围棋

The Game of Go

Modeling Complex Systems
DMKM

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Abstract

https://youtu.be/Wvm0ZgCsm1E
https://github.com/mr3m/GameOfGo

1 Introduction

The game of Go, also known as Wéiqí: 围棋 in Chinese, which means literally *surround game*, is a two-player board game in which the aim is to surround more territory that the opponent [**?**].

It was originated in ancient China more than 2,500 years ago (figure 1). It was considered one of the four essential arts[1] of a cultured Chinese scholar.

Figure 1: Woman Playing Go (Tang Dynasty c. 744), discovered at the Astana Graves

Despite it's relative simple rules, the relative complexity of Go with respect to Western chess is far more superior (10^{761} compared to 10^{120} possible games).

Precisely because of this great complexity is that, different from chess which was *conquered* by IBM's Deep blue in 1996 agains't world's Grand Master Gary Kaspárov, no equivalent conquest has been achieved by computer go until recent victory of Google's Alpha Go agains't the European Go Champion [**?**].

In this study we took a multiagent system approach to the problem of computer Go, first, a description of the implementation is made, after some tests were carried out and described at the end some conclusions and future work are drawn.

1.1 Game Mechanics

The two players alternately place black and white playing pieces, called *stones*, on the vacant places of a board with a 19×19 grid of lines.

Each stone is said to have 4 *liberties* (Qì: 气) when the four orthogonal-adjacent points are empty, this stone loses each of it's liberties whenever a stone is placed in this points. If the recently placed stone is of the opposite color, then the liberty is just lost, however, if the recently placed stone is of the same color, the individual liberty is lost and a *group* liberty is created, composed of the sum of the liberties of these two stones. Generalizing the previous principle, one can form huge groups of stones of the same color, which have a collective liberty. The particular form of this groups is essential part of the strategy of the game.

Once placed on the board, stones may not be moved, but stones may be removed from the board if captured. A stone (or group of stones) it's captured by the opponent when all the liberties are suppressed.

An enclosed liberty (or liberties) is called an *eye*[2] (眼), and a group of stones with at least two separate eyes is said to be unconditionally *alive*. Such groups cannot be captured, even if surrounded. *Dead* stones are stones that are surrounded and in groups with poor shape (one or no eyes), and thus cannot resist eventual capture.

There are only two rules in Go, namely:

1. **The rule of Liberty**: Every stone remaining on the board must have at least one liberty.

[1] The four arts (siyi: 四艺): To play the guqin, a stringed instrument (Qín: 琴), the strategy game of Go (Qí: 棋), Chinese calligraphy (Shu: 书), Chinese painting (Huà: 画)

[2] see figure 2

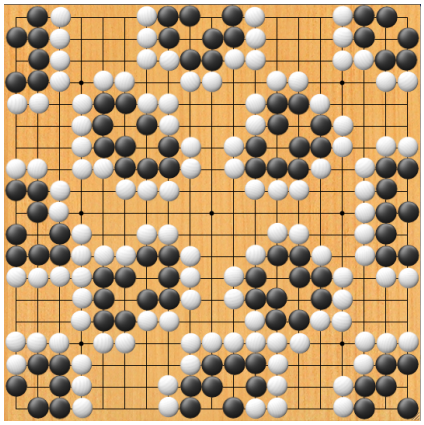

Figure 2: All the smallest groups with two eyes by blacks, enclosed by whites without being able to capture the groups

2. **The ko rule (劫)**: The stones on the board must never repeat a previous position of stones

Remark that by rule 1, suicide moves are forbidden, that is jumping into an eye of the opponent contained in a at-least-two-eye-group; if the group is a one-eye-group then this move is allow. Also please note that to blocks one eye, though permitted is by no means desired, since it can turn alive groups into dead ones. Also as a common consensus, blacks play first.

The two players place stones alternately until they reach a point at which neither player wishes to make another move. When a game concludes, the territory is counted along with captured stones to determine the winner.

2 Implementation

A box world was set up in NetLogo, to represent the board game, that is, with no periodicity in the edges.

3 Results

4 Conclusions

5 Future Work

References

[1] D. R. Kunkle, *The Game of Go and Multiagent Systems*, (2002).

[2] D. Silver, A. Huang, C. J. Maddison, A. Guez, L. Sifre, G. van den Driessche, J. Schrittwieser, I. Antonoglou, V. Panneershelvam, M. Lanctot, S. Dieleman, D. Grewe, J. Nham, N. Kalchbrenner, I. Sutskever, T. Lillicrap, M. Leach, K. Kavukcuoglu, T. Graepel, and D. Hassabis, *Mastering the game of Go with deep neural networks and tree search*, Nature, 529 (2016), pp. 484–489.