

LAB 10

Home Run Derby

Learning Goals:

Use of vectorization and ‘while’ loops.

Use various conditional and if statements.

More practice with plotting.

In a game of baseball, if the batter hits the ball at the right angle and the right speed it will go over the wall of the playing field and be a “home run.” However, if the batter does not hit the ball at the right angle and speed, it will either hit the ground before reaching the wall or hit the wall itself. Your goal is to simulate this situation.

First, begin by asking the user to input the initial speed v_0 and angle θ_0 of the hit ball. Next, compute the ball’s flight time using the equation:

$$t_{\text{flight}} = \frac{2v_0}{g} \sin(\theta_0),$$

where $g = 9.8 \text{ m s}^{-2}$. Then, create a vector t of time values that runs from 0 to t_{flight} and uses equal spacing between values (the units of t are seconds).

Now we want to calculate the trajectory of the ball as a function of time. To do this, we need to compute the x and y coordinates of the ball as a function of t . Create two vectors x and y using the following equations:

$$x = v_0 t \cos(\theta_0), \quad y = v_0 t \sin(\theta_0) - \frac{1}{2} g t^2,$$

where x is the horizontal position of the ball and y is the ball’s height, both in meters. Using a ‘while’ loop, at each time t , print out the values of t , x , and y . However, your loop should run and print output *only* until the ball either reaches the location of the wall or hits the ground before the wall, whichever comes first. Assume that the wall is located at a distance of 100 meters and has a height of 8 meters. Also, be sure that your print statement is nicely formatted and includes the correct units for all printed variables.

After the 'while' loop, have your program print what happened. In other words, print whether the ball hit the ground, hit the wall, or is a home run (i.e., will go over the wall).

Next, plot the trajectory of the ball $y(x)$. Include in your plot a straight vertical line that represents the wall (be sure that your 'wall' is located at the right place and has the correct height). However, only plot the portion of the ball's trajectory where the ball is in flight, i.e., in the case where the ball hits the wall, only plot up until the moment of impact. In the case of a home run, only plot until the location of the wall. For the case when the ball hits the ground before the wall, you should get a complete curve that starts and ends at height $y = 0$. Be sure to include a proper title, axes labels, and units on your plot. Also, to keep the scaling of the x and y axes correct, add the line: `ax = fig.add_subplot(111, aspect='equal')` just before you use `plot()`.

Finally, create three plots, one for each case of ball hits the ground, ball hits the wall, and a home run. Be sure that all three plots are included when you submit your lab. An example of what your plot should look like in the case when the ball hits the wall is shown below.

