

ECE 111 - Homework #3

Week #3: Linear Algebra. Due February 1st

Please submit as a Word or pdf file to BlackBoard or email to Jacob_Glower@yahoo.com with header ECE 111 HW#3
www.BisonAcademy.com

Note: Solutions will be slightly different from previous homework solutions. We have one more year's worth of data.

1) Solve for {x, y}

$$16x + 3y = 13$$

$$18x + 18y = 2$$

```
>> A = [16, 3 ; 18, 18]
```

```
    16     3
    18    18
```

```
>> B = [13; 2]
```

```
    13
     2
```

```
>> XY = inv(A) * B
```

```
x    0.9744
y   -0.8632
```

2) Solve for {x, y, z}

$$3x + 11y + 12z = 8$$

$$17x + 3y + 7z = 2$$

$$12x + 17y + 10z = 5$$

```
>> A = [3, 11, 12 ; 17, 3, 7 ; 12, 17, 10]
```

```
     3     11     12
    17     3     7
    12     17     10
```

```
>> B = [8; 2; 5]
```

```
     8
     2
     5
```

```
>> xyz = inv(A) * B
```

```
x   -0.1750
y   -0.0005
z    0.7109
```

3) Solve for {a, b, c, d}

$$2a + b + 10c + 2d = 8$$

$$4a + 18b + 7c = 2$$

$$5b + 19c + 18d = 3$$

$$8c + 10d = 19$$

```
>> A = [2,1,10,2 ; 4,18,7,0 ; 0,5,19,18 ; 0,0,8,10]
```

```
     2     1     10     2
     4     18     7     0
     0     5     19    18
     0     0     8     10
```

```
>> B = [8;2;3;19]
```

```
     8
     2
     3
    19
```

```
>> abcd = inv(A)*B
```

```
a  19.4723
b  -2.7341
c  -3.8018
d   4.9486
```

Problem 4) The CO2 levels measured at Mauna Loa observatory for the past 52 years are... Determine a parabolic curve fit for this data in the form of

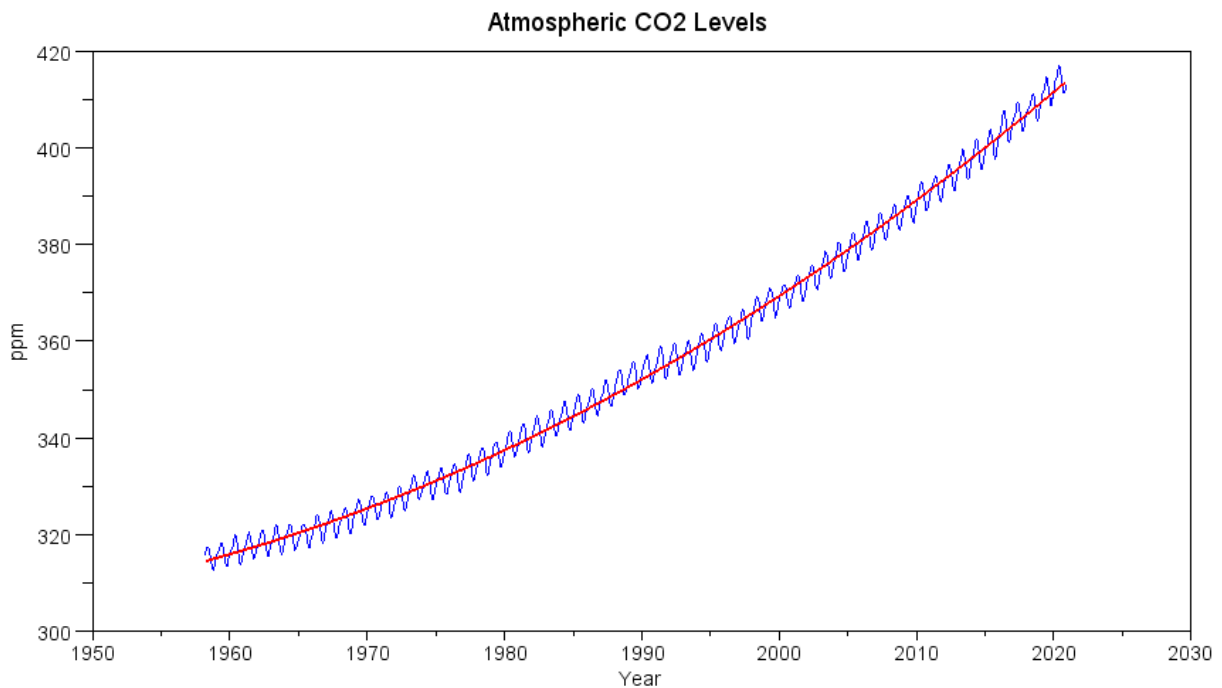
$$CO_2 \approx ay^2 + by + c$$

where 'y' is the year.

```
-->y = DATA(:,1);
-->CO2 = DATA(:,2);
-->B = [y.^2, y, y.^0];
-->A = inv(B'*B)*B'*CO2

    0.0129423
    - 49.917174
    48434.613

-->plot(y,CO2,y,B*A);
-->xlabel('Year');
-->ylabel('ppm');
-->title('Atmospheric CO2 Levels');
```



Problem 5) From this data, when do you predict that we will hit

- 400ppm?
- 2000 ppm of CO2? (the same as what was observed during the Permian extinction)

```
roots(A - [0;0;2000])
```

```
2290.5486 At the current rate, we'll hit 2000ppm in the year 2290
1566.3606
```

Problem 6-7) Sea Ice: The area covered by sea ice is recored by the National Snow and Ice Data Center:

6) Approximate this data from the years 1979 - 2020 with a line

$$Area \approx ay + b$$

From this curve fit, when do you expect the Arctic to be ice free? (First time in 5 million years)

```
-->y = DATA(:,1);
-->ICE = DATA(:,2);

-->B = [y, y.^0];
-->A = inv(B'*B)*B'*ICE

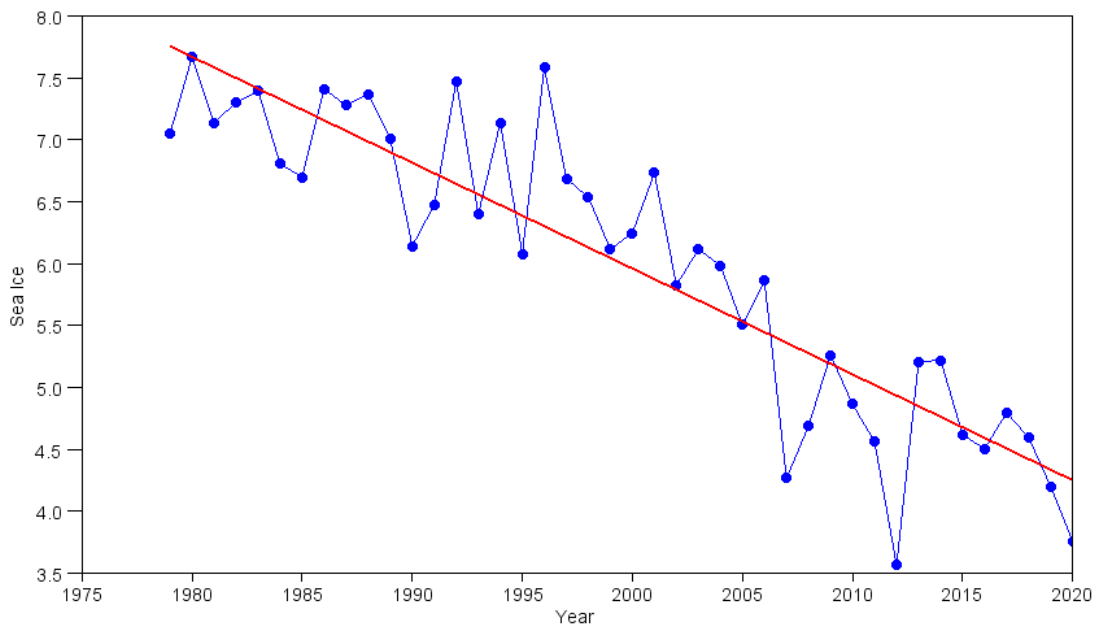
a - 0.0854889
b 176.93806

-->plot(y,ICE,'b.-',y,B*A,'r');
-->xlabel('Year');
-->ylabel('Sea Ice');

-->roots(A)

ans = 2069.7188
```

Assuming a linear curve fit, the Arctic will be ice free in the year 2069 (48 years from now)



7) Approximate this data with a parabolic curve fit:

$$Area \approx ay^2 + by + c$$

From this curve fit, when do you expect the Arctic to be ice free?

```
-->y = DATA(:,1);
-->ICE = DATA(:,2);

-->B = [y.^2, y, y.^0];

-->A = inv(B'*B)*B'*ICE

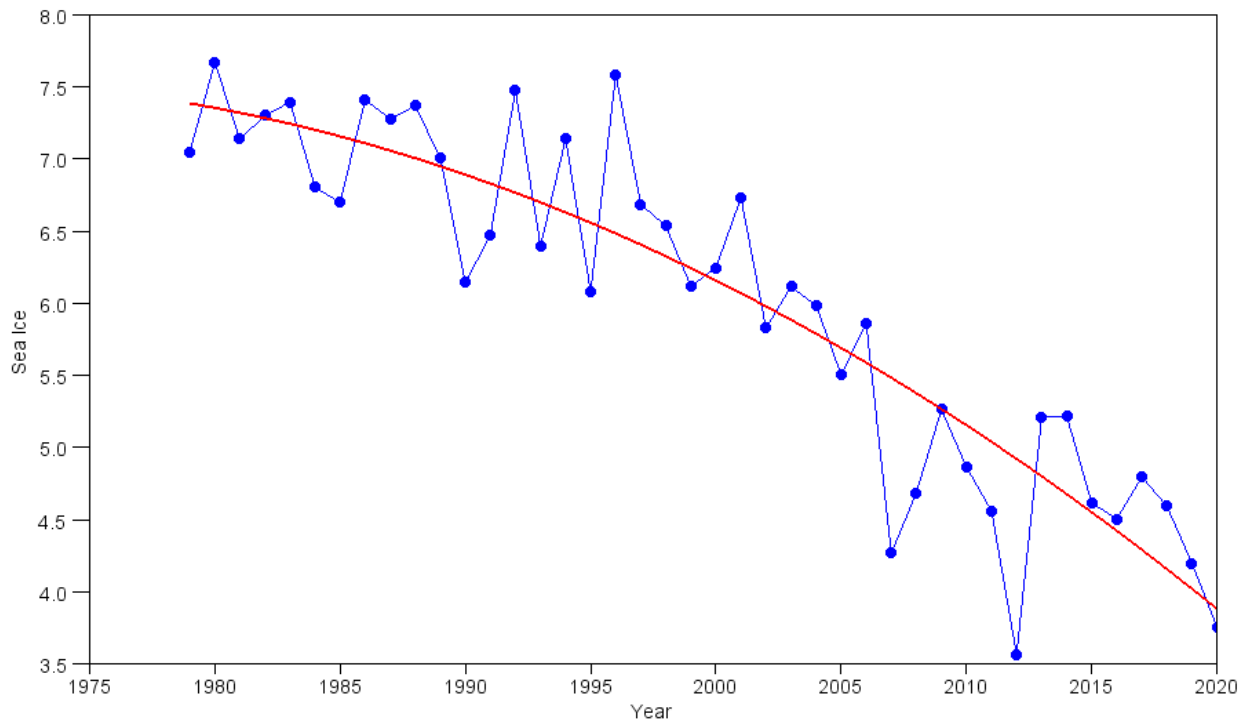
a - 0.0013494
b  5.3108454
c - 5217.8489

-->plot(y,ICE,'b.-',y,B*A,'r');
-->xlabel('Year');
-->ylabel('Sea Ice');

-->roots(A)

2042.6491
1892.9986
```

Assuming a parabolic curve fit, the Arctic will be ice free in the year 2042 (21 years from now)



Problem 8-9: World Temperatures. NASA Goddard has been keep records since 1880 (138 years of data).

8a) Determine a least-squares curve fit for this data from the year 1970 - 2020 in the form of

$$\delta T = aT + b$$

Based upon this data, predict when we will see a 10 degree temperature increase if nothing changes.

```
-->y = DATA(:,1);
-->dT = DATA(:,2);

-->B = [y, y.^0];

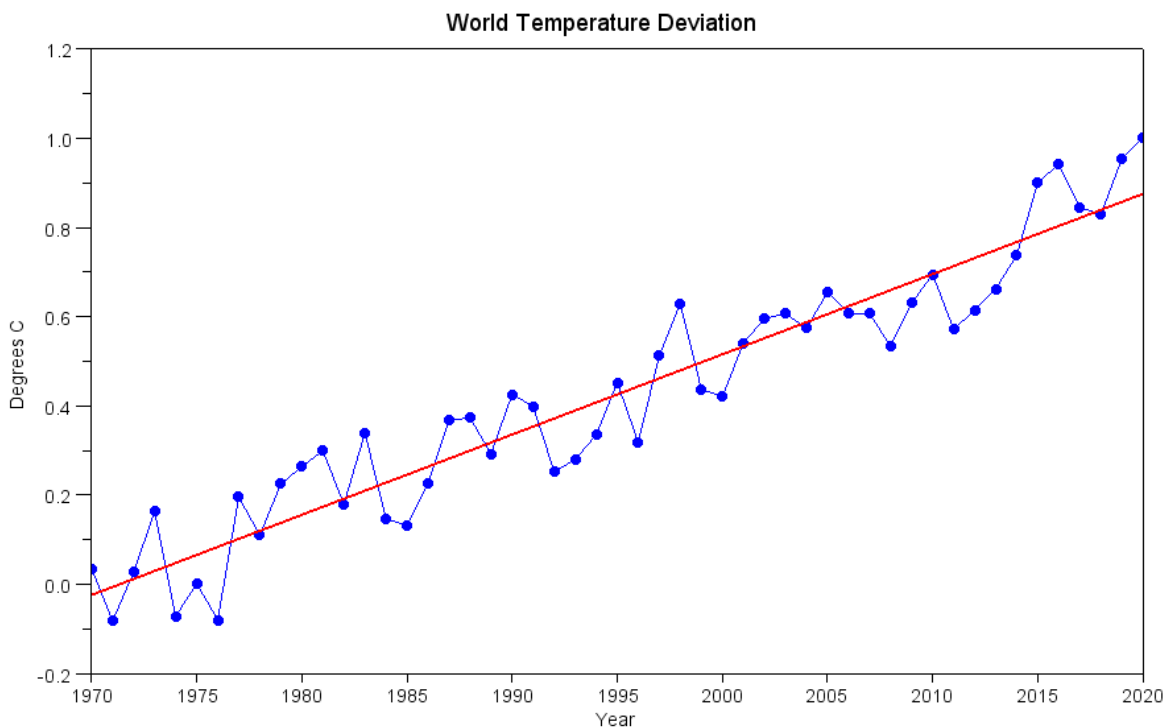
-->A = inv(B'*B)*B'*dT

a 0.0179924
b - 35.469045

-->plot(y,dT,'b.-',y,B*A,'r');
-->xlabel('Year');
-->ylabel('Degrees C');
-->title('World Temperature Deviation');
-->roots(A - [0;10])
```

2527.1279

Using the data since 1970 and a linear curve fit, the data predicts that the world will hit +10C in the year 2527 (326 years from now)



8b) Determine a least-squares cubic curve fit for this data from the year 1880 - 2020 in the form of

$$\delta T \approx ay^3 + by^2 + cy + d$$

Based upon this data, predict when we will see a 10 degree temperature increase if nothing changes.

```
-->y = DATA(:,1);
-->dT = DATA(:,2);

-->B = [y.^3, y.^2, y, y.^0];

-->A = inv(B'*B)*B'*dT

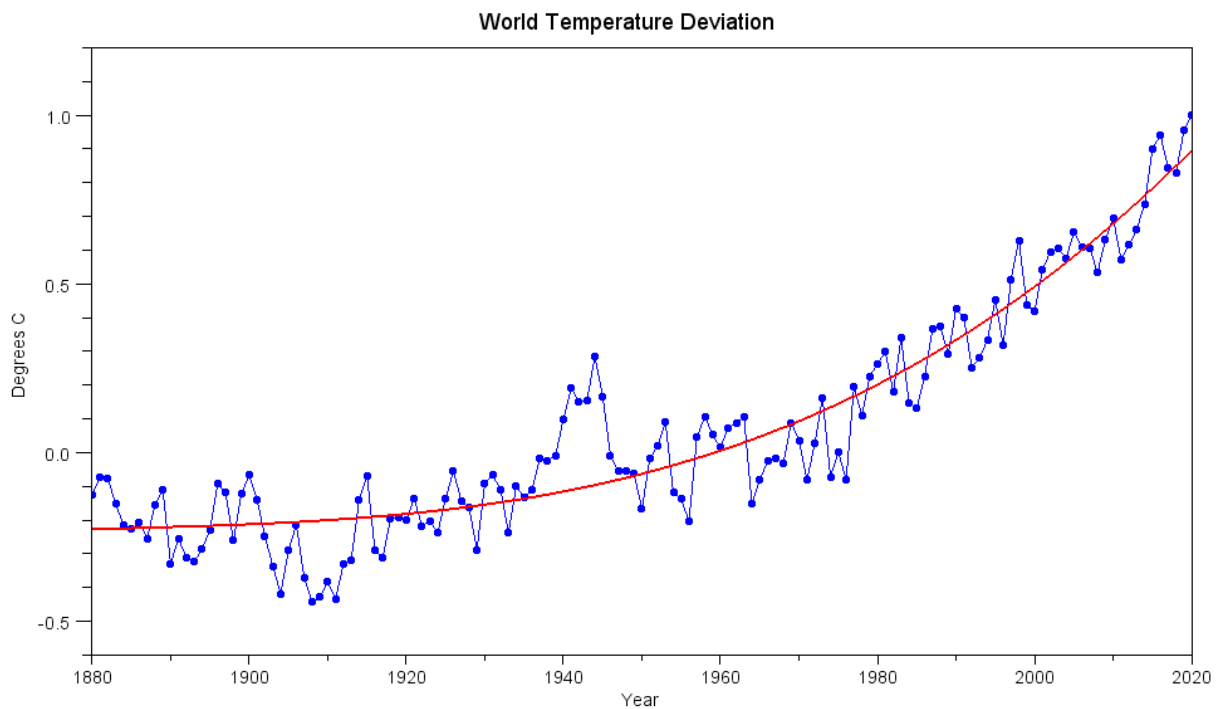
a 0.0000004
b - 0.0023047
c 4.3421935
d - 2727.5768

-->plot(y,dT,'b.-',y,B*A,'r');
-->xlabel('Year');
-->ylabel('Degrees C');
-->title('World Temperature Deviation');

-->roots(A - [0;0;0;10])

2174.6025
1738.3215 + 255.04137i
1738.3215 - 255.04137i
```

Using all of the data back to 1880 and a cubic curve fit, we should reach +10C in the year 2174 (153 years from now)



9) What does a temperature rise of 10 degrees mean for the planet?

- From <http://globalwarming.berrens.nl/globalwarming.htm>

One Degree: 2024 Summers like 2003 where a heat wave in France caused 10,000 deaths become the norm. Flows of the Po and Rhine river decrease. Crop production drops.

-->roots(A - [0;0;0;1])

2024. 3123

1813.4666 + 128.13158i

1813.4666 - 128.13158i

Two Degrees: 2056. Oceans absorb less CO2 (too hot) and soils start to release CO2. Vacations to the Mediterranean in the summer are just too hot. Crop failures in Africa and Central America cause mass migration. Coastal cities flood. 1/3rd of species face extinction.

-->roots(A - [0;0;0;2])

2056. 7453

1797.25 + 155.06453i

1797.25 - 155.06453i roots(A - [0;0;2])

Three Degrees: 2080. Crop failures in China cause the migration of more than 1 billion people. Collapse of equatorial governments.

-->roots(A - [0;0;0;3])

2080. 2873

1785.4791 + 174.84194i

1785.4791 - 174.84194i

Four Degrees: 2099. Spain becomes a desert. Mass migration to Northern latitudes. Rain forests burn up.

-->roots(A - [0;0;0;4])

2099. 2884

1775.9785 + 190.89831i

1775.9785 - 190.89831i

Six Degrees: 2129. Ice caps are gone. Methane hydrates become unstable raising temperatures in a positive-feedback loop. Ocean circulation stops. Hydrogen sulfide producing bacteria flourish poisoning the air. The Ozone layer dissipates leaving the land sterilized with UV radiation. End-Permian-like conditions make life nearly impossible.

-->roots(A - [0;0;0;6])

2129. 6492

1760.7981 + 216.6782i

1760.7981 - 216.6782i

Scary? Yes. That's why the rest of the world sees the Paris Climate Accord as being important. That's why the United Nations sees Global Warming as the #1 threat - far greater than terrorism. Far greater than COVID.