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Professor Rémi Abgrall, Editor
Journal of Computational Physics

Dear Professor Abgrall,

Please find attached a copy of our manuscript titled "Quadratic Serendipity Discontinuous Finite Element Discretization for S_N Transport on Arbitrary Polygonal Grids" for submission to the *Journal of Computational Physics*.

In this paper, we analyze the S_N transport equation on arbitrary polygonal grids with a higher-order discontinuous finite element (DFEM) discretization using the quadratic serendipity space of functions. This work follows closely prior works by Alexander Rand (CD-adapco), Teresa Bailey (LLNL), Marvin Adams (Texas A&M University), Jean Ragusa (Texas A&M University), Yaqi Wang (INL), and Todd Palmer (Oregon State).

Our work is based on Rand et. al, where they constructed a space of quadratic serendipity functions compatible with FEM applications. The quadratic serendipity functions are constructed from products of the linear Generalized Barycentric Coordinates that are compatible with polygonal mesh elements. They span the $\{ 1, x, y, x^2, xy, y^2 \}$ space of functions and they grow by $2n$ on a mesh element where n is the number of the polygon's vertices. Numerical tests confirm that the functions capture exactly quadratic solutions and appropriate convergence rates are observed, including a test case involving spatial adaptive mesh refinement. Finally, the functions are analyzed for a diffusive problem and retain full resolution in the thick diffusion limit.

Solving the DFEM transport equation on polygonal grids is not commonly done. Also, FEM spatial discretizations of the transport equation have been mostly limited to first-order functions for robustness and computational performance. However, there has been an interest in higher-order functions for the DFEM transport equation on large computer architectures to allow for more work before communication. These functions can allow for the use of higher-order functions for the DFEM transport equation on arbitrary grids, yielding more flexibility in meshing strategies.

Thank you for considering this manuscript for publication in JCP.

Best Regards,
Michael W. Hackemack