Self-Stabilizing Counting in Mobile Sensor Networks

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August 15, 2007
Mobile Sensor Networks

- **SIVAM project**: The impact of the climate evolution
- **Wireless Distributed Sensor Networks for In-situ Exploration of Mars**: Mars exploration
- **Wireless Sensor Networks for Habitat Monitoring**: Studying of Leachs Storm Petrels
- **A wireless sensor network for structural monitoring**: Effect of the wind or of an earthquake on a building
The Model

Modelization

- A group of penguins evolves on an island, carrying on their body a small sensor.

- Whenever a penguin is close enough to the antenna, its sensor interacts with the antenna.

- Depending on the hypothesis, the sensors may or may not interact with each other when two penguins approach close enough.
Population Protocols

Limitation of the sensors
- Small amount of memory
- Low power
- Carried on unpredictably moving supports (animals)
- May be resetted or corrupted

Population Protocols are well adapted
- Inspired by papers from D. Angluin, J. Aspnes and D. Eisenstat in DISC and PODC
- **New goal:** Find Self-Stabilizing protocols to count the number of penguins.
Two different scenarios

- The penguins-To-Antenna-Only model \((TA)\)
- The penguins-To-Antenna-And-To-penguins model \((TATP)\)
  - The symmetric one \((STATP)\) : two penguins meeting in the same state have to change to the SAME state.
  - The asymmetric one \((ATATP)\) : two penguins meeting in the same state don’t have to change to the SAME state.
## The TA model

<table>
<thead>
<tr>
<th>model \ memory</th>
<th>Finite</th>
<th>Bounded</th>
<th>Bounded, k-fair daemon</th>
<th>Unbounded</th>
</tr>
</thead>
<tbody>
<tr>
<td>deterministic</td>
<td>impossible</td>
<td>impossible</td>
<td>Algorithm 2</td>
<td>Algorithm 1</td>
</tr>
<tr>
<td>convergence time</td>
<td></td>
<td></td>
<td>4k events</td>
<td>depends on initialization</td>
</tr>
<tr>
<td>probabilistic</td>
<td>impossible</td>
<td>impossible</td>
<td>Algorithm 3</td>
<td>unneeded</td>
</tr>
<tr>
<td>convergence time</td>
<td></td>
<td></td>
<td>exponential in $k$</td>
<td></td>
</tr>
</tbody>
</table>
## The TATP model

<table>
<thead>
<tr>
<th></th>
<th>Finite</th>
<th>Bounded, $\alpha(P) &lt; P$</th>
<th>Bounded, $\alpha(P) \geq P$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>symmetric deterministic</strong></td>
<td>impossible</td>
<td>impossible</td>
<td>Algorithm 6</td>
</tr>
<tr>
<td>convergence time</td>
<td></td>
<td></td>
<td>$\alpha(P) = 4P$, 3 rounds</td>
</tr>
<tr>
<td><strong>asymmetric deterministic</strong></td>
<td>impossible</td>
<td>impossible</td>
<td>Algorithm 4 or 5</td>
</tr>
<tr>
<td>convergence time</td>
<td></td>
<td></td>
<td>$\alpha(P) = P$, $P+1$ rounds</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$\alpha(P) = P + 1$, 3 rounds</td>
</tr>
</tbody>
</table>
Algo 2: TA model, k-fair adversary
Algo 4: ATATP model
Algo 4: ATATP model
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Algo 4: ATATP model
Future works

- Find "message passing" algorithms
- Fix the movement of the penguins
- Improve complexity bounds
- Implement the protocols