Genetic Based Algorithm for STSP

Group 23

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Metaheuristic

- Solution representation
- Initial solution
- Stopping criteria
- Parents selection
- Mate
- Population update

Basic Blocks

- Solution Representation
  - Ordered list of customers, represented by an array of integer (16-bits signed)
- Initial solution
  - A first tour is generated by using the nearest neighbor search
  - More tours are generated by using random solutions (Fisher–Yates shuffle)
- Neighborhood definition
  - For each customer it is defined an ordered list of list, based on its distance to all the other customers.
- Fast 2-Opt
  - On each new solution is applied a fast 2-opt algorithm (implementation based on the article «Fast Algorithms for Geometric Traveling Salesman Problems», JL Bentley, 1992). The algorithm takes advantage of the neighborhood previously generated.

Basic Blocks

- Stopping criteria
  - The execution ends when the *best known* value of the current TSP istance is reached out
  - In the case where this value was not available, the execution would be arrested after 5 minutes (time provided as an upper limit of time)
- Parents selection
  - It is selected a list of candidates between the best individuals, equal to the number of individuals divided by the minimum number of individuals per population. The parents choice is based on the fitness attribute relative to the cost of the tour associated with it: the lower the cost of tour the higher the probability that this individual is selected.
- Mate
  - Two individuals are combined together using the order crossover genetic operator. If the child just generated happens to be equal to another individual of the population (their associated tours are the same), the inversion genetic operator would be applied on it, and if this new individual was not equal to another one, it would be added to the population.

Basic Blocks

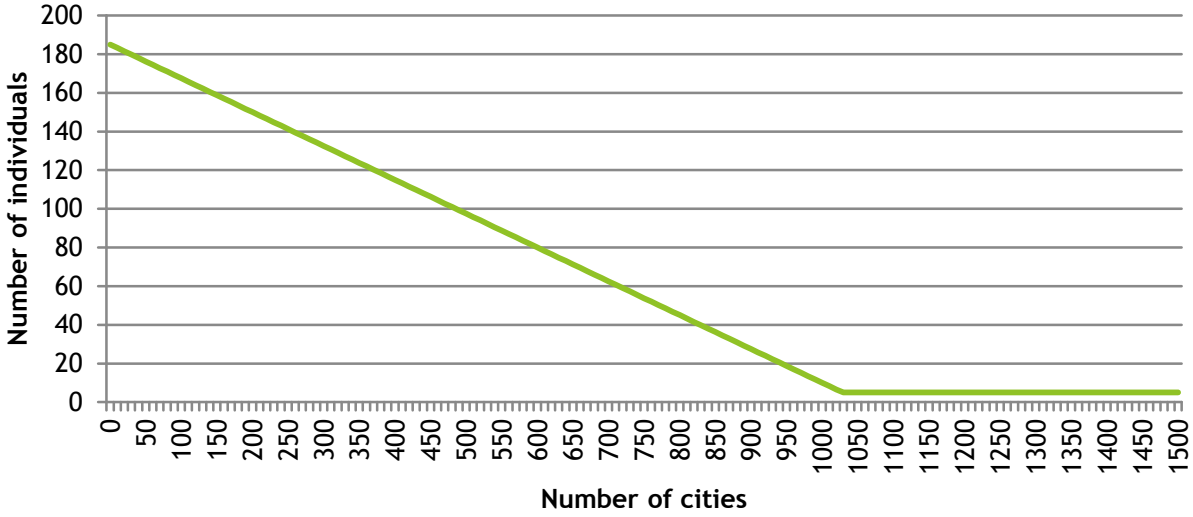
- Population Update
  - After having generated the new individuals, the population is update considering the number of generations without any improvement. If this number exceeds the established maximum number, it would be performed a *massacre* ensuring: a maximum number of survivors, and making the killings according to the inverse of the probability that each individual has to be chosen for mating. This operation is followed by the generation of new random individuals, in order to return, in the best cases, to the maximum number of individuals permitted. A new individual has to be different to all the other individuals already present in the population in order to be added.
  - If the killing process was not performed, the update would only consist on the killing of the weakest individuals in order to comply with the constraint of the maximum number of individuals of the population (the addition of the children could temporarily exceed this limit).

Parameters tuning

- Tested on the full istance set and on all the istances with less than 1500 cities included in the TSPLIB
- Repetitions: 10 (for each instance)
- Mutation probability: 20%
  - Each new individual have a chance to "fall victim" of a genetic mutation that corresponds to the random exchange of two cities belonging to the tour.
- Killing rate: 50%
  - Ensures that at least 50% of individuals will be killed.
- Maximum number of acceptable generations without any improvement: 50
- Neighborhood dimension: min { #Cities, 60 }

Parameters tuning

Population size



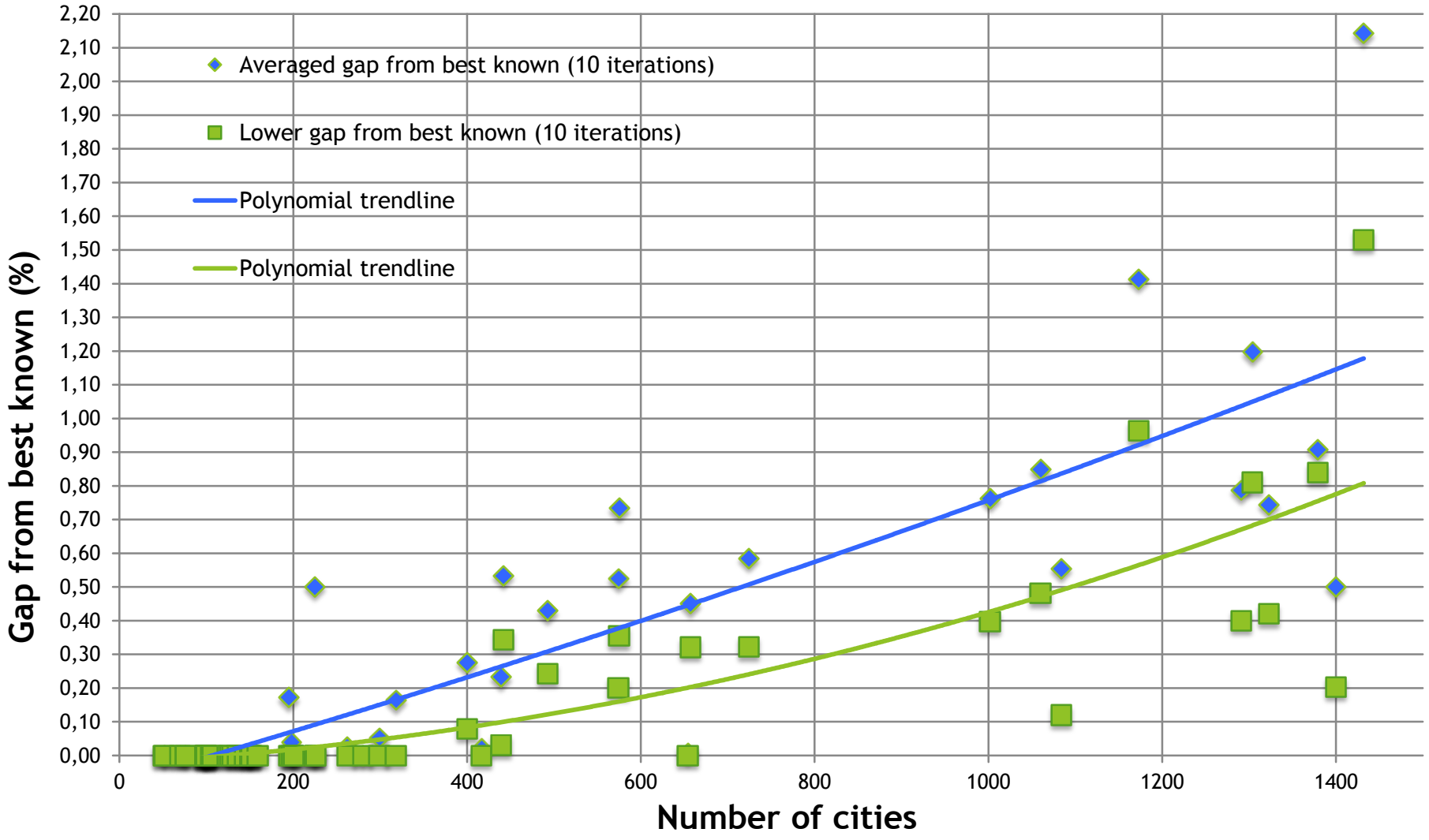
- The maximum size of the population is function of the number of cities in the tour:

  max_population = max { min_population, -0.175 * #Cities + 185 }

- The equation, obtained empirically, regulates the maximum size of the population for an instance of 200 cities in 150 individuals, and for an instance of 1000 cities in 10 individuals (straight line through two points), and also ensuring that the maximum number of individuals never falls below the minimum number.
- The minimum number of individuals is set to 5

Results

Instance	Mean Gap (%)	Mean Time [s]	Best Gap (%)
berlin52	0.00	0.0	0.00
eil51	0.00	0.0	0.00
eil76	0.00	0.0	0.00
pr152	0.00	2.6	0.00
rat195	0.17	259.1	0.00
pr1002	0.76	295.2	0.40
Mean	0.16	92.9	0.07



2,5 GHz Intel Core i5