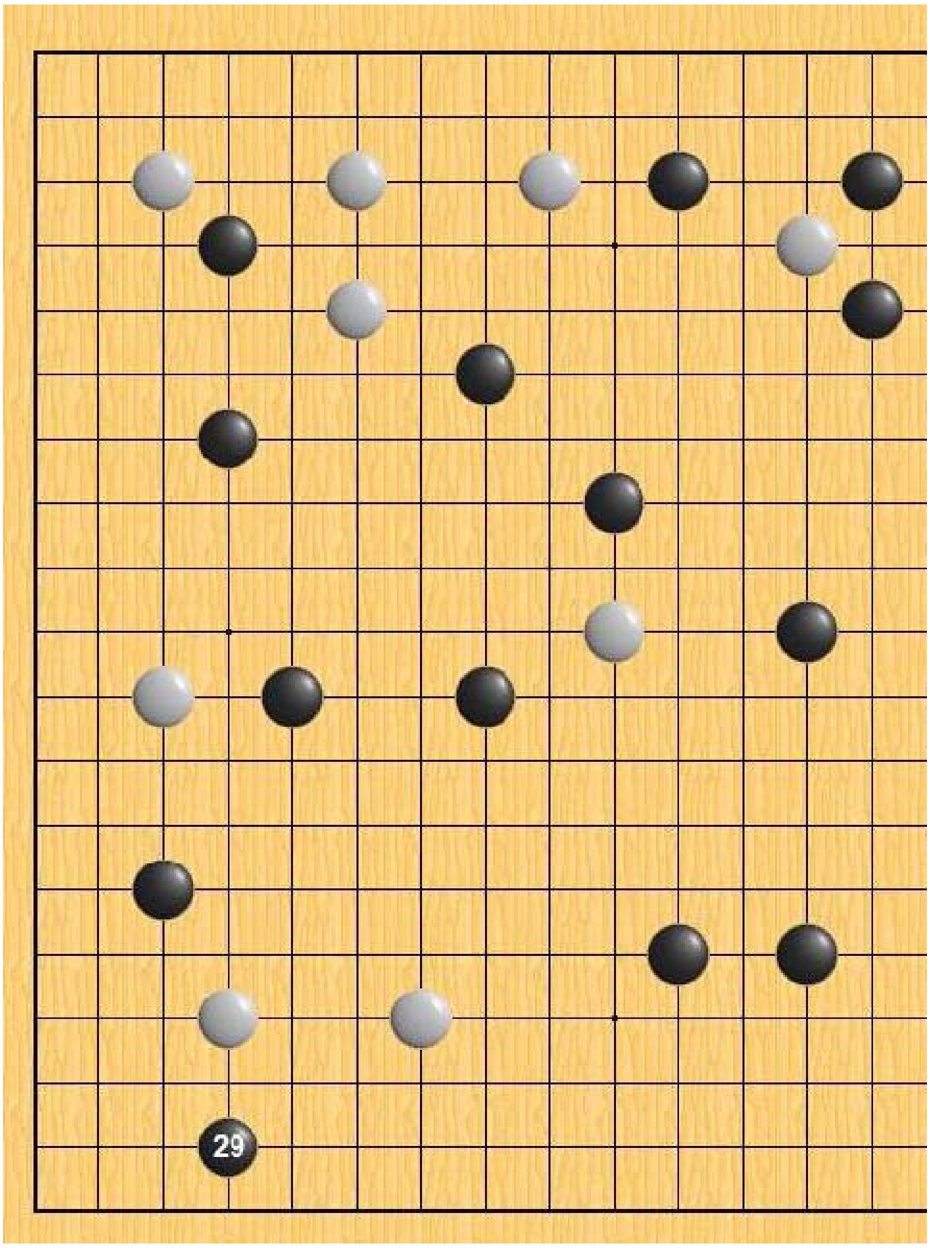
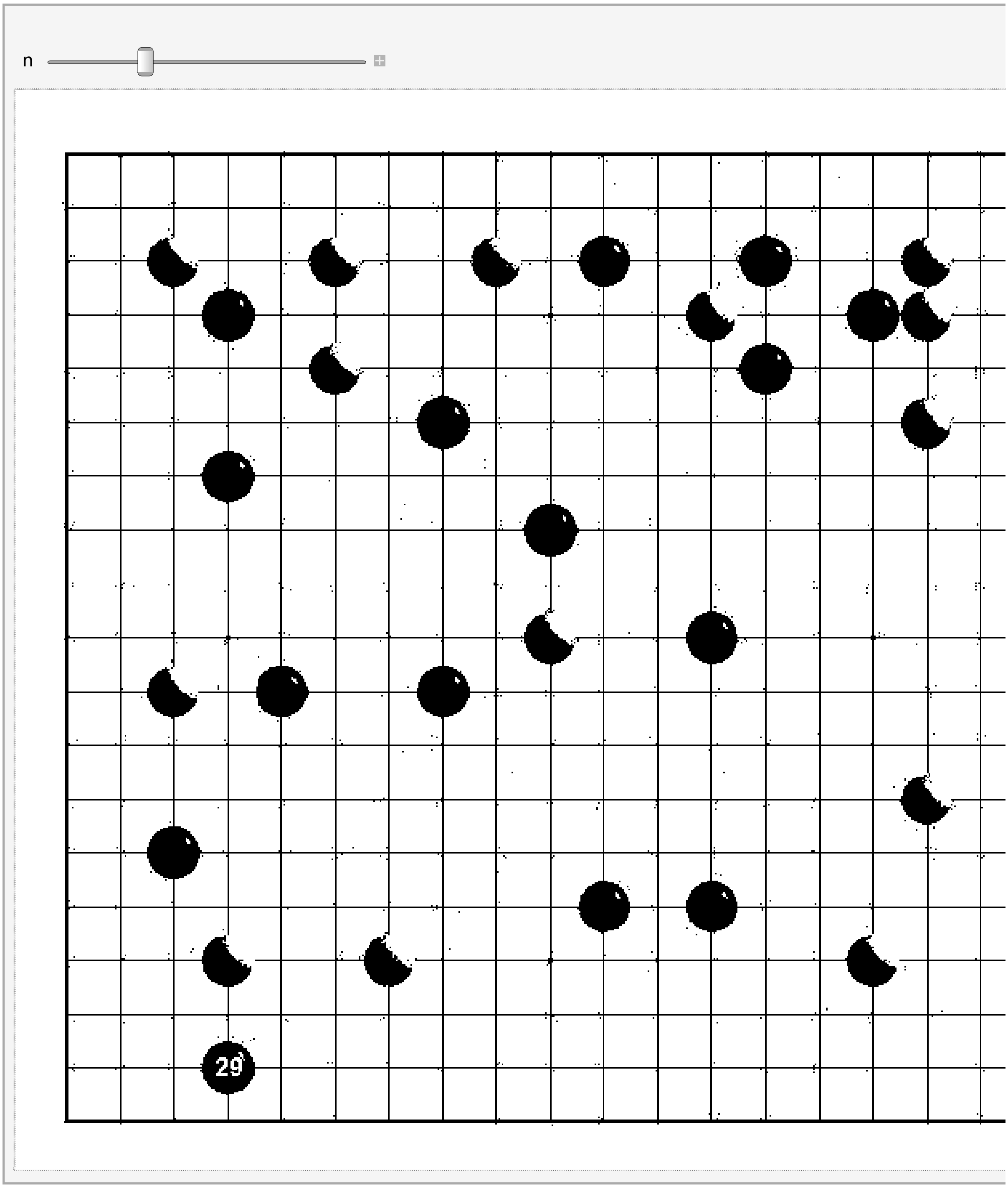
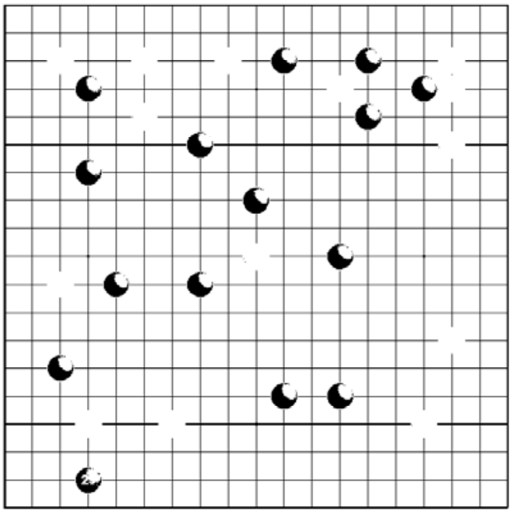
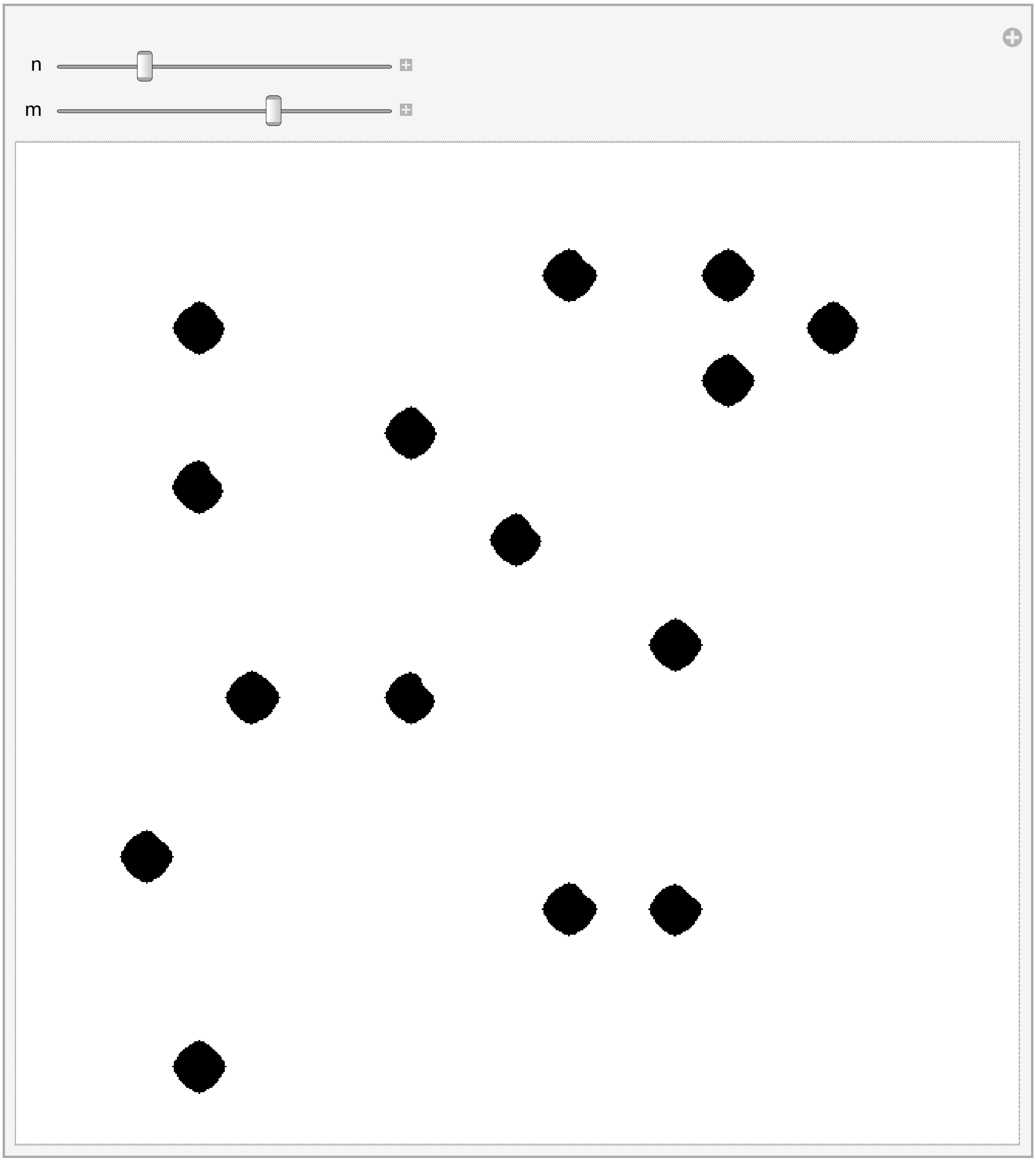
`Manipulate[Binarize[`


n
29

In[110]:= **img1 = ImageCrop[**  **];**

```
Manipulate[Closing[Opening[img1, DiskMatrix[n]], DiskMatrix[m]],
 {n, 10, 1}, {m, 1, 10, 1}]
```



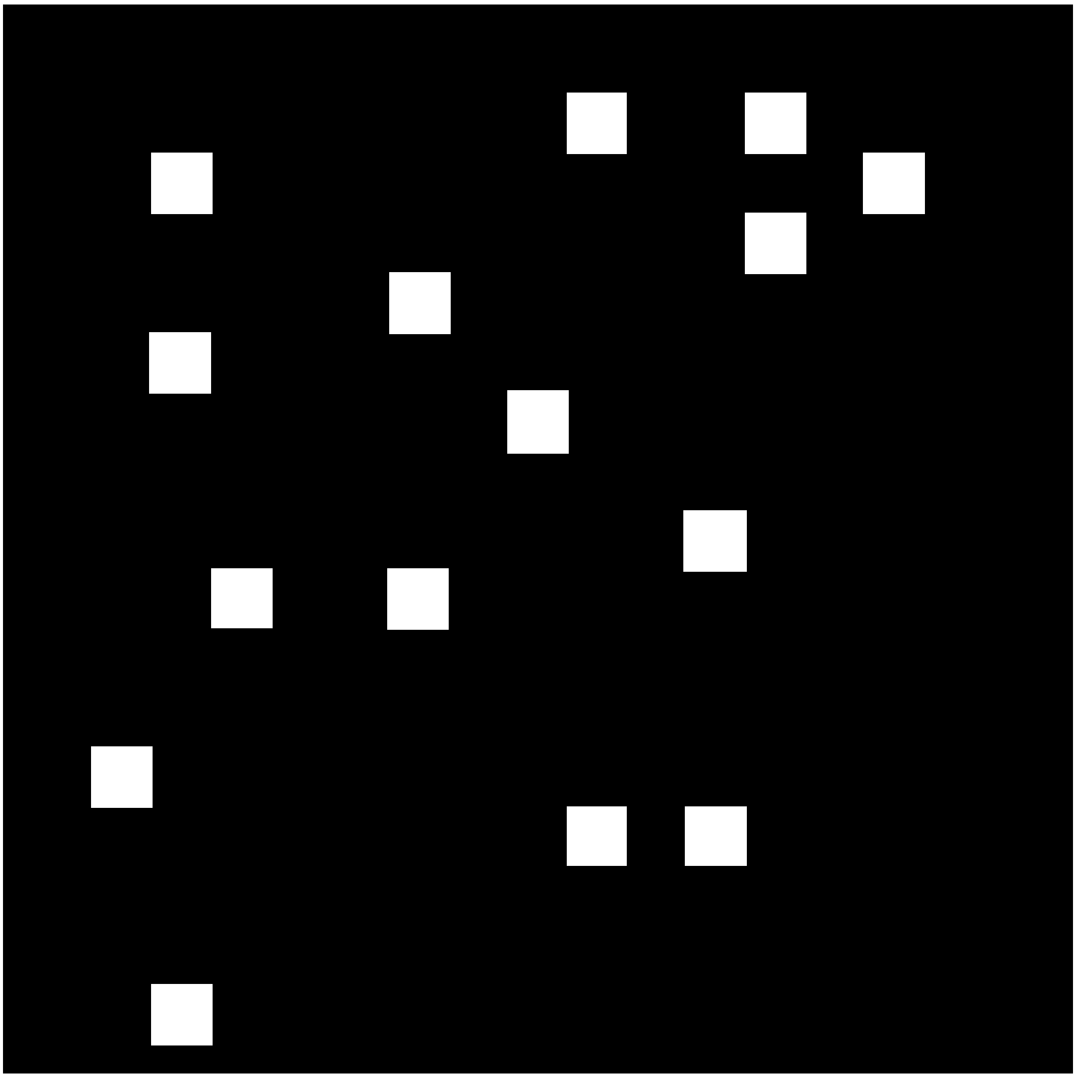
```
In[111]:= dim = 18 IntegerPart[ImageDimensions[img1][[1]]
                               ─────────────────────────
                                          18              ]

Out[111]= 612
```

```
In[169]:= imgBlack = ImageResize[ (image) , dim, AspectRatio → 1];
```

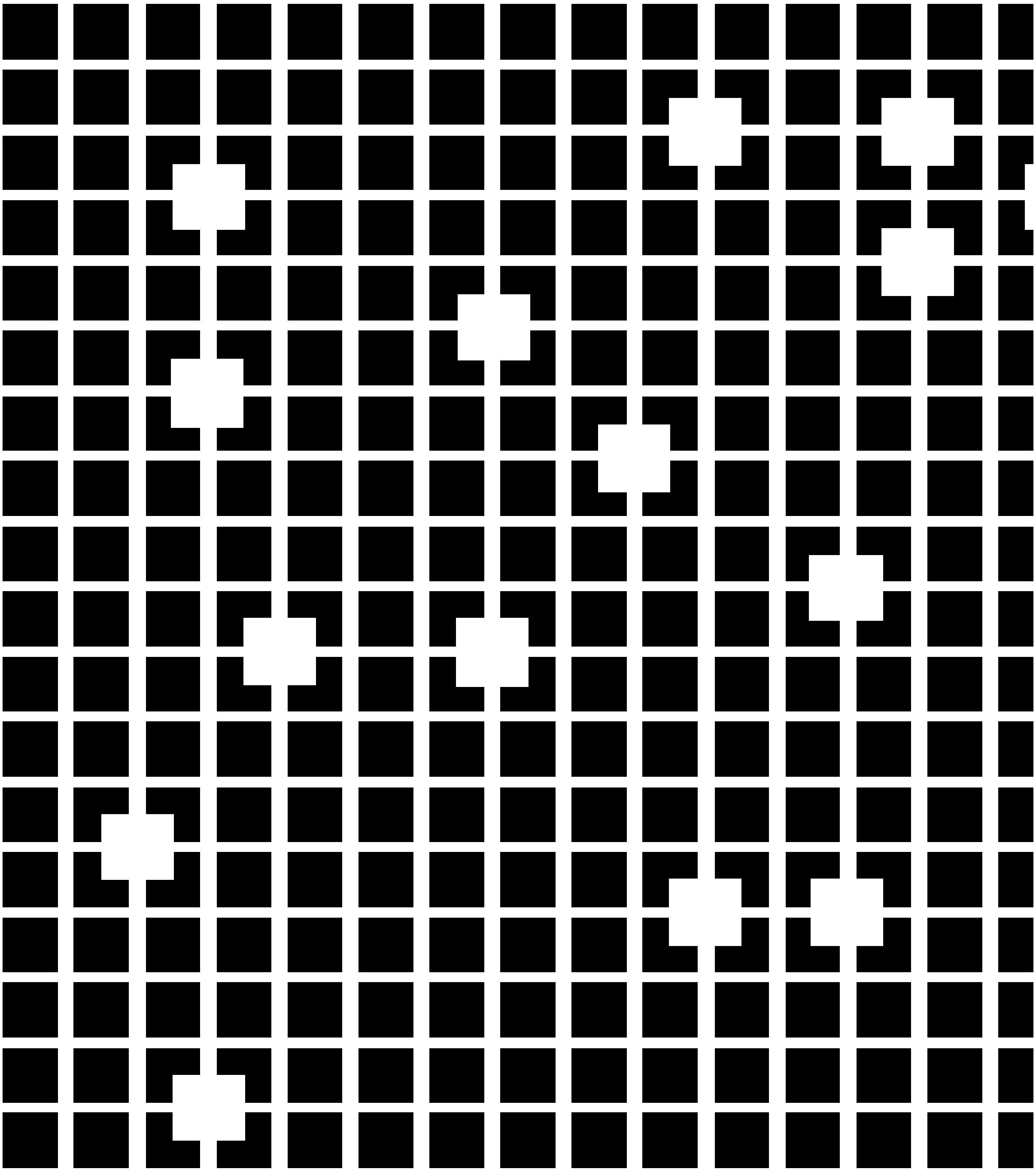
```
In[170]:= imgBlackCubs = Dilation[Dilation[imgBlack // ColorNegate, 17] // Thinning, 17]
```

Out[170]=



```
In[171]:= ImagePartition[imgBlackCubs, dim / 18] // Grid
```

Out[171]=



```
In[172]:= imageBlackMatrix = ImageResize[imgBlackCubs, {36, 36}] // ImageData;
          imageBlackMatrix // MatrixForm
```

```
Out[173]//MatrixForm=
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 0 0 0 0 1 1 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 0 0 0 0 1 1 0 0 0 0 0 0 0 0 0
0 0 0 0 0 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 0 0 0 0 0
0 0 0 0 0 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 1 1 0 0 0 0 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 1 1 0 0 0 0 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 0 0 1 1 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 0 0 1 1 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
```
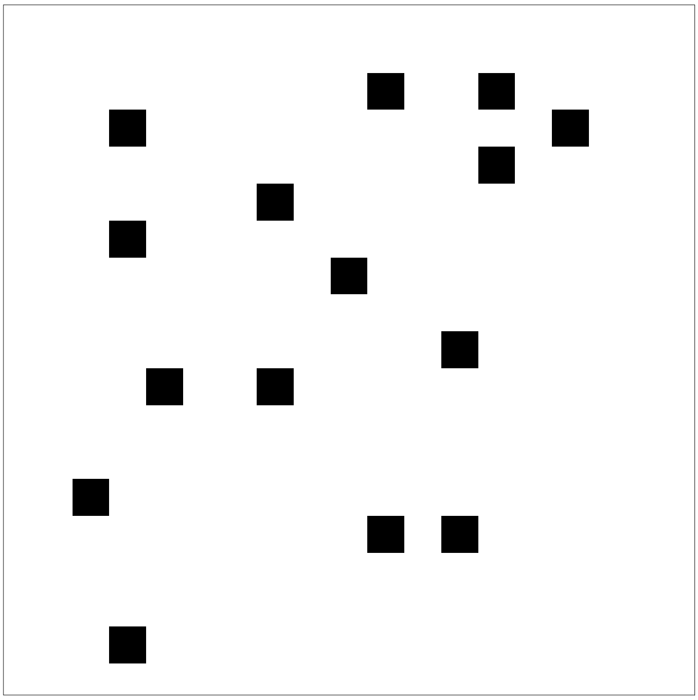

In[174]:=
```
ArrayPlot[imageBlackMatrix]
```

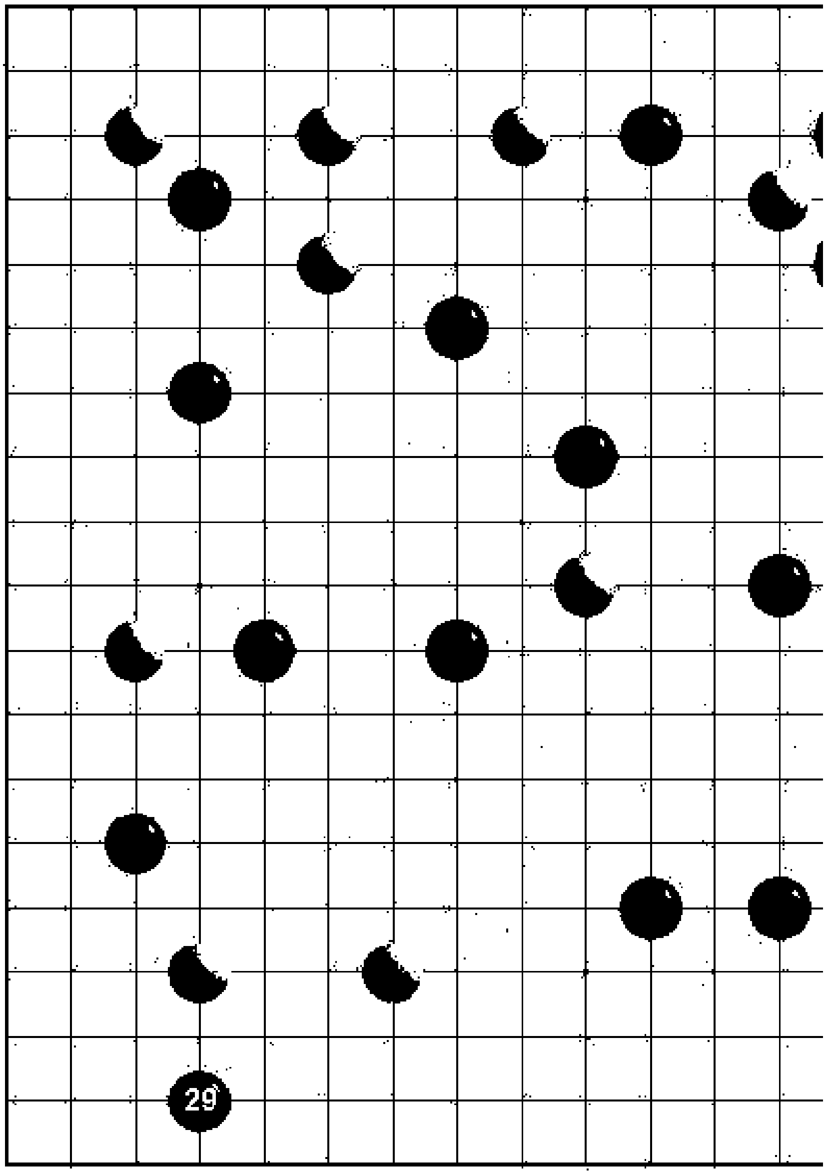
Out[174]=



In[175]:=
```
clusters = FindClusters[Position[imageBlackMatrix, 1],
    Count[Flatten@imageBlackMatrix, 1] / 4, Method → "Agglomerate"];
```

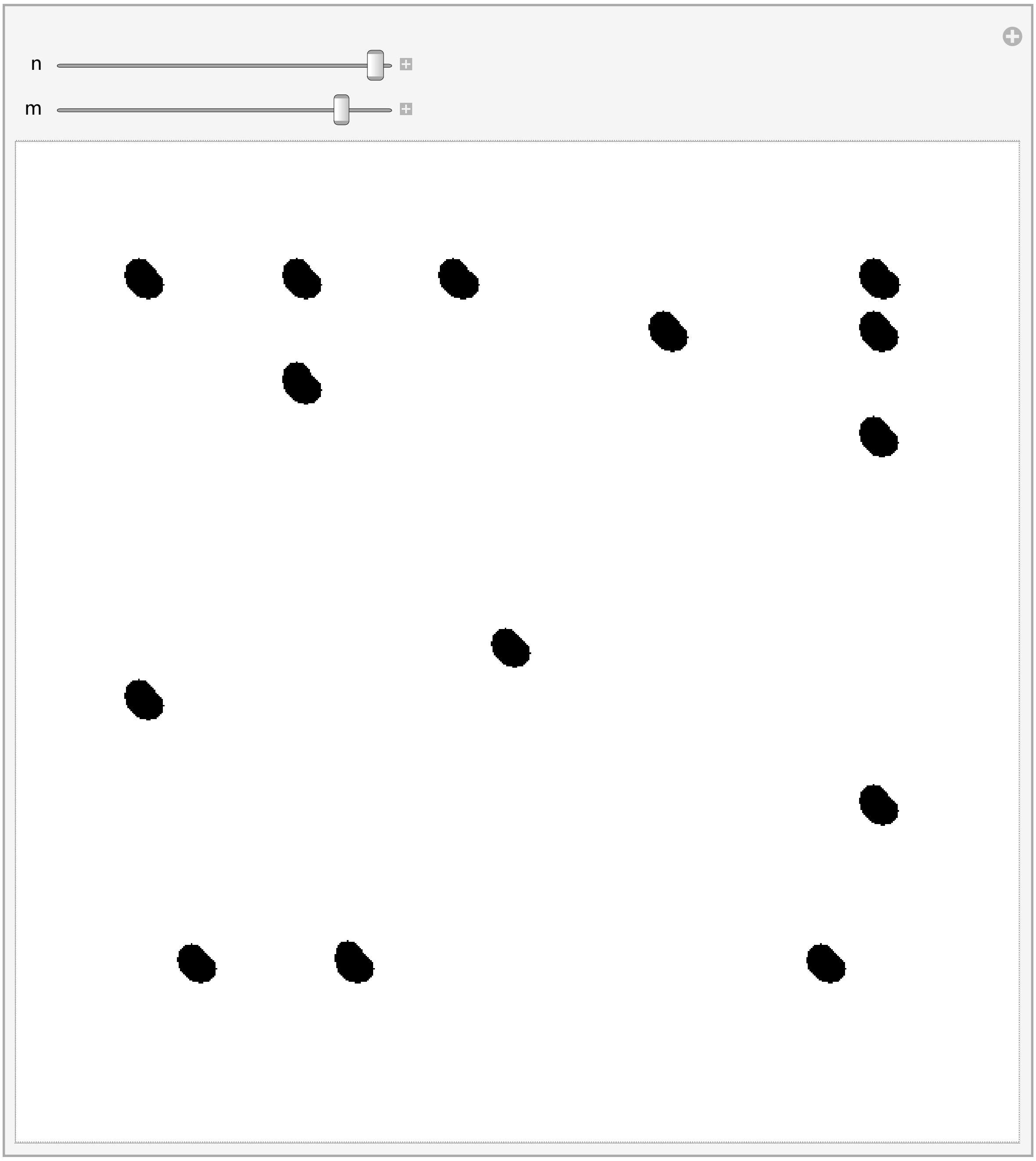
In[176]:=
```
blackCoordinates = Total /@ Transpose@# / 4 & /@ clusters / 2 + 1 - 1 / 4;
```

```
In[121]:= img2 = ImageAdd[ImageCrop@
```



In[122]:=
```
Manipulate[Closing[Opening[img2, DiskMatrix[n]], DiskMatrix[m]],
 {n, 10, 1}, {m, 1, 10, 1}]
```

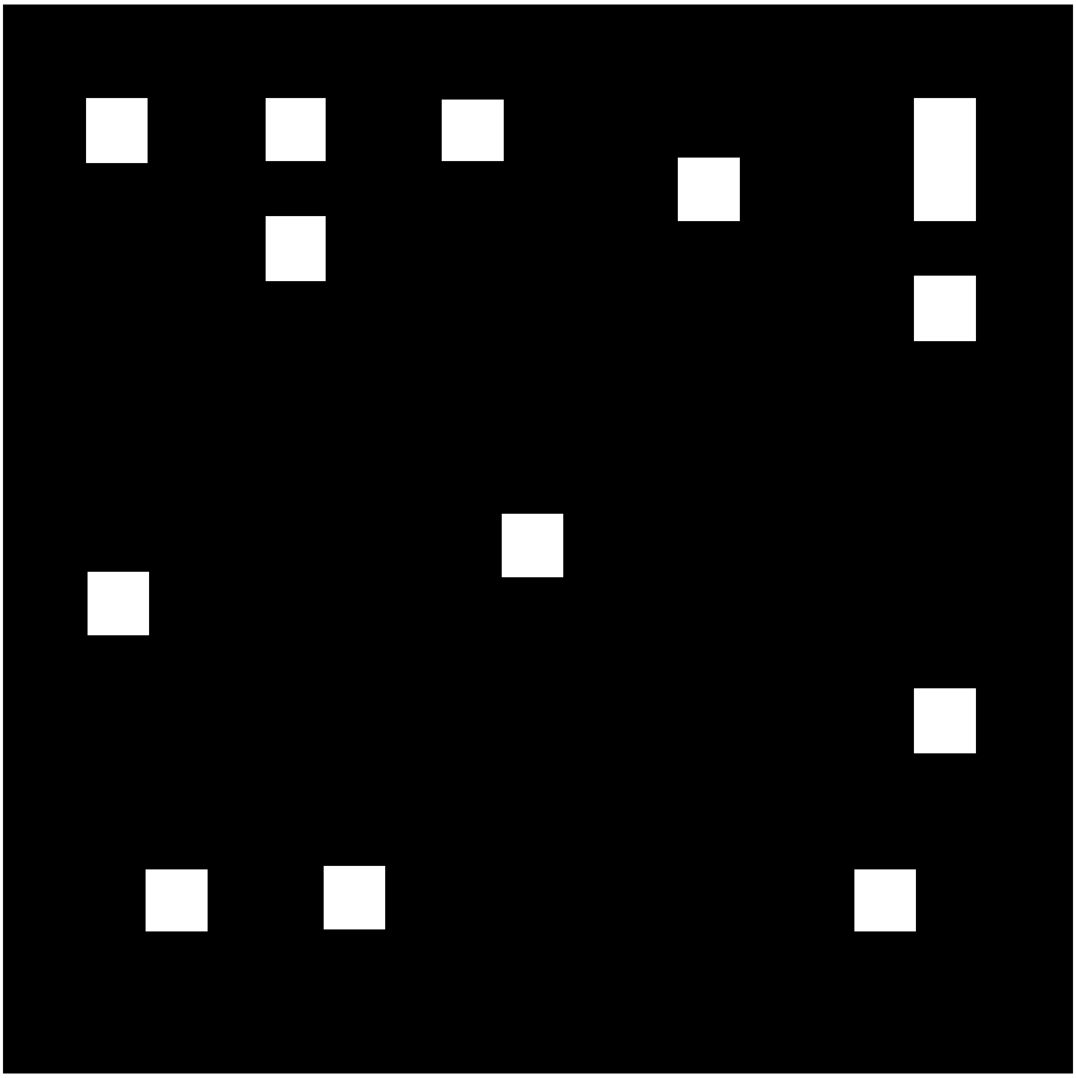
Out[122]=



In[123]:= `imgWhite = ImageResize[`  `, dim, AspectRatio → 1];`

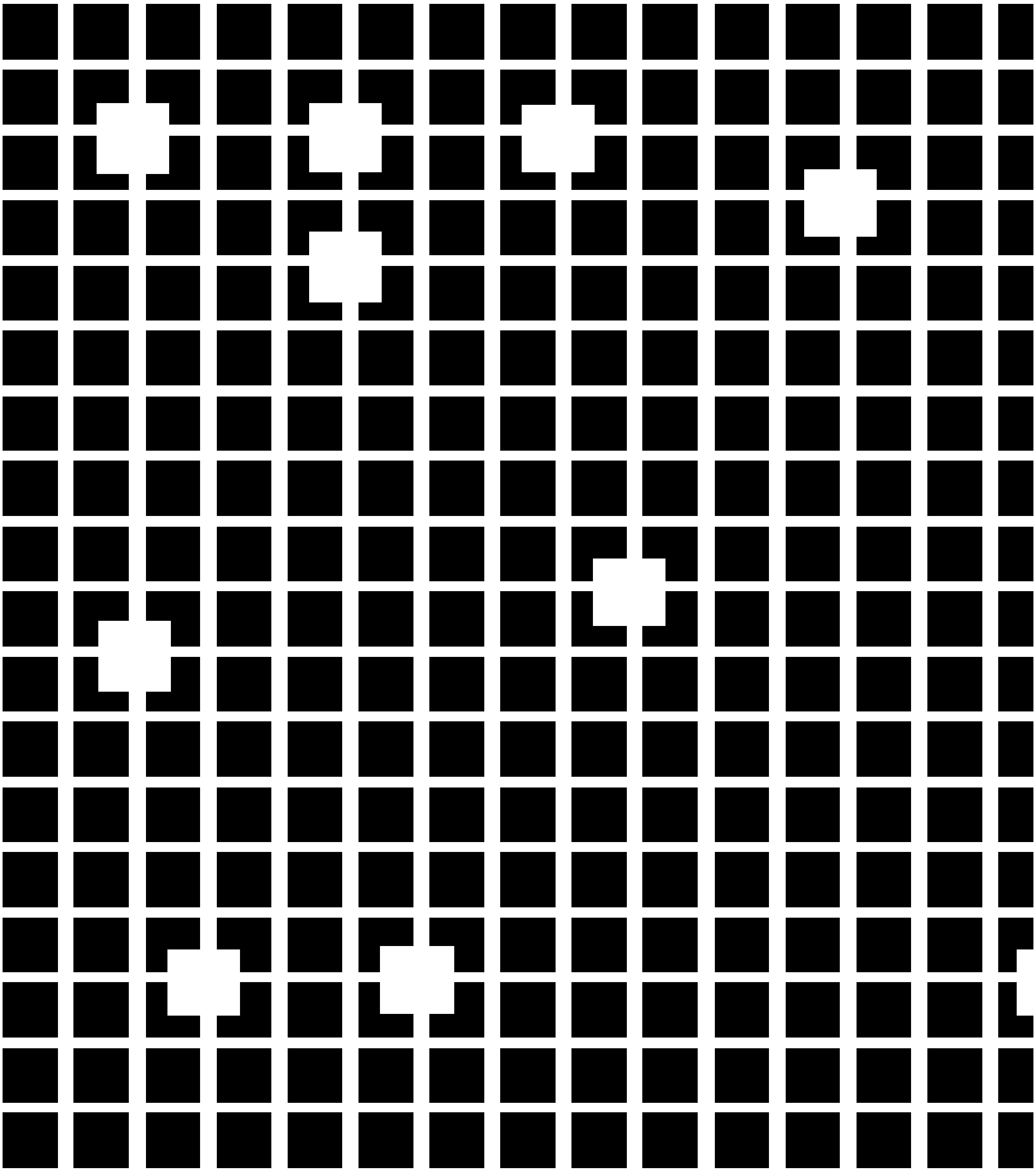
In[127]:=
```
imgWhiteCubs = Dilation[Dilation[imgWhite // ColorNegate, 17] // Thinning, 17]
```

Out[127]=



In[128]:=
```
ImagePartition[imgWhiteCubs, dim / 18] // Grid
```

Out[128]=



```
In[129]:= imageWhiteMatrix = ImageResize[imgWhiteCubs, {36, 36}] // ImageData;
          imageWhiteMatrix // MatrixForm
```

```
Out[130]//MatrixForm=
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 1 1 0 0 0 0 1 1 0 0 0 0 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 0 0 0
0 0 0 1 1 0 0 0 0 1 1 0 0 0 0 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 0 0 0 0 0 0 1 1 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 0 0 0 0 0 0 1 1 0 0 0
0 0 0 0 0 0 0 0 0 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 1 1 0 0 0 0 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 0 0 0 0 0
0 0 0 0 0 1 1 0 0 0 0 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
```
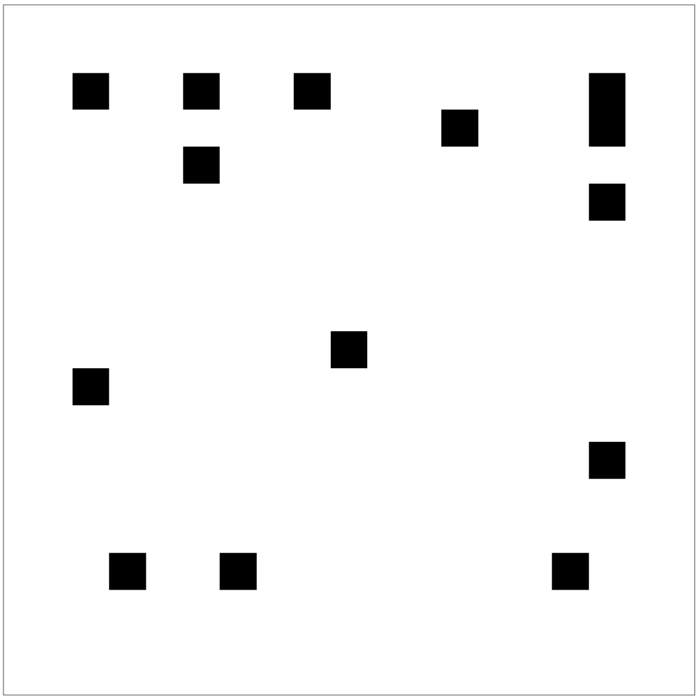

```
In[131]:= ArrayPlot[imageWhiteMatrix]
```

Out[131]=



```
In[146]:= clusters = FindClusters[Position[imageWhiteMatrix, 1],
            14, Method → {"Agglomerate", "Linkage" -> "Median"}]

Out[146]= {{{4, 4}, {4, 5}, {5, 4}, {5, 5}}, {{4, 10}, {4, 11}, {5, 10}, {5, 11}},
            {{4, 16}, {4, 17}, {5, 16}, {5, 17}}, {{4, 32}, {4, 33}, {5, 32}, {5, 33}},
            {{6, 24}, {6, 25}, {7, 24}, {7, 25}}, {{6, 32}, {6, 33}, {7, 32}, {7, 33}},
            {{8, 10}, {8, 11}, {9, 10}, {9, 11}}, {{10, 32}, {10, 33}, {11, 32}, {11, 33}},
            {{18, 18}, {18, 19}, {19, 18}, {19, 19}}, {{20, 4}, {20, 5}, {21, 4}, {21, 5}},
            {{24, 32}, {24, 33}, {25, 32}, {25, 33}}, {{30, 6}, {30, 7}, {31, 6}, {31, 7}},
            {{30, 12}, {30, 13}, {31, 12}, {31, 13}}, {{30, 30}, {30, 31}, {31, 30}, {31, 31}}}

In[147]:= whiteCoordinates = Total /@ Transpose@# / 4 & /@ clusters / 2 + 1 - 1 / 4;

In[148]:= whiteCoordinates

Out[148]= {{3, 3}, {3, 6}, {3, 9}, {3, 17}, {4, 13}, {4, 17}, {5, 6},
            {6, 17}, {10, 10}, {11, 3}, {13, 17}, {16, 4}, {16, 7}, {16, 16}}
```

```
In[178]:= linesColor = LightYellow; boardColor = LightGray;
          board = {
             boardColor, Polygon[{{-10, -10}, {10, -10}, {10, 10}, {-10, 10}, {-10, -10}}],
             linesColor,
             Table[Line[{{xx, -9}, {xx, 9}}], {xx, -9, 9}],
             Table[Line[{{-9, yy}, {9, yy}}], {yy, -9, 9}]
            };
          applycolor[{coordinates_, black}] := {Black, Disk[coordinates, .5]}
          applycolor[{coordinates_, white}] := {White, EdgeForm[Black], Disk[coordinates, .5]}
          showBlack[record_, movenumber_] :=
           Graphics[
            {
             board,
             Take[applycolor /@ Partition[Riffle[record, black], 2, 2, 1, black],
              Min[Length[record], movenumber]]
            }
           ]
          showWhite[record_, movenumber_] :=
           Graphics[
            {
             board,
             Take[applycolor /@ Partition[Riffle[record, white], 2, 2, 1, white],
              Min[Length[record], movenumber]]
            }
           ]
```

```
In[218]:= showGame[whiteRecord_, blackRecord_, movenumber1_, movenumber2_] :=
           Graphics[
            {
             board,
             Take[applycolor /@ Partition[Riffle[whiteRecord, white], 2, 2, 1, white],
               Min[Length[whiteRecord], movenumber1]] ~ Join ~
              Take[applycolor /@ Partition[Riffle[blackRecord, black], 2, 2, 1, black],
               Min[Length[blackRecord], movenumber2]]
            }
           ]
```

```
In[219]:= coordinates = blackCoordinates ~ Join ~ whiteCoordinates

Out[219]= {{3, 11}, {3, 14}, {4, 4}, {4, 16}, {5, 14}, {6, 8}, {7, 4}, {8, 10}, {10, 13}, {11, 5},
           {11, 8}, {14, 3}, {15, 11}, {15, 13}, {18, 4}, {3, 3}, {3, 6}, {3, 9}, {3, 17}, {4, 13},
           {4, 17}, {5, 6}, {6, 17}, {10, 10}, {11, 3}, {13, 17}, {16, 4}, {16, 7}, {16, 16}}
```

In[220]:=

```
Manipulate[showGame[(blackCoordinates - 10).RotationMatrix[90 n Degree],
   (whiteCoordinates - 10).RotationMatrix[90 n Degree], movenumber1, movenumber2],
 Button["NextMove", movenumber1 = movenumber1 + 1], {n, 1, 4, 1},
 {movenumber1, 0, Length@whiteCoordinates, 1},
 {movenumber2, 0, Length@blackCoordinates, 1}]
```

Out[220]=