

Report of FFR120 HM2: Chapter 5-8

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2024-11-17

1 Exercise 1 Brownian Dynamic

1.1 Q1

x different stiffnesses 0.01884955592153876

y different stiffnesses 0.0020943951023931952

set $dt = 0.00010471975511965977$

1.2 P1

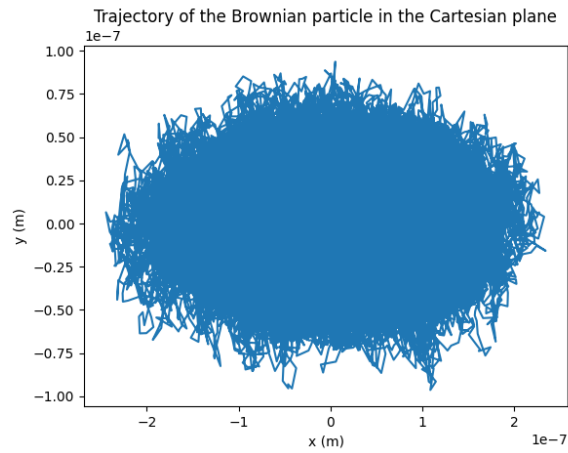


Figure 1: Trajectory

1.3 P2

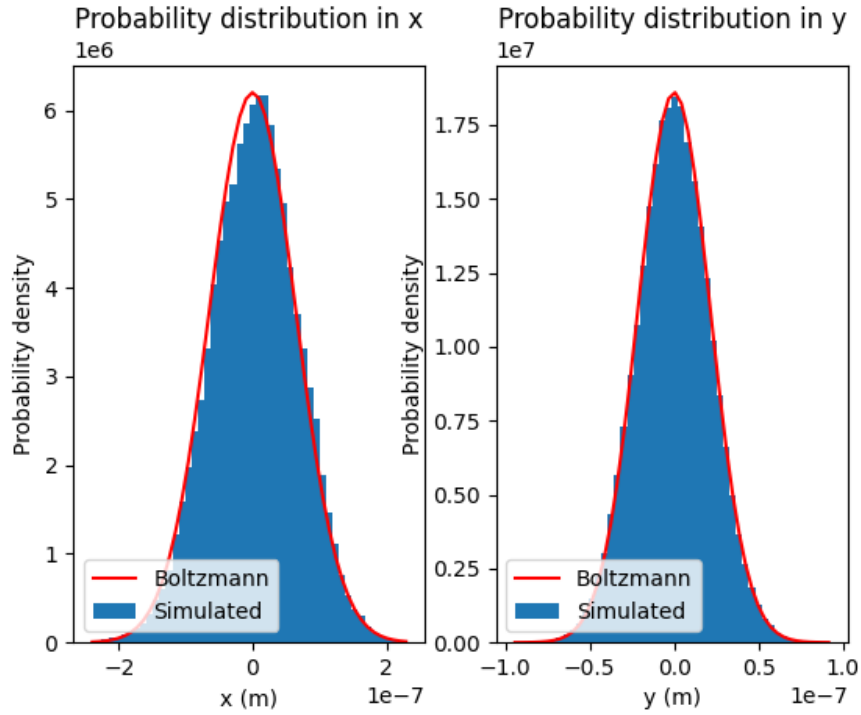


Figure 2: Probability distribution

1.4 Q2

In this experiment, $(\sigma_x)^2 = 4.196631458265196e - 15$, $(\sigma_y)^2 = 4.607489519704521e - 16$, x variance is larger.

Theoretical variance in a harmonic trap, $(\sigma_x)^2 = 4.1399999999999994e-15$, $(\sigma_y)^2 = 4.599999999999999e-16$.

Overall, the experimental values are close to the theoretical values for both x and y variances, indicating that the experiment is in good agreement with the theoretical model for a harmonic trap.

1.5 P3 - P4

As time increases, the position autocorrelation of the particle decreases, indicating that the particle has forgotten its initial position.

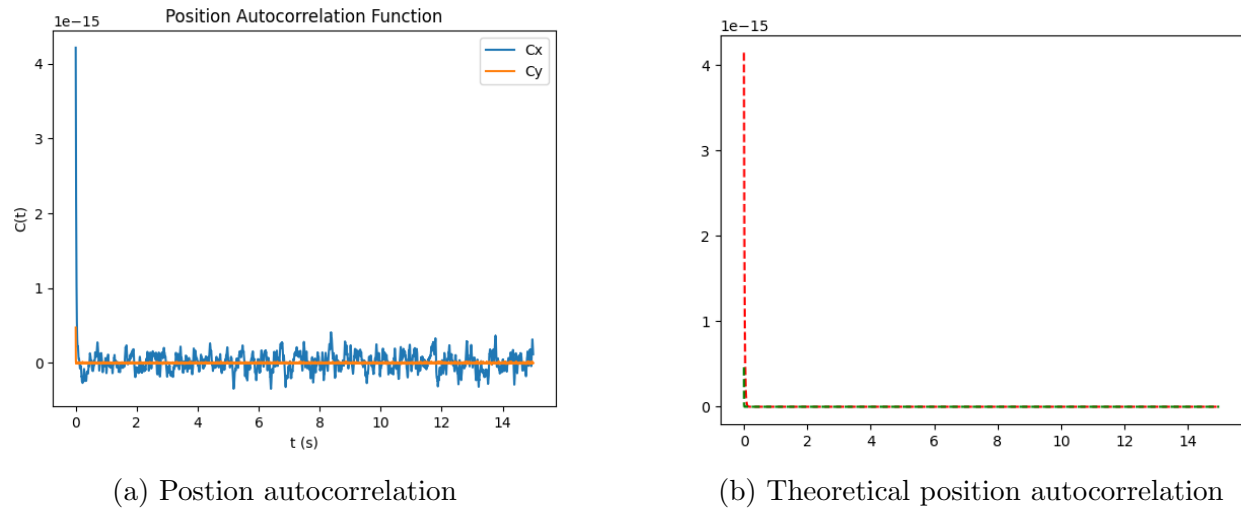


Figure 3: Position autocorrelation

2 Exercise 2 Anomalous DiffusionI

2.1 P1

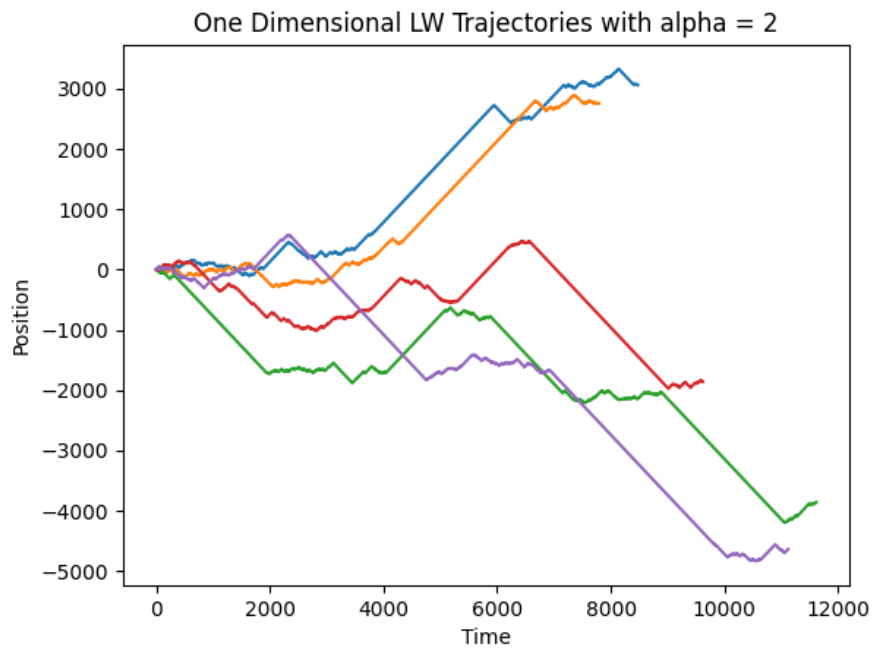


Figure 4: One Dimentional LW Trajectories

2.2 P2

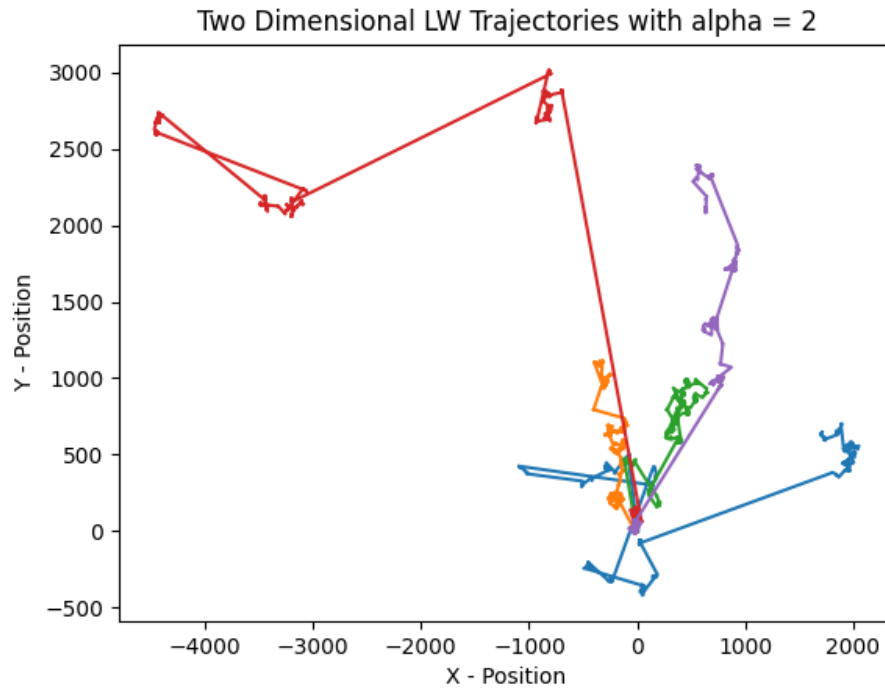


Figure 5: Two Dimensional LW Trajectories

2.3 P3 - P4

A larger value ($\alpha > 1$) may cause the diffusion to deviate more from normal diffusion (Brownian motion) and exhibit superdiffusion characteristics. Specifically, MSD may grow at a faster rate than ($\alpha \leq 1$), and the relationship with time may show a higher power relationship

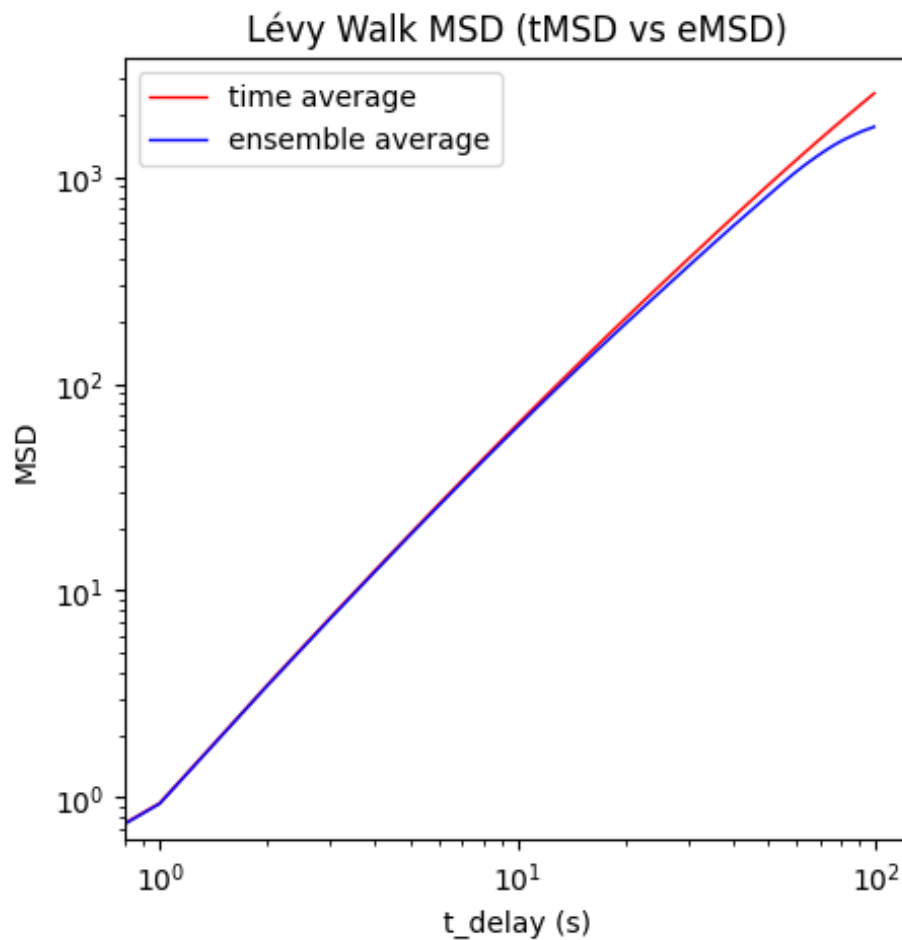
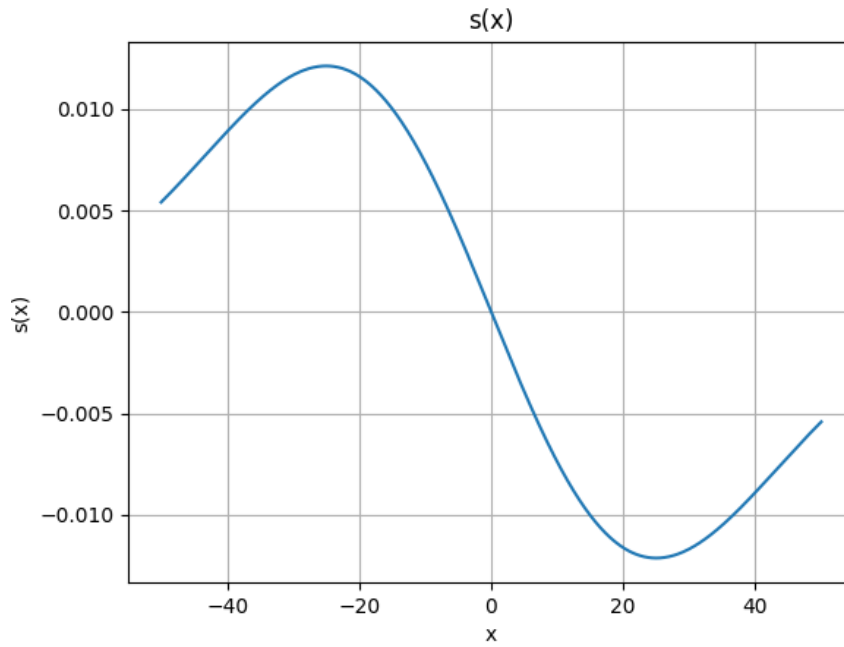


Figure 6: Mean Square Displacement for 1D LW ($\alpha = 2$)

3 Exercise 3 Multiplicative Noise

3.1 P1

Figure 7: $s(x)$

3.2 P2 P3 P4

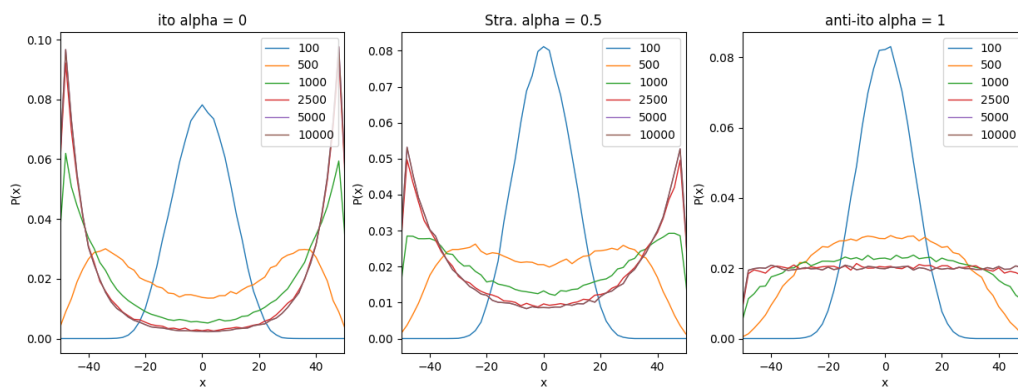


Figure 8: Final position distribution with ito, Stratonovich, anti-ito convention

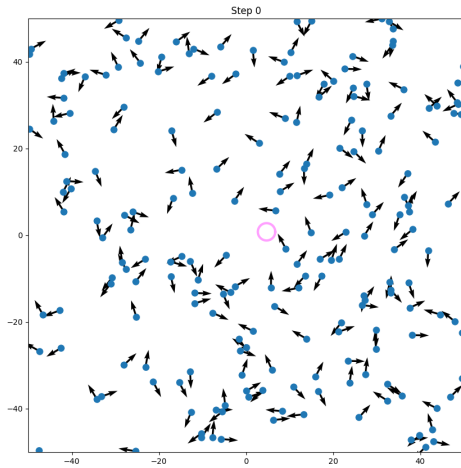
3.3 Q1

The three distribution of the final points symmetrical, because the $\sigma(x)$ noise formula is symmetrical.

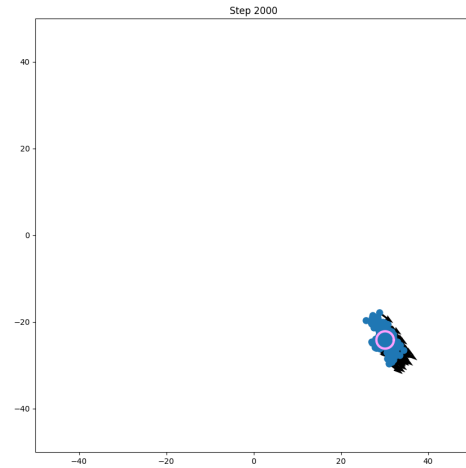
4 Exercise 4 The Vicsek Model

4.1 Task 1 P1

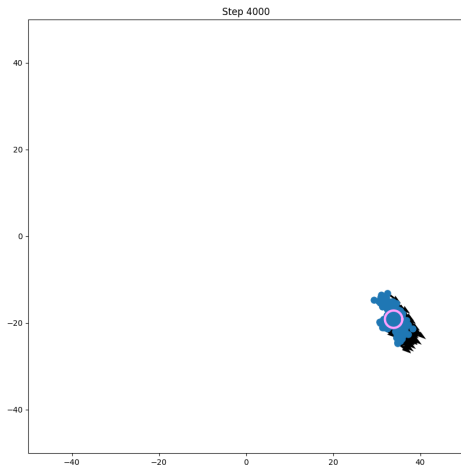
From the Figure below, one can observation that the particles will become more clustering and share the same orientation with each other.



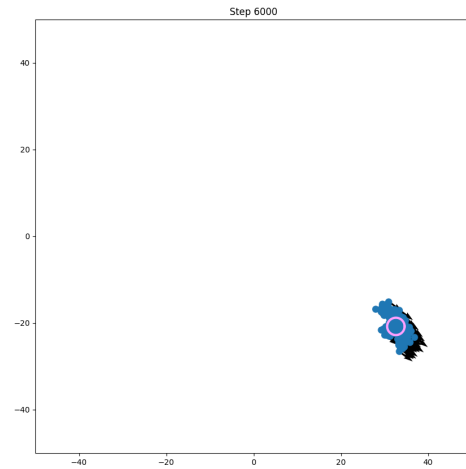
(a) a) time step = 0



(b) b) time step = 2000



(c) c) time step = 4000



(d) d) time step = 6000

Figure 9: Particles status

4.2 Task 1 P2

The global coefficient of alignment is close to 1.0 over 6000 time steps, as global coefficient of clustering is close to 0.0.

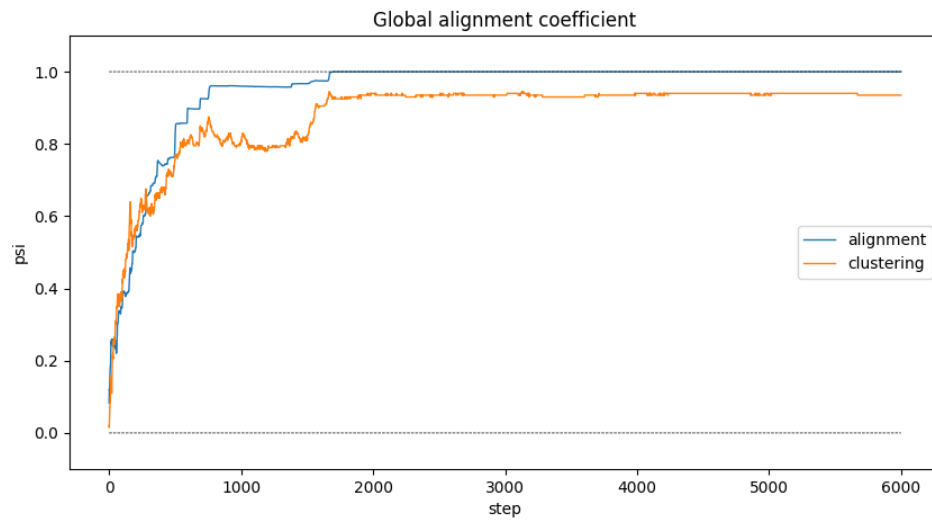
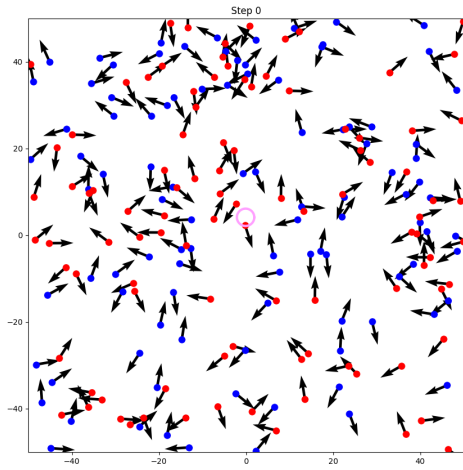


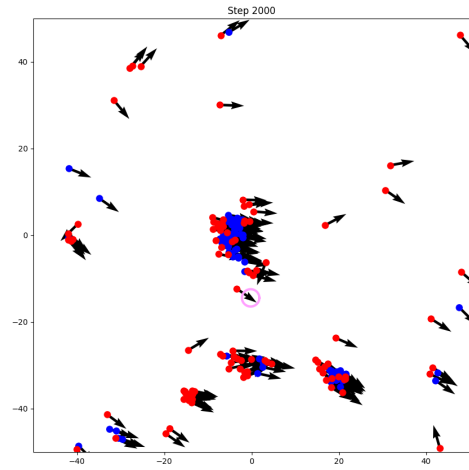
Figure 10: Enter Caption

4.3 Task 2 P3

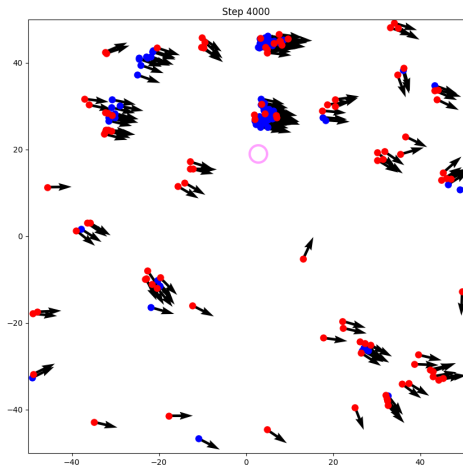
The Vicsek model with 2 subpopulation of particles.



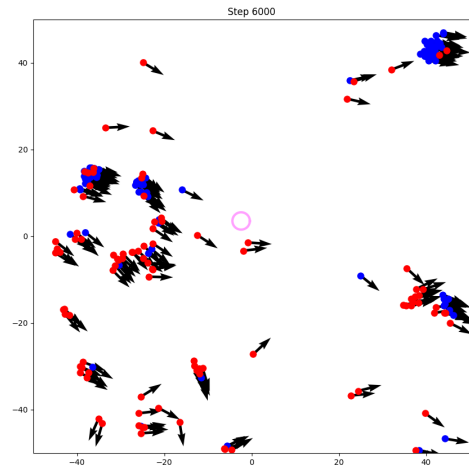
(a) a) time step = 0



(b) b) time step = 2000



(c) c) time step = 4000



(d) d) time step = 6000

Figure 11: Particles status

4.4 Task 2 P4

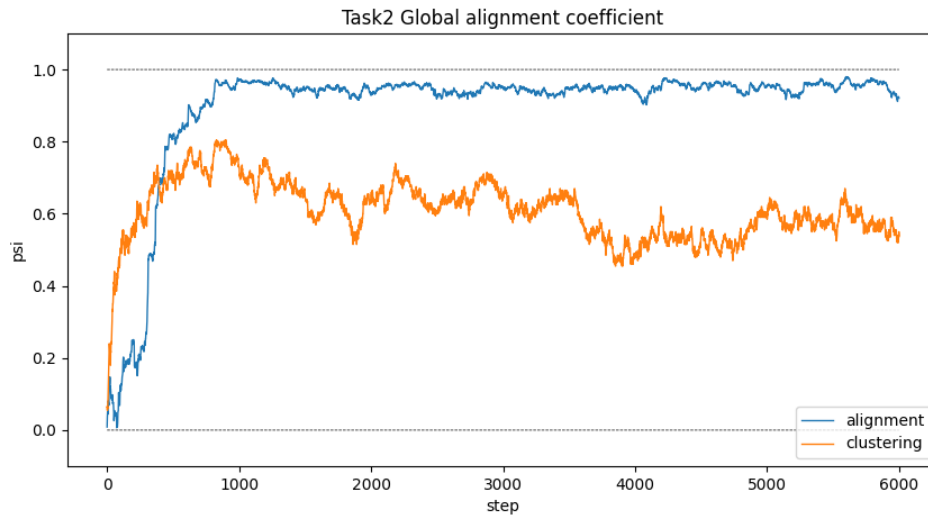


Figure 12: Enter Caption

4.5 Task 2 Q1

Comparing Figures P1 and P4, one can conclude that having a population with two distinct traits will result in a lower upper limit for the global clustering coefficient and increased fluctuations. Similarly, it will also lead to greater fluctuations in the global alignment coefficient. This indicates that the two groups of particles cannot achieve the same level of clustering as a single group within the same time frame, and their distribution within the region will remain relatively scattered.