The Maximum Seats Allocation Problem

Context. The current Covid-19 outbreak caused changes not only in different areas like social life, economy, health system, education but also in our behaviors. Wearing a mask, taking more care on hygiene etc., respecting distances etc. become parts of our life in order to hopefully prevent the spread of the pandemic. In universities, respecting the distances among students, attending the classes in classrooms and amphitheaters, is even more important. Hence, the topic of this project is the problem of designing an optimum seat layout of classrooms that minimizes the risk of the infection for students and teachers.

Problem Definition. The Maximum Seats Allocation Problem (MSAP) aims to maximize the number of seated students in a classroom, while maintaining the minimum social distance restriction. Let a classroom (amphitheater) containing n seats, with seats number from 1 to n. Each set i is considered as a point with coordinates (x_i, y_i) and hence the distance between two seats is calculated as the Euclidian distance between two points in the plane. For example, the distance d_{ij} between two seats i and j is calculated as $d_{ij} = \sqrt{(x_i - x_j)^2 + (y_i - y_j)^2}$. The minimum social distance restriction requires that the minimum distance between two occupied seats is greater or equal than a given parameter β.

Benchmark instances. The instance to be considered has the following layout. Seats are divided in three sectors. The first sector S1 contain 32 seats organized as 8 rows of 4 seats, sector S2 contains 9 rows of 3 seats and sector S3 contains 10 rows of 4 seats. Hence, in total classroom has 99 seats. The distance between sectors S1 and S2 and between S2 and S3 is 120 cm. The distance between neighboring seats in the same row is 50 cm, while the distance between the neighboring rows and hence the distance between sets in neighboring rows in the same sector is 75 cm. Using the preceding information generate the benchmark instance considering that the first seat in the first row of sector S1 has coordinates (0,0). The values of parameter β, minimum distance, to be considered are 1m, 1.2m, 1.4m, 1.6m, 1.8m and 2m.

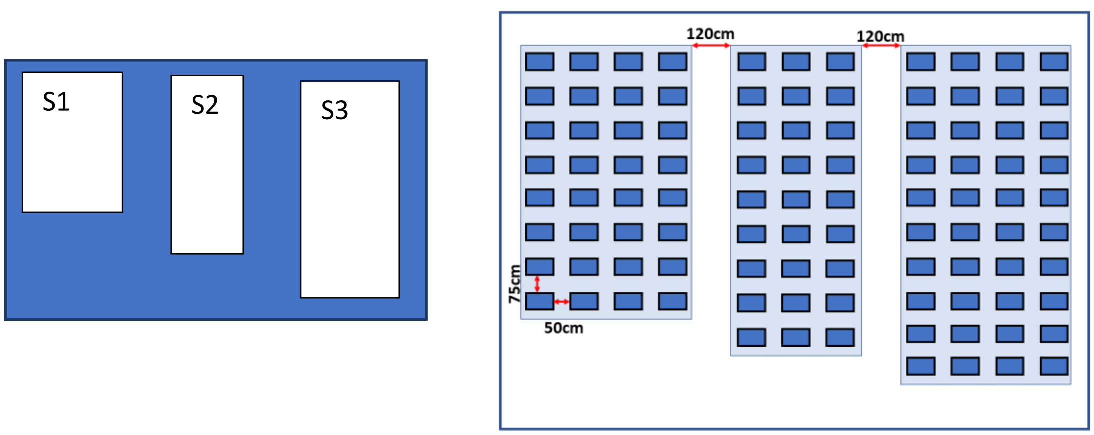

Figure 1. Classroom layout to be considered.

Tasks. Design an algorithm which determines (near-)optimal solution of The Maximum Seats Allocation Problem and hence determines the optimal occupation of seats in a classroom while respecting the minimum distance requirement. The complexity of used data structures and different sub-routines of algorithm need to be estimated and explained.

The “compte rendu” needs to contain report with the detailed description of the designed algorithm and the detailed computational results (Tables need to include solution values and CPU times). In addition, the source code of the algorithm along with explanation how to execute it needs to be uploaded on Moodle.

Routines to be developed:

1) Reading the data and representing a solution (Hint: solution may be represented as 0-1 (matrix/array));
2) Procedure for constructing an initial feasible solution (Hint: greedy initial solution)
3) Procedure to verify if solution is feasible or not;
4) Procedure to calculate the number of occupied seats in the solution;
5) Local search procedures (Hint: 1-flip LS (changing one element in the matrix (e.g., 0 becomes 1, 1 becomes 0)); LS swap);
6) Developing a metaheuristic algorithm that uses above procedures.