

ECMM409 Nature-Inspired Computation

CA2: Solving Complex Problems with Nature-Inspired Algorithms

This is a **TEAM AND INDIVIDUAL** assignment and is worth 60% of the module

Hand out: **31st October 2022**

Hand in: **14th December 2022**

Feedback: **January 2023**

You are reminded of the University's Regulations on Collaboration and Plagiarism. You are required to cite the work of others used in your solution and include a list of references, and must avoid plagiarism, collusion and any academic misconduct behaviours. Further details about Academic Honesty and Plagiarism can be found at <https://vle.exeter.ac.uk/course/view.php?id=1957>

INTRODUCTION

What you will do in this assignment is tackle a problem from a conference using a Nature-Inspired technique. The problems are part of an international competition to develop a Nature-Inspired algorithm to solve a given problem in accordance with the goals as stated for each problem.

You may also select a problem from the following competitions, providing that you have access to the required material (e.g. datasets) and/or resources (e.g. GPUs). Note that there may be a lack of relevant datasets or resources to conduct some of the competitions, especially for older past competitions, so please carefully choose your problem. Your work will be marked based on the quality of your submission, not the selection of any specific problems. (Hint: Try not to select too complicated problems that may take lots of time and different resources.)

<http://www.sigevo.org/gecco-2007/competitions.html>

<https://www.irit.fr/wind-competition/>

<https://www.sigevo.org/gecco-2010/docs/GECCO2010-EVOART.pdf>

<http://www.sigevo.org/gecco-2015/competitions.html>

<http://gecco-2016.sigevo.org/index.html/Competitions>

<http://gecco-2017.sigevo.org/index.html/Competitions>

<http://gecco-2019.sigevo.org/index.html/Competitions>

<https://gecco-2020.sigevo.org/index.html/Competitions>

<https://gecco-2021.sigevo.org/Competitions>

<https://gecco-2022.sigevo.org/Competitions>

<https://cec2021.mini.pw.edu.pl/en/program/competitions.html>

<https://wcci2022.org/accepted-competitions/>

You should select **one** problem and write a Nature-Inspired algorithm to solve the problem and write up your experiments as if they were to be presented at the conference. You can test more than one algorithm if you wish but you should only present one as the final 'best' algorithm. Once you have made your selection, and no later than the **9th November 2022**, **please submit your selection & team name using this form <https://forms.office.com/r/J8nrnJW7Us>**

HINT: *To make the most of your time, it is likely to be beneficial for you to separate the task into subproblems that you can work on in parallel.*

TASK

- Select a competition from the above website and **carefully study the rules of the competition** which in some cases are quite restrictive. Make sure your implementation adheres to the requirements of the competition as far as possible.

- **In your team, discuss the various approaches that might be taken to solve this problem.** There is invariably more than one way to solve a particular problem and there will be a number of ways in which you might solve this problem with a Nature-Inspired method. You should perform research into the range of possible techniques that might be applied to this problem, including methods not covered in lectures. You should include a discussion of likely representations and fitness functions for each method you describe and select on a final method or methods to implement.
- **Develop an algorithm in your choice of language** (but bear in mind the deliverables for each competition, some of which include the provision of an executable) to solve the problem in the competition.
- **Perform experimentation** on the competition data/problem and make adjustments to the algorithm to improve performance. This might include the introduction of heuristics or modified operators to increase the performance of the algorithm (for instance, an adaptive mutation operator which varies the rate according to convergence).
- **Produce the deliverables for the problem** as stated on the competition page.
- **Keep minutes of the team meetings that have taken place, including who attended (either in-person meetings or virtual attendance through Teams/Zoom/Skype or similar is acceptable).** This should be signed by all team members before submission.

TEAM SUBMISSION (max 4 pages)

You will need to submit several elements electronically:

1. A short report of **maximum 4 pages (sides of A4)** submitted by **one team member** and **clearly identified with your team name**. This report should describe the project including the research undertaken, the division of the larger problem into tasks, details of the developed algorithm and the results obtained.
2. The problem deliverables (as specified by the problem webpage) and commented code for your algorithm.
3. A set of signed minutes from the meetings.
4. A README file explaining how to reproduce the outputs.

Submit these electronically using E-BART (<https://bart.exeter.ac.uk/>), by **no later than 12 noon on the submission deadline given above**.

INDIVIDUAL SUBMISSION (max 4 pages)

You will need to submit an individual report. The individual report and any material for the competition can overlap in content (max 10%), but please note that they will need to consist of mostly different information. The individual report should be **maximum 4 pages (sides of A4)** and should contain the following:

- A description of how you contributed to the project (e.g., sections of code that you wrote, experiments you conducted, or other tasks you undertook).
- A discussion of the algorithm survey: e.g.
 - What research was conducted to determine the best nature-inspired approach to this problem?
 - Which methods were identified as suitable for solving this problem?
 - Why were these chosen?
 - What representations and objective functions would be required for each method?
 - What were the reasons for the final algorithm selection?

- A discussion of the experimentation process: e.g.
 - What experiments did you conduct and why?
 - What changes to the algorithm were made to try to improve its performance?
 - Were the changes successful? If not, why not?
- A discussion of the teamworking process: e.g.
 - Did all members of the team contribute?
 - Did the team make use of all its available resources? If not, why not?
 - What were the most challenging and enjoyable aspects of working in a team?
- A conclusion section discussing the success of the overall approach, the teamworking process, and briefly any further approaches you consider might be appropriate.

Your individual report should be submitted via E-BART (<https://bart.exeter.ac.uk/>) no later than **12 noon on the submission deadline given above.**

MARKING CRITERIA

Submissions will be marked as follows:

TEAM (from the team deliverables)

10% How well you worked as a team. (How well were tasks identified, planned and distributed amongst the team members?)

20% Algorithm selection and implementation. (Did the algorithm selection process consider a broad range of possibilities and provide logical reasoning for the exclusion of algorithms? Which algorithm was selected? Why was it selected? What representation was used? Were any modified operators included?)

10% Overall success and quality of the team submission. (e.g. Does the algorithm solve the problem? Does it provide good results in reasonable computational time? Are the team submissions of good quality in terms of presentation and commenting?)

INDIVIDUAL (from individual report)

20% Individual contribution to the task. (To what extent did the individual contribute to each of the aspects of the task including the division of the task, the algorithm selection process, the implementation of the code and experimentation).

20% Discussion of experiments and modifications made to the algorithm. (To what extent did the individual make use of their knowledge of Nature-Inspired Computation in determining the algorithm to use and suitable modifications to improve performance based on experimental results?)

20% Quality of teamworking discussion and conclusions. (To what extent does the individual provide reasoned critical analysis of the team working process taking into account the skillsets, personalities and availability of other members in team?)

Finally, you may be asked to individually attend a 15-minute 'viva' to discuss your role in the project in the case that there are conflicting accounts between team members and/or between the team and individual reports.

Overlength submissions will receive a penalty of -10% for each additional page over the limits described above.