

# ECE 341 - Homework #10

Testing with Normal Distributions, Regression Analysis

## Testing with Normal Distributions

Assume the monthly temperatures in Fargo, ND are normal distributions with the following mean and standard deviation:

| Monthly Low (Degrees F: Fargo, ND) |          |          |         |         |         |        |         |         |         |        |         |         |
|------------------------------------|----------|----------|---------|---------|---------|--------|---------|---------|---------|--------|---------|---------|
|                                    | Jan      | Feb      | Mar     | Apr     | May     | Jun    | July    | Aug     | Sep     | Oct    | Nov     | Dec     |
| mean                               | -23.8725 | -20.6238 | -8.1475 | 15.1775 | 27.3413 | 40.425 | 46.4875 | 43.3387 | 30.6763 | 19.15  | -1.0875 | -17.025 |
| st dev                             | 8.2179   | 7.8559   | 10.0237 | 7.0423  | 4.3864  | 4.1576 | 4.0938  | 4.1522  | 4.8861  | 5.5212 | 9.0417  | 9.1069  |

1) How cold will this June be

- With a confidence level of 80%?
- With a confidence level of 95%?
- With a confidence level of 99.9%?

The z-scores are

- $z = 0.84162$  (20% tail)
- $z = 1.64485$  (5% tail)
- $z = 3.09023$  (0.1% tail)

Using Matlab

```
>> x = 40.425;  
>> s = 4.3864;  
>> F = x - 0.84162 * s
```

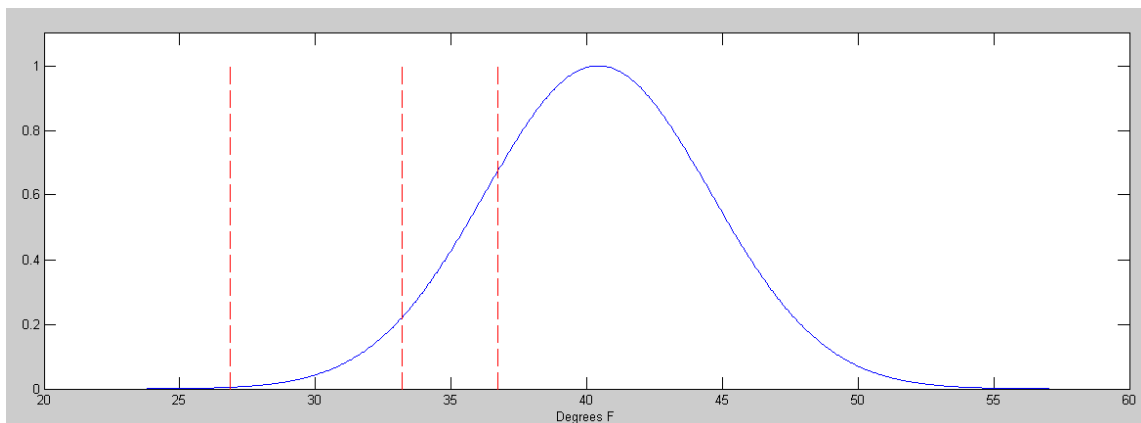
$F = 36.7333$                       20% chance June will get colder than 36.73F

```
>> F = x - 1.64485 * s
```

$F = 33.2100$                       5% chance June will get colder than 33.21F

```
>> F = x - 3.09023 * s
```

$F = 26.8700$                       0.1% chance June will get colder than 26.87F



## Testing with Two Populations

| Monthly High (Degrees F: Fargo, ND) |         |         |         |        |         |         |        |         |        |        |        |         |
|-------------------------------------|---------|---------|---------|--------|---------|---------|--------|---------|--------|--------|--------|---------|
|                                     | Jan     | Feb     | Mar     | Apr    | May     | Jun     | July   | Aug     | Sep    | Oct    | Nov    | Dec     |
| mean                                | 38.5363 | 41.0038 | 56.0625 | 78.1   | 87.8625 | 92.0138 | 94.625 | 94.6262 | 89.575 | 79.5   | 59.425 | 41.7875 |
| st dev                              | 6.4057  | 7.1528  | 10.7118 | 7.7909 | 4.5472  | 4.5281  | 4.0043 | 4.5967  | 5.6294 | 6.7842 | 7.4728 | 6.5327  |

2) What is the probability that June will be warmer than July?

- High for June > High for July

```
>> Xjune = 92.0138;
>> Sjune = 4.5281;
>> Xjuly = 94.625;
>> Sjuly = 4.5281;
>>
>> Xw = Xjune - Xjuly

Xw =    -2.6112

>> Vw = Sjune^2 + Sjuly^2

Vw =    41.0074

>> Sw = sqrt(Vw)

Sw =     6.4037

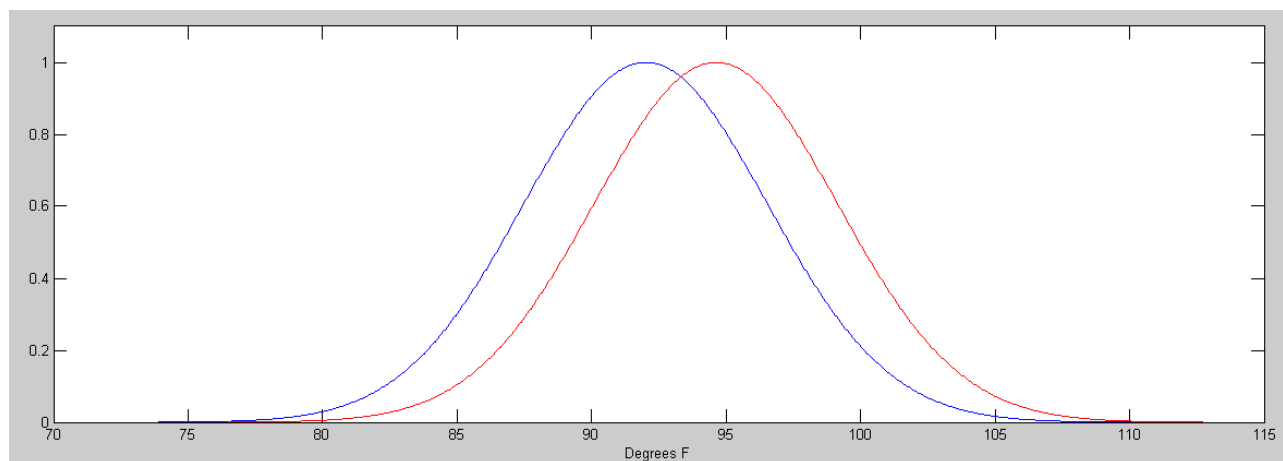
>> z = Xw / Sw

z =    -0.4078

>> p = ( erf(z/sqrt(2)) + 1) / 2

p =     0.3417
```

**There is a 34% chance that June will be warmer than July**



pdf for th high temperature in June (blue) & July (red)

| Monthly Low (Degrees F: Fargo, ND) |          |          |         |         |         |        |         |         |         |        |         |         |
|------------------------------------|----------|----------|---------|---------|---------|--------|---------|---------|---------|--------|---------|---------|
|                                    | Jan      | Feb      | Mar     | Apr     | May     | Jun    | July    | Aug     | Sep     | Oct    | Nov     | Dec     |
| mean                               | -23.8725 | -20.6238 | -8.1475 | 15.1775 | 27.3413 | 40.425 | 46.4875 | 43.3387 | 30.6763 | 19.15  | -1.0875 | -17.025 |
| st dev                             | 8.2179   | 7.8559   | 10.0237 | 7.0423  | 4.3864  | 4.1576 | 4.0938  | 4.1522  | 4.8861  | 5.5212 | 9.0417  | 9.1069  |

3) What is the probability that June will be colder than July?

- Low for June < Low for July

In Matlab

```
>> Xjune = 40.425;
>> Sjune = 4.1576;
>> Xjuly=46.4875;
>> Sjuly = 4.0938;
>> Xw = Xjune - Xjuly

Xw =    -6.0625

>> Vw = Sjune^2 + Sjuly^2

Vw =    34.0448

>> Sw = sqrt(Vw)

Sw =     5.8348

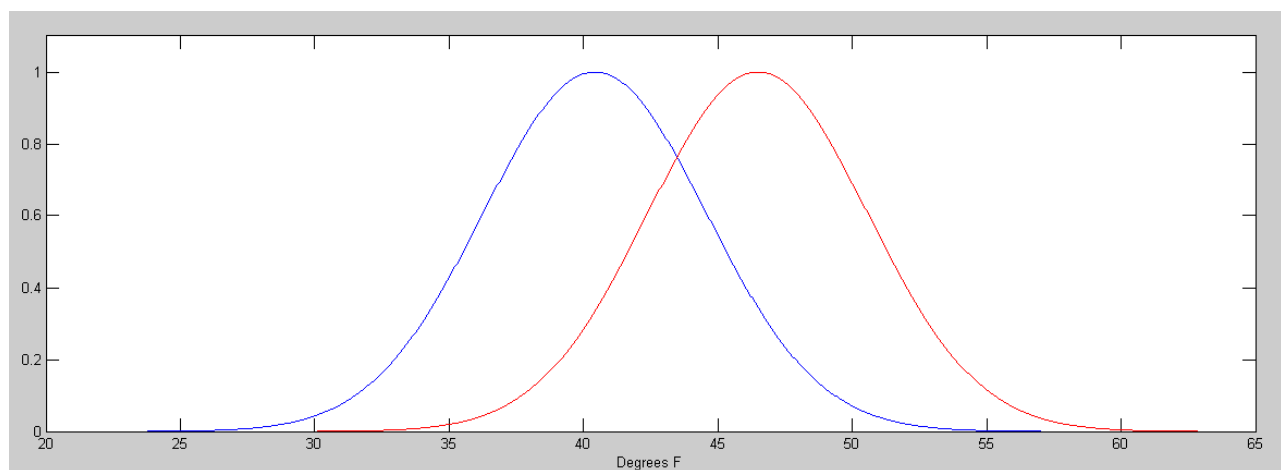
>> z = Xw / Sw

z =    -1.0390

>> p = ( erf(-z/sqrt(2)) + 1) / 2

pW =     0.8506
```

**There is an 85% chance that June will get colder than July**



pdf for the low temperature in June (blue) and July (red)

## Regression Analysis

5) Global CO2 levels have been measured by NASA Goddard since 1958.

a) Determine a parabolic curve fit for global CO2 levels since 1958

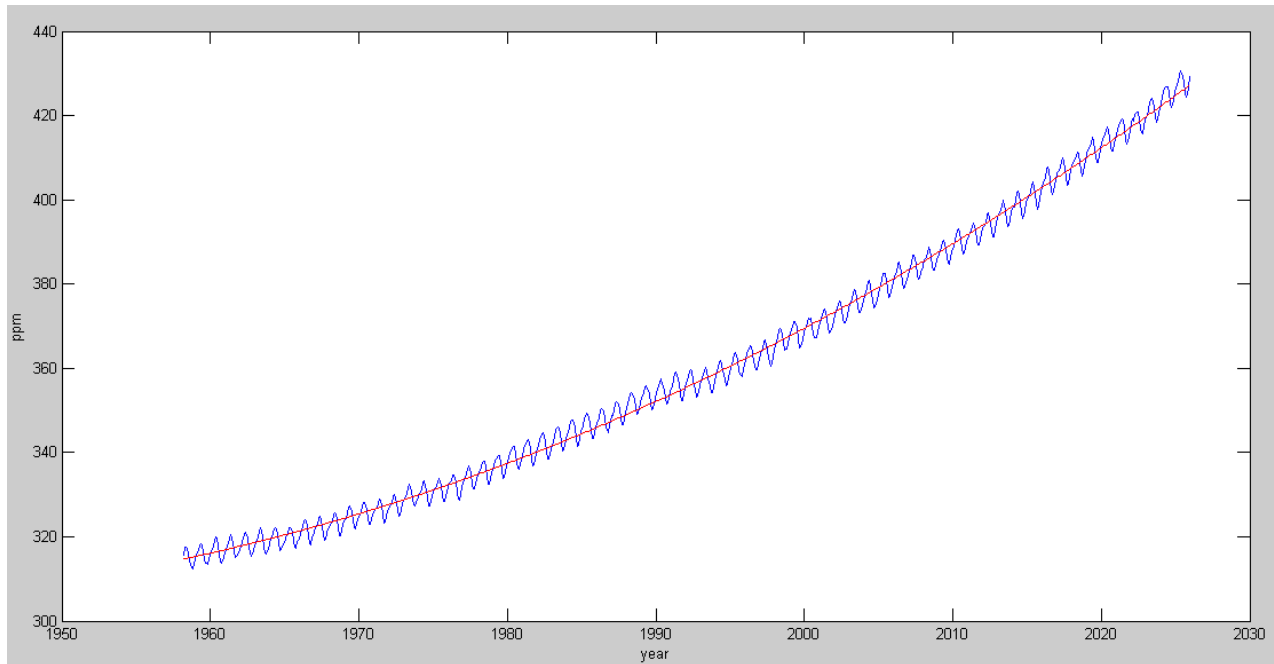
$$CO_2 \approx ay^2 + by + c$$

In Matlab

```
>> year = Data(:,3);
>> CO2 = Data(:,4);
>> B = [year.^2, year, year.^0];
>> A = inv(B'*B)*B'*CO2

a 1.3463e-002
b -5.1980e+001
c 5.0477e+004

>> plot(year, CO2, 'b', year, B*A, 'r')
>> xlabel('year');
>> ylabel('ppm');
```



b) From your curve fit, what will the CO2 levels be in the year 2050?

```
>> [2050^2, 2050, 1]*A

ans = 496.81
```

c) When will global CO2 levels reach 1000 ppm?

```
>> roots(A - [0;0;1000])

2157.8
1703.1
```

6) The National Oceanic and Atmospheric Administration has been monitoring global temperatures since 1880.

a) Determine a parabolic curve fit for global temperatures from 1950 - present.

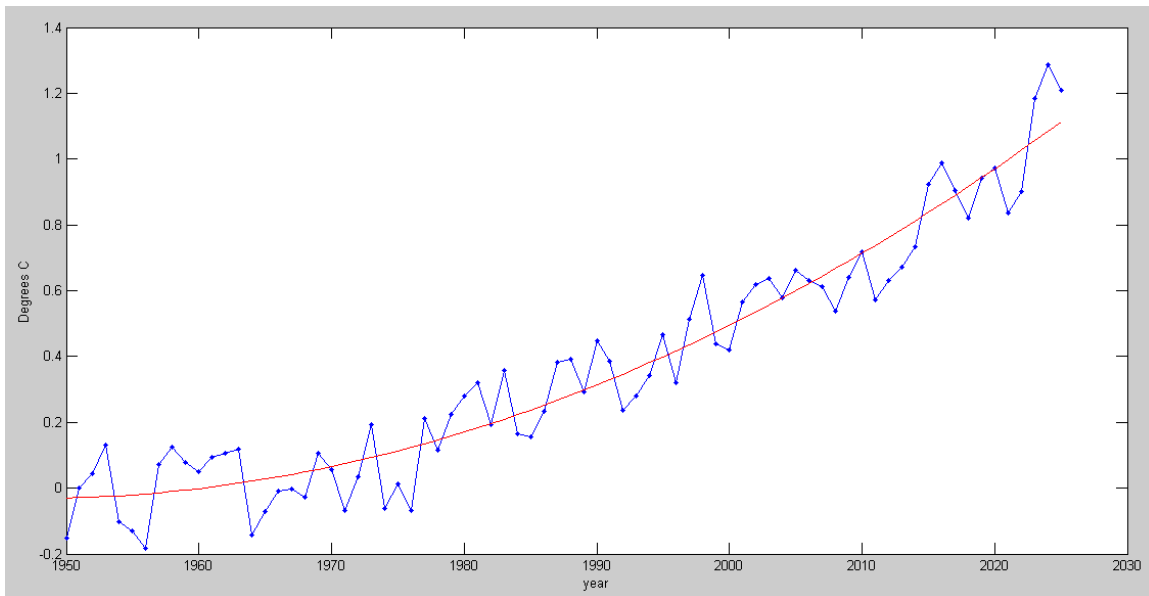
$$\delta T \approx ay^2 + by + c$$

In Matlab

```
>> year = Data(:,1);  
>> dT = Data(:,2);  
>> B = [year.^2, year, year.^0];  
>> A = inv(B'*B)*B'*dT
```

```
a 1.9065e-004  
b -7.4260e-001  
c 7.2307e+002
```

```
>> plot(year, dT, 'b', year, B*A, 'r')  
>> xlabel('year');  
>> ylabel('Degrees C');  
>>
```



b) From your curve fit, what will global temperatures be in the year 2050?

```
>> [2050^2, 2050, 1]*A  
ans = 1.9721
```

c) From your curve fit, what will global temperatures be in the year 2100?

```
>> [2100^2, 2100, 1]*A  
ans = 4.4030
```