PROJECT REPORT

Reading Data and Population Generation:

- Course, student, and instructor data is read from csv and stored in data frame (through pandas).
- Available classrooms, exam times and exam day are stored in a list .
- getRandomExam() used to generate a chromosome by randomly selecting course, classroom, exam time, and day.
- The population is structured as a data frame of data frames, where each index contains a chromosome represented as its own data frame.

Fitness Calculation:

- All hard and soft constraints are checked in Fitness Function
- The Fitness is calculated out of 400
- Individual functions are made for constraints which return a value (no. of violations) which is then subtracted from 400 to calculate Fitness.
- Best solution has fitness value of 400.

Roullet Wheel Selection:

- Calculate total fitness of population and randomly selecting a fitness threshold.
- Traversing through the population, accumulating fitness values until reaching or exceeding the threshold to select a chromosome.

Crossover:

- Crossover happens if randomly generated probability is below the set preset crossover probability.
- Randomly selects a point along the columns of the two selected parents and exchanges their columns beyond the point to create new offspring

Mutation:

- If randomly generated probability is less than set mutation rate, the exam starts time and exam day get mutated and get chosen at random, introducing variability into population.

Replacement:

- Identify the least fit individuals in the population by finding least fitness score.
- Calculate fitness score of the two offspring and replace the least fit individual with fitter offspring if fitness score of offspring is greater than the least fit individual.

Main Loop:

- Initialize population and continuously evolve it through selection, crossover, and mutation and replacement operations.
- Fitness evaluated for each individual in population to guide the selection process towards optimal solution.
- Iteratively search for a chromosome in population that meets all constraints, terminating when it finds a solution with a fitness score of 400, indicating all constraints are satisfied.
- Once best solution is found, loop breaks and the fulfilled constrains are displayed along with the fitness value.
- The best chromosome which is the best exam schedule is then displayed.

SAMPLE INPUT

- Data needed for algorithm to run: instructors' names, students name, exam duration, courses (course codes), and list of allowed classrooms.
- Instructors' names, students' names and their courses, course name and their course code are read from given data set.
- Exam Day, Exam Duration and Exam Time are set as follows:

```
classRooms = [("C-301", 0), ("C-302", 1), ("C-303", 2), ("C-304", 3), ("C-305", 4),
              ("C-306", 5), ("C-307", 6), ("C-308", 7), ("C-309", 8), ("C-310", 9)]

examStartTimings = [(9, 0), (11, 1),(2, 2),(4, 3)]

days = [("Monday", 0), ("Tuesday", 1), ("Wednesday", 2), ("Thursday", 3), ("Friday", 4),
        ("Monday", 5), ("Tuesday", 6), ("Wednesday", 7), ("Thursday", 8), ("Friday", 9),
       ("Monday", 10), ("Tuesday", 11), ("Wednesday", 12), ("Thursday", 13), ("Friday", 14)]

crossover_probability = round(random.uniform(low=0.3, high=1.0), 1)
mutation_probability = round(random.uniform(low=0.0, high=0.5), 1)
population_size = random.randint(50, 150)
```

OUTPUT

When all constraints met and main loop halts:

```
Current generation: 18040
Best solution so far: 399, Goal: 400
min fitness :  396

Current generation: 18050
Best solution so far: 399, Goal: 400
min fitness :  396

Current generation: 18060
Best solution so far: 399, Goal: 400
min fitness :  396

Current generation: 18070
Best solution so far: 399, Goal: 400
min fitness :  396

Current generation: 18080
Best solution so far: 399, Goal: 400
min fitness :  396

BEST SOLUTION FOUND!


Current generation: 18090
Best solution: 400, Goal: 400

Hard Constraints:
1: An exam will be scheduled for each course                          ✔
2: A student is enrolled in minimum three courses                     ✔
3: A student can not give more than one exam at a time                ✔
4: Exam will not be held on weekends                                  ✔
5: All exams must be held between 9 AM and 5 PM                       ✔
6: A teacher can not invigilate two exams at the same time            ✔
7: A teacher can not invigilate two exams in a row                    ✔

Soft Constraints:
1: All students and teachers shall be given a break on Friday from 1-2  ✔
2: A student shall not give more than one exam consecutively            ✔
3: MG courses preferably be held before CS courses                      ✔
4: Two hours of break for faculty meeting                               ✔
```

Displaying the best Exam Schedule:

```
[925]: display_exam_schedule(sortPopulation(population[max_idx]))
```

```
Week 1 Schedule
-----------------------------------------------------------------------
Day       | Course    | Room      | Time      | Invigilator
-----------------------------------------------------------------------
Monday    | AI2011    | C-301     | 9:00 AM   | Maheen Arshad
-----------------------------------------------------------------------
Monday    | SS118     | C-303     | 4:00 PM   | Ameen Chilwan
-----------------------------------------------------------------------
Tuesday   | DS3011    | C-309     | 2:00 PM   | Naveed Ahmad
-----------------------------------------------------------------------
Tuesday   | SE110     | C-302     | 4:00 PM   | Sajid Khan
-----------------------------------------------------------------------
Tuesday   | CS302     | C-305     | 4:00 PM   | Hammad Majeed
-----------------------------------------------------------------------
Wednesday | SS113     | C-307     | 9:00 AM   | Muhammad Usman
-----------------------------------------------------------------------
Wednesday | EE227     | C-309     | 2:00 PM   | Muhammad Usman
-----------------------------------------------------------------------
Thursday  | EE229     | C-306     | 9:00 AM   | Sajid Khan
-----------------------------------------------------------------------

Week 2 Schedule
-----------------------------------------------------------------------
Day       | Course    | Room      | Time      | Invigilator
-----------------------------------------------------------------------
Monday    | CS211     | C-301     | 9:00 AM   | Irum Inayat
-----------------------------------------------------------------------
Monday    | CS217     | C-308     | 2:00 PM   | Amna Irum
-----------------------------------------------------------------------
Monday    | EE229     | C-306     | 4:00 PM   | Maimoona Rassol
-----------------------------------------------------------------------
Monday    | CS218     | C-309     | 4:00 PM   | Mehwish Hassan
-----------------------------------------------------------------------
Wednesday | MG220     | C-304     | 9:00 AM   | Shoaib Mehboob
-----------------------------------------------------------------------
Thursday  | CS220     | C-310     | 11:00 AM  | Maimoona Rassol
-----------------------------------------------------------------------
Thursday  | CS307     | C-308     | 11:00 AM  | Kashif Munir
-----------------------------------------------------------------------
Friday    | CS328     | C-305     | 11:00 AM  | Asma Nisa
-----------------------------------------------------------------------
Friday    | SS152     | C-308     | 4:00 PM   | Hamda Khan
-----------------------------------------------------------------------
```

```
Week 3 Schedule
-----------------------------------------------------------------------
Day       | Course    | Room      | Time      | Invigilator
-----------------------------------------------------------------------
Monday    | CS118     | C-304     | 9:00 AM   | Maheen Arshad
-----------------------------------------------------------------------
Monday    | CS211     | C-301     | 2:00 PM   | Mehreen Alam
-----------------------------------------------------------------------
Tuesday   | CY2012    | C-305     | 9:00 AM   | Muhammad bin Qasim
-----------------------------------------------------------------------
Tuesday   | SS111     | C-303     | 11:00 AM  | Usman Rashid
-----------------------------------------------------------------------
Tuesday   | CS219     | C-310     | 4:00 PM   | Zeeshan Qaiser
-----------------------------------------------------------------------
Tuesday   | MG223     | C-304     | 4:00 PM   | Aqeel Shahzad
-----------------------------------------------------------------------
Thursday  | MT205     | C-301     | 2:00 PM   | Muhammad bin Qasim
-----------------------------------------------------------------------
Friday    | MT224     | C-308     | 11:00 AM  | Sara Aziz
-----------------------------------------------------------------------
Friday    | CS328     | C-304     | 4:00 PM   | Hammad Majeed
-----------------------------------------------------------------------
```