Udacity Artificial Intelligence nanodegree
Project: Build a Game-Playing Agent

Research Review

by C. Chevalier, June 2017.

Rivest R. L., **Game Tree Searching by Min / Max Approximation**,
Artificial Intelligence, 34 (1998) pp. 77 - 96.

In this paper published in 1988 in the Artificial Intelligence journal, Ronald L. Rivest (the author) presents, evaluates and discusses a new technique for searching min / max game trees.

The technique or method develop by the author and named by him “min / max approximation” aims at exploring the game tree by focusing on the important lines of play. The game tree is using an iterative search heuristic (see section 3.3) The “min / max approximation” method is based on a approximation of the min and max operators by generalized mean-valued operators (introduced in section 2) which allows to identify the leaf in a tree whose value has the largest effect on the value at the root and which should therefore be explored next (see section 3.5). As such the “min / max approximation” is a special case of the penalty-based iterative search methods presented by the author in section 3.4. Further details of the implementation are discussed in section 4.

In order to evaluate this new technique the author has conducted some experimental tests on the “Connect-Four” game (see section 5.1). The “min / max approximation” (MM) developed by the author is compared to the minimax search with alpha-beta pruning and iterative deepening (AB which is the very same method introduced in the AIND course and used in the isolation game project). All possible starting positions and agent’s starting turn are combined in a complete experiment of 98 games. Each complete experiment is then conducted with 5 increasing resource bound of two type each: elapsed CPU time and calls to the game “move” operator.

The results are the following:

- For games based on the time usage alone, the AB game agent is superior to the MM one;
- While, for games based on the “move” operator usage, the MM game agent is superior.

It was also noted that the number of positions considered by the AB agent is approximately three times larger than the one of the MM agent when a time bound was in effect. The calls to the move operator are also larger with the AB agent than the MM agent.

Based on these experimental results, the author concludes that the “min / max approximation” is superior to the minimax search with alpha-beta pruning and iterative deepening when both agents are restricted to the same number of calls to move operator.