CSE 524 Project Report

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1 Introduction

Given a set of points in a two plane, $R \times R$ in set S, we attempt to find a "good" ordering P of points in S. Let c_i be, the center of mass of P after the i^{th} point is placed. Some definitions of good are, ordering points in P such that the interval of c_i is minimized or the total distance c_i moves as each point is placed, is minimized. These are the two factors considered for evaluating any ordering in this project. For measuring the interval, we consider the area of the convex hull of set of points from c_0 to c_{n-1}. We also consider a variant of the problem where we are allowed to pick at most k points to be placed in set P at a time, instead of exactly one in the original problem description.

2 Heuristics

We have compared 5 heuristics during the test runs.

Greedy Range Minimization (H1) Keep c_i closest to c_n, picking one point at a time. It aims to minimize the area of the convex hull enclosing the set of points formed by c_i.

Greedy Movement Minimization (H2) Keep c_i closest to c_{i-1}, picking one point a time. Greedily tries to minimize the total movement of c_i.

Greedy Range Minimization (Two simultaneous selections -H3) Pick two points at a time such that c_i after picking two points at the i^{th} attempt is closest to c_n.

Greedy Movement Minimization (Two simultaneous selections -H4) Pick two point at a time such that, the center of mass after the i^{th} attempt c_{i-1} is closest to c_i.

Greedy Balancing Pair (Two simultaneous selections -H5) : Pick two points at a time such that their average is closest to c_n.

3 Results

For the experiment we randomly generated points in $R \times R$. In each case the range (interval) or the movement of center of mass is compared with respect to the corresponding optimal value. If input points are collinear, the $2D$ heuristics for the interval do not apply, as the area of the convex hull of midpoints is 0 for any ordering points. But, we can identify such cases and run $1D$ heuristics on them instead of $2D$ heuristics. If the center of masses of a set of points happens to be collinear in a selection, we have no means to compare the result with other arrangement of points, which are not collinear.

The figure below shows the comparison of the interval of center of mass with respect to the optimal value. Greedy Range Minimization Heuristic (H1) performs better than other heuristics. Though the interval value from H1 is always within two times the optimal value for all test runs for $1D$ case, for $2D$ case, there are some inputs for which the ratio is above 4.0. For heuristics that pick 2 points at a time, we evaluate range/interval value for Fig 1. as if the pair of points were picked one after the other.

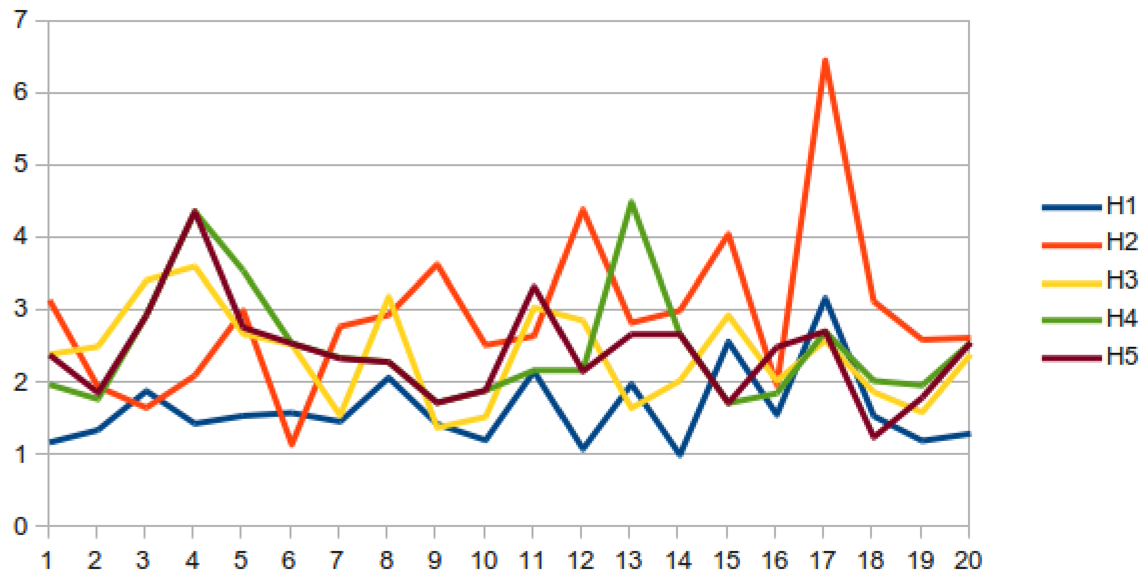

Fig 1. Interval of Center of Mass

In Fig 2. we evaluate the movement of center of mass, where Greedy Movement Minimization (H2) performs the best. As in the $1D$ case, the approximation ratio remained below 2.0 during all test runs.

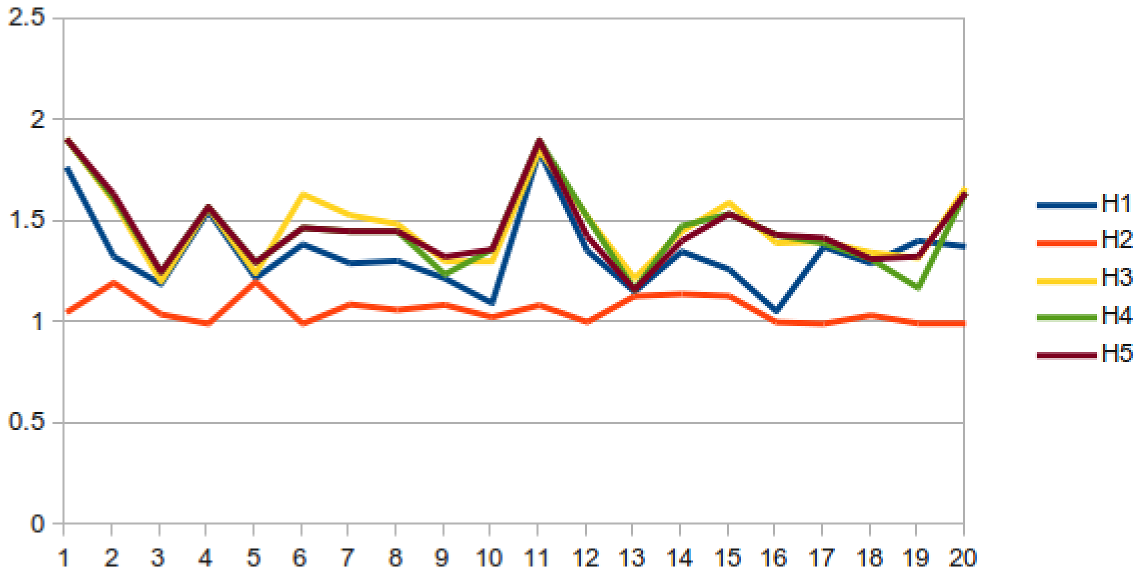

Fig 2. Movement of Center of Mass

Similar to the $1D$ analysis, comparisons of H3, H4 and H5 heuristics when we consider both the points are placed simultaneously to the performance of H1 and H2 was considered. For the two dimensional case, simultaneous selections proved more effective than H1 and H2.

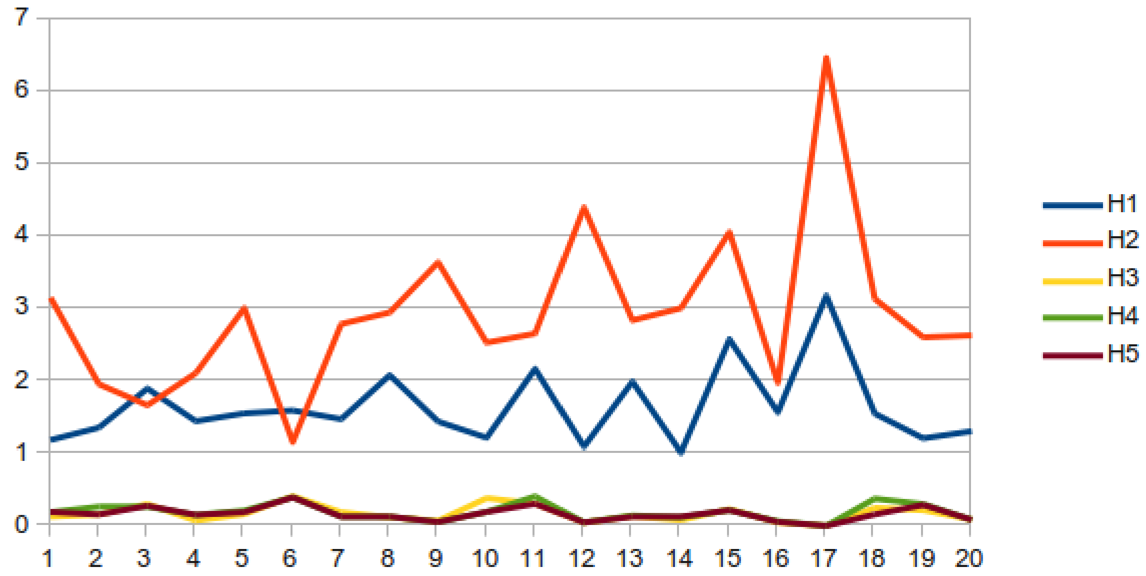

Fig 3. Interval of Center of Mass Simultaneous Selection

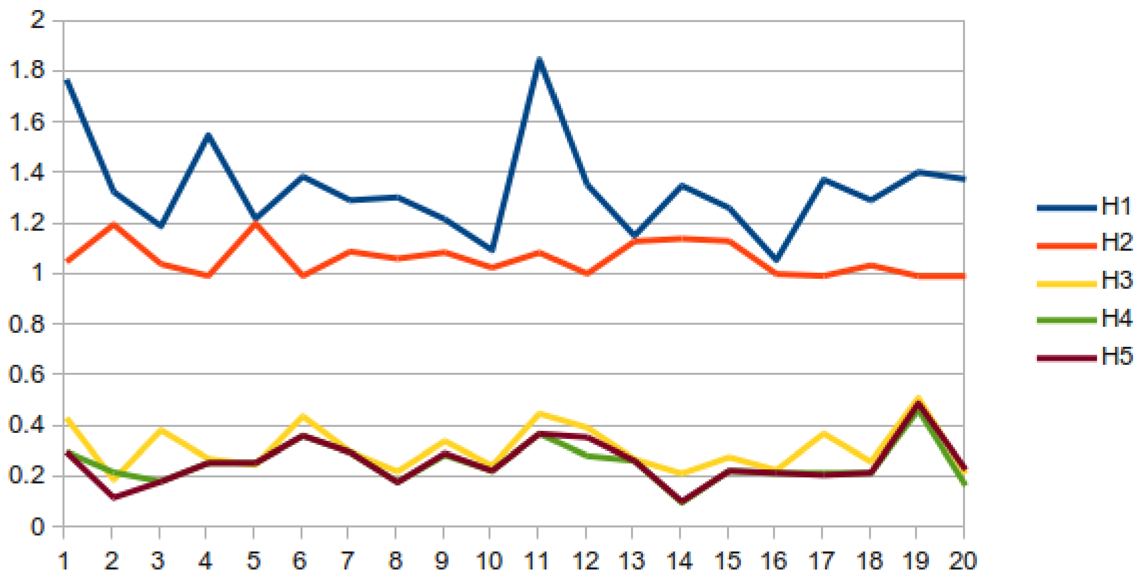

Fig 4. Movement of Center of Mass Simultaneous Selection