

File - Main

```
1 C:\Users\talha\AppData\Local\Programs\Python\Python38-32\python.exe "C:/Users
  /talha/Documents/CS Honours/COMP719 - OM/Assessments/Project/SA-HS-
  TimetableProblem/Main.py"
2
3
4 Solving the Timetabling Problem for Grades 7 to 9 based on the South African
  DOE's Curriculum Guidelines
5 using a Genetic Algorithm and Cat Swarm Optimization Algorithm and comparing
  the results
6 =====
  =====
7 =====
  =====
8 =====
  =====
9
10
11 Subjects:
12     Subject 1: Home Language
13     Subject 2: First Additional Language
14     Subject 3: Mathematics
15     Subject 4: Natural Science
16     Subject 5: Social Science
17     Subject 6: Technology
18     Subject 7: Economic and Management Science
19     Subject 8: Life Orientation
20     Subject 9: Arts and Culture
21 =====
22 =====
23
24
25 INPUT 1
26 -----
27 Number of classes in Grade 7:          2
28 Number of classes in Grade 8:          2
29 Number of classes in Grade 9:          2
30
31 Number of teachers teaching in Grades 7-9: 15
32
33
34 Teacher Class-Subject Allocation Table:
35
36 Subjects ->          1   2   3   4   5   6   7   8   9
37 Classes:
38 -----
39 Grade 7 - Class 1    |   1   4   7   10  4   10  7   13  13
40 Grade 7 - Class 2    |   1   4   7   10  4   10  7   13  13
41 Grade 8 - Class 1    |   2   5   8   11  5   11  8   14  14
42 Grade 8 - Class 2    |   2   5   8   11  5   11  8   14  14
43 Grade 9 - Class 1    |   3   6   9   12  6   12  9   15  15
44 Grade 9 - Class 2    |   3   6   9   12  6   12  9   15  15
45 -----
46
47 =====
48
49 Solving INPUT 1 using the GeneticAlgorithm:
50
51     Initialising Population (20 individuals):
52
53     Time taken to initialise population: 0.03699851036071777 seconds
```

```

54 Finding optimal solution...
55 Generation: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16,
17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35,
36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54,
55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73,
74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92,
93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107,
56
57 Time taken to solve: 50.860026121139526 seconds
58
59 Optimal solution found in Generation 7 with a fitness of 5335
60
61
62 SOLUTION:
63 Class-Lesson Timeslot Allocation Table:
64
65 Lessons ->
14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32
33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51
52 53 54 55
66 Classes:
67 -----
-----
-----
68 Grade 7 - Class 1 | 37 34 38 41 35 10 45 30 29 20 13 32 44
50 49 17 15 43 3 9 19 22 6 39 12 46 21 53 36 8 40 16
7 31 27 4 5 51 1 33 24 25 26 55 47 28 11 2 42 52 18
14 23 48 54
69 Grade 7 - Class 2 | 11 6 19 43 55 49 21 22 51 40 1 54 10
18 45 16 8 39 28 42 41 27 50 17 36 48 37 7 24 13 29 14
2 47 32 46 25 12 52 44 38 35 9 15 34 30 23 20 33 5 4
26 53 3 31
70 Grade 8 - Class 1 | 37 34 47 39 55 17 40 21 51 44 22 9 38
31 1 28 27 3 24 50 16 19 41 36 23 33 43 10 30 54 18 53
42 49 14 13 6 48 29 7 15 26 2 46 25 35 4 20 45 12 11
8 52 5 32
71 Grade 8 - Class 2 | 31 35 23 50 43 49 45 13 6 36 25 53 34
7 39 19 40 21 20 42 1 32 9 30 55 3 28 24 22 38 33 37
8 4 44 26 5 12 41 52 17 46 16 18 11 54 10 47 48 27 2
15 29 51 14
72 Grade 9 - Class 1 | 42 4 23 21 1 25 8 55 7 11 15 36 5
29 30 50 28 17 12 48 35 39 41 47 24 33 3 10 34 32 31 9
51 54 27 37 13 46 22 16 2 45 6 53 38 26 19 44 49 20 52
43 14 18 40
73 Grade 9 - Class 2 | 53 19 40 10 2 47 5 26 37 36 12 14 1
25 7 41 24 38 45 32 31 30 6 46 17 52 15 50 42 33 20 11
48 21 34 23 49 4 44 39 18 54 43 27 13 16 55 8 28 29 22
3 35 9 51
74 -----
-----
-----
-----
75
76
77 Solution Value (Fitness): 5335
78 -----
79
80
81 Master Timetable (Class-Timeslot Lesson Allocations):

```

82

83 Timeslots ->           1    2    3    4    5    6    7    8    9   10   11   12   13  
      14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32  
      33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51  
      52 53 54 55

84 Classes:

85 -----  
 -----  
 -----

86 Grade 7 - Class 1 |   39 48 19 36 37 23 33 30 20 6 47 25 11  
      52 17 32 16 51 21 10 27 22 53 41 42 43 35 46 9 8 34 12  
      40 2 5 29 1 3 24 31 4 49 18 13 7 26 45 54 15 14 38  
      50 28 55 44

87 Grade 7 - Class 2 |   11 33 54 51 50 2 28 17 43 13 1 38 30  
      32 44 16 24 14 3 48 7 8 47 29 37 52 22 19 31 46 55 35  
      49 45 42 25 27 41 18 10 21 20 4 40 15 36 34 26 6 23 9  
      39 53 12 5

88 Grade 8 - Class 1 |   15 43 18 47 54 37 40 52 12 28 51 50 36  
      35 41 21 6 31 22 48 8 11 25 19 45 42 17 16 39 29 14 55  
      26 2 46 24 1 13 4 7 23 33 27 10 49 44 3 38 34 20 9  
      53 32 30 5

89 Grade 8 - Class 2 |   21 51 26 34 37 9 14 33 23 47 45 38 8  
      55 52 43 41 44 16 19 18 29 3 28 11 36 50 27 53 24 1 22  
      31 13 2 10 32 30 15 17 39 20 5 35 7 42 48 49 6 4 54  
      40 12 46 25

90 Grade 9 - Class 1 |   5 41 27 2 13 43 9 7 32 28 10 19 37  
      53 11 40 18 54 47 50 4 39 3 25 6 46 35 17 14 15 31 30  
      26 29 21 12 36 45 22 55 23 1 52 48 42 38 24 20 49 16 33  
      51 44 34 8

91 Grade 9 - Class 2 |   13 5 52 38 7 23 15 48 54 4 32 11 45  
      12 27 46 25 41 2 31 34 51 36 17 14 8 44 49 50 22 21 20  
      30 35 53 10 9 18 40 3 16 29 43 39 19 24 6 33 37 28 55  
      26 1 42 47

92 -----  
 -----  
 -----

93

94

95 Teacher-Timeslot Allocations:

96

97 Teacher 1 |   6 10 11 19 20 21 22 29 30 34 35 37 38 40 41  
      43 45 49 51 55

98 Teacher 2 |   6 13 17 21 23 31 34 35 36 37 39 40 43 44 45  
      47 49 50 51 55

99 Teacher 3 |   1 2 4 5 7 8 10 11 19 21 23 25 26 36 37  
      40 42 47 53 55

100 Teacher 4 |   1 1 4 5 8 10 12 13 15 16 17 18 25 27 31  
      32 32 39 43 44 45 46 47 49 50 51 52 54

101 Teacher 5 |   1 3 4 5 6 7 9 12 13 14 19 21 22 25 26  
      27 28 29 31 34 38 39 40 41 44 48 49 53

102 Teacher 6 |   1 4 5 7 12 13 14 15 17 21 22 23 24 25 27  
      28 29 30 34 36 37 38 41 44 46 49 50 54

103 Teacher 7 |   3 6 9 11 12 15 17 19 21 22 23 27 28 28 30  
      34 36 37 39 41 42 46 47 48 50 55

104 Teacher 8 |   1 3 4 9 10 11 16 18 19 20 23 24 25 28 30  
      32 33 35 36 41 42 43 46 50 54 55

105 Teacher 9 |   3 6 12 13 15 16 17 19 24 26 27 30 31 32 33  
      35 38 39 41 45 46 47 48 52 53 55

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106 Teacher 10 | 2 7 7 8 9 13 14 16 24 24 25 26 29 33 35
    36 38 40 44 53
107 Teacher 11 | 2 7 8 10 15 16 17 18 22 24 26 30 33 37 38
    42 46 52 53 54
108 Teacher 12 | 2 6 9 10 11 16 18 20 31 32 33 34 39 42 43
    45 48 50 51 54
109 Teacher 13 | 2 3 4 5 14 18 20 23 26 31 33 42 48 52 53
    54
110 Teacher 14 | 2 5 8 11 12 14 15 20 27 29 32 45 47 48 51
    52
111 Teacher 15 | 3 8 9 14 18 20 22 28 29 35 40 43 44 49 51
    52
112 -----
113
114
115 =====
116
117 =====
118
119
120 INPUT 2
121 -----
122 Number of classes in Grade 7: 4
123 Number of classes in Grade 8: 4
124 Number of classes in Grade 9: 4
125
126 Number of teachers teaching in Grades 7-9: 22
127
128
129 Teacher Class-Subject Allocation Table:
130
131 Subjects -> 1 2 3 4 5 6 7 8 9
132 Classes:
133 -----
134 Grade 7 - Class 1 | 1 5 9 15 5 15 9 19 19
135 Grade 7 - Class 2 | 1 5 9 15 5 15 9 19 19
136 Grade 7 - Class 3 | 1 5 10 15 5 15 9 19 19
137 Grade 7 - Class 4 | 2 6 10 16 6 16 10 19 19
138 Grade 8 - Class 1 | 2 6 11 16 6 16 10 20 20
139 Grade 8 - Class 2 | 2 6 11 16 6 16 10 20 20
140 Grade 8 - Class 3 | 3 7 12 17 7 17 11 20 20
141 Grade 8 - Class 4 | 3 7 12 17 7 17 11 20 20
142 Grade 9 - Class 1 | 3 7 13 17 7 17 11 21 21
143 Grade 9 - Class 2 | 4 8 13 18 8 18 12 21 22
144 Grade 9 - Class 3 | 4 5 14 18 8 18 12 21 22
145 Grade 9 - Class 4 | 4 8 14 18 8 18 12 21 22
146 -----
147
148 =====
149
150 Solving INPUT 2 using the GeneticAlgorithm:
151
152 Initialising Population (20 individuals):
153
154 Time taken to initialise population: 0.14899492263793945 seconds
155 Finding optimal solution...
156 Generation: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16,
    17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35,
    36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54,
    55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73,
```

156 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92,  
 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109  
 , 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124  
 , 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136,

157

158 Time taken to solve: 150.32074356079102 seconds

159

160 Optimal solution found in Generation 36 with a fitness of 14570

161

162

163 SOLUTION:

164 Class-Lesson Timeslot Allocation Table:

165

166 Lessons ->

	1	2	3	4	5	6	7	8	9	10	11	12	13
14 15 16 17 18 19	20	21	22	23	24	25	26	27	28	29	30	31	32
33 34 35 36 37 38	39	40	41	42	43	44	45	46	47	48	49	50	51
52 53 54 55													

167 Classes:

168 -----

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-----

-----

169 Grade 7 - Class 1 | 24 12 44 45 13 50 16 18 55 52 1 41 46  
 8 20 15 6 49 38 36 11 43 47 32 17 22 28 19 21 48 54 27  
 5 30 14 34 23 51 3 29 40 39 42 25 53 9 10 31 4 7 37  
 26 33 2 35

170 Grade 7 - Class 2 | 26 4 28 10 38 25 11 17 21 9 22 32 48  
 53 18 39 7 44 35 13 51 27 52 42 55 5 34 45 33 23 12 46  
 8 36 49 40 19 24 31 15 41 47 1 37 2 50 6 14 29 20 54  
 3 30 43 16

171 Grade 7 - Class 3 | 7 22 39 41 49 6 44 23 31 1 35 25 55  
 11 12 43 26 33 53 2 15 34 48 18 16 14 24 27 37 38 10 21  
 4 30 5 9 28 54 47 13 52 50 51 20 3 19 29 32 36 8 17  
 46 45 42 40

172 Grade 7 - Class 4 | 46 42 14 15 33 35 30 8 31 22 12 2 49  
 16 27 39 4 55 24 54 40 17 43 3 37 36 20 10 26 21 53 51  
 11 25 7 45 6 1 50 23 32 44 34 38 29 41 13 28 52 47 19  
 5 48 9 18

173 Grade 8 - Class 1 | 2 49 12 41 5 45 16 54 6 7 39 4 9  
 36 13 15 19 17 42 53 18 8 34 11 52 46 25 29 32 47 1 37  
 30 48 27 26 40 38 24 21 35 33 22 44 28 51 3 31 20 10 50  
 43 55 14 23

174 Grade 8 - Class 2 | 10 33 42 44 43 1 37 36 38 9 29 51 3  
 30 5 32 46 34 4 25 16 28 23 40 47 45 17 2 24 27 13 49  
 55 31 14 11 7 52 22 18 54 41 15 35 26 20 50 12 53 21 48  
 19 39 8 6

175 Grade 8 - Class 3 | 16 31 18 25 8 6 12 44 32 37 20 23 1  
 36 48 39 5 26 3 11 51 33 47 14 38 13 34 2 49 7 42 24  
 4 27 46 28 53 19 17 52 10 43 50 21 9 15 55 54 35 45 22  
 40 29 30 41

176 Grade 8 - Class 4 | 20 52 49 23 41 35 47 19 42 33 27 21 32  
 13 8 6 40 24 28 15 50 31 39 12 26 46 44 7 29 16 53 55  
 48 43 14 11 54 37 9 5 3 18 45 25 22 30 10 51 36 17 2  
 34 1 38 4

177 Grade 9 - Class 1 | 2 24 11 43 53 48 17 21 30 6 33 4 55  
 13 7 42 25 27 50 10 12 54 19 18 14 52 20 32 39 28 16 46  
 5 49 37 1 34 47 41 44 29 9 38 31 15 35 36 8 40 23 45  
 51 3 26 22

178 Grade 9 - Class 2 | 40 43 50 8 23 25 47 35 33 15 2 1 46  
 3 28 51 22 17 5 4 14 42 41 11 53 30 13 21 20 32 45 6

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```
178 55 37 48 44 34 54 31 7 52 19 26 24 16 10 18 9 49 27 36
    39 38 12 29
179 Grade 9 - Class 3 | 26 27 3 38 17 6 46 54 31 21 52 20 44
    51 4 13 39 7 30 9 55 14 29 8 42 41 23 32 53 15 2 34
    49 16 50 45 43 33 36 37 40 18 25 48 1 22 19 11 12 35 47
    28 5 10 24
180 Grade 9 - Class 4 | 34 48 9 45 44 16 19 5 4 28 40 8 52
    32 15 23 47 6 35 7 41 17 26 54 3 11 31 25 30 29 42 46
    36 1 55 10 13 27 12 33 38 24 43 2 51 37 49 53 14 21 39
    18 50 22 20
181 -----
    -----
    -----
    -----
182
183
184 Solution Value (Fitness): 14570
185 -----
186
187
188 Master Timetable (Class-Timeslot Lesson Allocations):
189
190 Timeslots ->      1  2  3  4  5  6  7  8  9  10 11 12 13
    14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32
    33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51
    52 53 54 55
191 Classes:
192 -----
    -----
    -----
    -----
193 Grade 7 - Class 1 | 11 54 39 49 33 17 50 14 46 47 21 2 5
    35 16 7 25 8 28 15 29 26 37 1 44 52 32 27 40 34 48 24
    53 36 55 20 51 19 42 41 12 43 22 3 4 13 23 30 18 6 38
    10 45 31 9
194 Grade 7 - Class 2 | 43 45 52 2 26 47 17 33 10 4 7 31 20
    48 40 55 8 15 37 50 9 11 30 38 6 1 22 3 49 53 39 12
    29 27 19 34 44 5 16 36 41 24 54 18 28 32 42 13 35 46 21
    23 14 51 25
195 Grade 7 - Class 3 | 10 20 45 33 35 6 1 50 36 31 14 15 40
    26 21 25 51 24 46 44 32 2 8 27 12 17 28 37 47 34 9 48
    18 22 11 49 29 30 3 55 4 54 16 7 53 52 39 23 5 42 43
    41 19 38 13
196 Grade 7 - Class 4 | 38 12 24 17 52 37 35 8 54 28 33 11 47
    3 4 14 22 55 51 27 30 10 40 19 34 29 15 48 45 7 9 41
    5 43 6 26 25 44 16 21 46 2 23 42 36 1 50 53 13 39 32
    49 31 20 18
197 Grade 8 - Class 1 | 31 1 47 12 5 9 10 22 13 50 24 3 15
    54 16 7 18 21 17 49 40 43 55 39 27 36 35 45 28 33 48 29
    42 23 41 14 32 38 11 37 4 19 52 44 6 26 30 34 2 51 46
    25 20 8 53
198 Grade 8 - Class 2 | 6 28 13 19 15 55 37 54 10 1 36 48 31
    35 43 21 27 40 52 46 50 39 23 29 20 45 30 22 11 14 34 16
    2 18 44 8 7 9 53 24 42 3 5 4 26 17 25 51 32 47 12
    38 49 41 33
199 Grade 8 - Class 3 | 13 28 19 33 17 6 30 5 45 41 20 7 26
    24 46 1 39 3 38 11 44 51 12 32 4 18 34 36 53 54 2 9
    22 27 49 14 10 25 16 52 55 31 42 8 50 35 23 15 29 43 21
    40 37 48 47
200 Grade 8 - Class 4 | 53 51 41 55 40 16 28 15 39 47 36 24 14
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200	35	20	30	50	42	8	1	12	45	4	18	44	25	11	19	29	46	22	13
	10	52	6	49	38	54	23	17	5	9	34	27	43	26	7	33	3	21	48
	2	31	37	32															
201	Grade 9 - Class 1						36	1	53	12	33	10	15	48	42	20	3	21	14
	25	45	31	7	24	23	27	8	55	50	2	17	54	18	30	41	9	44	28
	11	37	46	47	35	43	29	49	39	16	4	40	51	32	38	6	34	19	52
	26	5	22	13															
202	Grade 9 - Class 2						12	11	14	20	19	32	40	4	48	46	24	54	27
	21	10	45	18	47	42	29	28	17	5	44	6	43	50	15	55	26	39	30
	9	37	8	51	34	53	52	1	23	22	2	36	31	13	7	35	49	3	16
	41	25	38	33															
203	Grade 9 - Class 3						45	31	3	15	53	6	18	24	20	54	48	49	16
	22	30	34	5	42	47	12	10	46	27	55	43	1	2	52	23	19	9	28
	38	32	50	39	40	4	17	41	26	25	37	13	36	7	51	44	33	35	14
	11	29	8	21															
204	Grade 9 - Class 4						34	44	25	9	8	18	20	12	3	36	26	39	37
	49	15	6	22	52	7	55	50	54	16	42	28	23	38	10	30	29	27	14
	40	1	19	33	46	41	51	11	21	31	43	5	4	32	17	2	47	53	45
	13	48	24	35															

205 -----  
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206

207

208 Teacher-Timeslot Allocations:

209

210	Teacher 1		1	4	6	7	9	10	11	12	13	16	17	18	21	22	23
	24	25	26	28	31	38	39	41	44	44	45	49	50	52	55		
211	Teacher 2		1	2	5	6	7	8	9	10	12	14	15	16	22	30	31
	33	33	35	36	37	38	41	42	42	43	44	45	46	49	54		
212	Teacher 3		2	6	6	8	11	12	16	17	18	19	20	21	23	24	25
	30	31	32	33	35	37	41	42	43	44	47	48	49	52	53		
213	Teacher 4		3	4	5	6	8	9	15	16	17	19	21	23	25	26	27
	28	31	33	34	35	38	40	43	44	45	46	47	48	50	54		
214	Teacher 5		1	3	4	5	6	7	7	8	9	11	12	13	14	15	18
	19	20	20	22	23	24	25	26	28	30	30	31	32	33	34	35	36
	40	41	43	44	44	46	47	48	49	49	51	51	52	53	54	55	
215	Teacher 6		1	2	3	4	4	5	6	7	7	9	11	12	13	14	15
	16	17	19	22	24	25	26	27	27	29	30	31	32	34	36	38	39
	45	46	48	49	50	51	52	55									
216	Teacher 7		1	1	4	5	6	7	8	9	11	13	13	14	17	19	20
	21	23	24	25	26	27	27	27	28	32	33	34	36	37	37	39	40
	43	46	47	48	49	53	54	55									
217	Teacher 8		1	1	2	3	6	8	10	12	13	15	16	17	22	23	27
	28	31	32	33	34	36	37	40	43	44	45	46	47	48	50	51	52
218	Teacher 9		2	3	5	6	9	10	11	13	17	19	20	22	25	27	28
	29	32	34	35	36	37	38	42	43	47	50	51	52	53	55		
219	Teacher 10		2	3	3	13	14	15	16	17	18	20	20	24	24	26	28
	29	34	35	36	37	38	40	41	43	44	48	50	51	53	54		
220	Teacher 11		4	8	9	10	11	15	15	16	17	18	21	22	23	25	25
	25	28	30	31	34	35	36	40	42	45	46	47	52	53	55		
221	Teacher 12		1	2	3	10	11	12	13	14	15	16	18	19	22	24	26
	28	31	33	34	37	38	39	44	46	47	48	49	50	51	51		
222	Teacher 13		4	5	10	11	12	13	14	14	18	19	20	30	41	42	50
	52	53	54														
223	Teacher 14		3	7	8	9	11	14	17	23	26	29	30	31	35	41	41
	42	54	55														
224	Teacher 15		1	4	5	8	10	12	13	15	19	21	21	23	27	27	29
	33	37	38	39	40	41	42	45	46	47	48	50	51	52	54		

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225 Teacher 16 | 1 2 10 11 13 15 18 21 21 22 23 24 26 27 29
    30 32 32 33 34 35 37 41 44 47 49 51 53 54 55
226 Teacher 17 | 2 3 4 5 5 7 7 9 10 16 16 18 24 28 29
    29 32 38 39 42 43 44 45 46 48 49 50 52 53 55
227 Teacher 18 | 2 6 7 15 18 19 20 21 24 25 25 26 29 30 32
    32 33 34 36 37 38 40 42 43 45 46 49 52 53 55
228 Teacher 19 | 2 3 4 5 7 8 9 14 16 17 18 19 20 26 28
    29 30 31 32 33 35 36 37 40 42 43 45 46 47 48 52 54
229 Teacher 20 | 1 2 4 6 8 10 12 14 17 19 20 21 22 23 29
    30 31 34 35 36 38 39 40 41 43 45 48 50 51 53 54 55
230 Teacher 21 | 3 8 9 11 12 14 21 22 23 26 27 35 36 39 40
    45 47 49 51 53
231 Teacher 22 | 5 10 12 18 20 22 24 28 29 38 39 50
232 -----
233
234
235 =====
236
237 =====
238
239
240 INPUT 3
241 -----
242 Number of classes in Grade 7: 3
243 Number of classes in Grade 8: 3
244 Number of classes in Grade 9: 6
245
246 Number of teachers teaching in Grades 7-9: 16
247
248
249 Teacher Class-Subject Allocation Table:
250
251 Subjects -> 1 2 3 4 5 6 7 8 9
252 Classes:
253 -----
254 Grade 7 - Class 1 | 1 5 9 12 5 12 9 15 15
255 Grade 7 - Class 2 | 1 5 9 12 5 12 9 15 15
256 Grade 7 - Class 3 | 1 5 9 12 5 12 9 15 15
257 Grade 8 - Class 1 | 2 6 9 12 6 12 9 15 15
258 Grade 8 - Class 2 | 2 6 10 13 6 13 10 15 15
259 Grade 8 - Class 3 | 2 6 10 13 6 13 10 15 15
260 Grade 9 - Class 1 | 3 7 10 13 7 13 10 16 16
261 Grade 9 - Class 2 | 3 7 10 13 7 13 10 16 16
262 Grade 9 - Class 3 | 3 7 11 14 7 14 11 16 16
263 Grade 9 - Class 4 | 4 8 11 14 8 14 11 16 16
264 Grade 9 - Class 5 | 4 8 11 14 8 14 11 16 16
265 Grade 9 - Class 6 | 4 8 11 14 8 14 11 16 16
266 -----
267
268 =====
269
270 Solving INPUT 3 using the GeneticAlgorithm:
271
272 Initialising Population (20 individuals):
273
274 Time taken to initialise population: 0.12601923942565918 seconds
275 Finding optimal solution...
276 Generation: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16,
    17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35,
    36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54,
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276 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73,  
74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92,  
93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105,

277

278 Time taken to solve: 100.31381368637085 seconds

279

280 Optimal solution found in Generation 5 with a fitness of 9765

281

282

283 SOLUTION:

284 Class-Lesson Timeslot Allocation Table:

285

286 Lessons ->

	1	2	3	4	5	6	7	8	9	10	11	12	13
14 15 16 17 18 19	20	21	22	23	24	25	26	27	28	29	30	31	32
33 34 35 36 37 38	39	40	41	42	43	44	45	46	47	48	49	50	51
52 53 54 55													

287 Classes:

288 -----  
-----  
-----

289 Grade 7 - Class 1 | 19 49 44 42 9 1 2 37 50 16 34 54 52  
30 11 7 13 4 12 15 51 40 25 28 17 43 45 29 38 26 5 55  
33 46 32 53 27 10 41 24 48 31 3 6 36 21 20 18 35 22 47  
23 8 39 14

290 Grade 7 - Class 2 | 39 47 28 15 51 25 17 27 4 10 12 23 14  
42 8 20 35 33 45 18 24 37 48 31 26 54 11 36 53 38 7 22  
41 3 44 40 29 21 5 13 49 6 16 2 46 30 1 34 55 32 52  
9 19 50 43

291 Grade 7 - Class 3 | 55 30 35 24 32 13 21 38 53 40 36 1 45  
15 9 39 37 19 41 42 4 29 34 5 23 3 8 44 11 46 26 17  
43 12 47 2 48 22 50 14 18 20 52 27 10 16 33 49 25 28 51  
6 54 31 7

292 Grade 8 - Class 1 | 20 16 28 44 29 5 19 52 10 31 47 26 41  
18 8 24 14 33 13 43 15 46 22 36 35 27 37 32 4 25 45 11  
30 7 1 54 53 55 38 3 39 2 34 23 49 6 51 50 21 9 40  
48 42 17 12

293 Grade 8 - Class 2 | 1 14 23 34 46 38 36 54 53 41 5 52 43  
27 12 44 42 51 49 50 9 25 37 2 26 17 31 55 48 18 15 28  
4 29 16 30 32 21 20 22 47 39 19 40 35 45 13 6 7 10 8  
3 11 33 24

294 Grade 8 - Class 3 | 49 33 7 40 12 51 32 9 37 4 55 10 3  
35 22 31 48 46 42 2 20 41 14 24 38 5 8 13 52 53 43 21  
50 17 54 11 23 47 28 39 6 27 1 16 30 34 36 45 44 15 29  
25 26 19 18

295 Grade 9 - Class 1 | 2 51 22 26 41 40 54 25 31 5 32 46 42  
14 17 18 19 55 49 28 10 15 27 53 44 47 3 30 12 45 35 21  
48 6 7 24 34 1 9 4 43 16 38 39 20 11 29 13 23 52 50  
37 36 33 8

296 Grade 9 - Class 2 | 24 7 27 35 16 8 38 9 15 12 51 17 22  
28 33 41 25 39 1 52 36 54 23 45 50 21 30 47 10 19 13 14  
32 4 44 31 3 43 2 26 49 11 18 6 46 42 37 20 5 34 48  
29 53 55 40

297 Grade 9 - Class 3 | 33 34 21 1 55 17 32 14 29 42 5 40 27  
30 15 36 35 53 18 51 9 11 12 28 10 26 16 41 47 48 25 49  
52 8 20 37 23 50 45 44 6 54 3 2 13 7 46 39 19 4 24  
43 22 38 31

298 Grade 9 - Class 4 | 48 12 46 9 29 37 30 20 52 3 13 6 8  
53 21 49 14 4 34 1 15 31 17 35 27 50 55 2 33 10 16 40  
22 5 24 18 45 44 36 23 39 38 42 43 19 47 32 51 41 7 11

File - Main

```
298 28 54 25 26
299 Grade 9 - Class 5 | 8 41 13 28 7 19 36 6 44 31 20 38 55
    26 34 47 9 54 17 16 23 52 24 25 3 4 22 10 48 46 43 1
    27 18 11 39 35 51 29 12 50 53 37 33 40 21 5 42 45 15 49
    30 32 2 14
300 Grade 9 - Class 6 | 39 23 24 54 50 11 42 22 55 32 33 43 34
    18 31 19 41 7 4 14 47 20 49 44 38 37 53 13 2 36 45 51
    5 40 15 52 1 25 17 27 28 30 26 8 48 46 29 12 35 6 9
    16 10 21 3
```

```
301 -----
    -----
    -----
    -----
```

302

303

304 Solution Value (Fitness): 9765

```
305 -----
```

306

307

308 Master Timetable (Class-Timeslot Lesson Allocations):

309

```
310 Timeslots ->      1  2  3  4  5  6  7  8  9 10 11 12 13
    14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32
    33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51
    52 53 54 55
```

311 Classes:

```
312 -----
    -----
    -----
    -----
```

```
313 Grade 7 - Class 1 | 6 7 43 18 31 44 16 53 5 38 15 19 17
    55 20 10 25 48 1 47 46 50 52 40 23 30 37 24 28 14 42 35
    33 11 49 45 8 29 54 22 39 4 26 3 27 34 51 41 2 9 21
    13 36 12 32
```

```
314 Grade 7 - Class 2 | 47 44 34 9 39 42 31 15 52 10 27 11 40
    13 4 43 7 20 53 16 38 32 12 21 6 25 8 3 37 46 24 50
    18 48 17 28 22 30 1 36 33 14 55 35 19 45 2 23 41 54 5
    51 29 26 49
```

```
315 Grade 7 - Class 3 | 12 36 26 21 24 52 55 27 15 45 29 34 6
    40 14 46 32 41 18 42 7 38 25 4 49 31 44 50 22 2 54 5
    47 23 3 11 17 8 16 10 19 20 33 28 13 30 35 37 48 39 51
    43 9 53 1
```

```
316 Grade 8 - Class 1 | 35 42 40 29 6 46 34 15 50 9 32 55 19
    17 21 2 54 14 7 1 49 23 44 16 30 12 26 3 5 33 10 28
    18 43 25 24 27 39 41 51 13 53 20 4 31 22 11 52 45 48 47
    8 37 36 38
```

```
317 Grade 8 - Class 2 | 1 24 52 33 11 48 49 51 21 50 53 15 47
    2 31 35 26 30 43 39 38 40 3 55 22 25 14 32 34 36 27 37
    54 4 45 7 23 6 42 44 10 17 13 16 46 5 41 29 19 20 18
    12 9 8 28
```

```
318 Grade 8 - Class 3 | 43 20 13 10 26 41 3 27 8 12 36 5 28
    23 50 44 34 55 54 21 32 15 37 24 52 53 42 39 51 45 16 7
    2 46 14 47 9 25 40 4 22 19 31 49 48 18 38 17 1 33 6
    29 30 35 11
```

```
319 Grade 9 - Class 1 | 38 1 27 40 10 34 35 55 39 21 46 29 48
    14 22 42 15 16 17 45 32 3 49 36 8 4 23 20 47 28 9 11
    54 37 31 53 52 43 44 6 5 13 41 25 30 12 26 33 19 51 2
    50 24 7 18
```

```
320 Grade 9 - Class 2 | 19 39 37 34 49 44 2 6 8 29 42 10 31
    32 9 5 12 43 30 48 26 13 23 1 17 40 3 14 52 27 36 33
```

File - Main

```
320 15 50 4 21 47 7 18 55 16 46 38 35 24 45 28 51 41 25 11
    20 53 22 54
321 Grade 9 - Class 3 | 4 44 43 50 11 41 46 34 21 25 22 23 45
    8 15 27 6 19 49 35 3 53 37 51 31 26 13 24 9 14 55 7
    1 2 17 16 36 54 48 12 28 10 52 40 39 47 29 30 32 38 20
    33 18 42 5
322 Grade 9 - Class 4 | 20 28 10 18 34 12 50 13 4 30 51 2 11
    17 21 31 23 36 45 8 15 33 40 35 54 55 25 52 5 7 22 47
    29 19 24 39 6 42 41 32 49 43 44 38 37 3 46 1 16 26 48
    9 14 53 27
323 Grade 9 - Class 5 | 32 54 25 26 47 8 5 1 17 28 35 40 3
    55 50 20 19 34 6 11 46 27 21 23 24 14 33 4 39 52 10 53
    44 15 37 7 43 12 36 45 2 48 31 9 49 30 16 29 51 41 38
    22 42 18 13
324 Grade 9 - Class 6 | 37 29 55 19 33 50 18 44 51 53 6 48 28
    20 35 52 39 14 16 22 54 8 2 3 38 43 40 41 47 42 15 10
    11 13 49 30 26 25 1 34 17 7 12 24 31 46 21 45 23 5 32
    36 27 4 9
```

```
325 -----
-----
-----
-----
```

326

327

328 Teacher-Timeslot Allocations:

329

```
330 Teacher 1 | 1 2 4 9 10 13 15 16 17 19 21 24 25 27 28
    30 32 35 37 38 39 40 42 44 47 49 50 51 53 55
331 Teacher 2 | 1 4 5 7 9 10 12 14 16 19 20 23 28 29 31
    32 33 34 36 37 38 40 41 44 46 49 51 52 53 54
332 Teacher 3 | 1 2 5 7 8 9 12 14 15 16 17 21 22 24 25
    26 27 29 31 32 33 34 35 38 40 41 42 51 54 55
333 Teacher 4 | 3 6 7 8 9 11 12 13 19 20 22 23 24 28 29
    30 31 32 36 37 39 41 42 44 46 48 50 52 54 55
334 Teacher 5 | 1 2 3 4 5 7 8 9 10 11 12 12 13 14 15
    19 20 21 22 23 27 29 30 32 33 34 35 36 37 39 40 41 42 44
    45 46 47 48 50 52 53 54
335 Teacher 6 | 1 3 5 7 8 10 11 12 14 16 17 18 20 21 22
    23 24 26 27 28 29 30 31 32 33 35 38 41 42 43 44 46 47 47
    48 51 52 53 54 54 55 55
336 Teacher 7 | 1 2 3 4 5 6 7 8 9 14 15 17 17 18 19
    20 22 23 24 25 27 28 30 31 32 33 34 35 36 37 39 40 41 42
    43 44 45 46 50 51 53 55
337 Teacher 8 | 1 4 5 6 7 8 9 11 13 14 15 17 18 18 18
    19 20 21 24 25 26 29 31 33 34 34 35 36 38 39 40 41 43 44
    45 47 49 51 52 53 54 55
338 Teacher 9 | 1 2 3 4 5 6 6 8 10 11 12 13 15 15 16
    17 18 20 21 22 23 23 24 25 26 27 27 28 29 30 31 33 34 35
    36 36 37 37 40 41 42 43 43 45 45 46 46 48 49 51 51 54
339 Teacher 10 | 1 2 2 3 5 6 8 9 10 11 13 14 15 16 17
    20 20 21 23 24 25 26 27 28 29 30 30 31 34 35 36 36 37 37
    38 39 40 41 42 42 44 45 45 46 47 49 49 50 50 52 53 54
340 Teacher 11 | 1 2 3 4 4 5 7 8 9 10 11 12 13 14 15
    16 16 17 17 18 19 20 21 22 23 24 25 26 27 28 29 31 32 33
    34 35 37 38 40 43 44 46 46 47 47 48 49 50 51 52 53 55
341 Teacher 12 | 2 3 3 4 5 6 7 11 11 13 14 16 17 18 20
    22 24 25 26 26 29 30 31 32 33 34 36 38 38 39 41 43 44 45
    46 48 49 52 53 55
342 Teacher 13 | 1 4 4 6 10 11 12 13 13 14 15 16 18 18 19
    19 21 21 22 26 27 28 30 32 35 38 39 39 43 43 45 47 47 48
```

File - Main

```
342 48 49 50 52 53 55
343 Teacher 14 | 1 2 2 3 5 6 10 10 12 13 16 22 23 25 26
    27 27 28 30 33 36 37 38 39 40 41 42 43 44 45 46 47 48 48
    49 50 51 52 53 54
344 Teacher 15 | 3 6 6 7 7 8 8 9 9 10 11 12 14 15 17
    18 18 19 19 21 22 23 24 25 25 26 28 29 31 32 33 34 35 39
    40 42 43 44 45 47 48 49 50 50 51 52 54 55
345 Teacher 16 | 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
    19 20 21 22 23 24 25 26 28 29 30 31 32 33 34 35 36 37 38
    39 40 41 42 43 45 48 49 50 51 52 53 54 55
346 -----
347
348
349 =====
350
351 =====
352
353
354
355 Process finished with exit code 0
356
```