Innovation Project
Ecole Centrale Paris.
Build a High-Performance Go Computer Program

X and Y, promo 2XXX,
Ecole Centrale Paris
Tuan Nguyen
Arbitragis Trading, Paris, France

April 25, 2009

Abstract

Since the historic chess game between Deep Blue and Kasparov, when, for the first time ever, a computer program defeated a World Chess Champion, one last challenge remains in the realm of Artificial Intelligence: the Go game. Indeed, the number of games is orders of magnitude bigger than in chess, as the total number of games is greater than the number of atoms in the universe. The combinatorial explosion of the number of games in Go has until now been a big obstacle in the resolution of the game. INRIA and the CMAP laboratory of Ecole Polytechnique have built MoGo, the best world Go program that won:

- the first blitz game against a professionnal player on a 9x9 board in 2007,
- the first non-blitz game against a professional player on a 9x9 in 2008,
- the dan-level on a 19x19 board [3].

This difficult and extremely challenging project is proposed to students of ECP and tries to solve a great challenge in Artificial Intelligence by improving Go computer program build by INRIA-Ecole Polytechnique. This will be done by transcoding the current parallel search algorithm part from MPI on CPU, to Cuda [1] on GPU [2]. Doing this should allow a 30 to 100-fold increase in computing speed.

Keywords: Go game, Monte Carlo, tree search, Upper Confidence Tree, Bandit Algorithm for Search in Trees, Graphical Processing Unit, Cuda, one-armed bandit algorithm, MPI, parallel computing, multithreading

1 Introduction

Inria and Polytechnique have used an implementation of Monte Carlo Tree Search (MCTS [1]): Upper Confidence Tree. Instead of making a tree search on the possibility of moves, MCTS plays a massive amount of games randomly and tries to pinpoint a zone where moves seem to be better. In that zone, it will launch a tree search, reducing then the number of games to be analyzed.

2 Tools provided by Arbitragis and Ecole Centrale

The MoGo source code is big and complex. As a consequence, selected students will need to be extremely proficient in C/C++, and have a good knowledge of multithreading. They will need to be very proficient in applied mathematics and be, ideally but not necessarily, Go players. They will be provided with the

[1] Cuda is a C-like language designed by NVidia to program GPUs.
[2] Graphical Processing Unit

same computing power as Meteo France and will benefit from our internal tools / methodologies that will help them generate tangible results. You will be helped partly by a researcher at INRIA on the algorithmic side, partly by Arbitragis on the GPU implementation side.

3 What you will gain from this experience

You will gain a massive expertise in C++ and be knowledgeable in a very *avant-garde*, yet useful area of applied mathematics. You will leverage on the huge research already done by researchers in Artificial Intelligence from INRIA [2]and Ecole Polytechnique. There will be a room for four passionate students in order to do this task.

4 Example of previous work between Arbitragis and ECP academics / students

Arbitragis has already cooperated with ECP on numerous subjects related to computational finance and derivatives pricing. Here is a non-exhaustive list:

- Teaching of *Computational Finance with Graphics Processing Units*, Applied Mathematics class, January 2009 with Ioane Muni Toke Click here for the schedule and the agenda.
- Study of Earthquake Predictions Applied to Financial Crashes. Michael Martos, ECP 2008
- Lookback Options Pricing and Trend Following Strategies. Francois Bouscarle & Fabien Charbonnel, ECP 2008
- Levy Laws used in Derivatives Pricing, Geoffrey Gascq, ECP 2008
- Classification Algorithms and Market Predictions, Otakar Frank, ECP 2008
- Massively Parallel Quasi Monte Carlo, Grégoire Jauvion, ECP 2009
- Visualization of High Frequency Market Data, Raphael Megzari & Hugo Delaborde, ECP 2010
- Pricing of Volatility Futures and Options on Volatility, Cyril Neyme & Kevin Maurice-Vallerey, ECP 2009

5 Prospects

The program with GPUs will be played against other computer programs, and if successful, will be a potential contender in the annual Go championship which is organized in Paris. `http://www.lri.fr/~teytaud/crmogo.en.html`

6 How to apply ?

Please send a resume in pdf form to stages@arbitragis.com. This document can also be found on http://www.arbitragis-research.com.

References

[1] Gelly, S., Wang, Y., Munos, R., Teytaud, O., Modification of UCT with Patterns in Monte-Carlo Go *INRIA, Rapport de recherche No 6063,* 2006.

[2] IA-Go challenge : Video interview of researchers from INRIA.

[3] Description of the Go program from INRIA, *INRIA Internet site*