8th Leslie Fox Prize in Numerical Analysis

The Leslie Fox Prize in numerical analysis was set up to commemorate the contribution made by Leslie Fox (born 30th September 1918, died 1st August 1992) to the development of numerical analysis. Prior to his retirement about ten years before his death, Leslie Fox was Professor of Numerical Analysis in the University of Oxford, and a Fellow of Balliol College. Before his move to Oxford, he had been at the National Physical Laboratory (in Teddington, Middlesex) with many of the pioneers in the area. His contributions to numerical analysis here and subsequently at Oxford ranged over a whole spectrum of what were then rapidly advancing fronts as the developments in electronic computing made their impact felt in the area of numerical computation.

The prize in memory of Professor Fox is administered through the Institute and the Editorial Board of the *IMA Journal of Numerical Analysis*, who select the (normally three) adjudicators. Each of the adjudicators serves until, by seniority of appointment, (s)he becomes chairman of adjudicators and then retires. The current adjudicators are Professor Christopher Baker (Manchester, the retiring chairman), Professor Iain Duff (Rutherford Appleton Laboratories), and Professor Nick Trefethen (previously at Cornell, now at Oxford).

Contestants must satisfy a number of criteria, with an upper age limit. For the 1997 prize, the adjudicators received twenty-five submissions. Selecting a short list that was short enough for a sequence of talks at a one-day meeting was made difficult by the high quality of the submissions, and the adjudicators proceeded by individually ordering the papers received, reviewing and reconciling (by email) the independent views, concluding after some negotiation with a short list somewhat longer than usual and comprising seven entries.

The contestants presented their papers in 40-minute time slots at the University of Dundee on 23rd June, the day preceding the 1997 Dundee meeting on numerical analysis. The oral presentation is taken into account, in addition to the written material (summarized below against each contestant's name), by the Adjudicators when judging. At the conclusion of the presentations, the Adjudicators retired to consider their verdicts. The photograph above shows the contestants (the youthful ones) and the adjudicators (the older ones) following the announcement of the prizes.

First Prize Winner

The adjudicators decided to award one First Prize, to **Wim Sweldens** (Bell Laboratories, Lucent Technologies, USA). His submitted paper was entitled *The Lifting Scheme: A Construction of Second Generation Wavelets*. Wavelets form a versatile tool for representing general functions or data, allowing efficient representations that can be computed quickly. First generation wavelets are traditionally defined as the dyadic translates and dilates of a mother wavelet; in this paper Wim introduced a more general setting where wavelets are not necessarily translates and dilates but are constructed by a lifting scheme (a simple but powerful tool). The highly technical mathematical paper that had been submitted was transformed, in its live presentation, to a highly successful "Technicolour" (audio-visual) presentation much appreciated by the adjudicators.

Second Prize Winners

The remainder of those giving papers at the meeting were awarded second prizes. In alphabetical order, these were Tobin A Driscoll (Boulder, USA), Valeria Simoncini (CNR, Pavia, Italy), Eric de Sturler (Swiss Centre for Scientific Computing, Zurich), Reha H Tütüncü (Carnegie-Mellon, USA), Antonella Zanna (Cambridge, England), and Tong Zhang (Stanford, USA).

Toby Driscoll's paper (co-authored by Stephen Vavasis) was entitled *Numerical conformal mapping using cross-ratios and Delaunay triangulation*. In this paper, the authors propose a new algorithm for computing the Riemann mapping of the unit disk to a polygon, also known as the Schwarz-Christoffel transformation. The new algorithm,

CRDT, is based on cross-ratios of the prevertices, and also on cross-ratios of quadrilaterals in a Delaunay triangulation of the polygon which, they say, produces an accurate representation of the Riemann mapping even in the presence of arbitrary long, thin regions in the polygon, unlike any previous conformal mapping algorithm.

Valeria Simoncini delivered a paper on *Non-linear spectral perturbation* relating to the analysis of nonlinear perturbation effects in the spectrum of a real nonsymmetric matrix A under linear perturbations. Some known results can be used to justify some recent experimental observations. She showed that appropriate information can be used to analyze the quality of the approximation of projection type methods.

Eric de Sturler's paper was entitled *Truncation strategies for optimal Krylov subspace methods*. Optimal Krylov subspace methods like GMRES and GCR have to compute an orthogonal basis for the entire Krylov subspace to compute the minimum residual approximation to the solution. Therefore, when the number of iterations becomes large, the amount of work and the storage requirements become excessive. In practice one has to limit the resources. The most obvious ways to do this are to restart GMRES after some number of iterations, and to keep only some number of the most recent vectors in GCR. This may lead to very poor convergence and even stagnation. Eric de Sturler described a method that reveals which subspaces of the Krylov space were important for convergence so far, and exactly how important. This information is then used to select which subspace to keep for orthogonalizing future search directions.

Reha H Tütüncü gave a paper entitled *Infeasible-interior-point potential-reduction methods for linear programming* in which he studies a new potential function and an infeasible-interior-point method based on this function for the solution of linear programming problems. Analyses of interior-point algorithms are usually carried out by imposing several regularity assumptions on the problem, but implementations can solve problems which do not satisfy these assumptions. The method and its analysis avoid the common regularity assumptions and have the flexibility to integrate any heuristic technique for implementation while maintaining the important polynomial complexity feature. In addition, the algorithm presented here provides a more reliable mechanism for detecting infeasible problems, both in the theoretical and practical senses.

Antonella Zanna gave a talk entitled *Lie-group methods for isospectral flows*. In her paper, Antonella addressed the problem of evaluating the numerical solution of a class of ordinary differential equations on matrices, known as isospectral flows. Her approach was based upon Lie group numerical methods. It was claimed that Lie group methods can be cheaper than explicit classical schemes, and that they possess properties that can lead to superior methods. Her general approach permits the analysis of methods of high order.

The paper of **Tong Zhang** was entitled *Subspace decomposition and convergence of the Schwarz methods*. A general theoretical framework for analyzing Schwarz methods has been developed during the past decade. The analysis focused mainly on the global error propagation rate for the multiplicative Schwarz method and the condition number for the additive Schwarz preconditioner. However, it is well-known that the block Gauss-Seidel method produces error localized in the low-frequency dimensions and the conjugate gradient method can give fast convergence even with a bad condition number (for example, when the spectrum of the linear operator is clustered). It is therefore fundamentally important to develop a theory to study the localization of error propagation in the multiplicative Schwarz method and the spectrum distribution of the preconditioner in the additive Schwarz method. This paper addressed these issues.

Concluding remarks

Although the Leslie Fox Prize was not originally linked to the Dundee meetings, the formula of holding the competition prior to a Dundee meeting (or to some similar international meeting) is clearly a success. Thanks are owed to Dr David Griffiths and his colleagues at the University of Dundee for making the arrangements a success. Thanks are also due to Mrs Francesca Moss in the General Office of the Department of Mathematics at Manchester for overseeing all the emailed exchanges, and to my co-adjudicators for their cooperation (and their forbearance when the administrative burden that these days falls upon a Head of Department diverted my attention to some apparent crisis in my own institution).

The Leslie Fox Prize is not over-endowed with funds, and additional charitable contributions will be welcome; they can be made via the IMA.

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