1 Introduction

An explicit Runge-Kutta method was implemented to solve the equation of motion for an inclined throw with air resistance in two dimensions.

2 Algorithm Description

The Runge-Kutta family of methods to solve ordinary differential equations is well known and described. The algorithm implemented is the classical and most used Runge-Kutta method usually referred to as RK4 or something closely similar.

3 Results

The program was implemented as described above and submitted with this report.

3.1 Task 1

For a fixed friction coefficient $\gamma = 1.0$, trajectories were calculated for launch velocities $v \in \{5, 10, 20, 40\}$ m/s and over a range of launch angles $10 \leq \alpha \leq 80$ deg over 15'000 time steps of size $\Delta t = 0.001$ s. The results are shown in figures 1, 2, 3 and 4.

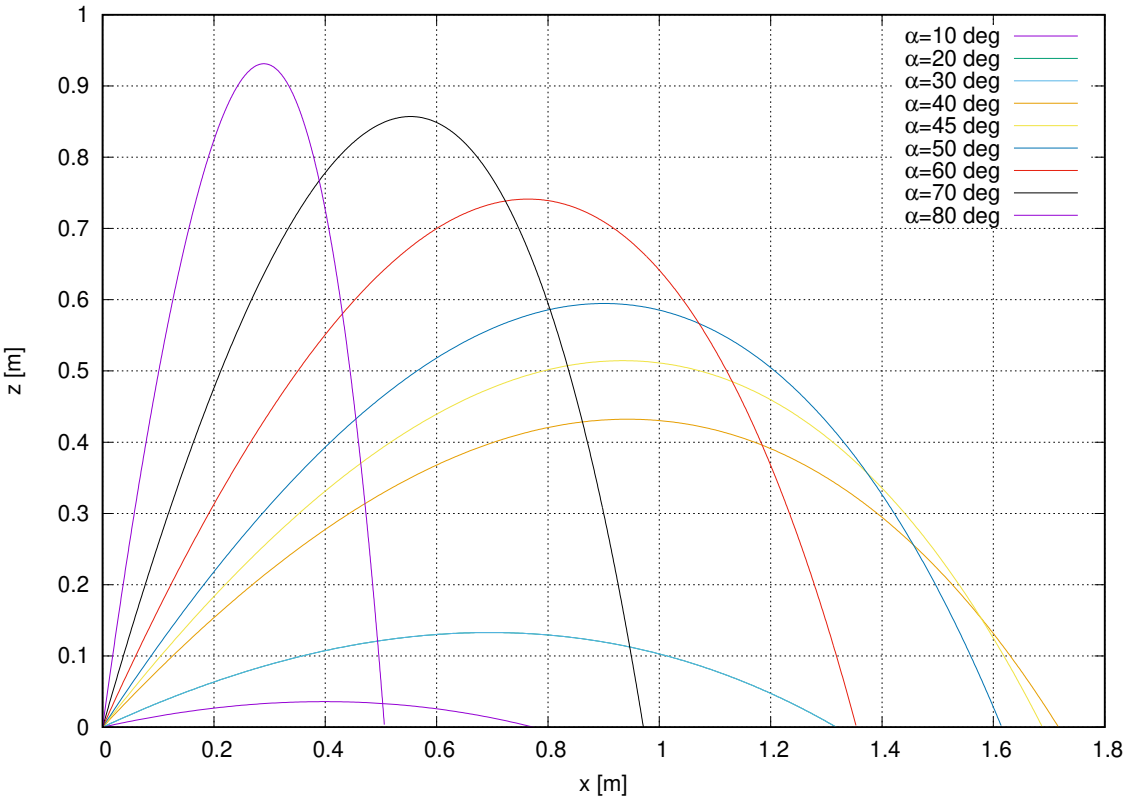

Figure 1: Flight trajectories for $\gamma = 1.0$, $v = 5.0$.

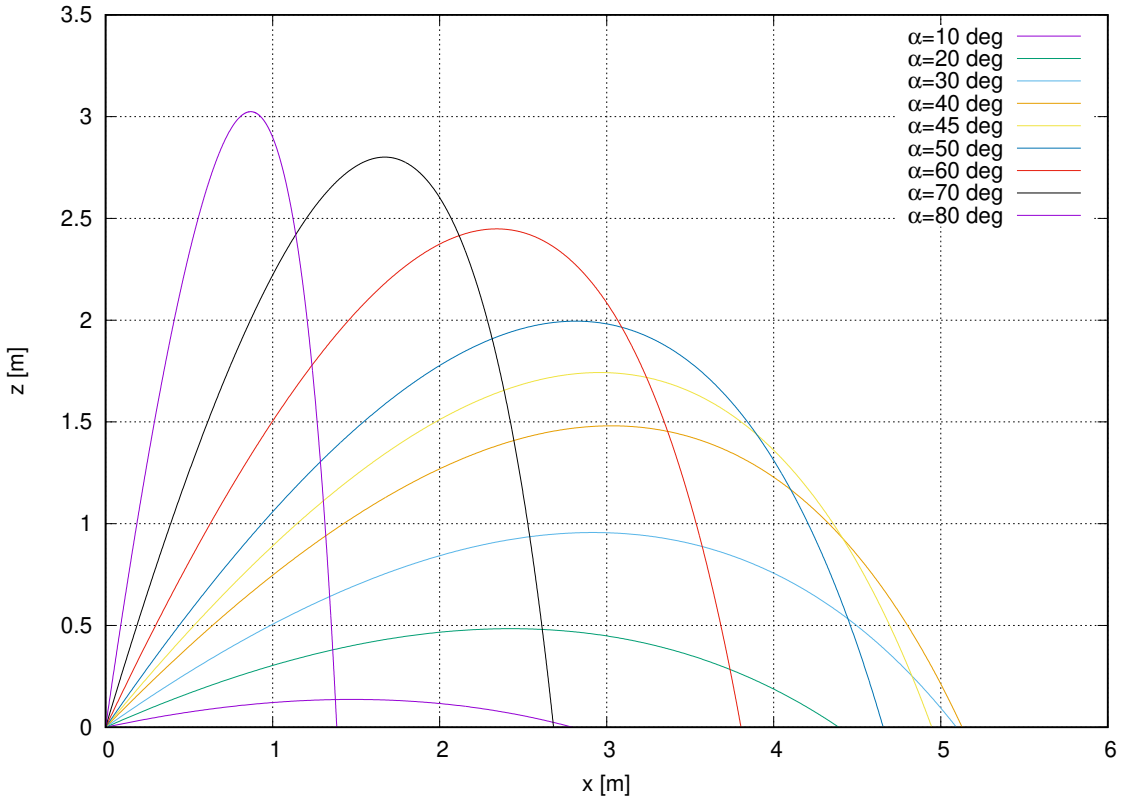

Figure 2: Flight trajectories for $\gamma = 1.0$, $v = 10.0$.

3.2 Task 2

For a fixed launch velocity $v = 40.0$ m/s, the friction coefficient was varied such that $0.25 \leq \gamma \leq 10.0$ and the maximum obtained flight distance x recorded. The result is shown in figure 5.

4 Discussion

The results seem physically plausible. No error analysis was performed.
Considerable effort went into templating the solver for generic use for the purpose of practice following the example of [1].

References

[1] Gottschling, Peter
Discovering Modern C++,
Addison-Wesley,
2016.

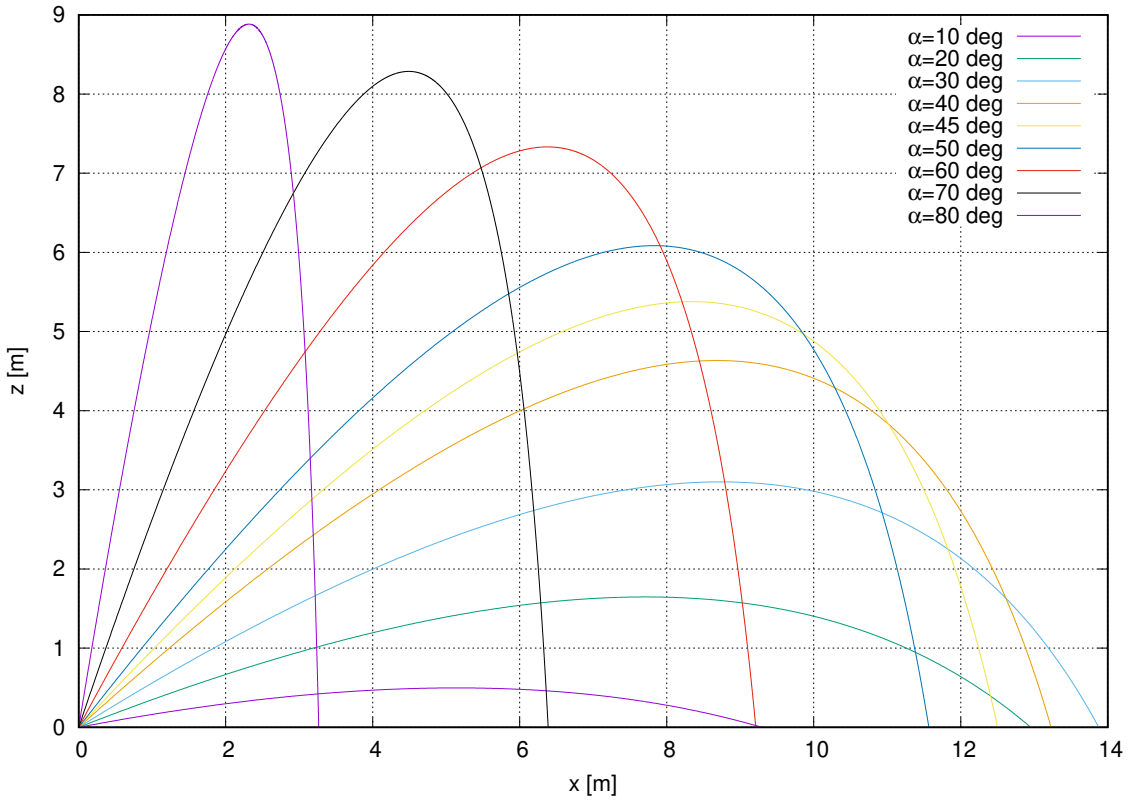

Figure 3: Flight trajectories for $\gamma = 1.0$, $v = 20.0$.

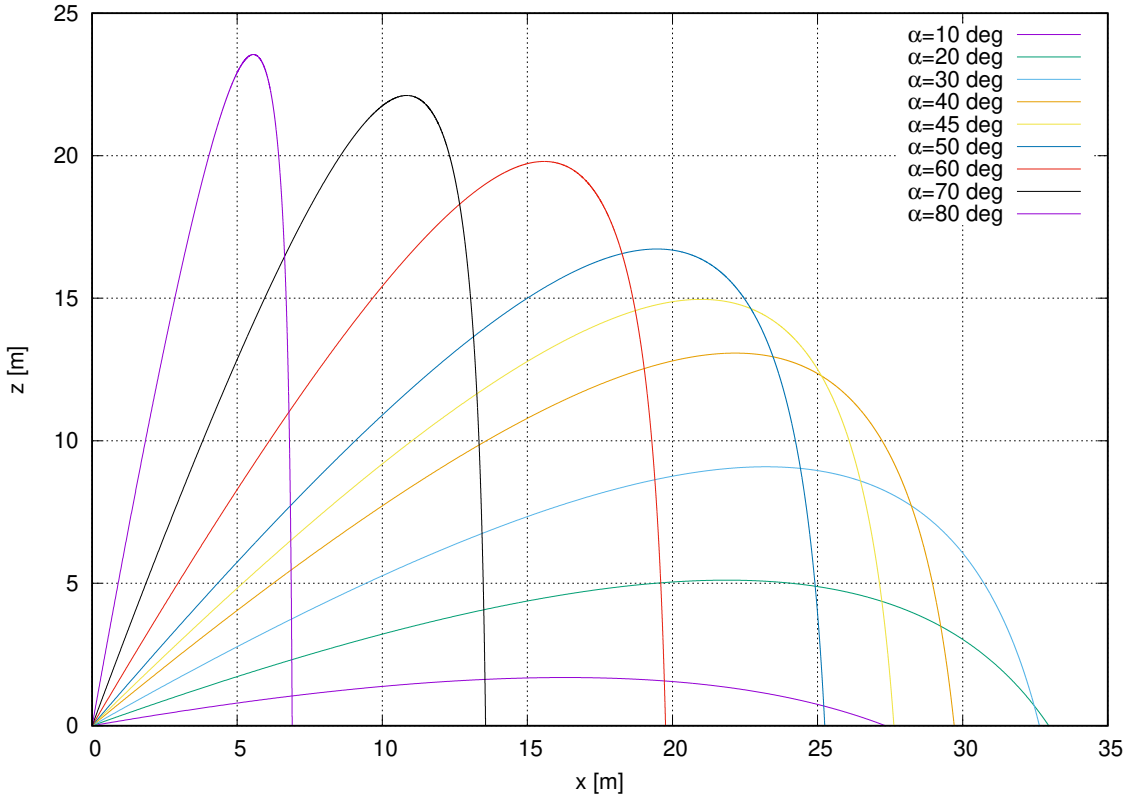

Figure 4: Flight trajectories for $\gamma = 1.0$, $v = 40.0$.

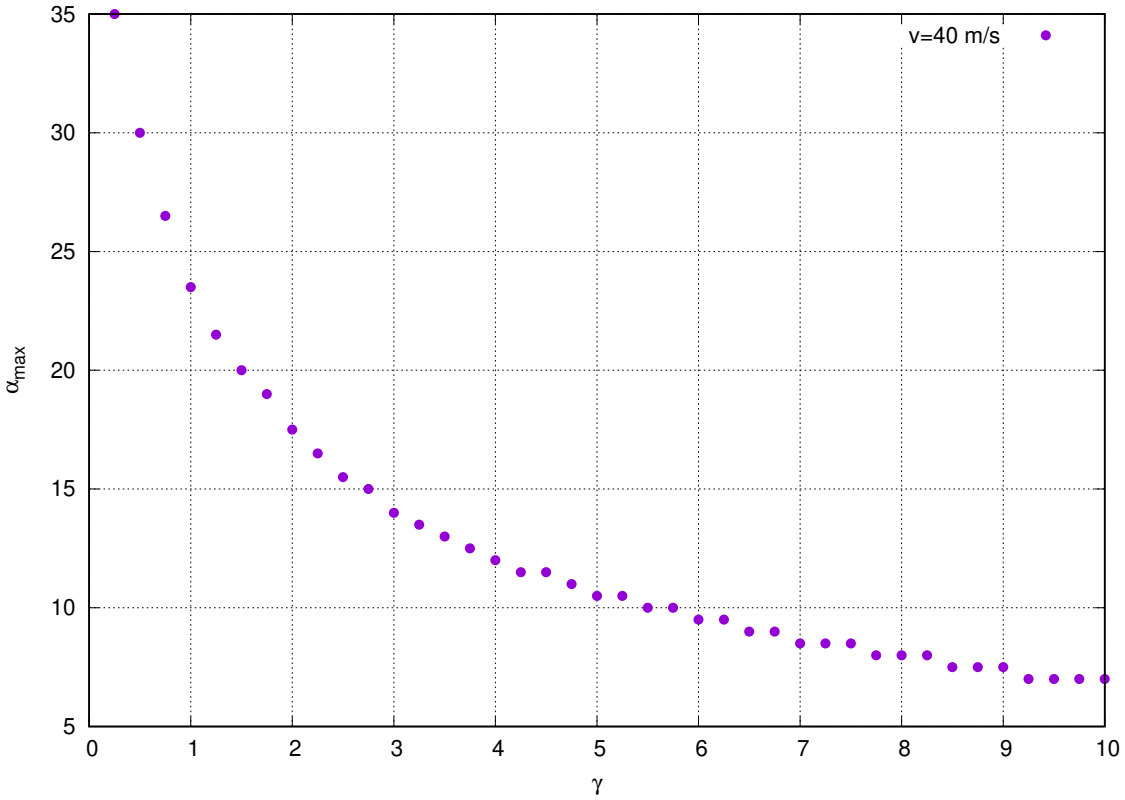

Figure 5: Launch angle a_{max} for maximum range as function of friction coeffcient γ, $v = 40.0$.