Two Forms of Explanations in Computational Assumption-based Argumentation

(Extended Abstract)

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ABSTRACT

Computational Assumption-based Argumentation (CABA) has been introduced to model argumentation with numerical data processing. To realize the “explanation power” of CABA, we study two forms of argumentative explanations, argument explanations and CU explanations representing diagnosis and repair, resp.

Keywords

Argumentation, Explanation

1. INTRODUCTION

Assumption-based Argumentation (ABA) [8] is a form of structured argumentation with applications in many areas [6]. However, when used as a modeling tool, ABA has limited ability to directly model systems involving numerical calculation. For instance, in ABA based decision making work, e.g. [3, 4], the relations between decision candidates and agent goals need to be “pre-compiled” into binary predicates rather than analyzed from data. The lack of numerical calculation is a major hindrance to ABA applications requiring intensive data processing.

The Computational Assumption-based Argumentation (CABA) framework [2], an ABA extension, introduced Computation Units (CUs) [5] to capture computation that is difficult to represent with standard ABA. A unique advantage of CABA is that, while supporting numerical calculation, it enhances the “explanation power” of argumentation by connecting results obtained from numerical calculation to high-level arguments. We study two forms of CABA explanations, argument explanation (arg-explanation) and CU explanation, for non-acceptable arguments. We leverage on the established relation between CABA and Abstract Argumentation (AA) [1] for our work. For a non-acceptable argument A, its arg-explanation gives a form of diagnosis, identifying attacking arguments that cannot be defended. Its CU-explanation represents a form of repair, identifying “fixes” that would render A acceptable.

2. EXPLANATION IN CABA

We introduce CABA explanations with a version of the Multiple Attri-bute Decision Making problem presented in [9]. Good Col-

Table 1: Student Candidate Admission Data.

<table>
<thead>
<tr>
<th>Student</th>
<th>Exam1</th>
<th>Exam2</th>
<th>Interview</th>
<th>EA</th>
</tr>
</thead>
<tbody>
<tr>
<td>s1</td>
<td>92</td>
<td>89</td>
<td>A</td>
<td>No</td>
</tr>
<tr>
<td>s2</td>
<td>93</td>
<td>85</td>
<td>A</td>
<td>No</td>
</tr>
</tbody>
</table>

lege is admitting students. To evaluate candidates, four attributes are considered: Exam1, Exam2, Interview and Extracurricular Activity (EA). Exam1 and Exam2 are scores ranging from 0 to 100; Interview is a rank from E to A; EA is a binary value, (Yes/No). The selection criterion is specified with two conditions C1 and C2, such that: (C1) The average score of Exam1 and Exam2 is greater than 90, or EA is Yes; and (C2) the Interview rank is A. A student is admitted iff both C1 and C2 are met.

Table 1 presents the attributes of two candidates, s1 and s2. Here, we can see that for student s1, his average exam score is \((92 + 89)/2 = 90.5\), hence meeting condition C1; his interview rank is A, meeting condition C2; therefore s1 should be admitted. For s2, his average exam score is \((93 + 85)/2 = 89\) and he has not performed any extracurricular activity, thus failing to meet C1; although s2 has an A for his interview, s2 cannot be admitted. Here, we need to compute the average scores of Exam1 and Exam2 and test if the average is greater than 90. We pack this computation into a CU, \(u_{90} = (T_{90}, C_{90}, E_{90})\), in which:

- \(T_{90} \subseteq Z \times Z\) are the two exam scores;
- \(C_{90}(x, y) = (x + y)/2;\)
- \(E_{90} = \top\) if \(C_{90} > 90\) and \(E_{90} = \bot\) otherwise.

Similarly, we pack the checks for Interview and EA into CUs \(u_{int}\) and \(u_{ea}\), resp, as follows.

\[u_{int} = (T_{int}, C_{int}, E_{int})\] in which:

- \(T_{int} = \{A, B, C, D, E\}\); • \(C_{int}(x) = x;\)
- \(E_{int} = \top\) if \(C_{int} = A\) and \(E_{int} = \bot\) otherwise.

\[u_{ea} = (T_{ea}, C_{ea}, E_{ea})\] in which:

- \(T_{ea} = \{\text{Yes}, \text{No}\};\) • \(C_{ea}(x) = x;\)
- \(E_{ea} = \top\) if \(C_{ea} = \text{Yes}\) and \(E_{ea} = \bot\) otherwise.

We use the following framework to model the admission problem.

- \(I\) is the following CUs:

\[u_{90}(s1), u_{ea}(s1), u_{int}(s1), u_{90}(s2), u_{ea}(s2), u_{int}(s2)\]

- \(L\) is the following sentences:

\[
\begin{align*}
\text{C1}(s1) & \quad \text{C2}(s1) & \quad \text{Ave>90}(s1) & \quad \text{EA}(s1) \\
\text{notC1}(s1) & \quad \text{notC2}(s1) & \quad \text{Adm}(s1) & \quad \text{INT}(s1) \\
\text{C1}(s2) & \quad \text{C2}(s2) & \quad \text{Ave>90}(s2) & \quad \text{EA}(s2) \\
\text{notC1}(s2) & \quad \text{notC2}(s2) & \quad \text{Adm}(s2) & \quad \text{INT}(s2)
\end{align*}
\]
Figure 1: An illustration of the non-admissible dispute tree for \{Adm(s2)\} ⊨ Adm(s2). This dispute tree is not admissible as it contains opponent leaf nodes \{0: \{notC1(s2)\} ⊨ notC1(s2)\} and \{0: \{notC2(s2)\} ⊨ notC2(s2)\}. The remaining rules can be seen in the appendix.

- **Definition 2.** Given a CABA framework \( F = \langle U, \mathcal{L}, R, A, C \rangle \), let \( U \) be the set of all CUs, \( f: U \mapsto \mathcal{U} \) an injective function such that for all \( u \in \mathcal{U} \), \( f(u) \) is a successful CU, then the repaired framework of \( F \) wrt some \( \Gamma \subseteq U \) is \( \Gamma' = \langle U', \mathcal{L}', R', A, C \rangle \) in which
  \[ U' = \{ f(u) | u \in \Gamma \} \cup \{ u | u \in U \setminus \Gamma \} \text{ and} \]
  \[ \mathcal{R}' = \{ s \leftarrow f(u_1, \ldots, s \leftarrow u_n, \ldots \in \mathcal{R} \text{ and } u \in \Gamma \} \cup \{ \rho | \rho \in \mathcal{R} \text{ such that there is no } CU \ u \in \Gamma \text{ in the body of } \rho \}. \]

The intuition of Definition 2 is that given a CABA framework \( F \) and some CUs \( \Gamma \) in \( F \), the repaired framework \( F' = \langle U, \mathcal{L}, R, A, C \rangle \) is another CABA framework with all CUs in \( \Gamma \) made successful and rules \( \mathcal{R} \) updated to \( \mathcal{R}' \) with new CUs replacing the ones in \( \Gamma \).

**Definition 3.** Given \( F = \langle U, \mathcal{L}, R, A, C \rangle \) with some non-admissible argument \( A \in F \), \( \Gamma \subseteq U \) is a CU-explanation for \( A \) iff the following conditions hold: (1) \( A \) is admissible in \( F' = \langle \Gamma \rangle \), (2) there is no \( \Gamma' \subseteq \Gamma \) such that \( \Gamma \) is admissible in \( F' = \langle \Gamma' \rangle \), (3) there is an admissible dispute tree \( T \) for \( A \) in \( F' = \langle \Gamma \rangle \) such that for each \( u \in \Gamma \), \( f(u) \) is not in any argument in the culprit \( \{8\} \) of \( T \).

Conditions 1 and 2 in Definition 3 specify that a CU-explanation needs to be minimum (wrt \( \subseteq \)). Condition 3 specifies that all CUs in \( \Gamma \) must be in arguments defending \( A \) in the repaired framework.

In our example, student \( s2 \) is not admitted as he does not meet condition C2, represented by the argument \( A = \{ notC1(s2) \} \cup notC1(s2) \). There are two (non-applicable) arguments, \( B = \{ \{\}, \{ u_{90}(s2) \} \} \cup C1(s2) \), and \( C = \{ \{\}, \{ u_{90}(s2) \} \} \cup C1(s2) \) attacking \( A \). If \( u_{90} \) or \( u_{90} \) were successful, then \( B \) or \( C \) would be applicable and \( A \) would be attacked. Hence, \( \{ Adm(s2) \} \cup Adm(s2) \) would be admissible. Thus, \( \{ u_{90} \} \) and \( \{ u_{90} \} \) are two CU-explanations for \( \{ Adm(s2) \} \cup Adm(s2) \). We read this as:

- **Proposition 1.** Given a CABA framework \( F \), let \( A \) be an applicable non-admissible argument in \( F \); if \( \Gamma \) is a CU-explanation for \( A \), then \( A \) also has an argument-explanation \( A' \) such that \( A \notin A' \).

Non-successful CUs are not always in a CU-explanation.

**Proposition 2.** There exists a CABA framework \( F \) with non-admissible \( A \) in \( F \) such that \( A \) is an argument-explanation for \( A \); there exists some non-applicable argument \( \{ \}, \Gamma \} \sim \{ \} \) attacking \( A \) for some argument \( A' \) for some non-successful \( u \in \Gamma \); \( u \) is not in any CU-explanation for \( A \).

**3. CONCLUSION**

In this paper, we studied two forms of explanations for non-admissible arguments in CABA, argument explanation and CU explanation, to realize diagnosis and repair, resp. In the future, we plan to explore justifications for acceptable arguments. We also plan to investigate CABA’s use in other applications and its properties related to existing argumentation frameworks.

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1. The symbol _ denotes an anonymous variable, as in Prolog.
REFERENCES


