

**Fast and Efficient Algorithms
for text and Video Compression**

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Ph.D. Dissertation

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Fast and Efficient Algorithms for Text and Video Compression¹

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Abstract

There is a tradeoff between the speed of a data compressor and the level of compression it can achieve. Improving compression generally requires more computation; and improving speed generally sacrifices compression. In this thesis, we examine a range of tradeoffs for text and video.

In text compression, we attempt to bridge the gap between statistical techniques, which exhibit a greater amount of compression but are computationally intensive, and dictionary-based techniques, which give less compression but run faster. We combine the context modeling of statistical coding with dynamic dictionaries into a hybrid coding scheme we call *Dictionary by Partial Matching*.

In low-bit-rate video compression, we explore the speed-compression tradeoffs with a range of motion estimation techniques operating within the H.261 video coding standard. We initially consider algorithms that explicitly minimize bit rate and combination of rate and distortion. With insights gained from the explicit minimization algorithms, we propose a new technique for motion estimation that minimizes an efficiently computed heuristic function. The new technique gives compression efficiency comparable to the explicit-minimization algorithms while running much faster. We also explore bit-minimization in a non-standard quadtree-based video coder that codes motion information hierarchically using variable-sized blocks.

For video coding at medium-to-high bit rates, we propose a framework that casts rate control as a resource allocation problem with continuous variables, non-linear constraints, and a novel lexicographic optimality criterion motivated for near-constant-quality video. With this framework, we redefine the concept of efficiency to better reflect the constancy in quality generally desired from a video coder. Rigorous analysis within this framework reveals elegant conditions for optimality, which leads to polynomial-time algorithms. Simulation studies confirm the theoretical analysis and produce encodings that are more constant in quality than that achieved with existing rate control methods. As evidence of the flexibility of the framework, we show how to extend it to allocate bits among multiple variable-bit-rate bitstreams for transmission over a constant-bit-rate channel.

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