**Better Computer Go Player with Neural Network and Long-term Prediction**

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**Introduction**

Go, originated in ancient China more than 2,500 years ago, is a two-player zero-sum board game with full information. The possible board situations of Go are much more than the atoms of universe, rendering any brute-force search intractable.

**Method**

Rather than brute-force search, human plays Go with both intuitions and reasoning: first think about a few possible alternatives, and then find the best move by careful analysis. With the advancement of Deep Learning, it is now possible to model human's intuition more precisely, yielding a better Computer Go player.

**Policy Network**

- **Feature Name**
  - Our/enemy liberties (6)
  - Ko location (1)
  - Our/enemy/empty (3)
  - Our/enemy history (2)
  - Enemy rank (9)

- **Current Board 25 feature planes**

- **Conv layer**
  - 92 channels
  - 5 x 5 kernels

- **Conv layers x 10**
  - 284 channels
  - 3 x 3 kernels

**Long-term Prediction**

- **Conv layers x 10**
  - 4 maps
  - 3 x 3 kernel

- **Conv layers x 10**
  - 4 parallel softmax

- **Long-term Prediction**
  - Our next move (next-1)
  - Opponent move (next-2)
  - Our counter move (next-3)

**Monte Carlo Tree Search (MCTS)**

- **Top 7 moves**
- **Use PUCT and virtual loss. Remove win rate noise.**
- **5% of threads skip DCNN evaluation**

**Default Policy**

- **Local 3x3 pattern matching with Zobrist hashing**
- **Incremental board status update with heap structure**
- **Handle special but critical cases with rules (nakade, etc)**

**Experiments**

**Dataset: 170k KGS / 80k GoGoD**

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>KGS rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Darkforest</td>
<td>Trained on KGS</td>
<td>1d</td>
</tr>
<tr>
<td>Darkfore1</td>
<td>Trained on GoGoD and nstep=3</td>
<td>2d</td>
</tr>
<tr>
<td>Darkfore2</td>
<td>Trained on GoGoD with nstep=3 and fine tuning</td>
<td>3d</td>
</tr>
<tr>
<td>Darkfore3</td>
<td>Trained on KGS and nstep=3 and fine tuning</td>
<td>3d</td>
</tr>
</tbody>
</table>

**Win rate for Pure DCNN**

- **AlphaGo* (RL)**

**Win rate for DCNN + MCTS**

**Competitions**

- **Stable KGS 5d** (kgs id: darkfmcts3)
  - 3rd in KGS January Go Tournament
  - 2nd in 9th UEC Cup for Computer Go

**Our Go engine will be open-sourced!**

See: [https://github.com/facebookresearch/darkforest](https://github.com/facebookresearch/darkforest)

- Standalone project with little dependency.
- Efficient Go/MCTS libraries written in C/Lua.
- Runnable on a single machine with 1-4 GPUs.
- Much stronger than existing open source engines.