Little Tricky Logic: Misconceptions in the Understanding of LTL

Ben Greenman, Sam Saarinen, Tim Nelson, and Shriram Krishnamurthi

Brown University, Providence, Rhode Island, USA

Talk Background Linear temporal logic (LTL) has long been a standard for writing property specifications in computer-aided verification. The language can express a variety of real-world phenomena while supporting good decision procedures [16]. It is also a small language, thereby presumably making it easy to learn and understand.

In recent years, LTL has been increasingly used for much more than verification. The old dream of temporal-logic synthesis [12, 14] has seen a revival [1, 2, 6]; LTL has enabled property-based testing for interactive web applications [13]; and roboticists have found intimate connections between LTL and robot planning [3, 11, 7], as a result of which numerous robotics systems now use LTL, e.g., [5, 17, 10, 15, 9, 4, 8].

All these efforts are predicated on a central belief: that users of the logic actually understand it. The quality of verification, synthesis, or planning is only as good as the property statement and its relation to the system being modeled. In particular, if a user *misunderstands* what the property is saying, there are no safeguards: an LTL-powered tool will blindly apply this property and check or generate the requested behavior, whether or not it was the desired one. It is therefore critical to know whether users accurately understand LTL, and if not, *in what ways*, and *what can we do about it*?

We have been studying LTL misconceptions over an 2-year span with multiple populations. Across them, there is considerable evidence of misconceptions. These include, but are not limited to, the following: implicitly wrapping terms in an "always" or "eventually" quantifier, assuming that the left-hand term of an "until" must be false when the right-hand term holds, and misunderstanding the state(s) that a term applies to. Based on these findings, we propose measurement instruments for educators and actionable advice for experts who build LTL tools and/or design temporal logics.

Talk Proposal We propose a remote talk aimed at researchers who use LTL and educators who teach LTL. Our talk will be *interactive*. It will assume basic familiarity with LTL (not at the Vardi level ☺) and focus on *demonstrating* misconceptions and expert blind spots.

The talk will begin with a very brief introduction that explains our focus on LTL misconceptions and states that we have conducted studies with multiple populations.

After the introduction, the talk will shift to an interactive style in which we will present several questions from our surveys and ask the audience to label answers to these questions as correct or incorrect. Each set of answers will contain one incorrect answer from our study populations that demonstrates a significant misconception. If our listeners are fooled by the incorrect answer, then we will have shown them a concrete example of LTL being tricky *even for experts*. If our listeners get all the answers correct, then arguably there is an expert blind spot at play. Either way, we can illustrate the value of rigorous user studies.

The talk will conclude by summarizing what we have done so far, outlining the road ahead, and showing where to find the study instruments that we have made available.

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