"Retrolife - revisited" – an exchange gift for the 10'th Gathering for Gardner

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Retrolife is the name of a puzzle we introduced at G4G7 [1]. The aim of the puzzle is to find predecessors (assuming certain constraints) for the Game of Life, a one-player cellular automata game invented by John Conway [2] and popularized by Martin Gardner [3]. Since then, a few Retrolife challenges have been published [4] [5] [6].

Retrolife puzzles can be redefined as a class of puzzles and generalized in the following manner [5]. A player is given an infinite chessboard, some pawns with which he creates a pattern on the board, and some tokens. Every square on the board has eight surrounding (or neighboring) cells in the directions north, south, west, and east and on the diagonals. p, t and e are whole numbers between 1 and 8. The challenge is to surround each pawn with p tokens, making sure that no token has t neighbors and no empty squares on the board are surrounded by e tokens. A formidable challenge is to find the minimum number of tokens that can be used.

Here is an example of a generalized Retrolife puzzle and a possible (not necessarily minimum) solution, given p = 3, t = 2 and e = 2. In other words, surround each pawn on the board with 3 tokens so that no token has 2 neighbors and no empty square is surrounded by 2 tokens.

The original Retrolife problem corresponding to the inverse Game of Life [4] is retrieved when p = 3, t = 2,3 and e = 3. Note that t is in this case a vector, meaning that a token may not have two or three neighboring tokens – but it may have more or less.

In the spirit of the X'th Gathering for Gardner we challenge the reader with the following three generalized Retrolife puzzles. Surround the X of pawns with tokens so that each pawn is surrounded by p tokens, no token has t neighbors and no empty square is surrounded by e tokens, where p, t and e are:
a) $p=2, t=2, e=2$

b) $p=4, t=2, e=2$

c) $p=3, t=2,3, e=3$

Use the minimum number of tokens possible.
Solutions may be sent to (or obtained) via email: yossi.elran@weizmann.ac.il

Bibliography