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Section: C
Assignment: 3&4

Introduction: In timetable Scheduling Assignment, we are required to generate a clash free schedule for university through genetic algorithm. Our solution must satisfy "Hard Constraint" mentioned in the assignment. However, "Soft Constraints" are not essential but they are better satisfied for solution efficiency.

Percentage of Assignment Completed:

Percentage Completed: *100%*

Hard Constraints Satisfied: *ALL*

Soft Constraints Satisfied: *ALL*

Classes in Assignment:

- **Individual:** I created this class to make a *"Gene".* Each gene has an allele which consists of "professor name, section and batch, course, day, duration, room number.
- **Chromosome:** I created this class to make a *"Chromosome"* which is a complete solution i.e. one Schedule.
- **Population:** I created this class to store a *"Population"* of chromosomes and feed that population to the genetic algorithm.
- **Genetic Algorithm:** I created this class to perform *"Genetic Algorithm"* on the population to get best fit schedule for the university.

Algorithm Steps:

1. **Chromosome Creation:**
   First of all, a gene is created to create a complete chromosome. A Gene consists of the following **attributes**:
   Professor Name, Section and batch, Course, Day, Duration, Room Number
   Then a chromosome is created by randomly incorporating all the classes of teachers and students within it. An example of chromosome from assignment is:

```
Dr.Ali 20A ITC Wednesday 4:00-5:00 305
Dr.Ali 20B ITC Thursday 1:00-2:20 305
Dr.Ali 20C ITC Thursday 1:00-2:20 304
Mr.Ahsan 20A ITC lab Thursday 4:00-5:00 306
Mr.Ahsan 20B ITC lab Friday 2:30-3:50 304
Mr.Ahsan 20C ITC lab Friday 2:30-3:50 305
Dr.Hamza 19A Data-Structure Wednesday 8:30-9:50 304
Dr.Hamza 19B Data-Structure Thursday 4:00-5:00 305
Mr.Ahsan 19A Data-Structure lab Wednesday 4:00-5:00 303
Mr.Ahsan 19B Data-Structure lab Friday 8:30-9:50 304
Mr.Ammar 18A Operating System Friday 8:30-9:50 306
Ms.Khadija 20A Calculus Monday 10:00-11:20 305
Ms.Khadija 20B Calculus Thursday 2:30-3:50 304
Ms.Khadija 18A Discrete Friday 8:30-9:50 302
Ms.Khadija 18B Discrete Thursday 10:00-11:20 303
Ms.Khadija 18C Discrete Tuesday 2:30-3:50 304
Dr.Ibrar 18A DataBase System Monday 2:30-3:50 303
Dr.Ibrar 18B DataBase System Wednesday 1:00-2:20 305
```

2. **Initial Population Creation:**
   An initial population of chromosomes is create to further proceed with the algorithm.
3. **Fitness Evaluation:**
   Each chromosome is evaluated against a fitness criteria to know how fit it is. In this assignment, the fitness criteria is "number of fulfillment of hard and soft constraints". There are total of 10 constraints including both soft and hard. So, if a chromosome satisfy 3 of the constraints then its fitness will be **3/10**.
4. **Roulette Wheel Selection:**
   Roulette wheel selection is performed in this assignment to select chromosomes for recombination.
5. **Reproduction Operator:**
   a. **Cross Over:** "*Single cross over*" method is used in the assignment to produce new off springs from the selected parents.
   b. **Mutation:** Mutation is done on the chromosomes according to a selected percentage. The mutation rate used in this assignment is **0.1** i.e. in each generation "One" chromosome is mutated. The **criteria** of performing mutation is the point where there exists a clash and that clash can never be removed through cross over.
6. **Population Recreation:**
   Next generation population is created by picking the better fitting chromosomes from children chromosomes as well as some from parent population
7. **Output:**
   The output of the Algorithm consists of a clash free schedule for university that satisfies all the soft and hard constraints given to us in the assignment. Also at each iteration, fitness value of the parent and child population is shown.
   Below picture is the output schedule of my assignment:

*****BEST FIT CHROMOSOME IS*****
SEQUENCE of Gene is
Professor Name, Section and batch, Course, Day, Duration, Room Number

Dr.Ali 20A ITC Thursday 10:00-11:20 304
Dr.Ali 20B ITC Thursday 2:30-3:50 304
Dr.Ali 20C ITC Thursday 1:00-2:20 306
Mr.Ahsan 20A ITC lab Friday 11:30-12:50 310
Mr.Ahsan 20B ITC lab Friday 4:00-5:00 307
Mr.Ahsan 20C ITC lab Friday 2:30-3:50 302
Dr.Hamza 19A Data-Structure Tuesday 4:00-5:00 306
Dr.Hamza 19B Data-Structure Thursday 8:30-9:50 304
Mr.Ahsan 19A Data-Structure lab Thursday 1:00-2:20 305
Mr.Ahsan 19B Data-Structure lab Thursday 2:30-3:50 302
Mr.Ammar 18A Operating System Friday 10:00-11:20 310
Mr.Ammar 18B Operating System Thursday 4:00-5:00 310
Mr.Ammar 18C Operating System Thursday 2:30-3:50 307
Ms.Khadija 20A Calculus Tuesday 8:30-9:50 304
Ms.Khadija 20B Calculus Tuesday 1:00-2:20 303
Ms.Khadija 18A Discrete Friday 8:30-9:50 302
Ms.Khadija 18B Discrete Tuesday 10:00-11:20 306
Ms.Khadija 18C Discrete Monday 2:30-3:50 304
Dr.Ibrar 18A DataBase System Thursday 4:00-5:00 304
Dr.Ibrar 18B DataBase System Thursday 10:00-11:20 309
Mr.Omer 17A SMD Tuesday 2:30-3:50 307
Mr.Omer 17B SMD Tuesday 8:30-9:50 310
Mr.Omer 17C SMD Wednesday 8:30-9:50 303
Ms.Rameen 17A SMD lab Wednesday 4:00-5:00 306
Ms.Rameen 17B SMD lab Tuesday 10:00-11:20 308
Ms.Rameen 17C SMD lab Thursday 2:30-3:50 306
Ms.Inji 17A Leadership Tuesday 4:00-5:00 304
Ms.Inji 17B Leadership Friday 11:30-12:50 308
Dr.Afaq 17A Artificial Intelligence Tuesday 11:30-12:50 306
Dr.Afaq 17B Artificial Intelligence Friday 4:00-5:00 306
Ms.Sidra 19A Marketing Thursday 10:00-11:20 306
Ms.Sidra 19B Marketing Tuesday 4:00-5:00 310
PRAYER BREAK FRIDAY 1:00-2:00 University MASJID
FACULTY MEETING MONDAY 8:30-9:00 302

CONSTRAINTS that are FULFILLED:
HARD CONSTRAINTS
No teacher can hold two classes at the same time
No section can listen for two classes at the same time
No classroom can receive two classes at the same time
No teacher can hold three consecutive classes
There will be no class before 8:30 am and after 5:00 pm.
University will remain close as there will be no class on weekends (Sat, Sun)

SOFT CONSTRAINTS
There will be no class from 1-2 on Friday.
No section can hold three consecutive classes.
preferred order is: lecture and lab.
One hour for faculty meeting in a week when there is no class except Friday’s prayer break.