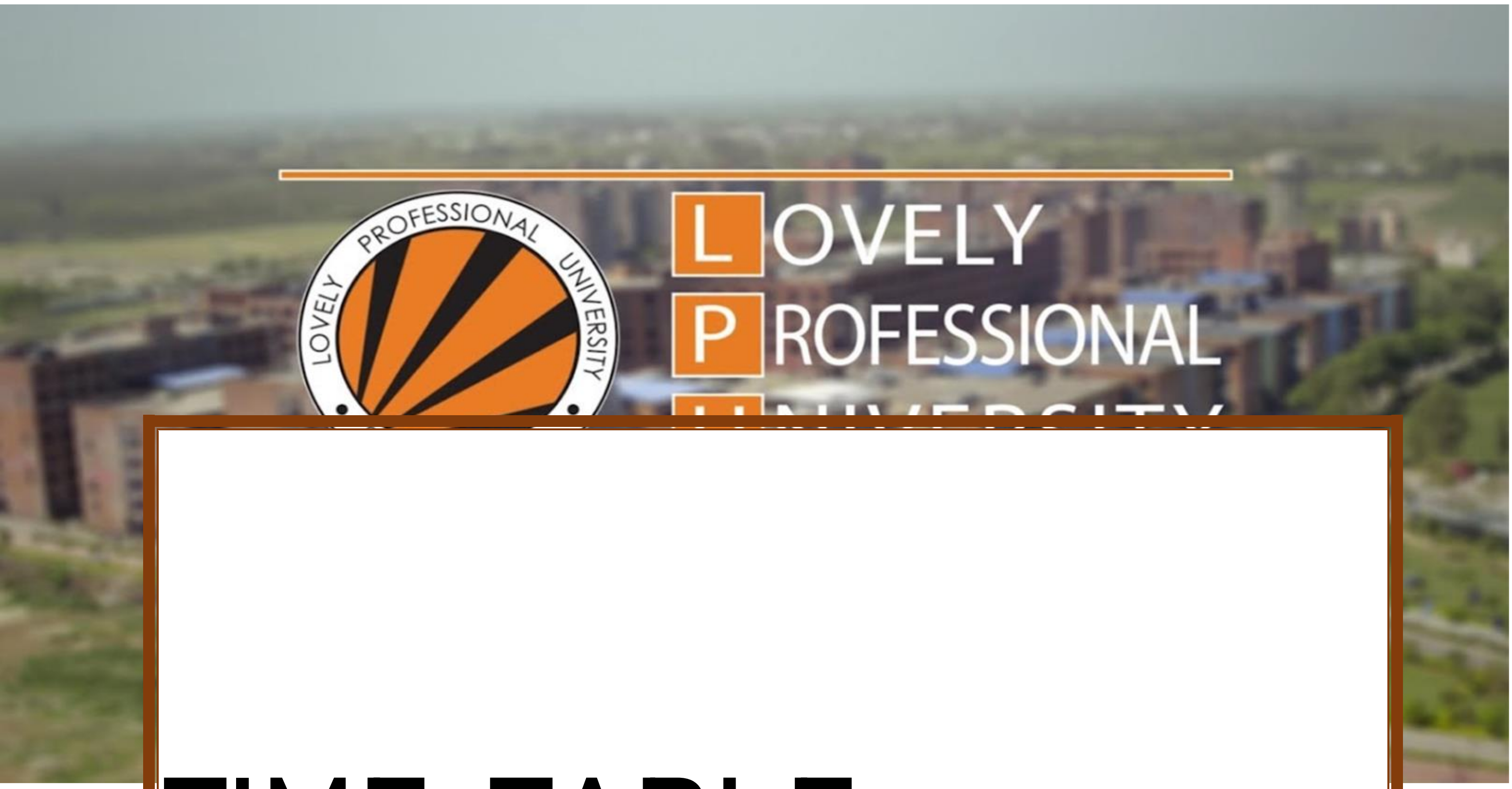

TIME-TABLE SCHEDULER

As a project work for course

ARTIFICIAL INTELLIGENCE{int-404}

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ROLL-55

INTRODUCTION

We worked on the topic allotted to us by our mam. The work is equally divided among all the members thus every member will have his own responsibility**.** The name of the topic is "the timetable scheduler". in this we created the algorithm. the algorithm comprised of

1. loading and processing of data
2. evolutionary strategy with shotgun hill climbing.

Our group worked well under our teacher's guidance. we were interested in doing this project because this was an essential topic nowadays. We faced some minor problems but still managed to do the project successfully and tested it. Results were surprising.

Our goal in this project report is to create a scheduler, which schedules the timetable.

The language used in this project was python language.

The version was (python 3.7.7)

METHODOLOGY

Algorithm

The algorithm is comprised in the following way:

Loading and processing the data

Load all the data from the input file and process it so that each class in the timetable has a list of acceptable classrooms instead of a type of classroom.

1+1 evolutionary strategy with shotgun hill-climbing (hard constraints)

This is the phase of the algorithm were we generate an arbitrary number of schedules that try to optimize for hard constraints, hence this is shotgun hill-climbing. They way we do this for each of these schedules is: Firstly, we generate a completely random timetable. Then, we use the 1+1 evolutionary strategy to improve out solution. The way in which find a neighbouring solution (one that we compare with the current one) is by using a mutation operator. As part of the mutation, we search for all classes that violate some hard constraint (with any resource) and we randomly choose one of them. Then we transfer that class in an unoccupied time frame, in one of the allowed classrooms for that class. If there exists no such combination of time frame and classroom, we transfer the class into a random time frame in one of the allowed classrooms. Also, we are careful of not accidentally placing a class to overlap days (start Monday evening, finish Tuesday morning) which is possible since we are representing the whole week as an array. If there are no more classes that violate hard constraints, we choose a random one and transfer it to an unoccupied time frame (in this phase we also optimize for the soft constraint of preferred order). Of all of the timetables we get by shotgun hill-climbing (recommended number is 5) we choose the best one (the one with the lowest cost function) to propagate to the next phase. Also, the recommended number of iterations for the 1+1 evolutionary strategy is 5000.

1+1 evolutionary strategy (soft constraints)

In this phase we optimize for soft constraints only, but we are wary of not violating any hard constraints in the process. The way we do this is similar as in the previous step. We run 15000 iterations of 1+1 evolutionary strategy on the previously obtained timetable. The difference compared to the previous step is that we use a different cost function (which takes into account all of the soft constraints, as well as the hard ones). Furthermore, we mutate the chromosome in a different way: We pick two classes at random and swap their places and assigned times. Besides this, we check if the two classes are compatible for swapping (if they use the same type of classrooms). After 15000 iterations, we assert that the algorithm has converged and we have our solution.

Saving the solution and displaying statistics

In the final step, we save the obtained schedule in a JSON file and we display all the relevant metrics regarding our solution. We also show metrics individually for all subjects, groups and professors

RESULTS

We were capable to run the time table scheduler. We scheduled the university teaching hours timetable. The basic elements were class, department, course (number, maximum no of students), room capacity, instructor…etc.

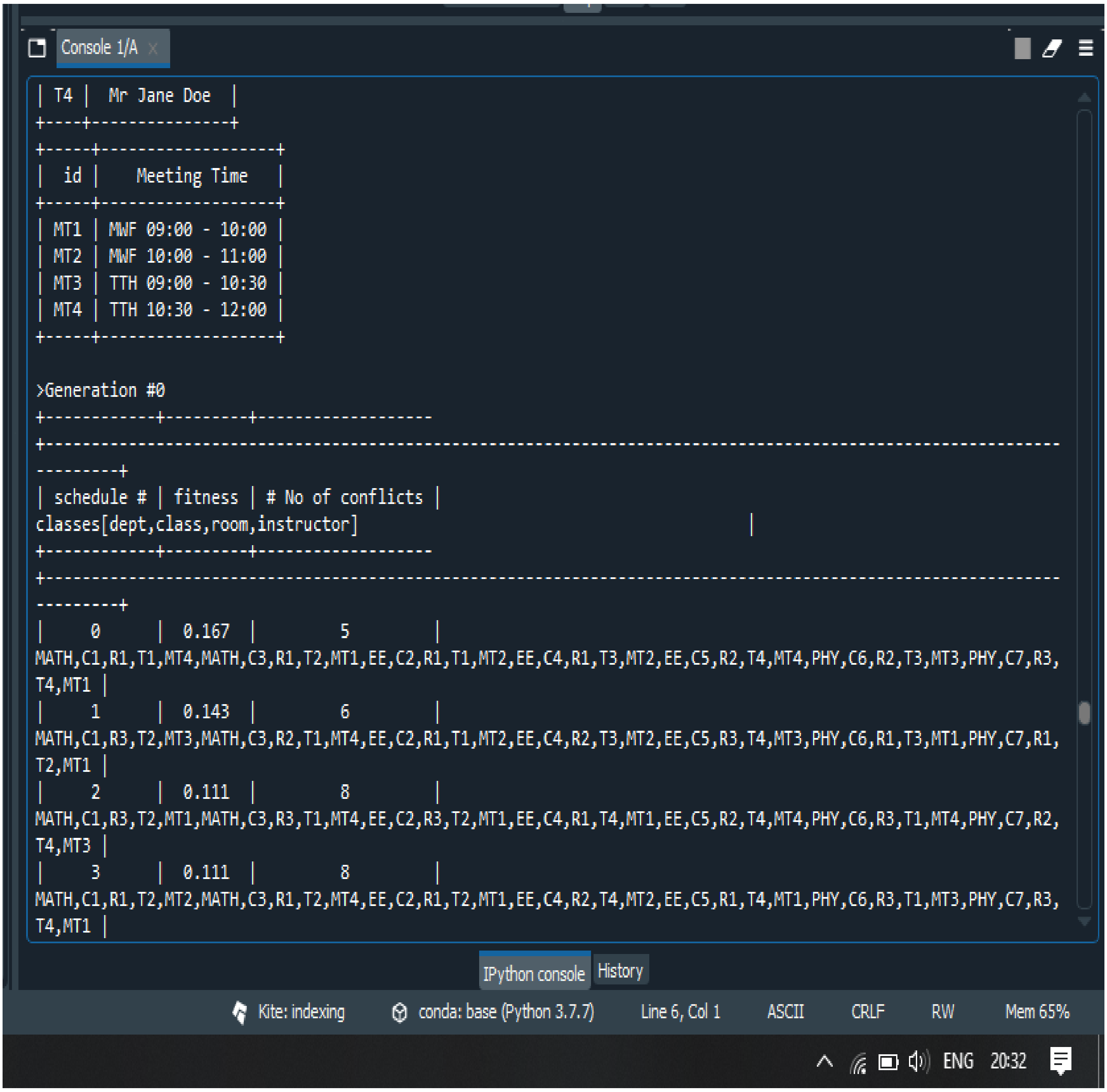
In the input phenomenon -The simple asks how many courses are there and which are they? It also asks that how many teachers are available? how much is the class room capacity? And what is the correct time slot?

And finally the scheduler gives this whole output to us.

We have added an example below for help with input and output.

Screenshots of outputs: -

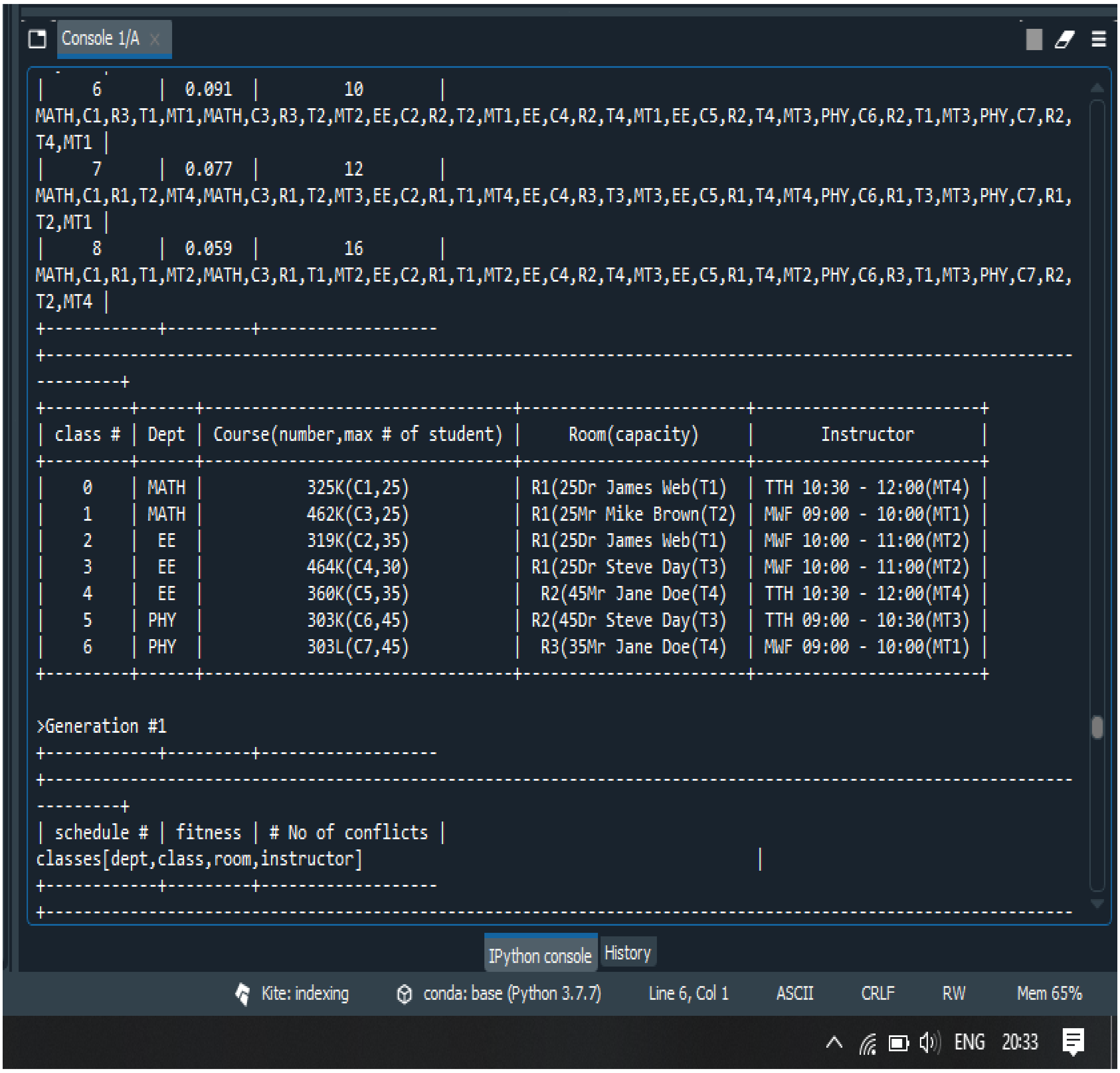
1.



```
| T4 |  Mr Jane Doe  |
+----+--------------+
+-----+------------------+
|  id |    Meeting Time   |
+-----+------------------+
| MT1 | MWF 09:00 - 10:00 |
| MT2 | MWF 10:00 - 11:00 |
| MT3 | TTH 09:00 - 10:30 |
| MT4 | TTH 10:30 - 12:00 |
+-----+------------------+

>Generation #0
+------------+---------+-----------------
+-----------------------------------------------------------------------------------------------------------
---------+
| schedule # | fitness | # No of conflicts |
classes[dept,class,room,instructor]                                           |
+------------+---------+-----------------
+-----------------------------------------------------------------------------------------------------------
---------+
|     0      |  0.167  |         5         |
MATH,C1,R1,T1,MT4,MATH,C3,R1,T2,MT1,EE,C2,R1,T1,MT2,EE,C4,R1,T3,MT2,EE,C5,R2,T4,MT4,PHY,C6,R2,T3,MT3,PHY,C7,R3,
T4,MT1 |
|     1      |  0.143  |         6         |
MATH,C1,R3,T2,MT3,MATH,C3,R2,T1,MT4,EE,C2,R1,T1,MT2,EE,C4,R2,T3,MT2,EE,C5,R3,T4,MT3,PHY,C6,R1,T3,MT1,PHY,C7,R1,
T2,MT1 |
|     2      |  0.111  |         8         |
MATH,C1,R3,T2,MT1,MATH,C3,R3,T1,MT4,EE,C2,R3,T2,MT1,EE,C4,R1,T4,MT1,EE,C5,R2,T4,MT4,PHY,C6,R3,T1,MT4,PHY,C7,R2,
T4,MT3 |
|     3      |  0.111  |         8         |
MATH,C1,R1,T2,MT2,MATH,C3,R1,T2,MT4,EE,C2,R1,T2,MT1,EE,C4,R2,T4,MT2,EE,C5,R1,T4,MT1,PHY,C6,R3,T1,MT3,PHY,C7,R3,
T4,MT1 |
```

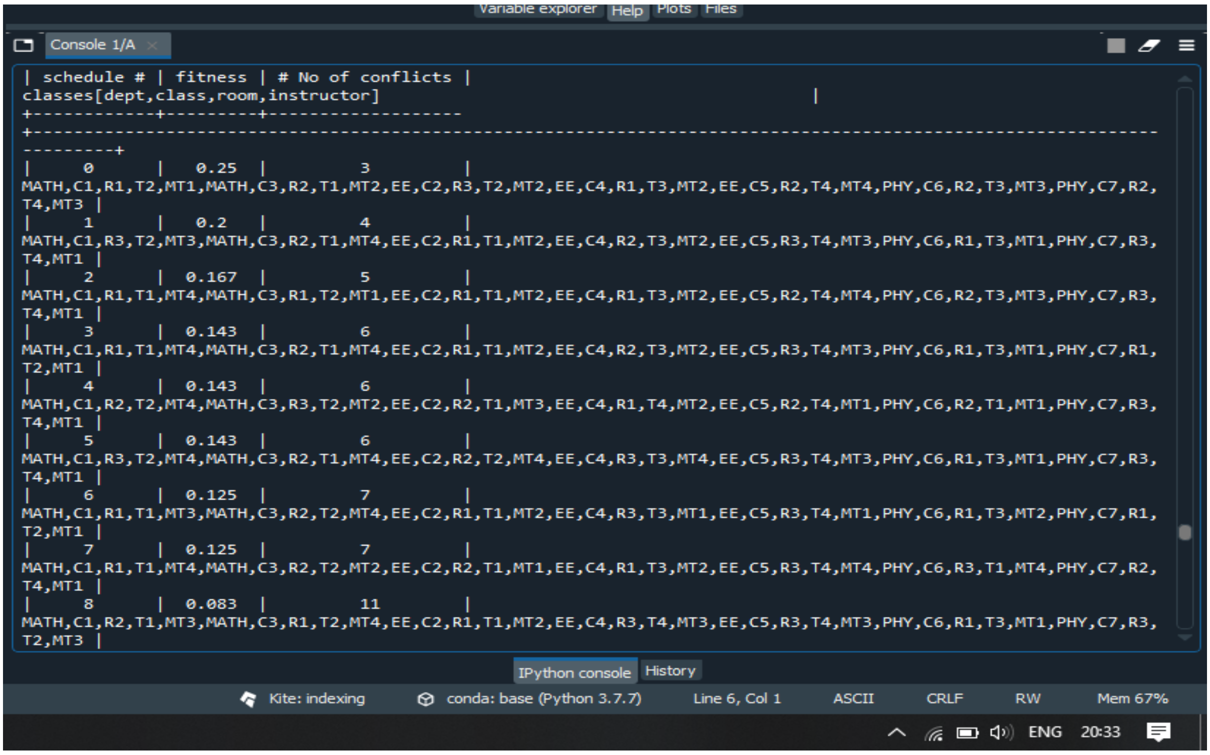
2.



```
|     6      |  0.091  |         10        |
MATH,C1,R3,T1,MT1,MATH,C3,R3,T2,MT2,EE,C2,R2,T2,MT1,EE,C4,R2,T4,MT1,EE,C5,R2,T4,MT3,PHY,C6,R2,T1,MT3,PHY,C7,R2,
T4,MT1 |
|     7      |  0.077  |         12        |
MATH,C1,R1,T2,MT4,MATH,C3,R1,T2,MT3,EE,C2,R1,T1,MT4,EE,C4,R3,T3,MT3,EE,C5,R1,T4,MT4,PHY,C6,R1,T3,MT3,PHY,C7,R1,
T2,MT1 |
|     8      |  0.059  |         16        |
MATH,C1,R1,T1,MT2,MATH,C3,R1,T1,MT2,EE,C2,R1,T1,MT2,EE,C4,R2,T4,MT3,EE,C5,R1,T4,MT2,PHY,C6,R3,T1,MT3,PHY,C7,R2,
T2,MT4 |
+------------+---------+------------------
+---------------------------------------------------------------------------------------------------------------
---------+
+---------+------+---------------------------------+-------------------------+-------------------------+
| class # | Dept | Course(number,max # of student) |     Room(capacity)      |        Instructor       |
+---------+------+---------------------------------+-------------------------+-------------------------+
|    0    | MATH |            325K(C1,25)          | R1(25Dr James Web(T1)   | TTH 10:30 - 12:00(MT4) |
|    1    | MATH |            462K(C3,25)          | R1(25Mr Mike Brown(T2)  | MWF 09:00 - 10:00(MT1) |
|    2    |  EE  |            319K(C2,35)          | R1(25Dr James Web(T1)   | MWF 10:00 - 11:00(MT2) |
|    3    |  EE  |            464K(C4,30)          | R1(25Dr Steve Day(T3)   | MWF 10:00 - 11:00(MT2) |
|    4    |  EE  |            360K(C5,35)          |  R2(45Mr Jane Doe(T4)   | TTH 10:30 - 12:00(MT4) |
|    5    | PHY  |            303K(C6,45)          | R2(45Dr Steve Day(T3)   | TTH 09:00 - 10:30(MT3) |
|    6    | PHY  |            303L(C7,45)          |  R3(35Mr Jane Doe(T4)   | MWF 09:00 - 10:00(MT1) |
+---------+------+---------------------------------+-------------------------+-------------------------+

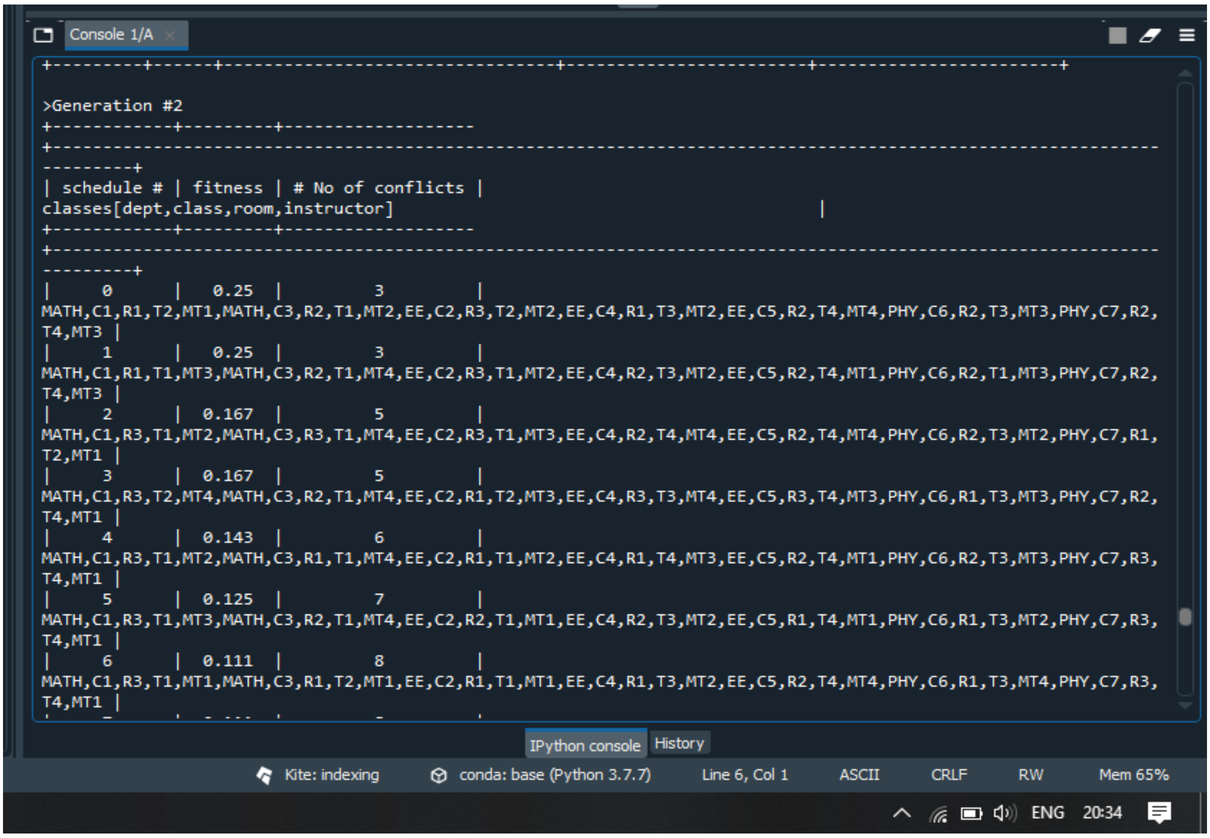
>Generation #1
+------------+---------+------------------
+---------------------------------------------------------------------------------------------------------------
---------+
| schedule # | fitness | # No of conflicts |
classes[dept,class,room,instructor]                                      |
+------------+---------+------------------
+---------------------------------------------------------------------------------------------------------------
```

3.



```
| schedule # | fitness | # No of conflicts |
classes[dept,class,room,instructor]                                    |
+------------+---------+------------------
+----------------------------------------------------------------------------------------------------------
---------+
|     0      |   0.25  |         3         |
MATH,C1,R1,T2,MT1,MATH,C3,R2,T1,MT2,EE,C2,R3,T2,MT2,EE,C4,R1,T3,MT2,EE,C5,R2,T4,MT4,PHY,C6,R2,T3,MT3,PHY,C7,R2,
T4,MT3 |
|     1      |   0.2   |         4         |
MATH,C1,R3,T2,MT3,MATH,C3,R2,T1,MT4,EE,C2,R1,T1,MT2,EE,C4,R2,T3,MT2,EE,C5,R3,T4,MT3,PHY,C6,R1,T3,MT1,PHY,C7,R3,
T4,MT1 |
|     2      |  0.167  |         5         |
MATH,C1,R1,T1,MT4,MATH,C3,R1,T2,MT1,EE,C2,R1,T1,MT2,EE,C4,R1,T3,MT2,EE,C5,R2,T4,MT4,PHY,C6,R2,T3,MT3,PHY,C7,R3,
T4,MT1 |
|     3      |  0.143  |         6         |
MATH,C1,R1,T1,MT4,MATH,C3,R2,T1,MT4,EE,C2,R1,T1,MT2,EE,C4,R2,T3,MT2,EE,C5,R3,T4,MT3,PHY,C6,R1,T3,MT1,PHY,C7,R1,
T2,MT1 |
|     4      |  0.143  |         6         |
MATH,C1,R2,T2,MT4,MATH,C3,R3,T2,MT2,EE,C2,R2,T1,MT3,EE,C4,R1,T4,MT2,EE,C5,R2,T4,MT1,PHY,C6,R2,T1,MT1,PHY,C7,R3,
T4,MT1 |
|     5      |  0.143  |         6         |
MATH,C1,R3,T2,MT4,MATH,C3,R2,T1,MT4,EE,C2,R2,T2,MT4,EE,C4,R3,T3,MT4,EE,C5,R3,T4,MT3,PHY,C6,R1,T3,MT1,PHY,C7,R3,
T4,MT1 |
|     6      |  0.125  |         7         |
MATH,C1,R1,T1,MT3,MATH,C3,R2,T2,MT4,EE,C2,R1,T1,MT2,EE,C4,R3,T3,MT1,EE,C5,R3,T4,MT1,PHY,C6,R1,T3,MT2,PHY,C7,R1,
T2,MT1 |
|     7      |  0.125  |         7         |
MATH,C1,R1,T1,MT4,MATH,C3,R2,T2,MT2,EE,C2,R2,T1,MT1,EE,C4,R1,T3,MT2,EE,C5,R3,T4,MT4,PHY,C6,R3,T1,MT4,PHY,C7,R2,
T4,MT1 |
|     8      |  0.083  |         11        |
MATH,C1,R2,T1,MT3,MATH,C3,R1,T2,MT4,EE,C2,R1,T1,MT2,EE,C4,R3,T4,MT3,EE,C5,R3,T4,MT3,PHY,C6,R1,T3,MT1,PHY,C7,R3,
T2,MT3 |
```

4.



```
+---------+------+---------------------------------+------------------------+------------------------+

>Generation #2
+------------+---------+------------------
+----------------------------------------------------------------------------------------------------------
---------+
| schedule # | fitness | # No of conflicts |
classes[dept,class,room,instructor]                                    |
+------------+---------+------------------
+----------------------------------------------------------------------------------------------------------
---------+
|     0      |   0.25  |         3         |
MATH,C1,R1,T2,MT1,MATH,C3,R2,T1,MT2,EE,C2,R3,T2,MT2,EE,C4,R1,T3,MT2,EE,C5,R2,T4,MT4,PHY,C6,R2,T3,MT3,PHY,C7,R2,
T4,MT3 |
|     1      |   0.25  |         3         |
MATH,C1,R1,T1,MT3,MATH,C3,R2,T1,MT4,EE,C2,R3,T1,MT2,EE,C4,R2,T3,MT2,EE,C5,R2,T4,MT1,PHY,C6,R2,T1,MT3,PHY,C7,R2,
T4,MT3 |
|     2      |  0.167  |         5         |
MATH,C1,R3,T1,MT2,MATH,C3,R3,T1,MT4,EE,C2,R3,T1,MT3,EE,C4,R2,T4,MT4,EE,C5,R2,T4,MT4,PHY,C6,R2,T3,MT2,PHY,C7,R1,
T2,MT1 |
|     3      |  0.167  |         5         |
MATH,C1,R3,T2,MT4,MATH,C3,R2,T1,MT4,EE,C2,R1,T2,MT3,EE,C4,R3,T3,MT4,EE,C5,R3,T4,MT3,PHY,C6,R1,T3,MT3,PHY,C7,R2,
T4,MT1 |
|     4      |  0.143  |         6         |
MATH,C1,R3,T1,MT2,MATH,C3,R1,T1,MT4,EE,C2,R1,T1,MT2,EE,C4,R1,T4,MT3,EE,C5,R2,T4,MT1,PHY,C6,R2,T3,MT3,PHY,C7,R3,
T4,MT1 |
|     5      |  0.125  |         7         |
MATH,C1,R3,T1,MT3,MATH,C3,R2,T1,MT4,EE,C2,R2,T1,MT1,EE,C4,R2,T3,MT2,EE,C5,R1,T4,MT1,PHY,C6,R1,T3,MT2,PHY,C7,R3,
T4,MT1 |
|     6      |  0.111  |         8         |
MATH,C1,R3,T1,MT1,MATH,C3,R1,T2,MT1,EE,C2,R1,T1,MT1,EE,C4,R1,T3,MT2,EE,C5,R2,T4,MT4,PHY,C6,R1,T3,MT4,PHY,C7,R3,
T4,MT1 |
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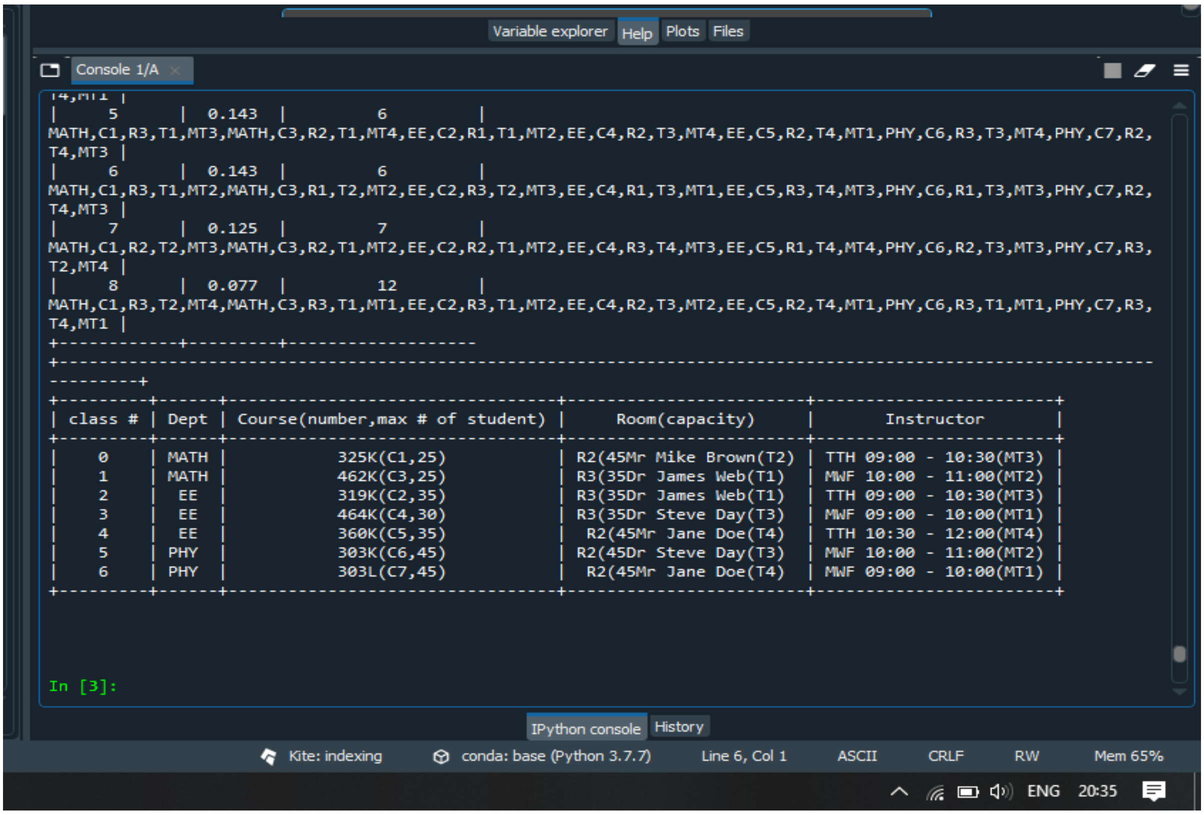
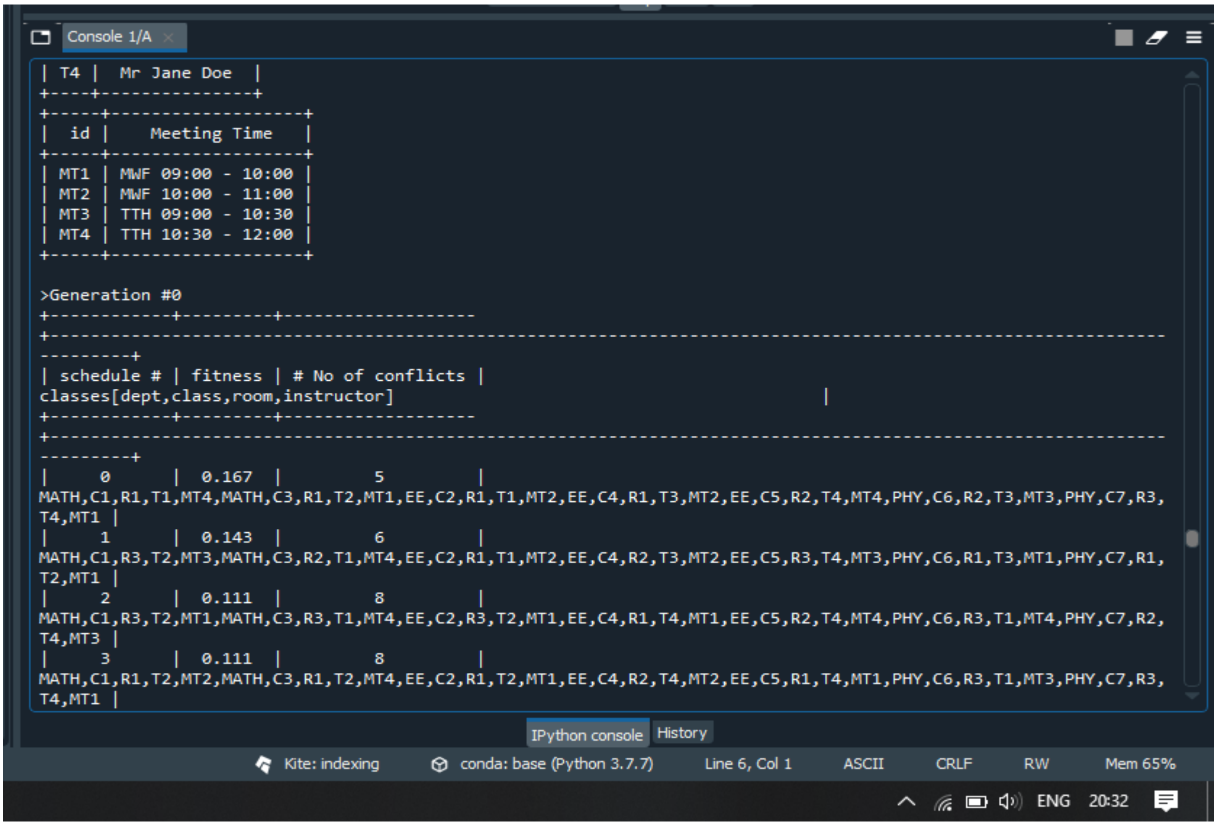
5.



```
T4,MT1 |
|     5      |  0.143  |         6          |
MATH,C1,R3,T1,MT3,MATH,C3,R2,T1,MT4,EE,C2,R1,T1,MT2,EE,C4,R2,T3,MT4,EE,C5,R2,T4,MT1,PHY,C6,R3,T3,MT4,PHY,C7,R2,
T4,MT3 |
|     6      |  0.143  |         6          |
MATH,C1,R3,T1,MT2,MATH,C3,R1,T2,MT2,EE,C2,R3,T2,MT3,EE,C4,R1,T3,MT1,EE,C5,R3,T4,MT3,PHY,C6,R1,T3,MT3,PHY,C7,R2,
T4,MT3 |
|     7      |  0.125  |         7          |
MATH,C1,R2,T2,MT3,MATH,C3,R2,T1,MT2,EE,C2,R2,T1,MT2,EE,C4,R3,T4,MT3,EE,C5,R1,T4,MT4,PHY,C6,R2,T3,MT3,PHY,C7,R3,
T2,MT4 |
|     8      |  0.077  |         12         |
MATH,C1,R3,T2,MT4,MATH,C3,R3,T1,MT1,EE,C2,R3,T1,MT2,EE,C4,R2,T3,MT2,EE,C5,R2,T4,MT1,PHY,C6,R3,T1,MT1,PHY,C7,R3,
T4,MT1 |
+------------+---------+-------------------
+------------------------------------------------------------------------------------------------------------
---------+
+---------+------+--------------------------------+-------------------------+------------------------+
| class # | Dept | Course(number,max # of student) |     Room(capacity)      |       Instructor       |
+---------+------+--------------------------------+-------------------------+------------------------+
|    0    | MATH |           325K(C1,25)          | R2(45Mr Mike Brown(T2) | TTH 09:00 - 10:30(MT3) |
|    1    | MATH |           462K(C3,25)          | R3(35Dr James Web(T1)  | MWF 10:00 - 11:00(MT2) |
|    2    |  EE  |           319K(C2,35)          | R3(35Dr James Web(T1)  | TTH 09:00 - 10:30(MT3) |
|    3    |  EE  |           464K(C4,30)          | R3(35Dr Steve Day(T3)  | MWF 09:00 - 10:00(MT1) |
|    4    |  EE  |           360K(C5,35)          |  R2(45Mr Jane Doe(T4)  | TTH 10:30 - 12:00(MT4) |
|    5    | PHY  |           303K(C6,45)          | R2(45Dr Steve Day(T3)  | MWF 10:00 - 11:00(MT2) |
|    6    | PHY  |           303L(C7,45)          |  R2(45Mr Jane Doe(T4)  | MWF 09:00 - 10:00(MT1) |
+---------+------+--------------------------------+-------------------------+------------------------+


In [3]:
```

6.



```
| T4 |  Mr Jane Doe  |
+----+---------------+
+-----+-------------------+
|  id |    Meeting Time   |
+-----+-------------------+
| MT1 | MWF 09:00 - 10:00 |
| MT2 | MWF 10:00 - 11:00 |
| MT3 | TTH 09:00 - 10:30 |
| MT4 | TTH 10:30 - 12:00 |
+-----+-------------------+

>Generation #0
+------------+---------+-------------------
+------------------------------------------------------------------------------------------------------------
---------+
| schedule # | fitness | # No of conflicts |
classes[dept,class,room,instructor]                                                   |
+------------+---------+-------------------
+------------------------------------------------------------------------------------------------------------
---------+
|     0      |  0.167  |         5          |
MATH,C1,R1,T1,MT4,MATH,C3,R1,T2,MT1,EE,C2,R1,T1,MT2,EE,C4,R1,T3,MT2,EE,C5,R2,T4,MT4,PHY,C6,R2,T3,MT3,PHY,C7,R3,
T4,MT1 |
|     1      |  0.143  |         6          |
MATH,C1,R3,T2,MT3,MATH,C3,R2,T1,MT4,EE,C2,R1,T1,MT2,EE,C4,R2,T3,MT2,EE,C5,R3,T4,MT3,PHY,C6,R1,T3,MT1,PHY,C7,R1,
T2,MT1 |
|     2      |  0.111  |         8          |
MATH,C1,R3,T2,MT1,MATH,C3,R3,T1,MT4,EE,C2,R3,T2,MT1,EE,C4,R1,T4,MT1,EE,C5,R2,T4,MT4,PHY,C6,R3,T1,MT4,PHY,C7,R2,
T4,MT3 |
|     3      |  0.111  |         8          |
MATH,C1,R1,T2,MT2,MATH,C3,R1,T2,MT4,EE,C2,R1,T2,MT1,EE,C4,R2,T4,MT2,EE,C5,R1,T4,MT1,PHY,C6,R3,T1,MT3,PHY,C7,R3,
T4,MT1 |
```