Interactive Quantization for Extremum Computation in Collocated Networks

Solmaz Torabi, Jie Ren, and John MacLaren Walsh

Department of Electrical and Computer Engineering
Drexel University, Philadelphia, PA 19104
solmaz.t@drexel.edu, jr843@drexel.edu, jwalsh@drexel.edu,

The problem of function computation arises in in many practical scenarios, such as query computation in distributed databases. In such scenarios, it is often possible to exploit the structure of the function to reduce the amount of information that needs to be exchanged in order to compute it. In a so-called a *collocated network*, information is exchanged as users take turns sending messages to a sink, the central estimation officer (CEO), with each user perfectly overhearing the message from every other user, as depicted in Fig 1. In this paper a problem of function computation is studied in a collocated network where m independent nodes in transmission range with each other, exchange messages with the aim of losslessly computing the extremization function $f = \arg\max_i X_i$, or $f = \max_i X_i$. An optimal dynamic quantizer for the user's observations is proposed via a dynamic program which provides the CEO just enough information to compute the desired functions with no error. Both fundamental limits and practical schemes are presented.

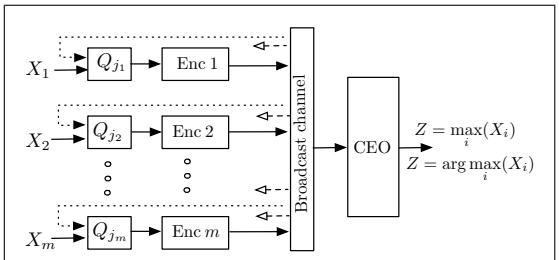

Figure 1: A collocated network.

Ma et al, in [1] studied this problem in a distributed source coding framework, and proposed an iterative algorithm via a convex geometric approach to compute the minimum sum rate of for any finite and infinite number of rounds. Building upon this prior work, we propose an achievable scheme using scalar quantizers followed by Huffman encoding the results. We compute the fundamental limit from [1] for the extrema function, and study the the fundamental tradeoff between the rate-cost and the delay in optimal interactive quantization schemes. We also design some low complexity suboptimal scheme which substantially shrinks the search space of the optimal dynamic program. Moreover, using optimal heterogeneous quantizers result in substantial rate savings relative to the parallel homogenous quantizers in [2].

References

[1] N. Ma, P. Ishwar, and P. Gupta, "Interactive source coding for function computation in collocated networks," *IEEE Trans. Inf. Theory*, vol. 58, no. 7, pp. 4289–4305, 2012.

[2] B. D. Boyle, J. Ren, J. M. Walsh, and S. Weber, "Interactive scalar quantization for distributed extremization," *arXiv preprint arXiv:1505.04202*, 2015.