Homework 6: Cream in your Coffee Diffusion Part 1

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Introduction

We are simulating cream in coffee. Each point in the output of the simulation represents a particle of cream.

Method

This is a stochastic simulation. We base the displacement of the particles per iteration of time on a random number chosen between 0 and 1. The particles are restricted to integer steps in either the x, y, -x, or -y directions. They can exist in the same place, but are bounded by the 200×200 grid (the 'mug').

Verification of program

The diffusion takes place as expected. This can be seen in **Figures 1-4**.

Data

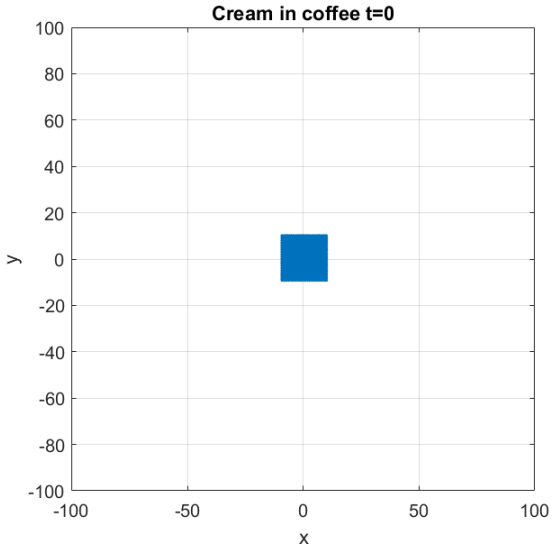

Figure 1: $t = 0$

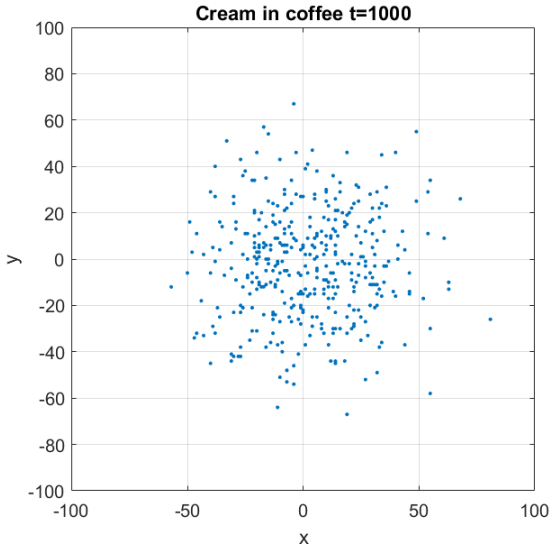

Figure 2: $t = 1000$

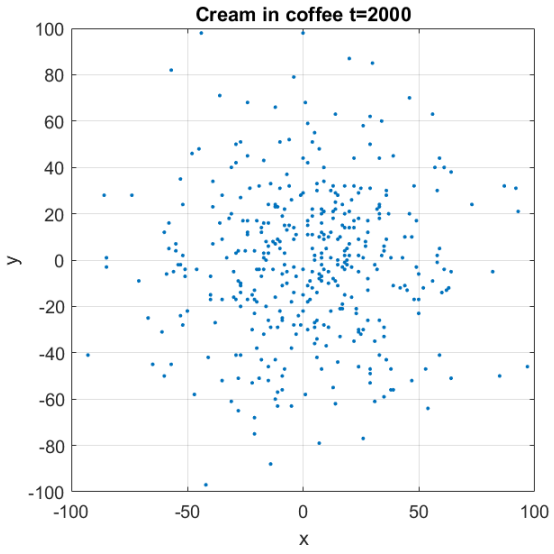

Figure 3: $t = 2000$

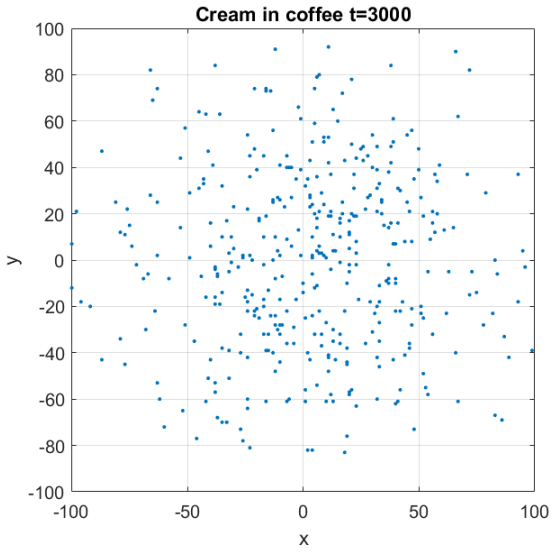

Figure 4: $t = 3000$

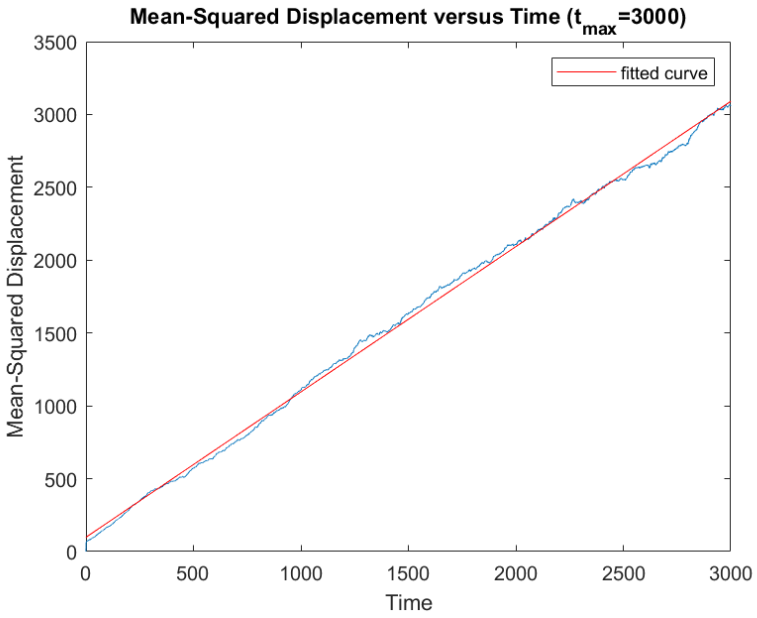

Figure 5: Mean-squared displacement versus time for $t_{max} = 3000$.

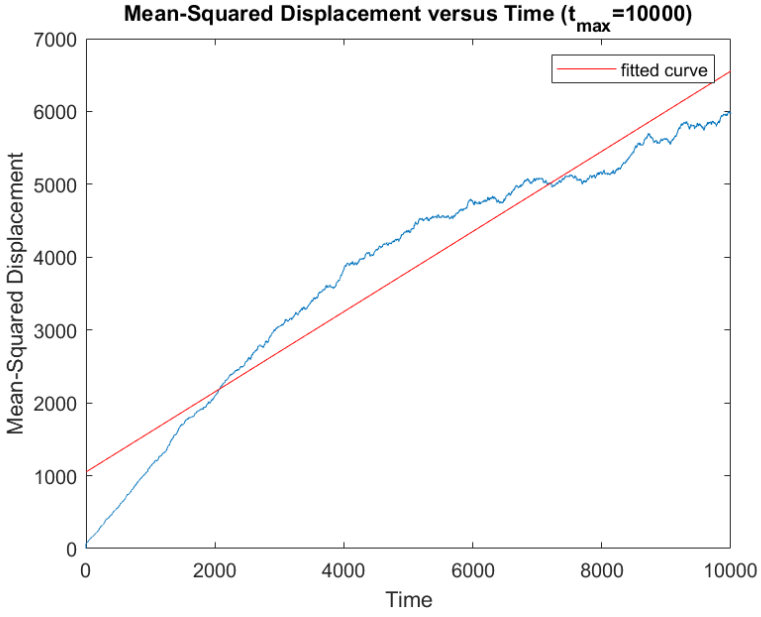

Figure 6: Mean-squared displacement versus time for $t_{max} = 10000$.

Analysis

The boundaries of the 'mug' present an interesting situation observed in **Figures 5-6**. In **Figure 5**, we note that there has been much time for a significant number of collisions with the boundaries of the grid. Hence, the fit for this situation is much more accurate then in **Figure 6**, where there as been much more time for boundary collisions. From this, we note that mean-square displacement (MSD) is approximately linear until particles hit the bounds; afterwards, MSD should level off when plotted against time.

Critique

I find this simulation quite interesting in its demonstration of the power of stochastic simulation.