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Human Behavior Recognition using a Context-Free Grammar

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HUMAN BEHAVIOR RECOGNITION USING A CONTEXT FREE GRAMMAR

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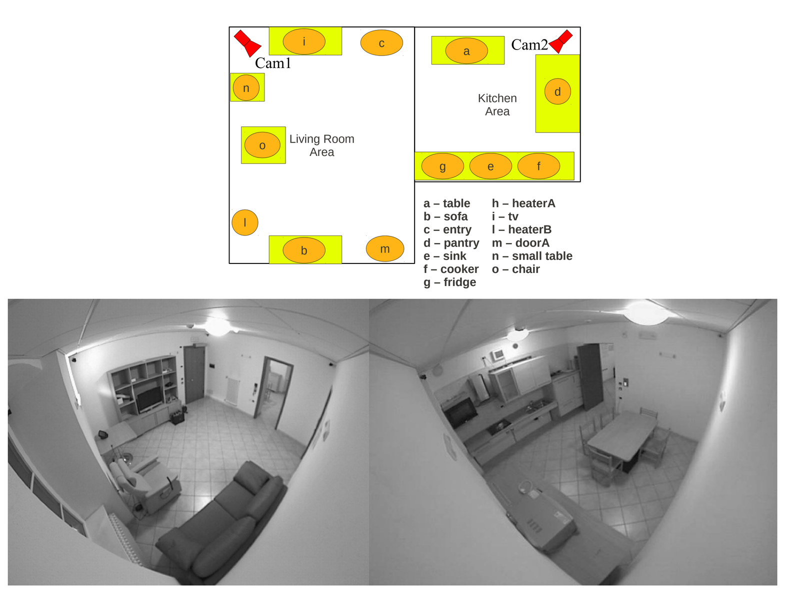
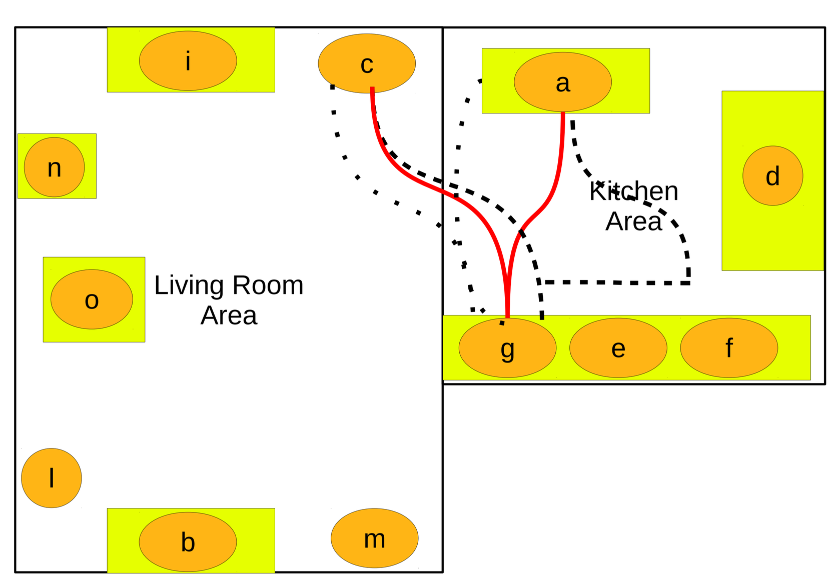
1. Introduction

Automatic recognition of human activities and behaviors is still a challenging problem for many reasons, including limited accuracy of the data acquired by sensing devices, high variability of human behaviors, and **gap between visual appearance and scene semantics**.

Symbolic approaches can significantly simplify the analysis and turn raw data into chains of meaningful patterns. This allows getting rid of most of the clutter produced by low-level processing operations, embedding significant contextual information into the data, as well as using simple syntactic approaches to perform the matching between incoming sequences and models.

2. Problem Statement



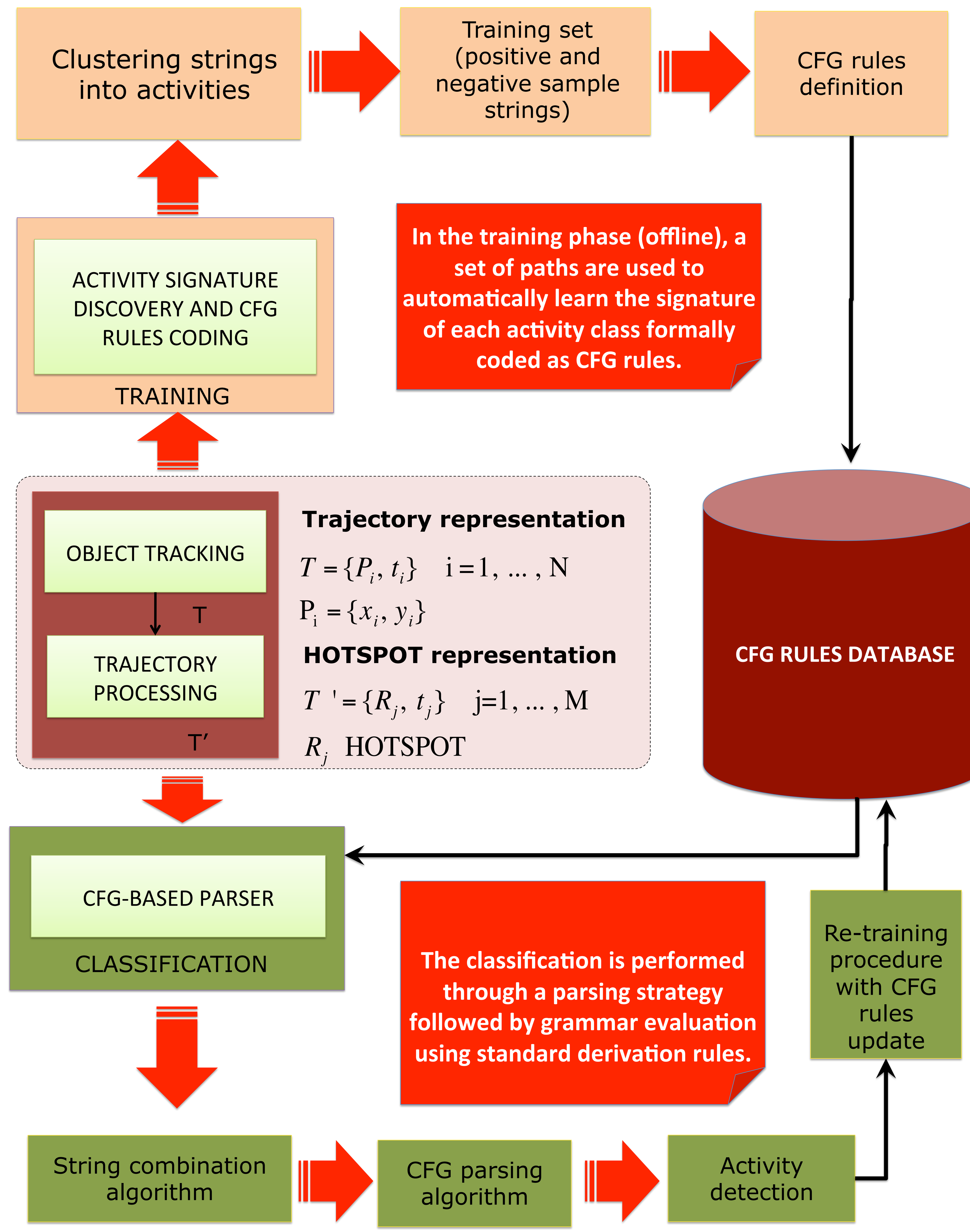


Human activity is highly variable: people tend to perform same actions using different paths in normal life. The objective of this work is to define a technique robust to the noise to represent, detect and classify **complex human behaviors.**

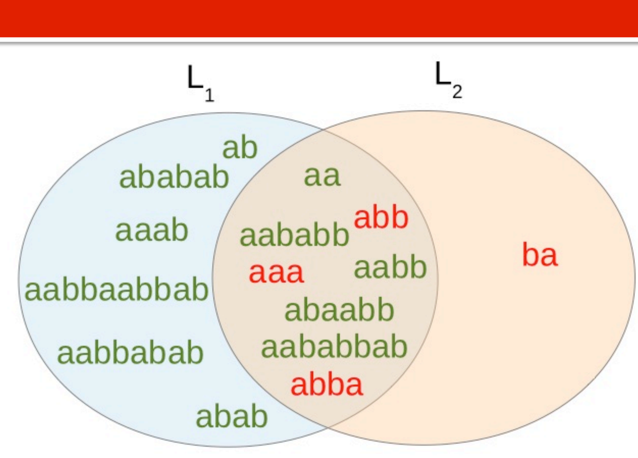
3. Solution based on a Context Free Grammar

(i) represent incoming path through a set of defined **hot spots**, in order to bring the the low level representation to a symbolic one;
(ii) during the training, apply an algorithm to extract the signature of each class and to code the CFG models based on both **positive and negative samples**;
(iii) introduce the possibility of efficiently **retraining** the system in the presence of misclassified or unrecognized events;
(iv) in the classification, operate a parsing procedure that allows correct detection of the activities also when they are **concatenated and/or nested** one with each other.

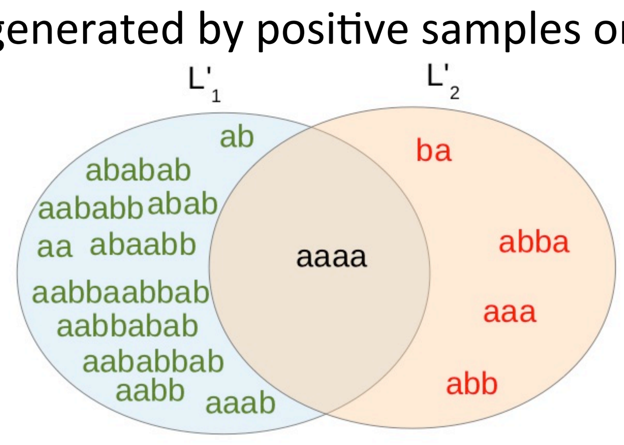
4. Framework description



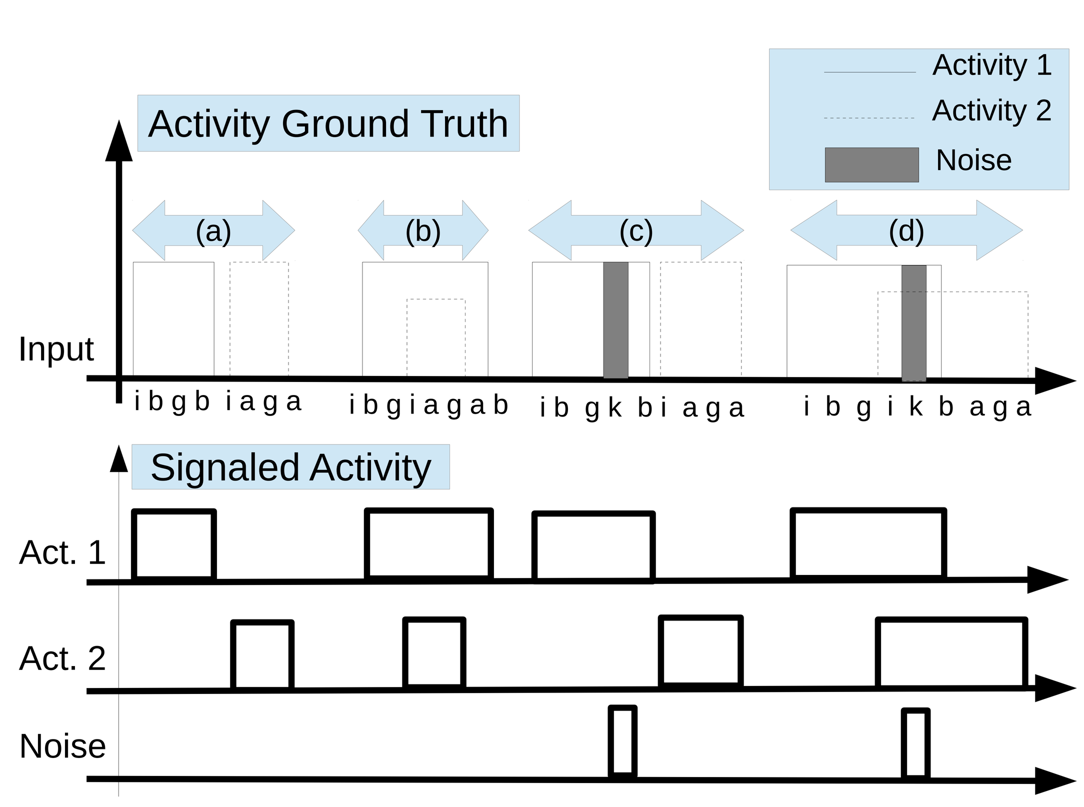
5. Results



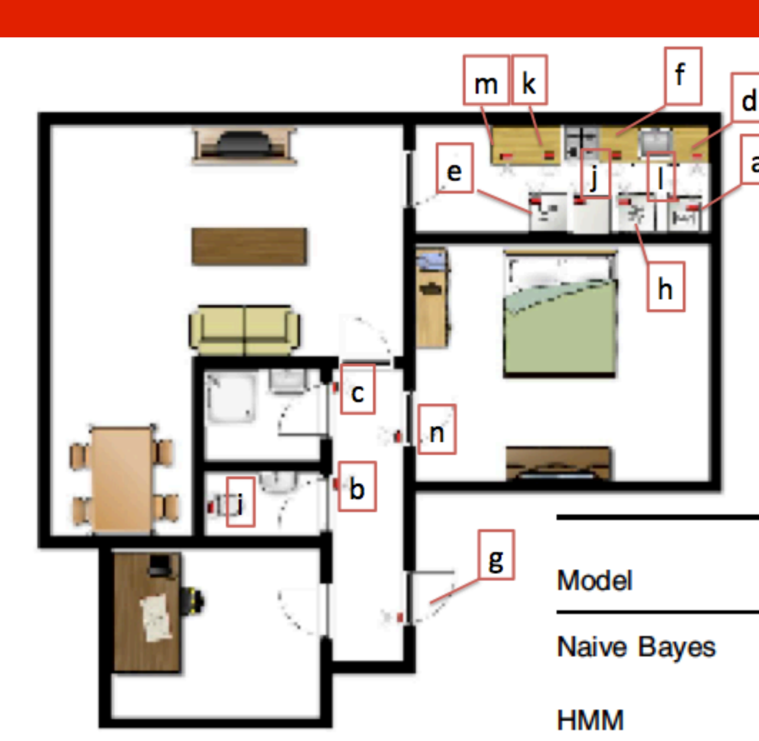
Example of intersection between the languages $L_1 = L(P_1)$ and $L_2 = L(P_2)$ generated by positive samples only.



Example of intersection between two languages $L'_1 = L(P'_1)$ and $L'_2 = L(P'_2)$ generated by **positive and negative samples**.



Activity spotting examples:
(a) two consecutive sequences;
(b) hierarchy between two activities;
(c) two nested activities with noisy symbols;
(d) two overlapping activities with noisy symbols.



Model	Precision	Recall	F-measure	Accuracy
Naive Bayes	67.3 ± 17.2	64.8 ± 14.6	65.8 ± 15.5	95.3 ± 2.8
HMM	54.6 ± 17.0	69.5 ± 12.7	60.8 ± 14.9	89.5 ± 8.4
HSMM	60.2 ± 15.4	73.8 ± 12.5	66.0 ± 13.7	91.0 ± 7.2
CRF	66.2 ± 15.8	65.8 ± 14.0	65.9 ± 14.6	96.4 ± 2.4
Our framework	89.9 ± 10.9	78.3 ± 19.6	83.7 ± 14.0	85.5 ± 11.8

Comparison of the obtained results against the reference method: *T. Kasteren, G. Englebienne, and B. Krse, "Human activity recognition from wireless sensor network data: Benchmark and software," in Activity Recognition in Pervasive Intelligent Environments, L. Chen et al., Eds, pp. 165–186, Atlantis Press, Amsterdam, Netherlands (2011).*

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