# Unblock Me

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*Abstract*—The aim of this paper is to implement and compare Artificial Intelligence algorithms for solving the game Unblock Me, in which rectangular pieces block the path of a red special piece. The objective of the game is for the special piece to reach the exit of the level, which is achieved by moving it and the other pieces. The problem will be described and then formulated as a *Search Problem*, together with some discussion on the reasoning behind some of the decisions taken during this process. Several algorithms will be investigated, along with testing them against levels with varying difficulty and branching factors. Both the efficiency in reaching a solution and the cost of the calculated solution will be taken into account in the pursuit for the optimal *Search Algorithm*. NEEDS PART ABOUT SECTION V THAT WILL BE CHANGED

*Index Terms*—Artificial Intelligence, Search Problems, Path finding algorithms, Graph Algorithms, DFS, BFS, Iterative Deepening, Greedy Search, A*, Bi-directional Search

## I. INTRODUCTION

The game that is the subject of study in this paper (*Unblock Me*) will be approached with several different *Search Algorithms*, implemented in *Python*, in order to conclude what is the best approach for solving it using *Artificial Intelligence Algorithms*.

Firstly, the game will be described in further detail, ensuring that all non-formal aspects of it are well documented. Secondly, it will be formulated as a *Search Problem*, with the approach taken in doing so being illustrated in increased depth, providing reasoning for the decisions taken. Thirdly, a research on related work on this topic will be presented, giving some insight on the problem from other points of view. Finally, a small section covers the conclusions and future work.

## II. PROBLEM DESCRIPTION

*Unblock Me* is a puzzle game that was released in 17-06-2009 by *Kiragames*. Each level consists of a 6x6 board, surrounded with walls (except for the puzzle's exit).
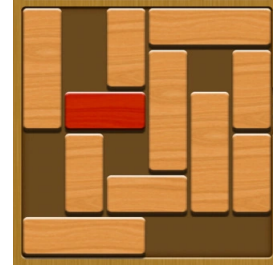


Fig. 1. Example of an *Unblock Me* level

The game's objective is to move a special piece to the level's exit, by moving that and the other pieces with the least number of movements possible. Pieces are rectangles with a given orientation (vertical or horizontal) and constant length. Pieces can only move in the direction of their orientation into empty cells (they may not overlap).
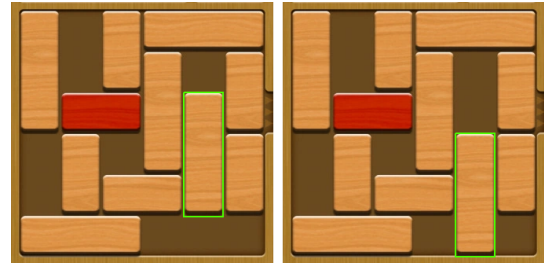


Fig. 2. Piece moving down one cell

Levels are fully surrounded by walls, except for the level's exit door that is alligned with the special piece and by which only the special piece can go through. The level is completed once the piece goes through the exit door.
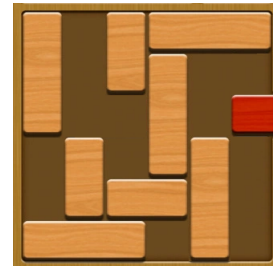


Fig. 3. Beating a level by going through the exit

Some levels may even contain fixed blocks that can not be moved, representing obstacles.
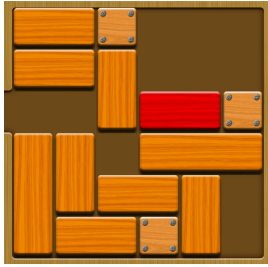


Fig. 4. Example of an *Unblock Me* level containing fixed blocks

## III. PROBLEM FORMULATION

The game's solving process can be formulated as a searching problem, in which the goal is to find the sequence of moves (state transitions) that take the special piece to the level's exit door - the problem's goal state.

### A. Game State Representation

- List of pieces, where each piece contains the following information:
  - Origin Square (top left piece corner, e.g. (0,0))
  - Length (e.g. 4)
  - Direction (H or V)
- Reference to the special piece
- Matrix of booleans, where True means the cell is empty

This representation of the game state makes the generation of the valid movements easier, due to the fact that to determine possible movements Esta representaçao do estado do jogo facilita a geraçao de todos os movimentos válidos, devido ao facto de que o que condiciona o movimento de uma peça no ser necessariamente dependente das outras peças, mas dos espaços vazios do estado atual. Para gerar estes movimentos, basta percorrer a lista de peças, verificando se cada peça possui algum espaço vazio em cada uma das suas duas extremidades (com base na sua orientaçao). A representaçao apresentada facilita a execuo desta tarefa, tornando-a tambm pouco custosa (facto importante devido ao elevado nmero de clculos deste tipo): Utilizando uma lista para armazenar todas as peças, trivial percorrł-la a fim de determinar quais delas se podem mover num dado estado; Utilizando uma matriz (de valores booleanos, que indicam se uma clula est ou no ocupada) trivial verificar se as duas clulas adjacentes s extremidades de uma peça esto ou no vazias Por fim, a utilizao de uma referłncia para a peça especial permite um acesso constante a essa peça, que ser til para as operaes relacionadas com as heursticas de avaliao.

### B. Initial State

The initial state depends of the level in question, being represented by a game state described in subsection III-A.

### C. Goal State

The goal state consists of a piece configuration where the special piece reaches the level exit.

### D. Operators

- Move piece to the left:
  - Pre-conditions:
    * Piece with horizontal orientation
    * Cell that is adjacent to the piece's left extremity must be empty
  - Results: The pieces position moves one cell to the left
  - Cost: 1 movement
- Move piece to the right:
  - Pre-conditions:
    * Piece with horizontal orientation
    * Cell that is adjacent to the piece's right extremity must be empty
  - Results: The pieces position moves one cell to the right
  - Cost: 1 movement
- Move piece up:
  - Pre-conditions:
    * Piece with vertical orientation
    * Cell that is adjacent to the piece's top extremity must be empty
  - Results: The pieces position moves one cell up
  - Cost: 1 movement
- Move piece down:
  - Pre-conditions:
    * Piece with vertical orientation
    * Cell that is adjacent to the piece's bottom extremity must be empty
  - Results: The pieces position moves one cell down
  - Cost: 1 movement

### E. Path cost

The solution's path cost that is to be minimized is equal to the number of movements made (number of state transitions).

## IV. RELATED WORK

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## V. CONCLUSIONS AND DEVELOPMENT PERSPECTIVES

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## REFERENCES

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## References

[1] G. Eason, B. Noble, and I. N. Sneddon, "On certain integrals of Lipschitz-Hankel type involving products of Bessel functions," Phil. Trans. Roy. Soc. London, vol. A247, pp. 529–551, April 1955.

[2] J. Clerk Maxwell, A Treatise on Electricity and Magnetism, 3rd ed., vol. 2. Oxford: Clarendon, 1892, pp.68–73.

[3] I. S. Jacobs and C. P. Bean, "Fine particles, thin films and exchange anisotropy," in Magnetism, vol. III, G. T. Rado and H. Suhl, Eds. New York: Academic, 1963, pp. 271–350.

[4] K. Elissa, "Title of paper if known," unpublished.

[5] R. Nicole, "Title of paper with only first word capitalized," J. Name Stand. Abbrev., in press.

[6] Y. Yorozu, M. Hirano, K. Oka, and Y. Tagawa, "Electron spectroscopy studies on magneto-optical media and plastic substrate interface," IEEE Transl. J. Magn. Japan, vol. 2, pp. 740–741, August 1987 [Digests 9th Annual Conf. Magnetics Japan, p. 301, 1982].

[7] M. Young, The Technical Writer's Handbook. Mill Valley, CA: University Science, 1989.

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