How can we design Tactile Interactive software for Argument Construction in Criminal Intelligence Analysis?

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ABSTRACT

Different domains have enhanced the research on argumentation construction, but each enhancement relate either to evidence or to the relevance of evidence, thus making them the foundation elements of argumentation construction. By understanding how Criminal Intelligence Analysts understands and manages these foundation elements, as well as how they differ to the law domain counterparts, I aspire to create an argumentation schema, which can support the fluid and rigour model. The fluidity refers to the explorative sense making phase were uncertainty is high and the commitment to outcomes is low. Rigour refers to the verification phase of sense making where uncertainty is low and the commitment to outcomes is high. Two qualitative studies have produced insights on how Criminal Intelligence Analysts understand and manage the foundation elements of argumentation. Further research is required to design an argumentation schema that can operate effectively within the fluid and rigour model.

KEYWORDS

Uncertainty; Sense making; Argumentation Schemas; Security; Government and Law

INTRODUCTION

The aim of this research is to answer the question, "How can we design Tactile Interactive software for Argument Construction in Criminal Intelligence Analysis?" This question originated by working on the Visual Analytics for Sense Making in Criminal Intelligence Analysis (VALCRI) project, in an attempt to understand how Criminal Intelligence Analysts (from now on referred to as Analysts) think, which then could inform designers on how to design software programs to assist Analysts with their daily analytical activities.

In the work of Wong (2014), he describes the concept of a fluidity and rigour model (See Figure 1). Rigour refers to the "ability of system processes and results to withstand interrogation that ensures that conclusions are valid" (Wong, 2014). During low rigour, the story about the case events is loose and the focus for the Analyst is to gain traction. As the case progresses and the Analyst have gained more knowledge about events and their inter-relationships, the Analyst enters the rigour stages of the analysis where a formal argument can be constructed. Fluidity refers to the "ease by which a system can be used to express the variability of the Analyst's thinking processes" (Wong, 2014).

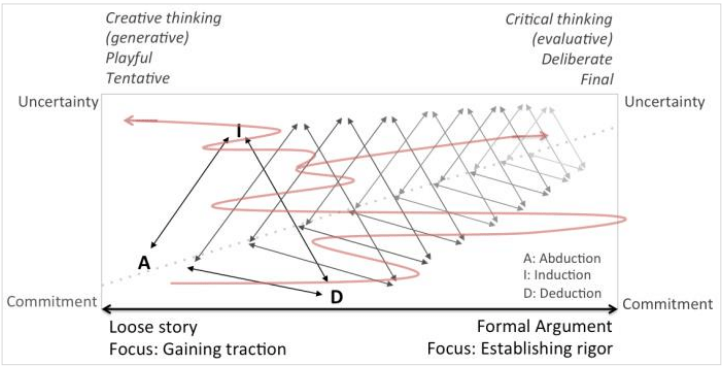

Figure 1 - Fluidity and Rigour Model (Wong,2014)

In an experiment by Takken and Wong (2013), they found that participants were able to construct twice as many relationships between items in a dataset, when they were allowed to interact directly with the data items using their hands, than the group who were deprived thereof. The VALCRI project has adopted tactile interaction as a design principle, therefore the Analyst should be allowed to construct an argument as such.

The construction of arguments is a well-researched topic in the law domain. The likes of Toulmin (2003) and Wigmore (1931) have provided researches with both simplistic and not-so-simplistic views on what is required

to create a well-formulated argument that can hold up in a court of law. Bex et al. (2014) elaborated on these argumentation formulation ideas by creating a formal hybrid theory model, encapsulating argumentation theories, narrative and criminal evidence into a single concept.

Current research in the law domain fits well in with the ideas of the rigour part of the model, but problems arise when trying to make the same constructs fit in the fluidity part without modification. The reason for this being that although the same terms occur in both the law and sense making domains, the understanding and interpretation is different. This raises the question on how much modification is required to make it work in the fluidity part, so that it can seamlessly evolve and contribute to the rigour. To answer this question, requires one to understand what the basic components of argumentation is, how the same components work in the sense making domain and finally, how to make it all work together.

The section below briefly outlines the relevant literature, which inspired this research.

LITERATURE

Argumentation has been around since Pre-Socratic times and Wigmore contributed to argumentation research in 1931, by creating an argumentation diagram (also known as an argumentation map). This shows the relevant components of an argument as a graphical representation and it was designed to assist the law domain with the construction of robust arguments for trial cases in a court of law. The notation was however difficult to learn and understand until Toulmin in 2003 presented a simplistic model for representing arguments in general. Toulmin's model is now preferred by scholars over Wigmore, but most still reverts to the hierarchical layout that Wigmore introduced to represent the argumentation components and the relationships between them. In the work of Pennington and Hastie (1993) which started as early as the nineteen eighties, introduced the role of narrative as way to convey and explain the argumentation components. This extended the concept of argumentation to have a social component, which assists the logical and rational side. But, it is this overwhelming logical and rational side which prompted the integration of artificial intelligence and law (AI&Law) in the mid nineteen nighties, by looking for ways to assist the formulation of argumentation using quantitative models (Nissan, 2009). Even though scholars have progressed research on argumentation, they all seem to have basic components on which these enhancements are made.

When looking at Toulmin's work (2003), he has formulated six basic components in constructing a general argument namely, *claim*, *datum*, *warrant*, *backing*, *qualifier* and *rebuttal*. In order for a claim (or conclusion) to be accepted as true, Toulmin asks us to formulate our persuasion by means of datum (or grounds of acceptance or premise). If the validity of the datum is under question, then the warrant is used to link the datum with other ground truths, which shows the relevance of the datum in support of the claim. One can strengthen the warrant with additional backing in the form of supporting information to strengthen the relevance. A qualifier indicates the applicability of the link from the datum to the warrant and could be used as a means to ring-fence the argument to be relevant to a set of conditions. A rebuttal is a counter argument, which contradicts the initial claim.

Wigmore (1931) diagrams are constructed using mainly the components of evidence and forces. Evidence are the statements or assertions made and the forces are the degree to which evidence supports (affirmatory) or opposes (negatory) another piece or pieces of evidence. Both the affirmatory and negatory forces play a role in determining the relevance of evidence as the affirmatory supports the argument and the negatory supports the counter-argument (rebuttal). For this reason, modern day lawyers are still focused on evidence and relevance when constructing arguments (Allen et al, 2015).

Pennington and Hastie (1992) concluded that showing mere evidence was not enough in a court of law and that narrative played an important part in conveying the facts to the jury. Their work concentrates on knowing what is required to successfully *explain* or *explain away* either the evidence or the relevance of evidence. Bex et al's (2010) hybrid theory concentrates on explaining the events in a judicial case by using narrative to explain the relevance of the causal connections between the events and using the evidence to anchor the facts in general and acceptable common sense rules.

AI have examined the possibility of using Bayesian logic (Nissan, 2009) to assign probabilities to different pieces of evidence and can use knowledge maps and ontologies to determine the relevance of evidence to a particular legal consequence. This in turn allows an artificial agent to quickly review the available evidence and then construct arguments and counter-arguments, which should ease the burden on lawyers, judges and juries.

It is of interest to note that although different domains have contributed to the construction of argumentation, they all use the similar elements of evidence and relevance from which to do so. Table 1 provides a summary of the different domains and their use of evidence and relevance.

Table 1 - Summary of the concepts of Evidence and Relevance in different domains

Scholars	Domain	Evidence	Relevance
Toulmin (2003)	Argumentation	Datum, Backing	Warrant, Qualifier
Wigmore (1931)	Argumentation & Law	Statements as evidence	Forces
Allan (2015)	Law	Legal Evidence	Relevance to legal consequences
Pennington & Hastie (1992)	Narrative & Law	Explain or explain away	Explain or explain away

Bex et al. (2010)	AI & Law	Evidence as Anchors	Narrative to explain causal relationships
Nissan (2009)	AI & Law	Assign probabilities	Link to knowledge graphs or ontologies

The section below looks at how the sense making domain regards evidence and the process of attaining it.

Pirolli and Card's (2005) Notional Model of Analytical Sense making provided researchers with a model, clearly illustrating the complexities of the processes involved to move from raw data to presenting a conclusion to the decision makers. These processes involve sixteen steps governed by three main loops that consist out of foraging, sense making and reality-policy loops. Foraging involves direct manipulation of the data such as searching, filtering, reading, extracting and the organisation of data. The sense making loop involves the building of a case by means of schemas, hypotheses and searching for support to substantiate these theories. The third loop governs the policies and procedures under which the other two loops operate.

Wong (2014) built upon this by defining the concepts of fluidity and rigour. Fluidity refers to how easily the system allows the Analyst to express their various types of thinking processes and rigour refers to the ability to test the validity of outcomes of processes. I have found that fluidity and rigour can also refer to the type of sense making that is required to occur at different stages of the analysis. Fluid sense making refers to the exploration of ideas and the extension of knowledge. Rigour sense making refers to the verification stage of sense making when the Analyst is required to verify the correctness of ideas and knowledge gained. Both of these stages require the Analyst to be "rigour" in the form of due-diligence, as it is part of their obligations. Ultimately, the systems design should match fluidity and rigour through interaction and processes, as well as the fluidity and rigour of sense making in the form of exploration and verification.

Klein et al. (2007) introduced the concept of using data elements as anchors to "create understanding and guide subsequent inquiry". Wong and Kodagoda (2015) used this to further investigated how the analytical inferencing process propagates from one conclusion to another and suggested that Analysts use both data and non-data anchors, which affords the process of gaining traction to reach a conclusion. These anchors have a variable level of certainty attached to it, which in turns influences the certainty of the conclusion reached by using it. This falls in line with the guidelines of the Association of Chief Police Officers (ACPO) Core Investigative Doctrine, which states that Analyst's conclusions should adhere to the highest degree of certainty to minimise personal bias and stereotyping (ACPO, 2005).

Evidence in the law domain therefore serves as anchors which validates the certainty of a conclusion, whereas the anchors in the sense making domain servers as exploratory elements to assist with reaching a conclusion of variable certainty. In the law domain, evidence refers to something tangible that could be handed over to a jury for inspection (i.e. a murder weapon), proven facts (i.e. a medical examiner's DNA report), witness statements or a collection of carefully formulated exhibits as support for evidential facts (Allen et al, 2015). In the sense making domain, the Criminal Intelligence Analyst mainly works with information which contains very few facts from the onset (if any at all) and their job is to determine the facts and create exhibits as evidence for a court of law. It is this difference between what is considered as evidence, the certainty it encapsulates and the role it plays, what sets the fluidity and rigour stages apart within sense making activities in relation to argumentation.

This suggests a rethink about how argumentation schemas can be used in the sense making domain to capture the Analyst's creative and exploratory path in finding evidence, which eventually will support their conclusion with the highest degree of certainty, but which does not hinder them from reaching a conclusion or forcing them to commit to outcomes prematurely.

If evidence and relevance can be regarded as the foundation concepts of argumentation, then understanding how the sense making domain understands these concepts, might shed light on how to construct arguments in this domain. Various other considerations play a role. The VALCRI system is an intentional system, which means that the system's functionality should not only match the procedural processes of the analytical task, but also the thinking processes (as intent) of the Analyst. This means that we as researchers should understand how Analysts think and then design tools to assist those intentions, rather than hindering creativity with inflexible processes that will not allow them to continue to the next step until the current is complete. The underlying rigour should still be present, so that when the Analyst has found enough information s/he can test the validity and make the required adjustments as needed. We therefore strive to develop tools, which would not just follow one processing path, but which allows the Analyst to construct many paths from a point of intent in a visible and tactile manner. The law of requisite variety says that "R's capacity as a regulator cannot exceed its capacity as a channel for variety" (Ashby, 1958). In our case, this means that the design of the system should as a minimum, accommodate the known number of possible intentions from the Analyst. By researching evidence and relevance as the foundation concepts of argumentation and how the Analyst perceives them, should allow us to determine what those intentions are and then design our tools in such a way to accommodate each, thus satisfying the law of requisite variety.

The next section outlines the relevant research questions.

METHODOLOGY

The research questions of interest are:

- RQ1 How do Analyst perceive and manage (un)certainty?
- RQ2 How do Analysts determine and manage Relevance of Evidence and information?
- RQ3 How can the Analysts populate and use a low commitment argumentation schema?

RQ1 and RQ2 are answered through the data analysis process conducted on Cognitive Task Analysis (CTA) interviews from five experienced Operational Criminal Intelligence Analysts in the UK and Belguim. Volume crime and serious crimes are two types of case classifications that the Analysts work with and the CTA interviews covered both types of classifications. Volume crime entails a significant impact on the community through sheer volume in the number of offences (College of Policing, 2009). The Police Act of 1997 define serious crime as, "(Section 93.4a) [the crime] involves the use of violence, results in substantial financial gain or is conduct by a large number of persons in pursuit of a common purpose or (Section 93.4b) the offence or one of the offences is an offence for which a person who has attained the age of twenty-one and has no previous convictions could reasonably be expected to be sentenced to imprisonment for a term of three years or more " (Legislation.gov.uk, 1997).

The data analysis was performed in line with the phases as outlined per Crandall et al. (2006) and the phases are, preparation, data structuring, discovering meanings and representing findings. The Open Coding technique was used to code the data during multiple passes through the data. This in term made it possible to find themes in support of the research questions.

RESULTS AND CONCLUSION

The results of RQ1 outlined eleven problems that hinder sense making and which collectively influence the level of uncertainty surrounding outcomes of sense making activities. By considering the inverse of each problem, reveals the likely aspirations that the Analyst could have had and why a particular strategy was successful in overcoming each problem. The identified aspirations are Certainty, Believable, Plausible, Simplicity, Clarity, New Possibilities, Connectivity, Meaning/Information, Correct (Data Quality), Creativity and Increased Understanding. These aspirations influence the collective level of certainty surrounding the outcomes of sense making activities, similarly, to how the problems contribute to the collective level of uncertainty. By understanding how the Analyst gradually increases certainty of outcomes, may assist with understanding the requirements of fluid schemas, which would support exploratory outcomes with varying levels of certainty and low commitment in using all of the outcomes in the schema.

The results of RQ2 outlined the concept of entities, which follows a lifecycle within a sense making environment. It was observed that these entities (which refer to both people and objects), are abstracted from the available information by the Analyst. They are then catalogued and their gradual changes in significance tracked for the duration of the analysis or until the entity loses its value in relation to the Analyst's goals. Significance refers to the implication the entity has on the current thinking regime of the Analyst. If the significance of an entity increases then the Analyst considers it as explaining or revealing more than what is currently known or understood and brings the Analyst closer to the answer. When the significance decreases then the Analyst found contradictory information, hit a dead end or the current explanation seems less likely than initially thought. So both types of significance enhances the Analyst's understanding, but in different ways and yielding different results. This abstraction of information into entities takes place when the most certain information is available or when the Analyst deems something interesting or strange. This ability to differentiate between what is normal and what is considered interesting and strange, may be a product of years of experience that the Analyst cultivated. The entity therefore has a lifecycle starting with creation, followed with growth by means of increased significance, stagnation through decreased significance, and then either death when the entity has no significance left or if there is no more information to continue the cycle. Resurrection is possible if new information becomes available and if it is significant to the goals of the Analyst.

RQ1 assists with understanding how Analysts gradually increases their understanding surrounding analytical outcomes and how those outcomes evolve into conclusions with the highest possible level of certainty. RQ2 assists with understanding how Analysts orient themselves in the analysis and how they determine which entities have significant impact on the goals of the analysis. This in turn allows the Analyst to determine what is relevant and worth investigating further and what is not.

RQ3 has not been investigated yet, but the aim is to use the results from RQ1 and RQ2 to determine how to design a schema that would allow analytical outcomes to evolve over time with different levels of certainty and low commitment to using all outcomes. RQ1 relates to the element of *evidence* and RQ2 relates to the element of *relevance* as found in the law domain. If designed correctly, then it may be possible to evolve a fluid sense making schema into a rigour argumentation schema. This would allow the Analyst to take advantage of the enhances in argumentation creation from the law domain, but at the same time allow them to playfully explore the information and enhance their understanding without overcommitting to something that may be too rigid for their sense making needs.

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