



**National University**  
of computer and emerging sciences

## **Exam Schedule Generator Using Genetic Algorithm**

**CS-461 Artificial Intelligence**

BS(CS) – D

Batch 2018

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## ASSUMPTIONS

- There are 2 time slots in a day: Morning and Noon (*Hard Const 4: Exam must be held between 9am - 5pm*)
- Each exam will be of 3 hours
- Morning Slot = 9am - 12pm
- Evening Slot = 2pm - 5pm
- It is possible that not all classrooms are used in a single day
- The higher the fitness score, the better the solution (*Our goal is to maximize fitness value*)
- Any day with exams scheduled will have exam at both morning and noon

## HYPERPARAMETERS

- Population size: randomly chosen within a range of 50 – 200
- Maximum number of generations: randomly chosen within a range of 100-1000
- Crossover probability: kept as 1 to ensure crossover
- Mutation probability: 0.6 (for a high chance of mutation)

## USER-DEFINED CLASSES

- Class **StudentData** for keeping track of a particular student and their assigned courses
- Class **Schedule**, which represents the chromosome in this algorithm and is a possible solution

## STEPS

- The first step is to generate a random population, or set of chromosomes/solutions. Each solution is represented by an object of the Schedule class. Every Schedule object is assigned days to hold exams on; for every day, a random number of classrooms is chosen then each classroom is assigned a morning exam, noon exam and their respective invigilators.
- A fitness value is calculated for each chromosome in the population. Fitness score is based upon the hard and soft constraints required, with their clashes/conflicts used to calculate the final value. Every constraint has an equal weightage in the score.
- Once fitness is calculated and stored, the population is passed through for parent selection. This is done using roulette wheel selection to get the fittest chromosomes in the population.
- Crossover is done using these parents. To generate a crossover-ed population, two parents are selected for every crossover. One is the fittest parent and the other is selected randomly, to ensure diversity. Two offspring are generated for every set of parents until there is a whole population of offspring. The actual crossover itself is done by splitting both parents at a randomly selected point and concatenating their separate parts to produce two offspring.
- The crossover-ed population are then passed for mutation. Within a predefined mutation probability, each chromosome is mutated at random positions. This is done by generating new values for a selected position e.g., replacing an exam, or an invigilator or a whole day and so on.
- This population, which has now been crossover-ed and mutated, has its fitness recalculated. The fittest chromosome is extracted as the local maximum and compared with the overall best solution generated so far.

- If the chromosome has satisfied the constraints, the algorithm finishes. Otherwise, the mutated population is now the population passed to step 2, and the whole process will repeat all over.
- Algorithm runs until a solution is found or max number of generations exceeded – in which case, it returns the best solution it had.
- If the best fitness values for the new population and the previous population are same for 50 generations, it is decided that this population is stagnant and cannot be improved. In this case, a new population is generated and the previous best solution stored. This process can go up to a fixed number of times (set as 3 for our purposes) and if it has not found a solution by then, the fittest solution is selected from all the previous best solutions and returned.
- At each iteration, the current generation, fitness of overall best solution, and the fitness of the local best solution (for that iteration) are displayed, along with how long the population has been stagnant.
- After every 25 iterations, the best solution so far is displayed, along with its fitness and the values of its constraints.
- The final solution is displayed at the end in main.

# LOGIC

- We firstly created a collection of named tuples. The tuple contained following things:
  1. Room Name
  2. Morning Exam
  3. Morning Invigilator
  4. Noon Exam
  5. Noon Invigilator
- Each tuple consists of 10 classes (*i.e.*, C301 – C310). Each room will have the forementioned data.
- Next, every schedule object has 2 attributes:
  1. Fitness (float)
  2. Days (dictionary where every key is a day and the value is a named tuple of classrooms as mentioned above.
- We are considering each schedule to be a chromosome
- The usage of user-defined classes, dictionaries and named tuples allowed us to organize and access the data very easily
- The output displayed is the perfect schedule (*in most cases*) in actual date sheet format.

# CONSTRAINTS IMPLEMENTED

## Hard Constraints:

1. Exam is scheduled for each course = ☒
2. Student cannot give more than one exam at a time = ☒
3. Teacher invigilates one exam at a time = ☒
4. Teacher invigilates one exam in a row = ☒
5. Student is enrolled in at least 3 courses = ☒
6. Exam won't be held on weekends = ☒
7. Exam must be invigilated by a teacher = ☒
8. Use at max 10 classrooms = ☒

## Soft Constraints:

- 1. Break on Friday from 1-2pm = ☒
- 2. Student should not give more than 1 exam consecutively = ☒
- 3. MG Course scheduled before CS Course = ☒
- 4. Exam is scheduled in less days = ☒
- 5. Almost equal number of invigilation duties = ☒

## EXECUTION TIMELAPSE

Following is the link for execution time-lapse of both the sample dataset and the provided dataset:

- 1. Sample Dataset:  
<https://drive.google.com/file/d/1y9alaTJcvJKdK9TL2edszigX942ni4q4/view?usp=sharing>
- 2. Provided Dataset:  
[https://drive.google.com/file/d/1r2QzIT6q7glqEZEI4W99uRphV\\_yGuSFH/view?usp=sharing](https://drive.google.com/file/d/1r2QzIT6q7glqEZEI4W99uRphV_yGuSFH/view?usp=sharing)

## ISSUES FACED

- Data was being overwritten a lot
- We were initially scheduling in 5 days only due to which the algorithm kept running infinitely without ever giving the perfect solution.
- Constraints weren't specified clearly
- Requirements kept changing with each day forcing us to update the code
- Another issue we faced was that crossover was returning same schedules.
- Most of solutions were empty initially, as empty timetable satisfied most of the constraints.

## SAMPLE DATASET:

temp_teachers.csv	temp_courses.csv	temp_studentcourses.csv
Bilal Khalid Shehreyar Rashid Umair Arshad Subhan Ullah Ejaz Ahmed Kifayat Ullah Waseem Shahzad Adnan Tariq Asif Naeem Hasan Mujtaba Sidra Khalid Faisal Cheema Shoaib Mehboob Tayyaba Zainab Arshad Islam Noor ul Ain Zeeshan Qaiser Muhammad Asim Behjat Zuhaira Kashif Munir Hammad Majeed Noreen Jamil Hassan Mustafa Farwa Batool	CS111 OOP CS112 DS CS113 DB CS114 Algo CS115 CNET MG211 DLD CS116 PF CS117 OS CS118 DF CS119 SE	Abeera CS111 Abeera CS115 Abeera CS116 Adil CS111 Adil CS119 Adil CS113 Ali CS118 Ali CS119 Ali CS117 Aysha CS112 Aysha CS114 Aysha CS117 Azka CS115 Azka CS118 Azka MG211 Hassan CS112 Hassan CS114 Hassan CS117 Hurriya CS113 Hurriya CS114 Hurriya MG211 Sana CS112 Sana CS113 Sana MG211 Sundus CS111 Sundus CS112 Sundus CS117 Wajeeha CS119 Wajeeha CS114 Wajeeha MG211 Zaynab CS111 Zaynab CS114 Zaynab CS119 Zeeshan CS111 Zeeshan CS112 Zeeshan CS115

SCREENSHOTS OF OUTPUT

SOLUTION FOUND!!!!

Week 1 : Mon				
Room No	9 - 12	Morning Invigilator	2 - 5	Evening Invigilator
C304	CS113	Noor ul Ain	CS116	Kifayat Ullah
C309	CS113	Adnan Tariq	CS117	Umair Arshad
C301	CS119	Subhan Ullah	CS117	Shoaib Mehboob

Week 1 : Wed				
Room No	9 - 12	Morning Invigilator	2 - 5	Evening Invigilator
C306	CS111	Asif Naeem	CS117	Tayyaba Zainab
C303	CS113	Faisal Cheema	CS112	Farwa Batool
C310	CS118	Adnan Tariq	CS115	Noor ul Ain
C304	CS111	Muhammad Asim	CS114	Waseem Shahzad
C301	MG211	Subhan Ullah	CS113	Zeeshan Qaiser

Week 1 : Thu				
Room No	9 - 12	Morning Invigilator	2 - 5	Evening Invigilator
C306	CS113	Hasan Mujtaba	CS117	Kashif Munir
C303	MG211	Tayyaba Zainab	CS113	Arshad Islam
C301	CS113	Muhammad Asim	CS119	Faisal Cheema

Week 1 : Fri				
Room No	9 - 12	Morning Invigilator	2 - 5	Evening Invigilator
C305	CS114	Shehreyar Rashid	MG211	Faisal Cheema
C302	CS114	Asif Naeem	CS119	Waseem Shahzad
C308	CS114	Kashif Munir	CS112	Arshad Islam
C306	CS111	Noor ul Ain	CS119	Tayyaba Zainab
C304	CS112	Zeeshan Qaiser	CS111	Behjat Zuhaira

HARD CONSTRAINTS	
1: Exam is scheduled for each course =	✓✓
2: Student cannot give more than one exam at a time =	✓✓
3: Teacher invigilates one exam at a time =	✓✓
4: Teacher invigilates one exam in a row =	✓✓
5: Student is enrolled in atleast 3 courses =	✓✓
6: Exam wont be held on weekends =	✓✓
7: Exam must be invigilated by a teacher =	✓✓
8: Use at max 10 classrooms =	✓✓

SOFT CONSTRAINTS	
1: Exam is scheduled for each course =	✓✓
2: Student cannot give more than one exam at a time =	✓✓
3: Teacher invigilates one exam at a time =	✓✓
4: Teacher invigilates one exam in a row =	✓✓
5: Student is enrolled in atleast 3 courses =	✓✓

PROVIDED DATASET:

teachers.csv	courses.csv		studentCourse.csv	
Ayesha Bano	CS217	Object Oriented Programming	Sam D Edwards	AI2011
Aqeel Shahzad	EE227	Digital Logic Design	Sheila Hughton	DS3011
Farah Naz	CS211	Discrete Structures	Yasmin Ahmed	SE110
Hamda Khan	SE110	Intro to Software Engineering	Sarah N Md Sallehuddin Khan	EE229
Usman Rashid	CS118	Programming Fundamentals	Sarah Nolasco	AI2011
Farah Jabeen Awan	CS219	Database Systems	Jenna Riley	EE229
Sara Aziz	CS220	Operating Systems	Usman Rafiq	CS307
Gul e Aisha	CS302	Design & Analysis of Algorithms	Reem N Hassan	MG220
Maimoona Rassol	CY2012	Digital Forensics	Sarah Hinett	CS328
Sajid Khan	CS307	Computer Networks	Kamal Anwar	EE229
Tayyab Nadeem	CS328	Software Engineering	Mika Tatsumoto	CS219
Mehboobullah	EE229	Computer Organization and Assembly Language	Muhammad Ijaz-UI-Haq	AI2011
Muhammad bin	AI2011	Programming for AI	Abdul Gafur	SS118
Qasim	DS3011	Big Data Analytics	Ana Vukojevic	CS307
Zainab Moin	CS328	Software Engineering	Arooba Zahoor	CS302
Sumera Abbas	CS218	Data Structures	Ahmad F Yang Abd Talib	MG223
Sadia Nauman	EE229	Computer Organization & Assembly Language	Natasha Leeson	CS328
Shahzad Mehmood	CS211	Discrete Structures	Ramesh R Singh	MG220
Sanaa Ilyas	MT224	Differential Equations	Sara Zamberlan	CS211
Nagina Safdar	SS113	Pakistan Studies	Adam N Starling	CS217
Asma Nisa	MG220	Marketing Management	Maria M Ponce Carpio	EE229
Sehrish Hassan	MG223	Fundamentals of Management	Iram Matloob	MT224
Waqas Munir	SS111	Islamic and Religious Studies	Sarah J Roberts	SS152
Usman Ashraf	SS152	Communication & Presentation Skills	Maria Lytras	CS307
Muhammad Usman	SS118	Psychology	Mohammad Abir	CS218
Naveed Ahmad	MT205	Probability and Statistics	Nabila Altaf	CS211
Zainab Abaid			Yasmin Ahmed	CS307
Rohail Gulbaz			Maria A Grenfell	MT205
Hassan Raza			Mohamed A Baalousha	MG220
etc.			Ayan Lowe	SE110
			Mohammed I Al Arfaj	SS152
			etc.	

SCREENSHOTS OF OUTPUT

SOLUTION FOUND!!!!

Week 1 : Mon

Room No	9 - 12	Morning Invigilator	2 - 5	Evening Invigilator
C308	MG220	Maheen Arshad	MT224	Sajid Khan
C303	SS113	Mehwish Hassan	SS118	Zainab Abaid
C306	SS111	Hamda Khan	CY2012	Muhammad Asim

Week 1 : Tue

Room No	9 - 12	Morning Invigilator	2 - 5	Evening Invigilator
C304	MG223	Aqeel Shahzad	MG223	Muhammad Usman

Week 1 : Thu

Room No	9 - 12	Morning Invigilator	2 - 5	Evening Invigilator
C304	DS3011	Behjat Zuhaira	CS211	Gul e Aisha
C303	EE227	Farah Naz	CS219	Sanaa Ilyas
C308	CS328	Hasan Mujtaba	MT224	Usman Rashid
C305	SE110	Rohail Gulbaz	AI2011	Shehreyar Rashid

Week 1 : Fri

Room No	9 - 12	Morning Invigilator	2 - 5	Evening Invigilator
C301	AI2011	Noor ul Ain	SS113	Farah Naz

Week 2 : Mon

Room No	9 - 12	Morning Invigilator	2 - 5	Evening Invigilator
C305	MT205	Noreen Jamil	CS328	Zainab Moin
C307	DS3011	Farah Jabeen Awan	CS302	Tayyab Nadeem
C302	MT205	Gul e Aisha	CS217	Muhammad bin Qasim

Week 2 : Tue

Room No	9 - 12	Morning Invigilator	2 - 5	Evening Invigilator
C309	CS307	Shoaib Mehboob	DS3011	Noreen Jamil
C304	CS307	Farwa Batool	CS302	Tayyaba Zainab

Week 2 : Wed

Room No	9 - 12	Morning Invigilator	2 - 5	Evening Invigilator
C306	CS218	Shahzad Mehmood	SE110	Ejaz Ahmed
C307	SS118	Tayyaba Zainab	CS328	Hassan Raza
C305	AI2011	Adnan Tariq	SS113	Arshad Islam

Week 2 : Thu

Room No	9 - 12	Morning Invigilator	2 - 5	Evening Invigilator
C309	CY2012	Ayesha Bano	SS111	Shafaq Riaz
C302	CS219	Farah Naz	MT224	Tayyaba Zainab
C304	CS220	Hasan Mujtaba	CS217	Subhan Ullah
C301	SE110	Asma Nisa	MT224	Mehreen Alam

Week 2 : Fri

Room No	9 - 12	Morning Invigilator	2 - 5	Evening Invigilator
C301	CS118	Farah Jabeen Awan	EE229	Sehrish Hassan
C309	SE110	Hassan Raza	CS328	Maimoona Rassol
C304	SS152	Usman Ashraf	CS219	Adnan Tariq
C305	CS217	Bilal Khalid	SS113	Subhan Ullah
C306	EE229	Hasan Mujtaba	SS113	Usman Rashid
C303	CS118	Shoaib Mehboob	SS113	Hassan Mustafa

HARD CONSTRAINTS

1: Exam is scheduled for each course = ☒☒  
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