COMPUTER SCIENCE TRIPOS Part IB – 2025 – Paper 4

4 Prolog (ijl20)

This question concerns a two-player game (white pieces vs. black pieces) played on an 8x8 game board represented as an 8-element list for the rows, each row being a list of eight values for the contents of squares on that row. The board columns/rows are numbered 1...8 starting at bottom/left from the white player perspective. Both players have one type of piece, attacking one or more squares diagonally up and to the right. An empty square is represented by the atom e, a white piece by w and a black piece by b. So the empty board is,

> [[e,e,e,e,e,e,e,e,e], [e,e,e,e,e,e,e,e,e]]

In your answers ensure each relation has a comment giving a declarative reading of its behaviour. Avoid unnecessary use of cut or other extra-logical relations. The library relations = and is may be used. Other library relations should not be assumed.

- (a) Write a relation set/4 which, if given a board, square location and a piece, will place that piece on that square. For example set(Board1,sq(3,2),Piece,Board2) will succeed with Board2 having the same contents as Board1 except that the square on the 3rd column from left and 2nd row from bottom contains the given piece. [4 marks]
- (b) Write a relation contains(Board,sq(Column,Row),S) which, if given a board and square position, will succeed with S being the content of that square.
 [5 marks]
- (c) Write a relation white_move(sq(Column,Row),sq(Column1,Row1)) which given a starting position for a white piece at sq(Column,Row) will generate in sq(Column1,Row1) each position that could be reached on an empty board by moving diagonally up and to the right from the starting position. [4 marks]
- (d) Assuming a board populated with pieces from both sides, write a relation white_attack(Board,sq(Col,Row),sq(Col1,Row1)) which, given the current board state and sq(Col,Row) containing a white piece, will succeed with sq(Col1,Row1) containing the location of an enemy piece that can be successfully attacked, if one exists. An attack on an enemy piece would be blocked by a piece of either colour earlier on the same diagonal. [7 marks]