Assume that you are observing the movement of a ballistic object, that is you observe the height z_i, $i = 1 \ldots N$ at coordinates x_i, Figure 1. The coordinates x_i are arbitrary, i.e. you do not know if it was launched at the origin of the x axis, but you know that it was launched at ground level. We assume that the gravitational acceleration g is known and constant and that the ballistic object does not experience any air resistance. The observations z_i are uncertain, but you are given an estimate σ_i of every measurement uncertainty.

1. Formulate the FORWARD PROBLEM which allows you to predict the height of the ballistic object given its launch position x_0, launch angle θ and launch speed v. Explain what are the model and data parameters. Motivate your choice of parameters. What relation links the model and data parameters?

2. Formulate an INVERSE PROBLEM to determine the launch position x_0, the launch angle θ and the launch speed v given the observations provided. Plot the observations and the trajectory of the ballistic object using the parameters obtained from your solution to the INVERSE PROBLEM.

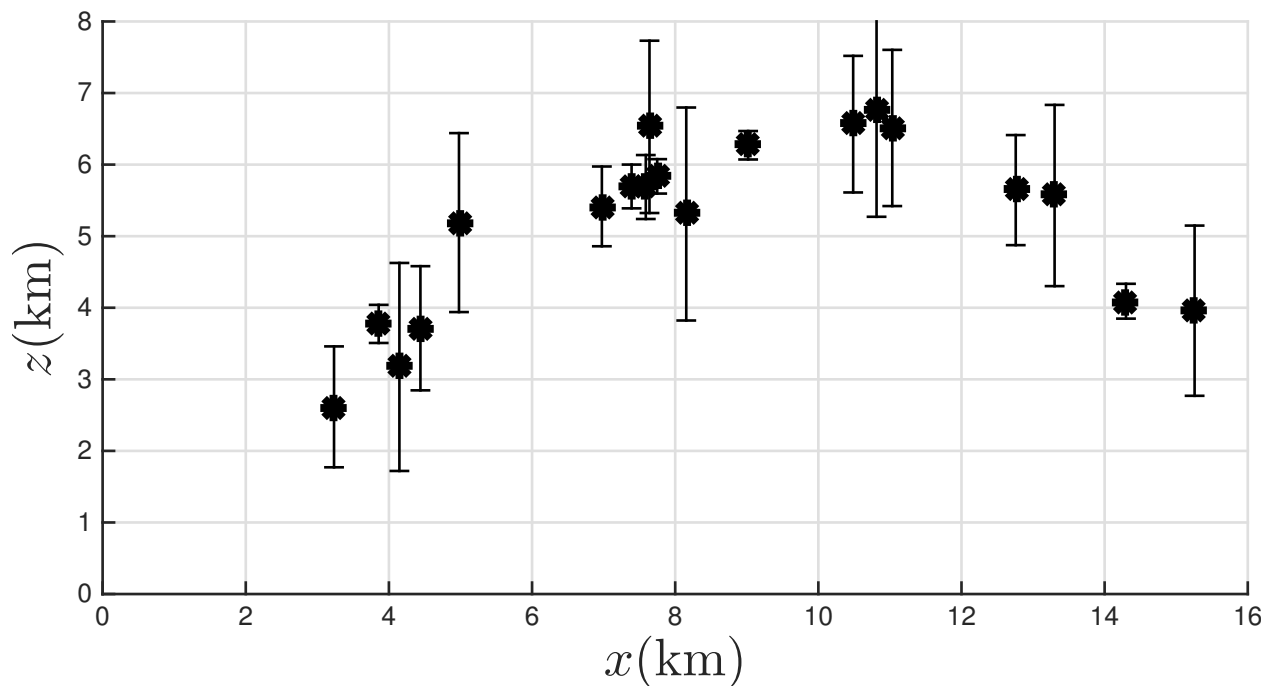Please attach all the programs you wrote for this assignment.

Figure 1: Observations of the ballistic object.

N.B. This is an individual assignment – your work is subject to the Mines Student Honor Code.

x	z	s
3.2331	2.6154	0.8446
3.8569	3.7742	0.2663
4.1465	3.1728	1.4531
4.4402	3.7134	0.8674
4.9790	5.1899	1.2501
6.9754	5.4163	0.5572
7.3906	5.6946	0.3057
7.5891	5.6868	0.4469
7.6406	6.5274	1.2037
7.7484	5.8358	0.2404
8.1545	5.3097	1.4879
9.0189	6.2704	0.1988
10.4865	6.5652	0.9542
10.8133	6.7713	1.5002
11.0329	6.5120	1.0912
12.7579	5.6437	0.7689
13.3009	5.5682	1.2660
14.2984	4.0913	0.2434
15.2570	3.9589	1.1891