Criticality: a Monte-Carlo Heuristic for Go Programs

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Talk Outline

1. Introduction
2. Criticality Heuristic
3. Experiments with Crazy Stone
4. Conclusion
Introduction: Principle of Monte-Carlo Evaluation

Root Position

Random Playouts

MC Evaluation

+ + =
Introduction: the Semeai Problem

- Human
- Crazy Stone

Black territory
White territory

Evaluation error:
White is alive
Criticality: Graphical Representation

Intuitively: How important is it to own this point in order to win the game?

Useful information for pruning the search tree.
Criticality: Mathematical Definition

Criticality at point $x$

$$c(x) = \frac{v(x)}{N} - \left( \frac{w(x)}{N} \times \frac{W}{N} + \frac{b(x)}{N} \times \frac{B}{N} \right)$$

Notations

- $N$: number of playouts;
- $W/B$: playouts won by White/Black;
- $w(x)/b(x)$: playouts where $x$ is owned by White/Black;
- $v(x)$: playouts where $x$ is owned by playout winner.

A similar idea was independently proposed by Seth Pellegrino, Andrew Hubbard, Peter Drake, and Yung-Pin Chen, in *Localizing Search in Monte-Carlo Go Using Statistical Covariance* (in preparation).
Criticality as a Pattern Feature

Gamma-value of criticality

- Used for progressive widening and progressive bias
- Details in *Computing Elo Ratings of Move Patterns in the Game of Go*, Coulom (2007)
### Influence on Program Strength

<table>
<thead>
<tr>
<th></th>
<th>against GNU Go L10</th>
<th>against CS0</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS0: reference</td>
<td>49.3%</td>
<td>(50.0%)</td>
</tr>
<tr>
<td>CS0+Owner</td>
<td>58.5%</td>
<td>60.0%</td>
</tr>
<tr>
<td>CS0+Criticality</td>
<td>53.8%</td>
<td>60.0%</td>
</tr>
<tr>
<td>CS0+Owner+Criticality</td>
<td>60.5%</td>
<td>66.0%</td>
</tr>
</tbody>
</table>

19 × 19, 600 games, 5k playouts per move, 95% confidence interval = ±2%.

(note: old results obtained in July 2008. FIT’2008 version scores 72.2% against GNU Go 3.7.12 Level 10, after minor improvements and parameter tuning)
Summary of Criticality
- MC pattern feature, like point owner
- Improves playing strength of Crazy Stone

Future Work
- The semeai problem still has to be solved.
- Criticality of first play: alternative to AMAF?