Computerized Board Game: Dara

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*Abstract :*Dara is a Nigerian Board Game, which has a generic name Mancala and in specific, Mancala II. Very little work has been done concerning Nigerian indigenous gaming culture with respect to computerization. This paper envisages that our gaming culture will soon go extinct due to lack of computerization. The main motivation for this work is to preserve our gaming culture by computerization, alongside enhancing computer literacy among Nigerians through gaming culture. An algorithm was designed that will enable two human players play against each other, and also allow a human player to play against the computer. Among other approaches to solving this problem, a greedy algorithm was used for the computer agent's artificial intelligence.

Keywords: Board Game; Dara Algorithm; Gamming; Culture; Computerized Gamming Culture;

I. INTRODUCTION

Nigeria is one of the unique African countries that is blessed with different indigenous gaming cultures.

In recent years, most indigenous games have gone into extinction. Statistics have shown that about 70% of indigenous games still played by Nigerians today are board games; good percentage of Nigerians both in the rural and urban areas still enjoy board games.

Generically, games have indeed changed in the computer age, therefore it is important to computerize our indigenous games in order to preserve and keep them from going extinct.

Dara is a Nigerian board game for two players, who are sitting opposite to each other. It is played with 12 compartments, called houses. Initially, each player owns 6 houses, and each house contains 4 seeds. The purpose of the game is to win houses from the other player.

However, the rapid change in the way games are played in recent time is having a serious effect on preserving our indigenous gaming culture. Most of the games played by majority of Nigerian's today are computerized by developed nations and it is therefore local to them.

The key research question in this paper asks whether or not our indigenous gaming culture is being encouraged in Nigeria today?

This paper seeks to remedy this major challenge by designing a Computerized Dara board game.

This study makes a major contribution to the research on gaming culture by demonstrating how our Nigerian indigenous games can be documented by computerization.

II. HISTORY OF AFRICAN BOARD GAMES

African board games have distinct names, rules, strategies and styles that vary from region to region. Unfortunately for some reasons non-African writers have always lumped them together under the generic name of Mancala [1].

This view is supported by [3] who argues that Dara is one of the Mancala games referred to as Mancala II.

University of waterloo Elliot avedon virtual museum of games defines Mancala as a popular game in the Levant and Egypt which is played on a board containing two to six rows of cup-shaped depressions or holes in which the pieces are arranged and moved [6].

Anthropologists use the term mancala for any similar game played on a board in which the pattern of lines and cells usual for board-games is replaced by two, three, or four rows of holes deep enough to contain a number of pieces at the same time.

Today mancala games are widely spread over the tropical and sub-tropical regions of Asia, Africa, and the adjacent islands, and African slaves carried them to the West Indies and America. The popularity of mancala in Africa is so great and so general. It was seen played in the Cyclades in 1810. The wide distribution today of mancala games and the varieties of ways in which they are played make it difficult to trace the connections of the existing games, but their diffusion in Asia seems to have been from west to east, and in Africa from north-east to west and south, both pointing to an earlier practice of mancala in Egypt or Arabia [3].

III. DETAILED DESCRIPTION AND RULES OF DARA

The board game Dara originates from Nigeria. The board has two rows and six holes as shown in figure 1.

Figure 1. Dara board

Boards can be without storehouses. Each of the players owns one row (territory) nearest to him. At the start of the game, each hole has four seeds deposited and none in the storehouses.

The player takes seeds from any hole on his side, and sows them one to consecutive holes in an anticlockwise direction as far as the seeds can go. Relay sowing is permitted. If the last hole has more than one seed, he takes the content of hole in which the last seed falls, and sows them one to a hole, and continues the process until the last seed in hand falls into an empty hole, which ends his turn.

The objective of the game are to buy up all the opponent's holes. The opponent can win back holes he has sold if at the end of a round he has more than enough seeds in his storehouse to fill the holes he still owns. He can win back as many holes as he can fill with groups of four seeds from his storehouse after he has filled all the holes he still owns.

Provided the last seed drops in a hole so that it contains 4 seeds, on either side of the board, the player captures them into his storehouse. During the game each player captures all 4's that appear on his side. When a player has no seeds in his territory to take a turn, the opponent captures all the seeds on his (opponent) territory. This ends a round. Reentrancy is also allowed. For the next round, each player refills his holes from his own storehouse. The player who has a surplus fills empty holes. The rented holes temporarily belong to the winner. The loser may win them back for the next game. As the players proceed, four seeds will accumulate in some of the holes again. Each player, even the opponent's turn, quickly takes to his storehouse the groups of four seeds that appear on his side. If a player makes a hole of four when he drops his last seed, he takes that group even if it is on his opponent's side. Watch far this opportunity and try to win as many groups of four as you can. Also try to prevent groups of four from appearing on the opponent's side. When it is your turn, it is better to start in the hole that has more than four seeds rather than in holes with one, two or three seeds. This strategy enhances the chances of those one's, two's and threes of becoming four's. A player may sometimes start with one or two or three on his side if he thinks by doing so he prevents his opponent from getting four on his side.

There is only one condition to end of game. When either of the player's holes have all been captured by an opponent. The winner of each round is the player with more than enough seeds in his storehouse to fill his holes with four each. The loser will not have enough seeds to fill all his holes with fours. The winner must fill those empty holes for the loser, and he thus buys the empty holes from his opponent by filling them with his own seeds. The winner of the game is the player that has captured all the holes on the board after rounds of the game.

IV. SIMILARITIES BETWEEN DARA AND OTHER GAMES

Despite the diversity of African board games, most of them have some things in common which are as follows:
- They have board made of hallowed
- The seeds or stones used to play them are 48 in number. Initially, 4 are placed in each of the 12 holes
- Two players alternate making moves. Each player's side of the board has six holes.
- The purpose of these games is to capture the most stones.

To make a move, player chooses a non-empty hole from his or her side of the board, and removes all of its stones. The stones are redistributed (sown), one per hole, among the holes in a counter clockwise direction beginning with the hole after the chosen hole.

African board games similar to Dara amounts to more than two hundred but we will be looking at two common ones.

A. Awele

The game of Awele is played by two players on a board with 2 rows of 6 holes. Each player has his own territory; the row on his side. At the beginning of the game, each hole must hold 4 seeds. Each player takes a turn. A move is made by taking all the seeds in a chosen hole of one's row and dropping them one by one, anticlockwise. The purpose of the game is to capture seeds in the opponent's holes. A capture happens when the last seed dropped falls into a hole on the opponent's side that already holds one or two seeds, so that after the move, the hole now holds 2 or 3 seeds which are then captured. A player may capture several sets of 2 or 3 seeds, provided that all the sets are consecutive and on the opponent's side [1] [4]. The game ends when one of the following cases occurs:
- There are so few seeds remaining on the board that it is not possible to capture any more.
- One of the players has no hole containing enough seeds to reach his opponent's side and his opponent's holes are all empty.
- The players decide by mutual agreement to stop playing and share the remaining seeds according to their analysis of the situation. This is the most common way of ending games between good players.

B. Tampoduo

Tamoduo is another version of Ayo J'odu a traditional Nigerian board game played by the Yoruba people. Among the Ghanaian's it is known as Oware; The name is derived from the Twi language spoken amongst the Akans of Ghana and means "to collect a big bunch of seeds". In Somalia it is called LayliGoobaly. Although LayliGoobaly has a few extra rules, the principal rules are the same. Tamoduo is known amongst the West African Coast by various names [1].

The board is made up of two rows of six holes and each player owns the row (territory) next to him. Four seeds are deposited in each hole on the board. When a board has extra end holes they are used to store captured seeds. These storehouses are not sown into [1]. Each player takes turns to start. The player chooses a hole from their own territory, from which all the seeds are taken and sown one seed at a time. The seeds are sown in an anticlockwise direction placing one seed in each hole as one traverses the board. Tampoduo permits relay sowing. If the last seed drops in a hole with seeds in it, all the seeds are taken and then sown until such a time the last seed falls in a hole that is empty on either side of the board. If before a player wins the game and at a point in the game one player does not have any seeds, the other player must sow seeds from a hole that will result to the opponent having seeds to continue playing the game. If this **"seeding"** of the opponent is not possible then the game comes to an end. The remaining seeds goes to the player who has the seeds in their territory. The purpose of the game is to capture seeds when the last seed among the seeds that are sown by either player falls in an empty hole on their side. If the opposing hole on the opponent's territory contains seeds, they are captured as well. If there are no seeds in the opposite hole nothing is captured. If a player's last seed falls into an empty hole on the opponent's side and the opposing hole on your own side has seeds in it, no seeds are captured. In Tampoduo, there is no restriction as to

the number of seeds that may be captured from a hole. The game ends under the following three conditions:

- When there are only two seeds left, one on each side of the board
- When there are too few seeds for any meaningful game to continue
- When one player has captured 25 seeds or more

V. MATHEMATICAL STRENGTH OF AFRICAN BOARD GAME

African board games provide among others the following key strengths:
- Strategic thinking
- Employment of mathematical skills
- Employment of logical skills
- Ability to plan and forward thinking in playing
- Ability for abstract thinking

African board games are games of intellect and thinking rather than chance. They require strategies, mathematical thinking and character building. African board games "can be introduced purely as a game of chance to young children. This has a subtle educational value in encouraging the child to count. A young or inexperienced player progressively learns the concept of one-to-one correspondence as he drops each one seed into each of a sequence of consecutive holes. Then simple sum arithmetic when evaluating options and keeping scores". Both young as well as aged players keep advancing in the discovery of the game. Board games generally exposes the players to strategic importance of planning and the discipline involved in the actual implementation of long-term strategies appreciating the importance of foresight, correct timing and awareness of the principle of cause and effect [1].

VI. GREEDY ALGORITHM

An algorithm is a step-by-step procedure for calculations or for solving a problem. Greedy algorithms look for simple, easy-to-implement solutions to complex, multi-step problems by deciding which next step or action will constitute the most obvious benefit.

Greedy algorithm can also be describe as an algorithm that develops a solution in bits or piece by piece, choosing always the next bit that provides the most optimal and immediate benefit. Such algorithms are called greedy because while the optimal solution to each smaller instance will provide an immediate output, the algorithm doesn't consider the larger problem as a whole. Once a decision has been made, it is never reconsidered [2].

Advantages to using this algorithm is that solution to smaller instances of the problem can be straight forward and easy to understand. In as much as advantages exist, the disadvantage is that it is entirely possible that the most optimal short-term solutions may lead to the worst long-term outcome [5].

Greedy algorithms are used in machine learning, business intelligence (BI) artificial intelligence (AI) and programming.

VII. PLAYER ALGORITHM

```
// board is an array of 12, each cell containing four seeds each.
// method accepts input from mouse (integer input)
// validate input to be sure is of the players territory
// counter1, counter2 are global variables that keeps players capture
```

```
input = mouseInput
position = input -1
hand = board [input]
for i: = hand to 1
check if (position < 0)
    reset position to 11;
end if
check if (board [position] = 3)
    check if (player1)
    add four (4) to the value of counter1;
    else check if (player2)
add four (4) to the value of counter2;
    end if
set board [position] = 0;
check if(i = 1)
break out of loop
else
        -- position;
continue
        end if
end if
check if (i = 1 and board [position] > 0)
reseti = board [position] + 2;
reduce position by 1;
continue;
end if
increment board [position] by 1;
    -- position;
end for loop
```

To determine the end of the game its either counter1 + counter2 = 48 or there is no seed in the opponents hole to play anymore.

To determine the winner of a round check whether counter1 is greater than counter2 then player1 won otherwise plaer2 won. However they can draw if counter1 is equals to counter2.

VIII. COMPUTER PLAYER ALGORITHM

The algorithm of the artificial intelligence of the computer agent is based on the concept of a **greedy algorithm**. Since the algorithm look for simple, easy-to- implement solutions to complex, multi- step problems by deciding which next step or action will constitute the most obvious benefit, the computer player makes a copy of the board each time before play, plays the game without the players knowledge and chose the move with the most optimal capture as its best move. The computer agent's algorithm is as below:

```
initializebestMove = -1
initializemaxNewStone = -1
for: each hole in the computer player's territory:
Make a copy of the current board:
called it say testBoard
```

check if: the content of the present hole on the test board is not equal to zero

pass the hole number to playerAlgorithm and keep the result in a variable
/* The brain behind this is that the computer plays the game without the human players knowledge and

return the number of capture to the calling method */

resettestCounter = 0
/* testCounter is a variable that keeps track of the computer's capture */

check if: newStone is greater or equal to maxNewStones
-reset maxNewStone = newStone
-reset bestMove = present hole number
end if
end if
end for loop colon.

IX. CONCLUSION

As much as technology is made available, computerization of indigenous games will go a long way in documenting, preserving rules and showcasing the rich African game culture to the world.

The computerization of Dara has come to eradicate the problems associated with it which includes among others: making the game mobile and portable, giving the player an opportunity to enjoy playing against the computer. Meaning the player can play even without a human opponent.

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