Optimization Methods for Solving Irregular Covering Problem

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The paper is devoted to the study of planar irregular covering problem. The shape and metric parameters (sizes) of items are assumed to be given. Items can be rotated. Two formulations of such optimization problem are considered. In the first task is to maximize a coverage of a bounded area when its metric parameters are fixed. The second task is to determine the full coverage of the region of maximum area of a given shape. The variables of the optimization problem are placement parameters of items, which specify their location, as well as the metric parameters of region.

Mathematical models of these tasks as nonlinear optimization problems are proposed. Given the complexity of formalizing the objective function and constraints of emerging optimization problems, we recommend using computational geometry packages, in particular the Python Shapely library, to calculate them. To solve Tasks 1,2, an approach based on the combined use of local and global optimization methods is described. At the local optimization stage, a so-called elastic model is proposed, which can significantly reduce the executed time to solve tasks. Global optimization is based on metaheuristic algorithms. We provide numerous numerical examples of solving tasks and analyze the runtime.

References

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