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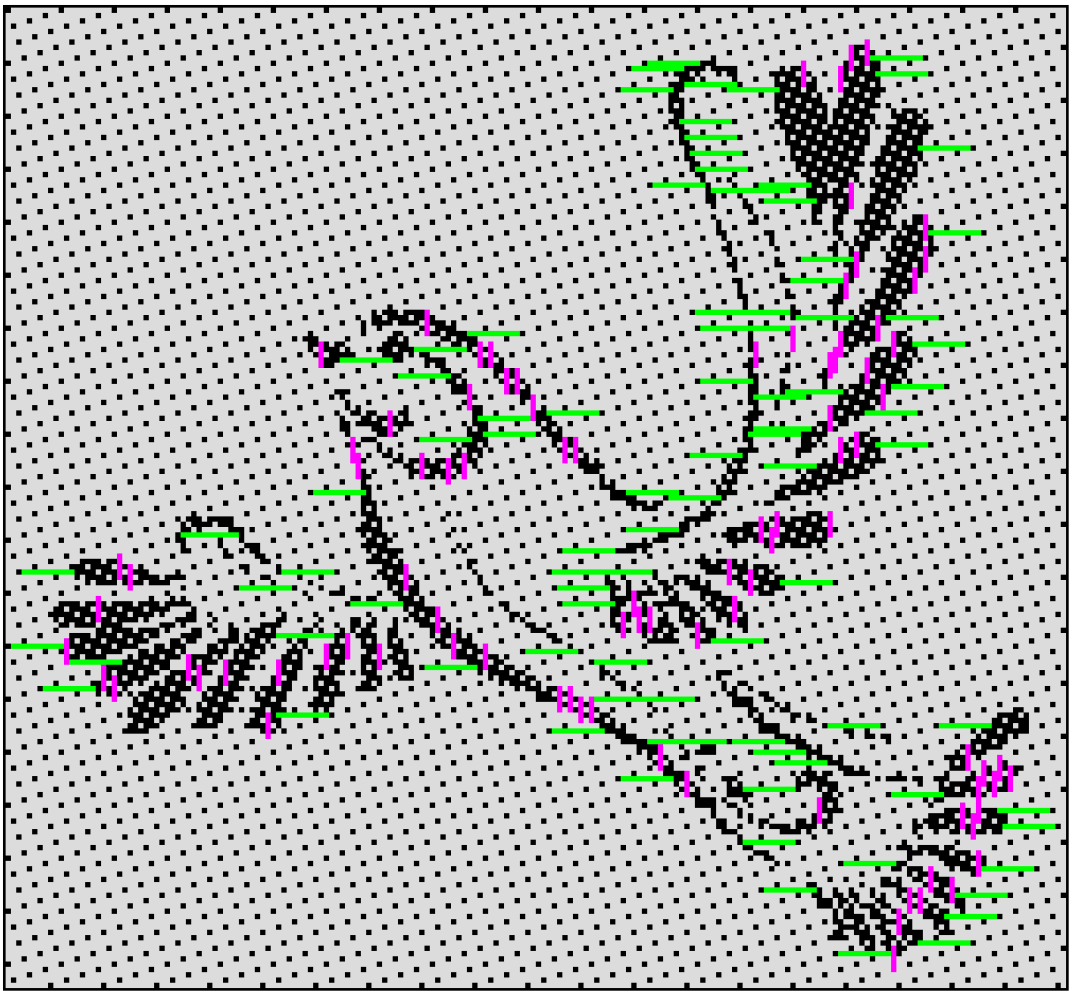
Date : Juin 2019 , May 2021.

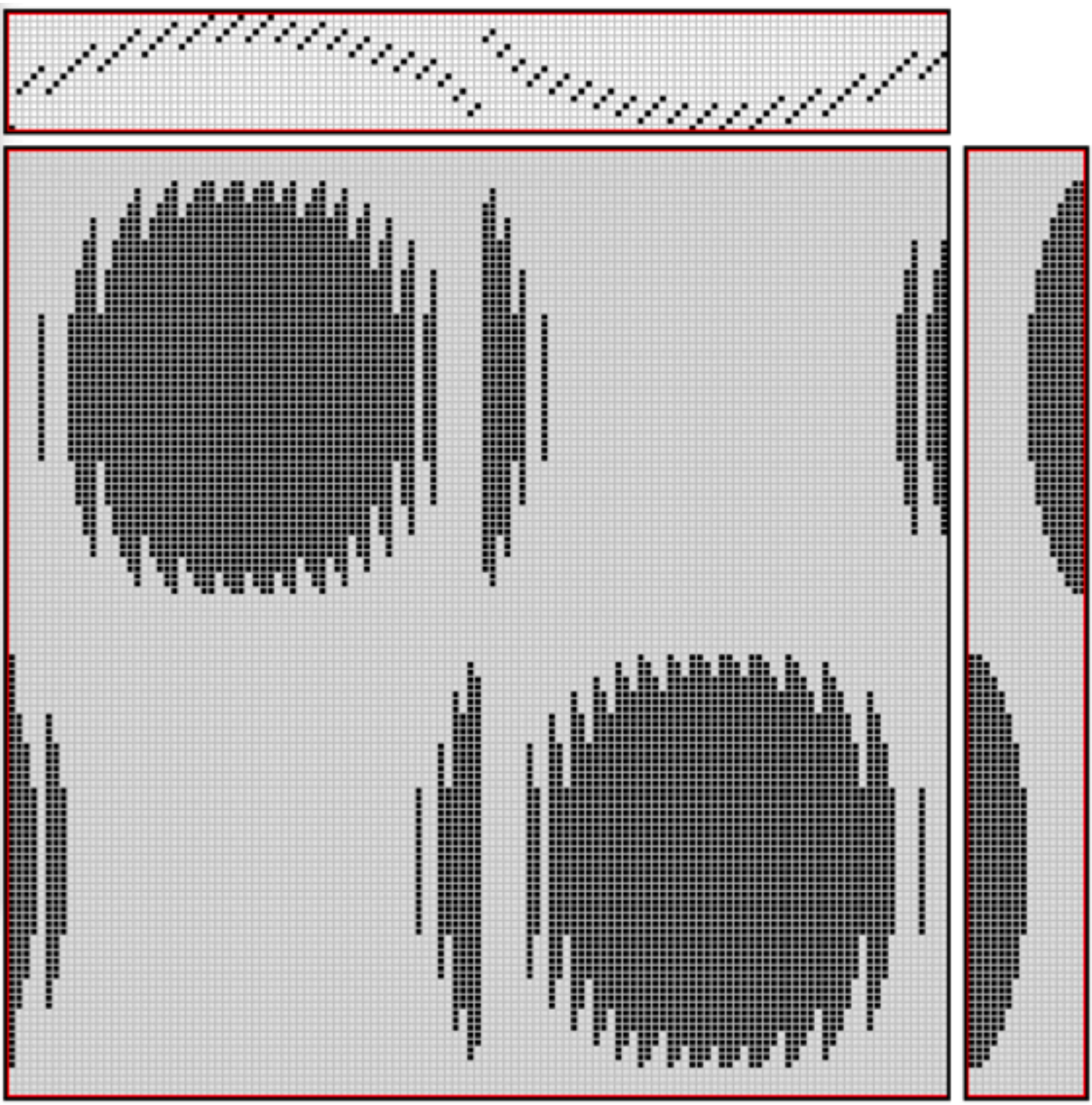
Abstract :

For damask fabrics in shaft weaving or more generally for all weave structures in jacquard weaving, how to find weave structures compatible with each other or "opposable", a set of weave structures that induce a minimum of floats on their borders ?
This article proposes a practical method for analyzing floats generated by two weave structures, along any boundary.

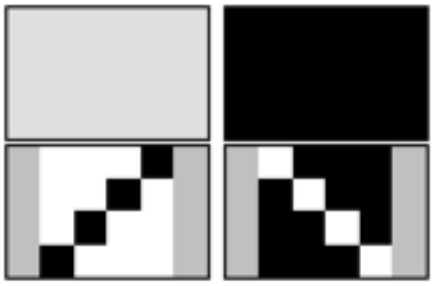


When we were doing demos of the initial method with Pointcarré software we always used the same weave structures, namely a 1/3 twill and a 3/1 twill, to have a good contrast between the two areas of the drawing.

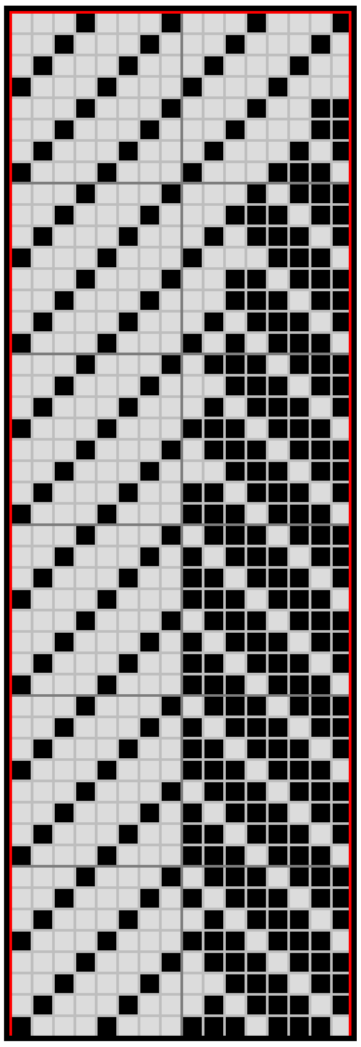
Typically, we built a threading on initial 4 and then calculate the fabric generated by a full circle :

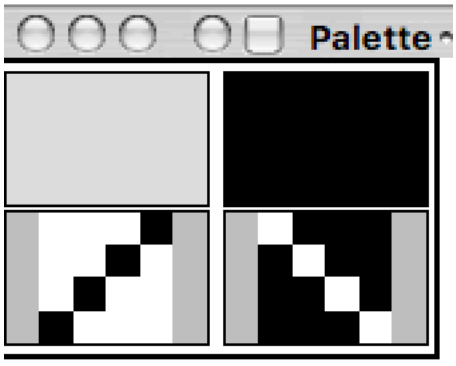


We noticed that if we applied a symmetry to 1/3 twill before inverting it in 3/1 twill with the inverse video function we had a good opposition of the weave structures to the borders of the drawing, without floats.

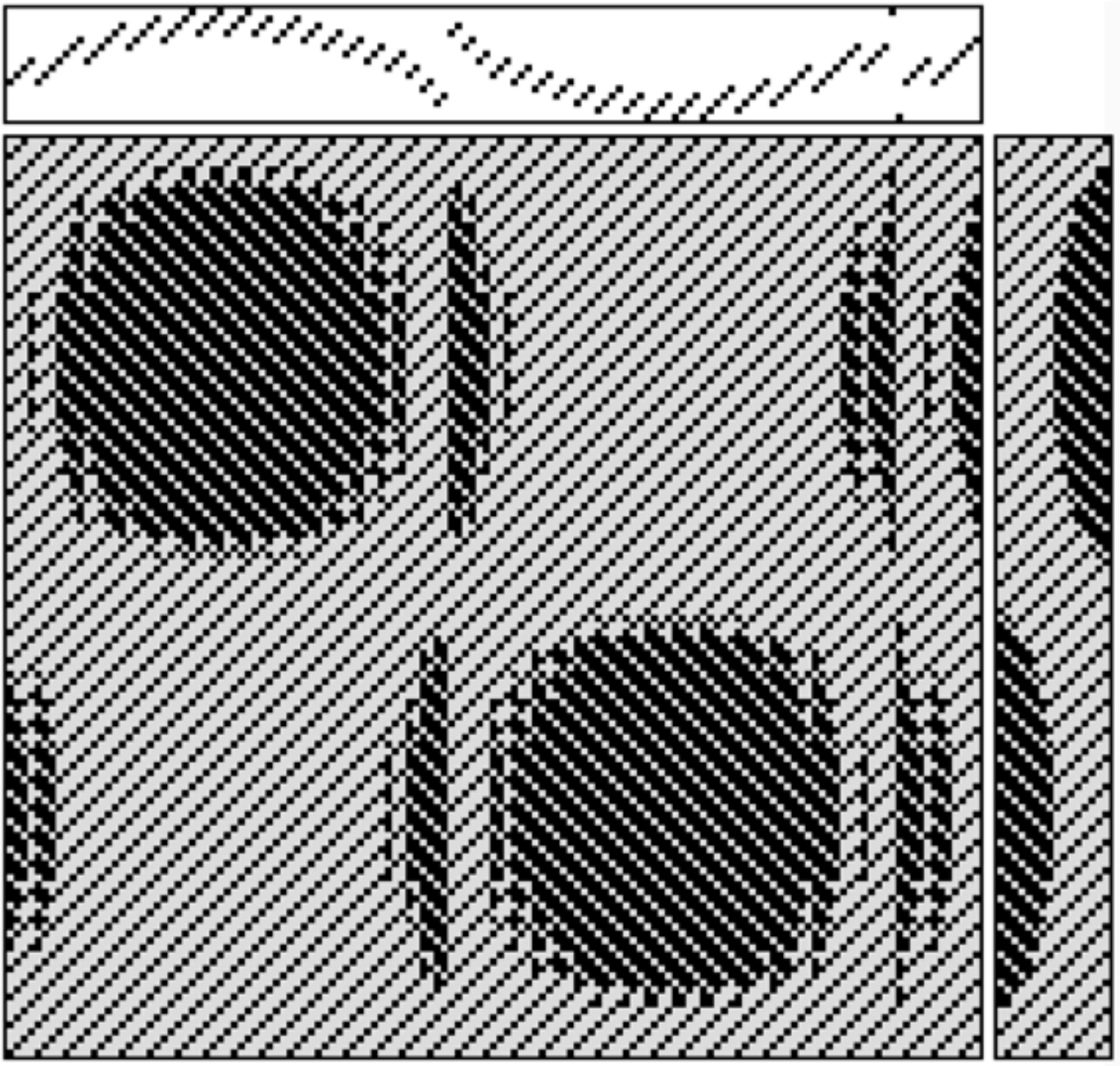


If we then evaluated the peg-plan with these two weave structures :
The twill 1/3 for the gray background and the reverse twill 3/1 for the pattern in black,

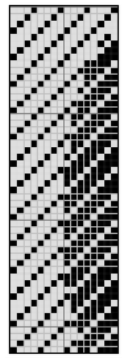


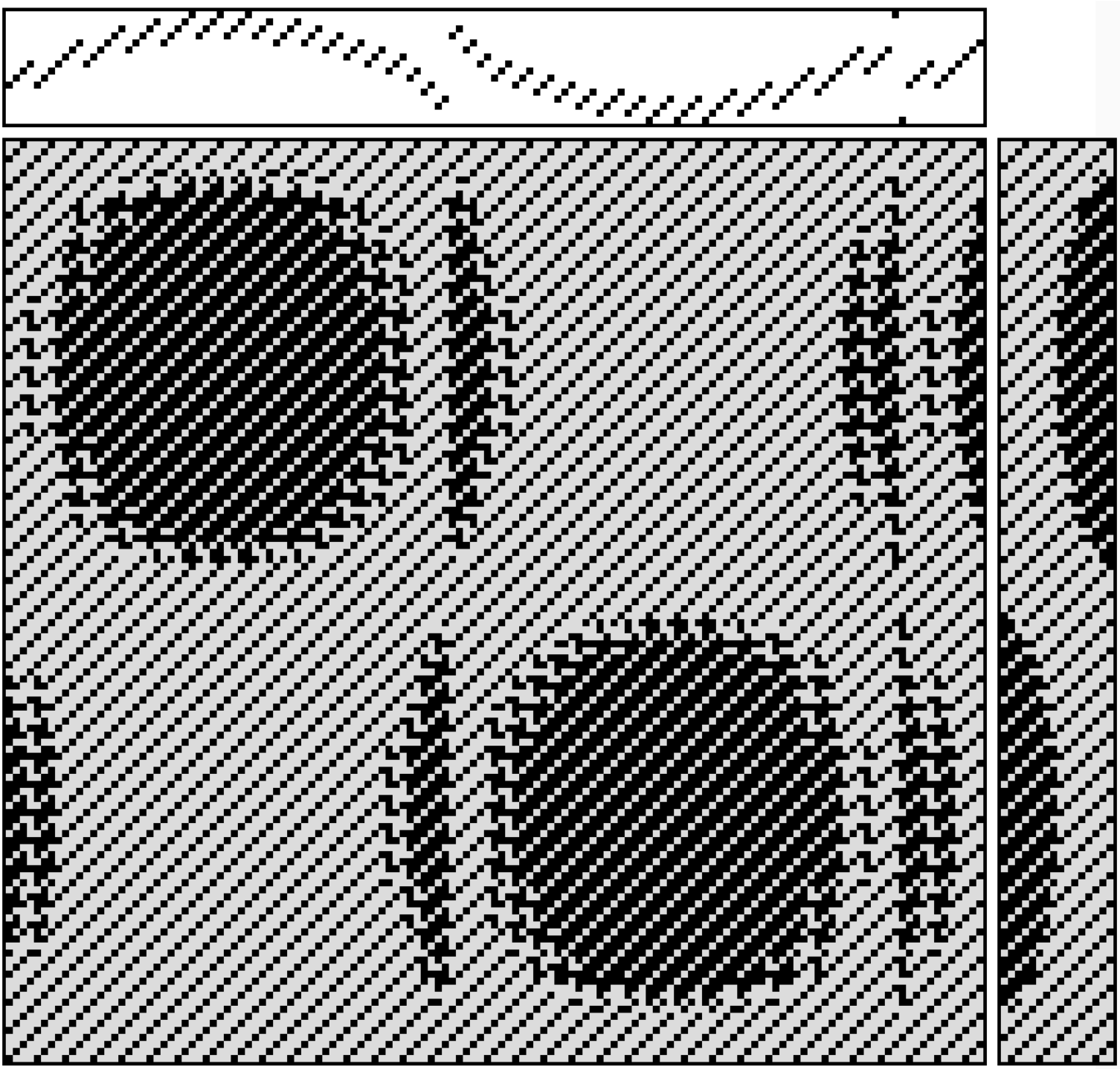


we obtained the following fabric without floats :

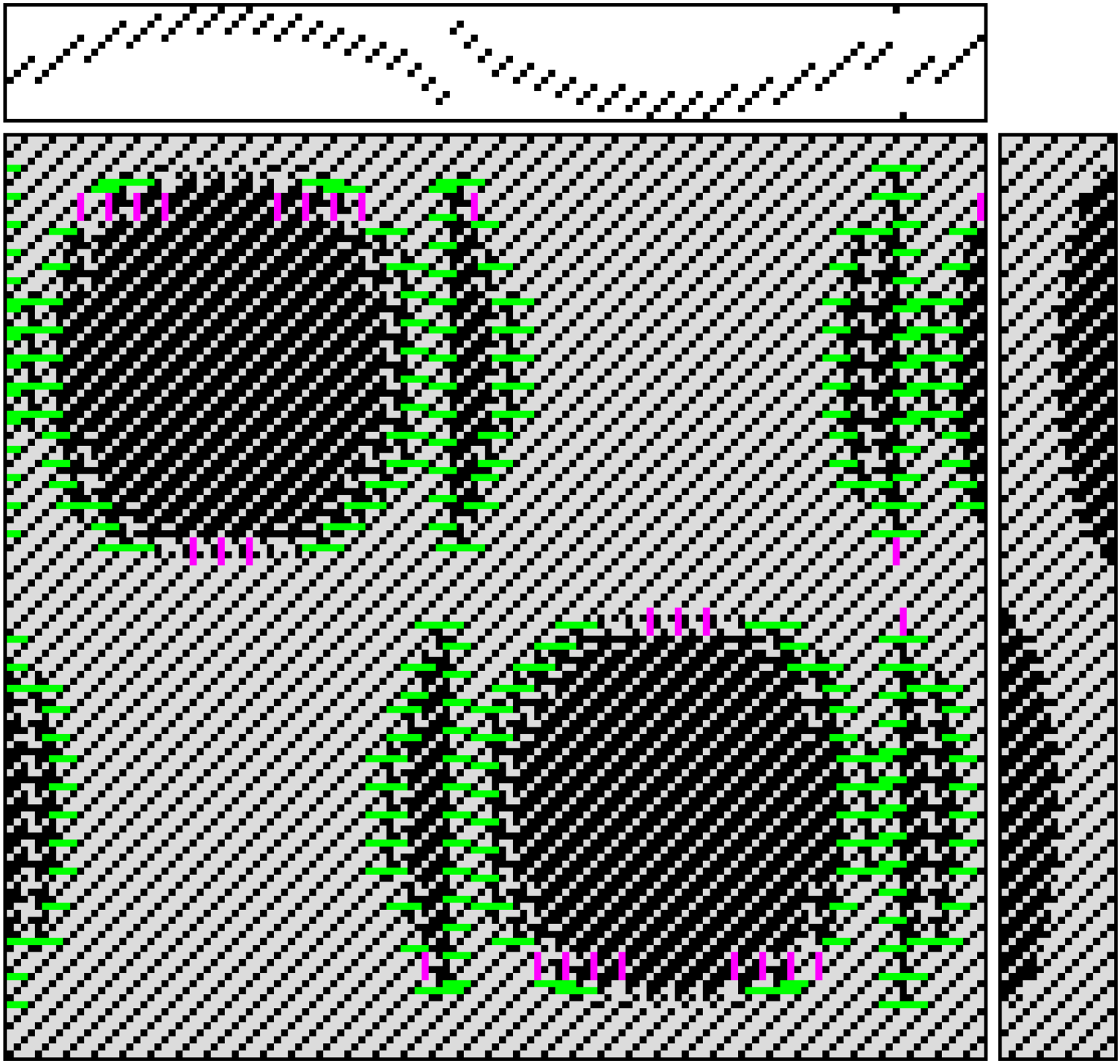


However, every other time we forgot to apply symmetry and here is what we got :





This fabric had floats of more than 3 pixels :



Floats of 4 pixels or more. Warp floats in pink, weft floats in green.

The initials method guarantees the production of a weave structure inside a peg-plan surface.
The maximum floats inside the surface are therefore the maximum floats of the filling weave structure. Here the twill 1/3 guaranteed weft floats at the maximum of 3 pixels in all the background. Similarly in the black surface the twill 3/1 guaranteed warp floats at the maximum of 3 pixels.

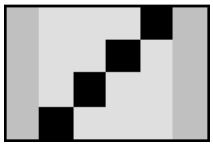
Problems occur at the boundary between the black surface and the background.
If a 3-pixel weft float is touching the border where there is a weft point of the weave structure filling the black surface, then we will have a weft float of at least 4 pixels.

This technique (a weave structure associated with the inverted and symmetrical weave structure) also worked with other weave structures, especially with crow foot satin. This is evoked in  p 128.

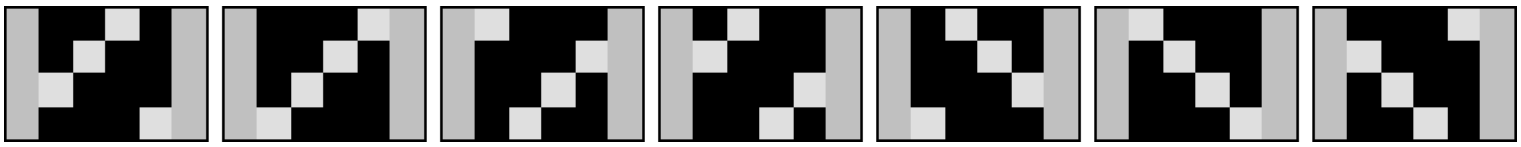
Is this a general rule ? Apparently not because it depends on the starting point of each weave structure.

Today I would like to study this problem of the transition from one weave structure to another, according to any surface. How best to minimize potential floats, warp or weft, which are created on the borders of a drawing?

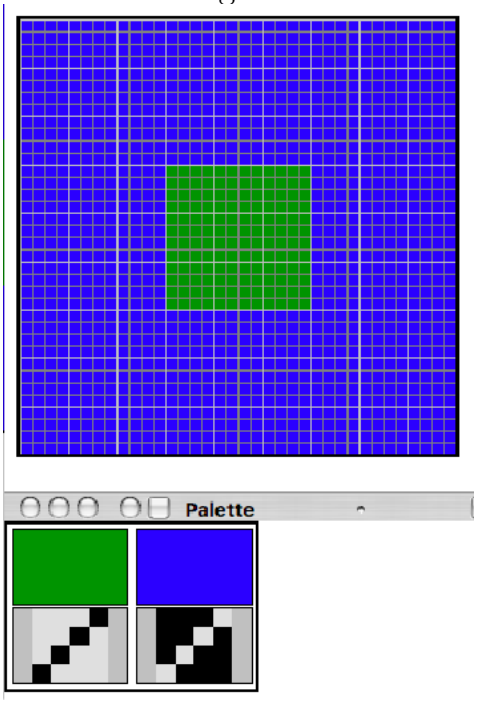
The problem arises for damask fabrics in shaft weaving or more generally for all weave structures in Jacquard weaving.
How to find weave structures compatible with each other or "opposable", set of weave structures that induce a minimum of floats on their borders.

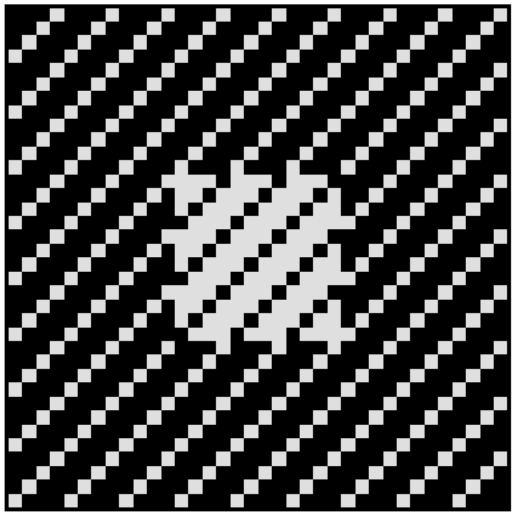
To start we will study the case of twill 1/3 

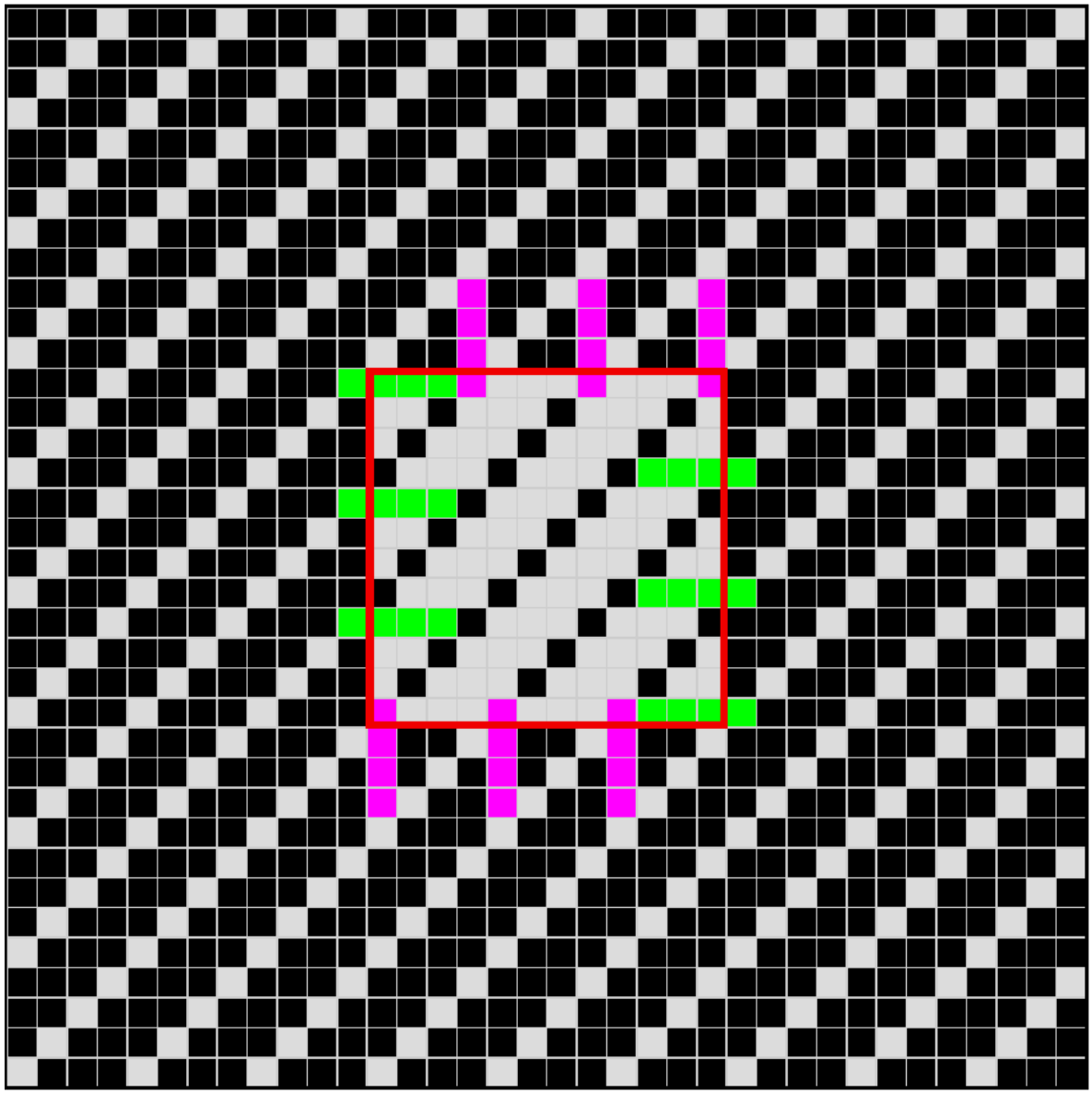
opposed to twill 3/1 in all its forms:



Let's start with twill 1/3 and its inverse.
Let's take a simple surface, a green square, for filling with 1/3 twill.
The blue background will be filled with the opposite twill.







The weft floats are the horizontal lines of down, in gray.
Warp floats are the vertical lines of up, in black.
Floats of more than 3 pixels are colored in green for weft floats and in pink for warp floats.
The red frame shows the surface filled by 1/3 twill. Around the red frame one filled with the reverse twill.

If inside the square a weft float of 3 pixels is touching the edge of the square where is a down of inverted twill, left or right, then we will have a weft float of 4 pixels (in green).
If inside the square a warp float of 3 pixels is touching the edge of the square where there is an inverted twill up, up or down, then we will have a warp float of 4 pixels (in pink).

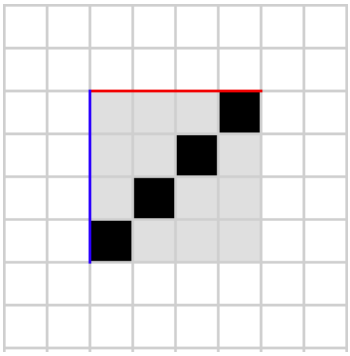
Along a line, the pattern is repeated every 4 threads, for both a horizontal and a vertical. Floats of 4 are found every four threads.

But what about a surface with more complicated contours ? How to envisage all the cases ?

Let's start from the 1/3 twill padding.
If the surface is any, it can stop anywhere along the pixels of the weave structure.
For each pixel of the twill 1/3 weave structure, the border may be above the pixel, below, to the right, or to the left. There are 4 cases to study for each pixel. There are 16 pixels in twill 1/3 weave which makes 16 x 4 = 64 cases

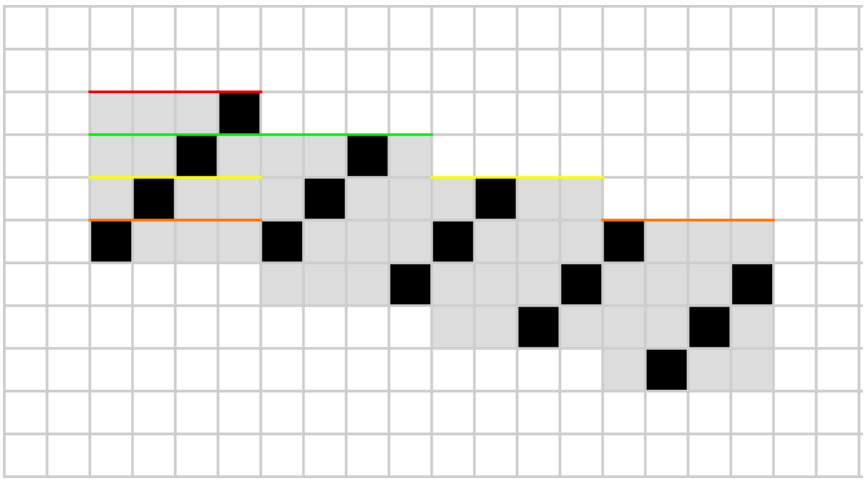
It will be assumed that the surface to be filled will everywhere have at least a thickness of the width and height of the weave structure.
That is, if the boundary of the surface stops to the right of a pixel, all pixels even further to the right will belong to the background filled with the other weave structure, on at least one repeat.
And this also in all directions.
In fact what interests us is the possibility, on the borders, of creation of floats larger than the maximum floats of each weave structure.

To visualize all the cases I had the idea to build the following surface :
at the beginning we must at least explore the borders of the weave structure filling, the twill 1/3, or a square of 4x4 pixels



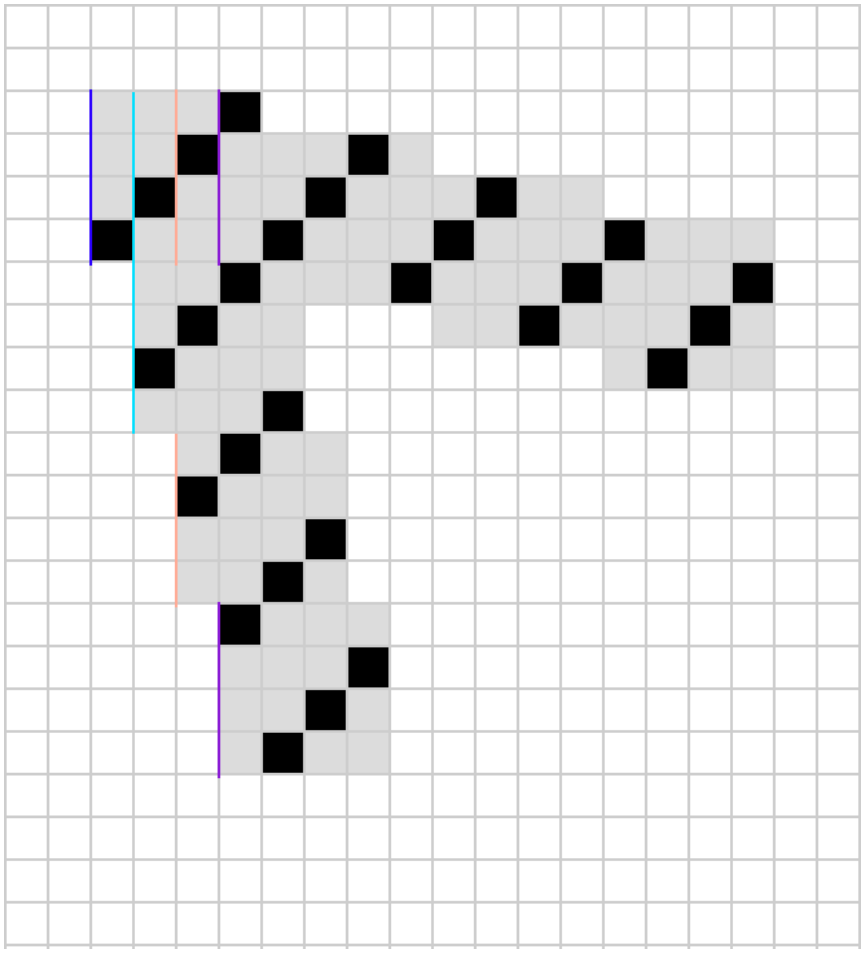
At the top of the surface, along the red line we can study the case of the border passing above the four pixels of the first line of the weave structure.
To the left of the surface, along the blue line we can study the case of the border to the left of the four pixels of the first column of the weave structure.

To study the case of the border above the four pixels of the second line of weave structure, along the green line, we will enlarge the area to the right by 4 pixels by shifting the border one pixel down .



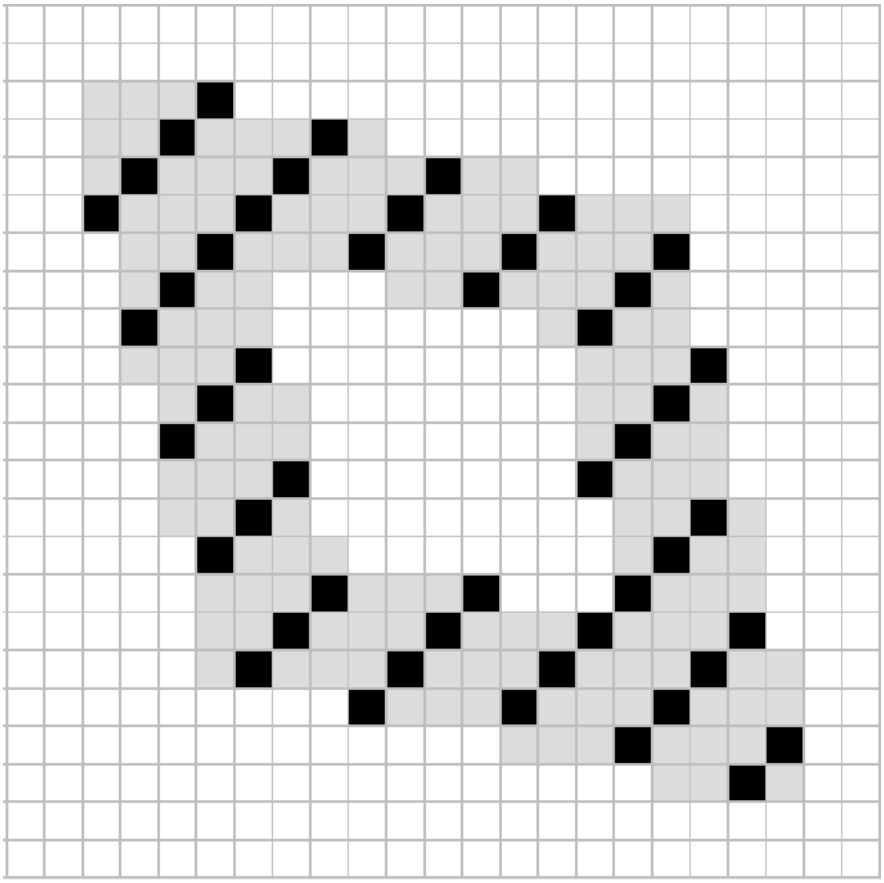
We then do the same thing for the case of the border above the four pixels of the third line of the weave structure, in yellow and for the fourth line in orange.
All border cases above all pixels are treated as well.

In the same way, to study the case of a border to the left of the four pixels of the second column of the weave structure, we will enlarge the surface by carrying the weave structure below shifted by one pixel on the right.
The same will be done for the third and fourth columns.

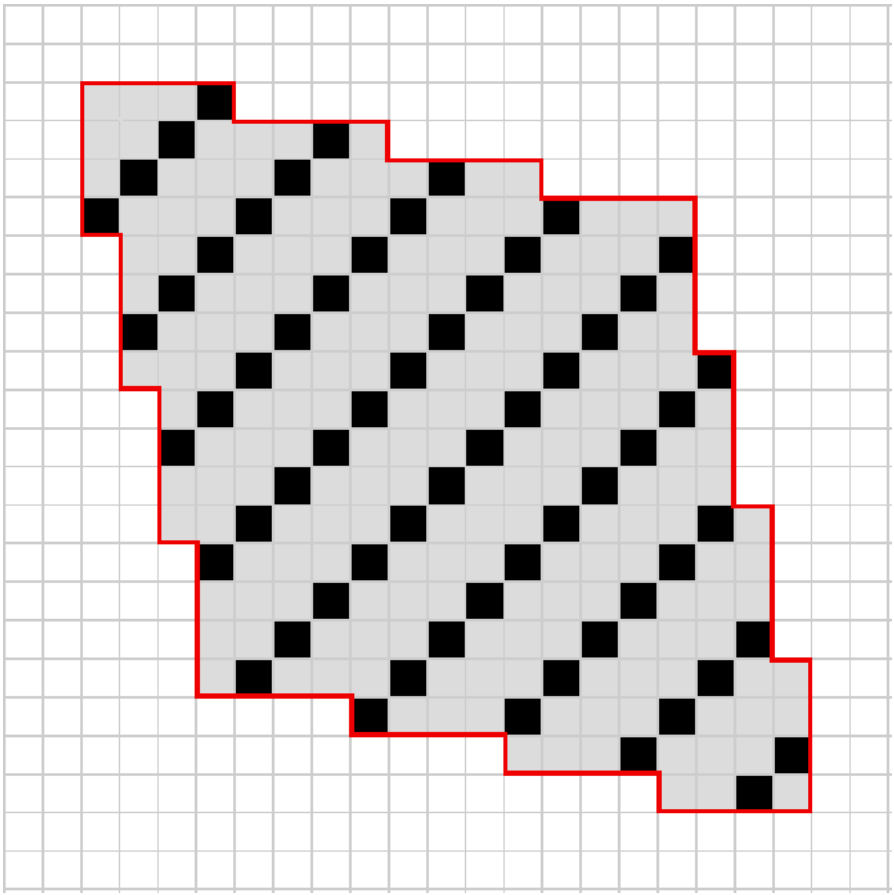


All border cases to the left of all pixels are thus processed.

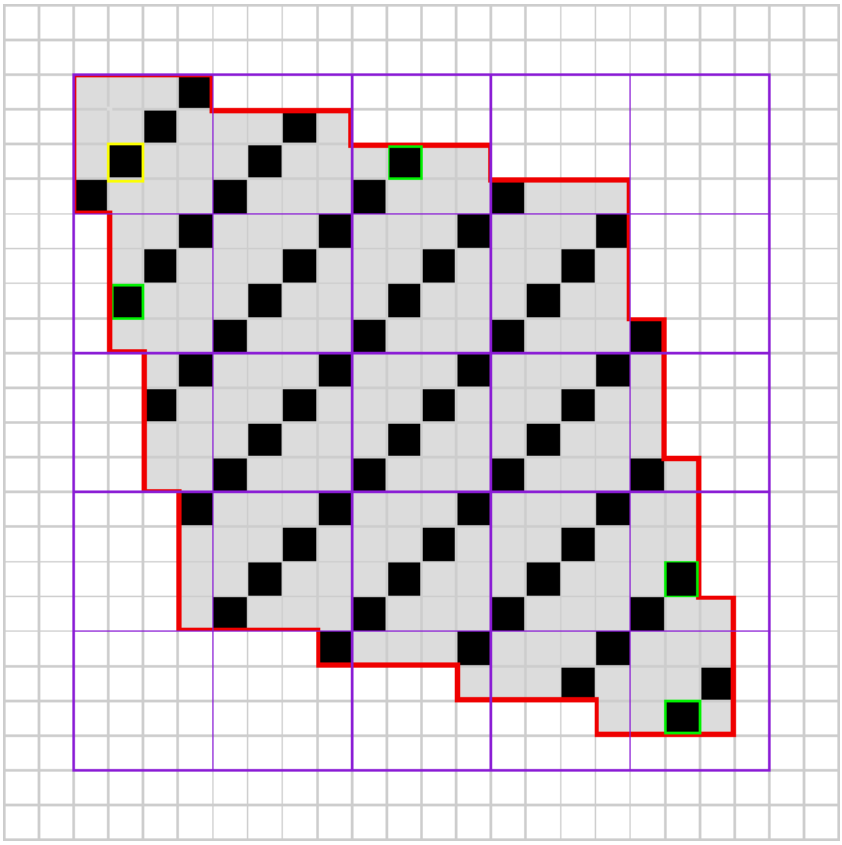
In the same way we are going to enlarge the surface to treat all the cases of borders to the right and below all the pixels.



With this surface drawn in red below one can study at once all border cases for all the pixels. Its outline consists of 4 x 4 x 4 pixels, 16 times the top of the 16 pixels of the weave structure, 16 times the underside, at right and at left. We find again the 64 cases.

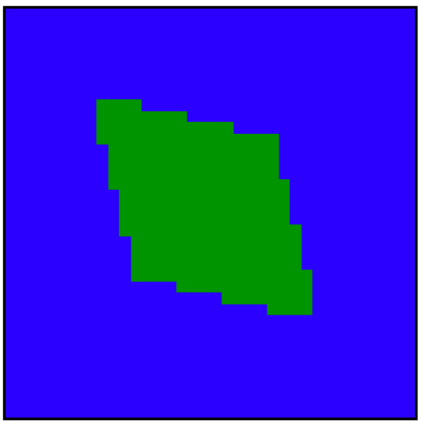


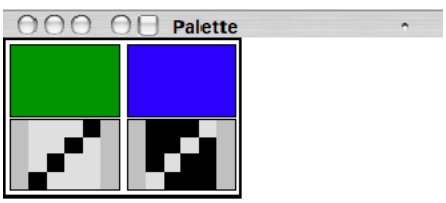
We can find for each pixel framed in yellow in the weave structure at the top left, at which point of the border will be tested the cases above, right, below and left (in green).



So now we have a method to test all the weave structure twill 1/3 transition scenarios with other weave structures. Now just fill the outside of this surface with another weave structure.

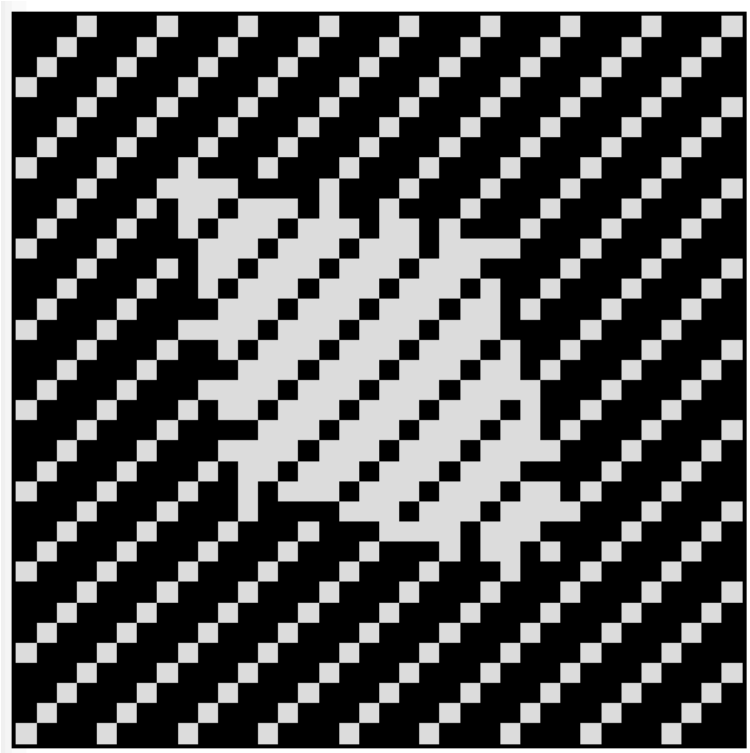
For this we will build a Jacquard fabric with this surface as point paper.



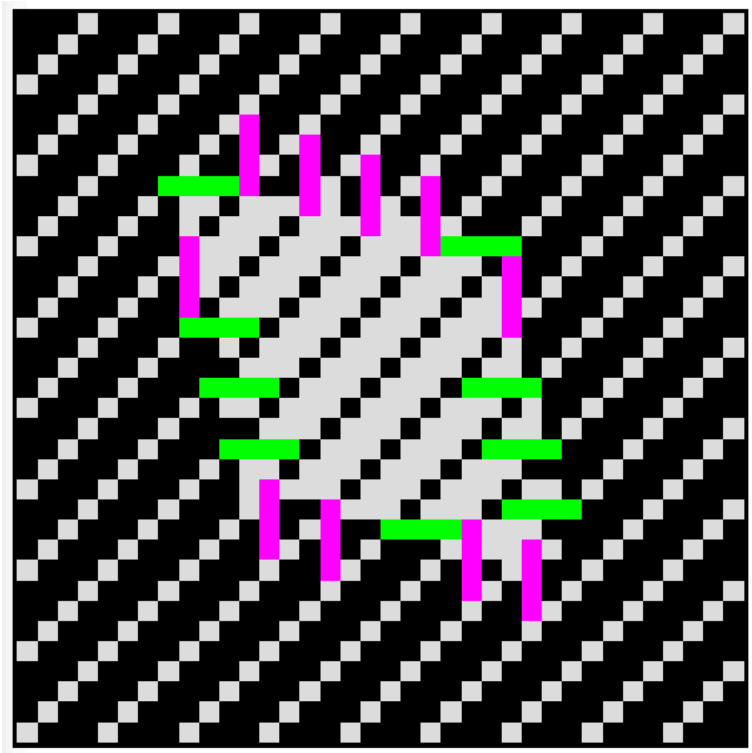


The green color of the point paper is associated with the weave structure twill 1/3 and the blue background with inverted twill.

To study the transition between the two weave structures, you just have to display the fabric.

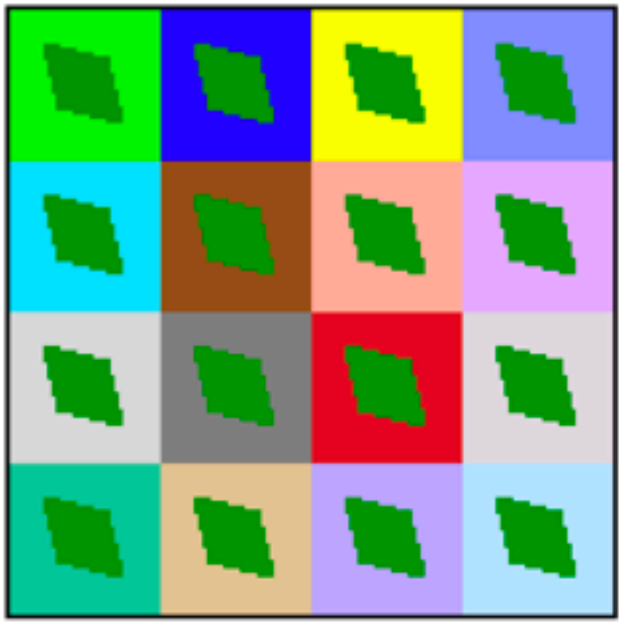


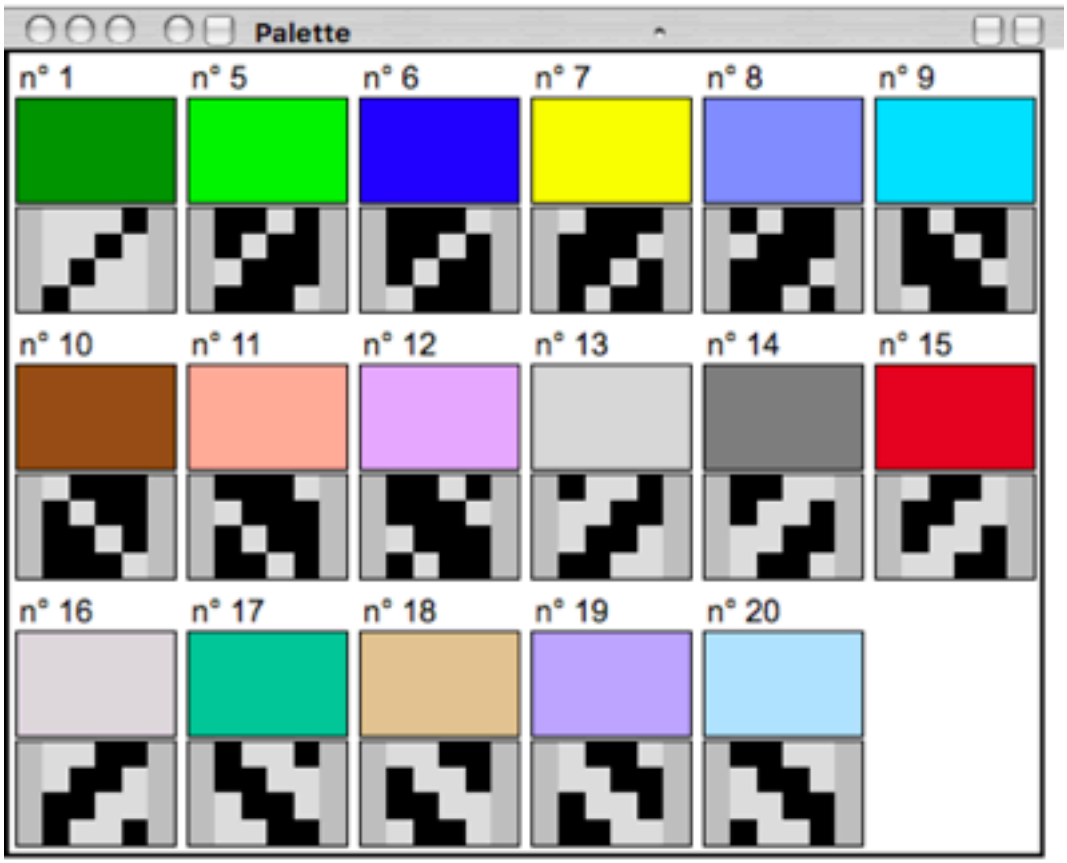
The "Show floats" menu will allow us to visualize floats larger than 4 pixels.



We can now say that these two weave structures present 10 transition cases that generate warp floats (in pink) of more than 4 pixels and 9 cases of weft floats (in green) of more than 4 pixels.
This association of weave structure is therefore to be avoided.

To study the transition of twill 1/3 with all the positions of twills 3/1 and twills 2/2, reverse or not, we will build a jacquard fabric with a point paper that repeats the surface developed above.

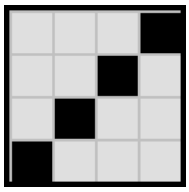


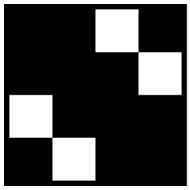


The point paper has 4 x 4 squares with a base surface in dark green in the middle, with a different background.
The 1/3 twill fills the dark green base surfaces.
And each background color is associated with a different weave structure ; all starting positions of twill 3/1 and twill 2/2

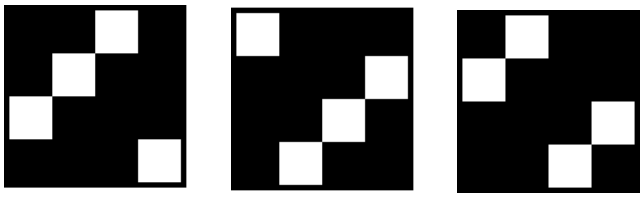
Floats of 4 pixels or more. Warp floats in pink, weft floats in green.

We find the result we had found by experience.
In the square of the second line and the second column (brown background)

The twill 1/3  on background twill 3/1  obtained by symmetry and inverse video produces no floats.

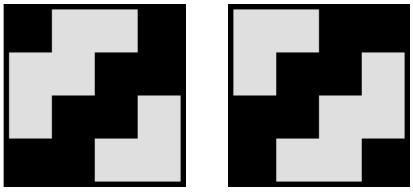
For reverse twills 3/1 another position without floats exists : 
(square line 2 column 4)

There are three positions of the straight twill 3/1 which are also without float :



(squares : row 1 column 1, row 1 column 3, row 1 column 4)

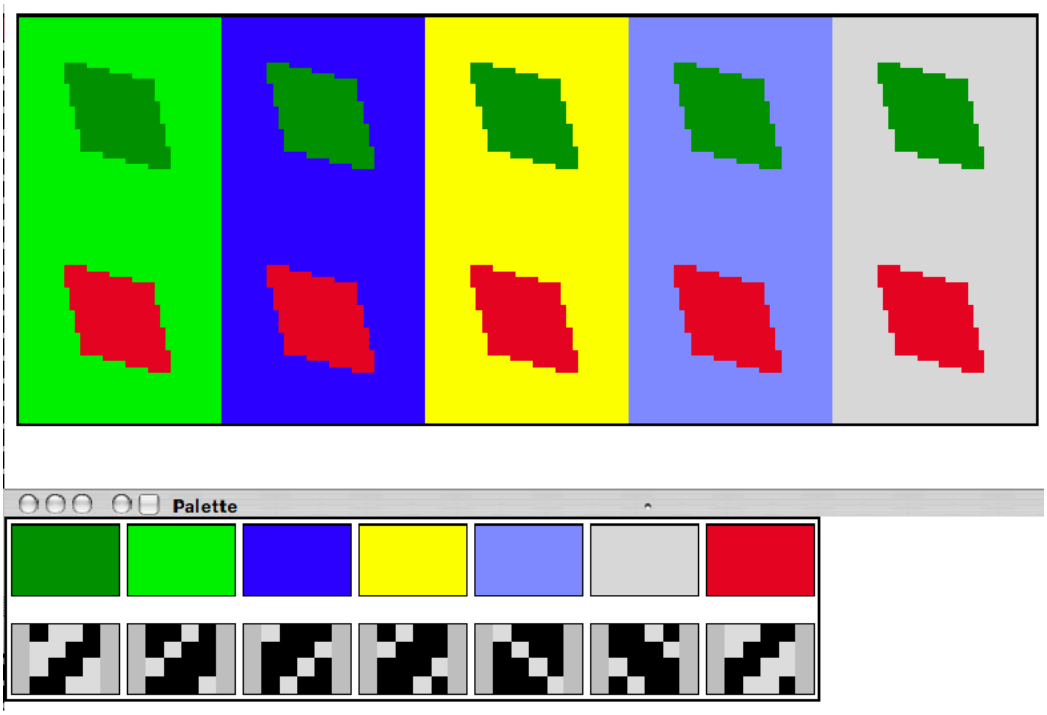
For the transition with a twill 2/2, the reverse twills produce all floats and only two straight twills 2/2 do not produce floats :

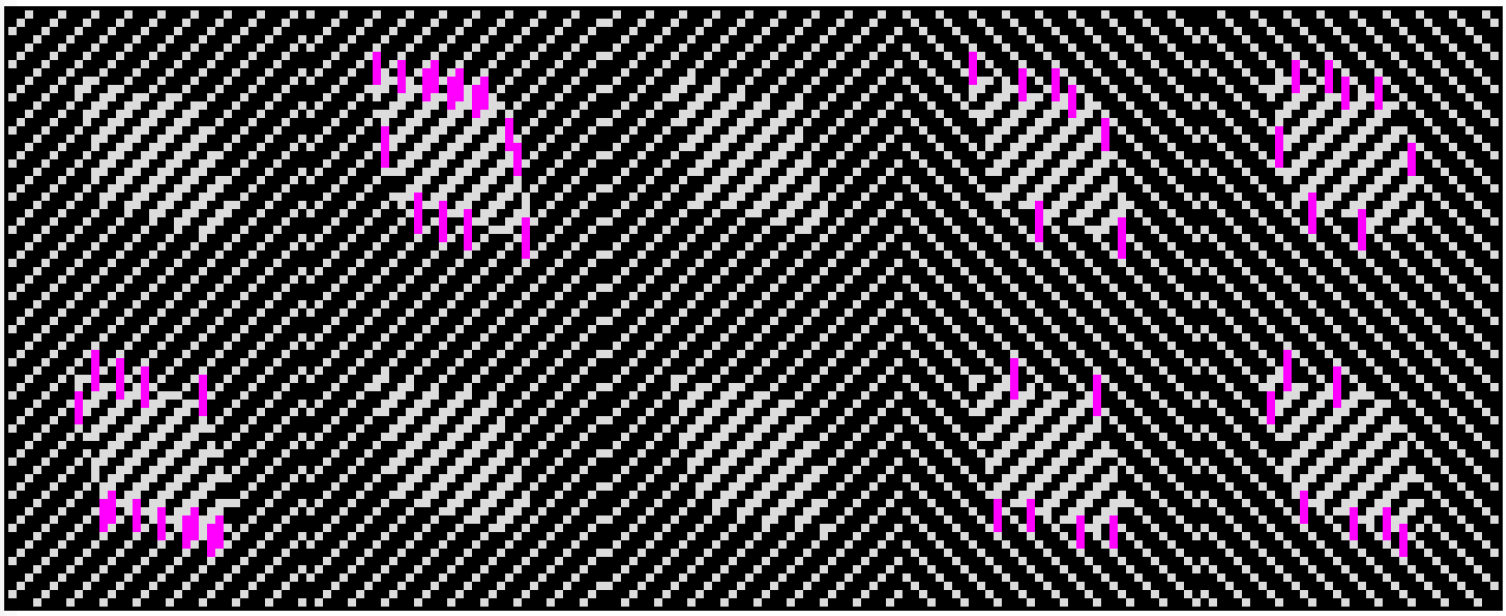


(squares : line 3 column 1, line 3 column 4)

Let's look at how these two 2/2 twills behave with respect to twill 3/1.

For this, let's build a new Jacquard with the five 3/1 opposable twills to the first 1/3 twill in the background of 5 columns, and the two opposable 2/2 twills, in the base surface repeated twice in each column.

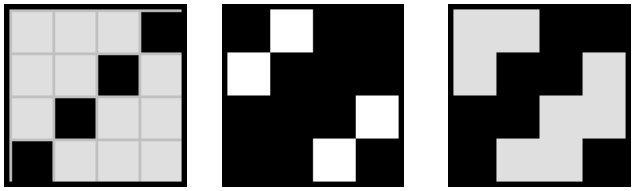


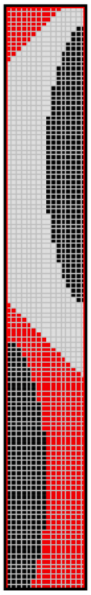


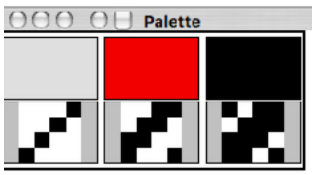
There are two solutions without float for the two 2/2 twills.
The twill 3/1 of the 3rd column is opposable to two twill 2/2.

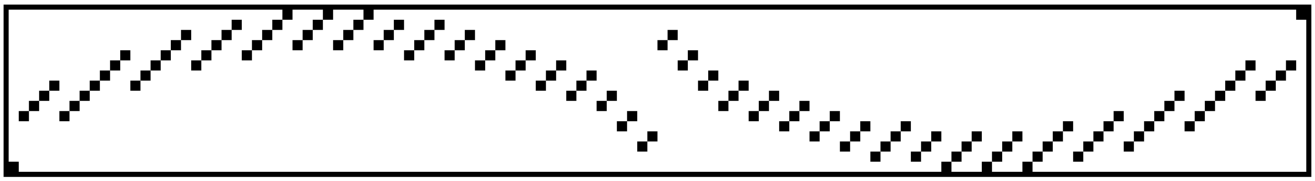
Several combinations of the three twills 1/2, 2/2 and 3/1 opposable between them two by two (without floats) are possible.

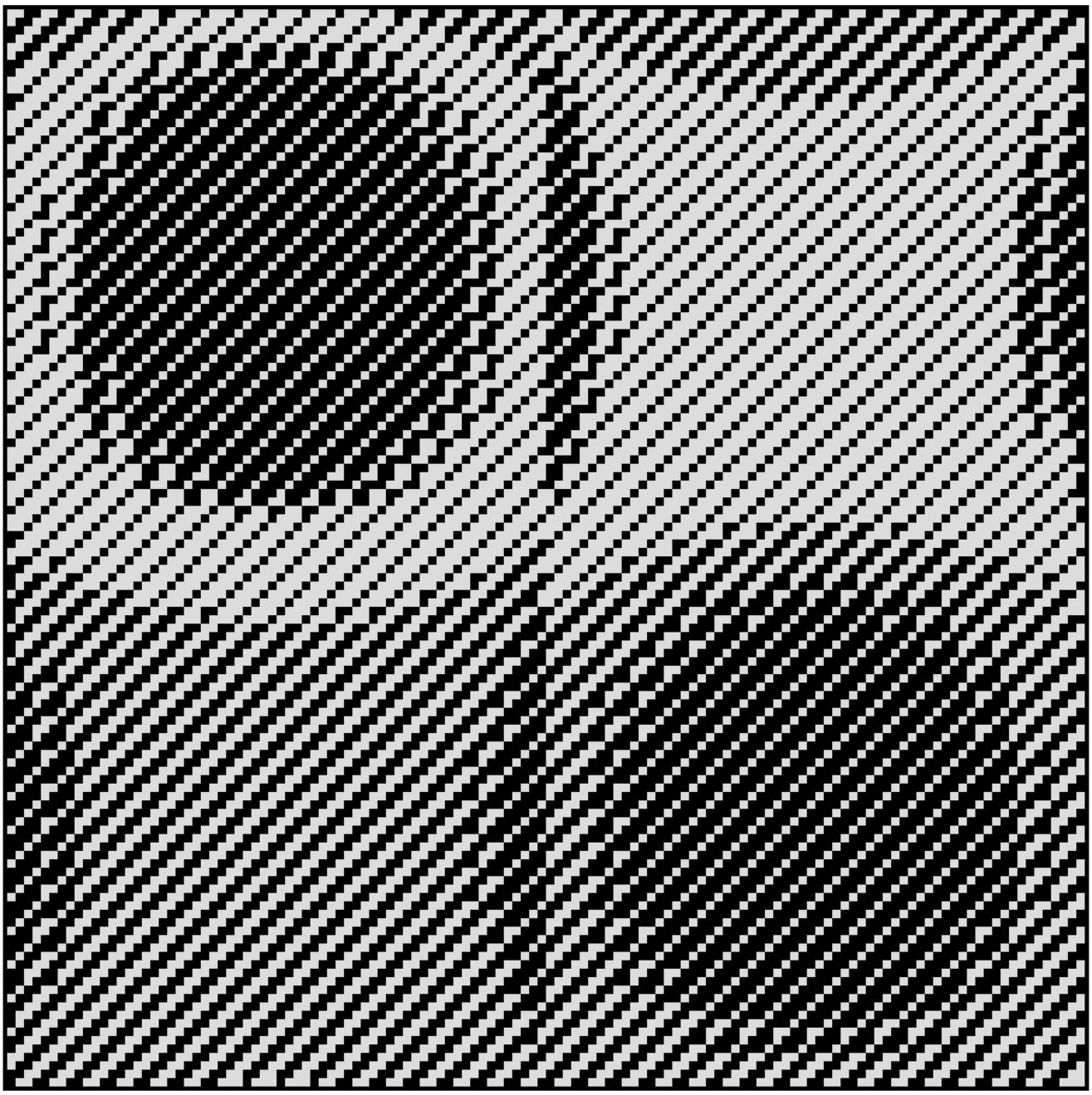
Here is one:

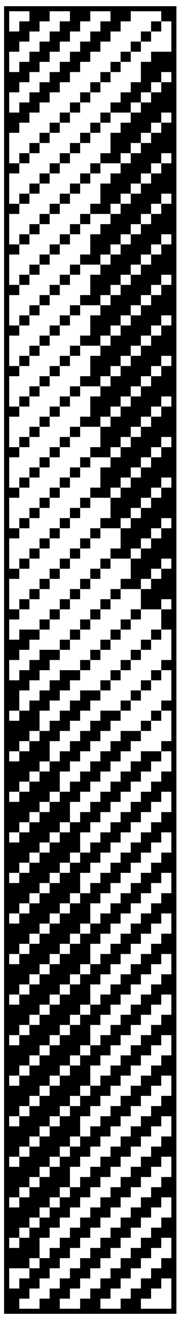




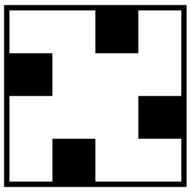






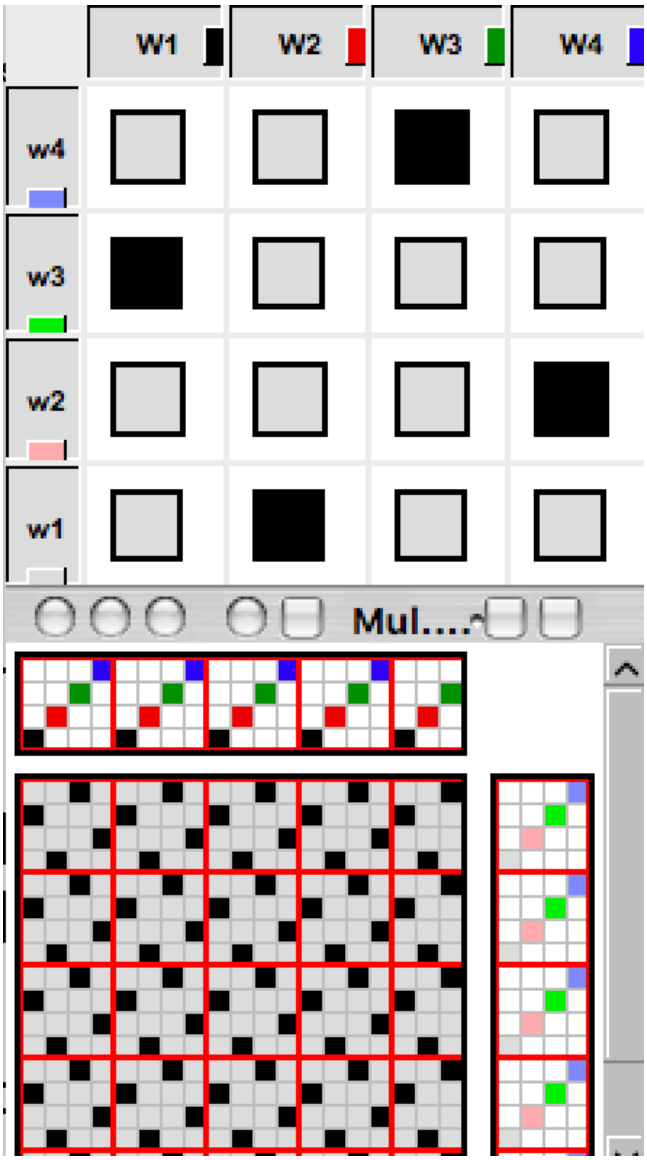


Let's look now if we can add to this family of 3 opposable twills between them the crow foot



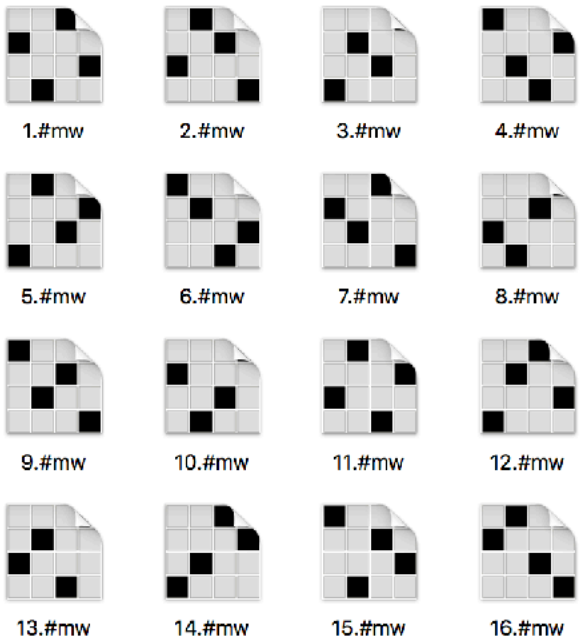
To calculate all the possible starts of the crow foot, here is a tip for Pointcarré users :

let's first build the crow foot as a weave multiple structure, 4 straight warps and 4 straight wefts.



All basic weave structures are "mass lowering" or "mass raising" for crow foot black point.

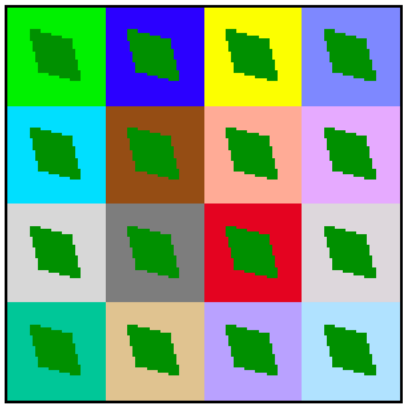
Then using the "Create structures by shifting" menu, after selecting all the warps and wefts, we will produce in a folder all the 16 weave structures corresponding to a shifted crow foot.

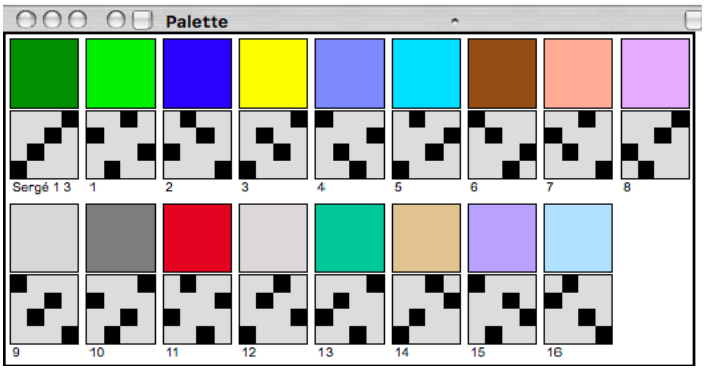


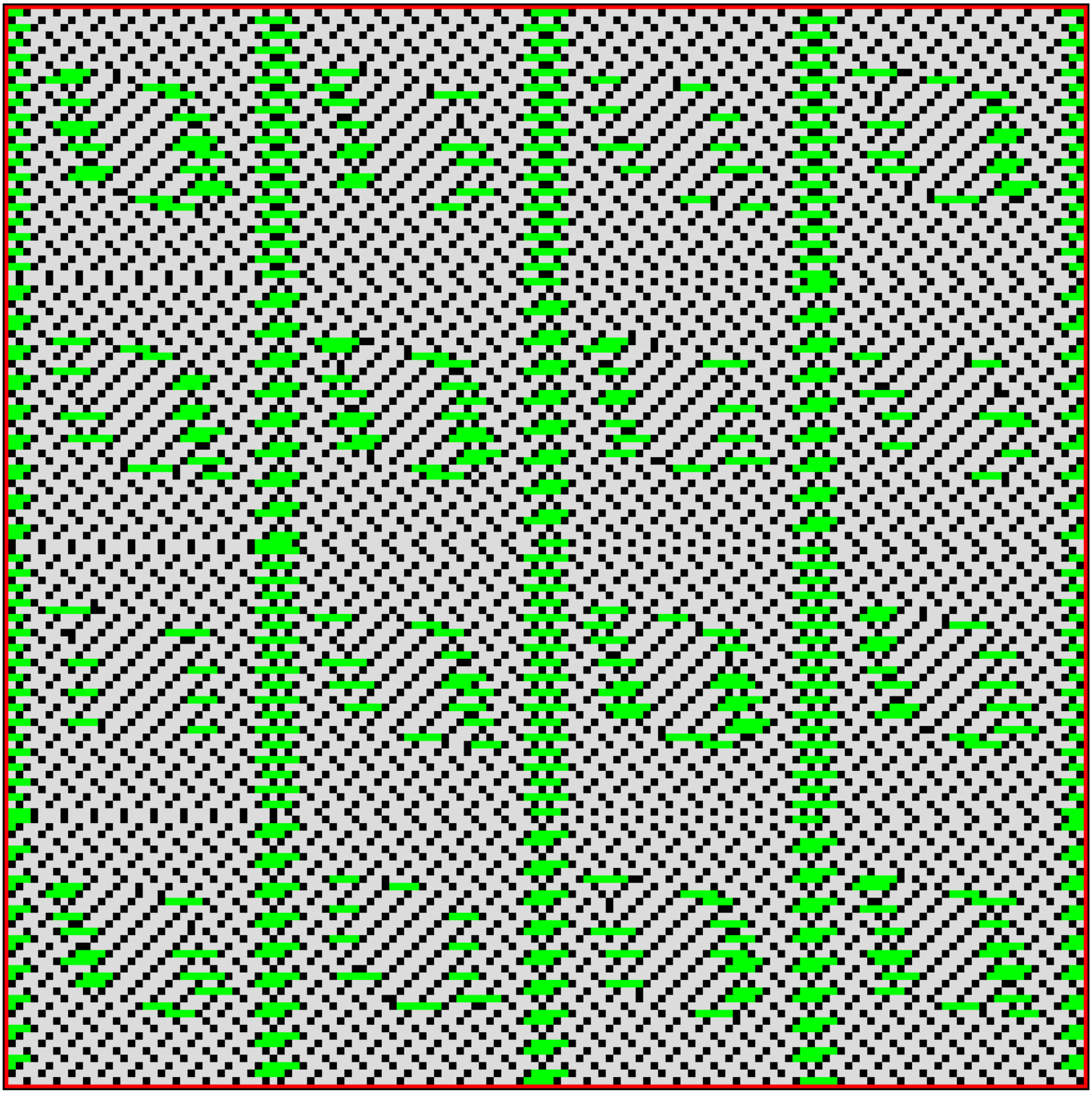
As all these weave structures are symmetrical with respect to the vertical two by two, there is no point in listing the departures of the symmetric crow foot, we would fall on the same weave structures.

Let's look now if one of these weave structures is opposable with twill 1/3

This new Jacquard always contains the twill 1/3 associated with the dark green color, for the basic surfaces in the middle of each square. The background colors are associated with the 16 positions of the crow foot.





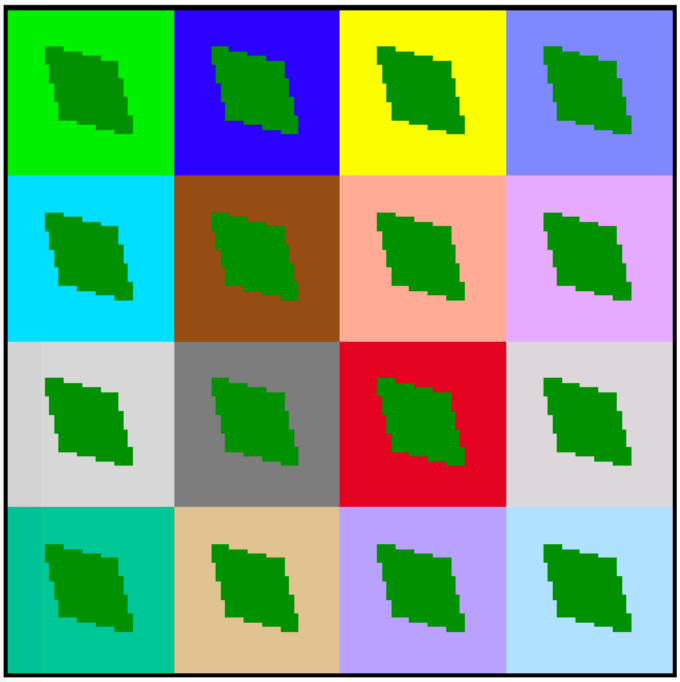


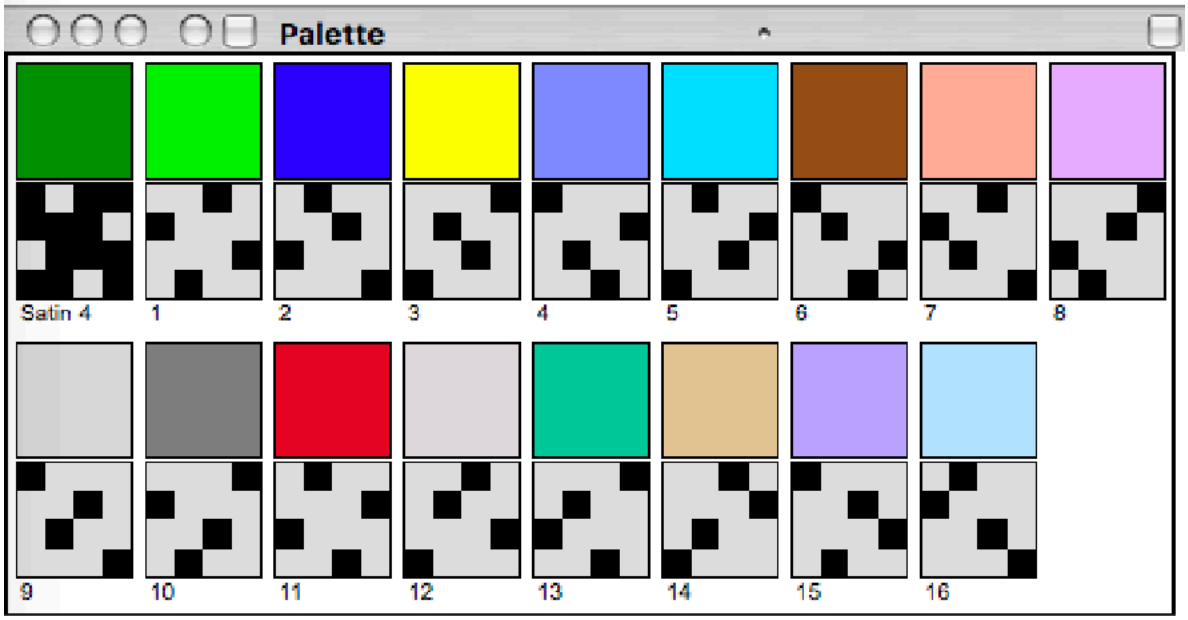
None of the positions of crow football is opposable at twill 1/3, all produce floats of 4 and more.

However 1 position produces less floats than the others :

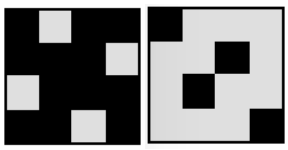
 square light gray, line 3 column 1, with only 8 weft floats.

Take advantage of this Jacquard to look at the opposability of Turkish satins with the crow foot satin warp effect.

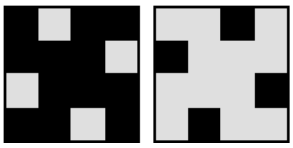


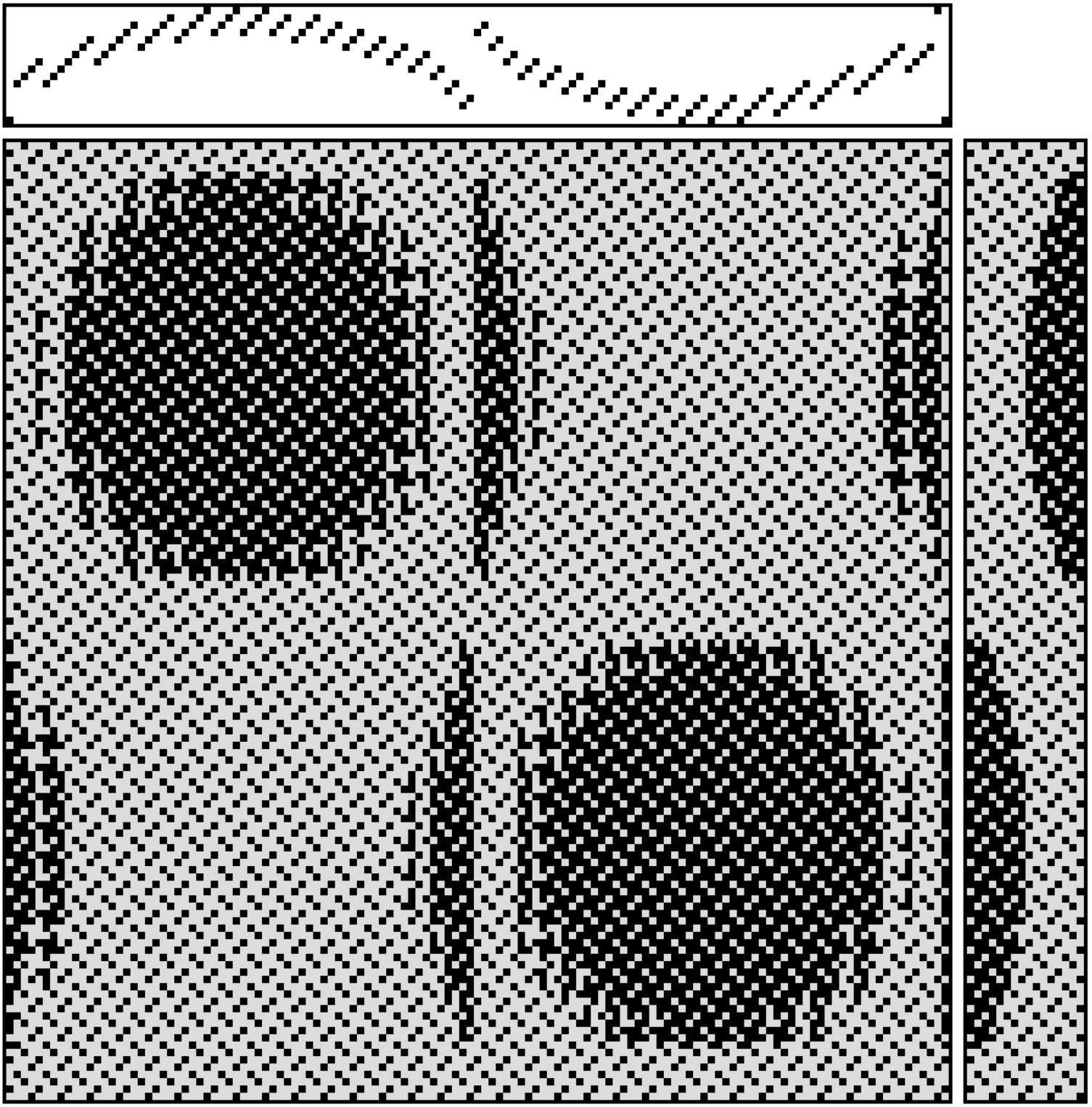


There are 7 associations that do not produce floats :

for example  line 3 column 1.

and the one already reported, inverse plus symmetry :

 which is used in the following fabric :

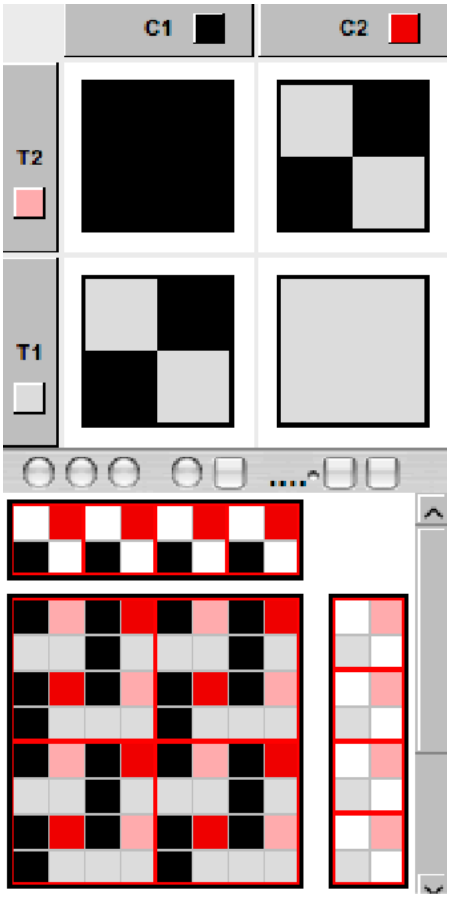


Now let's take a look at double plain weave structures.

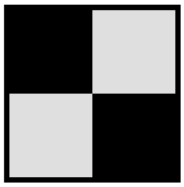
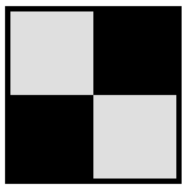
Specifically to fabrics with two colors.
Warp with black odd wires, and even red wires.
The weft with gray odd threads, and even pink threads.

above the fabric we can produce 4 different plain weaves:
A plain black-gray weave (odd warp threads, above)
A plain red-pink weave (even warp threads, above)
A plain black-pink weave (even warp threads, odd weft picks, above)
A plain red-gray weave (odd warp threads, even weft picks, above)

Let's start from the double plain weave black-gray above :

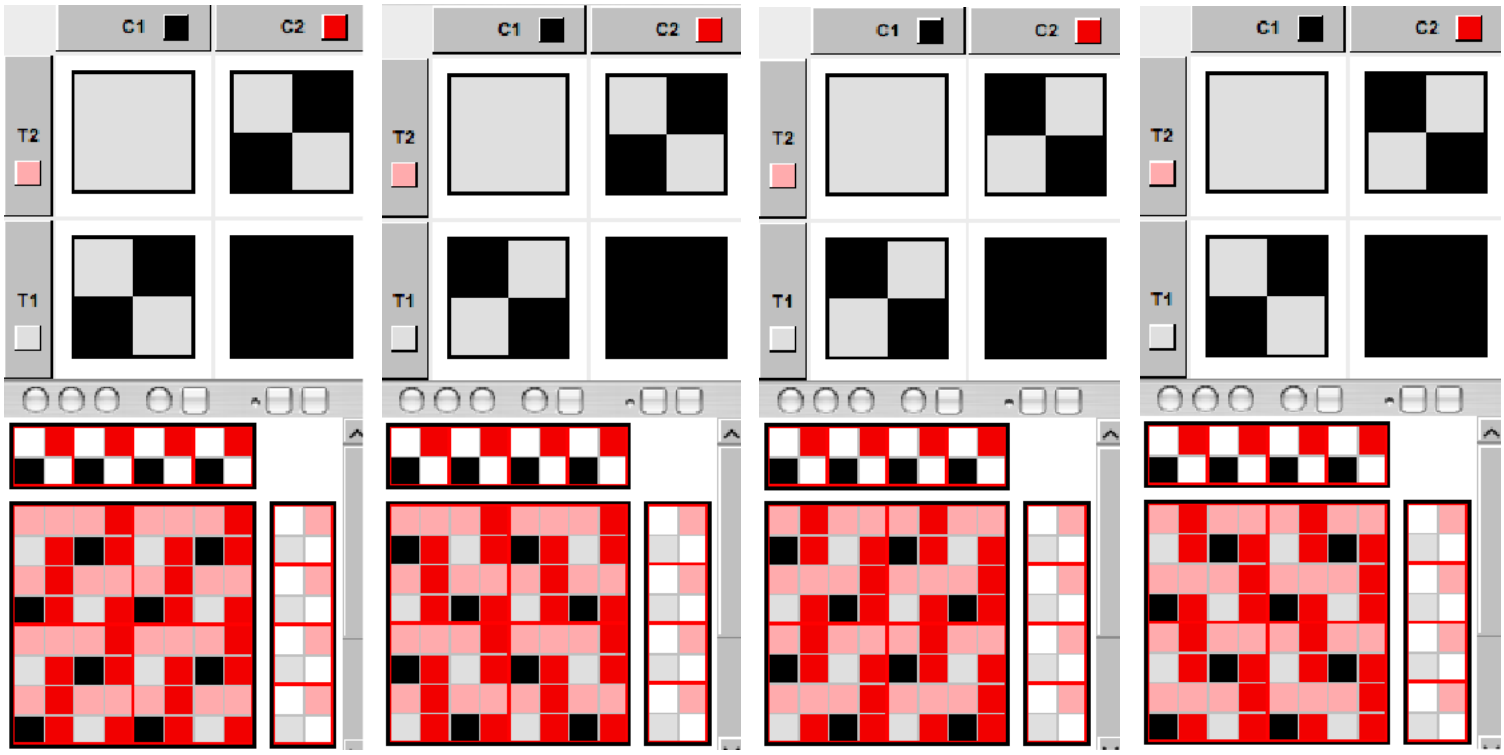


What are the departures of the other double plain weaves that produce the least floats at the transition with this weave structure?

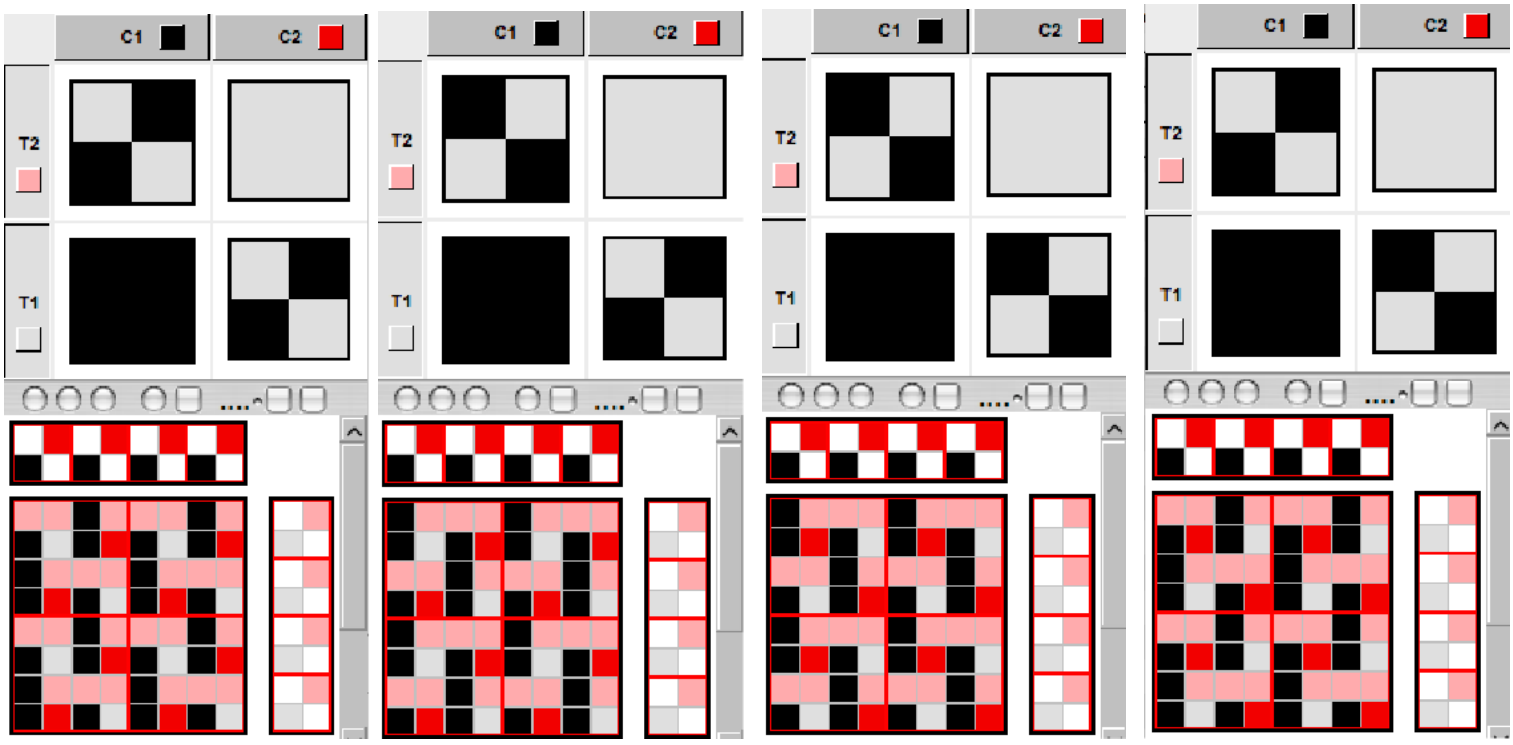
For the plain weave, there are two possible starts :  or 

Which gives us 4 cases of departures for each weave structures : plain weave red-pink, plain weave black-pink, plain weave red-gray

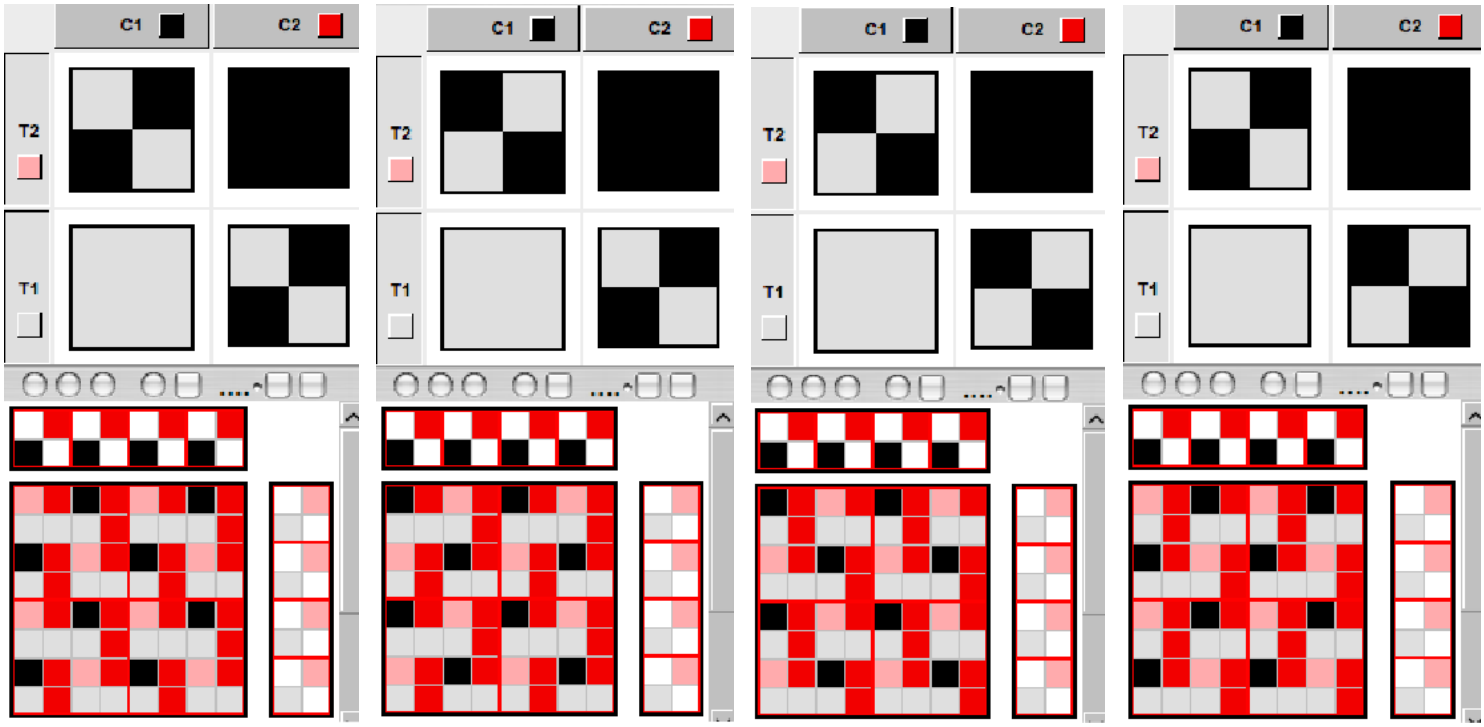
4 plain weaves red-pink



4 plain weaves black-pink

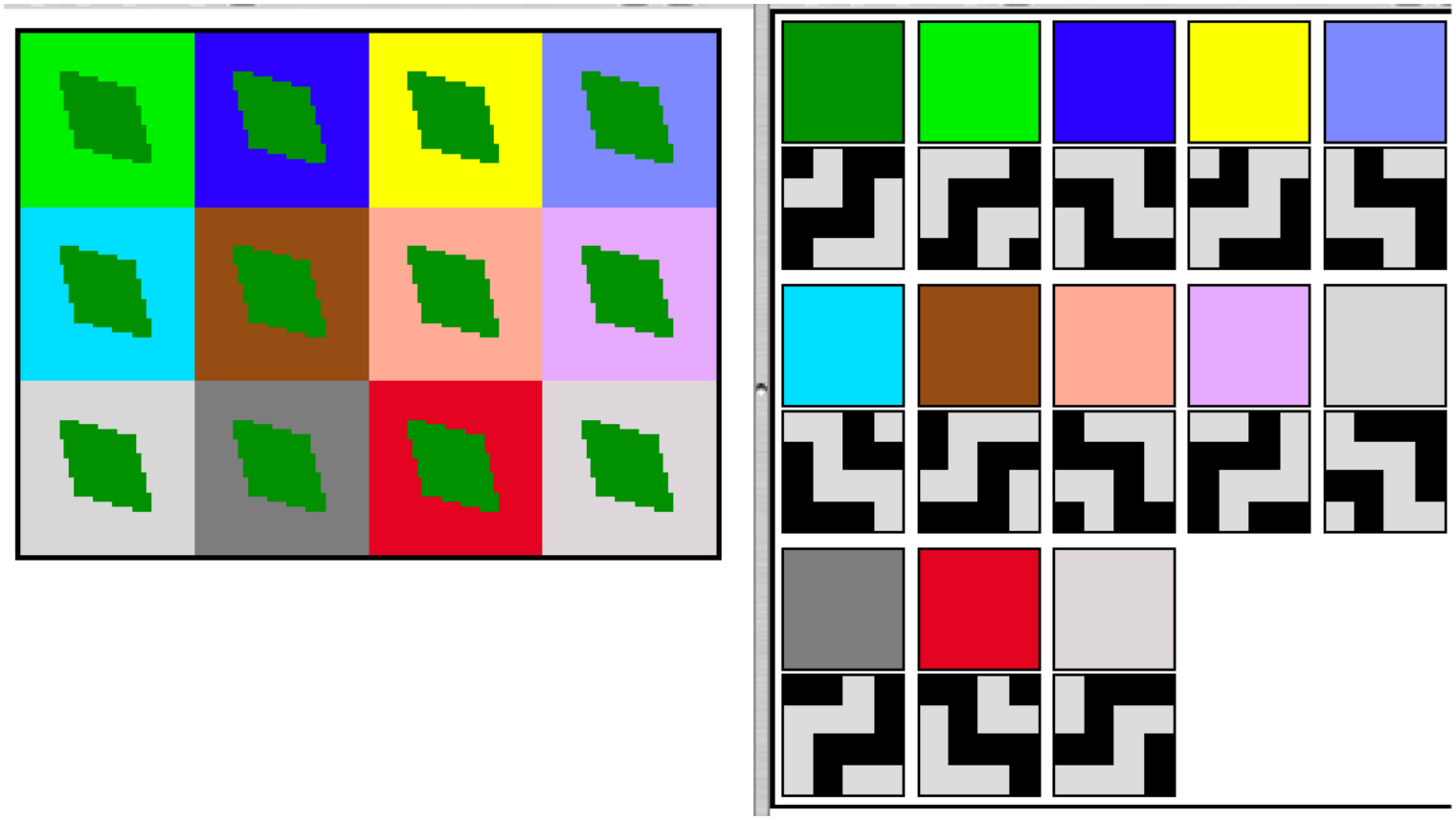


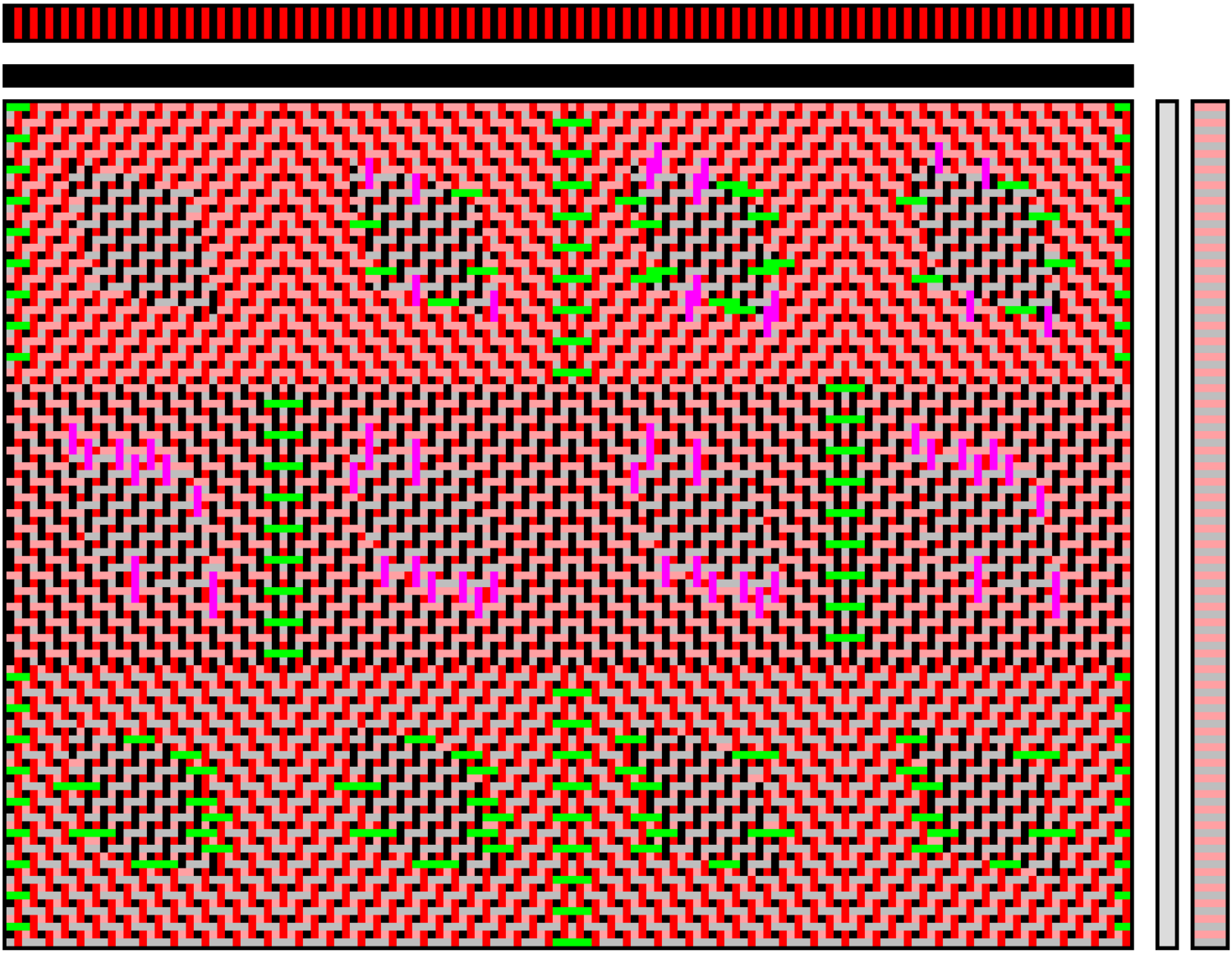
4 plain weaves red-gray



Let's now build a Jacquard with the double plain weave black-gray in the base surface, color 1, dark green.

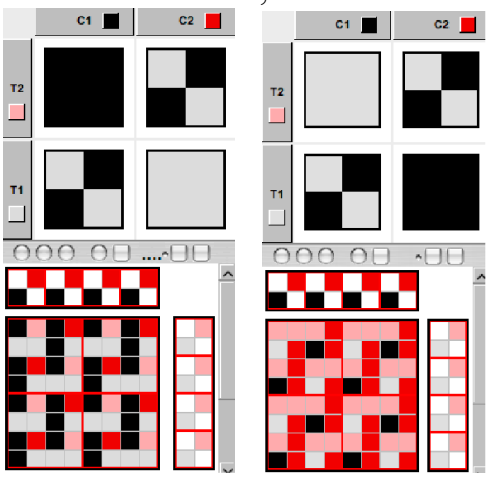
The backgrounds of the first row of squares include the 4 double plain weaves, red-pink.
The backgrounds of the second line of squares include the 4 double plain weaves, black-pink.
The backgrounds of the third row of squares include the four double plain weaves, red-gray.



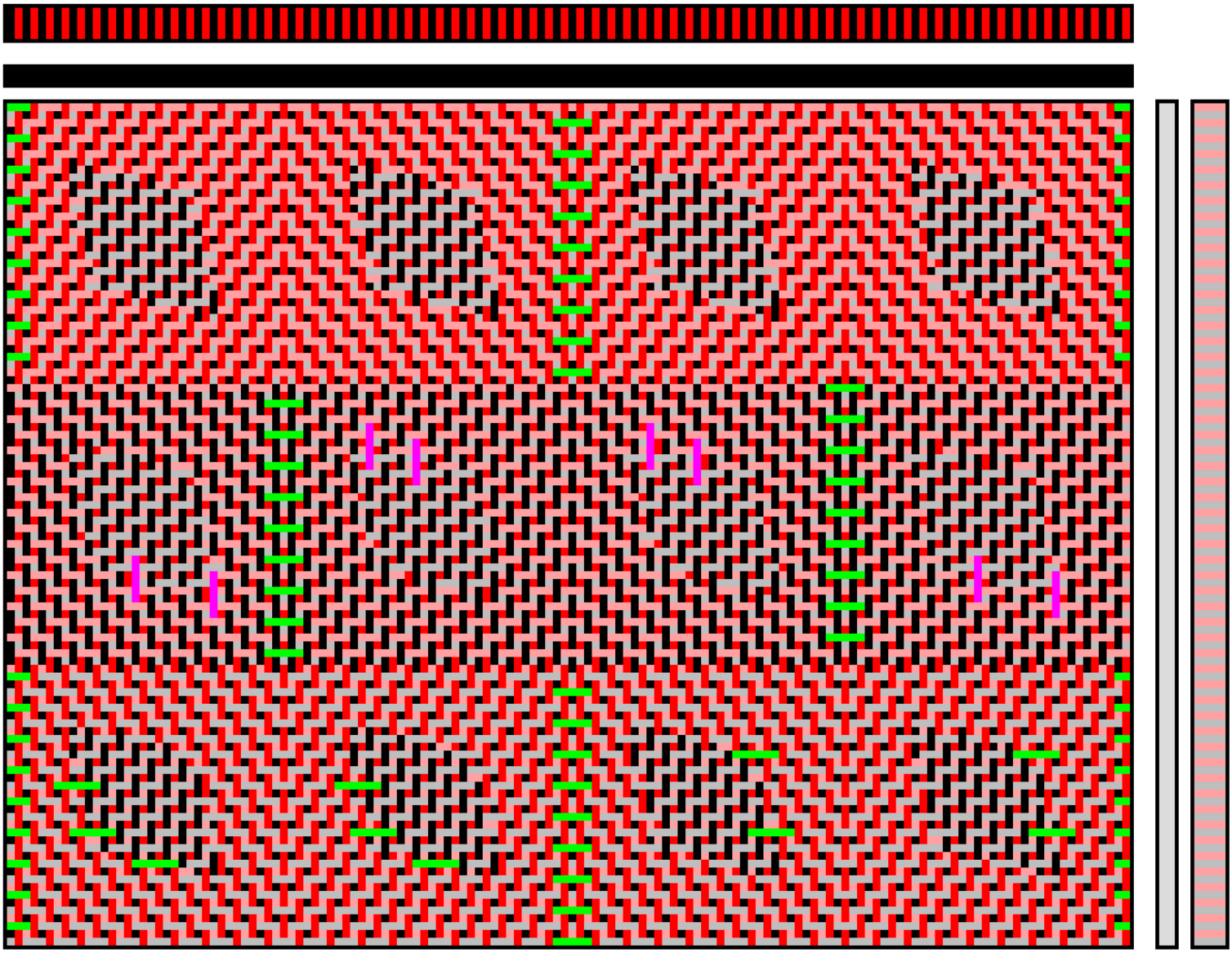


Only the first square at the top left has no floats of 4 pixels or more.
The second line of squares presents, 4 times 9 warp floats,
The third line of squares present, 10 floats, 10 floats, 9 floats, 9 weft floats.

The association double plain weave black-gray, double plain weave, red-pink  is therefore good.Plain weave with odd threads above, associated with plain weave even threads above.

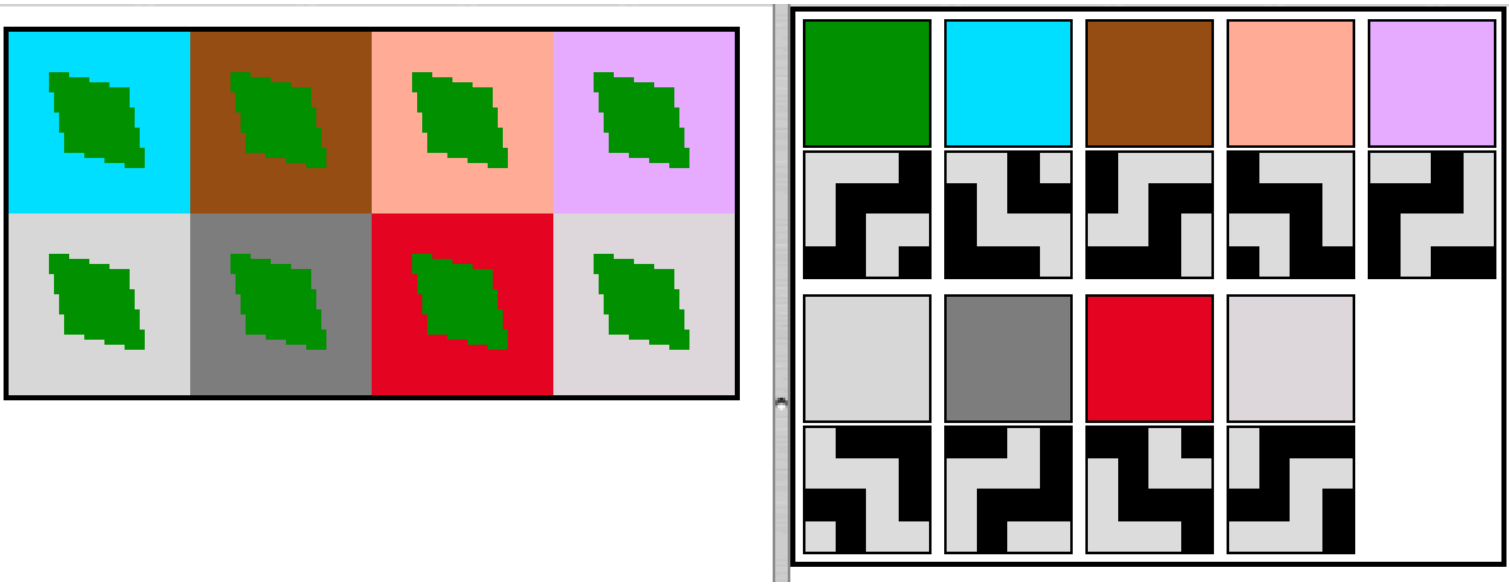


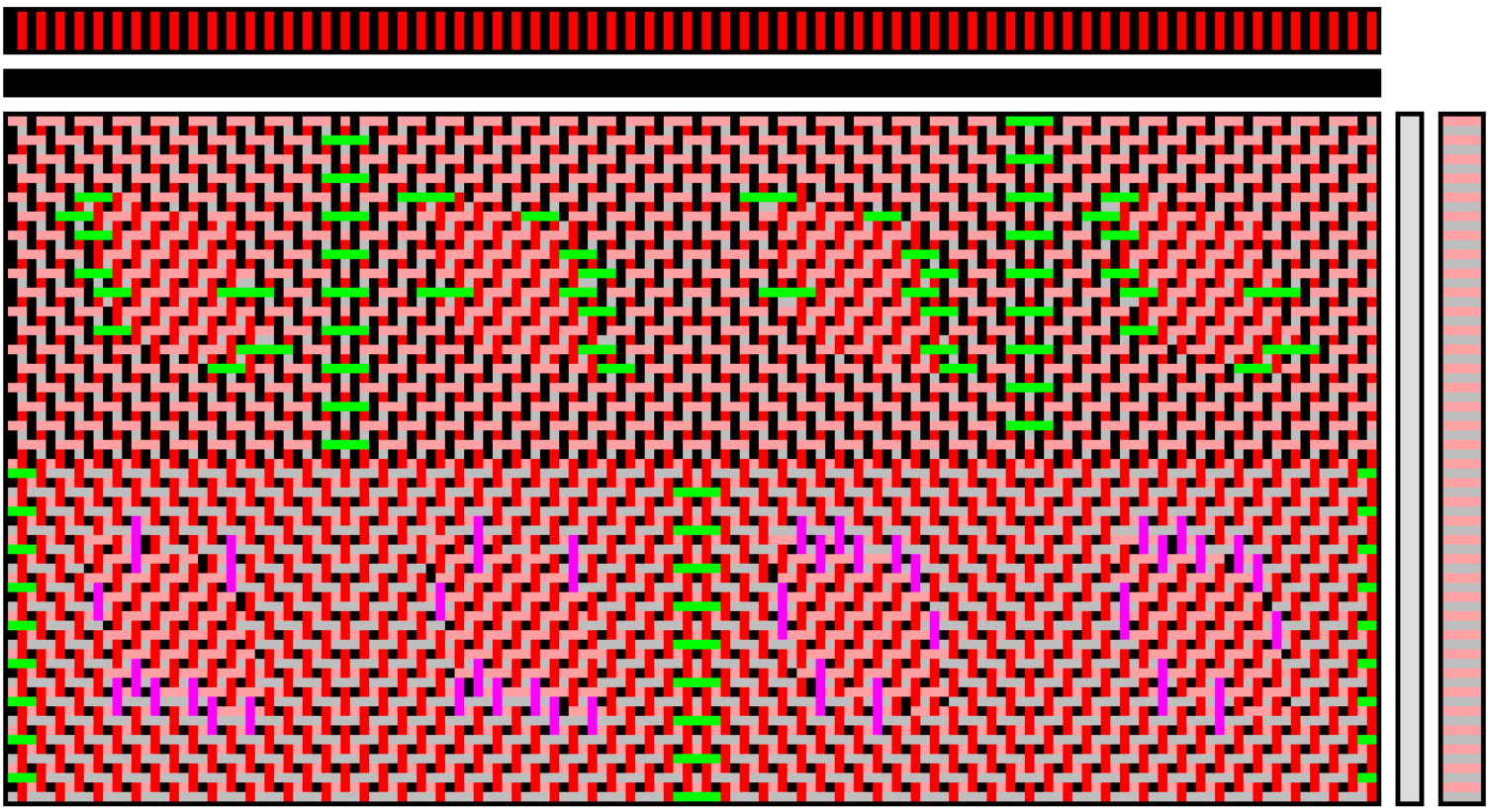
Now let's look at the floats of 5 pixels and more.



The second line of squares presents, 4 times 2 warp floats,
The third line of squares present, 3 floats, 3 floats, 2 floats, 2 weft floats.

Let's now look at how the red-pink double plain weave, opposable to the double plain weave black-gray of the departure, against other doubles plain weave.

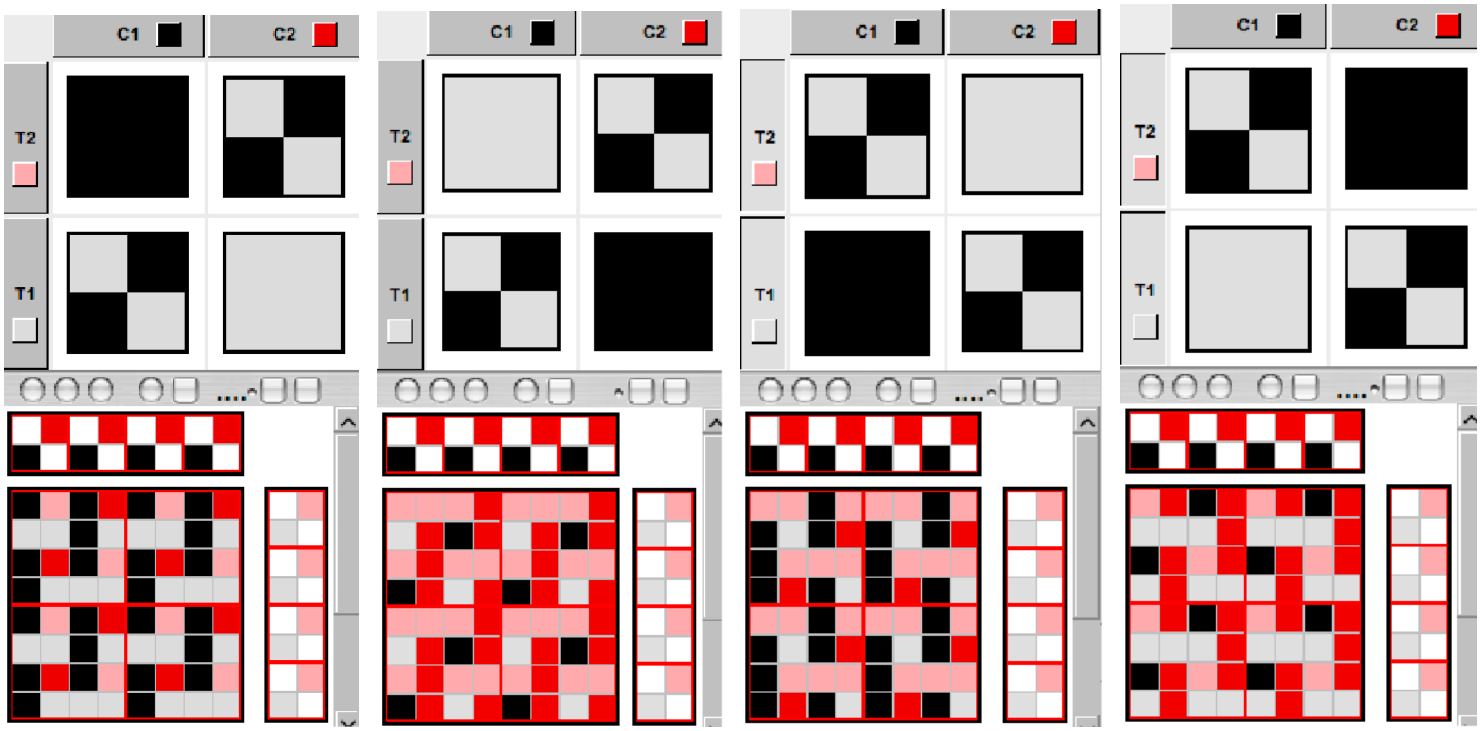




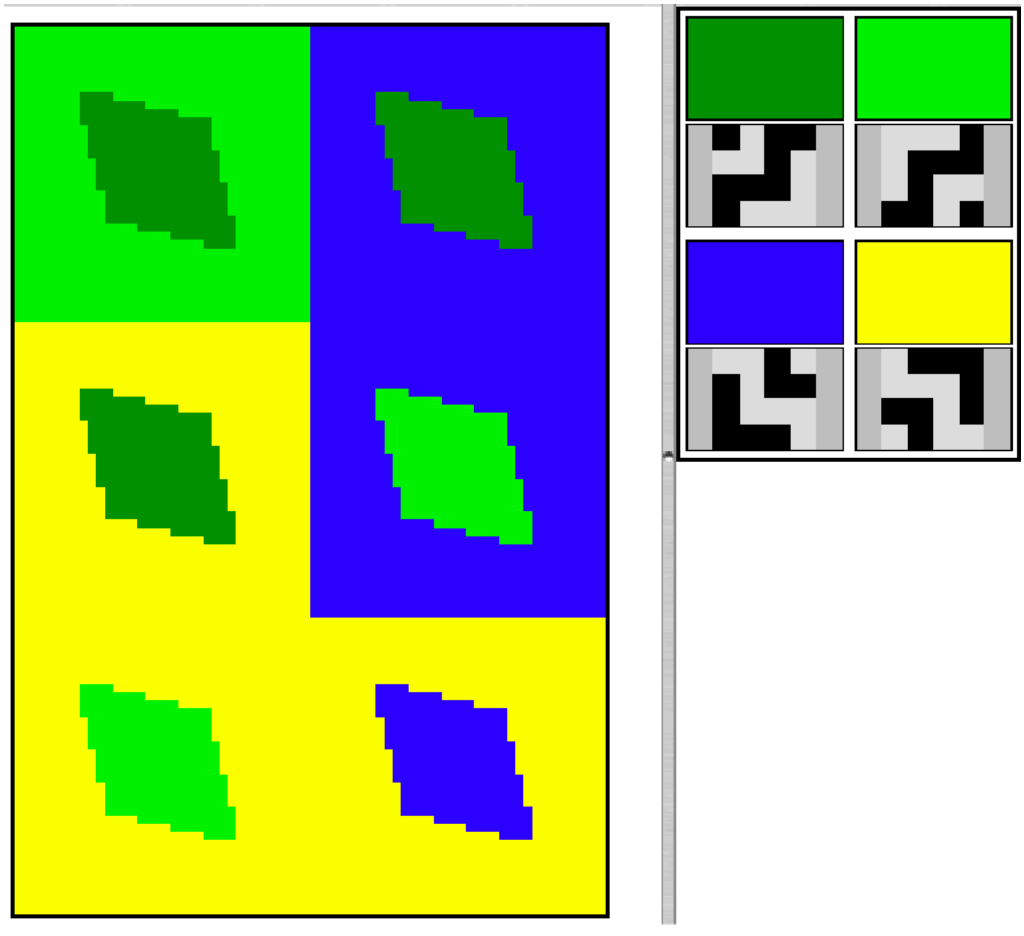
The first line of squares present, 4 times 9 weft floats,
The second row of squares present, 9 floats, 9 floats, 10 floats, 10 warp floats.

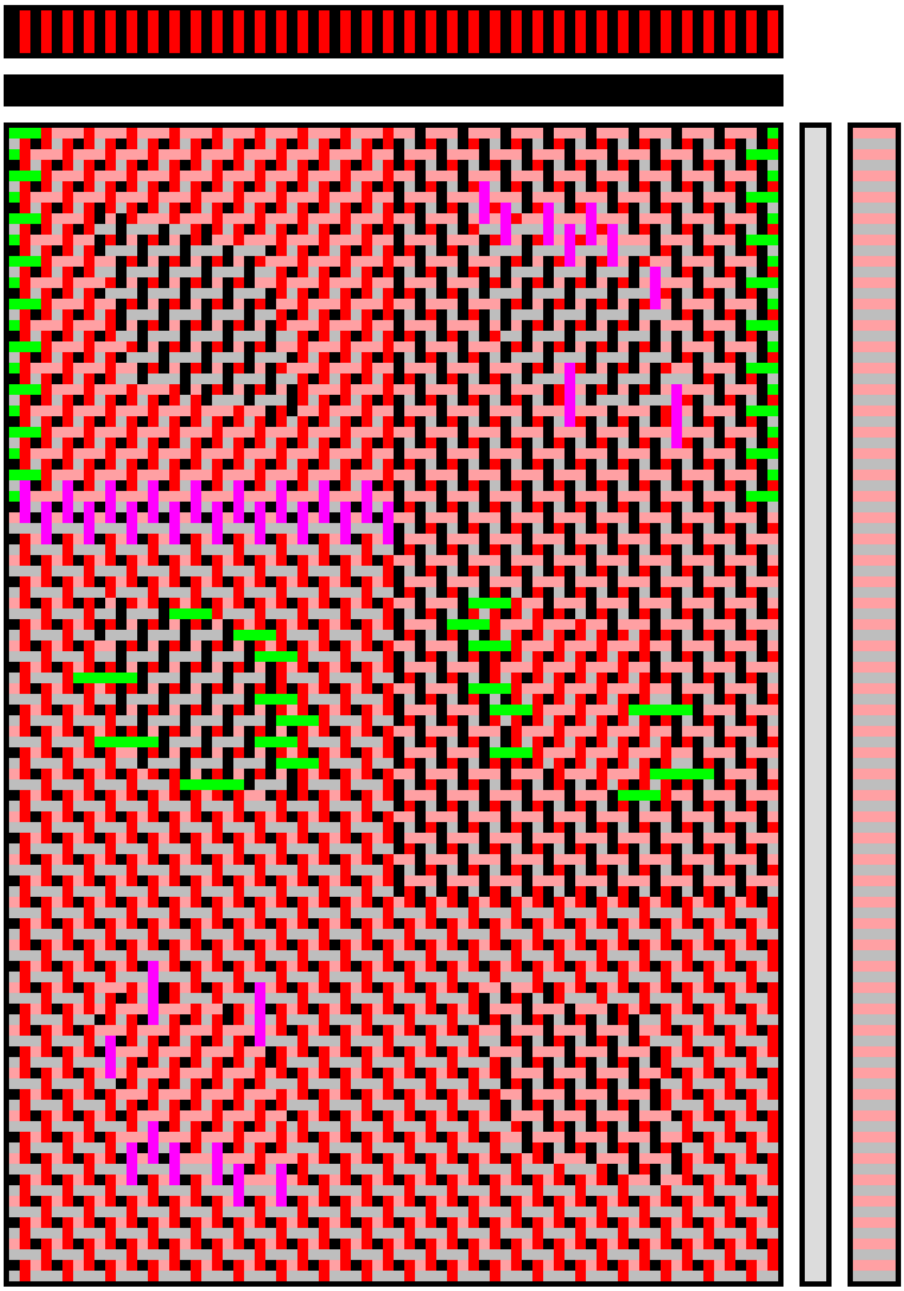
So there is not really a better choice. The 2 double plain weaves red-gray right are a little better opposed to the double plain weave black-gray but a little less good opposed to the double plain weave red-pink.

We can therefore stick to the most natural association of the following four double plain weaves.



Let's see all the transitions of these 4 weave structures between them :





The transition is without floats of 4 for :
- double plain weave black-gray opposed to double plain weave red-pink, top left (odd threads above opposed to even threads above)
- double plain weave black-pink opposed to double plain weave red-gray, lower right.

All other transitions will have floats of 4 or more.

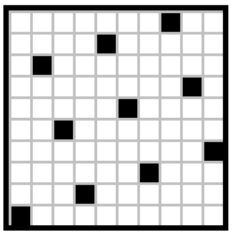
We now have a method to answer the question : are these two weave structures opposable between them ?

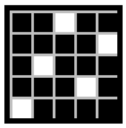
If the two weave structures do not have the same size, we will consider the two weave structures repeated at their LCM (least common multiple) in width and in height.

1) Build a basic surface presenting all border cases with all the pixels of the largest weave structure.
1) Construct a basic surface showing all the border cases, above, below, to the right and to the left, with all the pixels, that is to say 4 x LCM of the widths x LCM of the heights cases.
We will shift a black rectangle LCM of the widths x LCM of the heights, in width and in height.

2) Generate all the different starts of the smallest of the weave structure by shifting the warps and wefts of a Pointcarré multiple weave structure.

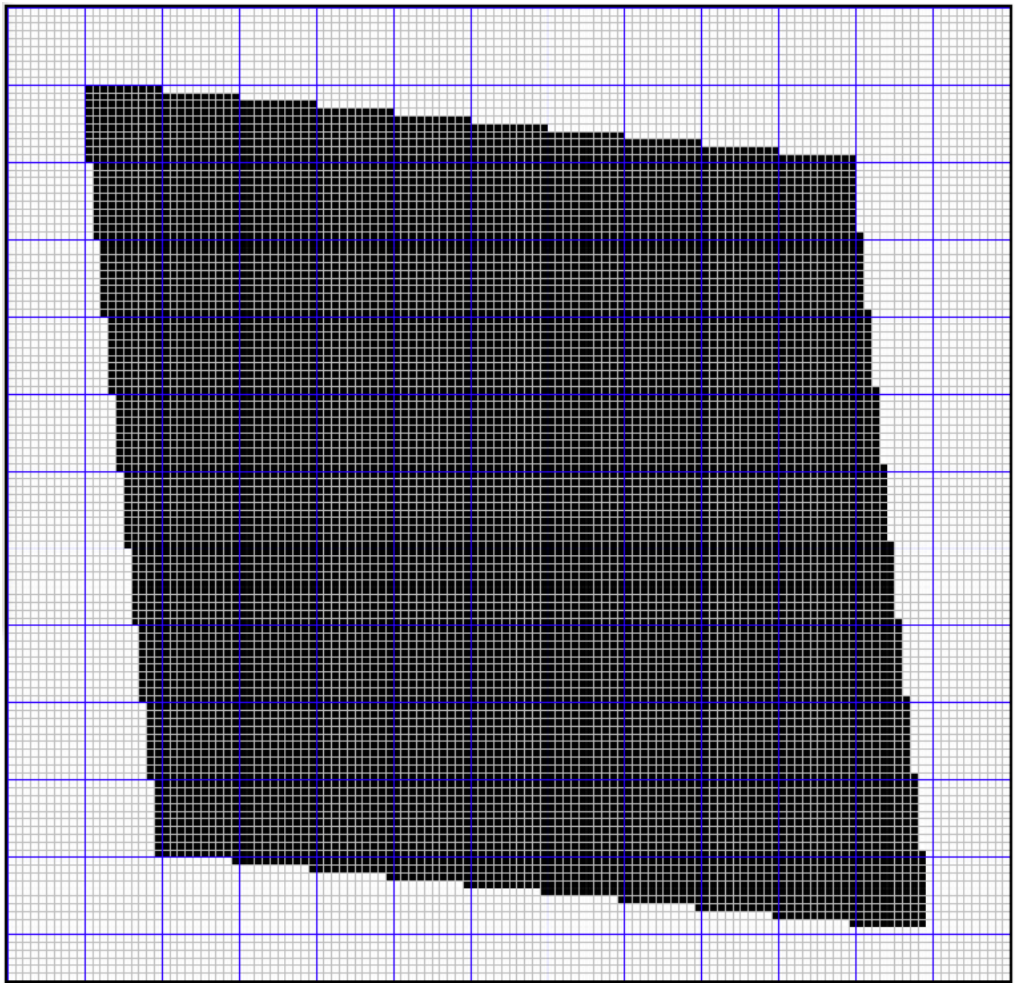
3) Visualize the floats of a Jacquard fabric consisting of squares with the base surface in the middle associated with the largest weave structure and as backgrounds the different starts of the smallest weave structures

Let's take an example with the 10 satin weft effect shift 3 

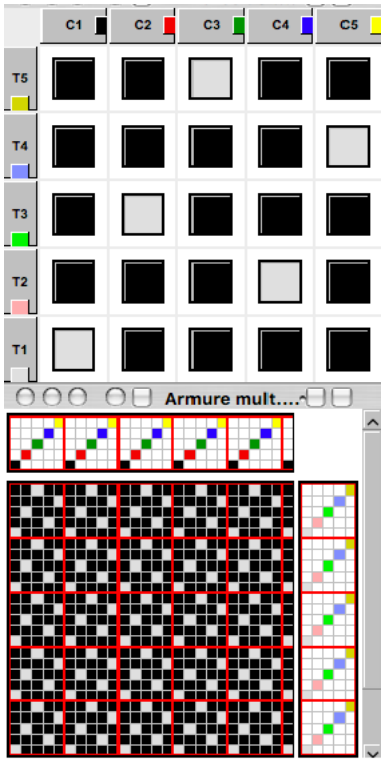
and the 5 satin warp effect shift 3 

The LCM of 10 and 5 is 10.

1) The base area of 10x10 = 100 pixels for each border, top, bottom, right and left.Or 400 cases.
We shift a black square 10x10, ten times in width and height.

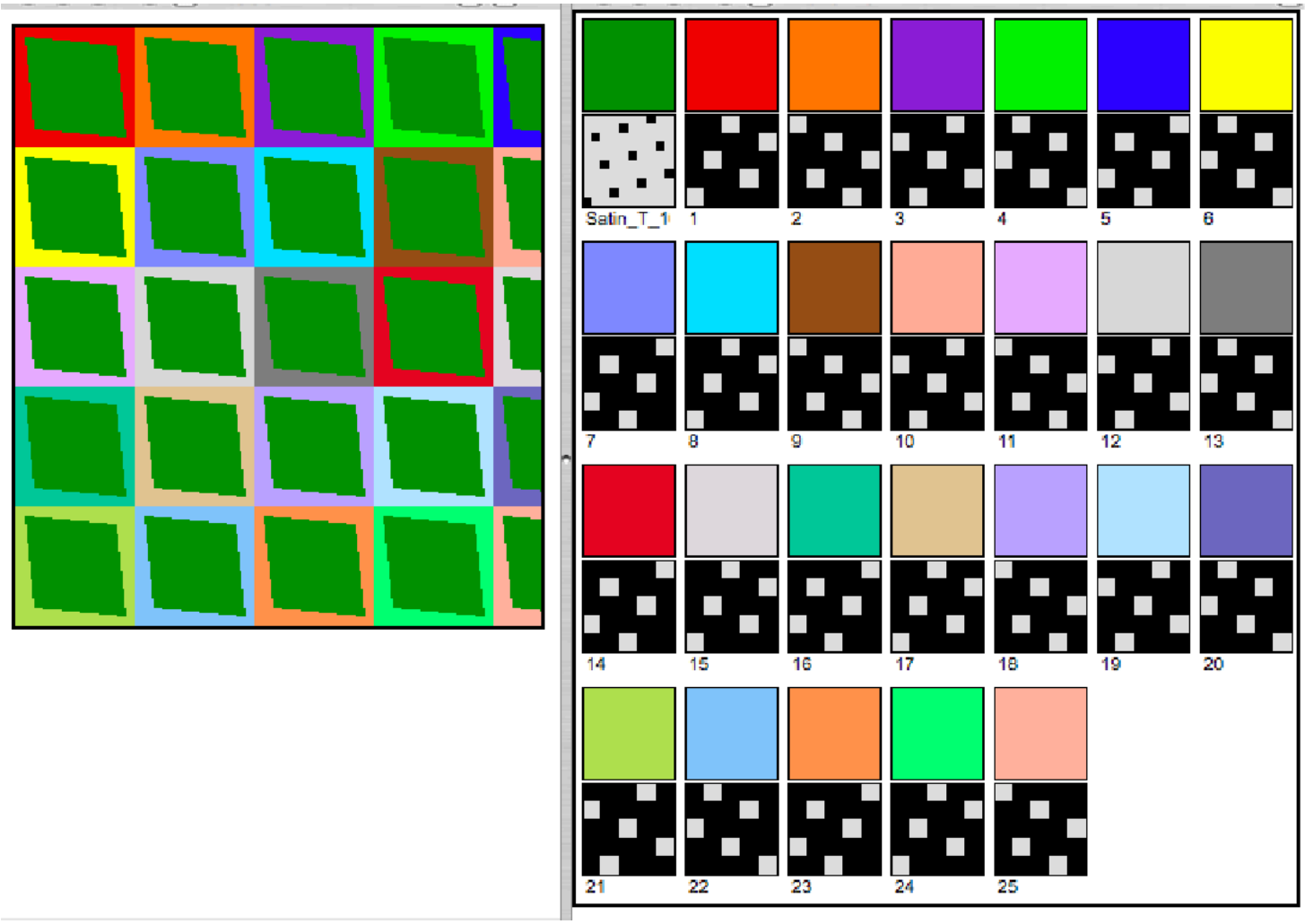


2) The multiple weave structure



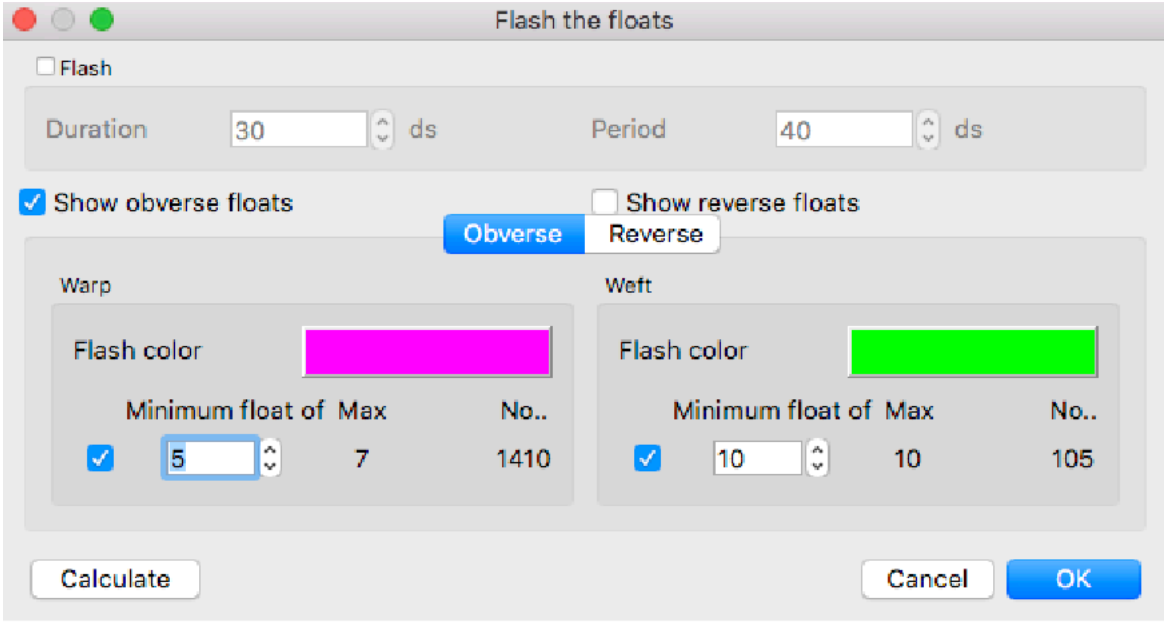
All possible starts generated by warps and wefts offset of the multiple weave structure :

3) The Jacquard with 25 squares for the 25 starts of the 5 satin and the base surface associated with the 10 satin.

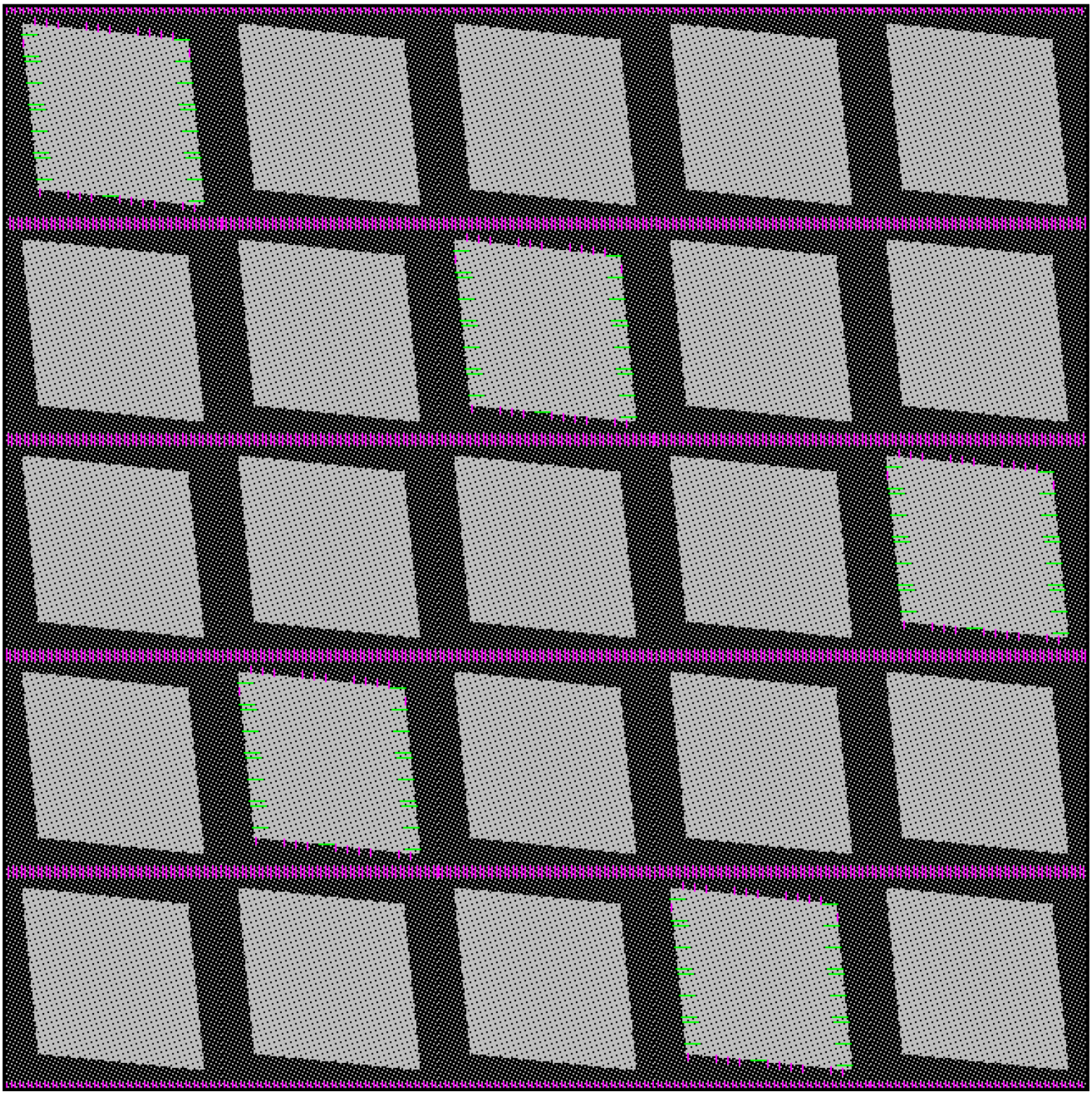


Visualization of the floats.
Warp floats maxi 1 for 10 satin and 4 for 5 satin ; the warp floats are flashed by 5 pixels or more.

Weft floats max 9 for 10 satin and 1 for 5 satin ; the weft floats are flashed by 10 pixels or more.

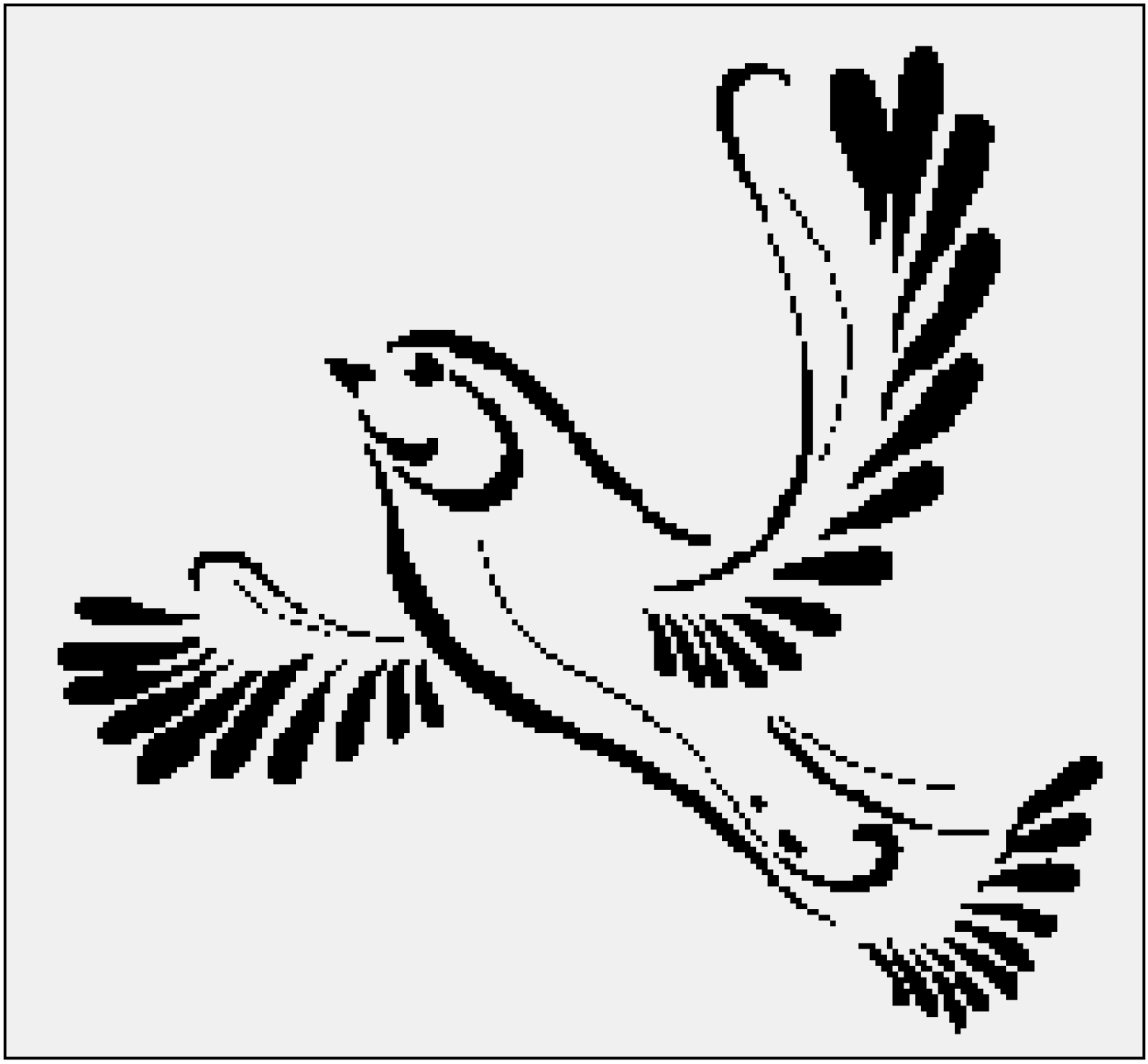


Here's the result :



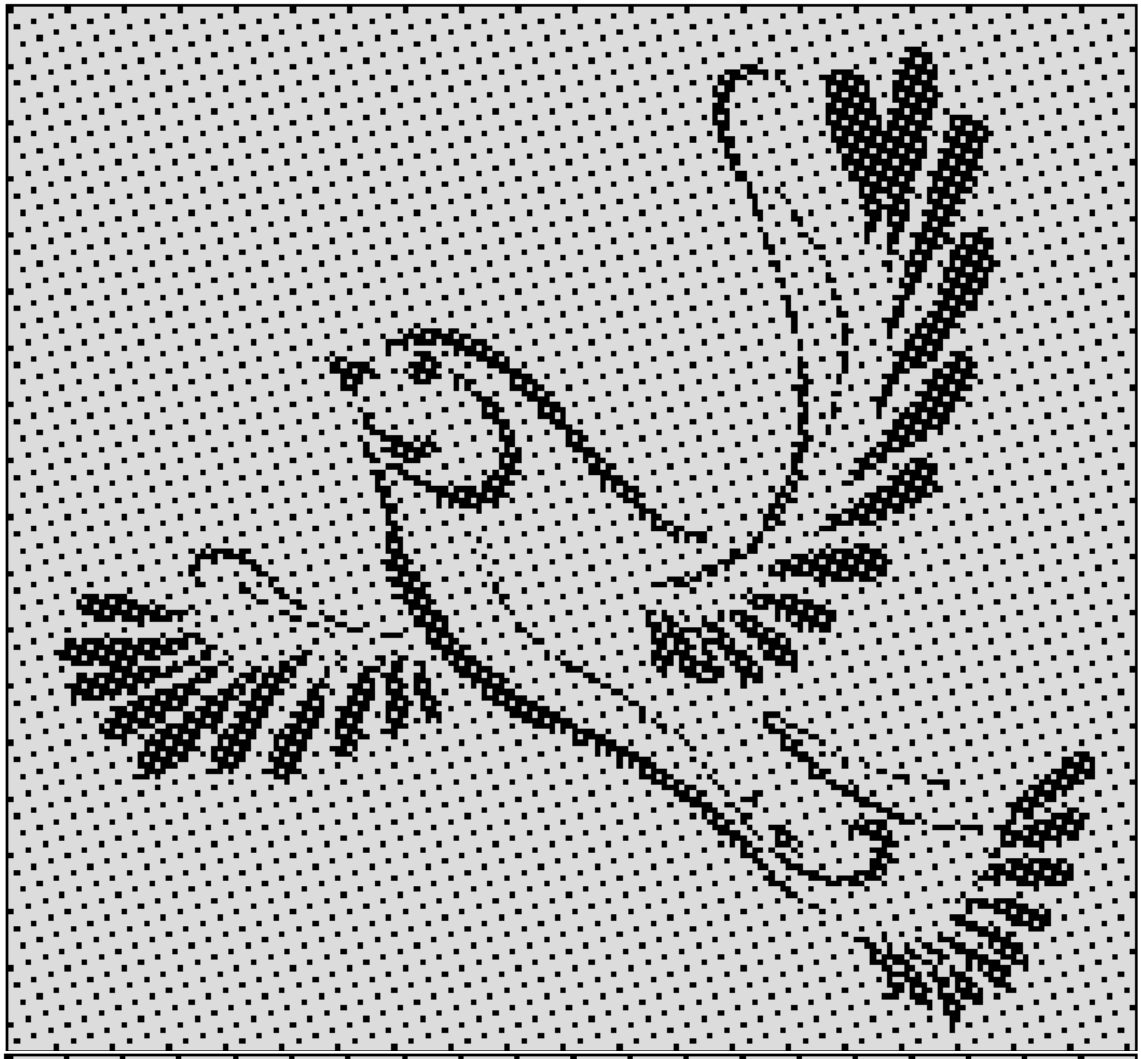
5 squares show floats and the others do not.

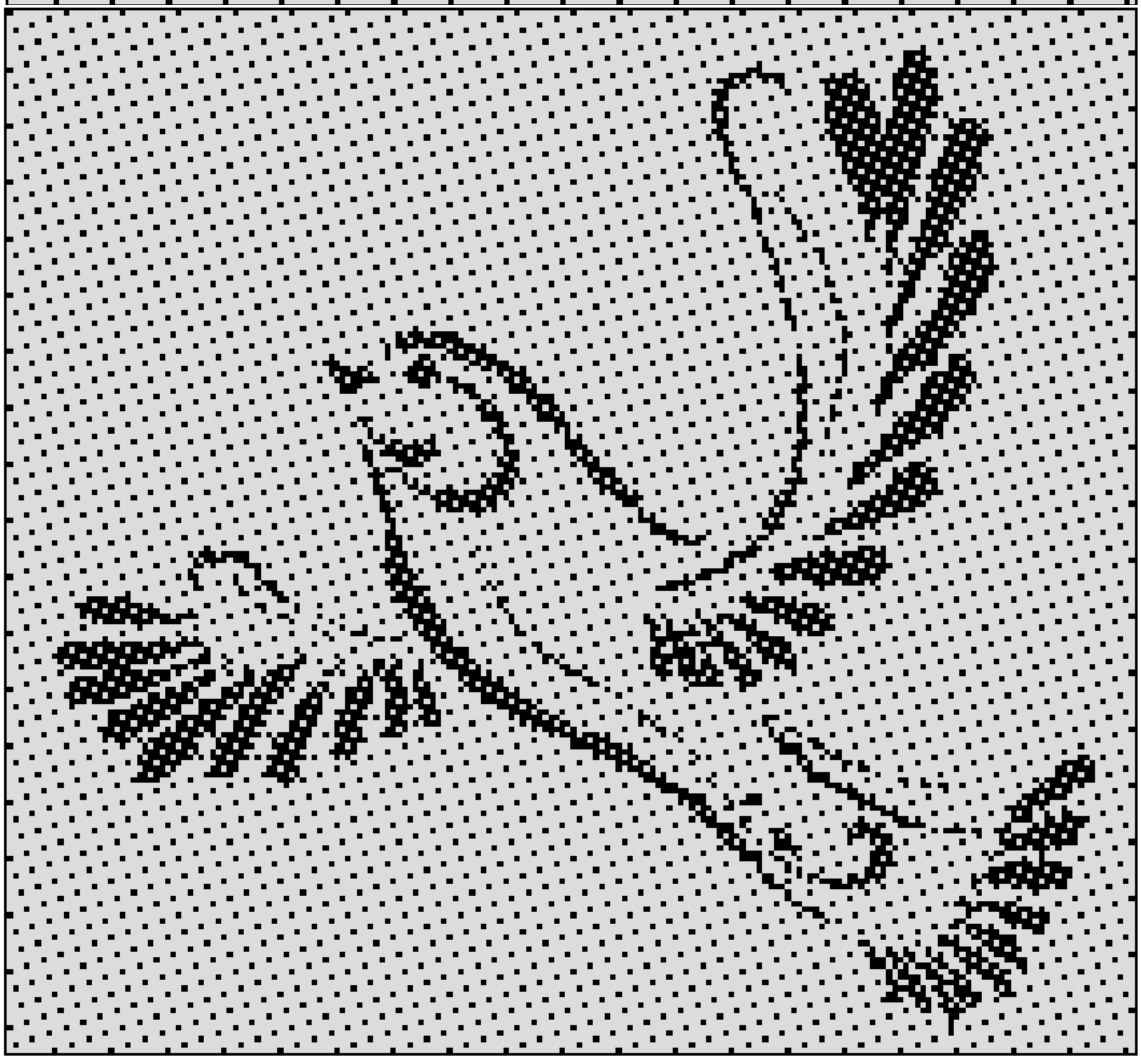
Let's apply this damask recipe with this bird as point paper :



With 5 satin starting  we get the fabric at the top of the next page:

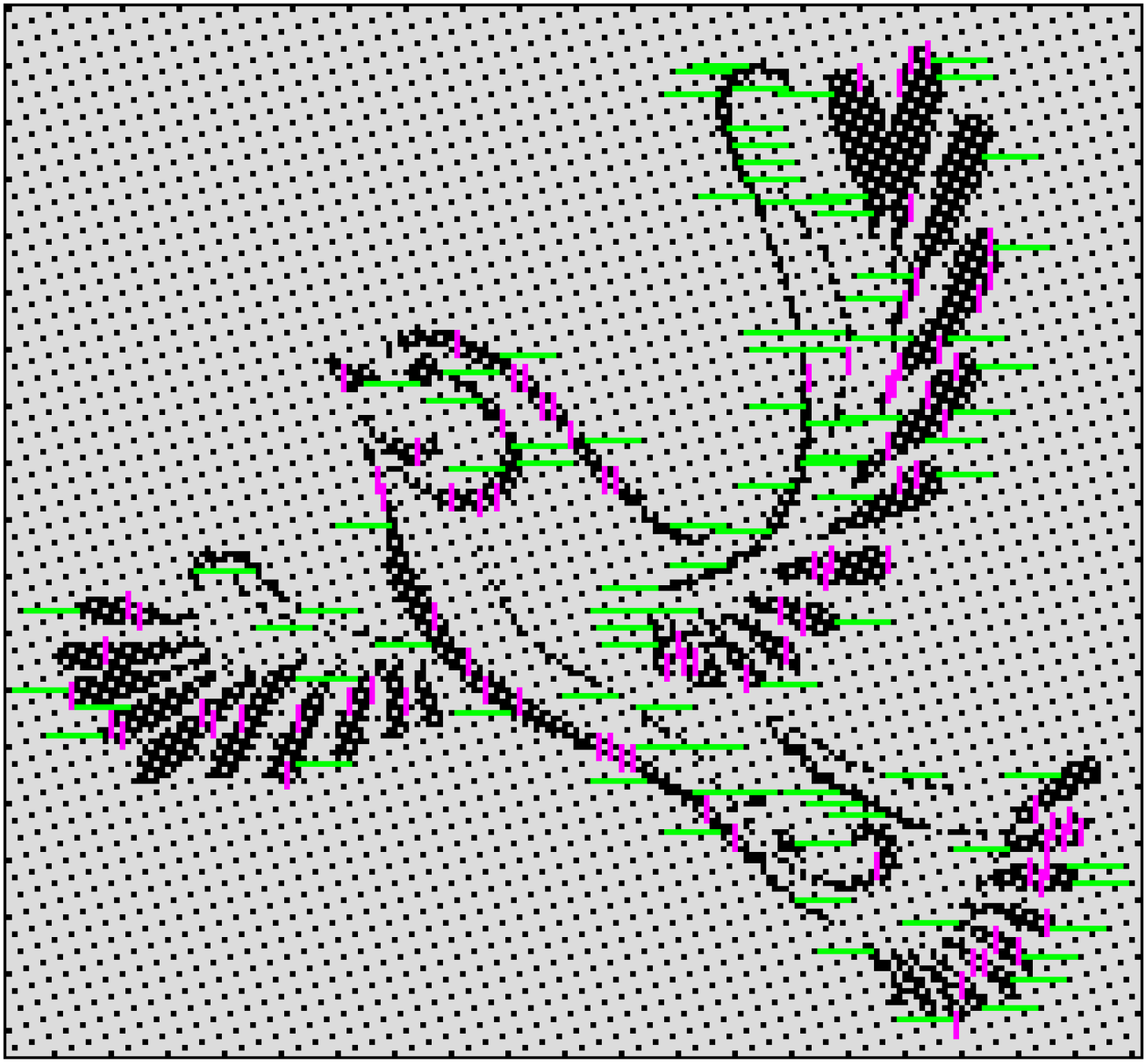
With 5 satin starting  we get the fabric at the bottom of the next page:





The point paper is represented more clearly in the first case. There are no extra floats at the borders of the drawing.

The second fabric, on the other hand, has many floats.



Definitions

Given two weave structures of the same size, with a horizontal repeat r.
Given a rectangular area of the size of the weave structures, divided vertically into a rectangle on the left and a rectangle on the right.
There are r cases of possible verticals, to the left of each column.
We fill the left with a weave structure by repeating the weave structure on the left on a horizontal repeat.
We fill the line with the other weave structure by repeating the other weave structure on the right on a horizontal repeat.
There are therefore 2 possible cases depending on whether the first weave structure is on the left or on the right.

We will say that the two weave structures are "opposable in width" if none of these 2 r cases produces a weft float greater than or equal to the horizontal repeat.

Given two weave structures of the same size, with a vertical repeat R
Given a rectangular area the size of the weave structures, divided horizontally into a rectangle above and a rectangle below.
There are R cases of possible horizontals, at the top of each row.
We fill the top with a weave structure by repeating the weave structure above on a vertical repeat.
We fill the bottom with the other weave structure by repeating the other weave structure below on a vertical repeat.
There are therefore 2 possible cases depending on whether the first weave structure is above or below.

We will say that the two weave structures are "opposable in height" if none of these 2 R cases produces a chain float greater than or equal to the vertical repeat.

We will say that the two weave structures are “opposable” if they are “opposable in width” and “opposable in height”.

If we want to study two weave structures of different sizes, we will consider the two weave structures repeated at their LCM in width and in height.

Conclusion

It is better to take a little time to study weave structure sympathy, rather than correct the floats afterwards.

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