Abstract

$G = (T, h)$ is called a *game tree*, if $T = (V_{MIN} \cup V_{MAX}, E)$ is a directed tree with two different kinds of nodes V_{MIN}, V_{MAX} and if h is a function, running from the set of nodes into the set of integers. Nodes of a game tree are identified with positions of an underlying game, edges with moves from one position to another one. A *strategy* is a subtree of a game tree, which contains the root of G and all successors of $G's$ nodes for the first player, and exactly one successor of $G's$ nodes for the second player. A strategy proves a lower or an upper bound of the minimax-value of the root.
The central notion of this thesis is that of *leaf-disjoint strategies*. The algorithms and analyses, done here, give hints from various points of view that leaf-disjoint strategies have a central meaning in game tree search.

1. Our new 'Controlled Conspiracy Number Search' algorithm is able to build up and evaluate search-trees efficiently. It searches for (and examines) game trees in which lower bounds for the value of the best root-successor as well as upper bounds for the values of the other root-successors are proved by several leaf-disjoint strategies. The leaves of these strategies must have a pre-defined minimal distance to the root. Results: **a)** After our new algorithm has terminated, the search tree contains the a priori demanded properties, and the result itself is based on minimax-values. **b)** If a pre-defined and finite game tree is to be examined, the algorithm will terminate in finite time. **c)** If one does not demand several leaf-disjoint strategies for security, the presented algorithm will examine the minimal possible number of leaves.

2. The 'Parallel Controlled Conspiracy Number Search' algorithm, as introduced in this thesis, embeds its game tree into a network of processors. There have been observed efficiencies of more than 30% on an SCI-workstation-cluster, using up to 160 processors. Under the consideration that this machine is a cluster of workstations, and not a conventional parallel machine, and considering that not only the load, but also the used memory has to be distributed, this is a remarkable result.

3. Let a game tree model be given, in which errors of a non-perfect evaluation procedure are modelled by random events. Inside this model, we could prove, that the error probability of a minimax-evaluation of a game tree depends in its order of magnitude from the number of leaf-disjoint strategies, which are contained in the game tree and which prove the value of the root.

This thesis is of special importance because the described algorithms have shown remarkable results in the chess program P.ConNerS. The widely considered victory of P.ConNerS in the 10^{th} Lippstadt Grandmaster tournament shows that the Controlled Conspiracy Number Search is a nice alternative to the fixed-depth search algorithms like the alphabeta algorithm.