

Artificial Intelligence(CS 411) Assignment I – 14/09/18

DIFFERENTIAL EVOLUTION

Team

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Introduction :

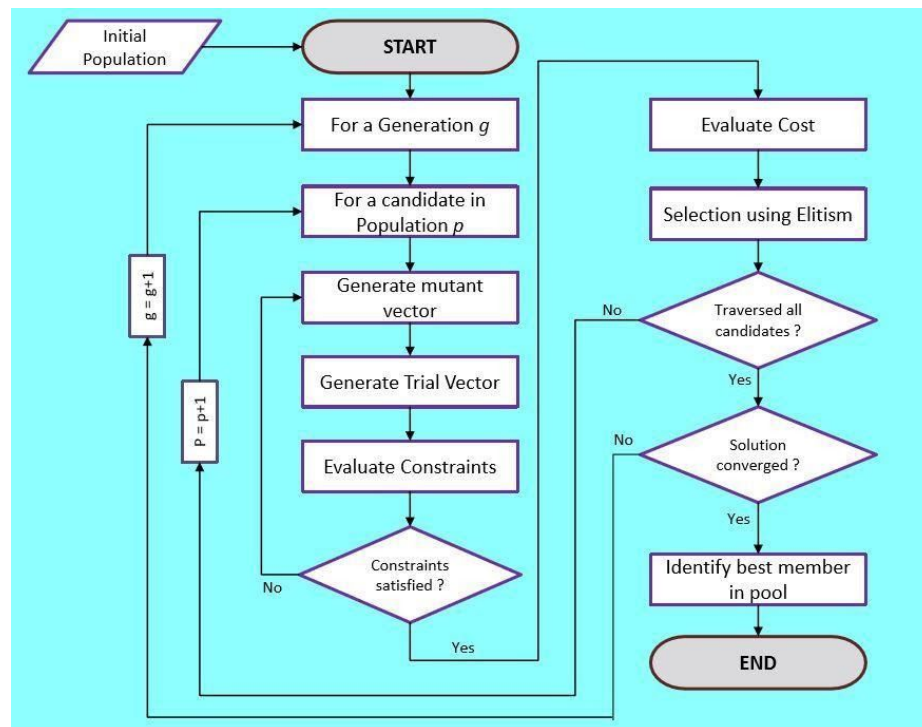
Differential Evolution is an optimization algorithm to find the minimum value of an objective function. It iteratively modifies a population of solutions to make it converge to an optimum value of the function. It was invented by Kenneth Price and Rainer Storn in 1997.

The method we chose to calculate the mutant vector and the rest of the procedure can be illustrated as follows :

$$\bar{x}_{i,g} = \bar{x}_{i,g} + K * (\bar{x}_{r1,g} - \bar{x}_{i,g}) + F * (\bar{x}_{r2,g} - \bar{x}_{r3,g})$$

where $i, r1, r2, r3$ are all different, randomly selected members of the chromosome pool (i.e. population) in generation "g",

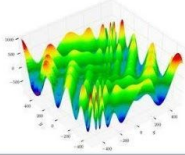
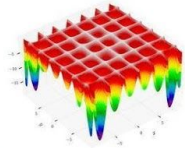
K and F are relaxation parameters



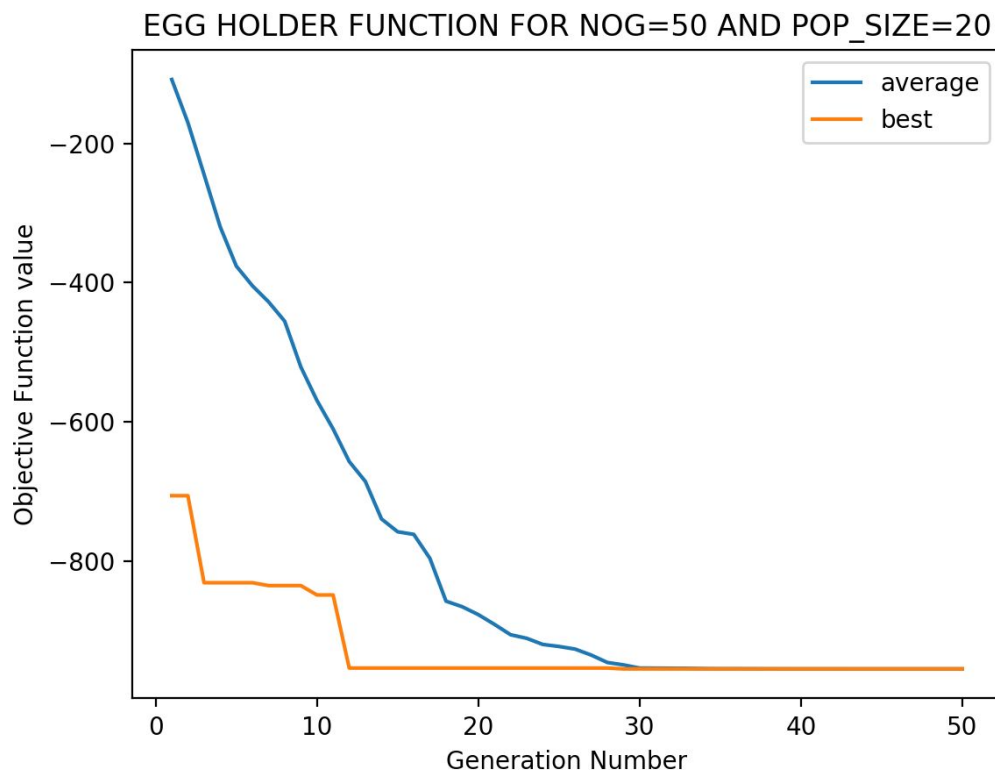
Implementation details :

We chose to use Python programming language considering the ease of implementation of the algorithm. All the tests were run on a system with i7-4600U, 8Gb RAM, Windows 10 operating system. Uniform random distribution was used to initialize the population.

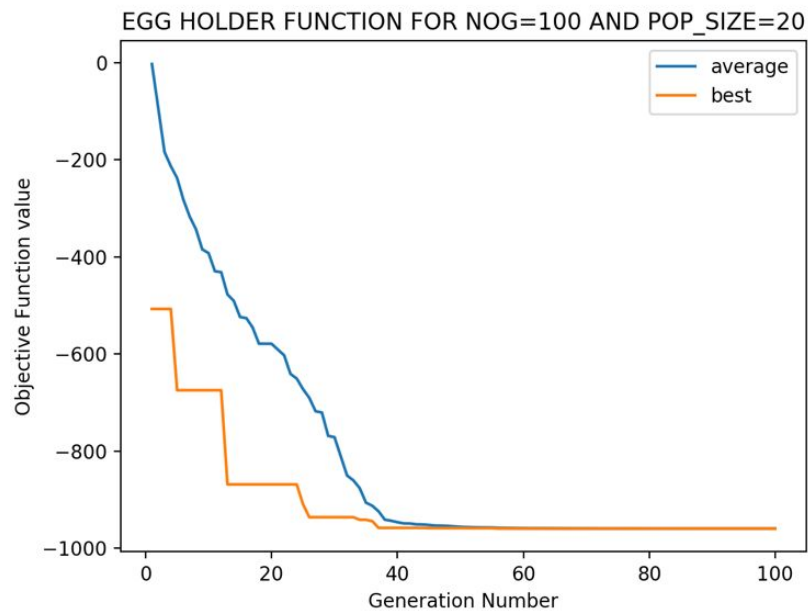
Correct Solution :

Eggholder function		$f(x, y) = -(y + 47) \sin \sqrt{\frac{x}{2} + (y + 47)} - x \sin \sqrt{ x - (y + 47) }$	$f(512, 404.2319) = -959.6407$
Hölder table function		$f(x, y) = - \left \sin x \cos y \exp \left(1 - \frac{\sqrt{x^2 + y^2}}{\pi} \right) \right $	$\text{Min} = \begin{cases} f(8.05502, 9.66459) & = -19.2085 \\ f(-8.05502, 9.66459) & = -19.2085 \\ f(8.05502, -9.66459) & = -19.2085 \\ f(-8.05502, -9.66459) & = -19.2085 \end{cases}$

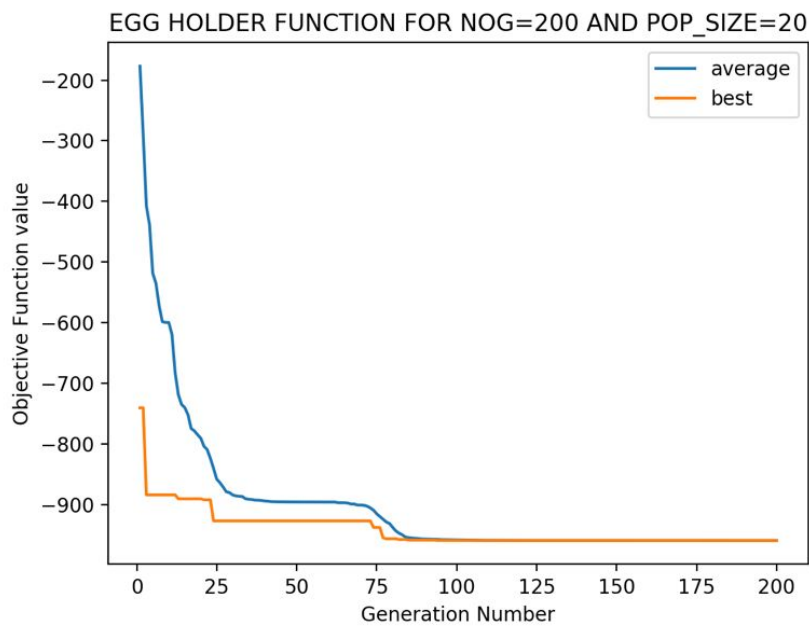
Results :



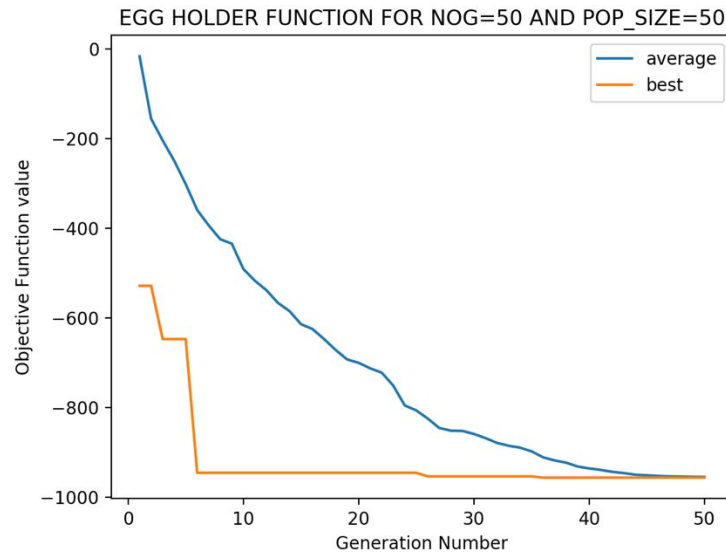
Global optimum is at -955.05090483 at [510.72297380172984,403.0990572051795]



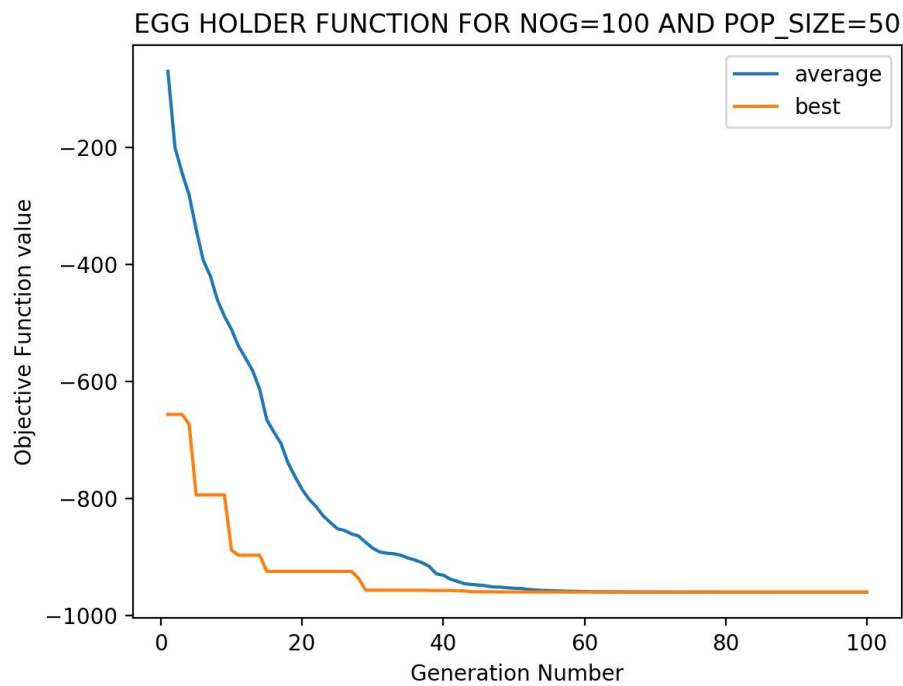
Global optimum is at -959.640118727 at [511.9998429500206,404.2283770679271]



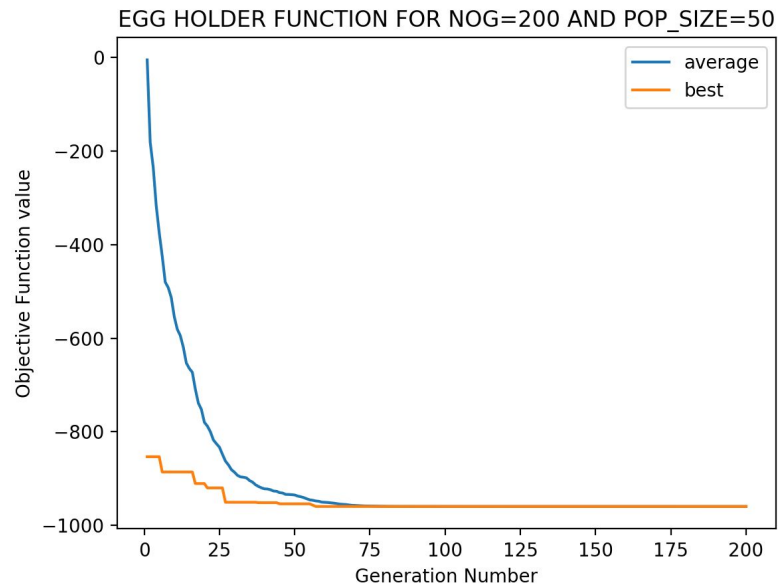
Global optimum is at -959.64066272 at [511.99999999971584,404.23182207181446]



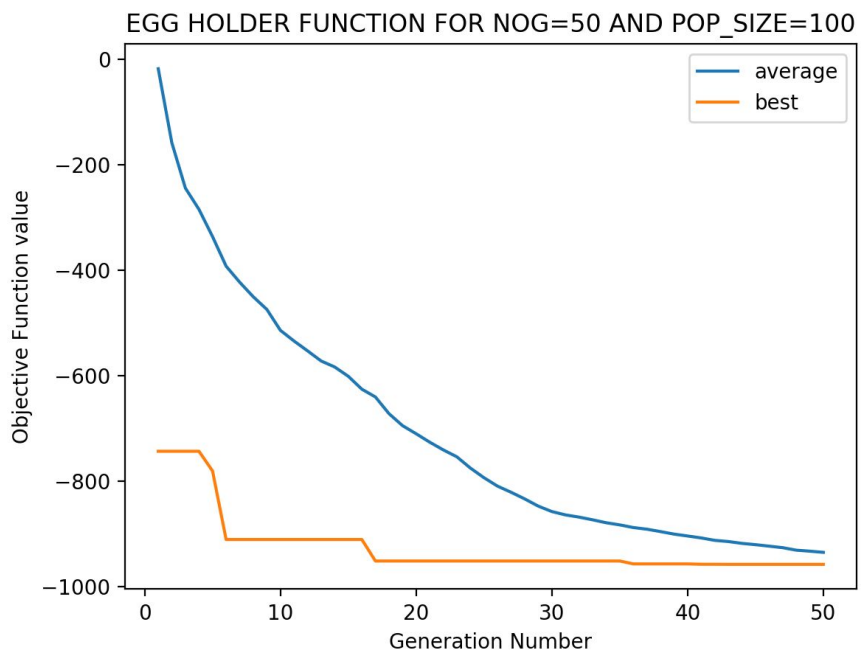
Global optimum is at -954.742390871 at [510.92306701387537,402.296671519552]



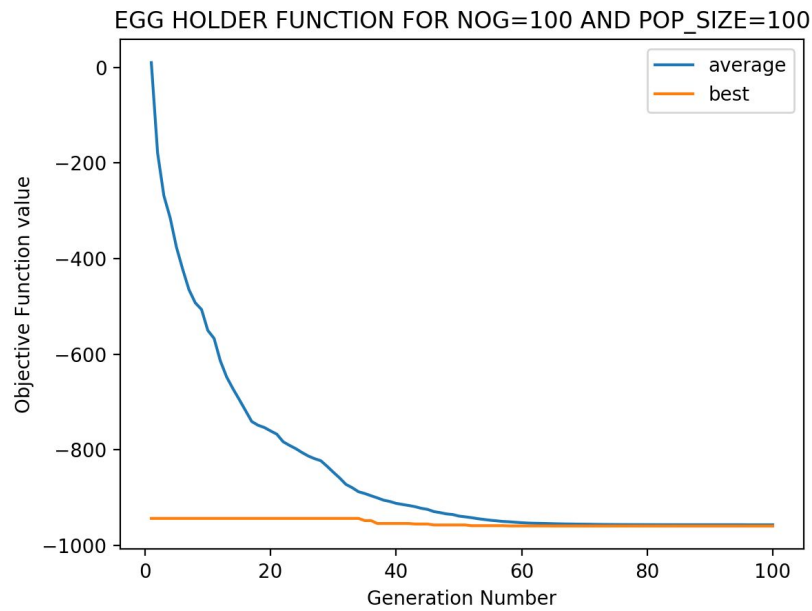
Global optimum is at -959.640552059 at [511.9999698057883,404.23450227723924]



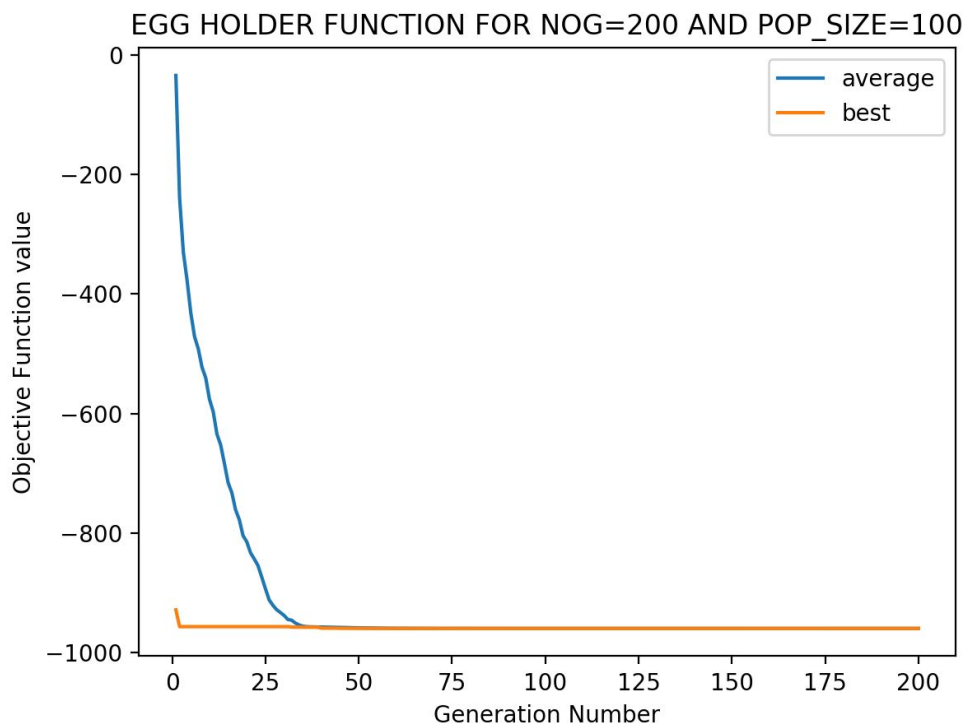
Global optimum is at -959.640662721 at [511.9999999999915,404.23179263845805]



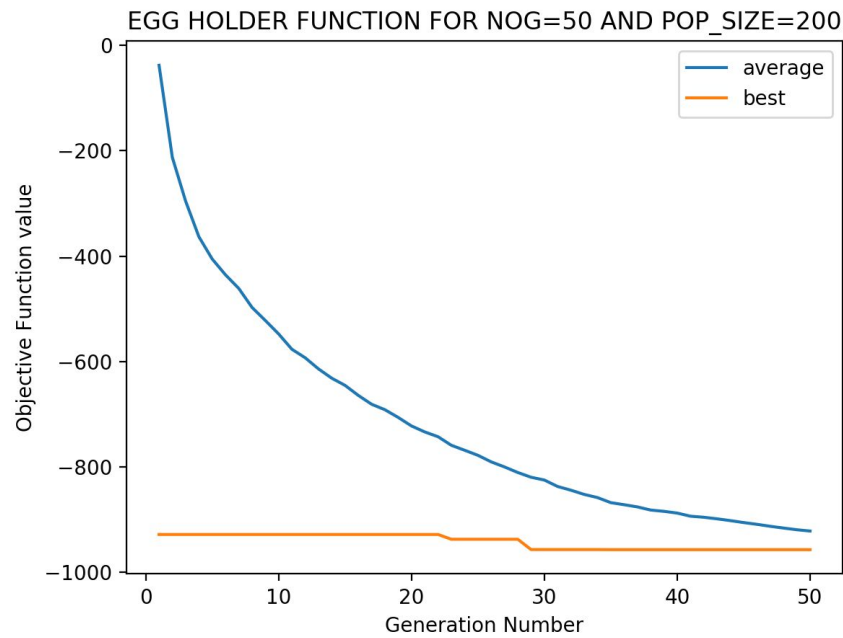
Global optimum is at -957.337444029 at [511.39189011907575,403.2842119651134]



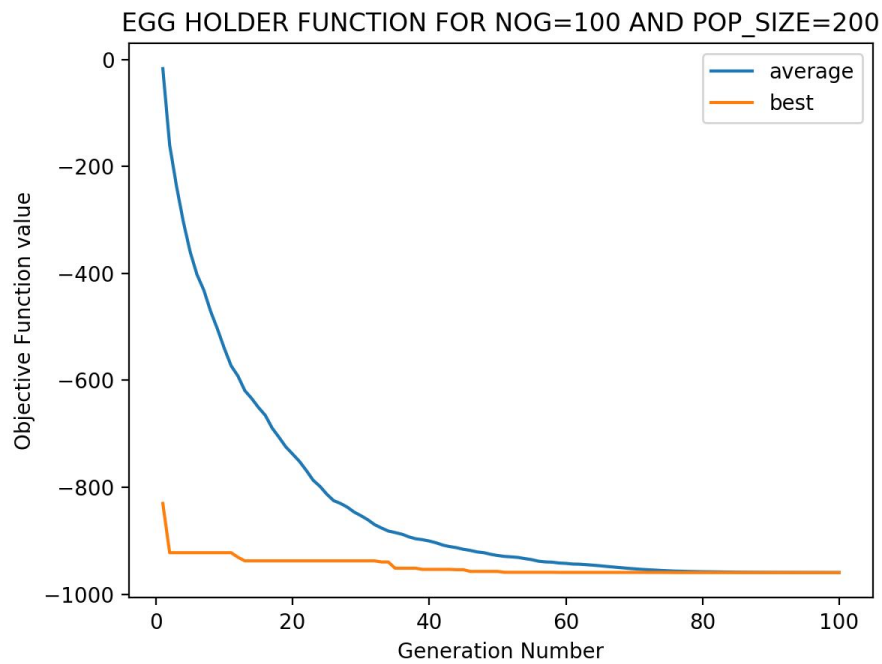
Global optimum is at -959.636105563 at [511.99908416739737,404.1951880383121]



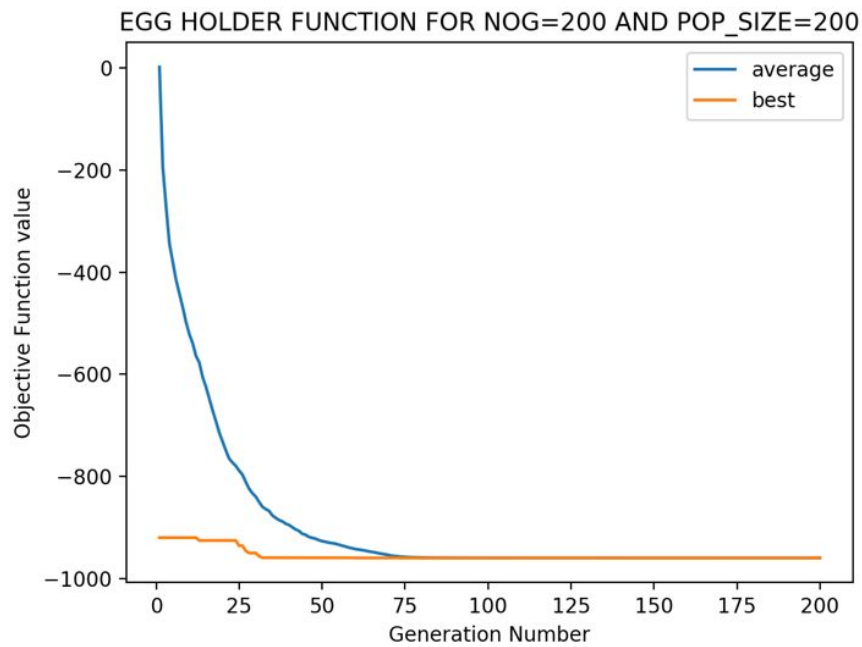
Global optimum is at -959.640662721 at [511.9999999999808,404.2318043878814]



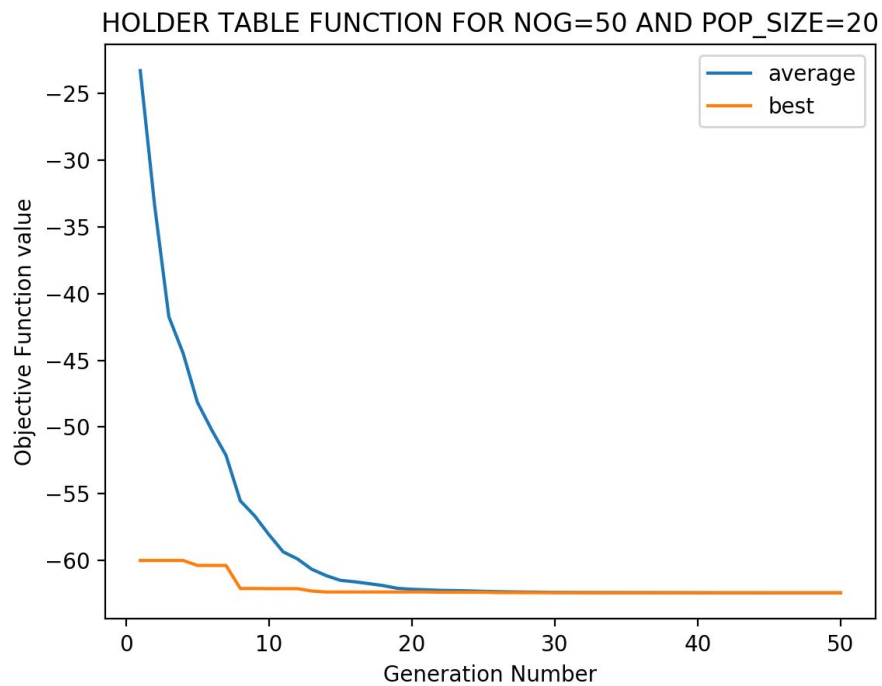
Global optimum is at -956.00038617 at [511.2967495449093,402.5799497210798]



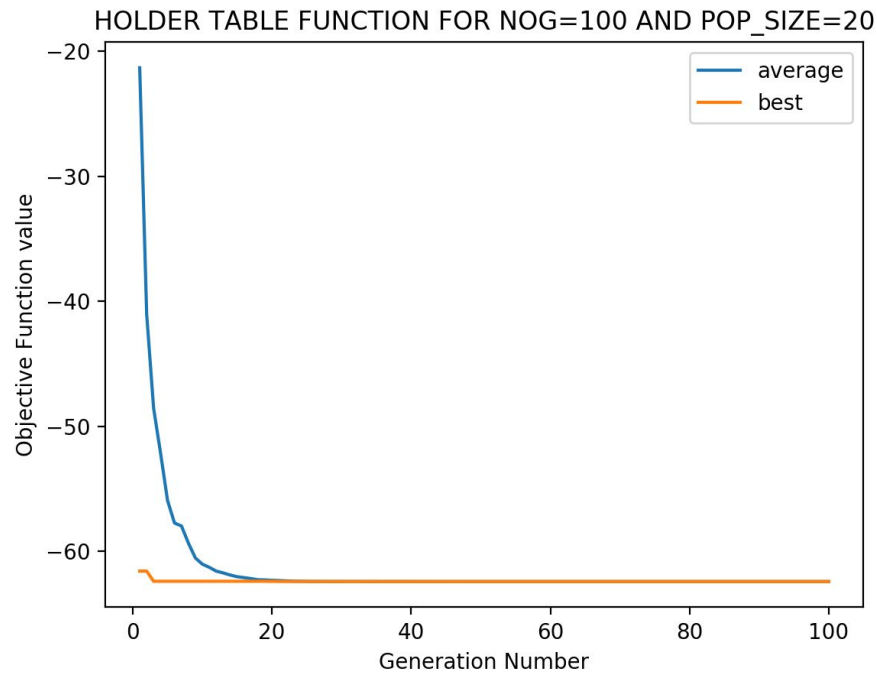
Global optimum is at -959.611871498 at [511.9919551186698,404.2614504231291]



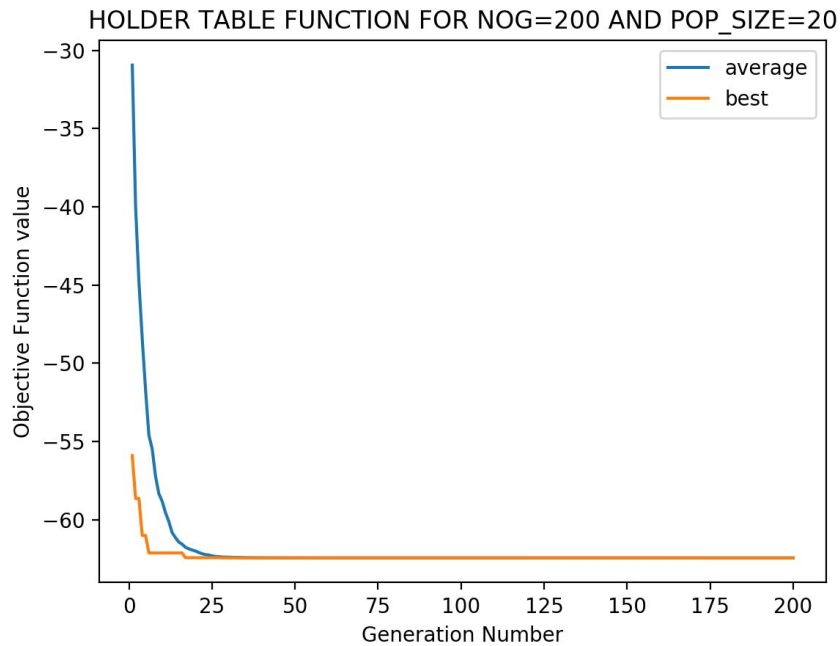
Global optimum is at -959.640662718 at [511.99999999958015,404.23183472437415]



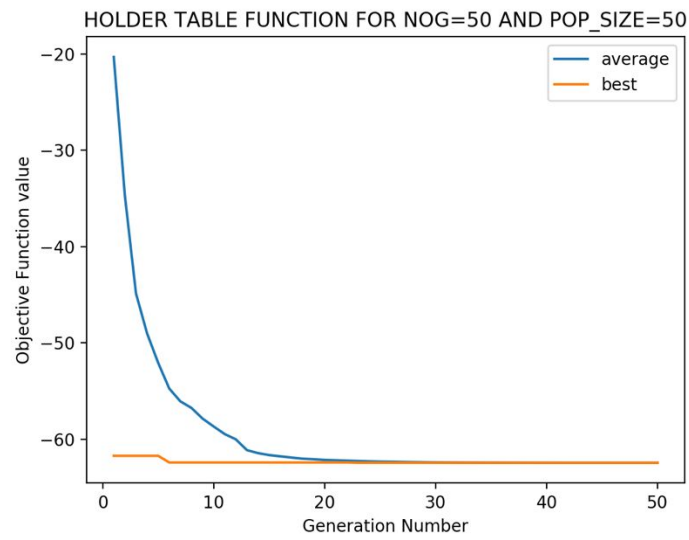
Global optimum is at -62.4326692437 at [9.50907996531026,9.999984800896364]



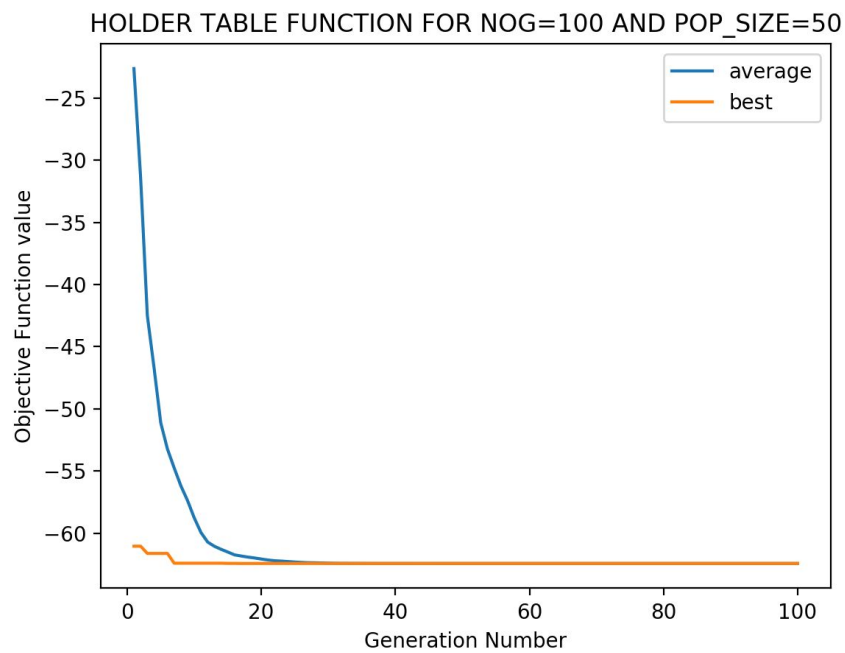
Global optimum is at -62.4327121953 at [9.495358074919046,9.999999996868306]



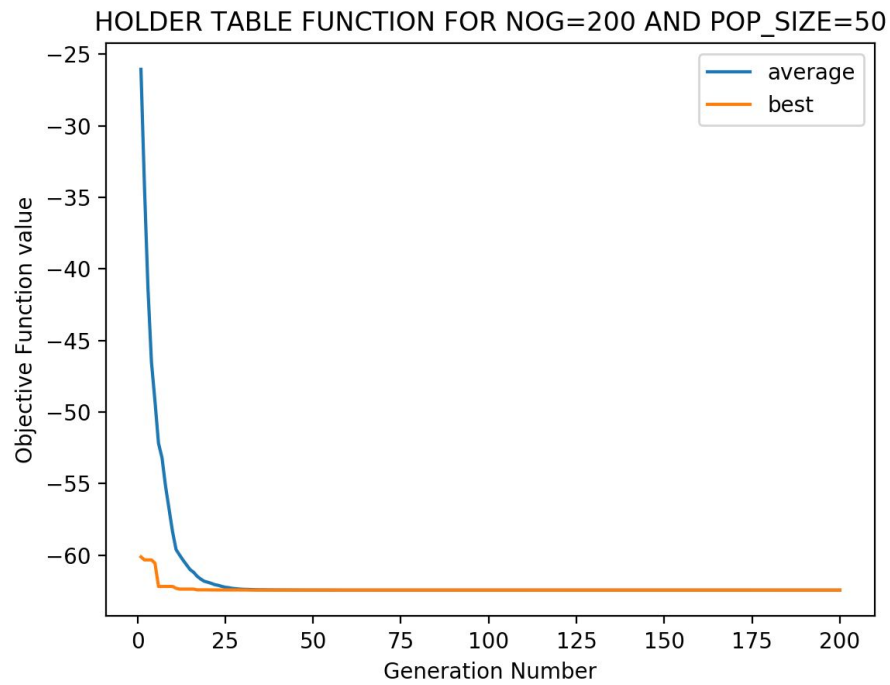
Global optimum is at -62.4327122032 at [9.495527479230365,9.999999999999996]



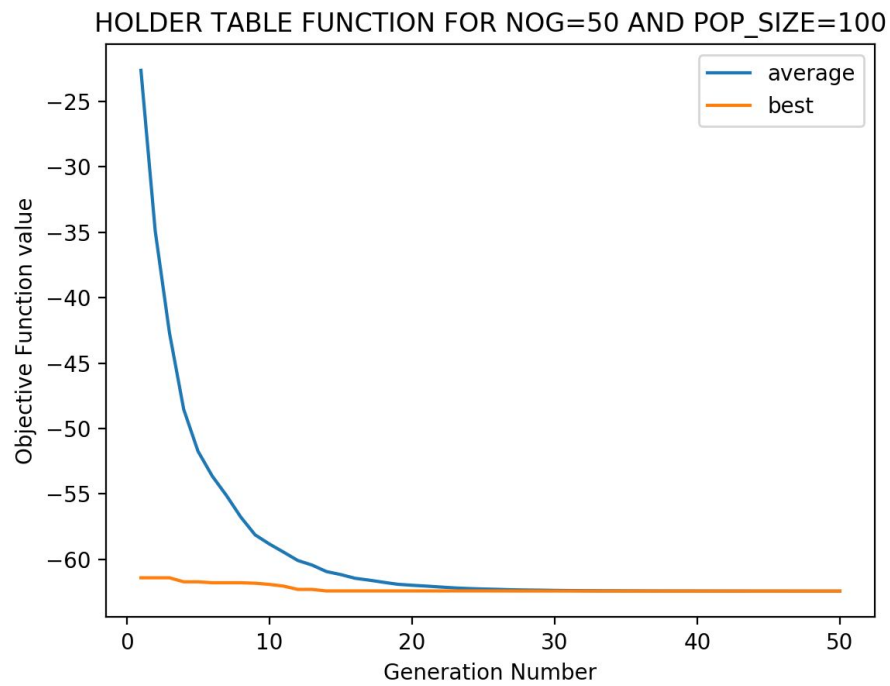
Global optimum is at -62.432681152 at [9.500450030030091,9.999981622001888]



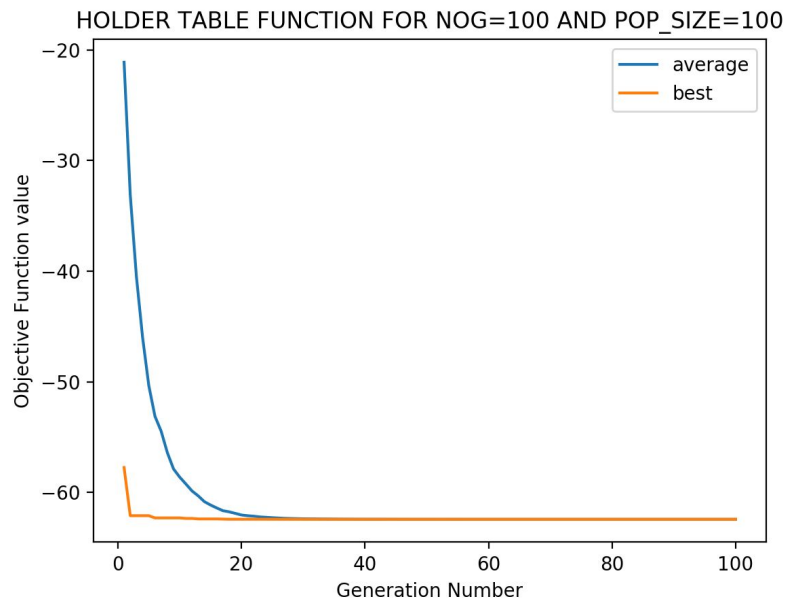
Global optimum is at -62.4327121738 at [9.495021618835448,9.999999998476218]



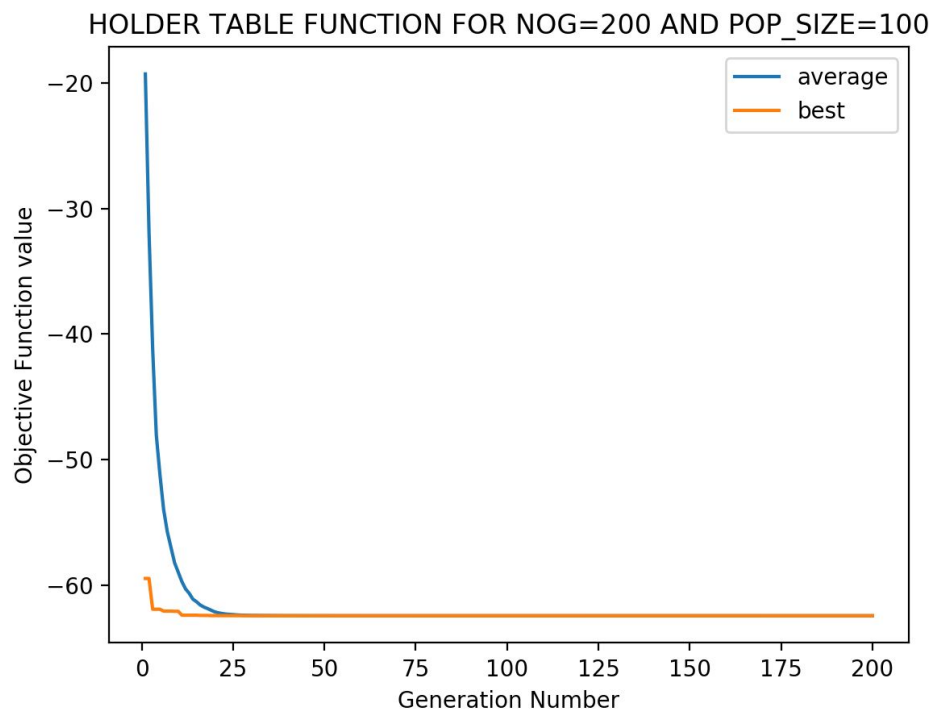
Global optimum is at -62.4327122032 at [9.49552755964229,9.999999999999998]



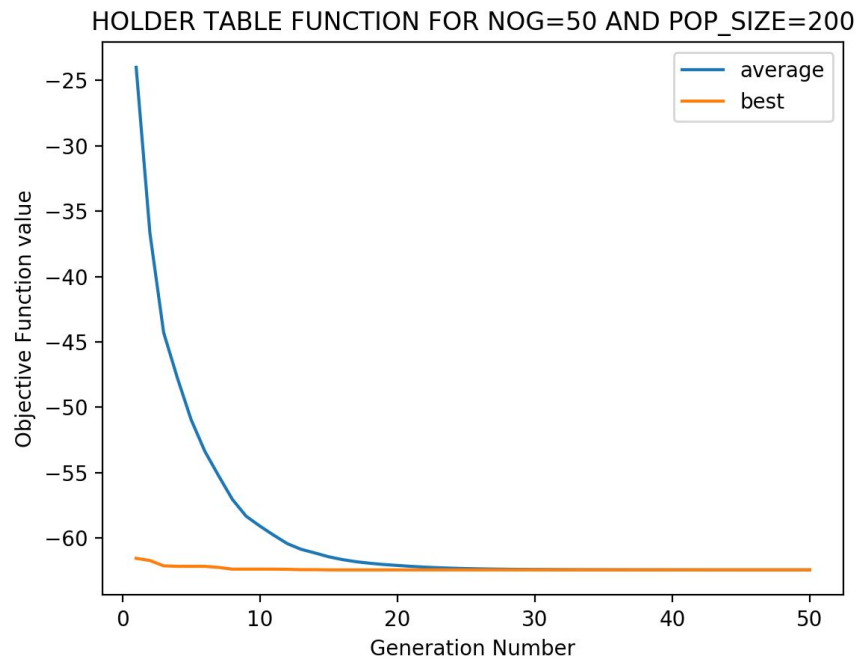
Global optimum is at -62.4326437549 at [9.476397869401687,9.99998077498711]



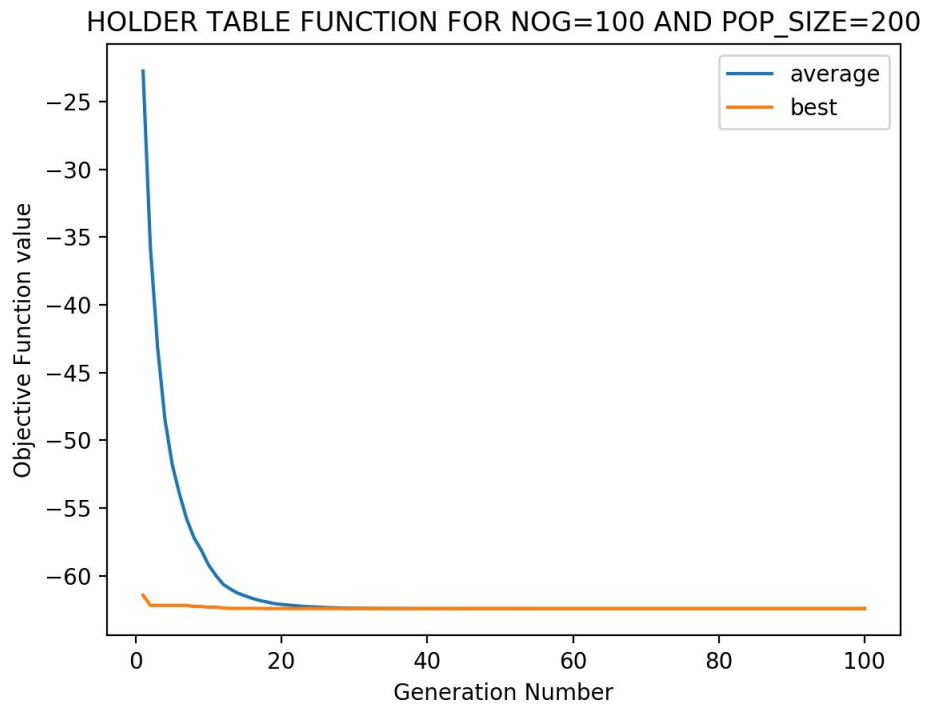
Global optimum is at -62.4327122008 at [9.495642655118727,9.999999999338133]



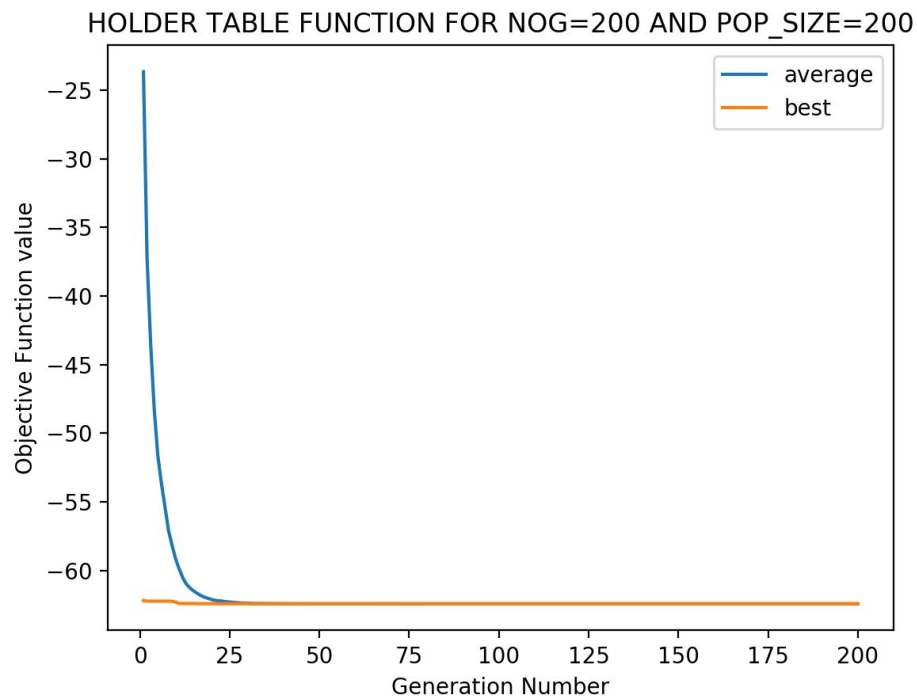
Global optimum is at -62.4327122032 at [9.495527697256009,9.999999999999998]



Global optimum is at -62.4325888667 at [9.476223227663649,9.999945840137157]



Global optimum is at -62.4327121523 at [9.495047394769868,9.99999998287511]



Global optimum is at -62.4327122032 at [9.495527709735743,9.999999999999996]

Conclusions :

It was observed that an increase in the value of population size or number of generations resulted in a more accurate answer. Also, we could not arrive at a satisfactory answer by running the differential evolution algorithm only once, hence we had to call it multiple times(e.g. 20-40) to arrive at a solution and then grab the best one among all the solutions. In this way, there were very high chances of the obtained solution being very close to the correct solution.

References :

<https://www.python.org>

https://en.wikipedia.org/wiki/Differential_evolution

https://en.wikipedia.org/wiki/Test_functions_for_optimization

<https://matplotlib.org/>

Lesson learnt : Not all the assignments in fourth year can be completed in one night.