Evaluation of Tsume-shogi with the Method of Least Squares

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Abstract

It's very difficult for computers to deal algorithmically with the human sense of the 'artistic value' of Tsume-shogi (shogi end game) problems. We propose an objective method for automatically producing evaluations similar to those of humans. We use the least square method, whose input consists of the factors: sacrificed piece numbers, the number of a king's move, etc.. All the weights attached to the factors are calculated by the method, using human scores of tsume-shogi problems in "Tsume-shogi Paradise" magazine as training values. We examined the difference between our automatic evaluation values and score by human, and verified the correctness of the result.

1 Introduction

Tsume-shogi is a puzzle game to find the checkmate move sequences when both players are assumed to play optimally. Tsume-shogi has a 400-years history in Japan as an artistic problem. Evaluation of tsume-shogi problems is determined by human sense. So far there is proposal of describing an evaluation value with the weighted linear sum. But the all weights for the value and human evaluation factors are determined by human sense [1]. We will derive the weights from parameters surveyed from the problems of "tsume-shogi paradise" journal. After that, we put it into practice to evaluate tsume-shogi using those parameters. To calculate the all weight, we make an experiment with the method of least squares.

2 The Method of Evaluation

This chapter shows how to calculate the evaluation value, and what factors are used for the purpose.

2.1 The Factor to Evaluate Tsume-shogi

We consider the following to evaluate a tsume-shogi problem:

(1) Constant
(2) The free area around King in the first position
(3) The free area around King in the end position
(4) The number of dropped sacrificed pieces
(5) The number of non-dropped sacrificed pieces
(6) The number of offence pieces on the first position
(7) The number of defence pieces on the first position
(8) The number of pieces in offence's hand in first position
(9) The extent of position pieces put on
(10) The number of King moves
(11) The number of check moves at start
(12) The number of pieces offence captures
(13) The number of unpromoted moves
(14) The number of double checks
(15) The number of discovered checks

"The free area" means the number of squares around King no having any pieces.

"Sacrificed pieces" means that defence gets the piece after the offence moves the check. This move is frequently used in Tsume-shogi.

2.2 The Method to Calculate the Value of Evaluation

The position is denoted by x_j. The evaluation value calculated by the evaluation function is $F(x_j)$. The factor i of position x_j has the value $f_i(x_j)$, the weight of the factor i is w_i. The evaluation value $F(x_j)$ is determined by the following linear sum:

$$F(x_j) = \sum_{i=0}^{n} w_i f_i(x_j)$$

The value of "Tsume-shogi paradise" journal is y_j, the sums of the squares of the

differences between $F(x)$ and y_j is Q.

$$Q = \sum_{j=1}^{m} \left[f(x_j) - y_j \right]^2$$

The both sides of the above expression were differentiated by w_i, that value is made equal to 0.

$$\frac{\partial Q}{\partial w_i} = 0$$

The differential equation is solved, we get the linear equation. Calculating this linear expression about w, we can find the weight of all the factors.

3 Evaluation of Tsume-shogi

This chapter shows the results of evaluating Tsume-shogi.

3.1 Find the Weight

For determining the weights, we used 80 tsume-shogi problems from the shogi magazine "Tsume-shogi Paradise". All the problems have solution lengths of between 5 and 7 moves, and come from either the "Primary School" a "short solution contest" in the magazine.

Table 1. The result of calculation of weights

Evaluation Factors	Value of Weight
Constant(1)	1.187059
The free area around King at start	0.063114
The free area around King at end	-0.047179
The number of dropped sacrificed pieces	0.077269
The number of non-dropped sacrificed pieces	0.095142
The number of offence pieces on start position	0.062577
The number of defense pieces on start position	0.010568
The number of pieces in offence's hand	-0.004848
The extent of position pieces put on	0.002101
The number of King moves	0.018093
The number of checkmate moves at start	0.009809
The number of pieces offence captures	-0.120283
The number of unpromoted moves	0.043834
The number of double checks	0.026583
The number of discovered checks	0.116201

3.2 Evaluation of Tsume-shogi

We used the weights determined in Sec3.1 to calculate evaluations for 30 new problems that were not used in the training process.

The evaluation value of a tsume-shogi problem was determined in "Tsume-shogi" paradise using the way: readers evaluate a problem, evaluate it and choose one of the values: 3, 2 and 1. The problem thought best is valued at 3. We created a single value by averaging all the numbers chosen by about 140 readers who solved the problem.

The results to compare the true value and the value calculated by our system are shown in figure 1.

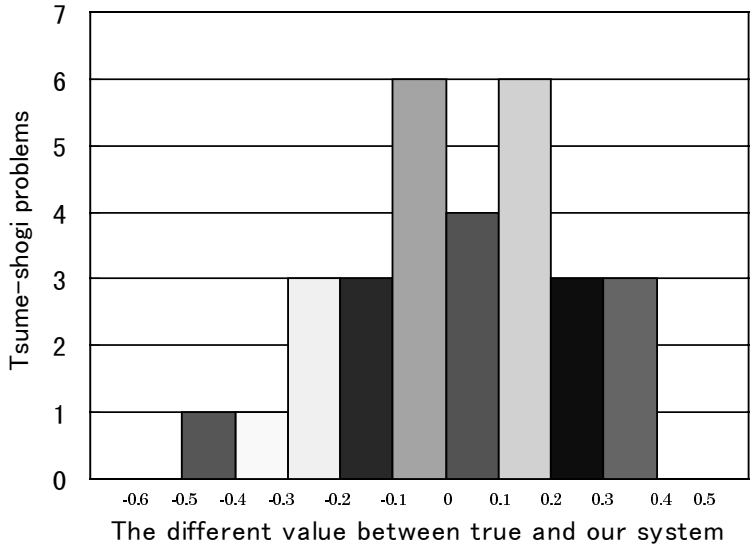


Figure 1. a distribution map of difference

The examples of the results are shown in appendix.

4 Discussion

The evaluation that our system calculated has a lot of difference from the human evaluation of "Tsume-shogi paradise" journal, in spite of obvious similarities. This interests us, since the factors reflect our common sense of tsume-shogi property.

The results showed the values our system calculated was lower than true values. It may be caused by the free area around King at end. Usually, it makes a favorable

impression that the pieces around King are fewer. But that weight reduces a value. The more freedom the area around King has, the lower the value becomes.

Generally, it's supposed to be advantageous if the number of defense piece is bigger than the offence one. However, our system had the results opposite. The more pieces the offense has, the higher the value the problem would be.

When true values were very high or low in problems having as same factors, our system score was different from them. Human sense evaluates an aim of a tsume-shogi problem, too. If a system can understand it and obtain a good value, our system may be able to evaluate problems nearer true value.

5 Conclusion

We proposed a method of evaluation of tsume-shogi problems with the method of least square, and calculated evaluation values for the problems of Tsume-shogi paradise journal. A number of particular patterns were found, which relatively differ from human common sense. One of the reasons probably is that the set for the experiment was well selected, and did not reflect primitive quality difference. This may rather reflect the sense of enthusiasts' view.

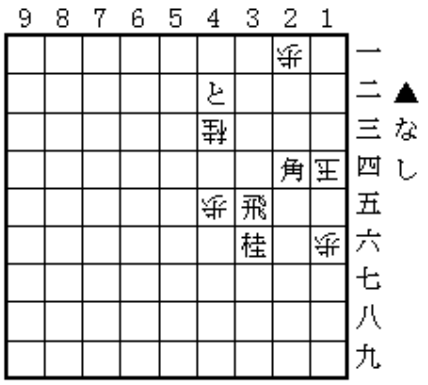
6 References

[1] The editorial department of Tsume-shogi Paradise : Tsume-shogi Paradise,1996.5 – 1998.5.

[2] K.Koyama: The Database and Evaluation by Human Sense of Tsume-shogi, Advance in Computer Shogi, kyoritsu publ., pp.90-124, 1996.

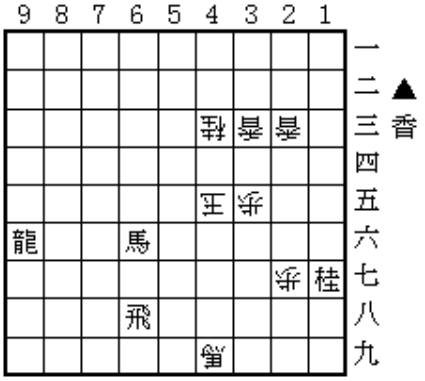
[3] M.Hirose, T.Ito, H.Matsubara : Automatic Composition of Tsume-Shogi by Reverse Method, Game Programming Workshop'96, pp.34-43, 1996.

Appendix



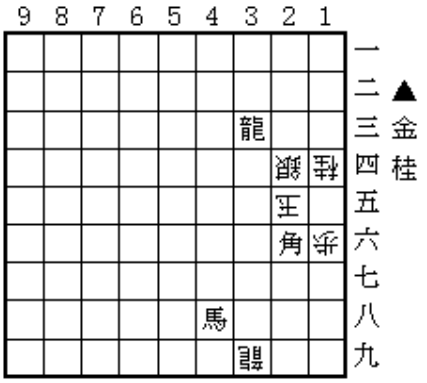
NO.1

True value	1.396226
Our system	1.769568



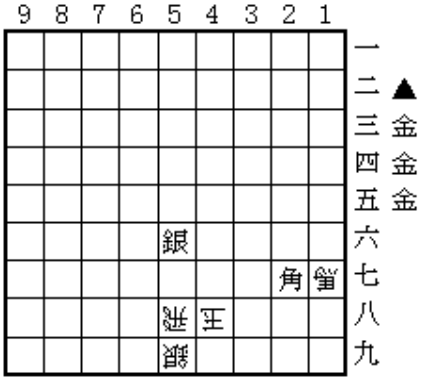
NO.2

True value	2.773333
Our system	2.612687



NO.3

True value	2.595960
Our system	2.236203



NO.4

True value	1.950355
Our system	1.962546