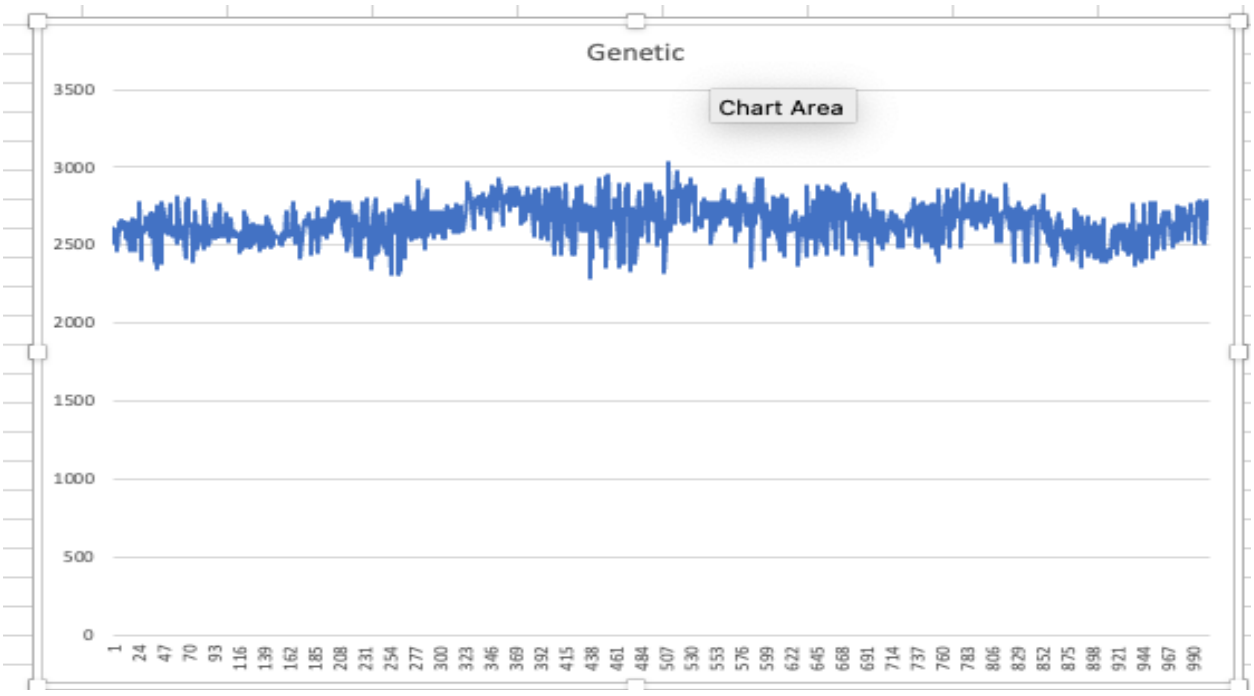
Output:
File1

```
506
507         //while (temp > MIN_TEMP && iterations <= maxIterations) {
508         while (temp > MIN_TEMP ) {
509             int ranIndex1;
510             int ranIndex2;
511             // Generate the first random index
512             do {
513                 // Generate the second random index
514                 ranIndex1 = random.nextInt(path.size());
515                 ranIndex2 = random.nextInt(path.size());
516             } while (ranIndex2 == ranIndex1); // Repeat if the indices are the same
517
518 //          System.out.println("RANDOM VALUES: ran1= " + ranIndex1 + " ran2= " + ranIndex2);
519             // swap
```

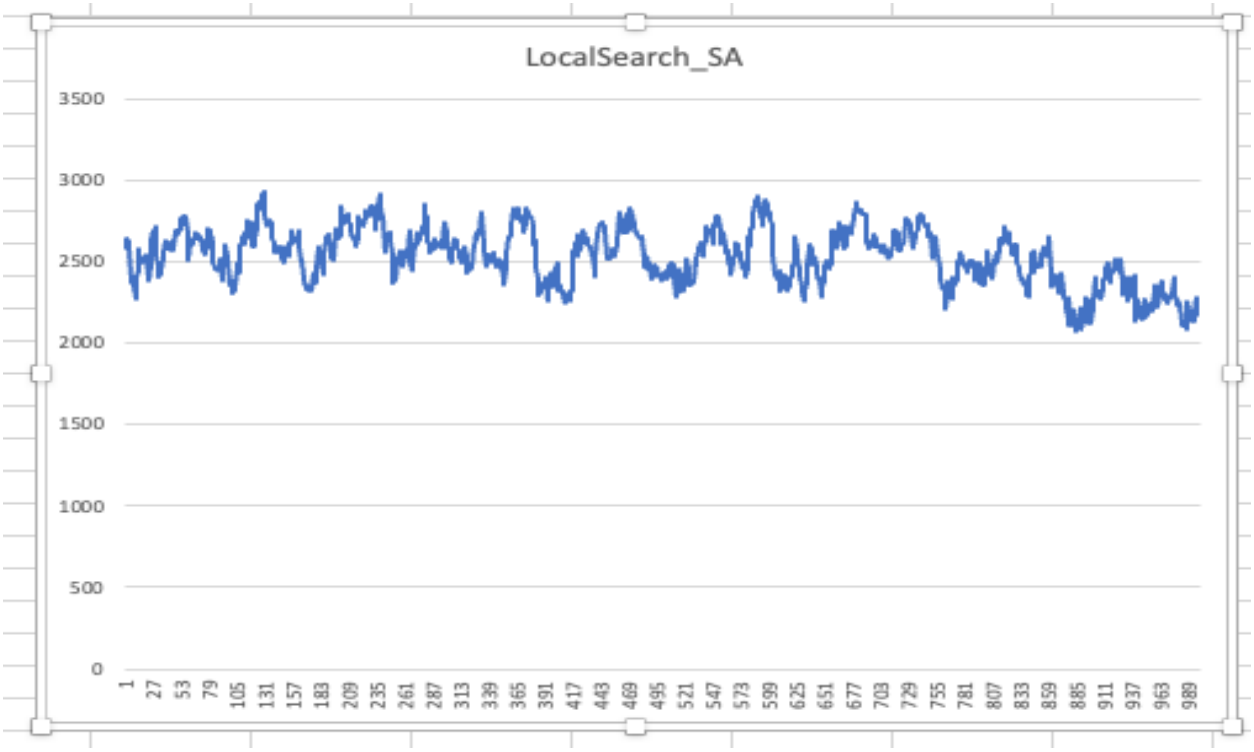
Problems Javadoc Declaration Console

```
<terminated> Driver_3_4 [Java Application] /Users/xzyloneagora/.p2/pool/plugins/org.eclipse.justj.openjdk.hotspot.jre.full.macosx.aarch64_17.0.6.v20230204-1729/jre/bin/java (Dec 8, 2023, 10:47:44 PM – 10
Driver_3_4
Grabbing input...
Done

Using Input File 1
------------------------------------------------------------------
Local Search Algorithm
Shortest Path: [[(20,86), (22,83), (35,70), (28,36), (96,44), (75,33), (73,42), (73,44), (76,63), (85,86), (48,85), (42,89), (36,99), (19,90), (35,88)
Shortest Path Distance: 1057.1825120299977
------------------------------------------------------------------
Local Search Algorithm with Simulated Annealing
Shortest Path: [[(72,7), (58,8), (91,9), (96,44), (76,63), (85,52), (73,44), (49,30), (66,25), (80,23), (73,42), (3,67), (7,47), (14,37), (28,36), (56
Shortest Path Distance: 1095.533020276861
------------------------------------------------------------------
Genetic Algorithm
Shortest Path: [[(33,22), (35,88), (28,4), (44,17), (80,23), (22,83), (14,37), (43,38), (73,44), (48,51), (96,44), (56,43), (91,9), (8,100), (66,25),
Shortest Path Distance: 2277.753063347363
```

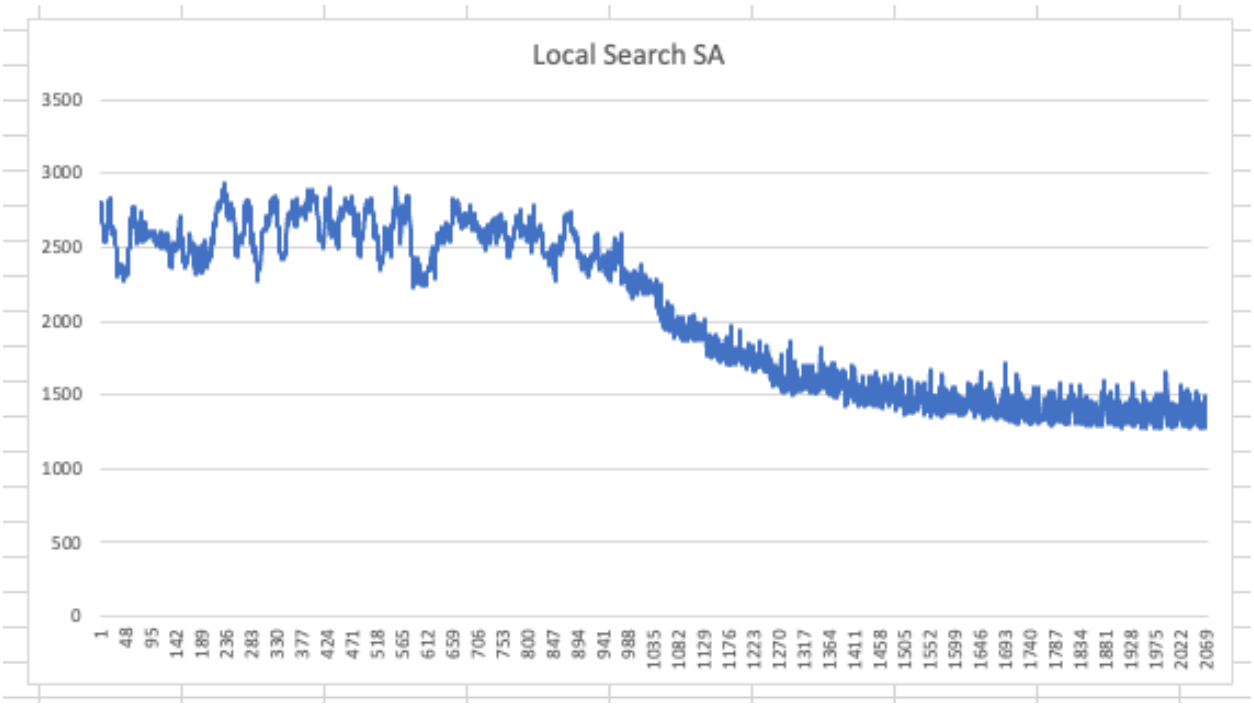
Genetic- file 1



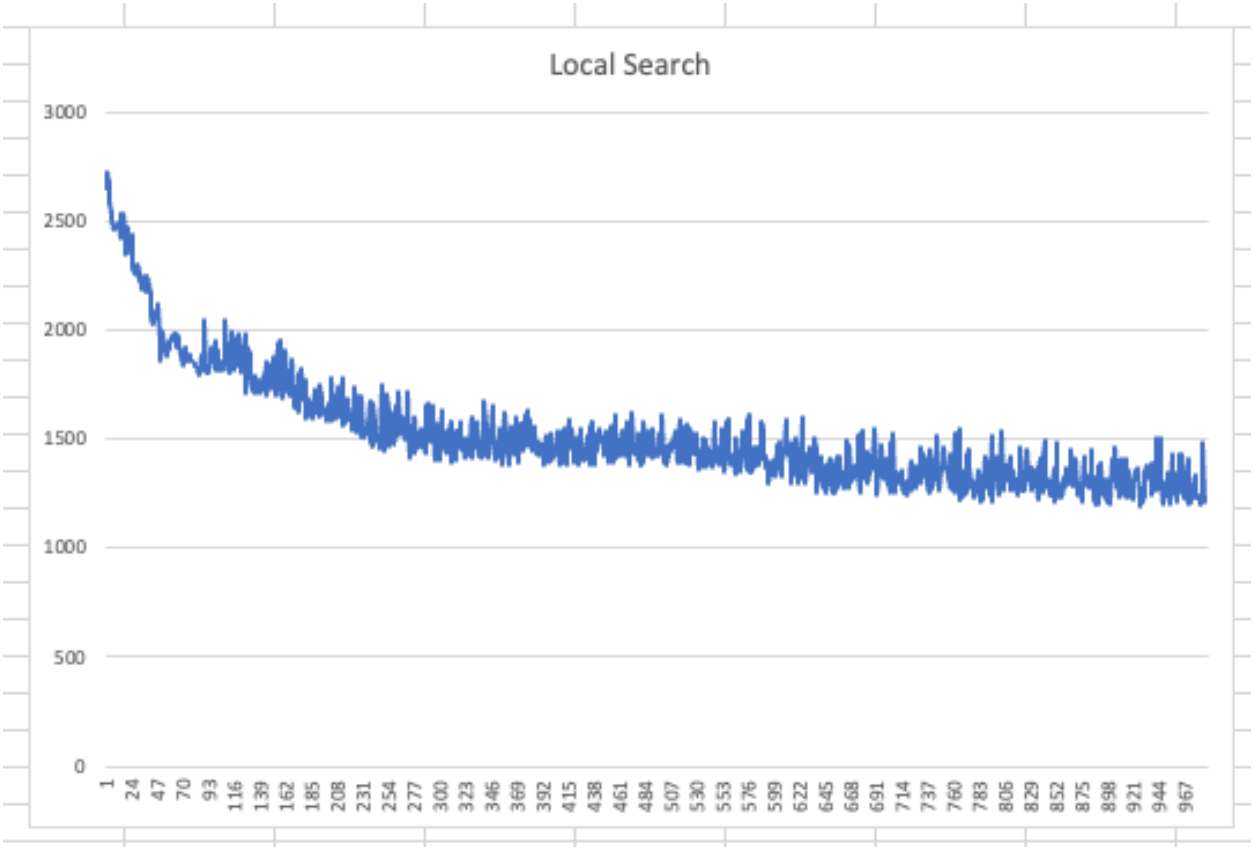
Local search Simulated Annealing - File 1 Case: while (temp > MIN_TEMP && iterations <= maxIterations) {



Local search Simulated Annealing – file 1 Case: while (temp > MIN_TEMP) {



Local Search- file 1



File output 2

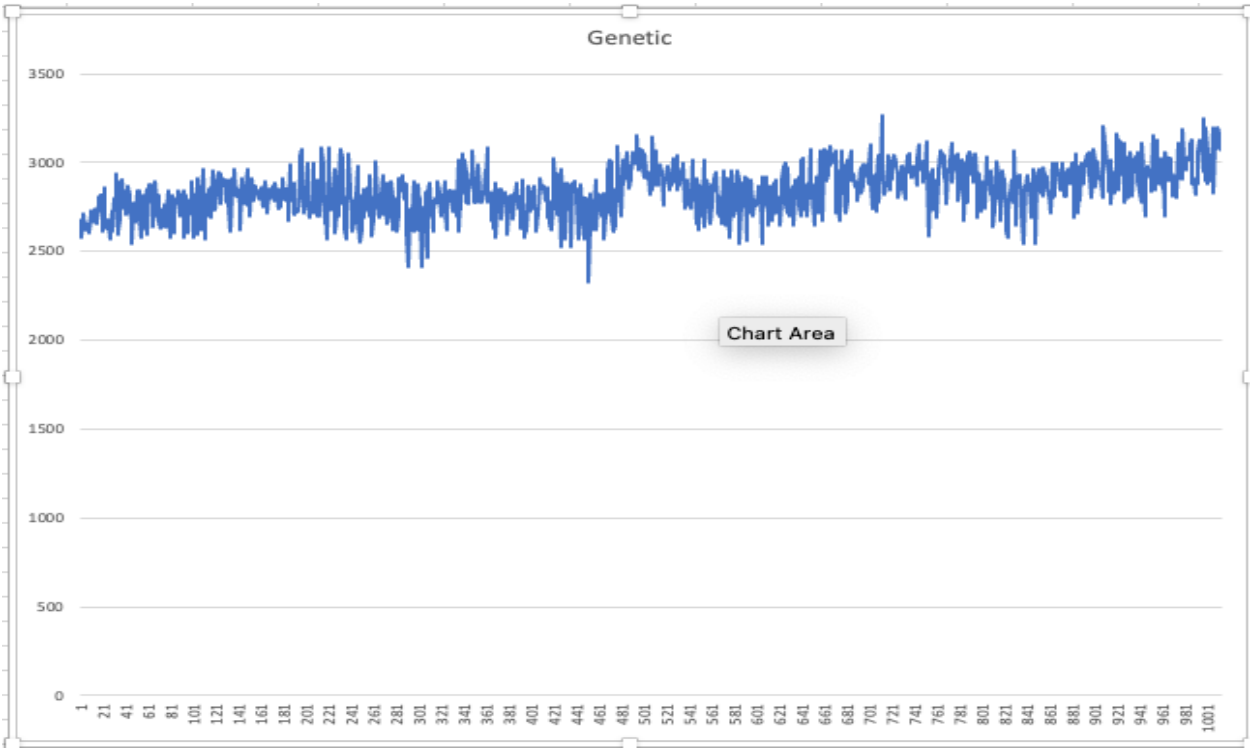
```
498         double temperature = 1000000; // Initial temperature
499         double coolingRate = 0.99; // Cooling rate
500
501         double MAX_TEMP = 10000;
502         double MIN_TEMP = 0.00001;
503         double temp = MAX_TEMP;
504
505         Random random = new Random();
506
507         //while (temp > MIN_TEMP && iterations <= maxIterations) {
508         while (temp > MIN_TEMP ) {
509             int ranIndex1;
510             int ranIndex2;
511             // Generate the first random index
512             do {
513                 // Generate the second random index
514                 ranIndex1 = random.nextInt(path.size());
```

Problems Javadoc Declaration Console

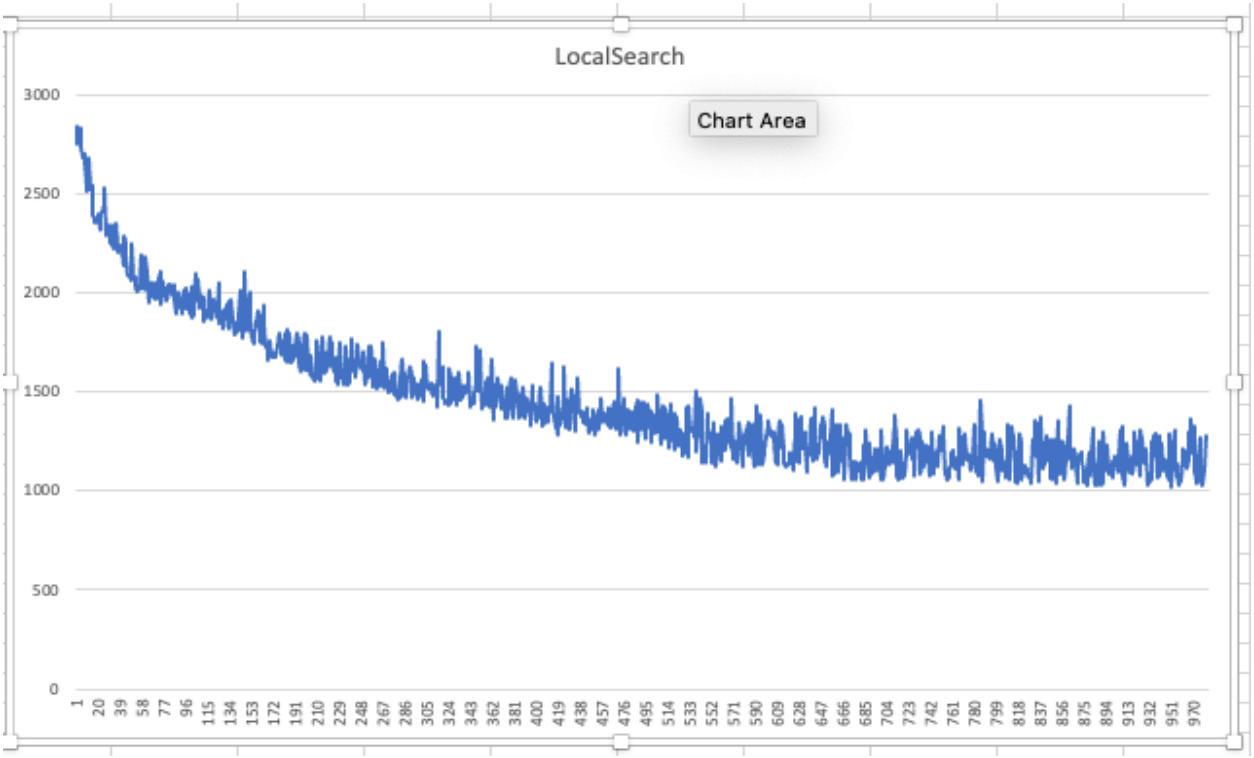
```
Driver_3_4 [Java Application] /Users/xzyloneagora/.p2/pool/plugins/org.eclipse.justj.openjdk.hotspot.jre.full.macosx.aarch64_17.0.6.v20230204-1729/jre/bin/java (Dec 8, 2023, 10:52:11 PM) [pid: 98737]
Driver_3_4
Grabbing input...
Done

Using Input File 1
------------------------------------------------------------------
Local Search Algorithm
Shortest Path: [[(35,75), (11,32), (6,20), (3,23), (8,14), (4,4), (30,26), (45,22), (47,31), (62,22), (64,14), (71,13), (76,28), (67,46), (56,93), (63
Shortest Path Distance: 1019.0278064056713
[(35,75), (11,32), (6,20), (3,23), (8,14), (4,4), (30,26), (45,22), (47,31), (62,22), (64,14), (71,13), (76,28), (67,46), (56,93), (63,95), (71,95), (
------------------------------------------------------------------
Local Search Algorithm with Simulated Annealing
Shortest Path: [[(62,22), (89,98), (95,96), (90,79), (71,59), (62,28), (86,16), (81,23), (76,28), (67,46), (59,49), (47,31), (64,14), (53,4), (41,20),
Shortest Path Distance: 1136.779425197609
[(62,22), (89,98), (95,96), (90,79), (71,59), (62,28), (86,16), (81,23), (76,28), (67,46), (59,49), (47,31), (64,14), (53,4), (41,20), (4,4), (8,14),
------------------------------------------------------------------
Genetic Algorithm
Shortest Path: [[(62,28), (38,90), (35,75), (10,96), (23,38), (41,20), (51,78), (76,28), (86,16), (11,32), (35,97), (4,4), (81,23), (71,59), (62,21),
Shortest Path Distance: 2328.3138744495955
[(62,28), (38,90), (35,75), (10,96), (23,38), (41,20), (51,78), (76,28), (86,16), (11,32), (35,97), (4,4), (81,23), (71,59), (62,21), (61,7), (18,42),
```

Graphs:

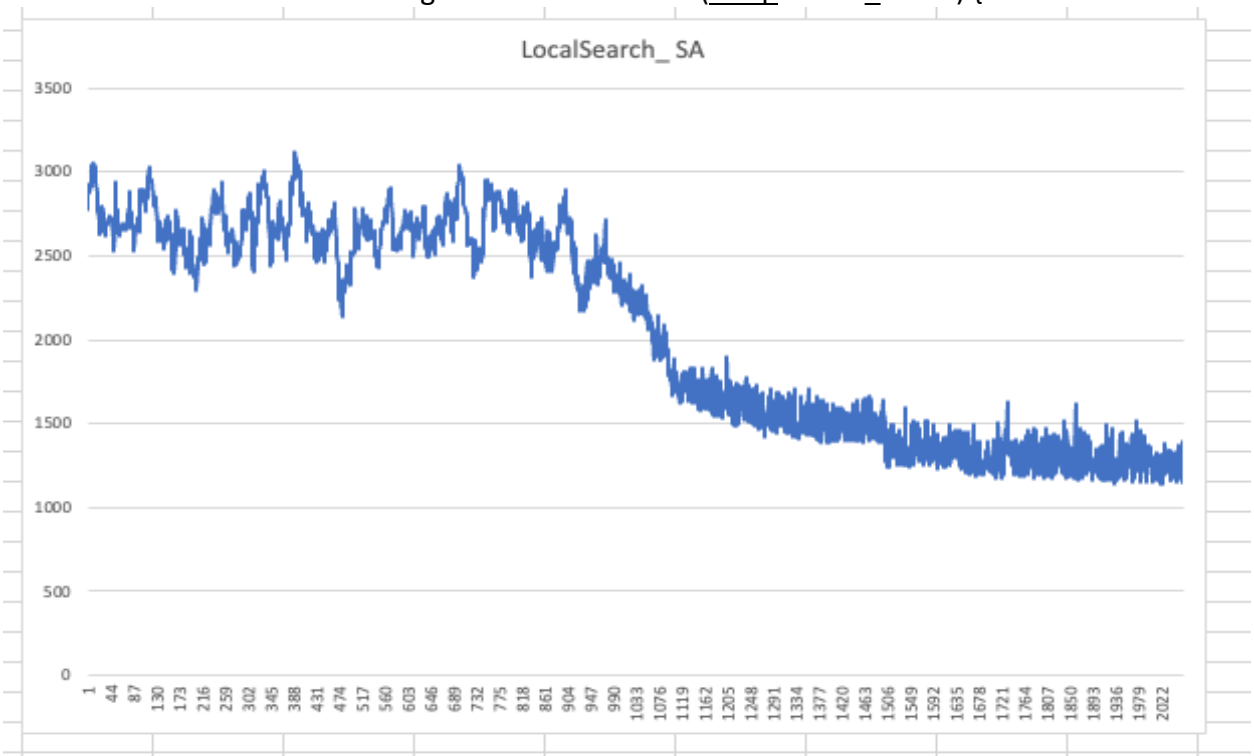
Genetics - File 2



Local Search - File 2



Local search Simulated Annealing- File 2 - Case: while (temp > MIN_TEMP) {

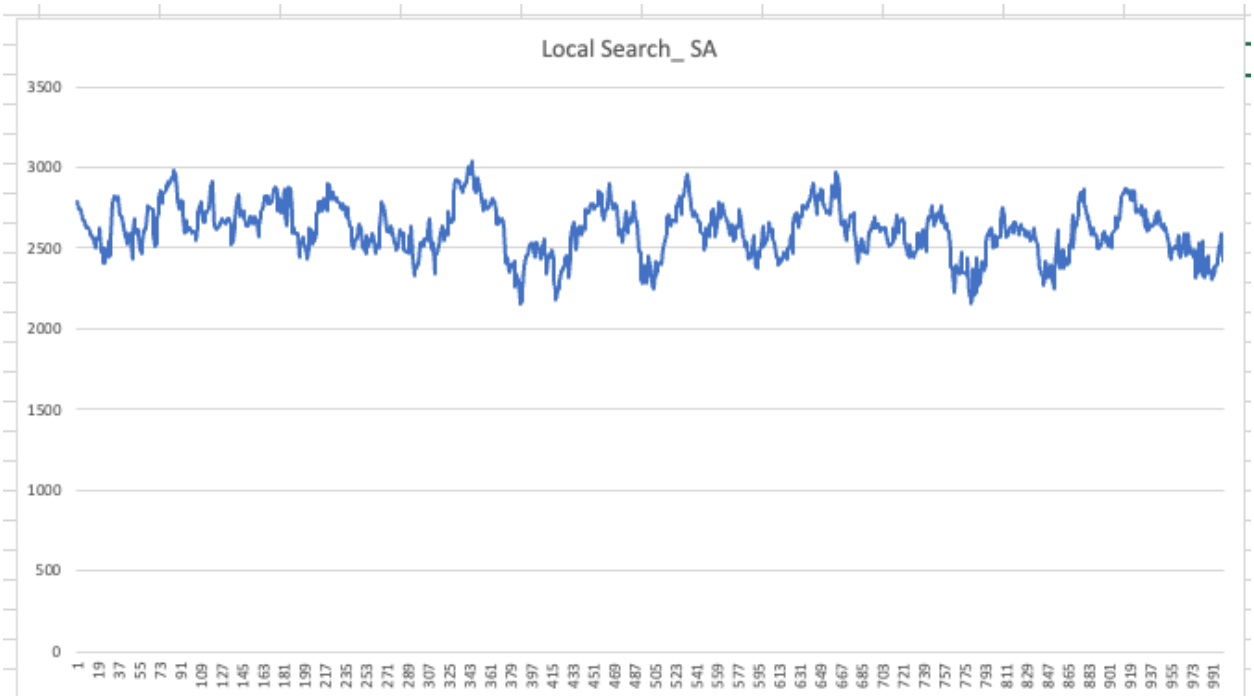


Local search Simulated Annealing - File 2 Case: while (temp > MIN_TEMP && iterations <= maxIterations) {

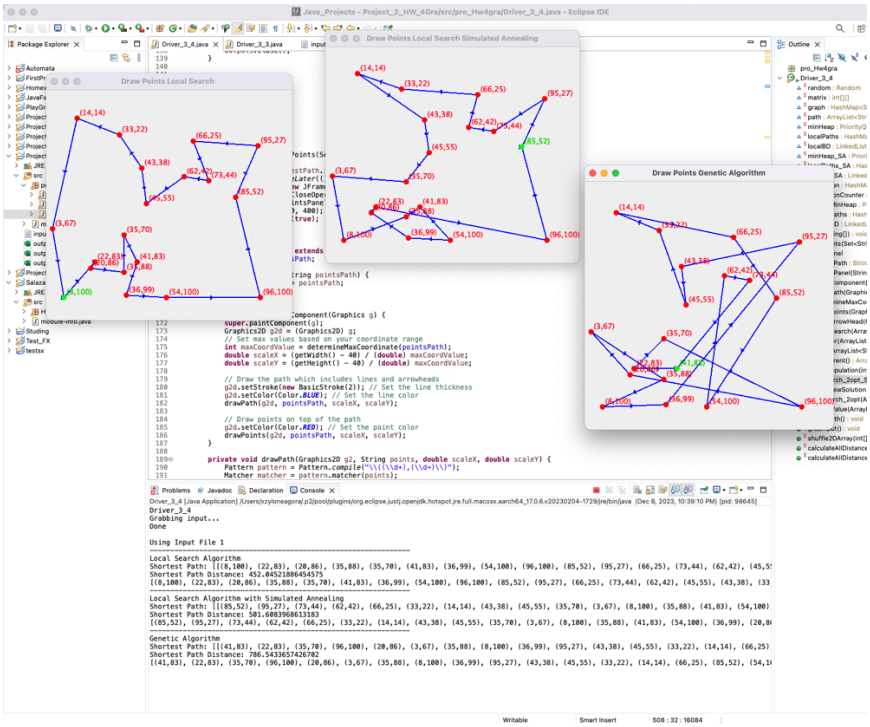
```
501         double MAX_TEMP = 10000;
502         double MIN_TEMP = 0.00001;
503         double temp = MAX_TEMP;
504
505         Random random = new Random();
506
507         while (temp > MIN_TEMP && iterations <= maxIterations) {
508 //      while (temp > MIN_TEMP ) {
509             int ranIndex1;
510             int ranIndex2;
511             // Generate the first random index
512             do {
513                 // Generate the second random index
514                 ranIndex1 = random.nextInt(path.size());
515                 ranIndex2 = random.nextInt(path.size());
516             } while (ranIndex2 == ranIndex1); // Repeat if the indices are the same
517
518 //          System.out.println("RANDOM VALUES: ran1= " + ranIndex1 + " ran2= " + ranIndex2);
```

Problems Javadoc Declaration Console

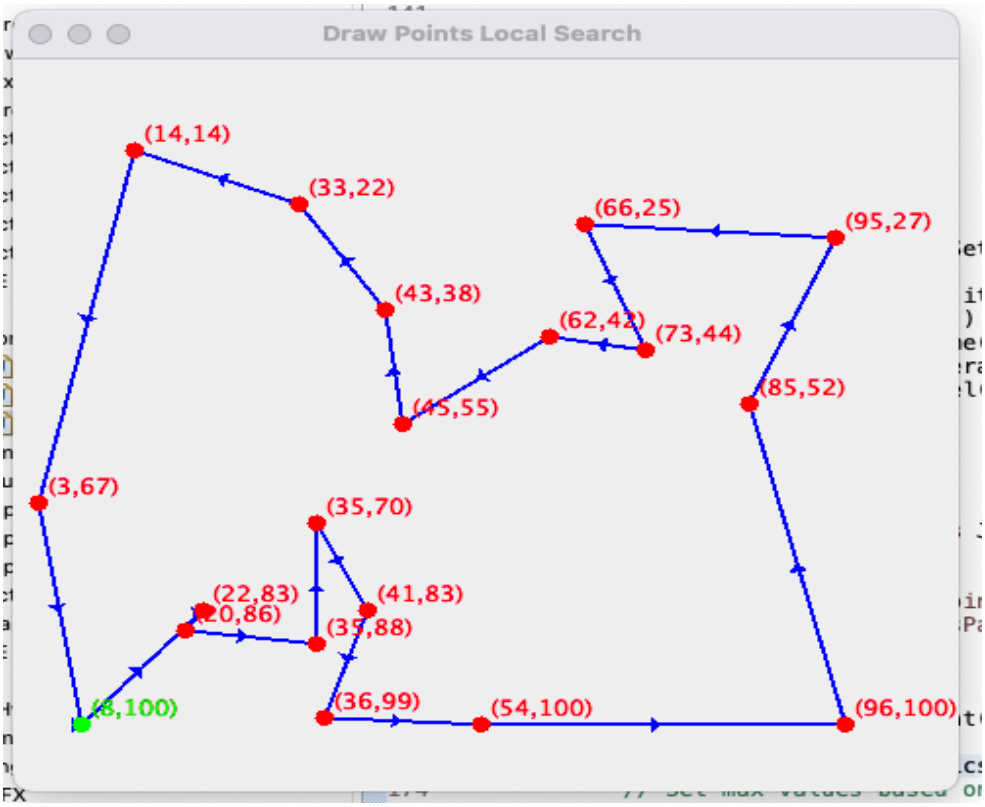
```
Driver_3_4 [Java Application] /Users/xzyloneagora/.p2/pool/plugins/org.eclipse.justj.openjdk.hotspot.jre.full.macosx.aarch64_17.0.6.v20230204-1729/jre/bin/java  (Dec 8, 2023, 11:01:01 PM) [pid: 98804]
Driver_3_4
Grabbing input...
Done

Using Input File 1
------------------------------------------------------------------
Local Search Algorithm
Shortest Path: [[(4,4), (41,20), (53,4), (45,22), (30,26), (12,38), (14,49), (35,75), (38,90), (39,90), (10,96), (5,44), (23,38), (46,86), (63,95), (7
Shortest Path Distance: 1146.7057482616967
[(4,4), (41,20), (53,4), (45,22), (30,26), (12,38), (14,49), (35,75), (38,90), (39,90), (10,96), (5,44), (23,38), (46,86), (63,95), (71,95), (95,96),
------------------------------------------------------------------
Local Search Algorithm with Simulated Annealing
Shortest Path: [[(4,4), (95,59), (95,96), (63,95), (35,97), (16,86), (71,95), (59,49), (71,13), (41,20), (81,23), (51,78), (62,22), (23,38), (43,35),
Shortest Path Distance: 2149.956009284569
[(4,4), (95,59), (95,96), (63,95), (35,97), (16,86), (71,95), (59,49), (71,13), (41,20), (81,23), (51,78), (62,22), (23,38), (43,35), (62,28), (52,95),
------------------------------------------------------------------
Genetic Algorithm
Shortest Path: [[(3,23), (18,42), (64,14), (6,20), (63,95), (5,44), (30,26), (89,98), (95,96), (46,72), (8,14), (62,28), (61,7), (95,59), (81,23), (79
Shortest Path Distance: 2176.46109752605
[(3,23), (18,42), (64,14), (6,20), (63,95), (5,44), (30,26), (89,98), (95,96), (46,72), (8,14), (62,28), (61,7), (95,59), (81,23), (79,48), (67,46), (7
```



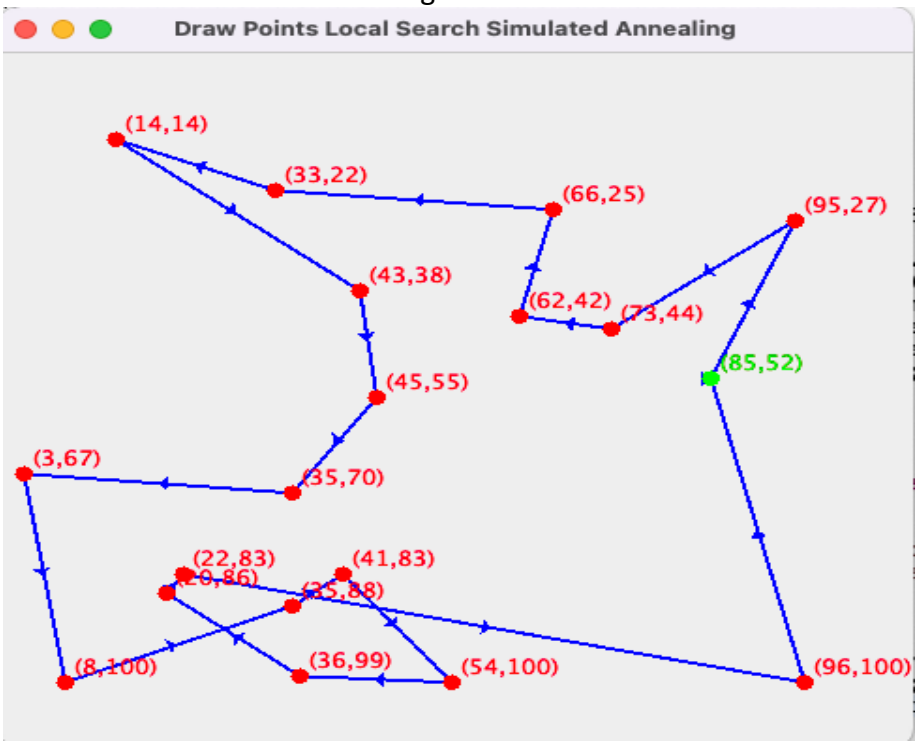
Extra credit:



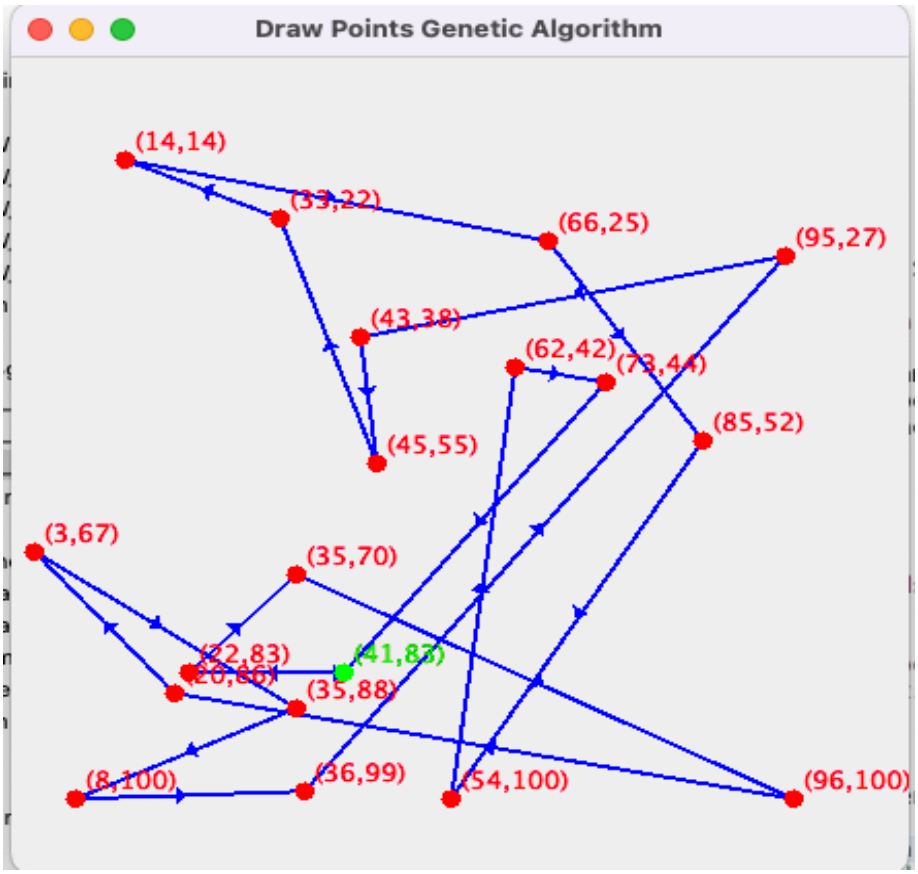
Local Search



Local search Simulated Annealing



Genetic



Conclusion:

Algorithm Speed Comparison

In my experimentation, Local Search consistently emerged as the fastest algorithm. This was followed by the variant that integrated Local Search with Simulated Annealing, and finally, the Genetic Algorithm trailed as the slowest among the three. This speed hierarchy is crucial, particularly in scenarios where computational efficiency is a priority. The stark contrast in execution speed between Local Search and the Genetic Algorithm highlighted the inherent efficiency of Local Search for quick computations.

Modified Iteration Approach in Local Search Simulated Annealing

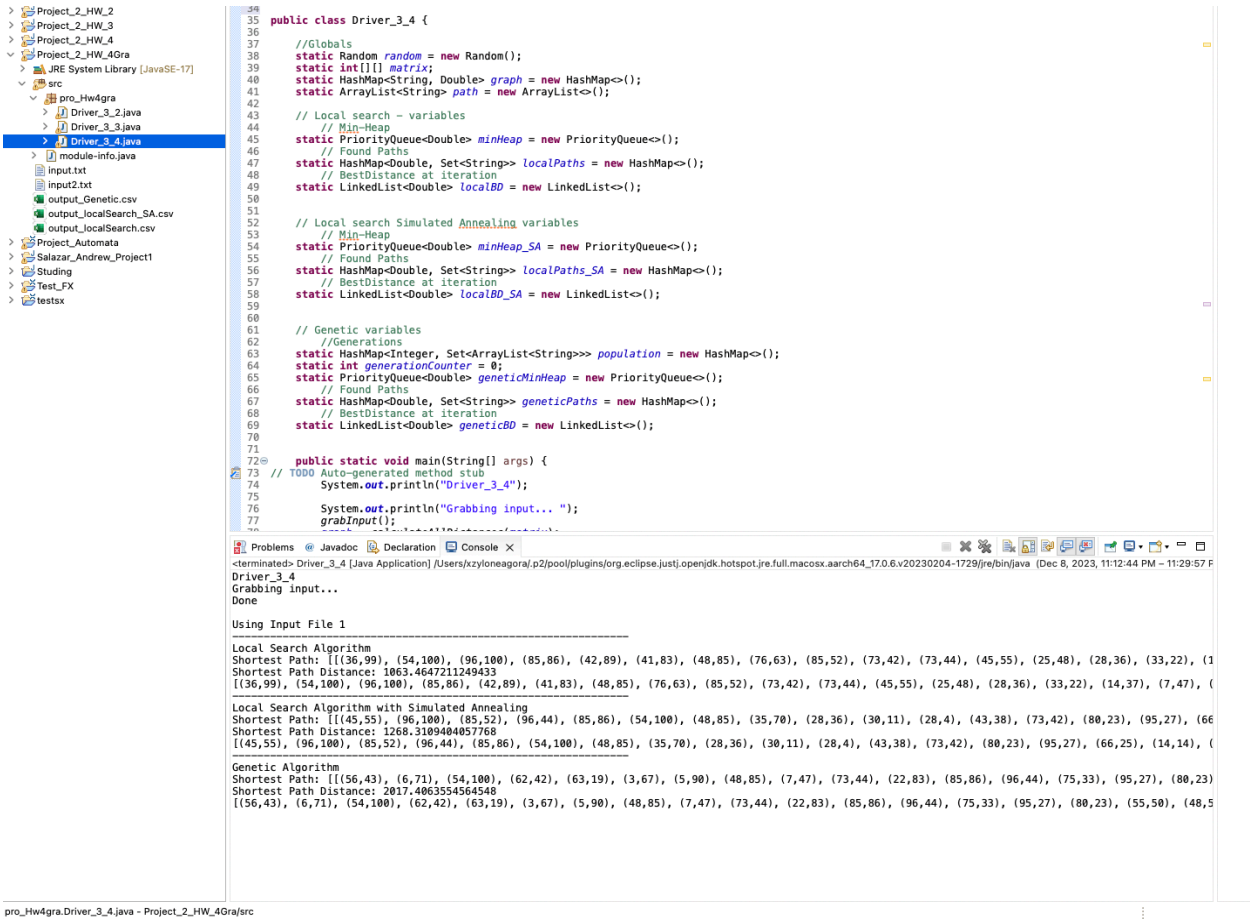
A notable observation was made when I modified the iteration process of the Local Search Simulated Annealing algorithm. By iterating based solely on the temperature condition (temp > MIN_TEMP) instead of the combined criteria of temperature and maximum iterations (temp > MIN_TEMP && iterations <= maxIterations), I noticed that the algorithm could potentially find shorter paths. However, this adjustment led to longer iteration times for the Simulated Annealing, indicating a trade-off between the speed of execution and the quality of the solution.

Experiment Setup and Graphical Representation

For a comprehensive comparison, I ran the Local Search and Simulated Annealing algorithms for 1000 iterations each. In contrast, for the Genetic Algorithm, I employed a setup of 10 populations across 100 generations. This setup aimed to balance the operational differences among the algorithms. In presenting the results, I chose to graph them using 20 data points to ensure clarity and ease of interpretation. It's worth noting that the graphical representation could handle up to 50 points, demonstrating the scalability of this visualization approach in handling more complex datasets.

For graphics
Might need inside a module-info.java

```
module Project_2_HW_4Gra {
     requires java.desktop;

}
```



pro_Hw4gra.Driver_3_4.java - Project_2_HW_4Gra/src