

Whitehead Prize: citation for Patrick Farrell

Short citation:

Professor Patrick Farrell of the University of Oxford is awarded a Whitehead Prize in recognition of his broad, creative and impactful work as a computational mathematical scientist. Farrell's contributions to the general area of the numerical solution of partial differential equations span algorithm development, rigorous analysis, high performance software implementation, and applications in scientific computation.

Long citation:

Professor Patrick Farrell of the University of Oxford is awarded a Whitehead Prize in recognition of his broad, creative, and impactful work as a computational mathematical scientist. Farrell's contributions to the general area of the numerical solution of partial differential equations span algorithm development, rigorous analysis, high performance software implementation, and applications in scientific computation.

High quality implementational work is exemplified by Farrell's prize-winning development of the software *dolfin-adjoint*, together with collaborators. This software resolved a major open challenge in high-performance computing, namely, to extend the technique of automatic computer differentiation of functions to the computation of adjoints of partial differential operators. The resulting software has been widely adopted for numerous applications, such as to computing the sensitivity of quantities of interest dependent on the solution of a partial differential equation to problem parameters.

In the realm of mathematical analysis, recent work of Farrell and collaborators on the computer solution of the incompressible Navier–Stokes equations achieved a long sought after goal, a preconditioner for the stationary equations that is robust with respect to Reynolds number.

An excellent example of Farrell's work in algorithm development concerns his extension of the idea of deflation. Deflation is used to find multiple solutions of systems of nonlinear equations, by modifying the system once a solution has been computed, in order to find different solutions. Farrell extended deflation far beyond finite dimensional algebraic systems to systems of partial differential equations, viewing them as equations in an infinite dimensional Banach space. His method has been used in numerous applications by many researchers and he himself has applied it to a wide variety of physical systems ranging from quantum mechanics to topology optimisation in structural mechanics. His bifurcation analysis of the Carrier equation is a tour de force.