforced: no escape from the consequences
  – Pre-authorized exceptions permitted
  – Consequences if exceptions are not logged and justified
## Sample Language of Business Rules

### Quantification
- each
- some
- at least \( n \)

#### Logical Operations
- it is not the case that \( p \)
- \( p \) and \( q \)
- \( p \) or \( q \)

#### Modal Operations
- it is obligatory that \( p \)
- it is prohibited that \( p \)
- it is necessary that \( p \)

### Other Keywords
- the who
- a, an is of
- another what
- a given that
Business Rules: Business Meaning of Rules

Community
- Business Community with sub-communities that may use different natural languages and specialized vocabularies

Business Meaning
- Concepts, Facts & Rules (Unique, Discrete Meaning)

Forms of Meaning
- Forms of Concepts, Facts & Rules (different ways of saying the same thing)

Business Expression
- Expression of Forms of Concepts, Facts & Rules in a Business Language

Content
- Business Rules: Clause 12

Formal Logic
- Semantic Formulations + Formal Logic Grounding

defines
uses
formulated as
expressed as
underpins
underpins
underpins
Defining a Business Rule

Underlying verb concept (in SBVR’s Vocabulary for Business Rules):
- **element of guidance is based on verb concept**

We know that (also in SBVR’s Vocabulary for Business Rules):
- **element of guidance introduces an obligation or necessity**
- **business rule is a category of element of guidance**

So, in the SBVR Business Vocabulary+Rules for a specific business (e.g. EU-Rent)

- **Start with a verb concept, e.g.**
  - rental *has* driver

- **Apply an obligation or necessity to it, e.g.**
  - it is obligatory that rental *has* driver.

- **Add qualifications, quantifications and conditions, if necessary e.g.**
  - it is obligatory that each rental *has at most 4* drivers.
Supporting Verb Concepts

The structural business rule:

it is necessary that the rental charge of each rental is calculated in the business currency of the rental.

... is based on the verb concept

rental charge is calculated in business currency

But it needs two supporting verb concepts (also defined in the EU-Rent Business Vocabulary)

rental has rental charge

rental has business currency
Additional factual connections

The operative business rule

it is obligatory that the rented car of each assigned rental is stored at the pick-up branch of the rental.

… is based on the verb concept

rental car is stored at branch

It needs support from these additional factual connections:

– the concept ‘rented car’ is a role of the concept ‘rental car’
– ‘being assigned’ is a characteristic of the concept ‘advance rental’
– the concept ‘advance rental’ is a category of the concept ‘rental’
– the concept ‘pick-up branch’ is a role of the concept ‘branch’

Supporting factual connections are based on characteristics, roles and categories.
Adding Conditions

The operative business rule:

It is obligatory that the rental incurs a location penalty charge.

... is based on the verb concept

rental incurs location penalty charge

The added condition:

if the drop-off location of a rental is not the EU-Rent site of the return branch of the rental.

... uses these supporting verb concepts

rental has drop-off location
rental has return branch
branch is located at EU-Rent site
thing$_1$ is thing$_2$

... to produce this conditioned rule:

It is obligatory that the rental incurs a location penalty charge if the drop-off location of a rental is not the EU-Rent site of the return branch of the rental.
Trade-off with Vocabulary

The business rule:

it is necessary that the rental charge of each rental is calculated in the business currency of the rental.

... was defined simply, and supported by the verb concept

rental has business currency

This was possible only because this verb concept had been defined in the EU-Rent Business Vocabulary.

Strictly, it is redundant. The business rule could have been defined as:

it is necessary that the rental charge of each rental is calculated in the national currency of the operating country of the operating company that contains the local area that contains the pick-up branch of the rental.

Getting the right trade-off in the enterprise Business Vocabulary is important in having manageable and understandable vocabulary and rules.
Rules based in time

(1) The operative business rule

It is obligatory that the fuel level of the rented car of each rental is full at the actual start date/time of the rental.

… is supported by the verb concept

rental car has fuel level (synonymous form: fuel level is of rental car)

Its point in time is supported by the verb concept

state of affairs occurs at date/time

(2) The operative business rule

It is obligatory that each driver of each rental is qualified after the booking date/time of the rental and before the actual return date/time of the rental.

… is supported by the verb concept

rental has driver (synonymous form: driver is of rental)

The duration of its effect is supported by the verb concepts

state of affairs occurs after date/time

state of affairs occurs before date/time

date/time₁ is before date/time₂
Business Rules: Forms of Meaning

Community

Business Community with sub-communities that may use different natural languages and specialized vocabularies

Content

Uses

Forms of Meaning

Different ways of saying the same thing

Business Rules: Clause 12

Business Meaning

Formulated as

Concepts, Facts & Rules (Unique, Discrete Meaning)

Expression of Forms of Concepts, Facts & Rules (different ways of saying the same thing)

Forms of Meaning

expressed as

underpins

Business Expression

Expression of Forms of Concepts, Facts & Rules in a Business Language

Formal Logic

Formal Logic

Semantic Formulations + Formal Logic Grounding

underpins

underpins

Different Ways of Saying the Same Thing
Multiple Rule Forms for One Rule (Discrete Meaning)

- One Rule Meaning (e.g. Obligation)
  - Don’t rent a car to a drunk!

can be put together in many forms:
- Obligatory Forms
  - It is obligatory that an intoxicated person is not accepted for a walk-in rental
  - An intoxicated person should not be accepted for a walk-in rental
- Prohibitive Forms
  - It is prohibited that an intoxicated person is accepted for a walk-in rental
  - No intoxicated person may be accepted for a walk-in rental
- Conditional Permissive Form
  - A person may be accepted for a walk-in rental only if that person is not intoxicated

- The meaning of a rule is structured (formulated) into a ‘Form of Meaning’ by using a Semantic Formulation
  - One Semantic Formulation for each Form of Meaning
    (see section explaining Semantic Formulations)
Business Rules: Business Expression

Community

Business Community with sub-communities that may use different natural languages and specialized vocabularies

Business Meaning

Concepts, Facts & Rules (Unique, Discrete Meaning)

Formularized as

Forms of Meaning

Forms of Concepts, Facts & Rules (different ways of saying the same thing)

Content

Expression of Forms of Concepts, Facts & Rules in a Business Language

Formal Logic

Semantic Formulations + Formal Logic Grounding

underpins

Business Rules: Clause 12
Multiple Rule Statements
Expressing One Rule Form

• One Rule Form (e.g. Obligatory Form)
  – It is required that the drop-off date of a rental precedes the expiration date on the driver's license of the customer reserving the rental.

can be expressed in many language, notation & speech community combinations:

– Expressed in English
  • The drop-off date of a rental must precede the expiration date on the driver's license of the customer reserving the rental.

– Expressed in French
  • La date de retour d'une location de voiture doit précéder la date d'échéance sur le permis de conducteur du client réservant la location de voiture.

– Expressed in Structured English
  • It is obligatory that the drop-off date of a rental precedes the expiration date on the driver's license of the customer who reserves the rental.

– Expressed in RuleSpeak
  • The drop-off date of a rental must precede the expiration date on the driver's license of the customer who reserves the rental.

– Expressed in ORM (“ActiveQuery” notation)
  – (see next slide)
Expressed in ORM
("ActiveQuery" notation)

Outline View

"Rental Drop-off Date Validation"

┐ √1 Rental
├ (definitely) is for use of √2 Rented Car
│ (definitely) is returned on √3 DateTime < Date
└ and (definitely) is contractual responsibility of √4 Customer
    (definitely) is authorized to drive under √5 Drivers License
    (definitely) expires on √6 Date

Verbalization View

List each rental, rented car, date time, customer, drivers license, and date
where
  • rental is for use of rented car that is returned on date time that is less than Date
  • and rental is contractual responsibility of customer that is authorized to drive under drivers license that expires on date.
Meaning Structured and Interpreted within a Formal Logic Theory

Community
Business Community with sub-communities that may use different natural languages and specialized vocabularies

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Concepts, Facts & Rules (Unique, Discrete Meaning)

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Forms of Meaning
underpins

Semantics Formulations + Formal Logic Grounding

Structure of Meaning
Clause 9

Formal Interpretation
Clause 10

Formal Logic
derives

Clause 10

Clause 9
Semantics and Business Rules

Semantic Formulation

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From Business Rule to XML

1. Start with a business rule statement.
   It is prohibited that a barred driver is a driver of a rental.

2. Identify symbols in vocabulary.
   It is prohibited that a barred driver is a driver of a rental.

3. Parse according to language rules.
   It is prohibited that
   is
   a driver of
   a barred driver
   a rental

4. Restate as facts of logical formulation.
   An obligation claim embeds a logical negation....

5. Represent facts of logical formulation as objects.

6. Write objects as XML.
   <is-obligation-claim .../>
Logical Formulation of Semantics

• Provides a vocabulary to describe the formal semantic structures of business discourse.
  – Not for discussing business
  – For discussing the semantic structures underlying business communications of concepts, facts and rules.

• A typical business person:
  – does not talk about quantifications – but expresses quantifications in almost every statement he makes
  – doesn’t talk about conjuncts, disjuncts, negands, antecedents and consequents - but these are all part of the formulation of his thinking.

• Logical formulation of Semantics is about explicitly using these conceptual devices (that people use unconsciously all the time) to capture the semantics of their discourse.

• This is new – one of the unique features of SBVR
What is a Semantic Formulation?

• What it’s NOT:
  – A *language* for stating business rules
  – A *language* for stating constraints
  – About software design
  – Intended for use by business people in general
  – Intended to parse free-form natural language

• What it is
  – Language for talking about meanings of concepts and rules
    • regardless of the languages or notations used to state them
  – A way of *structuring* the *meaning* of:
    • Definitions
    • Rules that govern the operation of an organization
    • Questions (Queries)
  – *Optimized for people and natural language* – not for machine processing
  – Interpretable in formal logics: first order and restricted higher order
  – Recursive

• Scope: Whatever business people mean by the vocabularies they use and the rules they make
It is prohibited that a barred driver is a driver of a rental.
It is prohibited that a **barred driver** is a **driver** of a **rental**.

---

**It is prohibited that**

- **is a driver of**
  - **a barred driver**
  - **a rental**

**obligation claim**

- **embeds** a **logical formulation** that is a **logical negation**
- **has** a **negand** that is an **existential quantification**
- **introduces** a **variable**
  - **has** the **type** **barred driver**
  - **scopes over** an **existential quantification**
  - **introduces** a **variable**
    - **has** the **type** **rental**
    - **scopes over** an **atomic formulation**
    - **is based on** the **verb concept**: 'rental has driver'
    - **has** a **role binding**
      - **is of** the **fact type role** that is 'rental' of 'rental has driver'
      - **binds to** the **variable** that **has** the **type** **rental**
      - **has** a **role binding**
        - **is of** a **fact type role** that is 'driver' of 'rental has driver'
        - **binds to** the **variable** that **has** the **type** **barred driver**
XML (for Logical Formulation)

<is-obligation-claim obligation-claim="oc"/>
<modal-formulation-embeds-logical-formulation modal-formulation="oc" logical-formulation="n"/>
<logical-negation-has-negand logical-negation="n" negand="eq1"/>
<is-existential-quantification existential-quantification="eq1"/>
<quantification-introduces-variable quantification="eq1" variable="v2"/>
<variable-has-type variable="v1" type="bdt"/>
<quantification-scopes-over-logical-formulation quantification="eq1" logical-formulation="eq2"/>
<is-existential-quantification existential-quantification="eq2"/>
<quantification-introduces-variable quantification="eq2" variable="v2"/>
<variable-has-type variable="v2" type="rt"/>
<quantification-scopes-over-logical-formulation quantification="eq2" logical-formulation="af"/>
<is-atomic-formulation atomic-formulation="af"/>
<atomic-formulation-is-based-on-fact-type atomic-formulation="af" fact-type="ft"/>
<atomic-formulation-has-role-binding atomic-formulation="af" role-binding="rb1"/>
<role-binding-is-of-fact-type-role role-binding="rb1" fact-type-role="ftr1"/>
<atomic-formulation-has-role-binding atomic-formulation="af" role-binding="rb2"/>
<role-binding-is-of-fact-type-role role-binding="rb2" fact-type-role="ftr2"/>
<esbr:thing xmi:id="oc"/> <esbr:thing xmi:id="n"/> <esbr:thing xmi:id="eq1"/>
<esbr:thing xmi:id="v1"/> <esbr:thing xmi:id="bdt"/> <esbr:thing xmi:id="eq2"/>
<esbr:thing xmi:id="v2"/> <esbr:thing xmi:id="rt"/> <esbr:thing xmi:id="af"/>
<esbr:thing xmi:id="ft"/> <esbr:thing xmi:id="rb1"/> <esbr:thing xmi:id="rb2"/>
<esbr:thing xmi:id="ftr1"/> <esbr:thing xmi:id="ftr2"/>
Semantics and Business Rules

Formal Logic Grounding

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Formal Logic Basis of SBVR

• Oriented to logicians’ perspective

• Documented in an Appendix to the submission, as the “Authoritative Source”

• Aligned with “Common Logic” – draft standard 24707, currently being fast-tracked by ISO

• Validated with Pat Hayes, consultant to ISO on Common Logic
Formal Logic

- Underpins Body of Shared Meanings and Semantic Formulation
- Required:
  - To ensure formal basis for automated processing in repositories and for interchange
  - For alignment with other OMG specifications
- Typed predicate logic:
  - First order
  - Restricted higher order
- Modal Operators – needed for business rules:
  - Alethic: “It is necessary that …”, “It is possible that …”
  - Deontic: “It is obligatory that …”, “It is permitted that …”
- Grounded in Common Logic (draft ISO standard 24707)
  - Needed to allow “irregular expressions” to handle modal operators
Modality

SBVR needs two kinds of modality in order to create business rules:

• **Alethic**, for Structural Business Rules with two operators:
  - “It is necessary that …”
  - “It is possible that …” (and its negation, “It is impossible that …”)

They are used in the sense of ‘logically necessary’ and ‘logically possible/impossible’

Alethic operators, when introduced into verb concepts, define “Structural” Business Rules.

**Structural business rules** are always true, by definition.

• **Deontic**, for Operative Business Rules with two operators:
  - “It is obligatory that …”
  - “It is permitted that …” (and its negation, “It is forbidden that …”)

Deontic operators, when introduced into verb concepts, define “Operative” Business Rules, rules that govern activity in the business.

**Operative business rules** can be broken, and require enforcement

These operators are the only elements of modal logic included in SBVR
Full (and possibly controversial) modal logics are not necessary