EDA Lab 2

Simulated Annealing Approach to the Travelling Tournament Problem

Overview:

Travelling Tournament Problem is a well-known problem in sports timetabling that addresses the difficulty in creating a time-table when team travel is the main issue.
Simulated annealing is one of the approaches that use a double round-robin and annealing algorithm to get an optimized solution for this problem.
This algorithm consists of the following features:

1. TTSA separates the tournament constraints and the pattern constraints into hard and soft constraints and explores both feasible and infeasible schedules.
2. TTSA uses a large neighborhood of size O(n3), where n is the number of teams. Some of the moves defining the neighborhood are rather complex and affect the schedule in significant ways. Others can be regarded as a form of ejection chains.
3. TTSA includes a strategic oscillation strategy to balance the time spent in the feasible and infeasible regions.
4. TTSA incorporates the concept of “reheats” to escape from local minima with very low temperatures.

Functions

To start with, a backtrack search method is used to create an initial random schedule.
Hard Constraint: Should follow a double round-robin method.
Soft Constraint: 1. No more than three consecutive home/away games.
2. A game of Ti at Tj’s home cannot be followed by a game of Tj at Ti’s home.
There are five different functions performed on this schedule S. The neighborhood of a schedule S is the set of the (possibly infeasible) schedules which can be obtained by applying one of five types of moves.

1. SwapHomes: (Ti, Tj)
   This function swaps home/away roles of Ti and Tj in the schedule.

2. SwapRounds: (r1, r2)
   This function swaps round r1 and r2.
3. SwapTeams: (Ti, Tj):
   This function swaps two teams' schedules.
4. PartialSwapRounds:(r1,r2,t)
   This function swaps round r1 and r2 for team t.
5. PartialTeamSwap: (t1,t2,r)
   This function swaps values of team t1 and t2 for round r.

TTSA uses a reheating method to avoid the local minima of temperature.
The parameters defined to perform this method are maxP, maxC, maxR, temperature T, w, beta b

Outcome

1. Number of Teams = 4

Initial input parameters:
Number of Teams: 4
Number of Rounds: 6
maxP: 10
maxR: 10
maxC: 10
w :6000.0
Temperature: 400

Time Required: 29 ms
bestFeasible: 8559.0
bestInfeasible: Infinity
bestTemperature: 400

```
Initial input parameters:
Number of Teams: 4
Number of Rounds: 6
maxP: 10
maxR: 10
maxC: 10
w :6000.0
Temperature: 400

Initial Schedule:
Rounds   1    2    3    4    5    6
Teams
1        -4   -3   -2   4   3   2
2        3   -4   1   -3   4   -1
3        -2   1   4   2   -1   -4
4        1   2   -3   -1   -2   3

Cost of the schedule: 9736

Distance Matrix:
[0, 745, 665, 929]
[745, 0, 80, 337]
[665, 80, 0, 380]
[929, 337, 380, 0]

Rounds   1    2    3    4    5    6
Teams
1        4   -2   -3   2   3   -4
2        3   1   4   -1   -4   -3
3        -2   4   1   -4   -1   2
4        -1   -3   -2   3   2   1
Time Required: 29 ms
bestFeasible: 8559.0
bestInfeasible: Infinity
bestTemperature: 400
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Best feasible schedule
Rounds-> 1    2    3    4    5    6
Teams
1        3   -2   -4   -3   4   2
2        -4   1   3   4   -3   -1
3        -1   4   -2   1   2   -4
4        2   -3   1   -2   -1   3
The Cost for feasible is : 8559
++++++++++++++++++++++++++++++++++++++++++++
Best infeasible schedule
Rounds-> 1    2    3    4    5    6
Teams
1        2   -4   -2   4   -3   3
2        -1   -3   1   3   4   -4
3        -4   2   4   -2   1   -1
4        3   1   -3   -1   -2   2
The Cost for infeasible is : 15763
```

2. **Number of Teams: 6**

Initial input parameters:

Number of Teams: 6
Number of Rounds: 10
maxP: 10
maxR: 10
maxC: 10
w :6000.
Temperature: 400

Time Required: 40 ms
bestFeasible: 26964.0
bestInfeasible: 27486.0
bestTemperature: 396

```
Initial input parameters:
Number of Teams: 6
Number of Rounds: 10
maxP: 10
maxR: 10
maxC: 10
w :6000.0

Initial Schedule:
Rounds   1    2    3    4    5    6    7    8    9    10
Teams
1        -5   -4   -6   5   -3   2   4   -2   3   6
2        -3   -5   4   3   -6   -1   5   1   6   -4
3        2   6   -5   -2   1   -4   -6   4   -1   5
4        -6   1   -2   6   -5   3   -1   -3   5   2
5        1   2   3   -1   4   -6   -2   6   -4   -3
6        4   -3   1   -4   2   5   3   -5   -2   -1

Cost of the schedule: 28950

Distance Matrix:
[0, 745, 665, 929, 605, 521]
[745, 0, 80, 337, 1090, 315]
[665, 80, 0, 380, 1020, 257]
[929, 337, 380, 0, 1380, 408]
[605, 1090, 1020, 1380, 0, 1010]
[521, 315, 257, 408, 1010, 0]

Rounds   1    2    3    4    5    6    7    8    9    10
Teams
1        3   -5   -4   5   2   -6   -3   6   4   -2
2        -6   -4   3   4   -1   -5   6   5   -3   1
3        -1   -6   -2   6   5   -4   1   4   2   -5
4        -5   2   1   -2   -6   3   5   -3   -1   6
5        4   1   6   -1   -3   2   -4   -2   -6   3
6        2   3   -5   -3   4   1   -2   -1   5   -4
Time Required: 40 ms
26964.0 27486.0 396
++++++++++++++++++++++++++++++++++++++++++++
best feasible table
Rounds-> 1    2    3    4    5    6    7    8    9    10
Teams
1        2   -6   -5   6   4   -3   -2   3   5   -4
2        -1   -4   3   4   -5   6   1   -6   -3   5
3        -4   5   -2   -5   -6   1   4   -1   2   6
4        3   2   -6   -2   -1   5   -3   -5   6   1
5        6   -3   1   3   2   -4   -6   4   -1   -2
6        -5   1   4   -1   3   -2   5   2   -4   -3
The Cost for feasible is : 26964
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best infeasible table
Rounds-> 1    2    3    4    5    6    7    8    9    10
Teams
1        -4   -3   -6   6   2   3   4   -5   -2   5
2        3   -5   4   -4   -1   5   -3   6   1   -6
3        -2   1   5   -5   6   -1   2   4   -6   -4
4        1   6   -2   2   -5   -6   -1   -3   5   3
5        -6   2   -3   3   4   -2   6   1   -4   -1
6        5   -4   1   -1   -3   4   -5   -2   3   2
The Cost for infeasible is : 40206
```

3. Number of Teams: 10

Initial input parameters:
Number of Teams: 10
Number of Rounds: 18
maxP: 10
maxR: 10
maxC: 10
w :6000.0
Temperature: 400
Time Required: 331 ms
bestFeasible: 66932.0
bestInfeasible: 67098.25546619005
bestTemperature: 760

```
Initial input parameters:
Number of Teams: 10
Number of Rounds: 18
maxP: 10
maxR: 10
maxC: 10
w :6000.0
Temperature: 400

Initial Schedule:
Rounds   1    2    3    4    5    6    7    8    9    10    11    12    13    14    15    16    17    18
Teams
1        6   -9    3   10    7   -3   -5   -7  -10   -8   -2    8   -4    9    5    2   -6    4
2       -7    4    6    3   -8   -4    9    5   -9   -6    1   -5  -10    8   -3   -1    7   10
3       -4    8   -1   -2   -9    1  -10    9    7   -5   -7    4    5    6    2   -8   10   -6
4        3   -2   -5    6  -10    2    8   10   -6   -7   -9   -3    1    7   -8    5    9   -1
5        9    7    4   -7   -6  -10    1   -2   -8    3    6    2   -3   10   -1   -4    8   -9
6       -1   10   -2   -4    5   -8   -7    8    4    2   -5   -9    7   -3    9  -10    1    3
7        2   -5    8    5   -1    9    6    1   -3    4    3   10   -6   -4  -10   -9   -2   -8
8       -10   -3   -7   -9    2    6   -4   -6    5    1   10   -1    9   -2    4    3   -5    7
9       -5    1  -10    8    3   -7   -2   -3    2   10    4    6   -8   -1   -6    7   -4    5
10       8   -6    9   -1    4    5    3   -4    1   -9   -8   -7    2   -5    7    6   -3   -2

Cost of the schedule: 89101.41431734225

Distance Matrix:
[0, 745, 665, 929, 605, 521, 370, 587, 467, 670]
[745, 0, 80, 337, 1090, 315, 567, 712, 871, 741]
[665, 80, 0, 380, 1020, 257, 501, 664, 808, 697]
[929, 337, 380, 0, 1380, 408, 622, 646, 878, 732]
[605, 1090, 1020, 1380, 0, 1010, 957, 1190, 1060, 1270]
[521, 315, 257, 408, 1010, 0, 253, 410, 557, 451]
[370, 567, 501, 622, 957, 253, 0, 250, 311, 325]
[587, 712, 664, 646, 1190, 410, 250, 0, 260, 86]
[467, 871, 808, 878, 1060, 557, 311, 260, 0, 328]
[670, 741, 697, 732, 1270, 451, 325, 86, 328, 0]
```

```
Time Required: 331 ms
bestFeasible: 66932.0
bestInfeasible: 67098.25546619005
bestTemperature: 760
++++++++++++++++++++++++++++++++++++++++++++++
Best infeasible schedule
Rounds-> 1    2    3    4    5    6    7    8    9    10    11    12    13    14    15    16    17    18
Teams
1        9   -5   -2   3   -8   -7   6   4   2   -9   -10   5   10   8   -3   -4   -6   7
2        10   4   1   -6   -7   -4   7   -3   -1   -5   8   9   -8   3   -9   6   5   -10
3        4   8   -7   -1   -5   10   -9   2   7   -6   -4   6   9   -2   1   5   -10   -8
4        -3   -2   8   5   10   2   -10   -1   9   7   3   -7   -6   -5   6   1   -8   -9
5        7   1   -10   -4   3   6   8   -9   -8   2   9   -1   -7   4   10   -3   -2   -6
6        8   -10   -9   2   9   -5   -1   -8   10   3   -7   -3   4   7   -4   -2   1   5
7        -5   9   3   -8   2   1   -2   10   -3   -4   6   4   5   -6   8   -10   -9   -1
8        -6   -3   -4   7   1   -9   -5   6   5   -10   -2   10   2   -1   -7   9   4   3
9        -1   -7   6   -10   -6   8   3   5   -4   1   -5   -2   -3   10   2   -8   7   4
10        -2   6   5   9   -4   -3   4   -7   -6   8   1   -8   -1   -9   -5   7   3   2
The Cost for infeasible is : 67268.55571478521
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Best feasible schedule
Rounds-> 1    2    3    4    5    6    7    8    9    10    11    12    13    14    15    16    17    18
Teams
1        -3   9   -2   3   -8   -7   6   4   2   -9   -10   5   10   8   -5   -4   -6   7
2        -9   -10   1   -6   -7   4   7   -3   -1   -5   8   9   -8   3   -4   6   5   10
3        1   4   -7   -1   -5   10   -9   2   7   -6   -4   6   9   -2   8   5   -10   -8
4        6   -3   8   5   10   -2   -10   -1   9   7   3   -7   -6   -5   2   1   -8   -9
5        10   -7   -10   -4   3   6   8   -9   -8   2   9   -1   7   4   1   -3   -2   -6
6        -4   8   -9   2   9   -5   -1   -8   10   3   7   -3   4   -7   -10   -2   1   5
7        8   5   3   -8   2   1   -2   10   -3   -4   -6   4   -5   6   9   -10   -9   -1
8        -7   -6   -4   7   1   -9   -5   6   5   -10   -2   10   2   -1   -3   9   4   3
9        2   -1   6   -10   -6   8   3   5   -4   1   -5   -2   -3   10   -7   -8   7   4
10        -5   2   5   9   -4   -3   4   -7   -6   8   1   -8   -1   -9   6   7   3   -2
The Cost for feasible is : 66932.0
```

4. Number of Teams : 12

Initial input parameters:
Number of Teams: 12
Number of Rounds: 22
maxP: 10
maxR: 10
maxC: 10
w :6000.0
Temperature: 400

Time Required: 660 ms
bestFeasible: 133138.0
bestInfeasible: 130916.12777334794
bestTemperature: 1497

```
Time Required: 660 ms
bestFeasible: 133138.0
bestInfeasible: 130916.12777334794
bestTemperature: 1497
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Best infeasible schedule
Rounds-> 1    2    3    4    5    6    7    8    9    10    11    12    13    14    15    16    17    18    19    20    21    22
Teams
1        -6   2   11   4   -7   -4   3   -5   8   6   -3   -9   -12   9   -11   7   10   -8   12   -10   -2   5
2        -4   -1   8   6   5   -10   7   9   11   -7   -11   3   -9   -12   -8   12   -5   4   -3   -6   1   10
3        9   -8   -10   8   12   5   -1   7   -12   -5   1   -2   4   11   -6   -9   -11   10   2   -7   -4   6
4        2   -11   -5   -1   6   1   11   -10   -9   -12   9   8   -3   -7   10   5   12   -2   -6   -8   3   7
5        -11   -12   4   12   -2   -3   -10   1   10   3   -8   -6   11   8   9   -4   2   6   7   -9   -7   -1
6        1   7   9   -2   -4   12   8   11   -7   -1   -12   5   -8   -10   3   -11   -9   -5   4   2   10   -3
7        -8   -6   -12   9   1   11   -2   -3   6   2   -10   -11   10   4   12   -1   8   -9   -5   3   5   -4
8        7   3   -2   -3   10   -9   -6   12   -1   9   5   -4   6   -5   2   -10   -7   1   -11   4   11   -12
9        -3   10   -6   -7   -11   8   -12   -2   4   -8   -4   1   2   -1   -5   3   6   7   -10   5   12   11
10        -12   -9   3   11   -8   2   5   4   -5   -11   7   12   -7   6   -4   8   -1   -3   9   1   -6   -2
11        5   4   -1   -10   9   -7   -4   -6   -2   10   2   7   -5   -3   1   6   3   -12   8   12   -8   -9
12        10   5   7   -5   -3   -6   9   -8   3   4   6   -10   1   2   -7   -2   -4   11   -1   -11   -9   8
The Cost for infeasible is : 131054.1262821146
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Best feasible schedule
Rounds-> 1    2    3    4    5    6    7    8    9    10    11    12    13    14    15    16    17    18    19    20    21    22
Teams
1        -7   -9   -12   11   4   5   -10   -8   2   3   7   -3   -2   10   -6   9   12   -11   6   8   -5   -4
2        4   -6   -10   -8   3   -9   7   10   -1   -5   6   -4   1   -12   8   -3   5   -7   -11   9   12   11
3        8   -10   -6   4   -2   10   5   7   -12   -1   -5   1   -7   -9   -11   2   -4   9   -8   6   11   12
4        -2   8   5   -3   -1   -11   9   12   -5   -6   -12   2   11   -7   -10   6   3   -8   -9   10   7   1
5        -9   -7   -4   6   10   -1   -3   -11   4   2   3   -8   -10   8   12   7   -2   -6   -12   11   1   9
6        -12   2   3   -5   -11   7   -8   -9   10   4   -2   -10   12   11   1   -4   9   5   -1   -3   8   -7
7        1   5   -8   10   12   -6   -2   -3   8   9   -1   -11   3   4   -9   -5   11   2   -10   -12   -4   6
8        -3   -4   7   2   -9   12   6   1   -7   -12   11   5   9   -5   -2   -11   10   4   3   -1   -6   -10
9        5   1   -11   -12   8   2   -4   6   11   -7   10   12   -8   3   7   -1   -6   -3   4   -2   -10   -5
10        -11   3   2   -7   -5   -3   1   -2   -6   11   -9   6   5   -1   4   12   -8   -12   7   -4   9   8
11        10   12   9   -1   6   4   -12   5   -9   -10   -8   7   -4   -6   3   8   -7   1   2   -5   -3   -2
12        6   -11   1   9   -7   -8   11   -4   3   8   4   -9   -6   2   -5   -10   -1   10   5   7   -2   -3
The Cost for feasible is : 133208.0
```

5. n= 14

Initial input parameters:
Number of Teams: 14
Number of Rounds: 26
maxP: 10
maxR: 10
maxC: 10
w :6000.0

Cost of the schedule: 149709

Time Required: 302 ms
bestFeasible: 252564.0
bestInfeasible: 30455.9466
Best Temperature : 798

```
Console output is saving to: /Users/sharvari/Documents/My Documents/EDA/log.txt
Initial input parameters:
Number of Teams: 14
Number of Rounds: 26
maxP: 10
maxR: 10
maxC: 10
w :9000.0
Temperature: 400

Initial Schedule:
Rounds   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
Teams
1        7   -4   -9    5   -7    4   -2    6   -8   13   -3    9   14  -13   -5   12    3    8  -11  -10  -12  -14   10   11    2   -6
2        8   -9    6   14    5   10    1   13   -3   -5    7   -6    4  -12    3   -7  -10   -4  -14   -8    9   11  -13   12   -1  -11
3       13   -8  -10    6   -9   -6  -14   -7    2   -4    1    4    5   10   -2   14   -1  -13  -12   -5   11   12  -11    7    8    9
4        6    1   14   -9  -10   -1    9   12    7    3    8   -3   -2    5   -7   -8  -11    2   13  -12  -14   10   -6   -5   11  -13
5        9   14  -13   -1   -2    8   -7  -14  -10    2    6  -11   -3   -4    1   -6    7   11   -9    3   -8   13   12    4   10  -12
6       -4    7   -2   -3   -8    3   13   -1  -11   -7   -5    2   10    8  -14    5   12    9  -10   11  -13   -9    4   14  -12    1
7       -1   -6   12   13    1   11    5    3   -4    6   -2  -13  -11   14    4    2   -5  -12   -8    9  -10    8   -9   -3  -14   10
8       -2    3  -11  -10    6   -5   12   10    1    9   -4  -12   -9   -6   11    4  -13   -1    7    2    5   -7  -14   13   -3   14
9       -5    2    1    4    3   13   -4   11   12   -8   14   -1    8  -11  -12  -10  -14   -6    5   -7   -2    6    7   10  -13   -3
10       11  -12    3    8    4   -2  -11   -8    5   12  -13   14   -6   -3   13    9    2  -14    6    1    7   -4   -1   -9   -5   -7
11      -10   13    8   12   14   -7   10   -9    6  -14  -12    5    7    9   -8  -13    4   -5    1   -6   -3   -2    3   -1   -4    2
12       14   10   -7  -11   13  -14   -8   -4   -9  -10   11    8  -13    2    9   -1   -6    7    3    4    1   -3   -5   -2    6    5
13       -3  -11    5   -7  -12   -9   -6   -2  -14   -1   10    7   12    1  -10   11    8    3   -4   14    6   -5    2   -8    9    4
14      -12   -5   -4   -2  -11   12    3    5   13   11   -9  -10   -1   -7    6   -3    9   10    2  -13    4    1    8   -6    7   -8

Cost of the schedule: 305217.8501460728
```

```
Distance Matrix:
[0, 745, 665, 929, 605, 521, 370, 587, 467, 670, 700, 1210, 2130, 1890]
[745, 0, 80, 337, 1090, 315, 567, 712, 871, 741, 1420, 1630, 2560, 2430]
[665, 80, 0, 380, 1020, 257, 501, 664, 808, 697, 1340, 1570, 2520, 2370]
[929, 337, 380, 0, 1380, 408, 622, 646, 878, 732, 1520, 1530, 2430, 2360]
[605, 1090, 1020, 1380, 0, 1010, 957, 1190, 1060, 1270, 966, 1720, 2590, 2270]
[521, 315, 257, 408, 1010, 0, 253, 410, 557, 451, 1140, 1320, 2260, 2110]
[370, 567, 501, 622, 957, 253, 0, 250, 311, 325, 897, 1090, 2040, 1870]
[587, 712, 664, 646, 1190, 410, 250, 0, 260, 86, 939, 916, 1850, 1730]
[467, 871, 808, 878, 1060, 557, 311, 260, 0, 328, 679, 794, 1740, 1560]
[670, 741, 697, 732, 1270, 451, 325, 86, 328, 0, 1005, 905, 1846, 1731]
[700, 1420, 1340, 1520, 966, 1140, 897, 939, 679, 1005, 0, 878, 1640, 1300]
[1210, 1630, 1570, 1530, 1720, 1320, 1090, 916, 794, 905, 878, 0, 947, 832]
[2130, 2560, 2520, 2430, 2590, 2260, 2040, 1850, 1740, 1846, 1640, 947, 0, 458]
[1890, 2430, 2370, 2360, 2270, 2110, 1870, 1730, 1560, 1731, 1300, 832, 458, 0]
```

```
Time Required: 3291 ms
bestFeasible: 264950.0
bestInfeasible: 263097.5943255448
bestTemperature: 384
++++++++++++++++++++++++++++++++++++++++++++++++
Best infeasible schedule
Rounds-> 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
Teams
1       8   -9   -8   -3   9   -4   -2   -10   13   14   4   -14   -11   3   6   10   -6   2   5   12   -5   -13   7   -12   -7   11
2       -7   3   -11   8   -12   -14   1   5   -9   12   6   -3   -6   -5   13   11   -4   -1   10   -8   -10   9   -13   7   14   4
3       -6   -2   -7   1   14   -10   11   8   10   -5   -9   2   -4   -1   -11   9   13   -14   6   -13   7   -12   -8   5   4   12
4       -11   -13   10   12   -5   1   6   -14   5   -7   -1   -10   3   -6   14   13   2   -9   -8   7   11   8   -12   9   -3   -2
5       -10   -12   -13   6   4   13   -9   -2   -4   3   -11   -7   -8   2   7   -14   9   12   -1   -6   1   14   10   -3   11   8
6       3   -14   12   -5   -11   7   -4   -13   14   10   -2   -12   2   4   -1   -8   1   11   -3   5   8   -7   9   13   -9   -10
7       2   -10   3   14   13   -6   12   11   -8   4   8   5   -13   9   -5   -12   -11   10   -9   -4   -3   6   -1   -2   1   -14
8       -1   -11   1   -2   10   11   -14   -3   7   -9   -7   9   5   -10   -12   6   12   -13   4   2   -6   -4   3   14   13   -5
9       -13   1   -14   11   -1   12   5   -12   2   8   3   -8   -10   -7   10   -3   -5   4   7   -11   14   -2   -6   -4   6   13
10       5   7   -4   13   -8   3   -13   1   -3   -6   -12   4   9   8   -9   -1   14   -7   -2   -14   2   11   -5   -11   12   6
11       4   8   2   -9   6   -8   -3   -7   12   13   5   -13   1   14   3   -2   7   -6   -12   9   -4   -10   -14   10   -5   -1
12       -14   5   -6   -4   2   -9   -7   9   -11   -2   10   6   14   -13   8   7   -8   -5   11   -1   13   3   4   1   -10   -3
13       9   4   5   -10   -7   -5   10   6   -1   -11   -14   11   7   12   -2   -4   -3   8   14   3   -12   1   2   -6   -8   -9
14       12   6   9   -7   -3   2   8   4   -6   -1   13   1   -12   -11   -4   5   -10   3   -13   10   -9   -5   11   -8   -2   7
The Cost for infeasible is : 263278.37258379103
++++++++++++++++++++++++++++++++++++++++++++++++
```

```
Best feasible schedule
Rounds-> 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
Teams
1       4   -9   -4   -3   9   -2   -6   -10   13   14   2   -14   -11   3   8   10   -8   6   5   -12   -5   -13   7   12   -7   11
2       -11   -13   10   12   -5   1   8   -14   5   -7   -1   -10   3   -8   14   13   -6   -9   -4   7   11   4   -12   9   -3   6
3       -8   -6   -7   1   14   -10   11   4   10   -5   -9   6   -2   -1   -11   9   13   -14   8   -13   7   12   -4   5   2   -12
4       -1   -11   1   -6   10   11   -14   -3   7   -9   -7   9   5   -10   12   -8   -12   -13   2   6   8   -2   3   14   13   -5
5       -10   -12   -13   8   2   13   -9   -6   -2   3   -11   -7   -4   6   7   -14   9   12   -1   -8   1   14   10   -3   11   4
6       -7   3   -11   4   -12   -14   1   5   -9   12   8   -3   -8   -5   13   11   2   -1   10   -4   -10   9   -13   7   14   -2
7       6   -10   3   14   13   -8   12   11   -4   2   4   5   -13   9   -5   -12   -11   10   -9   -2   -3   8   -1   -6   1   -14
8       3   -14   12   -5   -11   7   -2   -13   14   -10   -6   -12   6   2   -1   4   1   11   -3   5   -4   -7   9   13   -9   10
9       -13   1   -14   11   -1   12   5   -12   6   4   3   -4   -10   -7   10   -3   -5   2   7   -11   14   -6   -8   -2   8   13
10       5   7   -2   13   -4   3   -13   1   -3   8   -12   2   9   4   -9   -1   14   -7   -6   -14   6   11   -5   -11   12   -8
11       2   4   6   -9   8   -4   -3   -7   12   13   5   -13   1   14   3   -6   7   -8   -12   9   -2   -10   -14   10   -5   -1
12       14   5   -8   -2   6   -9   -7   9   -11   -6   10   8   -14   -13   -4   7   4   -5   11   1   13   -3   2   -1   -10   3
13       9   2   5   -10   -7   -5   10   8   -1   -11   -14   11   7   12   -6   -2   -3   4   14   3   -12   1   6   -8   -4   -9
14       -12   8   9   -7   -3   6   4   2   -8   -1   13   1   12   -11   -2   5   -10   3   -13   10   -9   -5   11   -4   -6   7
The Cost for feasible is : 264950.0
```

Problems Faced

1. With an increasing number of teams, my solution was taking forever to converge. So I modified my backtracking function and included soft constraints while creating the first random schedule.
2. Making the above modification sometimes gave me a best infeasible value of zero/infinity.
3. The new algorithm for creating the first schedule is not very optimized. So, it still takes more time to converge for values above 10.

Run-time and Quality of Results Trade-offs

1. By varying parameters, affects the algorithm converging time. Increasing the value of maxP, maxC, maxR and Temperature increases the time as per obtained observations.
2. For values (number of teams) greater than 10, increasing w and making beta parameters 0.998 helped the program to converge faster.
3. Following is the observation table of various outcomes taken by changing given parameters:

n	maxC	maxP	maxR	Best Feasible as per the CMU website	Initial Feasible	Final Feasible	Time(ms)
	10	10	10		9736	8559	29
	100	10	10		9107	5708	221
4	10	100	10	8276	10095	5708	97
	10	10	10		28950	26964	40
	100	10	10		29853	21663	540
6	10	100	10	22969	25522.559	22012	280
	10	10	10		89101	67268	331
10	100	10	10	56506	85623.369	66107	1777
	10	10	10		155404	133138	634
12	100	10	10	107483	167038.9325	132257	4651
14	10	10	10	182797	305217.8	264950	1885

					501		
	100	10	10		296233.1 108	257200	5989

The highlighted cells in the table show optimized feasible output for a given number of teams.

4. \The graph below shows the relation between number of teams and average time required to get the final schedule.