

# Report on Simple Chinese Chess AI Program

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## Introduction

This is a simple Chinese Chess Program by applying the search methods and evaluation functions introduced in the course.

## Representation

This program is using Chinese pinyin to represent those pieces. Here's the corresponding relationship:

W: King, J: Rook, Z: Pawn, M: Knight, S: Assistant, P: Cannon, X: Elephant

## Basic Analysis

Chinese chess is a relatively sophisticated game among artificial intelligence area. According to Chuanqi Li, the state-space complexity is around 48 and the game-tree complexity is around 150 (The numbers are as log to base 10)<sup>1</sup>, which is a quite big number for us to fully develop the game tree. Thus we have to use technics and search algorithms to cut off some branches and limit the search depth in order to get a balance between AI's response time and its performance.

## Search Engine

This program is build and tested on an Intel Core i5-5200 CPU with 8GB RAM. The language used for implementation is java and test are all done in command line.

## Search Method

In order to increase search efficiency, MinMax algorithm with  $\alpha$ - $\beta$  pruning technic is used in order to cut off some useless branches earlier. Heuristics and multiple evaluation functions are

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<sup>1</sup> Liu, Hal-Tao, and Bao-En Guo. "A new pruning algorithm for game tree in Chinese Chess Computer Game." *Machine Learning and Cybernetics (ICMLC)*, 2012 *International Conference on*. Vol. 2. IEEE, 2012.

also used to let AI predict what will happen next.

## Search Depth

The search depth is actually a changing value. Given the same space and time, this program can dig to deeper level if the piece number is lower than some specific number.

The search depth is originally 3. After the piece number is less than 7, the depth will be expend to 4. And finally the depth can be 5 if piece number is less than 4.

## Evaluation Functions

The evaluation functions can actually divide into several different parts.

### 1. Piece Value

This part is mainly used to represent the strength and importance of the pieces. Values used in ELP Chinese chess program is as followed:<sup>2</sup>

Pieces:	King	Guard	Elephant	Rook	Horse	Cannon	Pawn
Value:	6000	120	120	600	270	285	30

I also use this as my piece value in the program

### 2. Position Value

Position is also an important fact that should be considered when building the program. The positions that are closer to enemy's palace or easier to defense his side's king will definitely get higher value than other positions. The program only choose four kinds of pieces of which the position value will actually make great difference.

This is the position values used in the program of a Rook.

14	14	12	18	16	18	12	14	14
16	20	18	24	26	24	18	20	16
12	12	12	18	18	18	12	12	12
12	18	16	22	22	22	16	18	12
12	14	12	18	18	18	12	14	12
12	16	14	20	20	20	14	16	12
6	10	8	14	14	14	8	10	6
4	8	6	14	12	14	6	8	4
8	4	8	16	8	16	8	4	8
-2	10	6	14	12	14	6	10	-2

### 3. Mobility of the Piecet different.ue will actually make great different.ding the program.he search depth in order to get a balance

Mobility and flexibility is also an important issue that should be taken into consideration. If pieces like horse and elephant can't move around, their value will definitely less than a

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<sup>2</sup> Chen, Shi-Jim Yen1 Jr-Chang, Tai-Ning Yang, and Shun-Chin Hsu. "Computer chinese chess." *ICGA Journal* 27.1 (2004): 3-18.

“flexible” horse that can move to more than 3 or even 4 direction. As this calculation will take a lot of time in this program’s design. Only the mobility of horse is calculated.

The value is 7 per move.

#### 4. Relationship Value

The piece value is actually changing due to the change of time and board state. Even a pawn may be very important in some specific game states. In this program, we only considered the time issue. When the piece number is lower than 16 (half of the whole number), the value of horse will become higher than the value of a cannon since a cannon has a stricter requirement to attack enemy’s pieces.

## Structure and Implementation

This program consisted of 5 java files.

ChessGame.java: Main function of the program. Contains the greeting message and game controller.

Piece.java: Piece information and move functions.

Search.java: Search methods.

Board.java: Board information and evaluation functions.