Open Internship in the ESA Advanced Concepts Team in 2016
on

Genetic Programming: Introducing Back-Propagation Algorithm

Topic description

Genetic programming (GP) is a machine learning technique that consists in evolving a computer program to have the desired output for a given dataset. After being highly popular and studied during the 70s, genetic programming experienced increasing criticism in the following years. The criticism was mainly stemming from it being a computationally intensive task, preventing it to be competitive with other emerging machine learning tools. Neural networks were in a similar situation until the use of the backpropagation algorithm was popularized in the 80s, which made possible to efficiently train large networks.

The Advanced Concepts Team (ACT) has recently developed a framework equivalent to the back-propagation algorithm to evolve a computer program making use of Cartesian Genetic Programming [1]. The potentials of this approach are still under investigations, but the use of genetic programming to do symbolic regression has already been proposed as a way to learn differential equations [2], which can be helpful to discover the laws that explain physical processes [3].

The ongoing research of the team include the study of machine learning for space related tasks, some examples include the use of neural networks for stellar clustering or optimal landing on unknown extra-terrestrial surfaces. In a similar way, we expect genetic programming to be a powerful tool for space applications.

Candidate's tasks

The successful candidate will investigate the potential space applications of the differential version of Cartesian Genetic Programming (d-CGP) developed by the ACT researchers. The main goal will be to help the team understanding the applicability of this approach to machine learning tasks.

The candidate's tasks will be to:

- Get familiar with the d-CGP framework;
- Study a back-propagation algorithm to learn models in a d-CGP framework (details of the algorithms will be available upon arrival);
- Test the results on some space related task comparing it to neural based approaches.

The ideal candidate

Mandatory

- Programming skills (Python, C/C++)
- Background in genetic programming and/or general machine learning methods

References

[1] Miller, Julian F., and Peter Thomson. "Cartesian genetic programming", Genetic Programming. Springer Berlin Heidelberg, 2000. 121-132. http://rd.springer.com/chapter/10.1007%2F978-3-540-46239-2_9

[2] Gaucel, Sébastien, et al. "Learning dynamical systems using standard symbolic regression", Genetic Programming. Springer Berlin Heidelberg, 2014. 25-36. http://evelyne.lutton.free.fr/Papers/evostar-2014-differential-equations.pdf

[3] Schmidt, Michael, and Hod Lipson. "Distilling free-form natural laws from experimental data", Science 324.5923 (2009): 81-85.http://creativemachines.cornell.edu/sites/default/files/Science09_Schmidt.pdf