PHYS338:Computational Physics HW8

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First, we construct a linear equation describes the system. We have:

$$M = c_0 + c_1 a + c_2 s + c_3 v + c_4 \rho \tag{1}$$

Let $C_{5\times1}$ be the coefficients values, $M_{N\times1}$ be the masses matrix, and $A_{N\times5}$ be the data matrix, such that: the first column is ones, and the other columns are the data of a, s, v, and ρ respectively. Therefore we have the following linear equation:

$$A * C = M \tag{2}$$

We want to find a matrix such that if we multiply it by A (from the right), it results the identity matrix, i.e, the inverse of a non-square matrix. In *matlab*, such a matrix is defined as *pinv(A)*. Hence,

$$pinv(A) * A = I \tag{3}$$

Then, to find C:

$$A * C = M \tag{4}$$

$$pinv(A) * A * C = pinv(A) * M \tag{5}$$

$$C = pinv(A) * M \tag{6}$$

Matlab Code:

```
A =

    1.0000    0.2160   -0.0016   89.5300    1.2500
    1.0000    0.2110   -0.0015   89.1100    1.2500
    1.0000    0.2610   -0.0023   89.9600    1.2400
    1.0000    0.2040   -0.0015   85.4200    1.2700
    1.0000    0.2010   -0.0016   86.3000    1.2800
    1.0000    0.1960   -0.0017   84.1400    1.2500
    1.0000    0.2370   -0.0020   88.0600    1.2300
    1.0000    0.2070   -0.0015   86.5200    1.2200
    1.0000    0.1990   -0.0021   82.7500    1.2100
```

```
M =

   1.0e+04  *

    6.7291
    6.7829
    5.6629
    6.3580
    6.6519
    5.7042
    5.7709
    6.3551
    5.4550
```

Figure 1: The matrices A and M

```
>> pinv(A)

ans =

   1.0e+03 *

   -0.0147   -0.0054   -0.0060    0.0074   -0.0150   -0.0003    0.0077    0.0230    0.0041
   -0.0295   -0.0139    0.0113    0.0294   -0.0109   -0.0041    0.0173    0.0214   -0.0210
   -1.1559   -0.1183   -0.3768    1.5075   -0.6749   -0.2796    0.6002    1.8246   -1.3268
    0.0002    0.0001   -0.0000   -0.0002    0.0000   -0.0000   -0.0001   -0.0001    0.0001
   -0.0013   -0.0027    0.0032    0.0067    0.0101    0.0029   -0.0027   -0.0107   -0.0055
```

Figure 2: pinv(A) matrix

```
>> pinv(A)*A

ans =

    1.0000    0.0000   -0.0000    0.0000   -0.0000
    0.0000    1.0000   -0.0000    0.0000   -0.0000
    0.0000    0.0000    1.0000    0.0000    0.0000
   -0.0000   -0.0000    0.0000    1.0000    0.0000
    0.0000   -0.0000    0.0000   -0.0000    1.0000
```

```
>> C=pinv(A)*M

C =

   1.0e+06 *

   -0.0977
   -0.1649
    6.0750
    0.0018
    0.0377
```

Figure 3: $pinv(A) * A = I$ & C matrix

Now, if we add a new flight data, then we have :

```
>> M1=C(1,1)+0.209*C(2,1)-0.0014874*C(3,1)+83.52*C(4,1)+1.24*C(5,1)

M1 =

   5.7931e+04

>> error=M1-57715.48

error =

  215.5317

>> percentage_error=error*100/57715.48

percentage_error =

    0.3734
```

The percentage error is 0.3734%, which is a good predicting for the mass of the aircraft.