

CE-Solver 0.1v - Correlated Equilibrium Solver

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1 Introduction

CE-Solver is a tool computing the Correlated equilibrium (CE) [1, 2] of a given strategic game

$$(Q; S_1, S_2, \dots, S_N; U_1, U_2, \dots, U_N)$$

where

- Q is a set of N -players, $Q = \{1, \dots, N\}$
- S_i are strategy sets of players $i \in Q$
- U_i are payoff function of layers $i \in Q$

Correlated equilibrium is well described in literature. This particular tool computes an unique Pareto efficient outcome where no player has an incentive to deviate (equilibrium).

2 Implementation

For the purpose of computing the game equilibria, the strategies have no concrete labels (just numbers $0..|S_i|-1$). We say that the game has certain number of players (N), each player has its number of strategies $|S_i|$ and the utility functions are given as a $|S|$ -long listing of N -dimensional vectors of payoffs.

The profiles are ordered in the manner described below:

```
void iterate(int *addr, int level)
{
    if (level==N) {
        // sample profile - load/save/...
        return ;
    }

    for (addr[level]=0; addr[level]<number_of_strategies_of(level); addr[level]++)
        iterate(addr, level+1);
}

void load_save()
{
    int addr[N];
    iterate(addr, 0);
}
```

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2.1 Running the program

CE-Solver expects the input in form of a text file called "gmain.game" (or a file specified as a program argument) with the following structure:

```
number_of_players
number_of_strats_of_0_player number_of_strats_of_1_player ... number_of_strats_of_(N-1)_player
the_utility_functions_listing
```

The program loads the input file and computes the solution (the method was described deeply in [3]). The solution is a list of pairs (*profile*, *probability*). Let us have look at the example printed on the computer screen:

```
1 items in the stochastic profile
profile num: 29999 [ 0 0 9 9 9 0 9 2 ] 1.00
```

At the end, the program displays number of profiles with non-zero probability and their listing in form: number, its coordinate in the N -dimensional state space (pure strategies chosen) and its probability. Probability 1.00 means a pure equilibrium.

3 Installation

The tool has been developed on Linux operating system and GNU C++ compiler (version 4.3.2). The program itself requires some important libraries:

- Boost Multi-thread Library [4] (Debian: libboost-thread-dev) – Provides threads and locks.
- GNU Linear Programming Toolkit [5] (Debian: glpk*) – The CE is based on solving linear programming task.
- OpenMP (Debian: libgomp1) – front-end to boost-thread.
- Multi-precision Arithmetic Library (Debian: libgmp*) – Allows large numbers.
- g++-4.3.2 - OpenMP works only with 4.3.1-2 currently.

Adjust the makefile to set the right paths and names. Then it should be easy to build the program.

4 Conclusion

CE-Solver represents a very efficient tool for computing the correlated equilibria in large games. It may be used as a tool reading the input file or as a part of another program (both following the GNU GPL licence rules).

The author will be very happy for any comments and messages (e-mail: hrubym at fit.vutbr.cz). Clearly, the author is not responsible for any damage caused by use of this tool.

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References

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- [4] Boost HP: <http://www.boost.org/>
- [5] GLPK HP: <http://www.gnu.org/software/glpk/>