A Matrix Adaptation Evolution Strategy for Optimization on General Quadratic Manifolds

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Supplementary Material

D FURTHER EXPERIMENTAL EVALUATION RESULTS

For the quantitative evaluation, problems are generated by randomly sampling N eigenvalues $\lambda_j \sim \mathcal{N}(0, 1)$ for $j \in \{1, \dots, N\}$ resulting in a quadratic constraint. Using those eigenvalues, a randomized $\mathbf{S}$ matrix is computed with $\mathbf{S} = \mathbf{U}^T \mathbf{D} \mathbf{U}$, where $\mathbf{U}$ is also randomly generated such that $\mathbf{U}^T \mathbf{U} = \mathbf{I}$ and $\mathbf{D} = \text{diag}(\lambda_1, \dots, \lambda_N)$. To ensure that there are not only hyperbolically constrained problems, additional problems are considered: Absolute eigenvalues are considered to have additional elliptically constrained problems. In addition, half of the absolute eigenvalues are set to 0 to generate additional parabolic problems. For the objective function, a randomized ellipsoid function

$$f(\mathbf{x}) = \sum_{i=1}^N 10^{\frac{i-1}{N-1}} (\mathbf{R}\mathbf{x} + \mathbf{t})_i^2 \quad (35)$$

is used, where $\mathbf{R}_{jk} \sim \mathcal{N}(0, 1)$ and $\mathbf{t}_j \sim \mathcal{N}(0, 1)$. ECDF plots are shown in Figure 5 for dimension 10, Figure 6 for dimension 20, Figure 7 for dimension 30, and Figure 8 for dimension 40. The optimal values used as a reference for creating the ECDF plots are determined by solving the randomly generated optimization problems using `fmincon`.

Figure 5: Results (as ECDF plots) of applying the proposed algorithm to the randomly generated problems for dimension 10.

Figure 6: Results (as ECDF plots) of applying the proposed algorithm to the randomly generated problems for dimension 20.

Figure 7: Results (as ECDF plots) of applying the proposed algorithm to the randomly generated problems for dimension 30.

Figure 8: Results (as ECDF plots) of applying the proposed algorithm to the randomly generated problems for dimension 40.