Using Semantic Relationships to Describe, Enhance, and Extend *United States Nuclear Tests: July 1945 through September 1992*

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Abstract

In the context of library and information science (LIS), ontologies can be used to describe rich semantic relationships between concepts–not only to organize, but also to extend and extrapolate from existing knowledge. Knowledge organization systems such as name authorities and thesauri can go a long way toward organizing concepts by exerting synonym and ambiguity control and codifying hierarchical and associative relationships, but those systems stop short of providing specific context for relationships or extending knowledge beyond what is made explicit by a particular information object.

Using as a source the unclassified information published in DOE/NV--209-REV 16, *United States Nuclear Tests: July 1945 through September 1992* (NV209), we built an ontology–a model of custom semantic relationships between concepts–that brings additional structure and meaning to the information contained in NV209. The concepts described by this ontology can then be applied to information objects related to NV209 for traditional LIS purposes including indexing and search and retrieval, as one might utilize the concepts described by a name authority or thesaurus. Further, the ontology's custom semantic relationships can be used to extend the information contained in a particular information object to build context for the object and to create broader understanding.

Describing Concepts

Different people use different terms to represent the same concepts; in such situations, one term is typically selected as the preferred term.

The relationship between the preferred term and all non-preferred terms is one of ***equivalence***.

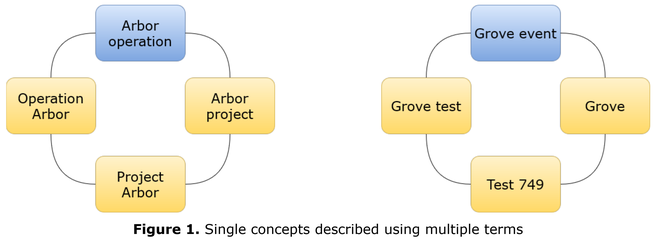

Figure 1. Single concepts described using multiple terms

Relating Concepts

Just as terms are related to each other as synonyms to form equivalency relationships, concepts can be related each other.

For example, events are part of operations, which can be represented as ***hierarchical*** relationships.

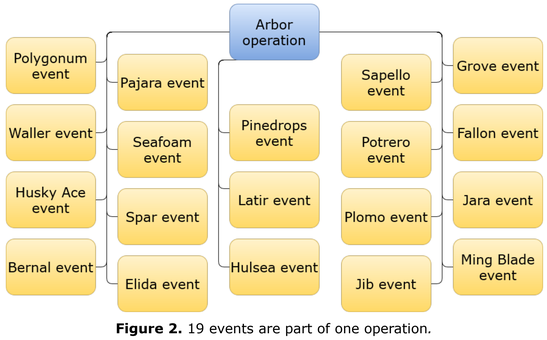

Figure 2. 19 events are part of one operation.

Events may be associated with other concepts such as named entities (real world objects, i.e., people, locations, organizations, products, etc.).

For example, events took place at a variety of locations and were sponsored by one or more organizations; these associations can be represented as ***associative*** relationships.

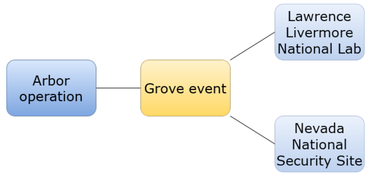

Figure 3. One event associated with two named entities.

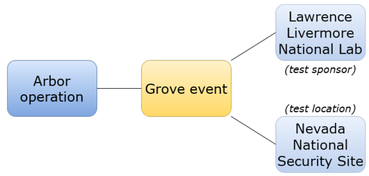

Figure 4. The nature of ***associative relationships*** is not always the same.

Describing Relationships

The network of relationships between concepts is starting to get more complicated:

- Tests and events are synonyms (***equivalency relationships***)
- Events are part of operations—except for Trinity, of course (***hierarchical relationships***)
- Events are associated with locations and organizations (***associative relationships***)

Relationships create context around concepts, but we're starting to push against the limits of the most common relationship types.

In Figure 3, the relationships between the *Grove event* and both *Lawrence Livermore National Lab* and the *Nevada National Security Site* appear to be the same–all we can tell is both *Lawrence Livermore National Lab* and the *Nevada National Security Site* are ***associated with*** the *Grove event*.

But the relationships are different–the *Grove event* was ***sponsored by*** *Lawrence Livermore National Lab* and was ***conducted at*** the *Nevada National Security Site* (Figure 4).

Enhancing Relationships

We need another type of relationship—a ***semantic relationship***. Using semantic relationships, we can get specific about precisely how a test and an organization or a location are associated with each other.

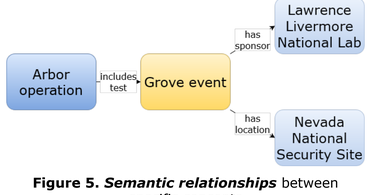

Figure 5. ***Semantic relationships*** between specific concepts

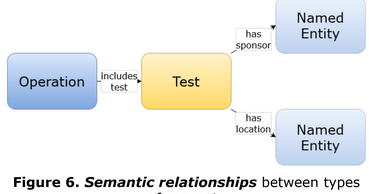

Figure 6. ***Semantic relationships*** between types of concepts

The specificity of ***semantic relationships*** allows us to model relationships not only between *concepts* (Figure 5) but also between general types of concepts, or *classes* (Figure 6).

Extending Relationships

These ***semantic relationships*** enable a richer understanding by implicitly linking together *concepts* and *classes* without having to explicitly document these linkages.

For example, by looking at Figure 7, it is possible to discern, among other things, that *Lawrence Livermore National Laboratory* is one organization that sponsored tests conducted at the *Nevada National Security* Site, even though no explicit relationship links these two concepts.

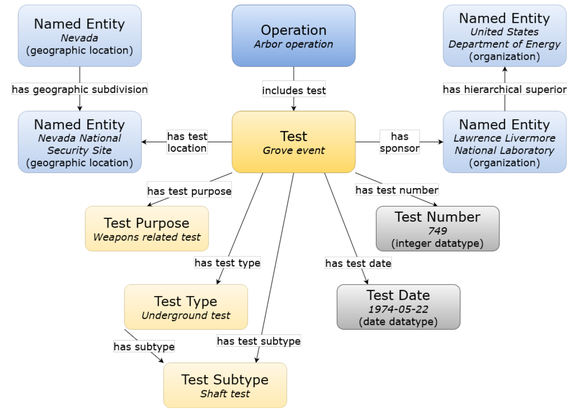

Figure 7. A sample network of ***semantic relationships***

Semantic relationships can be further extended, making them even more information-rich:

- A *domain* and a *range* can be defined for each relationship, specifying how *classes* can be related to each other or to a particular data type. For example, a ***semantic relationship*** might specify that a *test* (class) may only have a *has sponsor* relationship with a *named entity* (class), or that a *test* (class) may only have a *has test number* relationship with an integer (datatype).
- *Classes* can be related to each other in a variety of logical ways–symmetrically, inversely, transitively, or functionally–and new relationships can be defined as needed without changing the underlying *classes* or *concepts*.

References

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