2 Artificial Intelligence (sbh11)

This question concerns the *Partial-Order Planning Algorithm*.

(a) How does an ordering constraint differ from a causal link? [2 marks]

(b) Why is it necessary for the Partial-Order Planning Algorithm to consider both ordering constraints and causal links? [2 marks]

A game involves filling a finite grid with coloured tiles. For a position \((x, y)\) not on the first row or column, its ancestors are defined as positions \((x - 1, y)\) and \((x, y - 1)\), where the origin is at the bottom-left. For a given grid state, a tile can be placed at an empty position \((x, y)\) if and only if:

- its four adjacent squares are empty; or
- both ancestors have a tile, and the placement satisfies the Placement Rules; or
- only one ancestor has a tile, and the other ancestor can be filled later in a way consistent with the Placement Rules.

If a tile has been placed on every square, then the \textit{Finish} state has been reached.

We will focus on a specific instance of the game with a 6-by-6 grid, where the colours are white, gray and black, and the Placement Rules are as follows:

- In our instance the start state is fixed. Here are some possible moves from the start state, where a crossed square represents an empty grid position:

  ![Possible Moves](image)

  Solve the following problems using the Partial-Order Planning Algorithm.

(c) Explain how the \textbf{Start} and \textbf{Finish} states can be represented for the instance given above. Only a description is required. [3 marks]

(d) Explain how actions can be represented modeling the placement of tiles, by giving examples based on the specific instance described above. [7 marks]

(e) Explain the concepts of promotion and demotion, which are of central importance in the Partial-Order Planning algorithm. To what extent might they be useful in the case of this particular algorithm and planning problem, given your formulation? Illustrate your answer with an example. [6 marks]