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Puzzle game solving with breadth first search algorithm

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Abstract. Today's games have been played by many people from young to old age. There are many types of games, one of which is a puzzle game. Puzzles, which are brain teasers that challenge the skills of their players, never seem to lose their popularity and are never consumed by age. Puzzle is one type of game that is enough to squeeze the brain to solve it. The solution that can be used to simplify problem solving is to apply a search algorithm that is used to check the initial state to the final state and provide the most optimal solution for completing the puzzle, the purpose of this study were using algorithm used to solve these problems using the Breadth First Search algorithm. The use of the Breadth First Search algorithm in solving puzzle games can make it easier for users to get the best solution in the form of completion steps and also the possibility of solving various conditions based on the puzzle conditions that you want to solve.

1. Introduction

Along with the development of the digital era, human needs also increased, especially in terms of education. Humans, education and technology cannot be separated [1,2]. Therefore, humans compete with each other and compete in innovating and creating new things, one of them is the educational game application program [3].

With the advancement and development of information technology and computers [4], it makes it easier for game makers to create and create games in various shapes and types. Puzzle is a type of game that deals with solving puzzles [5,6], whether composing blocks, equating the color of the ball, solving mathematical calculations, and passing through the maze, these are all included in this type.

Puzzles, which are brain teasers that challenge the skills of their players, never seem to lose their popularity and are never consumed by age. Puzzle is one type of game that is enough to squeeze the brain to solve it. Players are challenged to think creatively how to make all parts of the puzzle lie in their true position. This game looks pretty simple but to put all the puzzles in place is actually a big obstacle. The player must exert all his brain's ability to make the puzzle lie in its true position.

The application of Breadth First Search (BFS) algorithm [7] in puzzle games can be used as a solution to solve puzzles faster without having to think hard, using BFS algorithm to complete and provide steps solution for completion game with the most optimal solution from step and even time processing.



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1 Methodology

In the Breadth-First Search method, all nodes at level n will be visited first before visiting nodes at level $n + 1$. The search starts from the root node and continues to level 1 from left to right, then moves to the next level [8–10].

The advantages of this method:

- None deadlocked will be occur.
- If there is one solution, then breadth-first search will find it. And if there is more than one solution, the minimum solution will be found.

The disadvantages of this method:

- Requires a lot of memory, because it stores all nodes in a tree.
- It takes a long time, because it will test n levels to get a solution at the level $(n + 1)$.

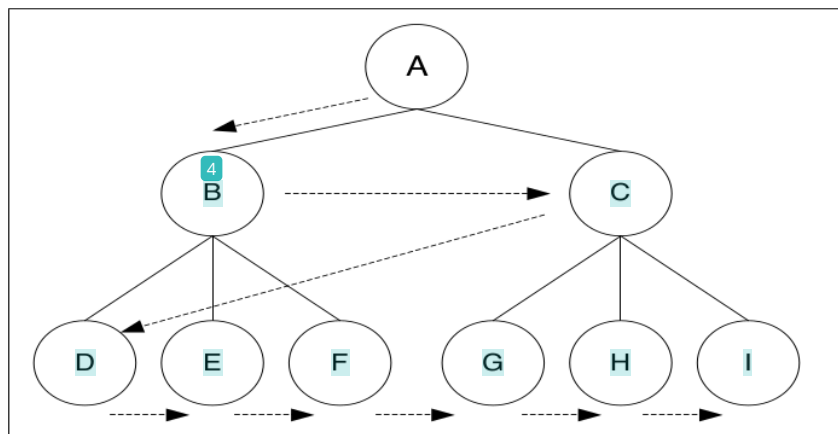


Figure 1. Breadth first search process.

Figure 1 shows a search for each node starting from the left node to the right node until all nodes are examined or the desired solution is obtained, this process requires a relatively longer time if the nodes examined are very large.

3. Results and discussion

The use of the Breadth First Search algorithm as a solution for searching and tracing solutions of games is done by many other researchers, Rahim uses the BFS algorithm to complete the game of *congklak* and get the right move, and Ratnadewi uses the BFS algorithm to determine steps optimal from solving the crossing river problem by finding steps to resolve from Initial State to Goal State [7,11].

Experiment in this puzzle are carried out using images with a size of 3×3 and then randomized so that the shape of the image is different from the original, like the figure 2 below.

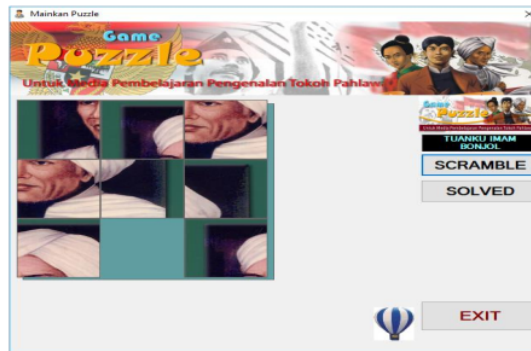


Figure 2. Puzzle image.

The scramble process is carried out and produces puzzles such as figure 2 and to solve the puzzle can be done manually or also automatically by applying the BFS algorithm to solve the puzzle, the results of step completion with the BFS algorithm as shown in the following figures 3 and 4.

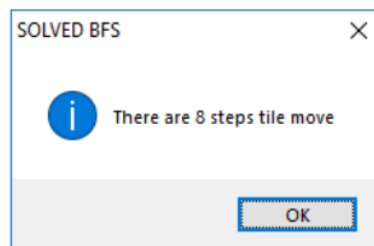


Figure 3. Steps move.

Figure 3 is information on solving puzzle games using the BFS algorithm, the results of this solution will be different for each random puzzle position that appears, the tests performed for puzzles 3 X 3 and the more number of puzzles completed, the more steps that must be tested and definitely takes longer. The final result of using the BFS algorithm in solving the 3 x 3 puzzle is the position of the image arranged as before as shown in the following figure 4.

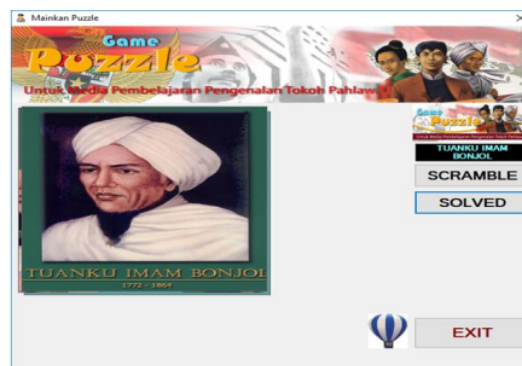


Figure 4. Solving puzzle.

Completion done using the BFS algorithm can be done quickly and does not require a long time compared to the manual solution.

4. Conclusion

Puzzles that are completed are 3 X 3 in size and then randomized to be completed using the BFS algorithm, BFS algorithm completion based on testing less than 5 seconds to solve the existing puzzle. Puzzle testing is done for sizes 3 x 3 and for other measures can be completed in the same way but it may be necessary to take a longer time because the steps that must be completed are also very much possible solutions.

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