First report

Marek Marzec

Multiscale Modeling

In this project I decided to use C# mainly because of ease of creating almost anything in this language. It can be quickly applied to develop Windows desktop applications and games. Also Winforms made it infinitely faster to develop transparent GUI within minutes.

User interface :

User interface consists of few buttons and inputs that are used to control process of grain growth simulation. Window of application have two parts. On left hand side we have simulation board where visualisation of modelled process is performed. On right hand side is simulation control panel where all meaningful parameters of simulations are placed.

Most of those inputs are already named in such way it is very self-explanatory but I will go out of my way to describe it in best manner I can imagine.

Selecting button Grain growth right away is going to start simulation with default parameters what are already set in all fields.

Button reset is as name suggests is used for start simulation over again.

Next up is Neighbourhood type that has two options, either it is von Neumann or Moore. This changes the way that grain growth behaves.

Number of grains is influencing amount of initial grains. This number have to be in range between 1 and 100.

Number of inclusions decides whether there should be any more grains that already are.

This number have to be in range between 1 and 100.

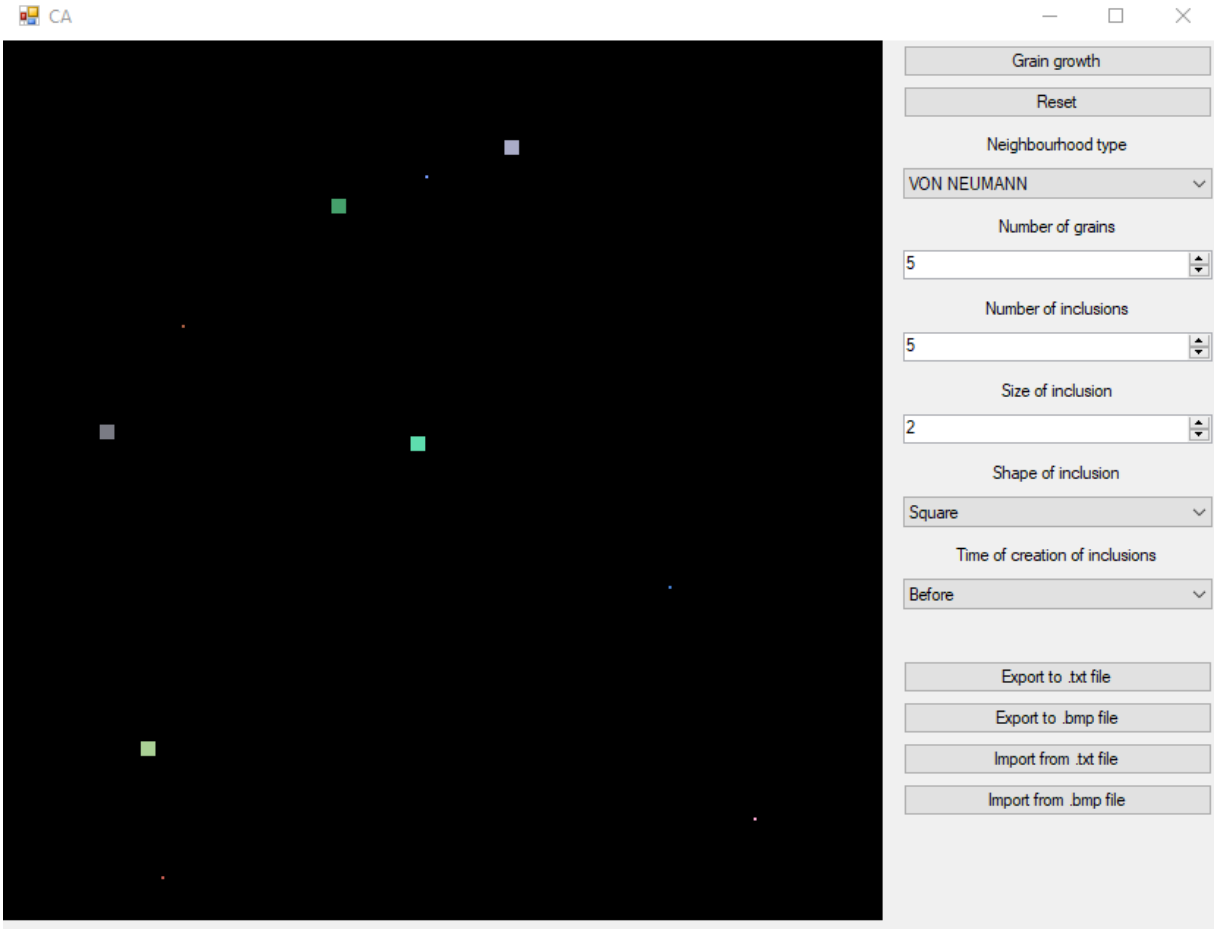
Input called size of inclusion changes how many pixels make each inclusion is made of. This number have to be in range between 1 and 100.

Shape of inclusion governs the way the inclusion is shaped. It is either circle or square.

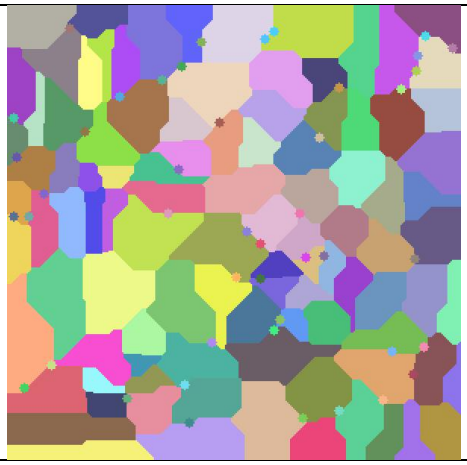
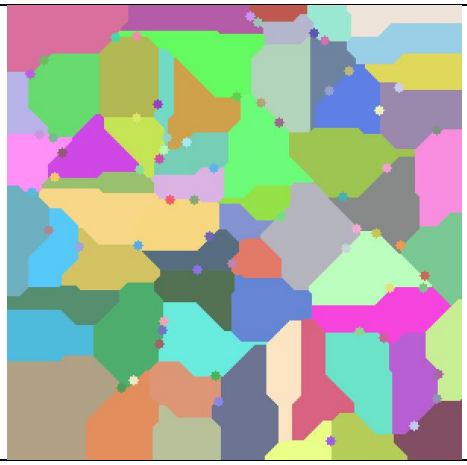
Last input is changing whether inclusions are added to simulation space before or after grain growth.

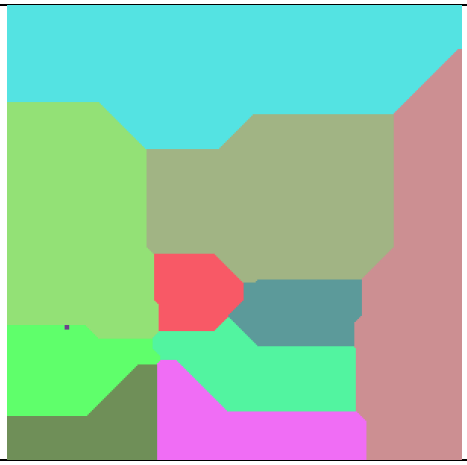
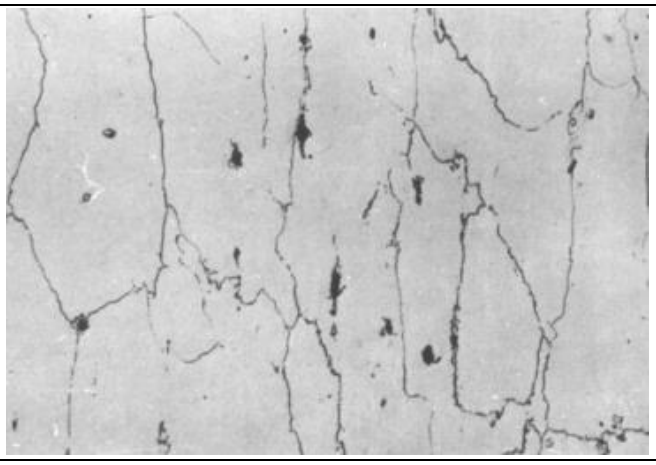
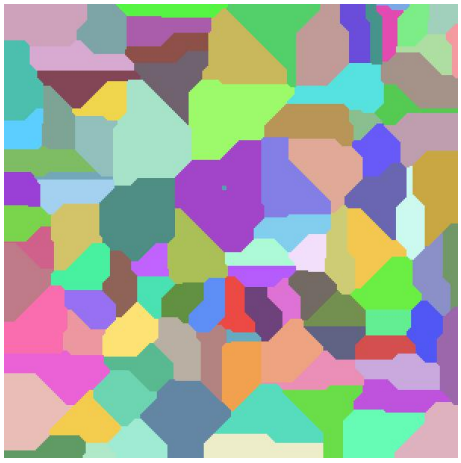
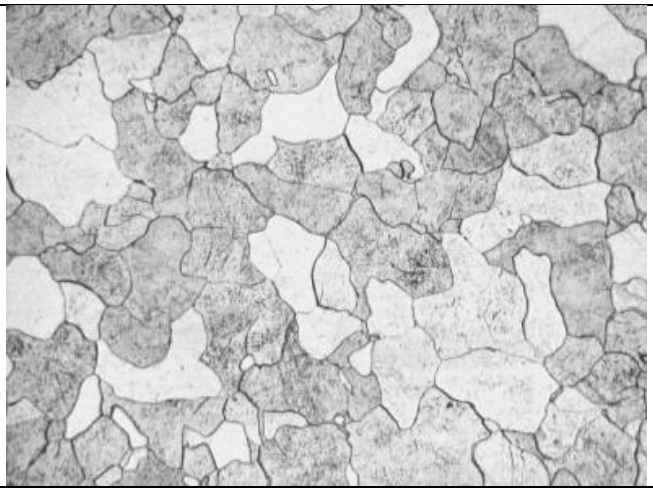
Four buttons on the bottom are dedicated to export/import actions. This makes it possible to export simulation space to .txt or .bmp files in any desired location with any name and also import it in the same manner.

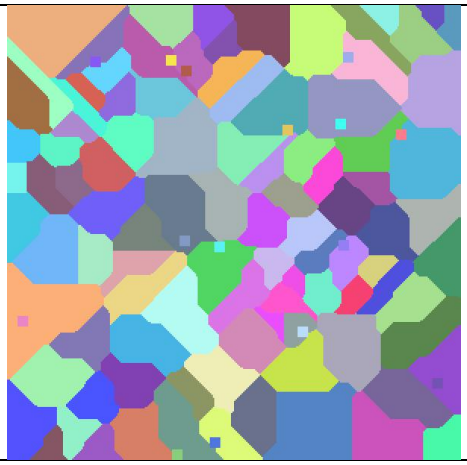
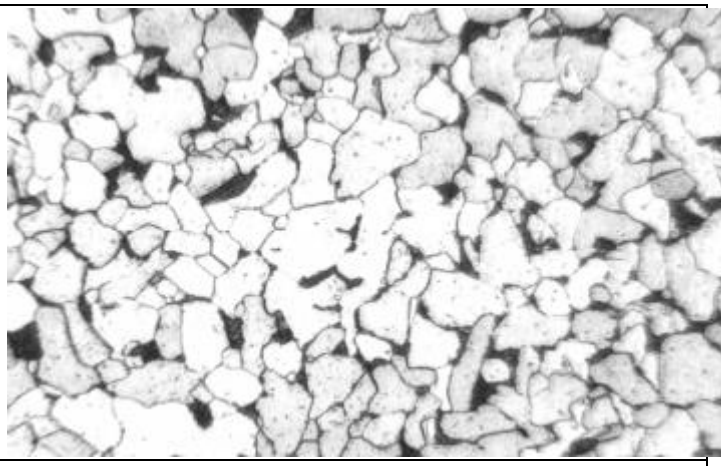
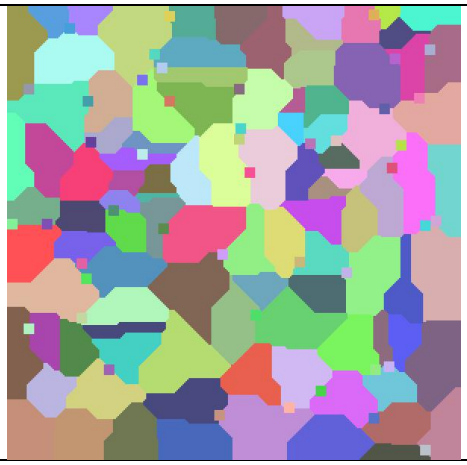
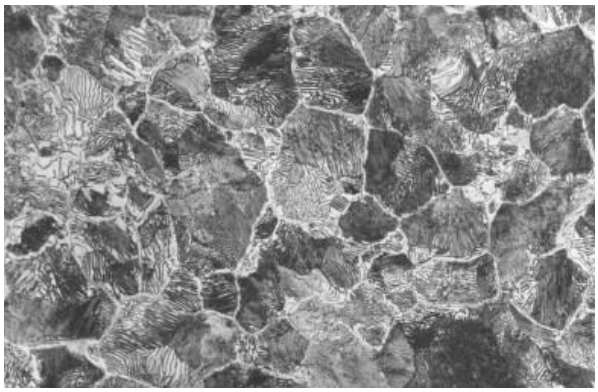
Exemplary start up screen of project application.



Examples of generated stuctures and comparison between real ones and generated.

	
After the simulation Number of circular inclusions : 45 Numer of grains : 100 Von neumann	After the simulation Number of circular inclusions : 60 Numer of grains : 60 Von neumann

	
Before the simulation Number of inclusions : 1 Numer of grains : 30 Moore	After the simulation Number of inclusions : 1 Numer of grains : 10 Moore
	
Before the simulation Number of inclusions : 1 Numer of grains : 30 Moore	Microstructure of technical iron Armco (C = 0.03%). Visible ferrite with elongated grains, due to plastic forming cold. On the background of ferrite visible dark secretions non-metallic inclusions.
	
Before the simulation Number of inclusions : 1 Numer of grains : 100 Moore	Electrolytic iron microstructure (C = 0.02%) in stock annealed.

	
Before the simulation Number of inclusions : 15 Numer of grains : 30 Moore	Microstructure of structural steel grade S235J2 with content C = 0.13%, after annealing normalizing. Visible clear ferrite grains and dark grains pearlite.
	
After the simulation Number of inclusions : 45 Size of inclusions : 3 Numer of grains : 100 Moore	Microstructure of non-depectoid steel (C = 1.3%) in the annealed state. Perlite with a bright mesh secondary cementite on grains.

In all of examples above we can see many similarities but also many significant or not differences between generated structures and real life ones. Random way of generation grain initialization is main way why structure of steel won't be always looking naturally. Generation of inclusions in material in general reflects in good way how material form in real life situations. Created substructures share some common similarities with real ones. Algorithm required further development to include more mechanism that assimilate generated structures to that which are found metallographic examinations.