2024

Exam Scheduler

Exam Scheduler Using Genetic Algorithm

Introduction

The exam scheduling system objective is to efficiently allocate exam slots for a group of students across different courses while looking out to set constraints and preferences. This report gives a detailed overview of the system's design, implementation, and evaluation, including the “genetic algorithm” used for scheduling and the comprehensive constraint testing suite.

System Overview

The system is built using Python language and leverages the pandas library for data handling. It uses a Genetic Algorithm (GA) to generate optimal schedules by iteratively evolving a population of potential solutions. The GA considers both hard and soft constraints to ensure the feasibility and fairness of the generated schedules.

Implementation Details

- Class Structures:
  - Course: Holds course code and name.
  - Teacher: Stores teacher names.
  - Student: Contains student names and their enrolled courses.
- Data Handling:
  - Data regarding courses, teachers, and students are loaded from CSV files. Each course, teacher, and student are represented as an object, hence easy manipulation, and access to relevant information during scheduling.
- Algorithm Parameters:
  - Population Size: 60
  - Crossover Rate: 70%
  - Mutation Rate: 40%
  - Generations: 50

Genetic Algorithm

def genetic_algorithm()

Main loop that evolves the population over multiple generations.

- **Population Initialization:**

def initialize_population(size)

Initial schedules are randomly generated, ensuring that each course is assigned a valid exam slot while avoiding conflicts.

- **Fitness Calculation:**

def calculate_fitness(individual)

The fitness function evaluates the quality of each schedule by deducting points for violations of constraints, both hard and soft. Higher fitness scores indicate better schedules meaning all constraints are being satisfied.

- **Selection:**

def roulette_wheel_selection(population, fitness)

Roulette wheel selection is used to choose parents for crossover, favoring the schedules with higher fitness.

- **Crossover and Mutation:**

def crossover(parent1, parent2)

def mutate(individual, mutation_rate=0.1)

Crossover and mutation operations introduce diversity and explore the solution space, aiming to improve the quality of schedules over the generations.

Termination:

The algorithm runs for a predefined number of generations, continually improving schedules towards better solutions.

Constraint Testing Suite:

A suite of functions is provided to comprehensively test the adherence of generated schedules to specified constraints. These tests cover both the hard and soft constraints, ensuring that the schedules are feasible and are optimized.

def test_hard_constraints(schedule, students, teachers, courses)

def test_soft_constraints(schedule, students, teachers, courses)

```
Testing Hard Constraints:
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Pass: Test for scheduling an exam for each course.
Pass: Test for no student taking more than one exam at a time.
Pass: Test for no exams scheduled on weekends.
Pass: Test for all exams scheduled between 9 AM and 5 PM.
Pass: Test for each teacher not invigilating two exams at the same time.
Pass: Test for teachers not invigilating two consecutive exams.
Pass: Test for no double booking of rooms.
Pass: Test that all students are enrolled in at least two courses.
```

```
Testing Soft Constraints:
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Pass:  Test for Friday break from 1-2 PM.
Fail:  Test for no more than one consecutive exam for any student.
Pass:  Test for MG course before CS course for any student enrolled in both.
Pass:  Test for two hours of faculty break in the week.
```

Conclusion:

The exam scheduling system effectively uses the Genetic Algorithm to generate optimal schedules while also considering the various constraints and preferences. By including a detailed constraint testing suite, the system checks the integrity and fairness of generated schedules, facilitating efficient examination management for educational institutions. More enhancements can include additional optimization techniques and user interface improvements for enhanced usability.

Screenshots of the output:

```
----- Generated Parameters -----
Population size.....: 60
Crossover probability: 0.7
Mutation probability.: 0.4


Current generation: 1
Best solution so far: 810, Goal: 1000
Current generation: 11
Best solution so far: 810, Goal: 1000
Current generation: 21
Best solution so far: 810, Goal: 1000
Current generation: 31
Best solution so far: 810, Goal: 1000
Current generation: 41
Best solution so far: 810, Goal: 1000

Final best schedule found:
```

```
Final best schedule found:

EXAM SCHEDULE:

       Course Code | Room       | Teacher             | Day             | Start Time      | Students
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       Monday

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       | MT205       | C-306      | Arshad Islam        | Monday          | 9:00 AM         | Zeenat K Guness-Goolbar, Sarah R Young, Arooba Zahoor, Kamila H
       | MT205       | C-307      | Maimoona Rassol     | Monday          | 11:00 AM        | Sarah Hanley, Reem N Hassan, Zahir Hussain, Natasha Lelijveld,
       | MT205       | C-304      | Faisal Cheema       | Monday          | 11:00 AM        | Kiran K Chahal, Maria A Grenfell, Sam Dalgleish, Mohammad Abir,
       | MT205       | C-303      | Sidra Khalid        | Monday          | 1:00 PM         | Mika Tatsumoto, Sam Dalgleish, Shahzada S Niwaz, Sarah Armstron
       | MT205       | C-309      | Ameen Chilwan       | Monday          | 3:00 PM         | Kiran K Chahal, Syed M Abbas, Sarah Austin, Mohammed Riyaz Shah
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       Tuesday

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       | MT205       | C-303      | Aqeel Shahzad       | Tuesday         | 9:00 AM         | Syed M Abbas, Mika Tatsumoto, Shari K Rasmussen, Soha Siahpoosh
       | MT205       | C-302      | Umair Arshad        | Tuesday         | 9:00 AM         | Maria A Grenfell, Farzana Yamin, Faheema Korumtollee, Natasha T
       | MT205       | C-304      | Usman Ashraf        | Tuesday         | 1:00 PM         | Salma Khanam, Mohammed Riyaz Shahul Hameed Mohammed Yakub, Sara
       | MT205       | C-301      | Maimoona Rassol     | Tuesday         | 1:00 PM         | Sarah Austin, Parastoo Jamshidi, Sarah Armstrong, Adam Mickiewi
       | MT205       | C-302      | Bilal Khalid        | Tuesday         | 3:00 PM         | Yasmin Ahmed, Sarah Hanley, Syed M Ghufran, Mohammed A Suleman,
       | MT205       | C-310      | Sidra Khalid        | Tuesday         | 3:00 PM         | Sarah Austin, Reem N Hassan, Mohamed A Baalousha, Zahra Faraji
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```

Wednesday

MT205	C-306	Mehwish Hassan	Wednesday	9:00 AM	Zahir Hussain, Maria A Grenfell, Shari K Rasmussen, Tina Nasers
MT205	C-302	Sumera Abbas	Wednesday	9:00 AM	Sarah Hanley, Nabila Altaf, Shahzada S Niwaz, Zaki Choudhury, S
MT205	C-304	Hasan Mujtaba	Wednesday	1:00 PM	Farzana Yamin, Zahra Faraji Rad, Usman Rafiq, Nadine Meyer, Ada
MT205	C-301	Usman Ashraf	Wednesday	3:00 PM	Mohammed Azam, Nabila Altaf, Arsheen Rajpar, Natasha Leeson, Ze
MT205	C-305	Ejaz Ahmed	Wednesday	3:00 PM	Syed M Abbas, Nausheen Saleem, Usman Rafiq, Mohammad Abir, Jan

Thursday

MT205	C-302	Mehreen Alam	Thursday	9:00 AM	Yasmin Ahmed, Damian A Cummings, Mohammed A Suleman, Tina Naser
MT205	C-309	Farwa Batool	Thursday	9:00 AM	Sam D Edwards, Sarah Nolasco, Ana Vukojevic, Leila C Payne, Sad
MT205	C-309	Zainab Abaid	Thursday	11:00 AM	Yasmin Ahmed, Sarah J Roberts, Damian A Cummings, Ana Vukojevic

Friday

MT205	C-307	Sajid Khan	Friday	11:00 AM	Salma Khanam, Sarah L Barber-Jones, Syed M Ghufran, Parastoo Ja
MT205	C-301	Shoaib Mehboob	Friday	11:00 AM	Sarah J Roberts, Sam D Edwards, Ana Vukojevic, Sarah Armstrong,
MT205	C-309	Mehwish Hassan	Friday	3:00 PM	Mohammed Azam, Mohammed Riyaz Shahul Hameed Mohammed Yakub, Far
MT205	C-310	Asif Naeem	Friday	3:00 PM	Sarah L Barber-Jones, Sam D Edwards, Nabila Altaf, Mohammed Zaf