Internship in ESA's Advanced Concepts Team
on
Cartesian Genetic Programming for modelling space data

Topic description

In preliminary design phases of satellite missions, as well in later test and operational phases, a large number of data is collected that can be described by statistical or mathematical models. In these cases, a Pareto front describing the trade offs between model complexity and prediction quality is of interest: simple models have the interest of being more understandable and easily queried, while more complex model may have a higher prediction accuracy. A classical technique able to perform the symbolic regression required to build these Pareto fronts is Genetic Programming [1]. While, traditionally, the technique has always had problems to deal with real data as per its impossibility to construct and use non fractional physical constants, the Advanced Concepts team has developed a new technique [2] called differential genetic programming (dCGP) that surpass this limitation and allows for models to contain and learn also the values of any number of constants.

The application of dCGP to space data, coming from real missions such as Cheops [3], is the main objective of this internship in order to asses its potentials and performances for the selected applications.

Candidate's tasks

- Understand and, if needed, further develop the dCGP code base [4].
- Performing dCGP, symbolic regression on the collected data sets.
- Investigating possible alternative application for other ESA's missions.

The ideal candidate

Mandatory:

- Programming skills in Python.
- Programming skills in C++.

Desirable:

- Knowledge of Genetic Programming.
- Knowledge of symbolic regression.

References

[1] Koza, J.R. *Genetic programming II, automatic discovery of reusable subprograms.*. MIT Press, Cambridge, MA., 1992

[2] Izzo, Dario and Biscani, Francesco and Mereta, Alessio. Differentiable genetic programming *European Conference on Genetic Programming*, Springer, 2017.

[3] http://sci.esa.int/cheops/. Accessed October 2018.

[4] https://github.com/darioizzo/d-CGP. Accessed October 2018.