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The Abel prize 2003 – 2007: The first five years, by Helge Holden and Ragui Piene (Editors). Pp. 327. £58.99 (Hardback). 2010. ISBN: 978-3-642-01372-0 (Springer).

Graham Hoare

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use. From random computer-based questions, to computer-marked individualised-coursework, there is much that technology can offer teachers of statistics. I'm not sure my school is ready for such a process, but when dealing with much larger number of students the need to get beyond hand-written assessment seems fairly self-evident.

In summary – this book is interesting and thought-provoking and although set in situations outside my experience, I have greatly enjoyed reading it and will come back to it over the next few months as I think a little more about the assessments it has described.

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The Abel prize 2003 - 2007: The first five years, by Helge Holden and Ragui Piene (Editors). Pp. 327. £58.99 (Hardback). 2010. ISBN: 978-3-642-01372-0 (Springer).

In 2002, to mark the bicentennial of Abel's birth, the Norwegian Parliament established the Niels Henrik Abel Memorial Fund with the intention of creating an annual international prize for outstanding scientific work in the field of mathematics. It was to be awarded over time in a broad range of areas in mathematics. The upshot, the Abel Prize, worth NOK 6 million, was first awarded in 2003. This superbly presented book begins with the history of the prize and is followed by a biographical sketch of Alte Selberg who was presented with an Honorary Abel Prize in Oslo in 2002. Each of the five sections into which the rest of the book naturally falls begins with an autobiographical sketch of the laureate(s), followed by descriptions and analyses of their work. Each part contains a bibliography and a curriculum vitae. The text is adorned throughout with many photographs.

Such is the depth, power and range of the mathematical output of the prize-winners, spanning many years, (except for Varadhan all were born in the nineteen twenties), the authors had a very demanding task to extract the essence of their achievements in a limited space. This is especially true in the case of Jean-Pierre Serre, the first Abel prize-winner, whose work is surveyed by Pilar Bayer. Not only did Serre's work involve important advances in the areas of algebraic topology, algebraic geometry, algebra and number theory but it has been a catalyst and inspiration for other mathematicians. One of Serre's earliest successes, the *finiteness theorem*, proved in 1951, was the fundamental result on the successive homotopy groups of the n-dimensional sphere. It was this result which won him the Field's Medal in 1954 and contributed to his winning the Wolf Prize in 2000.

The prize for 2004 was awarded jointly to Sir Michael Atiyah and Isadore M Singer. *The Atiyah-Singer index theorem*, as the Abel Prize citation reads, 'is one of the great landmarks of twentieth-century mathematics, influencing profoundly many of the most important later developments in topology, differential geometry and quantum field theory'. The theorem concerns elliptic equations on closed manifolds and facilitates a generalisation of the *Riemann-Roch* theorem to a complex manifold of any dimension. The reviewer, Nigel Hitchin, sets out the background, including K-Theory, clearly and succinctly and leads the reader rapidly through the various versions of the theorem which the laureates gave, together with later refinements and applications.

Among the pioneers of the development of stability theory for finite difference approximations of partial differential equations (PDEs) was the 2005 winner of the prize, Peter Lax. The advent of supercomputers after World War II gave numerical analysis a crucial fillip but Lax's work illustrates the interplay between original and

concise mathematical analysis and numerical experiments. The *Lax equivalence theorem*, published by Lax and Richtmeyer in 1956, involves the notions of consistency, stability and convergence and states that for linear initial value problems stability is necessary and sufficient for convergence if the scheme is consistent. The key point was the uniform boundedness principle. The *Lax-Wendroff* formula and its relatives have grown into a very powerful subject known as *computational fluid dynamics*. These and many other processes and theorems generated by Lax and his collaborators are dealt with sensitively, although of necessity, selectively, by the reviewers Helge Holden and Peter Sarnak.

The next winner, in 2006, was Lennart Carleson who is perhaps best known for *Carleson's theorem* which states that the Fourier Series of a function f in $L^2(0, 2\pi)$ converges almost everywhere. Thus Carleson answered Luzin's conjecture. Tom Körner takes us through this result and two other famous Carleson theorems. One of these, the *Corona theorem*, concerns the H^∞ of functions f where $f(z) = \sum_{n=0}^{\infty} a_n z^n$ where the series converges for all $|z| < 1$ to a bounded function. There is a typo in the statement of the theorem (p259); the second set of fs should be gs. No matter; as Körner observes, important though the theorem is, the 'Carleson measures' which he introduced to prove it have turned out to be even more important in various branches of analysis. At the end of his review there is a bonus as Körner addresses the general reader and mounts a stout defence of the activities of mathematicians, bewilderingly remote as they may seem.

The 2007 laureate was Srinivasa Varadhan whose contributions to Stochastic Analysis have been fundamental. Indeed, his creation and development of a unified theory of *Large Deviations* has underpinned the understanding of stochastic systems. Applications of Varadhans's work are vast; linking the theory of probability to the theory of PDEs is but one such. The reviewer, Terry Lyons, is successful in capturing the substance and ramifications of Varadhan's output.

The autobiographical pieces by the prize-winners are invaluable but the lengthy interviews included on the accompanying DVD, most of which were shown on Norwegian TV, are even more rewarding. The charm, warmth, modesty and humour of the interviewees are transparent and their ability to illuminate their mathematical developments, preoccupations and opinions hugely impressive. We hear, for example, of Carleson, under the influence of Zygmund, trying to find a counter-example to Luzin's conjecture. Then there is Varadhan's remark, "A great day for the coinflippers", when he was discussing with Lyons and others the awards of Fields Medals to Werner, Okounkov and Tao. And there was the idea that unlocked homotopy theory for Serre which he had in a moment of illumination. One more anecdote must suffice. Serre and his friend Raoul Bott went to Israel to receive the Wolf Prize awarded by the Knesset in Jerusalem. Bott had to say a few words on mathematics and sought Serre's guidance on what to say. Serre's reply was, "It's very simple, all you have to explain is this: other sciences seek to discover the laws that God has chosen; mathematics seeks to discover the laws which God has to obey". Discuss. Incidentally, the Knesset appreciated the comment.

This text is an invaluable contribution to the history of twentieth-century mathematics. Save your pennies and buy it.

GRAHAM HOARE

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