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Solving Inverse Problems using A Multiple Criteria Model with Collage Distance, Entropy, and Sparsity

In recent years, the Collage Theorem, a central result in fractal imaging, and some similarly-motivated results have been used to solve inverse problems in differential equations, integral equations, and other areas. In this talk, we extend the previous method for solving inverse problems for steady-state equations using the Generalized Collage Theorem by searching for an approximation that not only minimizes the collage error but also maximizes the entropy and minimize the sparsity. In this extended formulation, the parameter estimation minimization problem can be understood as a multiple criteria problem, with three different and conicting criteria: The generalized collage error, the entropy associated with the unknown parameters, and the sparsity of the set of unknown parameters. We implement a scalarization technique to reduce the multiple criteria program to a single criterion one, by combining all objective functions with different trade-off weights. Numerical examples confirm that the collage method produces good, but sub-optimal, results. A relatively low-weighted entropy term allows for better approximations, while the sparsity term decreases the complexity of the solution in terms of the number of elements in the basis.