Journal of Quality Measurement and Analysis *JQMA 4(1) 2008, 1-9*
Jurnal Pengukuran Kualiti dan Analisis

NUMERICAL ANALYSIS

JOHN BUTCHER

ABSTRACT

Mathematics has applications in virtually every scientific discipline. Many of these applications yield mathematical models which involve numerical approximations or evaluations to give a complete answer. Over the years, especially within the computer age, a body of knowledge has grown up which seeks to understand how calculations should best be performed to carry out these evaluations. Much of this knowledge is in the form of algorithms for solving certain standard and widely used problems. This is the subject of Numerical Analysis. In this broad survey of numerical analysis, I will attempt to survey some of the problem areas it deals with. I will then conclude by focussing specifically on some aspects of the area of my own specialist interests, that is differential equations and their numerical approximations. In the numerical solution of differential equations, where the numerical approximation is developed in small time-steps, there are typically three challenges. These are (a) to keep errors in each step small, (b) to make sure that the overall algorithm is stable and that errors generated in any step do not have an overwhelming affect on the accuracy of later steps and (c) to keep the computational costs as low as possible. Selecting a numerical method, or family of methods, and integrating the method or methods into a software package, deals with all these challenges and, of necessity, seeks compromises between them. It is found that the analysis of possible methods, and algorithm design questions, makes extensive use of results and techniques from many areas within the mathematical sciences, and even contributes to them.

Keywords: Numerical analysis; differential equations; numerical methods

References

Bashforth F. & Adams J. C. 1883. *An Attempt to Test the Theories of Capillary Action by Comparing the Theoretical and Measured Forms of Drops of Fluid, with an Explanation of the Method of Integration Employed in Constructing the Tables which Give the Theoretical Forms of Such Drops*. Cambridge: Cambridge University Press.

Brouder C. 2000. Runge–Kutta methods and renormalization. *Eur. Phys. J. C.* **12:**521–534.

Dahlquist G. 1956. Convergence and stability in the numerical integration of ordinary differential equations. *Math. Scand.* **4**: 33–53.

Heun K. 1900. Neue Methoden zur approximativen Integration der Differentialgleichungen einer unabhängigen Veränderlichen. *Z. Math. Phys*.**45** (1900), 23–38.

Kutta W. 1901. Beitrag zur näherungsweisen Integration totaler Differentialgleichungen. *Z. Math. Phys.* **46**: 435–453.

Moulton F. R. 1926. *New Methods in Exterior Ballistics*. Chicago: University of Chicago.

Runge C. 1895. Über die numerische Auflösung von Differentialgleichungen. *Math. Ann.* **46**: 167–178.

Department of Mathematics
The University of Auckland
Private Bag 92019
Auckland
NEW ZEALAND
Email: butcher@math.auckland.ac.nz