AnyGammon: Playing Backgammon Variants Using Any Board Size

Nikolaos Papahristou, Ioannis Refanidis
Department of Applied informatics
University of Macedonia
Thessaloniki, Greece
nikpapa@gmail.com, yrefanid@uom.gr

ABSTRACT
In this paper we describe AnyGammon, a program that extends the casual board game of backgammon to different board sizes while retaining the familiar game rules. Small board sizes make it easier to analyze algorithms and game evaluation functions. Large board sizes make the original games more challenging and interesting for the players. Finally, we demonstrate how ancient, forgotten variants of backgammon can be resurrected by AnyGammon.

Categories and Subject Descriptors
K.8.0 [**Personal Computing**]: General – Games, I.2.1 [**Artificial Intelligence]**: Applications and Expert Systems - Games

General Terms
Algorithms, Experimentation.

Keywords
Casual games, Backgammon, Artificial Intelligence

1. INTRODUCTION
Backgammon [1] is one of the oldest board games for two players. The playing pieces are moved according to the roll of dice, and players win by removing all of their pieces from the board. There are many variants of backgammon [2], most of which share common traits: the board has 24 points where the pieces (also called checkers) can be placed, two six-sided dice are used by the players and both sides have 15 checkers.

AnyGammon is a casual game [8] that ultimately can enable players to play many backgammon variants using a variety of board sizes, arbitrary number of checkers and any kind of dice (3-sided, 4-sided, 7-sided etc.) under the same software package. The program is available for free and can be downloaded from http://ai.uom.gr/nikpapa/AnyGammon. Currently the program runs on the Windows operating system and on Android devices (https://play.google.com/store/apps/details?id=gr.uom.ai.nikpapa.anygammon), but other OSes will be supported in the future.

2. EXTENDING BACKGAMMON TO ARBITRARY BOARD SIZES
Like other popular board games such as chess and go, backgammon has been studied with great interest by computer scientists. While game artificial intelligence (AI) for standard backgammon has reached world-class strength [12], the same claim cannot be stated for other variants like Narde, Plakoto, Fevga, Acey-Deucey, to name a few [9, 10].

A popular method for developing, troubleshooting and understanding any game evaluation function in board games is to try it out first in smaller board sizes. For example in Go, apart from the standard 19x19 board, the game can be played at any board size, with 9x9 and 13x13 being the most popular ones. Standard practice for AI Go programmers is to start developing their algorithms in smaller board sizes like 9x9 and upscale from there. Furthermore, small board sized games (like 5x5 Go) can be solved more easily, giving an additional evaluation tool for the developers [13].

This paper attempts to reduce/extend the complexity of backgammon games in a natural way. Previously, the only other attempt to simplify the backgammon games is the hypergammon variant [6] that uses the same board size as standard backgammon but only 3 checkers for each opponent. The resulting game is simple enough in order to be strongly solved [5], but does not offer the strategic elements found in the original. In contrast the underlying framework of AnyGammon called *bcd*Gammon, not only captures the key elements of the games in reduced versions, but also can easily extend the game into virtually any board size.

Another extendible game worth mentioning is Nannon [11]. This game is played on a backgammon board and can be extended on the number of checkers and the number of points on the board. However, the rules for moving the checkers are much different from the original game (e.g. the player cannot stack checkers on a point) making the strategies required completely different. Another drawback of Nannon is that it uses a single six-sided die in all configurations, thus prohibiting the study of the effects of different chance events.

3. THE *bcd*GAMMON FRAMEWORK
The *bcd*Gammon is a framework for fully parameterization of all key characteristics of a backgammon game: the total number of points on the *board* (*b*), the number of available *checkers* for each player (*c*), and the maximum number available when rolling a *die* (*d*). For example, parameterizing backgammon (Fig. 1) with *b*=16, *c*=10, *d*=4, named in short Backgammon(*b*=16, *c*=10, *d*=4), results in a board with 16 points (4 for each quadrant), 10 checkers for each player, and 4-sided dice.

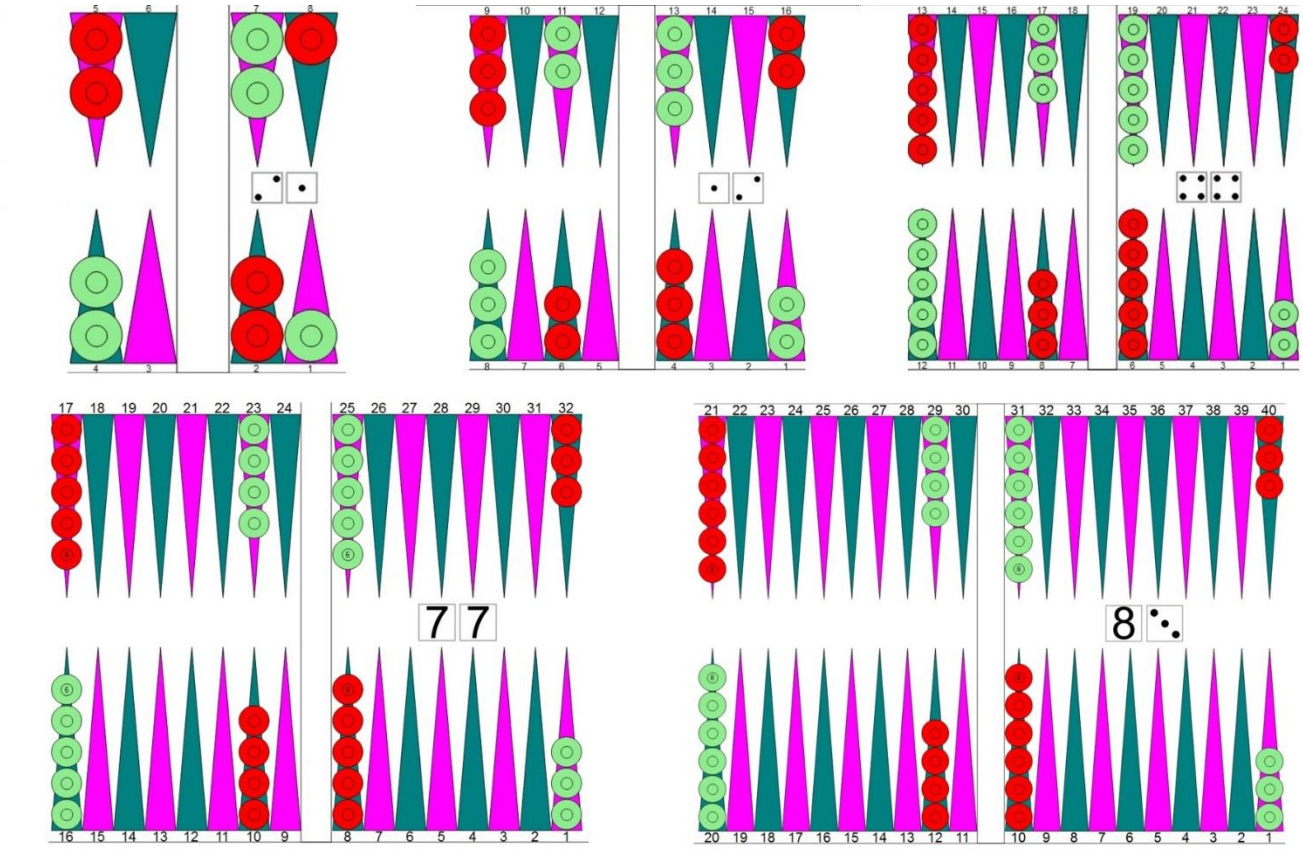

Figure 1: Screenshots of AnyGammon showing playable backgammon configurations. Upper Left: *b=8, c=5, d=2*, Upper middle: *b=16, c=10, d=4*, Upper right: *b=24, c=15, d=6* (Standard backgammon), Lower left: *b=32, c=19, d=8*, Lower right: *b=40, c=23, d=10*

Theoretically, any number can be assigned to the three parameters, as far as $b>3$, $c>0$, $d>1$. In practice, and in order to preserve the look-and-feel of the original games, additional constraints should be added: $b \bmod 4 = 0$ and $d = b/4$. The former constraints are necessary in order to retain the look of the board as four quadrants; otherwise, the board must be represented in a straight line and additional rules regarding the home board[1] must be added. The latter constraint is needed in order to preserve the strategic elements of the original games. We are not certain what would happen if d is different from $b/4$, so we leave this investigation for future work. In all configurations, two dice are used as in the original game. The original backgammon games are a subset of the *bcd*Gammon framework where $b=24$, $c=15$, $d=6$.

Another crucial element of backgammon variants is the initial position. For some variants like Narde and Plakoto, all checkers are placed in the starting point, so there is no problem in adapting any version of *bcd*Gammon. Standard backgammon however, has a specific placement of the checkers at the start of the game. In all configurations supported, we adjusted the initial position to resemble standard backgammon.

[1] An area of the board (usually the last quadrant for each player) where the checkers are borne off

4. GAMEPLAY

4.1 Supported Variants

Players start a game in AnyGammon by selecting the key parameters of the game: game type, *b*, *c*, *d*. Currently, supported game types are standard backgammon, as well as the Plakoto and Fevga variants. The goal of this project is to support dozens of backgammon variants. Notable variants planned for the immediate future are Narde, a variant similar to Fevga that is popular in Russia, and Acey-Decuey, a variant popular within the US military personnel. All games are played without the doubling cube; we plan to support this in future updates.

We placed several restrictions to the b and d parameters: board size (*b*) is restricted to a maximum of 40 points in increments of four and maximum number on the dice (*d*) is always b / 4. The number of checkers is also limited to a maximum of 30. Under these restrictions the player can select between 3x9x30=810 possible configurations at the start of a game. We plan to lift these restrictions once we have fully investigated all aspects of these parameters.

4.2 Game AI

The game AI of AnyGammon is currently in its initial stages. The user can select between two simple Monte Carlo methods, FlatMC and FlatUCB [3], as well as the thinking time in seconds per move. Monte Carlo methods were chosen because of their simplicity and the easy application to all available configurations without parameterization. These methods can be

further enhanced by inserting heuristic rules to the simulation specific to each variant. We are also planning to compare many algorithms such as Artificial Neural Networks [9], which are very popular in backgammon software, and MCTS/UCT [4], currently the dominant method in Go computer programs [3]. Finally, we want to investigate methods for transferring game evaluation functions learned for small boards to large boards and vice-versa.

5. OLD GAMES RESURRECTED

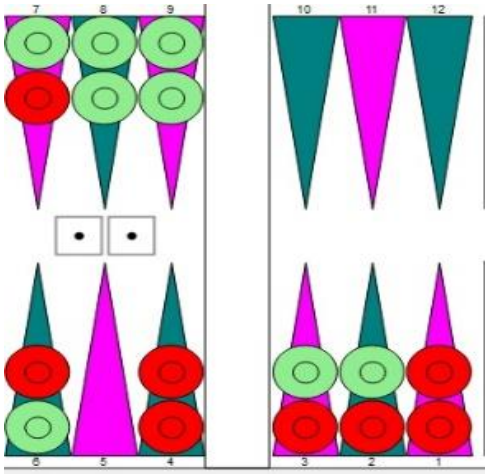

Figure 2: Up: Brädspel ("board game") set recovered from the warship Vasa, which sank in 1628 [1],

Down: A screenshot of AnyGammon showing a Plakoto game with similar board size.

Backgammon, like any other ancient board game, has taken many forms, during its evolution throughout the centuries. Archeological findings (Fig. 2 Up) and old manuscripts like The Libro de Los Juegos ("Book of games"), one of the most important document for researching the history of board games [7], have uncovered some of the older versions of the game which used different board sizes, number of dice and the number of players. Using AnyGammon, many of these games can be brought back to life and analyzed, provided the game rules are known (Fig. 2).

6. GAME APPEAL

AnyGammon was created primarily for research purposes as a testbed for game AI. Is it possible that some of the playable configurations will be also entertaining for humans? As this game is in its early stages of development we have no clear answer yet. Small board sizes result in shorter games that are influenced more by luck than skill. Large board sizes seem to make the game less influenced by chance but also increase the duration of play. Since much of the game's entertainment value is influenced by each player's interests, we believe that AnyGammon has the potential of adapting to the individual needs of a large group of casual gamers.

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