Specific Reasoning for Connectionist AI in CP solver

Keywords : Static analysis, Constraint Programing, Connectionist AI, Floatting point.

Institution

The French Alternative Energies and Atomic Energy Commission (CEA) is a key player in research, development, and innovation. Drawing on the widely acknowledged expertise gained by its 16,000 staff spanned over 9 research centers with a budget of 4.1 billion Euros, CEA actively participates in more than 400 European collaborative projects with a large number of academic (notably as a member of Paris-Saclay University) and industrial partners. Within the CEA Technological Research Division, the CEA List institute addresses the challenges coming from smart digital systems.

Among other activities, CEA List's Software Safety and Security Laboratory (LSL) research teams design and implement automated analysis in order to make software systems more trustworthy, to exhaustively detect their vulnerabilities, to guarantee conformity to their specifications, and to accelerate their certification. In particular, the topic of verifies AI became a strong strength of the laboratory.

One of our tool named *COLIBRI*, is a constraint solver specialized in program verification. Its reimplementation *Colibri2* in OCaml, have the additional aim to verify connectionnist AI, neural networks.

Verification of connectionnist AI became of paramount importance due to the number of critical place it is put in. Compared to programs, neural networks tackles nearly always problems that are hard to define, moreover they can't be easily seaprated in well defined pieces. That's why the verification of such object created new challenges.

One technique used is to propagate through the neural networks relations between the values of the inputs and floating point errors, and the value of the nodes. This can be done with zonotopes (i.e. affine form), and with specific approximation of ReLu or other non-linear operator used in the neural networks.

Objectives

The extension of *Colibri2* to neural networks verification will requires specific handling. The goal of the intership is to add to this generic CP/SMT solver technique specificaly developped to scale on large neural networks. Particularly they use the same techniques used for computing neural networks fast: vectorized operations. The OCaml library *Owl* is a possibility to get accessed to those operations.

The internship could be adapted to the level of the student by adapting the objectives: - implementation of the techniques in *Colibri2* and comparison to other tools - implementation and proof of the techniques in *Why3* and extraction of the code in *Colibri2*

Qualifications

- **Minimal**
- from licence 3 to master 2 student in Computer Science
- knowledge of OCaml
- notions of communication protocols
- ability to work in a team
- **Preferred**
- familiarity with Python
- familiarity with ML

Characteristics

- **Duration:** up to 6 months from early 2022
- **Location:** CEA Nano-INNOV, Paris-Saclay Campus, France
- **Compensation:**
  - up to €1300 monthly stipend (determined by CEA compensation grids)
  - maximum €229 housing and travel expense monthly allowance (in case a relocation is needed)
  - CEA buses in Paris region and 75% refund of transit pass
  - subsidized lunches

Application

If you are interested in this internship, please send to the contact persons an application containing:

- your resume;
- a cover letter indicating how your curriculum and experience match the qualifications expected and how you would plan to contribute to the project;
- your bachelor and master 1 transcripts;
- the contact details of two persons (at least one academic) who can be contacted to provide references.

Applications are welcomed until the position is filled. Please note that the administrative processing may take up to 3 months.

Contact persons

For further information or details about the internship before applying, please contact:

- François Bobot (francois.bobot@cea.fr)
- Zakaria chihani (zakaria.chihani@cea.fr)