Integrating Ontology into SBVR

Dane Sorensen and Anthony Pastiak
With
Amit Mitra and Amar Gupta

MAP 459: Accelerating Business Process Engineering and Systems Development with Reusable Business Knowledge

Eller College of Management
University of Arizona

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Problem Definition:

The Semantics for Business Vocabulary and Business Rules (SBVR) was released in 2005 by the Object Modeling Group (OMG) as the industry standard for business semantics. However, the lack of an integrated ontology limits the reasoning ability of SBVR. The purpose of this paper is to outline the metamodel of ontology taught in the *Accelerating Business Process Engineering and Systems Development with Reusable Business Knowledge*[1] course at the University of Arizona, and display how integration into the SBVR could improve future releases of the standard. As supplements to the course material, materials from three books by Amit Mitra and Amar Gupta were referenced.[2] We will illustrate how the integration of the metamodel of ontology could enable the SBVR to reason and thus provide the requisite agility to create resilient business processes and agile automation. We will also attempt to reconcile terms and describe gaps between the models taught in the course mentioned above; as referenced to throughout this paper as AMAG models, and SBVR.

Impact

[1] Taught by co-author Amit Mitra

[2] The three books are as follows: *Agile Systems With Reusable Patterns of Business Knowledge*, its companion *Creating Agile Systems With Reusable Business Knowledge,* which is in the process of being published by Cambridge University Press, and a third that completes the trio *Knowledge Reuse in the Outsourcing Era*, which is currently being published by Idea Group but is still to be released.

Background:

Globalization is driving an intensifying competitive business environment where agility and the ability to change with the chaotic times are paramount to the long-term success of an enterprise. The economy and business world are becoming increasingly global in terms of communication and competition. Along with this, the global economy is quickly shifting from the industrial era to the knowledge economy. In order to accommodate the global communications and extended enterprises necessary to compete in the global economy, new paradigms will have to be implemented to address the complex and diverse needs of users and systems. Continual innovation is necessary in order to compete and progress with the times.

The focus is shifting from optimizing computer technology, to leveraging concepts such as Service Oriented Architechture (SOA) and Business Process Management (BPM), which work to process business meanings in order to obtain business agility. SOA attempts to individualize each component business service that comprises a business offering, in order to provide business agility through plug and play techniques. Unlike traditional point-to-point architectures, SOAs comprise loosely coupled, highly interoperable services. The software component becomes very reusable because the interface is standards-compliant and is independent from the underlying implementation of the service logic (wikipedia.com). Although it can be said that organizations have always used BPM, a new movement has arisen based on the advent of software tools (business process management systems or BPMS) which allow for the direct execution of the business processes without a costly and time intensive development of the required software (wikipedia.com). In addition to focusing on the above-mentioned concepts, consortiums have formed to maintain industry standards.

The Object Modeling Group (OMG) is a consortium that produces and maintains computer industry specifications for interoperable enterprise applications (omg.org). When OMG believes something new or improved needs to be designed, they will publish a RFP, which if accepted becomes OMG standard. The SBVR is the OMG standard for Business Semantics and Business Rules. The SBVR standard is about the meaning and representation of Business Vocabulary and Business Rules (omg.org*SBVRpdf*). The SBVR is an advance into new territory that was not covered by earlier standards, however its scope is limited in the following ways:

- SBVR does not have a metamodel of ontology integrated, which limits its reasoning ability (omg.org-*SBVRpdf*).
- SBVR does not have the agility to handle business processes (omg.org-*SBVRpdf*).

The current version of SBVR recognizes these limitations, and the future direction of SBVR will move toward integrating a metamodel of ontology, thus gaining reasoning ability. This paper addresses the issue of integrating ontology into SBVR and discusses the benefits that could arise from this integration.

Analysis

SBVR Limitations:

SBVR is related to the Ontology Definition Metamodel (OMD), which is being developed concurrently, but is still incomplete (omg.org*SBVR pdf*). Thus, SBVR does not yet have a metamodel of ontology integrated. Ontology is a description (like a formal specification of a program) of the concepts and relationships that can exist for an object or a community of objects (-ksl.stanford.edu). Ontology is designed so that information and knowledge can be shared and reused with and among these objects. Ontology helps to give the system reasoning ability, and when merged with SOA or BPM metamodels of ontology could lead to agile systems and process automation. For an example of how an integrated ontology provides reasoning ability see the example under the heading *validate*.

Possible Recommendations:

Similar to the SBVR, co-authors Amit Mitra,[3] and Amar Gupta[4], have developed a metamodel of knowledge. The individual models that comprise the metamodel of knowledge[5] are outlined in their books *Agile Systems With Reusable Patterns of Business Knowledge*, its companion book *Creating Agile Systems With Reusable Business Knowledge*, and a third book *Knowledge Reuse in The Outsourcing Era,* which also deal with the meaning and representation of Business Vocabulary and Business Rules. The AMAG model uses a metamodel of ontology as its backbone, therefore it is possible that the AMAG metamodel of ontology could be considered for integration into future versions of SBVR,

[3] Amit Mitra is an Industry expert and visiting faculty at the University of Arizona
[4] Amar Gupta is Thomas R. Brown chair in management and technology and globally renowned advisor and professor
[5] The models created by Amit Mitra and Amar Gupta will be referred to throughout this paper as AMAG models for shorthand**.**

conforming to its stated intent. Integration starts with the semantics and ontology of patterns and the concept of information space.

Solution

Law of Location and Proximity Metric

Meanings are considered to be abstract patterns of information. These patterns of information are conceived as patterns in an abstract place called Information Space. Information space and the meanings contained within, cannot be felt, touched, heard, or even sensed. Thus, it is difficult to visualize the patterns that exist in information space and it becomes difficult to understand how these patterns are assembled from other patterns. Pattern is the primary object from which all meanings in the AMAG models arise.

A pattern can be thought of as an arrangement of objects. For a pattern to be considered a pattern, a law must govern the arrangement of the objects contained within that pattern. Therefore, for a pattern to exist, the information conveyed by the law cannot exceed the information conveyed by the ensemble of objects that constitute the pattern in the absence of the law. This follows Shannon's information theory, which asserts information is a measure of surprise based on uncertainty. A prominent mathematician A.N. Kolmogorov, showed Shannon's measures of information are consistent with the increasing amounts of information transmitted by the nominal, ordinal, difference scaled, and ratio scaled domains, respectively (Mitra & Gupta p.323).

Objects must satisfy certain criteria to be included as part of a pattern in state space. The criteria that must be followed are what create the law that determines the identity and meaning of the pattern. Due to these requirements; in all AMAG models, a pattern is defined by its law of location.

Although concepts of patterns can carry physical presence such as weight, color, location, and time, the concepts can also be abstractions. For example, the concept 'parent' is an abstraction delimited by another abstraction, the concept 'generation', which is normalized by the concept 'ancestor'. Objects of this type exist in information space as abstract patterns of information. This shows that information space contains all the information conveyed by an object, whether it be a physical object or an abstract concept.

In order to create a pattern, there must be a measure of similarity or contrast, which will serve as the foundation for the arrangement of objects in the pattern. Measures of similarity and contrast between objects in a pattern are how it is determined what objects will be included or excluded from the pattern. In the AMAG models, the similarity between a set of objects is measured by the proximity metric. For a visual depiction of the proximity metric see appendix A.

The proximity metric lies at the heart of every pattern and is an essential part of the law of location. This measure of similarity means, all else equal, two green apples will be considered closer in information space than a red and a green apple. Any measure can be considered a proximity metric, so long as it satisfies the following four constraints:

- The Proximity of a pair of states cannot exceed the summation of proximities of states over any trajectory that connects the pair.
- The proximity between a pair of dissimilar states cannot be nil or less.
- The proximity of a state to itself must be nil.
- The proximity between a pair of states must be the same in both directions.

The proximity metric determines what information space a pattern can be represented in and the closeness of two objects in information space.

Ontology of information space

A pattern exists only because it expresses information. As noted before, information is only as good as the amount of surprise it holds within its contents. This being so, it may be somewhat counterintuitive that the first pattern recognized; the pattern of “everything”, expresses no information. This is where the ‘any’ or ‘all’ values are contained. As more information is gained the unknown domain emerges. For a visual of the ontology of information space see appendix B.

In the unknown space, only a single ‘unknown’ value exists. In the proximity metric where the unknown domain emerges it is known that objects differ, but the measure of difference is not known. Therefore, it is possible to make distinctions between instances of objects, but not classes of objects because these classes are not known. It is known objects are different, just not what those differences are.

As more information is added to the unknown space the nominal scaled space emerges. In this type of information space enough information is present to rank similarities between objects in the space. It can be asserted that an object is closer/further to one object than to another, yet no information on the actual extent of the distance between the objects involved is known. Because similarities are known, the concept of neighborhood emerges; acknowledging an association between objects, and also the fact that some objects may be closer to each other than others. The ability to rank objects relative to one another allows the concept of sequence to emerge.

The ordinal-scaled space emerges as more information is added to the nominal space. In this information space, all properties and patterns of measurability that exist in the unknown and nominal information space are inherited. Additionally, ordinal space is where patterns of separation in terms of quantitative differences start (eg. Military rank: 2 ranks between a sergeant and a private). Quantitative information on differences exists, but no information on the magnitude of ranks exists. The ordinal domain with a nil value emerges when ranking or preference are known. If ranks between a number of objects are known it is possible that there may be a neutral feeling between two of the objects involved, thus the nil value is present. The nil value not only allows preferences to be ordered but also makes possible the absence of preference. In addition, the concept of sequence gains more depth in meaning. This concept determines whether sequence of the pattern matters or not. In the ordinal space patterns can be any of the following: unsequenced, sequenced, or sequenced with incomplete order. Just as the other domains emerged by having additional information added to its parent, the difference scaled domain emerges by having additional information added.

Difference scaled space conveys more information than an ordinal space and may be considered a polymorphism. The requisite information for the difference scaled space to emerge can be added in two ways. The first is by adding information on subtraction to the ordinal domain, and the other deals with the concept of neighborhood. Take for example a space with a neighborhood. From this neighborhood choose any two points in the space. An object could be inserted into the gap between the two chosen points in such a way that the inserted object is closer to the objects at the end of the gaps than they are to each other. This procedure could be replicated until a space exists where it is possible to locate an object between two others regardless of how small the gap between them is. When enough points have been input or are known, the space that emerges is called a dense space. Similar to ordinal space, dense spaces have enough information for quantitative measurements, however, unlike in ordinal space, in dense information space difference in proximity are not discrete but rather they form a continuum. In difference scaled space quantitative information on magnitudes of individual ranks is present and holds meaning (eg. Difference in age between two people).

When information on the nil value is added to the difference scaled domain, the ratio scaled space emerges, which have the highest information carrying capacity of all the spaces discussed above. This implies that all patterns that exist in the information spaces discussed above may also exist in the ratio scaled information space.

Properties of pattern

Patterns in information space are constrained by a number of universal properties. Measures of degrees of freedom (information carrying capacity) are the most abstract and fundamental properties of a pattern. The other universal properties of pattern are determined by the kind of information space (the domains discussed above) that contains the pattern. All of the universal properties of pattern are polymorphisms of the concept of constraint. Constraints limit the pattern to a specific structure and shape. For example, the concept square has more freedom compared to the concept square balanced on one corner because the meaning of square will not change when rotated in space, but a square balanced on one corner will no longer have the same meaning if reoriented. Because constraints limit the pattern, each property of pattern exists as a polymorphism of the stock theme of freedom, and adding information to distinguish one type of freedom from another derives each property.

Constraints limit the shape and structure of a pattern, and information needs to be normalized at the primal level, it is therefore necessary attach constraints to the right components, at the correct level for information to be normalized throughout the model. Resilience of meaning and business process is obtained by the AMAG models following the principle of parsimony and Liskov's principle. The principle of parsimony asserts that it is necessary to eliminate concepts, variables, or constructs that are not really needed to model a phenomenon, which implies generalizing as much as possible leaves no room for error. This simplifies the model, and reduces the risk of inconsistencies, ambiguities and redundancies within or without the model. The principle is a guiding star in the shadowy domain of extreme abstraction, where few other guideposts exist (Mitra & Gupta p.351). Liskov's principle asserts that a subtype may always be substituted for a supertype in a model without affecting the semantics of the model (Mitra & Gupta p.61).

The principle of parsimony allows a pattern to be expressed or modeled in its least constrained form. Each constraint molds a pattern of information through adding additional information to other patterns that exist in information space, which may also exist as meanings. The effect of adding more information to other patterns makes them more constrained and narrower in scope. Constraints always carry information and therefore create new meanings out of old meanings. On the other hand, removing or relaxing a constraint will change the shape of the meaning in information space to a more generalized pattern, thus giving the pattern a broader scope. The process of broadening the scope of the pattern through reductions in constraints is how the AMAG models absorb learning and can innovate.

Each type of information space discussed above in the ontology of information space inherits all of its parents capabilities, but also adds more, which creates the ability for richer and more specific meanings to be represented. Based on the principle of parsimony and the knowledge of how inheritance operates through adding information to other patterns the following universal properties of pattern can be inferred:

Association- The fact of association conveys information and is the foundation of the concept of pattern; all patterns are patterns of association. The fact of association only explains which objects are mutually included in a pattern. From association comes the concept of neighborhood. Association may carry no information on sequence, direction or nature of the association.

Inclusion/exclusion- Patterns can be either patterns of inclusion or exclusion. Patterns of inclusion convey which objects are associated with which, whereas patterns of exclusion convey what is excluded or disassociated.

Cardinality- Cardinality refers to the number of objects that create the pattern. The AMAG models recognize patterns of infinite cardinality. Although SBVR does not explicitly say it recognizes infinite cardinality, it defines maximum cardinality as cardinality that is a maximum in a range of cardinalities, such as for an at-most-n-quantification, which implies cardinality is not limited to finite number (omg.org*SBVRpdf*). Dense domains are also a subtype of infinite cardinality.

Sequence- This is the law that determines if sequence matters or not in the Pattern. Sequence emerges as a polymorphism of the concept association and neighborhood. Association just conveys that objects are or are not connected in some way, while sequencing rules further constrains the pattern by specifying the order in which objects in the pattern must be arranged. Patterns of collocation cannot be sequenced because they are located at the same point. For sequence to carry meaning their must be enough information to make distinctions between points in information space, in order to distinguish a beginning from an end.

Extent- Out of cardinality and order flows the concept of extent. Patterns may be of infinite or finite extent. Patterns of finite extent are polymorphisms of patterns of infinite extent because they are more constrained. For example the concept ancestor is a pattern of infinite extent normalizing the concept of generation. Therefore, the first generation relationship parent is a finite pattern that emerges from the concept ancestor.

Delimitation- Patterns that are of finite extent may or may not be delimited by boundaries. Finite patterns can exist as bounded delimited patterns, unbounded patterns, and patterns that are unbounded in one direction, while delimited in another.

Open and closed patterns- A delimiter serves as a boundary that marks the edge of a pattern. The delimiter can be used as an inclusion constraint, including the delimiter, or as an exclusion constraint, which excludes the delimiter. The two forms are equivalent when considering discrete finite patterns. Yet, when a pattern is finite and dense a polymorphism of delimitation emerges. Closed and open bounds emerge. A closed bound exist as a boundary that is included in the pattern it delimits, while an open bound is a boundary excluded (cannot touch the boundary) from the pattern. For a visual of what type of patterns can exist in which kids of space see appendix C.

Cohesion/ Separation- The concept of cohesion/separation measures the mutual proximity of the elements of a pattern. The cohesiveness of pattern is determined by the proximity metric. The cohesiveness of patterns follows the ontology of information space, being the least cohesive at the unknown level and gaining cohesiveness through the nominal, ordinal, difference-scaled, and ratio-scaled spaces respectively.

Density- When cohesion is high enough density emerges as a polymorphism. Dense patterns have more information carrying capabilities than patterns that are not dense.

Dimensionality- The dimensionality of a pattern may not exceed the dimensionality of the space that holds it. This means a 2 dimensional pattern could carry patterns with 0, 1, 2, but 3 dimensions. Most often the greater the dimensionality of a pattern, and the higher dimensionality of the space that contains it, the larger the information content will be.

Equivalence of Pattern- Patterns can represent other patterns without losing information if the patterns information carry capacity equals or exceeds the information content of the essential pattern it is representing. This follows Liskov's principle.

Order of Pattern- The concept of order of a pattern refers to the number of levels of patterns involved in defining a pattern. A second order pattern would be a pattern of a patterns; third order would be a pattern of patterns of patterns ect.

For a visual table of the universal properties of pattern see appendix D.

Domains of Meaning

The previous discussion showed how the concept of measurability is derived from patterns and normalized in the concept of Domain. The ontology of domain emerges from the ontology of pattern and follows the same structure recognizing both qualitative and quantitative measurements. The concept of a property of an object emerges because of this inherent measurability and therefore relationship with domain. The domains that comprise the metamodel of ontology are information sparse. They exist as a timeless, stateless class of values, and a basic guide to measurability. However, when time is added to domains, the meaning of the temporal object (buildings, organization/person) emerges. For temporal objects to exist they must exist in a finite span of time. Every feature of a temporal object draws its value from a domain of meaning. As additional real world information and business rules are input into the model, physical and business meanings emerge. In the AMAG models causality and business process then emerge as polymorphisms of relationships when temporal information is added. The integration of ontology into SBVR would enable this. By having the reasoning ability provided by an integrated ontology, as more information is added to the model and new meanings are derived from old, constraints, attributes, and properties will not need to be manually input or even specified because they will be inherited from their parent. Again, this type of inheritance is possible because certain information is normalized at the primal level and as information is added constraints are added to the right objects at the right level so information remains normalized throughout the model and all parent constraints are inherited. The following example of a check signing relationship will help to display some of the reasoning capabilities an integrated ontology could provide.

An Example of Automated Inheritance

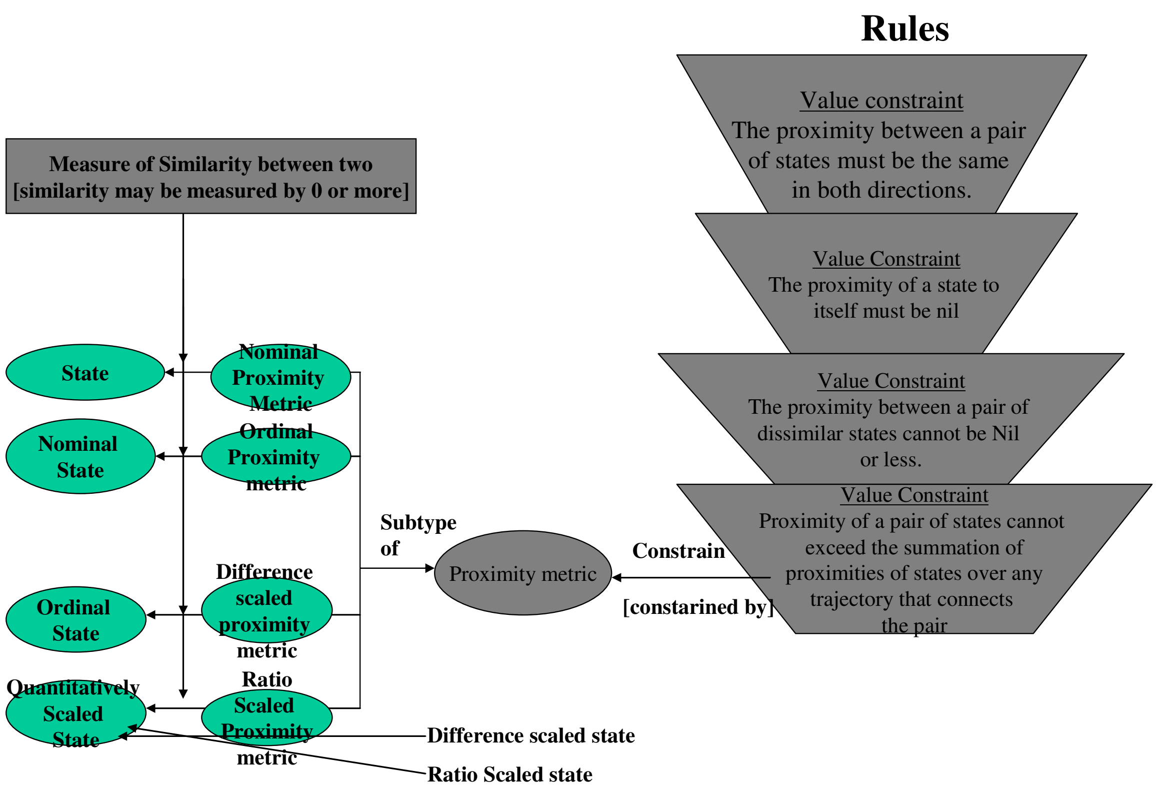
For example, for a check to be payable within an organization both the CEO and CFOs signatures must be present. This example is being constrained by the necessity of having both signatures present and many would also think the check has to be a physical object. In being a physical object the check inherits the constraints of physical objects and being in one place in time. However, with an integrated ontology the system would separate check as a pattern of payment information; which is pure information as inherited from the pattern of payment, from the document; which is a physical pattern of the payment format. The AMAG model would derive that payment is pure information and does not need to be constrained by a physical document. Therefore, the system would remove the constraint, broadening the scope of the pattern and allowing for payment as an item of information instead of as a physical document. Thus, through the use of ontology and relying on the principle of parsimony the check could be dematerialized to mean payment and its status. Therefore, payment will then not be constrained to occur one physical place in time. For a visual of the relationship that allows the document constraint to be removed see Figure 2.15 p. 177 of *Agile Systems With Reusable Patterns of Business Knowledge*. With the check dematerialized, an electronic copy could be sent to both the CEO and CFO, where they could sign in any sequence or even simultaneously, and make the check payable. In addition to this, through the reasoning ability of ontology the invoice or receipt of payment would be recognized as a pattern of pure information on the status of payment and the receipt/invoice could be provided in any format or language as pure information on record or on a physical document. This provides even more opportunities for process improvement and streamlining of workflow automation. This example shows how automation and innovation are possible with ontology integrated into the metamodel. These are the types of benefits that will flow from enhancing SBVR by integrating ontology into the metamodel. The AMAG models can facilitate this integration.

Conclusion

The problem addressed in this paper was the lack of agility information sytems have due to the lack of an integrated ontology. The limited reasoning ability that exists without ontology was mentioned and the semantics of pattern and metamodel of ontology were then outlined. Through these descriptions, the reasoning ability that an integrated ontology provides became apparent. Integrating ontology into SBVR could provide reasoning ability, thus providing the requisite agility to create resilient business processes and agile automation. An integrated ontology creates an information system with reasoning ability and the agility to satisfy the global communications and extended enterprises that comprise the current business environment.

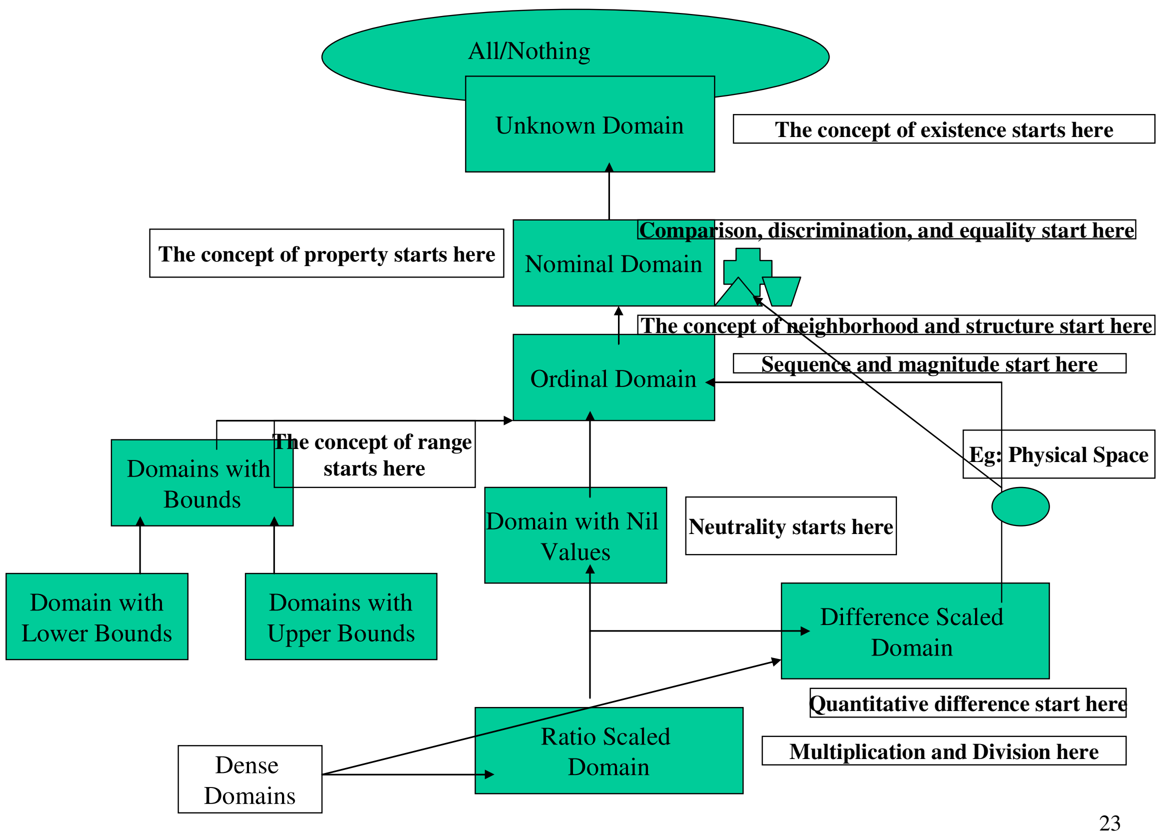
APPENDIX A: The Proximity Metric

The Proximity Metric lies at the heart of every pattern

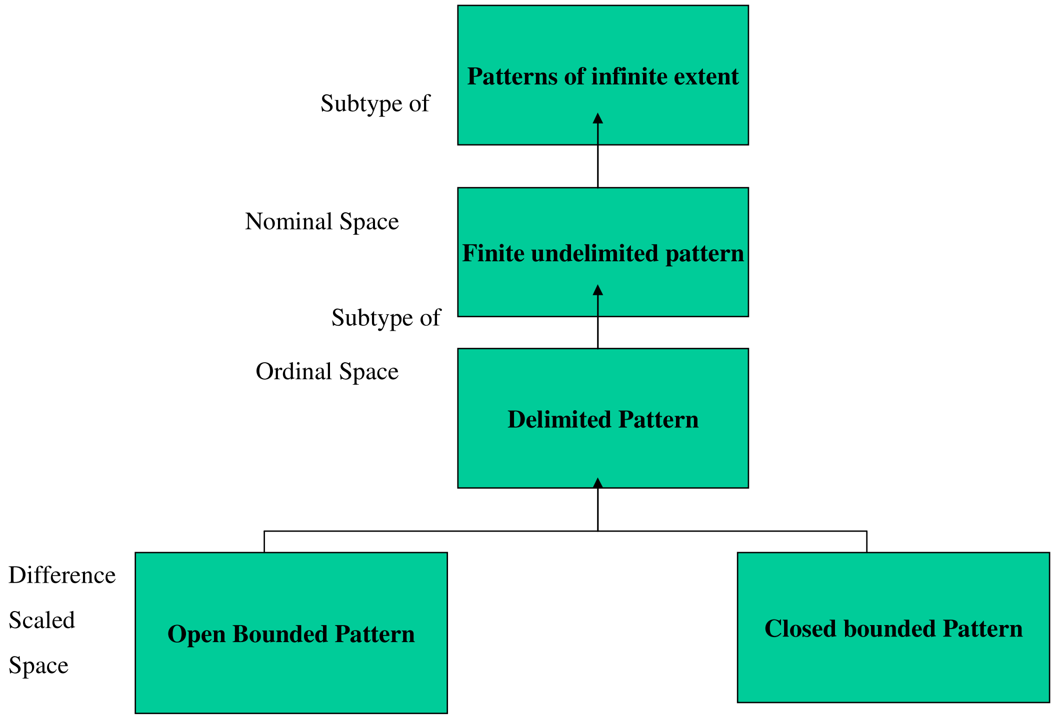


APPENDIX B: ONTOLOGY OF INFORMATION SPACE

Information Content limits the meanings domains can convey



Appendix C: Ontology of Patterns



IMPLIED ALL THESE KINDS OF PATTERNS MAY ALSO EXIST IN RATIO SCALED SPACE

Appendix D: Properties of Patterns

Degrees of freedom (information carrying capacity)

Order of a pattern (pattern of patterns, pattern of pattern of patterns etc.)

Partition

Subtype of

Parameter/ Feature	Directional?	Subtypes	Valid in (Space)
Association (May be infinite; Cardinality (No. of participating Objects))	Y	Patterns of Associations	All
		Sequencing Patterns	Ordinal
Dimensionality	N	Dimensionality of state space	All
		Dimensionality of pattern	Ordinal & subtypes
Cohesion/ Separation	Y	Patterns of distinction	All
		Ranking patterns	Nominal & Subtypes
		Patterns of separation in terms of quantitative *differences* (eg: differences in military rank)	Ordinal & Subtypes
		Patterns of separation in terms of ratios of separation (eg: Physical distance)	Difference scaled & Subtypes
Location	Y	Absolute location	Spaces with "Nil" value (Ratio scaled and Ordinal with Nil value)
		Differences in absolute location	Ordinal with Nil value
		Ratios of absolute location	Ratio scaled space
Inclusion vs. Exclusion	Y	Patterns of inclusion	Nominal & Subtypes
		Patterns of exclusion	Nominal & Subtypes
Extent	Y	Infinite	Nominal & Subtypes
		Finite	Nominal & Subtypes
Delimitation	Y	Unbounded (Undelimited)	Nominal & Subtypes
		Bounded (Delimited)	Ordinal & Subtypes
		Open	Difference Scaled & Subtypes
		Closed	Difference Scaled & Subtypes

Appendix E

AMAG-SBVR Mapping

Quantification

Like SBVR the AMAG model has the concept of quantification. In SBVR the basis of measurability starts by recognizing an irreducible fact (omg.org-*SBVRpdf*). To this fact quantification introduces variables adding information and constraining the fact moving it to a richer level of measurability. AMAG too uses the concept of constraints to add information and enrich measurability (see discussion on domains). In SBVR as more variables are added the constraints that the previous variables introduced are inherited. Quantification in SBVR deals with either exact cardinality or numerical ranges with minimum and maximum cardinality when variables are imposed (omg.org-*SBVRpdf*).

AMAG is more comprehensive in addressing the concept of quantification, as measurement relationships may be occurrence, unknown, nominal, ordinal, difference scaled or ratio scaled. Again see appendix B for the ontology of domains. AMAG recognizes information at the unknown level and as information is added the domains of meaning (nominal, ordinal, difference-scaled, ratio-scaled) emerge and serve as a basis for measurability, as well as allowing all features of parent types to be inherited. As we have seen, the benefits that flow from integrating the ontology of quantification with the business rules model can be significant in terms of inheritance and innovation.

Subtyping

SBVR and AMAG are similar in their methods of subtyping. SBVR supports rules for deriving object types (subtyping definitions) or fact types using either iff (if and only if→one thing occurs the other must) formulations for full derivation, or if-rules for partial derivation (omg.org-*SBVRpdf*). The iff method of derivation is the same as the concept of mutual inclusion in the AMAG model. The 'if' method of derivation follows the normal subtyping method saying if one object exists another may or may not exist. Lastly, to deal with mutual exclusion SBVR use the logical operators ‘or’ and ‘not’ (omg.org*SBVRpdf).* AMAG simply uses the concepts mutual inclusion, subtype, and mutual exclusion for subtyping criteria.

For a derivation rule for a partly derived subtype:

Person(1) is a grandparent if person (1) is a parent of some person (2) who is a parent of some person (3) (omg.org-*SBVRpdf*). SBVR specifically has to input these rules so that subtypes are known and can derived correctly. With ontology integrated the AMAG model is able to add constraints to the right components at the right levels in order to normalize information and derive subtypes. The concept of grandparent would be derived from its parent type ancestor. Ancestor would exist in the unknown level as a pattern of infinite extent. However, the concept of grandparent and parent are contained within ancestor. When the concept of grandparent is taken from ancestor a second-generation finite pattern emerges. Within this pattern it is known that a grandparent must be a parent of a parent because of the second-generation transitive relationship. By relying on the principle of parsimony (specifying the minimal amount of information) as the guiding light through the shadowy domains of abstraction, as well as using Liskov’s principle (a subtype may always be substituted for a supertype in a model without affecting the semantics of the model) the metamodel of ontology provides the reasoning ability to complete subtyping as shown above. As a last note the integrating AMAG model could help SBVR to support variadic fact types. Currently SBVR does not support variadic predicates but the AMAG explains the concept by supporting complex relationships between the degree and order of relationships.

Terminology Differences

SBVR	AMAG	COMMENT
Expression- thing used to communicate (eg. Sounds, text, diagrams, gestures), but apart from their meaning.	Symbol- anything used to communicate that one can sense, constrained by physical space and time.	In AMAG symbols are also patterns, which may be comprised from other symbols which gives more flexibility.
Symbol- representation of a concept by a signifier as owned by a speech community and used within a symbol context, which means the concept and denotes its extension.	Language- a set of formats in visual domains (written script) and audible domains (speech). The concept language recognizes that scripts and conventions may be reused across languages.	It seems the AMAG's way of looking at language resolves SBVR's concept of symbol but also generalizes all speech communities to recognize primitive languages that have no written script and computer languages that have no audible representation.
Representation- the connection between expression and a meaning or a portrayal of a meaning by an expression. The whole ensemble of expression, representation, and meaning must be looked at to understand the meaning behind the expression.	Same as SBVR	Same
Meaning- What is meant by a word (a concept) or by a statement (a proposition)- how we think about things.	Same as SBVR.	In both models meaning i thought of as the way one thinks about things.

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