Projectile Motion with drag

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Plan of talk

Anurag Das (2020phy1116) will begin the presentation with the following sections:

- Theory
- Packages and methods used

... and will be followed by Lucky Upadhayay (2020phy1041) taking over for the following sections:

- Results and anaylsis
- Conclusion

Projectile Motion

An object that is in flight after being thrown or projected is called a projectile. Such a projectile might be a football, a cricket ball, javelin or any other object.

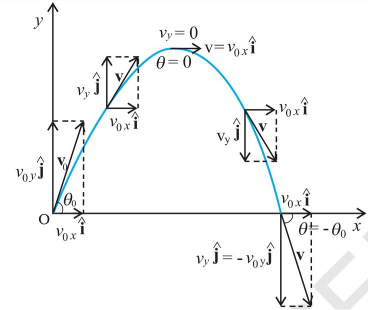

Figure: Path of a projectile is a parabola

Theory

Taking friction into account

$$\vec{f} = -k|v_o|\vec{v_o}$$

$$\therefore f_x = -k|v_o|^2 \cos\theta_o \quad f_y = -k|v_o|^2 \sin\theta_o$$

... Which brings us to our differential equations

$$\frac{dY_0}{dt}\left(\equiv \frac{dx}{dt}\right) = Y_1 \tag{1}$$

$$\frac{dY_1}{dt}\left(\equiv \frac{d^2x}{dt}\right) = \frac{f_x}{m} \tag{2}$$

$$\frac{dY_2}{dt}\left(\equiv \frac{dy}{dt}\right) = Y_3 \tag{3}$$

$$\frac{dY_3}{dt}\left(\equiv \frac{d^2y}{dt}\right) = \frac{f_y}{m} - g \tag{4}$$

Packages and Methods used

Tools used to run simulations, write the report, and make beamer

- Python
- GNU plot
- $\LaTeX$

Numerical methods used to solve the equations

- Euler method
- rk2 method
- rk4 method

Results and Analysis

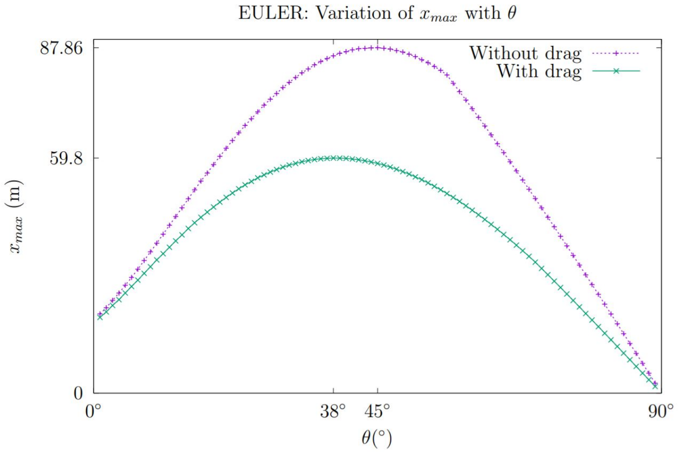

Figure: Figure shows the variation of x_{max} with θ, computed using the Euler method

Results and Analysis

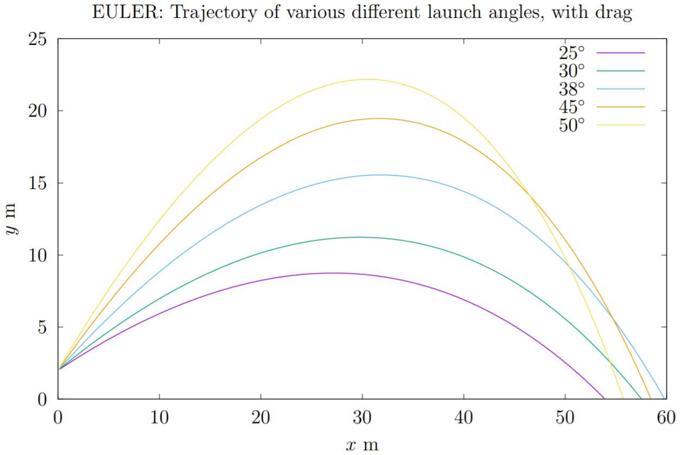

Figure: Figure shows trajectories of javelin thrown with different launch angles, computed using the Euler method

Results and Analysis

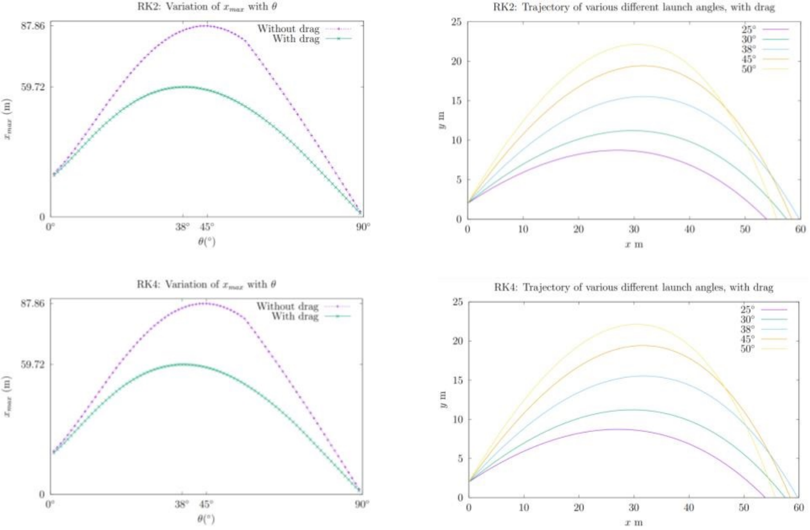

Figure: Results with rk2 and rk4 method

Conclusion

Primary conclusions

- Optimal angle $= 38^\circ$, for all cases.
- $x_{max} = 59.8$m by Euler, 59.72m by rk2, rk4.
- Variation in x_{max} for 35° to $40^\circ = 0.23\%$, by euler method.
- $\therefore$ it depends more on the athlete's execution.

Learning

Things that we learned:

- LaTeX (Writing reports, and making beamers)
- GNU plot
- Euler, rk2, and rk4 methods
- Accounting for air drag
- Working in a team for an extended period of time