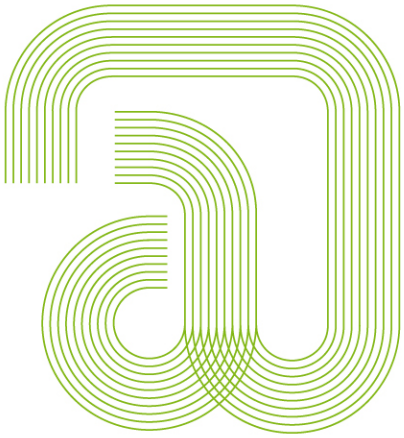
Universidade Vigo

Evolutionary Computation – Lab-Sessions



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1. First Week

Objectives: Install all necessary packages in python (maybe we will extend the tools in the following weeks). Run the jupyter notebooks to check that everything works. Get some first impressions of how genetic algorithms (and other heuristic algorithms) work on two problems: minimizing a real-values multi-dimensional function, the traveling salesperson problem (TSP).

1. Download all files ncessary for this week from the web-page

   http://formella.webs.uvigo.es/doc/ec23/index.html

   of from the corresponding reaching platform available at your university.

2. Install all necessary python components, including the `scikit-opt` package from

   https://github.com/guofei9987/scikit-opt

3. Take a look at the web-pages:

   a) https://www.sfu.ca/~ssurjano/optimization.html
   b) https://www.kaggle.com/code/kooaslansefat/cec-2017-benchmark
   c) http://comopt.ifi.uni-heidelberg.de/software/TSPLIB95/

4. Run the jupyter notebooks to check whether everything works.

5. Play around with the parameters regarding: objective functions, genetic algorithm parameters, Monte Carlo rounds, underlying datasets, etc.

6. Generate some statistics output, especially mean and variance, for a certain number of Monte Carlo rounds and genetic algorithm iterations for parameter sets that you found interesting.

2. Second Week

Objectives: Understand the genome codifications available in the Guofei-package. Understand the mutation and crossover operations implemented in the Guofei-package. Generate convergence plots.

1. Run the jupyter notebook on sorting to repeat and to settle what has been presented in the lecture.

2. Run the examples of the Guofei-packages that minimize the Schaffer-function (with both encodings).

3. Run the examples with different parameter settings and generate the corresponding convergence plots.

4. Which types of mutation operations does the package implement? Give a brief description.

5. Which types of crossover operations does the package implement? Give a brief

description.

6. Add the eta-parameter to the corresponding crossover operation. Do you experiment differences in the convergence rate when changing eta for the Schaffer function (maintaining the rest of the parameters)?

3. Third Week

Objectives: Dig somewhat deeper into the Guofei-package. Run the genetic algorithm in a Monte Carlo loop to obtain some statistical data.

1. Run the examples of the Guofei-packages that minimize the Schaffer-function (with both encodings) in a Monte Carlo loop and log the mininum, mean, and variance of the objective function.
2. Try to find a parameter set of the genetic algorithms that you consider sufficiently good. Argue why you took that decision.
3. Replace the Schaffer-function by the Rosenbrock-function (in three or four dimensions) in your code and study what happens: for instance, does the same parameter set, give equally good results? does the search area (defined by the lower and upper bound) have some influence?

   Here is the code for the d-dimensional Rosenbrock-function:

```
def rosenbrock(p):
  sum = 0;
  for i in range(len(p)-1):
    xi = p[i];
    xii = p[i+1];
    part = 100*(xii-xi**2)**2 + (xi-1)**2;
    sum+=part;
  return sum
```

4. Use the Guofei-package to find the optimal tour in a Monte Carlo loop and log the mininum, mean, and variance of the objective function. Do you win against the three heuristics?
5. Are the parameters you chose to win against the heuristics on one problem instance well suited over all problems instances? Argue with data.

4. Fourth Week

Objectives: Finish the already started tasks and prepare the deliverable, i.e., homework to be uploaded or sent by email (formella@uvigo.es) til Sunday 3rd of March.

1. Take a deeper look into the Guofei-package and find out which types of recombination/crossover, mutation, selection, initialization, and stopping criteria, the package implements.
2. Implement and run (using the Guofei-package) the minimization of the Schaffer-function and (3d- or 4d-) Rosenbrock function with both encodings in a Monte Carlo loop and log the mininum, mean, and variance of the objective function.

   Argue why you took the decisions when chosing your parameter set.
3. Use the Guofei-package to find a sufficiently good tour with the genetic algorithm approach, on some of the smaller instances from the TSPLIB. Compute mininum, mean, and variance of the objective function whenever you use a Monte Carlo approach. Compare to the three more simple heuristics (nearest neighbor, quick tour, and pair-center tour).

   Argue why you took the decisions when chosing your parameter set.

Use a python notebook to implement, execute, and document your homework.

5. Fifth Week

Objectives: Start to work with particle swarm optimization, on the same problems as already used and with the Guofei-package.

1. Implement and run (using the Guofei-package) the minimization of the Schaffer-function and 4d-Rosenbrock function. You can use the examples given in the package as baseline. Experiment with the settings of the free parameters and argue about your findings.

   You find more problem instances with their corresponding optimal tour on the public webpage accompanying the lecture.
2. Again calculate simple statistics (such as average, mean, and standard deviation) regarding the best values found by your Monte Carlo runs. Discuss your findings.

Use a python notebook to implement, execute, and document your work.

6. Sixth Week

Objectives: Continue to work with particle swarm optimization, on the same problems as already handled with the Guofei-package.

1. Implement and run (using the Guofei-package) the minimization of the traveling salesperson problem. You can use the examples given in the package as baseline. Experiment with the settings of the free parameters and argue about your findings.
2. Again calculate simple statistics (such as average, mean, and standard deviation) regarding the best values found by your Monte Carlo runs.

3. Compare briefly to your results obtained with the genetic algorithm. With your limited knowledge and experience acquired so far: which method would you prefer?

Use a python notebook to implement, execute, and document your work.

7. Seventh Week

Objectives: Finish the second deliverable.

1. Implement and run (using the Guofei-package) the minimization of the traveling salesperson problem. You can use the examples given in the package as baseline. Experiment with the settings of the free parameters and argue about your findings.
2. Take into account that the parameters—in order to converge—should fulfill the following conditions:

   $1 > \xi > \frac{1}{2}(\varphi_1 + \varphi_2) - 1 \geq 0$

   For other values, the algorithm may converge, and does it often but there is no guarantee. Hence we should set: $\varphi_1 + \varphi_2 < 4$.
3. Again calculate simple statistics (such as average, mean, and standard deviation) regarding the best values found by your Monte Carlo runs.

Use a python notebook to implement, execute, and document your work.