ECE 6260 – Data Compression and Modeling

Topical Outline

Introduction
- – signal compression, lossless and lossy compression
- – communication systems and building blocks: sources, channels, and codes
- – issues - fixed rate and variable rate, robustness to channel errors, degradation and perceptual effects

Quantization theory
- – uniform quantization, distortion and bit rates
- – amplitude distribution and high-rate quantization theory
- – Bennett approximations and optimal performance, Lloyd's code optimality and algorithm
- – elementary distortion-rate theory

Architecture for data compression & introduction to data modeling
- – signal models & spectral analysis
- – quantization with memory
- – fixed-rate vs. variable-rate code
- – entropy, estimated entropy, complexity and typical sequence of an ergodic source
- – variable rate quantization: lossless codes, prefix code

Lossless Coding Techniques
- – Huffman coding, arithmetic coding
- – Universal lossless codes, adaptive and predictive lossless coding

Distortion & Similarity Measures
- – sample difference, sum of squared deviations and Euclidean distance
- – Lp-norm, city-block distance, Mahalanobis distance
- – transformation and transformation invariant similarity measures
- – spectral distortion measures
- – mutual-information, divergence, and Kullback-Liebler number
- – perceptual issues

Coding algorithms – scalar quantization
- – clustering algorithms for quantizer design
- – the Lloyd algorithm and its generalization
- – entropy-constrained quantizers

Coding algorithms - vector quantization (VQ)
- – sphere packing and optimal uniform lattice quantizers
- – Lloyd algorithm - revisited
- – progressive vector quantization
- – variations of vector quantization
- – finite-state VQ and Markov models
- – tree and trellis encoding

Applications
- – speech and audio coding
- – image and video coding

Compression standards and formats
- – Historical and evolutional aspects behind development of standards
- – Application areas