James A. Storer

Professor of Computer Science

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Education:

Ph.D. Princeton University, computer science (1979)
M.A. Princeton University, computer science (1977)
B.A. Cornell University, mathematics and computer science (1975)

Employment History:

Brandeis University, Professor of Computer Science (1993 - present)
Brandeis University, Associate Professor of Computer Science (1986 - 1992)
Harvard University, Visiting Professor of Computer Science (1987 - 1988)
Brandeis University, Assistant Professor of Computer Science (1981 - 1986)
Bell Laboratories at Murray Hill, MTS (1979 - 1981)

Research Interests:

Computer algorithms, communications and internet related computing, data compression and archiving (including text, images, video, and multi-media), storage and processing of large data sets, image retrieval, object recognition, text, image, and video processing, parallel computing, applications of deep learning to image analysis.

Professional Activities:

- In 1991 I founded the Annual IEEE Data Compression Conference (DCC), the first major international conference devoted entirely to data compression, and have served as the conference chair since then.
- I am a member of the ACM and IEEE Computer Society. I routinely serve as referee for papers submitted to journals (JACM, SICOMP, Theoretical CS, J. Algorithms, Algorithms, *Signal Processing*, JPDC, Acta Inf., Algorithmicia, IPL, IPM, Theoretical CS, J. Alg., Networks, IEEE J. Rob. & Aut., IEEE Trans. Inf. Theory, IEEE Trans. Comp., IEEE Trans. Image Proc., Proceedings of the IEEE, IBM J. of R&D, JCSS, etc.). I have served as an editor for *Information Processing and Management, Journal of Visual Communication and Image Representation*, and the *Proceedings of the IEEE*. I have served as a program committee member for various conferences, including *IEEE Data Compression Conference*, *Combinatorial Pattern Matching* (CPM), *International Conference on String Processing and Information Retrieval* (SPIRE), *Conference on Information and Knowledge Management* (CIKM), *Sequences* and *Combinatorial Algorithms on Words*, *DAGS*.
- I consult in the areas of computer algorithms, data compression and communications (including text, image, and video), data storage and backup, cell phone, digital camera, and DVR technology, image and video processing, information and image retrieval, including providing expert services for computing technology related litigation.
- I have obtained patents and SBIR funding to engage in research projects (such as high speed data compression hardware) that were not possible within the university environment, but which complemented my academic research and provided practical experience on which to base research directions.

Books

Hyperspectal Data Compression

G. Motta, F. Rizzo, and J. A. Storer, Editors
Springer-Verlag, www.springer.com, November 2006
(425 pages, 6" x 9", hard-bound)
ISBN: 0-387-28579-2

This book provides a survey of recent results in the field of compression of remote sensed 3D data, with a particular interest in hyperspectral imagery. This material is intended to be of interest to researchers in a variety of areas, including multi dimensional data compression, remote sensing, military and aerospace image processing, homeland security, archival of large volumes of scientific and medical data, target detection, and image classification.

The interest in remote sensing applications and platforms (including airborne and spaceborne) has grown dramatically in recent years. Remote sensing technology has shifted from panchromatic data (a wide range of wavelengths merged into a single response), through multispectral (a few possibly overlapping bands in the visible and infrared range with spectral width of 100-200*nm* each), to hyperspectral imagers and ultraspectral sounders, with hundreds or thousands of bands. In addition, the availability of airborne and spaceborne sensors has increased considerably, followed by the widespread availability of remote sensed data in different research environments, including defense, academic, and commercial.

Remote sensed data present special challenges in the acquisition, transmission, analysis, and storage process. Perhaps most significant is the information extraction process. In most cases accurate analysis depends on high quality data, which comes with a price tag: increased data volume. For example, the NASA JPL's *Airborne Visible/Infrared Imaging Spectrometer* (AVIRIS, http://aviris.jpl.nasa.gov) records the visible and the near-infrared spectrum of the reflected light of an area 2 to 12 kilometers wide and several kilometers long (depending on the duration of the flight) into hundreds of non overlapping bands. The resulting data volume typically exceeds 500 Megabytes per flight and it is mainly used for geological mapping, target recognition, and anomaly detection. On the other hand, ultraspectral sounders such as the NASA JPL's *Atmospheric Infrared Sounder* (AIRS, http://www-airs.jpl.nasa.gov), which has recently become a reference in compression studies on this class of data, records thousands of bands covering the infrared spectrum and generates more than 12 Gigabytes of data daily. The major application of this sensor is the acquisition of atmospheric parameters such as temperature, moisture, clouds, gasses, dust concentrations, and other quantities to perform weather and climate forecast.

Chapter 1 addresses compression architecture and reviews and compares compression methods. Chapter 2 through 4 focus on lossless compression (where the decompressed image must be bit for bit identical to the original). Chapter 5 (contributed by the editors) describes a lossless algorithm based on vector quantization with extensions to near lossless and possibly lossy compression for efficient browsing and pure pixel classification. Chapters 6 deals with near lossless compression while Chapter 7 considers lossy techniques constrained by almost perfect classification. Chapters 8 through 12 address lossy compression of hyperspectral imagery, where there is a tradeoff between compression achieved and the quality of the decompressed image. Chapter 13 examines artifacts that can arise from lossy compression.

An Introduction to Data Structures and Algorithms

James A. Storer
Birkhäuser / Springer, www.springer.com, February 2002
(600 pages, 7" x 10", hard-bound)
ISBN 0-8176-4253-6, ISBN 3-7643-4253-6

A highly a highly accessible format presents algorithms with one page displays that will appeal to both students and teachers of computer science. The thirteen chapters include: Models of Computation (including Big O notation), Lists (including stacks, queues, and linked lists), Induction and Recursion, Trees (including self-adjusting binary search trees), Algorithms Design Techniques, Hashing, Heaps (including heapsort and lower bounds on sorting by comparisons), Balanced Trees (including 2-3 trees, red-black trees, and AVL trees), Sets Over a Small Universe (including on-the-fly array initialization, in-place permutation, bucket sorting, bit-vectors, and the union-find data structure), Discrete Fourier Transform (including an introduction to complex numbers, development of the FFT algorithm, convolutions, the DFT on an array of reals, the discrete cosine transform, computing the DCT with a DFT of n/2 points, 2D DFT and DCT, and an overview of JPEG image compression), Strings (including lexicographic sorting, KMP / BM / Rabin-Karp / Shift-And string matching, regular expression pattern matching, tries, suffix tries, edit distance, Burrows-Wheeler transform, text compression examples), Graphs (including DFS / BFS, biconnected and strongly connected components, spanning trees, topological sort, Euler paths, shortest paths, transitive closure, path finding, flow, matching, stable marriage, NP-complete graph problems), Parallel Models of Computation (including the PRAM, generic PRAM simulation, the hypercube/CCC/butterfly, the mesh, and hardware area-time tradeoffs).

- Concepts are expressed clearly, in a single page, with the least amount of notation, and without the "clutter" of the syntax of a particular programming language; algorithms are presented with self-explanatory "pseudo-code".
- Each chapter starts with an introduction and ends with chapter notes and exercises that promote further learning.
- Sorting, often perceived as rather technical, is not treated as a separate chapter, but is used in many examples (including bubble sort, merge sort, tree sort, heap sort, quick sort, and several parallel algorithms). Lower bounds on sorting by comparisons are included with the presentation of heaps in the context of lower bounds for comparison based structures.
- Chapters 1-4 focus on elementary concepts, the exposition unfolding at a slower pace. Sample exercises with solutions are also provided. These chapters assume a reader with only some basic mathematics and a little computer programming experience. An introductory college-level course on data structures may be based on Chapters 1 -4 and the first half of Chapters 5 (algorithms design), 6 (hashing), and 12 (graphs).
- Chapters 5-13 progress at a faster pace. The material is suitable for undergraduates or graduates who need only review Chapters 1-4. A more advanced course on the design and analysis of algorithms may be based on these chapters.
- Chapter 13 on parallel models of computation is something of mini-book itself. The idea is to further teach fundamental concepts in the design of algorithms by exploring exciting models of computation, including the PRAM, generic PRAM simulation, HC/CCC/Butterfly, the mesh, and parallel hardware area-time tradeoffs (with many examples). A sampling of this chapter can be a fun way to end a course based on earlier portions of the book. In addition, a seminar style course can spends its first half covering this chapter in detail and then study papers from the literature.
- Apart from classroom use, this book serves as an excellent reference text on the subject of data structures, algorithms, and parallel algorithms. Its page-at-a-time format makes it easy to review material that the reader has studied in the past.

Data Compression: Methods and Theory

James A. Storer
Computer Science Press (a subsidiary of W. H. Freeman Press), 1988
(419 pages, 6" x 9", hard-bound)
ISBN 0-88175-161-8

The first two chapters contain introductory material on information and coding theory. The remaining four chapters cover some of my data compression research performed in the period 1977 - 1987 (including substantial material that has not been reported elsewhere). Chapter 3 considers on-line textual substitution methods that employ "learning" heuristics to adapt to changing data characteristics. Chapter 4 considers massively parallel algorithms for on-line methods and their VLSI implementations. Chapter 5 considers off-line methods (including the NP-completeness of certain methods). Chapter 6 addresses program size (Kolmogorov) complexity. The appendices present source code and empirical results.

Image and Text Compression

James A. Storer, Editor
Kluwer Academic Press (part of Springer), 1992
(354 pages, 6" x 9", hard-bound)
ISBN 0-7923-9243-4

This is an edited volume of papers by leading researchers in the field; topics include: vector quantization, fractals, optical algorithms, arithmetic coding, context modeling, LZ methods, massively parallel hardware (the chapter I contributed), bounds on Huffman codes, coding delay, and 2D lossless compression. Also included is a 75 page bibliography of data compression research that I compiled specifically for this book.

Proceedings Compression and Complexity

B. Carpentieri, A. De Santis, U. Vaccaro, and J. A. Storer, Editors
IEEE Computer Society Press, 1998
(400 pages, 6" x 9", hard-bound)
ISBN 0-8186-8132-2

This is an edited volume of the papers presented at the *International Conference on Compression and Complexity of Sequences*, held in Positano, Italy in 1997.

Papers address the theoretical aspects of data compression and its relationship to problems on sequences, and include contributions from the editors.

Proceedings of the Data Compression Conference

James A. Storer, Co-Chair
IEEE Computer Society Press
1991 - present (approximately 500 pages hard-bound)

I have chaired DCC since it was founded in 1991; starting in 2013 the conference leadership has been expanded; I am currently co-chair (with M. Marcellin, formally committee chair).

The DCC proceedings are co-edited with the DCC program committee chair(s), which over the years has been J. Reif (1991), M. Cohn (1992-2006), M. Marcellin (2007-2012), Ali Bilgin & Joan Serra-Sagrista (2013-present).

Each volume has ten page extended abstracts of the presentations at technical sessions and one page abstracts of presentations at the posters session. The call for papers states that topics of interest include but are not limited to:

> An international forum for current work on data compression for text, images, video, audio, and related areas. Topics of interest include but are not limited to: Lossless and lossy compression algorithms for specific types of data (text, images, multi-spectral and hyper-spectral images, palette images, video, speech, music, maps, instrument and sensor data, space data, earth observation data, graphics, 3D representations, animation, bit-maps, etc.), source coding, text compression, joint source-channel coding, multiple description coding, quantization theory, vector quantization (VQ), multiple description VQ, compression algorithms that employ transforms (including DCT and wavelet transforms), bi-level image compression, gray scale and color image compression, video compression, movie compression, geometry compression, speech and audio compression, compression of multi-spectral and hyper-spectral data, compression of science, weather, and space data, source coding in multiple access networks, parallel compression algorithms and hardware, fractal based compression methods, error resilient compression, adaptive compression algorithms, string searching and manipulation used in compression applications, closest-match retrieval in compression applications, browsing and searching compressed data, content based retrieval employing compression methods, minimal length encoding and applications to learning, system issues relating to data compression (including error control, data security, indexing, and browsing), medical imagery storage and transmission, compression of web graphs and related data structures, compression applications and issues for computational biology, compression applications and issues for the internet, compression applications and issues for mobile computing, applications of compression to file distribution and software updates, applications of compression to files storage and backup systems, applications of compression to data mining, applications of compression to information retrieval, applications of compression to image retrieval, applications of compression and information theory to human-computer interaction (HCI), data compression standards including the JPEG, JPEG2000, MPEG (MPEG1, MPEG2, MPEG4, MPEG7, etc.), H.xxx, and G.xxx families.

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