

Verbalizing Business Rules: Part 16

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Business rules should be validated by business domain experts, and hence specified in a language easily understood by business people. This is the fourteenth in a series of articles on expressing business rules formally in a high-level, textual language. The first article [3] discussed criteria for a business rules language, and verbalization of simple uniqueness and mandatory constraints on binary associations. Article two [4] examined hyphen-binding, and verbalization of internal uniqueness constraints that span a whole association, or that apply to n -ary associations. Article three [5] covered verbalization of basic external uniqueness constraints. Article four [6] considered relational-style verbalization of external uniqueness constraints involving nesting or long join paths, as well as attribute-style verbalization of uniqueness constraints and simple mandatory constraints. Article five [7] discussed verbalization of mandatory constraints on roles of n -ary associations, and disjunctive mandatory constraints (also known as inclusive-or constraints) over sets of roles. Article six [8] considered verbalization of value constraints. Article seven [9] examined verbalization of subset constraints. Article eight [10] discussed verbalization of equality constraints. Article nine [11] covered verbalization of exclusion constraints. Article ten [12] dealt with verbalization of internal frequency constraints on single roles. Article eleven [13] considered verbalization of multi-role, and external, frequency constraints. Article twelve [14] discussed verbalization of ring constraints. Article thirteen [15] covered verbalization of basic subtype constraints. Article fourteen [16] discussed the need for subtype definitions, and how to verbalize them. Article fifteen [17] considered the verbalization of basic derivation rules. This article considers the verbalization of deontic rules.

Business Rule Modality

Business domains are constrained by various *business rules*, which specify required or desirable states of affairs or behavior. Business rules may be of different *modalities* (e.g. alethic and deontic). *Alethic* rules impose necessities, which cannot, even in principle, be violated by the business, typically because of some physical or logical law. For example: each employee was born on at most one date; no product is a component of itself. *Deontic* rules impose obligations, which may be violated, even though they ought not. For example: it is obligatory that each employee is married to at most one person; no smoking is permitted in any office. Using “constraint” in a liberal sense to include soft as well as hard constraints, deontic rules may also be called deontic *constraints*.

Various information modeling approaches exist for modeling business domains at a high level, for example Entity-Relationship Modeling (ER) [1], the Unified Modeling Language (UML) [21], and Object-Role Modeling (ORM) [2]. However, with the exception of ORM 2 (second generation ORM), these modeling approaches typically confine their specification of constraints to alethic rules. It is important for a business to have a clear understanding of all its rules, including deontic constraints, whether or not the business chooses to enforce these rules, or monitor violations of them, by means of an automated system.

In recognition of this need, as well as to facilitate exchange of semantics between businesses, the Object Management Group (OMG) is currently finalizing a proposal to specify a business semantics layer on top of its software-specific layers. A draft version of this Semantics of Business Vocabulary and Rules (SBVR) proposal is now available [22]. As a contributor to this submission, I focused on the formal logic underpinnings of SBVR, and elsewhere provided a technical discussion of rule modalities, including embedded deontics [19]. In this non-technical article, I merely provide an overview of the modal operators, and illustrate ways of verbalizing simple, static, deontic rules, where the only deontic operator is the main operator. Because of its richer semantics, the main graphic notation used is that of ORM 2 [18], as implemented in the NORMA tool [20]. However, the main ideas could be adapted for UML and ER.

Business rule formulations may use any of the basic alethic or deontic modal operators from modal logic, as shown in Table 1. These modal operators are treated as proposition-forming operators on propositions (rather than actions). Other equivalent readings may be used in whatever concrete syntax is used to originally declare the rule (e.g. “necessary” might be replaced by “required”, and “obligatory” might be replaced by “ought to be the case”). The derived modal operator “It is forbidden that p ” is defined as “It is not permitted that p ” ($Fp =_{df} \sim Pp$).

Table 1. Alethic and deontic modal operators

Alethic		Deontic	
Reading	Symbol	Reading	Symbol
It is necessary that	\Box	It is obligatory that	O
It is possible that	\Diamond	It is permitted that	P
It is impossible that	$\sim\Diamond$	It is forbidden that	F

The following *modal negation rules* apply: it is not necessary that \equiv it is possible that not ($\sim\Box p \equiv \Diamond\sim p$); it is not possible that \equiv it is necessary that not ($\sim\Diamond p \equiv \Box\sim p$); it is not obligatory that \equiv it is permitted that it is not the case that ($\sim Op \equiv P\sim p$); it is not permitted that \equiv it is obligatory that it is not the case that ($\sim Pp \equiv O\sim p$). In principle, these rules could be used with double negation to get by with just one alethic modal operator (e.g. $\Diamond p$ could be defined as $\sim\Box\sim p$, and Pp could be defined as $\sim O\sim p$).

In ORM 2, each rule has an associated *modality*, determined by the logical modal operator that functions explicitly or implicitly as its main operator. ORM 2 distinguishes between positive, negative, and default verbalizations of constraints. In positive verbalizations, an alethic modality of necessity is often assumed (if no modality is explicitly specified), but may be explicitly prepended. For example, the static constraint Each Person was born in at most one Country may be explicitly verbalized with an alethic modality thus: It is necessary that each Person was born in at most one Country.

We interpret this in terms of *possible world semantics*, as introduced by Saul Kripke and other logicians in the 1950s. A proposition is necessarily true if and only if it is true in all possible worlds. With respect to a *static constraint* declared for a given business domain, a possible world corresponds to a state of the fact model that might exist at some point in time. The above constraint means that for each state of the fact model, each instance in the population of Person is born in at most one country.

A proposition is possible if and only if it is true in at least one possible world. Impossible propositions are true in no possible world (i.e. false in all possible worlds). In ORM, the above constraint may be reformulated as the following negative verbalization: It is impossible that the same Person was born in more than one Country. In practice, both positive and negative verbalizations are useful for validating constraints with domain experts, especially when illustrated with sample populations that provide satisfying examples or counter-examples respectively.

Many business rules are *deontic* rather than alethic in nature. To avoid confusion, when declaring a deontic rule, the deontic modality should always be explicitly included. In ORM 2, positive verbalizations of deontic rules typically begin with the phrase “It is obligatory that”, and negative verbalizations of deontic rules typically begin with the phrase “It is forbidden that”. We now illustrate this approach with examples.

Verbalizing Deontic Uniqueness and Mandatory Rules

Previous articles described how to verbalize alethic uniqueness and mandatory constraints. In this section we consider deontic versions of such constraints. Consider the following *positive* verbalizations of static, deontic rules.

- It is obligatory that each Person is a husband of at most one Person.
- It is obligatory that each Person is a citizen of some Country.

The first rule is a *deontic uniqueness* constraint, and the second rule is a *deontic mandatory* constraint. Each rule indicates a condition that *ought* to be satisfied, while recognizing that the condition *might* not be satisfied. Including the obligation operator makes the rule much weaker than a necessity claim. The rules allow that there could be some states of the fact model where a person is a husband of more than one wife (excluding same-sex unions from instances of the husband relationship), and some states where the person is citizen of no country. For such cases, it is important to know the facts indicating that a person has multiple wives or is a non-citizen. Rather than reject such possibilities, we allow them and then typically perform an action that is designed to minimize the chance of such a situation arising again (e.g. send a message to inform legal authorities about the situation). These deontic rules may be reformulated as the following *negative* verbalizations:

- It is forbidden that the same Person is a husband of more than one Person.
- It is forbidden that any Person is a citizen of no Country.

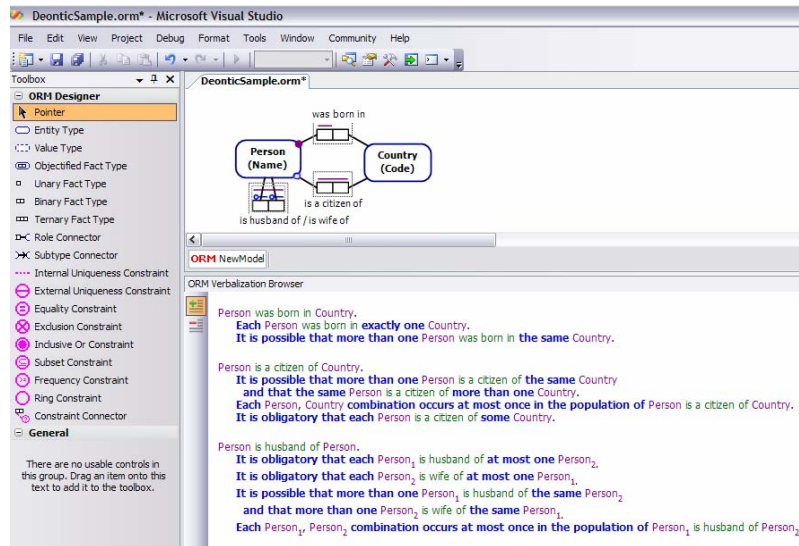


Figure 1. Screenshot from NORMA, showing positive verbalization of some constraints

Figure 1 shows a screenshot from NORMA (Neumont ORM Architect), illustrating positive verbalization of some alethic and deontic constraints in ORM 2. *Object types* (e.g. Person, Country) are depicted as named, soft rectangles. A logical *predicate* is depicted as a named sequence of *role* boxes, each connected by a line segment to the object type whose instances may play that role. The combination of a predicate and its object types is a *fact type*—the only data structure in ORM.

A bar spanning one or more roles depicts a *uniqueness constraint* over those roles (e.g. Each Person was born in at most one Country). A constraint over multiple roles applies to the combination of those roles (e.g. the citizenship fact type is many:many). A small “o” (for “obligatory”) at the end of a uniqueness bar indicates the constraint is deontic (e.g. It is obligatory that each Person₁ is husband of at most one Person₂). Subscripts distinguish object variables of the same type. A solid dot on a role indicates a *mandatory constraint* (e.g. Each Person was born in some Country). If the dot is open, the constraint is deontic (e.g. It is obligatory that each Person is a citizen of some Country). Deontic constraints are displayed in blue rather than the violet used for alethic constraints.

Figure 2 displays a screenshot from NORMA, illustrating negative verbalization of a deontic uniqueness constraint spanning the first two roles of the ternary fact type: Room at HourSlot was booked for Course. The constraint verbalization (It is forbidden that the same Room at the same HourSlot is booked for more than one Course) uses the deontic $F(\sim P)$ operator. All verbalizations in NORMA are performed automatically via XSLT transforms, and hence may be readily adapted for different native languages. In practice, most business rules include only one modal operator, where this is the main operator of the whole rule expression. For these cases, we simply tag the constraint as being of the modality corresponding to its main operator, without committing to any particular modal logic.

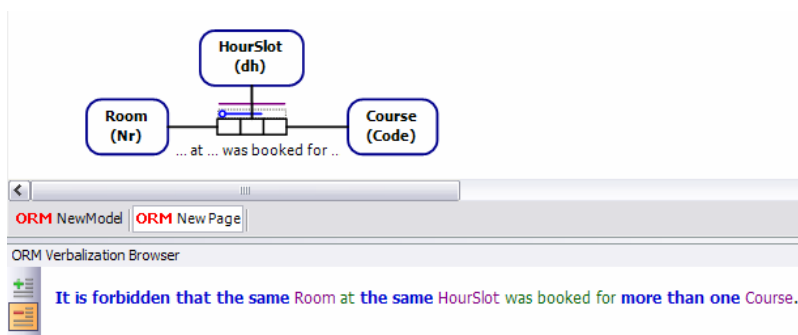


Figure 2. NORMA screen shot illustrating negative verbalization of a deontic constraint

The only impact of tagging a rule as a necessity or obligation is on rule enforcement. Enforcement of a necessity rule should never allow the rule to be violated. Enforcement of an obligation rule should allow states that do not satisfy the rule condition, and take some remedial action (e.g. generate a message when an update violates the rule). A business person ought to be able to specify a deontic rule first at a high level, without committing at that time to the precise action to be taken if the condition is not satisfied; the action still needs to be specified later in refining the rule to make it fully operational.

If a role has both deontic uniqueness and deontic uniqueness constraints, these two constraints may be captured in a single verbalization as shown below. The first example caters for the case where a predicate reading starts at the constrained role, and the second example caters for the case where a predicate reading from the other role only exists.

It is **obligatory** that each Immigrant has **exactly one** Passport
For each Immigrant, it is **obligatory** that **exactly one** Passport belongs to **that** Immigrant.

Verbalizing Other Deontic Rules

Previous articles discussed verbalization of several other kinds of constraints, including value, subset, exclusion, equality, inclusive-or, exclusive-or, frequency, subtyping, and various ring constraints. This section illustrates deontic versions of some these constraints.

Deontic, inclusive-or constraints:

It is **obligatory** that each Vehicle is purchased **or** is rented.
It is **obligatory** that each Vehicle was purchased on **some** Date **or** was rented on **some** Date.
It is **obligatory** that each Vehicle was purchased from **some** Branch of **some** AutoRetailer **or** is rented.

Deontic value constraints:

The permitted values of Grade(letter) are 'A' to 'F'.
The permitted values of PassScore are at least 50.
The permitted values of LuggageMass(kg) are at least 0 and at most 150.
The permitted values of AboveAverageIQ(nr) are above 100.
The permitted values of NonZeroTemperature are below 0, above 0.

Deontic subset constraints:

It is **obligatory** that each Patient **who** is cured pays for the treatment.
It is **obligatory** that each Person **who** drives **some** Car has **some** DriverLicense.
For each Person, it is **obligatory** that
 if that Person drives **some** Car
 then that Person has **some** DriverLicense.
It is **obligatory** that **if** **some** Person migrated to **some** Country on **some** Date
 then that Person had an entry visa for **that** Country on **that** Date.

Irreflexive ring constraints:

No Person is a parent of **the same** Person.
It is **obligatory** that **no** Person reviews a paper by **the same** Person.
It is **forbidden** that **some** Person reviews a paper by **the same** Person.
It is **impossible** that **some** Part contains **the same** Part in **some** Quantity.
It is **obligatory** that **no** Person gave **some** Rating to **the same** Person.
It is **forbidden** that **some** Person gave **some** Rating to **the same** Person.
It is **impossible** that **some** Person₁ introduced **the same** Person₁ to **some** Person₂.

Other examples of deontic ring constraints are discussed in a previous article [14]. That should be enough to illustrate the main verbalization patterns. Detailed specifications of all the constraint verbalization patterns (alethic and deontic) implemented by NORMA will be made available in technical reports on the NORMA website [20].

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