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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].

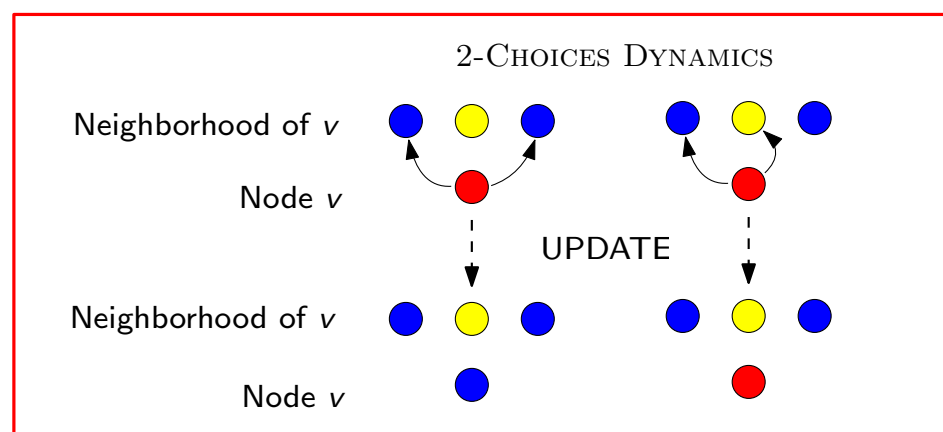
Here, we consider it as a LPA.

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]

Symmetry-breaking after time $\mathcal{O}(\log n)$

Almost agreement in time $\mathcal{O}(\log n)$. The bias in each community is $n - \mathcal{O}(\log n)$

Meta-stable phase of length $\Omega(n^\lambda)$, for some $\lambda > 0$

NOISE MODEL AND RESULTS

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

with prob. $1 - 3p$ it sees red

with prob. p it sees undecided

with prob. p it sees red

with prob. p it sees blue

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.

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

Symmetry-Breaking Almost-Consensus Meta-Stable Phase

time $\mathcal{O}(\log n)$ to bias $\Omega(\sqrt{n \log n})$ time $\mathcal{O}(\log n)$ to bias $\Theta(n)$ 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.

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