Computational Models of Argument
C. Reed et al. (Eds.)

doi:10.3233/FAIA240339

Identifying Diagnostic Arguments in Abstract Argumentation[1]

Jordan ROBINSON [a,2], Katie ATKINSON [a], Simon MASKELL [a] and Chris REED [b]
[a] *University of Liverpool*
[b] *University of Dundee*

Abstract. This demo paper introduces an application that is capable of identifying and visualising *diagnostic* arguments within abstract argumentation systems. The software presented is underpinned by a novel algorithm, called the *Diagnostic Argument Identifier*, that combines a semantic-based approach with a technique from the information-theoretic literature, to quantify the impact that the removal of an argument has on the acceptability of other arguments.

Keywords. abstract argumentation, information theory, intelligence analysis

Intelligence analysis involves reasoning with incomplete, conflicting and uncertain information. The Analysis of Competing Hypotheses (ACH) is a well-known tool that provides intelligence analysts with a simple yet systematic approach to complex analyses [1]. In short, the ACH includes: the generation of hypotheses using available data; the creation of a matrix with the hypotheses (as column headers) and information, evidence and assumptions (as row headers); the assessment of the consistency or otherwise of row entries with each hypothesis; the calculation of the likelihood of each hypothesis using inconsistency scores only; a sensitivity analysis to estimate the dependence of the probability of hypotheses on row entries; the reporting of the probabilities of hypotheses and diagnostic information to stakeholders operating within intelligence scenarios.

According to Pherson and Heuer [2], sensitivity analysis enables analysts to identify how dependent the likelihood of their conclusions are on row entries within the ACH matrix. In this context, sensitivity analysis compels analysts to critically reassess their conclusions after the removal of each row from the matrix. A data point is deemed *diagnostic* if the likelihood of a hypothesis changes after its removal.

We developed an algorithm, called the *Diagnostic Argument Identifier* (DAI), that draws upon the notion of sensitivity analysis, making it the first attempt within the literature to employ argumentation for this task. Using Dung's formalism [4], the algorithm computes mutual information (MI) [3] between partitions of the labels of multiple arguments, across the set of labellings. The algorithm computes *diagnosticity scores* which quantify the change in MI between partitions of argument labels before and after the removal of each argument from an argumentation framework (AF). After completion of a run of the algorithm, each argument's set of diagnosticity scores is stored within a *di-*

[1]This work was funded by both the Defence Science and Technology Laboratory and the United Kingdom's Engineering and Physical Sciences Research Council (Grant number: EP/S023445/1).
[2]Corresponding Author: Jordan Robinson, J.Robinson9@liverpool.ac.uk.

agnosticity vector, which holistically captures the sensitivity, dependence and robustness of an AF's evaluation as a function of that argument and its removal from an AF.

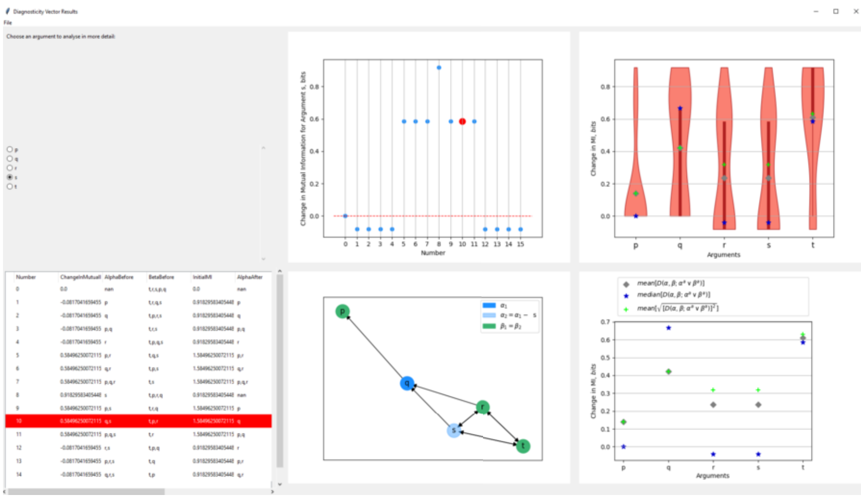

Figure 1. A window from our application visualising the diagnosticity vector output by the DAI.

This paper accompanies a demo that presents an application which can execute the DAI and visualise the diagnosticity vector (Fig. 1). The software allows intelligence analysts to instantiate abstract AFs pertaining to their particular problem, evaluate them, and run the algorithm to identify diagnostic arguments. The tool has multiple benefits. First, the application enables analysts to identify the arguments that are the most crucial. Second, the algorithmic approach employed produces repeatable and explainable results, reducing the subjectivity in sensitivity analyses relative to this being mentally assessed by analysts. Finally, the software allows analysts to focus their efforts in time critical situations by ranking the importance of arguments within an analysis. Thus, the DAI offers a wide range of potential applications in, e.g., decision and deliberations problems, and in the general assessment of the most critical arguments within a debate.

References

[1] Heuer RJ. Psychology of Intelligence Analysis. Center for the Study of Intelligence; 1999.

[2] Pherson RH and Heuer RJ. Structured Analytic Techniques for Intelligence Analysis. SAGE Publications; 2019.

[3] Shannon CE. A Mathematical Theory of Communication. The Bell System Technical Journal. 1948;27:379–423.

[4] Dung PM. On the acceptability of arguments and its fundamental role in nonmonotonic reasoning, logic programming and n-person games. Artificial Intelligence. 1995;77(2):321–57.