Revival of Arguments in Temporal Argumentation Networks

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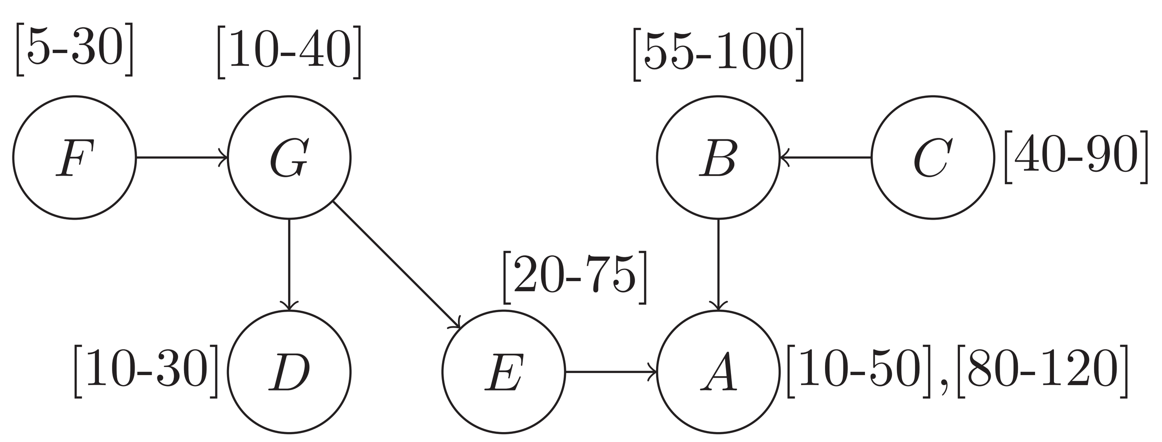
Motivation and previous work

Although the revival of arguments is a well-known phenomenon, little work has been done to characterize it. Below, we use a timed argumentation framework [1] as a case study and show its limitations. On the right, we give a general model for argument revival with a notion of coherence for extensions and apply it to an example.

Timed Argumentation Framework (TAF)

A *Timed Argumentation Framework* (TAF) [1] is an extension of Dung's [2] formalism where arguments are active only during specific time intervals. Attacks between arguments are considered *only* when both the attacker and the attacked arguments are active (see example figure below).

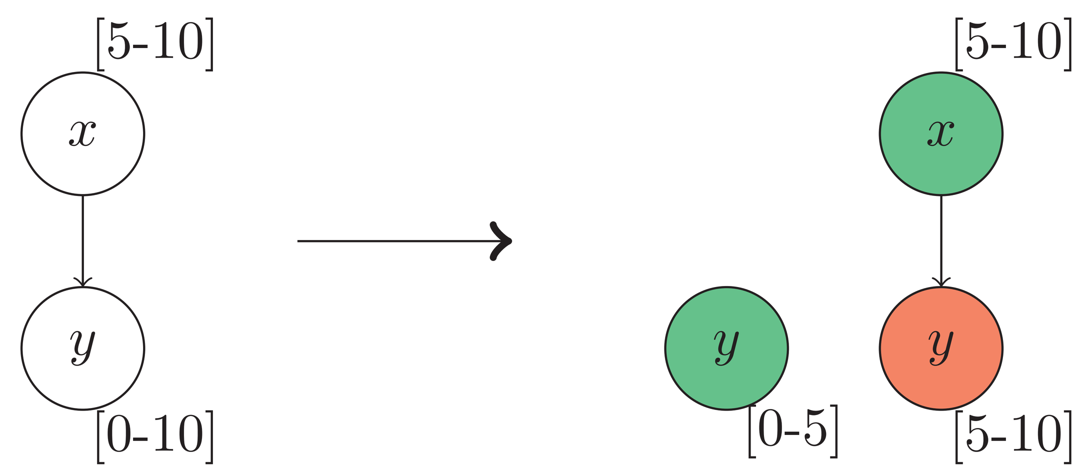
TAFs are extended [1] by also considering the availability of attacks, which intuitively means that time intervals are added to the attack relations too. The availability of an attack can not exceed the availability of the arguments involved in the attack.



Example TAF with time intervals for arguments

Limitations of TAF

In a TAF framework [1], arguments are not revived because attack relations between arguments are only considered when the arguments have overlapping time intervals. In fact, a TAF can be transformed into a regular argumentation network where each overlapping time interval between nodes is treated as a separate argument (see figure below). Instead, we would like revived arguments to have a different "status" than normal arguments.



References

[1] M. Budán, M. Lucero, C. Chesñevar and G. Simari. An Approach to Argumentation Considering Attacks Through Time. In *Lecture Notes in Computer Science, 2012.*

[2] P. M. Dung. On the Acceptability of Arguments and its Fundamental Role in Nonmonotonic Reasoning, Logic Programming and n-person Games. In *Artificial Intelligence, 1995*

Our proposal: A Model for Argument Revival

We propose a model for argument revival consisting of an *annotated network* and an algorithm to compute revival by considering only *coherent extensions*. Arguments are annotated using an *algebra of contexts*, which can be restricted to, for instance, time intervals (in the case of [1]) or locations.

Definitions

An **Annotated Network** $N = \langle S, R, \mathcal{C}, d\rangle$ consists of an ordinary argumentation network $\langle S, R\rangle$, an algebra of contexts $\mathcal{C}$, and a mapping $d : S \mapsto \mathcal{C}$ associating with each argument a context. An argument x that is annotated with some context c is denoted by $c : x$, meaning that argument x is valid in context c.

The **Immediate neighbors** of an annotated argument $c : x$, denoted by $\mu(x)$, are all its direct neighbors in the network, i.e. $\mu(x) =_{def} \{y \mid y = x \vee xRy \vee yRx\}$.

The **Context Neighbors** of $c : x$, denoted by $\nu(c)$, are arguments that have a related context to c. We leave the definition if ν unspecified for it depends on the instantiation of the context (time points, locations, etc.).

A **Revival Algorithm** $\mathcal{A} : \mathcal{C} \times S \mapsto 2^S$ returns a set of arguments that are immediately revived by some annotated argument $c : x$. This is a subset of all arguments in the *immediate neighborhood* $\mu(x)$ or in the *context neighborhood* $\nu(c)$:

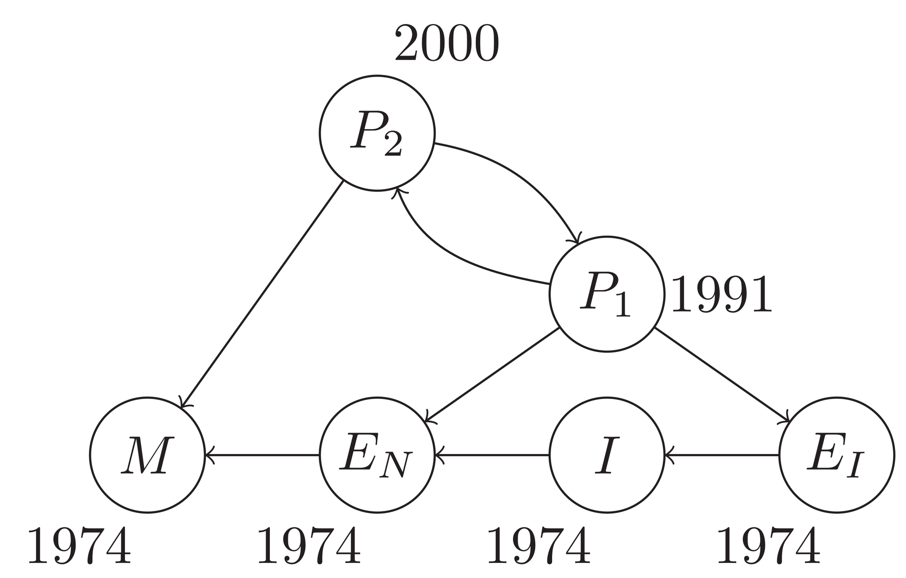
$$\mathcal{A}(c, x) \subseteq \{y \mid \nu(d(y)) \in \nu(c) \vee y \in \mu(x)\}$$

A **Revived network instantiation** N_c^{rev} contains are all arguments that are iteratively revived by the revival algorithm, starting with the arguments that are valid in c.

An **Incoherent extension** E in a revived network instantiation contains some argument $x \in E$ that is revived by the revival algorithm, but for each argument y that has revived x we have that $y \notin E$. In other words, there is no valid argument that justifies reviving x.

Case study: Murderer Scenario

Scenario In 1974, Mary died of an unknown cause. Initially, there was *no evidence* (E_N) to assume *she was murdered* (M). Then, it turned out she had acquired a very expensive *life insurance* (I), which making her husband John the main suspect. Due to *insufficient evidence* (E_I) the case against John was buried along with Mary. In early 1991 there was a scientific breakthrough in arsenic poisoning detection, showing that Mary was poisoned (P_1). John was found guilty and cursed himself for not cremating his wife when she died. Another 9 years later, an alternative method for detecting arsenic poisoning was developed, which was judged to be equally credible to the previous method and came back negative on Mary (P_2). Should John be freed from prison, or is he a murderer?



Analysis Let the context $c = 2000$ and the revival algorithm $\mathcal{A}$ "revive all connected arguments that occurred at most than 20 years ago", i.e. $\mathcal{A}(c, x) = \{y \mid (y \in \mu(x) \wedge 0 \leq \nu(d(x)) - \nu(d(y)) \leq 20) \vee \nu(x) = \nu(y)\}$. The revived network instantiation N_e^{rev} contains all arguments, since argument P_2 revives P_1, P_1 revives E_N and E_I, and all arguments that occur in 1974 (M, E_N, I, E_I) revive each other.

The two extensions of N_e^{rev} are $E_1 = \{P_2, E_N.E_I\}$ and $E_2 = \{P_1, M, I\}$. Are these extension coherent? E_2 is *incoherent*, because argument P_1 is only revived by P_2, but P_2 is out of the extension. E_1 is *coherent*, because all of the arguments in the extension have at least one argument that revives it which is in the extension as well.

Thus, using our framework we can conclude that John is *not* a murderer.

Conclusions

We proposed a novel framework for argument revival, a topic that to our knowledge has not be formalized yet. In this framework it is possible to analyze the validity of extension using a notion of coherence. Although this seems to work well in case of our example, we would like to study this in more detail by analyzing more case study. We are currently working on tax investigation, interpretation of laws and a formalization of [1]. This should help us to define the concept of revival more clearly and perhaps lead to changes in our formalism.