Conceptual Framework for Process Ontology

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Structure of the presentation:

− Some approaches to event and process specification
− Linguistically based process ontology
− A general proposal for the conceptual framework of process ontology

Different approaches to event and process specification

- in a number of approaches, the concepts of *process* and *event* overlap and these terms are treated as synonyms:
  - Bach called events, states and processes collectively *eventualities*, Barwise and Perry use the term *situation*

- John Sowa
  - processes can be described by starting and stopping points and by the kind of changes that take place between them
    - ***continuous process***: changes take place continuously
    - ***discrete process***: changes occur in discrete steps called *events*, which are interleaved with periods of inactivity called *states*

Different approaches to event and process specification

− similar approaches as John Sowa
  − *state-transition diagrams (finite-state machines)*
    − states – *circles*
    − transitions = events – *arrows that connect the circles*
  − *Petri nets*
    − states – *places*
    − events – *transitions*

Different approaches to event and process specification

- Situation calculus (McCarthy, Reiter)
  - logical formalism designed for representing and reasoning about dynamical domains and change
  - sorted, second-order language with equality
  - three sorts: *situations*, *actions* and *ordinary objects*
  - a dynamic world is modelled as progressing through a series of *situations*, which are conceptualized as states reachable by some *action*

Different approaches to event and process specification

− Situation calculus (McCarthy, Reiter)
  − *fluent*: the relation or the function whose last argument is a situation
  − used to describe the effects of actions
  − are changed by actions that have their preconditions and effects
    − *relational fluent* (example: *handempty* - is true in a situation if the robot's hand is not holding anything)
    − *functional fluent* (example: *battery-level* – its value in a situation is an integer between 0 and 100 denoting the total battery power remaining on one's laptop computer)

Different approaches to event and process specification

− Situation calculus (McCarthy, Reiter)

- − to describe a dynamic domain in the situation calculus, one has to decide

    - − on the set of *actions* available for the agents to perform

    - − and the set of *fluents* needed to describe the changes these actions will have on the world

Different approaches to event and process specification

− Hazal, Svátek, Vacura

  − *C1, Actions*. They assume an explicit or implicit deliberate agent performing them.

  − *C2, Happenings*. They cover the situations when "something happened" without being initiated by a deliberate agent.

  − *C3, Planned "social" events*. Besides being planned, they typically put emphasis on the spatio-temporal frame rather than on concrete participants.

  − *C4, Structural components of temporal entities*. These events are "more arbitrary" than those falling under other categories and can be viewed as "regions", however, as merely temporal (and not spatio-temporal) ones.

Linguistically based process ontology

- motivation:
  - ontologies may be linguistically based, as they intend to be shared
  - a necessary condition in order for an ontology to be shared is the respect for the role of conceptualized terms in natural language
  - each process can be constituted from the series of events and each event can be specified by a verb in natural language
  - the semantics of the respective verb is provided via its valency frame

Linguistically based process ontology

- it is useful to utilize the verb-valency theory as a framework for the conceptualization of processes

- verb valency determines the number of arguments (participants) controlled by verbal predicate

- these participants can play different roles

Linguistically based process ontology - Classifications of participants

- **verb valency dictionaries**
  - **VALLEX**
    - Institute of Formal and Applied Linguistics, Faculty of Mathematics and Physics, Charles University of Prague
  - **VerbaLex**
    - Natural Language Processing Centre Faculty of Informatics, Masaryk University of Brno

- **John Sowa's thematic roles**
  - *thematic roles* are the crucial part of his system of knowledge representation (conceptual graphs)

Linguistically based process ontology - John Sowa's thematic roles

− *Bob went to Danbury*

[Person: Bob] ← (Agnt) ← [Go] → (Dest) → [City: Danbury]

  − *Agent* as an active animate entity that voluntarily initiates an action

  − *Destination* as a goal of a spatial process

A general proposal for the conceptual framework of process ontology

- types of processes:
    - based on *actions* of deliberative agents
    - based on *passive events* like 'turning pale', which are not intentional

- each *process* is divided into at least two *states* and one *event*
    - an event starts the change of state to some other state and is triggered by the respective *action* of some deliberative agent or some passive event
    - actions and passive events = *activities*
    - each *activity* can involve other objects that are called *participants*

A general proposal for the conceptual framework of process ontology

− entities like individuals can be characterised by their properties and attributes

  − **substantive characteristics** are those that individuals have *nomically* necessarily

    − example: being a person is a *substantive* property of such an individual

  − **accidental characteristics** are possessed by individuals purely contingently

    − the property of being a student is accidental; one and the same person contingently becomes a student or stops being a student

    − other accidental characteristics of the person-type individuals can be, for example, *weight*, *height*, *age* etc.

A general proposal for the conceptual framework of process ontology

- − *dynamic entities* such as *activities* are detected by some <u>special types of verbs</u>

- − Tichý's distinction
  - − **<u>episodic verbs</u>** (e.g. *drive*, *tell*, etc.) express the actions of objects or people (=*activities*)
  - − **attributive verbs** (e.g. *is heavy*, *looks speedy*) ascribe some empirical properties to individuals

A general proposal for the conceptual framework of process ontology

− each *activity* has an *actor* (who/what is doing the activity) and may have another *participants*

− thematic role (participant), such as *Agent*, *Patient*, *Beneficiary*, *Destination*, *Instrument*, etc., expresses the role that a noun phrase plays with respect to the activity described by a governing verb and can be specified as relation

− the number and the categories of participants depend on the respective domain of interest and the functions of the system of agents

A general proposal for the conceptual framework of process ontology

− consider the example of the process of 'going of an agent'

− it is divided into the state$_1$ in which the *agent is standing*

− the action *start going* changes this state into the state$_2$ in which the *agent is going*

− the measure of the process's granularity depends on the aims of the application that the ontology serves for
  − if we want to capture the speed changes, we need to specify the process in more detail
  − each speed change has to be captured by adding *accelerate* and *decelerate* actions to the ontology

A general proposal for the conceptual framework of process ontology

− the logical type of participant is the relation between the activity and other involved objects

− processes are composed of at least one event and two states

− states can be also formed by some activity (*Petr is standing*, *Petr is going*), or they are simply the *states* of affairs (*Apple is red*)

− on the other hand, events are always triggered by some *activity*

Literature

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Thank you for your attention