COMPUTER SCIENCE TRIPOS Part IB – 2024 – Paper 7

2 Artificial Intelligence (sbh11)

This questions 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 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:



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

- (c) Explain how the Start and 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]