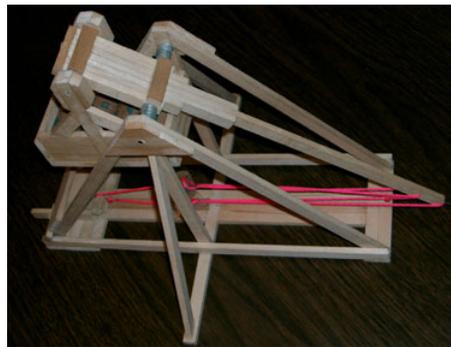


Math 77C Project 1 (Due May 3)

Instructions: This project will require a small amount of MATLAB code. It may therefore be convenient to answer the questions below and provide any related MATLAB code in the same `.m` file. Recall `%` produces inline comments in MATLAB and `{ ... }` can be used to block comment. When turning in the project, please name your file `project1_yourlastname.m` and email it to `eesser@uci.edu`. If you are submitting multiple files, please zip them together in a file named `project1_yourlastname.zip`.

A trebuchet is a medieval siege weapon that can sling heavy projectiles great distances by dropping a massive raised counterweight.



A very small example of a trebuchet

Suppose we have taken 10 shots with projectiles of varying masses and measured the distances they traveled. The data collected so far is tabulated in Table 1. Now we are about to launch a 30kg projectile and want to predict how far it will go.

1a. Model the distance traveled, d , as a linear function of the projectile mass, m , and use the given data to write an overdetermined system of linear equations of the form $Ac = d$, where c is a vector of the two unknown coefficients of the line. What is the matrix A ?

1b. What equation can you solve to find the best fit line in the least squares sense? Namely, how can you find c such that $\|Ac - d\|^2$ is minimized?

Projectile mass (kg)	Distance traveled (meters)
10	182.3
12.5	163.2
15	155.9
16	149
17.5	140.8
20	132.6
22.5	118.7
25	109
27	103.1
28	101.9

Table 1: Distance traveled and projectile mass measurements

1c. What is the best fit line? Show how to solve for it in MATLAB and plot this line along with the given data points in the same figure.

1d. Based on the best fit line, how far do you predict the 30kg projectile will travel?

1e. What is the sum of squares of the errors between the data points and the best fit line? In other words, for the optimal c you found in 1c, what is the value of $\|Ac - d\|^2$?

2a. Now model the distance traveled, d , as a 5th order polynomial function of the projectile mass, m , and use the given data to write an overdetermined system of linear equations of the form $Ac = d$, where c is now a vector of the 6 unknown coefficients of the polynomial. What is the matrix A ?

2b. What is the best fit 5th order polynomial in the least squares sense? Show how to solve for it in MATLAB and plot the result along with the given data points in the same figure.

2c. Based on the best fit polynomial from 2b, how far do you predict the 30kg projectile will travel?

2d. What is the sum of squares of the errors between the data points and the best fit polynomial? How does this compare to 1e?

2e. Which prediction do you think is more meaningful? Why?