Lab 6: Niching Methods for Multimodal Optimisation

CS408/CSE5012: Evolutionary Computation and Its Applications

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Updated Course Plan

- Lecture 1 (Feb 21): Introduction to Evolutionary Computation
- Lecture 2 (Feb 28): Operators for Discrete Representation
- Lecture 3 (Mar 6): Operators for Real-valued Representation
- Lecture 4 (Mar 13): Search Operators and Representations
- Lecture 5 (Mar 20): Evolutionary Combinatorial Optimisation
- Lecture 6 (Mar 27): Population Diversity, Niching and Speciation
- Lecture 7 (Apr 3): Presentations of Assignment 1 (marked, 25%)
- Lecture 8 (Apr 10): A Rigorous Theoretical Framework for Measuring Generalisation of Co-evolutionary Learning

Updated Course Plan (continued)

- Lecture 9 (Apr 17): Multi-objective Evolutionary Optimisation
- Lecture 10 (Apr 24): Constraint Handling
- Lecture 11 (May 8): Presentations of Assignment 2 (marked, 25%)
- Lecture 12 (May 15): Genetic Programming
- Lecture 13 (May 22): Evolutionary Learning
- Lecture 14 (May 29): Theoretical Analysis of EAs
- Lecture 15 :(June 5) Presentations of Assignment 3 (marked, 25%)
- Lecture 16 (June 12): Final exam (marked, 25%)

Outline

Assignment 2: Niching Methods for Multimodal Optimisation

Task (Short Version)

- Compare Niching Methods for Multimodal Optimization.
- Participate in the Competition on Niching Methods for Multimodal Optimization at GECCO2020.
- Better performance $\rightarrow$ higher mark.

Competition on Niching Methods for Multimodal Optimization

- Competition webpage: `http://epitropakis.co.uk/gecco2020/`
- Organisers: Mike Preuss, Michael Epitropakis, Xiaodong Li.
- Competitions organised in main conferences on EC since 2013.
- "*A common platform that encourages fair and easy comparisons across different niching algorithms*".
- Platform: `https://github.com/mikeagn/CEC2013/`
- Implemented in Matlab, python, Java, and C/C++.

Demo: `http://epitropakis.co.uk/gecco2020/`

References

1. X. Li, A. Engelbrecht, and M.G. Epitropakis, "Benchmark Functions for CEC'2013 Special Session and Competition on Niching Methods for Multimodal Function Optimization", Technical Report, Evolutionary Computation and Machine Learning Group, RMIT University, Australia, 2013.
   PDF available at: `https://titan.csit.rmit.edu.au/~e46507/cec13-niching/competition/cec2013-niching-benchmark-tech-report.pdf`

2. M.G. Epitropakis and M. Preuss, "The Most Recent Advances on Multi-Modal Optimization", Presentation, PPSN2018.
   PDF will be sent to you.

3. Website for IEEE CIS Taskforce on Multimodal Optimization:
   `http://www.epitropakis.co.uk/ieee-mmo/`

Besides the niching methods presented in our lecture, you can find some other methods in [2].

Assignment 2

- Task: Implement EAs using niching methods and compare implemented niching methods on a set of 20 multi-modal functions.
- Platform: `https://github.com/mikeagn/CEC2013/`
- Programming language: Matlab, Python, Java, and C/C++
- This assignment has 100 marks, which will take 25% in your final mark of this course.

Deadlines & Submissions

- **Individual presentation on 8 May (30%).**
- **Submission of your entry and report to the competition and to our course (50%).**
  - The report should contain the url to the GitHub project of your code.
  - To our course (via BlackBoard): no later than 23:59 (Beijing time) May 17th. Penalty for being late. You can't revise the report or program after 23:59 (Beijing time) May 20th.
  - To the competition: you can always revise and submit new entry and report after 17 May, before the competition submission deadline.
  - Format of program and solution files: detailed at `http://epitropakis.co.uk/gecco2020/#submission`
    Remark: you can submit multiple entries (algorithms).
- **Performance of entries (20%)**: your submissions will be ranked using the same evaluation criteria as in the competition.

Performance Measures

- Average Peak Ratio (PR): If the fitness of a solution reaches a given accuracy level ϵ, we consider that a global optimum is found.
- Success rate (SR).
- Convergence speed.

Work for students: Check [1] for more details.

Implementation Details

- 20 multi-modal benchmark functions, detailed in [1] and [2].
- 50 independent runs for each experiment.
- Accuracy levels $\epsilon \in \{10^{-1}, 10^{-2}, 10^{-3}, 10^{-4}, 10^{-5}\}$ independent runs for each experiment.

Evaluation of Entries

1. Rank based on average PR values.
2. (Static) $F1$ measure, to take into account the recall and precision of the final solution sets.
3. (Dynamic) $F1$ measure integral over the whole runtime, to take into account the computational efficiency of your algorithms.

Rank-based Marking

Rank	1	2	3	4	5	6	7	8
#Points	25	18	15	12	10	8	4	2

Table 1: Points assigned to entries at each evaluation scenario.

Final Rank	1	2	3	4	5	6	7	8
Mark	20	16	13	10	8	6	4	2

Table 2: Mark assigned to entries according to the final rank. The final rank is made by the sum of $\#points$ obtained in the 3 evaluation scenarios.

References

1. X. Li, A. Engelbrecht, and M.G. Epitropakis, "Benchmark Functions for CEC'2013 Special Session and Competition on Niching Methods for Multimodal Function Optimization", Technical Report, Evolutionary Computation and Machine Learning Group, RMIT University, Australia, 2013.
   PDF available at: `https://titan.csit.rmit.edu.au/~e46507/cec13-niching/competition/cec2013-niching-benchmark-tech-report.pdf`

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