Merging of vortex patches

Abstract

Merging of vortices with extent is being studied as a part of this assignment. Here, we use discrete vortex method to simulate the merging of two vortex patches. Each vortex patch is approximated by a uniform distribution of vortex blobs.

Description of computational methodology

The initial distribution of vortices was generated using a c code named *InitialDistribution.c*. This code generates the position data of the vortex blobs such that they will be uniformly distributed in the circular patch. The code makes sure that the number of vortex blobs at a radial location is proportional to the distance from center. This ensures uniform distribution of vortex blobs. If N_r is the number of radial locations at which blobs will be placed, and N is the total number of blobs to be placed, then it will be convenient if $N \propto N_r(N_r+1)$. This will ensure that there is symmetric placement of blobs in the circumferential direction. The number of blobs on the circumference of the circle at a radius r_i is N_θ. This N_θ should be proportional to the radius r_i. The proportionality constant has been chosen apppropriately to finally get N number of blobs.

$$r_i = \frac{i}{N_r} \tag{1}$$

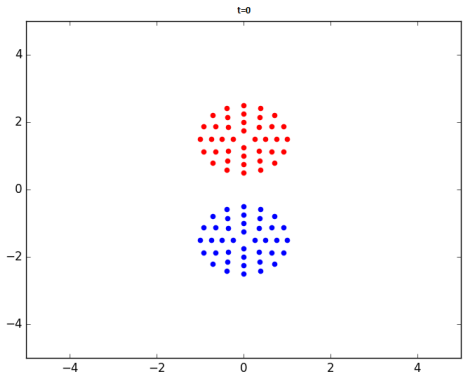
$$N_\theta = \frac{2Ni}{N_r(N_r+1)} \tag{2}$$

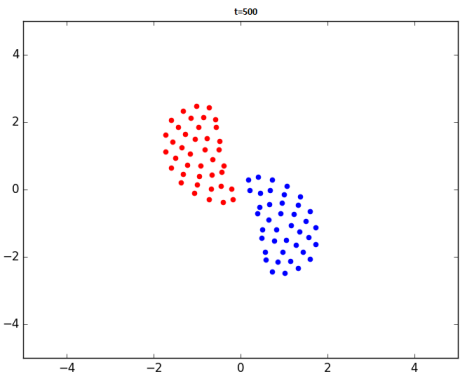
$$\theta_j = \frac{2\pi j}{N_\theta} \tag{3}$$

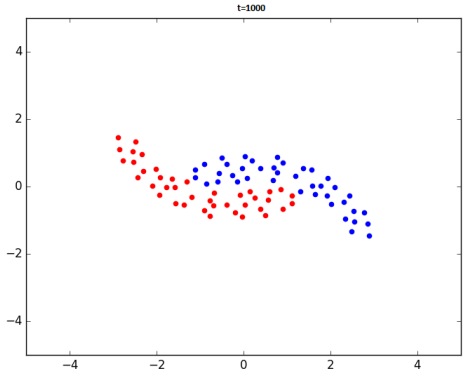
Finally, initial positions will be generated and outputed to a text file in a fashion which is expected by the python code for the simulation of the merging phenomenon. The python code *ME14B027-DiscreteVortexMethod.py* defines a class of vortex blobs and uses euler scheme of integration for computing the time evolution. The class of vortex blobs named *vortexParticle* contains function named *vel* which computes the velocity induced by the vortex blob on any point in space. Using this, we compute the instantaneous velocity of every vortex blob. Using euler scheme we march in time and simulate the merging of the patches.

Results

The following are the results obtained by simulating vortex patches of radius $R = 1$ which are separated by a distance $L = 3$. The Patches each contain 40 vortex blobs each of strength 10. The vortex blobs are of size 0.1.



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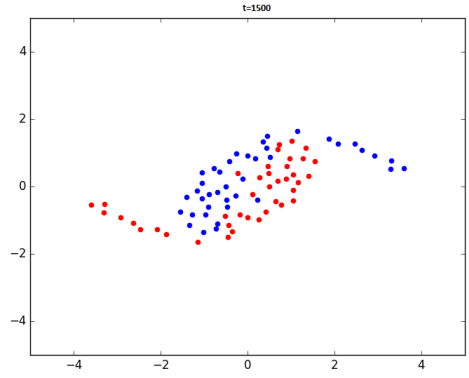
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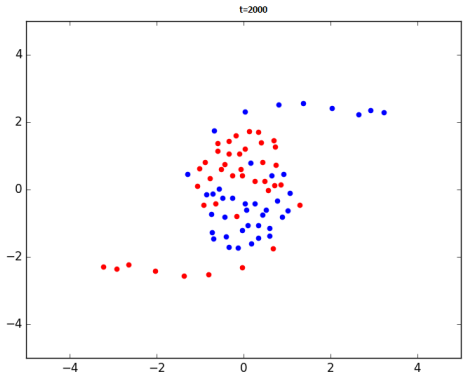
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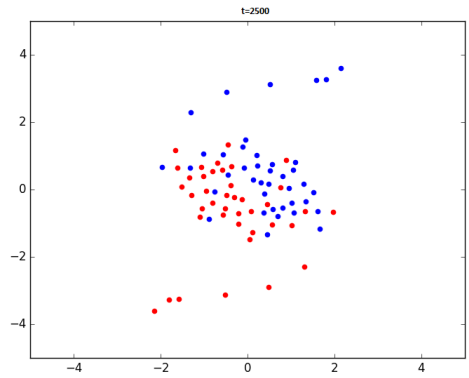
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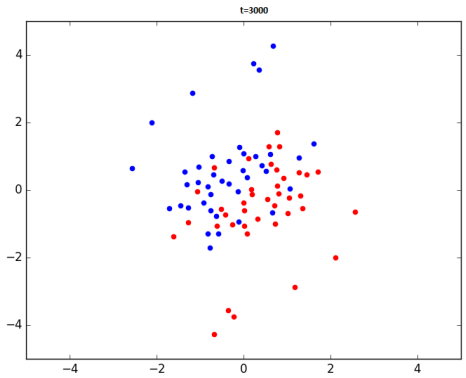
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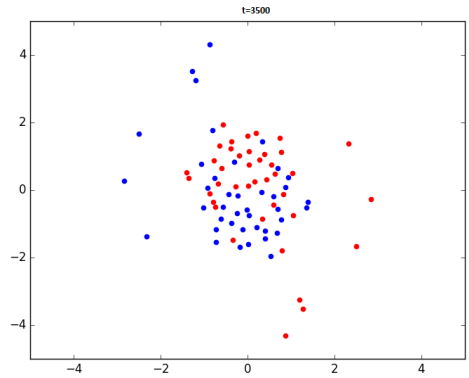
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