1. The Problem:
Learning probabilistic models for complex activities from low level data (measurements)

Data can be noisy Probabilistic models

Complex activities: can be the result of interactions between different objects

Interactions (or relations) cannot be observed we have to find a way to recognize them from measurements

Learning RDBNs for Activity Recognition
C. Manfredotti, H. J. Hamilton, S. Zilles

2. Our Approach
a. Different layer of abstractions:
- Measurements ($r^1$) abstracted into:
  1. single-object activities ($r^1$): changes in attribute values concerning an object alone
  2. Relations ($r^2$): degree of similarity between objects’ attribute values at the same time step

- Single-object activities and relations abstracted into atomic activities ($b^1$): activities of related objects
- Atomic activities abstracted into complex activities ($b^2$): sequences of atomic activities.

For each abstraction we learn a probabilistic model.

b. Multilayer approach

3. First Experiments
Domain: surveillance of encounters between ships
Data: 148 encounters, of these 76 Rendezvous (forbidden encounter). Sequences of 96 time steps, positions of 2 ships.

Black box learner for learning probabilistic models on each layer of abstraction e.g., here: clustering at each layer, learn a MoG from the classes obtained clustering the elements at the previous layer.

An encounter:

Data: vectors of change in sequences of positions
From the vectors of change, we learn the MoG that models the single-object activities from the clusters obtained with a k-means algorithm.
The MoG returns the probability: $p(s^1_t | s^1_{t-1})$

Clusters obtained with the MoG
Example of a track classified according to the single-object activities model learned

A sequence of positions:

1. Measurements ($r^1$) abstracted into:
   - single-object activities ($r^1$): changes in attribute values concerning an object alone
   - Relations ($r^2$): degree of similarity between objects’ attribute values at the same time step

2. Single-object activities and relations abstracted into atomic activities ($b^1$): activities of related objects
   - Atomic activities abstracted into complex activities ($b^2$): sequences of atomic activities.

For each abstraction we learn a probabilistic model.

We compare the performance of the two approaches for the rendezvous recognition with that of an HMM:

<table>
<thead>
<tr>
<th>Method</th>
<th>Precision</th>
<th>Recall</th>
<th>F-measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parallel MC</td>
<td>.8947</td>
<td>.8500</td>
<td>.8718</td>
</tr>
<tr>
<td>Clustering</td>
<td>.7647</td>
<td>.6842</td>
<td>.7222</td>
</tr>
<tr>
<td>HMM</td>
<td>.9474</td>
<td>.5333</td>
<td>.6824</td>
</tr>
</tbody>
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