Design of Multi-Agent Systems - B20
Gossip Simulations with Semi-Random Strategies

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Abstract

The abstract should briefly summarize your project in 150–250 words.

1 Introduction

In this paper we will consider communication problems between agents. Several problems can be found in the literature, such as the marble problem [Lan54], or the gossip problem [HMS72]. Both problems are the same in essence, but in this paper we will focus on the latter, because of its simplicity.

1.1 Problem

The gossip problem is described as the following:

There are n ladies, and each of them knows some item of scandal which is not known to any of the others. They communicate by telephone, and whenever two ladies make a call, they pass on to each other, as much scandal as they know at that time. How many calls are needed before all ladies know all the scandal

We know that the minimum time needed when only 1 call can be made per time step, is $t(n) = 2n - 4$ [HMS72]. We will however consider a situation where multiple calls can be made per time step.

1.2 State of the art

The minimum completion time needed by a group of agents to complete this problem for a group size of n, any possible arrangement of the communication net, combined with a number of messages per time step per agent (r), is τ where τ is the integer satisfying: $log_{r+1}n \leq \tau < 1 + log_{r+1}n$ [Lan54]. For $n > 4$, Landau could however not mention a set of rules so that the completion time of the task reduces to this minimal completion time. It is important to notice that this completion time can only be reached in the centralized version of the gossip problem, ”where the protocols tell the agents whom they have to call” [Coo+19].

The opposite of this is the distributed version, where "individual agents, on the basis of their own information, decide which other agent to call" [Coo+19].

1.3 New idea

This paper will take a look at the parallel version of the gossip problem, with r (the number of messages per time step per agent) being one. The new ideas proposed in this project are the introduction of semi-random strategies. Landau mentions in his paper that the minimum completion time is attainable by using the optimal strategy [Lan54]. This means that whenever the optimal strategy is not used, there is a large probability that the minimum completion time will not be reached. The optimal strategy Landau speaks of however, is the strategy where each agent knows which agent to speak to in order to reach that optimal time, and thus the centralized version of this problem. In real life, this sort of knowledge is usually unattainable. This paper will therefore investigate the distributed version of the gossip problem. The fact that r is chosen to be one, resembles real life the best. When we consider agents to be i.e. humans, or processors, only one connection can be made per time step. Distributed strategies that decrease completion time of the gossip problem, can be used in systems like bitcoin to be more time efficient.
The methods proposed in this paper have to do with the introduction of semi-randomness in the strategies the agents make use of. In these strategies, agents use randomness as well as a set of rules when they consider whom to call. The effect of these new strategies, and some existing strategies, will be studied by measuring the time needed for the completion of the task, and comparing these times with the theoretical minimal completion time.

2 Method

2.1 Simulation model

The gossiping task can be represented by a graph containing nodes and edges. The nodes represent the agents and the edges represent the possible lines of communication between the agents. Landau talks about different kinds of graphs, where the number of edges is not equal for each node 1954. In this paper, a fully connected graph structure is considered (see Figure 1). Each agent is then able to communicate to every other agent. This change was made because it seemed to model real world applications better (e.g spies in a spy network running around to pass on information to other spies).

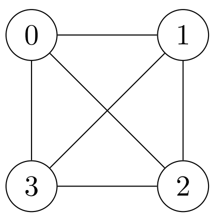

Figure 1: An example of a fully connected network of agents ($n = 4$). Each node represents an agent in the network. Each edge signifies a possible connection between agents, with which they can communicate their secrets to each other.

In Landau's work, computer simulations were performed using only 3 to 6 agents 1954. The reason for this is that the computers of those times were not nearly as fast as the computers in our time (2019). This project will also handle increased numbers of agents.

$n = 100$ agents will be used in all simulations. Different communication strategies will be implemented in each agent for different simulations. Agents can make $r = 1$ connection per time step to another agent.

2.1.1 Strategies

Multiple different strategies will be used in the experiments:

- Call-me-once: An agent may call another agent only once
- Learn-new-secrets: An agent may call another agent iff it does not have the other agent's secret yet.
- Some More.....

2.2 Implementation details

The simulations are done using a program written in Python 3.7. The libraries that are: NetworkX, to generate graphs easily and Dash to view and update the graph with ease.

2.3 Experiment design

3 Results

3.1 Experiment findings

The results of all strategies that we used can be found in table 1.

Strategy	completion time τ	τ/τ_{opt}
call-me-once	14	200%
learn-new-secrets	21	300%
some-more	10	142%
even-more	11	157%

Table 1: Table that displays completion times of all strategies, as well as the ratio of the completion time (τ) vs. the optimal completion time $\tau_{opt} = 7$.

3.2 Interpretation of findings

4 Conclusion

4.1 Discussion

4.2 Relevance

4.3 Team Work

References

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