Gathering Asynchronous Robots in a Tree

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GRASTA-MAC 2015
Definition of the problem

- Given a tree
Definition of the problem

- Given a tree
- Randomly distributed mobile agents/robots (autonomous, homogeneous, non distinguishable, silent) in nodes
Definition of the problem

- Given a tree
- Randomly distributed mobile agents/robots (autonomous, homogeneous, non distinguishable, silent) in nodes
- The robots have to gather at a single node
Computational model

- Robots have no identity
- Nodes and edges of the graphs are not marked
- The robots have their local coordinate systems
Computational model

[Diagram of a tree structure with nodes and edges indicating a gathering process]

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Computational model
Computational model
Computational model

- Oblivious: forget earlier computations.
- No multiplicity detection capabilities.
- Activation Schedule: Synchronous/Semi synchronous/Asynchronous
| Results 1: | Gathering in graph in general is not possible even with synchronicity.  
| Results 2 | Gathering in plane in general is not possible.  
| Results 3 | Gathering in plane is possible with agreement in coordinate axes even when the robots have limited visibility.  
Ref: Paola Flocchini, Giuseppe Prencipe, Nicola Santoro, Peter Widmayer, Gathering of asynchronous robots with limited visibility, Theoretical Computer Science, Volume 337, Issues 1–3, 9 June 2005, Pages 147-168, |
Some open questions

- Many results in gathering in grid, ring consider the knowledge of multiplicity detection. Can we remove this?

- All the results in continuous domain under Synchronous, Semi synchronous or Asynchronous model, do not hold in discrete domain. E.g., Gathering is possible under synchronous model in continuous domain but not in discrete domain.

- What happens in Limited visibility in general graph?
Gathering in tree under limited visibility

- No multiplicity detection
- Asynchronous
- Limited visibility
When destination is given
When destination is given

- Eliminate the peripheral nodes
- The robots only remember their parents
When destination is given

- Eliminate the peripheral nodes
- The robots only remember their parents
- Use pebbles\(^1\) to mark path towards leaf

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Movement strategy for a robot

- If I see a robot in neighbor(which is not destination) node, I will not move

Assured

- The robots will not toggle
- The robots will not be in deadlock: there always be a robot which will move unless it is already in destination.
When the destination is not given
When the robots are completely oblivious

- The graph (drawing) is oriented.
- Visibility graph of the robots is connected.
When the robots are completely oblivious

- The graph (drawing) is oriented.
- Visibility graph of the robots is connected.
- The robots gather to one of the corner most nodes, e.g., at down-right most node which has a robot.
Movement strategy for a robot

- If I see a robot in more than one neighboring nodes, I will not move.

Assured
- The visibility graph will not be disconnected.
Movement strategy for a robot

- If I see a robot in more than one neighboring nodes, I will not move.
- Else If I see a robot below my horizontal axis, I move to that node.

Assured
- The visibility graph will not be disconnected.
Movement strategy for a robot

- If I see a robot in more than one neighboring nodes, I will not move.
- Else If I see a robot below my horizontal axis, I move to that node. OR
- If I see a robot right to my vertical axis, I move to that node.

Assured

- The visibility graph will not be disconnected.
- The robots will move to the right-down most roots.
Gathering in tree under limited visibility

Gathering in Tree Under Limited Visibility

Gathering node given
The robots are not completely oblivious

Gathering node not given
The robots are completely oblivious
The graph is oriented
Gathering in tree under limited visibility

Gathering in Tree Under Limited Visibility

Gathering node given
The robots are not completely oblivious

Gathering node not given
The robots are completely oblivious
The graph is oriented

True for Grids in many cases
On going development

- What happens if the Graph is not oriented?
- To explore the limited visibility model in general graph
- Optimizing the robots movement
- Collision avoidance algorithm
- Directed Graph (characterization)
- ...

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Thank You