Research on Events in Computer Science

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1 Introduction

Humans think in terms of events and objects. Events provide a natural abstraction of happenings in the real world. Objects are participating in events. They can be living objects like persons and non-living objects. The concept of events has a long history in foundational sciences such as philosophy and linguistics. Computer science research first developed object-based approaches and is now addressing the concept of events and building many applications that consider events at least as important as objects. Consequently, we find many different solutions and approaches for modeling, detecting, and processing events. In addition, we find different applications that are based on events and make use of events.

2 Research on Events

Today's workshops and conferences on events in computer science such as the ACM International Distributed Event-based Systems (DEBS)[1] conference and the Event-driven Business Process Management Workshop (edBPM)[2] are typically dealing with the capturing, processing, and management of low-level events. Here, an event is considered the existence or non-existence of a signal within some computerized system. Relevant work are, e.g., publish/subscribe systems and middleware solutions [1], complex event processing [2] and event stream processing [3], Semantic Web services [4], and reactivity for the Semantic Web [5]. Thus, the focus is on technical events that happen within computerized systems.

This work is very essential for an efficient execution of the applications build on top of such approaches. However, the understanding of the concept of events is disconnected from the domain-level events that the actual users of such applications have to deal with. On the domain-level, events are understood as the occurrences in which humans participate. This notion of events can be applied to capture and represent human experience. Such high-level events are subject to discussions and interpretations by humans. They may be very complex and a variety of aspects need to be considered. Models of events exist in various domains

[1] http://debs10.doc.ic.ac.uk/

[2] https://www-927.ibm.com/ibm/cas/cascon/displayWorkshop?PublicView=true&Num=59

like the Eventory [6] system for journalism, the Event Ontology [7] as part of a music ontology framework, the ISO-standard of the International Committee for Documentation on a Conceptual Reference Model (CIDOC CRM) [8,9] for cultural heritage, the event markup language EventML [10] for news, the event calculus [11,12] for knowledge representation, the Semantic-syntactic Video Model (SsVM) [13] and Video Event Representation Language (VERL) [14,15] for video data, and the event model E [16,17] for event-based multimedia applications. From this related work one can derive that for domain-level events aspects such as time and space, objects and persons involved, as well as mereological, causal, and correlative relationships between events have to be considered [18]. Domain-level events are important in a large variety of domains such as lifelogs, cultural heritage, sports, news, law, surveillance, emergency response, and others.

3 Modeling Domain-Level Events with the Event-Model-F

With the Event-Model-F, we have created a formal ontology of events on domain level [18]. The Event-Model-F bases on the foundational ontology DOLCE+DnS Ultralight (DUL)[3] [19] and follows a pattern-oriented design approach for ontologies. More precisely, we use specializations of the *descriptions and situations* (DnS) ontology pattern [20]. The DnS pattern allows for representing different opinions about events and their participating objects. Thus, we can provide formally precise representations of different contextualized views on events. This is important, as the events we are modeling are subject to discussion and interpretation and may not be objectively observable. With respect to the aspects of events, we introduced specialized instantiations of the DnS ontology pattern. Here, the participation of objects in events is implemented by the participation pattern. It also provides for modeling the absolute time and location of events and objects. The mereology pattern, causality pattern, and correlation pattern implement the structural relationships between events. In addition, the mereology pattern allows for modeling the relative temporal relations and relative spatial relations between events and objects. In order to express such relative temporal relations between events, one can facilitate the provided means of DOLCE such as the formalization of Allen's Time Calculus[4]. The documentation pattern provides for annotating events. It can be seamlessly linked with other ontologies, e.g., the Multimedia Metadata Ontology (M3O) [21] for precisely describing digital media data like images and videos. Finally, the interpretation pattern supports different event interpretations.

With the Event-Model-F, we can create and exchange sophisticated descriptions of real world events. For example, in the domain of emergency response of the EU project WeKnowIt[5] one can model the participation of citizens in an emergency incident using an instantiation of the participation pattern. If the

[3] `http://wiki.loa-cnr.it/index.php/LoaWiki:DOLCE-UltraLite`
[4] `http://wiki.loa-cnr.it/index.php/LoaWiki:Ontologies`
[5] `http://www.weknowit.eu/`

incident is a flood, one may speculate about the cause for the flood applying an instantiation of the causality pattern and possibly also using the correlation pattern. A flood may typically be composed of multiple events, which is modeled using instantiations of the composition pattern. Thus, for describing an event, different instantiations of the Event-Model-F patterns are combined, each providing a specific part of the event description. As there might be different opinions about the cause of the flood, there can be multiple instantiations of the causality pattern. To manage these multiple instantiations of the causality pattern (or other patterns), the event interpretation pattern is used to form different nexuses of the pattern instantiations and providing different views onto the same event. Thus, the interpretation pattern supports reusing parts of event descriptions on the level of pattern instantiations. In emergency response, typically several professional entities are involved such as emergency hotline, police department, fire department, and emergency control center. All these entities need to exchange event descriptions like the one above. However, they typically use different systems and applications with their own proprietary data models for events. Using the formal model F instead, these systems can be integrated and effectively communicate event descriptions. The Event-Model-F ontology and examples are available from `http://isweb.uni-koblenz.de/eventmodel`.

4 Conclusions

This paper discusses the different notions of events in computer science and briefly presents a model of events, the Event-Model-F [18]. The goal for future work should be to understand the different notions of events in computer science and to promote the importance of events on domain level. In addition, research paths have to be shown up to bring together the low-level events and domain-level events. Here, researchers from the different communities in computer science have to be brought together that deal with events.

One step towards this vision is the 1st ACM International Workshop on Events in Multimedia (EiMM) [22] that has been held conjunct with the ACM Multimedia conference in Beijing, China in 2009. The EiMM workshop aims at the detection, processing, and representation of events in multimedia data. Researchers from different fields in computer science participated in this workshop such as computer vision, multimedia, Semantic Web, databases, and computer networks. Details about the workshop can be found online at `http://www.uni-koblenz.de/confsec/eimm09/`.

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References

1. Oberle, D.: Semantic Management of Middleware. Springer (2006)
2. Ericsson, A., Berndtsson, M.: Rex, the rule and event explorer. In Jacobsen, H.A., Mühl, G., Jaeger, M.A., eds.: DEBS, ACM (2007)
3. Zdonik, S.B., Stonebraker, M., Cherniack, M., et al.: The Aurora and Medusa projects. IEEE Data Eng. **26**(1) (2003)
4. Vaculin, R., Sycara, K.: Specifying and monitoring composite events for semantic web services. In: ECOWS, IEEE (2007)
5. May, W., Alferes, J.J., Amador, R.: An ontology- and resources-based approach to evolution and reactivity in the semantic web. In: OTM, Springer (2005)
6. Wang, X., Mamadgi, S., Thekdi, A., Kelliher, A., Sundaram, H.: Eventory – an event based media repository. In: Semantic Computing, IEEE (2007)
7. Raimond, Y., Abdallah, S.: The event ontology (2007) http://motools.sf.net/event.
8. Doerr, M., Ore, C.E., Stead, S.: The CIDOC conceptual reference model: a new standard for knowledge sharing. In: Conceptual modeling, Australian Computer Society, Inc. (2007)
9. Sinclair, P., Addis, M., Choi, F., et al.: The use of CRM core in multimedia annotation. In: Semantic Web Annotations for Multimedia. (2006)
10. IPTC: EventML (2008) http://iptc.org/.
11. Mueller, E.T.: Event Calculus. In: Handbook of Knowledge Representation. Elsevier (2008)
12. Cervesato, I., Franceschet, M., Montanari, A.: A guided tour through some extensions of the event calculus. Computational Intelligence **16** (1999) 200–0
13. Ekin, A., Tekalp, A.M., Mehrotra, R.: Integrated semantic-syntactic video modeling for search and browsing. IEEE Transactions on Multimedia **6**(6) (2004)
14. Francois, A.R.J., Nevatia, R., Hobbs, J., Bolles, R.C.: VERL: An ontology framework for representing and annotating video events. IEEE MultiMedia **12**(4) (2005)
15. Nevatia, R., Hobbs, J., Bolles, B.: An ontology for video event representation. In: Computer Vision and Pattern Recognition, IEEE (2004)
16. Scherp, A., Agaram, S., Jain, R.: Event-centric media management. In: SPIE. (2008)
17. Westermann, U., Jain, R.: Toward a common event model for multimedia applications. IEEE MultiMedia **14**(1) (2007)
18. Scherp, A., Franz, T., Saathoff, C., Staab, S.: F—A Model of Events based on the Foundational Ontology DOLCE+DnS Ultra Light. In: Int. Conf. on Knowledge Capturing; Redondo Beach, CA, USA, ACM (September 2009) URL: http://isweb.uni-koblenz.de/eventmodel.
19. Borgo, S., Masolo, C.: Foundational choices in DOLCE. In: Handbook on Ontologies. 2nd edn. Springer (2009)
20. Gangemi, A., Presutti, V.: Ontology Design Patterns. In: Handbook on Ontologies. 2nd edn. Springer (2009)
21. Saathoff, C., Scherp, A.: Multimedia metadata ontology. In: SeMuDaTe Workshop conjunct with SAMT; Graz, Austria, ACM (December 2009)
22. Scherp, A., Jain, R., Kankanhalli, M.S.: Events in multimedia. In: ACM Multimedia. (2009) 1147–1148