A Temporal Representation of Point-Interval Relations

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The Problem

- Situation
  - A large telecommunication company
  - Faults $\rightarrow$ alarms generated by network resources
    - e.g. devices are out of order or traffic bursts entail problems
  - System operator tries to identify underlying faults: problematic since
    the data stream of alarms is quite complex and dense
  - Furthermore: events are imprecise wrt. time (no access to precision)
The Problem

- **Aim**
  - Automise identification of faults
  - Intermediate aim: cluster alarms → simplification for operator

  Supporting network operators in localising faults
  Reduction of information by generating high-level alarms
  Reduction of workload for the operator

System Overview

- Focus on pattern representation
Data

A = alarm(?, "AdapterGGSN", "GGN", "Communication", "GGSN lost contact with all RADIUS authentication servers associated with APN")
B = alarm(?, "AdapterGGSN", ?, "Communication", "GGSN lost contact with all RADIUS accounting servers associated with APN")
C = alarm(?, "AdapterGGSN", ?, "SNMP AGENT", "10.22.170.129")

TemporalRelations:
A HEAD_TO_HEAD B
A OLDER_AND_CONTEMPORARY C
B OLDER_AND_CONTEMPORARY C

Method

- Relational system as a mean for representing temporal information, mainly based on
  - Allen 1983, 1984
  - Vilain, Kautz 1986
  - Ladkin, Maddux 1994
  - Cohn, Hazarika 2001
Method

- Coarse set of jointly exhaustive and pairwise disjoints relations between events (e.g. alarms)
- Relation algebra → CSP (e.g. for testing the consistency of pattern descriptions or to complete knowledge)

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<thead>
<tr>
<th>Name</th>
<th>Symbol</th>
<th>Converse</th>
<th>Relation</th>
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<tbody>
<tr>
<td>before</td>
<td>&lt;</td>
<td>&gt;</td>
<td>{P_i, l_k} &lt; {P_j, l_j}</td>
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<tr>
<td>equal</td>
<td>=</td>
<td>=</td>
<td>{P_i} = {P_j}</td>
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<tr>
<td>during</td>
<td>d</td>
<td>c</td>
<td>{P_i} ∩ {l_k}</td>
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<td>contains</td>
<td>c</td>
<td>d</td>
<td>{l_k} ⊂ {P_i}</td>
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<td>after</td>
<td>&gt;</td>
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<td>{P_i, l_k} &gt; {P_j, l_j}</td>
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### An example: composing relations

- Given three temporal entities: x, y, and z
- It holds: x > y and y c z
- The composition provides x > z

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Experimental Analysis

- Structure of test data set
  - 5 different adapters, 2 hour time range, 5810 alarms
  - Peak: 62 alarms per second, Mean: 0.8 alarms per second

Experimental Analysis

Based on the representation
Summary

- Method
  - A temporal (i.e. 1-dimensional) representation of events has been proposed (including points and intervals in time)
  - It can be dealt with using CSP techniques

- Application
  - Thrown alarms in telecommunication networks: mining for frequent patterns (mining for important patterns → expert knowledge)
  - The generality of the approach allows the application in other domains in the future