

Abstract and Publications

I. ABSTRACT

This thesis studies the learning properties of agents in a social network under uncertain conditions. We address the problem of how well agents perform during learning when the information received is incomplete or inaccurate. We analyze a model of a decentralized tandem network, where each agent receives some external information about a binary hypothesis (the state of the world), as well as a previous decision from an agent in the network, then makes a decision about the state of the world and relays this decision to the next agent in the network. If all agents know their position in the network and the exact distributions of all previous agents' external information, then it is possible for the minimax error probability of the network to converge to zero. We show that if there is some uncertainty about previous agents' external information, the minimax error probability is bounded above zero. Furthermore, we also propose a decision rule to minimize the minimax error probability when agents do not know their position in the network, and show that this minimax error probability is bounded above zero, whether or not the agents know the exact distributions of previous agents' external information. We then consider a model where one wishes to learn an optimal sequence of actions, with each action's reward being dependent on all actions' rewards in previous time steps. We show that this can be modeled using a string-submodular function. Taking the action with the best reward at each time step would lead to a greedy string. However, we impose an additional constraint that only some actions' rewards can be observed at each time step. We then propose various methods to select these actions and derive performance bounds compared to the optimal string of each length. Finally, we explore the multi-armed bandit problem in a social network setting. We assume that selecting an agent at each time step would give us a stochastically generated reward, as well as noisy information about the rewards of nearby agents. We propose a method of selecting which agents to use at each time step, and compare our method to scenarios where perfect information about the rewards of nearby agents is known, as well as that when no information about nearby agents is known.

II. PUBLICATIONS

- [1] Jack Ho, Wee Peng Tay, and Tony Q. S. Quek. Robust detection and social learning in tandem networks. In *Proc. IEEE Int. Conf. Acoustics, Speech, and Signal Processing*, pages 5457–5461, May 2014.
- [2] Jack Ho, Wee Peng Tay, and Tony Q. S. Quek. A pseudo-greedy strategy on string submodular functions. *IEEE Int. Conf. Acoustics, Speech, and Signal Processing*, Submitted.
- [3] Jack Ho, Wee Peng Tay, Tony Q. S. Quek, and Edwin K. P. Chong. Robust decentralized detection and social learning in tandem networks. *IEEE Trans. Signal Process.*, 63(19):5019 – 5032, Oct. 2015.