Interactive Distributed Source Coding in Asymmetric Communication Scenarios

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We provide a new unified framework, called “multiple correlated informants - single recipient” communication, to address the variations of the traditional Distributed Source Coding (DSC) problem [1]. Different combinations of the assumptions about the communication scenarios and the objectives of communication result in different variations of the DSC problem. For each of these variations, the complexities of communication and computation of the optimal solution is determined by the combination of the underlying assumptions. Starting with the seminal paper [1], most of the work in DSC has assumed the symmetric and noninteractive communication, [2] and references therein. However, in the recent past, attempts have been made to address other variants of the DSC problem, for example [3] and the references therein.

In the proposed framework, we address the asymmetric, interactive, and lossless variant of the DSC problem, with various objectives of communication and provide optimal solutions for those. Also, we consider both, the worst-case and average-case scenarios. A preliminary version of our ideas appeared in [3].

Formally, we have considered “$N$ multiple correlated informants - single recipient” interactive communication problem in the asymmetric communication scenarios. The objective of communication is that the recipient must learn losslessly about each informant’s data. Communication takes place over $N$ binary, error-free channels, where each channel connects an informant with the recipient. Using prefix-free messages and instantaneous decoding [3], reduces this problem to a serial communication problem, where the optimal schedule (along with the optimal number of messages and bits exchanged) to solve $N$ “single recipient - single informant” communication problems, is computed. We are interested in solving following problems (for details on notation, please refer to [3]).

$$\min_{m \geq 1} \min_{\pi \in \Pi} \max_{i=1,\ldots,N} \tilde{I}_{\pi(i),R}$$  \hspace{1cm} (1)  $$\min_{m \geq 1} \min_{\pi \in \Pi} \max_{i=1,\ldots,N} \tilde{I}_{\pi(i),R}$$  \hspace{1cm} (3)

$$\min_{m \geq 1} \min_{\pi \in \Pi} \max(\tilde{R}_{\pi}, \max_{i=1,\ldots,N} \tilde{I}_{\pi(i),R})$$  \hspace{1cm} (2)  $$\min_{m \geq 1} \min_{\pi \in \Pi} \max(\tilde{R}_{\pi}, \max_{i=1,\ldots,N} \tilde{I}_{\pi(i),R})$$  \hspace{1cm} (4)

We show that for the problems (1) and (3), interaction helps in reducing the complexity of the optimal solution and as few as two messages are sufficient to achieve the optimal performance, while for the problems (2) and (4), interaction offers no such reduction. Presently, we are working at other variations of the problems addressed here.

REFERENCES