FAST NATIONAL UNIVERSITY

SUBJECT: Artificial Intelligence

Project # 01

Exam Schedule Generation using Genetic Algorithm

Name:

➔**Talha Mustafa (18i-0573)**

➔**Tayyab Ali (18i-0531)**

Section: D

Exams Schedule Generator Using Genetic Algorithm

Reading Data from Excel Files:

First of all, we loaded the data provided in excel files into different classes (Teacher, Couse, Student, Room). We also defined Time and Day classes and stored Time and Date in them respectively.

Days: 2 Weeks (10 Days)

Time: 09:00 – 12:00, 02:00 – 05:00

Making Exam Schedule:

We defined an Exam Class which stores course, date, time, teacher, room of all available courses and makes a complete Schedule. This is referred as a Single Chromosome.

Explanation of Chromosome Created:

We are generating a 6-bit binary number for every value (course, room, teacher, day, time). If the same exam is scheduled in different rooms (more students) then different teacher and room binary values are added in a list. The minimum chromosome length of one exam is 30-bits. Length can vary depending on the number of rooms and teachers.

Sample Chromosome Screenshot of One Schedule:

```
Chromosomes Values Order:
Course       [Room]           [Teacher]        Time   Day
000000 [ 000011 001000 ] [ 000000 000001 ] 000000 000010
000001 [ 000001 000111 ] [ 000010 000011 ] 000001 000010
000010 [ 000010 ] [ 000100 ] 000000 000010
000011 [ 000010 ] [ 000101 ] 000000 000101
000100 [ 000101 ] [ 000110 ] 000001 000100
000101 [ 000010 000001 ] [ 000111 001000 ] 000001 000100
000110 [ 000101 000100 ] [ 001001 001010 ] 000000 000101
000111 [ 000100 000111 ] [ 001011 001100 ] 000000 000000
001000 [ 000001 001000 ] [ 001101 001110 ] 000001 000101
001001 [ 000111 000100 ] [ 001111 010000 ] 000000 001000
001010 [ 000101 000011 ] [ 010001 010010 ] 000000 000111
001011 [ 000000 000101 ] [ 010011 010100 ] 000001 001000
001100 [ 000101 000001 ] [ 010101 010110 ] 000000 000011
001101 [ 001001 001000 ] [ 010111 011000 ] 000000 000111
```

Generating Initial Schedules:

Then we defined a Population Class which creates multiple (about 50) initial schedules(chromosomes) at random on which we apply genetic algorithm to choose the best one. This is our initial population. An array of chromosomes which is stored in binary.

Then we apply genetic algorithm on the initial population of schedules(chromosomes).

Genetic Algorithm Functions:

Crossover:

In it, we are using **One Point Crossover.**

First, we keep selecting two chromosomes from our schedules and apply crossover on it. We combine half exams of both chromosomes to make two new schedules. We repeat the process till we have double the number of new schedules.

Mutation:

In it, we are using **Bit Flip Mutation**.

We apply mutation on the newly created chromosomes. In it, we randomly switch the date and time of randomly selected chromosome (single exam).

Parent Selection:

In it we are using **Roulette Wheel Selection.**

We first find the total fitness of the whole population. Then divide each individual Chromosome's fitness from the total fitness calculated in order to Find the probability of each chromosome. Then we make a probability Pie Chart in the form of a Python List. After that we generate a random number between 1 and 0 and depending upon the number generated, we select that respective chromosome by matching drawing the number on the probability pie chart. This process is repeat until a new population with size equal to the previous population if formed.

Fitness:

In fitness function, we calculate the number of hard and soft constraints being violated of each schedule and store it. Then we select the one best value. We have 500 initial fitness value for each schedule and it will decrease depending upon the number of constraints violated. The one with maximum value is best.

Find Fittest:

We sort the schedule based on fitness value and select the best one.

Run Genetic Algorithm:

Main Algorithm function to call other functions in a loop to apply genetic algorithm and select the best schedule found.

Display Functions:

Some Display functions to print the desired schedules, fitness, generations.

Our Data:

Since the given data was very big and was nearly impossible to get full correct schedule in 2 weeks, we created a smaller data from the given one to test all our constraints. The excel files are in 'Data' folder.

Teachers: We added 30 teachers.

Rooms: 10 rooms with 28 max capacity.

Courses: 15 Courses including 2 MG courses.

Student Names: 100 Students.

Student Courses: Assigning 3-5 courses to each student.

Days: One Week (Monday – Friday)

Time: (09:00 – 12:00, 02:00 – 05:00)

Schedule Screenshot:

```
Generation no :  20
Course Schedule Violations: 0  Same Time Exam[Student] Violations: 5  Same Time or Consecutive Duty[Teacher] Violations: 0  Self_Cond--Same Room Violations: 2
Total Fitness =  93  / 100
Generation no :  30
Course Schedule Violations: 0  Same Time Exam[Student] Violations: 5  Same Time or Consecutive Duty[Teacher] Violations: 0  Self_Cond--Same Room Violations: 2
Total Fitness =  93  / 100
------------------------------Examination Schedule-------------------------
Course      Room No           Day             Date         Timming         Invigilator
MG220   C-301              Monday      01/05/2021   09:00 - 12:00   ['Muhammad bin Qasim']
MG223   C-302              Monday      01/05/2021   09:00 - 12:00   ['Zainab Moin']
CS307   C-308              Monday      01/05/2021   02:00 - 05:00   ['Mehboobullah']
EE227   C-306 C-301        Tuesday     02/05/2021   09:00 - 12:00   ['Aqeel Shahzad', 'Farah Naz']
SS118   C-310              Wednesday   03/05/2021   09:00 - 12:00   ['Sadia Nauman']
CS211   C-306              Wednesday   03/05/2021   02:00 - 05:00   ['Hamda Khan']
CS302   C-302              Wednesday   03/05/2021   02:00 - 05:00   ['Sajid Khan']
CY2012  C-305              Wednesday   03/05/2021   02:00 - 05:00   ['Tayyab Nadeem']
SS111   C-302              Wednesday   03/05/2021   02:00 - 05:00   ['Sumera Abbas']
CS217   C-306              Thursday    04/05/2021   09:00 - 12:00   ['Ayesha Bano']
SE110   C-308              Thursday    04/05/2021   02:00 - 05:00   ['Usman Rashid']
CS219   C-306              Thursday    04/05/2021   02:00 - 05:00   ['Sara Aziz']
CS118   C-302              Friday      05/05/2021   09:00 - 12:00   ['Farah Jabeen Awan']
CS220   C-309 C-304        Friday      05/05/2021   09:00 - 12:00   ['Gul e Aisha', 'Maimoona Rassol']
MT205   C-310              Friday      05/05/2021   02:00 - 05:00   ['Shahzad Mehmood']

Fitness ::  100 / 100
Generation = 36
```

Run different files:

To switch between data just change the folder name here.

```
28    # 'Data/' for data generated by us
29    # 'Data1/' for provided data
30    folder = 'Data1/'
```

Data Provided:

The excel files of these are in ‘Data1’ folder. The best we got was 84% fit on 2 weeks (10 days) and 97% fit for 3 weeks (15 days) for exams. Only one hard constraint was being violated.

[Constraint]	[Status]
[Hard] No exams on weekend	[Followed]
[Hard] Exams between 9 am to 5 pm	[Followed]
[Hard] All Courses Were Scheduled	[Followed]
[Hard] No Student With Exam At Same Time	[Violated]
[Hard] Teacher With Two Duties Same Time	[Followed]
[Hard] Teacher With Consecutive Duties	[Followed]
[Hard] Exam in Same Room[Same Time]	[Followed]
[Soft] Break from 1 pm - 2 pm on Friday	[Followed]
[Soft] 2 hours break for faculty meetings	[Followed]
[Soft] Students with Consecutive Exams	[Followed]
[Soft] MG Courses before CS[Each Student]	[Followed]

Schedule Screenshot (FOR 2 WEEKS):

Course	Room No	Day	Date	Timming	Invigilator
MG223	C-306 C-301	Monday	01/05/2021	09:00 - 12:00	['Mehwish Hassan', 'Shams Farooq']
SS118	C-302	Monday	01/05/2021	09:00 - 12:00	['Amna Irum']
SS152	C-305	Monday	01/05/2021	02:00 - 05:00	['Khadija Farooq']
MG220	C-302 C-309	Tuesday	02/05/2021	09:00 - 12:00	['Zohaib Iqbal', 'Mehreen Alam']
CS328	C-302 C-301	Wednesday	03/05/2021	09:00 - 12:00	['Sadia Nauman', 'Shahzad Mehmood']
MT205	C-307 C-301	Wednesday	03/05/2021	09:00 - 12:00	['Irum Inayat', 'Bilal Khalid']
CS217	C-303 C-309	Wednesday	03/05/2021	02:00 - 05:00	['Ayesha Bano', 'Aqeel Shahzad']
SS111	C-301 C-302	Thursday	04/05/2021	09:00 - 12:00	['Ameen Chilwan', 'Shafaq Riaz']
EE227	C-307 C-309	Friday	05/05/2021	09:00 - 12:00	['Farah Naz', 'Hamda Khan']
CS302	C-306	Friday	05/05/2021	09:00 - 12:00	['Mehboobullah']
SS113	C-301 C-306	Friday	05/05/2021	09:00 - 12:00	['Javaria Imtiaz', 'Maheen Arshad']
SE110	C-302	Friday	05/05/2021	02:00 - 05:00	['Sara Aziz']
AI2011	C-307 C-301	Friday	05/05/2021	02:00 - 05:00	['Sehrish Hassan', 'Waqas Munir']
MT224	C-309 C-302	Friday	05/05/2021	02:00 - 05:00	['Rohail Gulbaz', 'Hassan Raza']
CS220	C-309	Monday	08/05/2021	09:00 - 12:00	['Tayyab Nadeem']
EE229	C-302 C-301 C-305	Monday	08/05/2021	09:00 - 12:00	['Sanaa Ilyas', 'Nagina Safdar', 'Asma Nisa']
CS219	C-310	Monday	08/05/2021	02:00 - 05:00	['Sajid Khan']
CS307	C-305 C-309	Monday	08/05/2021	02:00 - 05:00	['Zainab Moin', 'Sumera Abbas']
CS118	C-302 C-306	Tuesday	09/05/2021	09:00 - 12:00	['Gul e Aisha', 'Maimoona Rassol']
CS211	C-309 C-304	Wednesday	10/05/2021	09:00 - 12:00	['Usman Rashid', 'Farah Jabeen Awan']
CY2012	C-307	Wednesday	10/05/2021	02:00 - 05:00	['Muhammad bin Qasim']
DS3011	C-301 C-307	Thursday	11/05/2021	09:00 - 12:00	['Usman Ashraf', 'Muhammad Usman']
CS218	C-309 C-301	Friday	12/05/2021	09:00 - 12:00	['Naveed Ahmad', 'Zainab Abaid']

Fitness :: 84 / 100
Generation = 200