18th IMA Leslie Fox Prize in Numerical Analysis

Six numerical analysts presented their work at the University of Strathclyde for a chance to win the prestigious Leslie Fox prize on 26 June 2017.

David Griffiths started the day by describing Professor Leslie Fox himself. Leslie was a prominent British numerical analyst at the University of Oxford, who was particularly noted for his work on relaxation methods, finite difference methods, and numerical methods for partial differential equations. As David recalled, he was one of the last numerical analysts to use human computers! After Leslie's retirement in 1983, former students and colleagues set up the Leslie Fox Prize in recognition of his broad contributions to Numerical Analysis.

The audience were then treated to six delightful presentations. For the reader's convenience, we briefly describe the talks in the same order that the presentations were given on the day.

Aretha Teckentrup (University of Edinburgh) gave the first talk on *Posterior consistency for Gaussian process approximations of Bayesian posterior distributions* [1]. In many Bayesian inverse problems, sampling from a posterior distribution via Markov Chain Monte Carlo methods requires the evaluation of a model. For computational efficiency, the model can be replaced by a surrogate that is based on Gaussian emulators. Despite their widespread use, the error introduced by these emulators was not well understood. Aretha showed how to rigorously bound the distance between the true posterior distribution and different Gaussian emulator approximations. These results can then bound errors in other quantities of interest such as the error in expected values.

… celebration of the emerging talent in numerical analysis …

Nicole Spillane (École Polytechnique) spoke about her work [2], which improves on the iterative method for symmetric positive definite linear systems [3]. She chooses, at each iteration, an optimal combination from a set of preconditioners. Nicole introduced a test that automatically determines whether multipreconditioning is useful, and showed that the resulting adaptive algorithm can save considerable computation on a range of problems. Her ideas are ideally suited to balancing domain decomposition preconditioners, since each local subdomain solve can be treated as a separate preconditioner. She demonstrated the method on several industrial applications involving heterogeneous materials, one of them being a composite weave pattern.

Robert Gower (École Normale Supérieure) introduced a two-parameter family of sketch-and-project iterative solvers for $Ax = b$ that had six equivalent interpretations [4]. Particular choices of the two parameters – an inner product and a random matrix – give the randomised Kaczmarz method, randomised Newton method, randomised coordinate descent method, and random Gaussian pursuit as special cases. Using this framework, Robert was able to develop new variants of classical algorithms and make links between existing methods. He presented a unified proof of linear convergence in a single theorem that recovered many of the known asymptotic convergence rates of existing methods.

Mario Berljafa (KU Leuven) characterised the relationship between the rational Arnoldi matrix decomposition and rational Krylov spaces [5]. His rational implicit Q theorem shows that the rational Arnoldi decomposition is essentially determined by a column vector and a set of poles. The theorem provides a new perspective on rational Krylov spaces, allowing for better theoretical and algorithmic understanding. These ideas were then employed for rational least squares fitting in RKFIT, which is part of the RKToolbox for computations with rational functions.

Lise-Marie Imbert-Gérard (New York University) derived a new set of generalised plane waves to obtain a numerical method for the scalar wave equation with smoothly varying coefficients [6]. Lise-Marie employed a Trefftz finite element method in which shape functions approximately satisfy a homogeneous differential equation on each element. There was an ingenious construction of the underlying shape functions for variable coefficient problems that involved a hierarchy of linear subsystems. Their interpolation properties were also studied, and the order of convergence of the method determined.

Evan Gawlik (UC San Diego) showed us how the generalised polar decomposition could be used for the interpolation and extrapolation of manifold-valued data on symmetric spaces – smooth manifolds with inversion symmetry about every point [7]. It was a general framework for constructing finite elements on Lorentzian metrics as well as computing the exponential map on the Grassmannian. Numerical experiments indicated that the interpolant operators have optimal approximation properties.

After the talks the committee deliberated for a short while to discuss the various merits of each presentation. During this time the audience were wagering small cash notes. The committee entered the room at exactly 4.30 pm and the room hushed in anticipation. Andy Wathen announced that Nicole Spillane received the first-place prize for her multipreconditioning work, while the others were given second-place prizes. David Griffiths had the pleasure of officially presenting the awards to the prize winners. The day was a wonderful celebration of the emerging talent in numerical analysis.

If you are under 31 years old on 1 January 2019 and have authored a worthy paper in numerical analysis, then please consider submitting for the next Leslie Fox prize meeting.

Alex Townsend, Cornell University
Jennifer Pestana, University of Strathclyde

References

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