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Large Batch Sampling for Boundary Estimation Using Active Learning: A Case Study from Additive Manufacturing

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This paper explores the problem of estimating the contour location of a computationally expensive function using active learning. Active learning has emerged as an efficient solution for exploring the parameter space when minimizing the training set is necessary due to costly simulations or experiments.
The active learning approach involves selecting the next evaluation point sequentially to maximize the information obtained about the target function. To this aim, we propose a new entropy-based acquisition function specifically designed for efficient contour estimation. Additionally, we address the scenario where a large batch of query points is chosen at each iteration. While batch-wise active learning offers efficiency advantages, it also presents challenges since the informativeness of the query points depends on the accuracy of the estimated function, particularly in the initial iterations.
To illustrate the significance of our work, we employ the estimation of processability window boundaries in Additive Manufacturing as a motivating example. In experimental campaigns using this technology, a large number of specimens is printed simultaneously to accommodate time and budget constraints. Our results demonstrate that the proposed methodology outperform standard entropy-based acquisition functions and space-filling design, leading to potential savings in energy and resource utilization.

Keywords

Active Learning; Batch strategies; Additive Manufacturing

Classification

Both methodology and application

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