Unblock Me

Guilherme Silva (201603647)
IART
FEUP
Porto, Portugal
up201603647@fe.up.pt

Miguel Duarte (201606298)
IART
FEUP
Porto, Portugal
up201606298@fe.up.pt

Rui Alves (201606746)
IART
FEUP
Porto, Portugal
up201606746@fe.up.pt

***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.**

The aim of this paper is to implement a solution to a scheduling problem for a Computation Center, in which Tasks provided by users will be allocated to Machines, using Constraint Logic Programming (*CLP*). The implemented algorithm allocates the given Tasks with certain Base Durations and Resource Consumptions to Machines which have specific Resources. This algorithm attempts to optimize the achieved allocation, by minimizing a factor that takes into consideration the earlier completion of tasks, while also taking heed of the Priority of each Task. Furthermore, the impact of several solution Search Strategies in the algorithm *runtime* is studied. Despite considerable effort, and the implemented algorithm being able to solve simple cases in a short amount of time, situations with a higher number of intervening Machines and/or Tasks and a larger *search domain* confirm that a scalable solution to this problem is difficult to find, for it is a complex optimization problem.

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

I. Introduction

The optimization problem that is the aim of this paper will be approached by employing Constraint Logic Programming (*CLP*), with the use of `SICStus`'s Constraint Logic Programming over Finite Domains (`clpfd`) library.

Firstly, the problem will be described in further detail, and its structure will be formalized as an optimization problem. Secondly, the approach taken will be illustrated with an increased depth, with several subsections for each relevant topic. Thirdly, the manner in which the solution is presented is specified. In addition, an example of a problem instance, its solution and interpretation of its results is portrayed. Finally, a small section covers the conclusions and future work.

Alguns pargrafos motivando e introduzindo o tema e os objetivos do documento e descrevendo a estrutura do artigo.

II. Problem Description

'Unblock Me' is a puzzle game that was released in 17-06-2009 by Kiragames. Each puzzle consist in a 6x6 cells board, surrounded with walls (except for the puzzle's exit). 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). 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. Some levels may even contain fixed blocks that can not be moved, representing obstacles.

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 representao do estado do jogo facilita a gerao de todos os movimentos vlidos, devido ao facto de que o que condiciona o movimento de uma pea no ser necessariamente dependente das outras peas, mas dos espaos vazios do estado atual. Para gerar estes movimentos, basta percorrer a lista de peas, verificando se cada pea possui algum espao vazio em cada uma das suas duas extremidades (com base na sua orientao). A representao 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 peas, 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 pea esto ou no vazias Por fim, a utilizao de uma referłncia para a pea especial permite um acesso constante a essa pea, 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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