BIRZEIT UNIVERSITY

Faculty of Engineering & Technology

Computer Science Department

Artificial Intelligence (COMP-338)

Assignment-2 Report

"Seating Arrangement Optimization"

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Section: 1

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Introduction:

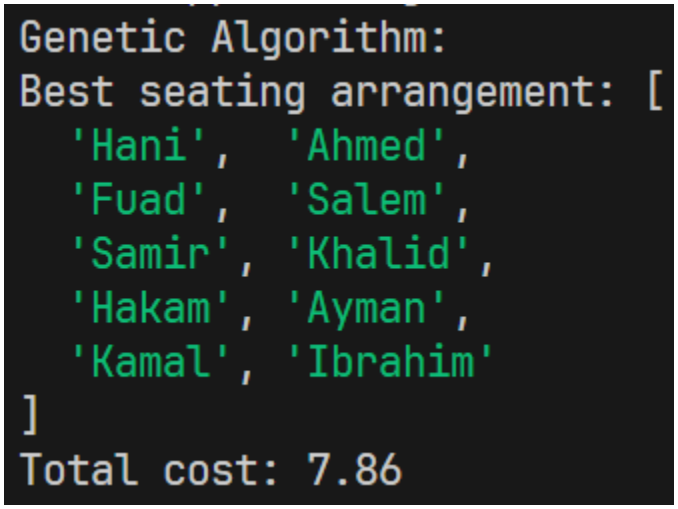
This report explores the optimization of a seating arrangement based on mutual dislikes using Genetic Algorithm, Simulated Annealing, and Hill Climbing. The task involves minimizing the total dislike cost from a 10x10 matrix.

The report compares the performance of the three algorithms in finding optimal seating arrangements.

1. Genetic Algorithm (GA):

A genetic algorithm is a **search technique** used in computing to find true (or approximate) **solutions to optimization and search problems** that otherwise would take a lifetime to solve. It is frequently used to solve optimization problems, in research, and in machine learning.

1.1 Results:



1) A random arrangement of 100 individuals is generated.
2) Find the cost of each individual and select the elite individuals (60%).
3) Apply crossover and mutation on random individuals from the elite to generate a new population.
4) Then we pick the individual with the minimum cost out of all the individuals.
5) As you can see in the figure this is the individual with the minimum cost.

Best seating arrangement:
['**Hani**','**Ahmed**','**Fuad**','**Salem**','**Samir**','**Khalid**','**Hakam**','**Ayman**','**Kamal**','**Ibrahim**']
Total cost: **7.86**

2. Simulated Annealing (UCS):

Simulated Annealing (SA) is an iterative improvement algorithm in which randomness is incorporated to expand the search space and avoid becoming trapped in a local minimum. It uses randomness using the probability function to move to another state: if the next state is better, then move to that state, otherwise try another move.

The Choice of picking the next step is getting better each time the temperature decreases on each iteration:

```
initialTemperature * Math.pow(coolingRate, t);
```

Where t is the iteration number.

2.1 Results:

```
Simulated Annealing:
Best seating arrangement: [
  'Khalid', 'Ibrahim',
  'Hani',   'Salem',
  'Samir',  'Kamal',
  'Fuad',   'Ahmed',
  'Hakam',  'Ayman'
]
Total cost: 7.66
```

1) Starts with a random arrangement and considers it as the best one found so far.
2) Cool down the temperature and pick a random neighbor
3) If the neighbor's cost is better than the current state then move to the neighbor

4) If the neighbor's cost is not better check the following:

```
Math.random() < Math.exp(deltaE / temperature)
```

Where deltaE is the difference between the current cost and the neighbor cost, and Math.random() is between [0,1]

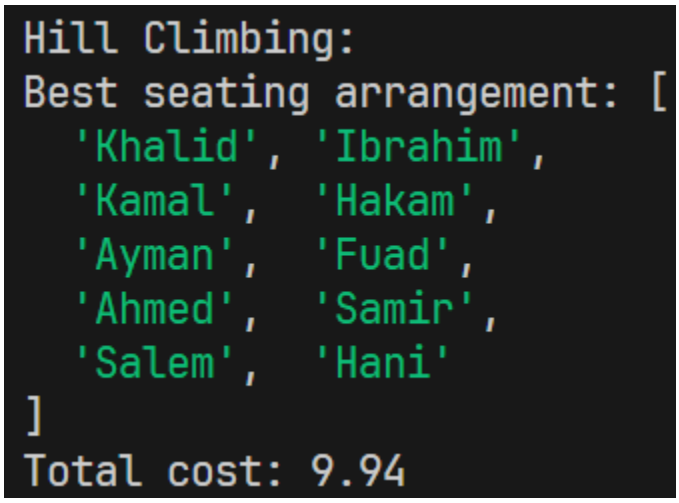
Best seating arrangement:
['**Khalid**','**Ibrahim**','**Hani**','**Salem**','**Samir**','**Kamal**','**Fuad**','**Ahmed**','**Hakam**','**Aymen**']
Total cost: **7.66**

3. Hill-Climbing Search:

Also called greedy local search. Looks only for immediate good neighbors and not beyond. Continually moves in the direction of increasing value (i.e., uphill) to find the top of the mountain. Terminates when it reaches a "peak", and no neighbor has a higher value

One of its issues that is not making it complete is getting stuck at local minima, and one way to avoid that is by using another variation of it which is Random-Restart Hill Climbing.

3.1 Results:



1) We make multiple restarts to avoid local minima
2) Start with random arrangement and check for the best out of its neighbors
3) Restart with another random arrangement to check if there's a better solution than the previous one.
4) And keep manage of the overall best cost and best arrangement

Best seating arrangement:
['**Khalid**','**Ibrahim**','**Kamal**','**Hakam**','**Ayman**','**Fuad**','**Ahmed**','**Samir**','**Salem**','**Hani**']
Total cost: **9.94**

4. Analysis:

4.1 Seating Arrangements:

The Simulated Annealing, Genetic Algorithm, and Hill Climbing all produce different seating arrangements.

4.2 Efficiency of Algorithms:

- The Genetic Algorithm has a total cost of 7.86
- The Simulated Annealing has a total cost of 7.66
- The Hill Climbing has a total cost of 9.94

5. Conclusion:

Overall, Simulated Annealing found the best solution with the lowest cost, showcasing its strength in escaping local minima and thoroughly exploring the solution space.