

HOW MANY MUTUALLY NON-ATTACKING, NON-KNIGHT PIECES CAN WE PLACE ON AN $m \times n$ CHESSBOARD?

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Abstract

How many black and white chess pieces – excluding knights – can we place on the squares of an $m \times n$ chess board so that none of those pieces attack any other piece? We answer this question for all rectangular boards. If $n > 1$, the answer is $\lceil \frac{2m}{3} \rceil n$ plus either 0, 1, or 2.

1 Introduction

There are many puzzles that involve placing chess pieces on the squares of a chessboard so that none of those pieces attack any other of those pieces. For example, the classic “Eight Queens Problem” asks for arrangements of eight queens on a standard 8 row, 8 column chessboard so that none of those queens are on the same row, column, or diagonal [BS09]. The “Eight Officers Problem” asks for an arrangement of two rooks, two knights, two bishops, one queen, and one king such that no piece attacks any other piece [Gar01]. More recently, Pisa’s Problem asks for the maximum number of pieces that can be placed on a chessboard so that no piece attacks any other piece and there are at least two different types of piece on the board [Cha24].

The paper [Cha24] proposes a problem that is still open: What is the maximum number of pieces that we can place on the board so no piece attacks another, without Pisa’s mixed-type requirement? As part of an approach to that question, this paper instead answers a simpler variant question by determining the maximum number of mutually non-attacking *non-knight* pieces we can place on an $m \times n$ chessboard, which we call the *knight-free capacity* of the $m \times n$ chessboard. The maximum number of mutually non-attacking pieces of all types, including knights, we can place on an $m \times n$ board is the *full capacity* of the board.

Unlike standard chess, for us pieces attack other pieces regardless of color, and we ignore rules about check, castling, pawn promotion, initial placement, and *en passant* captures. We use ordered pairs to identify the squares of our chessboard; for example, the square in the 2nd row (counting from top to bottom) and 3rd column (counting from left to right) is referred to as square (2,3). We define the chess piece attacks in terms of the coordinate system:

- A *king* in square (i, j) attacks any piece in square $(i - 1, j - 1)$, $(i - 1, j)$, $(i - 1, j + 1)$, $(i, j - 1)$, $(i, j + 1)$, $(i + 1, j - 1)$, $(i + 1, j)$ or $(i + 1, j + 1)$.

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- A *rook* in square (i, j) attacks any piece in row i or column j
- A *bishop* in square (i, j) attacks a piece in square (u, v) if $i + j = u + v$ or $i - j = u - v$ (i.e. it attacks pieces in its “sum diagonal” or “difference diagonal”).
- A *queen* attacks like a bishop or rook (i.e. it attacks pieces in its row, column, or diagonals).
- A *white pawn* at square (i, j) attacks pieces in squares $(i - 1, j - 1)$ and $(i - 1, j + 1)$.
- A *black pawn* at square (i, j) attacks pieces in squares $(i + 1, j - 1)$ and $(i + 1, j + 1)$.
- A *knight* at one corner of a 2×3 or a 3×2 rectangular array of squares attacks a piece in the opposite corner. That is, a knight at (i, j) attacks pieces in squares $(i - 2, j - 1)$, $(i - 2, j + 1)$, $(i - 1, j - 2)$, $(i - 1, j + 2)$, $(i + 1, j - 2)$, $(i + 1, j + 2)$, $(i + 2, j - 1)$ and $(i + 2, j + 2)$.

We use $\lceil a \rceil$ to represent the least integer greater than or equal to a . For example, $\lceil \frac{8}{3} \rceil = 3 = \lceil \frac{9}{3} \rceil$.

In Section 2, we present arrangements of pawns that will produce lower bounds for the knight-free capacities. In Section 3, we show that for $m = 3a + i$, where $a \geq 1$ and $i = 0, 1, 2$, and $n \geq 2$, the knight-free capacity of an $m \times n$ board is $T = \lceil \frac{2m}{3} \rceil n$ when n is even, $T + 1$ when $m = 3$ and n is odd, and $T + (2 - i)$ when n is odd and $m > 3$. In Section 4, for some boards with knight-free capacity c we determine the number of arrangements of c mutually non-attacking non-knight pieces. Finally, in Section 5, we will summarize our results and discuss the many questions left open, such as what happens when knights are included.

2 Patterns

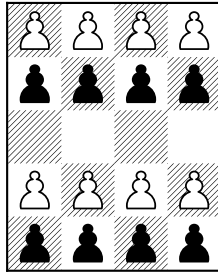
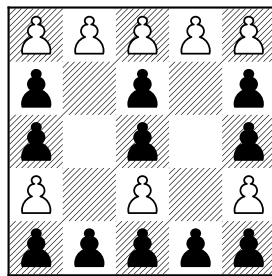
In this section we present some arrangements of mutually non-attacking pieces that we will use in the next section to prove lower bounds on the knight-free capacities of many boards.

1. *The “ m -layer” pattern:* On a $m \times n$ board, place white pawns on every square of each row of the form $3k + 1$, where $k \geq 0$, black pawns on every square of rows of the form $3k + 2$, where $k \geq 0$, and nothing on the remaining rows.

This pattern was noted in 2016 by Dave Barlow according to [Fri22] and is illustrated in Figure 1. On an $m \times n$ board, where $m = 3a + i$ for some $a \geq 0$ and $i = 0, 1$, or 2 , the m -layer pattern occupies $(2a + i)n = \lceil \frac{2m}{3} \rceil n$ squares.

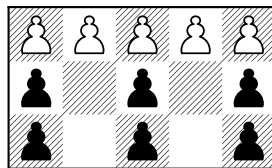
2. *The “ m -row loopy” pattern:* Let $m \geq 4$ and n be odd. On a $m \times n$ board, place white pawns on all squares of row 1 and all odd-numbered columns of row $m - 1$ and black pawns on all squares of row m and all odd-numbered columns of rows $2, 3, \dots, m - 2$.

This pattern is demonstrated in Figure 2. It occupies $2n + (m - 2)\frac{n+1}{2}$ squares.

Figure 1: “5-layer” pattern demonstrated on a 5×4 boardFigure 2: “Loopy” pattern demonstrated on a 5×5 board

3. The “ m -row (top) half-loopy” pattern: Let $m \geq 2$ and n be odd. Take a $2m$ -row loopy pattern and remove the bottom m rows. Alternatively, we could remove the top m rows and obtain an “ m -row bottom half-loopy” pattern.

The top half-loopy pattern is illustrated in Figure 3 and occupies $n + (m - 1)\frac{n+1}{2}$ squares.

Figure 3: “Top half-loopy” pattern demonstrated on a 3×5 board

4. The “(m -row) loopy covered with k roofs” pattern: Given an $(m+3k) \times n$ board, where $m \geq 4$ and n is odd, cover rows $1 - 3k$ with a $3k$ -layer pattern and cover rows $3k + 1$ through $3k + m$ with a loopy pattern.

This pattern is demonstrated in Figure 4, which is [Cha24, Figure 14]. It occupies $2(k+1)n + (m-2)\frac{n+1}{2}$ squares of the given board.

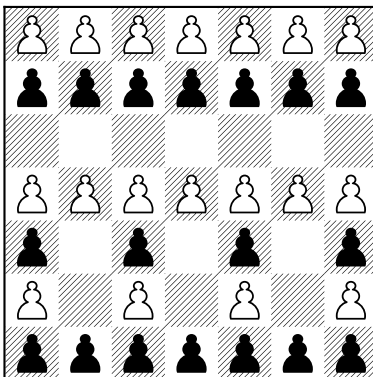


Figure 4: [Cha24, Figure 14] Loopy with one roof pattern on a 7×7 board

3 Knight-free Capacities

Our goal in this section is to determine the knight-free capacity of $m \times n$ boards.

First we note that if we have an arrangement with a maximum number of mutually non-attacking pieces, any queens can be replaced by bishops without reducing the number of mutually non-attacking pieces. Similarly, any bishop or king can be replaced by a pawn. So, to determine the knight-free capacity of a board, it suffices to consider arrangements of rooks, white pawns, and black pawns.

If the board has exactly one column or one row, we can place pawns on all squares. If a board has two rows, then we can fill all the squares with a 2-layer pattern.

We next consider boards with two columns.

Proposition 1. *For $m \geq 3$, the knight-free capacity of an $m \times 2$ board is $2\lceil \frac{2m}{3} \rceil$.*

Proof. The m -layer pattern shows that $2\lceil \frac{2m}{3} \rceil$ is a lower bound.

To show the claimed knight-free capacity is an upper bound, first we consider the 3×2 board. A rook on that board leaves only two unattacked squares for other pieces, so we would have at most 3 pieces. But we can arrange 4 pawns on the board using the 3-layer pattern, so we can assume all the pieces are pawns. If we place five pawns on the board, at least one column is filled, say column 1. Then the pawn at $(2, 1)$ attacks either $(1, 2)$ or $(3, 2)$, leaving one of those squares empty. Square $(2, 2)$ must also be empty, since otherwise a square in column 1 would be attacked. So at least two squares are empty, a contradiction. The 3×2 board has knight-free capacity 4.

Now consider $m = 3a + i$ for $a \geq 1$ and $i = 0, 1, 2$. Divide the board into a blocks of size 3×2 and a block of size $i \times 2$. The 3×2 blocks have knight-free capacity 4 and the other block has a knight-free capacity of $2i$, which gives an upper bound of $4a + 2i = 2\lceil \frac{2m}{3} \rceil$. $\square$

Next we consider boards with three columns.

Proposition 2. *The knight-free capacity of the 3×3 board is 7.*

Proof. We use the half-loopy pattern to show that 7 is a lower bound. To show that 7 is an upper bound, note that columns 1 – 2 have knight-free capacity 4 and column 3 has knight-free capacity 3. $\square$

Proposition 3. *Let $m \geq 4$. The knight-free capacity of an $m \times 3$ board is $2m + 2$.*

Proof. To show that $2m + 2$ is a lower bound, use a loopy pattern.

We show that $2m + 2$ is an upper bound for $m \geq 2$ by induction on m . This is clear for $m = 2$. For $m = 3$, Proposition 2 show that the knight-free capacity is $7 = 2m + 1 < 2m + 2$. We consider two more base cases.

$m = 4$: On the 4×3 board, by Proposition 1, columns 1 and 2 can hold at most 6 mutually non-attacking pieces. Column 3 can hold at most 4 pieces, so the total number of mutually non-attacking pieces on the board is at most $10 = 2(4) + 2$.

$m = 5$: On the 5×3 board, by Proposition 1, columns 1 and 2 hold at most 8 mutually non-attacking pieces. Column 3 holds at most 5 pieces. Suppose the board has 13 pieces on it. Then all squares of column 3 have pieces on them. Squares (2,2), (3,2), and (4,2) cannot have pieces on them since any such piece would attack at least one square of column 3. That leaves 7 squares in columns 1 and 2, so there are at most 12 pieces on the board, a contradiction to the assumption there are 13. So 12 is an upper bound for the knight-free capacity.

$m > 5$: We have proved that $2m + 2$ is an upper bound for $m \leq 5$, so suppose the claim is true for $2 \leq m \leq k$ for some $k \geq 5$ and consider a $(k + 1) \times 3$ board.

If row 1 has two or fewer pieces, then since rows 2 to $k + 1$ have at most $2k + 2$ pieces, the total number of pieces is at most $2 + 2k + 2 = 2(k + 1) + 2$. So, suppose row 1 has three pieces.

If row 2 has one or fewer pieces, then since the bottom $k - 1$ rows have at most $2(k - 1) + 2 = 2k$ pieces, the entire board has at most $2k + 4 = 2(k + 1) + 2$ pieces. So suppose row 2 has at least 2 pieces.

At least one of the pieces on row 2 is not in column 2. That piece must be a black pawn, and it attacks square (3,2), which must therefore be empty. If row 3 has no pieces, then rows 1-3 have at most 6 pieces, and since the bottom $k - 2$ rows have at most $2(k - 2) + 2 = 2k - 2$ pieces, the total number of pieces is at most $6 + 2k - 2 = 2k + 4$. So either (3,1) or (3,3) has a piece. That piece must be a pawn. Therefore, square (2,2) is empty.

If (3,3) is empty, then the rows 1-3 have 6 pieces and the entire board has at most $6 + 2(k - 2) + 2 = 2k + 4$ pieces. So suppose (3,3) is not empty.

Suppose row i is the first row with one or zero pieces, that $4 \leq i \leq k - 1$, and that rows 2 through $i - 1$ have two pieces each. Then the total number of pieces on the board is at most $3 + 2(i - 2) + 1 + 2(k + 1 - i) + 2 = 2k + 4$. So suppose all rows down to row $k - 1$ have at least two pieces.

Next suppose row j is the first row after row 1 and before row $k + 1$ that has a piece in $(j, 2)$. Since the rows above have pieces in columns 1 and 3, the piece in $(j, 2)$ must be a black pawn that attacks two squares of row $j + 1$, which is a contradiction of the supposition that row $j + 1$ had at least two pieces. So rows 2 through $k - 1$ have pieces in columns 1 and 3 but not column 2.

Working from the bottom, arguing as above with “black” and “white” interchanged and reversed indices, we get that row $k + 1$ has 3 pieces and that the rows above each have two pieces, except row 1. Therefore the entire board has $3(2) + 2(k + 1 - 2) = 6 + 2k - 2 = 2k + 4$ pieces. By induction $2m + 2$ is an upper bound for all $m \geq 2$. $\square$

We can now determine the knight-free capacity of all remaining rectangular boards.

Proposition 4. *Let $m \geq 3$ and $n \geq 2$. Let $T = \lceil \frac{2m}{3} \rceil n$. The knight-free capacity of an $m \times n$ board is*

1. T if n is even or $m = 3a + 2$ for $a \geq 1$
2. $T + 1$ if n is odd and either $m = 3$ or $m = 3a + 1$ for $a \geq 1$
3. $T + 2$ if n is odd and $m = 3a$ for $a \geq 2$

Proof. First we show the claimed numbers are lower bounds. For item 1, use an m -layer pattern. For item 2, if $m = 3$ use a half-loopy pattern and if $m = 3a + 1$ use a 4-row loopy pattern with $a - 1$ roofs. For item 3, use a 6-row loopy pattern with $a - 2$ roofs.

We next show the claimed numbers are upper bounds. If $n = 2b$, divide the board into b strips of two columns. By Proposition 1, each strip has knight-free capacity $2\lceil \frac{2m}{3} \rceil$, which gives an upper bound of T for the full board.

If $n = 2b + 1$ and $m = 3$, divide the board into b blocks of size 3×2 and one 3×1 block. The 3×2 blocks have knight-free capacity 4 and the 3×1 block has knight-free capacity 3, giving an upper bound of $4b + 3 = 2n + 1 = T + 1$.

If $n = 2b + 1$ and $m = 3a + i$ with $a > 1$ and $i = 0, 1, 2$, divide the board into one 3-column strip and $b - 1$ strips with 2-columns each. By Proposition 3, the 3-column strip has knight-free capacity $2m + 2 = 3\lceil \frac{2m}{3} \rceil + (2 - i)$, so the board has knight-free capacity at most $T + (2 - i)$. $\square$

4 Counts

Once we know there is a way to put a given number of pieces on the board under a given set of conditions, it is natural to ask how many ways there are. So, given an $m \times n$ board with knight-free capacity c , how many ways are there to place c pieces on the board so that no pieces are attacked?

For small boards these numbers are easy to determine. On the 1×1 board there are 6 choices to fill the board. On other boards with exactly one row or column, in each square we can have a bishop or black or white pawn, so the number of placements is $3^{\max(m,n)}$. On the completely-filled $2 \times n$ board, where $n \geq 2$, we have exactly 1 way to fill the squares, the 2-layer pattern.

Using the MiniZinc optimization software [NSB+07, SFS+14], we obtain the numbers of ways to fill an $m \times n$ board to knight-free capacity for most values of m and n less than or equal to 8 and present those results in Table 1.

We can verify some of the 1s claimed by Table 1.

$m \backslash n$	2	3	4	5	6	7	8
2	1	1	1	1	1	1	1
3	121	32	900	128	12100	512	184900
4	36	16	144	64	1024	256	6400
5	1	65	1	1	1	1	1
6	900	256	14161	4096	546121	65536	18688329
7	81	1056	400	128	3136	512	20736
8	1	4225	1	1	1	1	1

Table 1: Numbers of ways to fill the knight-free capacity of $m \times n$ boards

Proposition 5. *If $m = 3a + 2$ for $a \geq 0$ and n even, then the only pattern with $\lceil \frac{2m}{3} \rceil n$ mutually non-attacking non-knight pieces is the m -layer pattern.*

Proof. For $a = 0$, if all of the $2n$ squares have pieces, the pieces in row 1 must all be white pawns, and the pieces in row 2 must all be black pawns. So the Proposition holds for $a = 0$.

Suppose the Proposition holds for $a = a' - 1$ and consider the $(3a' + 2) \times n$ board. By Proposition 4, rows $1, \dots, 3a' - 1$ have knight-free capacity $\lceil \frac{2(m-3)}{3} \rceil n$ and rows $3a', 3a' + 1$, and $3a' + 2$ have knight-free capacity $2n$. By the inductive hypothesis, row $3a' - 1$ is filled with black pawns, so all squares in row $3a'$ are attacked. So there are $2n$ pieces in rows $3a' + 1$ and $3a' + 2$, and the 2-layer pattern is the only way to place those pieces. Thus the entire board follows the m -layer pattern. By induction the Proposition holds for all values of a . $\square$

We note in passing that by Propositions 4 and 5, the standard 8×8 has knight-free capacity 48, but the only arrangement of 48 mutually non-attacking non-knight pieces on the 8×8 board is the 8-layer pattern.

We also can show some cases where there is more than one arrangement.

Proposition 6. *For $b \geq 1$, there are exactly $2(4^{b+1})$ ways to place $4b + 3$ mutually non-attacking non-knight pieces on a $3 \times (2b + 1)$ board.*

Proof. We show by induction on b that any such placement must be a variation on either a 3-row top half-loopy or a 3-row bottom half-loopy, with pawns on all squares of odd-numbered columns and pawns on all squares of row 1 or on all squares of row 3. In either case, we show that row 1 and row 3 of each odd-numbered column can either be a white pawn or a black pawn, so the total number of arrangements is $2(4^{b+1})$.

Let $b = 1$ and consider the 3×3 board. Suppose we have 7 mutually non-attacking non-knight pieces on the board. Square (2,2) must be empty since otherwise the piece attacks a piece on a corner square. The other empty square is either (1,2) or (3,2), since otherwise (2,1) or (2,3) attacks a piece in column 2. Suppose (3,2) is empty. Then we get a top half-loopy pattern, square (1,2) must have a white pawn, squares (2,1) and (2,3) must have black pawns, and each of the four corner squares has either a white pawn or a black pawn. There are $2^4 = 16$ possible arrangements. If (1,2) and not (3,2) is empty, then by

similar arguments we get a bottom half-loopy pattern where the corner squares can either have a white or a black pawn. Hence the total number of arrangements is $2(2^4) = 32$.

Suppose the Proposition is true for $b = b' - 1$ and consider a $3 \times (2b' + 1)$ board with $4b' + 3$ mutually non-attacking non-knight pieces. By Proposition 4, the knight-free capacity of columns $1 - (2b' - 1)$ is $4(b' - 1) + 3$ and by Proposition 1, the knight-free capacity of columns $2b'$ and $2b' + 1$ is 4. So, by the inductive hypothesis columns $1 - (2b' - 1)$ have a variant of a 3-row half-loopy pattern. Suppose without loss of generality that it is a top half-loopy pattern and square $(1, 2b' - 2)$ is occupied. All squares of column $2b' - 1$ are occupied, so square $(2, 2b')$ is empty. Since $(1, 2b' - 2)$ is occupied, $(2, 2b' - 1)$ is a black pawn and $(3, 2b')$ is empty. The other squares of columns $2b'$ and $2b' + 1$ are occupied. Squares $(1, 2b')$ and $(3, 2b' + 1)$ must have a white pawn, squares $(2, 2b' + 1)$ must have a black pawn, and the corner squares $(1, 2b' + 1)$ and $(3, 2b' + 1)$ can each be either a white pawn or a black pawn. The number of arrangements for the $4 \times (2b' + 1)$ board is 4 times the number of arrangements for the $3 \times (2(b' - 1) + 1)$ board, which is $2(4^{b'+1})$. By induction we are done. $\square$

Proposition 7. *For $b \geq 1$, there are exactly 4^{b+1} ways to place $6b + 4$ mutually non-attacking non-knight pieces on a $4 \times (2b + 1)$ board.*

Proof. By Proposition 4, rows 1-3 have at most $4b + 3$ mutually non-attacking non-knight pieces. Row 4 has at most $2b + 1$ pieces. Since we have a total of $6b + 4$ pieces to place, rows 1-3 have exactly $4b + 3$ pieces and row 4 is full. By the proof of Proposition 6, rows 1-3 either has a top half-loopy pattern or a bottom half-loopy pattern. Rows 1-3 must have a top half-loopy, since otherwise the black pawn in $(3, 2)$ attacks pieces in $(4, 1)$ and $(4, 3)$. Hence the full board has a 4-row loopy pattern. In each odd-numbered column, row 3 must have a white pawn, row 2 must have a black pawn, and rows 1 and 4 can have either a white or black pawn. In the even-numbered columns, row 1 must have a white pawn, row 4 must have a black pawn, and all other squares are empty. Hence there are a total of $2^{2(b+1)} = 4^{b+1}$ possible arrangements. $\square$

Proposition 8. *For $b \geq 1$, there are exactly 16^{b+1} ways to place $8b + 6$ mutually non-attacking non-knight pieces on a $6 \times (2b + 1)$ board.*

Proof. By Proposition 4, rows 1-3 have at most $4b + 3$ mutually non-attacking non-knight pieces and rows 4-6 also have at most $4b + 3$ mutually non-attacking non-knight pieces. So each half-board has $4b + 3$ pieces. By the proof of Proposition 6, each half-board either has a top half-loopy pattern or a bottom half-loopy pattern. Rows 1-3 must have a top half-loopy, since otherwise the black pawn in $(3, 2)$ attacks pieces in $(4, 1)$ and $(4, 3)$. and rows 4-6 must have a bottom half-loopy, since otherwise the white pawn in $(4, 2)$ attacks pieces in $(3, 1)$ and $(3, 3)$. Hence the whole board has a 6-row loopy pattern. Each square in rows 1, 3, 4, and 6 of each odd-numbered column has either a white pawn or a black pawn, row 1 in each even-numbered column has a white pawn, row 6 in each even-numbered column has a black pawn, and the other squares are empty. The total number of possible patterns is $2^{4(b+1)} = 16^{b+1}$. $\square$

Proposition 9. *For $b \geq 1$, there are at least $2(4^{b+1})$ ways to place $8b + 4$ mutually non-attacking non-knight pieces on a $7 \times (2b + 1)$ board.*

Proof. We can either put (1) a 4-row loopy pattern variant on rows 1 – 4 and a 2-layer pattern on rows 6 – 7 (leaving row 5 empty) or (2) a 3-layer pattern on rows 1 – 3 and a 4-row loopy pattern variant on rows 4 – 7. By Proposition 7, there are 4^{b+1} variants of the 4-row loopy pattern. So there are at least $2(4^{b+1})$ possible arrangements. $\square$

5 Conclusions and Open Problems

In this paper we defined the knight-free capacity of a board to be the maximum number of mutually non-attacking non-knight pieces we can put on the squares of the board. We determined the knight-free capacity of all $m \times n$ boards, which for $n > 1$ is always between T and $T + 2$, where $T = \lceil \frac{2m}{3} \rceil n$. We also counted the number of possible arrangements for boards of at most eight rows and columns, and showed that there is a unique maximal arrangement for boards with $3a + 2$ rows and an even number of columns. We also showed that for boards with $2b + 1$ of columns and 3, 4, and 6 rows, there are, respectively, $2(4^{b+1})$, 4^{b+1} , and 16^{b+1} arrangements of the maximal number of mutually non-attacking non-knight pieces.

Our results provoke many open questions, some of which we list here.

1. The full capacity of a board can be greater than its knight-free capacity. For example, on the 3×3 board, the half-loopy pattern leaves room for a knight in square $(2, 2)$, making the full capacity at least 8. The 3×3 board cannot be filled with pieces, since otherwise the piece in $(2, 1)$ attacks at least one other piece. Hence the full capacity of the 3×3 board is 8.

A greater difference occurs on boards with 2 columns. A 2×3 board can be filled with pieces: white pawns on row 1, knights on row 2, and black pawns on row 3. For a 2-column board with $m = 4a + i$ rows, each block of four rows can have at most 6 pieces (with 7 pieces, one column is filled and the second and third squares of the other column must be empty since any piece in those squares would attack a piece of the filled column), so the full capacity is at most $6a + 2i = \lceil \frac{3m}{4} \rceil 2$. This number of pieces is attained by the “knighted m -layer” pattern with (for each possible value of j) white pawns on row $4j$, knights on rows $4j + 1$, black pawns on rows $4j + 2$, and empty squares on rows $4j + 3$. Figure 5 illustrates this pattern.

Experimentation with MiniZinc [NSB+07, SFS+14] suggests that for boards with more than two columns, the difference is at most 1. How much difference is there between the knight-free capacity and the full capacity?

2. As mentioned in Section 4, given that the knight-free capacity of an $m \times n$ board is c , how many ways are there to place c pieces on the board so that no piece attacks another? Also, how many of those arrangements include pieces other than pawns?
3. What is the maximum number of mutually non-attacking (non-knight) pieces if the pawns are all the same color?

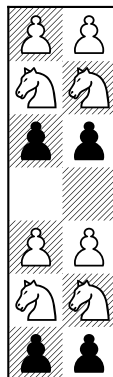


Figure 5: “Knighted 7-layer” pattern demonstrated on a 7×2 board

References

- [BS09] J. Bell, B. Stevens, A survey of known results and research areas for n -queens, *Discrete Math.* **309**(1) (2009), 1–31.
- [Cha24] D. Chatham, Arrangements of mutually non-attacking chess pieces of mixed type, *Recreational Mathematics Magazine* **11**(18) (2024), 1–16.
- [Fri22] E. Friedman, Problem of the Month (February 2001), *Math Magic*, available at <https://erich-friedman.github.io/mathmagic/0201.html>, accessed January 2022.
- [Gar01] M. Gardner, Some new results on nonattacking chess tasks, *Math Horizons* **8**(3) (2001), 10–12, available at <http://www.jstor.org/stable/25678300>.
- [NSB+07] N. Nethercote, P. J. Stuckey, R. Becket, S. Brand, G. J. Duck, and G. Tack, MiniZinc: Towards a standard CP modelling language, in: C. Bessiere (ed.), *Proceedings of the 13th International Conference on Principles and Practice of Constraint Programming*, LNCS **4741**, Springer, 2007, 529–543.
- [SFS+14] P. J. Stuckey, T. Feydy, A. Schutt, G. Tack, and J. Fischer, The MiniZinc challenge 2008–2013, *AI Magazine* **35**(2) (2014), 55–60.