

# Covering Orthogonal Polygons with Star Polygons: The Perfect Graph Approach

*Rajeev Motwani †*  
*Arvind Raghunathan ‡*  
*Huzur Saran ‡*

573 Evans Hall  
Computer Science Division  
U.C. Berkeley, CA 94720.

## 1. Introduction

A useful strategy for solving many computational geometry problems on general polygons is to decompose the polygon into simpler polygons, solve the problem on these polygons using a specialized algorithm, and then combine the solutions. The simpler polygons commonly used are convex polygons and star-shaped polygons [12, 17, 21].

A decomposition is called a partitioning, if the polygon is decomposed into non-overlapping pieces. Partitioning problems have received a lot of attention in the literature. See, for instance, [2, 3, 13, 22].

If overlapping pieces are allowed, the decomposition is called a covering. If the polygon has holes, the problems of covering the polygon with a minimum number of convex polygons or a minimum number of star-shaped polygons are NP-hard [22]. Aggarwal [1] later showed that even if the polygon does not contain holes, the problem of finding a minimum covering with star-shaped polygons remains NP-hard. The problem of finding a minimum covering for polygons without holes with convex polygons remains open.

In the light of these NP-hardness results, it becomes important to restrict our attention to orthogonal polygons. Several interesting results have been obtained for covering orthogonal polygons with simpler polygons. Franzblau and Kleitman [6] provide an  $O(n^2)$  algorithm for covering a horizontally convex orthogonal polygon with a minimum number of rectangles. Keil [14] has provided an  $O(n^2)$  algorithm for covering a horizontally convex orthogonal polygon with a minimum number of orthogonally convex polygons. Reckhow and Culberson [4, 19] extend this, providing an  $O(n^2)$  algorithm for covering an orthogonal polygon with concavities (dents) in two directions only with a minimum number of orthogonally convex polygons. Later, Motwani, Raghunathan and Saran [18] and independently, Reckhow [20], obtained polynomial algorithms for