## COMPUTER SCIENCE TRIPOS Part IB – 2023 – Paper 7

## 1 Artificial Intelligence (sbh11)

Evil Robot has decided to toy with his victims by placing them in a puzzle maze. Victims are initially at the **Start** node and need to navigate to the **Finish** node. Other nodes  $n_{i,j}$  are laid out on a grid and connected by two kinds of edge. Fixed one-way edges (single-source, solid lines) allow a victim to pass from one node to another, left to right. For example,  $n_{5,1}$  to  $n_{4,3}$  in the diagram. Switched edges (single-source, solid and dotted lines) can be moved among destinations. For example,  $n_{2,3}$  is currently connected to  $n_{5,4}$  but can be moved to connect to  $n_{1,4}$  or  $n_{2,4}$  instead.



A victim can set the switched edges as desired, but only if they have reached the switch's source node. Their aim is to cross the maze successfully.

(a) The victim decides to solve this problem by representing it as a planning problem using the *state-variable* representation. Give an example of how each of the following elements might appear in the representation.

- (*ii*) A rigid relation. [2 marks]
- (*iii*) A *function*, including a *state variable*, representing the destination of a switched edge. [3 marks]

- (b) Explain in detail how actions allowing (1) the victim to move around the grid, and (2) the destination of a switched edge to be altered, might be implemented in the state-variable representation. [6 marks]
- (c) The victim now wishes to solve their planning problem by converting it to a constraint satisfaction problem (CSP). Explain in detail, giving examples based on the diagram above and your earlier answers, the steps necessary to perform the conversion. [7 marks]