Report on TIME 2013

20th International Symposium on
Temporal Representation and Reasoning

Angelo Montanari
University of Udine, Italy

On the occasion of its 20th edition, the International Symposium on Temporal Representation and Reasoning (TIME) went back to the venue where it originally started: Pensacola, Florida, USA. It was hosted by the Florida Institute of Human Machine Cognition (IHMC) and co-chaired by Cesar Sanchez, IMDEA Software Institute, Madrid, Spain, K. Brent Venable, Tulane University and IHMC, USA, and Esteban Zimanyi, Universite Libre de Bruxelles, Belgium. Such an anniversary gave the opportunity to have a retrospective look at the history of the symposium and to look forward to its future possible developments.

TIME started as a workshop, co-located with the Florida Artificial Intelligence Society Conference (FLAIRS) and it was originally geared towards the AI community. Since then, it has progressively grown to become an international independent symposium that attracts people from a variety of computer science areas dealing with the concept of time, including temporal logic, formal verification, temporal databases, and natural language processing. This interdisciplinary flavor makes TIME a unique event in the landscape of computer science events, which serves as an forum for exchange among researchers from quite different computer science fields. In addition, it has as an important objective to bridge theoretical and applied research for mutual benefit. From a geographical point of view, it moved from Florida, where the first six editions took place, to Canada (Cape Breton, Nova Scotia) and then to Europe (Cividale del Friuli, Italy). Since then, most editions were organized in Europe (UK, France, Hungary, Spain, Italy, and Germany), but time to time it crossed the European borders to go to Australia (Cairns, Queensland) and back to the USA and Canada. TIME 2013 consisted of three invited talks, given by high-profile researchers, namely, James F. Allen (IHMC and University of Rochester, USA), who proposed to rethink logics of action and time in the light of the recent developments in the field, Ouri Wolfson (University of Illinois at Chicago, USA), who focused on the problem of spatio-temporal competition for transportation resources, that presents a number of interesting theoretical and applicative challenges, and Aaron R. Bradley (UC Boulder, USA), who described a recent, promising approach to model checking, called incremental, inductive model checking, and 15 paper presentations. The latter ones ranged from temporal constraint networks (e.g., the paper on "Minimal Consistency Problem of Temporal Qualitative Constraint Networks", by Condotta and

Kaci) to temporal planning (e.g., the paper on "Relaxation of Temporal Planning Problems", by Cooper, Maris, and Régnier), from deduction systems (e.g., the paper on "Extracting Unsatisfiable Cores for LTL via Temporal Resolution", by Schuppan) to satisfiability and model checking (e.g., the papers on "LTL Satisfiability Checking Revisited", by Li, Zhang, Pu, Vardi, and He, and on "Complexity of Model Checking over General Linear Time", by French, McCabe-Dansted, and Reynolds), from temporal logic (e.g., the paper on "A New Metric Temporal Logic for Hybrid Systems", by Reynolds) to spatio-temporal databases (e.g., the paper on "Making Time Just Another Axis in Geospatial Services", by Campalani, Misev, Beccati, and Baumann). A revised and extended version of a selected subset of these papers will apper in a special issues of Acta Informatica.

In addition, the symposium featured a panel on the future of research about time entitled: "Is there a future for research on time (and thus for TIME)?", that I introduced and moderated. I started the panel by summarizing the hot topics about time in AI discussed at the first edition of TIME in 1994, namely, representing and reasoning about temporal constraints (Interval Algebra, Point Algebra, STP, dynamic controllability), reasoning about actions and time (Situation Calculus and Event Calculus), time in planning and scheduling, time in truth maintenance systems, and qualitative physics. Ten years later, at TIME 2001, time in TCS and DB entered the scene with topics like temporal logic as a specification language (LTL, CTL, CTL*, ATL), consistency checking and model checking algorithms, timed automata, historical, transaction, and bi-temporal databases, spatio-temporal databases, and time in workflow systems. Then, I reminded the audience of a provocative invited talk by Moshe Vardi at TIME 2002, where he claimed that there was no more room for basic research in temporal logics, but only for applications (the main subject of his talk was the Property Specification Language - PSL), and I asked the panelists for their opinion about such a claim. The panel discussion was intense and stimulating. James F. Allen (IHMC and University of Rochester, USA) said that Vardi was wrong. In his opinion, many interesting problems are still there and ask for a (theoretical) solution. The lack of papers about time at AI conferences is a major concern: there are many relevant time-related problems to cope with, but very few people are working on them. Pat Hayes (IHMC, USA) pointed out a central problem in understanding of time: while we developed good formalisms to deal with time as a physical dimension, the treatment of time as a perception, which is fundamental in consciousness, is still inadequate. The problem of reconciling the phenomenological experience of time with the classical models of the time axis is a huge research area, and standard temporal logics do not help, as they are considered too difficult to use ("Is there a vanilla-flavored, universal and useful temporal logic?", he asked). Mark Reynolds (University of Western Australia) answered that there is no such universal logic. People today are much closer to applications, but a variety of temporal

logics is needed, as the choice of the best logic highly depends on the specific application. Robert Morris (Intelligent Systems Division, NASA, USA) emphasized the importance of time in a number of relevant applications ("It is time for applications"), including autonomous systems, like robots and spacecrafts, that must allow for a real-time execution of plan and must support a temporal re-planning based on sensing and the effects of actions, human-in-loop planning, and time modeling from huge collection of data (e.g., in medical domains). He also agreed with Hayes about the crucial role of "internal time", or time as a perception, for many of these applications ("robots have a rich space map, but not a rich time map yet"). Finally, Cesar Sanchez (IMDEA Software Institute, Spain) observed that in the field of formal verification, people experience that problems are much harder than expected. Nevertheless, there are new, promising research directions. In particular, he considers quite interesting the connections among temporal logics, automata, and games that have been established and studied in the last decade (for instance, they turned out to be quite useful for synthesis), and the extensions of temporal logic to capture hybrid properties, that is, properties that refer to both discrete and continuous behaviors.

The next edition of TIME will be held in Verona, Italy, in September 2014, and it will be co-located with the 5th International Symposium on Games, Automata, Logics, and Formal Verification (GandALF).