Generalized Gossip Algorithms for Solving Distributed Optimization Problems

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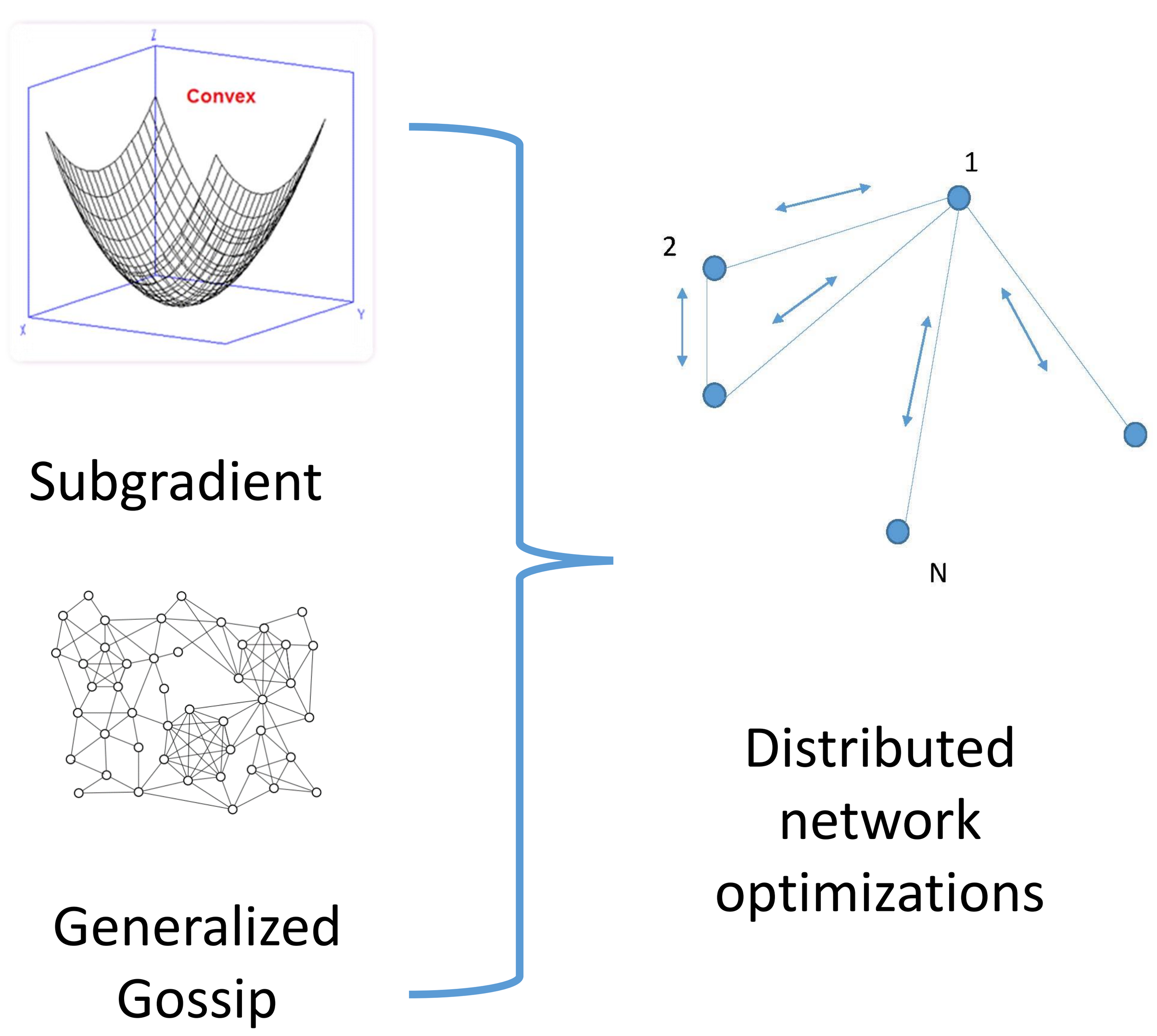
Introduction

- Large-scale networks have received considerable interest in areas such as robotics, transportation networks, and smart buildings.
- Subgradient methods are widely used methods in distributed optimization problems.
- Generalized gossip algorithms enable a tradeoff between the decision propagation radius and localization of information throughout the network.

Problem Setup and Method

- A distributed optimization problem defined on the network
- The generalized gossip-based subgradient optimization algorithm is applicable to networks with multiple resources and consumption entities.



Results

➢ Generalized gossip-based subgradient algorithm

- State update law:

$$x(k+1) = (1-\theta)\Pi(k)x(k) + \theta(x(k) - \nabla(k))$$

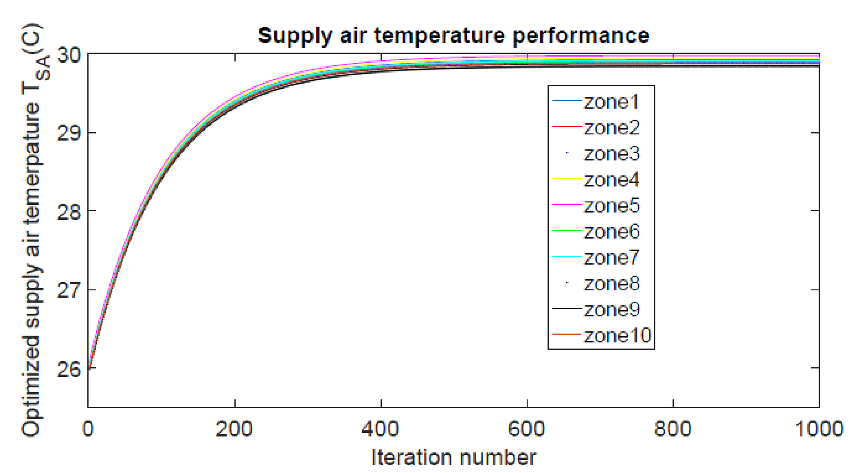
where $x \in \mathbb{R}^M$, θ is the user-defined control parameter, Π is a state transition matrix, ∇ is the subgradient at x, k is the time.

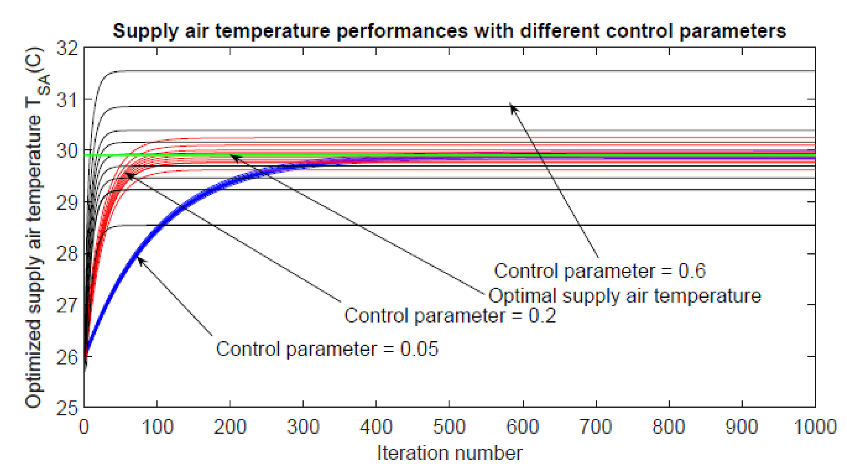
➢ Convergence analysis

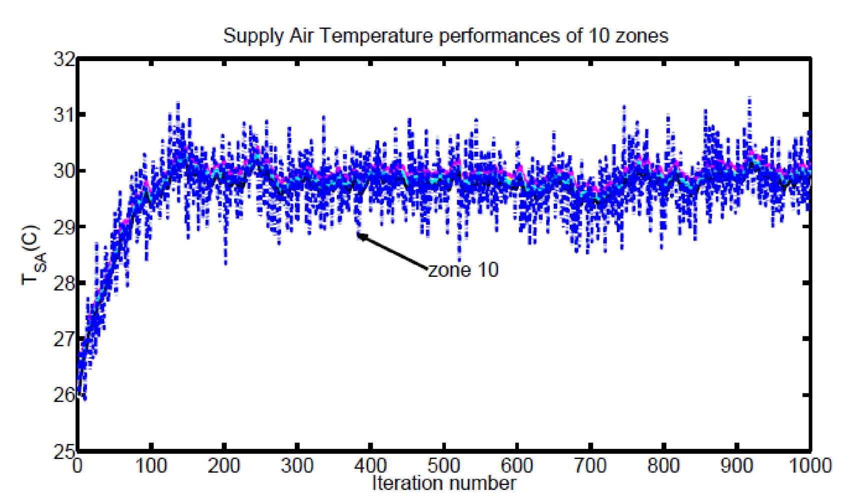
- The function values have the associated upper bounds no matter in the cases of $\theta \to 0, \theta \to 1$ or in the medium.
- θ controls the tradeoff between "degree of consensus" and "degree of disagreement".
- One can potentially adapt Π to suppress the impact of large uncertainty stemming from a particular agent.

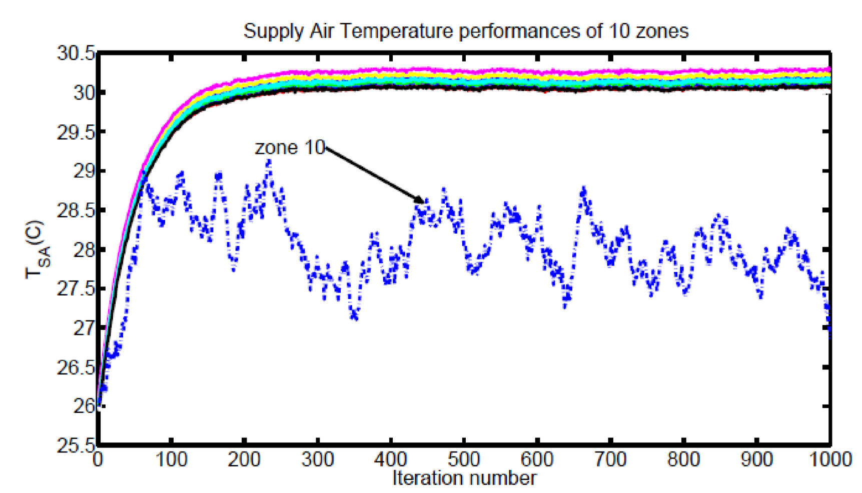
➢ Application

- Optimizing supply air temperature for minimizing energy consumption in a building involving ten zones while achieving their respective comfort requirements









Conclusions

- The proposed algorithm enables the optimization process to operate in the entire spectrum of "complete consensus" to "complete disagreement".
- Agent interaction matrix Π can be used to effectively suppress large uncertainties in subgradient estimation.

Future work

- Quantifying and propogation analysis of uncertainties stemming from subgradient computations.
- Extending to constrained optimization problem.
- Validation on real-life large scale supply-demand networks.

References

- A. Nedic and A. Ozdaglar, "Distributed subgradient methods for multi-agent optimization," Automatic Control, IEEE Transactions on, 2009.
- S. Sarkar, K. Mukherjee, and A. Ray, "Distributed decision propagation in mobile-agent proximity networks," International Journal of Control, 2013.