Pegboard Game Solver Report

*Thomas Laverghetta*,   
Old Dominion University – Computational Modeling and Simulation Engineering

# Introduction

In this report, I will be analyzing four different search algorithms when applied to a pegboard game.

# Pegboard Game Rules

Pegboard problems are single-player games played on a grid, in which moves are made by successively jumping and removing pegs from the pegboard. A peg can jump an adjacent peg if there is a slot adjacent to that peg in the opposite direction – horizontally or vertically. Diagonal jumps are not allowed. After a peg has been jumped, it is removed from the board (and possibly eaten). A typical objective of this problem is to begin with a full pegboard from which one peg has been removed and determine a sequence of jumps which will result in one peg remaining. The pegboard game has been a challenging problem for a human being. Figure 1 illustrates a solution of a 6x6 pegboard game. [1]

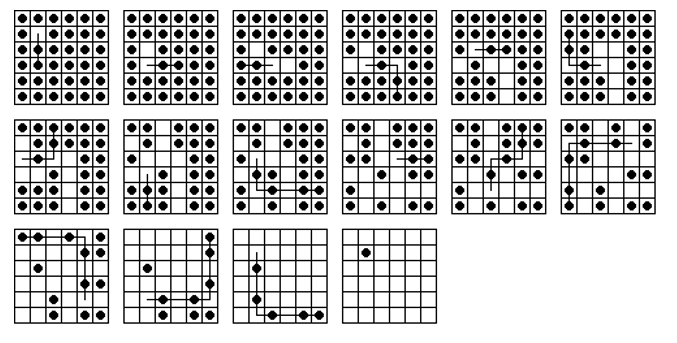


Figure . 6x6 Solution [2]

# Algorithms

In this section, I will be discussing the algorithms used to search for solutions to pegboard game. The algorithms I will be discussing are breadth-first search (BFS), depth-first search (DFS), greedy-best search, A\* (A-star) search, and heuristic to support greedy-best search and A\*.

## Breadth First Search Algorithm

*Bread First Search (State S)*

*1. create FIFO Queue*

*2. push S into Queue*

*3. While Queue Is Not Empty*

*4. T = Pop Queue*

*5. if T is the goal*

*6. return T*

*7. else*

*8. foreach successor of T*

*9. if successor state has not been visited*

*10. mark successor state has visited*

*11. push successor into Queue*

*12. end if*

*13. end for*

*14. end if*

*15. end while*

*16. return no solution found*

## Depth First Search

*Depth First Search (State S)*

*1. if S is the goal*

*2. mark S has goal*

*3. return S*

*4. else*

*5. foreach successor of S*

*6. if successor state has not been visited*

*7. mark successor state has visited*

*8. if Depth First Search (S) is the goal*

*9. return Depth First Search (S)*

*10. end if*

*11. end if*

*12. end for*

*13. end if*

## Heuristic

*Manhattan (State S)*

*1. create Sum*

*2. foreach row in S*

*3. foreach column in S*

*4. if S (row, column) does not equal 0*

*5. Sum = Sum + |row – max row| + |column – max column|*

*6. end if*

*7. end for*

*8. end for*

*9. return Sum*

## Greedy Best Search

*Greedy Best Search (State S)*

*1. create FIFO Queue*

*2. push S into Queue*

*3. While Queue Is Not Empty*

*4. T = Pop Queue*

*5. if T is the goal*

*6. return T*

*7. end if*

*8. foreach successor of T*

*9. if successor state not visited*

*10. mark successor state has visited*

*11. calculate and save heuristic for successor*

*12. push successor into Queue*

*13. end if*

*14. end for*

*15. sort Queue in ascending order based on heuristic scores*

*16. end while*

*17. return no solution found*

## A\* Search

A\* (A-Star)

*A\* (State S)*

*1. if S is the goal*

*2. return S*

*3. end if*

*4. create FIFO Queue*

*5. push S into Queue*

*6. While Queue Is Not Empty*

*7. T = Pop Queue*

*8. foreach successor of T*

*9. if successor state has not been visited*

*10. if successor is the goal*

*11. return successor*

*12. end if*

*13. calculate and save heuristic and cost function for successor*

*14. if successor state in Queue*

*15. if successor’s cost is less than equivalent state in Queue’s cost*

*16. replace equivalent state with successor in Queue*

*17. end if*

*18. else*

*19. push successor into Queue*

*20. end if*

*21. end if*

*22. end for*

*23. sort Queue in ascending order based on heuristic plus cost scores*

*24. end while*

*25. return no solution found*

# Experiments

In this section, I will be running each algorithm described in previous section to generate solutions for given 4x4, 5x5, 6x6, 7x7, 8x8, 9x9, and 10x10 pegboard puzzles. The data I will be collecting for each experiment will be (1) execution duration, (2) memory utilization, and (3) solution path size (path from initial state to goal state). The data collected with be analyzed in next section.

Experiment constrictions. For each experiment, there will be a limit on resources allowed duration execution: time and memory. I will only allow for the programs to run for 1-hour before a termination is initiated. I will only allow for the programs to use 3Gb of random-access memory before a termination is initiated. If either case occurs during execution, then a failure will be saved in the data collection.

Table 1 shows the data collected for each experiment.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Program Duration | | | | |
| NxN |  |  |  |  |
| 4x4 |  |  |  |  |
| 5x5 |  |  |  |  |
| 6x6 |  |  |  |  |
| 7x7 |  |  |  |  |
| 8x8 |  |  |  |  |
| 9x9 |  |  |  |  |
| 10x10 |  |  |  |  |

# Analysis