Suppose you observe a moving ballistic object at heights z_i and coordinates x_i for $i = 1 \dots N$, as shown in Figure 1, and you want to determine its launch position x_o, launch angle θ, and launch speed v, given the observations.

You may assume the following: 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, $z_o = 0$, the gravitational acceleration g is known and constant, and the object does not experience any air resistance. Do not consider uncertainty for this problem, i.e., use equal unit weights for all data when constructing the objective function.

1. Choose a set of parameters and formulate the objective function. Plot the value of the objective function for a range of parameter values. Choose a starting model, and plot the value of the objective function for your starting model.

2. Find the launch position x_o, launch angle θ, and launch speed v by solving the inverse problem using the **steepest descent method**. For the starting model and the updated model after the first three iterations, plot the trajectory that describes the motion of the object (**four** trajectories in total).

3. Find the launch position x_o, launch angle θ, and launch speed v by solving the inverse problem using the **conjugate gradient method**. For the starting model and the updated model after the first three iterations, plot the trajectory that describes the motion of the object (**four** trajectories in total).

Please attach all the programs you wrote for this assignment.

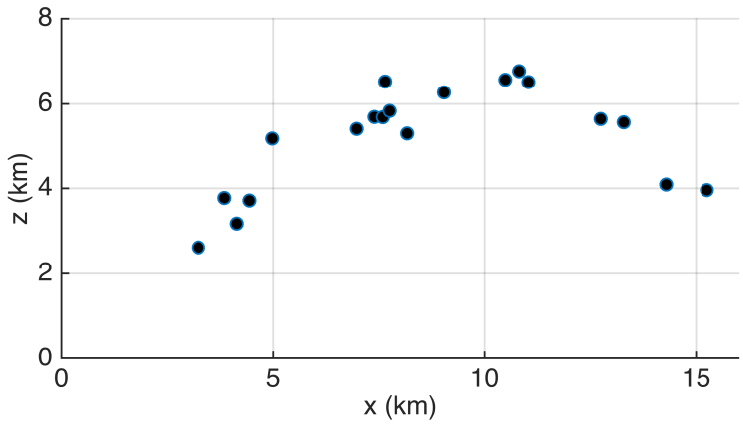

Figure 1: Observations of the ballistic object.

Useful matlab functions for plotting:

1. slice: volumetric slice plot;

2. scatter3: 3-D scatter plot.

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

x	z
3.2331	2.6154
3.8569	3.7742
4.1465	3.1728
4.4402	3.7134
4.9790	5.1899
6.9754	5.4163
7.3906	5.6946
7.5891	5.6868
7.6406	6.5274
7.7484	5.8358
8.1545	5.3097
9.0189	6.2704
10.4865	6.5652
10.8133	6.7713
11.0329	6.5120
12.7579	5.6437
13.3009	5.5682
14.2984	4.0913
15.2570	3.9589