SIGNAL PROCESSING OVER MULTI-TASK NETWORKS

Sahar Khawatmi

Technische Universität Darmstadt
Signal Processing Group
64283 Darmstadt, Germany
Email: khawatmi@spg.tu-darmstadt.de

ABSTRACT

There arises the need in many network applications to infer and track different models of interest in an environment where agents do not know beforehand which models are being observed by their neighbors. In our research, we propose an adaptive and distributed clustering technique that allows agents to learn and form their clusters in a robust manner from streaming data. Once clusters are formed, co-operation among agents with similar objectives can increase the performance of the inference task. Based on the cluster formation, the unused links among the agents that track different models are exploited to link the agents that are interested in the same model but do not have direct links between each other.

I. NETWORK MODEL

We consider a distributed mean-square-error estimation problem over an N-agent network. The connectivity of the agents is described by a graph. We assume that the data sensed by any particular agent can arise from one of C models. There are many applications in practice where agents can be subjected to data from different sources as, for example, in tracking multiple targets or swarming towards different food sources. In most prior works, it is generally assumed that each agent knows which neighbors are influenced by the same model. In our work, we consider agents that do not know which model has generated their observed data; they also do not know which other agents in their neighborhood sense data arising from the same model. Thus, we are interested in performing clustering. By clustering, we mean that the agents determine the neighbors that are interested in the same model. Then the agents keep the links among the neighbors which have agreed that they belong to the same cluster, and cut the remaining links. In the next phase, a linking process is performed over the network. Linking aims at connecting the largest number of sub-networks that belong to the same cluster by using the unused links.

II. CLUSTERING AND LINKING TECHNIQUE

By testing the difference among the agents' estimation performance at each time iteration based on smoothed variables, we couple the clustering and inference into a single iterative algorithm rather than to run the two tasks separately. This is because smoothing helps to reduce the influence of erroneous clustering decisions on the accuracy of the inference task. Fig. 1a illustrates the network structure for an illustrating scenario involving $C = 3$ unknown models and three clusters represented by the three colors. Agent k has neighbors that sense data originating from different clusters than its own. Fig. 1b shows the clustered topology that will result once agents identify which neighbors belong to the same cluster and cut links to the remaining neighbors. Fig. 1c shows the resulting linked topology where agents use the links that were cut during the clustering phase, the dashed lines indicate the links that connect the sub-networks which are interested in the same model $w^o_{\mathcal{C},1}$ through the unused links.

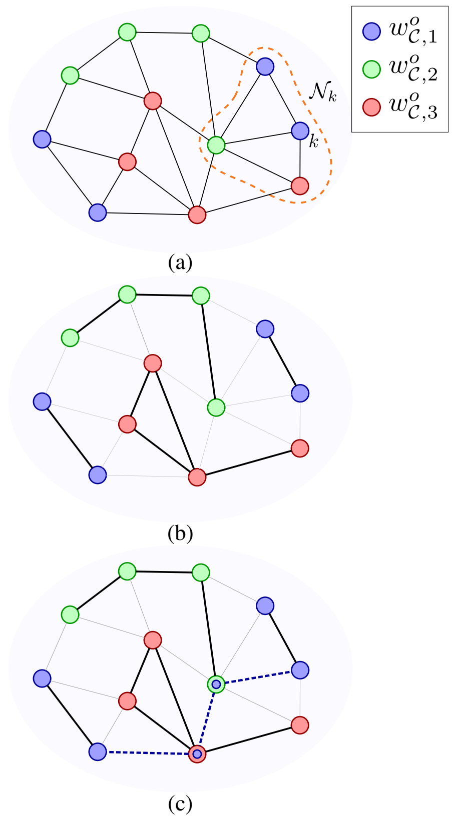

Fig. 1: (a) Network topology. (b) Clustered topology. (c) Linked topology.