Juris Hartmanis

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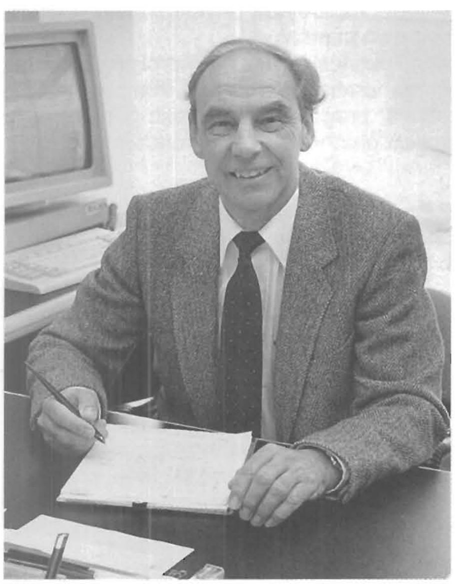
After completing his graduate studies in mathematics, Hartmanis taught at Cornell and Ohio State Universities, and then worked as a research scientist at the General Electric Research Laboratory. He returned to Cornell as chairman of the newly founded Department of Computer Science, and served as chairman from 1965 to 1971 and again from 1977 to 1982. In 1980 he was appointed Walter R. Read Professor of Engineering. He is a fellow of the American Association for the Advancement of Science and a member of the New York Academy of Sciences, the American Mathematical Society, the Association for Computing Machinery, and Sigma Xi. He was elected to the National Academy of Engineering in 1989. He is a member of the engineering advisory council at Rice University and a director of the Computing Research Board. He is an editor for Springer-Verlag.



Research in computational complexity during the last twenty years has clearly revealed that there are definite limits to what is feasibly computable and that many problems of practical importance exceed these limits. The long-term goal of our research is to contribute to the development of a comprehensive quantitative theory of computing that will make it possible to identify problems that are not feasibly computable and ascertain how much computing work is needed to solve various types of problems that *are* feasibly computable. Some of the most outstanding problems of computer science today are directly related to this quest.

Our current research is focused on the structure of classical complexity classes which are defined by bounded computation time or bounded memory (such as PTIME, NPTIME, PSPACE, EXPTIME, NEXPTIME, and EXSPACE). In this area, we have discovered very interesting relations between the "density" of problem sets to be solved and the behavior of corresponding classes of higher complexity. The main features of complete sets in complexity classes such as those listed give unity to this research area and make possible an elegant characterization of the computational complexity of each class. We have shown that these features have direct analogs for "sparse" or "thinned-out" problem sets. This permits a reduction in the size of the classic complete problems if one deals with sparse subclasses of the problems from NP, PSPACE, etc.

Recently, we have begun to investigate the information-theoretic complexity of finite objects with generalized Kolmogorov tests, which measure how *far* and how *fast* a finite string can be condensed without losing any of the information encoded in the original string. We are particularly interested in the connection between the Kolmogorov complexity of the descriptions of problems from a given class and the computational complexity of the solutions to these problems. Our initial results have revealed interesting connections between the information-theoretic complexity of problem descriptions and the difficulty of their computational solution—and this, in turn, is directly related to the structure of the higher-complexity classes. Study of the information-theoretic (or Kolmogorov) complexity of finite objects has already provided a new viewpoint for the formulation of problems in computational complexity, and this has contributed new avenues of proof and new techniques for the presentation of results. We expect that this research will continue to yield insights into the nature of computation.

Current Research Projects

Computational Complexity and Structure of Feasible Computations *(National Science Foundation)*

Structural Computational Complexity *(National Science Foundation)*
Other participants: R. Chang, D. Ranjan, and P. Rohatgi, graduate students

Selected Publications

Cai, J., T. Gundermann, J. Hartmanis, L. Hemachandra, V. Sewelson, K. Wagner, and G. Wechsung. 1988; 1989. The Boolean Hierarchy. I. Structural properties. II. Applications. *SIAM Journal of Computing* 17:1232–52; 18:95–111.

Cai, J., and J. Hartmanis. 1989. The complexity of the real line is a fractal. In *Proceedings, Conference on Structure in Complexity Theory*, pp. 138–46. Washington, DC: IEEE Computer Science Press.

Hartmanis, J, ed. 1989. *Computational complexity theory.* AMS Proceedings of Symposia in Applied Mathematics, vol. 38. Providence, RI: American Mathematical Society.

Hartmanis, J. 1989. Overview of computational complexity theory. In *Computational complexity theory,* pp. 1–17. AMS Proceedings of Symposia in Applied Mathematics, vol. 38. Providence, RI: American Mathematical Society.

Hartmanis, J. 1989. The structural complexity column: Goedel, von Neumann, and the P=? NP problem. *Bulletin of the European Association for Theoretical Computer Science* 38:101–07.

Hartmanis, J., and D. Ranjan. 1989. Space bounded computations: Review and new separation results. In *Proceedings, Mathematical Foundations of Computer Science Conference,* pp. 47–66. Lecture Notes in Computer Science, vol. 379. New York: Springer-Verlag.