metin, yazı tipi, ekran görüntüsü, logo içeren bir resim

Açıklama otomatik olarak oluşturuldu

**IE343 TERM PROJECT REPORT**

**By**

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**a. The Implementations**

1.

*currentSolution* = **new** **boolean**[*values*.length];

**for** (**int** i = 0; i < *currentSolution*.length; i++) {

*currentSolution*[i] = random.nextBoolean();

Here I wanted a random number to initialize the solution state variables with a random solution

2.

*bestSolution* = Arrays.*copyOf*(*currentSolution*, *currentSolution*.length);

*bestValue* = *currentValue*;

Since it is an optimization project, I started the best solution found so far with the first solution. in order to avoid confusion and to be able to use the array again, we copy and create another array

3.

**double** temperature = ***MAX\_TEMPERATURE***;

**int** iteration = 0;

**while** (temperature > 15) { // repeat until the temperature is low enough

iteration++;

here, I take my max temperature to start the sumilated anneling process and I want it not to fall below 15 in as a min temperature and starting to iterate.

4.

**boolean**[] neighborSolution = Arrays.*copyOf*(*currentSolution*, *currentSolution*.length);

**int** item = random.nextInt(neighborSolution.length);

neighborSolution[item] = !neighborSolution[item];

Here in this code, it is creating a "neighbor" solution for a given problem by flipping the value from true to false or false to true of a randomly chosen element in the currentSolution. So, if currentSolution represents a solution to a problem with true meaning including an item in the solution and false meaning excluding it, the code creates a neighbor solution by flipping the inclusion of a randomly chosen item.

**boolean**[] neighborSolution = Arrays.*copyOf*(*currentSolution*, *currentSolution*.length);

- creates a copy of the currentSolution array. This new copy is assigned to neighborSolution. It's making sure that any changes made to neighborSolution won't affect currentSolution.

**int** item = random.nextInt(neighborSolution.length);

This generates a random index within the range of 0 to neighborSolution.length

neighborSolution[item] = !neighborSolution[item];

Here it is flipping the boolean value at the randomly chosen index in neighborSolution. If the value at that index was true, it changes it to false.

5.

**int** neighborValue = *calculateValue*(neighborSolution);

**double** acceptanceProbability = *calculateAcceptanceProbability*(*currentValue*, neighborValue, temperature);

**double** acceptance\_random= random.nextDouble();

**if** (acceptanceProbability > acceptance\_random) {

*currentSolution* = Arrays.*copyOf*(neighborSolution, neighborSolution.length);

*currentValue* = neighborValue;

In first part ;

**int** neighborValue = *calculateValue*(neighborSolution);

code calculates the "value" of the neighbor solution that was generated previously.

Second part of the code;

**double** acceptanceProbability = *calculateAcceptanceProbability*(*currentValue*, neighborValue, temperature);

calculates the acceptance probability, which will decide if the algorithm should move to the neighbor solution or stay with the current solution. This calculateAcceptanceProbability() function likely compares the cost or score of the current solution with the neighbor solution, taking into account a "temperature" parameter that controls how much the algorithm is allowed to explore the solution. As the temperature decreases, the acceptance probability for worse solutions decreases.

Third part;

**double** acceptance\_random= random.nextDouble();

generates a random double between 0.0 and 1.0, which is then used to decide if the algorithm should move to the neighbor solution.

The last part of this implementation;

**if** (acceptanceProbability > acceptance\_random) {

*currentSolution* = Arrays.*copyOf*(neighborSolution, neighborSolution.length);

*currentValue* = neighborValue;

If the calculated acceptance probability is higher than the randomly generated number, the algorithm moves to the neighbor solution. This is accomplished by making a copy of the neighborSolution array and assigning it to currentSolution, and also setting currentValue to neighborValue. This represents a move to the neighbor solution in the algorithm.

6.

**if** (*currentValue* > *bestValue*) {

*bestSolution* = Arrays.*copyOf*(*currentSolution*, *currentSolution*.length);

*bestValue* = *currentValue*;

The idea of this part of the code is to keep track of the best solution found so fa. If the algorithm finds a solution that is better in this case, has a greater value than the current best, it updates the best solution and its value accordingly.

7.

System.***out***.println("Iteration: " + iteration);

System.***out***.println("Current solution: " + Arrays.*toString*(*currentSolution*));

System.***out***.println("Current value: " + *currentValue*);

System.***out***.println("Acceptance probability: " + acceptanceProbability);

System.***out***.println("Random number: "+acceptance\_random);

System.***out***.println("Best solution: " + Arrays.*toString*(*bestSolution*));

System.***out***.println("Best value: " + *bestValue*);

System.***out***.println("Temperature: " + temperature);

System.***out***.println("--------------------------");

At this part code is outputting the current state of the algorithm at each iteration to the console. Also with the implementation of the last line of dashes, it separates the output of different iterations for easier reading.

8.

temperature \*= ***COOLING\_RATE***;

This part decreases the cooling rate.

**b. The Output**

When I run the code together with the implementation that I explained above, the code finds the best in 19 iterations.   
  
*Iteration: 1*

*Current solution: [false, false, false, false, true, false, true, true, true, false, true, false, false, true, true, false, true, false, true, false, false, false, true, true, false, true, false, true, false, false, true, false, false, true, true, false, true, true, false, true, false, false, false, false, false, true, false, false, false]*

*Current value: 1273*

*Acceptance probability: 0.9932230676836347*

*Random number: 0.4205121223526449*

*Best solution: [true, false, false, false, true, false, true, true, true, false, true, false, false, true, true, false, true, false, true, false, false, false, true, true, false, true, false, true, false, false, true, false, false, true, true, false, true, true, false, true, false, false, false, false, false, true, false, false, false]*

*Best value: 1341*

*Temperature: 10000.0*

*--------------------------*

*Iteration: 2*

*Current solution: [false, false, false, false, true, false, true, true, true, false, true, false, false, true, true, false, true, false, true, false, false, false, true, true, false, true, false, true, false, false, true, false, false, false, true, false, true, true, false, true, false, false, false, false, false, true, false, false, false]*

*Current value: 1197*

*Acceptance probability: 0.9892015831938404*

*Random number: 0.5269630845572377*

*Best solution: [true, false, false, false, true, false, true, true, true, false, true, false, false, true, true, false, true, false, true, false, false, false, true, true, false, true, false, true, false, false, true, false, false, true, true, false, true, true, false, true, false, false, false, false, false, true, false, false, false]*

*Best value: 1341*

*Temperature: 7000.0*

*--------------------------*

*Iteration: 3*

*Current solution: [false, false, false, false, true, false, true, true, true, false, true, false, false, true, true, false, true, false, true, false, false, false, true, true, false, true, false, false, false, false, true, false, false, false, true, false, true, true, false, true, false, false, false, false, false, true, false, false, false]*

*Current value: 1142*

*Acceptance probability: 0.9888382697555476*

*Random number: 0.32802343035863024*

*Best solution: [true, false, false, false, true, false, true, true, true, false, true, false, false, true, true, false, true, false, true, false, false, false, true, true, false, true, false, true, false, false, true, false, false, true, true, false, true, true, false, true, false, false, false, false, false, true, false, false, false]*

*Best value: 1341*

*Temperature: 4900.0*

*--------------------------*

*Iteration: 4*

*Current solution: [false, false, false, false, true, false, true, true, true, false, true, false, false, false, true, false, true, false, true, false, false, false, true, true, false, true, false, false, false, false, true, false, false, false, true, false, true, true, false, true, false, false, false, false, false, true, false, false, false]*

*Current value: 1095*

*Acceptance probability: 0.9863908297040601*

*Random number: 0.8746341992286634*

*Best solution: [true, false, false, false, true, false, true, true, true, false, true, false, false, true, true, false, true, false, true, false, false, false, true, true, false, true, false, true, false, false, true, false, false, true, true, false, true, true, false, true, false, false, false, false, false, true, false, false, false]*

*Best value: 1341*

*Temperature: 3430.0*

*--------------------------*

*Iteration: 5*

*Current solution: [false, false, false, false, true, false, true, true, true, false, true, false, false, false, true, false, true, false, true, false, false, false, true, true, false, true, false, false, false, false, true, false, false, false, true, false, true, true, false, true, false, false, true, false, false, true, false, false, false]*

*Current value: 1161*

*Acceptance probability: 1.0*

*Random number: 0.43219386757368106*

*Best solution: [true, false, false, false, true, false, true, true, true, false, true, false, false, true, true, false, true, false, true, false, false, false, true, true, false, true, false, true, false, false, true, false, false, true, true, false, true, true, false, true, false, false, false, false, false, true, false, false, false]*

*Best value: 1341*

*Temperature: 2401.0*

*--------------------------*

*Iteration: 6*

*Current solution: [false, false, false, false, true, false, true, true, true, false, true, false, false, false, true, false, true, false, true, false, false, false, true, true, false, true, false, false, false, false, true, false, false, false, true, false, true, true, false, true, false, false, true, false, false, true, false, false, true]*

*Current value: 1212*

*Acceptance probability: 1.0*

*Random number: 0.22079454904942875*

*Best solution: [true, false, false, false, true, false, true, true, true, false, true, false, false, true, true, false, true, false, true, false, false, false, true, true, false, true, false, true, false, false, true, false, false, true, true, false, true, true, false, true, false, false, false, false, false, true, false, false, false]*

*Best value: 1341*

*Temperature: 1680.6999999999998*

*--------------------------*

*Iteration: 7*

*Current solution: [false, true, false, false, true, false, true, true, true, false, true, false, false, false, true, false, true, false, true, false, false, false, true, true, false, true, false, false, false, false, true, false, false, false, true, false, true, true, false, true, false, false, true, false, false, true, false, false, true]*

*Current value: 1276*

*Acceptance probability: 1.0*

*Random number: 0.8190179916636955*

*Best solution: [true, false, false, false, true, false, true, true, true, false, true, false, false, true, true, false, true, false, true, false, false, false, true, true, false, true, false, true, false, false, true, false, false, true, true, false, true, true, false, true, false, false, false, false, false, true, false, false, false]*

*Best value: 1341*

*Temperature: 1176.4899999999998*

*--------------------------*

*Iteration: 8*

*Current solution: [false, true, false, false, true, false, true, true, true, false, true, false, false, false, true, false, true, false, true, false, false, false, true, true, false, true, false, false, false, false, true, false, false, false, true, false, true, true, false, true, false, false, true, false, false, true, false, false, true]*

*Current value: 1276*

*Acceptance probability: 0.21237472236469554*

*Random number: 0.8090111772949659*

*Best solution: [true, false, false, false, true, false, true, true, true, false, true, false, false, true, true, false, true, false, true, false, false, false, true, true, false, true, false, true, false, false, true, false, false, true, true, false, true, true, false, true, false, false, false, false, false, true, false, false, false]*

*Best value: 1341*

*Temperature: 823.5429999999998*

*--------------------------*

*Iteration: 9*

*Current solution: [false, true, false, false, true, false, true, true, true, false, true, false, false, false, true, false, true, false, true, false, false, false, true, true, false, true, false, false, false, false, true, false, false, false, true, false, true, true, false, true, false, false, true, false, false, true, false, false, true]*

*Current value: 1276*

*Acceptance probability: 0.10932470652512138*

*Random number: 0.18019179131574803*

*Best solution: [true, false, false, false, true, false, true, true, true, false, true, false, false, true, true, false, true, false, true, false, false, false, true, true, false, true, false, true, false, false, true, false, false, true, true, false, true, true, false, true, false, false, false, false, false, true, false, false, false]*

*Best value: 1341*

*Temperature: 576.4800999999998*

*--------------------------*

*Iteration: 10*

*Current solution: [false, true, false, false, true, false, true, true, true, false, true, false, false, false, true, false, true, false, true, false, false, false, true, true, false, true, false, false, false, false, true, false, false, false, true, false, true, true, false, true, true, false, true, false, false, true, false, false, true]*

*Current value: 1347*

*Acceptance probability: 1.0*

*Random number: 0.3855536393986595*

*Best solution: [false, true, false, false, true, false, true, true, true, false, true, false, false, false, true, false, true, false, true, false, false, false, true, true, false, true, false, false, false, false, true, false, false, false, true, false, true, true, false, true, true, false, true, false, false, true, false, false, true]*

*Best value: 1347*

*Temperature: 403.5360699999998*

*--------------------------*

*Iteration: 11*

*Current solution: [false, true, false, false, true, false, true, true, true, false, true, false, false, false, true, false, true, false, true, false, false, false, true, true, false, true, false, false, false, false, true, false, false, false, true, false, true, true, false, true, true, false, true, false, false, true, false, false, true]*

*Current value: 1347*

*Acceptance probability: 0.008492605916466734*

*Random number: 0.359538936680613*

*Best solution: [false, true, false, false, true, false, true, true, true, false, true, false, false, false, true, false, true, false, true, false, false, false, true, true, false, true, false, false, false, false, true, false, false, false, true, false, true, true, false, true, true, false, true, false, false, true, false, false, true]*

*Best value: 1347*

*Temperature: 282.47524899999985*

*--------------------------*

*Iteration: 12*

*Current solution: [false, true, false, false, true, false, true, true, true, false, true, false, false, false, true, false, true, false, true, false, false, false, true, true, false, true, false, false, false, false, true, false, false, false, true, false, true, true, false, true, true, false, true, false, false, true, false, false, true]*

*Current value: 1347*

*Acceptance probability: 0.6948022657032652*

*Random number: 0.9913159902920917*

*Best solution: [false, true, false, false, true, false, true, true, true, false, true, false, false, false, true, false, true, false, true, false, false, false, true, true, false, true, false, false, false, false, true, false, false, false, true, false, true, true, false, true, true, false, true, false, false, true, false, false, true]*

*Best value: 1347*

*Temperature: 197.73267429999987*

*--------------------------*

*Iteration: 13*

*Current solution: [false, true, false, false, true, false, true, true, true, false, true, false, false, false, true, false, true, false, true, false, false, false, true, true, false, true, false, false, false, false, true, false, false, false, true, false, true, true, false, true, true, false, true, false, false, true, false, false, true]*

*Current value: 1347*

*Acceptance probability: 5.936808001760596E-5*

*Random number: 0.19178934518803537*

*Best solution: [false, true, false, false, true, false, true, true, true, false, true, false, false, false, true, false, true, false, true, false, false, false, true, true, false, true, false, false, false, false, true, false, false, false, true, false, true, true, false, true, true, false, true, false, false, true, false, false, true]*

*Best value: 1347*

*Temperature: 138.4128720099999*

*--------------------------*

*Iteration: 14*

*Current solution: [false, true, false, false, true, false, true, true, true, false, true, false, false, false, true, false, true, false, true, false, false, false, true, true, false, true, false, false, false, false, true, false, false, false, true, false, true, true, false, true, true, false, true, false, false, true, false, false, true]*

*Current value: 1347*

*Acceptance probability: 0.5165673354159392*

*Random number: 0.7372510045229805*

*Best solution: [false, true, false, false, true, false, true, true, true, false, true, false, false, false, true, false, true, false, true, false, false, false, true, true, false, true, false, false, false, false, true, false, false, false, true, false, true, true, false, true, true, false, true, false, false, true, false, false, true]*

*Best value: 1347*

*Temperature: 96.88901040699992*

*--------------------------*

*Iteration: 15*

*Current solution: [false, true, false, false, true, false, true, true, true, false, true, false, false, false, true, false, true, false, true, false, false, false, true, true, false, true, false, false, false, false, true, false, false, false, true, false, true, true, false, true, true, false, true, false, false, true, false, false, true]*

*Current value: 1347*

*Acceptance probability: 2.369179505899925E-9*

*Random number: 0.7405305045524642*

*Best solution: [false, true, false, false, true, false, true, true, true, false, true, false, false, false, true, false, true, false, true, false, false, false, true, true, false, true, false, false, false, false, true, false, false, false, true, false, true, true, false, true, true, false, true, false, false, true, false, false, true]*

*Best value: 1347*

*Temperature: 67.82230728489994*

*--------------------------*

*Iteration: 16*

*Current solution: [false, true, false, false, true, false, true, true, true, false, true, false, false, false, true, false, true, false, true, false, false, false, true, true, false, true, false, false, false, false, true, false, false, false, true, false, true, true, false, true, true, false, true, false, false, true, false, false, true]*

*Current value: 1347*

*Acceptance probability: 0.21946378939928057*

*Random number: 0.8075632315083475*

*Best solution: [false, true, false, false, true, false, true, true, true, false, true, false, false, false, true, false, true, false, true, false, false, false, true, true, false, true, false, false, false, false, true, false, false, false, true, false, true, true, false, true, true, false, true, false, false, true, false, false, true]*

*Best value: 1347*

*Temperature: 47.47561509942995*

*--------------------------*

*Iteration: 17*

*Current solution: [false, true, false, false, true, false, true, true, true, false, true, false, false, false, true, false, true, false, true, false, false, false, true, true, false, true, false, false, false, false, true, false, false, false, true, false, true, true, false, true, true, false, true, false, false, true, false, false, true]*

*Current value: 1347*

*Acceptance probability: 2.495391598650995E-18*

*Random number: 0.3265776225759235*

*Best solution: [false, true, false, false, true, false, true, true, true, false, true, false, false, false, true, false, true, false, true, false, false, false, true, true, false, true, false, false, false, false, true, false, false, false, true, false, true, true, false, true, true, false, true, false, false, true, false, false, true]*

*Best value: 1347*

*Temperature: 33.23293056960097*

*--------------------------*

*Iteration: 18*

*Current solution: [false, true, false, false, true, false, true, true, true, false, true, false, false, false, true, false, true, false, true, false, false, false, true, true, false, true, false, false, false, false, true, false, false, false, true, false, true, true, false, true, true, false, true, false, false, true, false, false, true]*

*Current value: 1347*

*Acceptance probability: 0.053767273043918255*

*Random number: 0.5245691073835378*

*Best solution: [false, true, false, false, true, false, true, true, true, false, true, false, false, false, true, false, true, false, true, false, false, false, true, true, false, true, false, false, false, false, true, false, false, false, true, false, true, true, false, true, true, false, true, false, false, true, false, false, true]*

*Best value: 1347*

*Temperature: 23.263051398720677*

*--------------------------*

*Iteration: 19*

*Current solution: [false, true, false, false, true, false, true, true, true, false, true, false, false, false, true, false, true, false, true, false, false, false, true, true, false, true, false, false, false, false, true, false, false, false, true, false, true, true, false, true, true, false, true, false, false, true, false, false, true]*

*Current value: 1347*

*Acceptance probability: 1.1906751309936196E-36*

*Random number: 0.0023064160644912235*

*Best solution: [false, true, false, false, true, false, true, true, true, false, true, false, false, false, true, false, true, false, true, false, false, false, true, true, false, true, false, false, false, false, true, false, false, false, true, false, true, true, false, true, true, false, true, false, false, true, false, false, true]*

*Best value: 1347*

*Temperature: 16.284135979104473*

*--------------------------*

*Final Best solution: [false, true, false, false, true, false, true, true, true, false, true, false, false, false, true, false, true, false, true, false, false, false, true, true, false, true, false, false, false, false, true, false, false, false, true, false, true, true, false, true, true, false, true, false, false, true, false, false, true]*

*Final Best value: 1347*

çizgi, metin, ekran görüntüsü içeren bir resim

Açıklama otomatik olarak oluşturulduThe code gives different results every time it runs, and the reason behind is the usage of random variables. I have translated the results into an excel spreadsheet to make it look easier.

The output here, I took the max temperature to 10000 and got 0.7 with the cooling rate.

**c. The Analysis**

I ran the code several more times with different values to understand that the result I accepted was closest to the optimal one.

Max Tempreture: 10000

makbuz, metin, ekran görüntüsü içeren bir resim

Açıklama otomatik olarak oluşturulduCooling rate: 0.5

Max Tempreture: 20000

Cooling rate: 0.7

**metin, ekran görüntüsü, makbuz içeren bir resim

Açıklama otomatik olarak oluşturuldu**