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The Track of the Chinese balloon.

BACKGROUND

In February, a discussion took place concerning a Chinese balloon that was propelled by heat. The Chinese authorities contended that the aircraft was a civil aircraft that had unintentionally drifted towards the United States, while the United States authorities maintained that it was intended for detection purposes. The aim of our investigation is to ascertain whether the aircraft could have drifted to the United States without an external power source. If this can be substantiated, it would demonstrate that the incident was indeed an accident and there is no justifiable reason to be alarmed.

OBJECTIVE/HYPOTHESIS

We will simulate different tracks that start from China and end at the United States. We will also calculate the probability of each track crossing the United States. Our main hypothesis is that the balloon is only affected by the wind, which implies that there is no power source on board.

MEDEL

Our study will primarily focus on the 2D heat diffusion equation and 2D random walk. If feasible, we will also explore the 3D heat diffusion equation and 3D random walk on a spherical surface. For the 2D random walk, we will use equations such as:

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In this formula, (x(t),y(t)) represents the location of the balloon at time t, ε represents the random walk process with an expected value of 0 and variance of σ, and W represents the influence of the wind.

For the diffusion equation, we will use the formula:

In this formula, x and y are the coordinates of the balloon, and C represents the parameters that reflect the effects of the wind.

METHODS

As we have not yet learned about PDE, we will consider using the PDE toolbox in Matlab. For the random walk, we believe that implementing a 'for' loop with an initial condition will suffice.

RESULTS

Figure 1: Depiction of a single random walk trajectory, originating in China and terminating in the United States. This image demonstrates that it is conceivable for the balloon to have started in China and, via a random process, arrived in the United States using random walk.

Figure 2: Representation of the balloon's trajectory using the heat diffusion equation. This figure shows that it is plausible for the balloon to have originated in China and, following a random process, arrived in the United States via heat diffusion equation.

Figure 3: Possible locations of the balloon and their corresponding probabilities, as determined by random walk. This figure is expected to reveal the most likely trajectory of the balloon via random walk.

Figure 4: Possible locations of the balloon and their corresponding probabilities, as determined by the heat diffusion equation. This figure is expected to reveal the most likely trajectory of the balloon via heat diffusion equation.

Figure 5: A comparison of the accuracy between the PDE toolbox in Matlab and other methods of analysis.

Figure 6 and beyond: A comparison between the results obtained using the heat diffusion equation and those obtained through random walk analysis. Additional results are forthcoming.

Timeline

Spring break: Learning about the heat diffusion PDE and exploring the link between the equation and our problem. The week after spring break: Simulating the 2D random walk and gathering information about 3D random walk. March 20th to March 26th: Simulating the 2D heat equations in Matlab. After March 26th: Expanding to 3D and writing the paper, preparing for the presentation.

Work Cited

Barnes, G. (2014). *Mathematical Modelling with Case Studies: Using Maple and MATLAB.* CRC Press.