

*Lifting the Curse of Dimensionality:
Numerical Integration in Very High Dimensions*



IAN H. SLOAN

Fellow of the Australian Academy of Science

Professor

School of Mathematics and Statistics

University of New South Wales

Abstract: Richard Bellman coined the phrase “the curse of dimensionality” to describe the extraordinarily rapid increase in the difficulty of most problems as the number of variables increases. One such problem is numerical multiple integration, where the cost of any integration formula of product type obviously rises exponentially with the number of variables. Nevertheless, problems with hundreds or even thousands of variables do arise, and are now being tackled successfully. In this talk I will tell the story of recent developments, in which within a decade the focus turned from existence theorems to concrete constructions that achieve the theoretically predicted results even for integrals in hundreds or thousands of dimensions many thousands of points. The theory has been shaped by applications, ranging from option pricing to the flow of a liquid through a porous medium, the latter modeled by a partial differential equation with a random permeability field.

Biographical Sketch: Dr. Sloan’s research interests include boundary integral methods, finite element methods, high dimensional numerical integration and related issues of information-based complexity, multivariate approximation theory, and the time discretisation of evolution problems. He was employed by Australia’s CSR Company from 1961 to 1965, before joining the University of New South Wales as a Lecturer. After several promotions, he was appointed to a Personal Chair in Mathematics in 1983. He was Head of the School of Mathematics from 1986 to 1990 and from 1992 to 1993. He completed a term as Chair of the Chemistry, Mathematics and Physics Panel of the Australian Research Council and member of the ARC’s Research Grants Committee, and is a former President of the Australian Mathematical Society. He was elected a Fellow of the Australian Academy of Science in 1993. In 1997 he was awarded the ANZIAM Medal by Australian and New Zealand Industrial and Applied Mathematics (ANZIAM), and in 2001 was awarded the Thomas Ranken Lyle Medal of the Australian Academy of Science. In 2002 he was awarded the Szekeres Medal of the Australian Mathematical Society, and in 2005 was awarded the Information Based Complexity Prize. In 2008 he was appointed an Officer of the Order of Australia (AO). From 2003 to 2007 he was President of the International Council for Industrial and Applied Mathematics. Before that he was the Chair of the International Program Committee for ICIAM 2003, the fifth International Congress on Industrial and Applied Mathematics, held in Sydney in 2003. He is currently Deputy Director of MASCOS, the ARC Centre of Excellence for Mathematics and Statistics of Complex Systems.