

IARPA REASON PROGRAM - CAPABILITY STATEMENT
CENTRE FOR ARGUMENT TECHNOLOGY

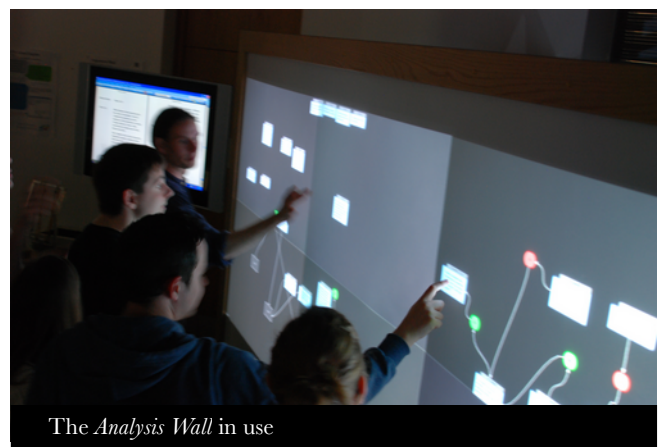
www.arg.tech

January 2, 2023

ORIENTATION. The Centre for Argument Technology, ARG-tech, based at the University of Dundee in Scotland, has a twenty-year track record of working in argument technology¹ and is the largest such research group in the world. Its interdisciplinary research runs from philosophical and linguistic foundations, through applied research in domains including intelligence, healthcare, finance, politics and law, through algorithm and theory development in AI, to system engineering and deployment. ARG-tech has over 200 publications, and has secured in excess of \$13m in research funding, almost a third of which is in the intelligence sector, including \$1.3m from the Ministry of Defence in the UK and \$2.5m from IARPA in the US. Its software has hundreds of thousands of users globally and it has partnered with organisations including IBM, the UN and the BBC. It is a world leader in the application of theories of argumentation in AI, and has pioneered the underpinning standards for the Argument Web, an open ecosystem of interoperable tools for analysing, representing, manipulating, evaluating, analysing and visualizing argumentation. It maintains data infrastructure and curates the largest datasets of analysed argumentation currently available, and provides tools for manual and automated analysis, as well as the design, hosting and publishing of such corpora. The Centre's commercial arm, Arg Technica Ltd., is responsible for taking results to market, and also coordinates one of the largest standing linguistics annotation teams ever assembled.

¹ Reed, C. (2021) "Argument technology for debating with humans", *Nature*, 591, pp373-374.

UNDERSTANDING IC PRODUCT. The Centre has developed a range of tools for analysing and representing the structure of reasoning, founded on the AIF standard² for computational models of argument. Our *OVA* software (ova.arg.tech) has over 100,000 users and provides a mature platform for analysis, whilst the *AIFdb* infrastructure (aifdb.org) that is managed by the Centre provides a robust environment for dataset curation for groups around the world, hosting over 200 corpora covering 3m words of analysed argumentation (corpora.aifdb.org). In research funded by the UK's Ministry of Defence, we have developed mechanisms by which structured techniques from the IC such as ACH are used as a means of providing coarse-scale navigation of complex argument-based information landscapes (achnav.arg.tech). Adding capability for live processing of reasoning data, we also engineered both hardware and software for the *Analysis Wall*, a 10-foot long touchscreen for the real-time analysis of argumentation.



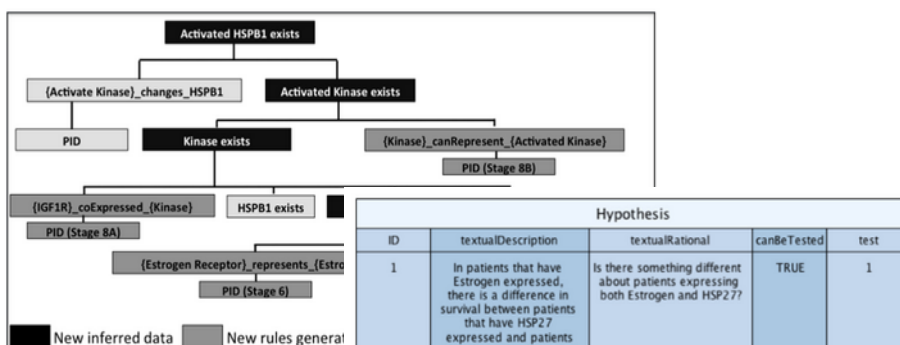
The *Analysis Wall* in use

² Chesnevar, C., McGinnis, J., Modgil, S. Rahwan, I., Reed, C., Simari, G., South, M., Vreeswijk, G., Willmott, S. (2006) "Towards an Argument Interchange Format", *Knowledge Engineering Review*, 21 (4), pp293-316.

DISCOVERING EVIDENCE & DEVELOPING HYPOTHESES. With rich reasoning structures come a range of algorithmic and semantic opportunities. Complementing visualisation of very large scale argument networks available in *ArgNav* (argnav.arg.tech), *Argument Analytics* (analytics.arg.tech) offers a suite of automatically generated infographics to provide answers to questions about the structure and quality of reasoning. These analytics were employed in work with the BBC aimed at providing audiences with insight into topical debate broadcast on Radio 4, becoming Radio 4's most-visited web page³ ever. The same underlying knowledge graph structures also support sophisticated semantic search algorithms (developed by FORTH, the top AI institute in Greece), as well as automated reasoning



techniques. In healthcare, the Centre has developed techniques for automatically identifying gaps in evidence and generating new hypotheses in the domain of cancer research. Systems used in this research formed the basis for subsequent laboratory investigation that then went on



King et al. *Breast Cancer Research* 2012, 14:R40
<http://breast-cancer-research.com/content/14/2/R40>

Breast Cancer RESEARCH

RESEARCH ARTICLE **Open Access**

Immunohistochemical detection of Polo-like kinase-1 (PLK1) in primary breast cancer is associated with TP53 mutation and poor clinical outcome

Sharon I King, Colin A Purdie, Susan E Bray, Philip R Quinlan, Lee B Jordan, Alastair M Thompson and David W Meek*

From automatic argumentation-based reasoning to testable hypotheses to published result: The hypothesis-generation pathway in cancer genetics

³ <https://www.bbc.co.uk/programmes/articles/251N2YBLWmPjNvDn94GQR/moral-maze-eight-ways-to-win-an-argument>

to be published in journals such as *Cancer Cell* and the *British Journal of Cancer*. Over the past eighteen months or so, an exciting new frontier has opened up, rooted in the philosophical notion of intertextuality – the way in which meaning in one discourse is developed in part through reference to other discourse. A reference from, say, a newspaper article to a discussion in parliament that in turn refers to scientific articles on climate change, is linguistically very sophisticated and such connections are enormously challenging for computational models to handle. In preliminary work, we have identified a number of linguistic mechanisms used to establish these connections⁴ and we are now using them to build techniques for automatically identifying relevant new information from unconstrained discourse.

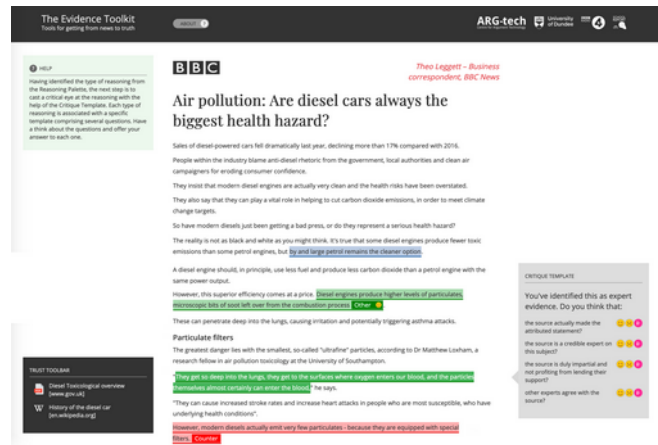
ASSESSING QUALITY & AUTOMATING CRITIQUE. In further work with the BBC, the Centre made use of its recent results in argument mining^{5,6} to develop *The Evidence Toolkit*⁷, an application aimed at helping school children identify fake news, drawing on correspondences between structures of fake news and structures of poor argumentation, as well as providing a Trust Toolbar for automatically identifying relevant additional evidence online. *The Evidence Toolkit* was deployed into every secondary school in the UK, supported by lesson plans and teacher resources. Supporting such critiquing of reasoning can also be automated in one of three ways: at a semantic level; at a

⁴ Visser, J., Duthie, R., Lawrence, J. & Reed, C. (2018) "Intertextual Correspondence for Integrating Corpora" in Calzolari, N. et al. (eds) *Proceedings of the Eleventh Language Resources and Evaluation Conference (LREC 2018)*, ELRA, Miyazaki, pp3511-3517.

⁵ Lawrence, J & Reed, C. (2019) "Argument Mining: A Survey", *Computational Linguistics*, 45 (4), pp765-818.

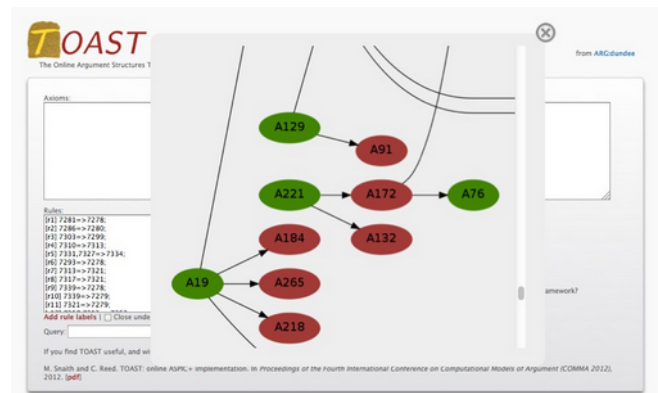
⁶ Jo, Y., Bang, S., Reed, C. & Hovy, E. (2021) "Classifying Argumentative Relations Using Logical Mechanisms and Argumentation Schemes", *Transactions of the Association for Computational Linguistics (TACL)*, 9, pp721-739.

⁷ Visser, J. Lawrence, J. & Reed, C. (2020) "Reason-Checking Fake News", *Communications of the ACM*, 63 (11), pp38-40.

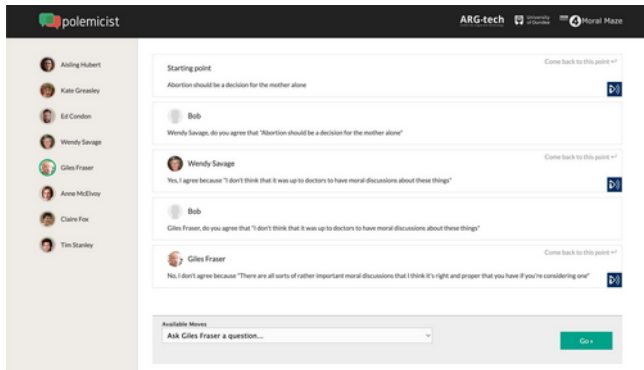


The Evidence Toolkit that was deployed in partnership with the BBC into every secondary school in the UK

deep structural level; and at a surface textual level. To automatically compute the results of argument attack semantics, we developed *TOAST* (toast.arg.tech) which provides a bridge to results from the abstract argumentation systems community. By using *TOAST*, algorithms for calculating which arguments to accept when there are many conflicting and uncertain pieces of information can be harnessed in tasks such as hypothesis testing, narrative consistency and assumption criticality analysis. At the structural level, judging and giving feedback on the quality of reasoning structures was the goal of our *argugrader* software (argugrader.com) that has been used by universities such as CUNY to automatically grade undergraduate assignments in critical thinking. At the textual level, in our *Skeptic* system we have provided a web service to which argumentation can be submitted for



The *TOAST* service



The *Polemicist* application

automatic identification of critique. After processing through our argument mining algorithms, *Skeptic* provides critique according to philosophical theories of argumentation that associate critical questions with stereotypical patterns of reasoning or argumentation schemes⁸. Although *The Evidence Toolkit*, *arggrader* and *Skeptic* all provide single-shot assessment of reasoning (albeit, in the first case, templated through a number of steps) such critique naturally forms a foundation for dialogical interaction – iterative deepening of critical assessment and enhanced rigour in reasoning. To handle dialogue, we have built both a programming language (the Dialogue Game Description Language, DGDL) and an accompanying interpreter, (the Dialogue Game Execution Platform, DGEP) by which rapid application development of dialogue systems becomes straightforward, reducing development time from months to hours⁹. An example application built on DGDL and DGEP is *Polemicist* (online at polemici.st) which provides for mixed-initiative argumentation in the context of broadcast debate, and was deployed in partnership with the BBC to allow audiences to take part in discussions after broadcast. As an example of the flexibility of the tools, the same DGDL-DGEP environment was also used

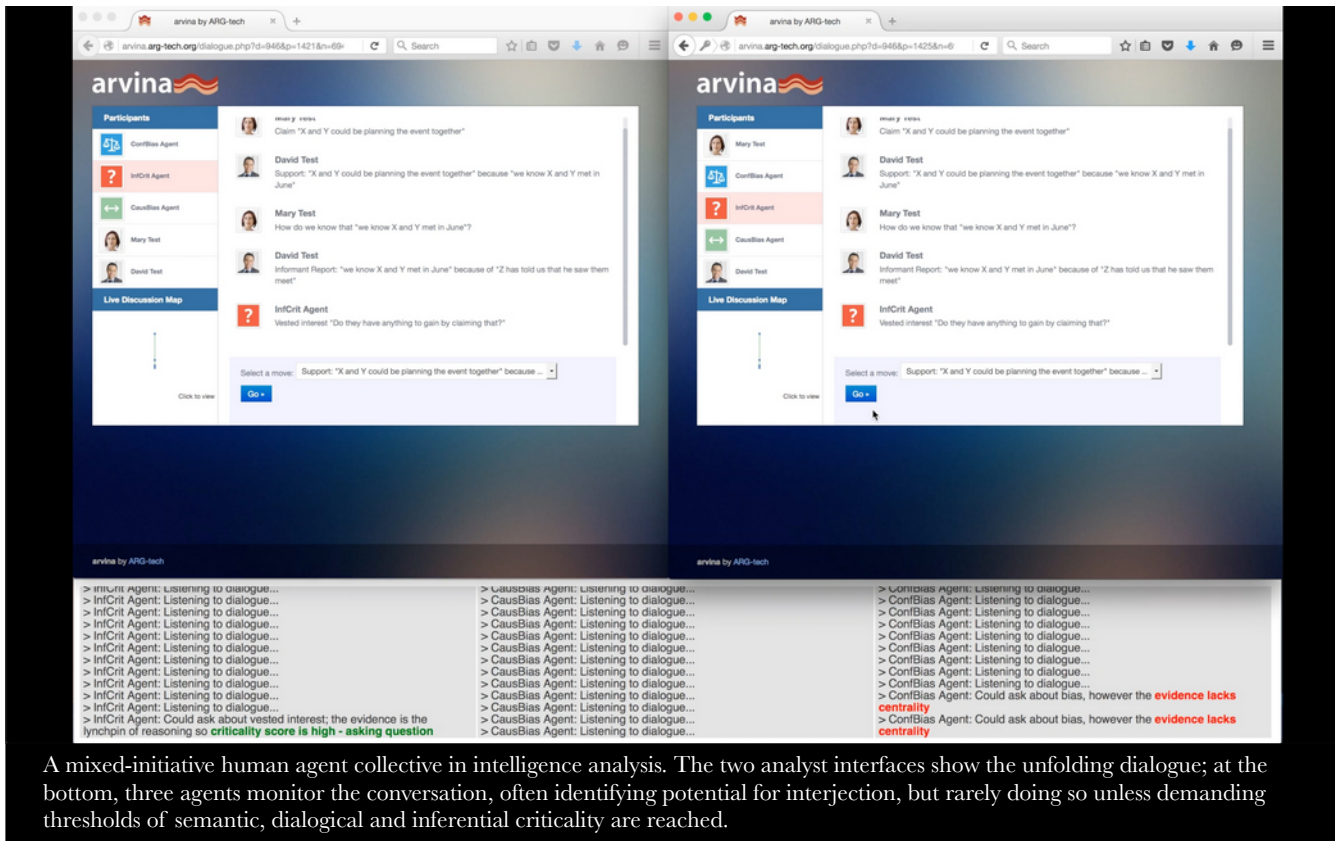
⁸ Walton, D., Reed, C. & Macagno, F. (2008) *Argumentation Schemes*, Cambridge University Press.

⁹ Reed, C., Budzynska, K., Duthie, R., Janier, M., Konat, B., Lawrence, J., Pease, A. & Snaith, M. (2017) "The Argument Web: an Online Ecosystem of Tools, Systems and Services for Argumentation", *Philosophy & Technology*, 30 (2), pp137-160.

in the development of a chatbot training tool for journalists tackling disinformation around Covid vaccination (fni.arg.tech). The tool has been adopted by the WHO as part of their media training programme. More recently, the DGDL-DGEP stack has been deployed for the Ministry of Defence, MoD, in the UK as an on-demand service, *Dialogue as a Service*, or DaaS. The DaaS infrastructure has been used in two settings so far. The first is in modelling and understanding the ways in which interlocutors take part in discourse. The Centre developed an initial prototype of this idea with seed funding from the MoD's Defence & Security Accelerator, which demonstrated proof of concept. With certain



The *Dialogical Fingerprinting* demonstrator at a Ministry of Defence R&D event



A mixed-initiative human agent collective in intelligence analysis. The two analyst interfaces show the unfolding dialogue; at the bottom, three agents monitor the conversation, often identifying potential for interjection, but rarely doing so unless demanding thresholds of semantic, dialogical and inferential criticality are reached.

assumptions and constraints, it is possible to identify speakers not by what they are saying but by how they contribute to discourse – what we called their *dialogical fingerprint*. Because dialogical fingerprints are likely to be stable across domains, cultures and even languages, our experience in this area led to funding from IARPA under the HIATUS program, focusing on identification, obfuscation and explanation of author attribution. The second area of application of DaaS has been in the development of a human-machine teaming prototype to critique IC analyst reasoning. Multiple analysts develop an understanding through communicating through the platform; their discussions are monitored in real time by several autonomous agents each of which has access to language processing and argument mining techniques in particular. Each agent is tracking argumentative structures of a particular type, aiming to identify potential stereotypical weaknesses, borne, for example, of cognitive biases. Given thresholds of relevance, structural

criticality, and interactional profiles, the agents will interject and offer critique when it is most valuable. The responses that analysts give to these interjections help to improve the rigour, quality and explainability of their judgements. A video showing this human-agent collective prototype in action can be seen at arg.tech/hac. Whether with explicit dialogue such as *Polemicist*, or systems that focus on iterative ‘nudging’ of the development of argumentative quality, DaaS provides a demonstrated environment for rapid application development.

TO find out more about the Centre for Argument Technology, visit our web page, www.arg.tech, or follow us on Twitter [@arg_tech](https://twitter.com/arg_tech). For a non-technical overview, try either watching a video narrated by Stephen Fry describing the motivation and approach in the work of the Centre youtu.be/7cN3rZ5h3LE or read an article we wrote for *Newsweek* www.newsweek.com/artificial-intelligence-argument-debate-752199.