Hao Chen

Udacity Artificial Intellegence

Summary- Game Tree Searching by Min/Max Approximation

Game playing by computers has a long history. However, further improvements are certainly possible. Technique such as alpha-beta pruning has been essential in reducing computational burden of exploring game trees. Still, new techniques are needed. This paper introduces a new technique for searching in game trees, based on the idea of approximating the min and the max operators with generalized mean-value operator.

The generalized mean value is used because they are more suitable for a sensitivity analysis than the min/max function. This is done by taking derivatives of the generalized mean value functions at each node and using the chain rule.

Consider a two-person zero-sum perfect information game tree; the tree could be explored completely when the tree is small, so optimal play is possible. Larger trees requires alpha-beta pruning with heuristics approximations. The min/max heuristic is special case of the penalty-based search method, where the penalties are defined in terms of the derivatives of the approximating functions. To decide which node to expand, the author proposed to pick a relatively large p and follow the below equations, where max has been approximated by "Mp" and min has been approximated by "M-p"

$$\tilde{v}_E(c) = \begin{cases} \hat{v}(c), & \text{if } c \in T(E), \\ M_p(\tilde{v}_E(d_1), \ldots, \tilde{v}_E(d_k)), & \text{if } c \in Max \backslash T(E), \\ M_{-p}(\tilde{v}_E(d_1), \ldots, \tilde{v}_E(d_k)), & \text{if } c \in Min \backslash T(E), \end{cases}$$

The author presented 5 experimental results (The game: Connected-Four, static elevator, resource bounds, minimax with AB pruning, penalty-based heuristic) demonstrating that min/max approximation approach can produce play superior to that produced by minimax search with alpha-beta pruning. The result shows that based on time usage alone, alpha-beta seems to be superior to the implementation of the min/max approximation approach. However, if we base our comparison on move-based resource limits, the story is reversed: min/max approximation is superior.

The author also addresses open questions such as 1) How should one best choose which generalized mean value functions, or penalty functions, to use 2) Can our ideas be combined effectively with more traditional approaches? …etc