INF4490 – Biologically Inspired Computing

Assignment 1

Name: Furqan Tariq

Username: furqant

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Instructions

The sources codes are written in python language and tested on python 3.6.
The organization of source codes as follow:

Exhaustive.py has exhaustive solution of problem with simulation (main function)
Hillclimbing.py has hill climbing solution with simulation
Evolutionary.py has evolutionary solution of TSP problem
Util.py contains commonly used functions
Pmx.py contains partially crossed over implementation. I used group lecture implementation.
Baldwanian.py and Lamarckian.py contains respective implementation of baldwanian and Lamarckian approach.
Hybrid.py contains simulation code which simulates both baldwanian and Lamarckian functions.
Tests_output folder contains test outputs data that was generated during my tests

Exhaustive Search

1. The shortest tour among the first ten cities is

> ['Copenhagen', 'Hamburg', 'Brussels', 'Dublin', 'Barcelona', 'Belgrade', 'Istanbul', 'Bucharest', 'Budapest', 'Berlin', 'Copenhagen']

And its distance is 7486.309999999999

2. It took 19.1704130173 seconds to calculate it.

3. Since, we are checking all the possible combinations that is 24! So it will take very long time

Hill Climbing

1. The hill climbing algorithm was faster than Exhaustive search. For first ten cities, it took 0.0003903150558 seconds.

For first 10 and 24 cities, the best, worst, mean and deviation of tour length as follow:

No. of Cities	10 Cities	24 Cities
Best	7503.1	21009.17
Worst	11428.9	29395.29
Mean	9796.4755	25448.856
Standard Deviation	1213.249231	2132.276727

Genetic Algorithm

1. In evolutionary approach to solve TSP, I tested it with three different population sizes (that are 50, 200 and 400) for both 10 cities and 24 cities
The results are as follow:

Parameters i used for this test:

no_of_generation = 1000
no_of_parents = 10
mutation_prob = 0.5
cross_prob = 1

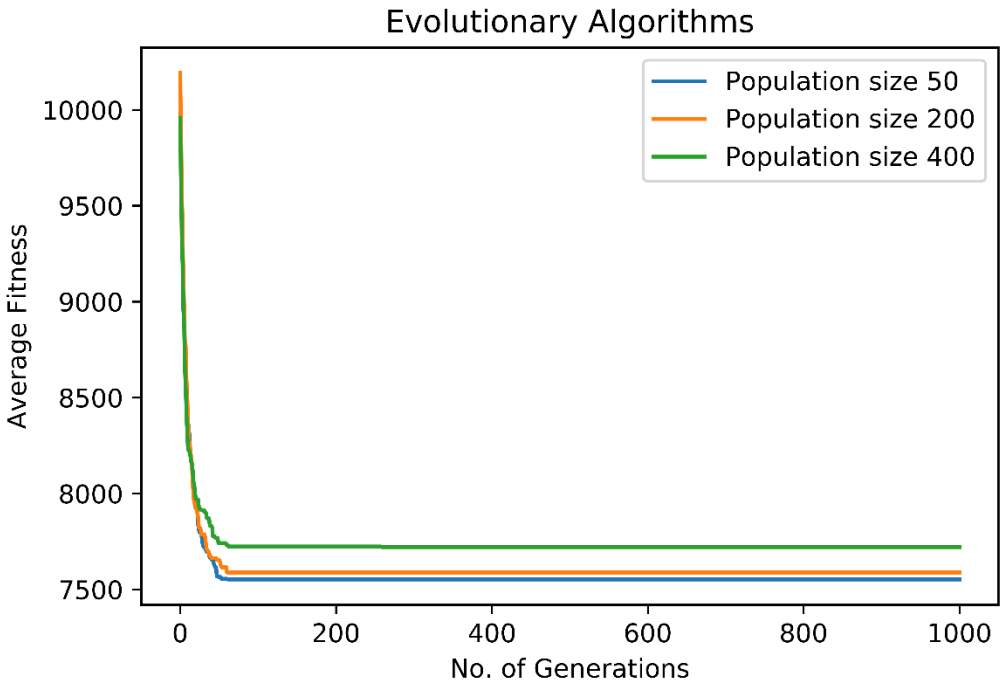
For 10 Cities

Population Size	50	200	400
Best	7486.31	7486.31	7486.31
Worst	7737.95	8407.18	8407.18
Mean	7551.7385	7593.055789	7720.3695
Standard Deviation	110.4634705	221.9215492	356.3565585

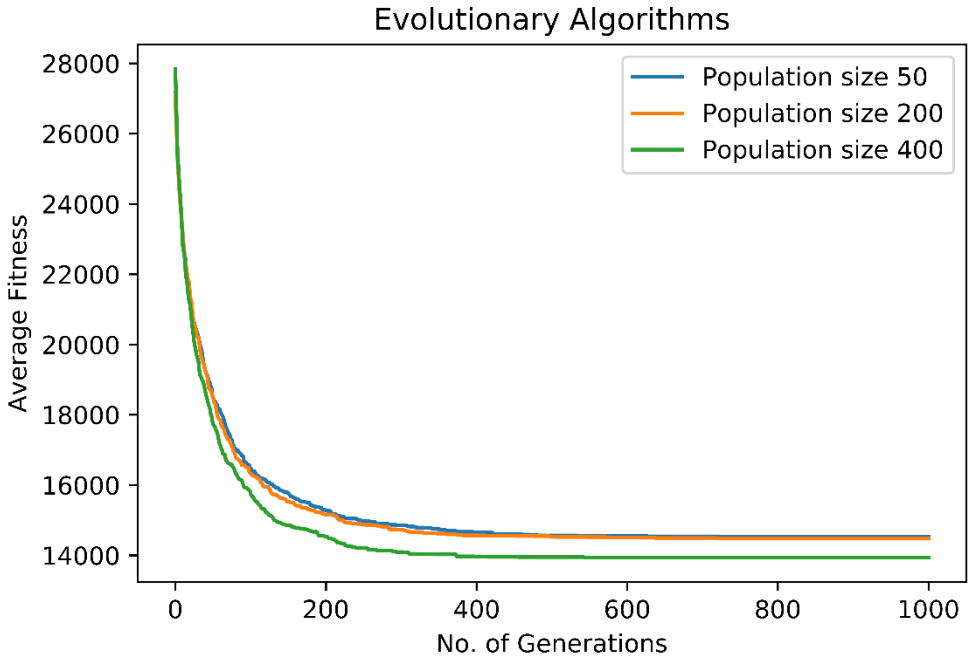
For 24 Cities

Population size	50	200	400
Best	12561.22	12853.95	12416.87
Worst	16274.58	16223.61	15685.79
Mean	14526.1075	14439.42579	13852.15368
Standard Deviation	1005.72295	818.2993311	935.9036519

Generational Plots For 10 Cities



Generational Plot For 24 Cities



Conclusion From Data

In case of 10 cities, 50 population is more suitable because it found a correct result and also it took lower number of evaluation. But in case of 24 cities, The 400 population is more suitable because it came close to the actual solution and the generation graph is showing that in every generation it is producing optimal results.

I am using distance as a fitness function so lower distance represents fittest solution.

2. Yes it did find the correct shortest distance among first 10 cities as found by exhaustive search which is 7486.31.

3. Yes it was significantly faster than exhaustive search.
The table of average time taken in execution is as follow:

	10 Cities	24 Cities
Population size 50	0.1375925899 seconds	0.2348968744 seconds
Population size 200	0.1556320818 seconds	0.2571892989 seconds
Population size 400	0.1760002971 seconds	0.2813682054 seconds

4. In exhaustive search, the number of tours examined were 24!
But in evolutionary algorithm, the number of tours examined should be equal to the number of generations multiply by population size in each generation.

In my case, it is 400*1000 which is far less than 24!.

Hybrid Algorithm

By using hybrid approach the best, worst, mean and deviation of tour length as follow:

Parameters i used for this test:

no_of_generation = 10
no_of_parents = 10
mutation_prob = 0.5
cross_prob = 1
population_size = 200
hill_climb_iteration = 5

For 10 Cities

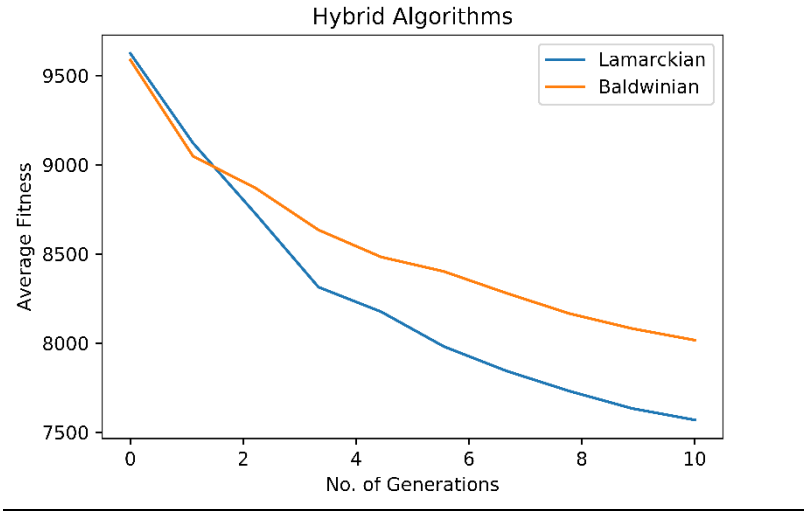
Learning Models	Baldwinian	Lamarckian

Best	7663.7	7486.31
Worst	10799.72	8204.06
Mean	8847.08	7569.279
Standard Deviation	987.928563	174.7544586

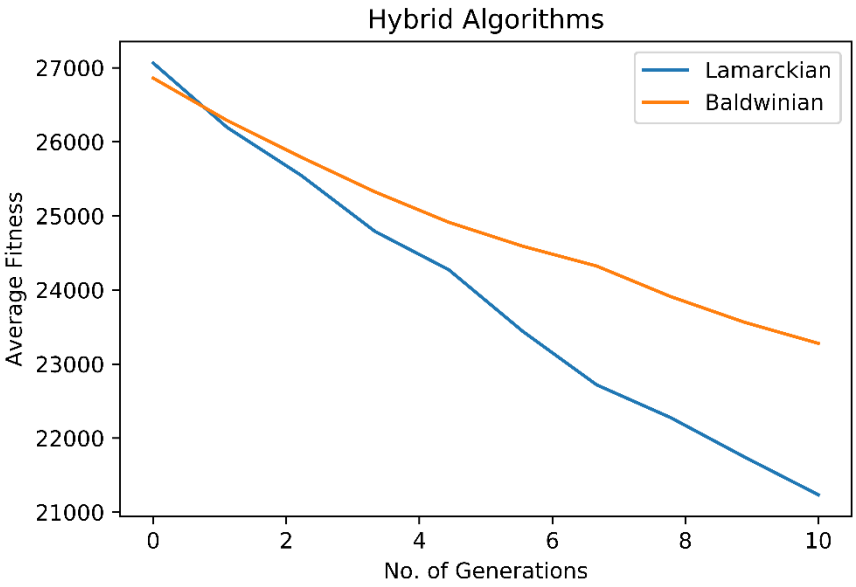
For 24 Cities

	Baldwinian	Lamarckian
Best	21655.07	18367.97
Worst	27731.36	22691.91
Mean	24594.07222	21234.1605
Standard Deviation	1448.110643	1247.608216

Generational Plot for 10 Cities



Generational Plot for 24 Cities



1. In hybrid solution, the number of evaluation is equal to the production of no_of_generations, population_size and hil_climb_iteration. In my case it is 10*200*5 which is less than pure GA approach and found a correct solution.
I couldn't implement programmatically way to calculate number of evaluation due to the misunderstanding of it and shortage of time.