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**mobility estimate**  
**Spherical Chess 400**

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**Comparative mobility between the two players is the most important indicator of which player has superior positioning. A method to quickly, manually estimate mobility short of calculating mobility by simulating every legal move available (which is a heavy burden even on a fast computer running a chess variant program with an AI player) is provided. The purpose is to enable dedicated human players to keep track of mobility reasonably well- esp. when competing against computer players.**

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**relevant background references-**

**universal calculation of piece values**  
<http://www.symmetryperfect.com/shots/calc.pdf>

**Spherical Chess 400**  
**material values**  
<http://www.symmetryperfect.com/shots/values-spherical.pdf>

**Spherical Chess 400**  
**conversion values**  
<http://www.symmetryperfect.com/shots/convert.pdf>

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**I. ideal attack values  
mobility per 2-D piece**

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"Ideal attack values" are a pure, simple calculation on a 20 x 20, continuous space 2-D gameboard that is ideally empty except for the 2-D piece itself. They exclusively measure mobility accurately.

The entire taxonomy of 38 2-D pieces usable in Spherical Chess 400 falls into only 3 distinct categories of ideal attack values that measure mobility.

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<b>4-directional sliders</b>	<b>10 points</b>
<b>5-directional sliders</b>	<b>15 points</b>
<b>6-directional sliders</b>	<b>15 points</b>
<b>7-directional sliders</b>	<b>20 points</b>
<b>8-directional sliders</b>	<b>20 points</b>

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[Even if they appear to be rounded-off, these ideal attack values actually are exact. Moreover, on a continuous space, 2-D gameboard, ideal attack values remain exactly the same at every space for every 2-D piece.]

Under no circumstances, should ideal attack values be confused with the more holistic, material values of 2-D pieces. They are different types of piece value calculations.

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**Notes:**

**A. The 5-directional sliders ("fives") are assigned the same ideal attack values as 6-directional sliders ("diagon rooks").**

**B. The 7-directional sliders ("sevens") are assigned the same ideal attack values as 8-directional sliders ("queens").**

In both cases, the reason is that the 2-D pieces with 1 fewer direction of movement have the potential ability, if there are no obstacles, to circumnavigate the continuous space, 2-D gameboard and hit just as many spaces.

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**ideal attack values for all 2-D pieces usable in game**

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10 points	15 points	20 points
<b>4-directional sliders</b>	<b>5-directional sliders</b>	<b>7-directional sliders</b>
-----	-----	-----
Rook-0-Zero	Five-NE-Add-0-Zero	Seven-NE-Sub-0-Zero
Rook-1-Positive	Five-NE-Add-1-Positive	Seven-NE-Sub-1-Positive
Rook-2-Positive	Five-NE-Add-2-Positive	Seven-NE-Sub-2-Positive
Rook-3-Positive	Five-SW-Add-0-Zero	Seven-SW-Sub-0-Zero
Rook-4-Positive	Five-SW-Add-1-Positive	Seven-SW-Sub-1-Positive
-----	Five-SW-Add-2-Positive	Seven-SW-Sub-2-Positive
-----	Five-NW-Add-0-Zero	Seven-NW-Sub-0-Zero
-----	Five-NW-Add-1-Positive	Seven-NW-Sub-1-Positive
-----	Five-NW-Add-2-Positive	Seven-NW-Sub-2-Positive
-----	Five-SE-Add-0-Zero	Seven-SE-Sub-0-Zero
-----	Five-SE-Add-1-Positive	Seven-SE-Sub-1-Positive
-----	Five-SE-Add-2-Positive	Seven-SE-Sub-2-Positive
-----	-----	-----
-----	<b>6-directional sliders</b>	<b>8-directional sliders</b>
-----	-----	-----
-----	Diagon-Rook-I-0-Zero	Queen
-----	Diagon-Rook-I-1-Positive	-----
-----	Diagon-Rook-I-2-Positive	-----
-----	Diagon-Rook-I-3-Positive	-----
-----	Diagon-Rook-II-0-Zero	-----
-----	Diagon-Rook-II-1-Positive	-----
-----	Diagon-Rook-II-2-Positive	-----
-----	Diagon-Rook-II-3-Positive	-----

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**II. ideal attack values  
mobility per army  
for players' 2-D pieces only**

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- 1. An inventory of the armies of both players must be taken.  
The exact 2-D piece types and numbers of each are needed.**
  - 2. Ideal attack values for all of the 2-D pieces within the armies of  
both players can be easily calculated, totaled and compared  
using the previous table.**
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**III. ideal attack values  
mobility per army  
for players' 2-D pieces and surrounding blocks**

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- 1. Separate counts of the number of neutral blocks surrounding each of the two armies of both players must be made and compared.**
- 2. Since neutral blocks greatly inhibit the mobility of the 2-D pieces within the armies they surround ...**

**As a general principle, the lower the number of neutral blocks in proximity to the 2-D pieces of each player from 32 per player at the start of the game, the higher the mobility of the (incompletely) surrounded army by an appropriate, linear formula.**

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**For the opening setup with 32 blocks surrounding, 96 positional moves are available.**

**For the opening setup with 0 (zero) blocks surrounding, 456 positional moves are available.**

**This means that the mobility for an army is increased 4.75 times from having all 32 blocks surrounding left to having 0 (zero) blocks surrounding left after all have been captured. This is an indisputable fact with impact to the game.**

**A table with the exact number of positional moves available for 32 & 0 (zero) blocks and an extremely-closely, estimated number of positional moves available for all numbers of blocks between 32 & 0 (zero) is provided. The mobility multiplier, needed for calculation, is not rounded-off to whole numbers like the number of positional moves is and must be.**

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**blocks – positional moves correlation**

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<b>blocks remaining</b>	<b>positional moves</b>	<b>mobility multiplier</b>
<b>32</b>	<b>096 (exact)</b>	<b>1.0000</b>
<b>31</b>	<b>107</b>	<b>1.1170</b>
<b>30</b>	<b>118</b>	<b>1.2340</b>
<b>29</b>	<b>130</b>	<b>1.3510</b>
<b>28</b>	<b>141</b>	<b>1.4690</b>
<b>27</b>	<b>152</b>	<b>1.5870</b>
<b>26</b>	<b>164</b>	<b>1.7040</b>
<b>25</b>	<b>175</b>	<b>1.8210</b>
<b>24</b>	<b>186</b>	<b>1.9375</b>
<b>23</b>	<b>197</b>	<b>2.0550</b>
<b>22</b>	<b>209</b>	<b>2.1720</b>
<b>21</b>	<b>220</b>	<b>2.2890</b>
<b>20</b>	<b>231</b>	<b>2.4070</b>
<b>19</b>	<b>242</b>	<b>2.5240</b>
<b>18</b>	<b>254</b>	<b>2.6410</b>
<b>17</b>	<b>265</b>	<b>2.7580</b>
<b>16</b>	<b>276</b>	<b>2.8750</b>
<b>15</b>	<b>287</b>	<b>2.9920</b>
<b>14</b>	<b>298</b>	<b>3.1090</b>
<b>13</b>	<b>310</b>	<b>3.2260</b>
<b>12</b>	<b>321</b>	<b>3.3440</b>
<b>11</b>	<b>332</b>	<b>3.4620</b>
<b>10</b>	<b>344</b>	<b>3.5790</b>
<b>09</b>	<b>355</b>	<b>3.6960</b>
<b>08</b>	<b>366</b>	<b>3.8125</b>
<b>07</b>	<b>377</b>	<b>3.9300</b>
<b>06</b>	<b>389</b>	<b>4.0470</b>
<b>05</b>	<b>400</b>	<b>4.1640</b>
<b>04</b>	<b>411</b>	<b>4.2820</b>
<b>03</b>	<b>422</b>	<b>4.3990</b>
<b>02</b>	<b>434</b>	<b>4.5160</b>
<b>01</b>	<b>445</b>	<b>4.6330</b>
<b>00</b>	<b>456 (exact)</b>	<b>4.7500</b>

mobility estimate  
example calculation

-----	white army	black army
<b>2-D piece number total</b>	<b>44</b>	<b>38</b>
<b>2-D piece inventory</b>	<b>22 4 directional sliders</b>	<b>16 4 directional sliders</b>
-----	+	+
-----	<b>16 5-6 directional sliders</b>	<b>14 5-6 directional sliders</b>
-----	+	+
-----	<b>6 7-8 directional sliders</b>	<b>8 7-8 directional sliders</b>
-----	-----	-----
<b>ideal attack values</b>	<b>4-directional sliders</b>	<b>4-directional sliders</b>
<b>2-D piece sub-totals</b>	<b>22 x 10 = 220</b>	<b>16 x 10 = 160</b>
-----	+	+
-----	<b>5-6 directional sliders</b>	<b>5-6 directional sliders</b>
-----	<b>16 x 15 = 240</b>	<b>14 x 15 = 210</b>
-----	+	+
-----	<b>7-8 directional sliders</b>	<b>7-8 directional sliders</b>
-----	<b>6 x 20 = 120</b>	<b>8 x 20 = 160</b>
-----	-----	-----
<b>ideal attack values</b>	<b>220 + 240 + 120 = 580</b>	<b>160 + 210 + 160 = 530</b>
<b>army total</b>	-----	-----
-----	-----	-----
<b>surrounding blocks</b>	-----	-----
<b>-starting</b>	<b>32</b>	<b>32</b>
<b>-present</b>	<b>30</b>	<b>28</b>
-----	-----	-----
<b>mobility multiplier</b>	<b>1.2340</b>	<b>1.4690</b>
<b>blocks - positional moves</b>	-----	-----
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<b>mobility estimate</b>	<b>580 x 1.2340 = 715.72</b>	<b>530 x 1.4690 = 778.57</b>

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## worthwhile refinements

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These are general guidelines for firstly, filtering-out surrounding blocks that should not be captured and secondly, amongst those eligible to be captured, setting the most resourceful order of their capture based upon their positions.

1. Do not ever capture any surrounding block that is also under threat from any opponent's 2-D piece(s).

Doing so would put the 2-D piece used to capture the surrounding block under threat as well as open a line of attack for your opponent.

2. There are 4 orthogonal lines consisting of the 8 surrounding blocks. They should be captured in order from the most exterior positions to the most interior positions.

This is especially conducive to giving rooks at the most exterior positions in the opening setup the largest increase in mobility- in all 4 orthogonal directions of their movement. Furthermore, the orthogonal defenses of the royal queens are kept maximized as long as possible.

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## playing considerations

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**At the opening setup, capturing any surrounding block will significantly increase a player's mobility by appr. 11 moves or a factor of appr. 1.117. Other positional criteria- not provided within this work- should be applied to correctly determine exactly which surrounding block is the best one to capture when that type of move is preferable.**

**At the opening setup, it is a simple, special case- easy to visualize. Wherever a surrounding block is captured, the rook behind it is set free to move beyond as far as circumnavigating the board and returning to its friendly army from the other side.**

**Whenever a player makes a positional move mainly for the purpose of increasing his/her mobility (instead of some other important purpose), he/she is likely to choose to capture one of the surrounding blocks (until/unless no more exist).**

**However ...**

- 1. Doing so to the negligent extreme can be tactically and/or strategically costly.**

**Investing too many moves in capturing worthless, neutral 2-D pieces is unlikely to be your best priority in a game where it is hazardous to neglect important, conversional (promotional) moves and other important, positional moves- esp. including captures of your opponent's 2-D pieces.**

- 2. Your surrounding blocks also serve as protective, buffer 2-D pieces to deter aggression against all of your valuable pieces.**
- 3. Each of your surrounding blocks that your opponent wants to get out of his/her way in order to attack costs your opponent one move to capture ... if you refuse to do it for him/her.**

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**Whenever preparing an attack against your opponent by removing a block surrounding his/her 2-D pieces, remember that doing so would measurably increase your opponent's mobility. Therefore, it is important to be sure that your material gain will outweigh your comparative (but not absolute) mobility loss.**

**This mobility estimate is in error to the extent that 2-D pieces venture outside of their block barrier. Of course, this is going to happen to an increasing extent as the game progresses.**

**At the start of the game (before any moves are made), it will be perfectly accurate.**

**In the opening game, it will be virtually accurate.**

**In the midgame, it will be majority accurate by a large margin.**

**In the endgame, it will be majority accurate by a small margin.**

**What the accuracy of this mobility estimate has going for it throughout the game is that danger "outside" keeps most of both players' remaining 2-D pieces bound "inside". At the opening setup, a vortex of coverage by rooks (the lowest-valued piece in the game) exists "outside" where each player's opponent is just a 2-move turn away from capturing any 2-D piece left in its path.**

**When 2-D pieces do go "outside", they usually go one-at-a-time and they usually don't last long. Typically, they are used for aggressive captures against opponent's 2-D pieces that compel the opponent to likewise end their existence.**

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