# Hierarchical Leader Election Algorithm With Remoteness Constraint

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November 11, 2019

# Outline

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ENSIAS

# What is the problem of leader election ?

Leader election is an important primitive for distributed computing, useful as a sub-routine for any application that requires the selection of a unique processor among multiple candidate processors (video conferencing, multi-player games, ...).

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# What is distributed computing ?

Distributed computing is a model in which components of a software system are shared among multiple computers to improve efficiency and performance.

# State of art

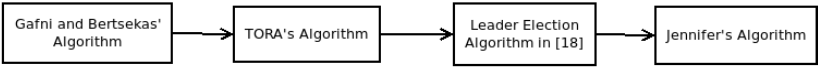


Figure:

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- and a queue $mqueue_{uv}$ of messages.

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- A configuration is a vector of node states, one for each node in $P$, and a vector of channel states, one for each channel in $\chi$.

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- each node is in an initial state (according to its algorithm),
- for each channel $Channel(u, v)$, $mqueue_{uv}$ is empty, and
- for all nodes $u$ and $v$, $status_{uv} = status_{vu}$ (i.e., either both channels between $u$ and $v$ are up, or both are down).

# Configurations & Executions

An execution is an infinite sequence $C_0, e_1, C_1, e_2, C_2, \ldots$ of alternating configurations and events, starting with an initial configuration and, if finite, ending with a configuration.

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- another local variable $slid_u$ to hold the identifier of the sub-leader whose remoteness towards $u$ obeys the constraint.

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# Informal description

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- First wave : initiated by one of the lost leader's neighbors looking for it;
- Second wave : initiated by the node located at the edge of the network if the search has hit a dead-end;
- Third wave : initiated by the same node which initiated the first wave updating the other nodes' heights and constructing the spanning tree.

# Nodes, Neighbors and Heights

- When a node $u$ gets a *ChannelUp* event for the channel from $u$ to $v$, it puts $v$ in a local set variable called $forming_u$.

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- And when u gets a *ChannelDown* event for the channel from $u$ to $v$, it removes $v$ from $forming_u$ or $N_u$ , as appropriate.

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- for each $v$ in $N_u$, $height_u[v] = height_v[v]$ (i.e., $u$ has accurate information about $v$'s height), and
- $\mathcal{T}_u$ is initialized properly with respect to the definition of causal clocks.

# Heights

The height for each node is a 7-tuple of integers $((\tau, oid, r), \delta, (nlts, lid), id)$, where the first three components are referred to as the reference level $(RL)$ and the fifth and sixth.

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- $r$, a bit that is set to 0 when the current search is initiated and set to 1 when the current search hits a dead end.
- $\delta$

# The Code triggered by Update Message

**When node $u$ receives** $Update(h)$ **from node** $v \in forming \cup N$**:**

```
// if v is in neither forming nor N, message is ignored
height[v] := h
forming := forming \ {v}
N := N ∪ {v}
myOldHeight := height[u]
if ((nlts^u, lid^u) = (nlts^v, lid^v)) // leader pairs are the same
    if (SINK)
        if (∃ (τ,oid,r) | (τ^w, oid^w, r^w) = (τ,oid,r) ∀ w ∈ N)
            if ((τ > 0) and (r = 0))
                REFLECTREFLEVEL
            else if ((τ > 0) and (r = 1) and (oid = u))
                ELECTSELF
            else // (τ = 0) or (τ > 0 and r = 1 and oid ≠ u)
                STARTNEWREFLEVEL
            end if
        else // neighbors have different ref levels
            PROPAGATELARGESTREFLEVEL
        end if
    // else not sink, do nothing
    end if
else // leader pairs are different
    ADOPTLPIFPRIORITY(v)
end if
if (myOldHeight ≠ height[u])
    send Update(height[u]) to all w ∈ (N ∪ forming)
end if
```

# Subroutines

ELECTSELF
1. $height[u] := (0,0,0,0,-\mathscr{T}_u, u, u)$

REFLECTREFLEVEL
1. $height[u] := (\tau, oid, 1, 0, nlts^u, lid^u, u)$

PROPAGATELARGESTREFLEVEL
1. $(\tau^u, oid^u, r^u) := max\{(\tau^w, oid^w, r^w) | \ w \in N\}$
2. $\delta^u := min\{\ \delta^w \ | \ w \in N$ and $(\tau^u, oid^u, r^u) = (\tau^w, oid^w, r^w)\} - 1$

STARTNEWREFLEVEL
1. $height[u] := (\mathscr{T}_u, u, 0, 0, nlts^u, lid^u, u)$

ADOPTLPIFPRIORITY $(v)$
```
1.  if ((nlts^v < nlts^u) or ((nlts^v = nlts^u) and (lid^v < lid^u)))
2.        height[u] := (τ^v, oid^v, r^v, δ^v + 1, nlts^v, lid^v, u)
3.  else send Update(height[u]) to v
4.  end if
```

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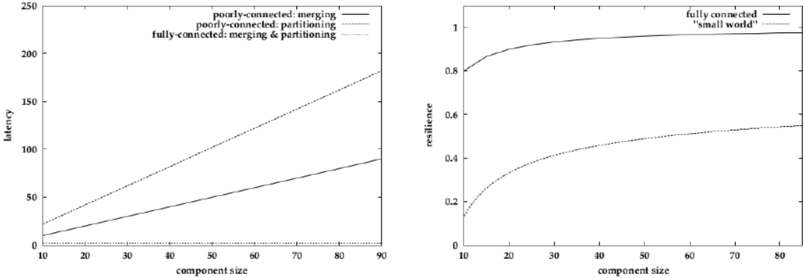
# What's JBotSim ?

JBoTSim is a java library that offers basic primitives for proto-typing, running, and visualizing distributed algorithms in dynamic networks.

## Simulation

# How is our algorithm's performance ?




(a) Latency (b) Resilience

Figure: Simulation Results

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# Is The Algorithm Perfect ?

An open question is how to extend our algorithm and its analysis to handle a wider range of clocks, such as approximately synchronized clocks and vector clocks.

# Question ?