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On some Opinion Dynamics in Multi-Agent Systems

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MULTI-AGENT SYSTEM

MAS = set of n agents interacting between each others, each supporting some opinion.

AGREEMENT TASK

The whole (or parts of the) system must agree on some opinion.

LABEL PROPAGATION ALGORITHMS

LPAs = class of algorithms for community detection in MAS:

1. an initial label/opinion to each agent;
2. activation rule for each agents;
3. majority-based update rule for labels.

At the end, each community agrees on some different label.

THE 2-CHOICES DYNAMICS

Opinion Dynamics for majority consensus studied also in non-complete topologies (e.g., expanders) [4,6].

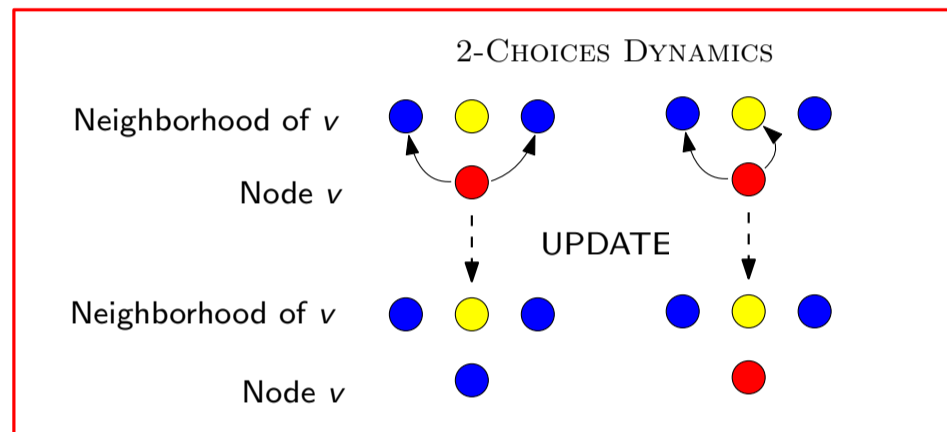
Here, we consider it as a LPA.

Initialization: random binary state, red or blue.

Activation: all nodes active in each round.

Update: each node samples two neighbors and, if they have the same state, updates to that state.

Underlying graph: $(2n, d, b)$ -clustered regular graph [2] with $d > 2b$, which exhibits nice clustered structure.



OPINION DYNAMICS WITH NOISE

Class of simple algorithms for the Majority Consensus Problem with noise perturbing communications. The dynamics must bring the system into a config. satisfying:

1. **Almost-Agreement**: the majority of agents agree on some opinion;
2. **Majority**: this opinion is the initial majority one;
3. **Almost-Stability**: such a configuration lasts for time $\text{poly}(n)$.

Applications in sensor networks [1], chemical reaction networks [3], biological systems [8], ecc.

RESULT: with constant prob. the initialization is asymmetric and, w.h.p., it holds that [5]

NOISE MODEL AND RESULTS

We introduce a simple model of uniform noise, bio-inspired [8].

We prove [7] the following holds w.h.p. for $p < 1/6$:

Symmetry-Breaking: time $\mathcal{O}(\log n)$ to bias $\frac{\Omega(\log n)}{\Omega(\sqrt{n \log n})}$

Almost-Consensus: time $\mathcal{O}(\log n)$ to bias $\Theta(n)$

Meta-Stable Phase: for $\text{poly}(n)$ rounds bias $\Theta(n)$

Note: if $p > 1/6$ every information about the majority color is lost in time $\mathcal{O}(\log n)$, w.h.p.

THE UNDECIDED-STATE DYNAMICS

Introduced by [1] as a fast, robust and simple dynamics for the majority consensus problem.

Rule:

1. each agent u samples one neighbor and look at its state x ;
2. if x is different from $\text{state}(u)$, then u becomes undecided;
3. if u is undecided, then it copies what it sees.

[3] has completely characterized the parallel binary case in the complete graph.

REFERENCES

1. Angluin et al., "A simple population protocol for fast robust approximate majority", Distributed Computing 2008
2. Becchetti et al., "Average Whenever You Meet", ESA 2018
3. Clementi et al., "A Tight Analysis of the Parallel Undecided-State Dynamics with Two Colors", MFCS 2018
4. Cooper et al., "Fast plurality Consensus in Regular Expanders", DISC 2017
5. Cruciani et al., "Distributed Community Detection via Metastability of the 2-Choices Dynamics", AAI 2019, <https://arxiv.org/abs/1805.01406>
6. Cruciani et al., "Phase Transition of the 2-Choices Dynamics on Core Periphery Networks", AAMAS 2018
7. d'Amore et al., "Phase Transition of a Non-Linear Opinion Dynamics with Noisy Interactions", SIROCCO 2020, <https://arxiv.org/abs/2005.07423>
8. Reina et al., "Model of the best-of- N nest-site selection process in honeybees", Physical Review 2016