

# Fun with Microsoft Excel

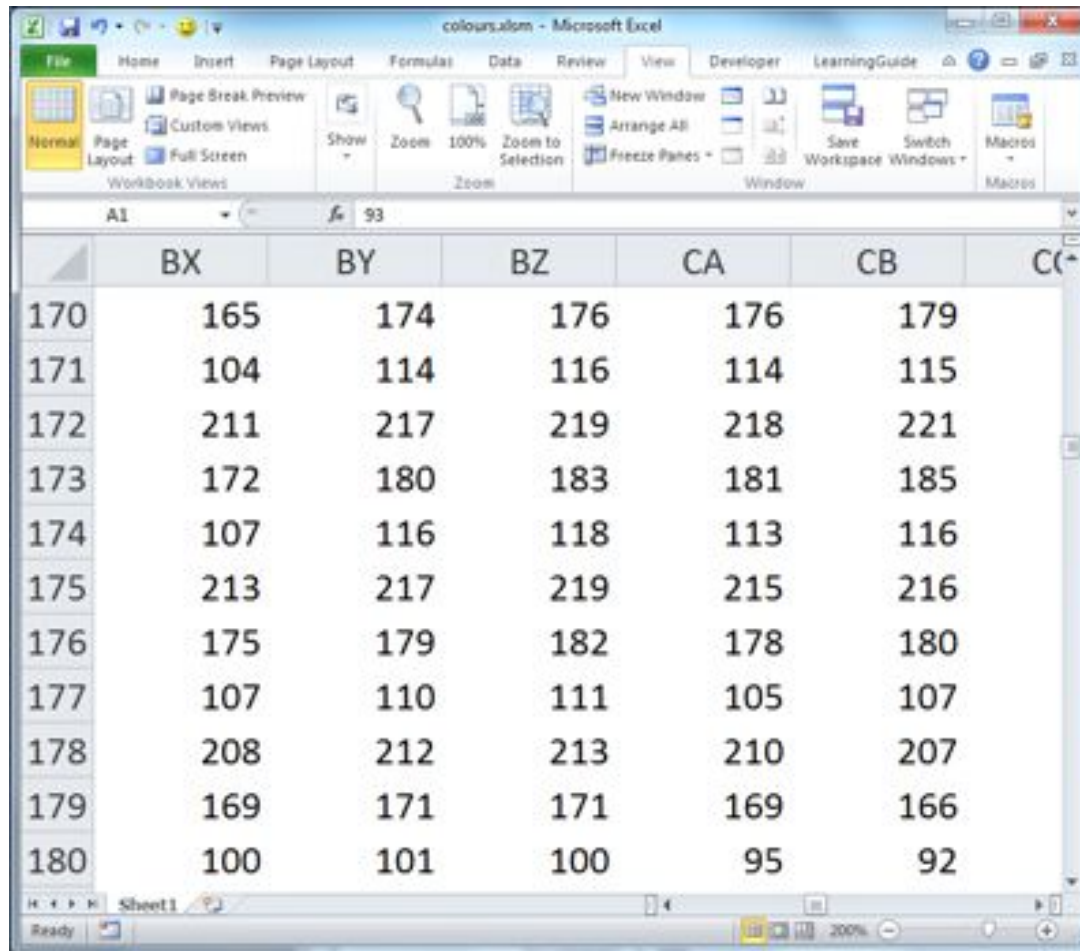
# Fun with Microsoft Excel

No, really

# Based on an idea by Matt Parker

- I saw him at a gig over the winter
- Laughed a lot
- Thought a lot...

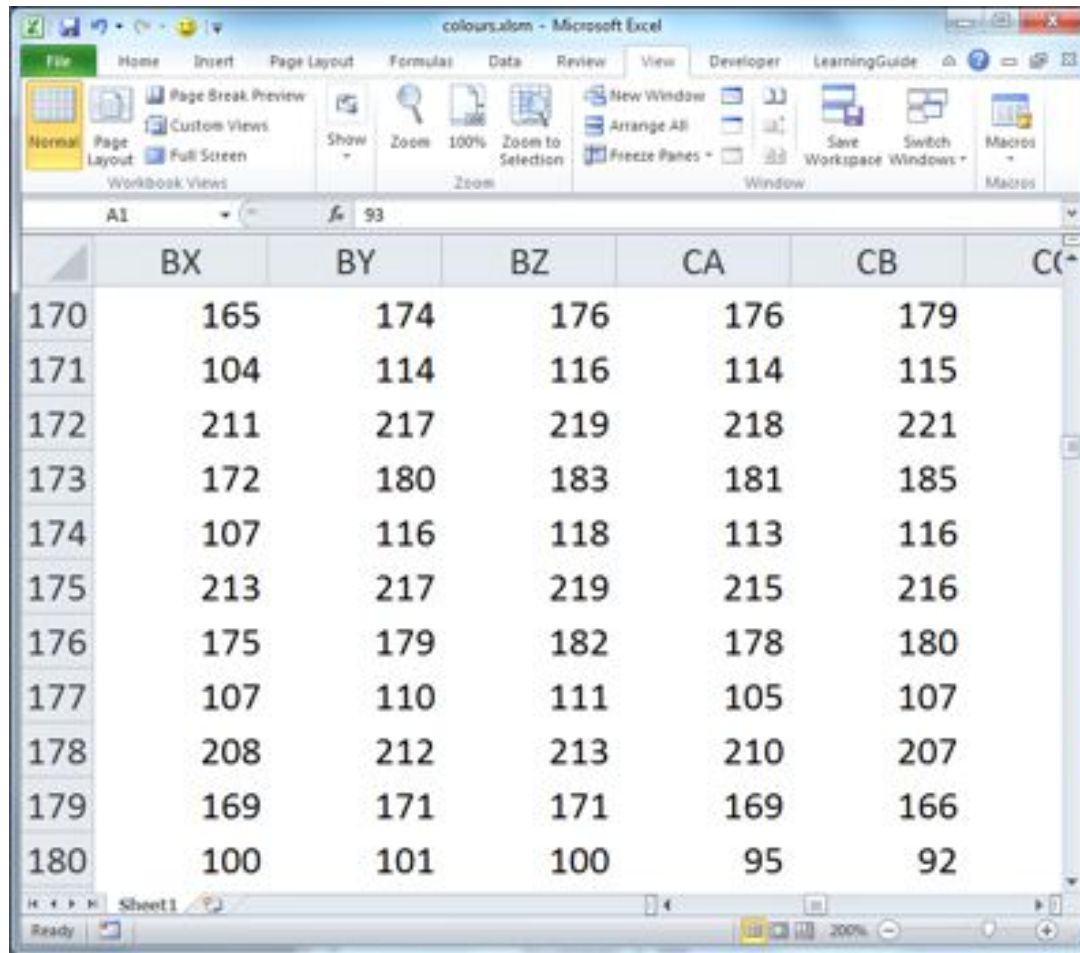
# Matt's idea



The image shows a screenshot of a Microsoft Excel spreadsheet. The title bar indicates the file is named 'colours.xlsx'. The ribbon is set to the 'View' tab, showing options like 'New Window', 'Arrange All', 'Freeze Panes', 'Save Workspace', and 'Switch Windows'. The active cell is A1, and the formula bar shows the value '93'. The spreadsheet contains a table with the following data:

|     | BX  | BY  | BZ  | CA  | CB  | CC |
|-----|-----|-----|-----|-----|-----|----|
| 170 | 165 | 174 | 176 | 176 | 179 |    |
| 171 | 104 | 114 | 116 | 114 | 115 |    |
| 172 | 211 | 217 | 219 | 218 | 221 |    |
| 173 | 172 | 180 | 183 | 181 | 185 |    |
| 174 | 107 | 116 | 118 | 113 | 116 |    |
| 175 | 213 | 217 | 219 | 215 | 216 |    |
| 176 | 175 | 179 | 182 | 178 | 180 |    |
| 177 | 107 | 110 | 111 | 105 | 107 |    |
| 178 | 208 | 212 | 213 | 210 | 207 |    |
| 179 | 169 | 171 | 171 | 169 | 166 |    |
| 180 | 100 | 101 | 100 | 95  | 92  |    |

# Colour cells according to data



The image shows a screenshot of the Microsoft Excel application window. The title bar reads "colours.xlsx - Microsoft Excel". The ribbon is set to the "View" tab, showing options like "New Window", "Arrange All", "Freeze Panes", "Zoom", and "Save Workspace". The active cell is A1, and the formula bar shows the value 93. The main grid displays a table with the following data:

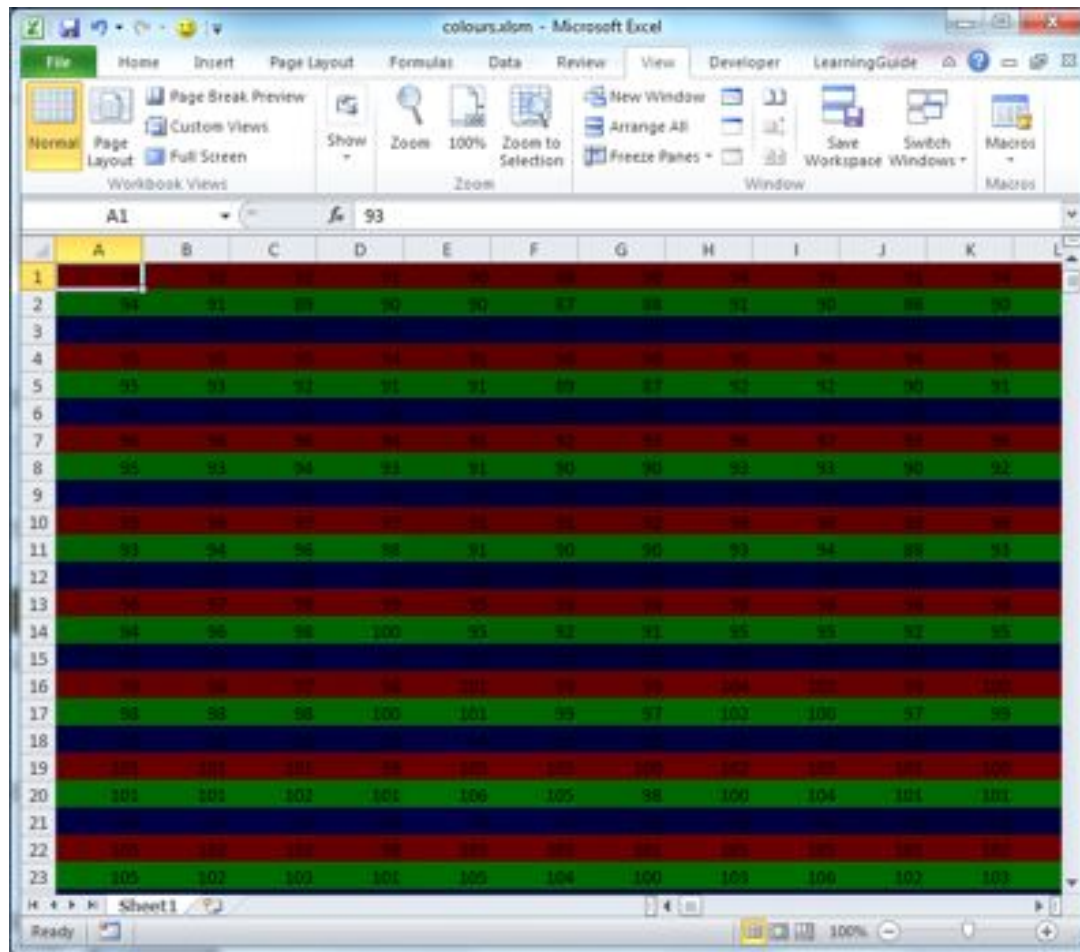
|     | BX  | BY  | BZ  | CA  | CB  | CC |
|-----|-----|-----|-----|-----|-----|----|
| 170 | 165 | 174 | 176 | 176 | 179 |    |
| 171 | 104 | 114 | 116 | 114 | 115 |    |
| 172 | 211 | 217 | 219 | 218 | 221 |    |
| 173 | 172 | 180 | 183 | 181 | 185 |    |
| 174 | 107 | 116 | 118 | 113 | 116 |    |
| 175 | 213 | 217 | 219 | 215 | 216 |    |
| 176 | 175 | 179 | 182 | 178 | 180 |    |
| 177 | 107 | 110 | 111 | 105 | 107 |    |
| 178 | 208 | 212 | 213 | 210 | 207 |    |
| 179 | 169 | 171 | 171 | 169 | 166 |    |
| 180 | 100 | 101 | 100 | 95  | 92  |    |

# Colour cells according to data

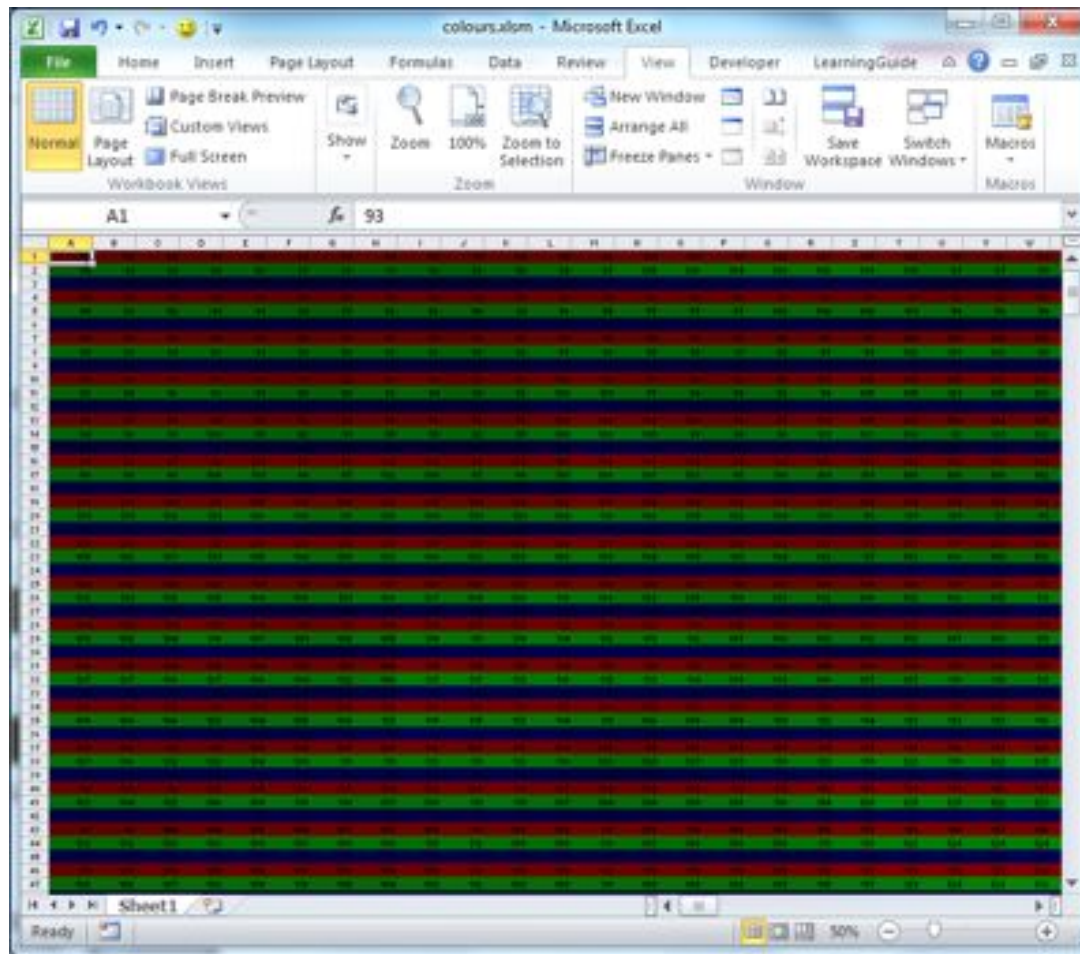
The screenshot shows a Microsoft Excel window titled 'colours.xlsx - Microsoft Excel'. The ribbon includes 'File', 'Home', 'Insert', 'Page Layout', 'Formulas', 'Data', 'Review', 'View', 'Developer', and 'LearningGuide'. The 'Developer' tab is active, showing options like 'Visual Basic', 'Add-Ins', 'COM Add-Ins', 'Insert', 'Design Mode', 'Properties', 'View Code', 'Run Dialog', 'Source', 'Map Properties', 'Import', 'Export', 'Expansion Packs', 'Refresh Data', and 'Document Panel'. The status bar shows 'A1' and '93'. The data table is as follows:

|     | BX  | BY  | BZ  | CA  | CB  | CC |
|-----|-----|-----|-----|-----|-----|----|
| 170 | 165 | 174 | 176 | 176 | 179 |    |
| 171 | 104 | 114 | 116 | 114 | 115 |    |
| 172 | 211 | 217 | 219 | 218 | 221 |    |
| 173 | 172 | 180 | 183 | 181 | 185 |    |
| 174 | 107 | 118 | 118 | 113 | 118 |    |
| 175 | 213 | 217 | 219 | 215 | 216 |    |
| 176 | 175 | 179 | 182 | 178 | 180 |    |
| 177 | 107 | 110 | 111 | 109 | 107 |    |
| 178 | 208 | 212 | 213 | 210 | 207 |    |
| 179 | 169 | 171 | 171 | 169 | 166 |    |
| 180 | 100 | 101 | 100 | 99  | 92  |    |

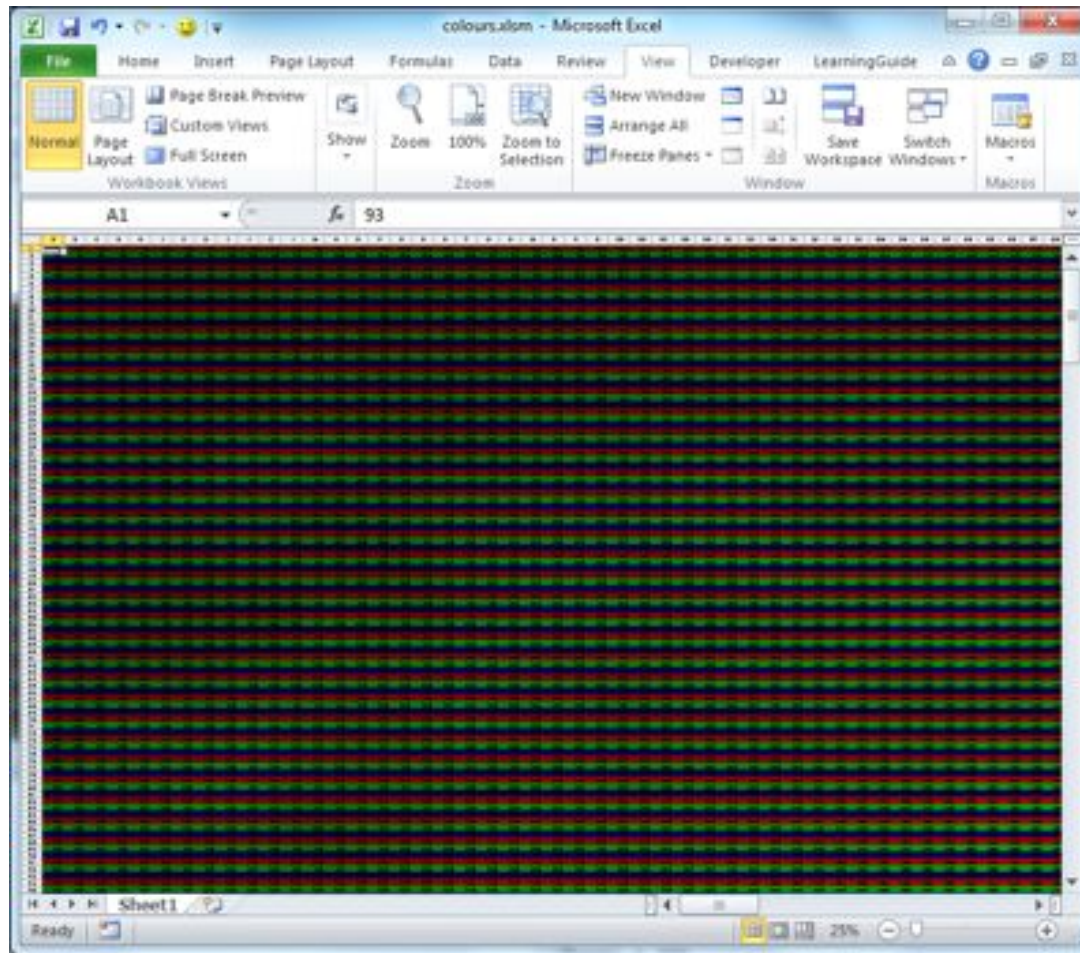
# Zoom out...



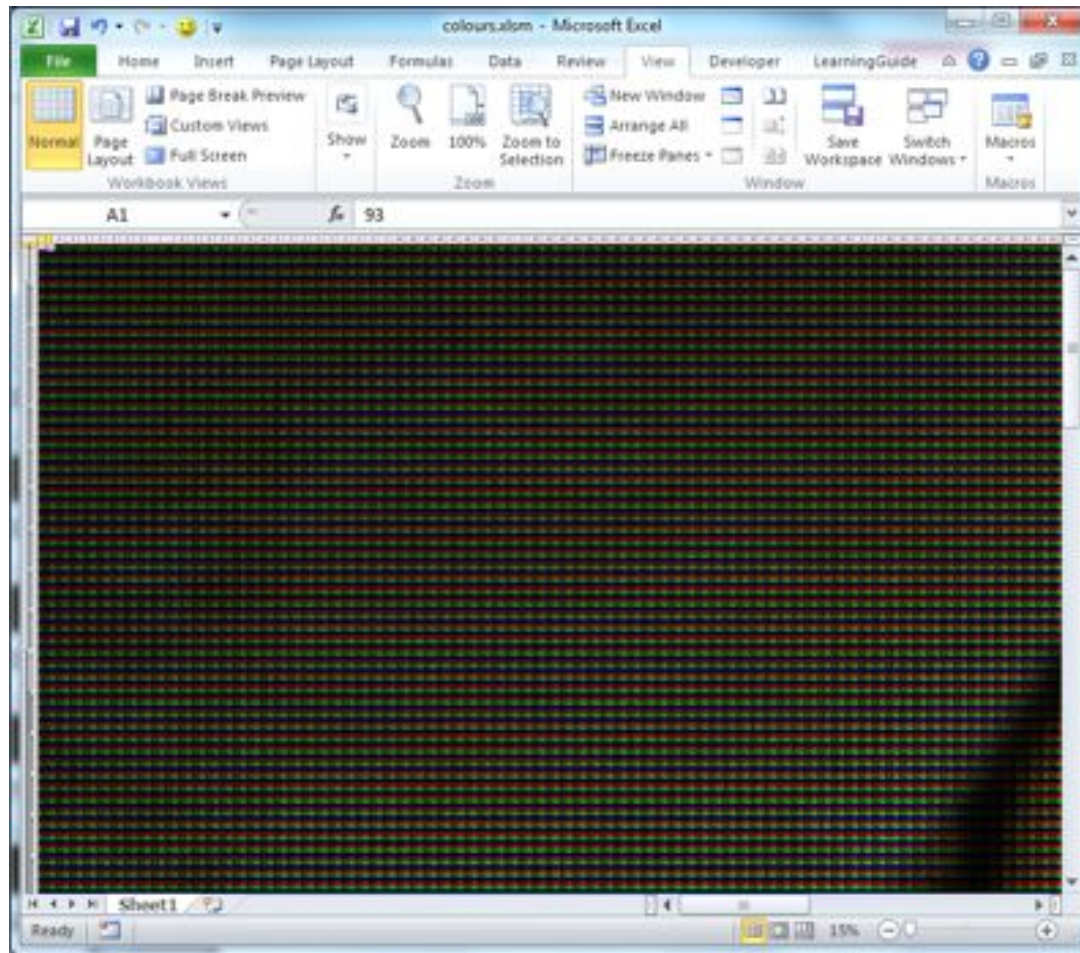
# Zoom out...



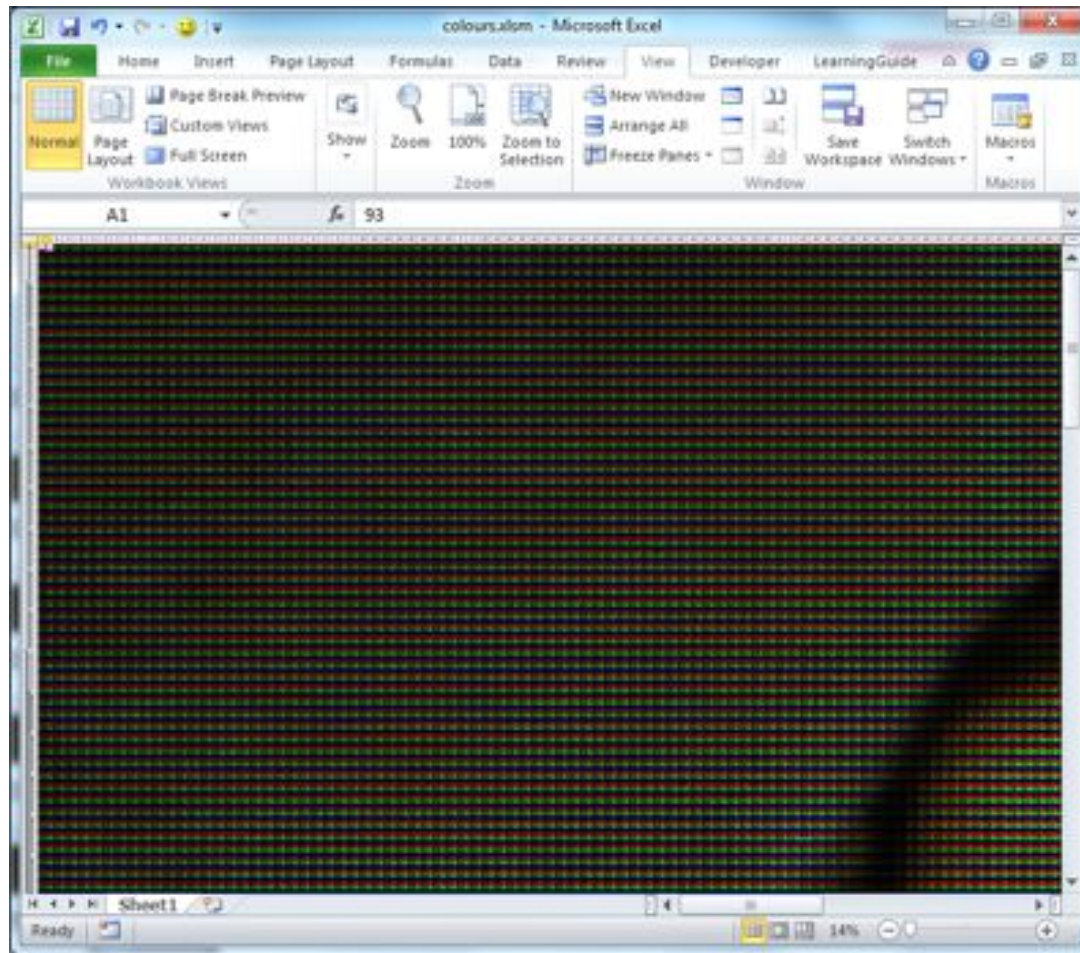
# Zoom out...



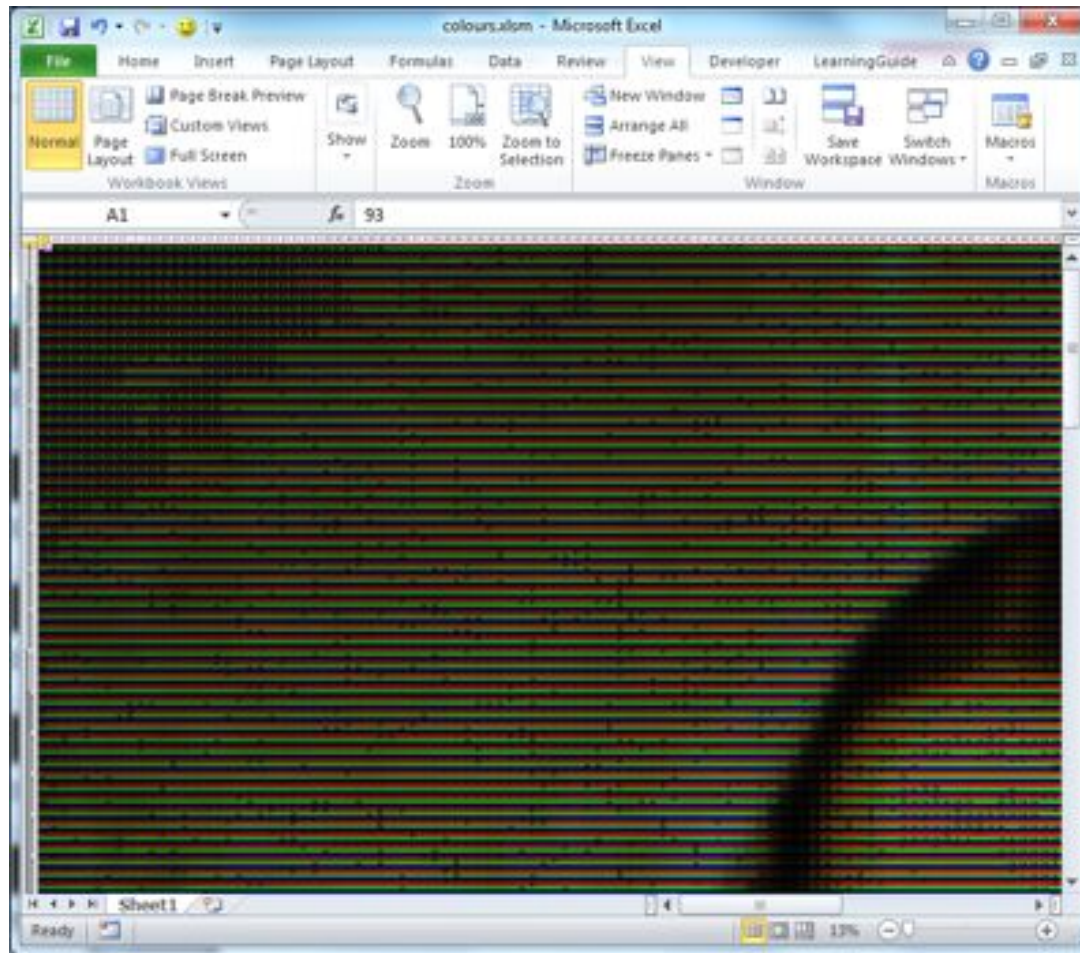
# Zoom out...



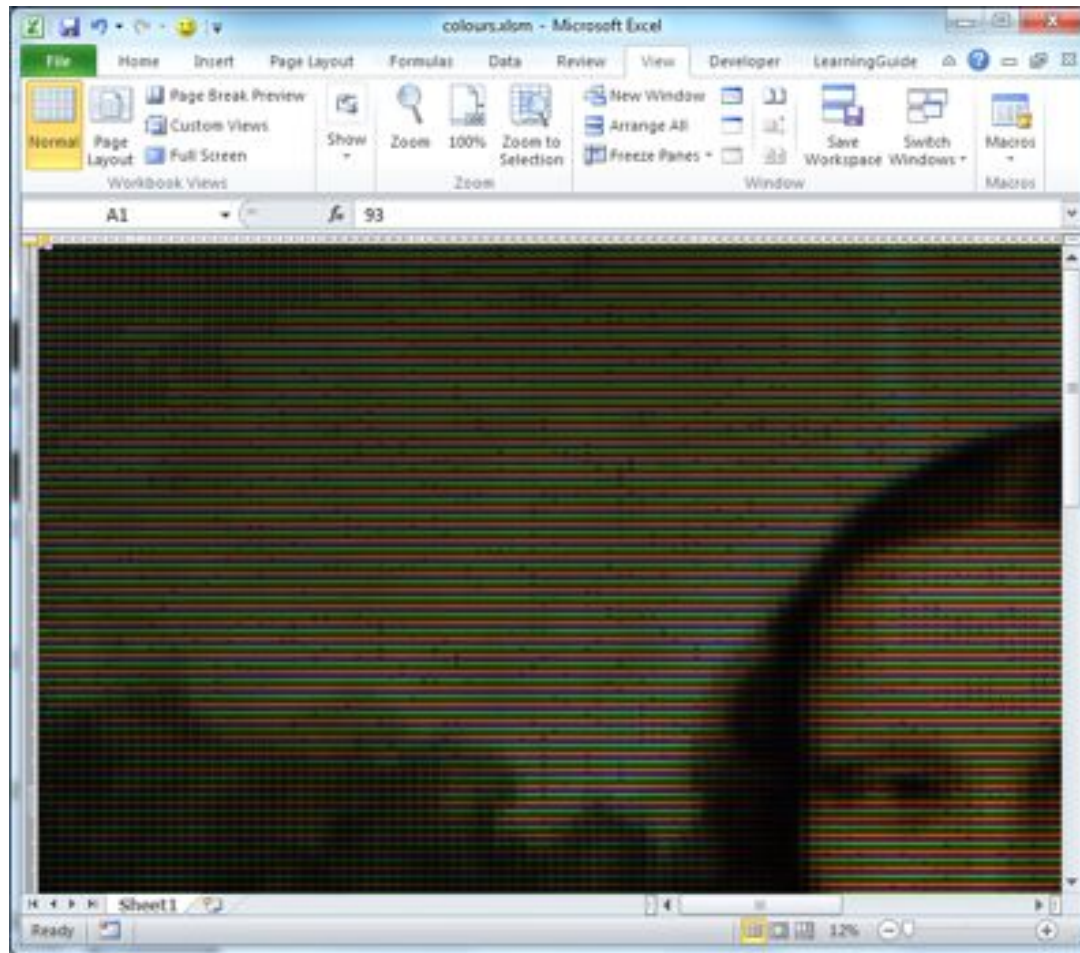
# Zoom out...



# Zoom out...

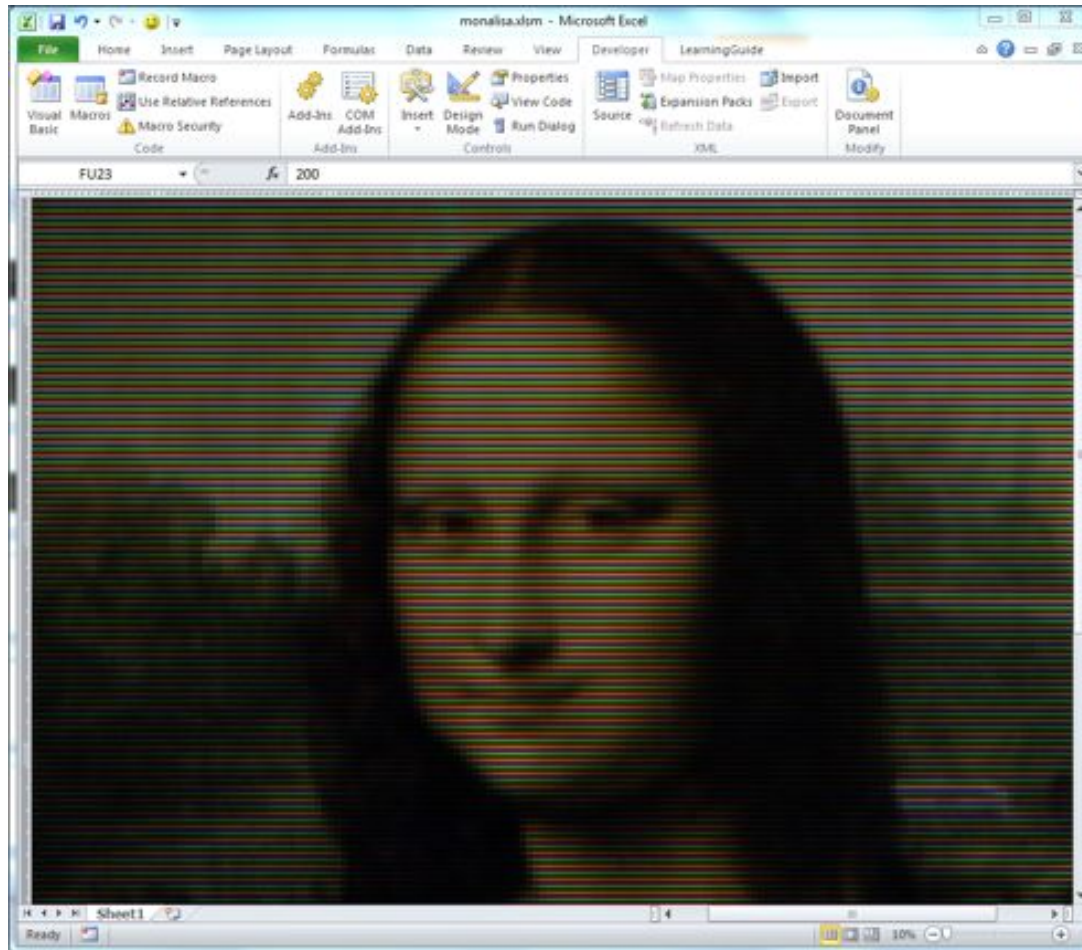


# Zoom out...

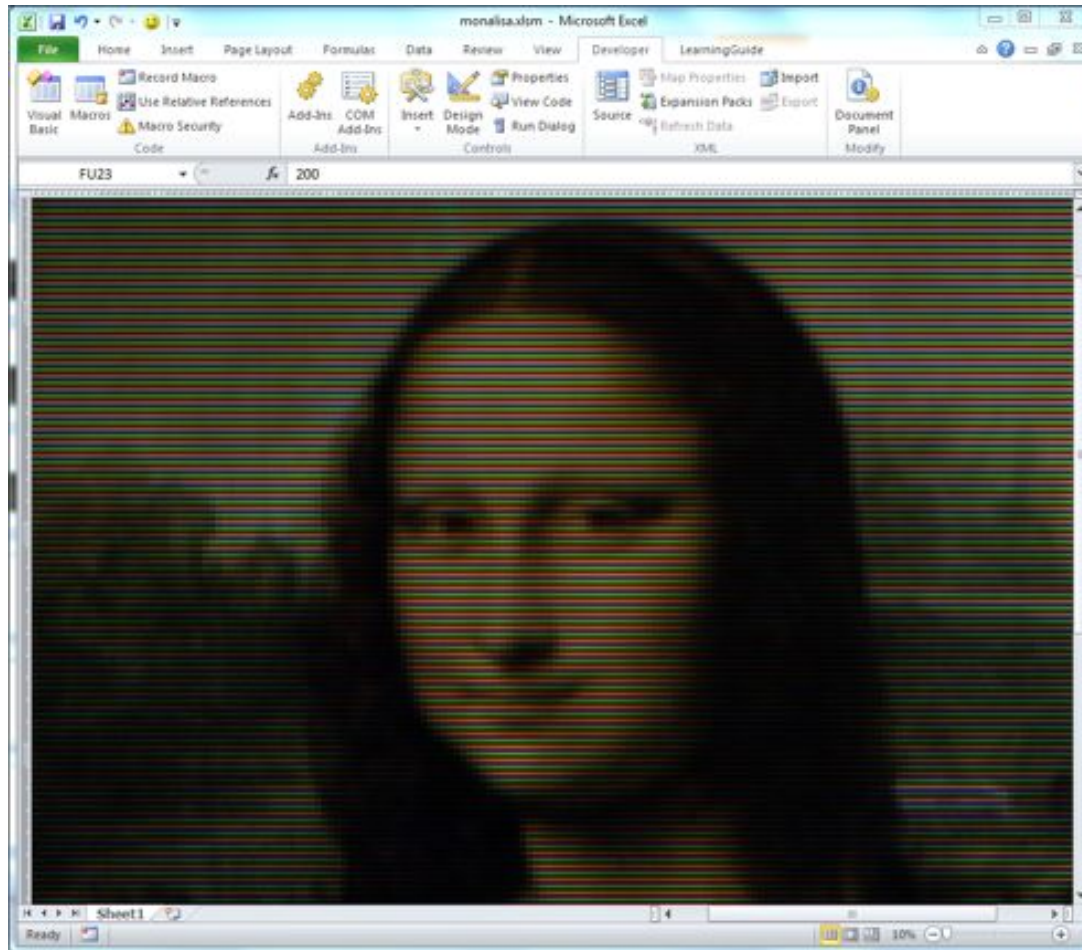


To cut a long story short...

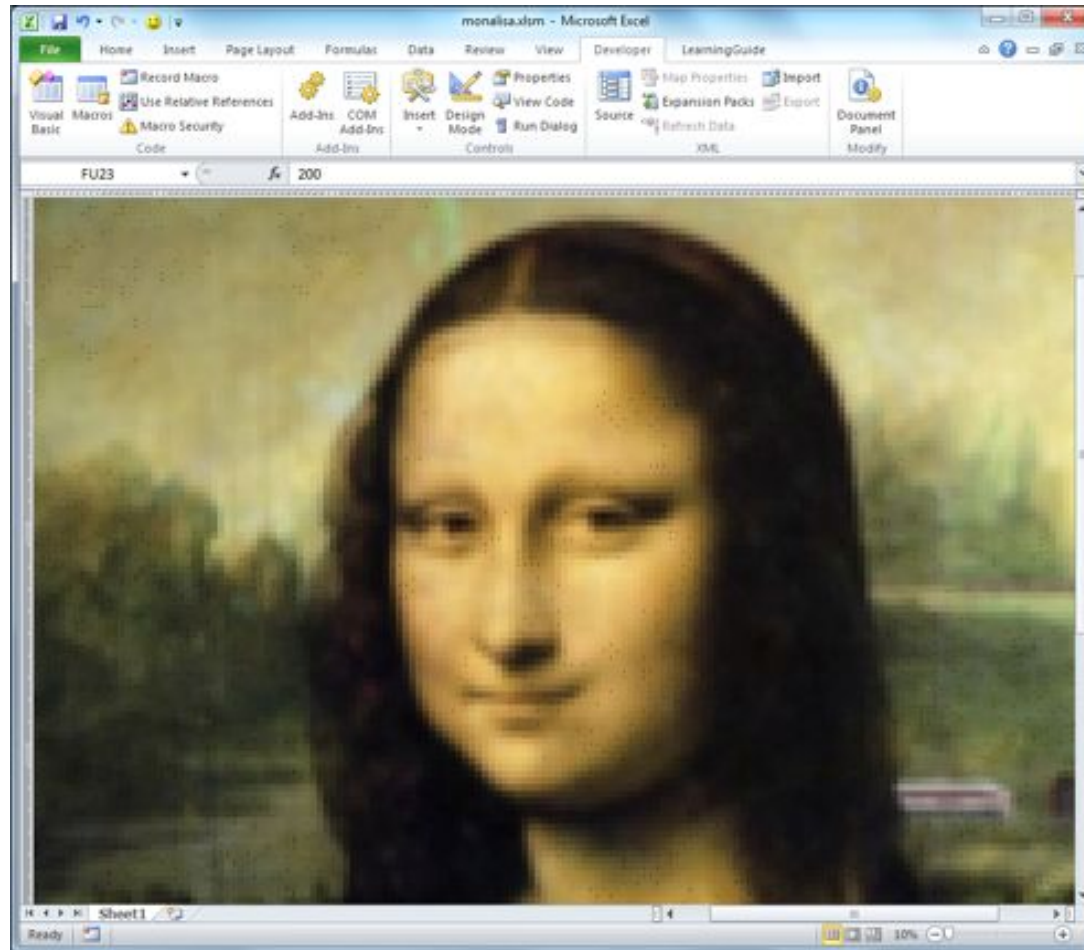
# To cut a long story short...



# “Cheating” ...



# “Cheating” ...



# Changed it slightly

- Ended up “cheating” by colouring in blocks of three
- Didn't use a picture of myself

# Then I thought...

- The data for our images came from somewhere else.
- Could we use the spreadsheet to *generate* the data?

# First example

# Blocks of three numbers

|   |
|---|
| x |
| y |
| n |

## **Initially**

x and y represent *coordinates*

n is 0 everywhere

# Blocks of three numbers

|   |
|---|
| x |
| y |
| n |

**Iterate:**

new x:  $x * x - y * y - 0.4$

new y:  $2 * x * y + 0.6$

new n:  $n + 1$

(But only if  $x * x + y * y < 4$ )

# Then:

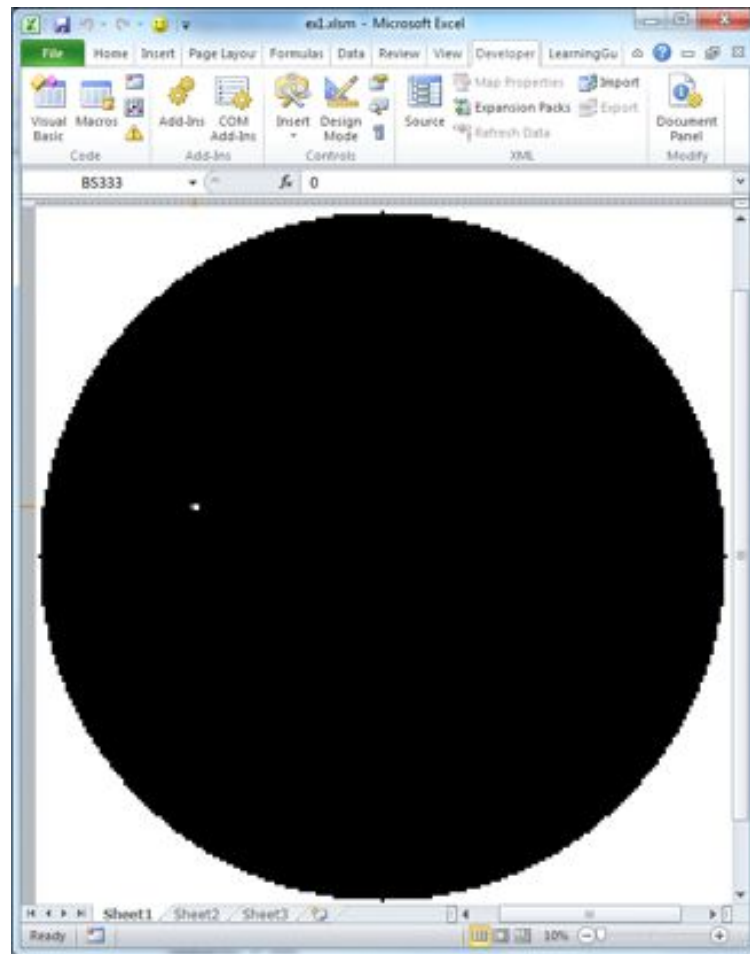
|   |
|---|
| x |
| y |
| n |

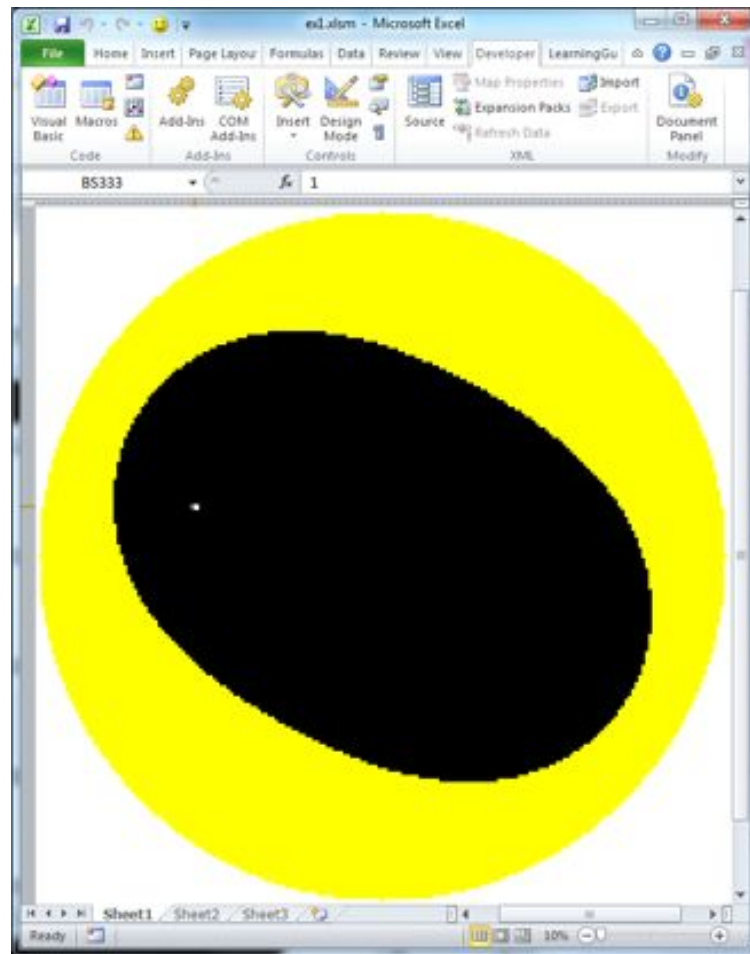
If  $x * x + y * y < 4$

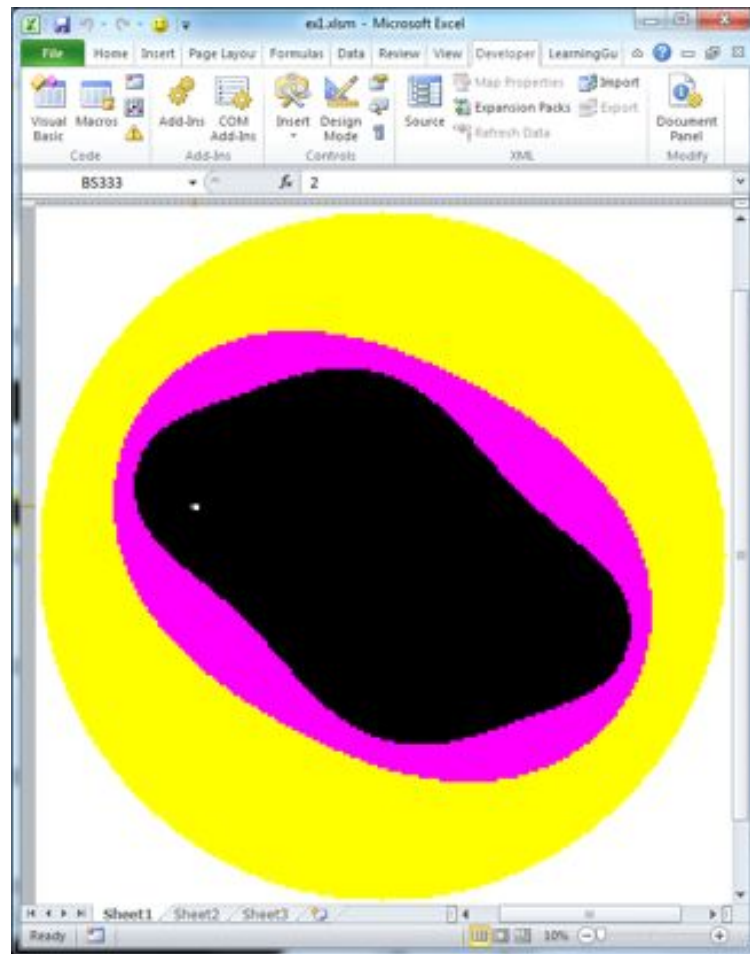
colour block black

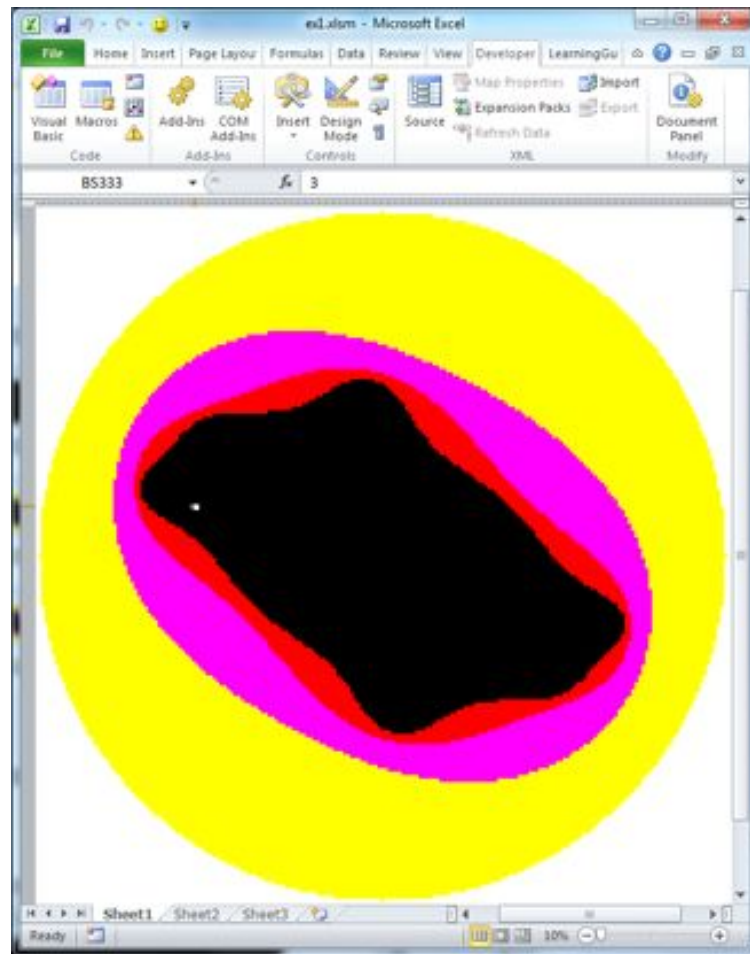
Otherwise

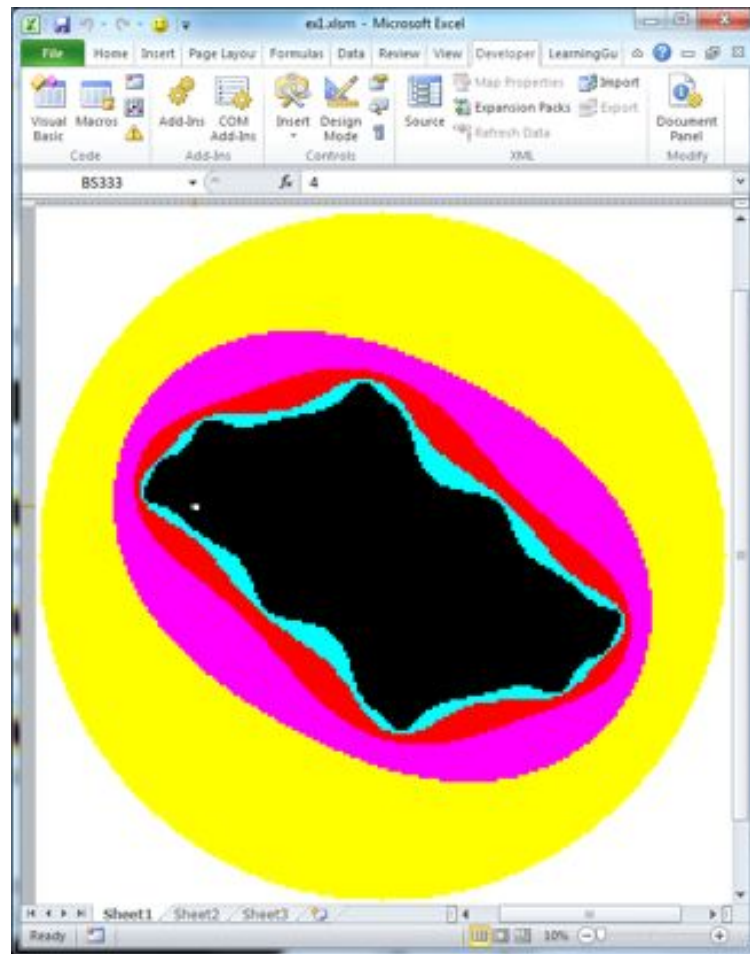
colour block depending on the value of n

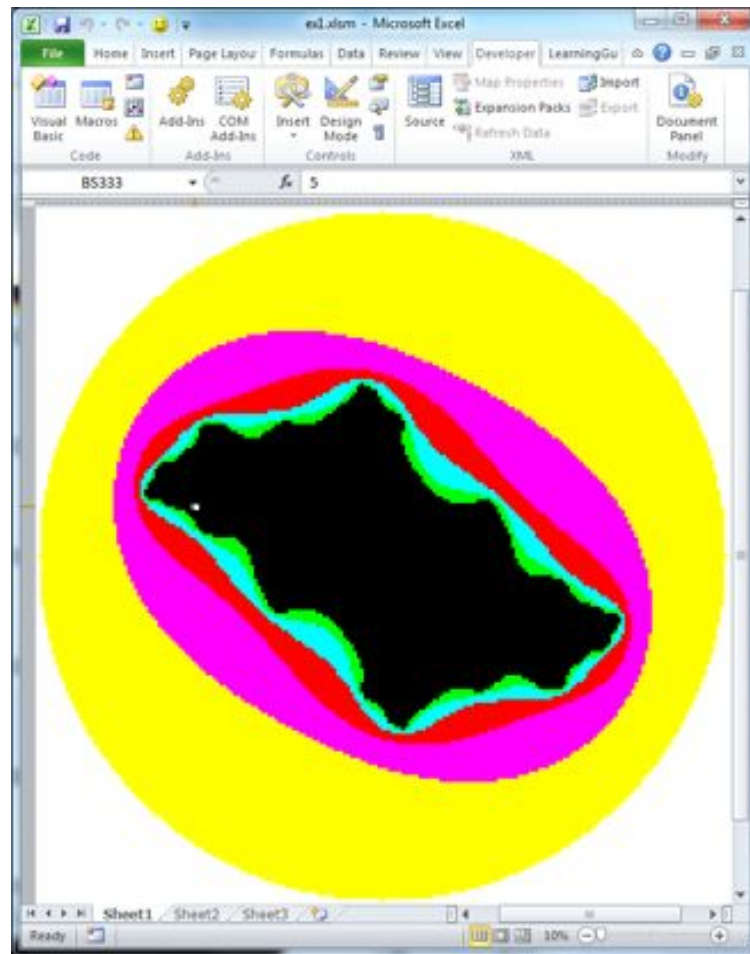


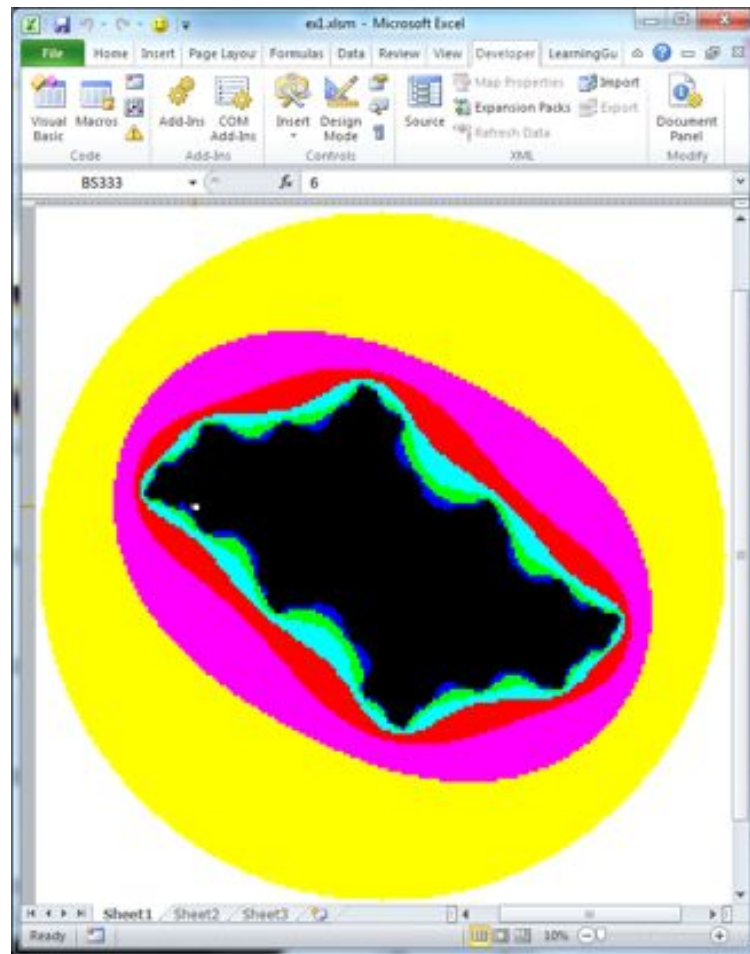


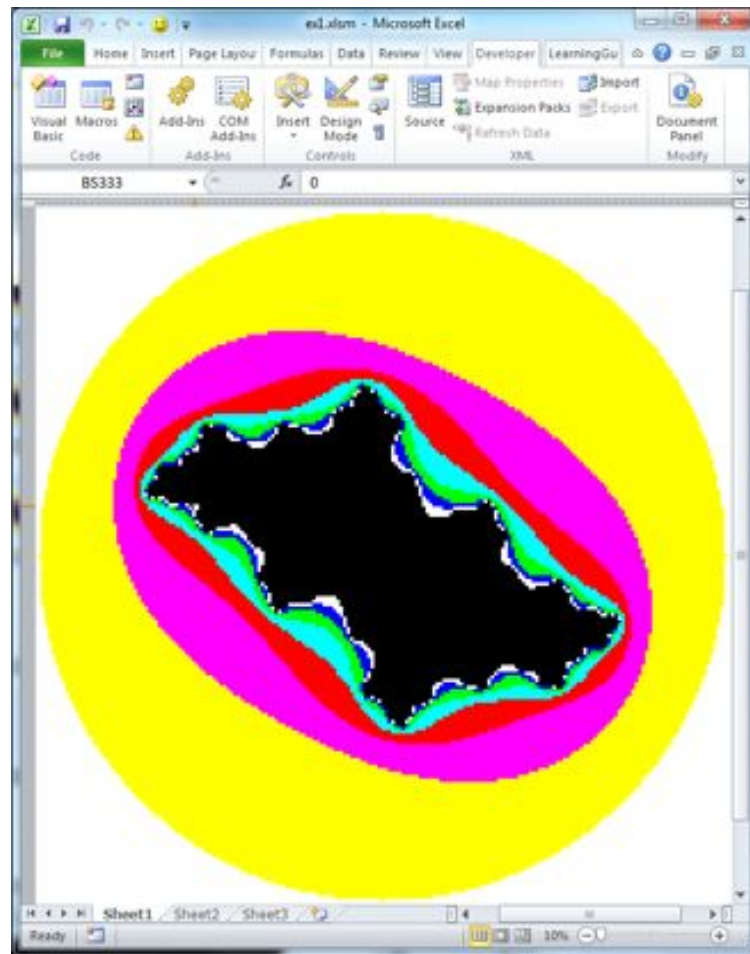


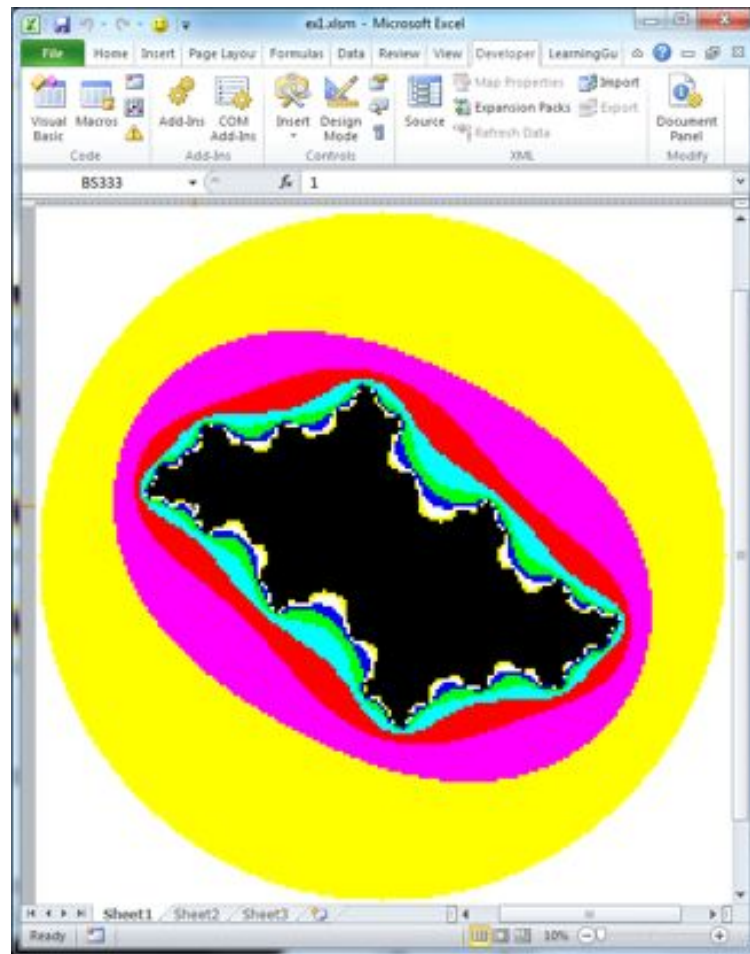


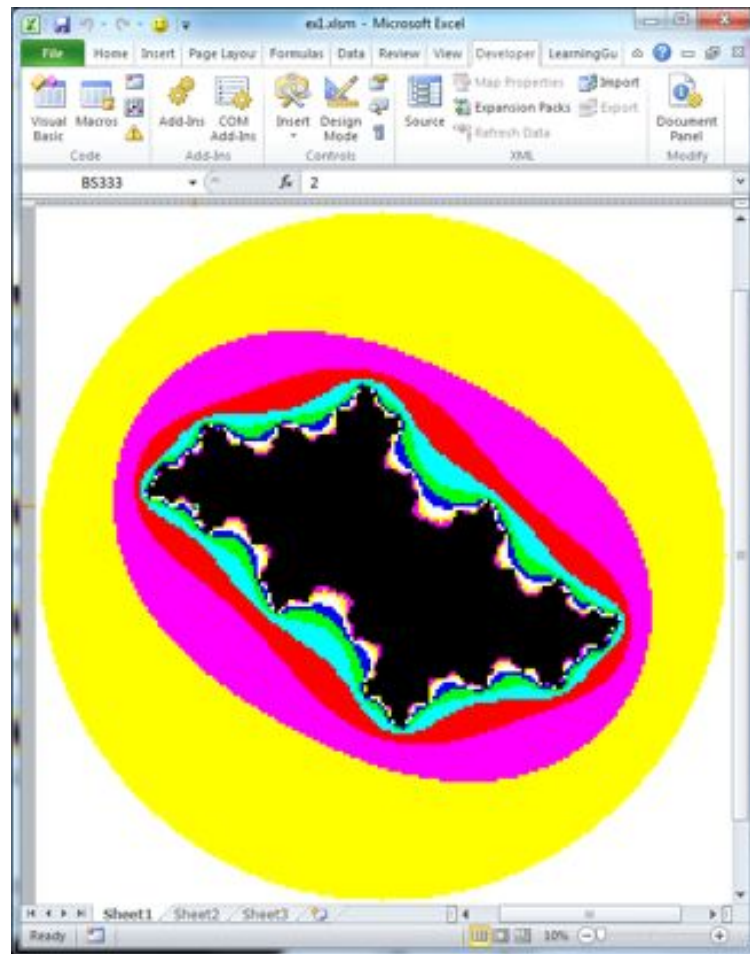


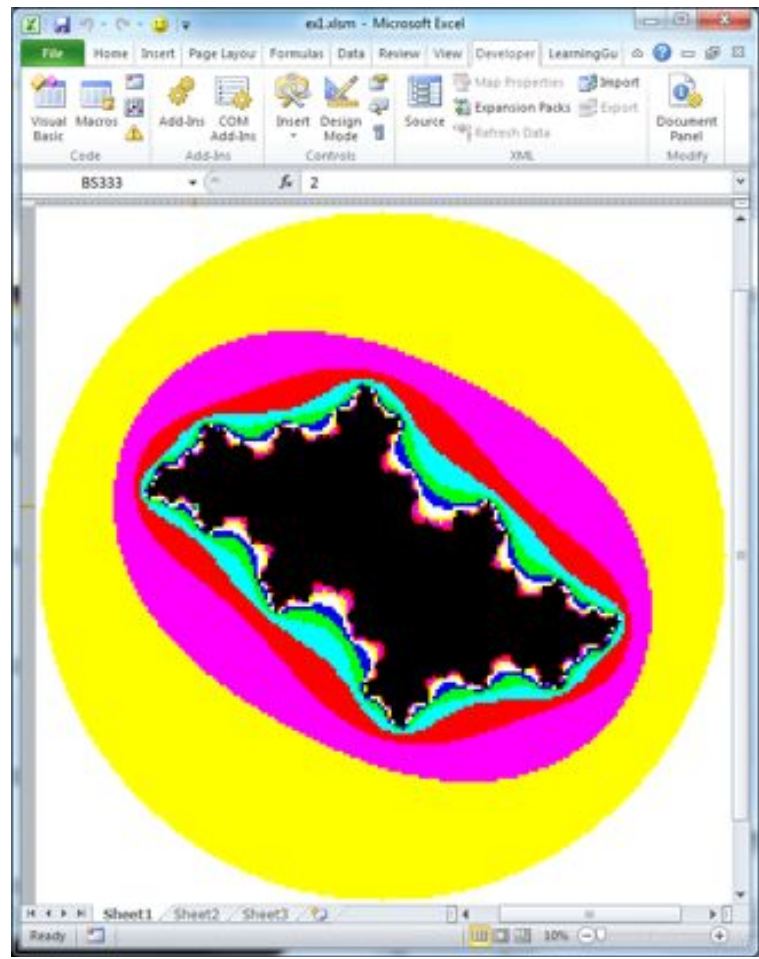


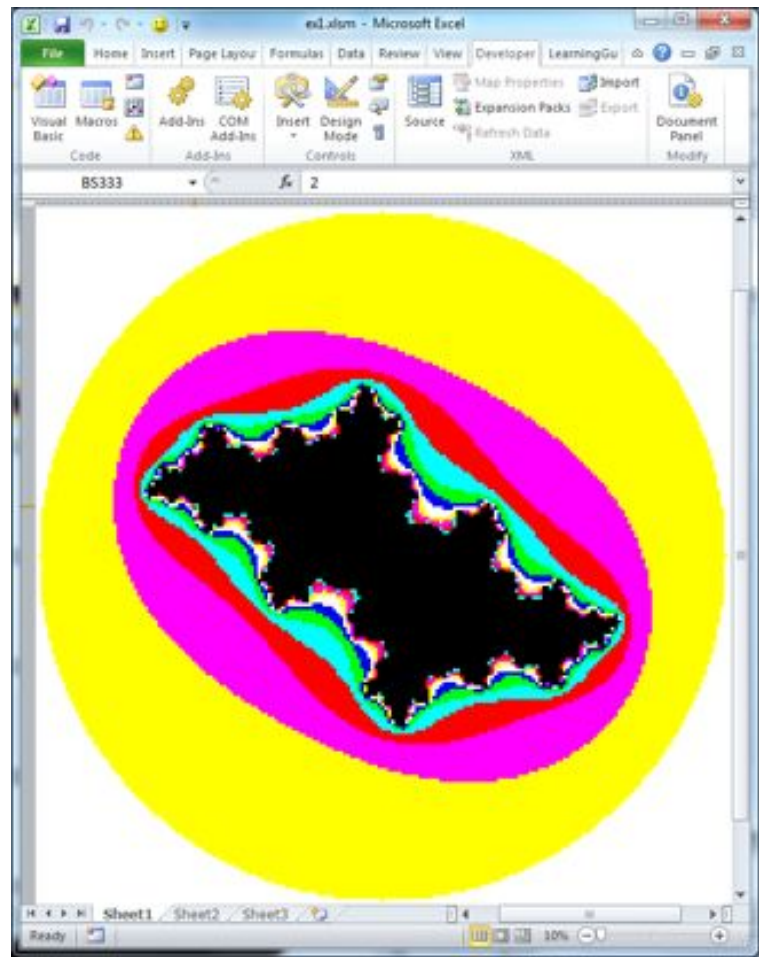


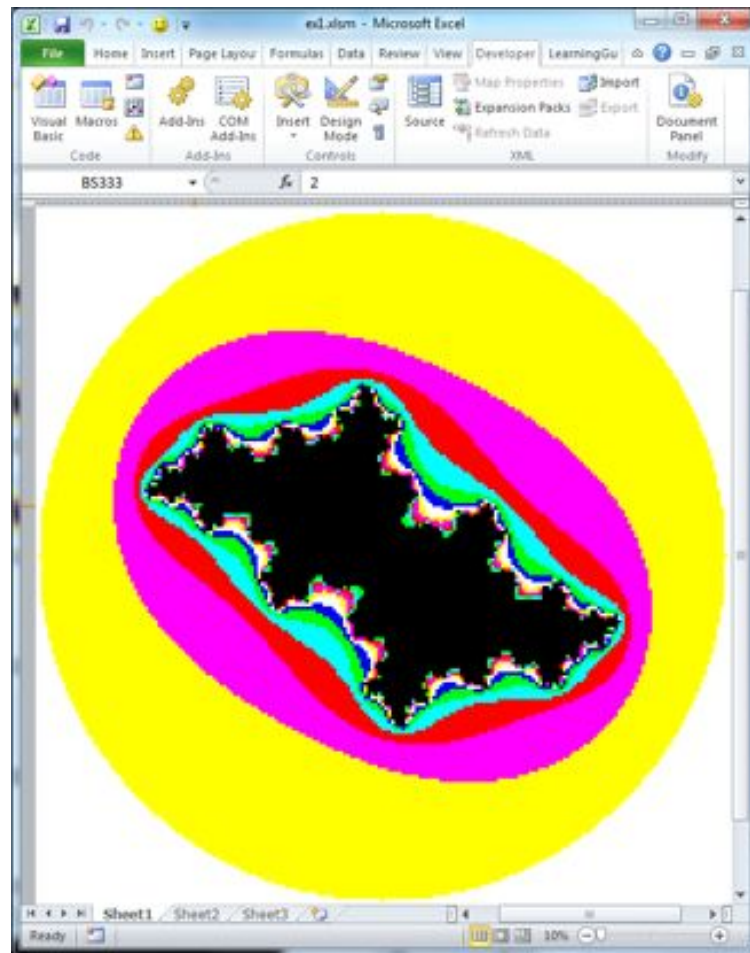


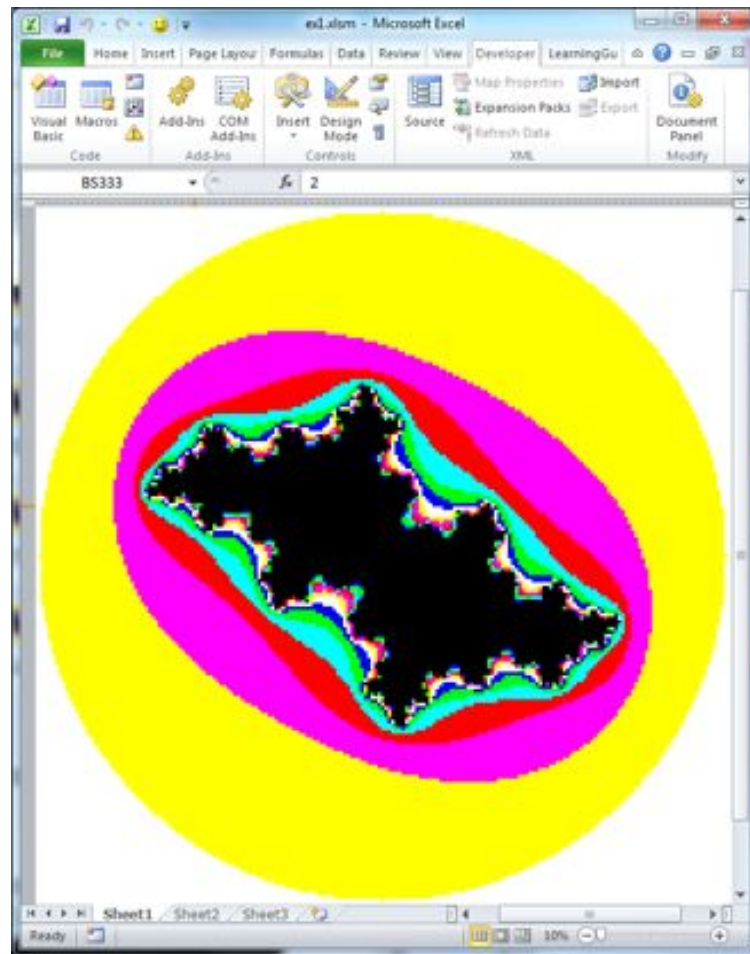


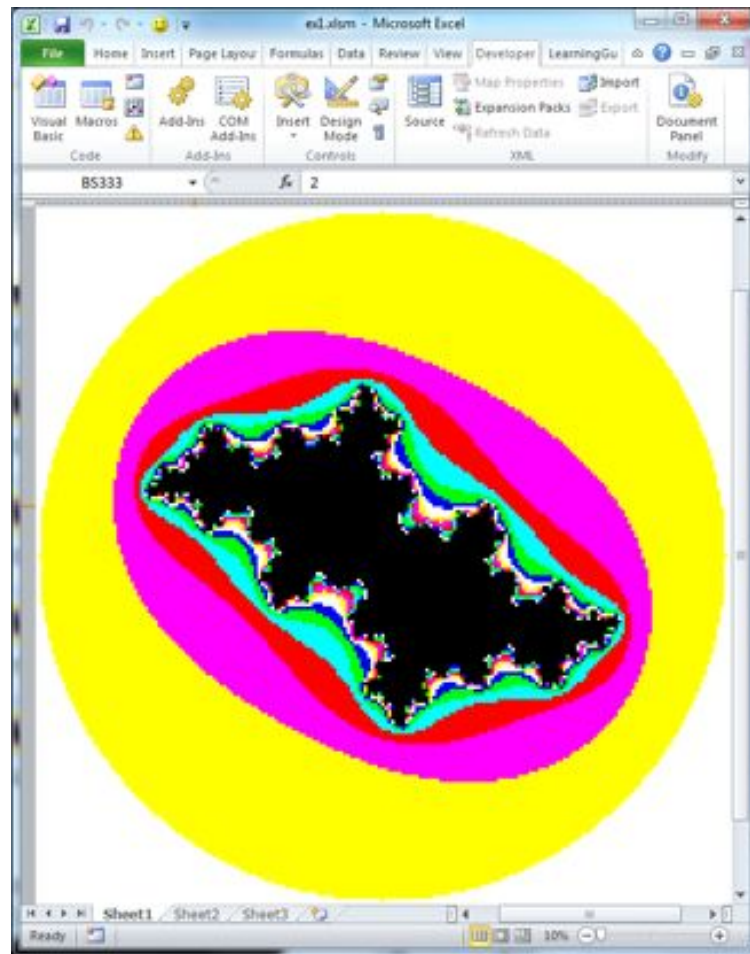


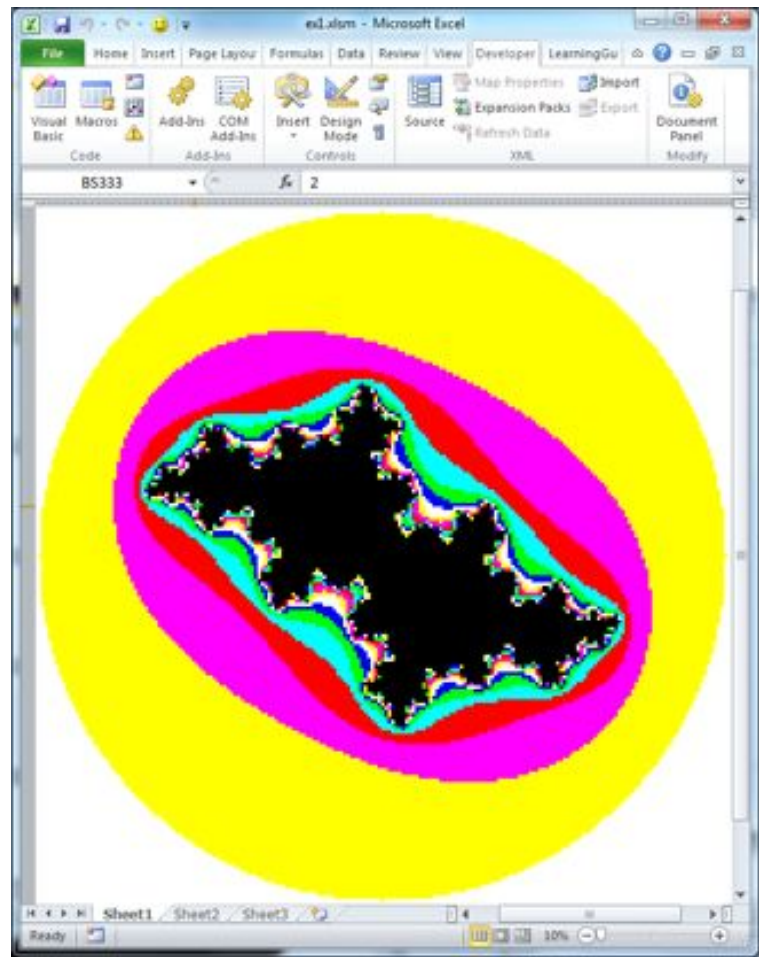


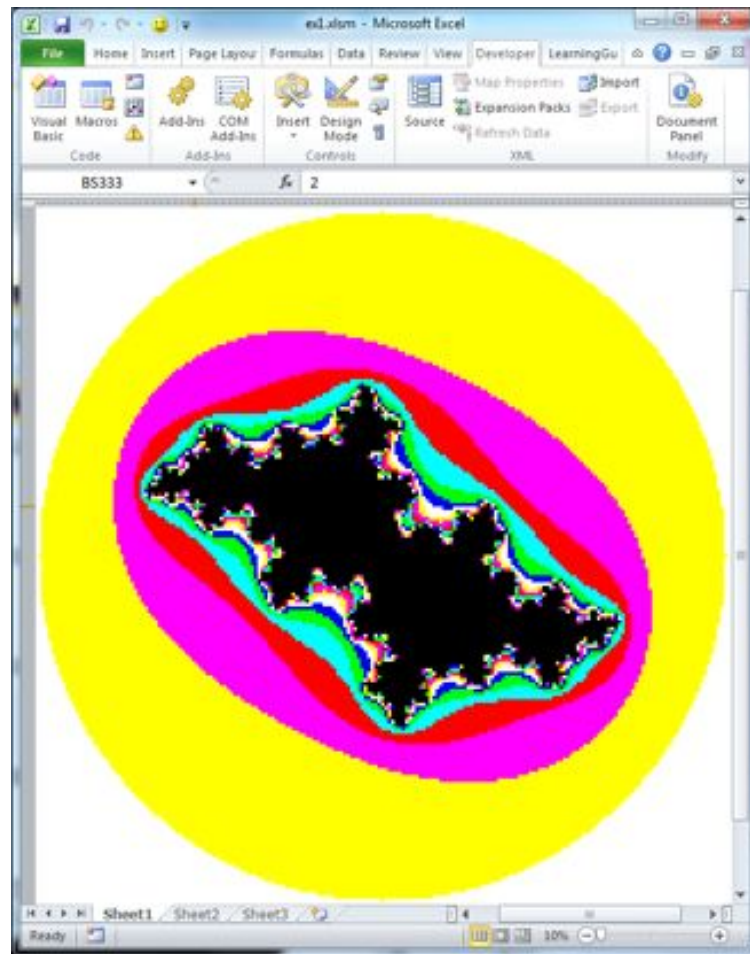


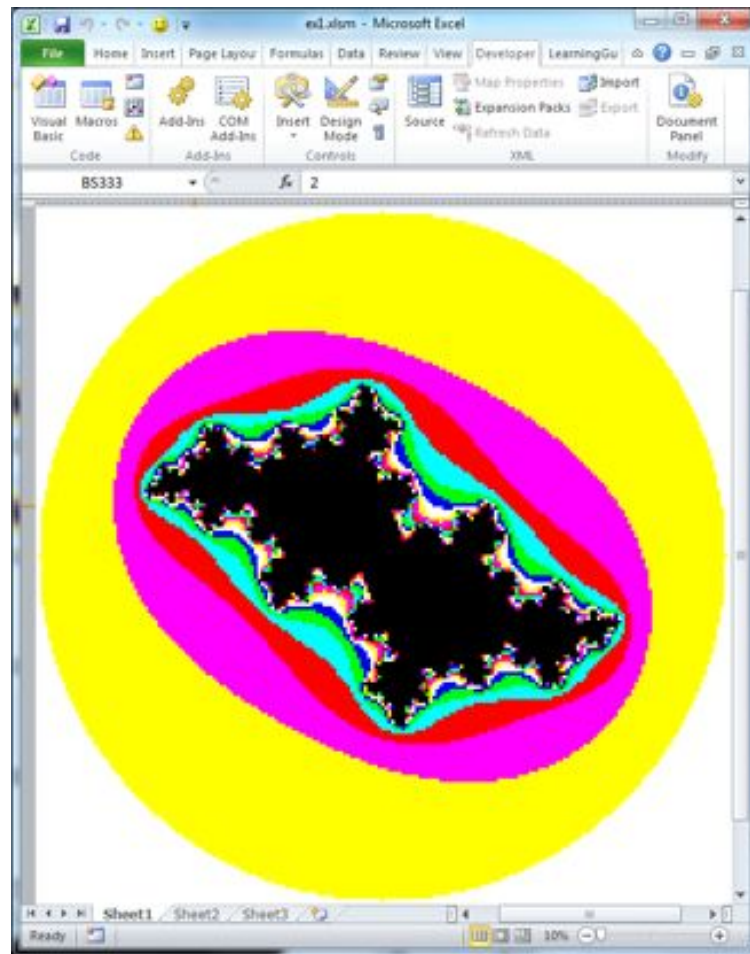


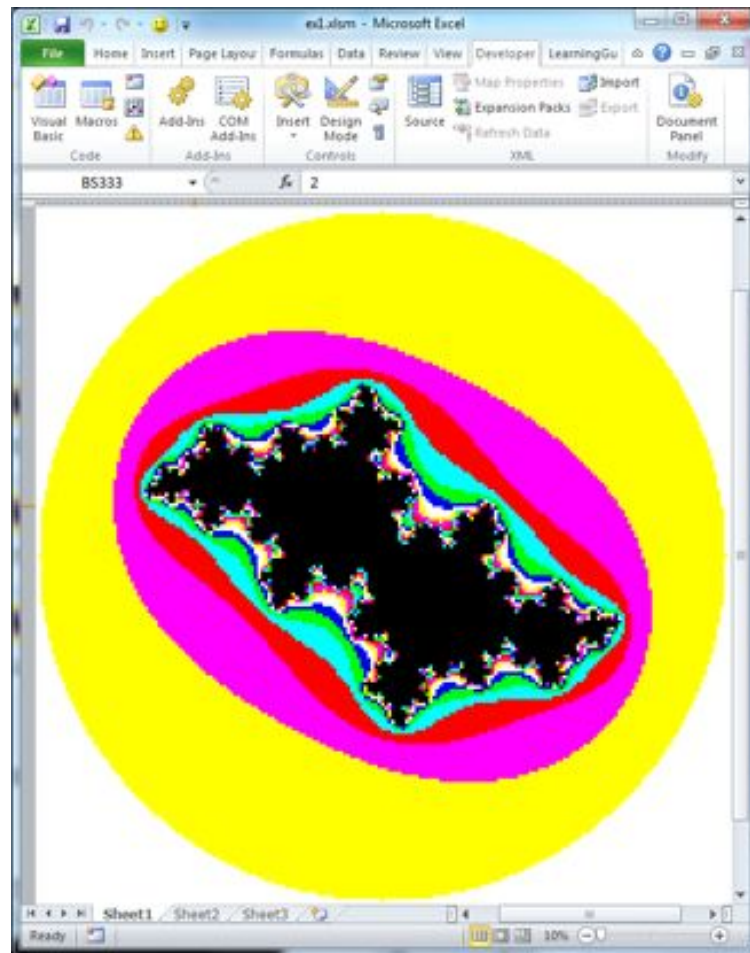


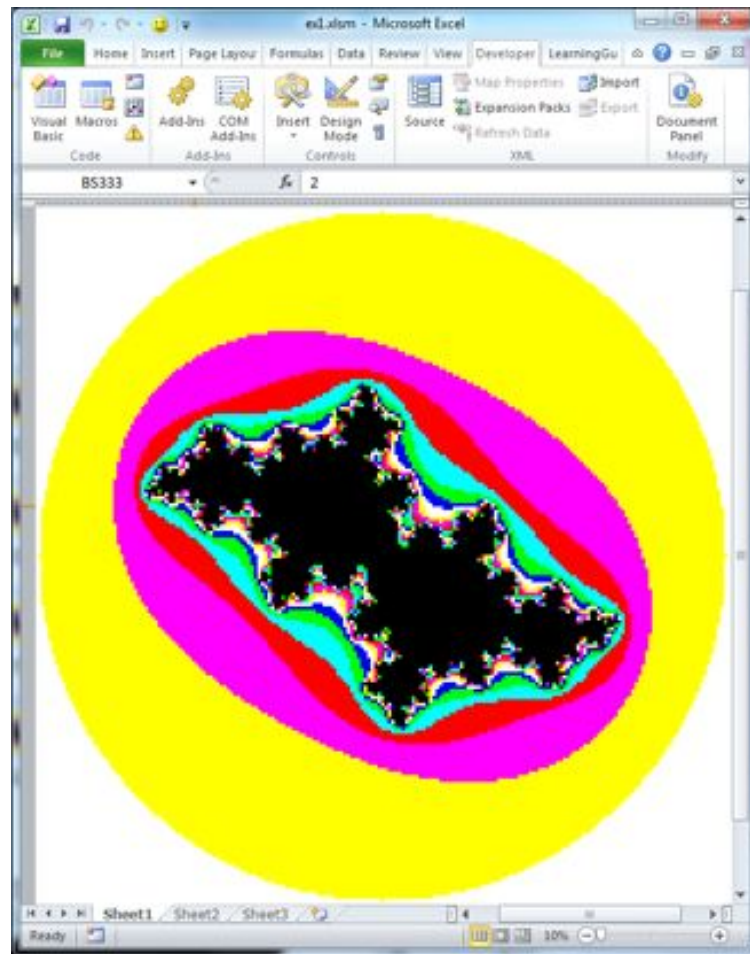


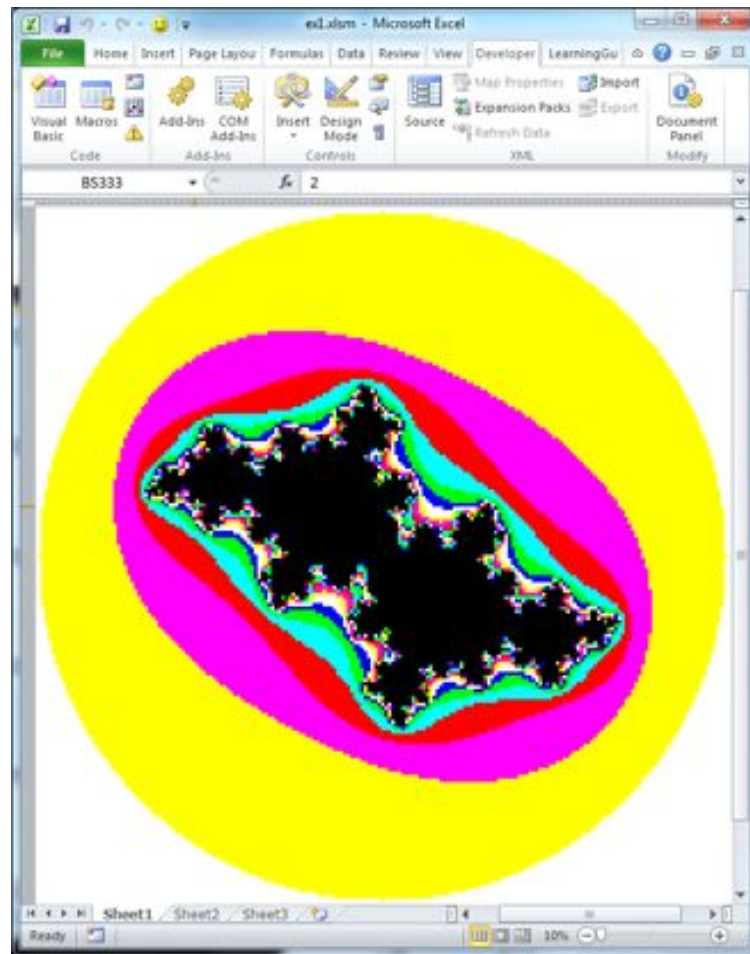


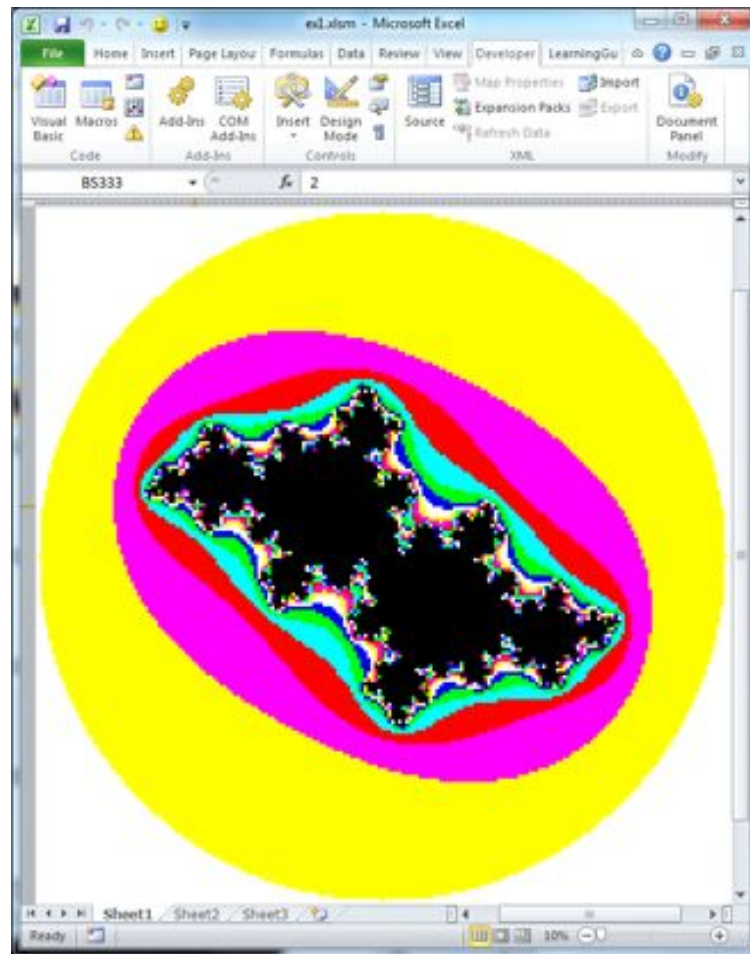


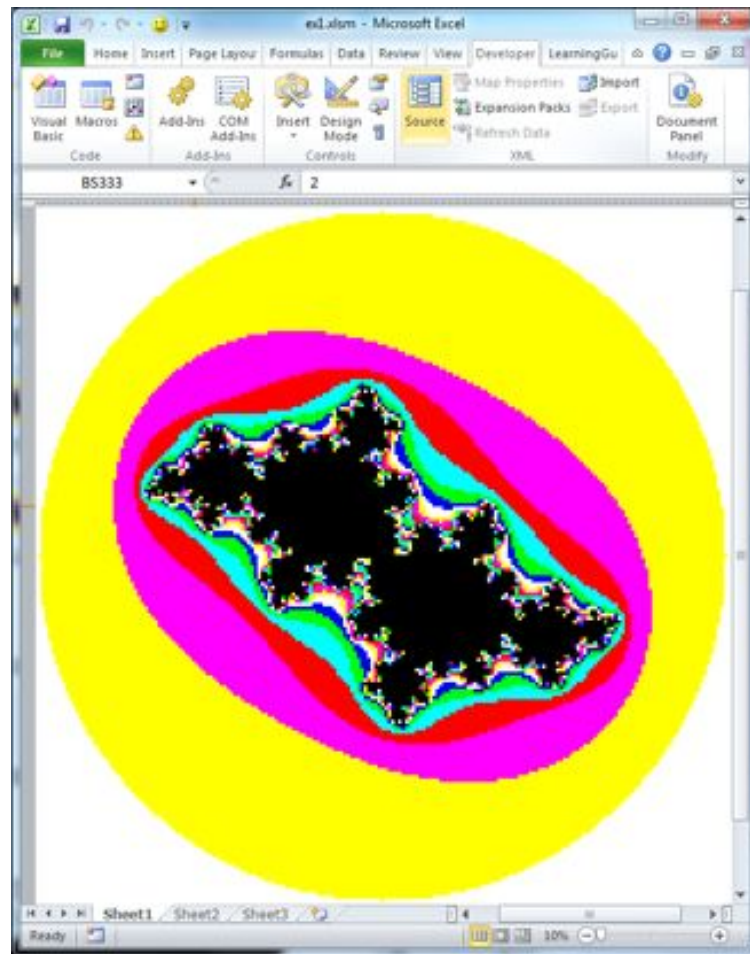


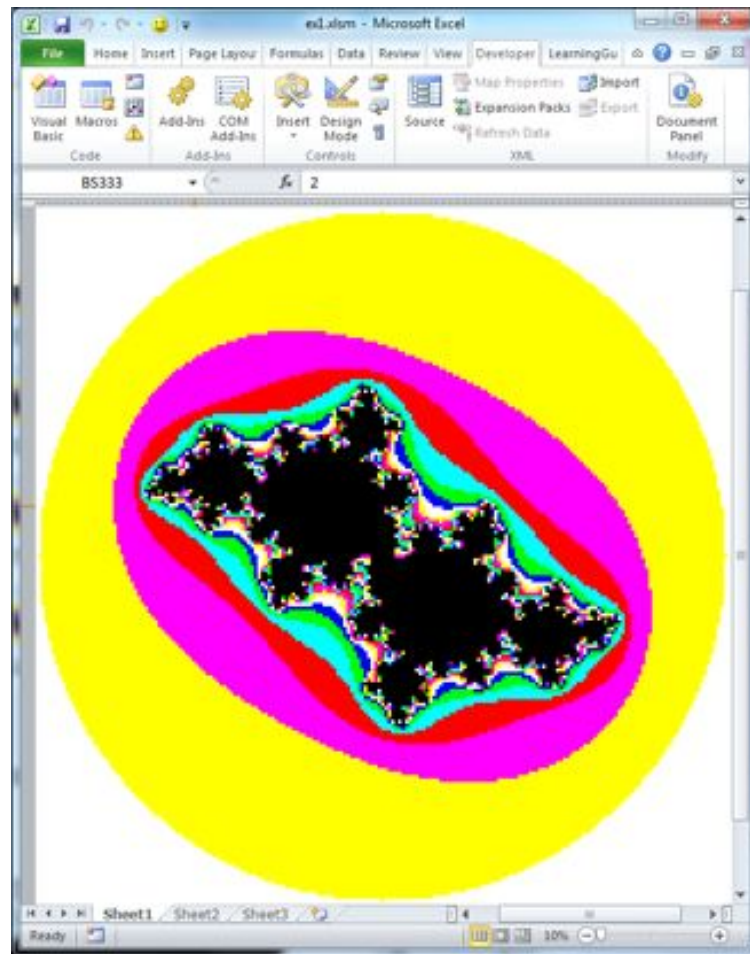


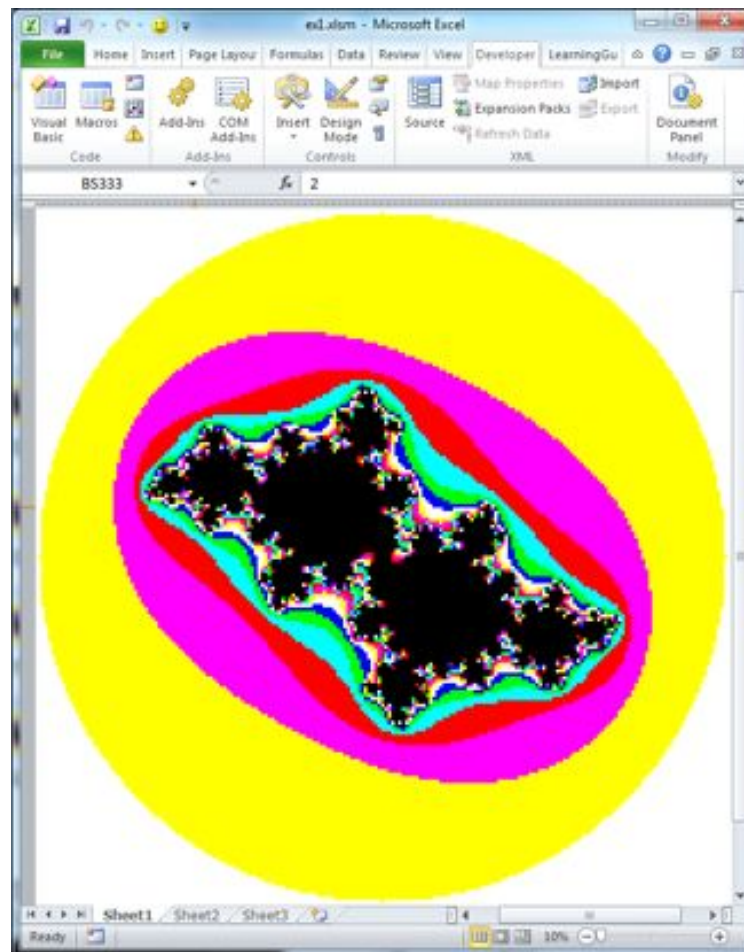


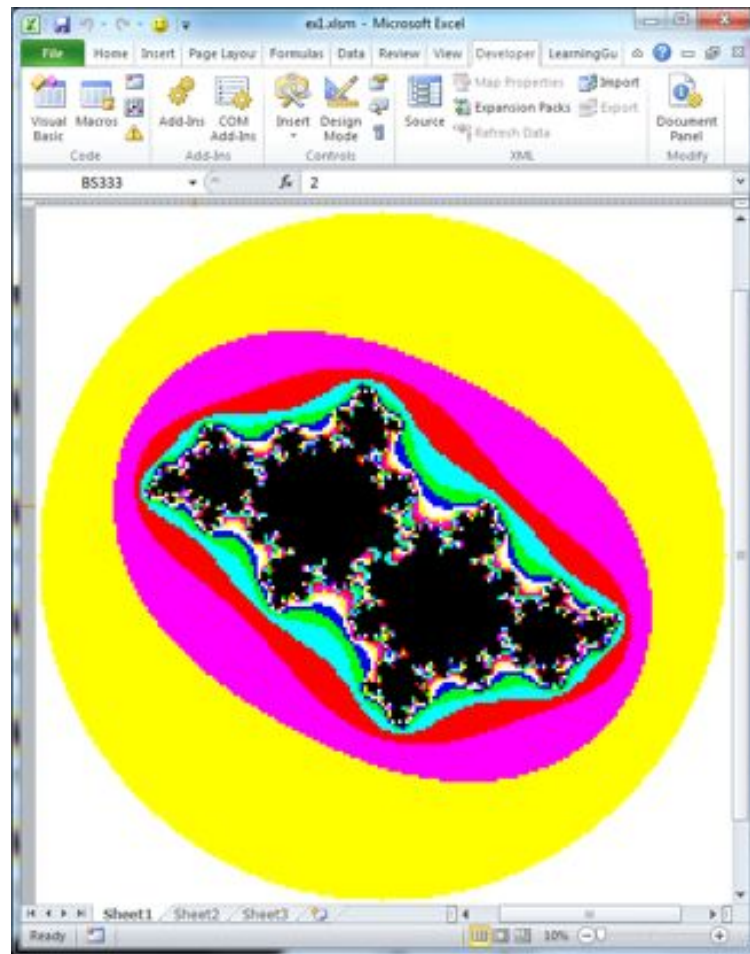


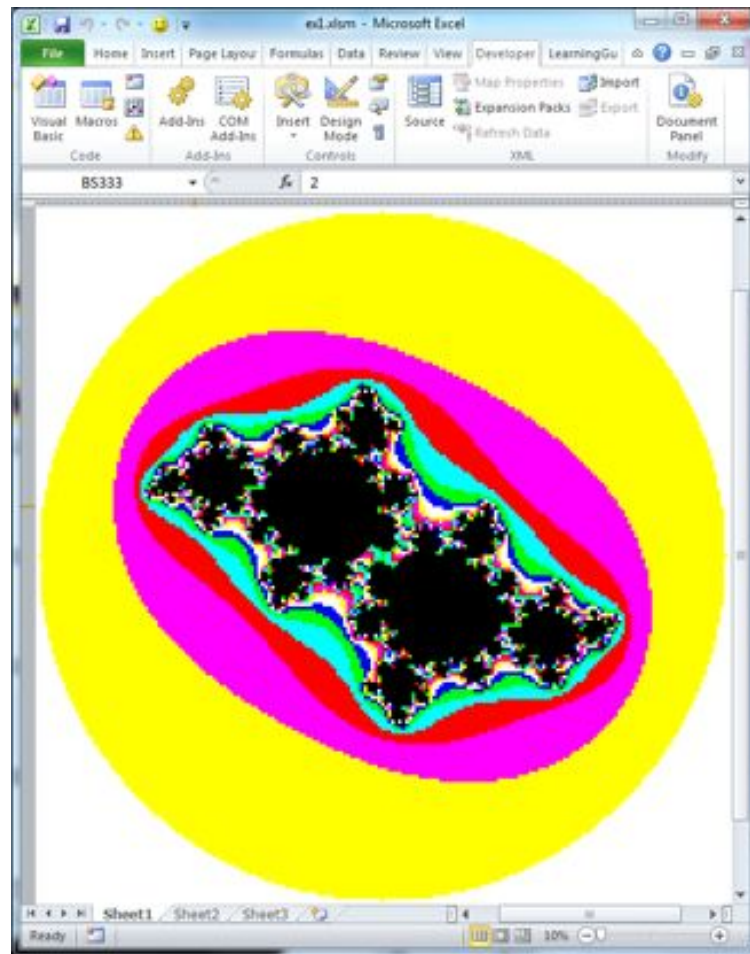


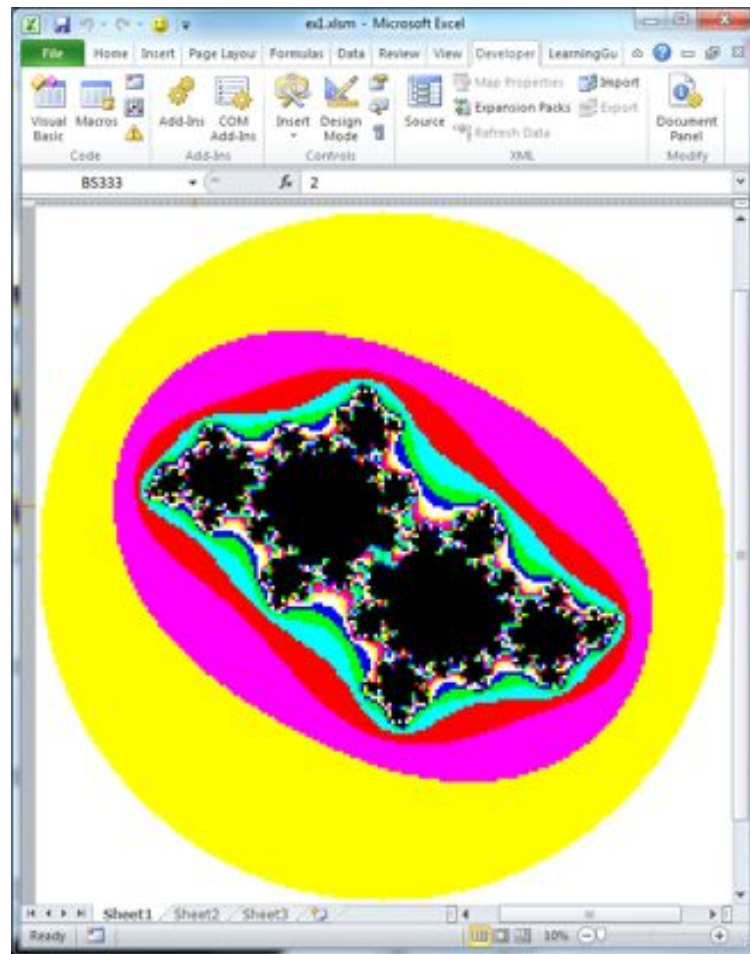


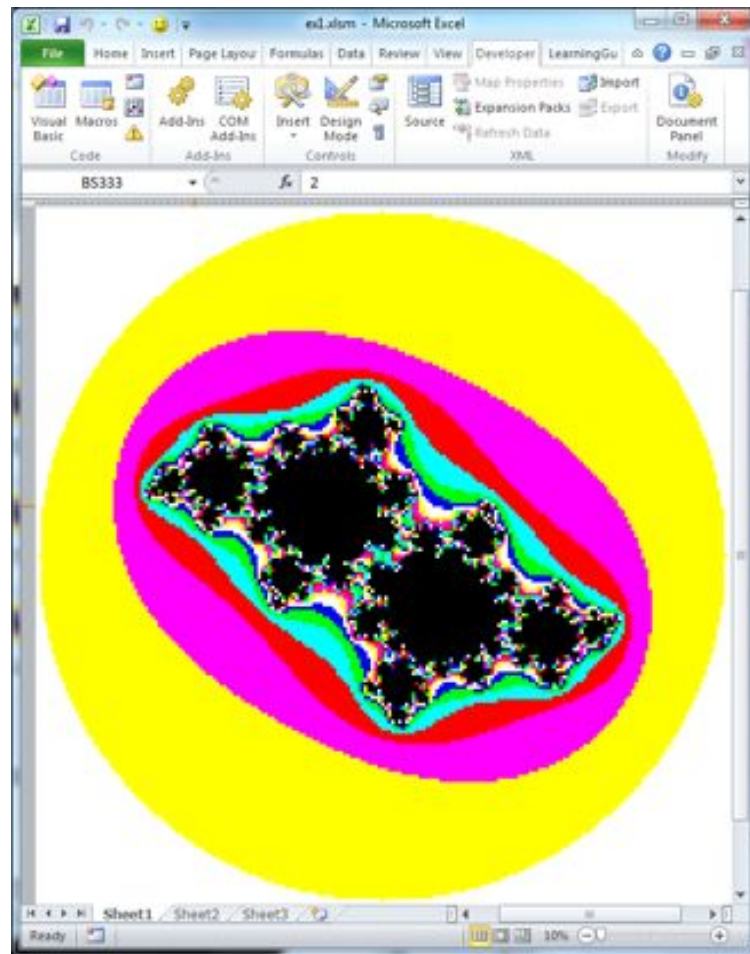


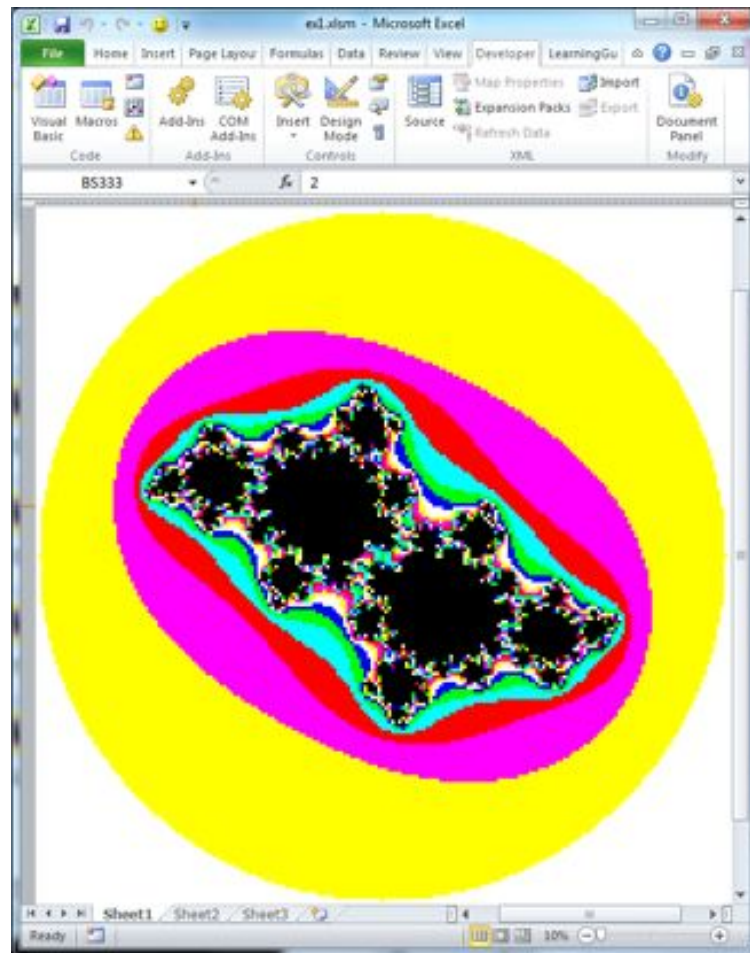


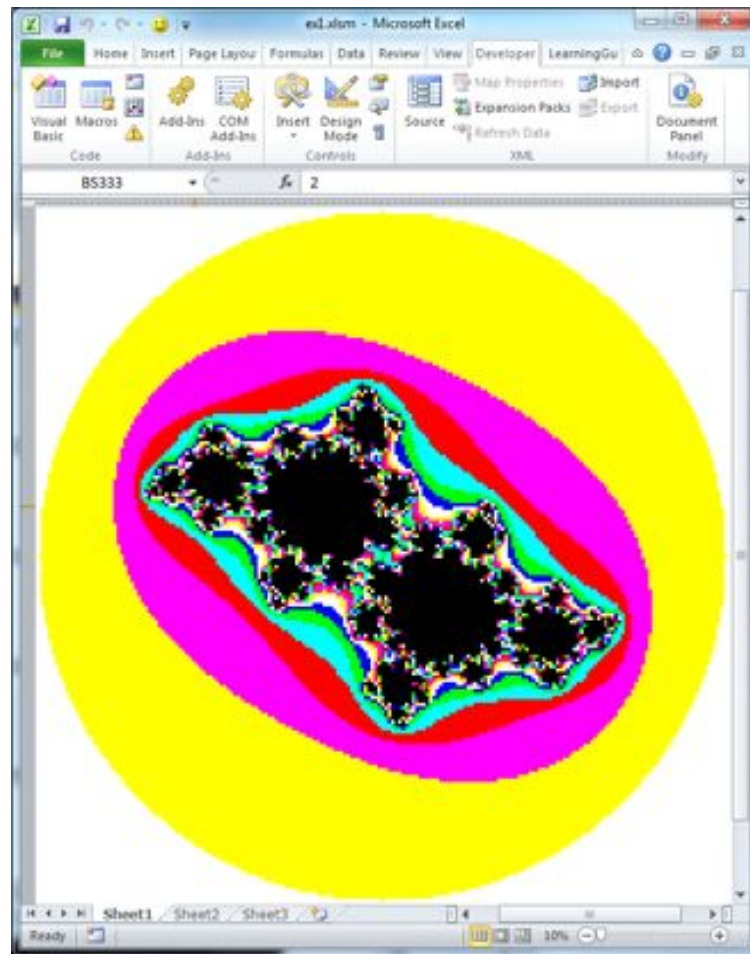


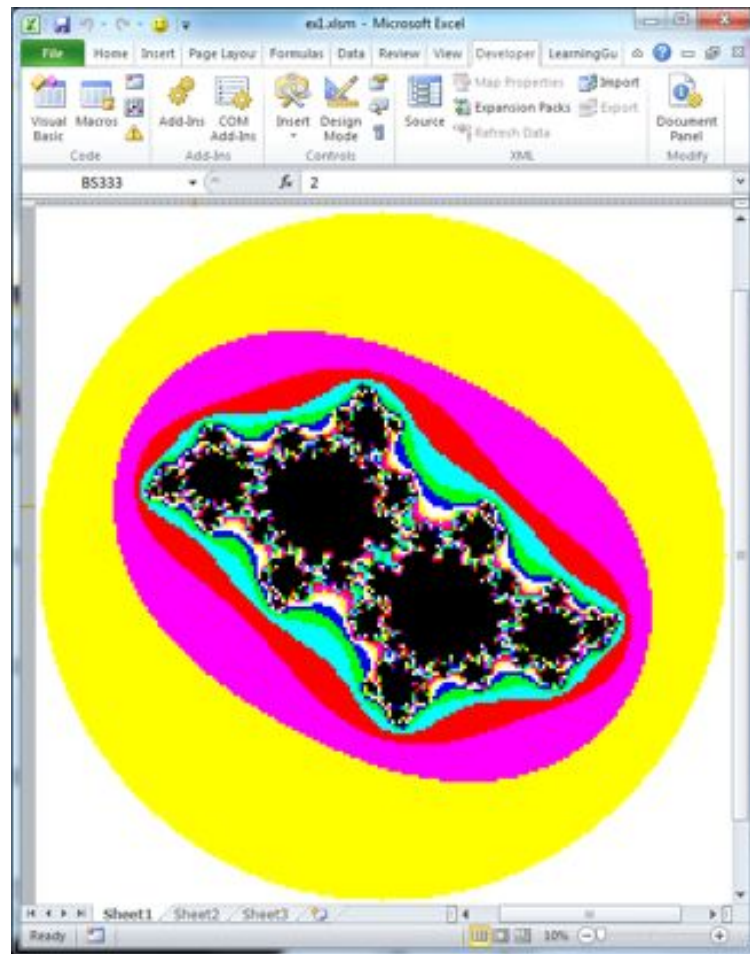


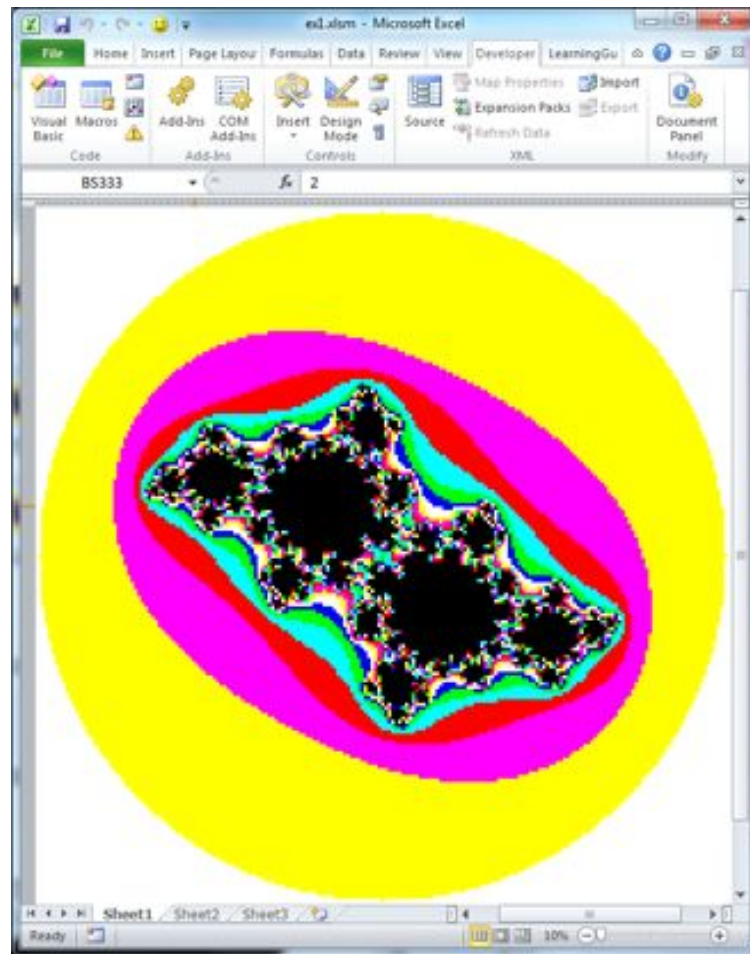


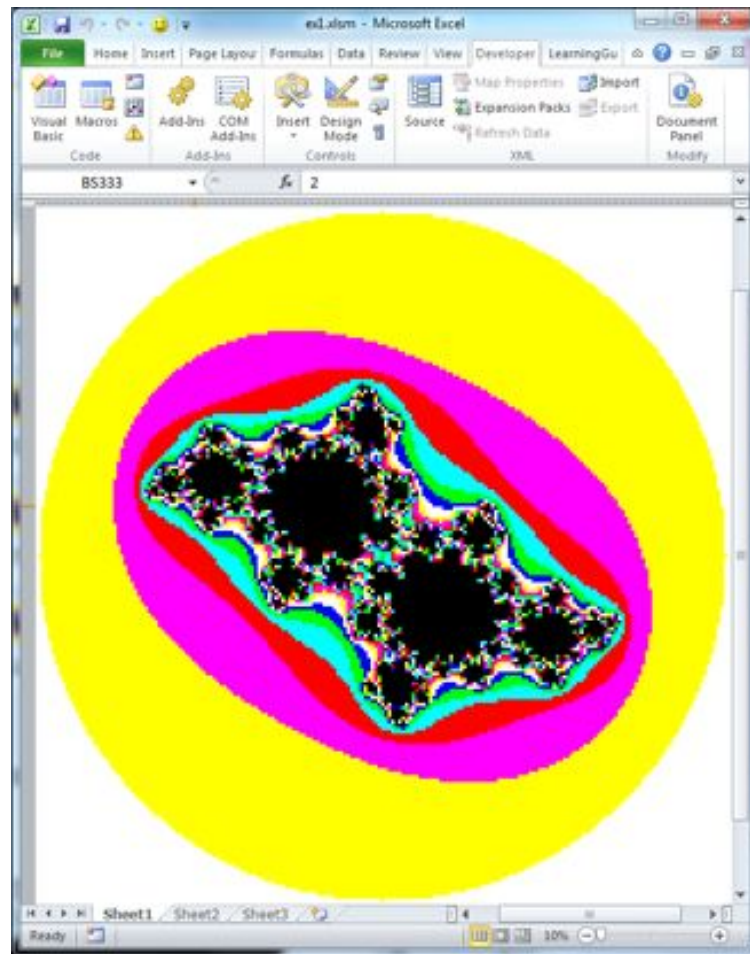




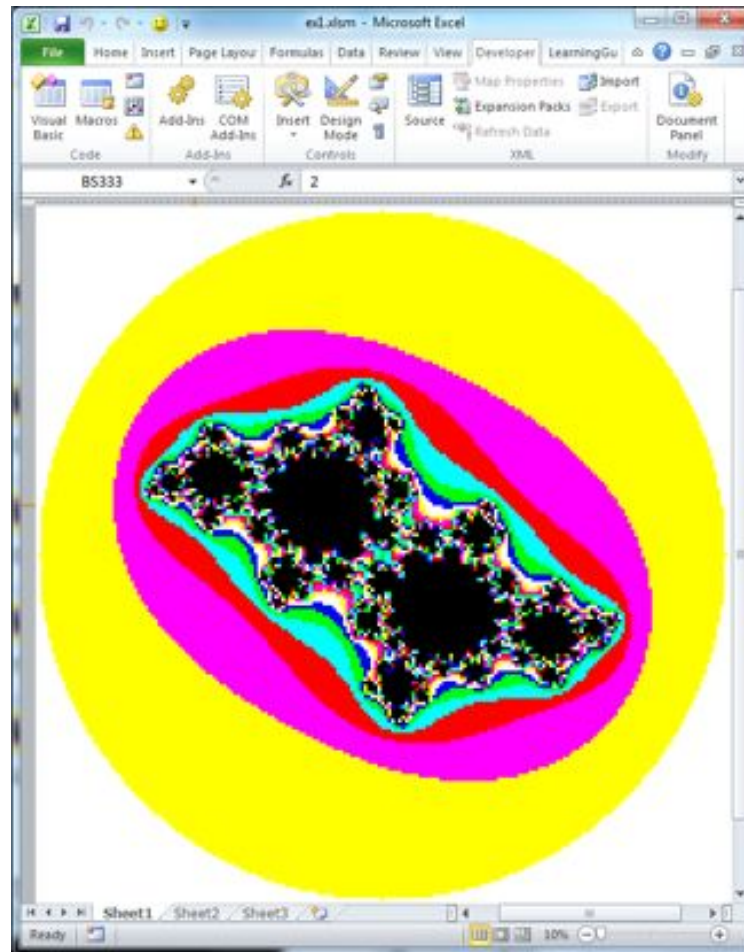




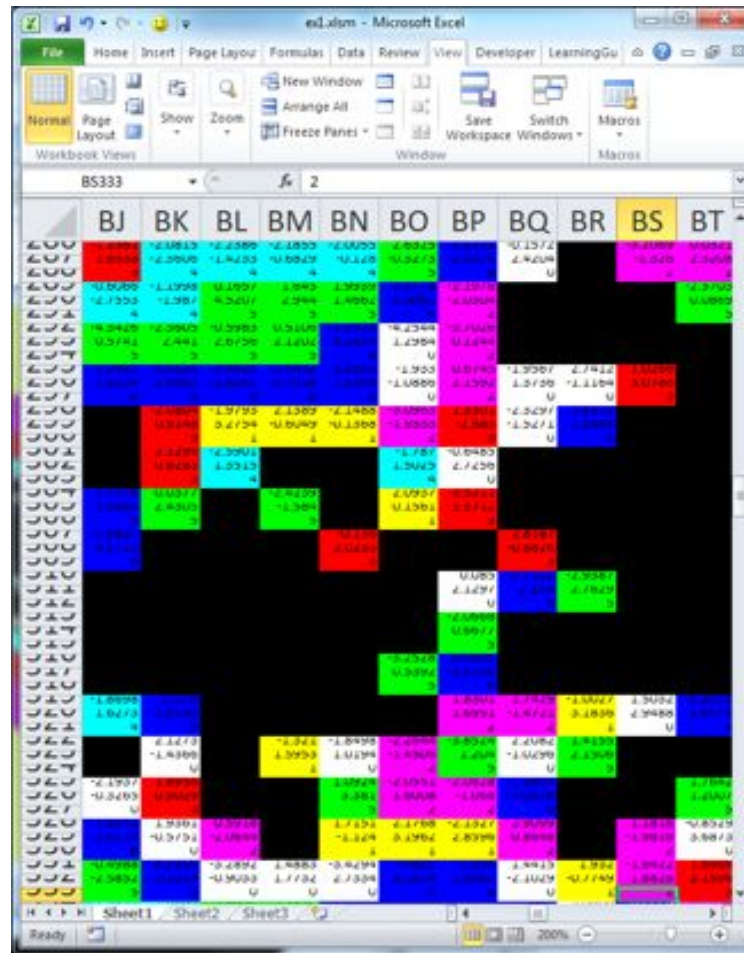




(final frame)



# It's really a spreadsheet!



# So what was that picture?

- **Julia set** for  $-0.4 + 0.6i$

# Second example

# Blocks of three numbers

|   |
|---|
| x |
| y |
| n |

## **Initially**

x and y represent *coordinates*

n is 0 everywhere

# Blocks of three numbers

|   |
|---|
| x |
| y |
| n |

## Iterate:

new x:  $x * x - y * y + (\text{initial x-coordinate})$

new y:  $2 * x * y + (\text{initial y-coordinate})$

new n:  $n + 1$

(But only if  $x * x + y * y < 4$ )

# Then:

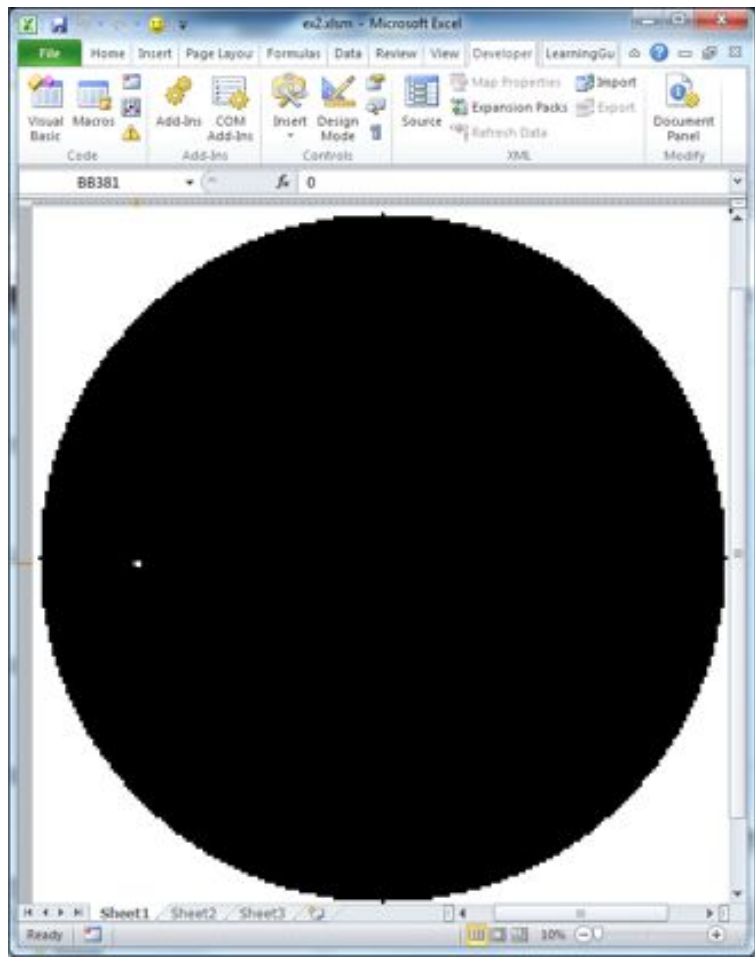
|   |
|---|
| x |
| y |
| n |

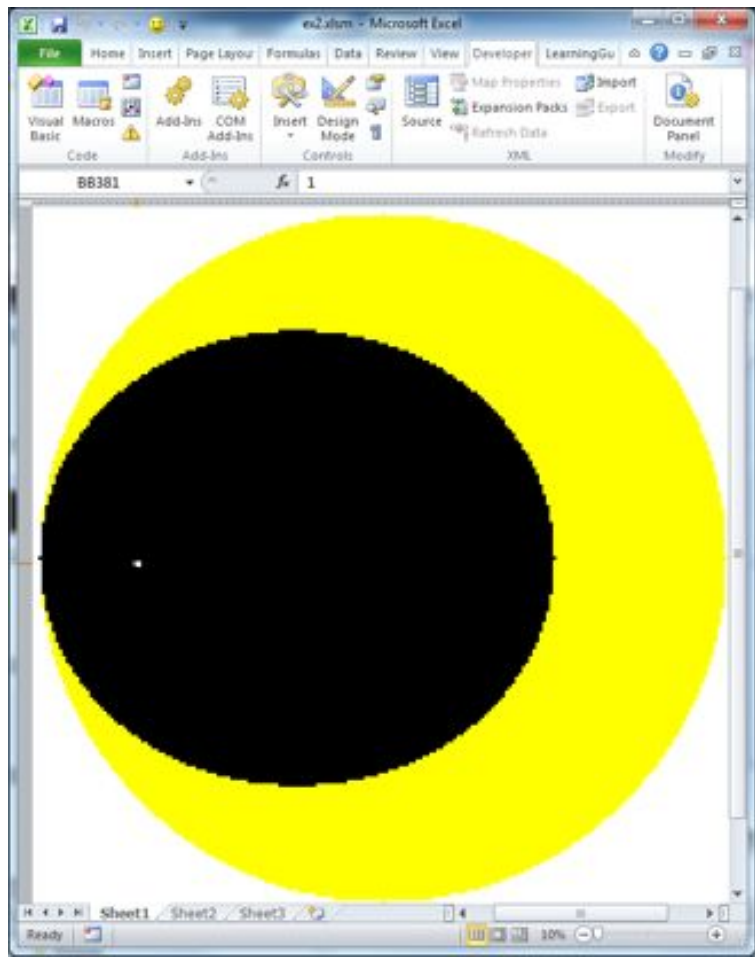
If  $x * x + y * y < 4$

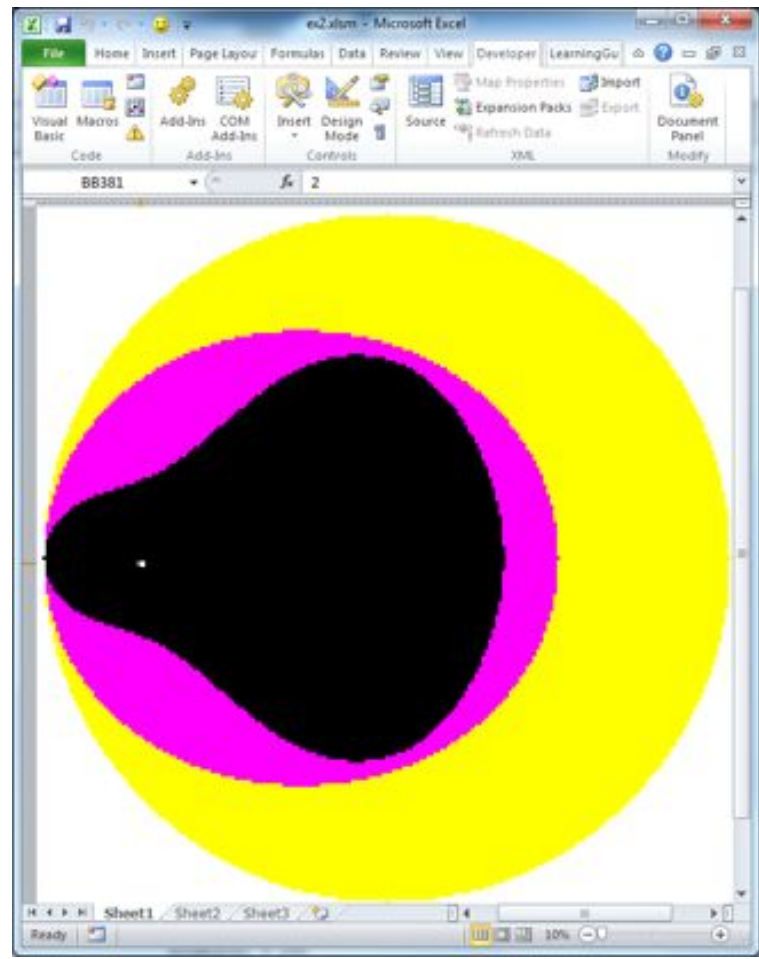
colour block black

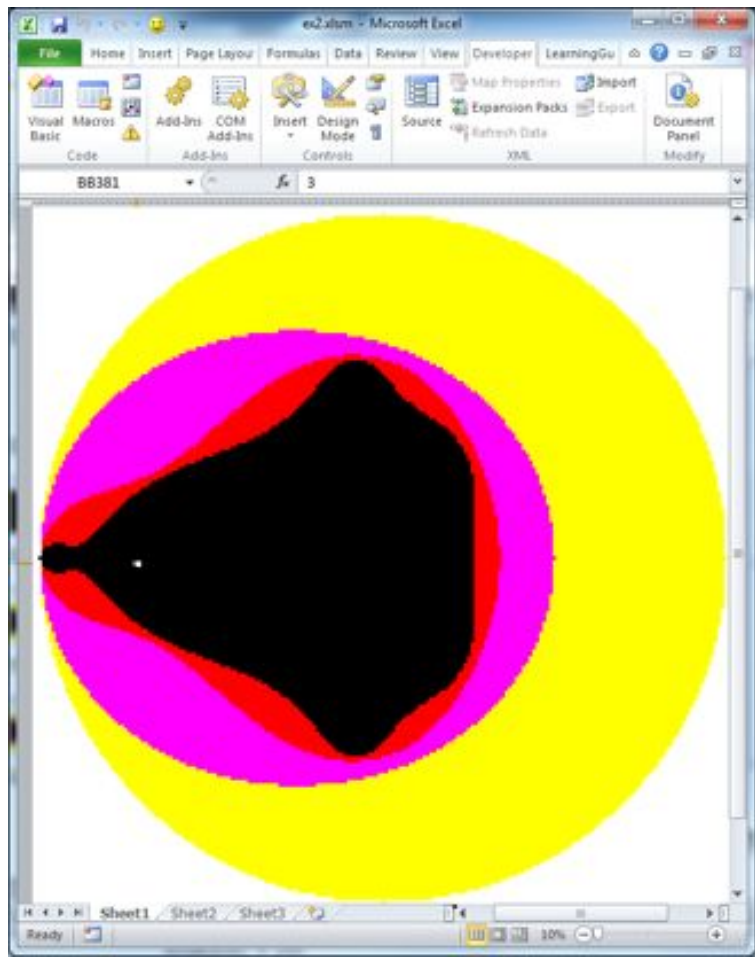
Otherwise

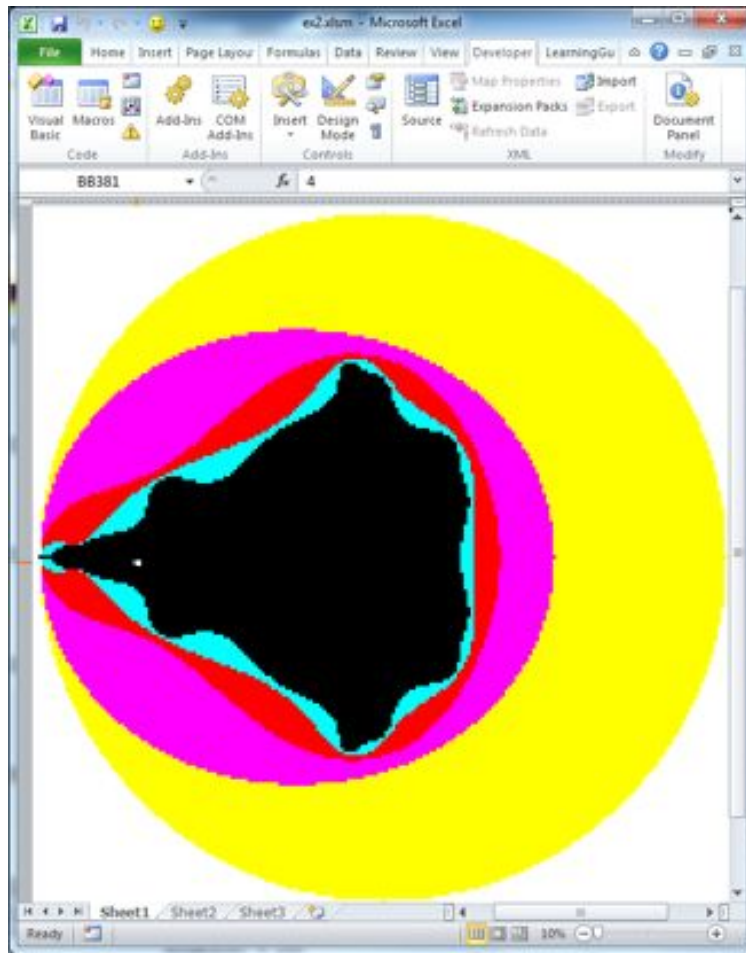
colour block depending on the value of n

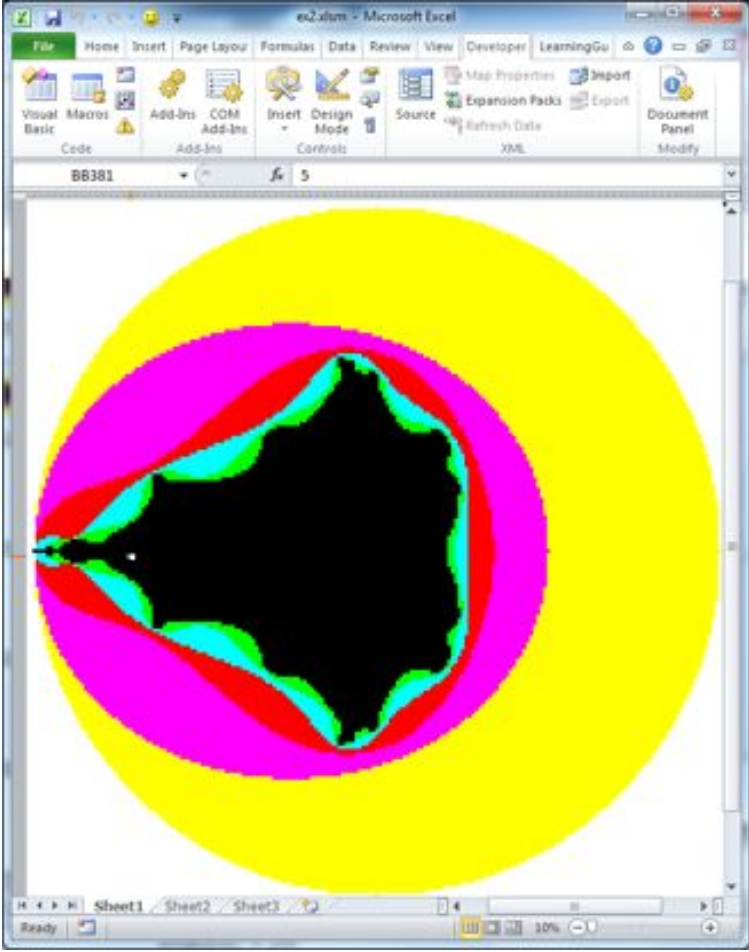


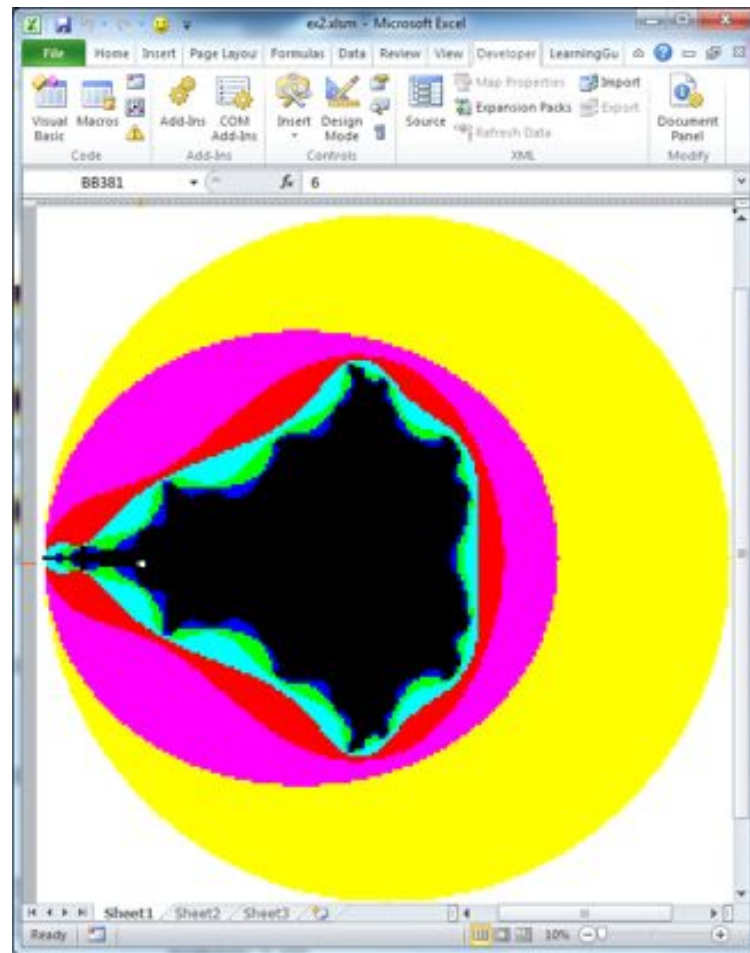


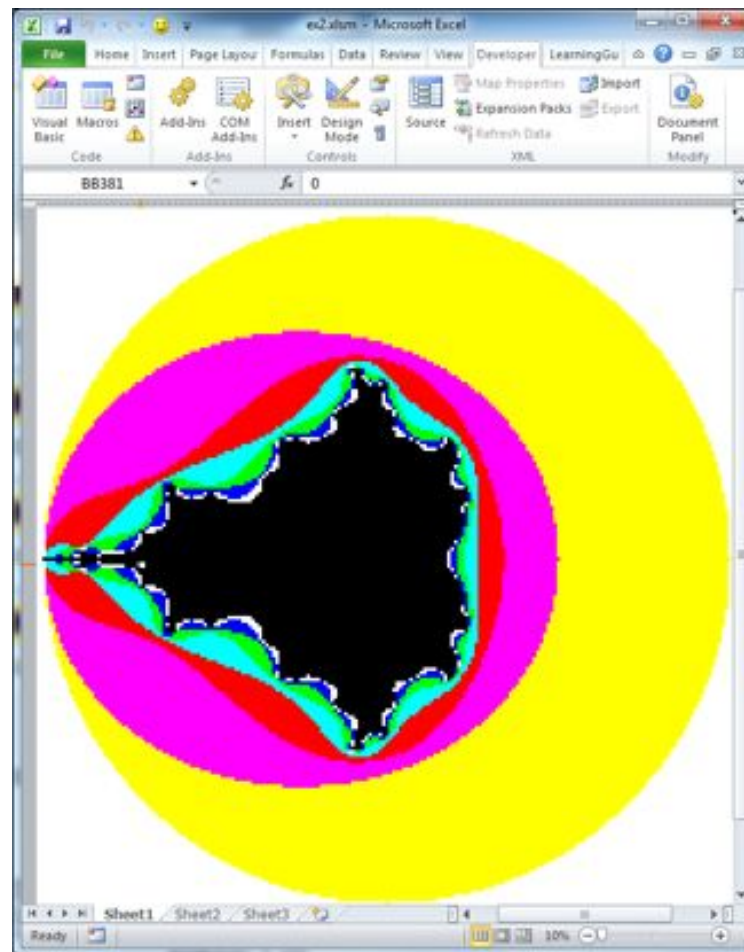


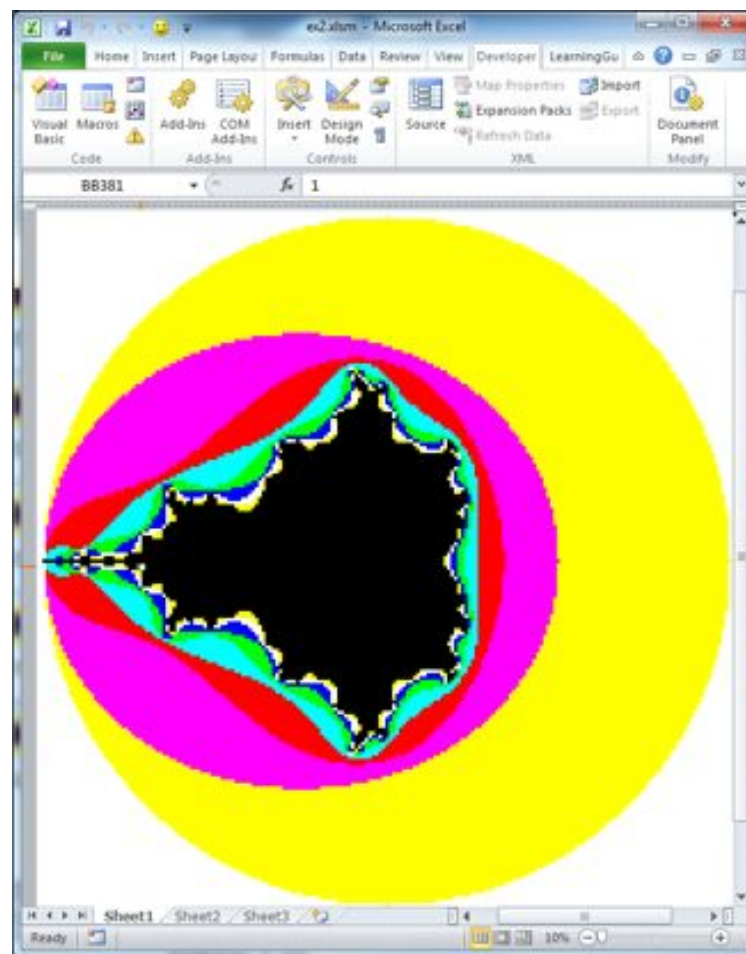


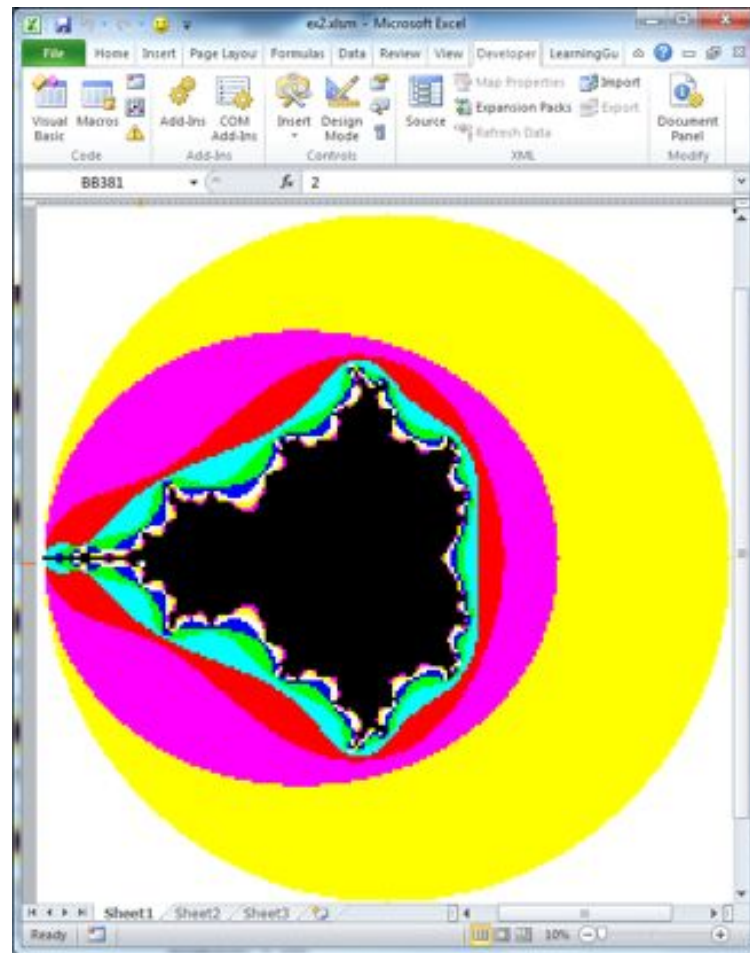


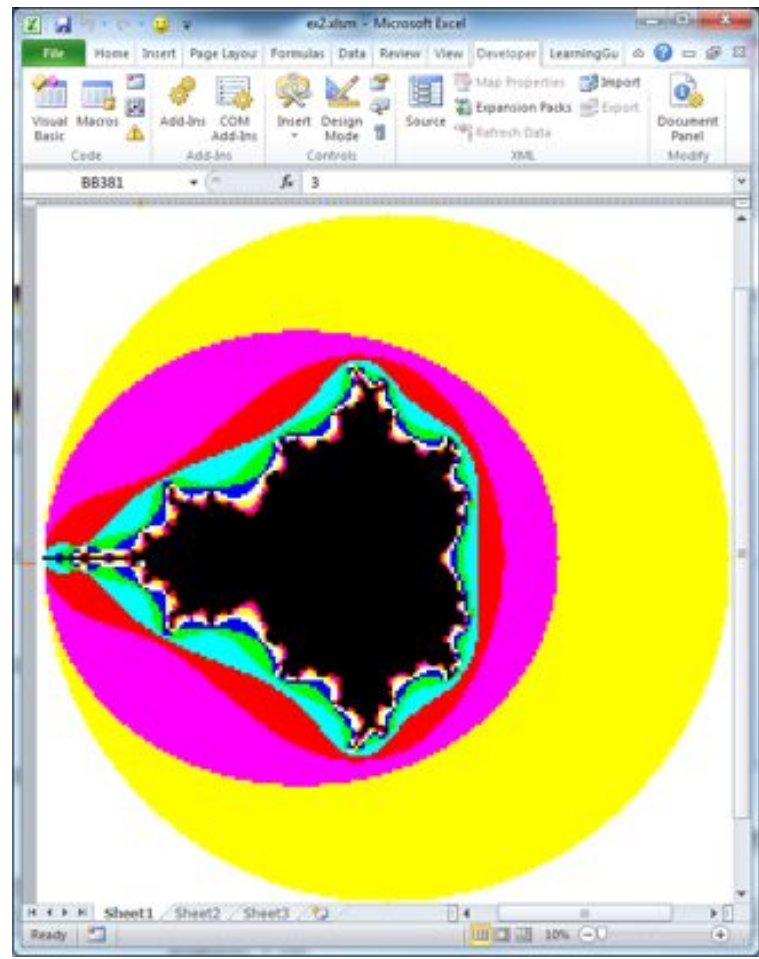


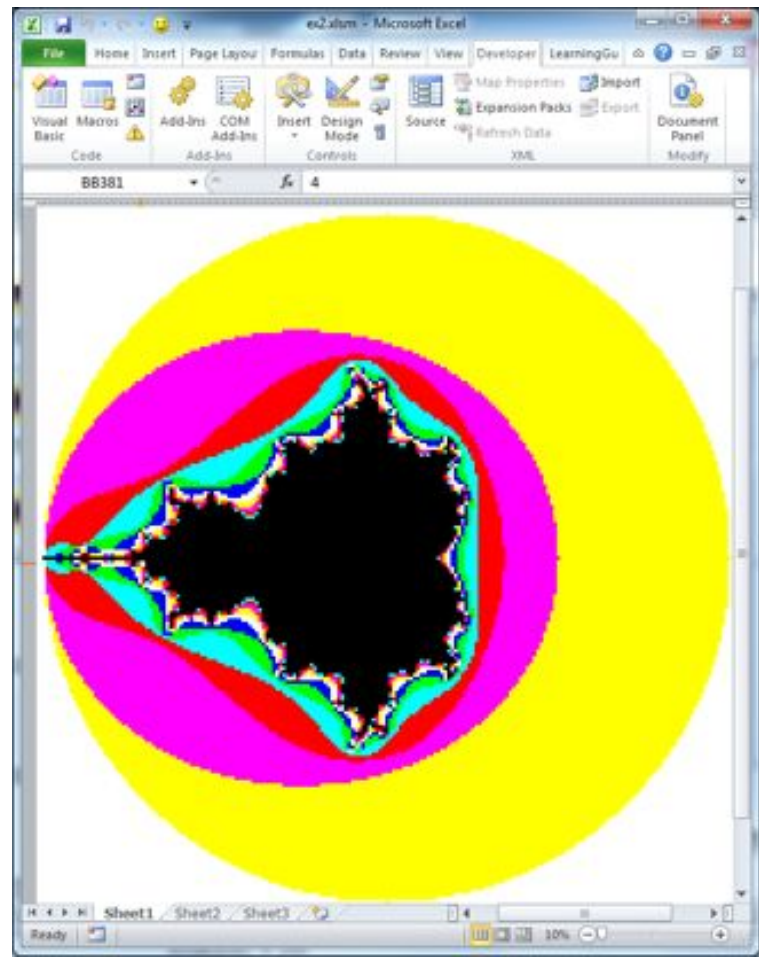


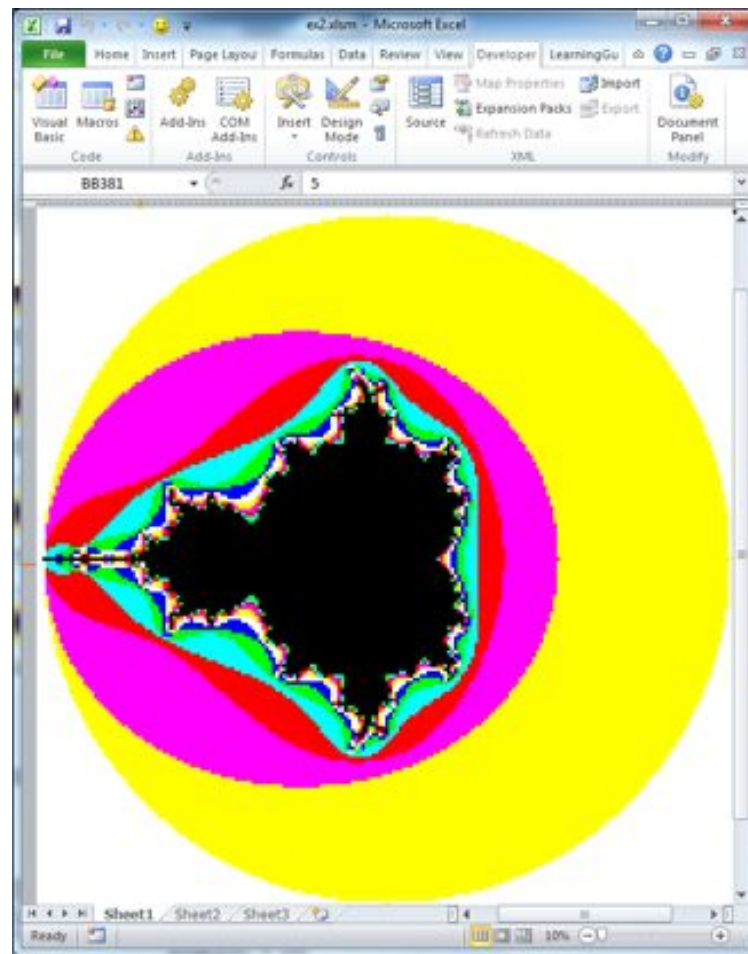


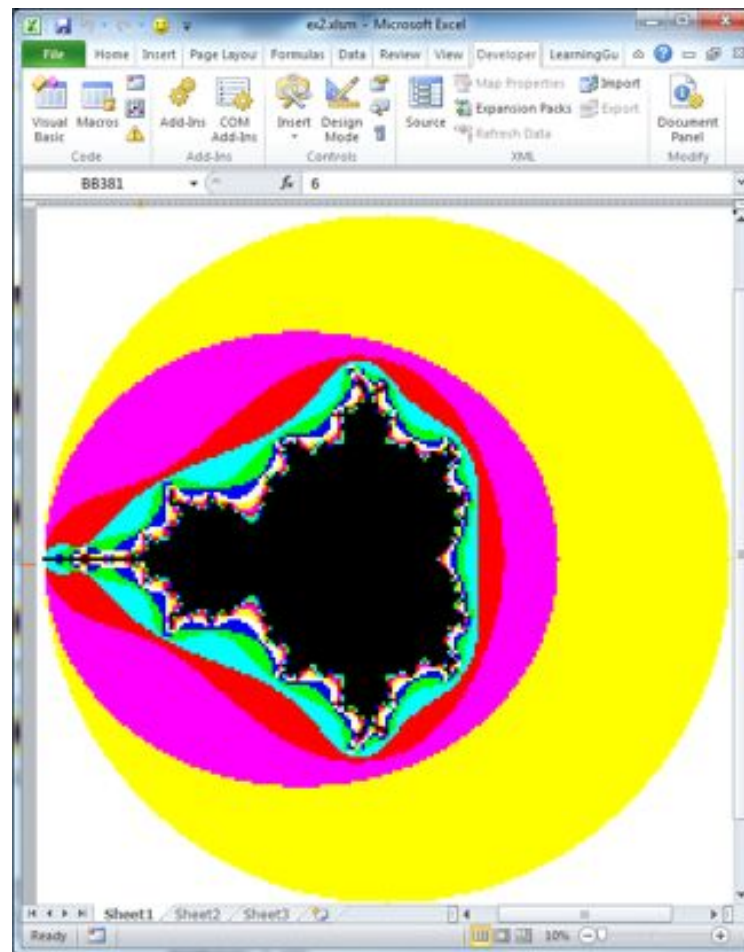


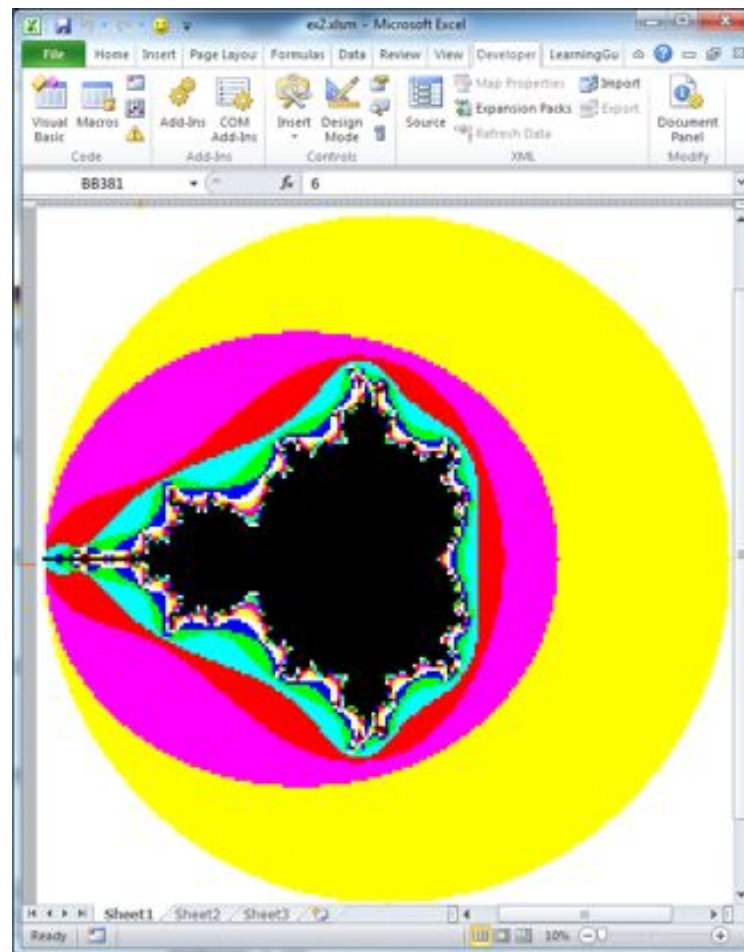


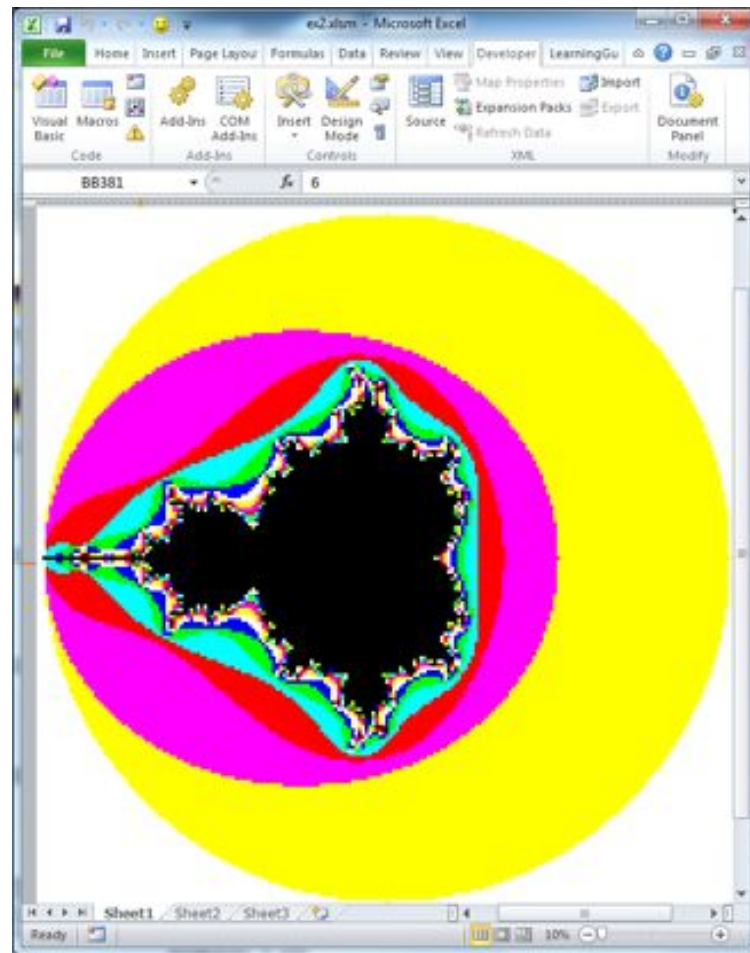


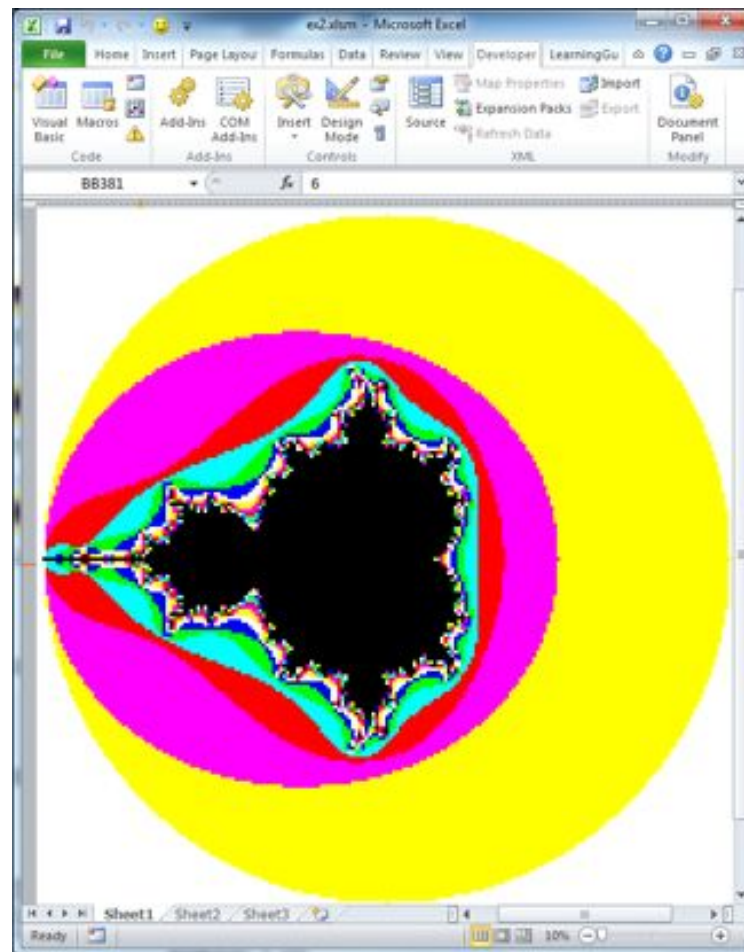


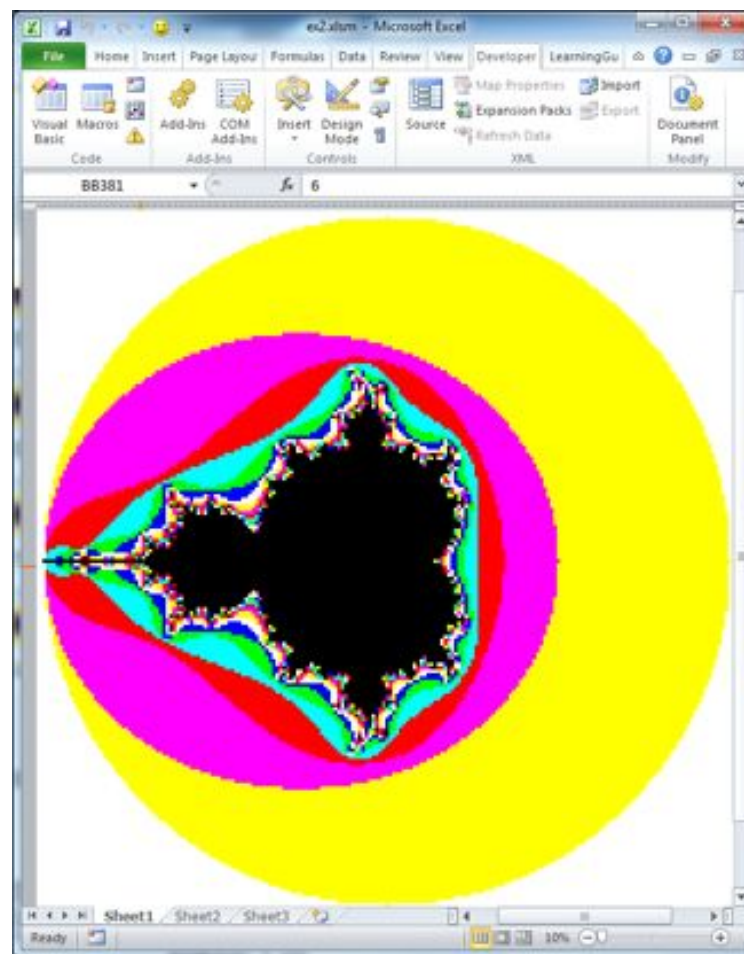


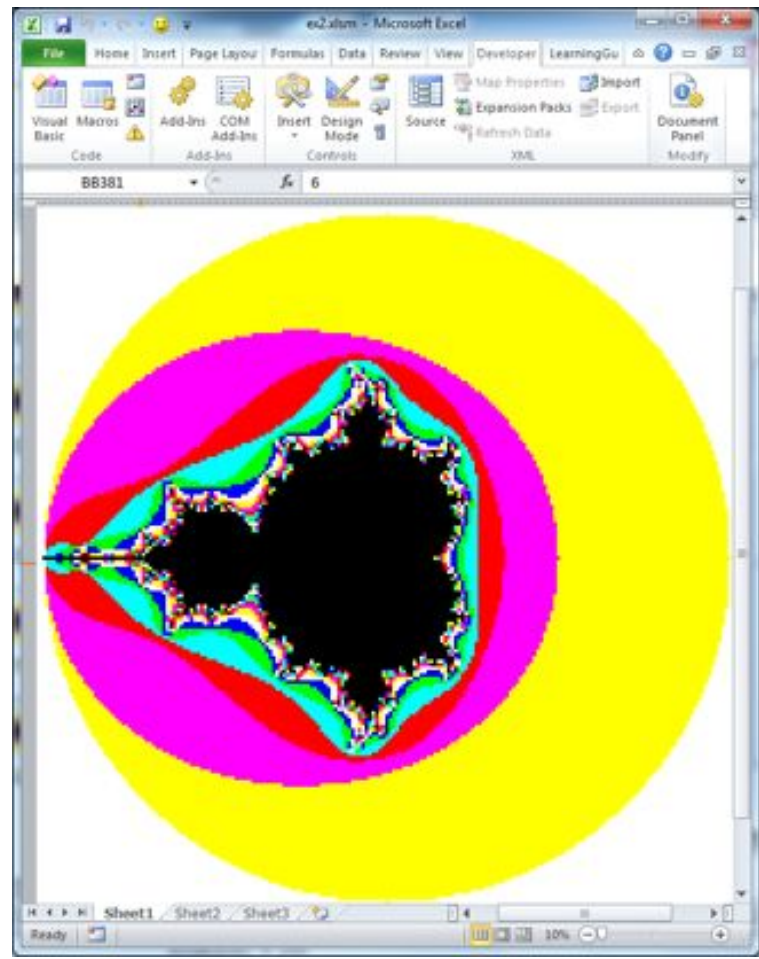


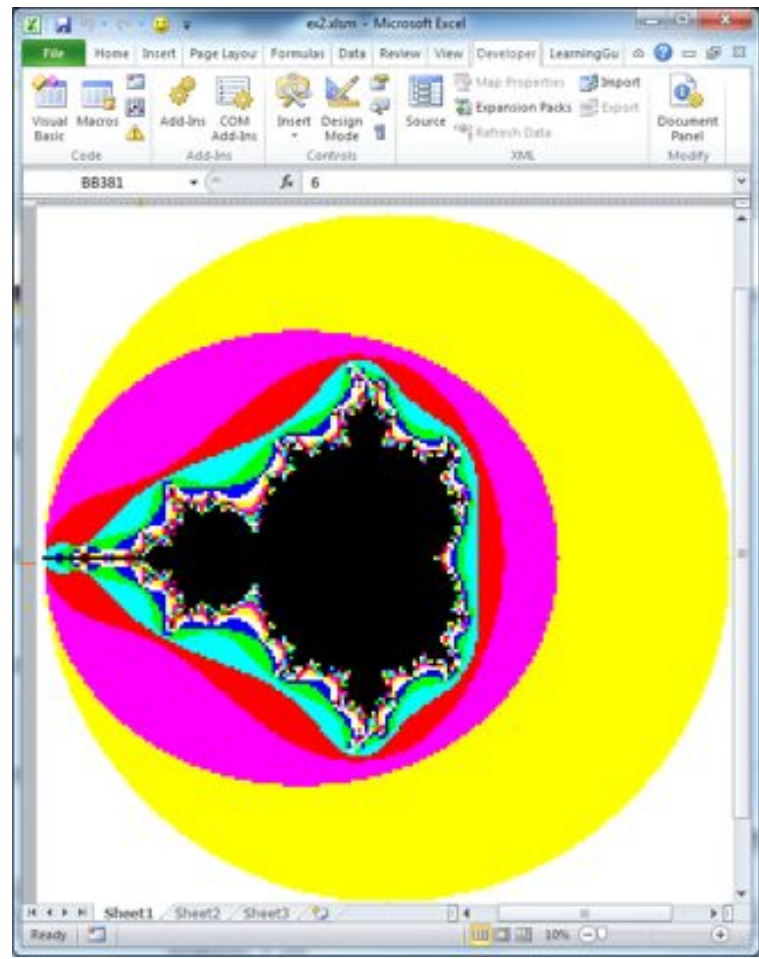




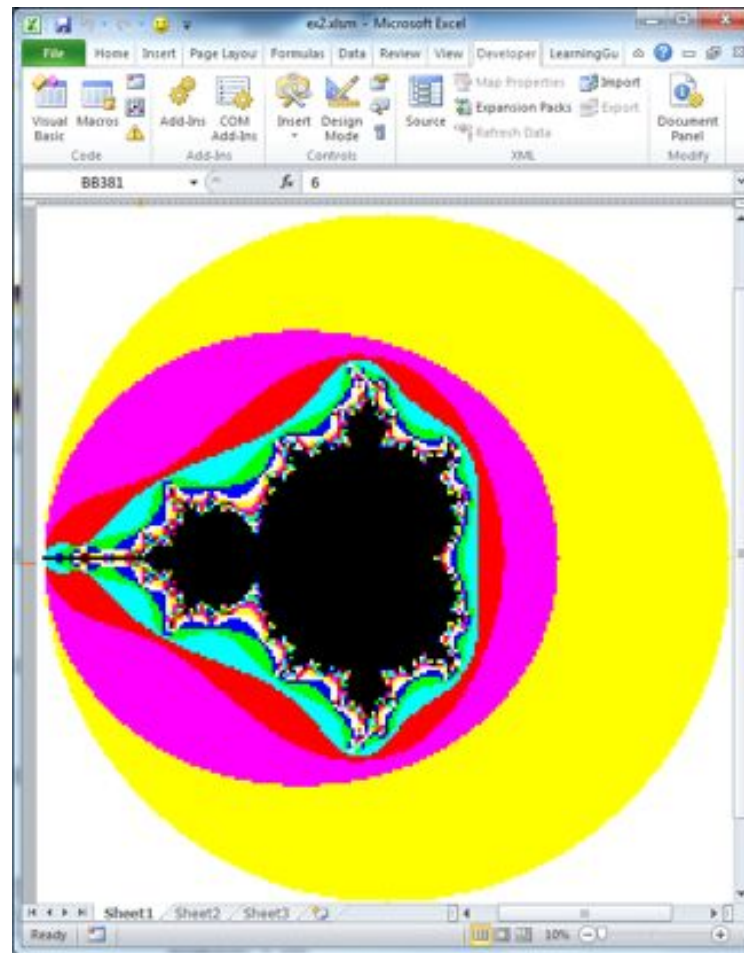








(final frame)



# So what was that picture?

- **Mandelbrot set**

# Third example

# Blocks of two numbers

|   |
|---|
| x |
| y |

## **Initially**

x and y represent *coordinates*

# Blocks of two numbers

|   |
|---|
| x |
| y |

**Iterate, for  $z = x + i y$ :**

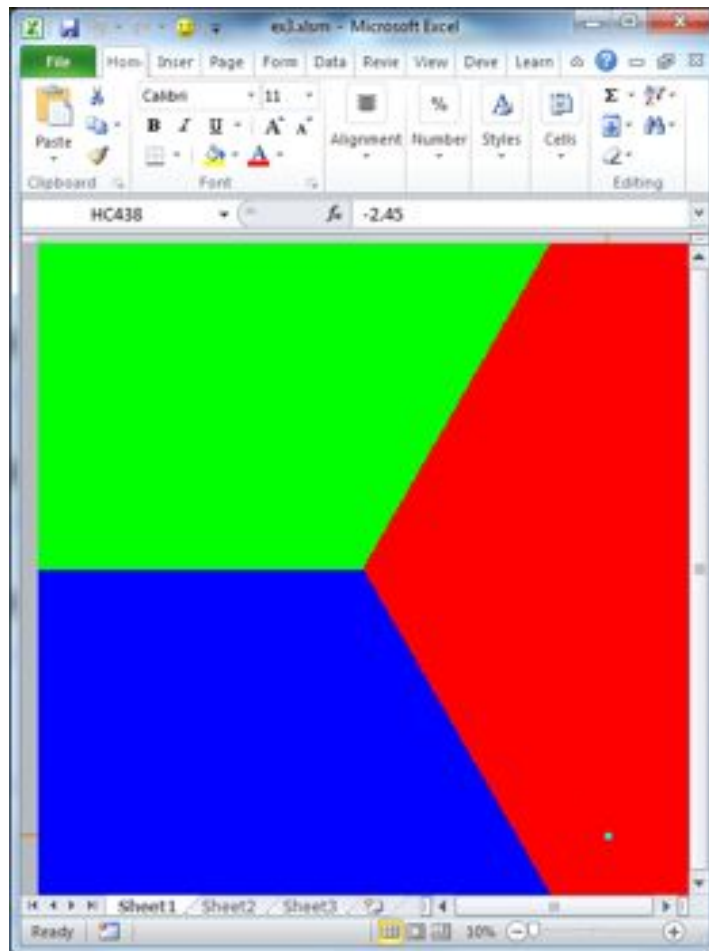
new z:  $z - (z^3 - 1)/(3*z^2)$  (Newton-Raphson)

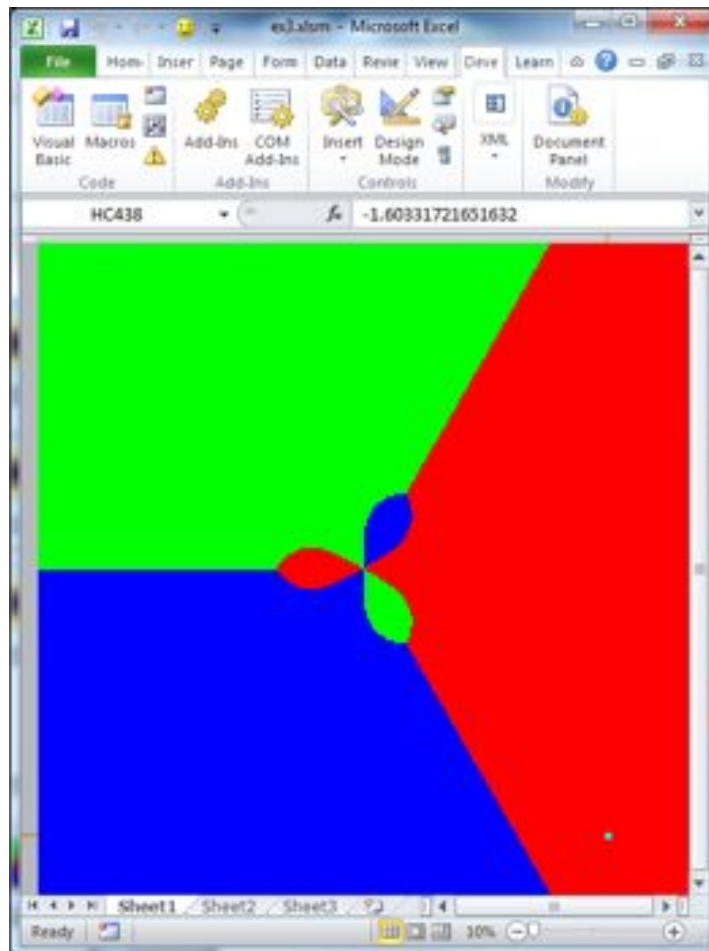
# Then

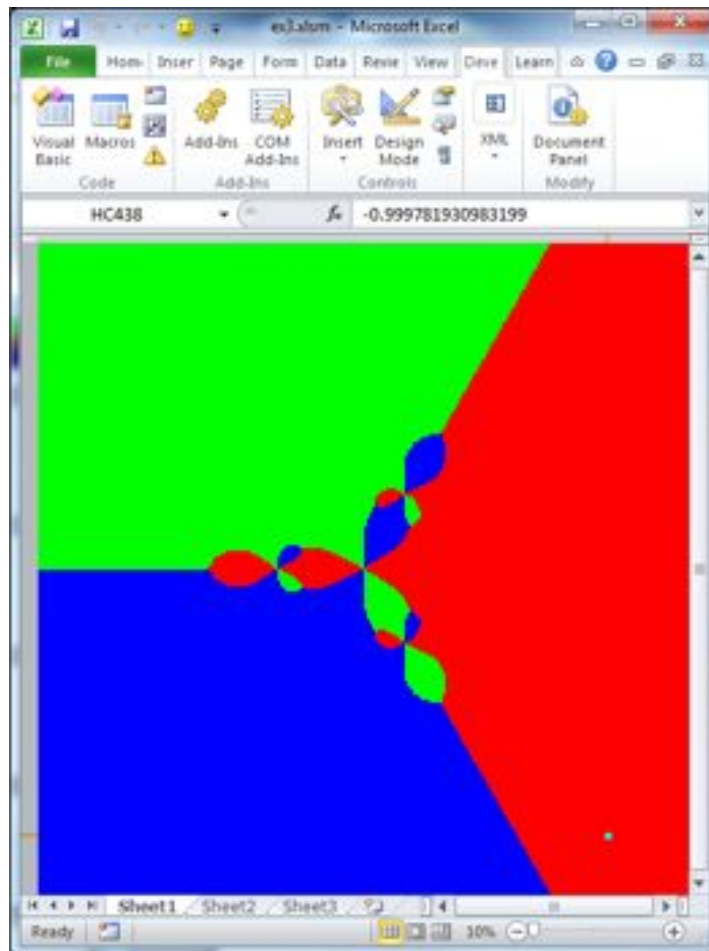
|   |
|---|
| x |
| y |

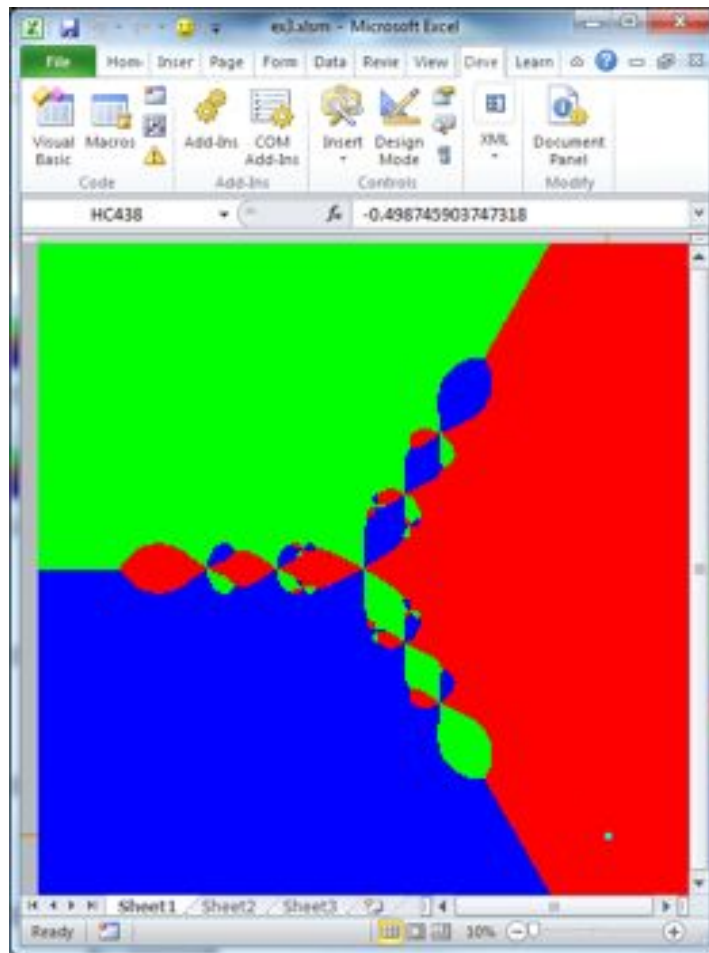
Colour according to which is nearest out of:

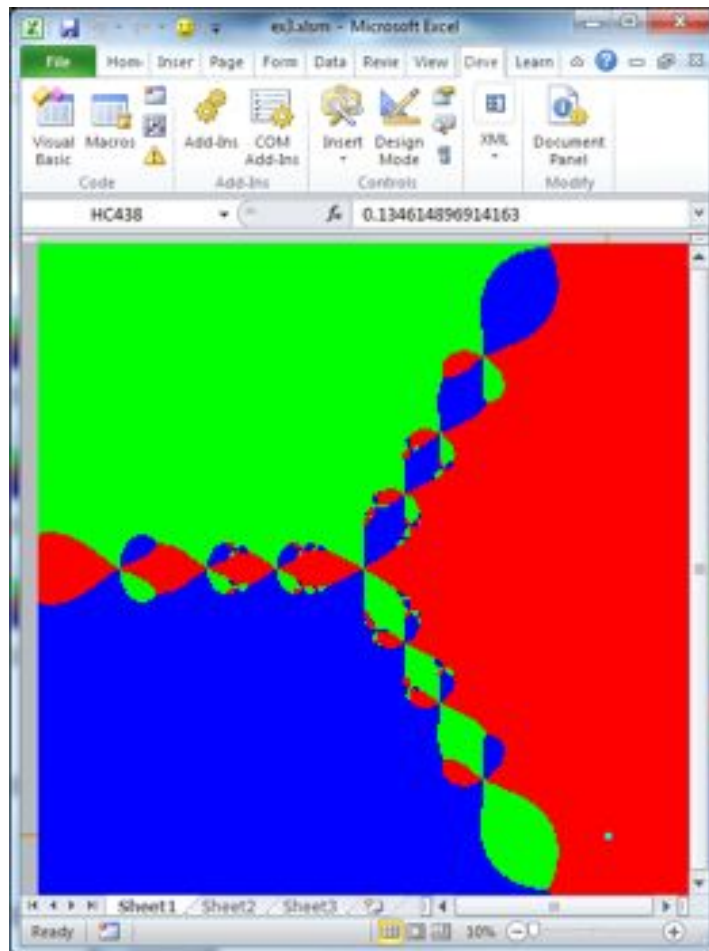
1,       $-0.5 + 0.866i$ ,       $-0.5 - 0.866i$

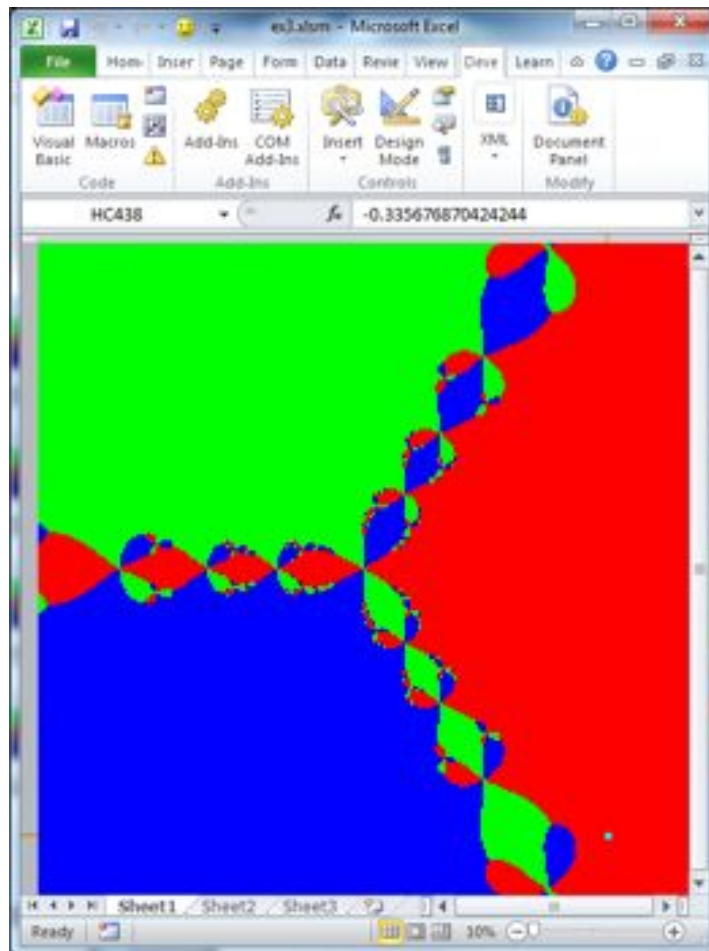


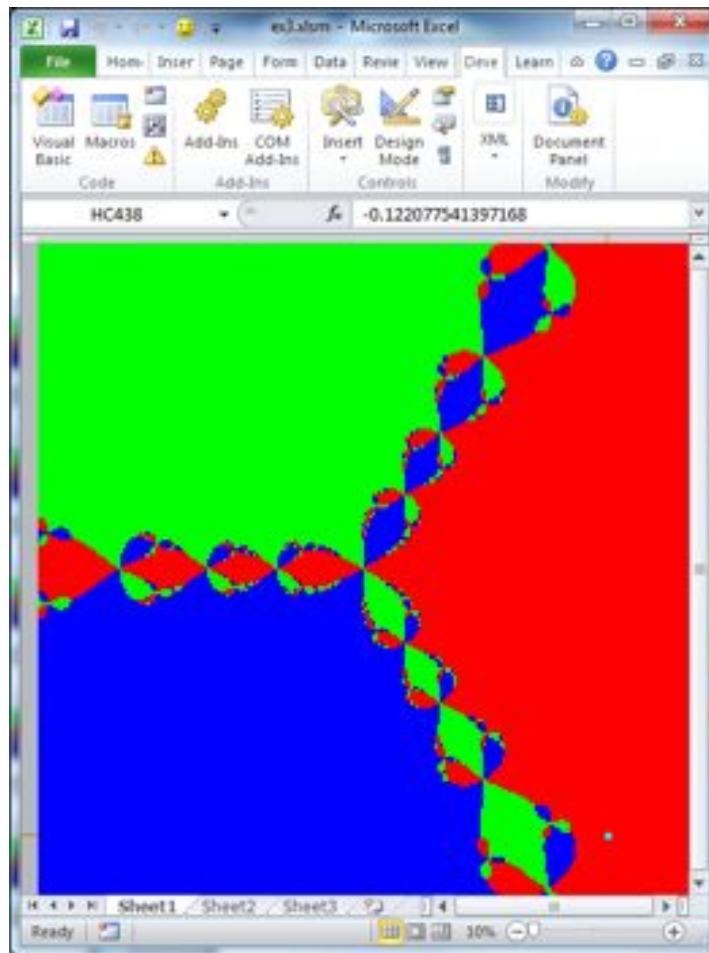


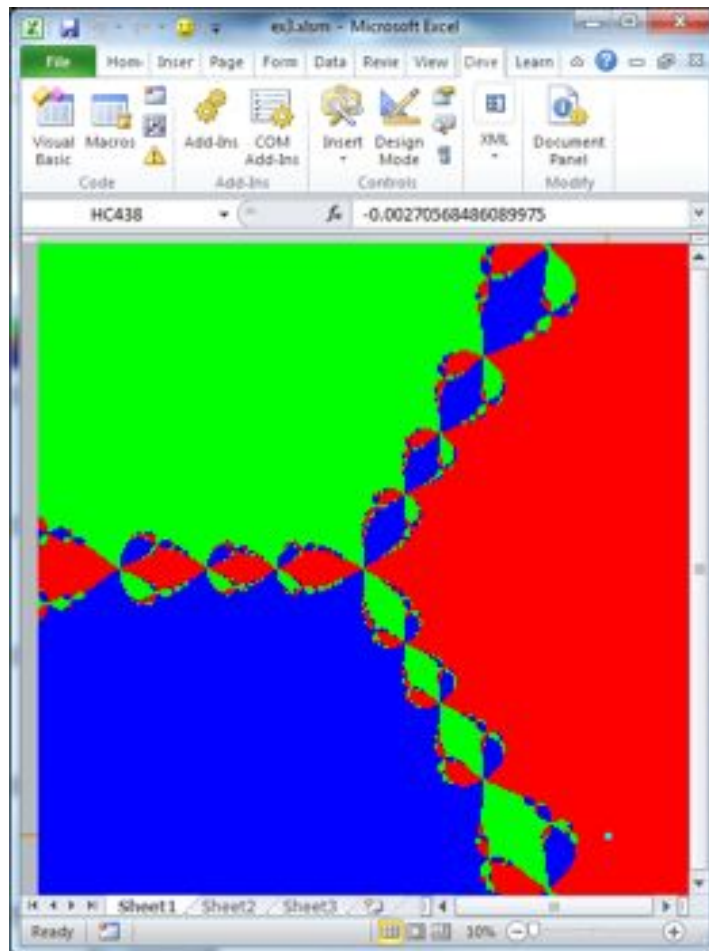


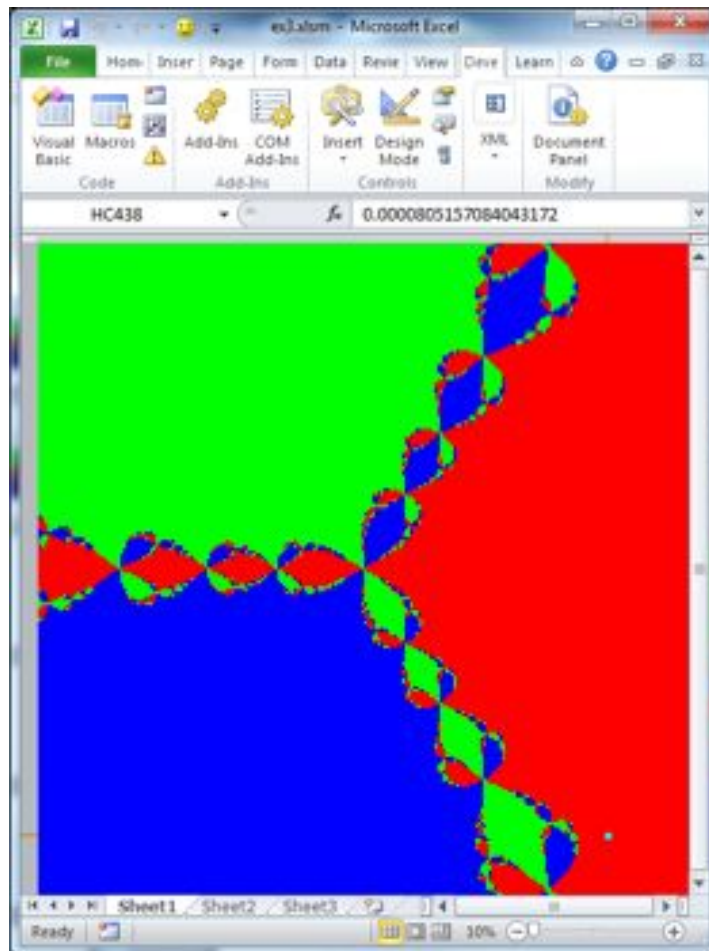


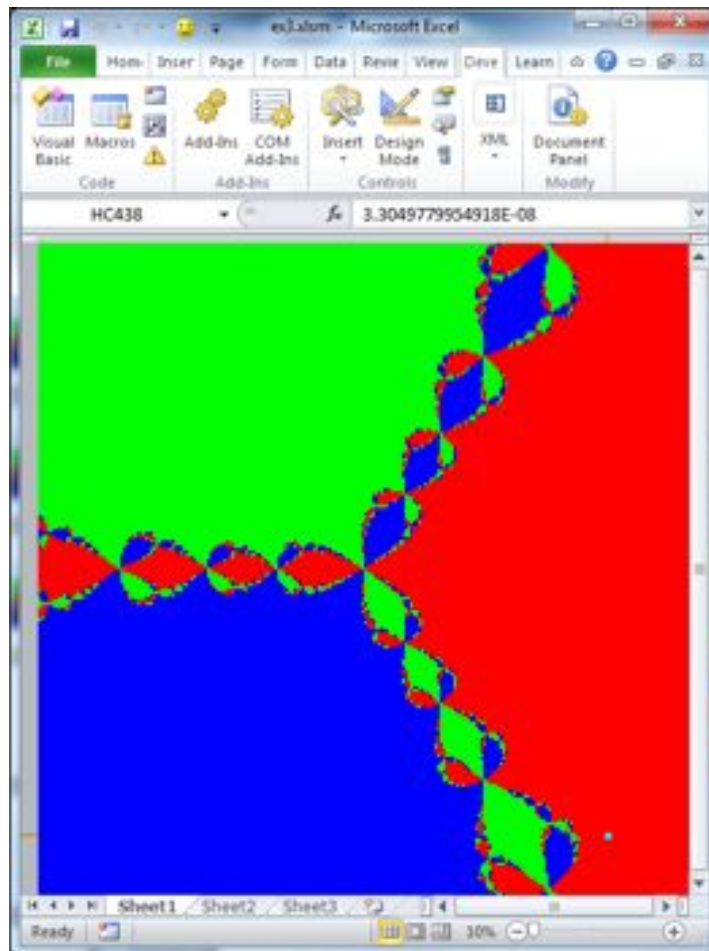


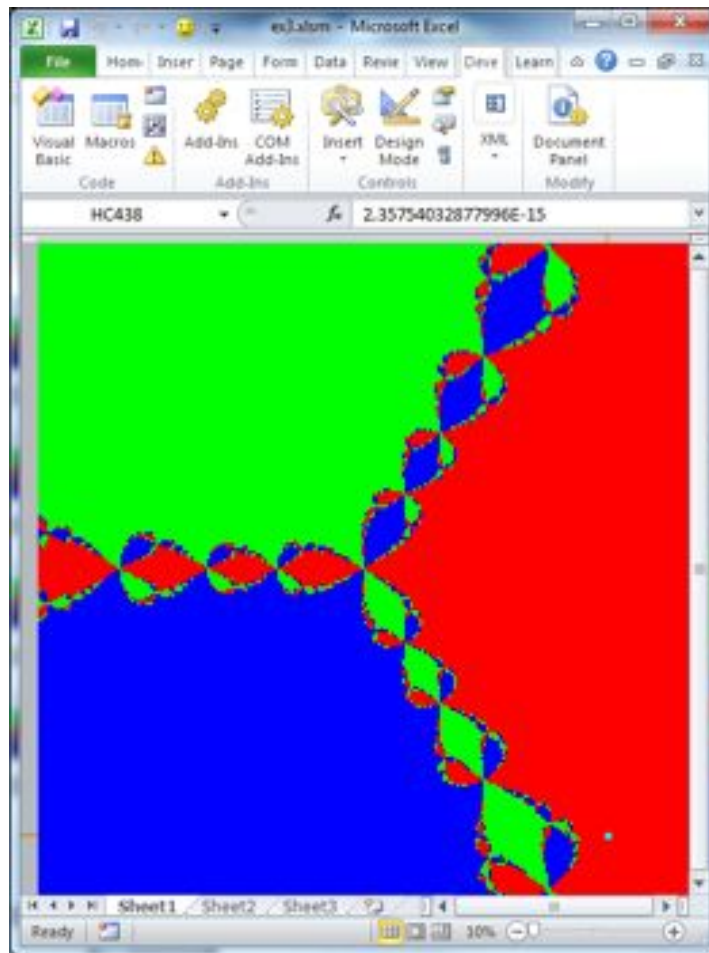


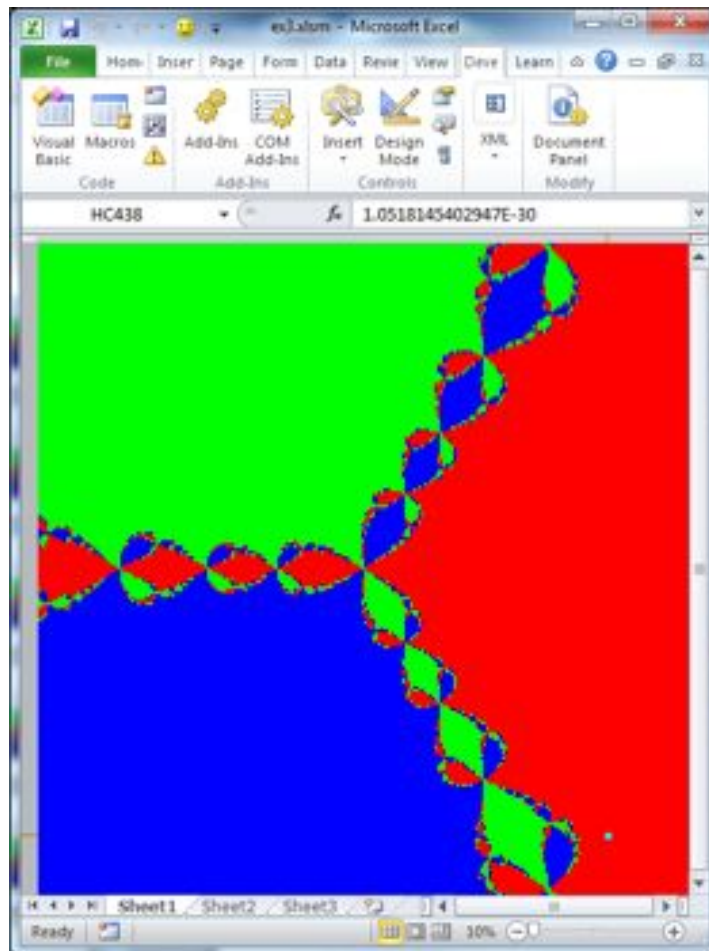


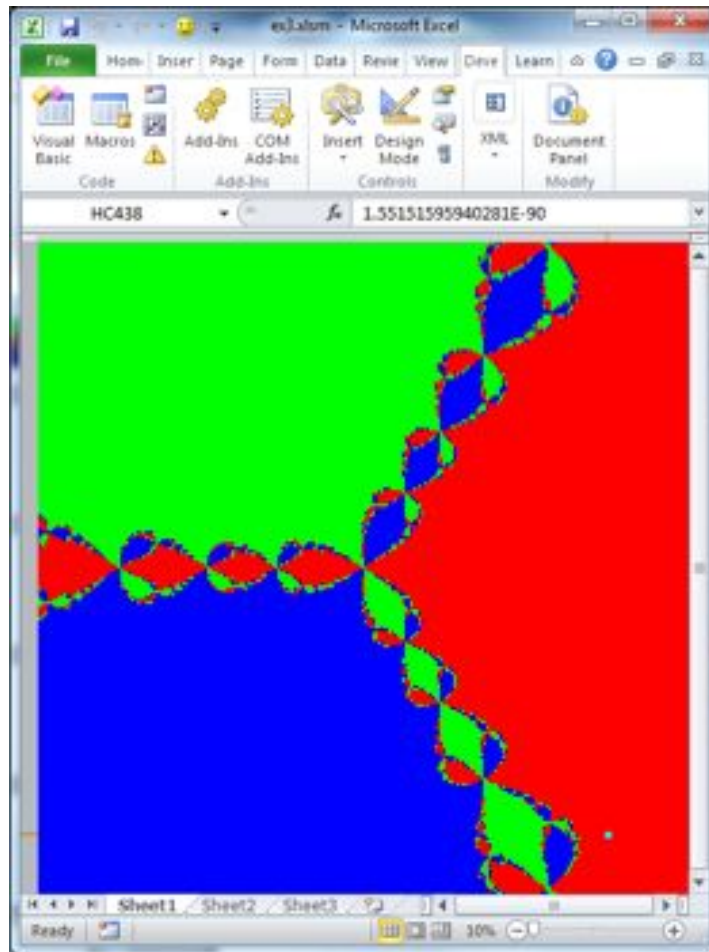


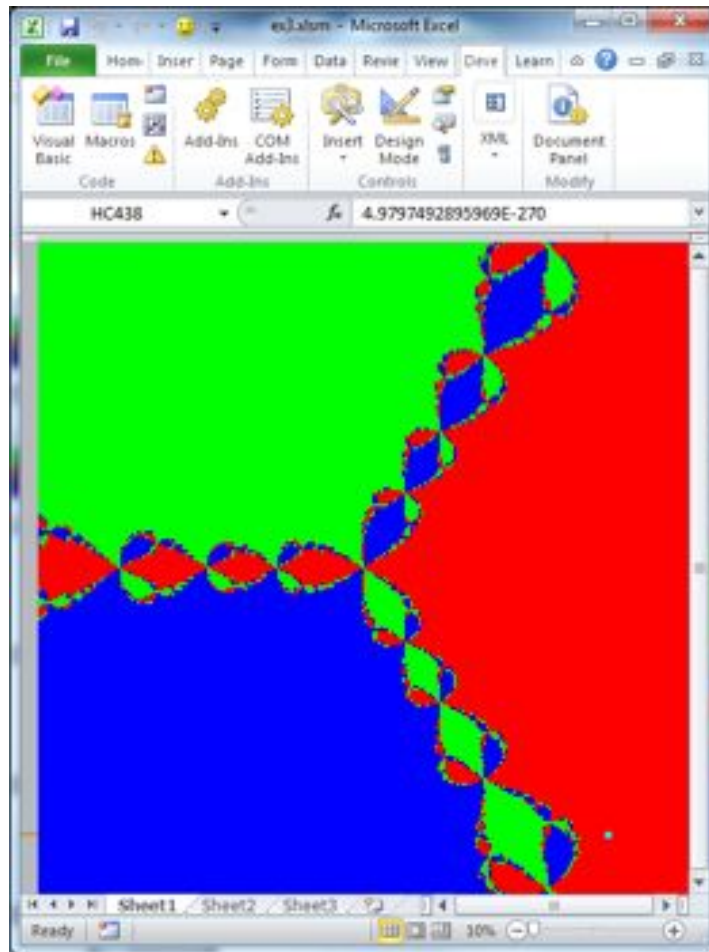


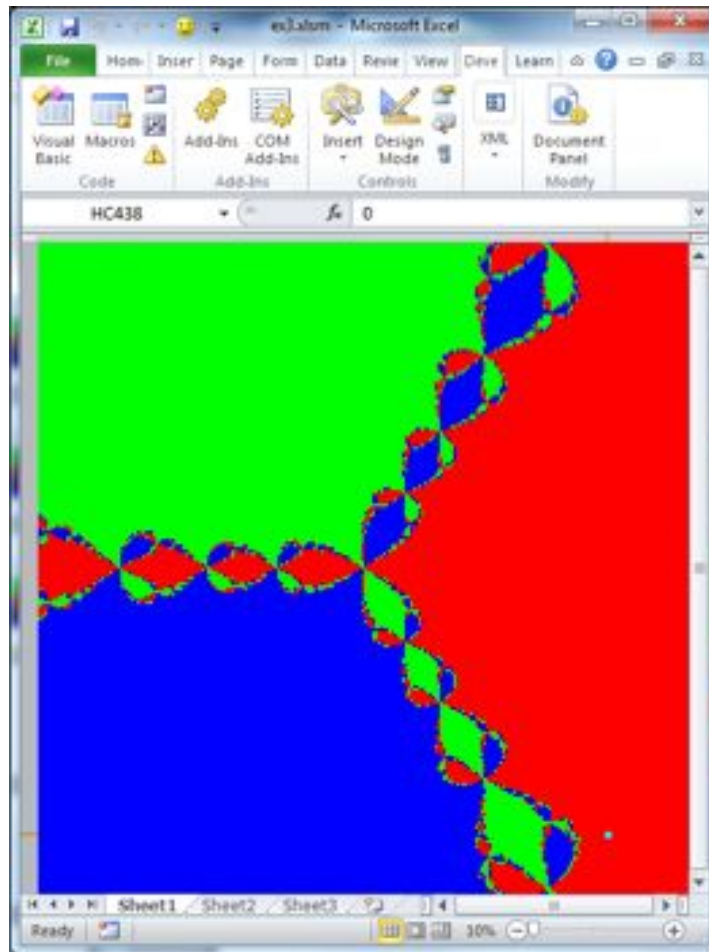


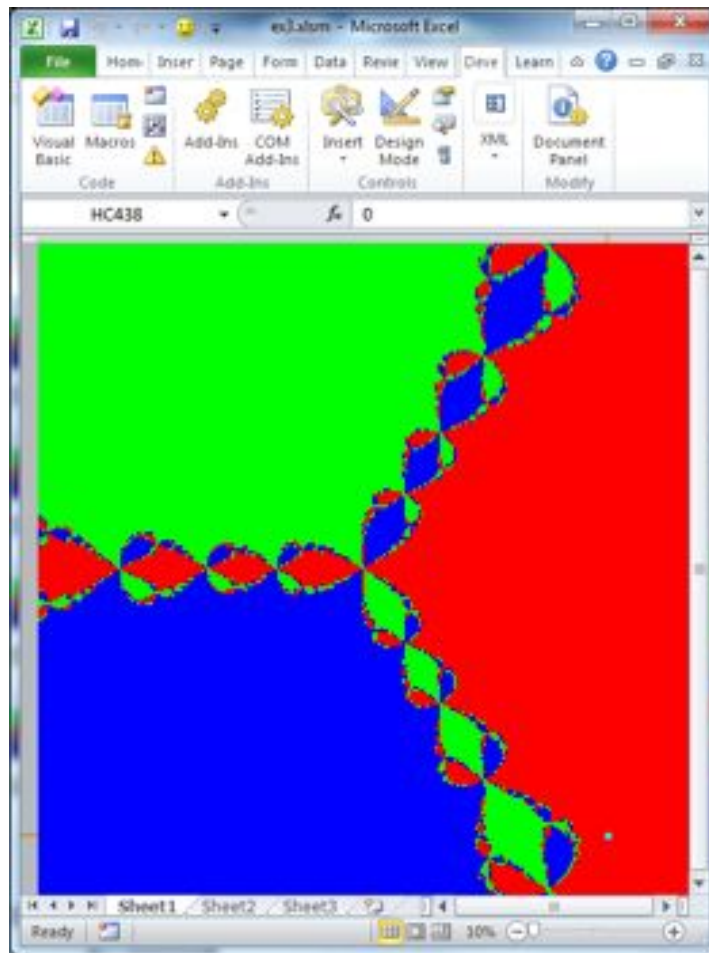




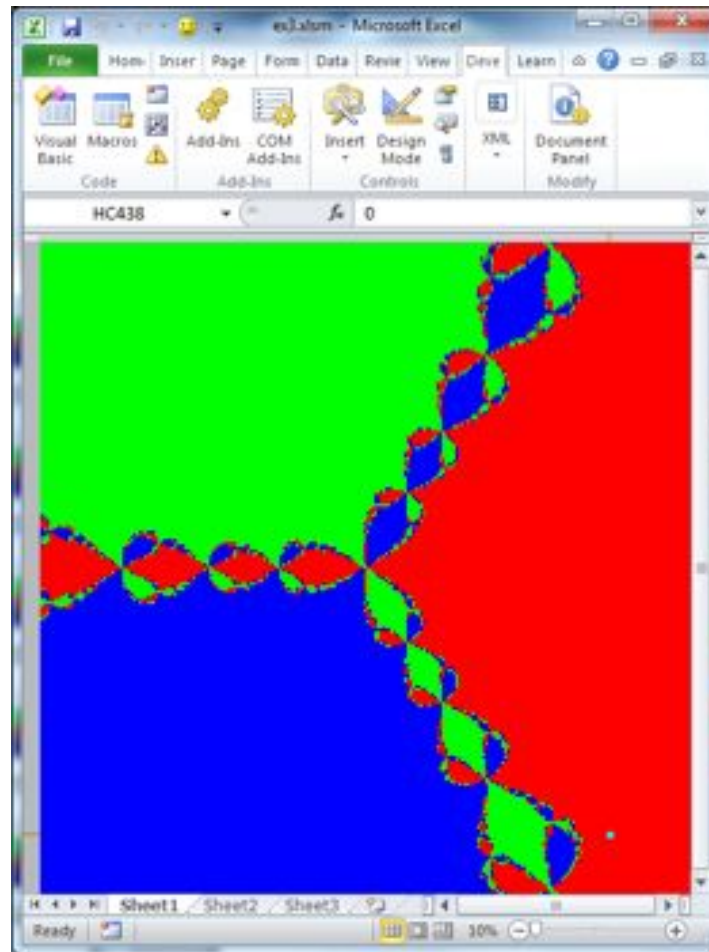






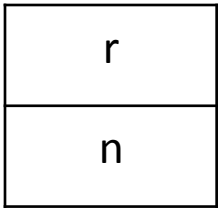


(final frame)



# Fourth example

# Blocks of two numbers

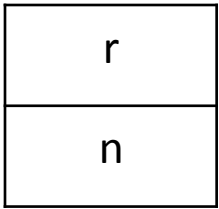


## Initially

*r is a random one or zero*

*n is a count of the neighbouring 1s*

# Blocks of two numbers



## Iterate:

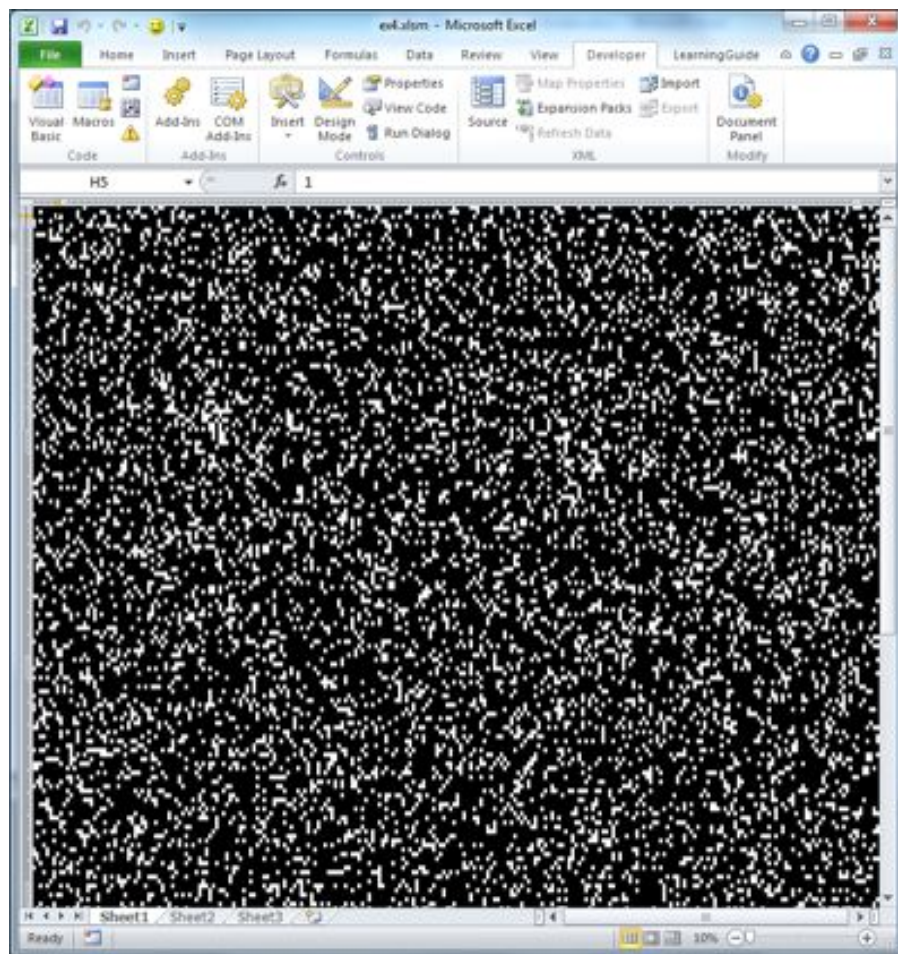
1 changes to 0 if  $n < 2$  or  $n > 3$

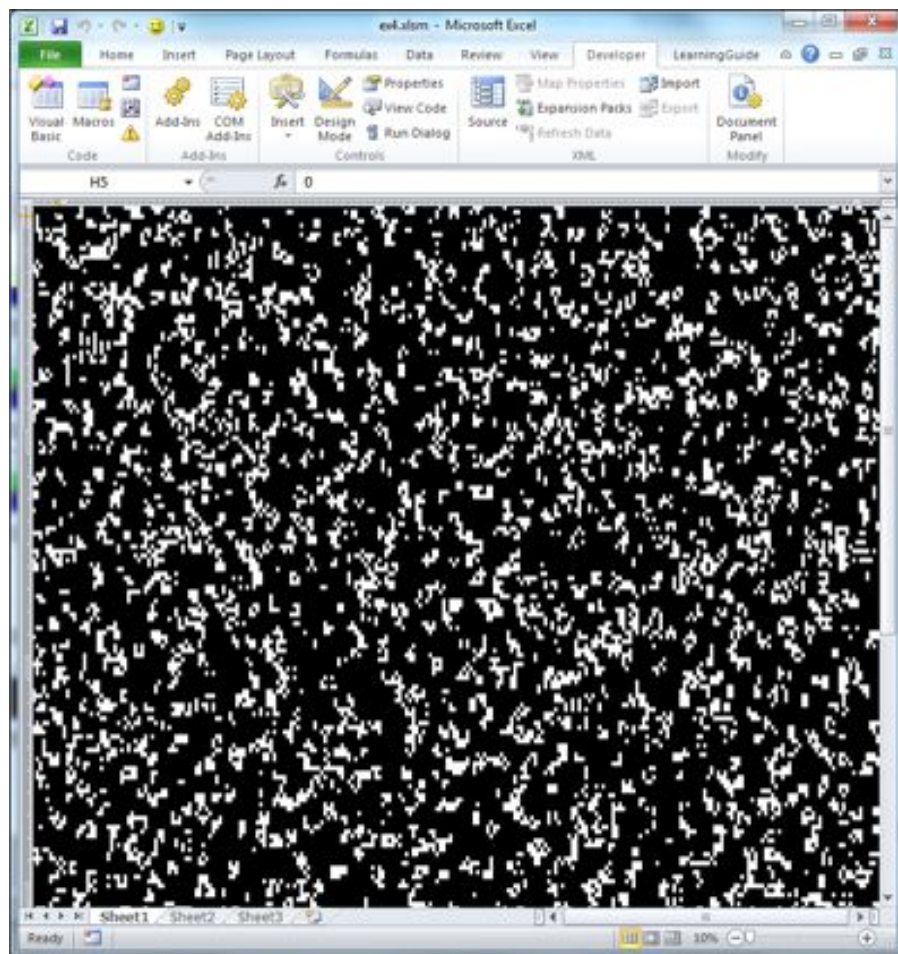
0 changes to 1 if  $n = 3$

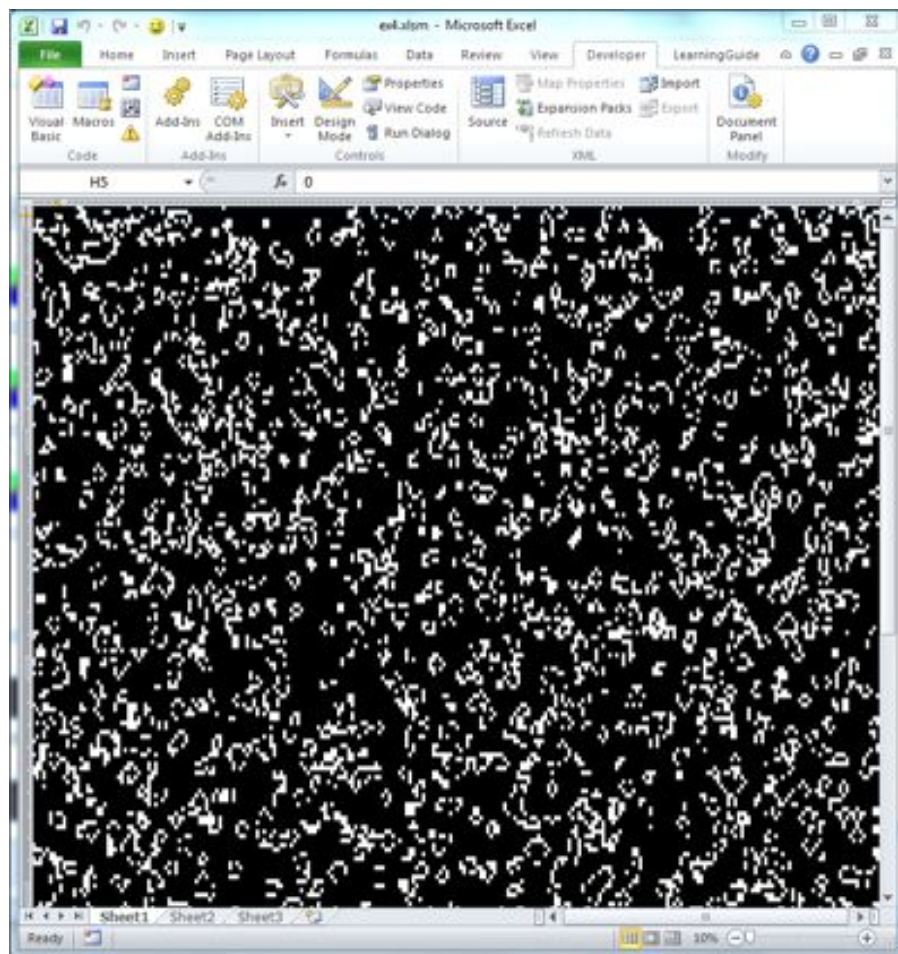
# Then

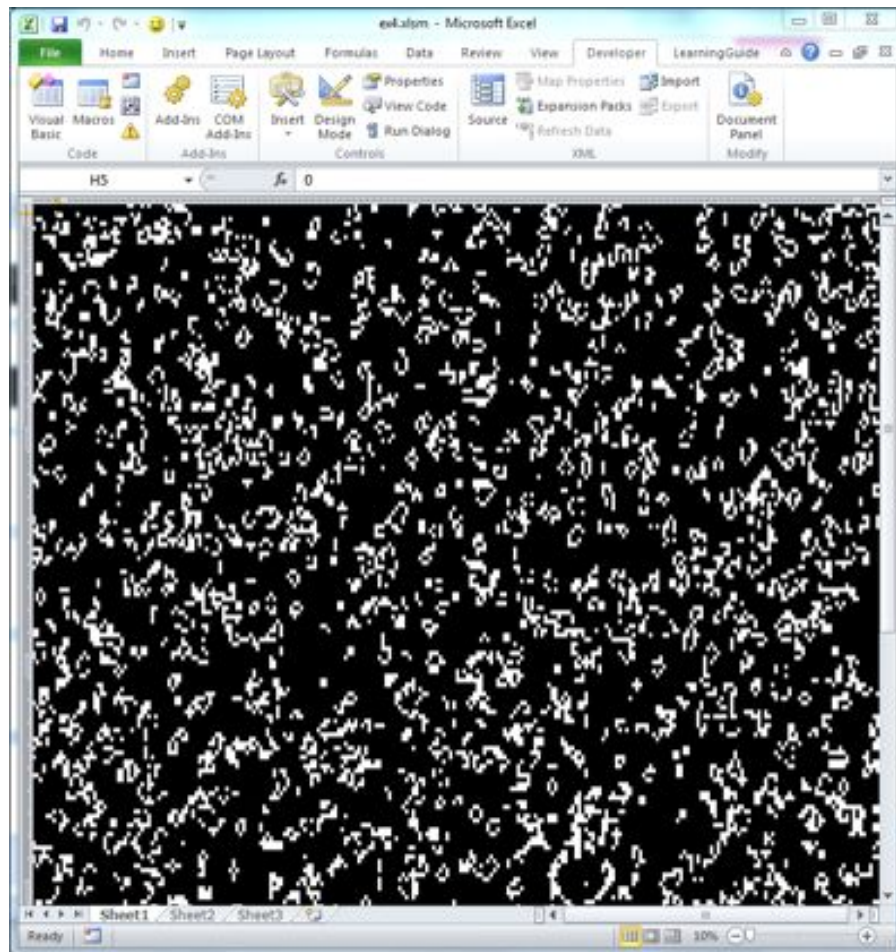
|   |
|---|
| r |
| n |

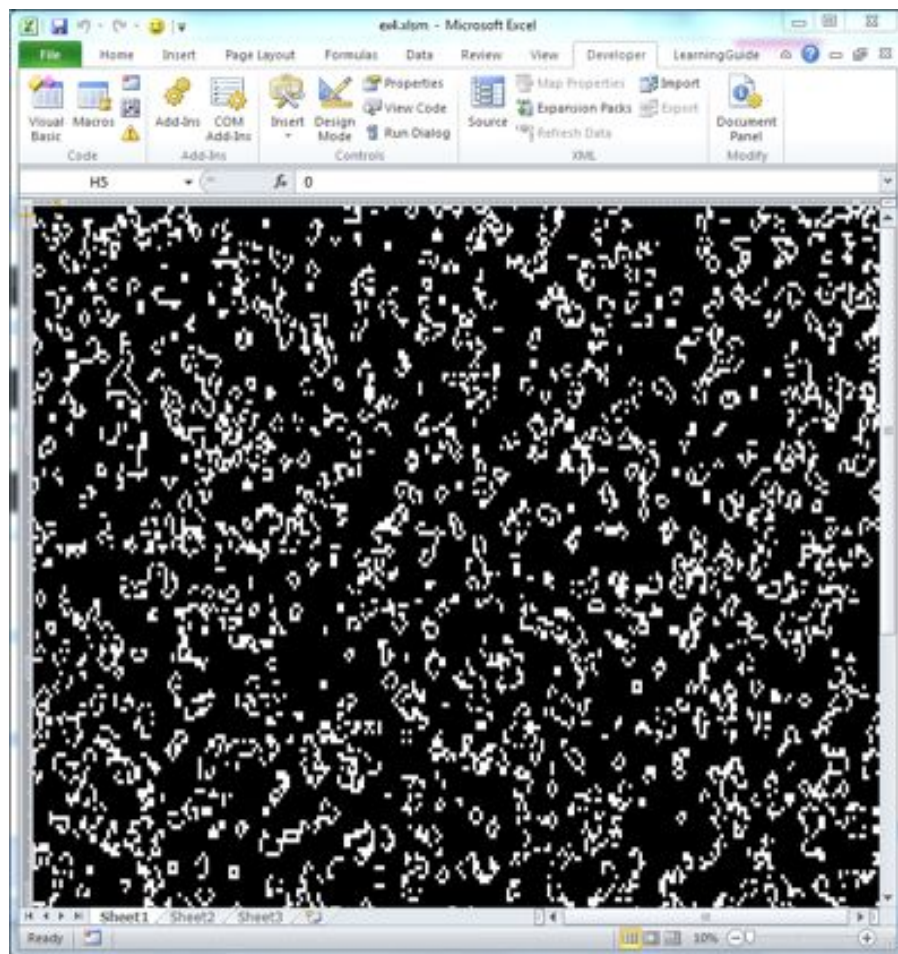
Colour black ( $r=0$ ) or white ( $r=1$ )

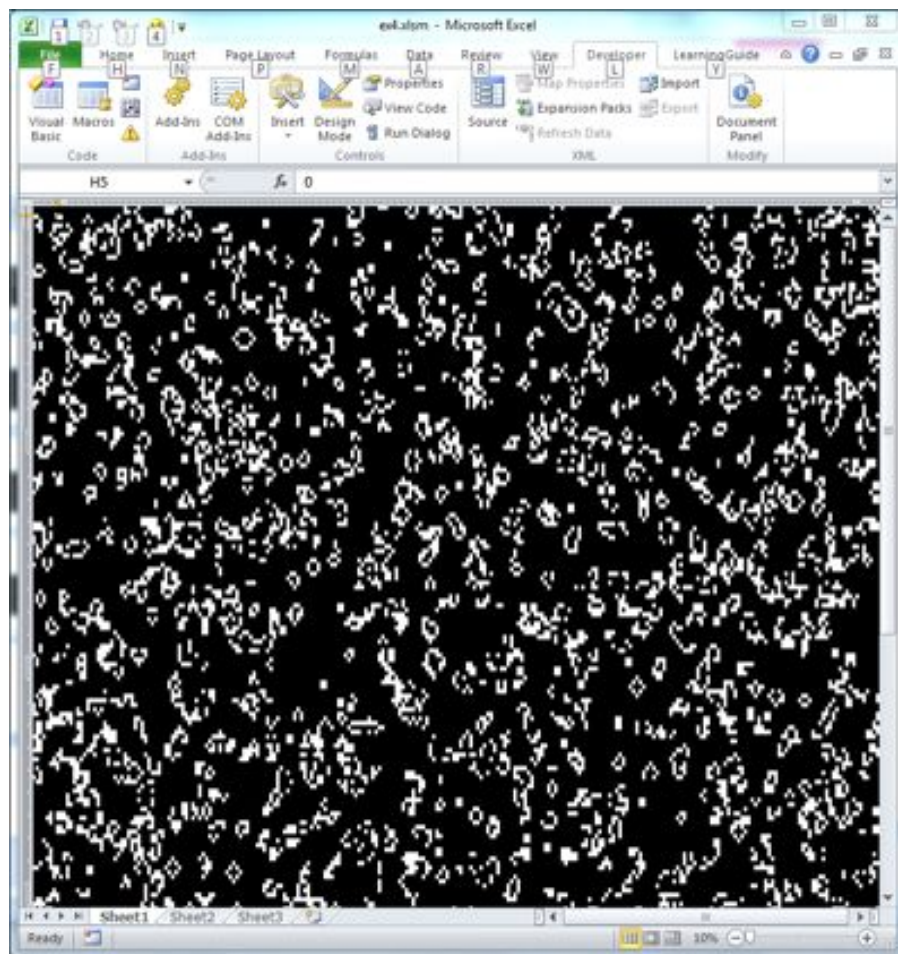


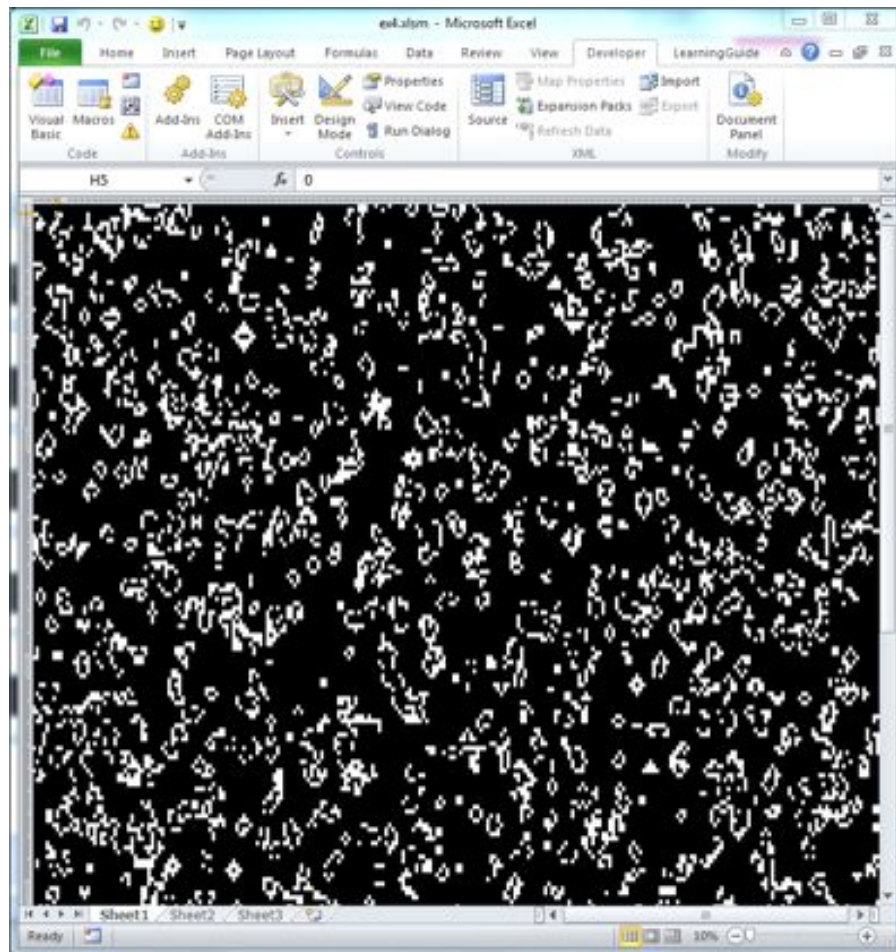


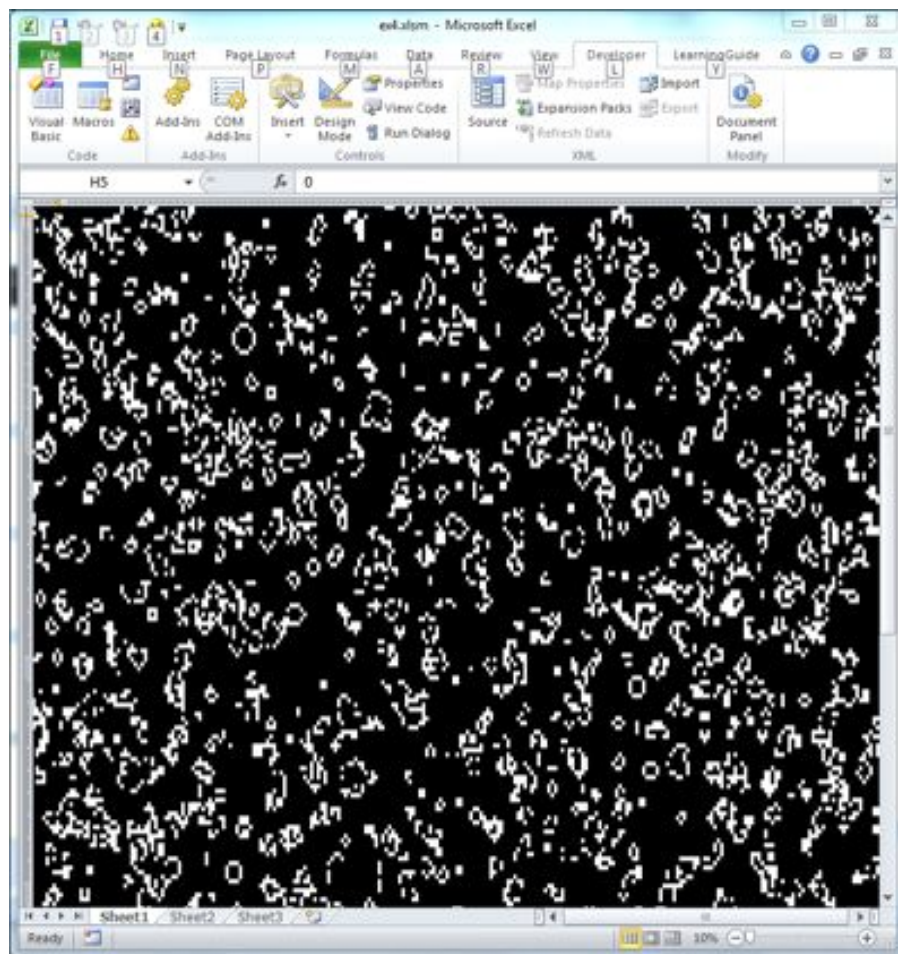


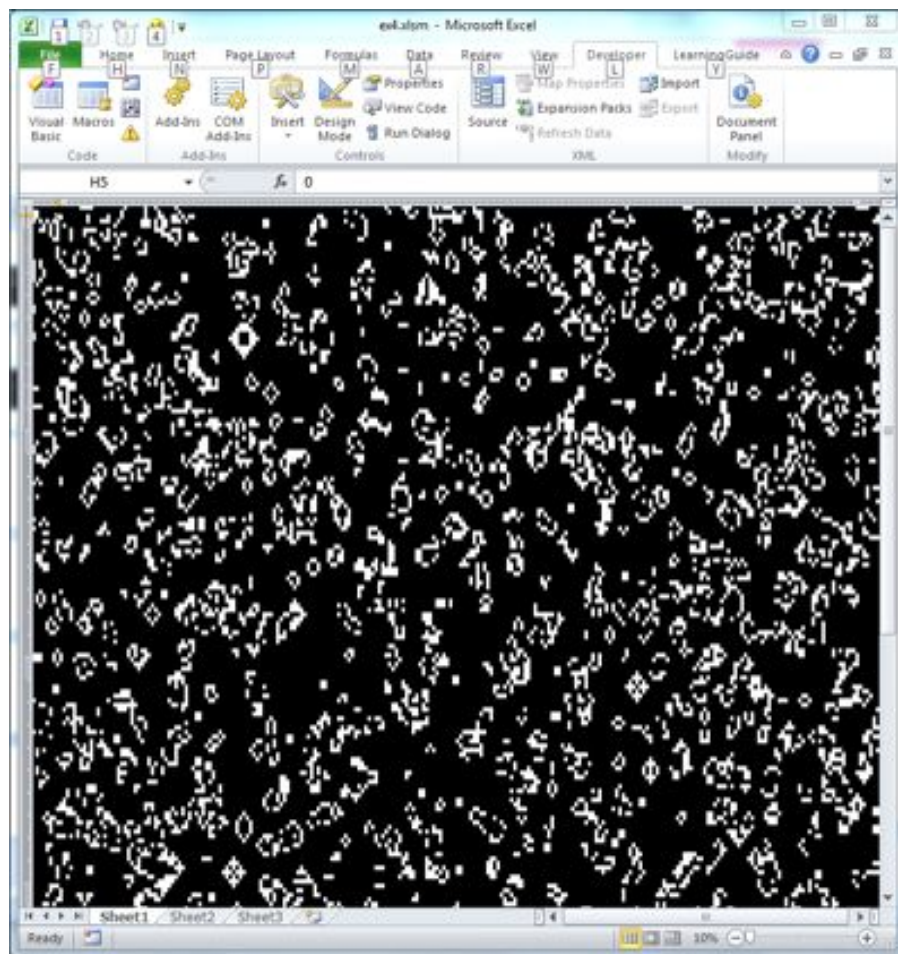


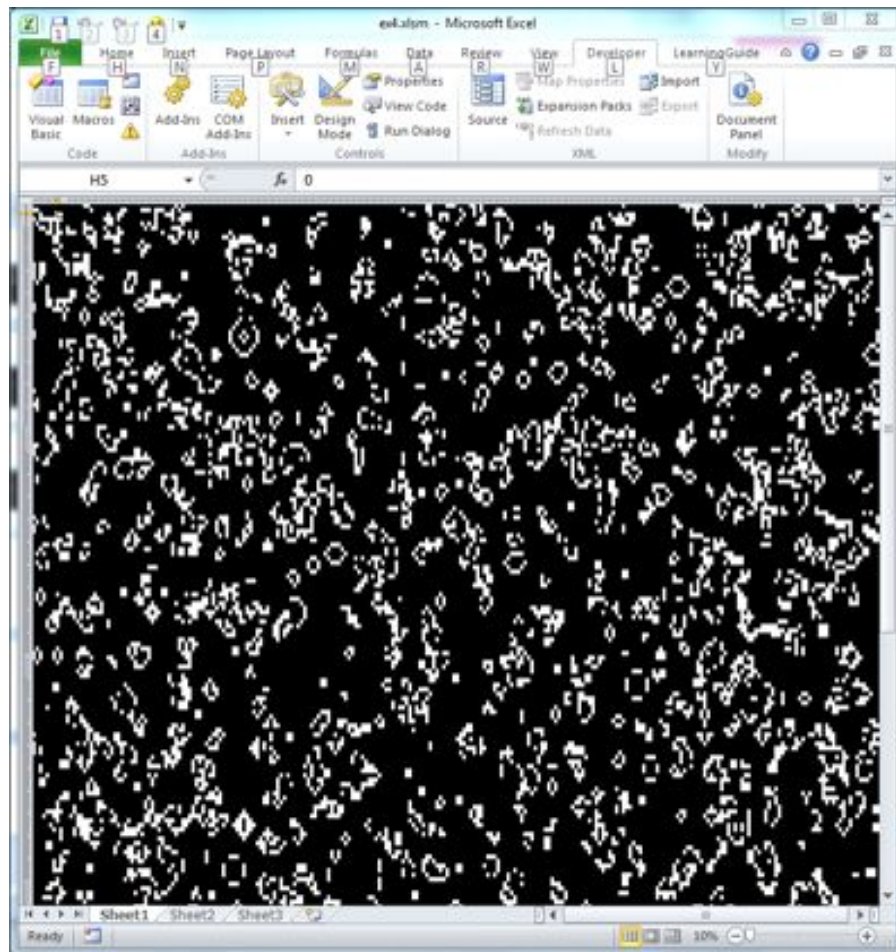


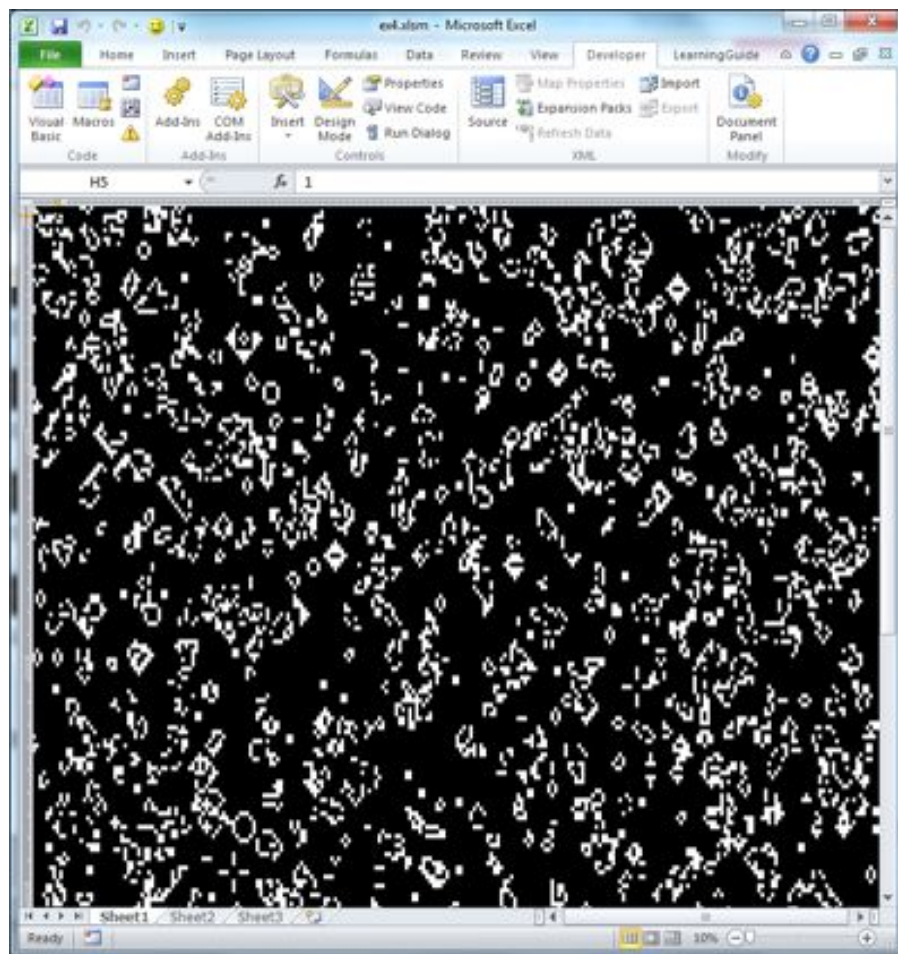


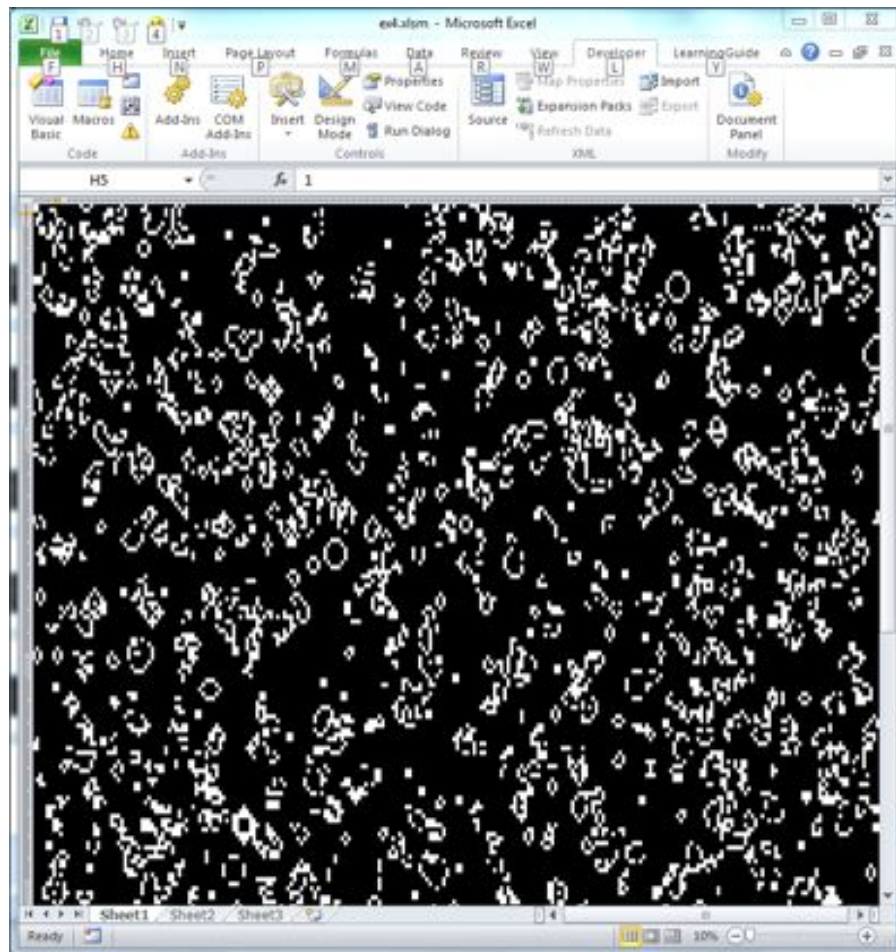


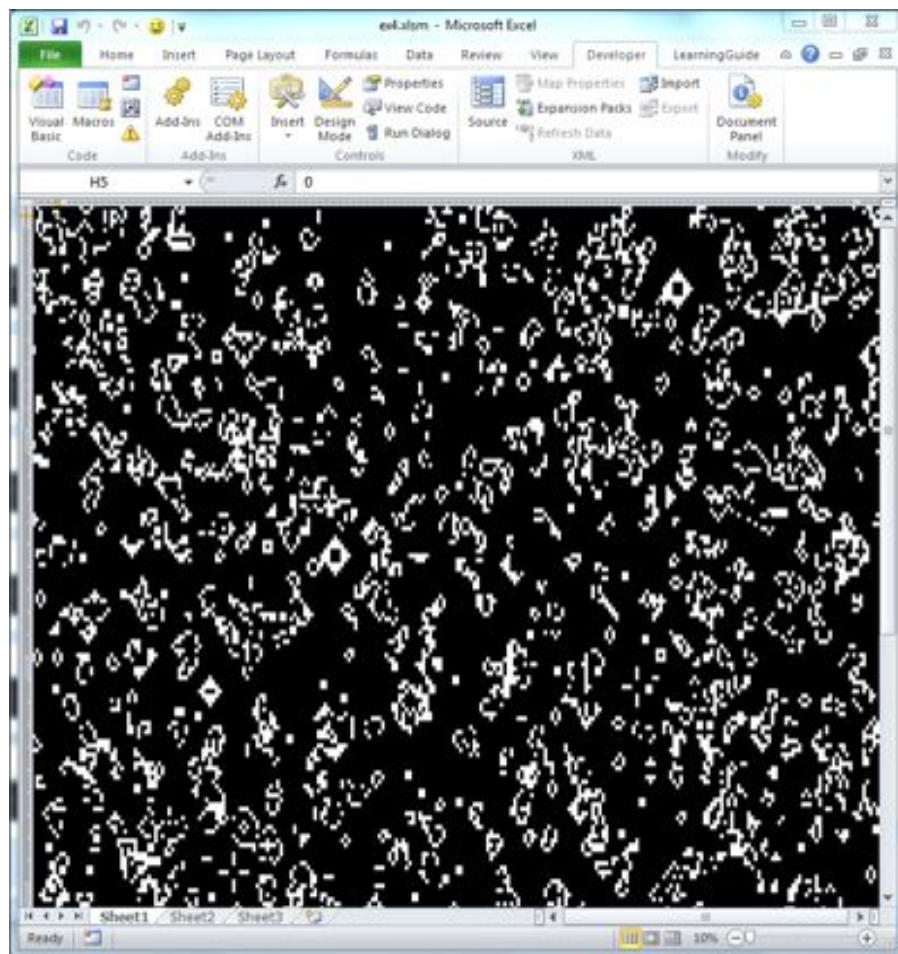


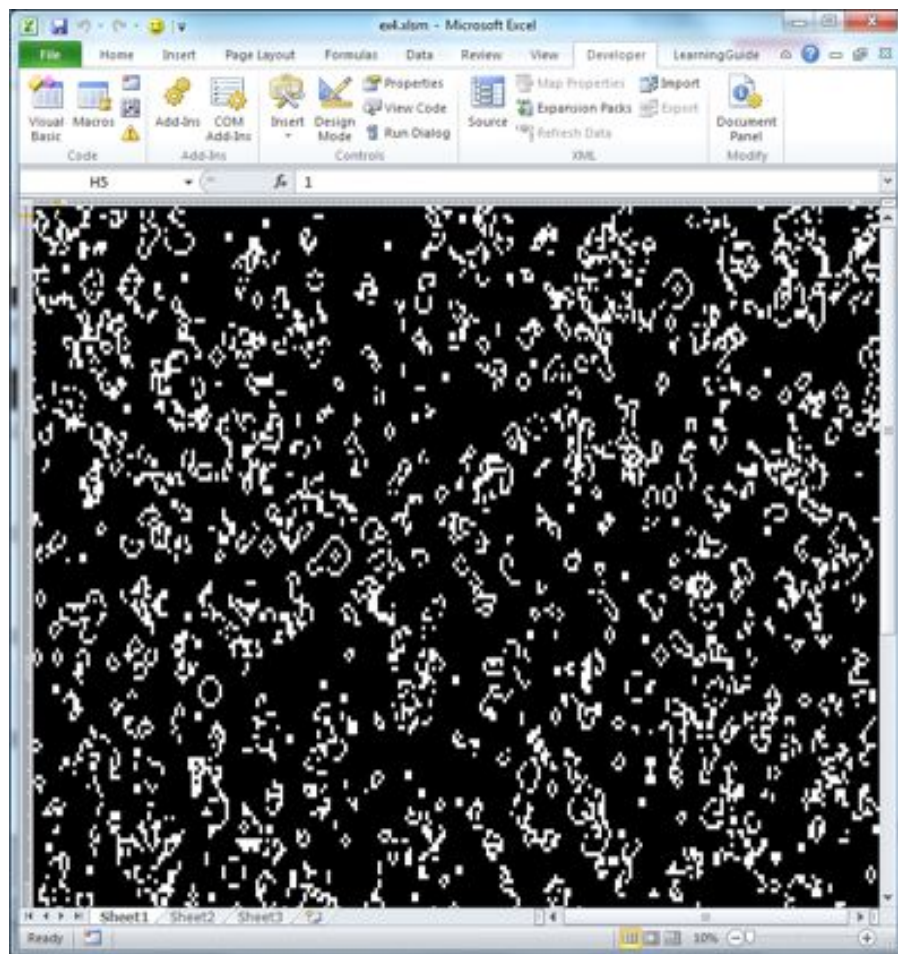


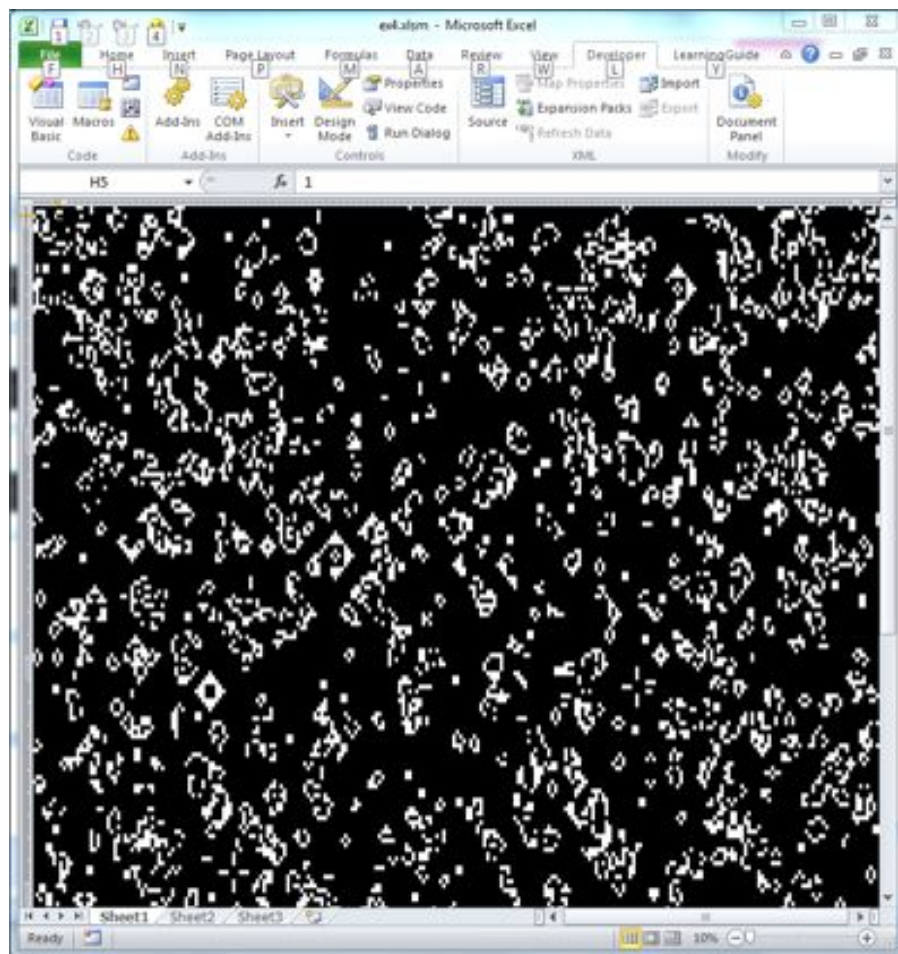


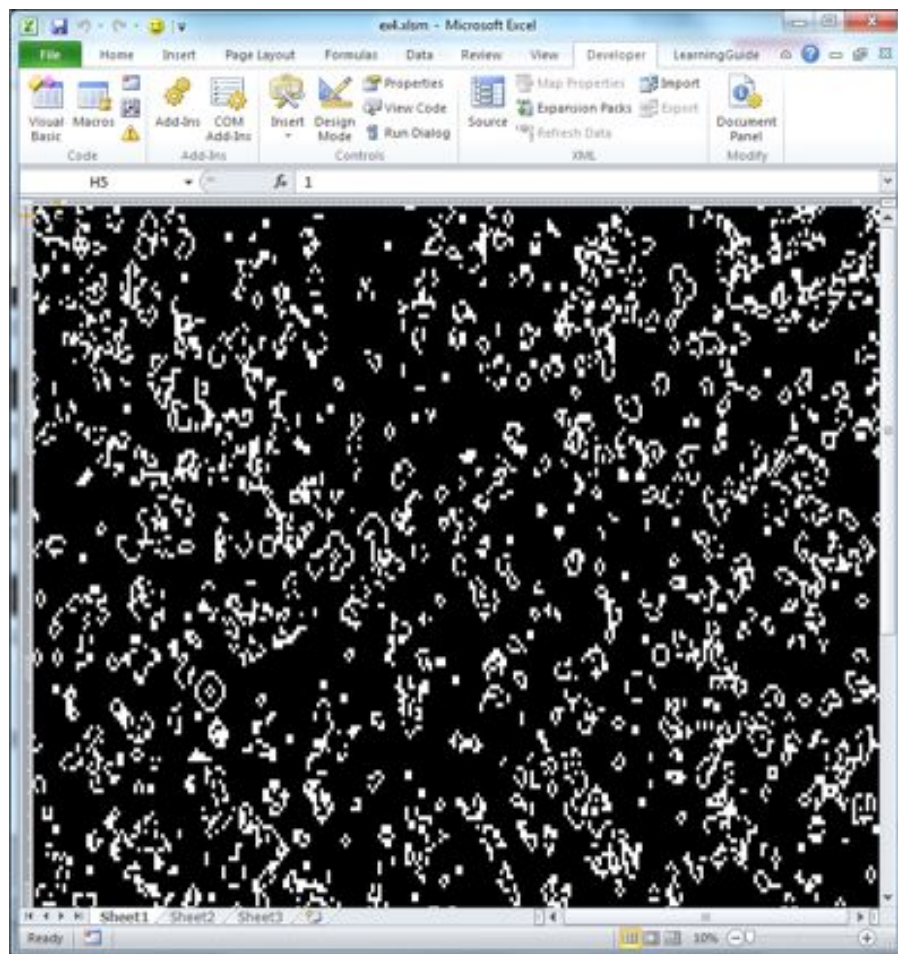


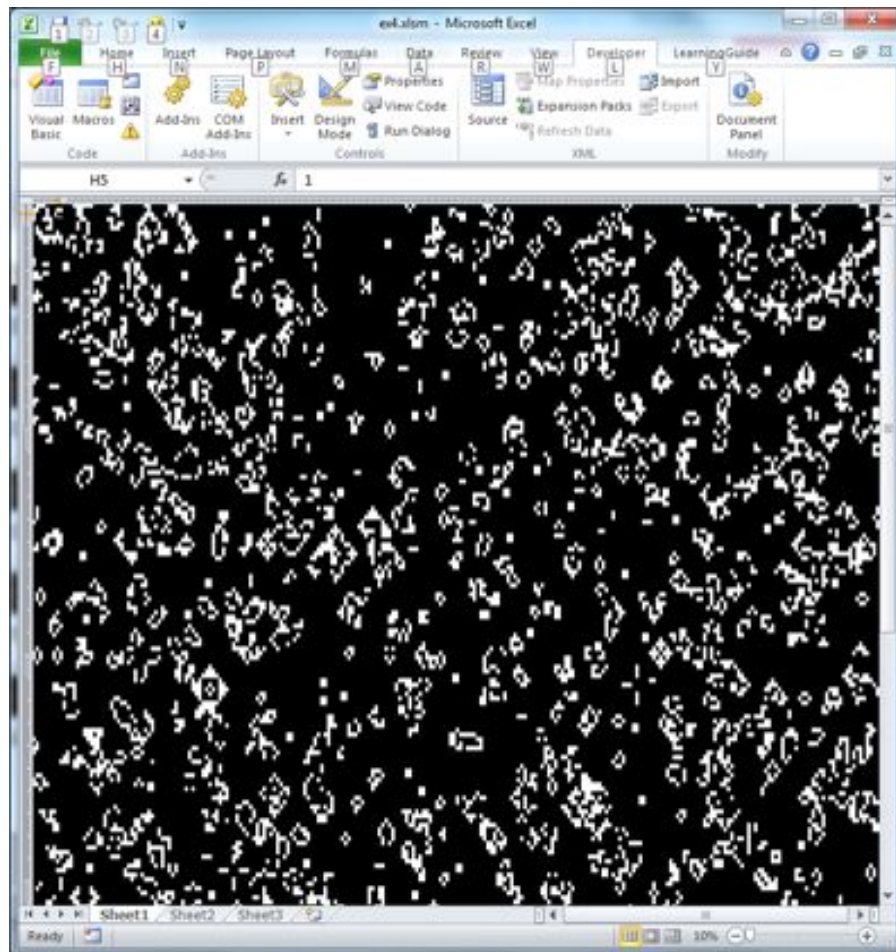


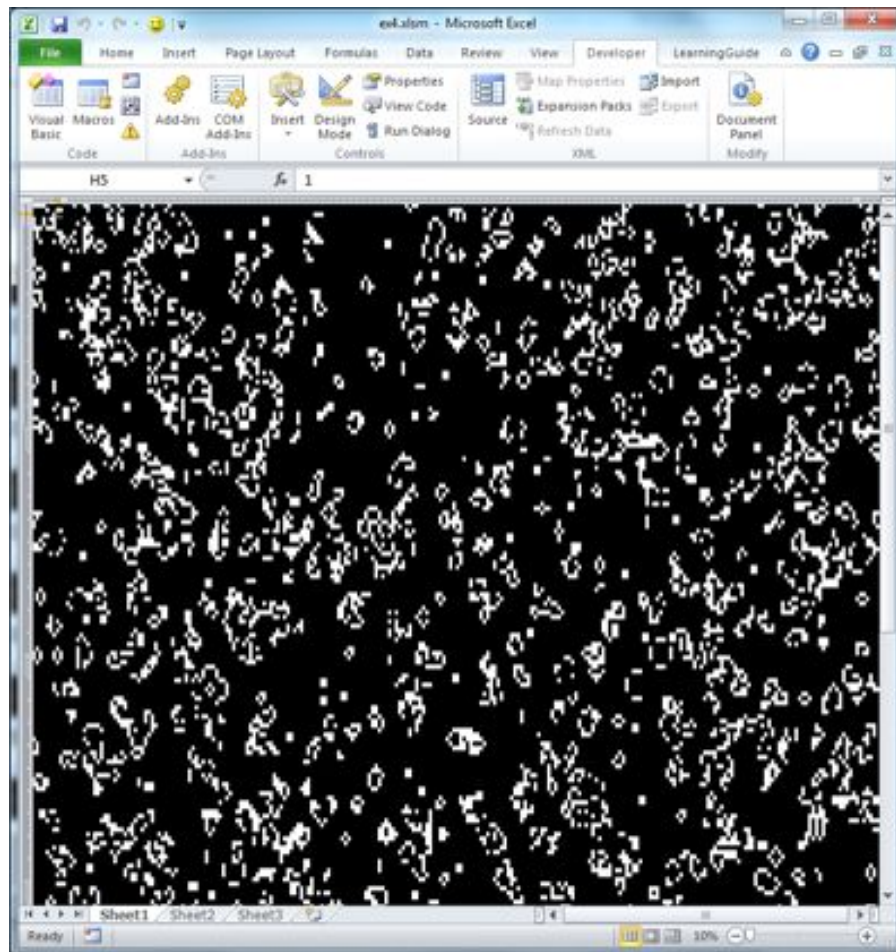


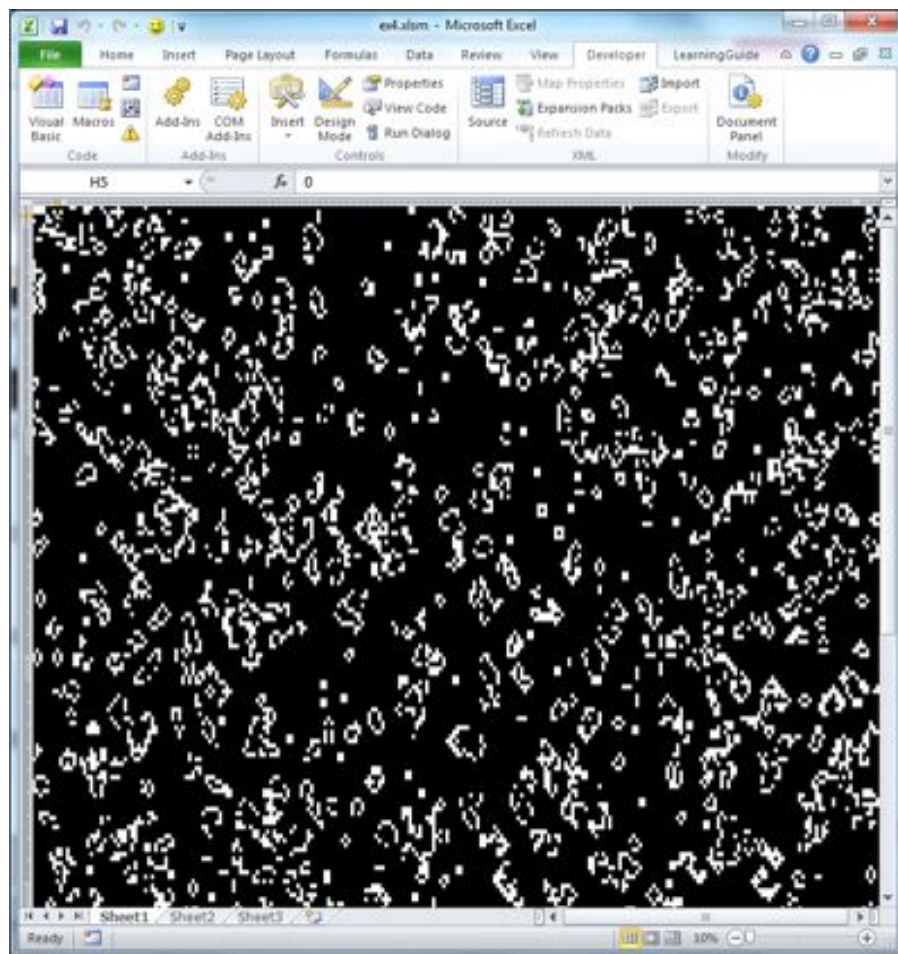


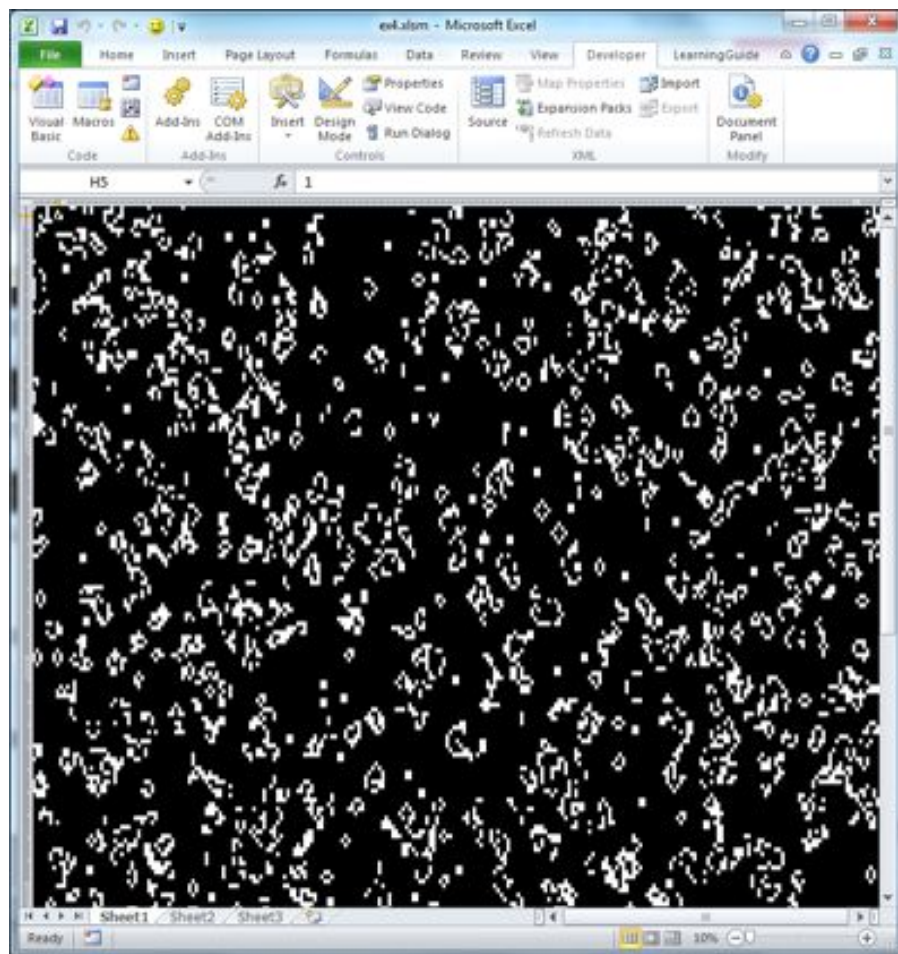


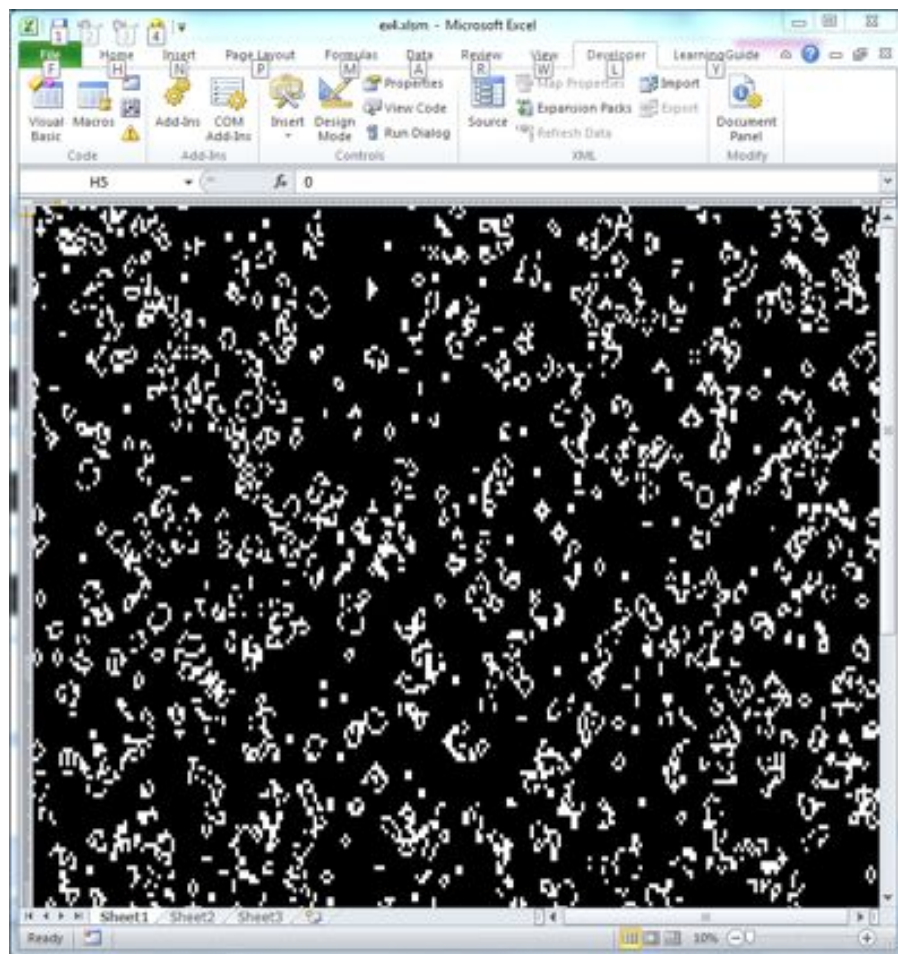


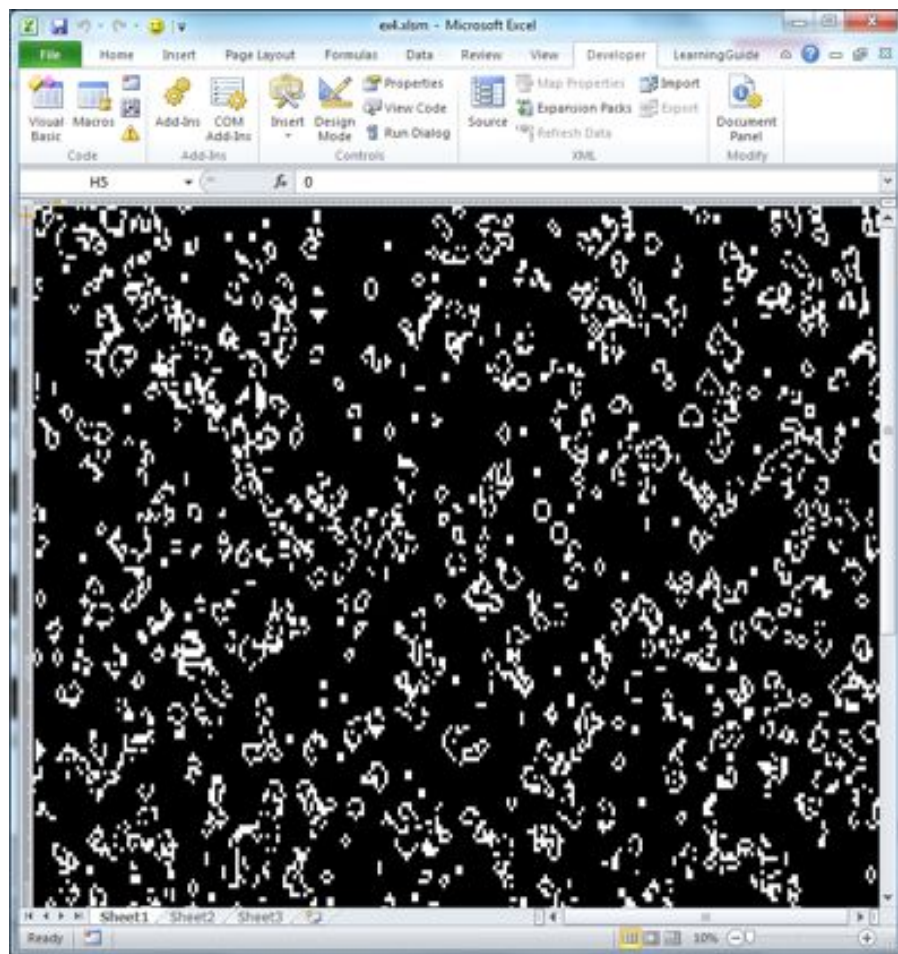


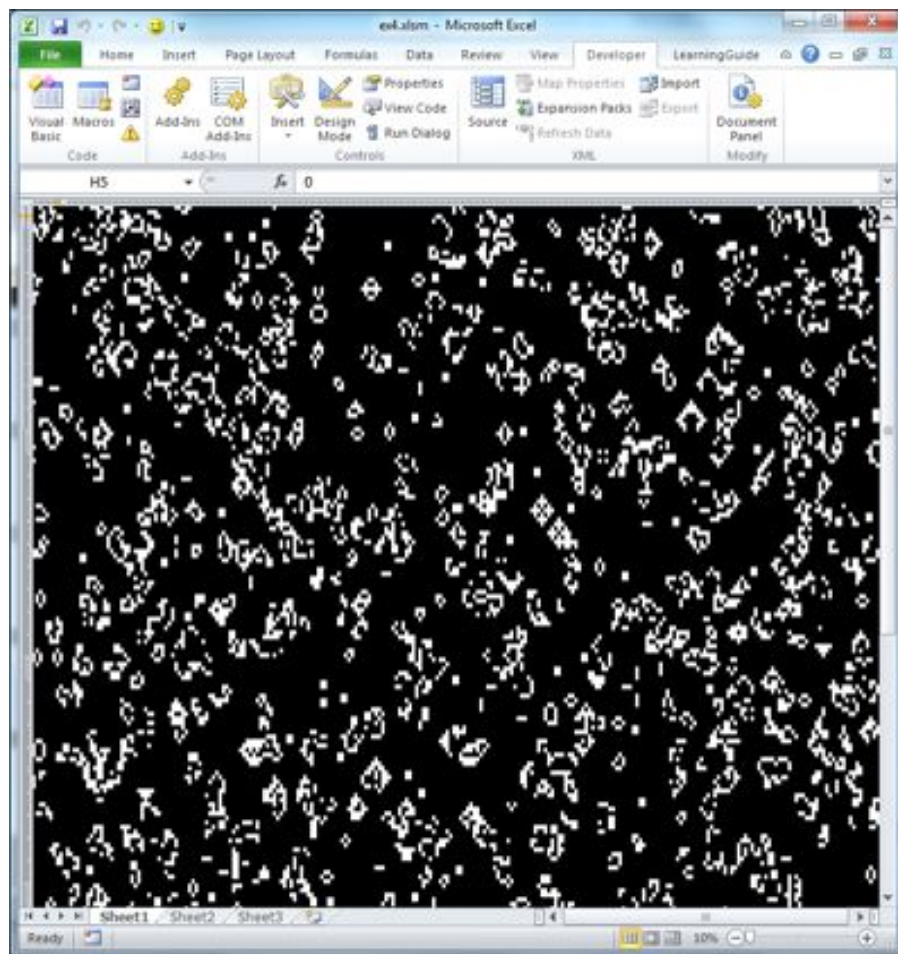


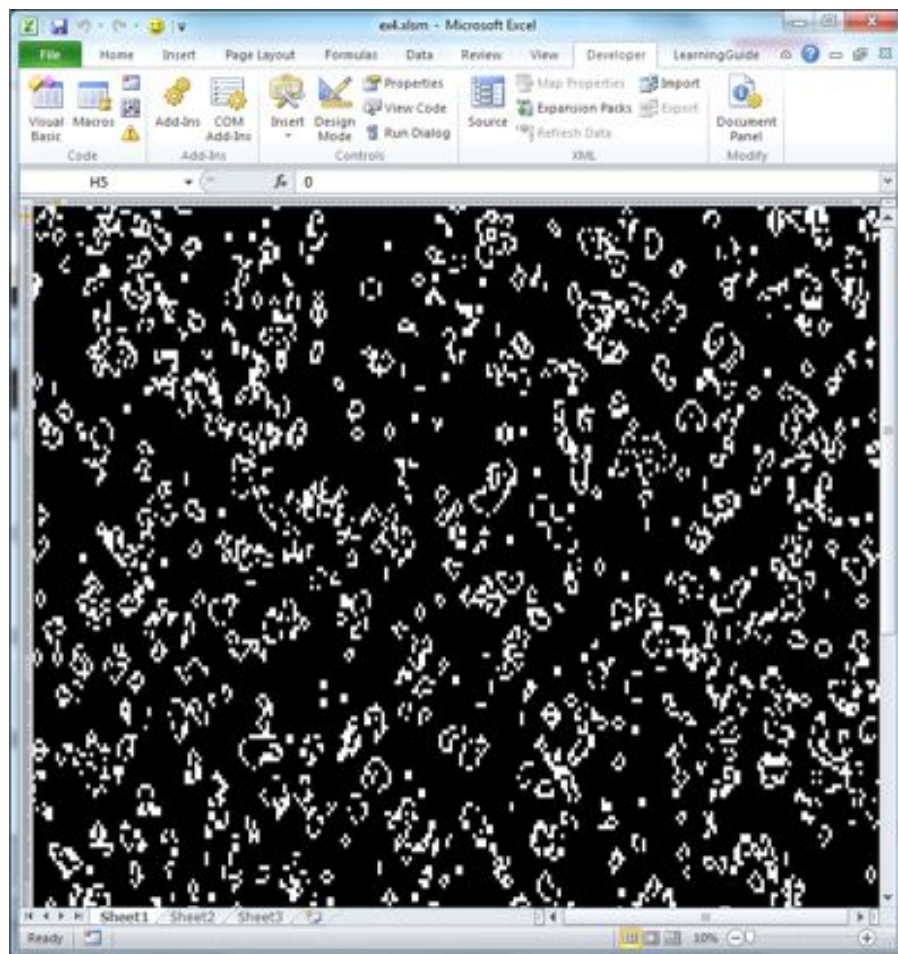


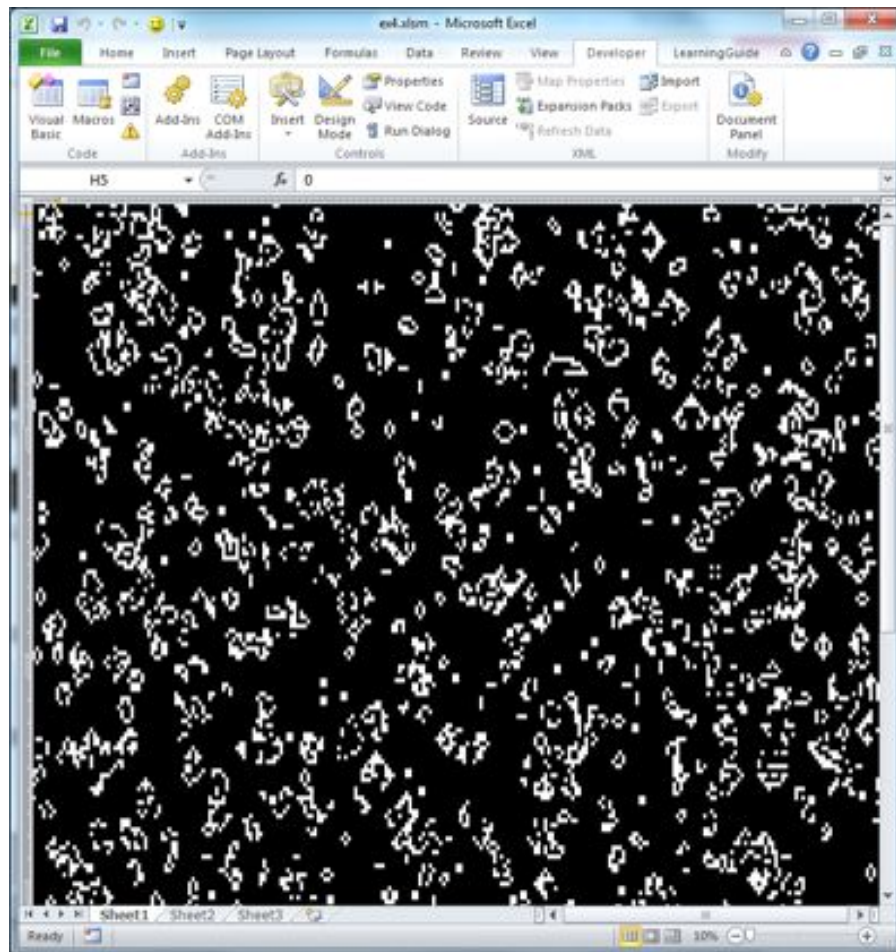


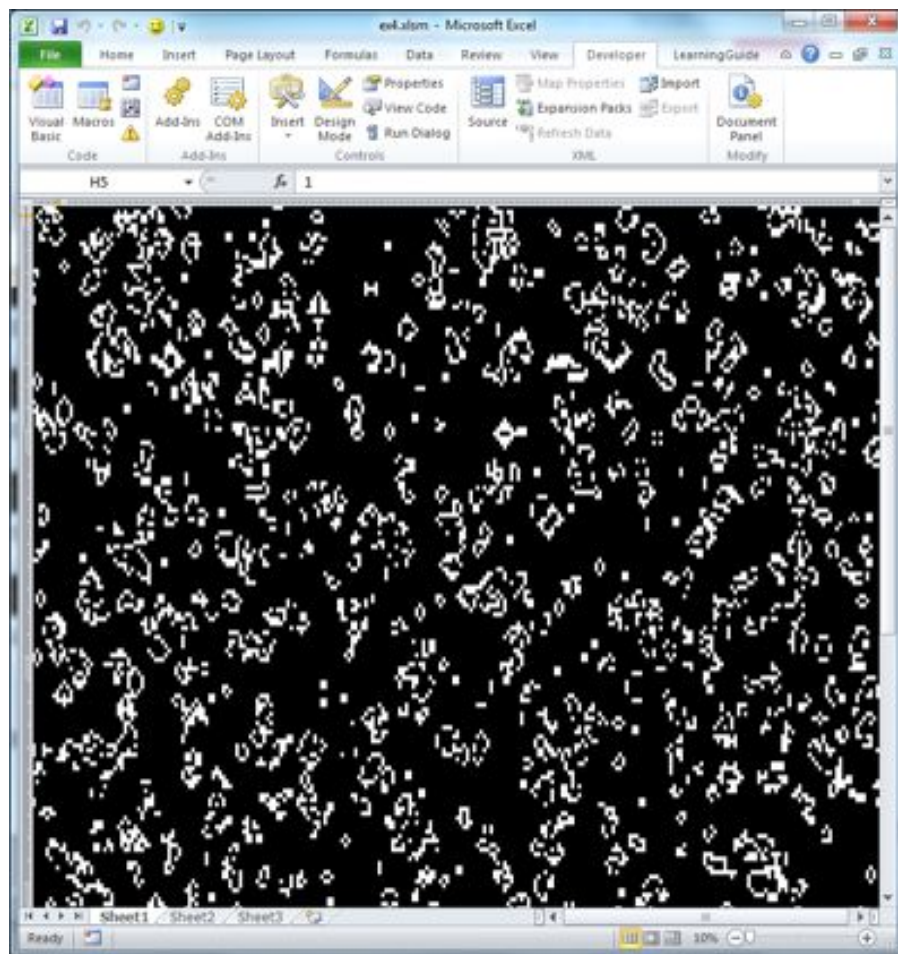


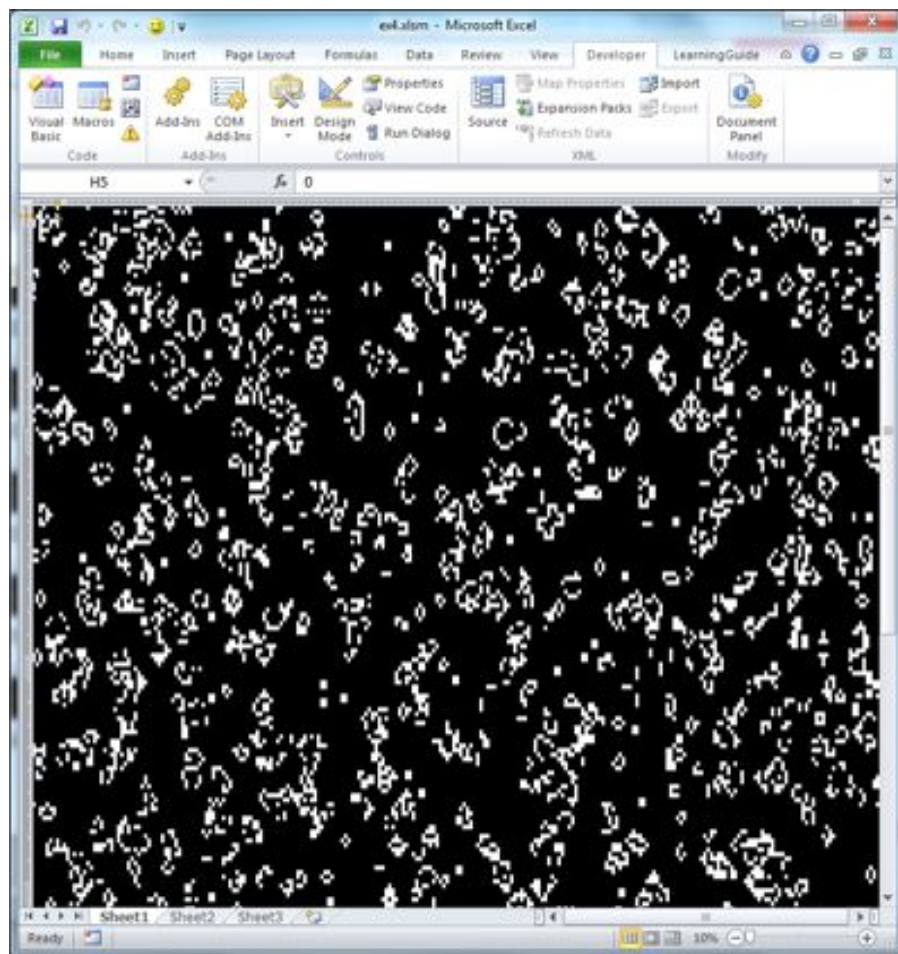


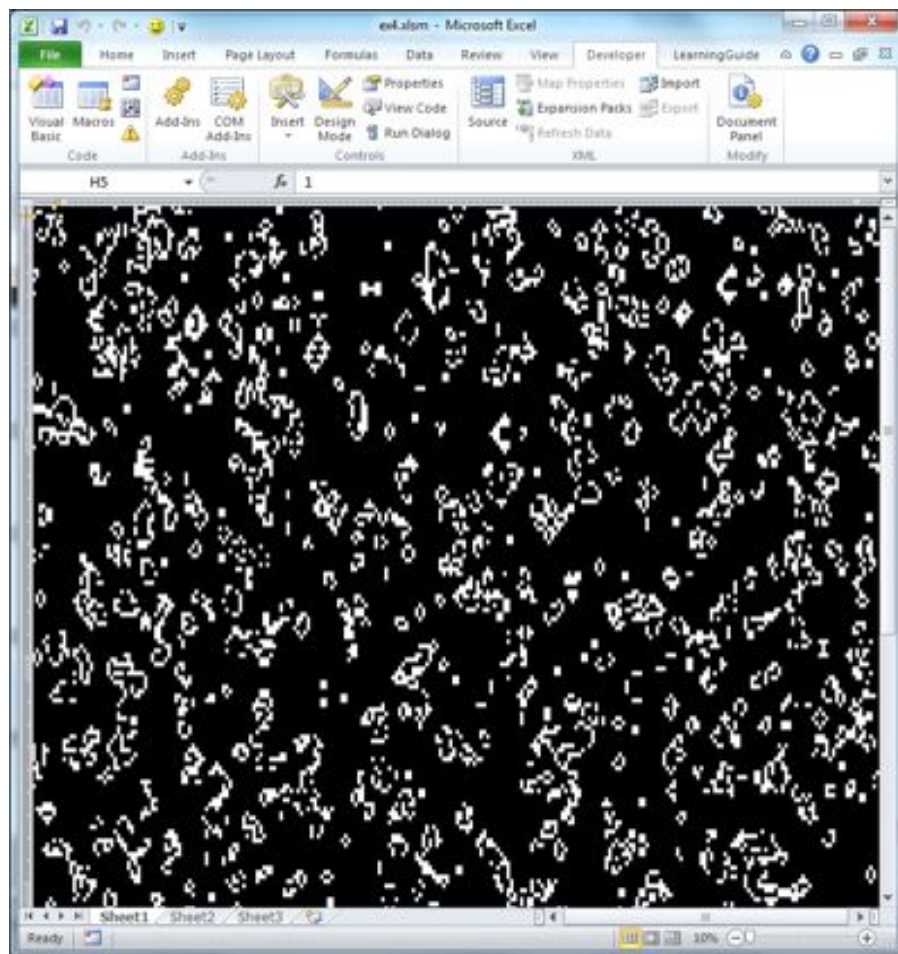


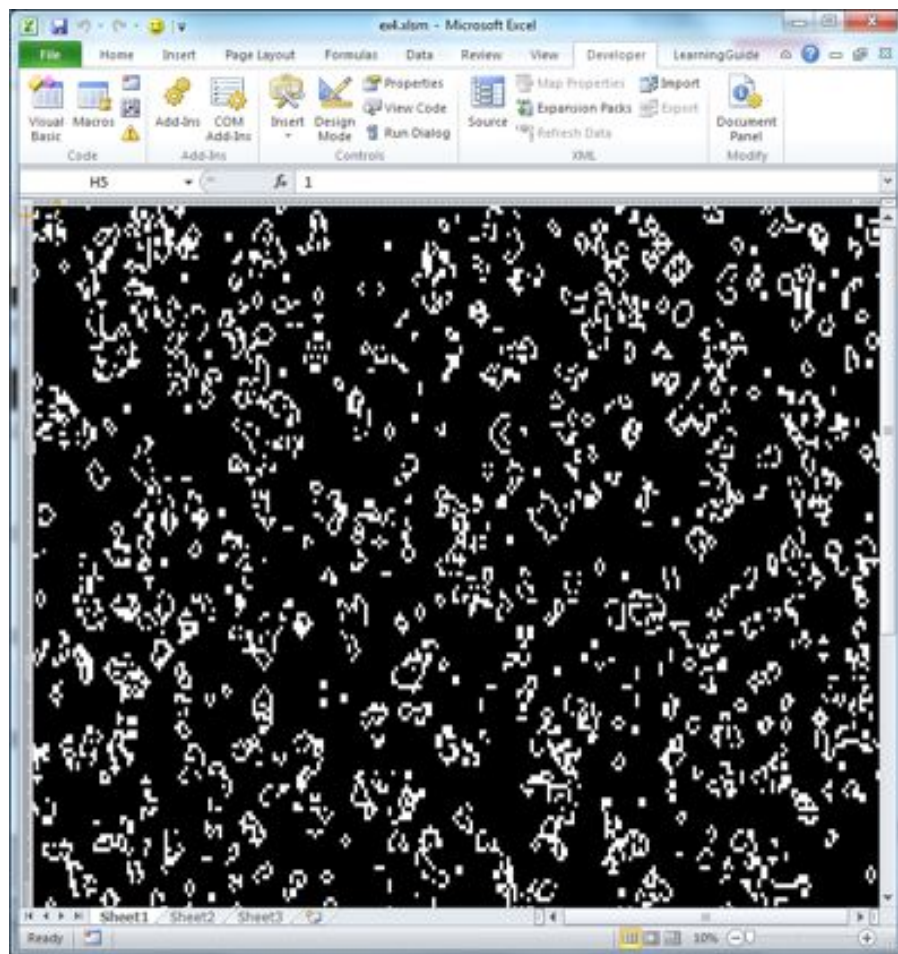


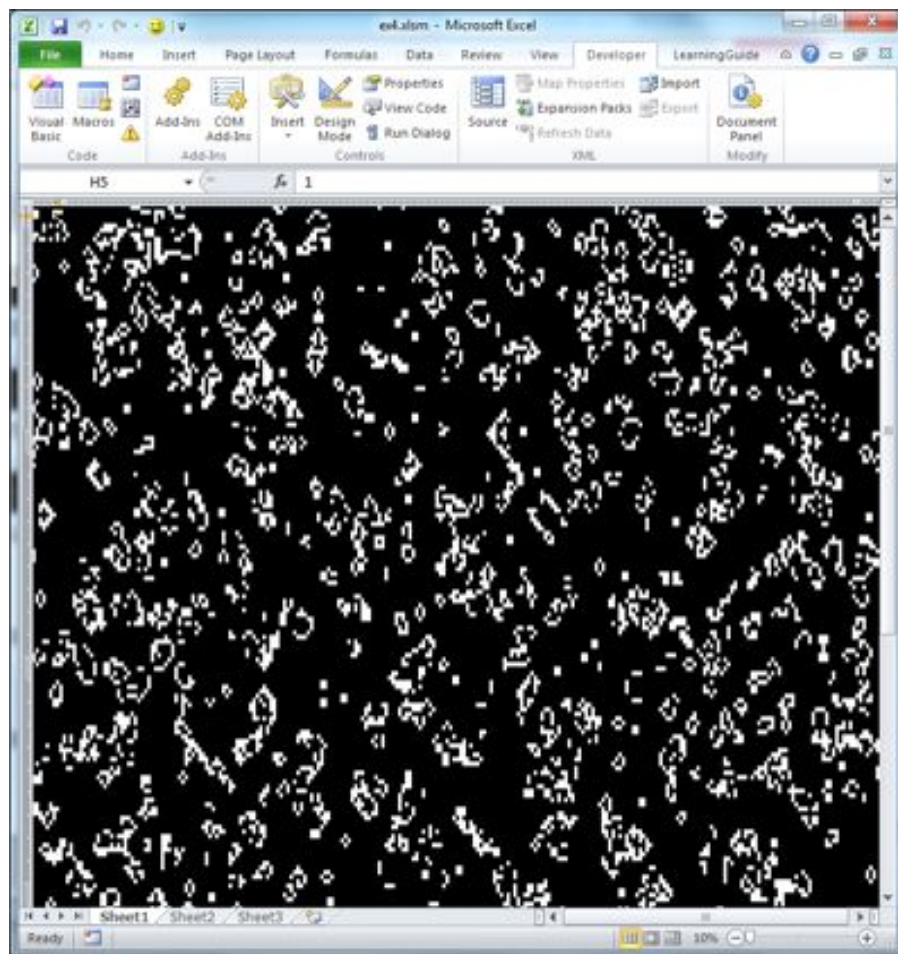


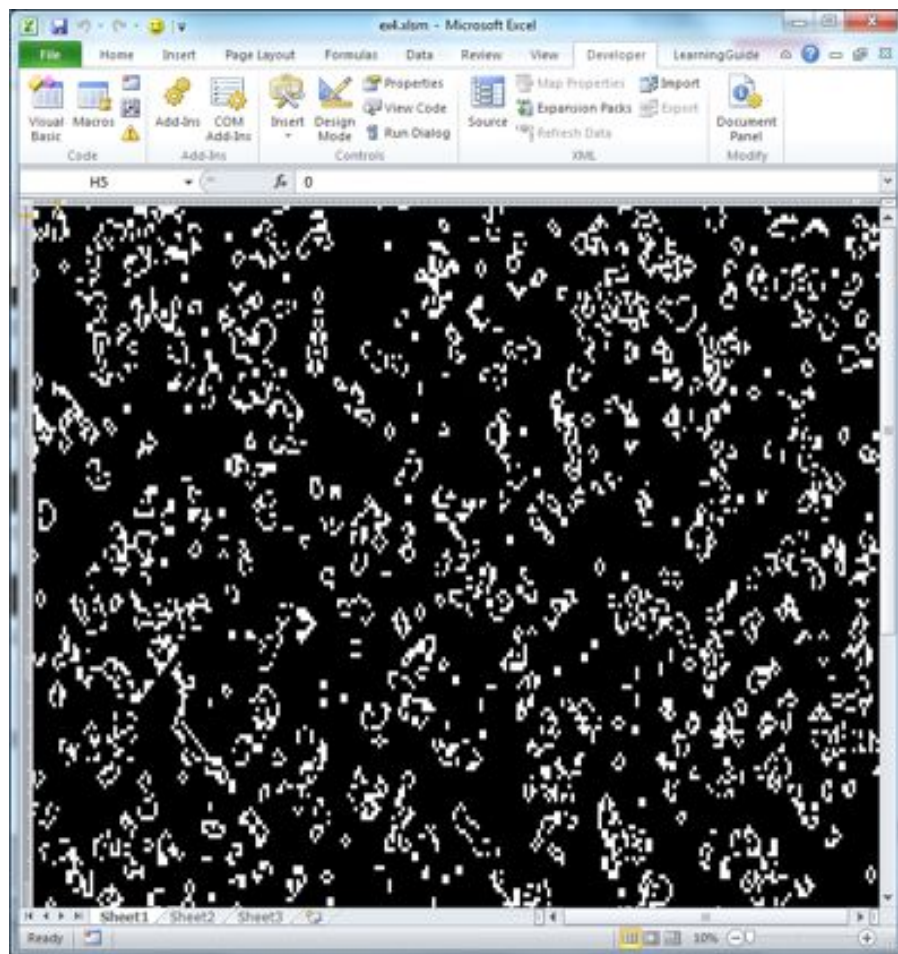


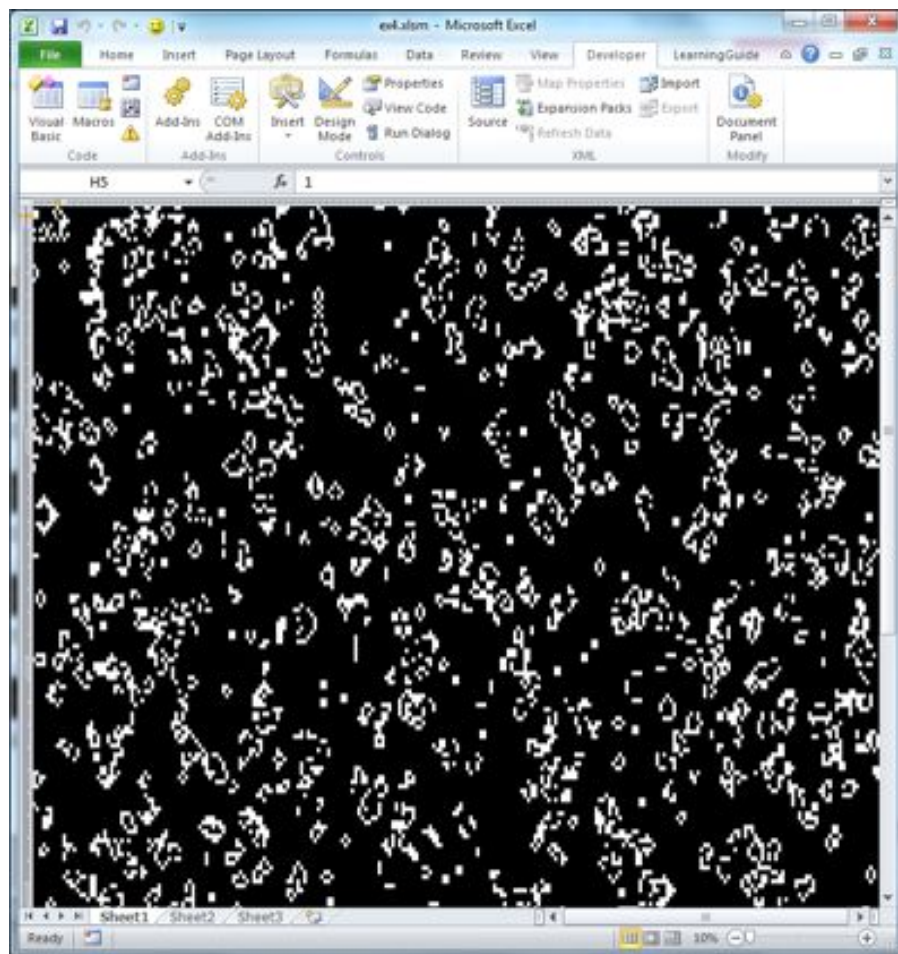


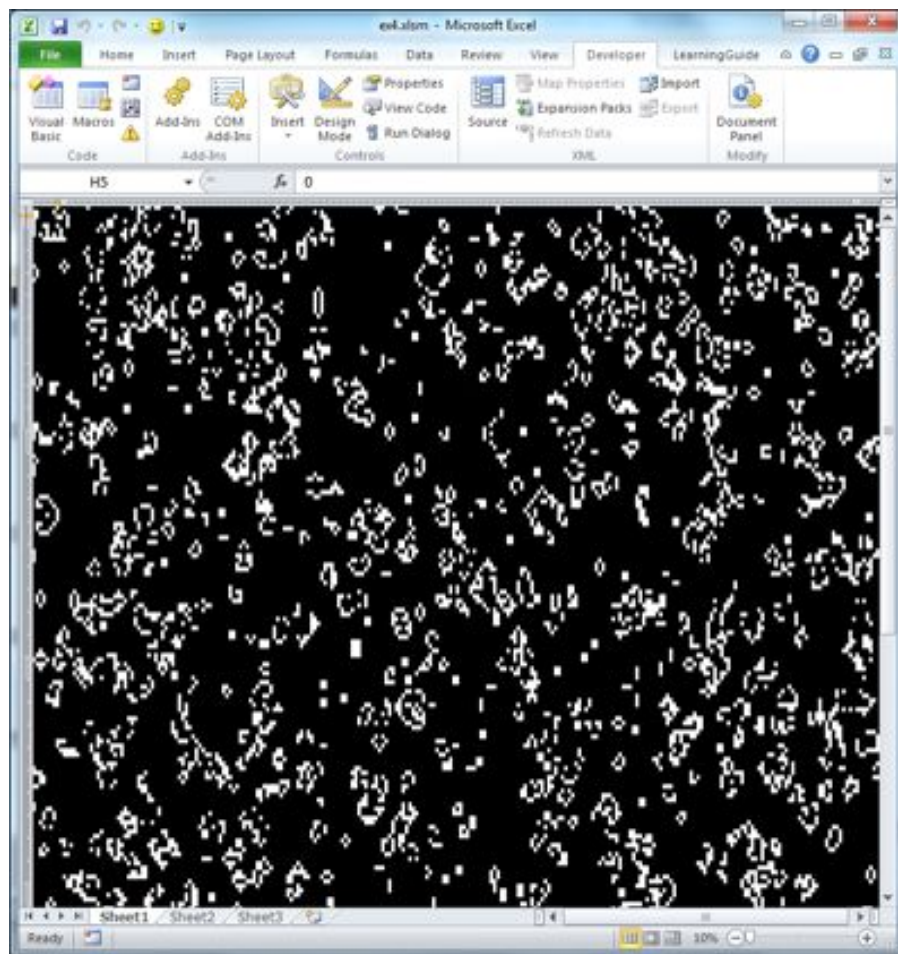


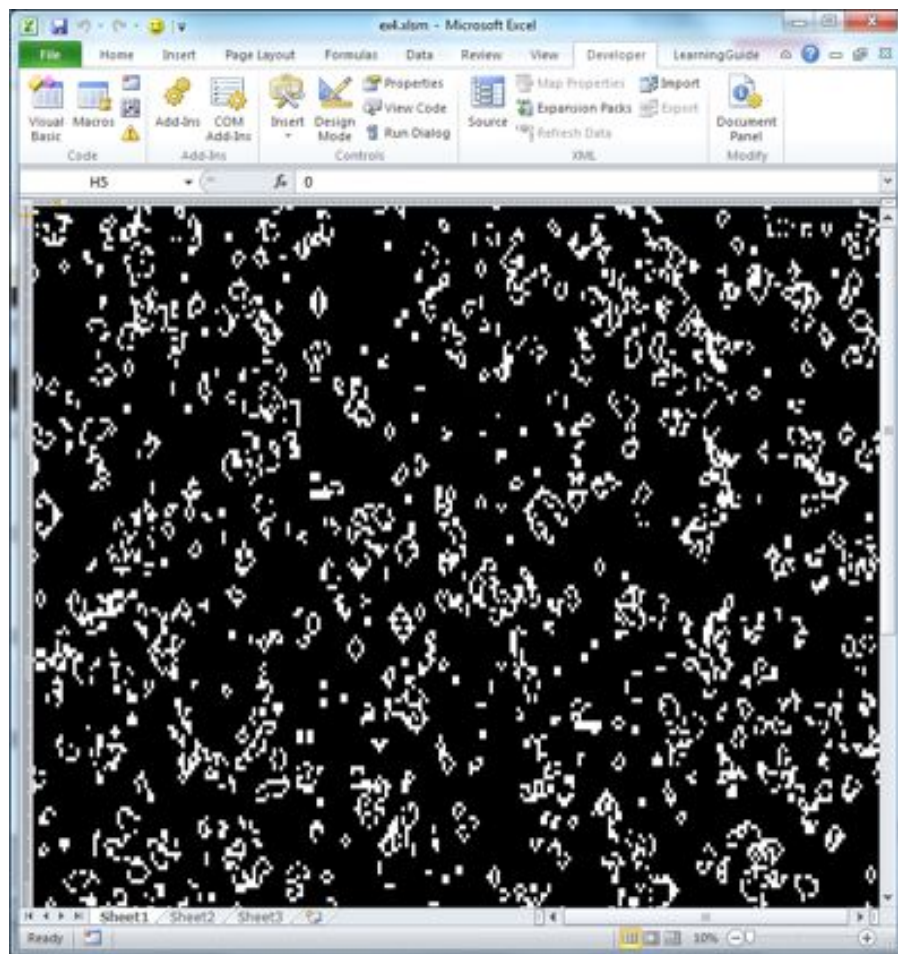


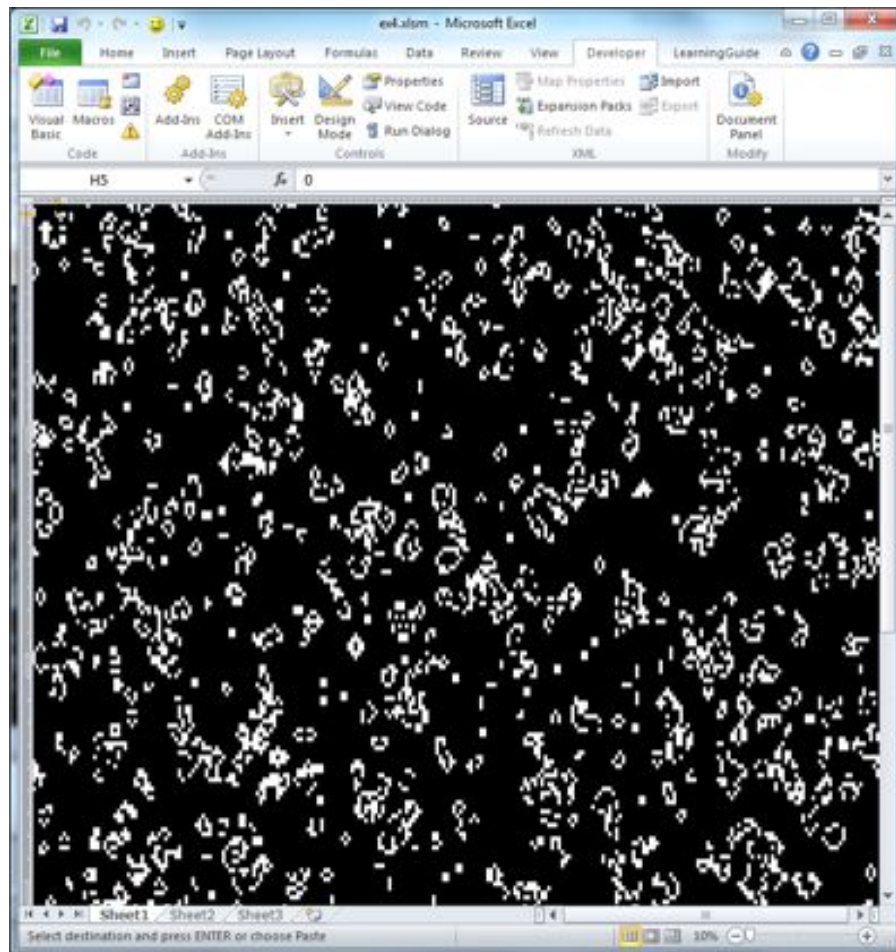


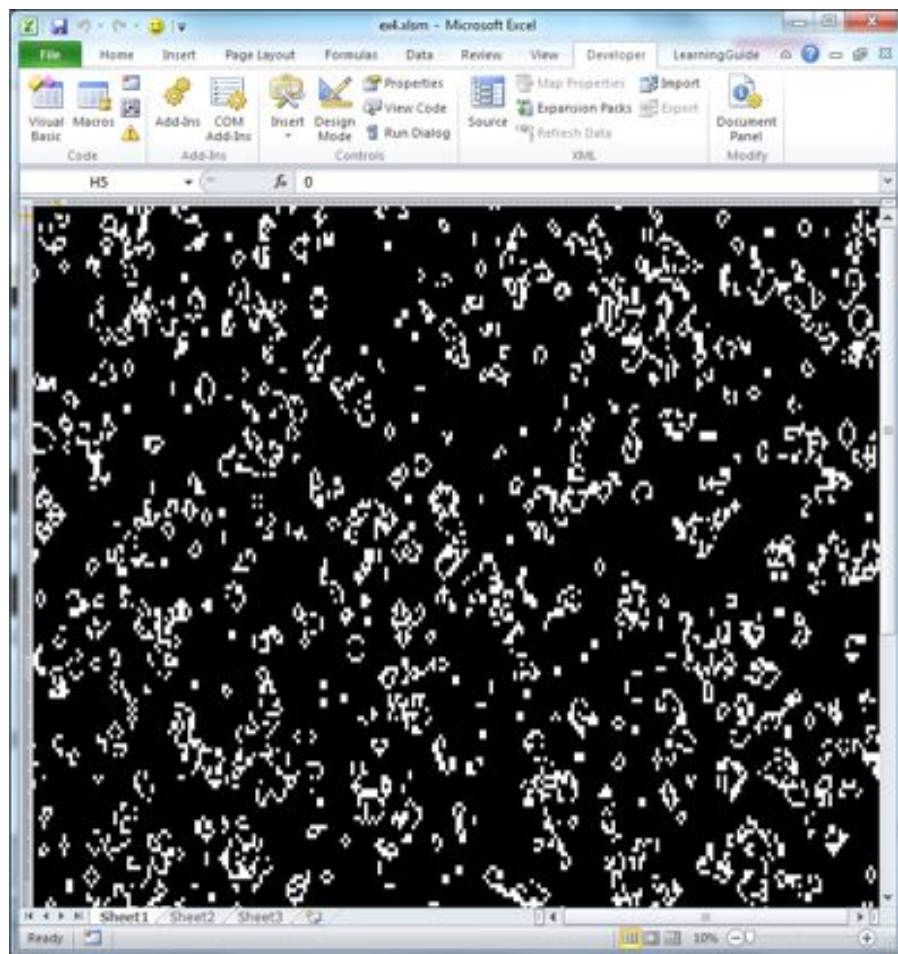


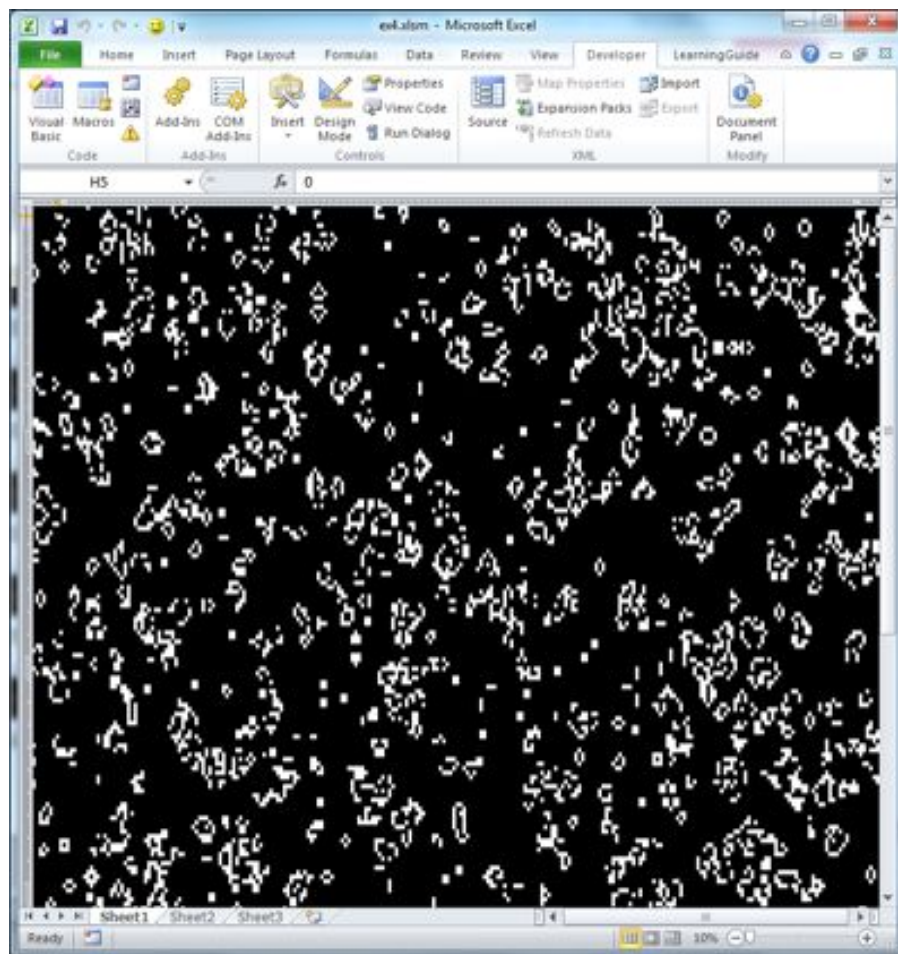


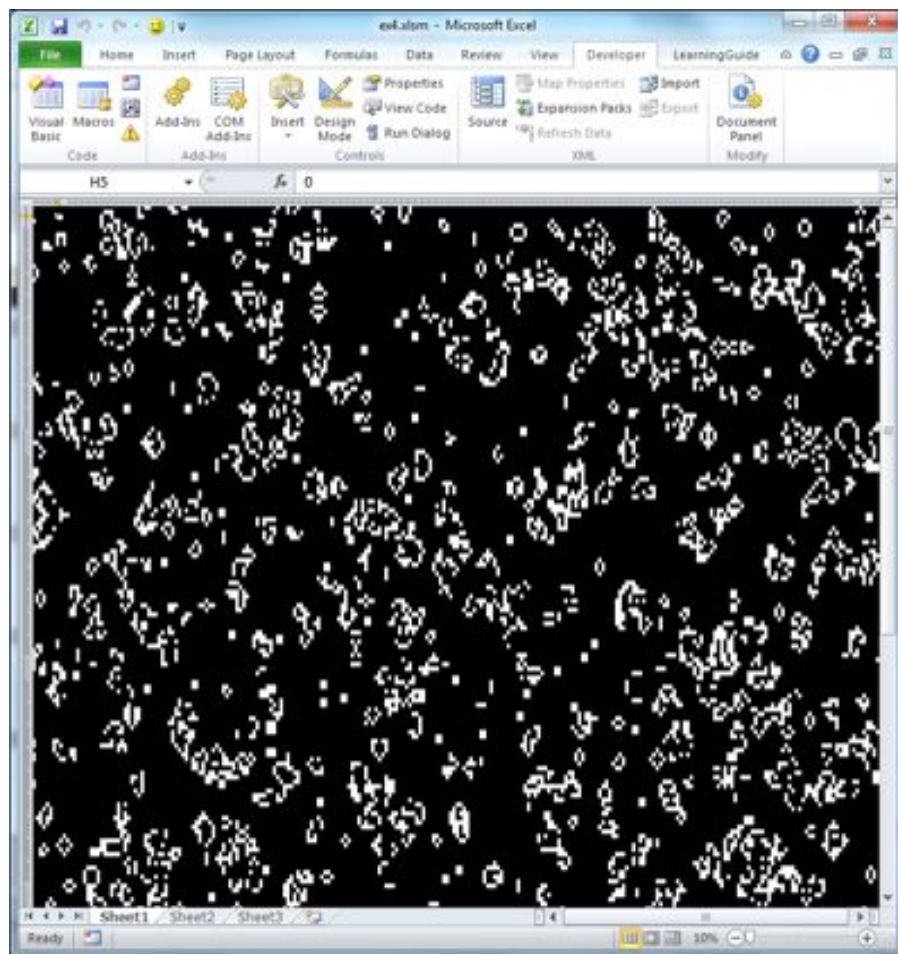


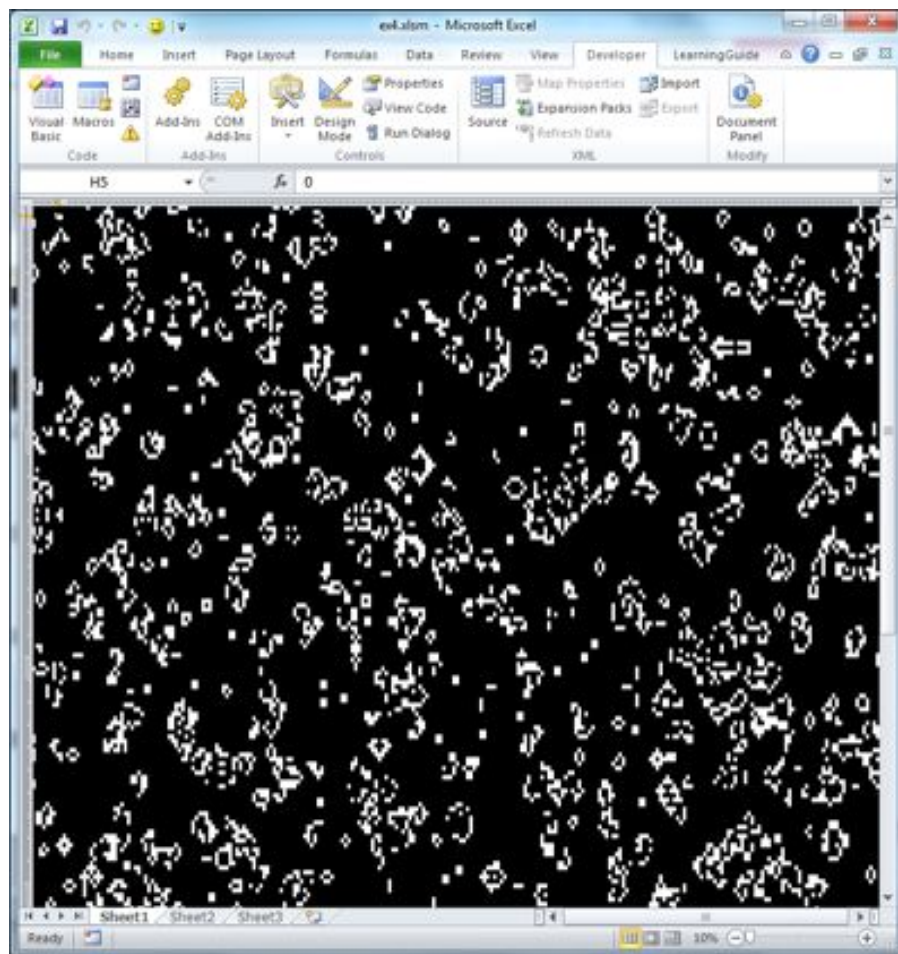


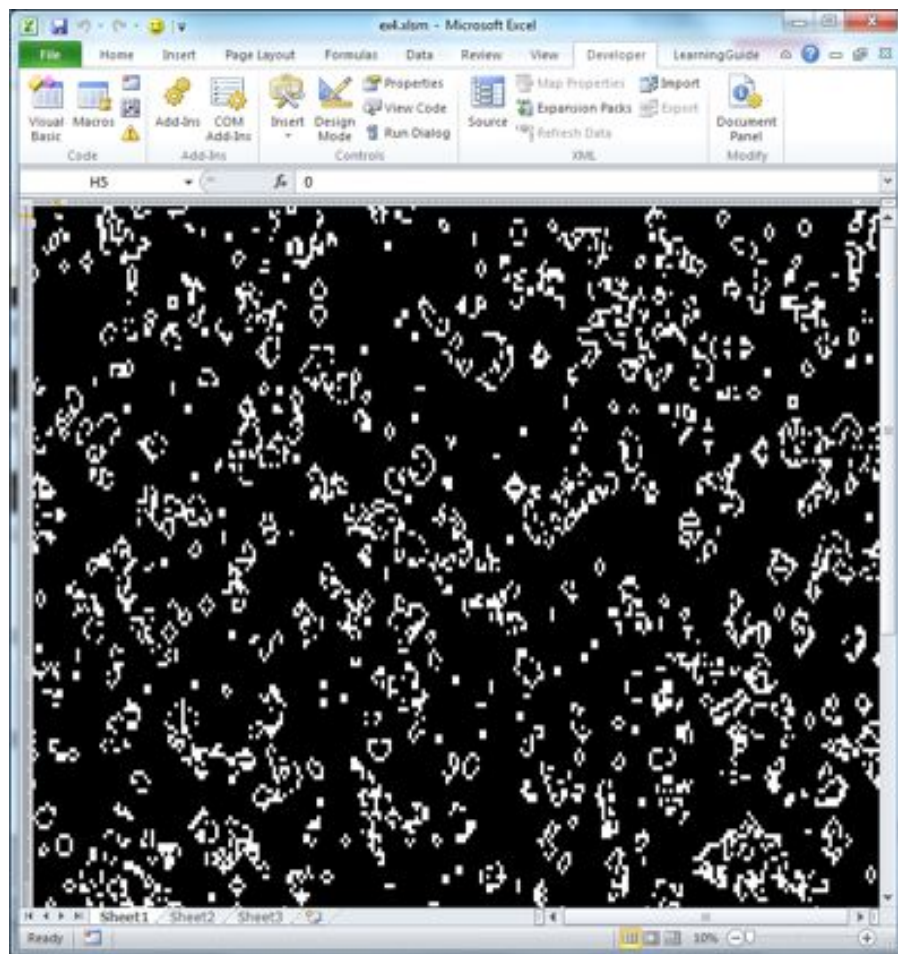


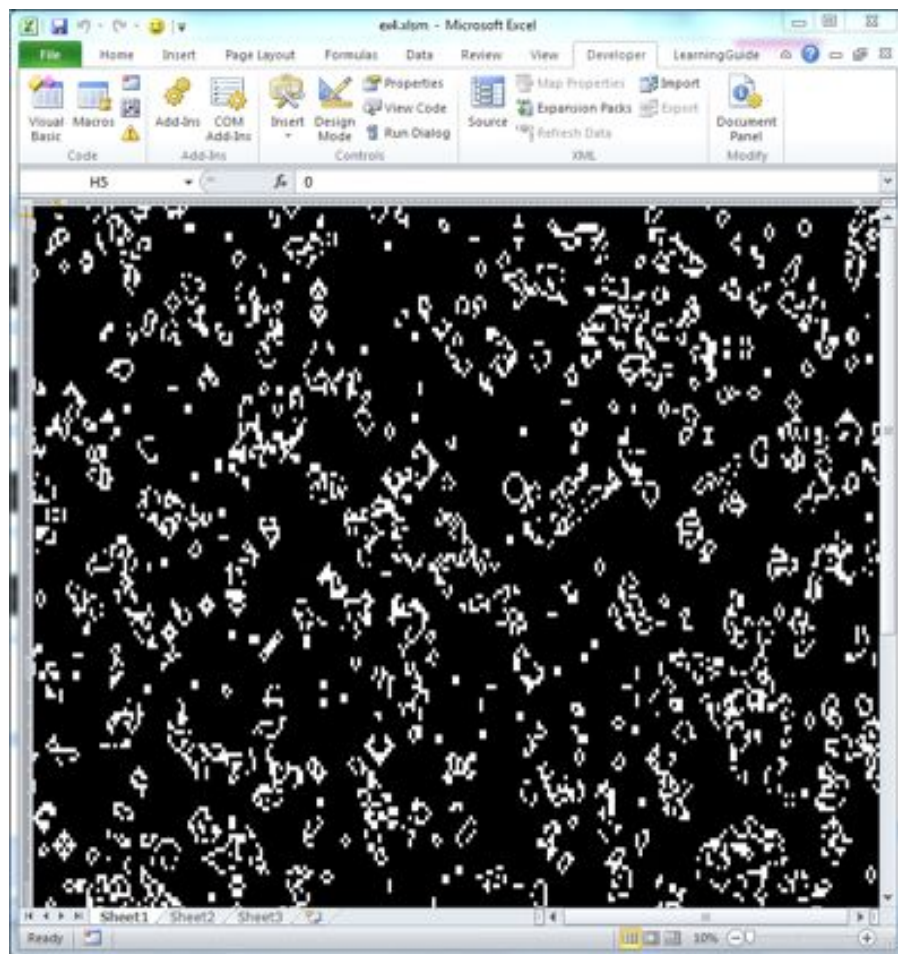




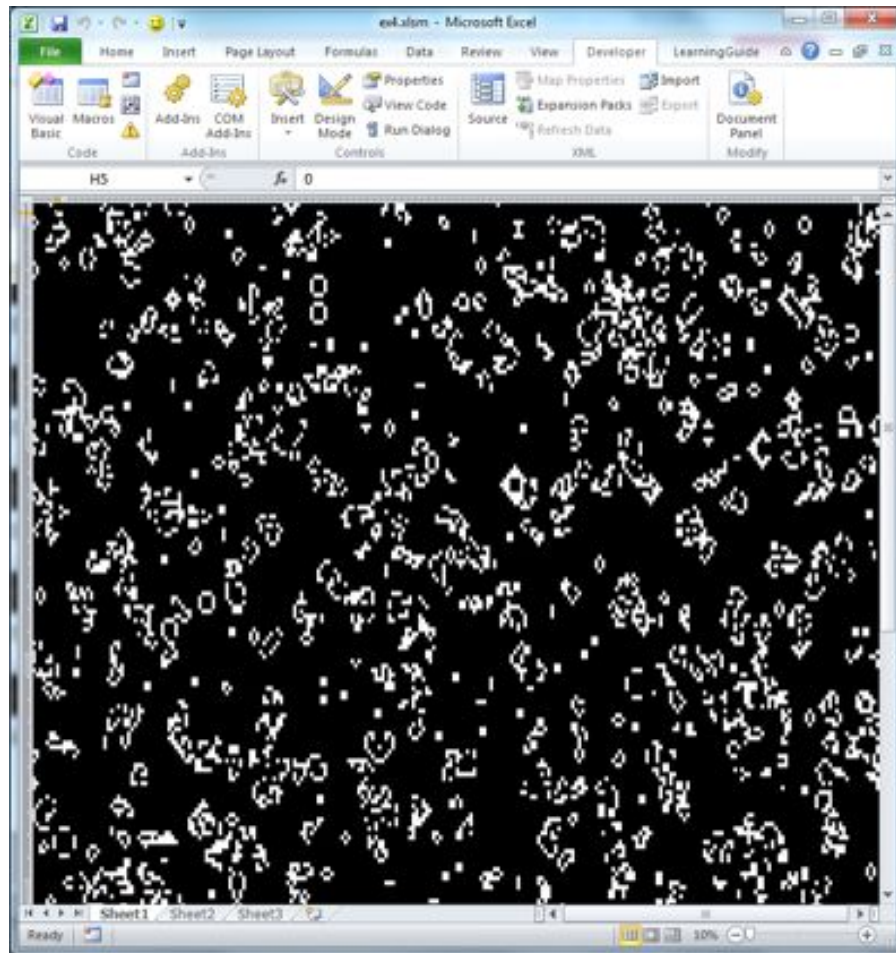




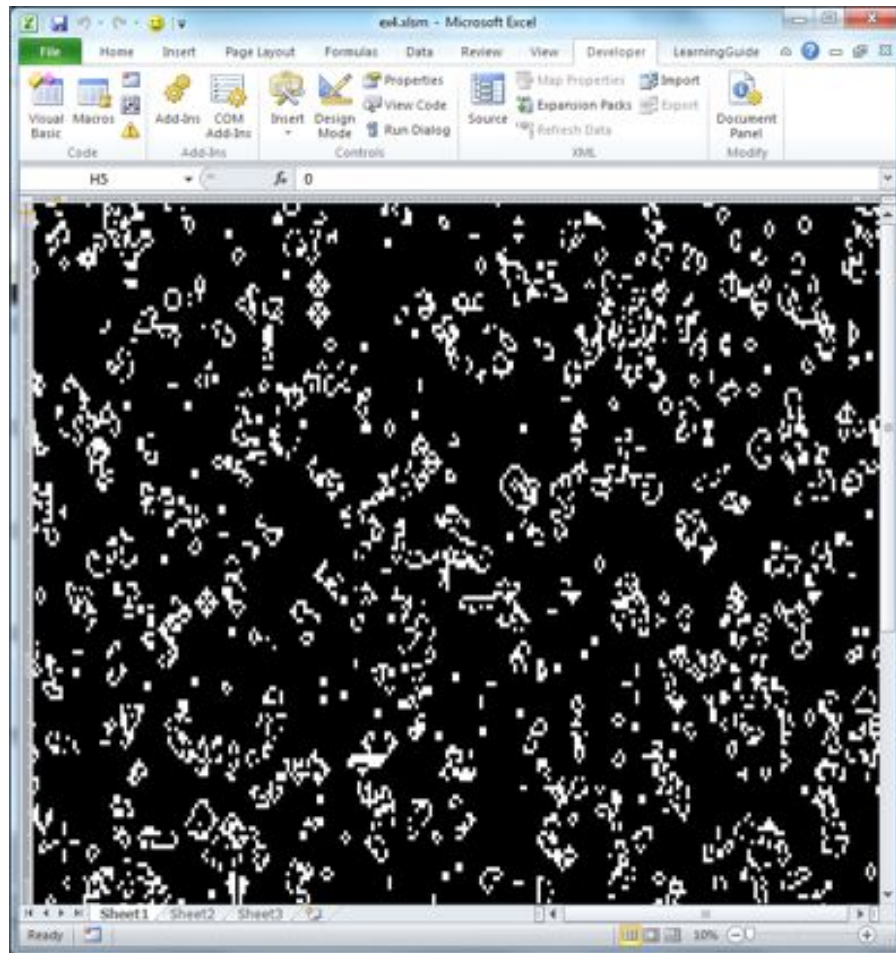




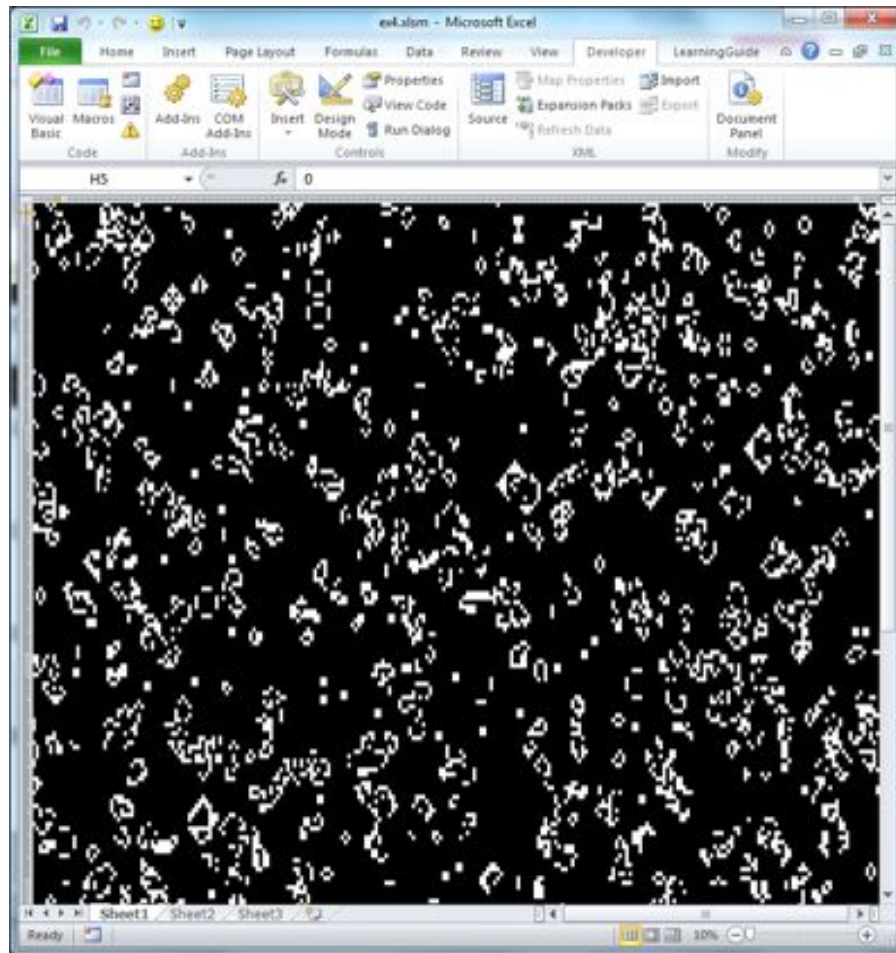
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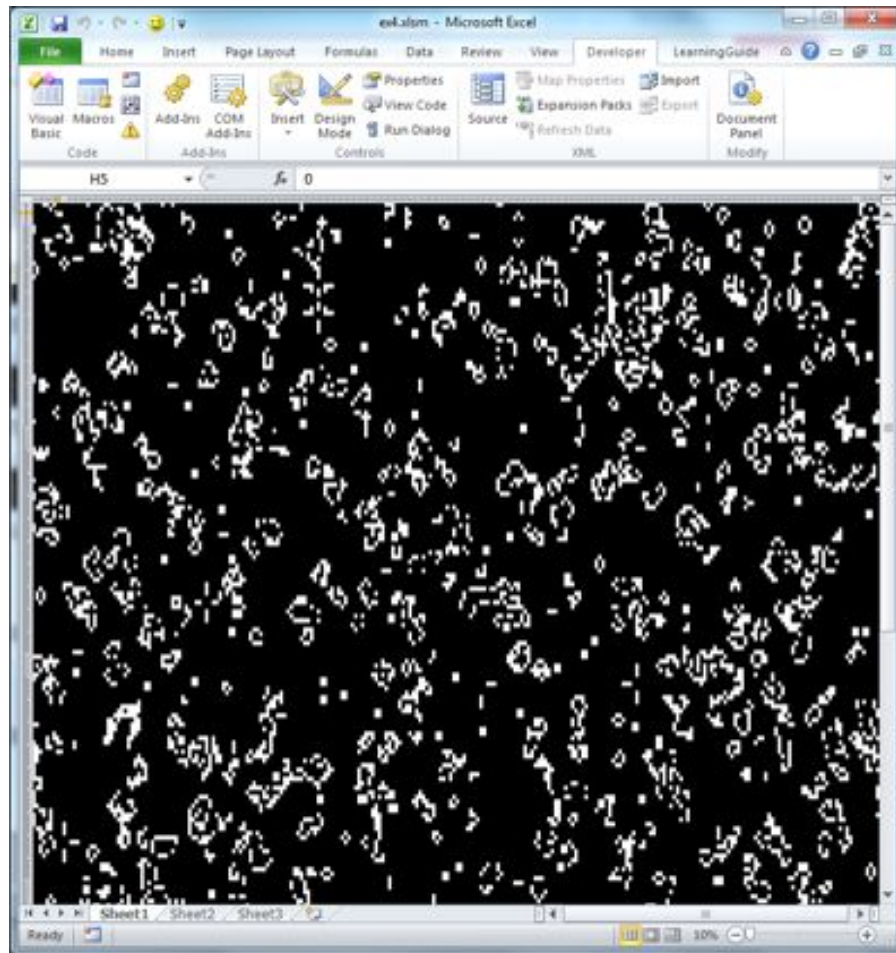
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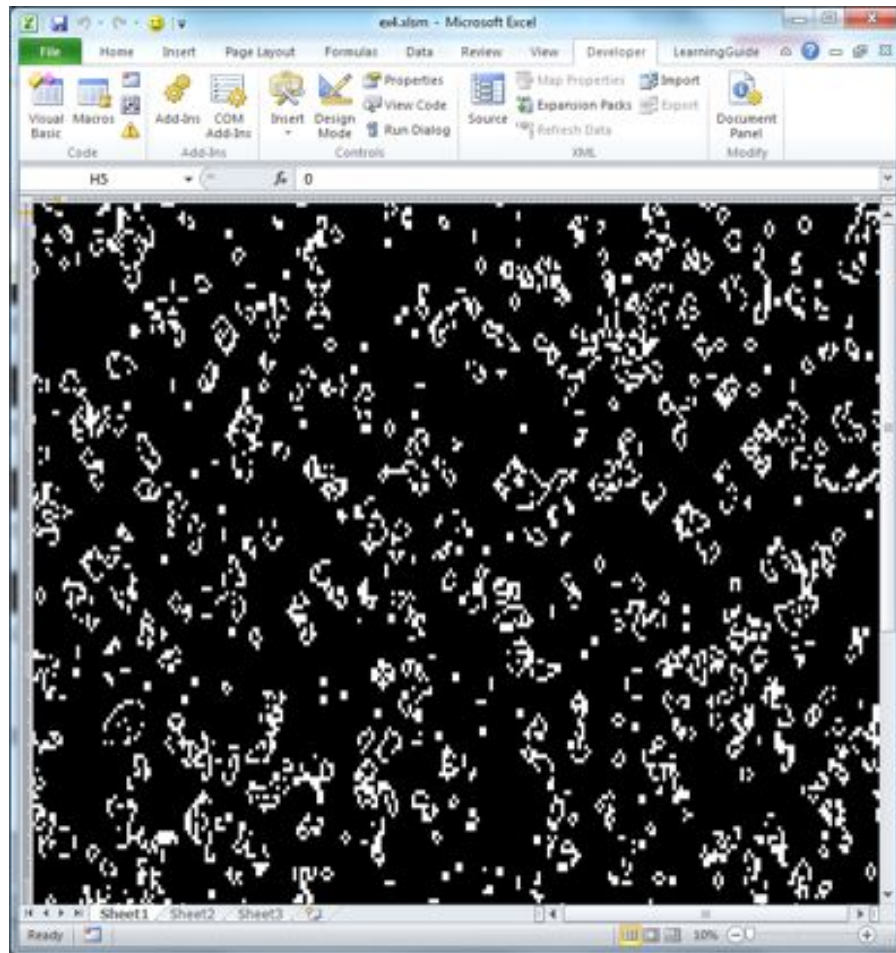
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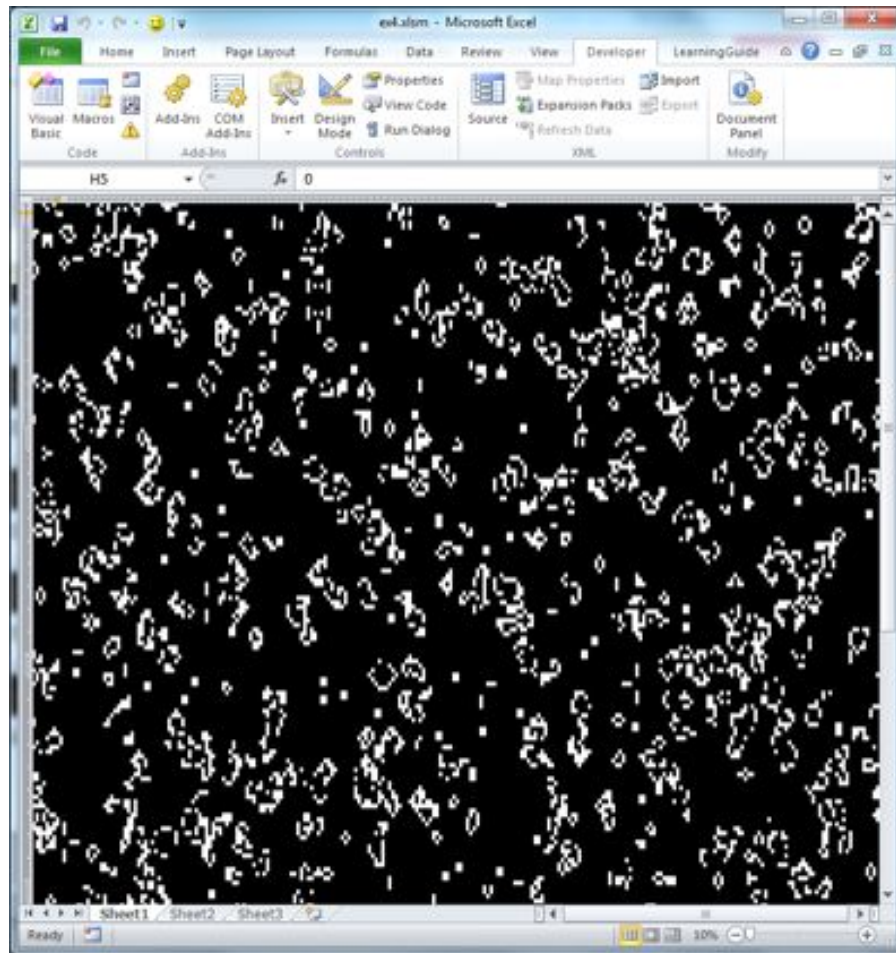
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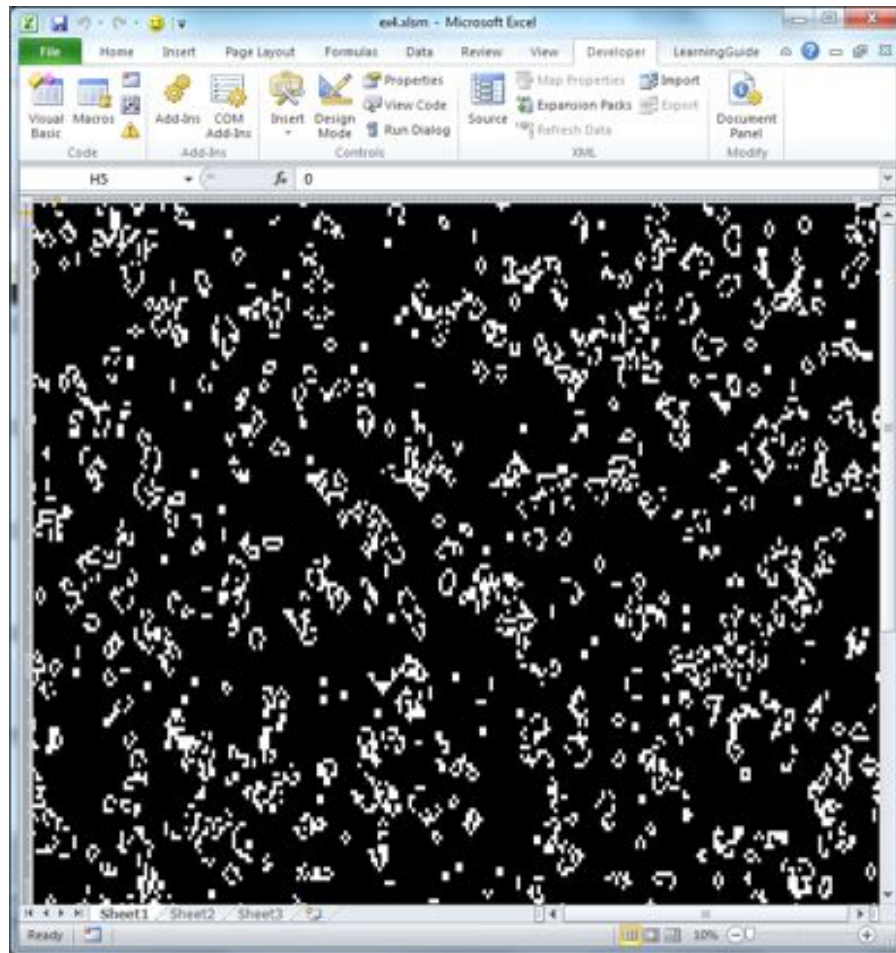
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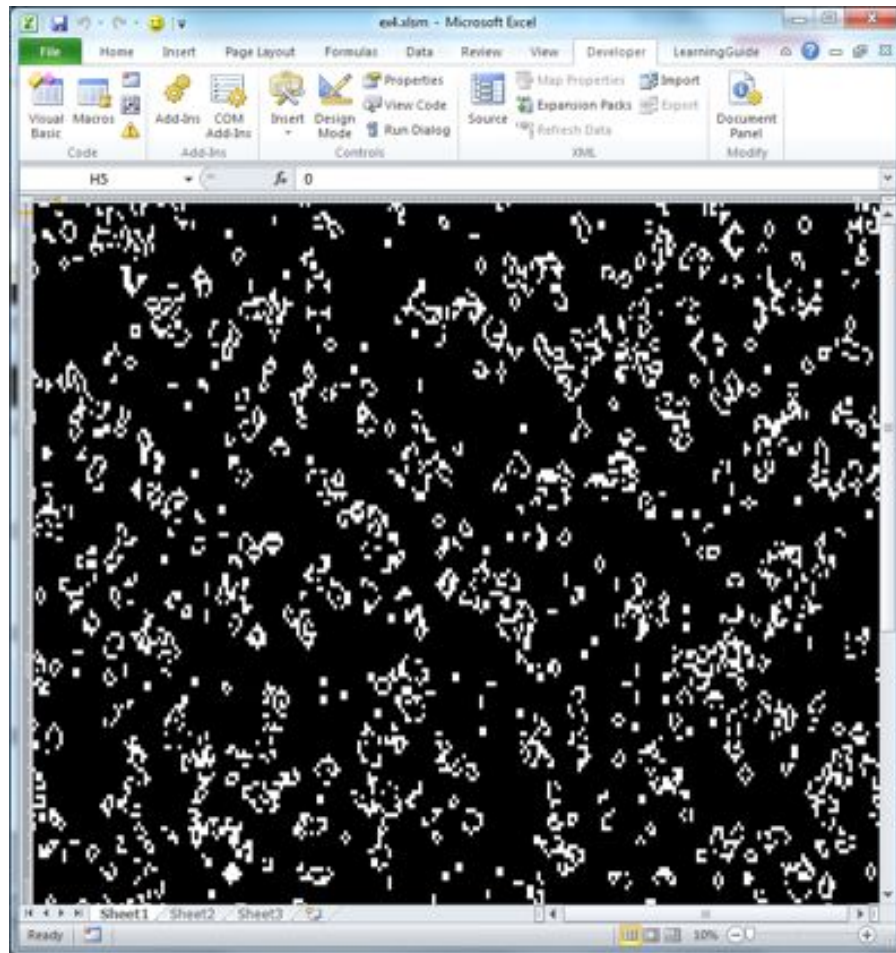
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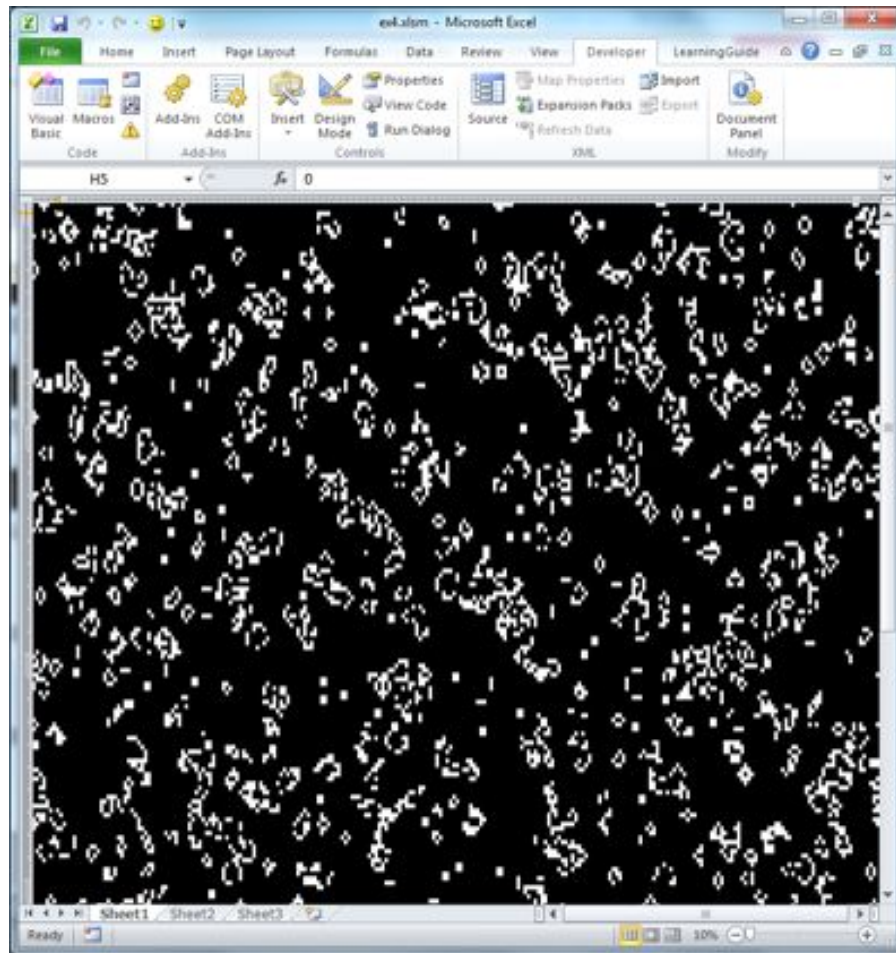
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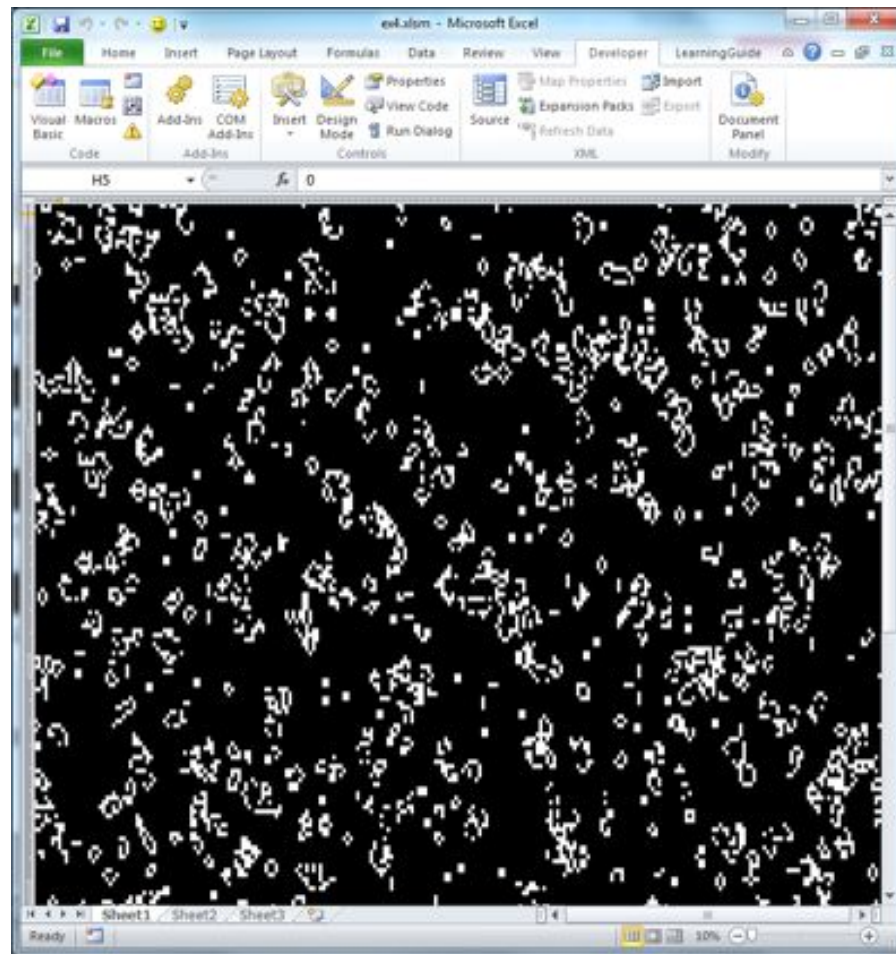
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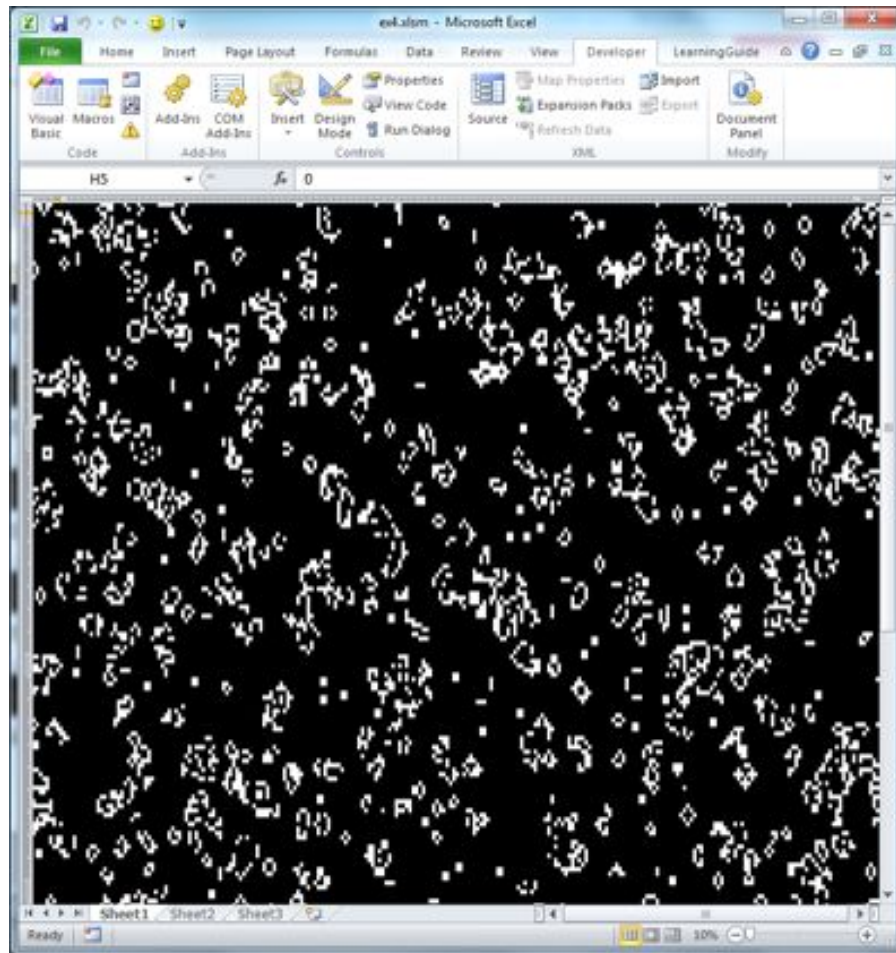
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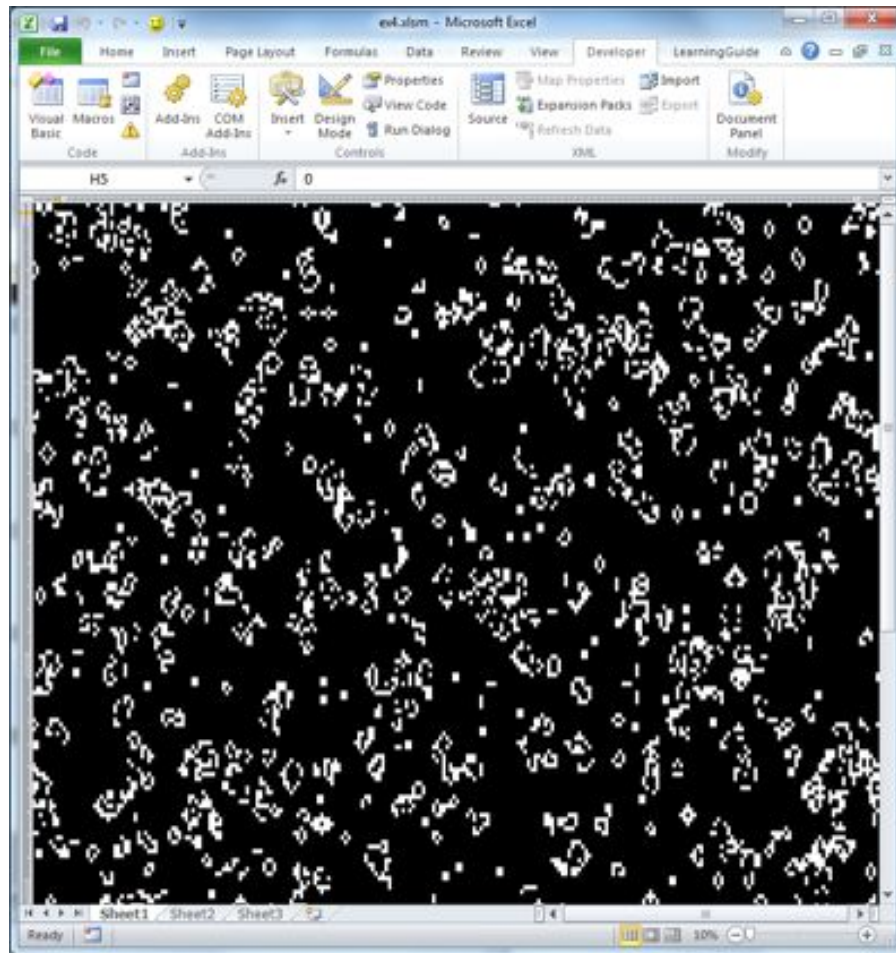
# 11



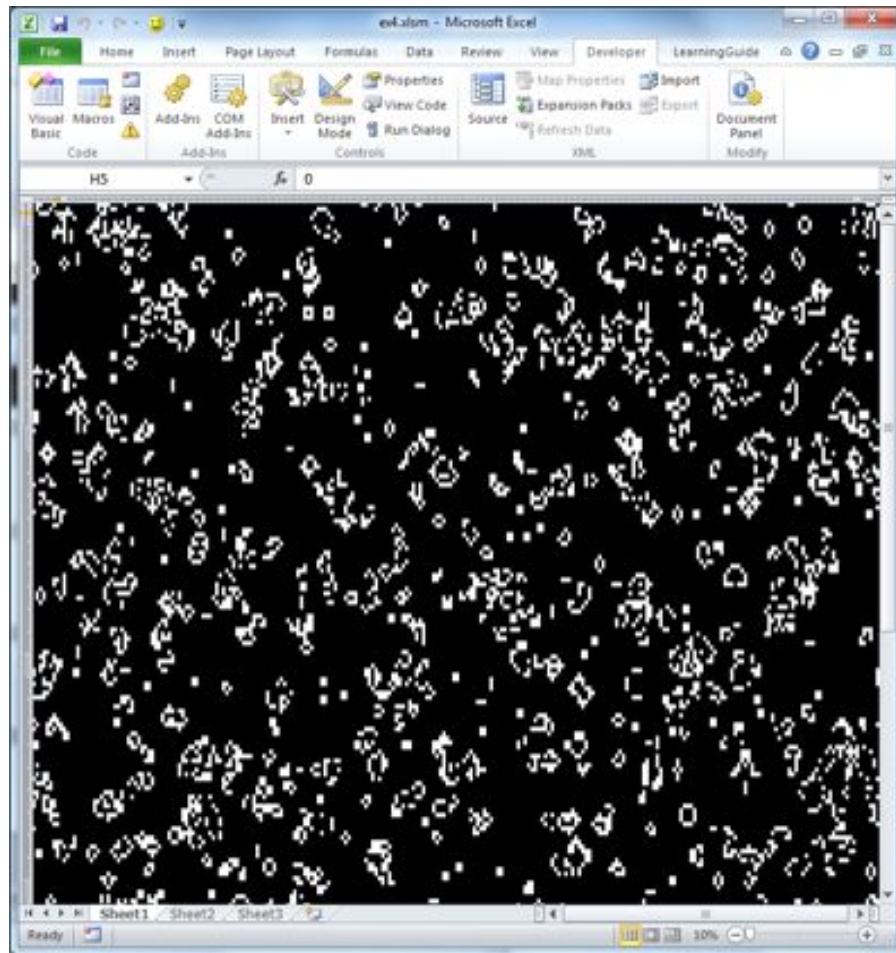
# 10



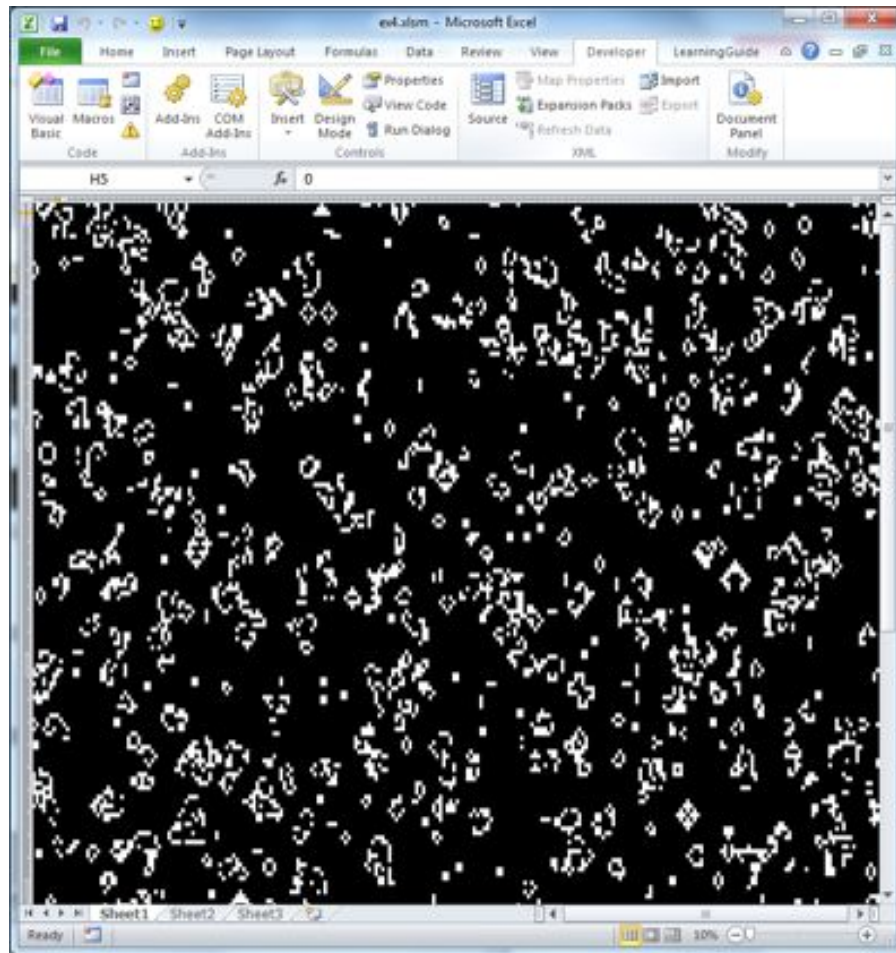
# 9



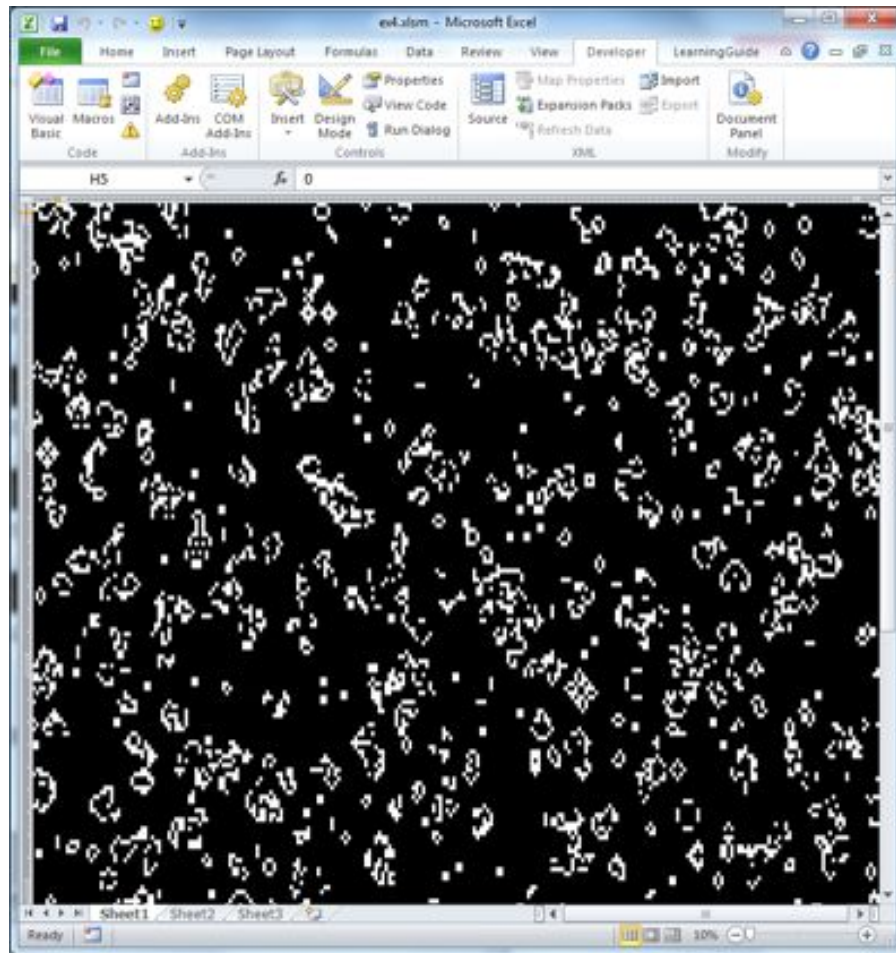
# 8



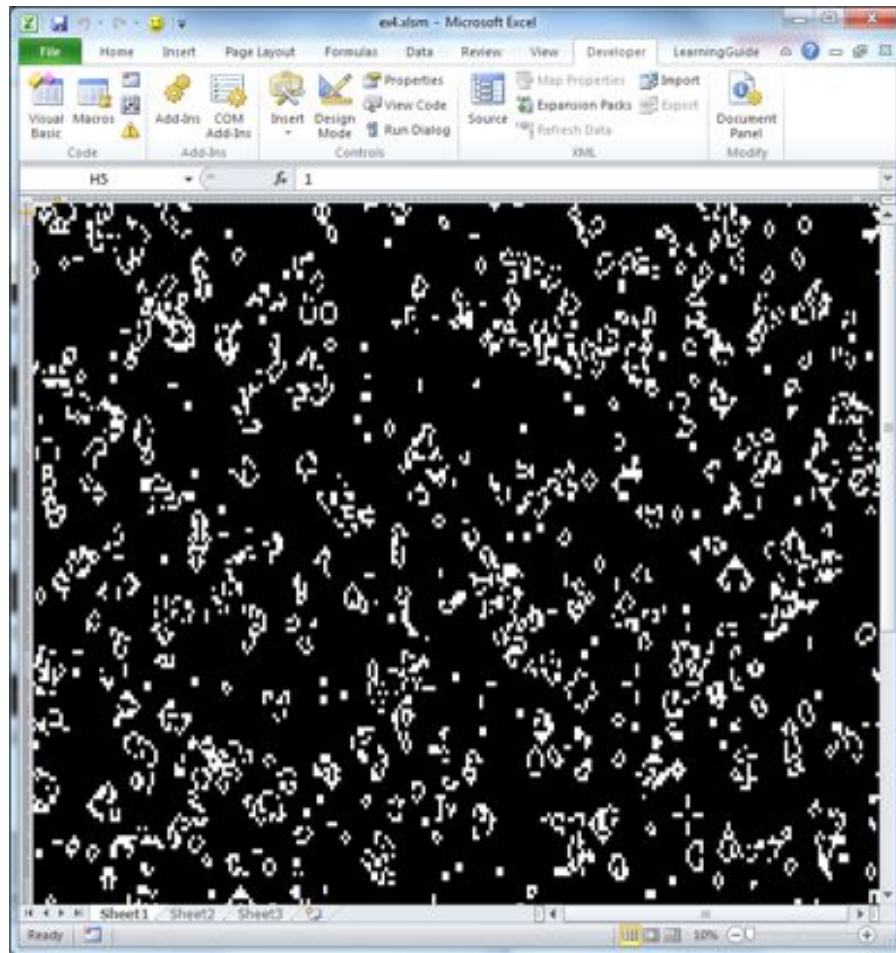
7



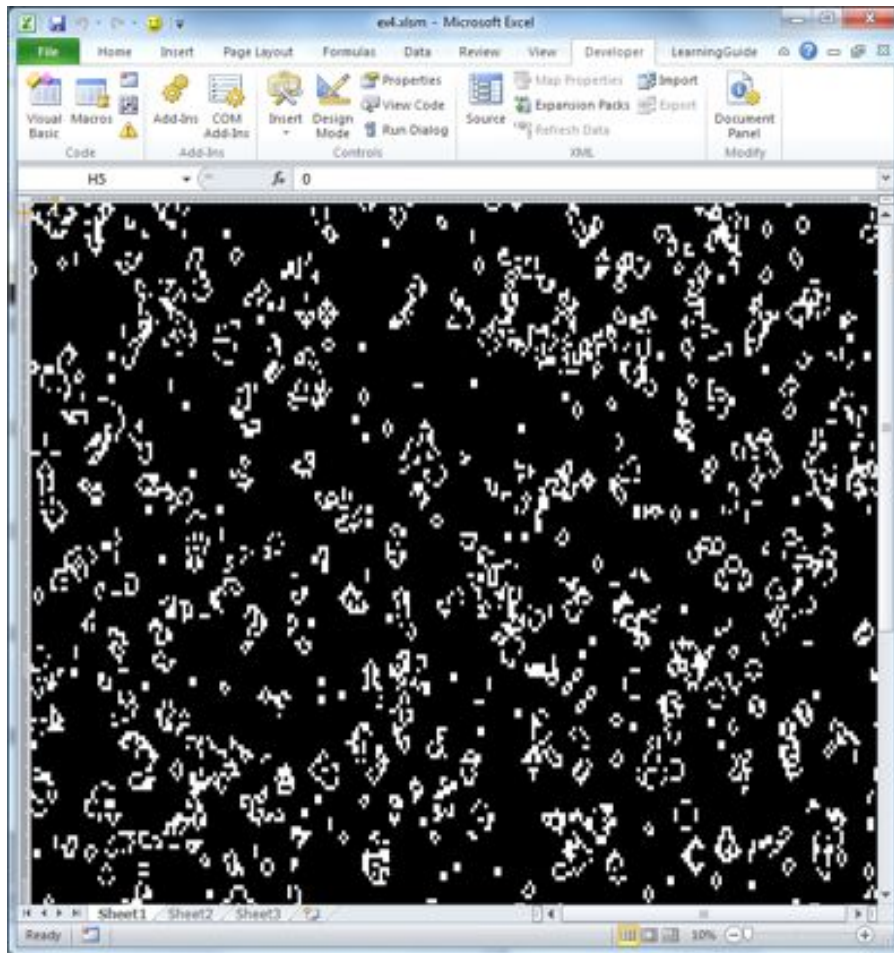
# 6



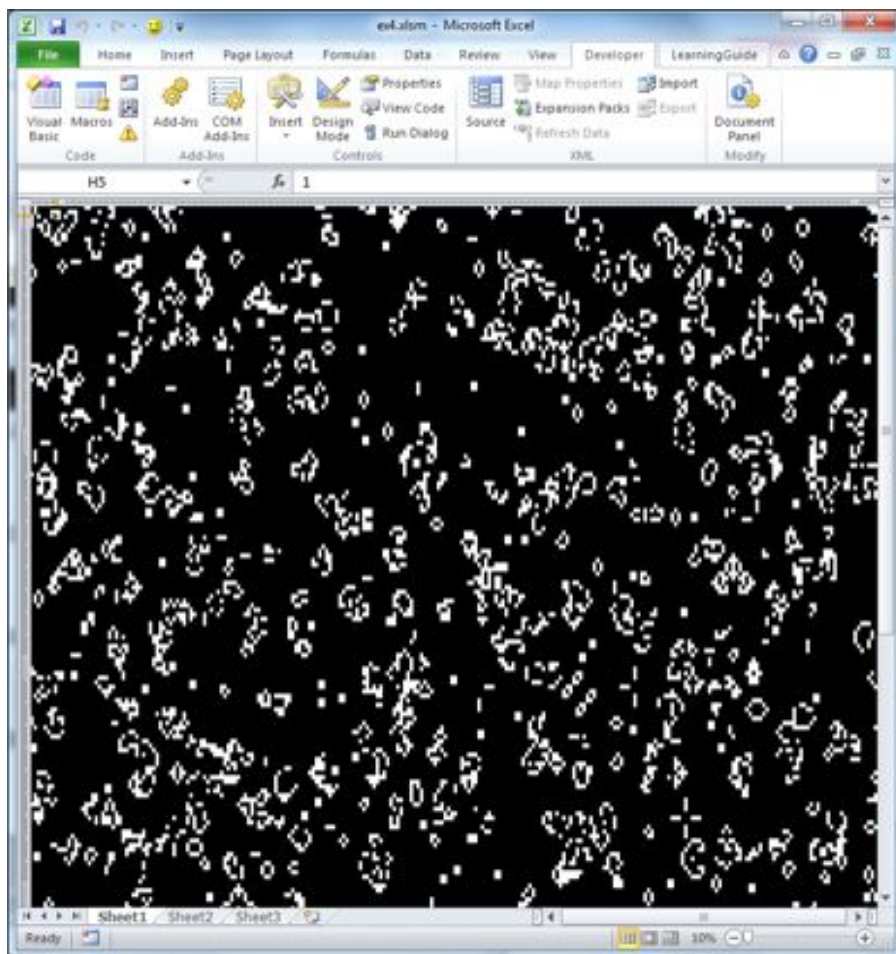
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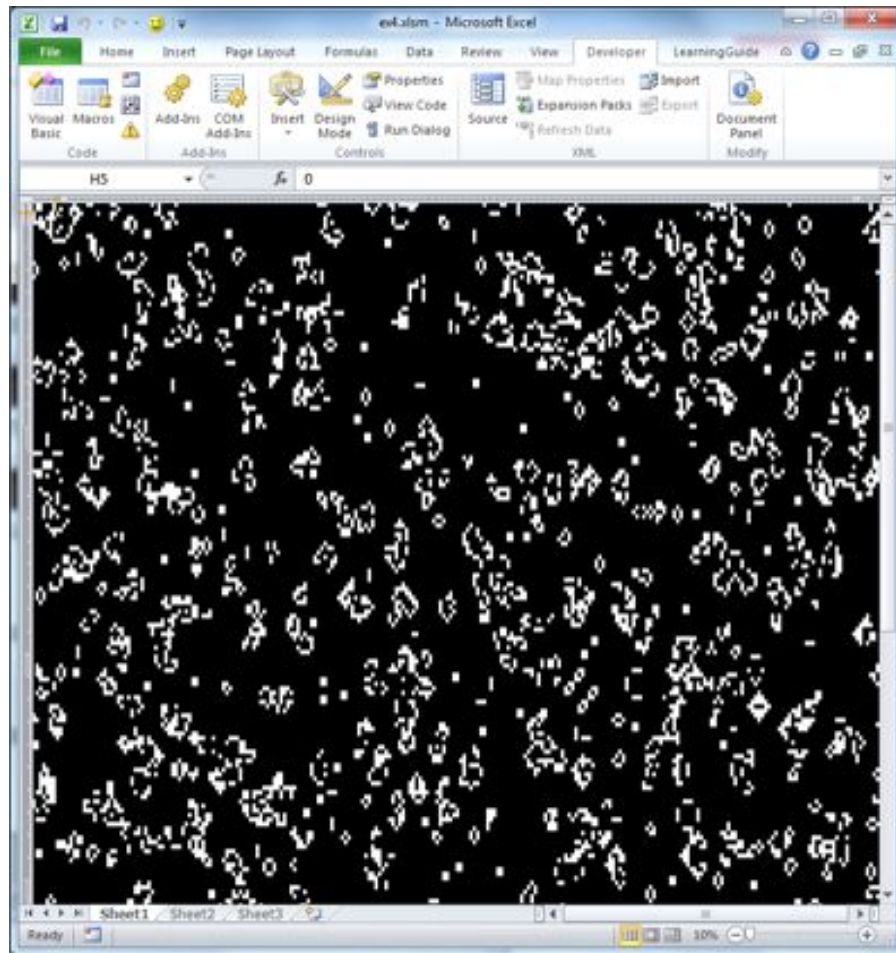
4



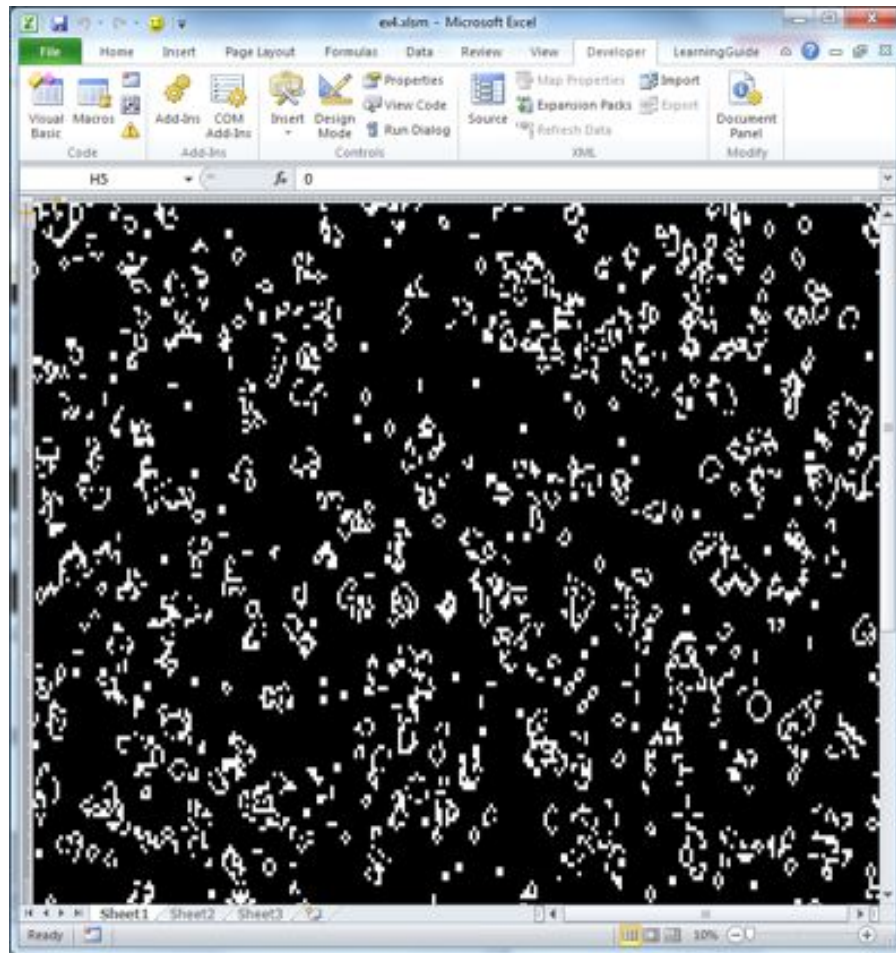
# 3



2



1



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