Assignment 2

Neuroscience 9520
Computational Models in Neuroscience
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Due Sep 30 2012 11:59pm EST

Submit your assignment as a single `.pdf` file sent by email to `paul@gribblelab.org` with the subject line `compneuro assignment 2`. Please name the pdf file with your last name and the assignment number, for example `gribble2.pdf`.

1 Modelling the Dynamics of Baseball Flight

The equations of motion governing the dynamics of the flight of a baseball traveling through air (in 2D) are the following:

$$\ddot{x} = (-k/m)(\dot{x})\left(\sqrt{\dot{x}^2 + \dot{y}^2}\right) \quad (1)$$

$$\ddot{y} = (-k/m)(\dot{y})\left(\sqrt{\dot{x}^2 + \dot{y}^2}\right) - g \quad (2)$$

where x and y are the horizontal and vertical position of the ball (metres), respectively, m is the mass of the ball (kg), g is the gravitational force (N), and k is a frictional coefficient that depends on the density of air, the surface area of the object, and the object's surface material (kg/m).

Assume the following constant values:

k	5.9 x 10^{-4} $kg\ m^{-1}$
m	0.15 kg
g	9.81 $m\ s^{-2}$

Questions

1. What is the order of the system?

2. Write a function in python that returns the state derivatives of the system given the current state. The header should be: `def baseball(state, t):`

3. Simulate 20 seconds of the system, in steps of 10 ms, starting from an initial position of $(x, y) = (0, 0)$ and an initial velocity of $(\dot{x}, \dot{y}) = (30, 50)$. Plot x and y position over time. Find the time, and x position, when the ball hits the ground ($y = 0$). Don't worry about explicitly modelling the ground, per se ... you can allow the ball to continue to fall into negative values of y. Just find the time at which the ball crosses the $y = 0$ line.

4. You can express initial velocity as $(\dot{x}, \dot{y})$ or alternatively as an elevation (angle above the horizon) and velocity (α, v). They are related by the following equations:

$$\dot{x} = cos(\alpha)v \tag{3}$$
$$\dot{y} = sin(\alpha)v \tag{4}$$

   Assume the initial position of the ball is $(x = 0, y = 0)$. Find the initial conditions for velocity (α, v) that will result in the ball hitting the ground ($y = 0$) 100 metres from the start ($x = 100$).

Include in your report the python code you used and any figures to illustrate your answers.