

Efficient Computation in Congested Anonymous Dynamic Networks

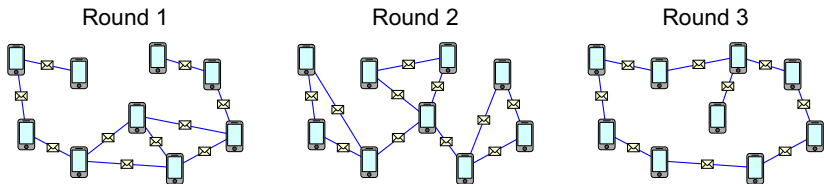
PODC 2023, Brief Announcement

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Dynamic Networks

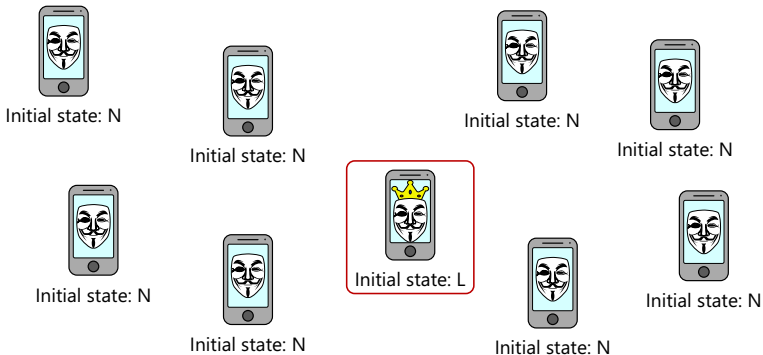
In a **dynamic network**, communication links between agents may unpredictably appear or disappear over time. The network is always connected, but its topology is unknown to the agents.



Each agent has an *input*, and all agents eventually have to agree on an *output*. How many *communication rounds* do they need?

Anonymity and Leader

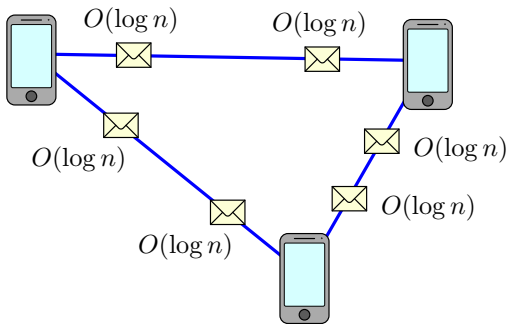
All agents are *anonymous*, i.e., they have no IDs and are indistinguishable, they start in the same state, etc.



The only exception is a unique agent, called the *leader*.

Congested Networks

Normally, there is no limit to the size of messages that can be sent through the links. Any kind of information can be sent.



In a *congested network*, each message must have size $O(\log n)$. This is a severe limitation on how much information can be sent.

Bounds on General Computation

LOCAL model (unlimited message size):

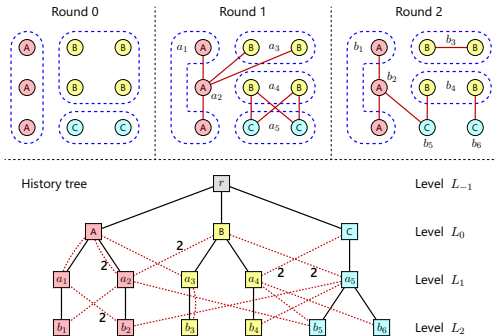
- **Looks impossible...** [Michail et al., SSS 2013]
- $O(n^{n+4})$ **rounds** [Di Luna–Baldoni, OPODIS 2015]
- $O(n^5 \log^2 n)$ **rounds** [Kowalski–Mosteiro, ICALP 2018 Best Paper]
- $O(n^{4+\epsilon} \log^3 n)$ **rounds** [Kowalski–Mosteiro, ICALP 2019]
- **$3n$ rounds (optimal)** [Di Luna–V., FOCS 2022]

CONGEST model ($O(\log n)$ message size):

- Lower bound of $\Omega(n^2 / \log n)$ **rounds** [Dutta et al., SODA 2013]
- $O(n^{5+\epsilon} \log^3 n)$ **rounds** [Kowalski–Mosteiro, ArXiv 2022]
- **$O(n^3)$ rounds** [Di Luna–V., [this work](#)]

History Trees

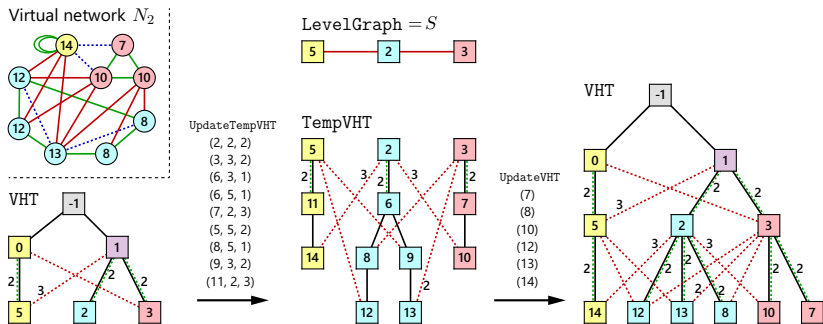
A **history tree** is a data structure that naturally captures the idea that anonymous agents become distinguishable as soon as they have different “histories” [FOCS 2022].



Constructing and sharing history trees is a way of doing arbitrary computations in linear time. Unfortunately, the size of a history tree is $O(n^3 \log n)$, unsuitable for the CONGEST model.

Our Solution

We developed techniques to enable the transmission of history trees on congested networks in $O(n^3)$ rounds, in spite of the anonymity of the agents and the dynamics of the network.



Full paper: <https://arxiv.org/abs/2301.07849>