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Programing Homework 1 Report

The program, nearest_neighbor.py, can calculate the distance between the closest pair of points in the input file which created by the program generate_test.py.

The result will be output to an output file.

Input Files	Brute Force Run-time (s)	Divide and Conquer Run-time (s)
input.txt	0.00005984	0.00004315
input10.txt	0.00005602	0.00003504
input15.txt	0.00010704	0.00006890
input100.txt	0.00352716	0.00169086
input1005.txt	0.34105300	0.17418098

For the theoretical run time of Brute Force,

$$T(n) = \frac{(n-1)(n-1+1)}{2} + \frac{(n-1)(n-1+1)}{2} = n(n-1) = n^2 - n = O(n^2)$$

For the theoretical run time of Divide and Conquer, in step 1, get the middle of x coordinate, x_{mid}, and split the points into two groups L and R is $n = O(n)$. Step2, finding the smallest distance d of L and R is $\frac{\left(\frac{n}{2}-1\right)\left(\frac{n}{2}-1+1\right)}{2} + \frac{\left(\frac{n}{2}-1\right)\left(\frac{n}{2}-1+1\right)}{2} = O(n^2)$. Step 3 is $n = O(n)$. And for step 4, let m to be the number of points in $(x_{mid} - d, x_{mid} + d)$, so the theoretical run time of step 4 is $\frac{(m-1)(m-1+1)}{2} = O(m)$. Therefore, for the theoretical run time of Divide and Conquer, $T(n) = O(n) + O(n^2) + O(n) + O(m)$. Since $m \leq n$, $T(n) = O(n^2)$.