Project Title: Fast Iterative Solvers for Option Pricing

Description: This project focuses on developing fast iterative solvers specifically tailored for option pricing in financial markets, involving multi-asset frameworks and fractional diffusive equations. The complexity of fractional diffusive equations, which are used to model anomalous diffusion or heavy-tailed processes in financial markets, necessitates advanced numerical methods capable of efficiently handling the associated computational challenges.

The project will explore the application of Krylov subspace methods such as Conjugate Gradient (CG), MINimal RESidual (MINRES), and Generalized Minimal RESidual (GMRES) methods in the context of multi-asset option pricing models. These iterative methods will be adapted to tackle the large, sparse linear systems resulting from the discretization of fractional diffusive PDEs. A significant component of the project will involve the development and analysis of novel preconditioning techniques, designed to enhance the convergence rates of these iterative solvers.

Given that the systems derived from fractional PDEs might exhibit complex spectral properties, the project will also incorporate theoretical analysis to study the eigenvalue distribution of the preconditioned matrices, ensuring stability and efficiency of the solvers. This analysis will be coupled with extensive numerical testing across various multi-asset models to evaluate the performance and robustness of the proposed methods.

Prerequisites: Candidates for this project should have a strong foundation in linear algebra and numerical analysis, familiarity with Partial Differential Equations (PDEs), and experience with programming in MATLAB or a similar computational platform. Knowledge of financial mathematics, particularly in the areas of option pricing and asset modeling, while not mandatory, would be highly beneficial.

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1 Introduction