# Bullet Trajectory Calculation Documentation

## Introduction

The "Bullet Trajectory Calculation" code is a Python script that simulates and visualizes the trajectory of a bullet fired at a specified angle and initial velocity. The simulation takes into account the effects of air drag and gravity on the bullet's motion. This documentation provides an overview of the code, its functionality, input parameters, output, and usage.

## Function Description

The code contains a single function called calculate\_bullet\_trajectory, which calculates the trajectory of a bullet given its initial conditions and physical parameters. The function takes the following input parameters:

### Input Parameters

1. initial\_velocity (float): The initial velocity of the bullet in meters per second (m/s).
2. angle (float): The launch angle of the bullet in degrees.
3. mass (float): The mass of the bullet in kilograms (kg).
4. bullet\_diameter (float): The diameter of the bullet in meters (m).

### Output

The function returns two lists trajectory\_x and trajectory\_y, which contain the x and y coordinates of the bullet's trajectory, respectively.

## Physics and Simulation

The simulation accounts for the following physical factors that affect the bullet's trajectory:

### 1. Drag Force

Air drag is a force that opposes the motion of the bullet and depends on its velocity. The code uses the drag equation to calculate the drag force in the x and y directions:

Drag force in the x-direction:

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drag\_force\_x = -0.5 \* air\_density \* pi \* (bullet\_diameter/2)^2 \* drag\_coefficient \* velocity\_x \* |velocity\_x|

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Drag force in the y-direction:

luaCopy code

drag\_force\_y = -0.5 \* air\_density \* pi \* (bullet\_diameter/2)^2 \* drag\_coefficient \* velocity\_y \* |velocity\_y|

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### 2. Gravitational Force

The force due to gravity pulls the bullet downward. The gravitational force is given by:

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gravitational\_force = mass \* gravitational\_acceleration

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### 3. Equations of Motion

The equations of motion are used to calculate the acceleration of the bullet in the x and y directions:

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acceleration\_x = drag\_force\_x / mass

acceleration\_y = (drag\_force\_y - gravitational\_force) / mass

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### 4. Numerical Integration

The simulation employs numerical integration to update the bullet's position and velocity at each time step. The time step is set as time\_step = 0.01 seconds, which can be adjusted for accuracy.

## Example Usage

The code provides an example usage at the end, demonstrating how to calculate and plot the trajectory of a bullet. The example sets the initial conditions and physical parameters as follows:

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initial\_velocity = 100 # m/s

angle = 45 # degrees

mass = 0.01 # kg

bullet\_diameter = 0.001 # m

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The function calculate\_bullet\_trajectory is then called with these parameters to obtain the trajectory points. Finally, the trajectory is plotted using matplotlib.pyplot.

## Limitations

It's important to note that the code employs some simplifications and neglects certain real-world factors that could affect the actual trajectory of a bullet. These include variations in air density, wind effects, the rotation of the Earth, and non-constant drag coefficients at different velocities.

## Conclusion

The "Bullet Trajectory Calculation" code provides a simple yet effective simulation of a bullet's trajectory based on given initial conditions and physical parameters. Users can adjust the inputs to model different scenarios and analyze the bullet's flight path under the influence of drag and gravity.