OPTIMIZATION

HOSTEL 76

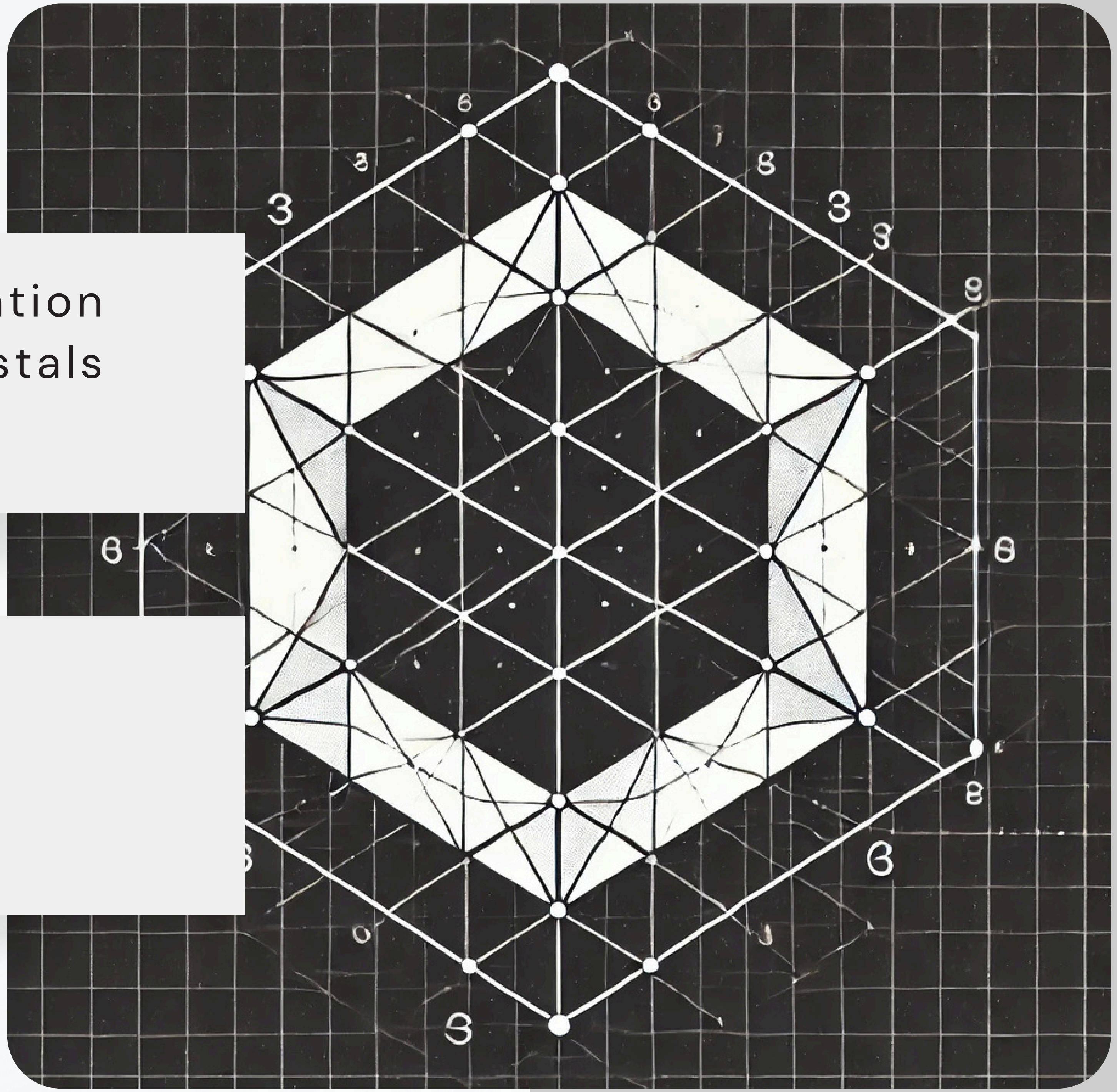
“The art of optimization lies not in perfection, but in the power of heuristics.”

CONTENT

INTRODUCTION

This project focuses on polygon optimization to maximize enclosed high-value crystals while avoiding negative-score mines.

It involves computational geometry and strategic algorithmic planning.
The goal is to maximize the score while adhering to predefined constraints.



PROBLEM STATEMENT

Objective

- Construct a polygon to maximize the enclosed score.
- Balance crystals (positive) and mines (negative).
- Optimize point selection for the highest score.

Constraints

- ≤1000 vertices, edges parallel to x/y-axis.
- Total points (crystals + mines) = 10,000.

Challenges

- Optimal Selection: Maximize score while minimizing mines.
- Efficiency: Process 10,000 points effectively.
- Geometric Limits: Maintain a valid polygon structure.

EXPERIMENTED APPROACHES

1. Brute Force Search
   - This approach would check all possible polygon configurations to find the optimal one.
   - Why Not? Exponential growth in possibilities makes it computationally infeasible for 10,000 points, exceeding the time limit.

2. Dynamic Programming (DP)
   - DP could break the problem into smaller subproblems, solving each optimally and combining the results.
   - Why Not? Requires complex state transitions and high memory usage, making it impractical for large datasets.

EXPERIMENTED APPROACHES

3. Geometric Algorithms (Convex Hull)
Convex hull algorithms could be used to construct a polygon by enclosing all given points in the smallest possible convex shape.
Why Not? A convex polygon often enclosed too many void mines, significantly reducing the final score and making the approach ineffective.

4. Clustering Algorithms
Clustering techniques could group high-value crystals together to form localized enclosures, potentially leading to better polygon selection.
Why Not? Finding optimal clusters required exponential time complexity, making it computationally infeasible within the 10-minute constraint for large datasets.

APPROACH & METHODOLOGY

The strict time constraint of 10 minutes for 20 test cases required an efficient solution. Due to the large input size of 10,000 points per test case, an exhaustive approach was impractical. This led us to adopt a greedy strategy, prioritizing high-value regions while ensuring computational efficiency.

01

STRIP_X()

Finds vertical strips with high cumulative scores, sorts them, and constructs a polygon using horizontal edges to maximize enclosed value.

02

STRIP_Y()

Identifies horizontal strips meeting a score threshold, selects optimal ones, and builds a polygon using vertical boundaries for efficient enclosure.

03

BEST_165()

Selects the top 165 highest-scoring crystals, forms a compact polygon, and ensures ≤1000 vertices, prioritizing high-value point selection.

04

WORST_165()

Excludes the worst 165 mines, reducing negative impact, and constructs a polygon around remaining high-value crystals to optimize the final score.

RESULT

We evaluated all four approaches for each test case and selected the one that yielded the highest score. This strategy ensured optimal polygon selection, effectively balancing score maximization and computational efficiency. The result we achieved is:

58.25%

Average Result Obtained

CHALLENGES FACED

1. Handling Large Input Size
- Challenge: Processing 10,000 points per test case efficiently.
- Solution: Used optimized data structures and sorting techniques to speed up computations.

CHALLENGE #1

2. Balancing Score Maximization & Constraints
- Challenge: Enclosing high-value regions while ensuring ≤1000 vertices.
- Solution: Implemented multiple approaches and dynamically selected the best-performing one.

CHALLENGE #2

3. Strict Time Constraints
- Challenge: Completing 20 test cases in 10 minutes.
- Solution: Adopted a greedy approach instead of exhaustive search, ensuring rapid execution.

CHALLENGE #3

FUTURE SCOPE

As we look ahead, several enhancements can be made to further improve the efficiency, adaptability, and real-world applicability of our approach.

IMPLEMENTING MACHINE LEARNING

Train a machine learning model to predict the optimal approach for each test case based on input patterns.

ENHANCING THE OPTIMIZATION STRATEGY

Explore advanced heuristics and metaheuristic algorithms (e.g., genetic algorithms, simulated annealing) to improve polygon selection.

HANDLING LARGER AND MORE COMPLEX DATASETS

Optimize the approach to work efficiently with even larger datasets and real-world applications like geospatial mapping.

THANK YOU FOR LISTENING!

We appreciate your interest in our work and the opportunity to share our approach.
We are ready for the questions