3. Semester report

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PhD program: *Statistical Physics, Biological Physics and Physics of Quantum Systems*

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Title: *Computer simulations of neutrophil swarming and phagocytosis at various stages of inflammatory events*

1. Introduction

Our research aims at modelling and simulating two different biological processes: neutrophil swarming and phagocytosis.

With regard to the neutrophil swarming, during the last semester, using an incremental approach, we focused on the model which does not consider the secretion of intracellular inhibitors. We ran simulations for a variety of parameters, trying to find the right parameters.

Regarding the cell shape dynamics during phagocytosis, we have proposed a model to study that dynamics using the Cellular Potts Model [1].

During the current semester, we kept scanning the parameters space in order to observe the different patterns that we may observe during the neutrophils swarming. We also started to analyse some experimental data.

2. Description of research work carried out in current semester

We have focused our research on the neutrophil swarming project.

Beyond the visualisation of the simulations, we have carried out some quantitative analyses that would allow us to objectively compare two or more simulations and the result of experiments.

In addition to the well-known velocity autocorrelation function, we defined the “directionality” for a given cell as its ability to keep a directional movement towards the wound.

Figure 1 is a sample depiction of the velocity autocorrelation and the directionality that we derived from the model.

Figure 2 depicts the pairwise velocity correlation function from one experiment. The size of the green dots represents the number of particles included in the average. These plots enable us understand how the velocities of each single pair of cells are correlated, depending on their distance.

Figure 3 shows how each single pair of cells are correlated, considering a given delay.

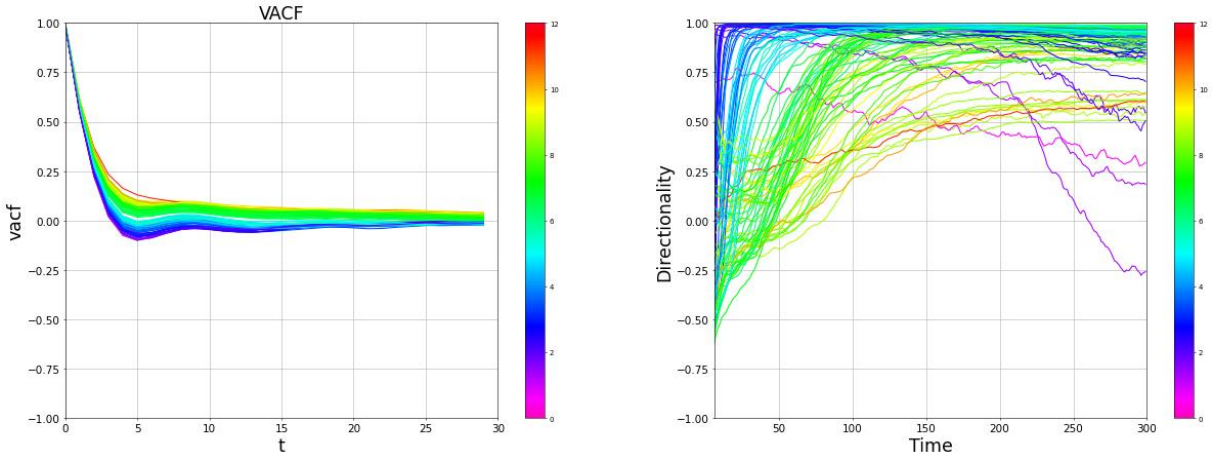

Figure 1: Velocity autocorrelation and Directionality (Chemotaxis active, Cell death inactive). The colour code represents the distance of the cell to the wound at the beginning of the simulation

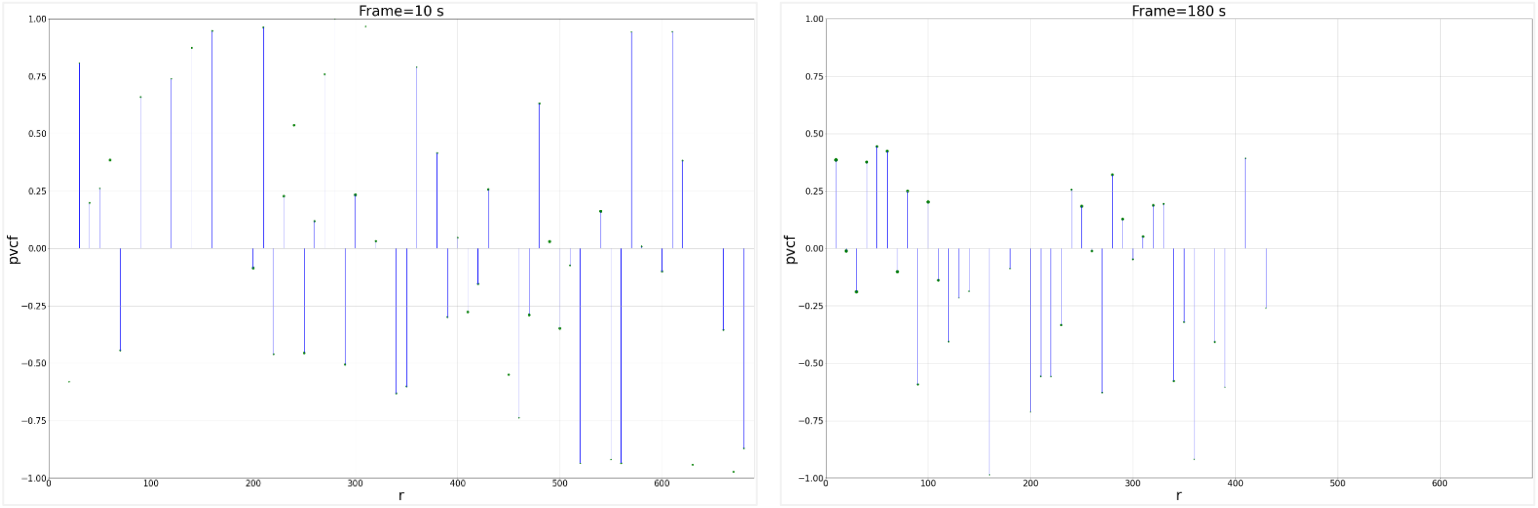

Figure 2: Pairwise velocity correlation at two differents points in time.

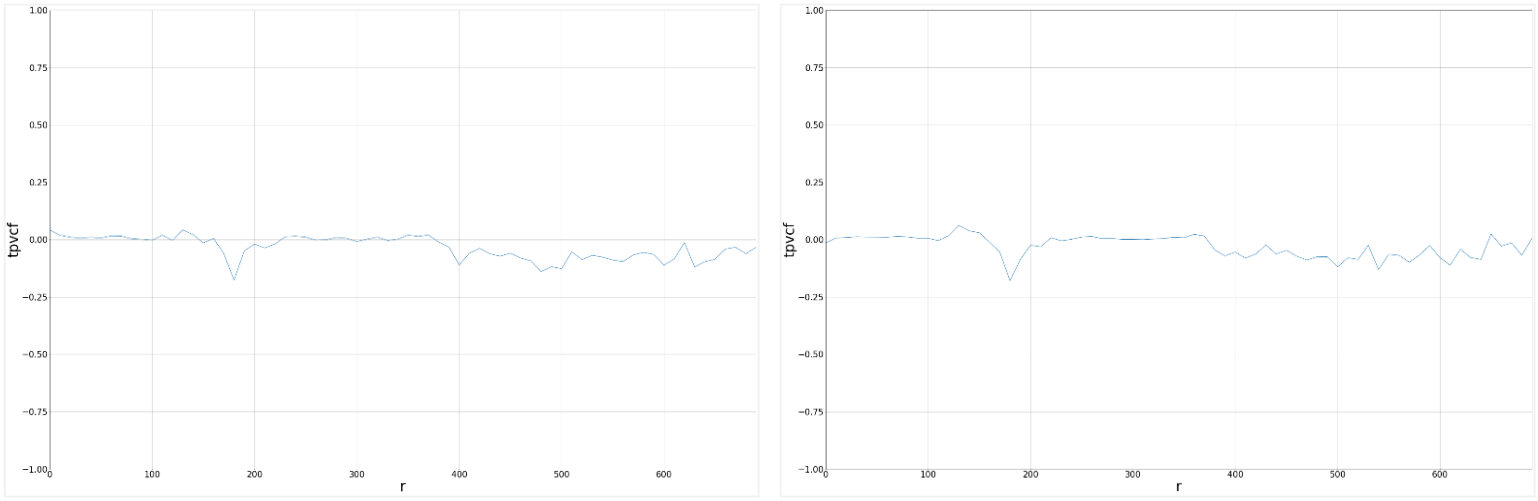

Figure 3: Time lagged pairwise velocity correlation. (Left) Delay = 1 frame. (Right) Delay = 6 frames.

3. Studies in current semester

During this semester, I enrolled to four courses: *Biophysics II* (biophys2f20ex) from the department of Physics, *Bioinformatics* (bioinfub22em and bioinfub17gm) from the department of Genetics, *Data Mining and Machine Learning* (FIZ/3/084) from the Doctoral School of Physics, and *Modelling in Neurobiology* (BIO/07/16) from the Doctoral School of Biology.

References

1. J. A. Glazier, F. Graner. Simulation of the differential adhesion driven rearrangement of biological cells. Physical Review E, 47(3), 2128-2154 (1993)