THE AMERICAN UNIVERSITY IN CAIRO
الجامعة الأمريكية بالقاهرة

CSCE330401/ Digital Design II

A Simple Simulated-Annealing Cell Placement Tool

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1. Introduction:

   We developed a simulated annealing cell placement tool that minimizes the total wire length used in connecting the cells in a grid using the half-perimeter of the smallest bounding box containing all pins for a net and depends on the cooling effect. Our work on Git Hub:

   https://github.com/YaraYahia17/DDII_Project

2. Algorithm:

   We create an initial random placement. Then mark the current temperature as the initial one and while is it still greater than the final one, we swap cells and calculate the change in the wire length. If it is a negative change, we accept the new wire length as the final one and if not, we reject with probability (1 - e-ΔL/T) and schedule temp.

3. Implementation:

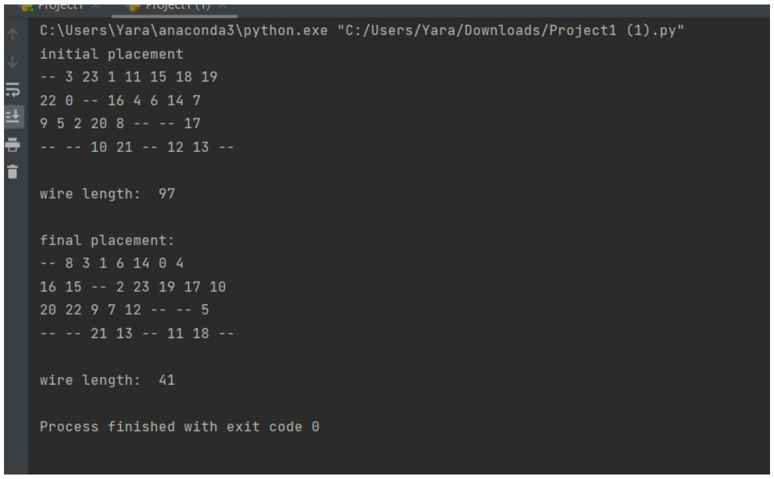
The algorithm is divided into three steps. First, it parses a text file that contains the number of cells, number of connections, grid size (to create the 2d array) , and a line for each net that describes the number of cells in the net and which cells are there. Secondly, we created a 2d array initially empty that represents the initial grid then we implemented a random function that loop over a list of the cells and put them in random locations in the 2d array. Then, we started calculating the wire length using the half-perimeter of the smallest bounding box containing all pins for each net (HPWL). We did that by selecting the net's cells and getting the difference of the minimum and maximum x and between the minimum and maximum y then adding them to get the initial total wire length. Third, we started doing the simulated annealing algorithm and scheduling. As long as the initial temperature calculated by (500*initial cost) is greater than the final temperature, as the temperature decreases by (0.95*current temperature) each time the number of swaps per temperature ends. We first picked any two cells and swapped these cells. Then, calculate the total wire length again, if it is less than the previous wire length, then we pick it as the best solution. If no, we reject with probability calculated in the code by the difference in the wire length and current temperature. After getting the best total wire length by iterating over the nets, we place the new cell locations on the grid. Then present the final cell placement on the 2d array.

We tried reducing the algorithm complexity by mapping the cells to the nets they appeared at and then when swapping any two cells, it check the map first and instead of going for the whole new grid to calculate the wire length. It go over the cells of the nets associated to the swapped cells to calculate the wire length again.

4. Results:

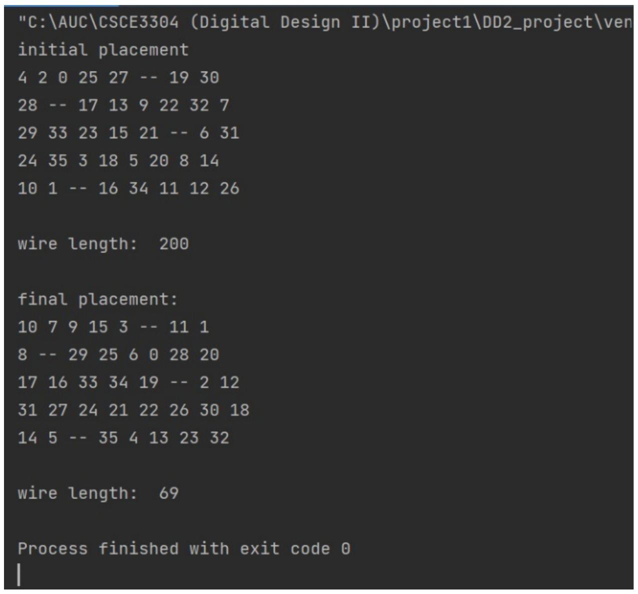
   We ran the three different test files. In each run it successfully changed the cells placement and reduced the wire length.

   Run of file d0.txt:



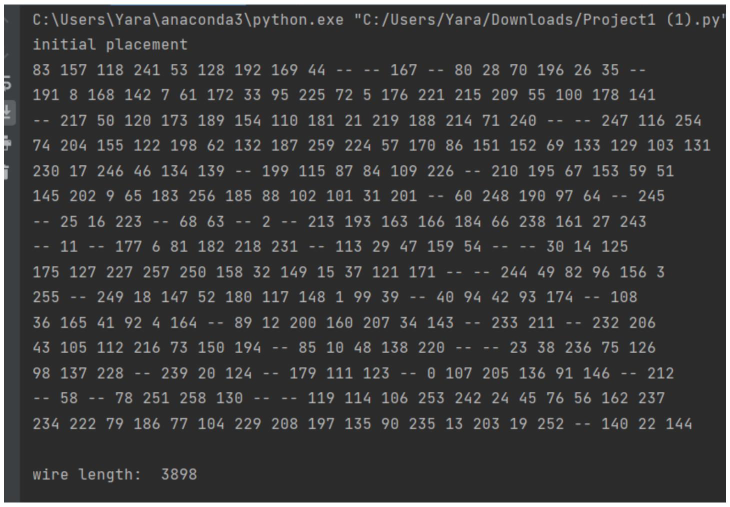
```
C:\Users\Yara\anaconda3\python.exe "C:/Users/Yara/Downloads/Project1 (1).py"
initial placement
-- 3 23 1 11 15 18 19
22 0 -- 16 4 6 14 7
9 5 2 20 8 -- -- 17
-- -- 10 21 -- 12 13 --

wire length:  97

final placement:
-- 8 3 1 6 14 0 4
16 15 -- 2 23 19 17 10
20 22 9 7 12 -- -- 5
-- -- 21 13 -- 11 18 --

wire length:  41

Process finished with exit code 0
```

Run of file d1.txt:



```
"C:\AUC\CSCE3304 (Digital Design II)\project1\DD2_project\ven
initial placement
4 2 0 25 27 -- 19 30
28 -- 17 13 9 22 32 7
29 33 23 15 21 -- 6 31
24 35 3 18 5 20 8 14
10 1 -- 16 34 11 12 26

wire length:  200

final placement:
10 7 9 15 3 -- 11 1
8 -- 29 25 6 0 28 20
17 16 33 34 19 -- 2 12
31 27 24 21 22 26 30 18
14 5 -- 35 4 13 23 32

wire length:  69

Process finished with exit code 0
```

Run of file d2.txt:



```
C:\Users\Yara\anaconda3\python.exe "C:/Users/Yara/Downloads/Project1 (1).py"
initial placement
83 157 118 241 53 128 192 169 44 -- -- 167 -- 80 28 70 196 26 35 --
191 8 168 142 7 61 172 33 95 225 72 5 176 221 215 209 55 100 178 141
-- 217 50 120 173 189 154 110 181 21 219 188 214 71 240 -- -- 247 116 254
74 204 155 122 198 62 132 187 259 224 57 170 86 151 152 69 133 129 103 131
230 17 246 46 134 139 -- 199 115 87 84 109 226 -- 210 195 67 153 59 51
145 202 9 65 183 256 185 88 102 101 31 201 -- 60 248 190 97 64 -- 245
-- 25 16 223 -- 68 63 -- 2 -- 213 193 163 166 184 66 238 161 27 243
-- 11 -- 177 6 81 182 218 231 -- 113 29 47 159 54 -- -- 30 14 125
175 127 227 257 250 158 32 149 15 37 121 171 -- -- 244 49 82 96 156 3
255 -- 249 18 147 52 180 117 148 1 99 39 -- 40 94 42 93 174 -- 108
36 165 41 92 4 164 -- 89 12 200 160 207 34 143 -- 233 211 -- 232 206
43 105 112 216 73 150 194 -- 85 10 48 138 220 -- -- 23 38 236 75 126
98 137 228 -- 239 20 124 -- 179 111 123 -- 0 107 205 136 91 146 -- 212
-- 58 -- 78 251 258 130 -- -- 119 114 106 253 242 24 45 76 56 162 237
234 222 79 186 77 104 229 208 197 135 90 235 13 203 19 252 -- 140 22 144

wire length:  3898
```