A Proposal of an Event Ontology for Urban Crowd Profiling

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Abstract. The definitions of "event" and "crowd" are still representing controversial issues that have been tackled by different disciplines like Sociology, Philosophy and Computer Science. The proposed ontology of events takes advantage of results and perspectives already present in literature and in available resources, like DBpedia. Events, such as celebrations, concerts, sport matches and so on, are, in this work, defined as structured entities spatially and temporally confined, codified by a specific script, and participated by urban crowds. The integration of an ontology of "event" with an ontology of "crowd" constitutes the originality of this work. A conceptual framework has been defined, and then implemented in Protègè, to create a versatile tool to profile crowds. In the paper the assumptions that underline the development of the ontology are introduced, then its implementation in Protègè and its application to a case study is presented.

1 Introduction

There is scarce agreement on what an event is and how it should be considered in the systematization of an ontology. From a philosophical point of view, realists consider that events are real things and that they should be considered to belong to the same class of objects. This position is adversed by non-realists that neglect that events can provide a fixed framework of reference for an ontology that could give account of our practices of definition. Also, while objects are said to exist in clear temporal and spatial boundaries, events instead can be said to occur, or to take place, but their boundaries of existence are not clearly defined. The

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dichotomy "event" vs "object" is not the only possible one and philosophical positions at this respect are several [1].

Gero Mühl and Fiege [2] introduced the notion of time and space in the event definition: a concrete experience in the world can be described as a sequence of events happening over the space and time. An event instance is a concrete object presenting attributes that describe it. According to this view, events can be seen as the combination of other events, which participate in the definition of a more complex one. The last definition is very similar to the one given by Kaneiwa et al. [3], who started from the consideration that objects and properties necessary to describe actions and changes in the real world are static, while events are typically dynamic. In classical approaches, events were methods for classifying relevant patterns of modifications rather than concrete entities of the world [4], as well as changes occurring in the discrete phases of a process [5]. Taking care of the object-oriented nature of events suggested by Guarino et al. [6], or frameworks like SUMO [7] and OpenCyc[1], Kaneiwa et al. [3] proposed an upper ontology for event description, where they tried to classify the types of events (e.g. natural events, artificial events). Then, each event is specified according to a couple of ontological views: *component structures* and *semantic functions* of it. Finally, they introduced event relations, like *causal* and *next-event* relations to point out the differences between instances and classes of events.The main difference between all the approaches introduced so far and the approach here presented is that event classification is strictly related to the kind of crowd that participates it. In other words, no definition of event is possible if it cannot be verified by a group of people sharing a given set of attributes at a given time and space.

The organization of big events[2] (such as trade exhibition, musical, artistic and cultural festivals) is becoming a consolidated urban policy to promote and refurbish urban areas (in particular dismissed industrial areas). These kinds of intervention are aimed at enhancing the city potentiality, catalyzing investments, improving urban services, creating a sense of belonging of citizens to the city [8]. The scarcely predictable impact of the extraordinary touristic flows during the event will make difficult for organizers and authorities to plan and manage the events. In particular, large cities have to be prepared to avoid disruption, and to guarantee accessibility and security. We consider as urban crowds the participants to this kind of events.

If the definition of what an event is remains an open issue, no agreement can be found in literature about what a crowd is either, because of the difficulty in empirical investigation of the phenomenon. Early interest in studying crowd started by the pioneering study of Gustave Le Bon [9], who defined crowd behaviour as irrational and a potential threat to society. Far from this perspective, the ESIM-Elaborated Social Identity Model [10] proposes a social-normative conception of collective behavior, arguing that social norms continue to shape behavior of people in the crowd. Taking advantage from these assumptions, the

[1] `www.opencyc.org`

[2] Properly named as "festivalization of the city".

most accepted definition of what a crowd is cites: "A crowd can be defined as a gathering of 20 people (at least), standing in close proximity at a specific location to observe a specific event, who feel united by a common social identity, and who are able to act in a socially coherent way, despite being strangers in an ambiguous or unfamiliar situation" [11, p. 43]. Considering the variability of crowd size and typology, Elias Canetti [12] codified a very detailed classification of crowds on the basis of criteria such as attitude to grow, attributes of density and equality, nature of the goal. Applying this grid, Canetti identified a variety of crowds: open and closed, stagnating and rhythmic, quick and slow. Canetti identified with the term "discharge" the cause of the assembling of the crowd: discharge is a mechanism that transforms single individuals in a proper crowd where individual differences are dropped.

An ontology that combines events and crowds offers the possibility to collect and systematize knowledge of these important phenomena that will require a great attention in the immediate future. With this work we want to propose a computational framework for crowd profiling and simulation, in order to support decision makers, designers and organizers of big events. In relation to several case studies performed by CSAI Research Centre and CROWDYXITY s.r.l., a spin-off of the University of Milan-Bicocca, the further aim of the framework is to organize and store gathered data related to crowd and pedestrian dynamics in high density situation during the events, such as: pedestrian walking speed, queue formations, waiting time, level of service, and so on.

After the previous theoretical introduction, in Section 2 a full description of our event ontology, both from a conceptual and a technical point of view, will follow. At last in Section 3, we will show a case study related to an urban crowd at a musical event. Final remarks and conclusions will be presented in Section 4.

2 The Ontology of Events: Definition and Implementation

In this section, starting from the previous discussion about the term "*event*", and considering the state of the art in the ontology literature, we will introduce our point of view on the definition of events and crowds, underlining their relationship. Then, we will present the ontology implementation by means of Protègè platform: a free, open source ontology editor and knowledge-based framework.

Starting from literature, we introduce the definition of an event as a structured entity, spatially-temporally defined. We enlarge this basic definition in order to consider aspects that are primary elements in the development of a computational model for crowd profiling and simulation, that is the target of this ontology.

The first investigated aspect is related to the spatial extension of events: every event should be located into a specific *place* (e.g. a building, a station, a park and so on), composed of *venue*, *entrances* and *exits*, and several *utilities* (i.e., objects that are necessary to support the spatial structure of the event). All of them are primary elements that must be considered in modeling the crowd behavior in the environment.

The second aspect is related to the temporal *duration* of events, that is composed of starting time, execution time, and ending time. From the participants point of view, the latter corresponds to three main time phases: *inflow*, *involvement*, and *downflow*.

We propose a more detailed definition of *persons* who take part in the event, basically conceptualized as audience, taking into account also other subcategories referred to the organizers of activities: *staff*, *security* and *artist*.

In the description of the architecture of the events, we point out that every event is characterized by a *script*: *"A script, as we use it, is a structure that describes an appropriate sequence of events in a particular context. [..] For our purposes, a script is a predetermined, stereotyped sequence of actions that define a well-known situation."* [13, p. 151]. People who participate the event as organizers are supported in their activities by specific scripts, which represent predefined sequences of procedures and tasks. All the organizers, depending on the level of intensity of their performance, concur to the growth of the *discharge*. As a consequence, people who participate the event as audience can live the discharge, depending on their level of motivation. Taking advantage from the Canetti's Theory, the discharge produced by organizers is able to assemble people within a *crowd*, that can be of different types (as previously defined in Sec. 1).

At the end, we propose a structural definition of event, as composed of subevents which are modeled following the same categories as the native event. The latter is a strategy that allows to represent complex events composed of subevent (such as big event participated by urban crowds), by means of the unique conceptual model (see Sec. 3). In Figure 1 we depict a synthetical representation of the ontology of events as proposed in this work.

After the conceptual analysis, we focus on the development of the ontology by means of Protègè[3] platform, the standard *de facto* editor for ontologies. We point out the following concepts: *Event* is a spatially-temporally structured entity, participated by person, and characterized by script; *Place* is the spatial extension of an event; *Venue* is the space where the event takes place; *Entrance*, those are the gates which permit persons to access the venue; *Exit*, those are the gates which allow persons to leave the venue; *Utility*, those are necessary objects to support the spatial structure of the event; *Duration* is the temporal duration of an event; *Inflow* is the starting time of the event; *Involvement* is the execution time of the event; *Downflow* is the ending time of the event; *Person*, those are the event participants; *Staff*, those the event managers; *Security*, those are the security managers; *Artist* is the manager of the event performance; *Script* is the procedural structure that characterizes an event; *Discharge* is the product of the performance, able to assemble people within a crowd; *Crowd* is a gathering of people, standing in close proximity at a specific location to observe a specific event, who feel united by a common social identity.

The aim of the development is to adequate the proposed event ontology to the existing works in literature. For this reason, we adopted the concepts of *Place*

[3] `http://protege.stanford.edu/`

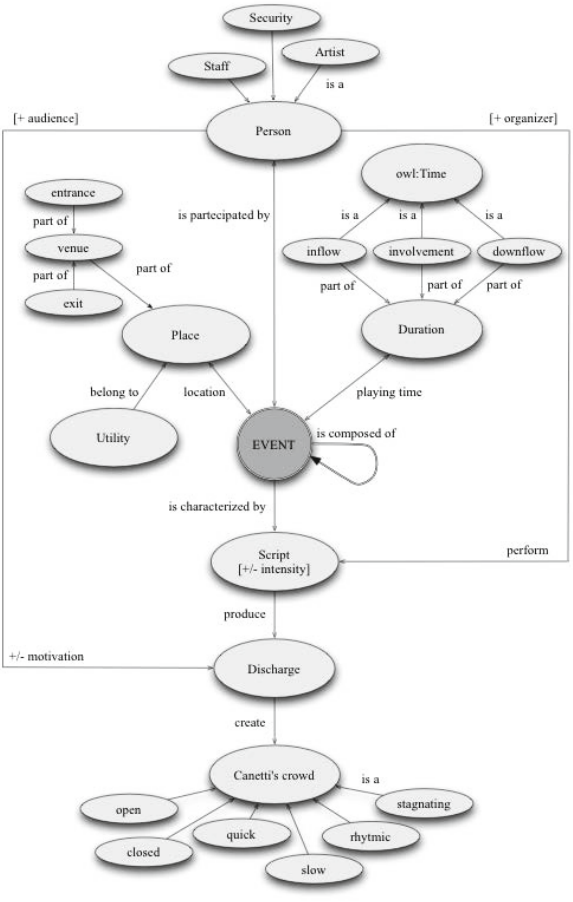

Fig. 1. A schematic representation of the concepts and relationships in our Event Ontology

and *Person* as they are defined in DBpedia Ontology[4]. The concepts of *Inflow*, *Involvement*, *Downflow* are modelled by means of the OWL-Time ontology[5]. We use a previous crowd classification ontology, developed within the research activities of CSAI [14] to implement concepts about *Crowd*.

Starting from these assumptions, the implementation of our Event Ontology in Protègè wass organized into two main phases: *Loading of existing ontologies*, in order to extend previous results found in literature. We imported in Protègè the version 3.6 of DBpedia Ontology, and the latest version of OWL-Time Ontology. Moreover, in order to exploit the previous work of conceptualization of the theories on crowd, we imported the Canetti's Crowd Ontology; *Classes, proper-*

[4] `http://dbpedia.org/ontology/`
[5] `http://www.w3.org/TR/owl-time/`

Table 1. Metadata representation of properties and datatypes for Event Ontology. Note that *p1* is the prefix for DBpedia ontology.

Label	Domain	Range	Comment
location	*Event*	*p1:Place*	relates an event to its spatial location
playingTime	*Event*	*Duration*	relates an event to its temporal duration
belongTo	*Utility*	*p1:Place*	relates an utility to its spatial position
isPartecipatedBy	*Event*	*p1:Person*	relates an event to involved people
isComposedOf	*Event*	*Event*	relates an event to its sub-events
isCharacterizedBy	*Event*	*Script*	relates an event to its script
produce	*Script*	*Discharge*	relates a script to the discharge produced
perform	*p1:Person*	*Script*	relates a person to the performed script
motivation	*p1:Person*	*Discharge*	relates a person to the experienced discharge
create	*Discharge*	*Crowd*	relates a discharge to the created crowd
motivationLevel	*p1:Person*	*xsd:integer*	level of motivation in participating to a discharge
intensity	*Script*	*xsd:integer*	level of intensity of the performed script
role	*p1:Person*	*xsd:String*	role of a person respect to the event

ties and data-types definition, where the innovative aspects of this Ontology of Events have been implemented.

An overview on the metadata description of properties and data-types are presented in Table 1, in which label, domain, range such as a textual definition of these elements are shown.

The ontology has been developed in Protègè, adopting the version 3.4 of the platform for its user-friendly interface and the integration with Jambalaya[6] plugin to visualize the knowledge bases the user has created.

3 Case Study: The Concert

In this section we will propose to apply our Event Ontology to describe and profile the urban crowd that participates to a concert. We chose this specific scenario as case study due to its ability to represent a typical urban big event. The chosen study represents also an opportunity to explain how a complex event can be divided into sub-events. Moreover, thanks to several research activities performed in this field by CSAI and CROWDYXITY s.r.l., we hold a deep knowledge about this kind of event and its organization, and we have collected several empirical data.

In particular, we refer to the observation of the *Jovanotti Ora Tour*[7], performed at the Mediolanum Forum, in May 11^{th}, 2011 - Assago, Milano (Italy). In the following we propose the analysis of the whole event *"Concert"*, and its sub-events *"Song"*.

We allocated the model as below: *Event* is the "Jovanotti Ora Tour", 05/11/2011; *Place* is the "Mediolanum Forum - Assago", Milano (Italy); *Venue* is the standing area and the tribunes of the Mediolanum Forum; *Entrance* is one

[6] `http://www.thechiselgroup.org/jambalaya`
[7] `http://www.soleluna.com/`

entrance, positioned in front of the stage; *Exit*, those are two exits positioned in front of the stage; *Utility*, those are the stage, sound-lights mixer, barriers, and so on; *Duration* is May 11^{th} , 2011; *Inflow* is from 8:00 pm to 9:30 pm; *Involvement* is from 9:30 pm to 11:30 pm; *Downflow* is 11:30 pm to 12:00 pm; *Person*, who participates to the Jovanotti Ora Tour, 05/11/2011; *Staff* is the Jovanotti Ora Tour Staff; *Security*, those are stewards, firefighters, paramedics; *Artist* is Jovanotti (and his band); *Script*, those are procedures to perform the concert from both the artistic and technical point of view, ensuring security conditions; *Discharge*, those are, depending on the intensity of the performance script, the track list, lights and sound effects; *Crowd* is closed, quick and rhythmic crowd[8].

Starting from the event description as a structured entity composed of 15 sub-events *"Song"*, the chosen case study can be analytically defined as a sequence of songs (i.e. the tack list of the concert). Each event *"Song"q* represents the atomic part of the main event *"Concert"*. The main differences with respect to the native event are related to the temporal duration and the script. The involvement starts at May 11, 2011 from 10:10pm to 10:14pm (no in-flow and down-flow phases are defined). The script overlaps with musical composition of the song, for both the speech and the melody. Due to its atomic definition, the event *"Song"* cannot be divided into sub-events.

4 Final Remarks and Conclusions

This work is aimed at supporting decision makers, designers and organizers in the managing of big events, by means of a computational framework for crowd profiling and simulation. The knowledge of crowd could be a useful contribution for a successful management of each phase of an event. We refer in particular to the best practices related to ensure security during the event. To achieve this objective we have illustrated a synthetic theoretical discussion about events and crowds. The implementation of this framework in the Protègè platform was developed thanks to the integration with existing ontologies such as DBpedia and OWL-Time. The innovative perspective of this work is based on the relationship between events and crowds: this fusion offers the possibility to collect and systematize knowledge, data and information on big event that will require a great attention in the immediate future.

Future works are devoted to fully integrate the "Event" and "Crowd" ontologies to make them capable to describe big urban events and the urban crowds who populate them, with the final aim to build up a complete and general conceptual and computational framework for supporting organizers in forecasting possible critical situations. A possible application scenario will be the upcoming World Meeting of Families in Milan[9].

[8] The profiling of crowd is based on the Canetti's Theory and on several physical characteristics of the environment and people within the crowd (e.g. density, lifespan, growth and so on).

[9] `http://www.family2012.com/`

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