TENSAR, A Context-oriented System Modeling Language

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August, 1995

Over the past two years, a series of research projects involving the formal use of contexts applied to information system modeling in general and computer security in particular has been supported by the Communications Security Establishment in Ottawa, Canada. The notion of context we have evolved is implemented in a language we call TENSAR (Taxonomies, ENtities, Sets and Relations). At present, the context mechanism in TENSAR allows abstract models constructed from a general set theoretic foundation to have distinct context-dependent specifications. The TENSAR interpreter stores all model information in a semantic frame knowledge-base that is partitioned by context. We have conjectured that an algebraic lattice of contexts would be appropriate for the applications envisaged, and the current implementation of TENSAR supports this.

Background

TENSAR was developed as a means of defining and expressing facts about general computing systems and their models. In particular, models used in computer security were considered as the main focus of application. In [SANDBERG:93] an initial version of the language was developed and some candidate systems defined in TENSAR. Initially, TENSAR was designed to form a link between Information Flow Algebras (IFAs) and a generic graphical user interface (GUI). The motivating concept behind this phase of the development was to demonstrate that the IFA constructions and models could be presented graphically in a consistent way. TENSAR declarations were seen to hold the essential information of a generic GUI oriented to generic modeling concerns.

The general purpose of TENSAR has remained relatively constant throughout its brief history. The syntactic definition and some details of scope have been modified to meet an evolving role within the Framework and Open Reference Model for Information Security (FORMIS). In [SANDBERG:95],TENSAR is described as a general ontological tool in documenting and referencing Systems in general, with a special interest in Information Security Models. In particular, TENSAR is proposed as the primary interchange format within FORMIS for : (a) IFAs, (b) Information Integrity Modeling, and (c) System Composability Modeling. While the full achievement of the above objectives is part of ongoing and future work, some proof of concept involving IFA implementation within TENSAR is carried out in [SANDBERG:95].

Context Semantics

Each TENSAR metafile has a finite set of contexts, each of which contain a set of constructions, i.e.entity, set, class, function, relation or axiom definitions. The constructions of any given context generate a finite set of first and/or second-order logical statements in Knowledge Interchange Format (KIF), developed by Knowledge Systems Laboratory, Stanford University. This set of formulas is called the context theory. In order for a context to be consistent, its theory must have a model. Alternatively, it must be demonstrated that there is some KIF statement which is not logical consequence of the context theory. Both of these tasks are beyond the scope of TENSAR, but could be formally verified in EVES (by Odyssey Research Associates, Canada), a formal methods tool for which a TENSAR interface has been planned.

Since a consistent context theory has a model, it has a meaning, or semantical content. If a context theory is inconsistent, no meaning can be ascribed to it, even though constructions within the context have meanings. Beyond these consistency conditions, there is no other constraint that a context must satisfy. It is not necessary that complete descriptions of objects be present in the context theory. It may also be possible that two or more non-isomorphic models satisfy a context theory. In such cases the context is ambiguous, but not inconsistent. A context is

non-ambiguous or finitely categorical if all finite models are isomorphic. In the area of application of TENSAR, infinite models are not generally required, therefore categoricity properties over infinite models are not dealt with at present. To define contexts in a more direct syntactic way, we can employ the notion of a model set, devised in [HINTIKKA:69]. [SANDBERG:95] describes these semantics in more detail.

Views

Views are described as a general filter on attribute domains, entities and other objects. The global view can restrict or expand the user's ability to detect the specified view elements. Views are not restricted to a specific context. The current view does not modify any existing TENSAR construction. The view controls the degree to which information is hidden or exposed to the viewer. The user has the capability to define a view and invoke any previously defined view. There is a capability to expand an existing view by adding attributes domains, attributes, component domains, components, relations, sets, entities and other things. Similarly, all of the foregoing categories can be excluded through a restriction of the current view.

In later versions of TENSAR, more sophisticated view mechanisms are planned involving pseudo-attributes. This would approach some of the capabilities of multi-media knowledge base systems (as in [YOSHITAKA:94]). Future versions of TENSAR will add notions of 'focus' and 'perspective', but the semantics of these are not resolved at this point. At present, the syntax of TENSAR is strongly modeled on that of Ontolingua from KSL, Stanford University.

The work on TENSAR and its use of contexts is available from Milan S. Kuchta, INFOSEC Scientific Advisor, Communications Security Establishment, Ottawa, Ontario, Canada, tel. (613) 991-7331, email: mkuchta@manitou.cse.dnd.ca; or the author at CGI Group Inc., 275 Slater St., Ottawa, Ontario, K1P 5H9, Canada, tel. (613) 234-2155.

TENSAR and information about it will shortly be available on the FORMIS WWW site:
http://www.cse.dnd.ca/~formis/

References

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