Travelling salesman problem
Genetic algorithm
Simulation in Greenfoot

Genetic Algorithms (GAs) are adaptive heuristic search algorithm based on the evolutionary ideas of natural selection and genetics. As such they represent an intelligent exploitation of a random search used to solve optimization problems. Although randomised, GAs are by no means random, instead they exploit historical information to direct the search into the region of better performance within the search space. The basic techniques of the GAs are designed to simulate processes in natural systems necessary for evolution [1].Genetic algorithms tend to thrive in an environment in which there is a very large set of candidate solutions and in which the search space is uneven and has many hills and valleys. [2].

GA is based on the notion of population composed of individuals, a population that is modified by selection, crossover and mutation operators. The selection seeks to choose individuals who have a better fittness. For selection, the roulette wheel method is usually used, where each individual has the chance to be selected, but those with the larger fitness are favored. The crossover operator creates new chromosomes by combining two randomly chosen parent chromosomes. The mutation operator changes the value of a gene from the chromosome .

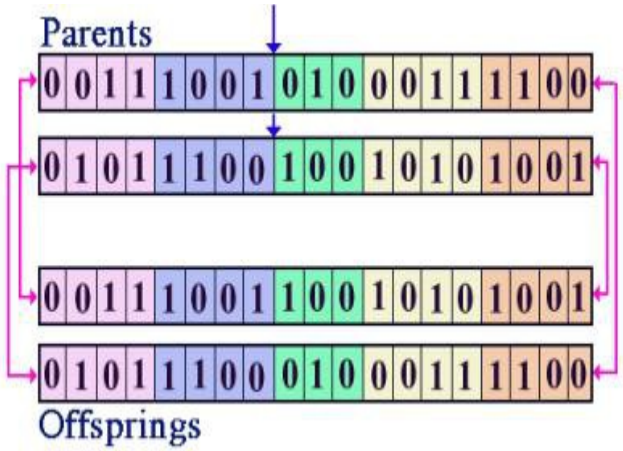


Illustration 2: http://www.intelligentsolutionsinc.com/Technology/AITheory/AI2-GA.shtml

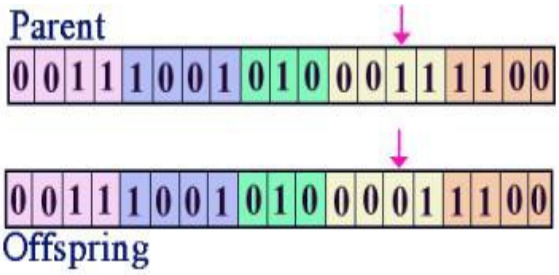


Illustration 1: http://www.intelligentsolutionsinc.com/Technology/AITheory/AI2-GA.shtml

Travelling salesman problem (**TSP**) asks the following question: "Given a list of cities and the distances between each pair of cities, what is the shortest possible route that visits each city exactly once and returns to the origin city?". It is an NP-hard problem in combinatorial optimization, important in operations research and theoretical computer science. The problem was first formulated in 1930 and is one of the most intensively studied problems in optimization. It is used as a benchmark for many optimization methods. The TSP has several applications even in its purest formulation, such as planning, logistics, and the manufacture of microchips. [3]

Rezolvarea TSP cu ajutorul GA-

There is the problem of representation - a sequence of cities represented by numbers. The chromosome will contain a random sequence, a real permutation of the town. Crossover - take a portion of a chromosome and then fill in the unused city numbers in the chromosome resulting from a second chromosome. Mutation is a swap between two cities.

Implementation in Greenfoot

I used for simulation a instance of 51 cities, a population of 100 chromosomes, fitness function Cartesian distance between cities. Cities are represented by points in a 2D plane.

Stages of the algorithm:

- inittialization of cities
- generating chromosomes with random paths
- population evaluting
- chromosome selection
- crosover
- mutation

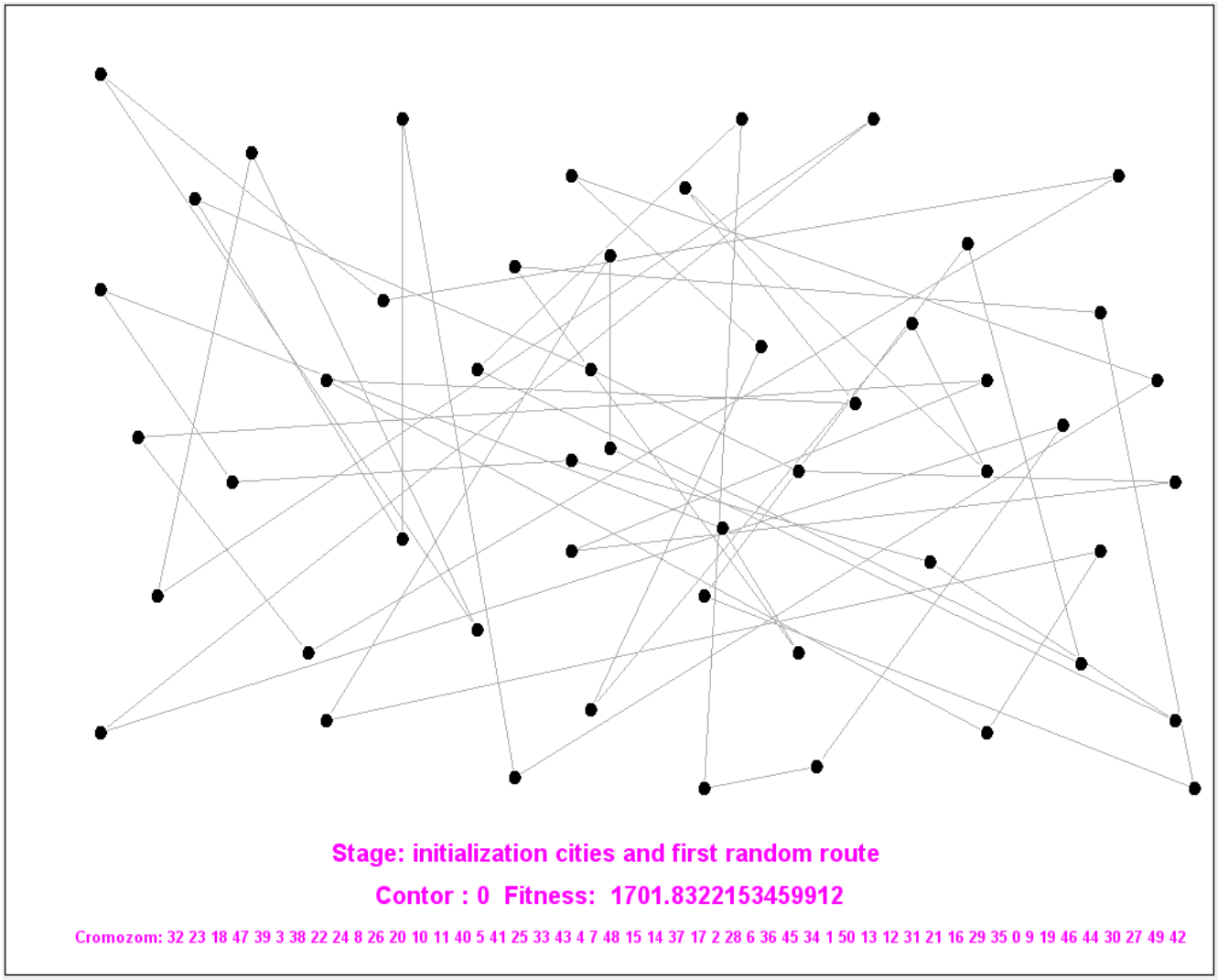


Illustration 3: Initialization cities and first random route

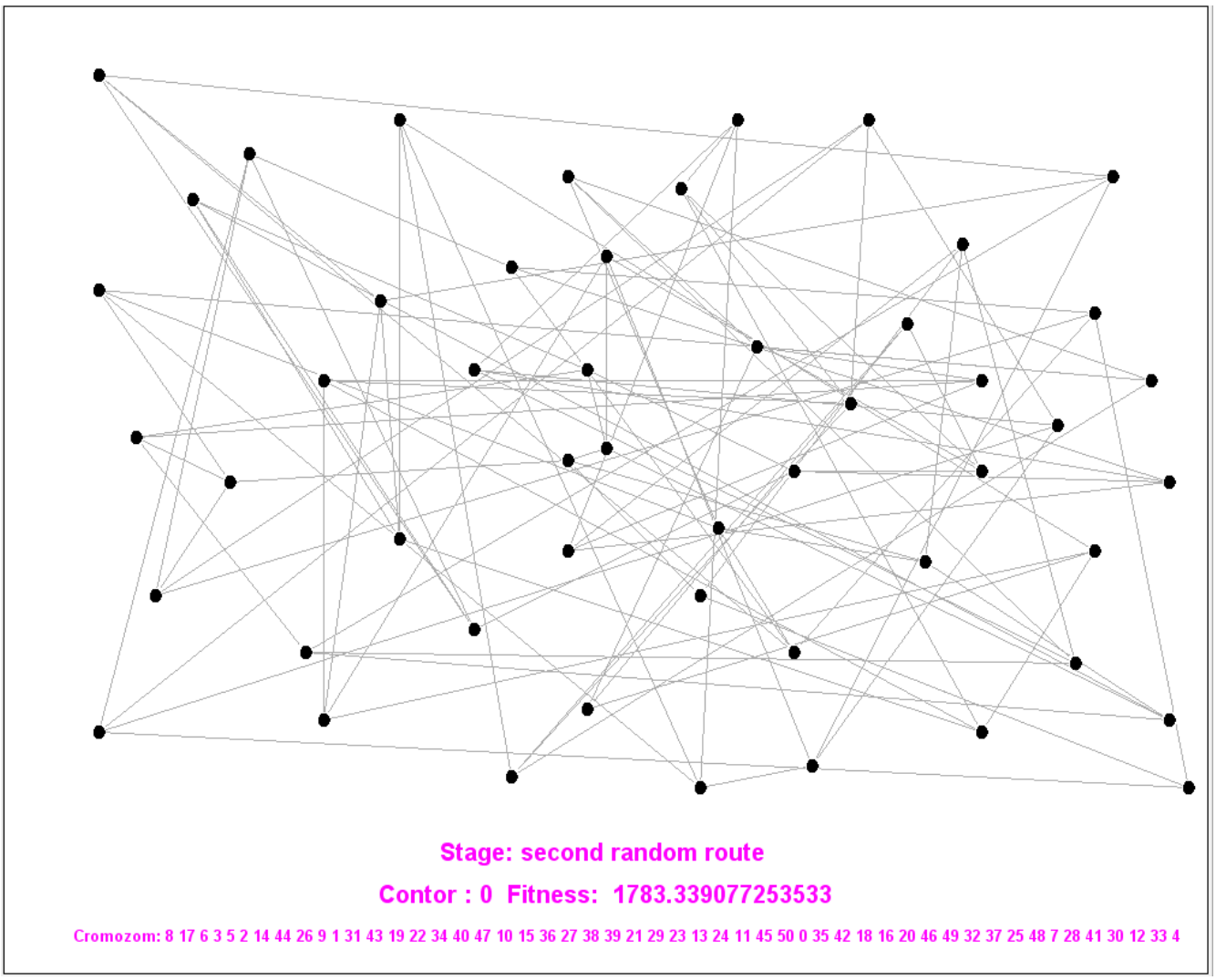
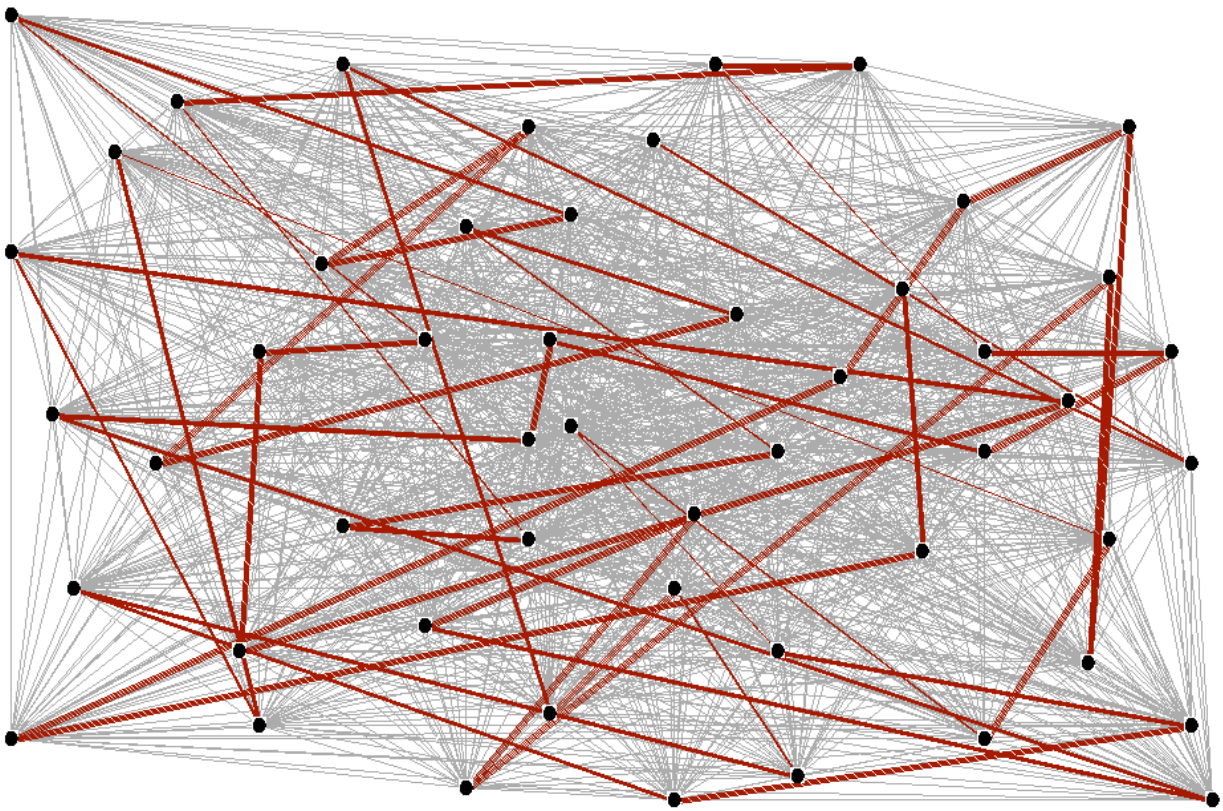


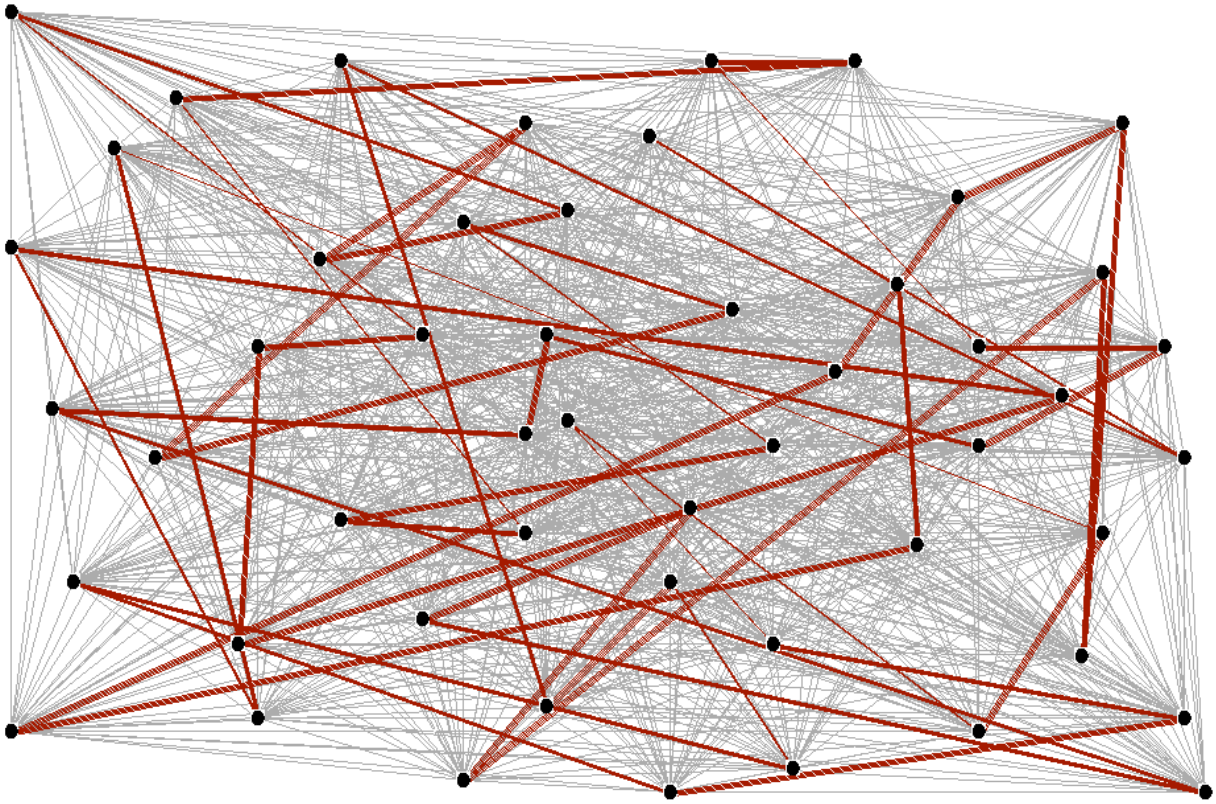
Illustration 4: Second random route



Stage: all the routes and the best route

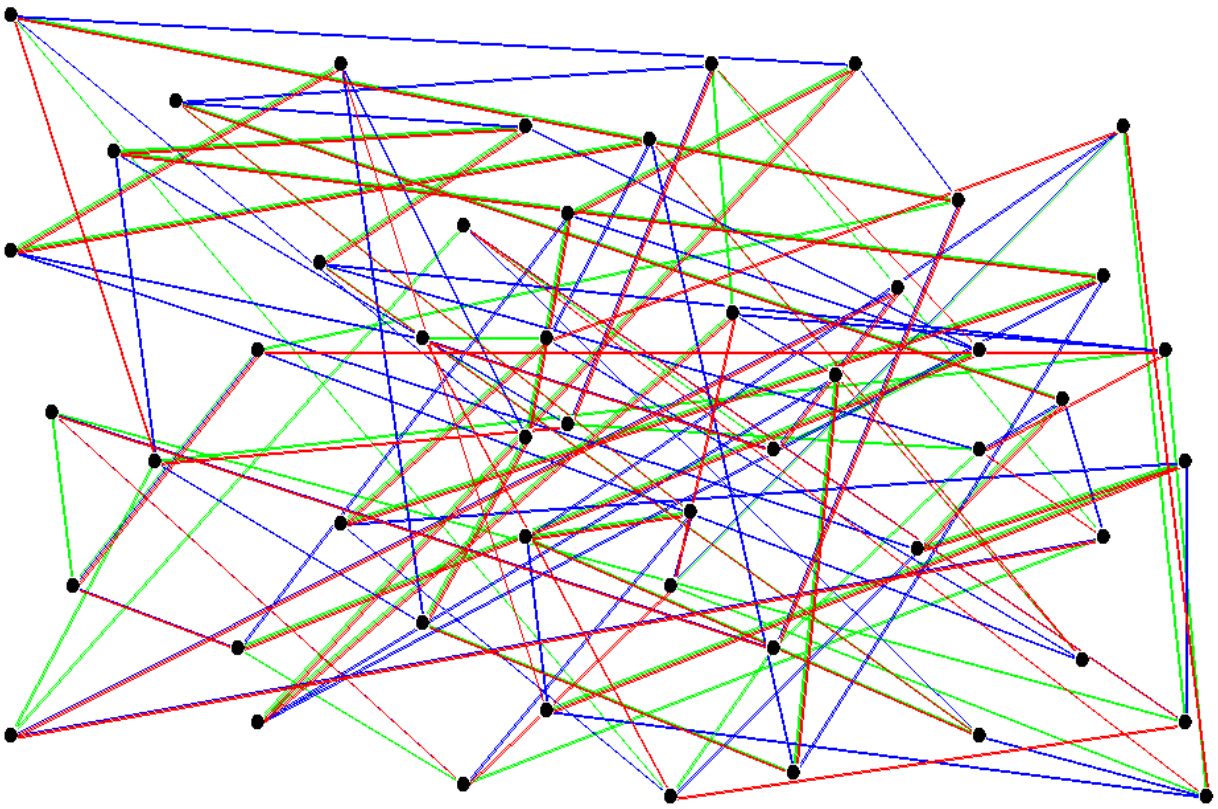
Contor : 0 Fitness: 1428.188520868203

Best route: 40-6-12-49-22-17-46-39-36-3-43-13-4-16-10-5-26-18-32-44-8-33-15-11-50-24-35-47-31-25-29-19-38-9-37-42-1-48-14-20-41-7-0-27-23-30-34-21-45-2-28.



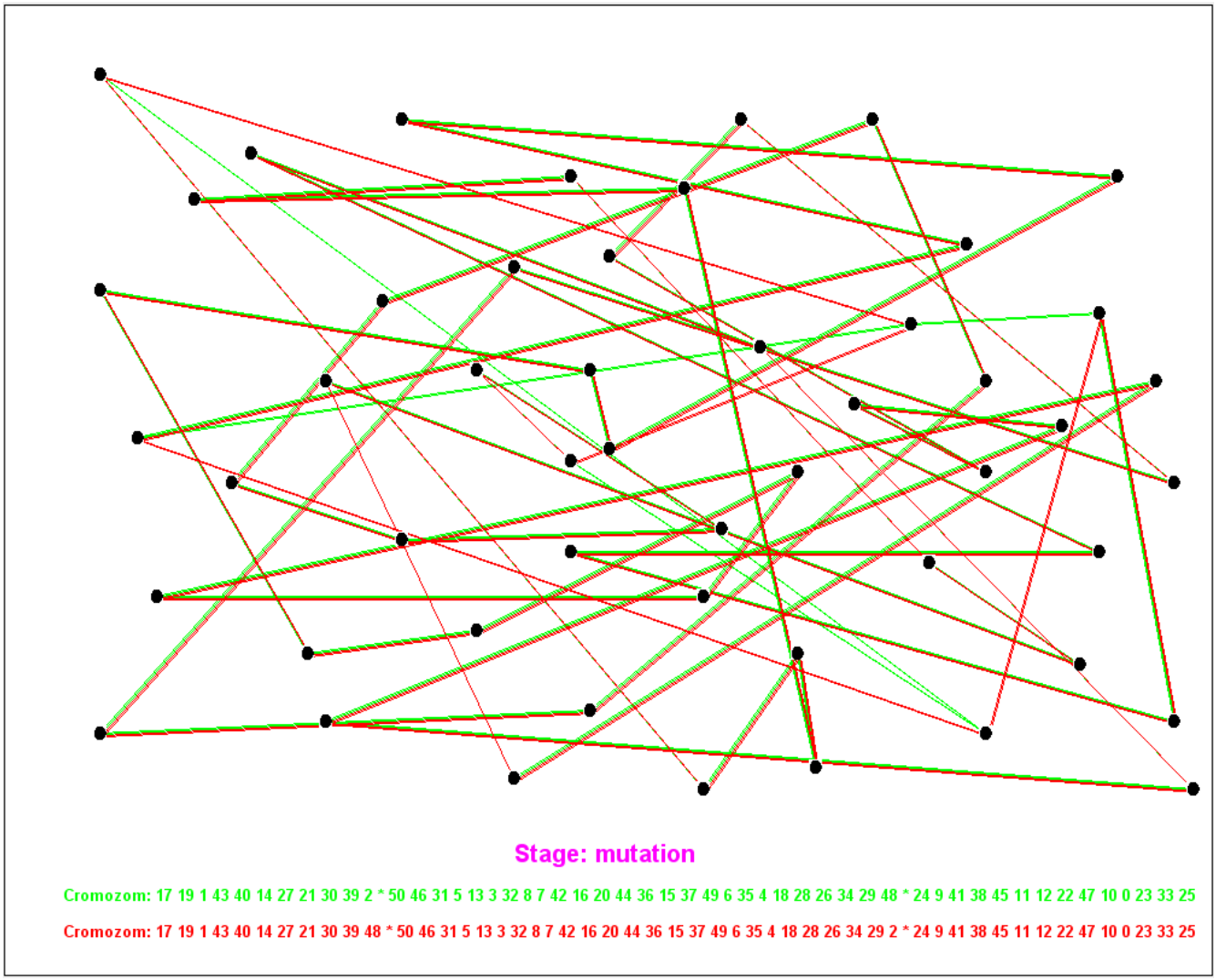
Stage: selection

Contor : 0 Fitness: 1428.188520868203



Stage: crossover

Cromozom: 7 20 1 49 18 31 26 2 3 43 40 29 5 11 * 46 45 15 21 30 39 9 17 23 24 34 38 0 35 33 13 42 16 10 8 22 25 28 48 44 * 4 6 32 36 50 47 27 37 19 14 12 41
Cromozom: 0 31 25 24 21 9 32 39 50 41 47 13 40 45 * 44 18 43 8 36 22 23 17 19 11 14 27 29 6 37 4 33 3 15 49 28 42 48 10 46 * 12 1 30 5 20 34 16 2 35 7 26 38
Cromozom: 7 20 1 49 18 31 26 2 3 43 40 29 5 11 * 38 35 16 34 30 46 10 48 42 28 15 33 17 23 22 8 44 45 13 39 9 21 24 25 0 * 4 6 32 36 50 47 27 37 19 14 12 41



References

[1] SURPRISE 96 Journal
[2] Geneteic algorithm warehouse - http://geneticalgorithms.ai-depot.com
[3] Wikipedia - https://en.wikipedia.org/wiki/Travelling_salesman_problem