

Alex Djalali
Stanford University
Temporal syllogistic-style reasoning

Here, I combine the temporal logic of Reichenbach (2005) and (parts of) Allen (1983) in a unified logical system in the style of a natural logic (van Benthem 1986, Moss 2007) in an attempt to provide a computationally feasible picture of English's tense and aspect system and its interaction with temporal quantifiers like *before*, *after*, *by* and not *before* -- a privileged set, which I show, form a temporal *square of opposition* isomorphic to the classical Aristotelean one.

According to Reichenbach, sentences like (1) refer to three temporal intervals:

(1) John will have left by Tuesday

The event time (E) of (1) is the temporal interval that John will leave. The reference time (R) is (some unspecified) Tuesday; and the speech time (S) is that time in which the token itself is uttered in space-time. The tense of a verb phrase of an utterance determines the order (<) between R and S, and the aspect of that VP determines the order between E and R.

According to Allen, temporal quantifiers like *before* denote binary relations, e.g., <, between the intervals expressed by their temporal and main clauses. Allen investigates thirteen temporal expressions and defines a relation for each. Given that both Reichenbach's logic Allen's logic (restricted to the expressions mentioned above) just are that of linear orders, the two can be combined straightforwardly, begging the question: How is the ordering between the event (E, E'), reference (R, R'), and speech (S, S') times of both the temporal and main clause in examples like (2) determined:

(2) I slept before John had eaten dinner

In this paper, I provide a simple algorithmic method for relating all six intervals, which has implications in the domain of natural language semantics and natural language processing.

Allen, James (1983). *Maintaining Knowledge About Temporal Intervals*. Communications of the ACM. 26:11, 832-843.

van Benthem, Johan (1986). *Essays in Logical Semantics*. D. Reidel. Dordrecht.

Moss, Larry (2007). *Completeness Theorems for Syllogistic Fragments*, unpublished.

Reichenbach, Hans (2005). The Tense of Verbs. In *The Language of Time*. Inderjeet Mani, James Pustejovsky and Robert Gaizauskas, eds. Oxford University Press, 71-78.