Derivative-free optimization approach for structured symmetric matrices with fixed eigenvalues

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A Derivative-Free Optimization (DFO) model is developed and analyzed for solving inverse structured symmetric matrix problems for which the eigenvalues are given. Some (zero and nonzero) entries are pre assigned and cannot be changed, and some others should be nonzero but their value is not given. The rest of the entries are completely free. The obtained matrix must satisfy these requirements and its eigenvalues must be the given ones. This specialized inverse eigenvalue problem appears in several applications and is related to the problem of determining the graph, with weights on the undirected edges, of the matrix associated with its sparse pattern. Our optimization model requires computing the eigenvalues of a symmetric matrix to evaluate the non-differentiable objective function. We propose derivative-free optimization schemes, specifically the well-known directional direct search method DDS and its global variant GLODS. We discuss their convergence properties which are based on the fact that the objective function is Lipschitz continuous. In addition, we also explore the potential benefits of using some well-established heuristic strategies that can be seen as natural competitors to the deterministic derivative-free schemes DDS and GLODS. We present some preliminary numerical results that demonstrate the effectiveness of our deterministic DFO proposals in a variety of possible scenarios.

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