Assignment 1 **Random Search**

Aims:

To perform a random search for a given problem, to compute a quality measure for the solution candidates, to make some statistical analysis to a sample set of possible solutions.

Task:

Develop an application in python that has the following functionalities:

1. Randomly creates possible solutions for your assigned problem (Random Candidate Solution Generator) (25p).
2. Check if a candidate to the solution is indeed a viable solution (25p).
3. Assigns a measure of quality (a positive value) to a candidate solution - where zero marks a correct one and, as the candidate is more and more farther from the correct solution the number grows (Fitness Function) (25p).
4. For a sample set (of size *n*) of random generated solutions, the mean and the standard deviation of their quality measures is computed (25p).

Time: 1 h 30 min (the deadline is at the end of the first lab.)

Example:

For the TSP (Travel Salesman Problem)

A random possible solution is a random itinerary between the cities. A candidate is a viable solution if there is a path between each two adjacent cities from the randomly generated permutation. A fitness can be: the number of cities - the number of existing paths between adjacent cities - 1.

The mean is:

$$m = (f_1 + f_2 + ... + f_n)/n$$

and the standard deviation is:

$$\sigma = \sqrt{\frac{\sum_{i=1}^{n} (f_i - m)^2}{n}},$$

where f_1, f_2, …, f_n are the fitness values for each of the *n* attempts to create a solution with the random candidate solution generator.

Problems:

1. *People sitting on chairs*

A group of *n* (*n* <= *10*) persons numbered from *1* to *n* are placed on a row of seats, but between any two neighbors arose some conflict of interest. Check possible ways of resettling the people in such way that between any two persons in conflict will sit one, or at most two other persons.

2. *Lottery*

We have *n* balls, *p* from them are white, and the rest blue. Each ball has a label of character type (letter of the alphabet). Check all the possibilities to select *k* balls, at least *a* of them have to be white, and at least one white ball has to be tagged with a vowel.

3. *Parents and children*

For *n* given people (*1, 2, ... , n*) and *p* pairs *(i, j)* meaning that *i* is the son of *j*, place all the people to sit in a row so that each person is before his sons.

4. *Soccer Tournament*

A football club must participate with a team at an important match in the national championship. Knowing the total goalkeepers, strikers, defenders and midfielders that are members of the club and knowing that a team has exactly a goalkeeper and at least every two forwards, two midfielders and two defenders, and the total number of athletes is 11 (we do not take in account the reserves), find possibilities to form a team.

5. *The tower of cubes*

Having *n* cubes labeled *1* to *n*, of edges L_i and colors C_i , $1 \leq i \leq n$, display towers of *k* cubes that can be formed such that the cubes in the tower have the sides in descending order from the bottom to up, and the adjacent cubes has to be of different colors.

6. *Orchard*

A farmer wants to plant 2*n saplings of fruit trees of different heights in two equal rows, in such way that the heights of the trees from the same line have be in ascending order (from left to right) and, in addition, each tree from the first line has to be higher than the corresponding tree from the second line. Display possible ways of planting.

7. *School Scheduling*

Specify arrangements for allocating math's hours (3 hours/week), physics (2 hours/week) and informatics (3 hours/week) in a class schedule knowing that in every day should be scheduled at least one of these classes and at most 3 of them.

8. *Contest*

At the start of a contest there are present *n* competitors. Find possibilities to enter the competitors in the contest (competitors enter in the competition one at a time) in the event that for reasons more or less objective the competitor with code c_1 must enter the contest between the top 3 and the competitor c_2 must enter the contest between the last two.

9. *Pupils' banquet*

Several students participate at some banquet. We know that students are part of *k* parallel classes. For each class is known the number of girls and the number of boys. Find proper ways to arrange the students (there is only one round table where all the students will be placed) so that:

- Every girl should have at the table two boys as neighbors;
- No student will be neighbor with colleagues from his class.

10. *Training*

A trainer must remove *m* lions and *n* tigers from arena in such way that no two tigers are taken out one after another. Display possible valid sequences of lions and tigers.

11. *Caravan*

A caravan of *n* camels is traveling through desert in a single line. To break the monotony of the long traveling days, each other day the camels are settled so it doesn't see the same camel in front of her before. Generate possibilities to arrange the camels, knowing how were place in the first day.

12. *Train*

For the composition of a train, the Regulation stipulates:

- Each dining car must have to the left and right at least one passenger coach;
- Each boxcar is followed (looking from the locomotive towards the last wagon) by at least one passenger coach;
- Any train set must contain at least one boxcar.

Consider n (n <= 10) the number of train cars from a train-set. Determine variants of trains that can be made.

13. *Aptitude test*

A set of n questions are available in order to develop an aptitude test, question *i* being rated with p_i points. It is required to develop questionnaires having the total number of questions between *u* and *v* and summarizing between *x* and *y* points.

14. *Travel Itinerary*

A tourist wants to visit several cities in a country. For every city is known the number of existing tourist attractions. The tourist wants:

- To visit at least x and y at most cities;
- Let's go through each city only once;
- The number of goals in the first half visited the tournament to be higher than the number of goals in the second half visited;
- To visit at least p sights.

Determine possible itineraries (it is known that there is direct path between any two cities).