**Kumoma Algorithm**

1. **what's Kumoma**

Kumoma is a chess game. Two players can take turn place one stone, black and white respectively, until K consecutive stones in a row, let’s say k black stones is in a row, in that case the black wins. It also be called k-in-row. The game board is the mxn grid, within each empty intersection, player can place the stone. [1]

We follow these steps to implementation Kumoma Algorithm：

1. Research the patter of Kumoma, and give each patten a score, the higher score, the higher possible to win.
2. Define the data structure.
3. Design searching algorithm which aims to go through the whole board.
4. Design the value algorithm which using different algorithm, for example game-tree to make the wise decision as human.
5. Trying to using α-β pruning Algorithm to speedy up the decision.
6. Descript how to use these Algorithms within industrial Applications scenario.
7. **The Patten of the Kumoma**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Pattern | Definition | Expression  （1 black，2 white，0 blank） | Picture[2] | Value |
| Overline | At least five of the same color in an unbroken row, either horizontally, vertically or diagonally. | 11111 | http://imgsrc.baidu.com/forum/w%3D580/sign=ca8f95c4d439b6004dce0fbfd9503526/9230fdfaaf51f3de6bce2f4395eef01f3a2979bb.jpg | 100 |
| Straight four | Four stones of the same color in an unbroken row (horizontally, vertically or diagonally) with both ends open. A straight four ensures a win. | 011110 | http://imgsrc.baidu.com/forum/w%3D580/sign=544199e43b87e9504217f3642038531b/fcf8b48f8c5494ee125e993e2cf5e0fe99257ebb.jpg | 80 |
| Four | Four stones of one color in a row, which in one move can become a five. One end open and another end intercept. Or miss a stone in the middle of one line. | 011112  0101110  0110110 | http://imgsrc.baidu.com/forum/w%3D580/sign=d36b654b113853438ccf8729a313b01f/ff393a292df5e0fe7f641f265d6034a85edf72bb.jpghttp://imgsrc.baidu.com/forum/w%3D580/sign=a21079a34bed2e73fce98624b701a16d/0560f21fbe096b63624ec8770d338744ebf8ac6c.jpg  http://imgsrc.baidu.com/forum/w%3D580/sign=334be987f703738dde4a0c2a831bb073/406c20a4462309f71a183b35730e0cf3d7cad64c.jpg | 70 |
| Straight three | Three stones of the same color in an unbroken row, or with one-intersection gap between the stones that can become a straight four on the next move | 01110  010110 | http://imgsrc.baidu.com/forum/w%3D580/sign=59503004b17eca80120539efa1239712/b3175c6034a85edf66f0680448540923dd5475bb.jpghttp://imgsrc.baidu.com/forum/w%3D580/sign=1bf30a164d086e066aa83f4332087b5a/db0c2834349b033bf8df6afd14ce36d3d539bd6c.jpg | 60 |
| Three | Three stones of the same color which only can become a four on the next move. | 001112  010112  011012  10011  10101  2011102 | http://imgsrc.baidu.com/forum/w%3D580/sign=27e3afe330adcbef01347e0e9caf2e0e/bcf89c82d158ccbf9bc0231d18d8bc3eb13541bb.jpg  http://imgsrc.baidu.com/forum/w%3D580/sign=d09c00db7dd98d1076d40c39113fb807/b318b13533fa828b585f0bc4fc1f4134970a5abb.jpg  http://imgsrc.baidu.com/forum/w%3D580/sign=e942cd111c950a7b75354ecc3ad1625c/3bbd033b5bb5c9eab08495c4d439b6003af3b34c.jpghttp://imgsrc.baidu.com/forum/w%3D580/sign=1e03059c86d6277fe912323018381f63/03158744ebf81a4cc80d7deed62a6059252da684.jpghttp://imgsrc.baidu.com/forum/w%3D580/sign=81c4d19c4610b912bfc1f6f6f3fcfcb5/bc3febc4b74543a9cef36ceb1f178a82b80114d6.jpghttp://imgsrc.baidu.com/forum/w%3D580/sign=63acab3343a7d933bfa8e47b9d4bd194/b7bfa9014c086e06718aae6c03087bf40ad1cb99.jpg | 50 |
| Straight Two | Two stones of the same color which can become a straight three on the next move | 00110  01010  010010 | http://imgsrc.baidu.com/forum/w%3D580/sign=032da31f29381f309e198da199014c67/5e29d9f9d72a6059b82f703d2934349b033bba84.jpghttp://imgsrc.baidu.com/forum/w%3D580/sign=afd63152d788d43ff0a991fa4d1fd2aa/85a4b9014a90f60320580a603812b31bb151edd7.jpghttp://imgsrc.baidu.com/forum/w%3D580/sign=a20cd7e783025aafd3327ec3cbedab8d/74d20ad162d9f2d32433b5c8a8ec8a136327cc99.jpg | 40 |
| Two | Two stones of the same color which only can become a Three on the next move. | 000112  001012  010012  10001  2010102  2011002 | http://imgsrc.baidu.com/forum/w%3D580/sign=e80aca111c950a7b75354ecc3ad1625c/3bbd033b5bb5c9eab1cc92c4d439b6003af3b384.jpghttp://imgsrc.baidu.com/forum/w%3D580/sign=bb97ae6c03087bf47dec57e1c2d3575e/5493c9ea15ce36d3733b12173bf33a87e950b184.jpg  http://imgsrc.baidu.com/forum/w%3D580/sign=f0bb7ed350da81cb4ee683c56267d0a4/893e367adab44aed73a628c3b21c8701a08bfbd7.jpghttp://imgsrc.baidu.com/forum/w%3D580/sign=580e15ea5366d0167e199e20a72ad498/21558bd4b31c8701c05e24c1267f9e2f0608ffd7.jpg  （TBD） | 30 |
| Dead four | Four stones of the same color in two blocked-end row | 211112 | （Omission） | 0 |
| Dead three | Three stones of the same color in two blocked-end row | 21112 | （Omission） | 0 |
| Dead two | Two stones of the same color in two blocked-end row | 2112 | （Omission） | 0 |

1. **The Data structure of the Kumoma**

We use a 2-D array to store the board, let’s say board[m][n] represents mxn board. Each element of the array represents the intersection of the board. The value should be 1(black), 2(white), 0(blank).

As we all know there are four direction to one stone on the board which is horizon, vertical, right-diagonal, and left-diagonal. We check these four directions to see whether there are five stones of the same color which means win or consider whether it is a better move. It’s safely draw the conclusion that we should set two 3-D array, let’s say xStone[m][n][4], yStone[m][n][4], to store the value of the two players decision’s value. After every move, we’ll check these 3-D array to find the best move.

1. **The Searching Algorithm of the Kumoma**

**4.1**  minimax algorithm

It’s naturally find a way to analysis the game pattern. First we scan the whole board from the left-up corner to right, when we meet a blank spot, we search four direction based on the blank spot and record the value of the pattern. If we encounter the other players’ stone, another blank spot, and boundary, we stop search. Using these method to fill in the 3-D array.

Since we’ve already refined the value for different pattern, the most likely win pattern get the highest value. In that case, the computer will easily choose the max value for its next move.

However, this approach just consider the right moment situation, it doesn’t have some predicates. The algorithm need to predicated N step situation, and score them, pick the highest one as its move, the lowest for the other one’s move.

1. **The value Algorithm of the Kumoma**
2. **The Speed-up Algorithm of the Kumoma**
3. **Game-Tree industrial usage**

Reference

[1] A New Family of k-in-a-row Games from I-Chen Wu and Dei-Yen Huang

[2] <http://tieba.baidu.com/p/2443877229>

[3] <https://www.ocf.berkeley.edu/~yosenl/extras/alphabeta/alphabeta.html>

[4] <https://www.cs.cornell.edu/courses/cs312/2002sp/lectures/rec21.htm>