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Submission date: 25-Jul-2021 03:41PM (UTC+0700)

Submission ID: 1623680995

File name: 5_6334531111774847679.pdf (692.63K)

Word count: 2526

Character count: 12987

The Implementation of Backtracking Algorithm on Crossword Puzzle Games Based on Android

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Abstract. The development of smartphones at this time is improving very fast and rapidly can affect to the renewal of all applications in the smartphone. At this time we can do anything with a smartphone in hand. In other hand smartphone also can reduce the saturation and boredom of many games made for smartphones. One of example is the crossword game application. Filling or playing crossword puzzles turns out many benefits, in addition to increasing the freshness of the mind from routine activities, this game can also add to our insight in various things, such as vocabulary, various important terms and popular words we often find in filling out cross-breeding. The backtracking algorithm is used to determine the exact steps to be taken in completing the crossword puzzle game. By using the backtracking algorithm, it is can expected the completion of the crossword puzzle game so this game can be more easily to solved. The system is built using Java with the ADT IDE for Eclipse as a programming language. The result of this final project is an application of a crossword puzzle game about the term computer and informatics that can give correct answers automatically.

1. Introduction

The development of smartphones is currently growing very fast and fast. There are many of the advanced technologies offered on smartphones always change quickly and are updated to the latest technology. One of the latest smartphone technologies is the Android-based operating system. This operating system is open source intended for users to be able to create their own applications in accordance with the desires [1].



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The advantage of open source, many developers or third parties participate to create various types of new applications in accordance with the desires and needs of users. In fact, Android has been equipped with a variety of useful and interesting applications. Therefore, to fill the needs and satisfaction of its users throughout the world, an Android Market was created. The application growth is also very rapid, in addition due to the number of downloads is increasing, especially the developers continue to research to create applications that are innovative and more useful for users. One application that can be made from the Android operating system is the game application.

Crossword puzzles is a game with how to play fill the empty spaces in the squares form with letters to shape a word in accordance with the instructions given [2]. Configuration a word from one box with another box that must have a match. The instructions are usually divided into horizontal and vertical categories depending on the position of the words that must be filled. Normally a puzzle is full of various interpretations of termination, so in completing this crossword puzzle we are required to be more thorough and carefully to solving it.

Along with the advancement of telecommunications technology, the game of crossword puzzles that will not be played traditional anymore, because it will be made in the form of applications that are easier to play. Therefore, a method will be implemented by using the backtracking algorithm which is used to determine the exact steps to be taken in this crossword puzzle game. For this reason, with the backtracking algorithm, it is expected to be able to provide the right and maximum results, whether the rows of answer boxes that have been made are in line with the answers to the words that have been provided and are able to handle the discontinuity that can occur if entering the wrong words.

4 Related Works

The backtracking algorithm was first introduced by D.H. Lehmer in 1950. In its development several experts such as RJ Walker, Golomb and Baumert presented a general description of backtracking and its application in various problems and applications. Backtracking algorithm is one of the problem solving methods included in search-based strategies in the status space. The backtracking algorithm works recursively and searches for problem solutions systematically in all possible solutions [3].

3. Research Methodology

3.1 Backtracking Algorithm

The algorithm can be defined as a well-defined computational procedure that uses several values as input and produces various values called outputs. So, the algorithm is a computational step that transforms the input into output [4]

In the backtracking algorithm all possible solutions are made in the form of a solution tree (in the form of an abstract) first, the tree was explored DFS until a feasible solution is found [5]. This algorithm works well to solve problems that state always changes from time to time (dynamic problem solving) so that it becomes the basis of the algorithm for Artificial Intelligence.

The name of backtrack is obtained from the character of this algorithm which utilizes the set of solution characteristics that have been compiled into a solution tree. For more details it can be seen in the following solution tree:

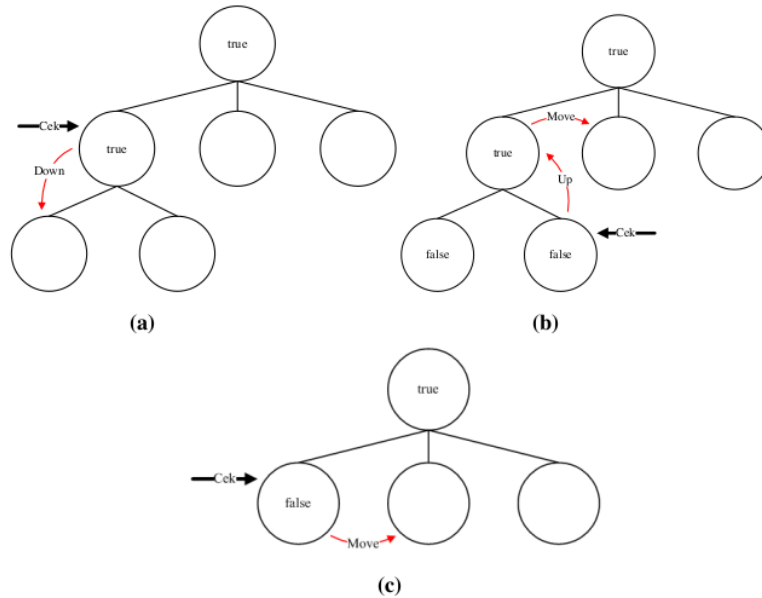


Figure 1. Searching for Backtracking (a) Flag Down (b) Flag Up (c) Flag Move[6]

Backtracking algorithms based on DFS (Depth First Search) will check in depth first. Checking if it's clogged or doesn't find a solution it will return to the previous node. Such checks will be carried out continuously until finding a solution.

According to Sulun and Munir (2010), the principle of finding solutions using the backtracking method is as follows [7]:

1. Solution is search by forming a path from root to leaf. The rules of formation used are to follow the DFS deep search rules. The knots that have been born are called live node.
2. Live node. The extended life node is E-node called the expand node.
3. Each time the E-node is expanded, the path built by it increases in length. If the path being formed does not lead to a solution, then the E-node is "killed" so that it becomes a dead node.
4. Dead node. The function used to kill the E-node is by applying the bounding function. The dead knot will never be expanded again.
5. If the formation of the path ends with the dead node, then the search process is continued by generating another child node. If there is no more child node that can be raised, then the solution search is continued by backtracking to the nearest live node (parent node). Then this node becomes the new E-node.
6. Seeking is stopped if we have found a solution or there are no more nodes for backtracking.

2 System Analysis

System analysis aims to identify the problems that exist in the system, where applicatio² are built covering the operating environment, user, and the results of the analysis of the system and related elements. This analysis is needed as a basis for the stages of system design, which includes discussion of system design, including system design, and system implementation.

3.3 System Design

6 he design of this crossword puzzle game application using the Java programming language with the Integrated Development Environment (IDE), Eclipse and plug-in Android Development Tools (ADT). The interface display is created using visual component facilities provided by Eclipse.

Table 1. Explanation of the Use Case Diagram

Actor	Name of Use Case	Description of Use Case
User	Choose Cross Puzzle	This use case functions for the selection of crosswords to be played, there are three levels of crossword puzzles
	Input the Answer (Alphabet)	This use case functions to input the character of the letters in the answer table crossword puzzles correspond to the questions given
	About	This use case serves to display the author's profile, about the application and procedures for playing crossword puzzles

4. Result and Discussion

4.1 Implementation of Backtracking on Crossword Puzzle

The backtracking algorithm in this game will be used to fill in the game boxes that were previously created. These boxes can be represented by a matrix data structure so the each box will have an index. This index will be used to do a suitable word search. In filling words into boxes, the program first determines the initial box you want to fill. The program will calculate the number of boxes in the row of boxes and then search for words in the word / answer data consisting of a collection of words / answers that have the same number of characters as the number of boxes.

In seeking for words data there are may several words that suitable to be inserted into a row of boxes, the program will choose words that are earlier in the word / answer data. The next step, the program will identify the index in a row of boxes that are connected to the row of other boxes. The program will record where the location of the relationships between rows of boxes is then record the index and take the characters contained in it to be compared back to the row of words in the word / answer data. If the next entered word matches, the search will continue, but if there is no matching word, the program will turn off the possibility of an answer based on the search and the program will do backtracking.

Backtracking was done by the program will delete the last word entered in a row of boxes, then the program will replace the word in other words that can also be loaded into the row of boxes and then the program will do a search again. The steps above will continue to be carried out recursively, until the program finds a solution to the problem or the entire box in the crossword puzzle game is fully filled`.

4.2 Application of Backtracking on Crossword Puzzle

As explained above, to run this program, the system must prepare word / answer data as answers filled with crossword questions. Following are examples of word / answer data provided for crossword puzzles:

Table 2. Words/Answers Data

Word	Amount of Character
HVS	3
SALAH	5
BEA	3
WTS	3
ALLOW	5
BUS	6

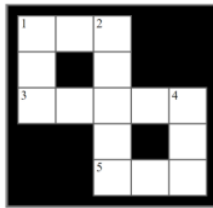


Figure 2. Manual crossword puzzle search with backtracking

The first thing to do is grouping the choice of words/ answers based on the contents of the box (domain). Cell is the number of nodes/ questions that will be filled

Table 3. Division of Word

Variable	Cell	Domain
1 Horizontal	1	HVS, BEA, WTS, BUS
1 Vertical	2	HVS, BEA, WTS, BUS
2 Vertical	3	SALAH, ALLOW
3 Horizontal	4	SALAH, ALLOW
4 Vertical	5	HVS, BEA, WTS, BUS
5 Horizontal	6	HVS, BEA, WTS, BUS

In the crossword box the conditions are known:

1. The 1st letter of the number 1 box is horizontal = the 1st letter of the number 1 box vertical
2. The 3rd letter box number 1 horizontal = the 1st letter box number 2 vertical
3. The 3rd letter box number 1 vertical = the 1st letter box number 3 is horizontal
4. The 5th letter box number 3 is horizontal = the 1st letter of box number 4 vertical
5. The 5th letter of box number 2 vertical = the 1st letter of box number 5 is horizontal

Crossword puzzles will be solved by backtracking. Select the word or answer according to the order in the database. The order of entering words is: 1 horizontal, 1 vertical, 2 vertical, 3 horizontal, 4 vertical and 5 horizontal.

2

5. Conclusion

The conclusions obtained from this study are 2 follows:

1. 6 his crossword puzzle game application is built using the Java programming language with the Integrated Development Environment (IDE) namely Eclipse and plug-in Android Development Tools (ADT). The interface display is created using visual component facilities provided by Eclipse.
2. The backtracking algorithm on the crossword game is applied to the help button. By clicking on the button the correct answer will be displayed automatically by the application. In this crossword puzzle game, the backtracking algorithm can provide definitive answers so that this backtracking algorithm can be implemented. This is due to principle, we do not need to examine all possible solutions. Search only leads to the solution being considered.
3. Application of crossword puzzle games can be run on any type of Android smartphone at least Android version 4.0 (Ice Cream Sandwich)..

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