Internship in ESA's Advanced Concepts Team

On

Al challenges for optimize.esa.int

European Space Research and Technology Centre ESA ESTEC

Candidates interested are encouraged to visit the ESA website: www.esa.int/gsp/ACT/

Topic description

The ESA's platform for optimization challenges, optimize.esa.int [2], was developed by scientists at the Advanced Concepts Team to reach out to scientists, professionals and interested individuals by providing them challenging tasks involving optimization. Many techniques in AI, most notably deep neural networks training e.g. via supervised or reinforcement learning, require the adjustment of thousands, even billions of weights. Such a task can be rephrased as an optimization problem where the loss-function is the final objective to minimize. These type of problems are becoming increasingly frequent in the aerospace domain [1], and their relevance is expected to increase over the next years.

The objective of the internship is to develop and deploy optimization problems suitable for the optimize web platform (i.e. single or multiobjective constrained box-bounded problems related to the use of AI techniques in space and to perform, prior to deployment, a thorough fitness landscape analysis [3].

Candidate's tasks

- Analyze different ways on how network architecture search (NAS) can be modified as an optimization problem
- Implementing user defined problems (UDPs) for new challenges on the webplatform
- Extent the functionality of optimize.esa.int
- Interacting with the ACT to brainstorm new challenges or conduct testruns
- Explore potential of CGP-representation of network cells to for network architecture design
- Creating of Hyper-parameter optimization (HPO) benchmarking
- Unsupervised learning by solving difficult clustering challenges
- Fitness landscape analysis and problem design

The ideal candidate

Mandatory:

- Strong programming skills in Python.
- Understanding of evolutionary techniques, operation research methods, non convex optimization in general.
- Previous exposure to optimization and/or simulation environments.
- Experience in mathematical modelling (designing objective functions).
- Experience with neural networks and related AI concepts.

Desirable:

- Generalist mindset: being able to feel comfortable working in various application domains.
- Knowledge about multi-objective concepts like Parteo-dominance and hypervolumes.
- Interest in web technologies (React, Javescript).

References

[1] Izzo D, Märtens M, Pan B. A survey on artificial intelligence trends in spacecraft guidance dynamics and control. Astrodynamics. 2019 Dec:1-3.

[2] Advanced Concepts Team (web site): optimize.esa.int (https://optimize.esa.int/)

[3] Pitzer E, Affenzeller M. A comprehensive survey on fitness landscape analysis. InRecent advances in intelligent engineering systems 2012 (pp. 161-191). Springer, Berlin, Heidelberg.

[4] Pagmo foundation (code): Pygmo (https://esa.github.io/pagmo2/)

[5] Advanced Concepts Team (code): Pykep (<u>https://esa.github.io/pykep/</u>)