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PRACTICAL ASPECTS OF THE BANK-WEISER ESTIMATOR IMPLEMENTATION AND BIOMECHANICS APPLICATIONS.

Raphaël Bulle[1]*, Stéphane P. A. Bordas[1], Franz Chouly[2], Alexei Lozinski[2] and Jack S. Hale[1]

[1]University of Luxembourg, raphael.bulle@uni.lu
[2]Université de Bourgogne Franche-Comté

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Explicit residual a posteriori error estimators [1] are widely used to drive adaptive mesh refinement algorithms in modern automated finite element softwares, e.g. FEniCS Project, Firedrake and FreeFem++. They are easy to implement and very quick to compute.

However, explicit residual error estimators typically grossly overestimate the total error. For a given fixed tolerance, an adaptive mesh refinement algorithm driven by an explicit residual error estimator will over refine the mesh, wasting computational resources.

In this contribution we will show how the implicit residual error estimator of Bank and Weiser [2] can be computed simply and cheaply, offering an attractive alternative to explicit residual estimators. The estimator gives a very accurate measure of the exact error and extends straightforwardly to higher order finite elements.

We will also show some initial results applying adaptive mesh refinement to the solution of the fractional Laplace equation using the Dunford-Taylor calculus [3]. This class of partial differential equations has important applications in a growing number of advanced biomechanics applications, e.g. the simulation of fluid flow through porous tissues [4].

This functionality is demonstrated in a small add-on package to the FEniCS Project finite element software [`https://doi.org/10.6084/m9.figshare.10732421`]. We show results in three dimension running on an high-performance computer cluster using Message Passing Interface (MPI).

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