

# Polyssimo Challenge

## Strategy guide v0.5

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*Tactics is knowing what to do when there is something to do, strategy is knowing what to do when there is nothing to do!*

- Xavier Tartakover

### Summary:

1. Introduction .....	1
2. Game rules .....	1
3. Size of the pieces .....	2
4. Imprints .....	2
5. Reserved areas .....	4
6. Confrontation areas .....	6
7. Start of placement phase .....	8
8. Choice of the pieces .....	8
9. Handicap games .....	9
10. Team games .....	9
11. Puzzles .....	9
12. Short history of polyominoes .....	10
13. Solutions .....	10

## 1. Introduction

This document presents strategic considerations and other informations about the game Polyssimo Challenge. As is often the case in tactical games <sup>1</sup> it is difficult to emit absolute strategic principles: for example, it is advised to put the king in safety in chess, but at the end of the game the king often becomes a strong piece which must take an active part in the endgame.

Therefore, these strategic considerations are mere thoughts and not intangible truths, you should not hesitate to try your own ideas.

To illustrate some ideas, tactical exercises are proposed. They are identified by a framed number and their solutions can be found at the end of document. If the exercise comes from a game, the remaining pieces of both players will be given above and below the position. Usually the player whose pieces are below is the one to play.

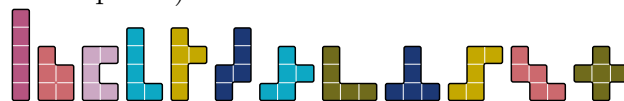
In the document you will find a few keywords in bold, followed by their definitions. These keywords will then be used in the rest of the document.

Finally Polyssimo Challenge is played in two phases: first piece choice and then piece placement. It is necessary to know the possibilities of placement in the second phase to guide the selection of the pieces in the first phase. This is why the emphasis is put on the placement of the pieces at the beginning of the document.

## 2. Game rules

Polyssimo Challenge is a tactical game for 2 to 4 players. It consists of a board with  $12 \times 11$  squares and 24 reversible pieces:

- 12 colored "pentominoes" (made with 5 adjacent squares):



- 12 black and white "hexominoes" (made with 6 adjacent squares):



At first, the players choose their pieces in turn and put them in their reserve.

When all the pieces have been taken, the players, beginning with the last one who took a piece and by reversing the order of play (which compensates the disadvantage of having chosen last) strive to place their own pieces on the board.

If a player can not place a piece, he passes his turn. When no one can place a piece anymore, each player counts the number of squares of his unplaced pieces, the winner is the one with the fewest squares. In case of equality, the player who has placed the last piece wins.

**Note:** Although it can be played with three or four players, it is mainly with two players that Polyssimo Challenge reveals all its richness, like most tactical games. In addition, with three players or more a "King Maker" effect might appear, which means that a player who can no longer hope for victory could decide to give advantage to one of his opponents during his turn. This is why the proposed exercises come from two-player games.

<sup>1</sup>or combinatorial games with perfect information

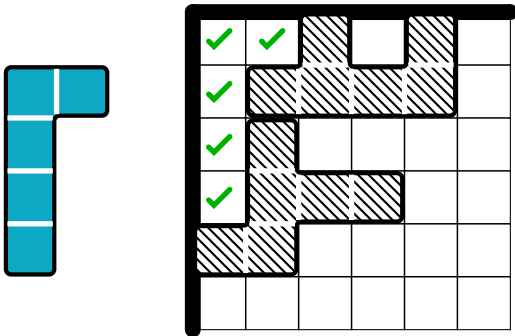
### 3. Size of the pieces

The winner being the one with the fewest squares left over, it is better to have pieces as small as possible. Which is why, in the choice phase, it will be preferable to take pentominoes first, since they are only made with 5 squares, before taking hexominoes made of 6 squares.

### 4. Imprints

To be able to place more pieces than the opponent, it is wise to create "imprints" for the pentominoes we possess, that is to say, a space of 5 squares which has the exact shape of one of our own pentominoes.

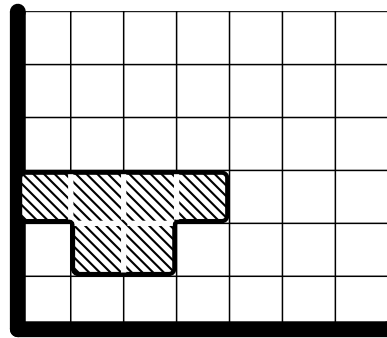
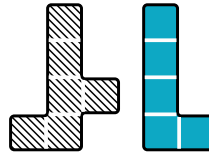
In the example below, the player who owns the blue piece created an imprint of 5 squares (marked with green ticks), where only his piece could be placed.



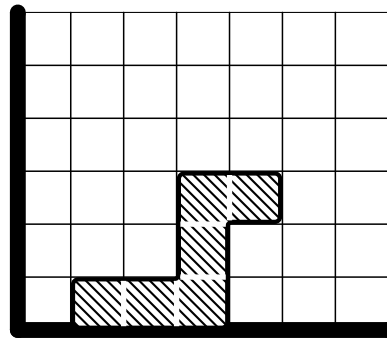
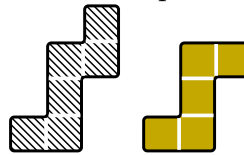
#### Notes:

- When an imprint (or a reserved area, see page 4) has been created for one of your pieces, it can be slightly separated from your pieces stock, in order to think to place it at the end. Of course, this might help the opponent(s), but if all the players do the same, they can concentrate on more interesting strategies on the game. In the exercises, the available pieces for which an imprint or a reserved area has already been created are separated from the other pieces by the symbole +.
- Even if an imprint (or a reserved area, see page 4) has been created for a piece, it's not mandatory to play it there. Sometimes it will be better to use it in a confrontation area (see page 6).

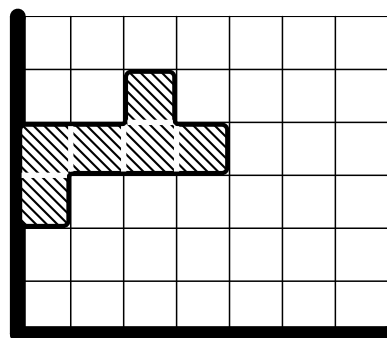
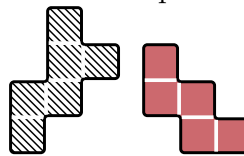
1 Use the black and white hexomino to create an imprint for the colored pentomino:



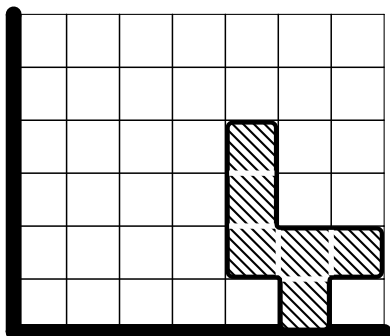
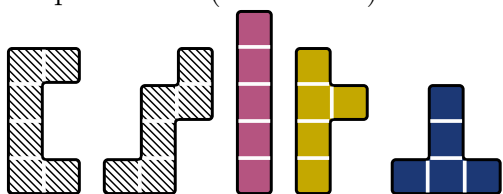
2 Use the hexomino to create an imprint for the colored pentomino:



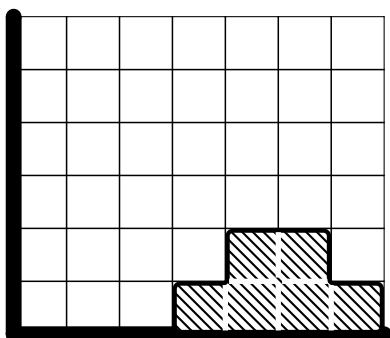
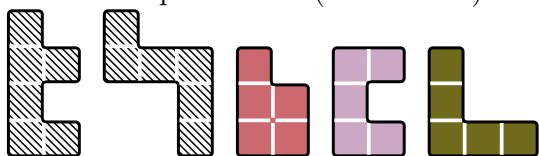
3 Use the hexomino to create an imprint for the colored pentomino:



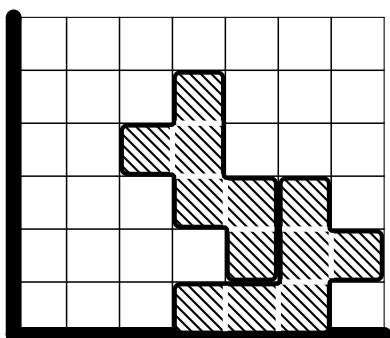
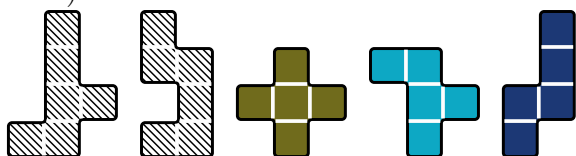
4 Use one hexomino to create an imprint for one colored pentomino (3 solutions):



5 Use one hexomino to create an imprint for one colored pentomino (3 solutions):

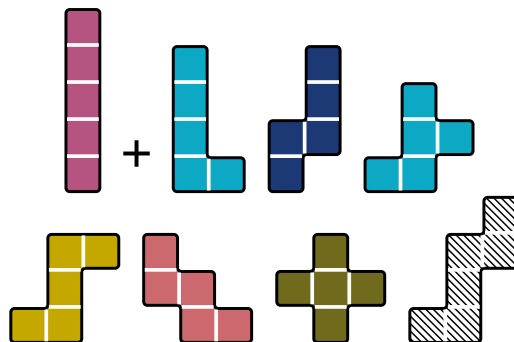


6 Use one piece (pentomino or hexomino) to create an imprint for one colored pentomino (6 solutions):

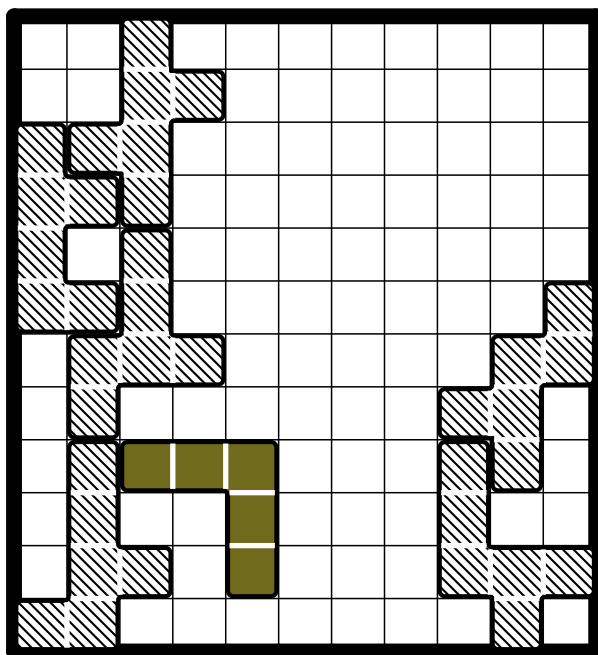


7 Making an imprint is good, making two imprints is better! Frédéric was the first one to create a double imprint in the position below.

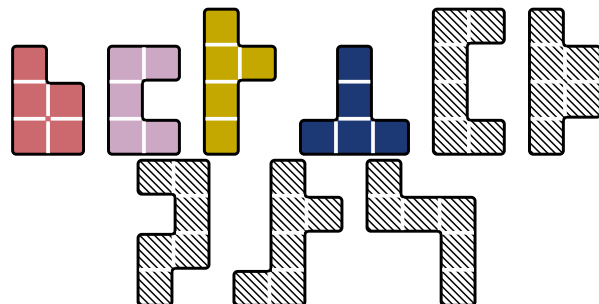
Using Frédéric's pieces, placed under the board, will you be able to find the clever move creating simultaneously two imprints: two spaces of 5 squares each and having the exact shape of two of his other pieces?



Alain

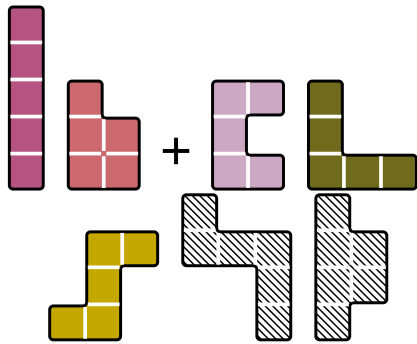


Frédéric to play

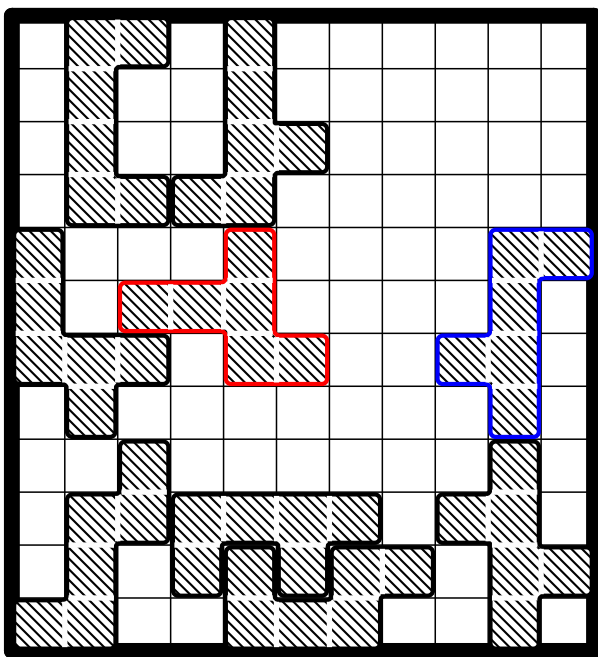


Unfortunately, despite this beautiful move, Frédéric did not win this game. Maybe because he had too many hexominoes left?

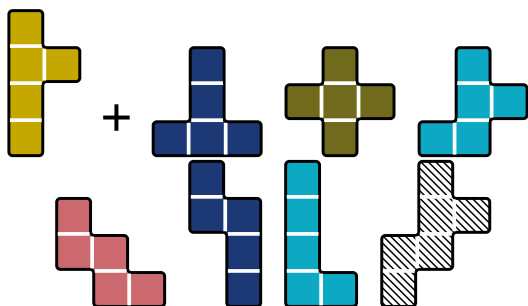
8 In the following position, Alain has two imprints against one for Roman, but it is Roman's turn to play. Use the pieces below the board to create two imprints at the same time.



Alain



Roman to play

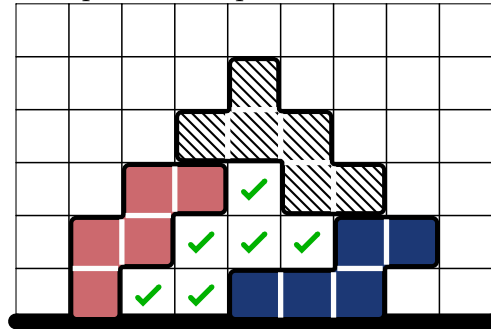


During this game, which Roman won, he prepared this double imprint in the previous move: he played the piece with the red borderline because he knew that I would play the piece with the blue borderline to finish my imprint. A superb move, psychological and deep!

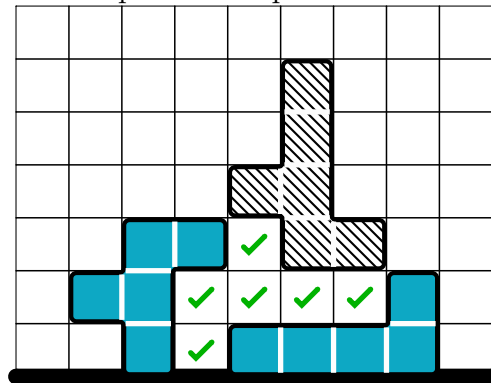
## 5. Reserved areas

It is not always possible to create a perfect imprint for one of our own pentominoes. We can then try to create a "reserved area", that is to say a space of more than 5 squares in which you can put one or more of your own pieces, but in such a way that this space cannot be accessed by your opponent(s).

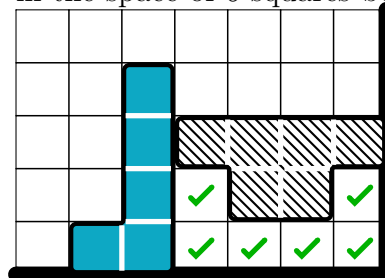
9 Find the only piece still available that can fit in the space of 6 squares below:



10 Find the only piece still available that can fit in the space of 6 squares below:



11 Find the only piece still available that can fit in the space of 6 squares below:



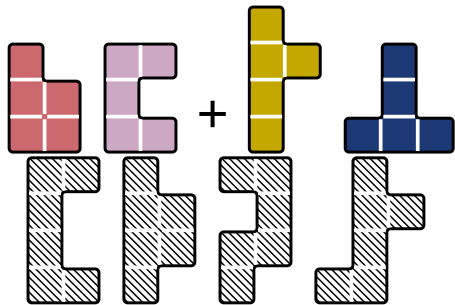
12 With only two pieces, create a closed area of 6 squares that can contain only one other piece of the game (numerous solutions).

13 Draw all the 35 possible hexominoes<sup>2</sup>. Then for each one indicate the number of game pieces that could be placed in a space having this shape. Deduce from this a "ranking" of pentominoes.

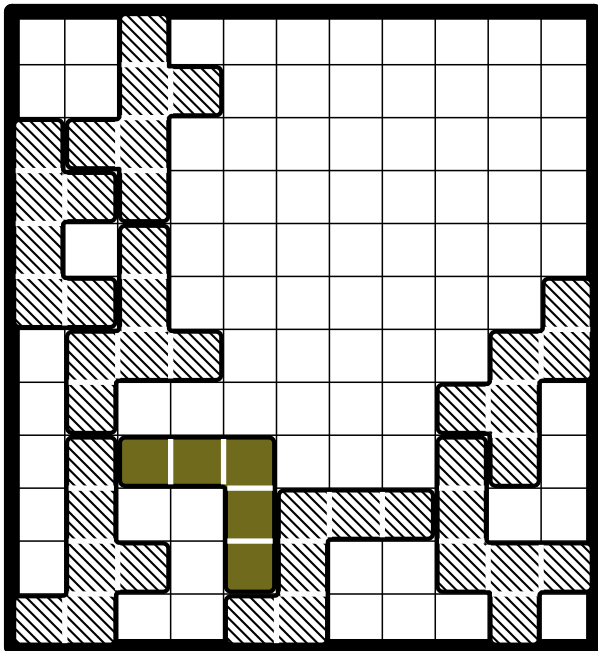
<sup>2</sup>

14 In the position below, Frédéric has just created two imprints in one move, so he has one imprint more than his opponent. But the later can create a reserved area.

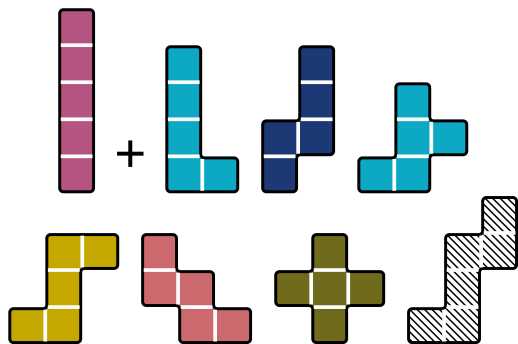
Use the pieces located below the board to create a reserved area in which some of Alain's pieces could be placed, but none of Frédéric's.



Frédéric

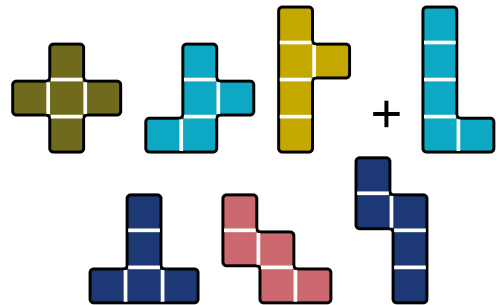


Alain to play

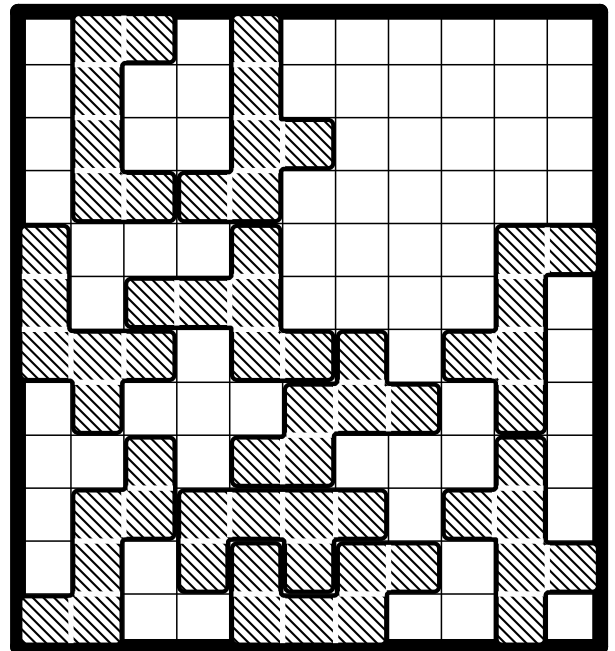


15 In the position below, Roman has just created two imprints in one move, so he has one imprint more than his opponent. But the later can create a reserved area.

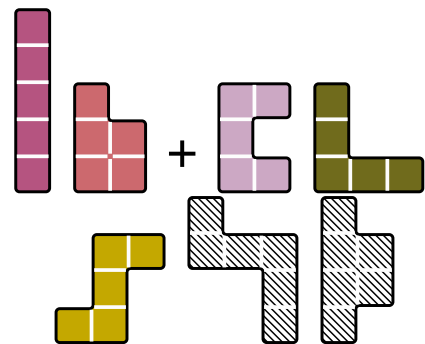
Use the pieces located below the board to create a reserved area in which some of Alain's pieces could be placed, but none of Roman's.



Roman

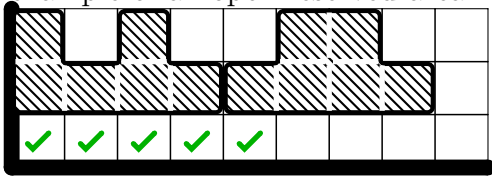


Alain to play

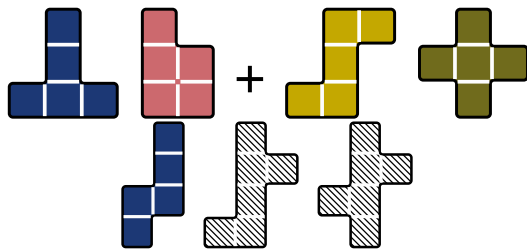


A reserved area is not necessarily closed: it can be an **open** area where we can place one or more of our pieces and which the opponent can by no means disrupt.

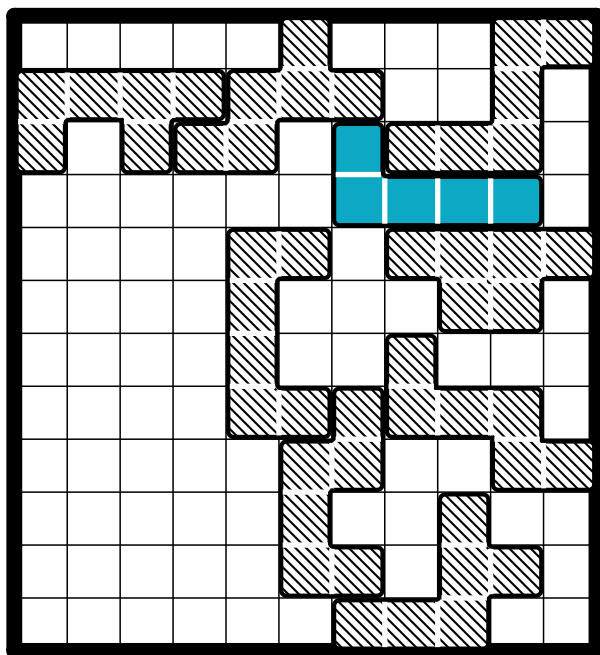
An example of an open reserved area:



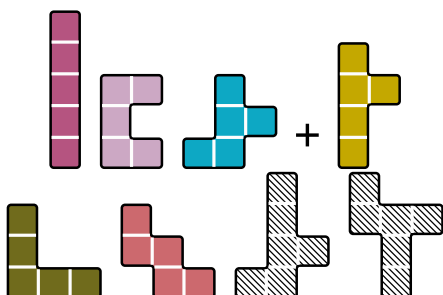
16 In the following position, what is Alain's best move?



Emmanuel



Alain to play



It should be noted that this move was not played in the game and that Emmanuel was the first player to win a game against the game's author.

## 6. Confrontation areas

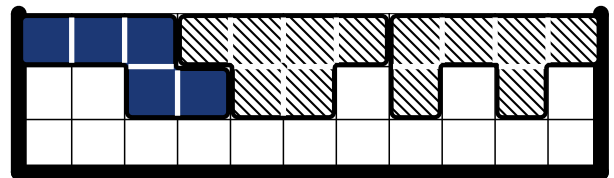
Near the end of the game, we can see different **areas** appearing on the board:

- **Useless areas**, because, either they have only 4 squares or less, or they can not contain an available piece anymore.
- **Imprints** and/or **reserved areas** that are no longer subject to challenge.
- And **confrontation areas** of 6 squares or more, in which pieces of several players may be placed.

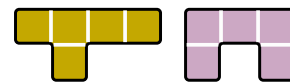
17 The fictitious position below contains a large confrontation area. The player who has the move wins! How? (One answer per player)



Player A



Player B

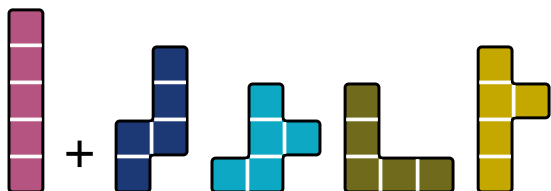


It seems advantageous to play first in a confrontation area, but it must be done at the right time: before the end of the game there may be better moves to play?

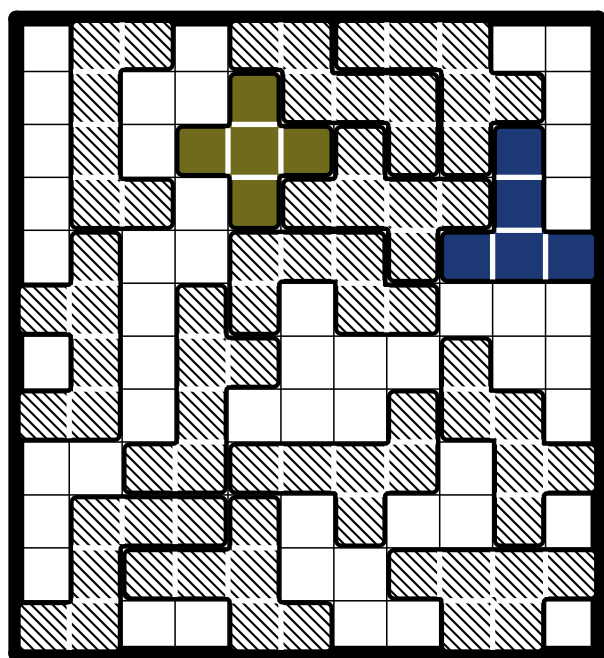
Things get complicated when there are several confrontation areas, as in the following examples. It is then necessary to anticipate all the possible reactions of the opponent to know in which area to play first. Two lines of thoughts: It would seem that the player who can place the most different pieces in confrontation areas has an advantage. Finally, it can be imagined that experienced players would voluntarily create the "right" number of confrontation areas.

To study the following problem, Roman advises us to number the areas and to determine which pieces can go into them. As we are not in a game, we can do it with a paper and a pencil rather than mentally, what a relief!

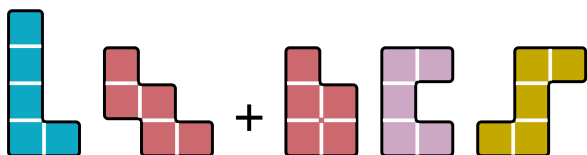
[18] Pierre can still place 4 pieces, while Alain can not place any more than 3. But it is Alain's turn, what should he play to win? (2 solutions)



Pierre

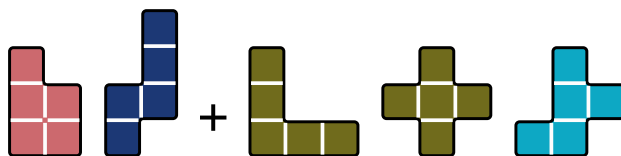


Alain to play

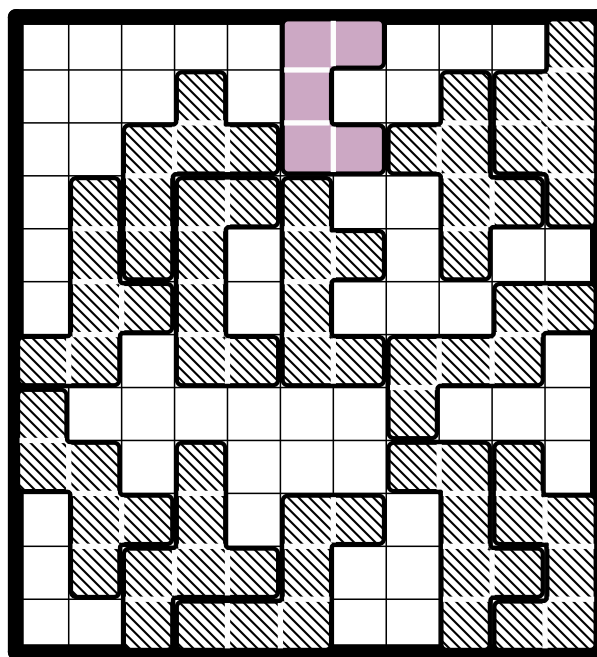


[19] Eveline and Alain have two imprints each, but there are still two confrontation areas.

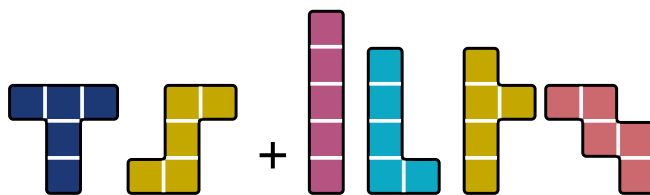
Find Eveline's winning move (when two players have the same number of remaining squares at the end of the game, the last one to have placed a piece wins):



Alain

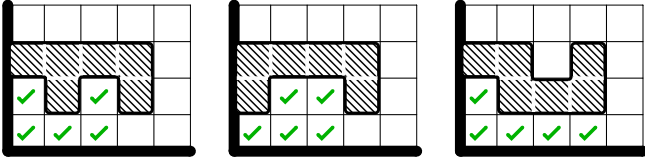


Eveline to play



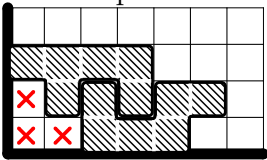
## 7. Start of placement phase

In most games, the first move of the placement phase attempts to **start an imprint with the help of the board's edges**. To do this one must study the interactions between the different pieces. For example:

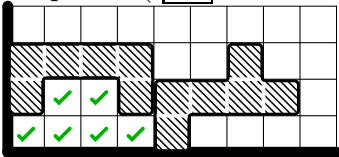


Fortunately, it is impossible to create a completely closed imprint on the first move with the pieces of the game ( [20] more specifically there is only one hexomino, not included in the game, which allows to create an imprint for a pentomino by using a corner, can you find which one? ).

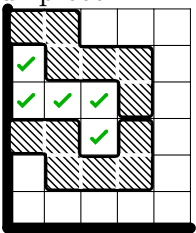
Thus the opponent has every opportunity to prevent the creation of the imprint by reducing the space to 4 squares or less:



Or by creating a confrontation area that can hold several pieces ( [21] which ones?).



Or worse, by creating his own imprint with the help of our piece:



Some players answer by playing on another part of the board, which may sometimes be better, but you really have to try to play a move that is both useful for you and annoying for your opponent, which is why it is more common to see the pieces played close to each other.

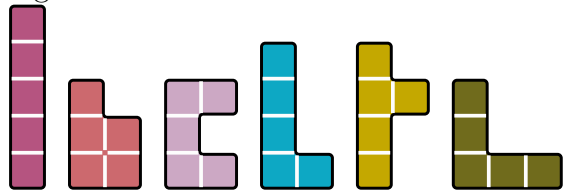
Finally, playing the very first move at the center of the board seems too passive to me, it is almost impossible to build an imprint quickly without using the edges of the board.

## 8. Choice of the pieces

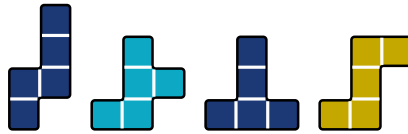
It is difficult to classify the pieces, because their "strength" depends on a large number of parameters and especially on the game in progress. Some possible parameters are: the size, the number of possible positions of the piece (for example the cross has only a single position), the size of the enclosing rectangle, the answer to the exercise [13]...

However, here is an attempt to classify the pieces, empirical and subject to caution.

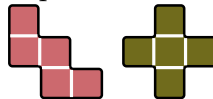
First some pentominoes which combine well with the edges or the corners of the board:



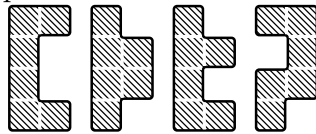
Then some irregular, but sometimes useful pentominoes (in particular the light blue piece, which is quite easy to place due to its quirky shape):



The last two pentominoes are harder to use judiciously, but we have already seen imprints for them in the previous exercises:



The following four hexominoes have an enclosing rectangle of  $4 \times 2$  squares, they are therefore less "wide" than the others and they marry well with the pentominoes of the first group:



The two following hexominoes assemble well with the long pieces, do not let your opponent have them both:

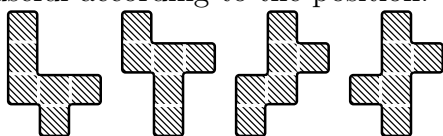


These two hexominoes will combine well enough with the pentominoes:





To finish, these are hexominoes which, again, can be useful according to the position:



## 9. Handicap games

A feature of Polyssimo Challenge I am proud of, is the ability to play games with a variable handicap, such as in the game of Go: before the game, we can decide that the most experienced player will take fewer pentominoes and more hexominoes (bigger and therefore more difficult to place) than his opponent.

For example, when I present the game, I propose to take 2 pentominoes and 10 hexominoes, my opponent then having 10 pentominoes and 2 hexominoes. I sometimes win. More often I lose after a hard battle and I'm the one who therefore need a boost. I then suggest to reduce my handicap for the next game, and to have 3 pentominoes and 9 hexominoes. And so on until having 6 pentominoes each.

In three player games it is still possible to give an advantage to one or more players, with the distributions of pentominoes  $2+5+5$  ;  $3+3+6$  ;  $3+4+5$  or  $2+4+6$ .

In four player games the number of pieces per player is very limited and allows few possibilities, we can however try the distributions of pentominoes  $2+3+3+4$  or  $2+2+4+4$ .

It is a pleasure to see the players progress, eventually losing against them in a game without handicap, which promises future captivating games.

Some people quickly appropriate the game and have no need of this advantage, even for their first game. Other people do not like the idea of a handicap game (nor of an advantage game ;-p ), they will thus play without this possibility.

## 10. Team games

In a four player game, each player has only 6 pieces, which is a small amount to create imprints. Therefore we can try to play in two teams of two players.

The players of the same team sit diagonally, the game is played according to the rules, but at the

end of the game we count the total number of squares of each team to know which one wins the game. It is therefore necessary to help the partner to create imprints and reserved areas.

Before the game, you must agree on the amount of communication allowed during the game: If talking about the game is allowed the risk is to see one of the players dictating the moves to his partner, but then unveiling the strategy to the opponents' team. One can also forbid to speak about the game, but to allow a player to show one or more pieces of his stock to his partner.

## 11. Puzzles

Below are a few problems that are not really connected to the game, but which have a theoretical interest. In particular, the question of how to fill the board is often asked when the game is presented, and brings Polyssimo Challenge a little closer to his elder brother Polyssimo.

**[22]** Try to find a perfect tiling of the  $11 \times 12$  board using all Polyssimo Challenge pieces (this is the same as searching a boring game of 24 moves).

**[23]** Same as above but try to create a foreplanned pattern, such as having all pentominoes in one group and all hexominoes in one group (the more regular the better), or to have all pentominoes (hexominoes) separated evenly in N groups...

**[24]** Try to place the minimum number of Polyssimo Challenge pieces on the board, so that no remaining piece can be added (it is equivalent to looking for the shortest possible game). If two positions have the same number of pieces, we will favor the one that uses the most squares.

**[25]** Same as above but if two positions have the same number of pieces, we will favor the one that uses fewer squares.

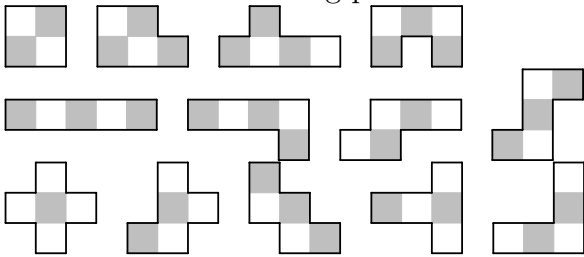
**[26]** What is the minimum number of pentominoes needed to surround the 12 hexominoes used in Polyssimo Challenge? (Question asked by Tick Wang)

## 12. Short history of polyominoes

**Polyominoes** are pieces made of squares adjacent by their sides. The monomino, the domino, the 2 trominoes, the 5 tetrominoes, the 12 pentominoes, etc... are special cases of polyominoes.

It is not easy to know when the idea of polyominoes appeared. One of the first (the first?) known problems of tiling a surface by polyominoes is "The broken chessboard"<sup>3</sup> by the English puzzle author Henry Dudeney:

[27] Reconstitute a correctly colored  $8 \times 8$  chessboard with the following pieces:

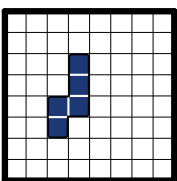


Polyominoes tiling problems were studied by the American Mathematician Solomon Golomb in the 1950s, then popularized by Martin Gardner in the Scientific American journal, and are still the subject of studies in today's Mathematics<sup>4</sup>.

During the same period, Solomon Golomb introduced the game "Pentominoes", a two player game using an  $8 \times 8$  board and the 12 pentominoes. The latter are placed next to the board, and in turn the players choose a piece and place it on the board. The first player who can no longer place a piece is the loser.

The game is interesting but too complex at the beginning because of the huge number of possibilities that are difficult to guide by short-term tactical considerations. Polyssimo Challenge is my attempt to improve on that game.

In 1996, Hilarie Orman demonstrated with a computer program<sup>5</sup> that the first player has a winning strategy in "Pentominoes" if he plays his first move as indicated in the figure:

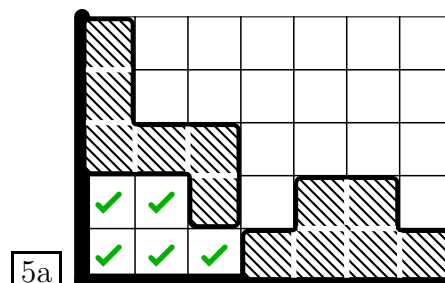
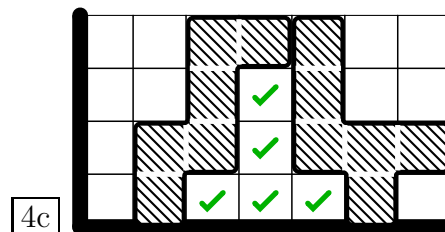
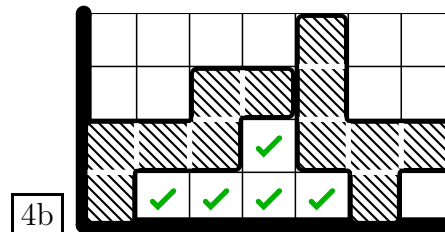
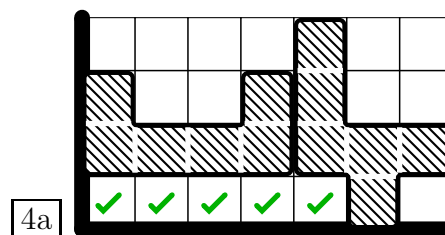
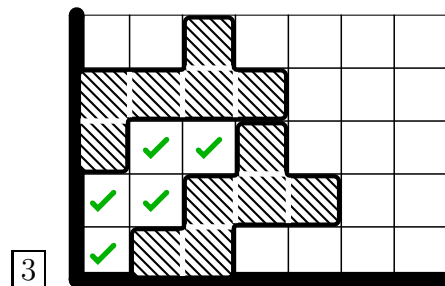
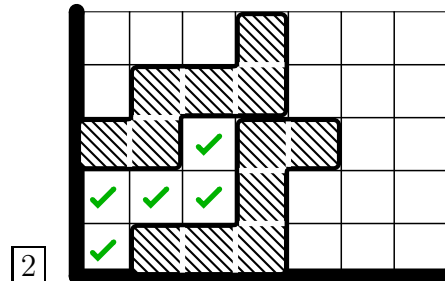
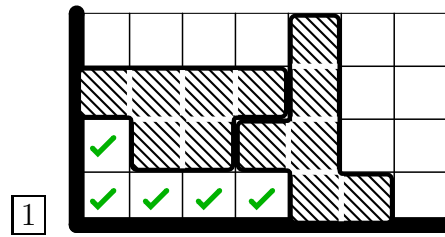


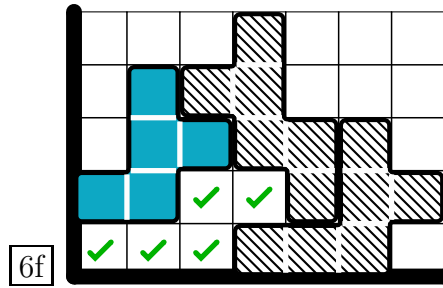
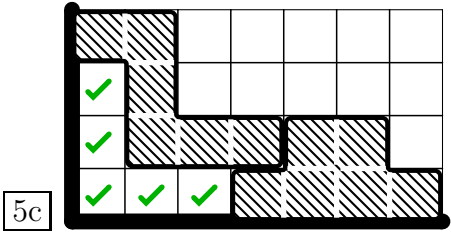
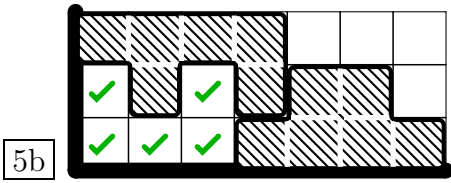
<sup>3</sup> "The Canterbury Puzzles", 1907

<sup>4</sup> "Jeux Mathématiques et mathématiques des jeux" de Jean Paul Delahaye, éditions Belin

<sup>5</sup> <http://library.msri.org/Book29/files/orman.pdf>

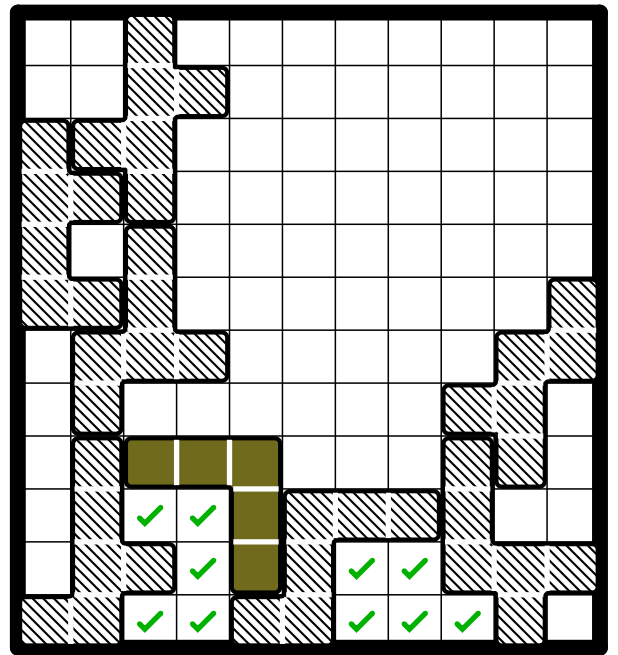
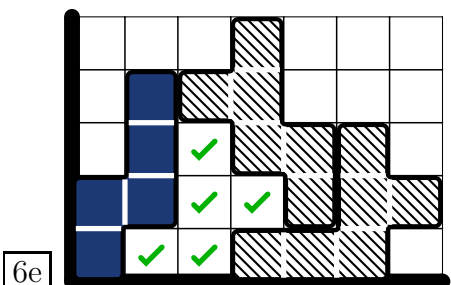
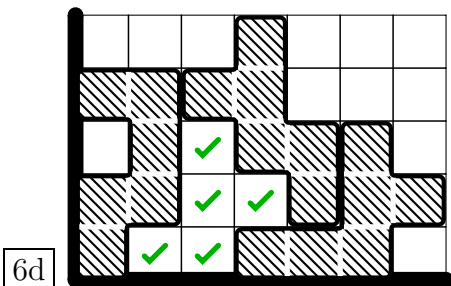
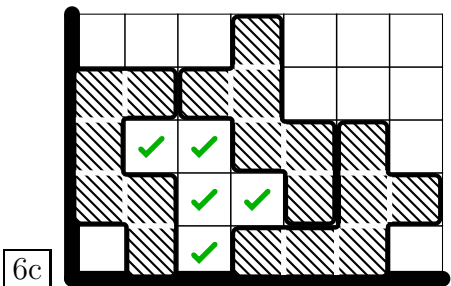
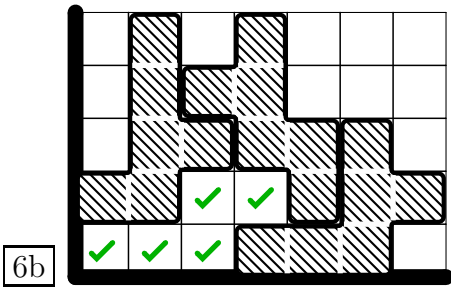
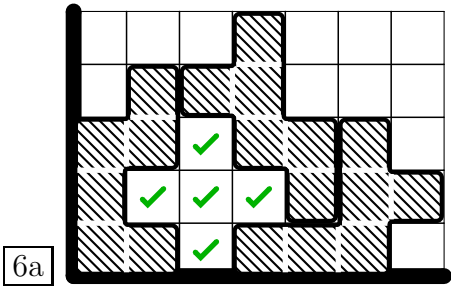
## 13. Solutions



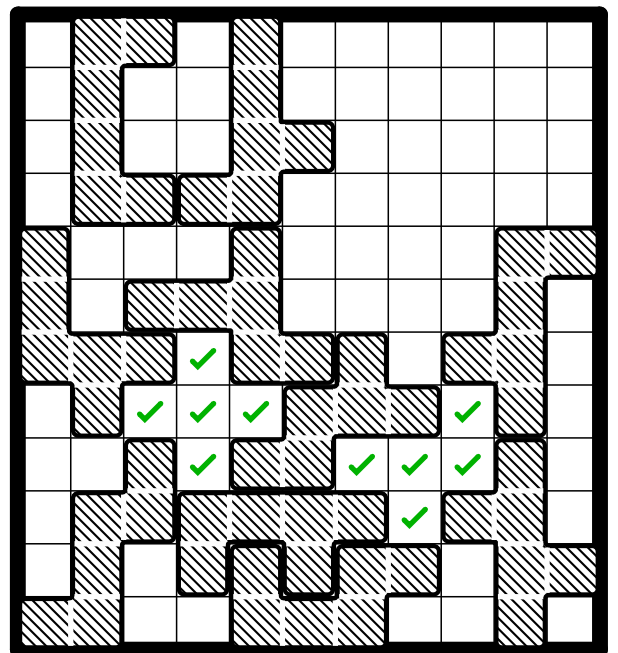


The last two solutions are not very interesting since the same result can be achieved by placing bigger pieces.

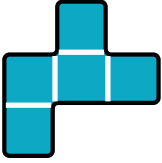
7 Two imprints at the same time!



8 Two imprints at the same time!



9 The only remaining piece that fits is:



10 The only remaining piece that fits is:

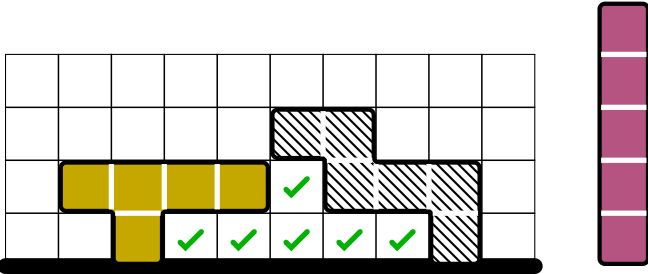


11 The only remaining piece that fits is:

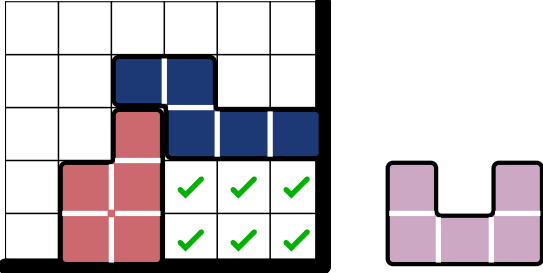


This position shows an example of reserved area for an hexomino, since the L shaped blue pentomino has already been played.

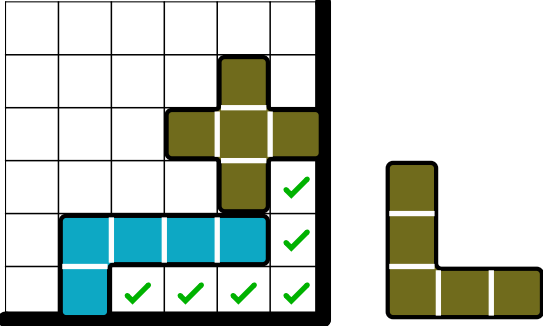
12 As an example, in the position below only the pentomino located on the right can be placed:



Or in the following position, only the pentomino on the right can be placed:

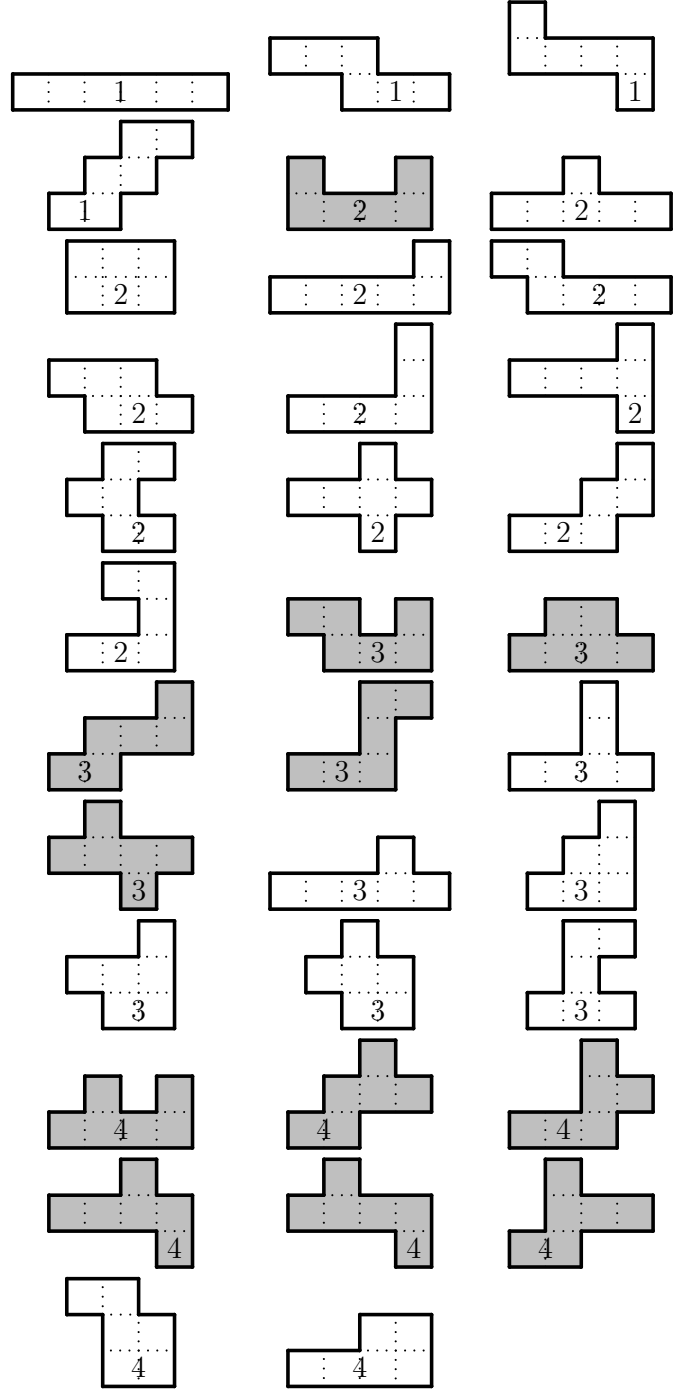


Or in the following position, only the pentomino on the right can be placed:

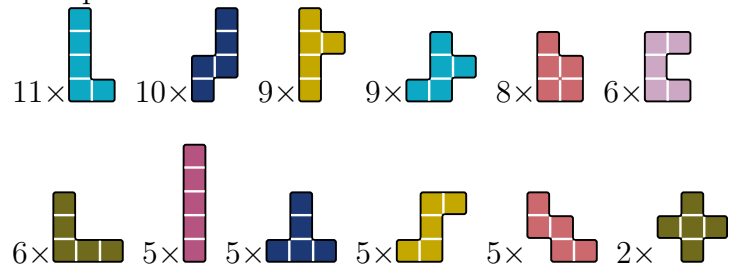


Numerous other examples are possible.

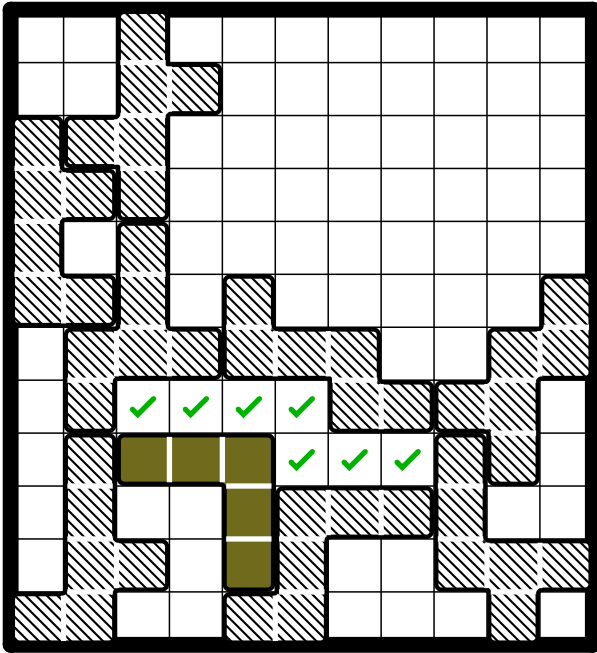
13 The number of pieces from the game that can be placed inside the given 6 square shape is indicated in it. If the shape is one of the hexominoes found in the game, it's colored in grey.

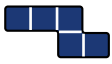


We deduce from this the number of times each pentomino can fit inside one of those areas:

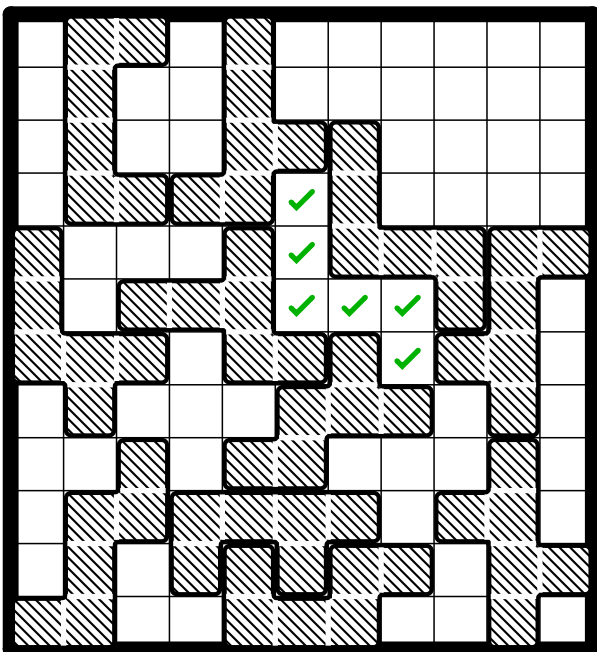
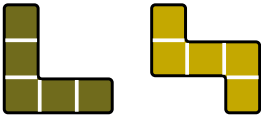



14 The only two pentominoes that can fit inside the reserved area marked with green check marks are:



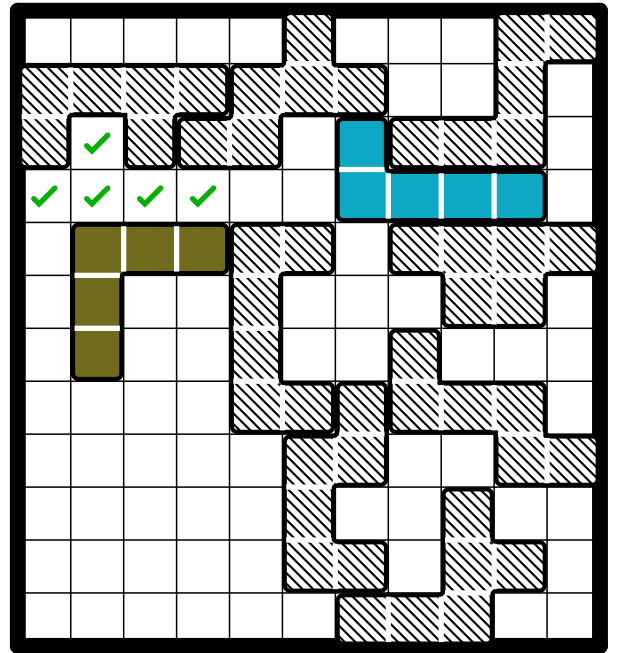
It's also possible to use  to create this reserved area, but it's less interesting.


15 The only two pentominoes that can fit inside the reserved area marked with green check marks are:



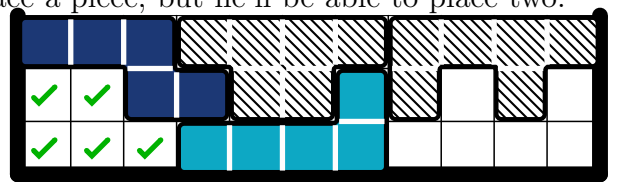
It's also possible to use  to create this reserved area, but it's less interesting.

16 If the green piece is placed as indicated in the position, only the yellow piece can go in the squares indicated with green check marks, and the opponent has no way to prevent it:

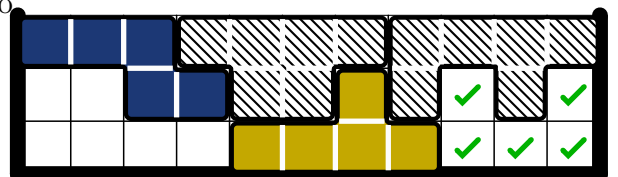


Using  leads to the same result, but it's less interesting since this piece already has an imprint.

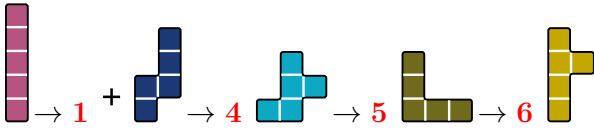
17 If player A is to move, he creates an imprint for his other piece in the confrontation area, as seen below. He won't prevent the opponent to place a piece, but he'll be able to place two.



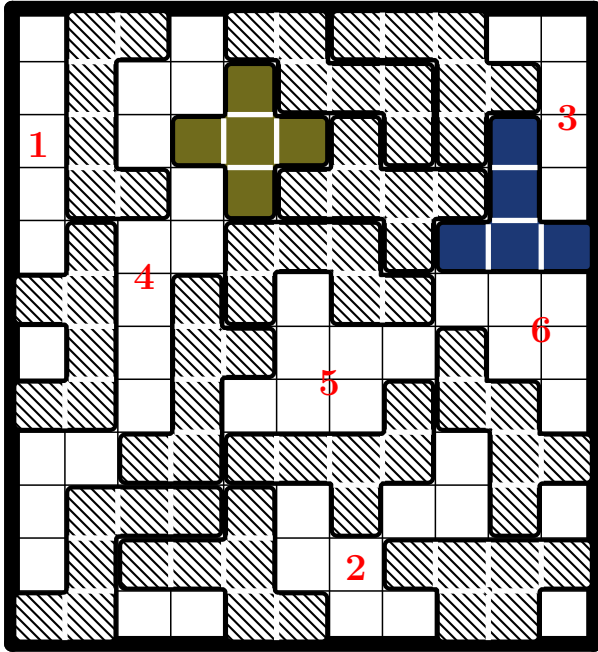
Similarly, if player B is to move, he creates an imprint for his other piece in the confrontation area, as seen below. He won't prevent the opponent to place a piece, but he'll be able to place two.



[18] Let us start by analysing the situation: there are 6 important areas, the areas 1 to 3 are imprints and the areas 4 to 6 are contested by both players. We then mark for each piece the areas in which they can go:



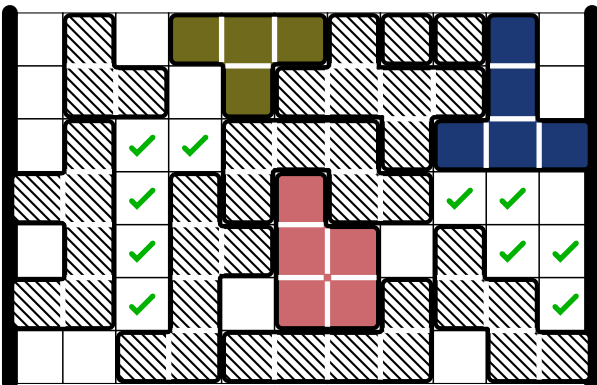
Pierre



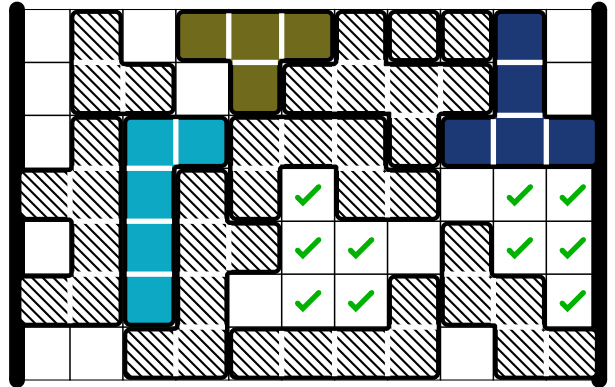
Alain to play



To win, Alain must place his 3 possible pieces and he must prevent Pierre from placing two. It is therefore absolutely necessary to place the "b" shaped piece which has no imprint. The most obvious is to place it in area 5, then, according to Pierre's answer, to play next in the last confrontation area, as shown with the green check marks.

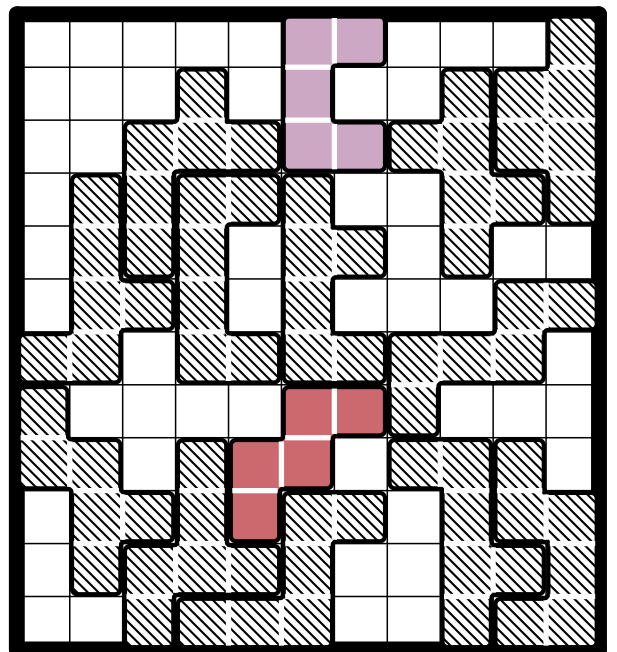


The second, less natural, method is to place the "L" shaped piece inside area 4, and next turn to play the "b" shaped piece in zone 5 or 6 depending on Pierre's response, as shown below.



[19] Eveline and Alain each have two reserved areas (or imprints) for two of their pieces. The only possibility to win for Eveline is to place two more pieces and to prevent Alain from placing more than one.

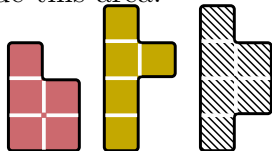
There are two confrontation areas, in the upper left corner and in the center. The first decision Eveline must make is in which area to play: by looking at Alain's pieces we see that he can not place two of his pieces in the upper left area, but that he could place two of his pieces in the central area (the green L and the cross) if allowed. Eveline must therefore prevent him from placing his two pieces and therefore Eveline must play in the center area. In addition, she must play in this area so that she can play a second piece in this center area. Here's this nice move, played during the game:



20 Don't waste time searching this piece in the game, it would have been too strong with the "b" shaped pentomino:

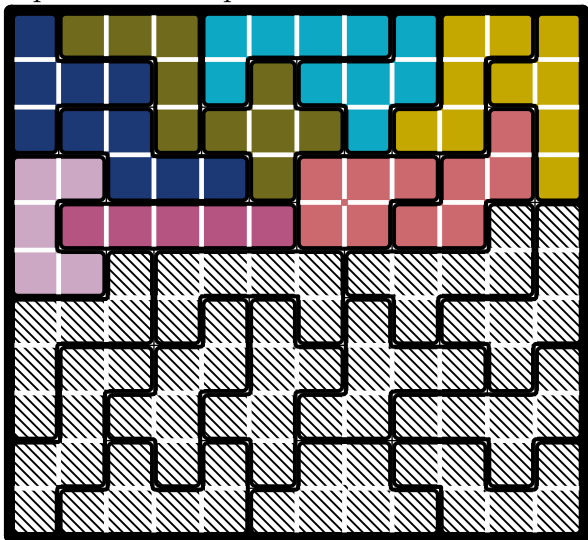


21 Two pentominoes and one hexomino can fit inside this area:

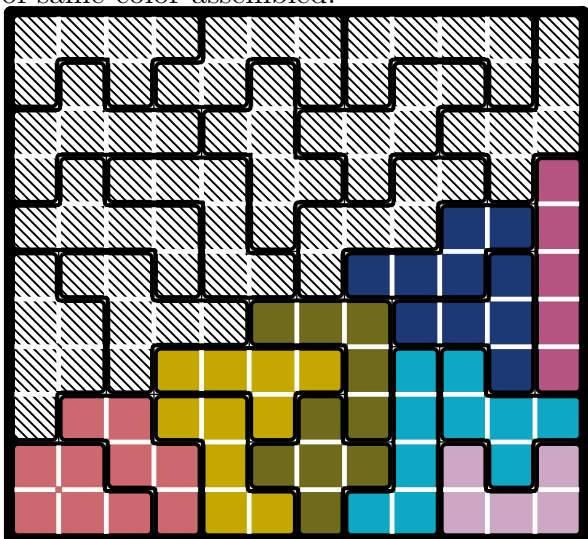


22 See examples in the Polyssimo Challenge solitaire puzzles on my website or the ones below.

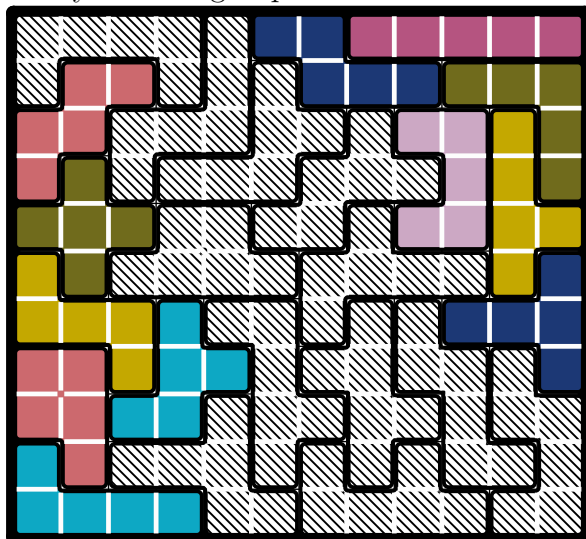
23 Here are two nice examples of a clear pentominoes/hexaminoes separation. First one almost shows rectangles (and some nice color scheme), is it possible to improve that?



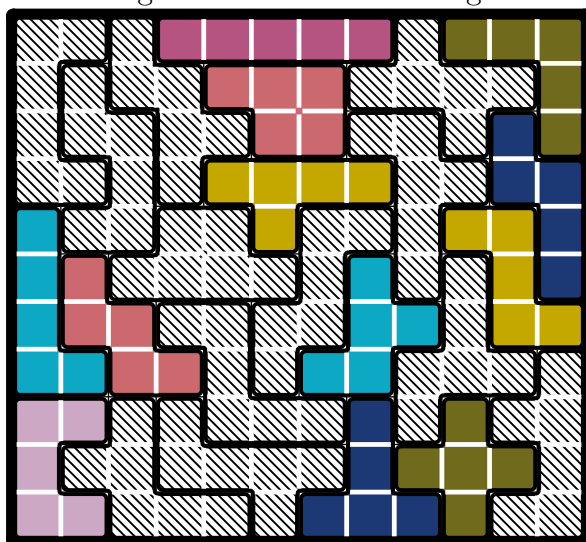
Second one shows a nice diagonal and with pieces of same color assembled:



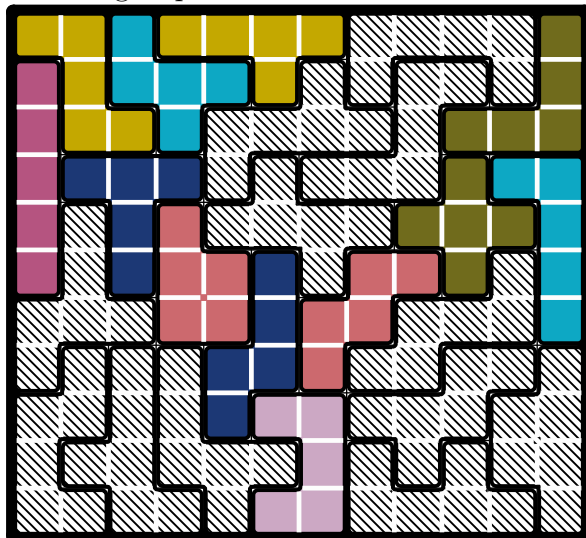
Here's an example for separating pentominoes evenly in N=2 groups:



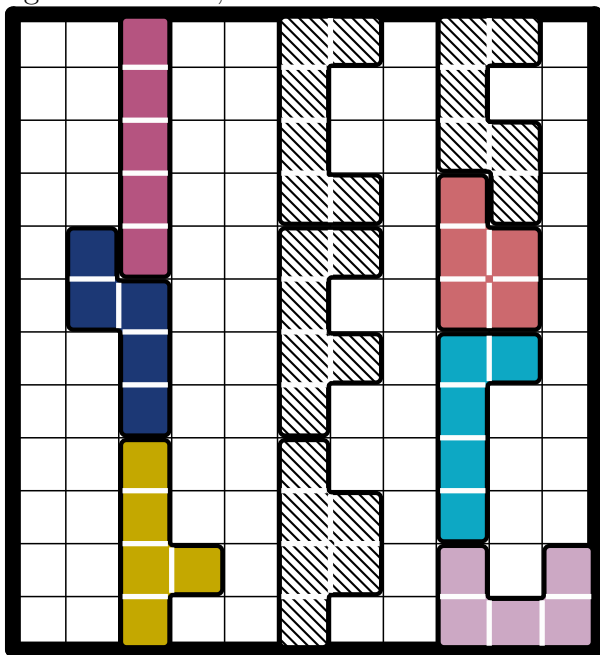
For separating pentominoes evenly in N=4 groups Tick Wang has found the following solution:



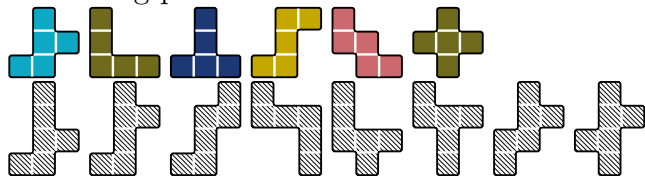
I would be very happy to find a solution for N=12 (not sure it exists). Concerning hexominoes, Tick Wang took some time to find a balanced separation in N=3 groups:



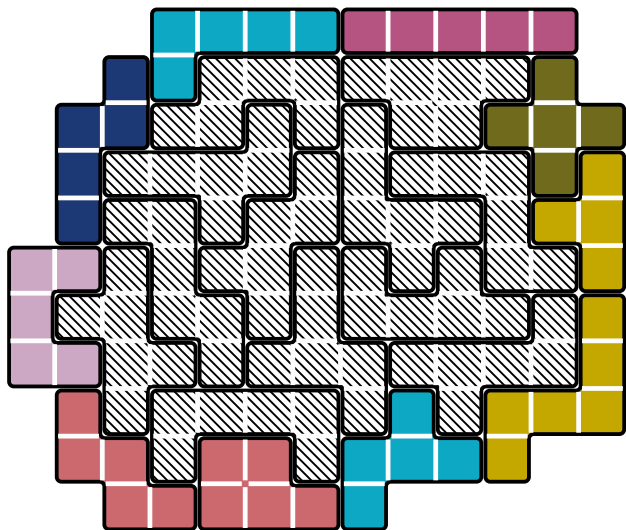
[24] + [25] Roman Ondrus has found a minimum of 10 pieces for a total of 54 squares (filling up  $\simeq 41\%$  of the board). Roman's setup is clever, doing stripes of width 2 and all remaining piece having a width of 3, thus not able to fit in:



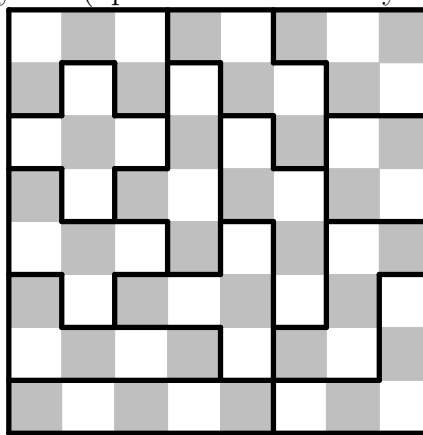
Remaining pieces:



[26] Tick Wang answered his own question with 10 pentominoes surrounding the 12 hexominoes:



[27] Here's the solution given in the book, is it the only one (up to rotations and symmetries)?



As a special gift, here is a heart made with Polyssimo Challenge pieces:

