# Research on some center selection algorithms for the RBF-FD (Radial Basis Function - Finite Difference) meshless method for solving elliptic partial differential equations in 2D space.

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**Abstract:** This study investigates several center selection algorithms for the Radial Basis Function-Finite Difference (RBF-FD) method applied to solving two-dimensional elliptic partial differential equations. The accuracy and stability of the RBF-FD approach are highly sensitive to the placement of computational nodes, yet systematic strategies for optimal center selection remain underexplored. We evaluate three distinct algorithms: a greedy algorithm based on local error indicators, a Poisson disk sampling technique for uniform node distribution, and a k-means clustering approach adapted for adaptive refinement. Numerical experiments are conducted on benchmark elliptic problems, including Poisson and Helmholtz equations, to compare the performance of these methods in terms of solution accuracy, condition number of the resulting system, and computational efficiency. Results indicate that the greedy algorithm achieves superior accuracy near boundary layers but at a higher computational cost, while Poisson disk sampling offers a robust balance between stability and efficiency. The k-means method proves effective for problems requiring local refinement. These findings provide practical guidance for node placement in RBF-FD simulations, contributing to more reliable meshless solutions of elliptic PDEs.

**Keywords:** RBF-FD, center selection, Elliptic equation, meshless