AKADEMIA GÓRNICZO-HUTNICZA
IM. STANISŁAWA STASZICA W KRAKOWIE

Wydział Inżynierii Metali i Informatyki Przemysłowej

An application that uses cellular automata

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Table of Contents

1. PURPOSE OF THE CLASS

During the six Multiscale Modelling classes we had to create an application that was supposed to have the following functions implemented:

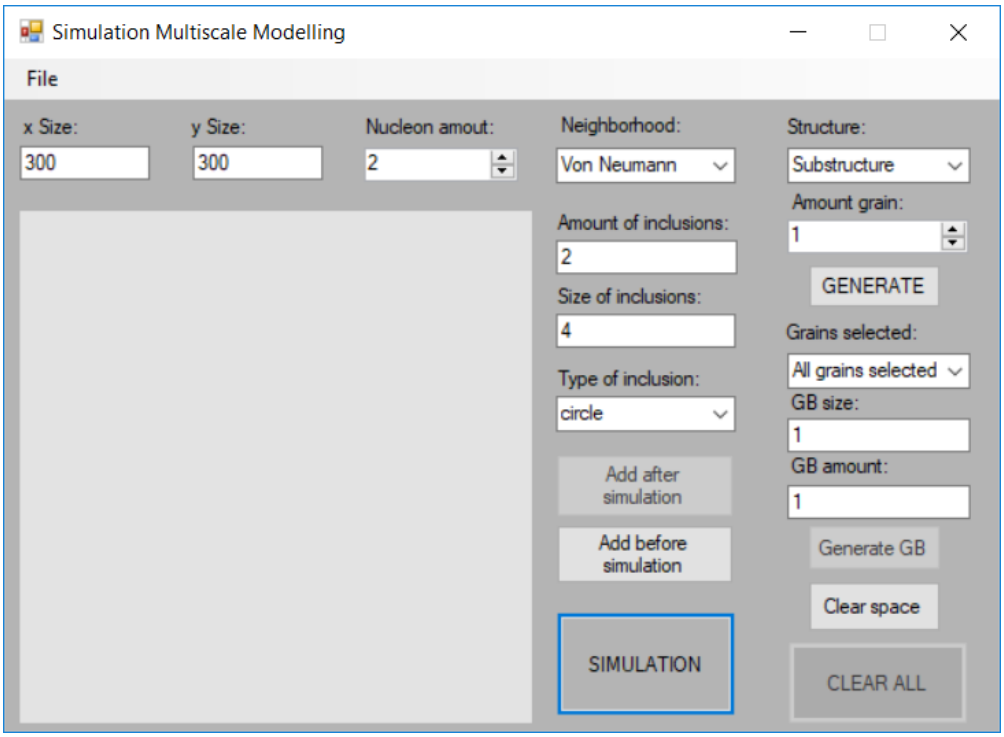
- Simple grain growth CA – Von Neumann and Moore types of neighborhood
- GUI of application
- Microstructures export/import to files .txt/ bitmap
- Microstructures export/import from files .txt/bitmap
- Modification of cellular automata grain growth algorithm which contain inclusions at the beginning, or at the end of the simulation. Two types of inclusions: square or circular
- Different microstructure type: substructure and dualphase
- Grain boundaries selection

Application Requirements:

- Simple grain growth CA (minimum requirements: 300×300, 1 Neighbourhood, 1 boundary conditions, GUI)
- Microstructure import/export: txt/bmp
- Inclusion: Types: square (with diameter d <1:100>), circular (with radius r <1:100>) Time of creation: beginning of simulation, or after simulation (on grain boundaries)
- Control of grain boundary shape: extension of Moore neighbourhood
- Different microstructure type: substructure and dualphase (CA -> CA)
- Grain boundaries selection (GB size, selection of grains)

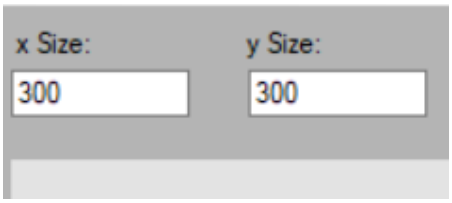
2. GRAPHICAL USER INTERFACE

The application was written in a C ++ programming language. It contains the necessary modules which were required. The main program window show below in the screenshot.

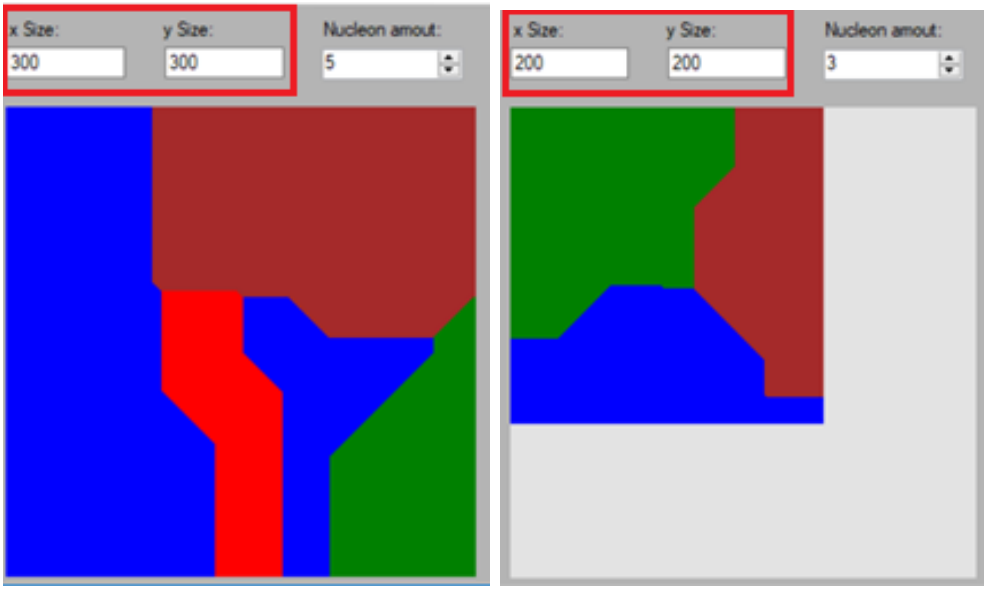


The program includes the following options:

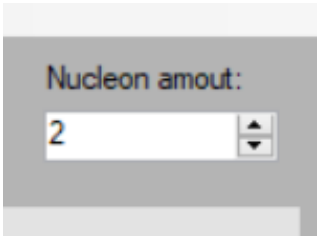
- Ability to change the size of the simulation window



Result:



- **Selection of the number of nucleons**



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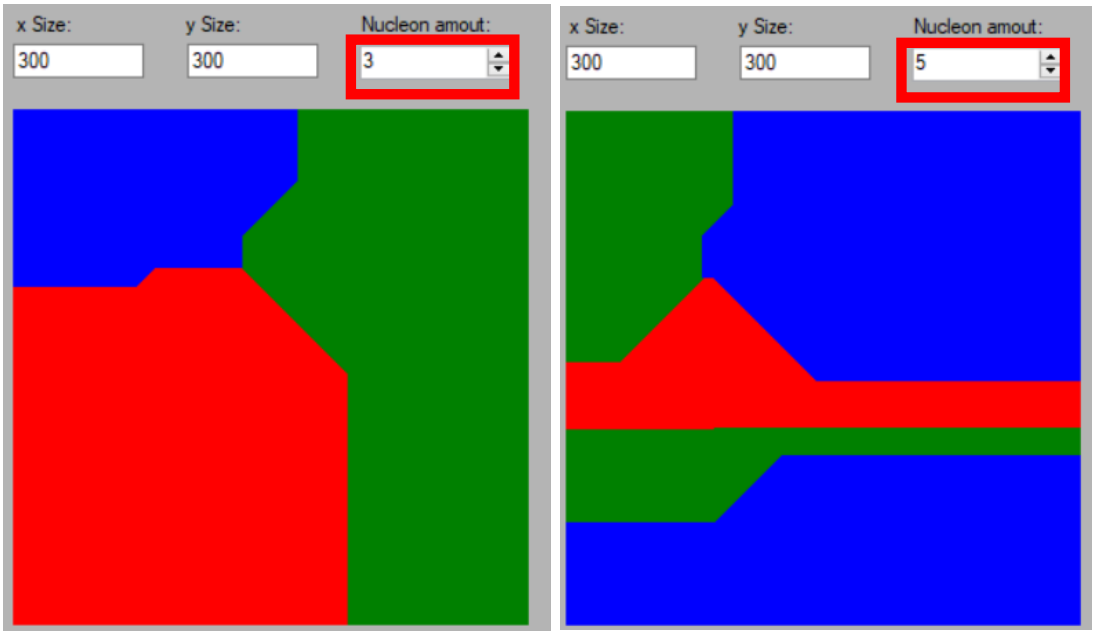
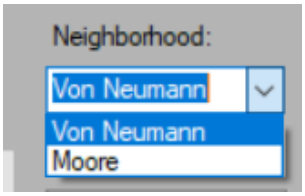


- **Choice the type of neighborhood**



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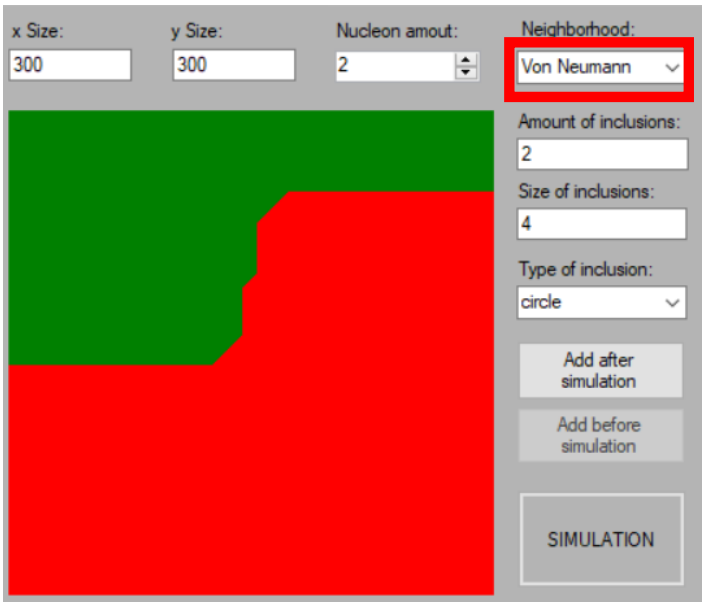
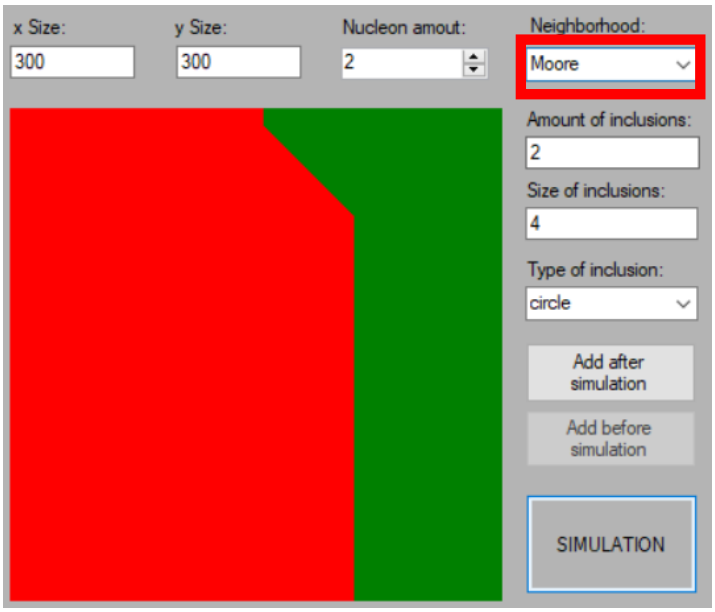
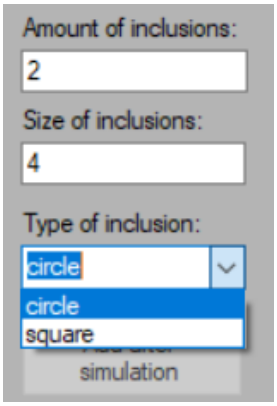




- **Possibility to decide about the number of inclusions, their size and shape**



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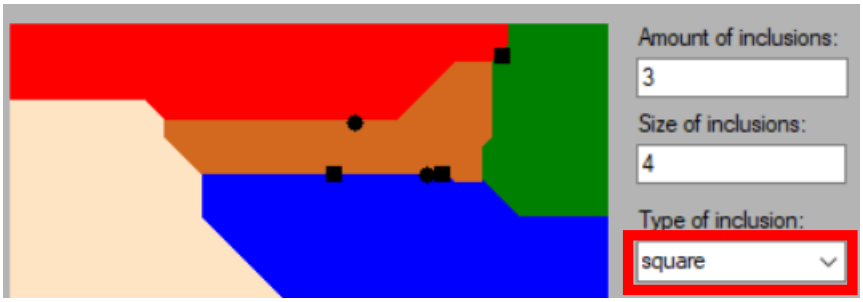
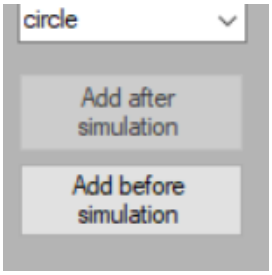


- **Buttons for changing the time of adding inclusions – after/before simulation**



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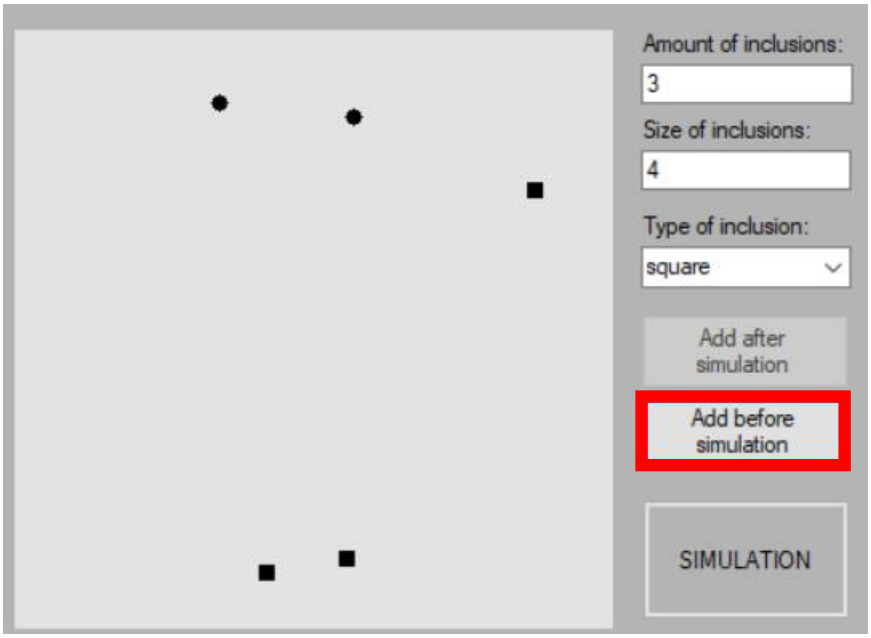
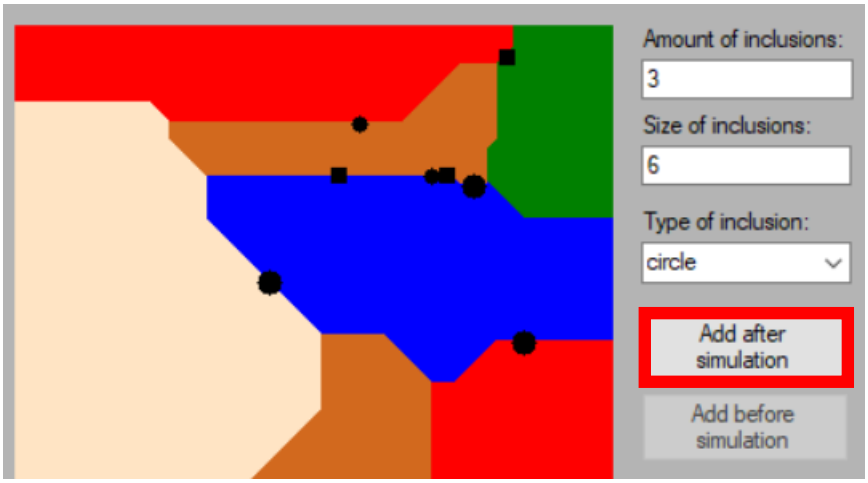
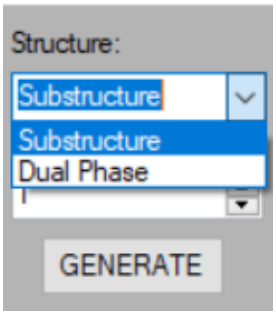




- **Selection of the type of structure**



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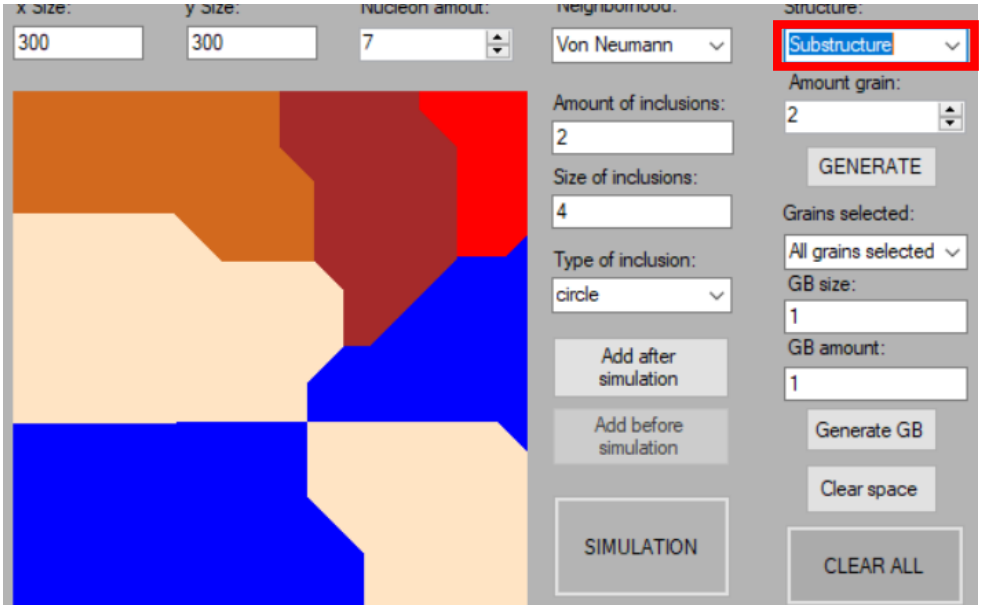
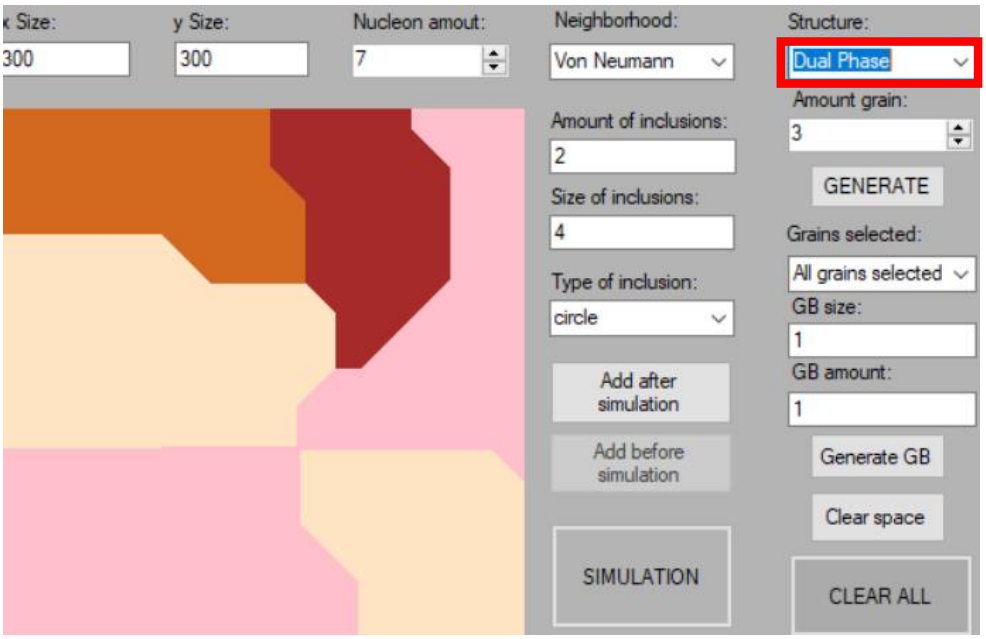
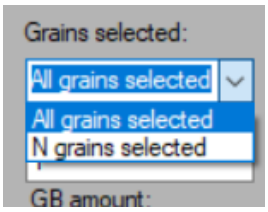




- **Grain boundaries selection – all/ n grains**



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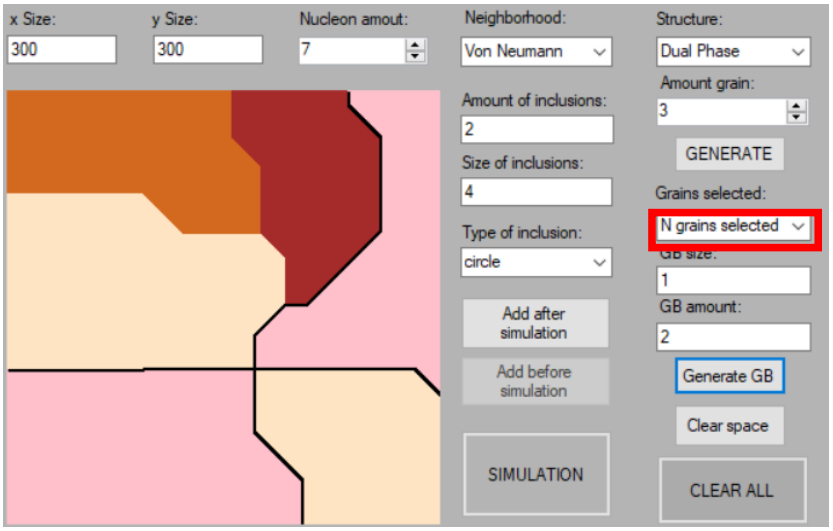
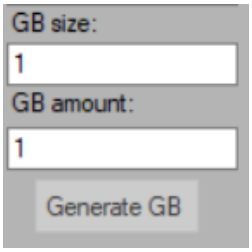


- **GB size and amount**



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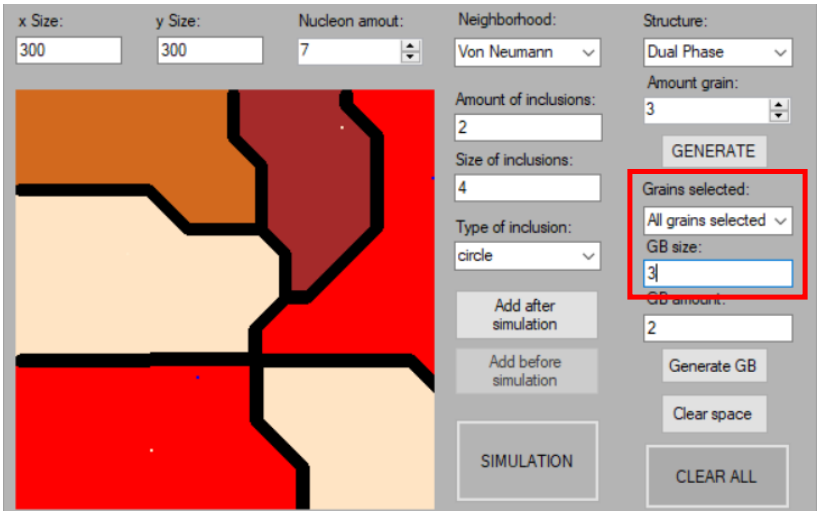
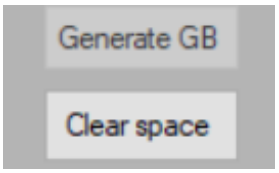


- **Clearing simulation space without grain boundaries**



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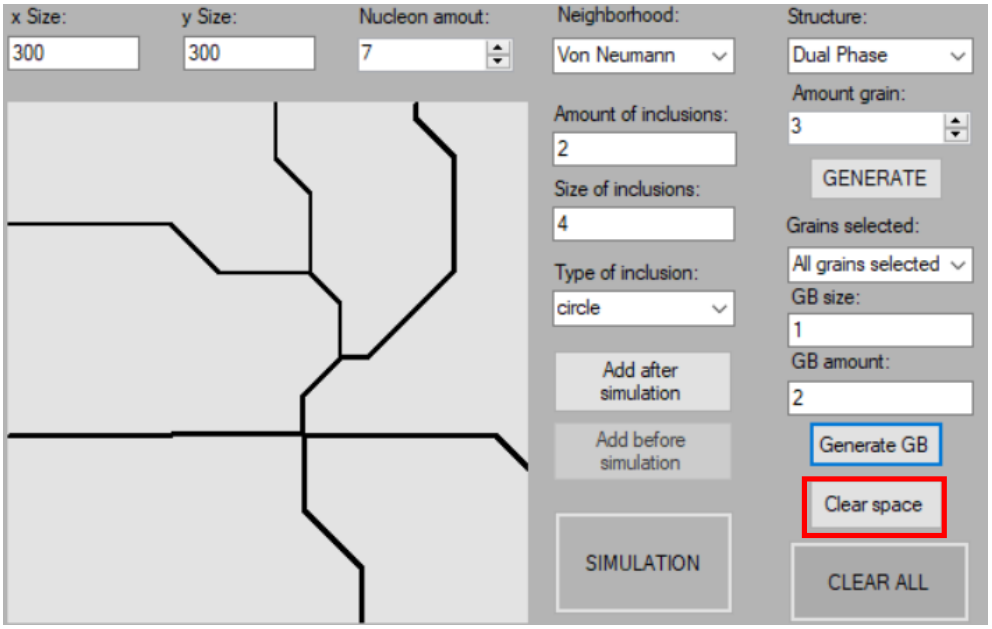
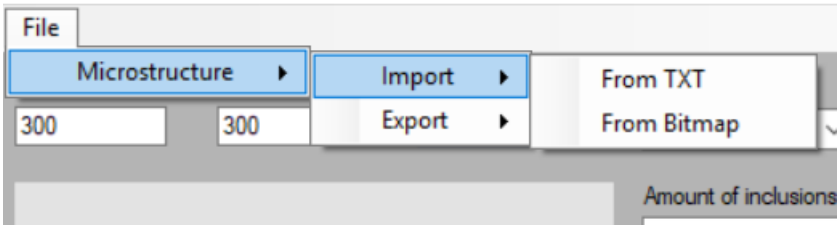
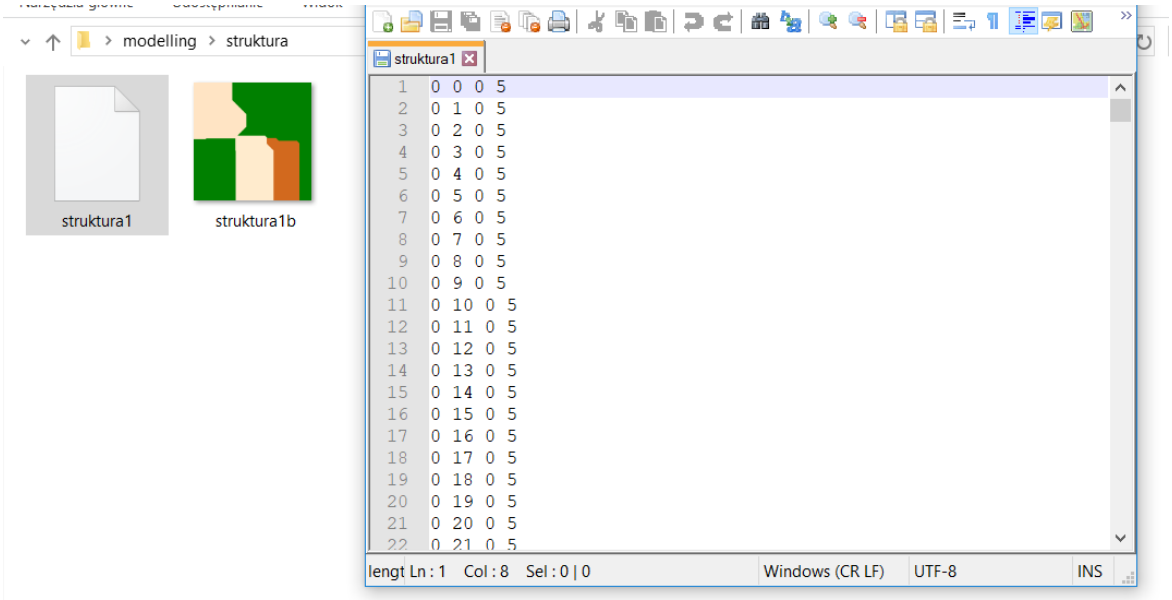


- **Import/export file .txt or bitmap**



Result:



3. PROGRAM CODE

The program code has been added in the attachment (second pdf file), and VisualStudio files.

4. CONCLUSIONS

Cellular automata are a tool use, among others for modeling dynamic systems. They are an example of how simple principles and local influences can lead to very diverse and complex behaviors.

Real microstructure of duplex steel *Simulation in the program*

The wrote program gives many possibilities. It allows for easy simulation of the microstructure and the grain growth process. Neighborhood can be defined in different ways. The program uses two types of neighborhood - Neumann and Moore. Cellular automata are a very good tool for simulating physical processes. The program that was written, can’t assess exactly how the real structure will behave. The generated microstructure is significantly different from the real one observed under the microscope.