Game 2048 AI Controller Competition @ GECCO 2015

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Game of 2048

Rules

- single-player, nondeterministic
- $4 \times 4$ board
- actions: left, right, up, down
- merging: score the sum
- every move: 2 or 4 in random position
- goal: construct tile 2048

http://gabrielecirulli.github.io/2048
Motivation

- Popularity:
  - 4mln visitors in the first weekend
  - 3000 man-years in 3 weeks
- Easy to learn but not trivial to master $\rightarrow$ ideal test bed for CI/AI
  - $10^{21}$ states (upper bound), Backgammon: $10^{20}$
- Few previous studies (RL only!):
Motivation & Goal

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Goals

1. Learning/evolving the strategy.
2. Learning/devising effective function approximators
Rules

- Java API provided, submitting a jar (any JVM language).
- 1 ms (enough!) for a given action (on average)
- Objective: expected score (average over 1000 games)

```java
import put.game2048.*;

public class MyAgent implements Agent {
    public Action chooseAction(Board board, List<Action> possibleActions, Duration timeLimit) {
        //TODO
    }
}
```
Submissions 1: Treecko

- Authors: T. Chabin, M. Elouafi, P. Carvalho, A. Tonda
- Affiliation: INRA (France),
- Linear Genetic Programming: (MicroGP)
- 19h with 16 cores
- (Code)
- (Demo)
Authors: Devanand and Shivaram Kalyanakrishnan
Affiliation: Indian Institute of Technology Bombay, India
Cross Entrophy Method
A linear weighed function approximator with 9 hand-designed features
2-ply Expectimax
(Demo)
**Ranking:**

1. *IeorIITB2048*
   - Avg. Score: 18245.6 ± 660.3
   - 2048: 0.341
   - 4096: 0.013

2. *Treecko*
   - Avg. Score: 5334.3 ± 171.0
   - 1024: 0.048
   - 2048: 0.0
State-of-the-art

1 Small number of hand-designed features + CMA-ES + ExpectiMax
2 Large number of binary features + TD + ExpectiMax

Systematic $n$-Tuple Networks

\[
f(s) = \sum_{i=1}^{m} f_i(s) = \sum_{i=1}^{m} \text{LUT}_i \left[ \text{index} \left( s_{loc_{i1}}, \ldots, s_{loc_{ini}} \right) \right]
\]

\[1\text{See also: EML1, Tuesday 17:05}\]
Summary

- 2048: new interesting **challenge for AI/CI** with simple rules and highly popular, quick to play (even 20ms for one game)
- Still early research, plenty of opportunities, also as a benchmark
Conclusions

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Open questions

- Effective learning (currently millions of games)?
- Automatically extracting useful features / function approximator.
- What is the expected score of the optimal policy? Currently $[437\,000, 3\,932\,100]$
- Highest possible winning rate for 2048, 4096, 8192, 16384, 32768, 65536…?