NOTES

CORRECTIONS AND SUBSTANTIATIONS TO KBNK

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The senior author, by letter of July 26, 1987, suggested that the junior authors' results, as published in the ICCA Journal, Vol.8, No.2, pp. 66-87, cannot possibly be right, since the full-board numbers of positions, summed over all moves to mate did not add up to 10,822,184, as they should, but only to 10,821,420. The culprits tender their apologies to readers and state that two errors have crept in. The rows as given for 12 and 26 moves-to-mate contain two familiar errors of typography, corrected below.

number of moves to mate	B (printed as)	B (should be)
12	142,048	142,084
26	949,080	949,808

These new values of B bring up the sum over B to the proper total, 10,822,184.

The senior author also independently implemented, by mid-September, on an Atari ST, the KBNK database, exactly reproducing the numbers and all but one of the optimal moves. The single discrepancy remaining is that the senior author, at move 26 in Van den Herik and Herschberg (185, p.84) found 26. Kd7 (*Kd8*) Bb8, i.e. two equi-optimal moves for White whereas the junior authors' article gave a single optimal continuation.

Van den Herik and Herschberg gladly concede Kd8 to be equi-optimal. They do not yet, however, have traced the discrepancy to its source, which again might be typographical.

We hope readers will forgive any inconvenience caused. The cure for these ills would appear to be a database-consulting program directly coupled to a lay-out program for its results, an effort still beyond us but not, we hope, for long.

REFERENCE

Herik, H.J. van den and Herschberg, I.S. (1985). The Construction of an Omniscient Endgame Data Base. *ICCA Journal*, Vol. 8, No. 2, pp. 66-87.

CHALLENGING THAT MOBILITY IS FUNDAMENTAL

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The notion of mobility has long been considered to be of fundamental importance in positional evaluation. Several different definitions of mobility exist, and they all show a high correlation with having a good position and eventually winning the game, as shown by experiments. However, this article contests the fundamental importance of mobility. Some alternative, and proposedly more useful, definitions of mobility are given. It is also argued that an extensive, second-order mobility analysis is not cost-effective.

1. INTRODUCTION

In most writings on computer chess, it has been contended that the notion of mobility is an important feature in human chess, and therefore likewise important in computerized chess. This has been described in the articles by Hartmann (1987a, 1987b). Several different definitions of mobility have been given, some of which are found in Hartmann.

Mobility, i.e., a count of the number of available moves, where the term "available move" is given some appropriate definition, is closely related to square control. Hartmann includes both move-count-based and square-control-based definitions.

In opposition to the standard view, I propose that the notion of mobility is not very important for evaluating a position. I also suggest that the definitions of mobility given by Hartmann do not reflect the human approach to mobility very well. A mobility concept based on a pre-search analysis of the pawn structure and first-order evaluation will be both more appropriate and more efficient.

2. THE NOTION OF MOBILITY IN HUMAN CHESS

When assessing a position, a (strong) human chess-player probably considers many different factors, such as the material balance, the pawn structure, the centre configuration, the placement of pieces according to the pawn structure, the pieces' cooperation, the king safety, the control of important squares, the available space, and the flexibility of the position (Kotov, 1971). The notion of mobility tries to reflect some of these factors, notably piece placement, square control, space, and flexibility. Among the different factors, the number of moves seems to be relatively unimportant. Factors like material balance, piece placement according to pawn structure, and dominance in the centre are often of much greater importance. A gain in one of these factors usually implies a gain in mobility also, while an increased number of legal moves does not necessarily imply an increase in the other, more important factors.

Considering that many of the other factors are just as easily and efficiently computed as is the mobility, it seems that a chess program is probably better off spending its processor time on things other than computing mobility.

While it must be conceded that mobility reflects some important factors in human chess, one should observe that the move count at a given instant is seldom important. Instead, controlling important squares, keeping manoeuvering space and good piece placements over a period of several moves and such are the main issues. For this reason, a human chess-player, in order to judge the degree of freedom of movement in a position, will most likely not count the number of moves available. Instead he will look at the pawn structure, and especially at opposing, blocked Pawns. He will also check whether the pieces are cooperating or whether they stand in each other's way. From this he will be able to find out the long-term mobility of the position.

The definitions of mobility given by Hartmann do not capture this very well, but there are other ways of scoring mobility that may do better. We shall come to these shortly.

3. HARTMANN'S DEFINITIONS OF MOBILITY

In his article, Hartmann gives a few different definitions of mobility. Together, they reflect some of the formulations that have been used in chess programs. Hartmann lists the following definitions.

1 *Legal mobility.* This is the count of moves legal with respect to the rules of chess. When checks occur, the move count will make dramatic and often irrelevant changes. An early version of the Los Alamos chess program is said to have sacrificed material in order to avoid being checked (Kister, *et al.*, 1957). As the percentage of in-check positions according to Hartmann is low, legal mobility still works well in Hartmann's correlation test.

2 *Pseudo-legal mobility.* This is the count of legal moves, disregarding whether the moving side's King would be in check after the move. It is not subjected to the drastic changes that plague the legal mobility, and may thus seem more reliable. Sometimes, however, a low legal mobility reflects that

many pieces are pinned, i.e., a real positional disadvantage. This will not be noticed by the pseudo-legal mobility count.

3 *Distinct-attacked-squares (DAS) mobility.* This is the count of squares by either side, regardless of how much power each side exercises on each of the squares. Many threats to the same squares, "overloading" in Nimzovich's (1925) terminology, will not be credited, but indirectly penalized.

4 *Total-attacked-squares (TAS) mobility.* This is the count of squares attacked by either side, including multiplicities. In my opinion, this is the best candidate, among Hartmann's definitions, for actual use in a chess program. Things like piece cooperation and mutual protection are not penalized by this kind of evaluation.

Hartmann also mentions de Groot (1965) Mobility, but as it is not a contender for inclusion in a practical program, I decided to skip it.

4. OTHER DEFINITIONS OF MOBILITY

The different definitions of mobility given above do not cover all possibilities. Several alternative variations have been described in the literature. The following are among the more important.

1 *Piece-differentiating mobility.* This means that different mobility scorings are used for the different piece types. In Chess 4.5, e.g., only the raying (far-ranging) pieces are scored for mobility (Slate and Atkin, 1977). In practice, this is probably good, as the mobility scores of the non-raying pieces largely depend on their locations only. Sometimes, however, this may not be true, e.g., when a Knight is hampered by its own Pawns.

2 *Weighting of squares.* This is a simple but important enhancement. Not all threatened squares are given equal weight; greater weights are assigned to, e.g., squares close to the centre or the enemy King.

3 *Undenied mobility.* In Chess 4.5, a square attacked by a Queen is only included if it is not threatened by an enemy Pawn or piece. In this way, many probable blunder moves are excluded from the mobility count. Likewise, a thorough swap-off analysis could be applied to each attacked square, giving a much more relevant measure of square control.

4 *Connectivity.* The TAS mobility is more sensible than the DAS mobility, as it does not penalize piece cooperation and defence of one's own men. A further development of this idea is to give an extra bonus for multiply-threatened squares, especially when central or positionally interesting. This would accentuate piece cooperation and the "overloading" of important squares.

5 *Pawn-position-based mobility.* As has been previously stated, it is important to assess the long-term mobility. The short-term measures are used because they give more or less accurate long-term information. An alternative way of assessing the long-term factors is to focus on the slowly-changing features of a position. The pawn structure changes relatively slowly, and is probably the most important factor for the long-term mobility. Therefore the mobility calculations could very well be done with respect to the Pawns only, i.e., the pieces would be scored for the (undenied) mobility they would have on a board with only Pawns left. This is also a simple way of avoiding a counter-intuitive feature of some other mobility measures. Doubled Rooks (or a Bishop and Queen on the same diagonal) usually have a smaller number of moves available than they would have if not on the same file or row (or diagonal). A mobility measure based on the Pawn structure *only* would not give this effect.

5. FIRST-ORDER VERSUS SECOND-ORDER EVALUATION

Apart from a good evaluation function, a chess program needs speed. One of the recipes for a fast program is to have the evaluation function such that it can be updated incrementally rather than be computed anew. In Ebeling's (1986) terms, this is called *first-order* evaluation, as opposed to the non-incremental or *second-order* evaluation. First-order evaluation is cheap and efficient, and it is often advisable to use fast, first-order approximations of complex, second-order concepts.

Mobility and square control require complex, second-order computations, and hardly lend themselves to any first-order approximations. The problems are much the same as in the move generation. This seems to be the reason for which many programmers, e.g., the Hitech team, have skipped the evaluation of mobility altogether. Personally I agree with this decision, believing that extra processing time is better spent in deeper searches, etc., than in computing mobility.

Some kinds of mobility measures may, however, be handled by a pre-search evaluation of the root node, as is done, e.g., in Hitech and Novag X (Welsh and Baczynskyj, 1985). The pawn structure usually does not change very much in a few moves, and hence, a pawn-position-based mobility measure would not suffer very much from a first-order approximation. My conjecture is therefore that such a mobility measure should be used, rather than a second-order, move-count-based measure.

6. SUMMARY

It is argued that mobility measures based on counting the number of available moves are not of fundamental importance for positional evaluation. At best they are a secondary effect of other, more relevant, and just as easily computed, positional factors. Furthermore, the immediate values of mobility are not as important as the long-term mobility-determining factors. A mobility measure based on pawn structure and other slowly-changing features may be better than one based on move counts. Such a measure also lends itself to firt-order approximation. In the light of this, the complex computation of legal or pseudo-legal moves is deemed not to be cost-efficient.

7. ACKNOWLEDGEMENT

I would like to give credit to Dap Hartmann for his articles. In addition to being interesting in their own right, they provided the main inspiration for this article.

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