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# Comparison of Ascent Hill Climbing Algorithm And Simple Hill Climbing Algorithm Solving The 8-Puzzle Case

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**Abstract**

*Puzzle 8 game is a game that shifts numbers in the form of a box consisting of 9 squares arranged with numbers 1 to 8 based on the order of count and there is an order of 3x3. This form of game is very easy to complete if you follow the rules that have been applied to the algorithm. Comparison of the ascent hill climbing algorithm and the simple hill climbing algorithm. The purpose of this algorithm is to help children who are just learning to arrange a sequence of numbers so that they explore brain power and increase imagination for children. The difference between the ascent hill climbing algorithm and the simple hill climbing algorithm lies in the search movement which does not start from the far left position but the next movement is searched based on the best heuristic value. To obtain the Goal, a systematic process is needed to make it easy and fast in finding solutions so as to save time in finding the final goal.*

***Keywords**: ascent hill climbing algorithm, simple algorithm hill climbing, Searching, Puzzle 8*

## 1. Introduction

In the search process, a state space is needed, in order to obtain a result thatrequired a suitable method to solve the problem. SolutionThis case uses the Ascent Hill Climbing Algorithm method. The first step is solving the puzzleThis is in the form of seeing the position of each puzzle box by following the 4 shift criteria. Shift The box is done alternately by changing the position on the left, top right and bottom. PuzzlesThis includes in the case of a search conditional on the problem to be solved and solvedthus producing a solution. Two things that must be considered, namely how to find a solution orgoals quickly and how long it takes to solve problems, The Hill Climbing method is one of the methods used in solving the nearest search problem (Rich et al., 1991 in Russel and Norvig, 2003). The way it works is to determine the next step by placing the dot that will appear as close to the target as possible. The testing process is carried out using a heuristic function [1]. The Steepest Ascent Hill Climbing method is an algorithm method that is widely used for optimization problems. One application is to find the shortest route by maximizing or minimizing it.

Heuristics is a technique that improves efficiency in the search process, but at the expense of completeness. To measure the performance of search methods, there are four criteria that can be used [2]:

a) Completeness: whether the method guarantees finding a solution if the solution does exist;
b) Time complexity : how long it takes;
c) Space complexity : how much memory is required;
d) Optimality: does the method guarantee to find the best solution if there are several different solutions [3].

The algorithm for SimpleHill Climbing Search is as follows:

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a) Initial state evaluation, If this state is a goal state, then return this state as a solution and exit the program. If this state is not a goal state, continue the process with the initial state as the current state.
b) Repeat until a solution is found or until no new operator (production rule) can be applied to the current state:
   1) Select an operator that has not been applied to the current state and apply the operator to produce a new state.
   2) Evaluation of new state.
      i. If this state is a goal state, then return this state as a solution and exit the program.
      ii. If this state is not a goal state but better than the current state, then make this state the current state.
      iii. If this state is not better than the current state, return to step 2a [4].

The Steepest-ascent Hill Climbing search algorithm is basically almost the same as the Simple Hill Climbing search algorithm, the difference is that the search movement does not start from the far left position but the next movement is searched based on the best heuristic value. The algorithm of Steepest Ascent Hill Climbing Search is:
a) Determine SUCC as the heuristic value of the successors.
b) Do it for each node used by the current state.
   i. Use the node and form a new state.
   ii. Evaluate the new state if it is an exit destination. If not, compare the heuristic values with SUCC. If better, set the value of the new state heuristic as SUCC, but if not better, the value of SUCC remains unchanged.
   iii. If SUCC is better than the current state heuristic value, change the SUCC node to the current state [5].

The simple hill climbing algorithm has the advantage that allpossible solutions will be generated and then checked from the left side one by one, so that a solution that is close to the optimal result will be obtained. Many studies using the hill climbing method have been carried out. Some of them are A simulated annealing and hill-climbing algorithm for the traveling tournament problem [6]. Where is the application of the Hill Climbing and A simulated annealing methods that are used to minimize the total shortest distance that will be traveled by the entire team in participating in a double round-robin tournament schedule, thus providing comparable or better results compared to most of the most popular solutions. know now. The advantage of the hill climbing method compared to other methods is that the search process is easier, because the search process always approaches the destination node.

This simplifies the livelihood process [7]. The Hill Climbing algorithm can be used to solve this case because the hill climbing method is a variation of the dept-first-search where the exploration of decisions is carried out by finding a path that aims to reduce the cost to get to the goal/decision through the smallest heuristic value. While the A* algorithm is a comparison algorithm that can test how good the solution is between these two methods. In solving this game, the A* algorithm helps find a state space search solution by considering the total cost of the path that is tracked according to the node to be traversed [8].
value of the existing optimization function. The optimization function in question is the replacement of the destination point and the user point, thereby affecting the shortest route sought [9]. Meanwhile, there are several opportunities for problems related to the simple hill climbing method:
1) The algorithm will stop if it reaches the local maximum value, i.e. the mention of the current pathis the shortest path to be traversed, but it has not been determined that the path will be used as a destination because other path opportunities have not beenallocated.

2) Ordering the use of the position used to make the exchange so that it can have an effect on determining the next position [8].

Steepest-Ascent Hill Climbing (Hill Climbing by choosing the steepest slope). Simple hill climbing, initially the next state will be determined by comparing the current state with one successor. This comparison process starts from the left. If a new successor is found that is better than the current state, the successor will become the next state. While on the steepest ascent hill climbing in determining the next state, the current state is directly compared with all the successors nearby [5].

## 2. Research Methodology

In collecting data, information and program design needed for preparation, researchers use the Waterfall Method, which is a method of working on a system carried out sequentially or step by step.Where the sequence of steps used becomes an important point in the implementation of writing where if step one has not been done it will not work Perform steps 2, 3 and so on. The steps for solving the case of this algorithm are [6]:

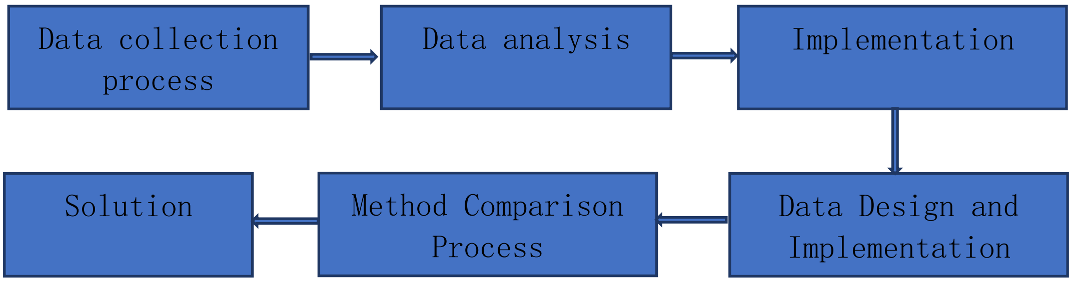


**Figure 1.** Research design

## 3. Results and Discussion

In the Ascent hill Climbing algorithm, there are 3 possible problems that will be faced including:

a) The condition of all neighbors is worse or equal to his condition
b) The condition of all neighbors is the same as his condition
c) Local optimum which is caused by the inability to use 2 operators simultaneously.

See the initial state generates the goal value.

**a) Algoritma Ascent Hill Climbing**

Goal

| | | |
|---|---|---|
| **1** | **2** | **3** |
| **4** | **5** | **6** |
| **7** | **8** | |

Raw data

| | | |
|---|---|---|
| **2** | | **3** |
| **1** | **6** | **8** |
| **4** | **7** | **5** |

State Room

| | | |
|---|---|---|
| **1 . 1** | **1 . 2** | **1 . 3** |
| **2 . 1** | **2 . 2** | **2 . 3** |
| **3 . 1** | **3 . 2** | **3 . 3** |

**Figure 2.** Initial Data

**a) Iteration 1**

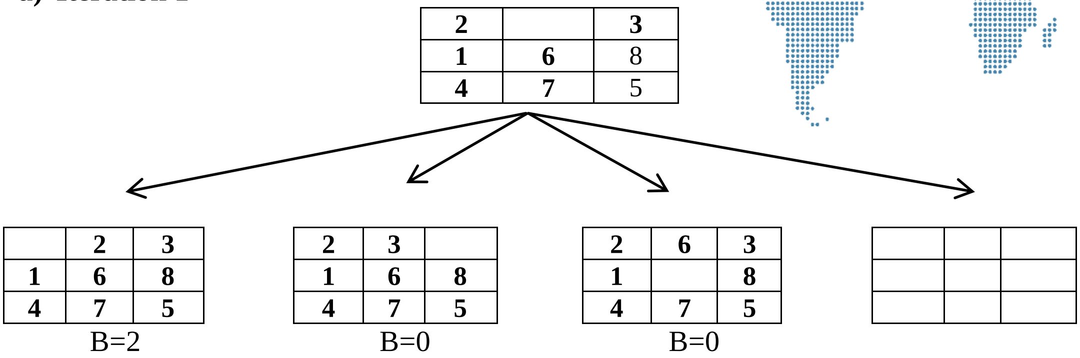


**Figure 3.** Initial 1

.

.

**b) Iteration 9**

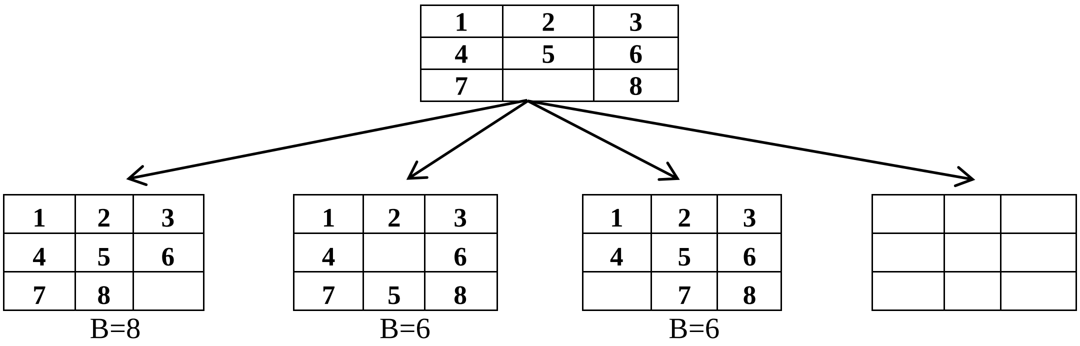


**Figure 4.** Initial 9

After going through the process of searching for the Ascent Hill Climbing method, 9 iteration processes were obtained and the results of the compilation of 8 puzzles were sequentially according to the objectives.

| | | |
|---|---|---|
| 1 | 2 | 3 |
| 4 | 5 | 6 |
| 7 | 8 | |

**Figure 5.** Algoritma Ascent Hill Climbing

**b) Algoritma Simple Hill Climbing**

The simple hill Climbing algorithm has 2 working principles, namely:

1) The algorithm will stop when it reaches the local optimum value.
2) The order in which the operators are used will greatly affect the solution finding.
3) No one is allowed to see the previous step.

Below is a step-by-step process for the simple hill climbing algorithm to find the final solution.

Goal

| | | |
|---|---|---|
| 1 | 2 | 3 |
| 4 | 5 | 6 |
| 7 | 8 | |

Raw data

| | | |
|---|---|---|
| 2 | | 3 |
| 1 | 6 | 8 |
| 4 | 7 | 5 |

State Room

| | | |
|---|---|---|
| 1 . 1 | 1 . 2 | 1 . 3 |
| 2 . 1 | 2 . 2 | 2 . 3 |
| 3 . 1 | 3 . 2 | 3 . 3 |

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**a) Iteration 1**
See first state /initial=Goal
Current position = State of initial position

| | | |
|---|---|---|
| **2** | | **3** |
| **1** | **6** | **8** |
| **4** | **7** | **5** |

Process operator 1

| | | |
|---|---|---|
| **2** | **3** | |
| **1** | **6** | **8** |
| **4** | **7** | **5** |

B=1 B=0

The correct position now > The correct position of the puzzle is the current state, then the state remains

**b) Iteration 2**
See first state /initial=Goal
Current position = State of initial position

| | | |
|---|---|---|
| **2** | | **3** |
| **1** | **6** | **8** |
| **4** | **7** | **5** |

Process operator =2

| | | |
|---|---|---|
| | **2** | **3** |
| **1** | **6** | **8** |
| **4** | **7** | **5** |

The correct position now < The correct position of the puzzle is the current state, Then the current state and the next state

**c) Iteration 3**
See first state /initial=Goal
Current position = State of initial position

| | | |
|---|---|---|
| | **2** | **3** |
| **1** | **6** | **8** |
| **4** | **7** | **5** |

Process operator =3

| | | |
|---|---|---|
| **1** | **2** | **3** |
| | **6** | **8** |
| **4** | **7** | **5** |

B=2 B=3

The correct position now < The correct position of the puzzle is the current state, Then the current state and the next state

**d) Iteration 4**
See first state /initial=Goal
Current position = State of initial position

| | | |
|---|---|---|
| **1** | **2** | **3** |
| | **6** | **8** |
| **4** | **7** | **5** |

Process operator =4

| | | |
|---|---|---|
| **1** | **2** | **3** |
| **4** | **6** | **8** |
| | **7** | **5** |

B= 3 B=4

The correct position now < The correct position of the puzzle is the current state, Then the current state and the next state

**e) Iteration 5**
See first state /initial=Goal
Current position = State of initial position

| | | |
|---|---|---|
| **1** | **2** | **3** |
| **4** | **6** | **8** |
| | **7** | **5** |

B=4

Process operator =5

| | | |
|---|---|---|
| **1** | **2** | **3** |
| **4** | **6** | |
| **7** | **5** | **8** |

B=5

The correct position now < The correct position of the puzzle is the current state, Then the current state and the next state

**f) Iteration 6**
See first state /initial=Goal
Current position = State of initial position

| | | |
|---|---|---|
| **1** | **2** | **3** |
| **4** | **6** | |
| **7** | **5** | **8** |

B=5

Process operator =5

| | | |
|---|---|---|
| **1** | **2** | **3** |
| **4** | **5** | **6** |
| | **7** | **8** |

B=6

The correct position now < The correct position of the puzzle is the current state, Then the current state and the next state

**g) Iteration 7**
See first state /initial=Goal
Current position = State of initial position

| | | |
|---|---|---|
| **1** | **2** | **3** |
| **4** | **5** | **6** |
| | **7** | **8** |

B=6

Process operator =6

| | | |
|---|---|---|
| **1** | **2** | **3** |
| **4** | **5** | **6** |
| **7** | | **8** |

B=7

The correct position now < The correct position of the puzzle is the current state, Then the current state and the next state

**h) Iteration 8**
See first state /initial=Goal
Current position = State of initial position

| | | |
|---|---|---|
| **1** | **2** | **3** |
| **4** | **5** | **6** |
| **7** | | **8** |

B=7

Process operator =7

| | | |
|---|---|---|
| **1** | **2** | **3** |
| **4** | **5** | **6** |
| **7** | **8** | |

B=8

View current state= Goal, Search stopped. The Simple Hill Climbing method takes 8 iterations of searching to find the goal

| | | |
|---|---|---|
| **1** | **2** | **3** |
| **4** | **5** | **6** |
| **7** | **8** | |

**Figura 6.** Algoritma Simple Hill Climbing

## 4. Conclusion

From the description of the comparison of the ascent hill climbing algorithm method and the simple hill climbing algorithm in solving cases in the puzzle game 8, it can be concluded The difference between the ascent hill climbing algorithm and the simple hill climbing algorithm lies in the search movement which does not start from the leftmost position but the next movement is searched based on the best heuristic value. By using the same data, the search for Puzzle Game 8 uses the ascent hill climbing algorithm and the simple hill climbing algorithm, the ascent hill climbing algorithm uses a heuristic function to get optimal results so that the drawback of this simple hill climbinga algorithm is the processing time in getting the best results. The most optimal depends on the number of calculation iterations used. By using the same data, the search for the ascent hill climbing algorithm and the simple hill climbing algorithm get a different iteration process. The ascent hill climbing algorithm requires 8 iteration processes and the simple hill climbing algorithm requires 9 iteration processes.

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