

TITLE: COMPARATIVE STUDY OF FEM, MASS-LUMPED FEM, AND DYNAMIC LOW-RANK APPROXIMATION METHODS FOR THE 2D DIFFUSION EQUATION

Joy Saha

Department of Mathematical Sciences, The University of Texas at El Paso

Email: jsaha@miners.utep.edu

Abstract: We investigate numerical methods for solving the two-dimensional diffusion equation using the dynamical low rank finite element method (DLR-FEM), dynamical low rank mass-lumped FEM (DLR-FEM). Spatial discretization is constructed with both linear (P₁) and quadratic (P₂) basis functions, combined with first-order backward Euler time discretization. The FEM is formulated with the consistent mass matrix, while the mass-lumped FEM replaces it with a diagonal mass-lumped matrix and is advanced through a newly designed algorithm that exploits the simplified structure. Numerical experiments with manufactured solutions confirm the expected convergence orders in the L^2 -norm: second order for P₁ and third order for P₂. The results highlight the trade-offs between accuracy and efficiency and demonstrate the potential of combining mass-lumped formulations with low-rank dynamics for large-scale diffusion simulations.