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Date: 05.02.2021r	**Project topic**: Cellular automata application	**Mark**:

1. An Application

1.1. User Interface clarification

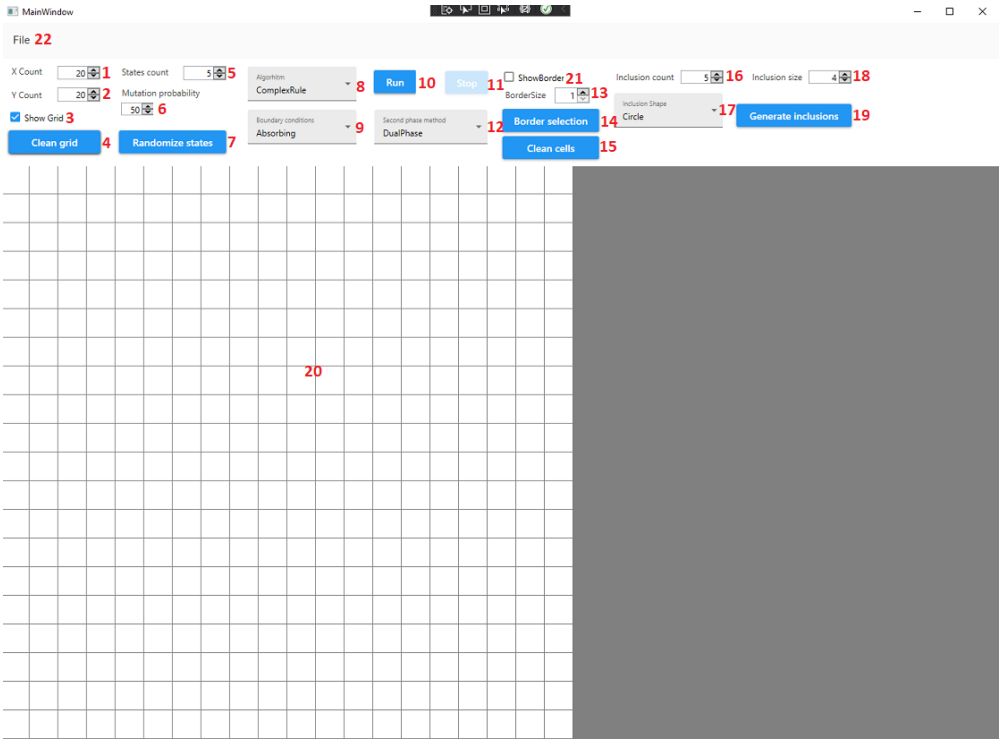

Fig.1. User Interface

1. X count input (integer, from 3, to 2000)
2. Y count input (integer, from 3, to 2000)
3. Show grid checkbox (on/off, not recommended for dense grids)
4. Clean grid button (restores the mesh to its original state)
5. States count input (integer, from 1, no upper limit)
6. Mutation probability (integer, from 0 to 100) – for Complex CA
7. Randomize states button (generates random grains in random places)
8. Algorithm dropdown (Complex, Moore, Von Neumann, Rule3)
9. Boundary conditions dropdown (absorbing/periodic)
10. Run button (disabled during simulation)
11. Stop button (enabled during simulation)
12. Show Border checkbox (can be checked in any moment)
13. Border Size input (integer, from 1 to 10)
14. Border Selection (after selecting user is able to select borders of only one grain)
15. Cleans cells (makes grains invisible and borders visible, turns on ShowBorder checkbox)
16. Inclusions amount (integer, from 1, no upper limit)
17. Inclusions shape dropdown (circle/square)

18. Inclusion size input (integer, from 1, no upper limit)
19. Generate inclusions button (If the simulation hasn't been started, inclusions are generated in the whole grid. If the simulation has been finished, inclusions are generated only on the grains borders.)
20. The grid
21. Show Border checkbox (on/off)
22. Save/load menu

1.2 Class Diagram

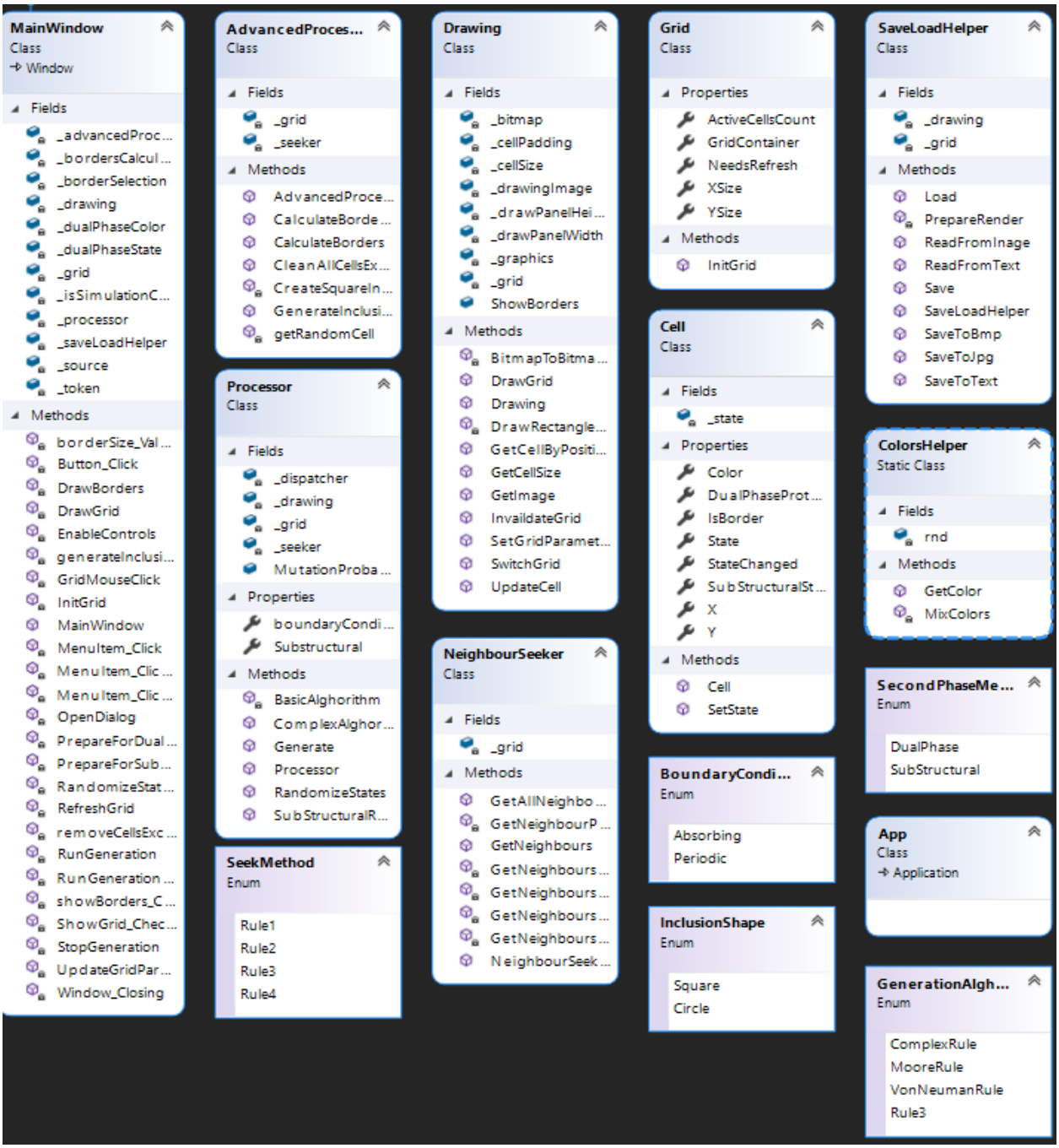

Fig.2. Class diagram

2. Usage Examples

2.1. Moore Neighbourhood

Fig.3. Simulation result

Grid size: 400 x 400
Show grid: off
States count: 50
Boundary: absorbing
Rule chosen: Moore
Borders: off
Inclusions: off
Inclusions type: -
Inclusions shape: -
Inclusions size: -
Inclusions amount: -

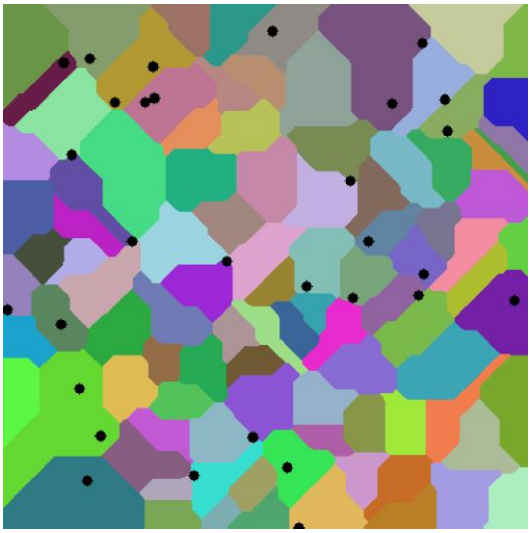

Fig.4. Simulation result

Grid size: 400 x 400
Show grid: off
States count: 100
Boundary: absorbing
Rule chosen: Moore
Borders: off
Inclusions: off
Inclusions type: Before
Inclusions shape: Circle
Inclusions size: 5
Inclusions amount: 30

2.2. Nearest Moore

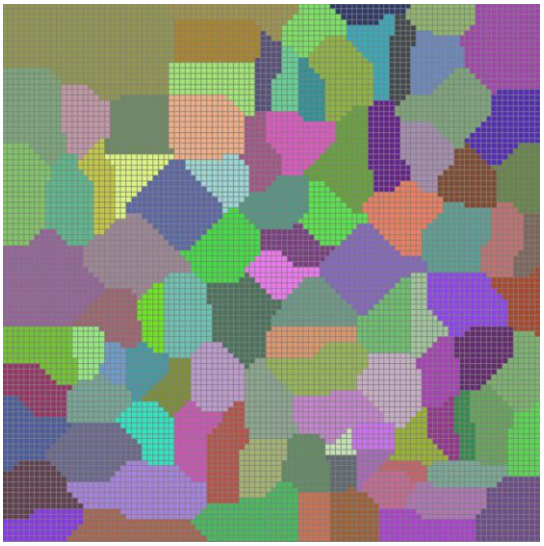

Fig.5 Simulation result

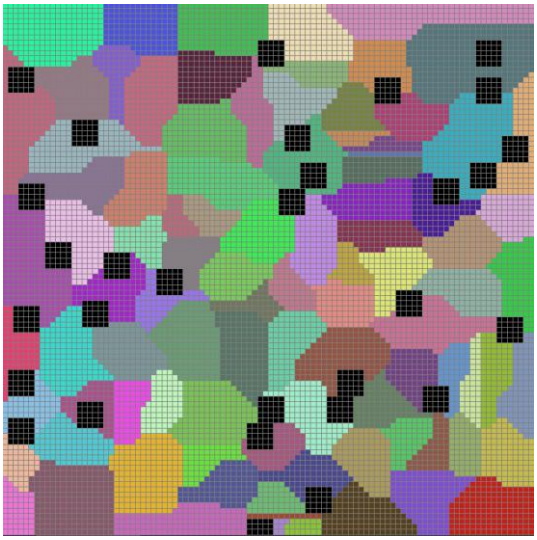

Fig.6. Simulation result

Grid size: 100 x 100
Show grid: on
States count: 100
Boundary: absorbing
Rule chosen: Nearest Moore
Borders: off
Inclusions: off
Inclusions type: -
Inclusions shape: -
Inclusions size: -
Inclusions amount: -

Grid size: 100 x 100
Show grid: on
States count: 20
Boundary: absorbing
Rule chosen: Nearest Moore
Borders: off
Inclusions: off
Inclusions type: Before
Inclusions shape: Square
Inclusions size: 5
Inclusions amount: 30

2.3. Grain Boundary Shape Control

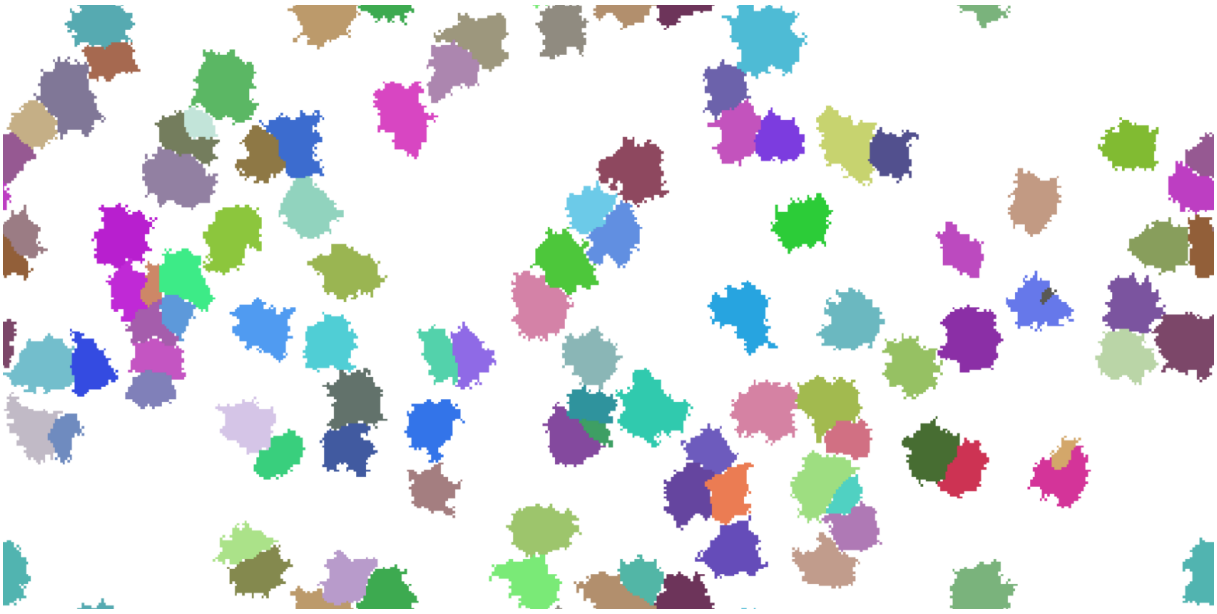

Fig.7 Simulation result after several steps

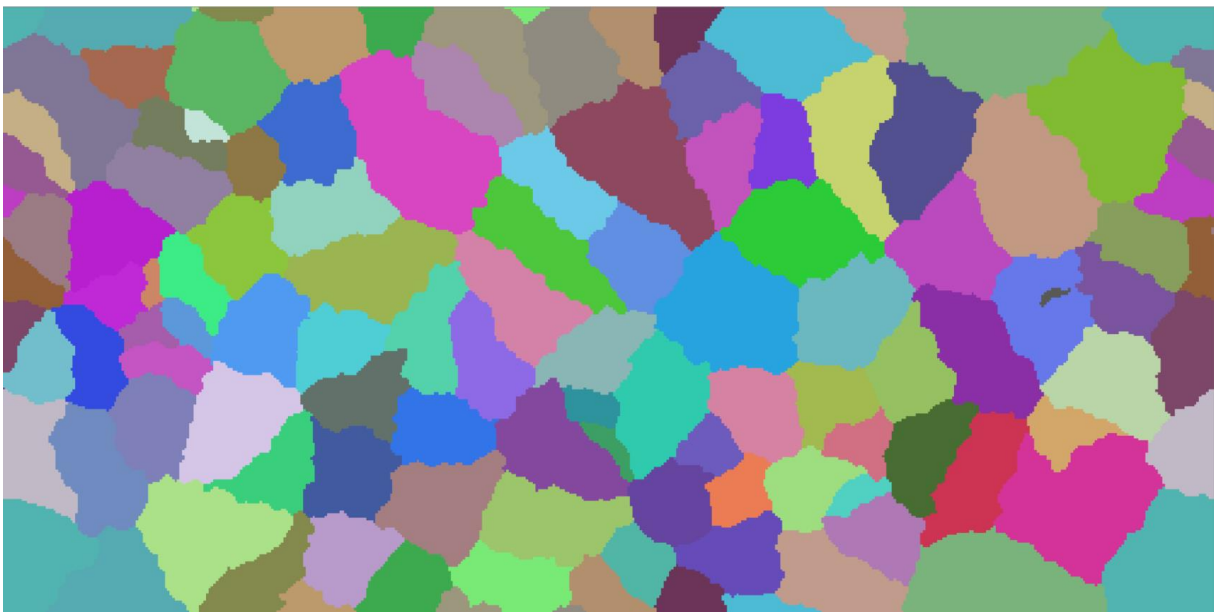

Fig.8 Simulation result

Grid size: 100 x 100
States count: 100
Boundary: Periodic
Rule chosen: Grain boundary shape control
Mutation probability: 10
Borders: off
Inclusions: off

Fig. 9. Simulation result – options the same as above, despite Mutation probability: 99

2.4. Inclusions added before simulation

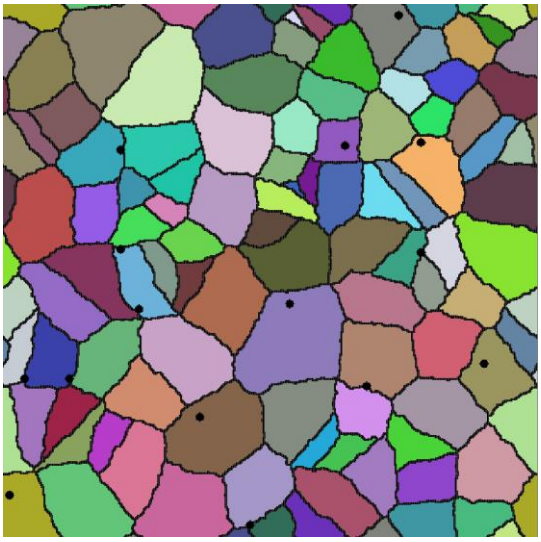

Fig.10. Simulation result

Grid size: 500 x 500
States count: 100
Boundary: Periodic
Rule chosen: Grain boundary shape control
Mutation probability: 50
Borders: on

Fig.11. Simulation result

Grid size: 50 x 50
States count: 3
Boundary: Absorbing
Rule chosen: Grain boundary shape control
Mutation probability: 50
Borders: off

Inclusions: on
Inclusions type: Before
Inclusions shape: Circle
Inclusions size: 5
Inclusions amount: 15

Inclusions: on
Inclusions type: Before
Inclusions shape: Square
Inclusions size: 5
Inclusions amount: 10

2.5. Inclusions added before simulation

Fig.12. Simulation result

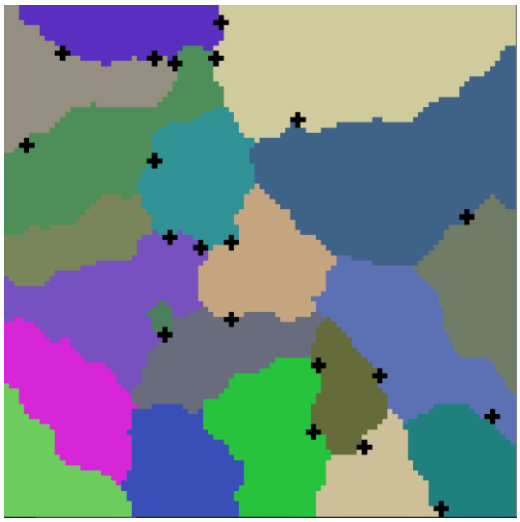

Fig.13. Simulation result

Grid size: 100 x 100
States count: 5
Boundary: Absorbing
Rule chosen: Nearest Moore
Mutation probability: -
Inclusions: on
Inclusions type: After
Inclusions shape: Square
Inclusions size: 5
Inclusions amount: 5

Grid size: 100 x 100
States count: 20
Boundary: Absorbing
Rule chosen: Grain boundary shape control
Mutation probability: 1
Inclusions: on
Inclusions type: After
Inclusions shape: Circle
Inclusions size: 2
Inclusions amount: 20

2.6. Dual Phase

Fig.14. Simulation result

Fig.15. Simulation result with selected 3 types of grains

Fig.16. Second phase with 20 new grains result

Grid size: 250 x 250
States count: 5
Boundary: Periodic
Rule chosen: Grain boundary shape control
Mutation probability: 10
Second phase: Dual Phase, second generation with 20 new grains

2.7. Sub-structural

Fig.17. Simulation result

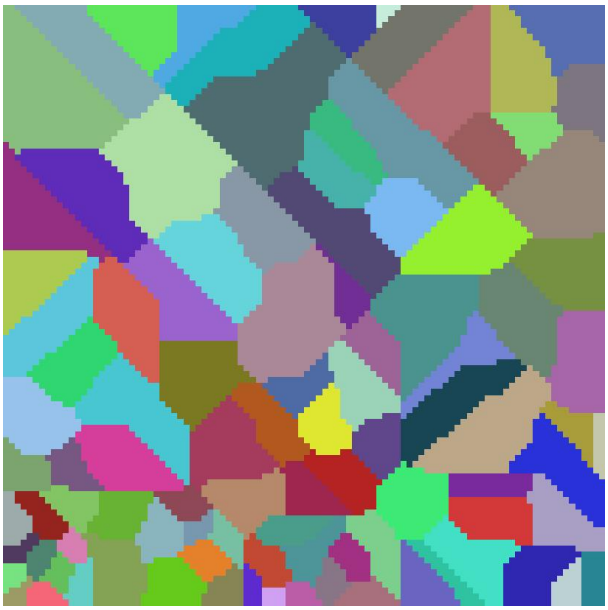

Fig.18. Second phase with 10 grains in each area simulation results

Grid size: 100 x 100
States count: 100
Boundary: Absorbing
Rule chosen: Grain boundary shape control
Mutation probability: 99
Second phase: Substructural, 10 grains generated in the second phase

2.8. Display boundaries

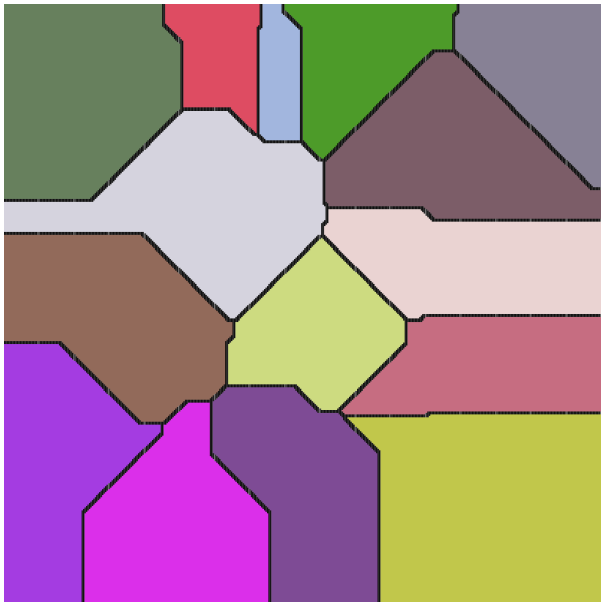

Fig.19. Simulation results with boundaries, size:1

Fig.20. Simulation results with boundaries, size:3

Grid size: 400 x 400
Show grid: off
States count: 15
Boundary: Absorbing
Rule chosen: Nearest Moore
Borders: on
Borders size: 1 -> 3

2.9. Clear all grains, display only boundaries

Fig.21. Simulation results with boundaries

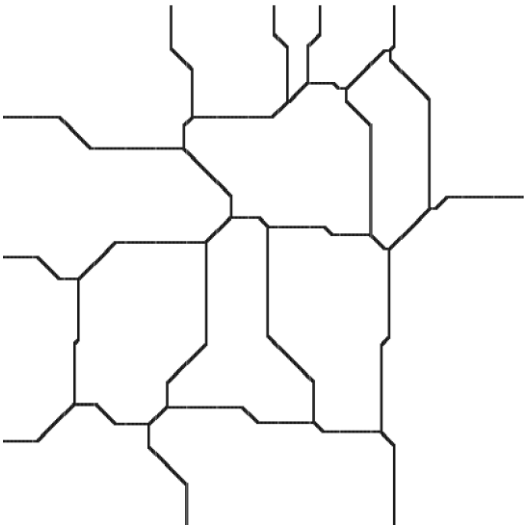

Fig.21. Simulation results, only borders are displayed

Grid size: 400 x 400
States count: 15
Boundary: Absorbing
Rule chosen: Nearest Moore
Borders: on
Borders size: 1

2.10. Display only one area boundaries

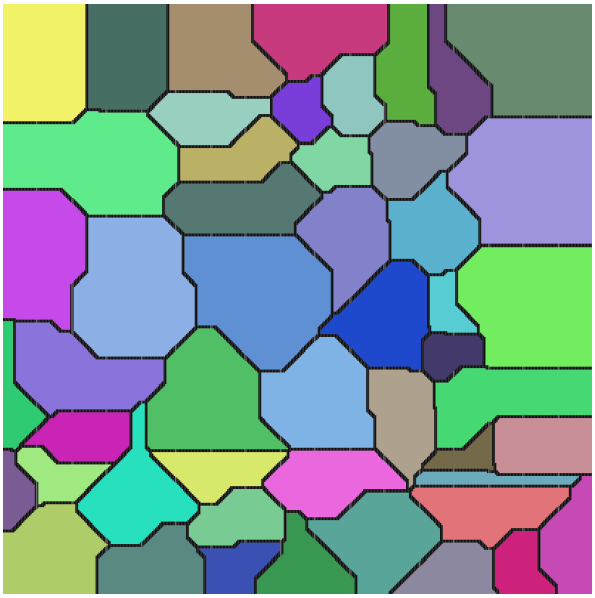

Fig.22. Simulation results, all areas are displayed

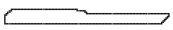

Fig.23. Simulation results, only one area border is displayed

Grid size: 400 x 400
States count: 50
Boundary: Absorbing
Rule chosen: Nearest Moore
Borders: on
Borders size: 2