# Exam Scheduler — Assignment 1

1) **Problem statement for this AI problem:**

- For the problem of scheduling the examinations, we can define the problem statement as:

  **Inputs:**

  A. Set of examinations
  B. Set of students for each examination
  C. Set of days available
  D. Set of time slots for each day

  **Output:**

  A schedule for the examinations based on the inputs given and the constraints mentioned underneath.

- For the problem of assignment of coordination duties for the invigilators, venue allotment and preparation of seating plan, we can define the problem statement as:

  **Inputs:**

  A. Set of examinations scheduled in each time slot for each day
  B. Set of classrooms available
  C. Seating capacity of each classroom, along with the number of benches in each of them.
  D. Set of research scholars and professors available for invigilation duty

  **Output:**

  A duty-schedule for the invigilators and seating plan of the students for each time slot of each day, based on the inputs given and the constraints mentioned underneath.

2) **Constraints:**

- Problem of scheduling the examinations :

  1. Atomic Variables: Exam
     Constraint: All exams must be scheduled only once.

  2. Atomic Variables: Time slot, Day, Exam, Student
     Constraint: A student should have at most one exam in a particular time slot of a day.

  3. Atomic Variables: Day, Exam, Student

Constraint: A student should have no more than two exams in a day.

4. Atomic Variables: Day, Exam, Student
   Constraint: If a student has two exams in a day, there should be a minimum of 1 hour duration between the completion time of the first exam and beginning of the second exam.

- Problem of assignment of coordination duties for the invigilators, venue allotment and preparation of seating plan for the students :

1. Atomic Variables: Time slot, Day, Classroom, Research scholar, Professor
   Constraint: A research scholar or a professor can be assigned invigilation duty in no more than one classroom in a particular time slot of a day.

2. Atomic Variables: Day, Time slot, Research scholar, Professor
   Constraint: A research scholar or a professor should be assigned invigilation duty in no more than one time slot in a day.

3. Atomic Variables: Classroom, Professor
   Constraint: Every classroom should have exactly one professor as invigilator.

4. Atomic Variables : Classroom, Seating capacity, Research scholar
   Constraint: If seating capacity of a classroom is less than 40, exactly one research scholar should be given invigilation duty in that classroom; else if seating capacity is more than 40 but less than or equal to 90, exactly 2 research scholars should be allotted; else if it is greater than 90, 3 research scholars should be alloted.

5. Atomic Variables: Classroom, Time slot, Day, Professor
   Constraint: Number of classrooms in which exams are to be conducted in a particular time slot of a day should be less than or equal to the number of professors available at that period of time.

6. Atomic Variables: Classroom, Seating capacity, Time slot, Day, Student
   Constraint: Number of students who are allotted a particular classroom in a time slot of a day should be less than or equal to the seating capacity of the classroom.

7. Atomic Variables: Classroom, Seats, Bench, Exam, Student
   Constraint: No two students giving the same exam should be allotted consecutive seats (one beside the other) in the same bench.

**3) a) Why is this an AI problem and not just a ML problem?**

Solution pipeline :

Firstly, we will focus on the problem of preparing the exam schedule. For this, at first we select an exam randomly and put it in the first slot of the first day. Then we will check the list of students of other exams and compare them with that of the exam scheduled. One of the exams which have no students common with the scheduled one is then put in the same slot of the same day. We can repeat this procedure of comparing the students' list of unscheduled exams with the scheduled ones for a particular slot of a day, until say at least 5 exams are scheduled in that slot of the day. We will repeat this procedure for other slots of each day. If two exams are scheduled for any student in the same day, then we will consider checking the constraint concerned with that condition.

Secondly, for the problem of venue allotment and preparation of seating plan, we calculate the total no. of seats in each venue. Then we compare the total no. of seats in the venue with maximum capacity with the total no. of students in the 4 or 5 exams (no. of exams may vary) consisting of maximum students. We then allot the proper no. of students giving those exams to that venue. We repeat this procedure until all exams get a venue allotted. For the seating plan, we calculate the total no. of seats available and compare it with total no. of students giving exams in a particular slot of a day. Accordingly, we assign seats to each student sequentially, by following the constraints concerned.

Lastly, for the duty schedule of invigilators, we will randomly assign a professor, from the available list of professors, to each classroom. Next we will assign the research scholars randomly to the classrooms, by following the constraint related to number of research scholars and seating capacity of a classroom. Once a professor or a research scholar is alloted duty in a slot of a day, he/she is to be removed from the list of available invigilators for that day, according to constraint 2 of duty assignment problem. This process is repeated for every slot of each day.

Why is this an AI problem and not a ML one?

In a ML problem, generally the parameters are trained on some training data and the prediction on new data is made based on those parameters (Supervised Learning); or the prediction algorithm tries to find some similarity between some sets of available data and predict accordingly (Unsupervised Learning).

In this problem, firstly we are not using any training data. We have some inputs and we are trying to prepare the best possible timetable and seating plan which follows all the constraints which we have modeled. Unlike ML problems, we are not using lots of timetables and sitting plans as training data to make the machine learn how to prepare exam scheduler. Rather, we are taking the inputs regarding the exams to be scheduled, students appearing in the exams, and the available resources; and then we trying to prepare a schedule and sitting plan which satisfies the constraints. Here we are using a human-like approach, and the machine continues to try until it finds a timetable and sitting plan in which all the constraints are satisfied. This is thus an AI problem in which the machine takes a human-like approach of satisfying all the constraints, and neither use loads of training data like a supervised ML problem nor does it try to cluster any available data like an unsupervised ML problem.

**b) If modelled as an ML problem, what "data" will you assume to have? What paradigm(s) and architecture(s) will form your models in the solution pipeline to solve the overall problem of automation?**

Data :
Inputs, as mentioned in the problem statement, and sufficient no. of pre-designed timetables, duty schedules ,and seating plans for training our model.

Formulation of the model :
We can take the inputs as specified in the problem statement and formulate some mathematical expressions for the constraints by taking the atomic variables as variables for those expressions. Next we can associate some cost to the conditions where the proposed constraints are violated and design some cost function accordingly. Our aim would be to minimize the cost for our designed timetable, duty schedule, or seating plan. We will make the parameters associated with the cost function to learn from the manually pre-designed timetables, or seating plans as necessary.

Architecture :
We can use the Neural Networks architecture for preparing our model.