


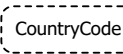
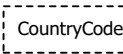
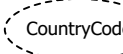




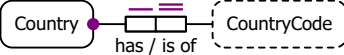




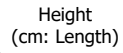
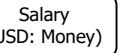
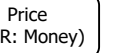
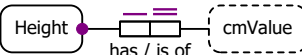



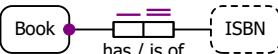







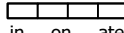

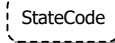

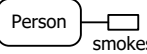
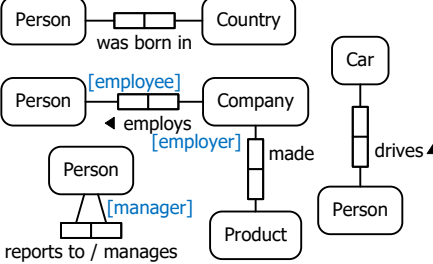
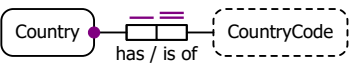
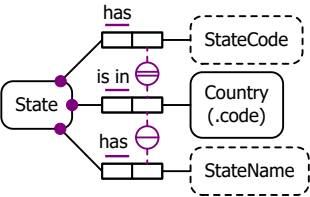
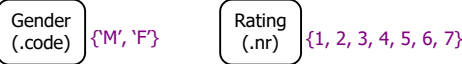
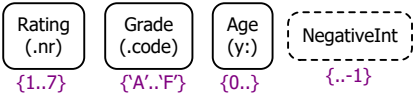
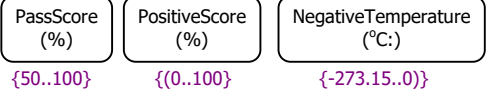
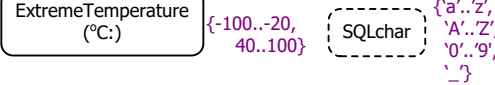
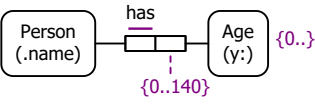
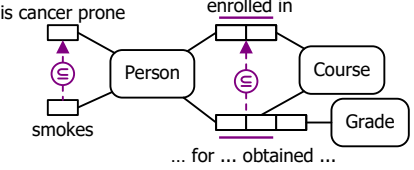
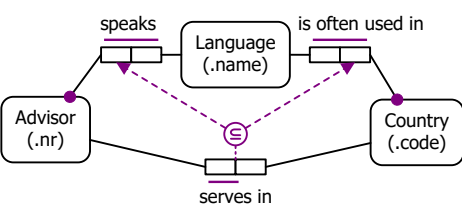
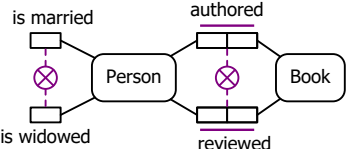


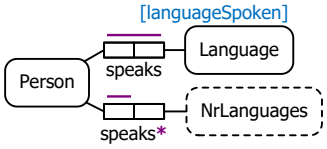
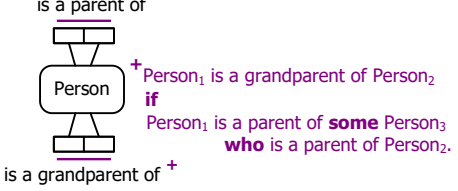
ORM 2 Graphical Notation

Terry Halpin

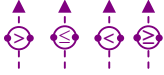
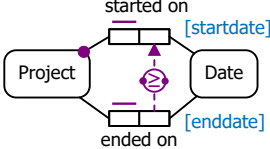

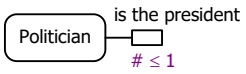

















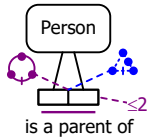
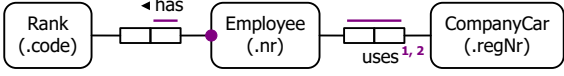
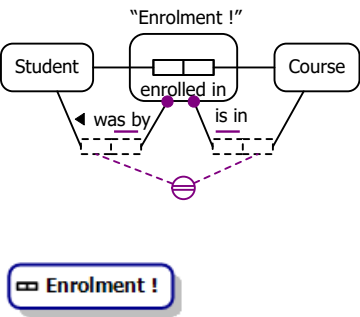
Construct	Examples	Description/Notes
Entity Type	 or  or 	Named soft rectangle, named hard rectangle, or named ellipse. The soft rectangle shape is the default.
Value Type	 or  or 	Named, dashed, soft rectangle (or hard rectangle or ellipse).
Entity type with popular reference mode	   	Abbreviation for injective reference relationship to value type, e.g. 
Entity type with unit-based reference mode	      	Abbreviation for reference type, e.g.  Optionally, unit type may be displayed.
Entity type with general reference mode	  	Abbreviation for reference type, e.g. 
Independent Object Type	 	Instances of the type may exist, without playing any elementary fact roles
External Object Type		This notation is tentative (yet to be finalized)
Predicate (unary, binary, ternary, etc.)	    	Ordered set of 1 or more role boxes with at least one predicate reading in mixfix notation. If shown, object placeholders are denoted by "...". If placeholders are not shown, unaries are in prefix and binaries are in infix notation.
Duplicate type or predicate shape	  	If an object type or predicate shape is displayed more than once (on the same page or different pages) it is shadowed.
Unary fact type		The smokes role may be played by instances of the Person object type
Binary fact type		By default, predicate readings (binary or longer) are read left-to-right or top-to-bottom. An arrow-tip is used to display a different reading direction. Role names may be displayed in square brackets beside their role. Forward and inverse readings for binaries may be shown together, separated by "/".

Construct	Examples	Description/Notes
Ternary fact type	<p>Person [player] Sport Country ... played ... for ... Person ... introduced ... to ... Date Food Cat ... on ... ate ... Cat Food Date [Cat] ate [Food] on [Date]</p>	<p>Role names may be added in square brackets.</p> <p>Arrow-tips are used to reverse the default left-right or top-down reading order.</p> <p>Reading orders other than forward and reverse are shown using named placeholders.</p>
Quaternary fact type	<p>Person City Date Food ... in ... on ... ate ...</p>	<p>The above notes for the ternary case apply here also.</p> <p>Fact types of higher arity (number of roles) are also permitted.</p>
Objectification (a.k.a. nesting)	<p>"Enrolment !" Student enrolled in Course Course resulted in Grade</p>	<p>The enrolment fact type is objectified as an entity type whose instances can play roles.</p> <p>In this example, the objectification type is independent, so we can know about an enrolment before the grade is obtained.</p>
Internal uniqueness constraint (UC) on unaries	<p>Person smokes Person smokes</p>	<p>These are equivalent (by default, predicates are assumed to be populated with sets, so no whole fact may be duplicated).</p>
Internal UC on binaries	<p>Gender is of Person was born in Country Language speaks Person is president of Country</p>	<p>The examples show the 4 possible patterns:</p> <p>1:n (one-to-many); n:1 (many-to-one); m:n (many-to-many); 1:1 (one-to-one)</p>
Internal UC on ternaries. For n -aries ($n > 1$) each UC must span at least $n-1$ roles	<p>Team Place Competition ... got ... in ... Person Sport Country ... played ... for ...</p>	<p>The first example has two, 2-role UCs: the top UC forbids ties; the other UC ensures that each team gets only place per competition (a dotted line excludes its role from the UC).</p> <p>The second example has a spanning UC (many-to-many-to-many).</p>
Simple mandatory role constraint	<p>Person was born in Country Person was born in Country</p>	<p>The constraint is displayed as a large dot at either end of the role connector. The example constraint means that each person was born in some country.</p>
Inclusive-or constraint (disjunctive mandatory role)	<p>Visitor has Passport Visitor has DriverLicence Person is a parent of / is a child of</p>	<p>The constraint is displayed as a circled dot connected to the constrained roles (or the junction of adjacent roles hosted by the same object type). The first constraint means that each visitor referenced in the model must have a passport or a driver licence (or both). The second means that each person is a parent of a person or a child of a person (or both).</p>

Construct	Examples	Description/Notes
Preferred internal UC		A double bar on a UC indicates it underlies the preferred reference scheme.
External UC (double-bar indicates preferred identifier)		Here, each state is primarily identified by combining its country and state code. Each combination of country and state name also applies to only one state.
Object Type Value Constraint		Enumerations
		Ranges are inclusive of end values by default. Round brackets are used to exclude an end value. Square brackets may be added to explicitly declare inclusion, e.g. the constraint on PositiveScore may also be specified as {[0..100]}.
		
		Multiple combinations are allowed.
Role value constraint		As for object type value constraints, but connected to the constrained role. Here, an age of a person must be at most 140 years.
Subset constraint		The arrow points from the subset end to the superset end (e.g. if a person smokes then that person is cancer prone). The role sequences at both ends must be compatible. A connection to the junction of 2 roles constrains that role pair.
Join subset constraint		The constrained role pair at the superset end is projected from a role path that involves a conceptual join on Language. The constraint declares that if an advisor serves in a country then that advisor must speak a language that is often used in that country.
Exclusion constraint		These constraints mean that no person is both married and widowed, and no person reviewed and authored the same book. Exclusion may apply between 2 or more compatible role sequences, possibly involving joins.

Construct	Examples	Description/Notes
<p>Exclusive-or constraint</p> <p>Also known as an xor constraint</p>		<p>An exclusive-or constraint is simply the conjunction of an inclusive-or constraint and an exclusion constraint.</p> <p>The first two examples say that each academic is male or female but not both, and is tenured or contracted till some date but not both.</p> <p>The third example says each spouse is a husband or wife of a spouse but not both. The 1:1 nature of the fact type assumes monogamy.</p>
Equality constraint		<p>This constraint means that a patient's systolic BP is recorded if and only if his/her diastolic BP is recorded.</p> <p>An equality constraint may apply between 2 or more compatible role sequences, possibly involving joins.</p>
Derived fact type, and derivation rule	 <p><i>*For each Person, nrLanguages = count(languageSpoken).</i></p>	<p>A fact type is either asserted, derived, or semiderived.</p> <p>A derived fact type is marked with an asterisk "*". A derivation rule is supplied. A double asterisk "**" indicates derived and stored (eager evaluation).</p>
Semiderived fact type, and derivation rule	 <p><i>Person₁ is a grandparent of Person₂ if Person₁ is a parent of some Person₃ who is a parent of Person₂.</i></p>	<p>A fact type is semiderived if some of its instances may be derived, and some of its instances may be simply asserted. It is marked by "+" (half an asterisk). "+" indicates semiderived and stored (eager evaluation for derived instances).</p>
Subtyping		<p>All subtypes are proper subtypes. An arrow runs from subtype to supertype.</p> <p>A solid arrow indicates a path to the subtype's preferred identifier (e.g. here, student employees are primarily identified by their employee number).</p> <p>A dashed arrow indicates the supertype has a different preferred identifier.</p>
Subtyping constraints		<p>A circled "X" indicates the subtypes are mutually exclusive. A circled dot indicates the supertype equals the union of the subtypes. The combination (xor constraint) indicates the subtypes partition the supertype (exclusive and exhaustive).</p>

Construct	Examples	Description/Notes
Subtype derivation status	<p>*Each MalePerson is a Person who is of Gender 'M'.</p> <p>+ Each derived Grandparent is a Person who is a parent of some Person who is a parent of some Person.</p>	<p>A subtype may be</p> <ul style="list-style-type: none"> asserted, derived (denoted by “*”), or semiderived (denoted by “+”). <p>If the subtype is asserted, it has no mark appended and has no derivation rule.</p> <p>If the subtype derived or semiderived, a derivation rule is supplied.</p>
Internal frequency constraint		<p>This constrains the number of times an occurring instance of a role or role sequence may appear in each population. Here: each jury has exactly 12 members; each panel that includes an expert includes at least 4 and at most 7 experts; each expert reviews at most 5 papers; each paper that is reviewed is reviewed by at least 2 experts; and each department and year that has staff numbers recorded in the quaternary appears there twice (once for each gender).</p>
External frequency constraint		<p>The example constraint has the following meaning. In this context, each combination of student and course relates to at most two enrolments (i.e. a student may enroll at most twice in the same course)</p>
Ring constraints	<p>Ring Constraints</p> <p>E.g.</p>	<p>A ring predicate R is locally reflexive if and only if, for all x and y, xRy implies xRx. E.g. “knows” is locally but not globally reflexive.</p> <p>Reflexive, symmetric and transitive properties may also be enforced using semiderivation rather than by constraining asserted fact types.</p> <p>The example constrains the subtyping relationship in ORM to be acyclic (no cycles can be formed by a chain of subtyping connections) and strongly intransitive (no object type A can be both a direct subtype of another type B and an indirect subtype of B, where indirect subtyping means there is a chain of two or more subtyping relationships that lead from A to B).</p> <p>Ring constraints may be combined only if they are compatible, and one is not implied by the other. ORM tools ensure that only legal combinations are allowed.</p>

Construct	Examples	Description/Notes
Value-comparison constraints	 e.g. 	The example constraint verbalizes as: For each Project, existing enddate >= startdate.
Object cardinality constraint		The example constraints ensure there is exactly one president and at most 100 senators (at any given time),
Role cardinality constraint		The example constraint ensures that at most one politician is the president (at any given time).
Deontic constraints	<p> <i>Uniqueness</i>   <i>Mandatory</i>   <i>Subset, Equality, Exclusion</i>    <i>Frequency</i>  <i>f</i> <i>Irreflexive</i>  <i>Acyclic</i>  <i>Asymmetric</i>  <i>Asym-Intrans</i>  <i>Intransitive</i>  <i>Acyclic-Intrans</i>  <i>Antisymmetric</i>  <i>Symmetric</i>  <i>Strongly Intransitive</i>  <i>etc.</i> </p> <p>e.g.</p> 	<p>Unlike alethic constraints, deontic constraint shapes are colored blue rather than violet. Most include “o” for “obligatory”. Deontic ring constraints use dashed lines.</p> <p>In the parenthood example, the alethic frequency constraint ensures that each person has at most two parents, the alethic ring constraint ensures that parenthood is acyclic, and the deontic ring constraint makes it obligatory for parenthood to be strongly intransitive.</p>
Textual constraints	 <p> ¹ Each Employee who has Rank 'NonExec' uses at most one CompanyCar. ² Each Employee who has Rank 'Exec' uses some CompanyCar. </p>	First-order constraints with no graphic notation may be expressed textually in the FORML 2 language. These examples use footnoting to capture a restricted uniqueness constraint and a restricted mandatory role constraint.
Objectification display options: link fact types, and compact display.		<p>Internally, link fact types connect objectified associations to their component object types. By default, display of link fact types is suppressed. If displayed, dashed lines are used.</p> <p>Objectification object types may also be displayed without their defining components, using an object type shape containing a small predicate shape, as shown.</p>