24-Months Postdoc Position in Genetic Programming Applied to Histopathological Image Analysis
Toulouse, France

Context and objectives

For about five years, we have been developing in our research team an alternative method to Deep Learning for image analysis. This method uses genetic programming and in particular an approach called Cartesian Genetic Programming (CGP) to assemble already existing image analysis functions. The idea is, rather than having to recreate all the filters "from scratch" as neural networks do, to rely on decades of development in computer science and in particular in image analysis. The goal is to create image analysis pipelines quickly and using very small image datasets. Over the past few years, this method has been successfully applied to video game control with the ATARI benchmark (Wilson 2018) and video images in the context of smart city (Biau 2021)

Recently, a PhD student has developed a library that allows to simply launch the automatic creation of pipelines on images from microscopy on immunological synapses detection problems. We have shown that in a few hours of computation on a dataset composed of 6 to 8 images, our approach allows to obtain accuracies equivalent to deep learning requiring 20 times more images (Cortacero, paper in preparation).

Building on these past successes, we now want to evaluate our approach in more complex situations. In collaboration with the department of histopathology of the Institut Universitaire de Cancérologie de Toulouse (IUCT – CHU Toulouse), we ambition to use our CGP approach in patient tissues. In comparison to our previous work, many challenges must be addressed. Whereas biological images from microscopy are usually very clean and very clear, images from patient can be harder to analyze due to its complexity (many cells of various types) and heterogeneity (differences of staining, machines and technicians) and the size of the pictures (tens of gigabytes).

To overcome this difficulty, the histopathology department have unprecedented data. Thousands of patient tissues have been stained with various makers giving easier access to the point of interests to be identify in images. The first task of the hired candidate will be to evaluate CGP to produce filters to analyze these specific images. We hope being able to easily generate the desired filters which will be helpful to produce a large dataset using standard markers. Classical methods (e.g. deep learning) will then be confronted to CGP on the standard markers to identify areas of interest.

Another objective of this project is to develop new technics with CGP to analyze 3D images. Currently, analyzing biomedical images mainly consists in analyzing 2D images. However, a lot of information is lost by losing the third dimension, often available in patient. In particular, the morphology of the tumor can be very

informative to adapt the therapeutic strategy. Few work currently exists on Machine Learning approaches extended to the third dimension. In our opinion, CGP can be instrumental to tackle this objective since it will use past decades of image analysis engineering and research, including 3D image analysis.

Expected competencies

We are looking for candidates graduated in computer science or applied mathematics with skills in evolutionary computation and, if possible, genetic programming. Candidates must have undeniable coding and scientific paper writing experiences. Skills in image analysis will be appreciated, in particular in the field of medical images. Candidates must be interested in collaborating with medical doctors as they will be co-supervised by expert in genetic programming and doctor in histopathology (see section “Supervision” above).

Supervision

The candidate will be supervised by:

- Sylvain Cussat-Blanc, Hervé Luga & Jean-Marc Alliot, IRIT CNRS UMR5505, experts in evolutionary computation and applications to biomedical images
- Camille Franchet & Pierre Brousset, IUCT CHU Toulouse, experts in histopathology

The hired candidate will be work at CRCT in the IRIT-CRCT project team. Computer science and artificial intelligence are taking an increasing place in the world of medical research, and in particular in the world of cancer research. The joint IRIT/ CRCT team, co-located on the Toulouse Oncopole site, aims to have computer scientists, cancer researchers and physicians work together on the same site.

Contract

12-months contract with a possible extension to 12 additional months. Salary will be discussed depending on the experience of the candidates. The postdoc contract can start as soon as possible and will be situated at CRCT, 2 avenue Hubert Curien, 31000 Toulouse, France.

References

Biau, J.; Wilson, D.; Cussat-Blanc, S. and Luga, H. (2021). Improving Image Filters with Cartesian Genetic Programming. In Proceedings of the 13th International Joint Conference on Computational Intelligence - ECTA,ISBN 978-989-758-534-0; ISSN 2184-2825, pages 17-27. DOI: 10.5220/0010640000003063

Wilson, D.G., Cussat-Blanc, S., Luga, H. and Miller, J.F., 2018, July. Evolving simple programs for playing Atari games. In Proceedings of the Genetic and Evolutionary Computation Conference (pp. 229-236).

Contacts

• Pierre Brousset brousset.p@chu-toulouse.fr
• Sylvain Cussat-Blanc Sylvain.Cussat-blanc@ut-capitole.fr
• Jean-Marc Alliot jm@alliot.fr