Adaptive Vector Quantization—Part I: A Unifying Structure

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Although rate-distortion theory establishes optimal coding properties for vector quantization (VQ) of stationary sources, the fact that real sources are, in actuality, nonstationary has led to the proposal of adaptive-VQ (AVQ) algorithms that compensate for changing source statistics. Because of the scarcity of rate-distortion results for nonstationary sources, proposed AVQ algorithms have been mostly heuristically, rather than analytically, motivated. As a result, there has been, to date, little attempt to develop a general model of AVQ or to compare the performances associated with existing AVQ algorithms.

In this two-part poster presentation, we summarize observations resulting from detailed studies of a number of previously published AVQ algorithms. To our knowledge, the observations discussed in these posters represent the first attempt to define and describe AVQ in a general framework. In the first poster of the series, we begin by proposing a mathematical definition of AVQ. Because of the large variety of algorithms that have purported to be AVQ, it is unclear from prior literature precisely what is meant by this term. Any resulting confusion is likely due to a certain imprecise, and sometimes ambiguous, use of the word "adaptive" in VQ literature. However, common to a large part of this literature is the notion that AVQ properly refers to techniques that dynamically vary the contents of a VQ codebook as coding progresses. Our definition of AVQ captures this idea of progressive codebook updating in a general mathematical framework.

After having established with this definition the fundamental nature of AVQ, we proceed to describe a communication-system model for AVQ algorithms. This model reflects the structure typical to AVQ algorithms as suggested by our observations and provides a context in which to discuss the numerous issues involved in practical implementation of these algorithms. In a discussion of these issues, we describe the general operation of each component of the communication-system model as well as illustrate briefly practical design solutions proposed previously by various authors. The second poster of the series continues with a review and classification of prominent AVQ algorithms from prior literature. This second poster also contains a performance comparison between several of these prominent AVQ algorithms.