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The Center for Education and Research in Information Assurance and Security

AutoMous Lab

Automated Resilience for Distributed Coordination in Large-scale Networks

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Motivation

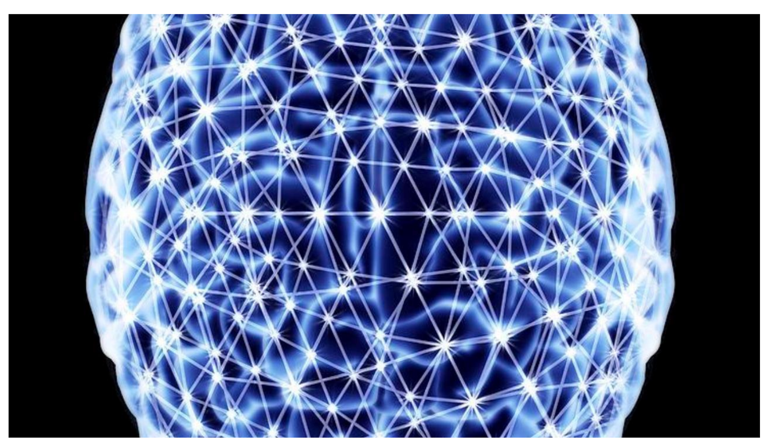
Distributed control of large-scale multi-agent networks achieve global objectives only through local coordination. On one hand, the lack of central controller leads to robustness against individual agent or link failures. On the other hand, the dependence on local coordination raises a major concern that the whole network may crash down under sophisticated attacks to one or more vulnerable agents. Motivated by this, our research aims to provide a systematic way to achieve **automated resilience** for consensus-based distributed algorithms, which purely based on **agents' locally available information.**

Application Backgrounds

❖ Multi-robot formation control

❖ Cooperative Traffic Control

❖ Distributed computing



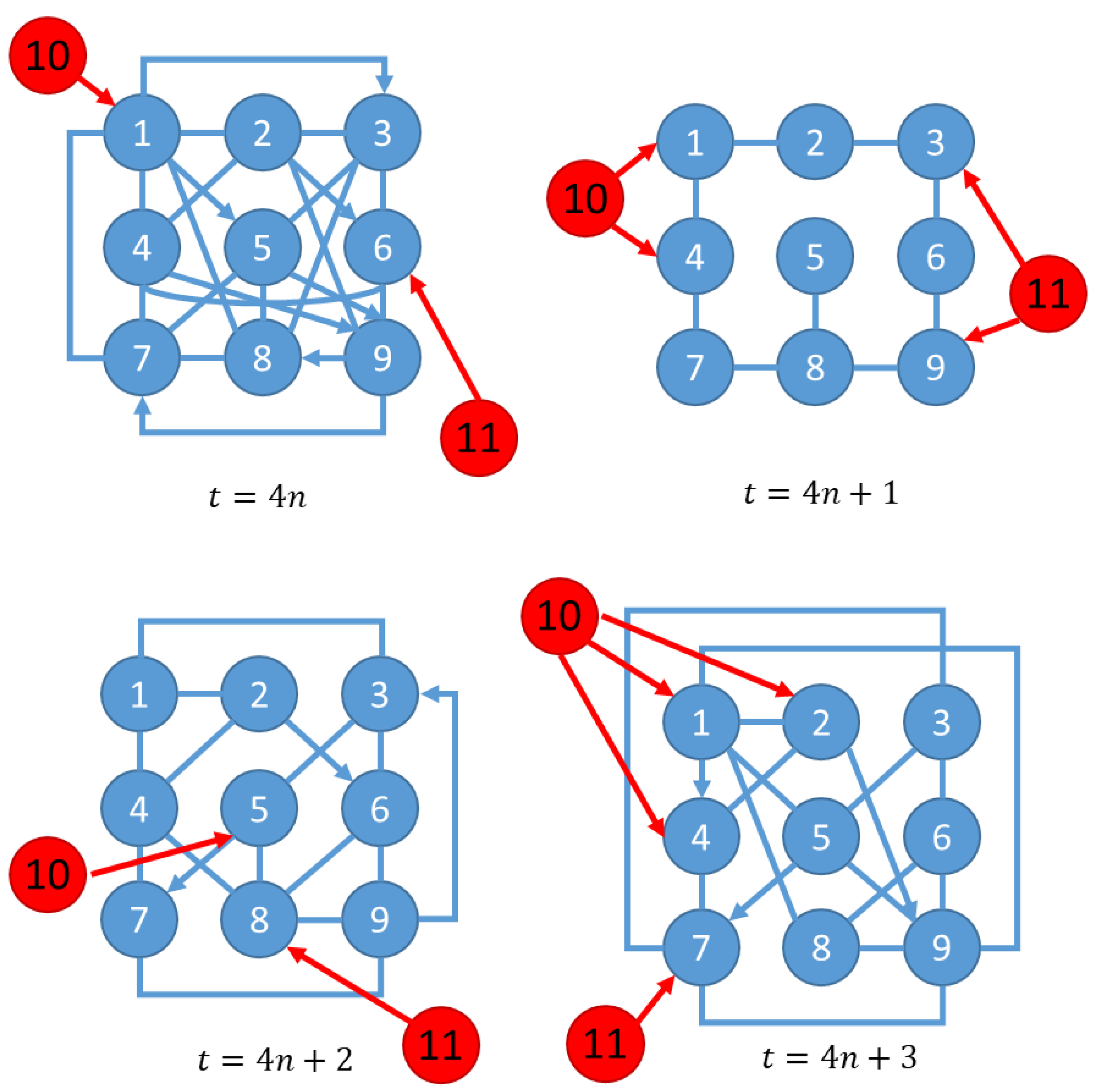
❖ Distributed machine learning

Main Result

Instead of directly using the state information of neighbors' states, our idea is to choose consensus vector by the idea of **intersection of convex hulls.** It is guaranteed that the new consensus vector is always the linear combination of normal agents, even in the presence of malicious ones. The proposed approach is **automated** and **distributed,** which has the following properties:

- The algorithm can be **integrated into any existing** consensus-based distributed algorithms.
- The method **does not require any identification** of malicious nodes.
- The computation is with **low complexity** and is based on only nodes **locally available information.**
- Compared with existing methods (*Tverberg*), the method has **faster convergence rate** and **relaxed requirement** on network redundancy.

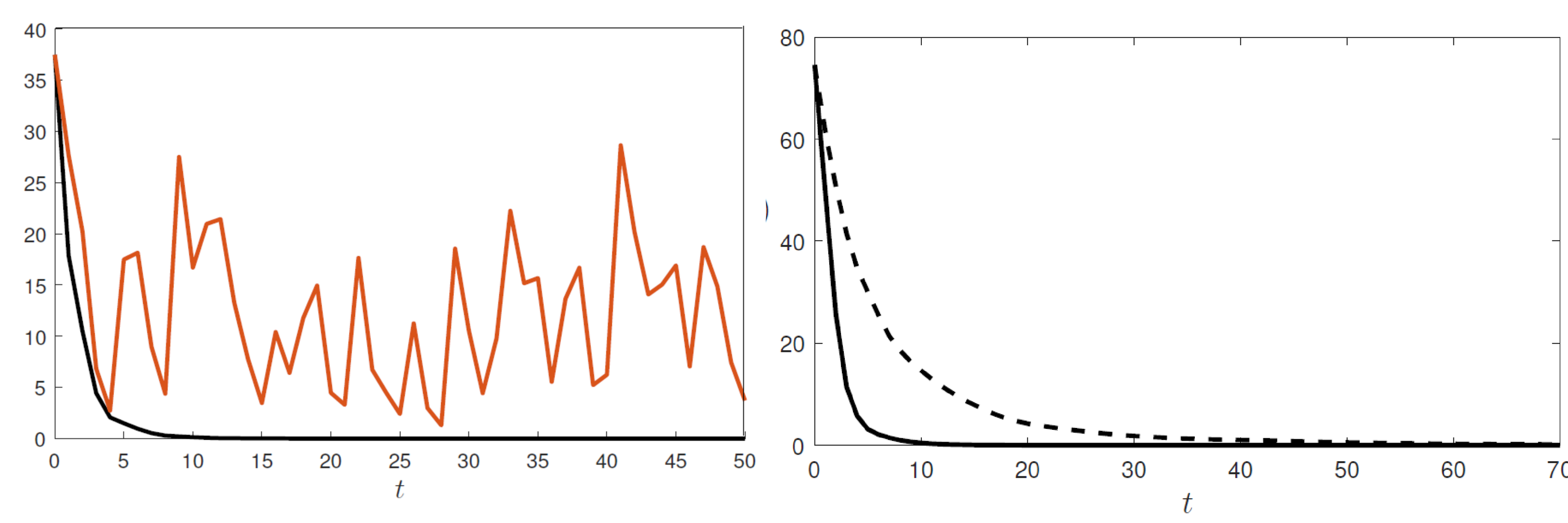
Challenges



- The network is **time-varying**.
- The malicious agent is with **high mobility**.
- **Only local information** is available.
- The cyber-attack such as Byzantine attacks **is too sophisticated to be identified.**

Simulation Result

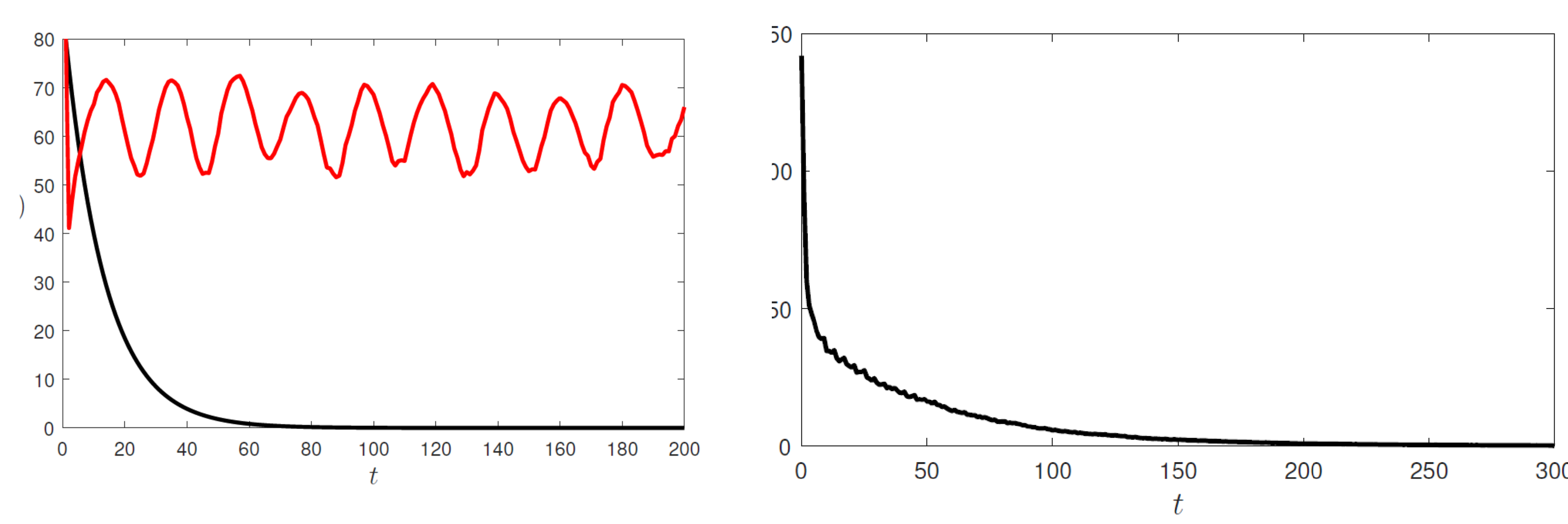
Example 1 Unconstrained Consensus.



Original consensus algorithm
Black: no attacks
Red: with attacks

Resilient consensus algorithm
Solid: Our approach
Dash: Tverberg approach

Example 2 Consensus with local linear constraints.



Original consensus algorithm
Black: no attacks
Red: with attacks

Our resilient consensus algorithm

PURDUE UNIVERSITY Discovery Park

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