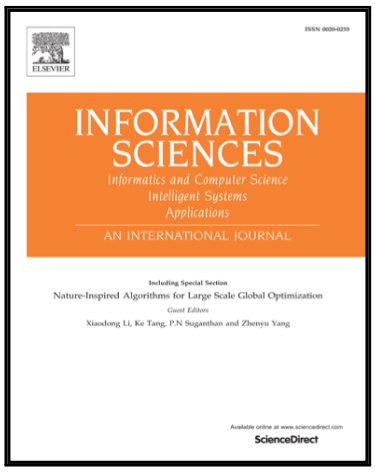

A Framework of Mining Semantic-Based Probabilistic Event Relations for Complex Activity Recognition

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A Framework of Mining Semantic-Based Probabilistic Event Relations for Complex Activity Recognition

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Abstract

Human activity recognition has become a key research topic in a variety of applications. Modeling activity events and their rich relations using high-level human understandable activity models such as semantic-based knowledge base hold promise. However, formulas in current semantic-based approaches are generally manually encoded, which is rather unrealistic in situations where event relations are intricate. Moreover, current approaches for learning event relations often lack the capability to handle uncertainties. To address these issues, we present a framework to learn an event knowledge base (EKB) of probabilistic interval-based event relations and use them to infer varied semantic-level queries about activity occurrences under uncertainty. Specifically, we formalize an activity model to represent eight temporal and hierarchical event relations and four commonly performed queries. We leverage pattern mining techniques to learn an EKB associated with these relations and queries in a unified way. Experimental results show that the proposed framework with the learned EKB involving temporal and hierarchical dependencies leads to a significant performance improvement on activity recognition, particularly in the presence of incomplete or incorrect observations.

Keywords: Activity model, Semantic-based representation, Probabilistic event relation learning, Pattern mining

1. Introduction

The maturity and prevalence of powerful sensors and high-speed processors facilitate advanced human activity recognition capabilities in a variety of applications. The data collected from these sensors is semantically rich, but scalable approaches to answer varied semantic-based queries are limited due to their inability to automatically generate representations of events that encode abstract temporal and hierarchical structure. Although *simple events* can often be inferred by sensor data directly, many *complex activities*, which consist of temporally and coherently related events, require more structured models that are not easy to handcraft.

First of all, an activity model should account for the temporal structures of complex activities. Also, an activity model should convey hierarchical relations among activities, as it is found that most human behaviors are hierarchically structured [48] and the hierarchical structures are necessary for improving recognition performance [6]. Besides, owing to the diversity and complexity in human activities, the model is required for handling uncertainties over events and their temporal dependencies. Last, a useful activity model should be applied to answer varied semantic-level queries associated with temporal and hierarchical relations under *uncertainty*. For example, "if the event `drill`

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