A Comparison of Search Space Visualization Techniques

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ABSTRACT

In order to understand a GA's search behavior, the user must examine the solutions considered at the level of the genotypic search space rather than the phenotypic evaluation space. The characteristics of two mapping techniques used to produce search space visualizations are described here: "Sammon mapping" and "search space matrices."

Sammon mapping is an iterative error-reducing technique for mapping high-dimensional data to fewer dimensions whilst preserving the Euclidean distances between the data points [Sammon, 1969]. *Search space matrices* are produced by a direct chromosome translation method based on the use of extensive repartitions [Collins, 1998].

A comparison of the accuracy and flexibility associated with each mapping technique found search space matrices to be more accurate and more flexible than Sammon mapping. In this case; Sammon's Euclidean-distance-based error measure was used to judge accuracy, and the computational complexity associated with each mapping technique was used to rate the flexibility of the resulting visualization.

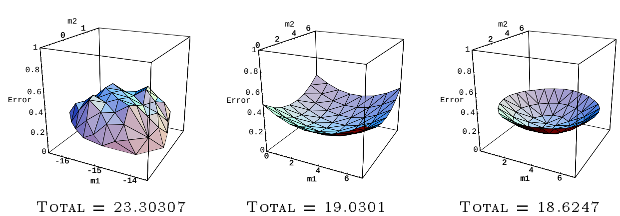

Figure 1: Non-uniformity of errors: The error surface, total-surface-error and mean-point-error ratings for a Sammon mapping (left), search space matrix mapping (middle) and a circular projection of a search space matrix mapping (right) of a six bit binary search.

Table 1: Mapping Accuracy: 6 bit binary search space.

MAPPING	TOTAL-SURFACE-ERROR	MEAN-POINT-ERROR
Sammon Map Average of ten 100-iteration runs	23.0307	0.395854
Search Space Matrix & Normal Proj.	19.0301	0.297345
Search Space Matrix & Circular Proj.	18.6247	0.291011
Search Space Matrix & Cartesian Fisheye Distortion	25.9669	0.405733
Search Space Matrix & Polar Fisheye Dist.	22.0671	0.344799

In an attempt to further improve these mapping techniques, the use of two complementary transforms were also investigated; circular projection and (cartesian and polar) fisheye distortion. For both mapping techniques circular projection improves the accuracy of the mapping whilst fisheye distortions worsen the accuracy (see Figure 1 and Table 1).

References

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[Sammon, 1969] Sammon, J. (1969). A nonlinear mapping for data structure analysis. *IEEE Transactions on Computers*, C-18(5):401–408.