Machine Reasoning and Learning

ONR Code 31

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At a Glance

What it is

- An integrated set of basic and applied research programs that enable analysis, understanding and interpretation of uncertain, incomplete, imprecise and contradictory data, regardless of the source

How it works

- A series of strategic research and technology investments focused upon: representation; analysis and interpretation; action/reaction; and system integration that addresses fundamental and applied technology issues coupled to limited objective experiments that demonstrate new capabilities

What it will achieve

- Provide situational awareness and control of heterogeneous sensor networks in support of rapid accurate decision making

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Research Challenges and Opportunities:

- Representation of structured and unstructured data that is imprecise and uncertain
- Automation that fuses, analyses and interprets all sources of data
- Mission-aware management of sensor networks that improves situational awareness while reducing uncertainty and resolving contradiction
- Analysis and integration of human decision makers with automation that provides a holistic system

The Office of Naval Research (ONR) Machine Reasoning and Learning program addresses topics important for efficiently obtaining and exploiting the information inherent in complex real-world data to gain situational understanding.

Representation of real-world information sources involves developing automated systems for supporting efficient storage, retrieval, conflation and deflation of heterogeneous data. Such data, whether derived from conventional sensors, intelligence or open sources, are inherently uncertain, incomplete, imprecise and contradictory (UIIC). Any method for data representation must also represent UIIC effectively. The representations must be linked to the goal of mission-focused autonomy and must be computationally efficient. For every situational awareness problem, representations also are required for assumptions, knowledge, activities, events and information that are typically described qualitatively.

The impact of UIIC on the representation and decisions must be quantified. We also seek methods that understand how, for a given mission, data and information should be combined to achieve mission-aware cognition of the environment in the presence of UIIC. The system should be adaptive, with a capability to acquire new data or information to improve situational understanding, and required fidelity or precision linked to the context of the mission and inference task that is being performed in support of the mission. The system also must have the ability to combine and interpret the data within the time window commensurate with the operational tempo so that important activities and events, as well as interpretations of intent and threats, are not missed.

The system also must be capable of automatically providing multiple hypotheses consistent with the data and commander's intent and developing mission strategies to resolve UIIC and enable analysis that reveals the intent of objects within the mission context. This implies a need for the system to understand and correctly interpret the intention and information needs of its human components. A desirable property for the system is to detect and recognize the emergence of novel situations and to provide alerts to the human decision makers.

Integrating the components into a holistic, scalable system with predictable properties and guarantees of correctness that support operations over multiple temporal and spatial time constants and interactions with humans are also desirable properties and present significant science and technology opportunities.