# Keynote: Context reasoning for human activity recognition

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## KEYNOTE ABSTRACT

The ability to recognise human activities has numerous applications in modern mobile and pervasive systems, including well being, medical, and safety applications. Knowing the current activity that a subject is performing is also an invaluable information to provide real-time context-aware adaptive services.

While many researchers have been investigating video and audio based human activity recognition (HAR), in the last decade many research efforts focused on HAR techniques based on signals collected from unobtrusive wearable and environmental sensors. Most efforts have taken a data-driven approach using supervised machine learning to predict the activities. Semi-supervised methods, including active learning, have been considered to overcome one of the main challenges: the difficulty to acquire significant annotated datasets, especially considering smart-home environments.

Several approaches showed to be effective on classifying a few activities, but their effectiveness on larger sets of more complex and context-dependent activities is still unsatisfactory.

For example, outdoor physical activities, detected by analysing the signal of inertial sensors on wearable devices, are usually limited to walking, running, biking, and not much more, despite the technology has reached a maturity to be integrated in commercial products. However, when activities are characterised by similar motion patterns, their recognition is challenging even when using the signal of on-board sensors of multiple wearable devices. For instance, activities like walking and taking the stairs, or standing still and standing on a bus are easily confused by purely statistical methods based on inertial sensors. The intuition is that no matter what algorithm we apply, the signal from the sensors may be insufficient to discriminate among some activities.

On the other hand, the context which surrounds the monitored subject is valuable information to mitigate this issue: a rich description of that context (e.g., semantic location, weather, traffic condition, speed, etc.) has the potential to discriminate among activities that exhibit similar signal patterns. While some could argue that, whatever context-data we can acquire, it could be used as additional features in the machine learning process, there is evidence that this may not be as effective as expected. Indeed, on one side it is unlikely that a labeled training set includes each activity performed in all the possible context conditions, and, on the other side, the connection between low level context data and possible activities typically requires a reasoning process involving domain knowledge.

When considering semi-supervised approaches, another interesting application of context reasoning is the optimization of the active learning process in terms of the number of questions that the system asks to the monitored subjects.

This talk will discuss these issues showing how context reasoning may be integrated with semi-supervised machine learning methods to increase the effectiveness of activity recognition in two challenging HAR scenarios: a) an extended set of outdoor activities based on smartphone and smartwatch signals, and b) activities of daily living jointly or concurrently performed in a smart-home by multiple inhabitants.

## KEYNOTE SPEAKER BIOSKETCH

Claudio Bettini is full professor in the Computer Science department at Università degli Studi di Milano, where he leads the EveryWare laboratory. He received his PhD in Computer Science from the University of Milan in 1993. Among several visiting appointments, he has been for more than a decade, an affiliate research professor at the Center for Secure Information Systems at George Mason University, VA. His research interests cover the areas of data management in mobile and pervasive computing, data privacy and security, context-awareness and context reasoning, temporal and spatio-temporal data management. He is the co-founder of a university spin-off developing innovative mobile apps for privacy and assistive technologies. He is a member of the steering committee of the IEEE PerCom conference and he has been associate editor of the Pervasive and Mobile Computing Journal, The VLDB Journal, and the IEEE Transactions on Knowledge and Data Engineering. He is a IEEE senior member.