INFORMATION CLUSTERING FOR COMMANDER CRITICAL INFORMATION REQUIREMENTS

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ABSTRACT
The focus of this paper is to describe recent developments of particular software applications that provide relevant information in context with the evolving situation and become useful warfighter's tools for time-critical decision-making. Such technology applications should attempt to go outside the key-word search paradigm by understanding the context of the user query and respond proactively to the reported changes within the battlespace to suitably alert a commander as the situation demands. The commander's critical information requirements (CCIR) contain the information elements deemed essential by the commanders for successful execution of a particular operation. The concept of CCIR provides a demonstrable framework to assess the utility of such tools.

INTRODUCTION

The tactical relevancy of information is related to and dictated by the situation and the mission. The common operational picture of the battlespace is an aggregate of data that provides a snapshot of the battlefield and is being shared among all friendly forces on the disposition of the friendly and the enemy forces and their assets. The information relevant to the warfighter at the appropriate level of detail varies with the functional area mission and the echelon. This is also termed situation awareness. The commander uses the situational awareness to form situational understanding for planning and execution of operations.

As a pivoting point of our discussion we have chosen the CCIR paradigm since it helps to provide the criteria for clustering information around the elements critical and relevant to the decision making context. Clustering of relevant information based on keywords alone does not provide the knowledge required to link critical information or to infer possible outcomes that may impact decision-makers goal.

RELEVANT TECHNOLOGIES

To push the envelope beyond keyword-search a semantic relationship of terms used in the CCIR and the terms found in the information traffic must be comprehensible to the machines. If machines had the understanding of the context of the query such intelligent search for information could be possible. Fortunately these enabling technologies are available and continue to grow in popularity as numerous applications fill the domains (Table 1) .

All of the technologies listed in Table 1 have something to do with ontology. Ontology provides conceptual representation needed for machine to understand the meaning of the question or task being asked. The conceptual representations could be stated in a form of axiomatic statements such as *Aristotle is a man*[1]. While the need for ontologies is evident, the incomplete ontologies may lead to undesirable results. To illustrate this we need a couple more statements such as *Every man is mortal* and *Work of Aristotle is immortal*. If a machine has only these three statements to respond to the question whether the work of any man is immortal it probably would erroneously infer that work of every man is immortal.

In the 1970s computer scientists looked for more efficient ways to use databases. In response to this search the Entity-Relationship Model (ERM) was proposed [P. Chen, 1976]. It was a significant step since it allowed queries to concentrate not only on data, but the relationships the data forms within the informational framework. The concept of ERM was taken further and applied to intelligent systems where it forms a computational tool as an Entity Relational Network (ERN) and emerges as instrument of focusing attention of an intelligent agent [A. Meystel, J. Albus 2002]. The significant contribution of introducing such model was in the emphasis on the need to model ERN in a multi-level, multi-resolutional hierarchy analogous to the way it is used in human reasoning. The application of ERN within Elementary Loop of Functioning (ELF) that serves a s building block of the architecture of intelligent nodes within as a distributed network of intelligent agents in a military domain is discussed in [E. Dawidowicz et al., 2002].

This modeling is crucial in extending the ability of machines to assist commander's staff in analyzing information and provide reliable alerts as the situations evolves. A commander specifies CCIR in terms that are somewhat general such that a commander may ask to be alerted if 3 or more enemy vehicles appear in the area of interest. If that is taken literally by a computer any lesser number of vehicles will go unreported and when a company or a battalion appear in a range of single Multiple Lunch Rocket System (MLRS) the alert will not be issued.

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[1] Aristotle (384-322 BC) proposed arranging knowledge in a form declarative form of axiomatic statements that can be evaluated as true or false. The collection of such statements forms an instance of ontology.

Technology	Intent
Semantic WEB	To develop languages for expressing information in a machine processable form [S. Palmer, 2001, Tim Berners-Lee, 1998].
RDF - Resource Description Framework	A language which allows the information to be mapped *directly* and *unambiguously* to a model, a model which is decentralized, and for which there are many generic parsers already available
XML- eXtensible Mark up Language	To describe information by means of tag and provide a relationship between the information. The user-defined tags allow its unique flexibility.
DAML- DARPA Agent Markup Language	To extend RDF capability, to be used as an ontology and inference language.[M. Burke, 2000] A language, which was, developed to facilitate communication between software agents.
KIF Knowledge Interchange Format	A language designed for use in the interchange of knowledge among disparate computer systems [M. Geneseret 1998]
Ontology	The subject of ontology is the study of the categories of things that exist or may exist in some domain [J. Sowa 2001, J. Sowa 2000] An ontology is an explicit specification of a conceptualization. The term is borrowed from philosophy, where an Ontology is a systematic account of Existence. For AI systems, what ``exists'' is that which can be represented. [T. Gruber1993]
ERN Entity Relational Network	To allow focusing attention on emerging patterns within relationships among objects and allows fast analysis of complex situations by means of clustering within many levels of multi-granular resolution.

Table 1. Technologies and their intent

The ERN also allows ranking of threats on most lethal based on threat capacity to inflict damage, temporal and spatial relationships. Clustering at a lower level of resolution allows the conceptualization of information analysis, while decomposition of the upper level allows for a detailed analysis at the lower level of resolution. Ability to go to lower levels of resolution permits a computer to understand questions that otherwise would be uncertain. Clustering to high level concepts also helps tracking knowledge to the lower details in a consistent manner {M. Mehrotra, et al., 2001}

CONCLUSION

As seen in the preceding discussion, technology and concepts are ahead of the tool development. The tools that are effective to filter relevant or contextual information at the appropriate level of detail are still in their infancy [A. Kott, et. al, 2002]. Adapting the tools and the technology to meet the critical information requirements of the decision makers is well within the means of Govt. and Industry resources. What is needed is the focused approach and partnership

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