

Artificial Intelligence

Assignment No. 2

Report

The assignment is done to optimize the scheduling of exams for a university. In which we are using fitness class which is calculating fitness value of populations, the algorithm is used to minimize the fitness score and selects best fit solution.

Firstly, we are defining parameters such as Courses, Halls, Time Slots, size of population in mine case I am using size 20. Tournament size is defined and initialized by 5. Globally defined array of chromosomes and fitness values array.

In C_Fitness class, calculate_fitness function is calculating the fitness of the chromosome based on several constraints, such as the number of exams in each hall, the number of conflicts, and the time slots, same Time and Halls constraint, and same time. The algorithm is optimizing the fitness score by minimizing the conflicts.

In main, we are generating the population by randomly generating the chromosomes, and GA runs for the specific no. of generations. Fittest chromosomes are selected, performs crossover and mutation, and creates new population.

Our output of chromosomes is like this:

```
Schedules: [['C1', 'H1', 'T1'], ['C2', 'H2', 'T1'], ['C3', 'H2', 'T1'], ['C4', 'H2', 'T1'], ['C5', 'H2', 'T1']]
Schedules: [['C1', 'H2', 'T1'], ['C2', 'H1', 'T2'], ['C3', 'H1', 'T1'], ['C4', 'H1', 'T2'], ['C5', 'H1', 'T3']]
Schedules: [['C1', 'H2', 'T2'], ['C2', 'H1', 'T1'], ['C3', 'H1', 'T2'], ['C4', 'H2', 'T3'], ['C5', 'H2', 'T3']]
Schedules: [['C1', 'H1', 'T3'], ['C2', 'H2', 'T3'], ['C3', 'H1', 'T2'], ['C4', 'H1', 'T3'], ['C5', 'H1', 'T3']]
Schedules: [['C1', 'H1', 'T1'], ['C2', 'H1', 'T2'], ['C3', 'H1', 'T3'], ['C4', 'H1', 'T1'], ['C5', 'H1', 'T2']]
Schedules: [['C1', 'H1', 'T3'], ['C2', 'H2', 'T1'], ['C3', 'H2', 'T3'], ['C4', 'H1', 'T2'], ['C5', 'H1', 'T2']]
Schedules: [['C1', 'H2', 'T1'], ['C2', 'H2', 'T1'], ['C3', 'H2', 'T1'], ['C4', 'H1', 'T3'], ['C5', 'H1', 'T1']]
Schedules: [['C1', 'H1', 'T2'], ['C2', 'H1', 'T1'], ['C3', 'H2', 'T3'], ['C4', 'H2', 'T3'], ['C5', 'H2', 'T2']]
Schedules: [['C1', 'H1', 'T2'], ['C2', 'H2', 'T2'], ['C3', 'H1', 'T3'], ['C4', 'H1', 'T2'], ['C5', 'H1', 'T2']]
Schedules: [['C1', 'H2', 'T2'], ['C2', 'H1', 'T1'], ['C3', 'H1', 'T1'], ['C4', 'H1', 'T1'], ['C5', 'H1', 'T3']]
Schedules: [['C1', 'H2', 'T1'], ['C2', 'H1', 'T2'], ['C3', 'H2', 'T1'], ['C4', 'H2', 'T1'], ['C5', 'H1', 'T3']]
Schedules: [['C1', 'H1', 'T1'], ['C2', 'H1', 'T2'], ['C3', 'H2', 'T1'], ['C4', 'H1', 'T1'], ['C5', 'H1', 'T1']]
Schedules: [['C1', 'H1', 'T2'], ['C2', 'H2', 'T1'], ['C3', 'H1', 'T1'], ['C4', 'H1', 'T1'], ['C5', 'H2', 'T1']]
Schedules: [['C1', 'H1', 'T1'], ['C2', 'H2', 'T3'], ['C3', 'H2', 'T3'], ['C4', 'H1', 'T2'], ['C5', 'H2', 'T2']]
Schedules: [['C1', 'H2', 'T2'], ['C2', 'H2', 'T1'], ['C3', 'H2', 'T2'], ['C4', 'H1', 'T1'], ['C5', 'H1', 'T2']]
Schedules: [['C1', 'H1', 'T1'], ['C2', 'H1', 'T3'], ['C3', 'H2', 'T2'], ['C4', 'H1', 'T2'], ['C5', 'H1', 'T1']]
Schedules: [['C1', 'H2', 'T3'], ['C2', 'H1', 'T3'], ['C3', 'H2', 'T2'], ['C4', 'H2', 'T1'], ['C5', 'H1', 'T3']]
Schedules: [['C1', 'H1', 'T1'], ['C2', 'H2', 'T3'], ['C3', 'H2', 'T1'], ['C4', 'H2', 'T2'], ['C5', 'H1', 'T1']]
Schedules: [['C1', 'T3'], ['C2', 'H2', 'T2'], ['C3', 'H2', 'T1'], ['C4', 'H1', 'T3'], ['C5', 'H1', 'T2']]
Schedules: [['C1', 'H2', 'T3'], ['C2', 'H1', 'T1'], ['C3', 'H2', 'T1'], ['C4', 'H2', 'T1'], ['C5', 'H2', 'T1']]
```

We are appending this chromosome to the population. And then select group of 5 and then do tournament selection. It chooses the best fit.

This is an example of subgroup:

```

subgroupss
[[['C1', 'H1', 'T3'], ['C2', 'H1', 'T3'], ['C3', 'H1', 'T2'], ['C4', 'H1', 'T1'], ['C5', 'H1', 'T1']], [['C1', 'H1', 'T2'], ['C2', 'H2', 'T2'], ['C3', 'H1', 'T1'], ['C4', 'H1', 'T2'], ['C5', 'H1', 'T2']], [['C1', 'H2', 'T1'], ['C2', 'H2', 'T2'], ['C3', 'H1', 'T1'], ['C4', 'H2', 'T2'], ['C5', 'H2', 'T2']], [['C1', 'H1', 'T1'], ['C2', 'H1', 'T1'], ['C3', 'H1', 'T1'], ['C4', 'H1', 'T1'], ['C5', 'H2', 'T3']], [['C1', 'H2', 'T1'], ['C2', 'H1', 'T3'], ['C3', 'H2', 'T1'], ['C4', 'H1', 'T1'], ['C5', 'H1', 'T2']]]
Fitness of subgroupss
[1840, 3030, 1530, 2740, 1700]
size of subgroupss
5
Selected:
[['C1', 'H2', 'T1'], ['C2', 'H2', 'T2'], ['C3', 'H1', 'T1'], ['C4', 'H2', 'T2'], ['C5', 'H2', 'T2']]

```

According to algorithm it is selecting the population which has least fitness value. So here it is choosing the last one which has fitness score equals to 1700.

It repeats the same with all groups of 5 and at the end it will have 4 population remaining.

And on that it will perform crossover. This is crossover output:

```

Original Parents:
[['C1', 'H1', 'T3'], ['C2', 'H2', 'T1'], ['C3', 'H1', 'T3'], ['C4', 'H1', 'T1'], ['C5', 'H1', 'T3']], [['C1', 'H2', 'T2'], ['C2', 'H1', 'T1'], ['C3', 'H2', 'T1'], ['C4', 'H2', 'T3'], ['C5', 'H2', 'T1']]

crossover childs:
[['C1', 'H1', 'T3'], ['C2', 'H2', 'T1'], ['C3', 'H1', 'T3'], ['C4', 'H1', 'T1'], ['C5', 'H2', 'T1']], [['C1', 'H2', 'T2'], ['C2', 'H1', 'T1'], ['C3', 'H2', 'T1'], ['C4', 'H2', 'T3'], ['C5', 'H1', 'T3']]

```

And another is this:

```

Original Parents:
[['C1', 'H1', 'T2'], ['C2', 'H1', 'T1'], ['C3', 'H1', 'T1'], ['C4', 'H1', 'T3'], ['C5', 'H2', 'T1']], [['C1', 'H1', 'T1'], ['C2', 'H2', 'T2'], ['C3', 'H2', 'T1'], ['C4', 'H1', 'T3'], ['C5', 'H2', 'T2']]

crossover childs:
[['C1', 'H1', 'T2'], ['C2', 'H2', 'T2'], ['C3', 'H2', 'T1'], ['C4', 'H1', 'T3'], ['C5', 'H2', 'T2']], [['C1', 'H1', 'T1'], ['C2', 'H1', 'T1'], ['C3', 'H1', 'T1'], ['C4', 'H1', 'T3'], ['C5', 'H2', 'T1']]

```

According to probability, it will also sometimes don't do crossover. For that it only print can't do crossover.

```
Original Parents:
[['C1', 'H2', 'T3'], ['C2', 'H1', 'T2'], ['C3', 'H2', 'T1'], ['C4', 'H1', 'T2'], ['C5', 'H1', 'T1']]
[['C1', 'H2', 'T1'], ['C2', 'H1', 'T3'], ['C3', 'H2', 'T1'], ['C4', 'H2', 'T2'], ['C5', 'H1', 'T3']]

crossover childs:
[['C1', 'H2', 'T3'], ['C2', 'H1', 'T2'], ['C3', 'H2', 'T1'], ['C4', 'H2', 'T2'], ['C5', 'H1', 'T3']]
[['C1', 'H2', 'T1'], ['C2', 'H1', 'T3'], ['C3', 'H2', 'T1'], ['C4', 'H1', 'T2'], ['C5', 'H1', 'T1']]

Can't do crossover
```

Then this performs the mutation. Here is output for that for all the populations.

```
Can't do crossover
Mutated chromosome:
[['C1', 'H1', 'T2'], ['C2', 'H2', 'T1'], ['C3', 'H2', 'T3'], ['C4', 'H2', 'T2'], ['C5', 'H2', 'T1']]
Mutated chromosome:
[['C1', 'H1', 'T3'], ['C2', 'H2', 'T2'], ['C3', 'H2', 'T2'], ['C4', 'H1', 'T1'], ['C5', 'H2', 'T3']]
Mutated chromosome:
[['C1', 'H1', 'T1'], ['C2', 'H1', 'T2'], ['C3', 'H2', 'T3'], ['C4', 'H1', 'T2'], ['C5', 'H1', 'T3']]
Mutated chromosome:
[['C1', 'H2', 'T1'], ['C2', 'H2', 'T1'], ['C3', 'H1', 'T2'], ['C4', 'H2', 'T3'], ['C5', 'H2', 'T2']]
Mutated chromosome:
[['C1', 'H2', 'T2'], ['C2', 'H1', 'T3'], ['C3', 'H2', 'T2'], ['C4', 'H2', 'T3'], ['C5', 'H2', 'T3']]
Mutated chromosome:
[['C1', 'H2', 'T2'], ['C2', 'H2', 'T2'], ['C3', 'H2', 'T3'], ['C4', 'H2', 'T2'], ['C5', 'H2', 'T1']]
```

It randomly generates the gene and calculate its fitness scores and append that in the population array and fitness scores array respectively.

After performing all the steps, output would be like this.

```
PopN
[[['C1', 'H1', 'T2'], ['C2', 'H1', 'T3'], ['C3', 'H2', 'T3'], ['C4', 'H2', 'T2'], ['C5', 'H2', 'T1']],
[['C1', 'H1', 'T3'], ['C2', 'H2', 'T2'], ['C3', 'H2', 'T2'], ['C4', 'H2', 'T3'], ['C5', 'H2', 'T3']],
[['C1', 'H1', 'T1'], ['C2', 'H1', 'T2'], ['C3', 'H2', 'T3'], ['C4', 'H1', 'T2'], ['C5', 'H2', 'T1']],
[['C1', 'H2', 'T2'], ['C2', 'H2', 'T1'], ['C3', 'H1', 'T2'], ['C4', 'H2', 'T3'], ['C5', 'H2', 'T2']],
[['C1', 'H1', 'T2'], ['C2', 'H1', 'T3'], ['C3', 'H2', 'T2'], ['C4', 'H2', 'T3'], ['C5', 'H2', 'T3']],
[['C1', 'H1', 'T3'], ['C2', 'H2', 'T2'], ['C3', 'H2', 'T3'], ['C4', 'H2', 'T2'], ['C5', 'H2', 'T1']],
[['C1', 'H1', 'T2'], ['C2', 'H2', 'T1'], ['C3', 'H2', 'T3'], ['C4', 'H2', 'T2'], ['C5', 'H2', 'T1']],
[['C1', 'H1', 'T3'], ['C2', 'H2', 'T2'], ['C3', 'H2', 'T2'], ['C4', 'H1', 'T1'], ['C5', 'H2', 'T3']],
[['C1', 'H1', 'T1'], ['C2', 'H1', 'T2'], ['C3', 'H2', 'T3'], ['C4', 'H1', 'T2'], ['C5', 'H1', 'T3']],
[['C1', 'H2', 'T1'], ['C2', 'H2', 'T1'], ['C3', 'H1', 'T2'], ['C4', 'H2', 'T3'], ['C5', 'H2', 'T2']],
[['C1', 'H2', 'T2'], ['C2', 'H1', 'T3'], ['C3', 'H2', 'T2'], ['C4', 'H2', 'T3'], ['C5', 'H2', 'T3']],
[['C1', 'H2', 'T2'], ['C2', 'H2', 'T2'], ['C3', 'H2', 'T3'], ['C4', 'H2', 'T2'], ['C5', 'H2', 'T1']]]

bestFitArray
[500, 1320, 0, 10, 1510, 10, 1220, 0, 10, 1020, 1520, 1540]
PSize
12
```

PopN is our New population which is generated after tournament selection, crossover and mutation.