Enabling Intelligence Analysis through Agent-Support: the CISpaces Toolkit

(Demonstration)

Alice Toniolo
Hengfei Li
Dept. of Computing Science
University of Aberdeen, UK

Timothy J. Norman
Nir Oren
Dept. of Computing Science
University of Aberdeen, UK

Robin Wentao Ouyang
Mani Srivastava
University of California
Los Angeles, CA, USA

Timothy Dropps
John A. Allen
Honeywell, USA

Paul Sullivan*
INTELPOINT Incorporated
Pennsylvania, USA

ABSTRACT

We demonstrate CISpaces, a system for agent-aided collaborative intelligence analysis. CISpaces exploits collaboration to ease the effort of constructing hypotheses from acquired information. Argumentation-based reasoning is employed by a sensemaking agent to identify plausible hypotheses and to compute their likelihood to be justified. Information requirements are handled by a crowdsourcing agent that elaborates responses mitigating biases and a provenance agent assists analysts in assessing the credibility of hypotheses.

Categories and Subject Descriptors

H.4 [**Inform. Systems Applications**]: Decision support

Keywords

Argumentation; Provenance; Crowdsourcing

1. INTRODUCTION

Intelligence analysts are responsible for elaborating information to determine plausible hypotheses for situations and events in the world. The results determine likely threats and improve situation awareness [5]. Our objective is to provide support to analysts to increase the reliability of analysis by leveraging the work of many contributors, and assist them to prevent information overload.

In this demo, we present *CISpaces* (Collaborative Intelligence Spaces[1]), a tool for agent-aided collaborative intelligence analysis. CISpaces enables a group of analysts to share and deal with inconsistent or uncertain information; maintains records of the origins of information (i.e. provenance); and permits information sensing from groups of collectors. Existing tools offer support for link analysis, or for sharing competing hypotheses or information (e.g. [3]). Our approach, however, focus on supporting the core process of making sense of information that leads to the identification of hypotheses, rather than its collection or presentation. We, thus, combine graphical representations of arguments previously used for argument analysis [4], with autonomous support for identification of hypotheses through argumentation-based reasoning and argument schemes (i.e., defeasible patterns of reasoning [6]). Additional autonomous support is provided via techniques for robustly interpreting crowd-sourced data, reasoning about provenance and computing the likelihood of hypotheses to address the diversity of requirements arising from the complexity of intelligence tasks [1, 2]. By facilitating individual and collaborative analysis, CISpaces enables a more complete and robust delivery of analytical products for improving situational understanding.

2. THE CISPACES TOOLKIT

The CISpaces interface, shown in Figure 1, provides both an individual and shared space for analysis. This interface includes an *InfoBox*, where information is streamed from intelligence reports, and a *WorkBox*, the space for hypotheses construction and sensemaking of information. Collaboration is supported in CISpaces via a shared WorkBox, which analysts can switch to when intending to share partial analyses. The *evidential reasoning service* facilitates the reasoning process by guiding the construction of hypotheses as graphical argument maps where users can draw supporting (Pro) or defeating links (Con) between nodes. The *ReqBox* is used for issuing requests for information to groups of contributors; a *crowdsourcing service* deals with distributing such requests and analysing the results. Collaborative analysis does, however, depend on rigorous methods of recording and interrogating the origins of information, which is handled by the *provenance reasoning service*.

CISpaces has a scalable and robust service-oriented architecture, and a portable interface developed in Kivy[2]. The information is maintained via a federated database and the communication is managed via the ZeroMQ messaging library [3]. CISpaces demonstrates how our agent-based model for reasoning with different evidence may effectively support analysts [5]. The system is built upon our early-stage prototype, now including an integrated argumentation-based reasoner [5] and a probabilistic extension [1], argument schemes to analyse crowdsourcing and provenance data [5], and an enhanced debiasing method for crowdsourcing [2].

*This research was sponsored by the U.S. Army Research Laboratory and the U.K. Ministry of Defence under Agreement Numb. W911NF-06-3-0001.

[1]CISpaces is shown at: `http://tinyurl.com/mwtck6t`

[2]Kivy Python Framework: `http://kivy.org/`

[3]ZeroMQ library: `http://zeromq.org`

Appears in: *Proceedings of the 14th International Conference on Autonomous Agents and Multiagent Systems (AAMAS 2015), Bordini, Elkind, Weiss, Yolum (eds.), May 4–8, 2015, Istanbul, Turkey.*

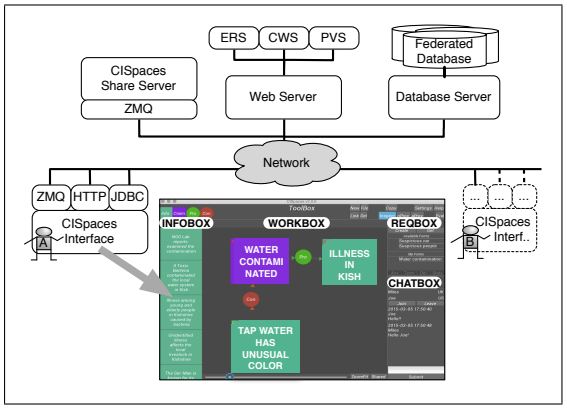

Figure 1: CISpaces Architecture and Interface

3. CISPACES AGENTS AND SERVICES

Here we show how services enable the delivery of agent support for analysis. This process is presented using a scenario in which an intelligence team is engaged in the investigation of water contamination and an explosion at a local hotel in the region of Kish.

Evidential Reasoning. TheWorkBox provides a space of analysis where inferences between information and claims (represented as nodes, see Figure 1) are structured as Pro or Con links. The collaboration is enabled by the possibility of highlighting and dragging part of this graph in a personal space to the shared Workbox. For example, an analyst attributes the hotel explosion to a gas released in the water supply by dangerous engineered bacteria. Another analyst may add an alternative explanation: a suspicious person was seen leaving the hotel and may have planted an explosive. A *sensemaking agent* maps this graph of inferences to an argumentation framework [5], where Pro links form arguments and Con links represent attacks. The agent provides timely support to analysts by identifying plausible hypotheses: the argumentation framework is evaluated to extract sets of consistent arguments. Each set is suggested to the user as an alternative hypothesis that may be supported. Moreover, the sensemaking agent interprets annotation of reason for Pro links as argumentation schemes [6]. In particular, the relevant arguments to intelligence analysis include the *argument from cause to effect* to form links between events and the *argument from identification of agents* to connect actors, locations, and resources. Schemes are associated with critical questions suggested by the agent to challenge analysis and avoid biases. Furthermore, acquired information may be uncertain, and evaluating its validity is an important step in the analytical process. Analysts can tag incoming information with an appropriate label that identifies the uncertainty attributed to it (e.g. probable, possible,...). This value may be interpreted by the agent as the likelihood that this information is accurate and, hence, can be used to support a plausible hypothesis. In order to evaluate hypotheses, the agent relies on PrAF [1] extended for structured argumentation frameworks. The underpinning idea of PrAF is that a valid premise is considered meaningful and, hence, should be used to support hypotheses. In contrast, an invalid premise should not be used because the information may be sent out by a malicious party to confuse the reasoner. PrAF employs a probabilistic method to measure uncertainty with respect to argument justifications in order to suggest to analysts the level of uncertainty in the justification of a hypothesis.

Crowdsourcing. The analysis may lead to additional information requirements to sense situation changes and emerging viewpoints. Crowdsourcing provides timely and effective responses to such requirements via a *crowdsourcing agent* that interprets reports and feeds the results back into the analysis. The analyst formulates the requirement and interacts with the agent to define guidelines for the interpretation of the results. We assume, for example, that the crowd is asked to monitor the status of the water supply in the area nearby Kish, through its colour or temperature. The analyst may interrogate the agent for water pollution data. The agent employs crowdsourcing methods to aggregate data, such as Dirichlet distribution and sample mean to present a map of arguments adapted from the *arguments from generally accepted opinion* [5]. For example, the results may be supporting the claim "the water is polluted" because of unusual colour, or defeating the claim due to a normal temperature. These results may be misleading, however, if information comes from noisy participants' reports, thus, the agent employs methods for bias mitigation. In particular, we show how the crowdsourcing agent employs a probabilistic model for truth discovery from noisy crowdsourced information [2].

Provenance. For effective collaborative analysis, the provenance of both source information and previous analyses must be considered. Provenance data helps analysts to understand how a piece of information was handled and why. CISpaces enables analysts to inspect the provenance records. However, managing large provenance dataset increases the workload of analysts. A *provenance agent* is employed to elaborate this data on behalf of the user and identify influential provenance elements that may inform the credibility of the hypotheses. The agent extracts relevant provenance using *argument schemes for provenance* [5] where the provenance chain acts as a warrant for stating that a piece of information is credible. The critical questions are used to gradually explore relevant provenance data. Recording provenance data will also help audit trail, showing what evidence underpinning hypotheses was available at the time of analysis to improve future analyses.

4. CONCLUSION

CISpaces brings together different approaches for reasoning with evidence to support analysts in making sense of conflicting information. In future work, we will support analysts in producing more accurate analyses by employing argumentation-based dialogue and refining crowdsourcing queries for gathering focussed information.

REFERENCES

[1] H. Li, N. Oren, and T. J. Norman. Probabilistic argument frameworks. In *Theory and Applications of Formal Argumentation*, Lecture Notes in Computer Science, pages 1–16. Springer Berlin Heidelberg, 2012.

[2] R. W. Ouyang, M. Srivastava, A. Toniolo, and T. J. Norman. Truth discovery in crowdsourced detection of spatial events. In *Proc. of the 23rd Intern. Conf. on Information and Knowledge Management*, pages 461–470, 2014.

[3] N. J. Pioch and J. O. Everett. POLESTAR: collaborative knowledge management and sensemaking tools for intelligence analysts. In *Proc. of the 15th Intern. Conf. on Information and Knowledge Management*, 2006.

[4] C. Reed and G. Rowe. Araucaria: Software for argument analysis, diagramming and representation. *Intern. Journal on Artificial Intelligence Tools*, 13(04):961–979, 2004.

[5] A. Toniolo, T. J. Norman, A. Etuk, F. Cerutti, R. W. Ouyang, et al. Supporting reasoning with different types of evidence in intelligence analysis. In *Proc. of the 14th Intern. Conf. on Autonomous Agents and Multiagent Systems*, 2015.

[6] D. Walton, C. Reed, and F. Macagno. *Argumentation schemes*. Cambridge University Press, 2008.