ECE 376 - Homework #7

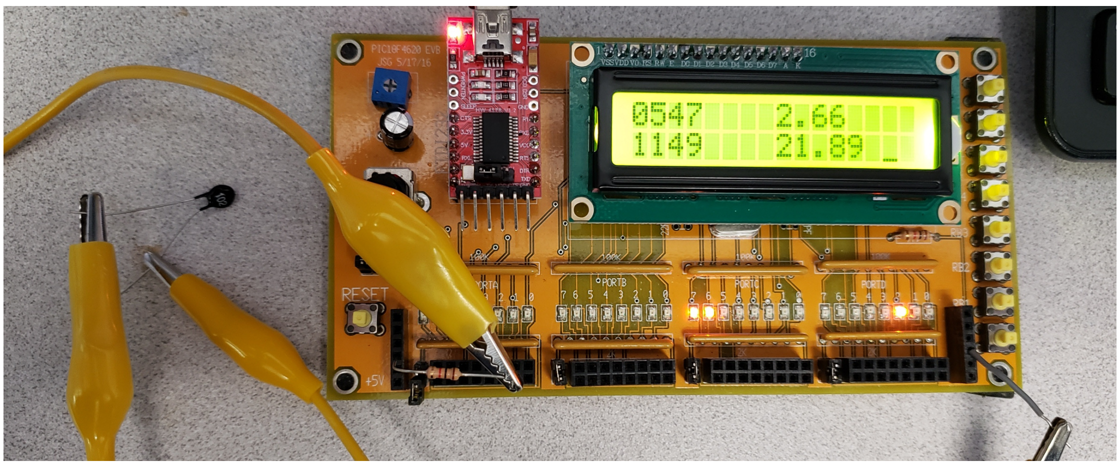
Data Collection & Student t-Test - Due Monday, March 17th

Data Collection (population A)

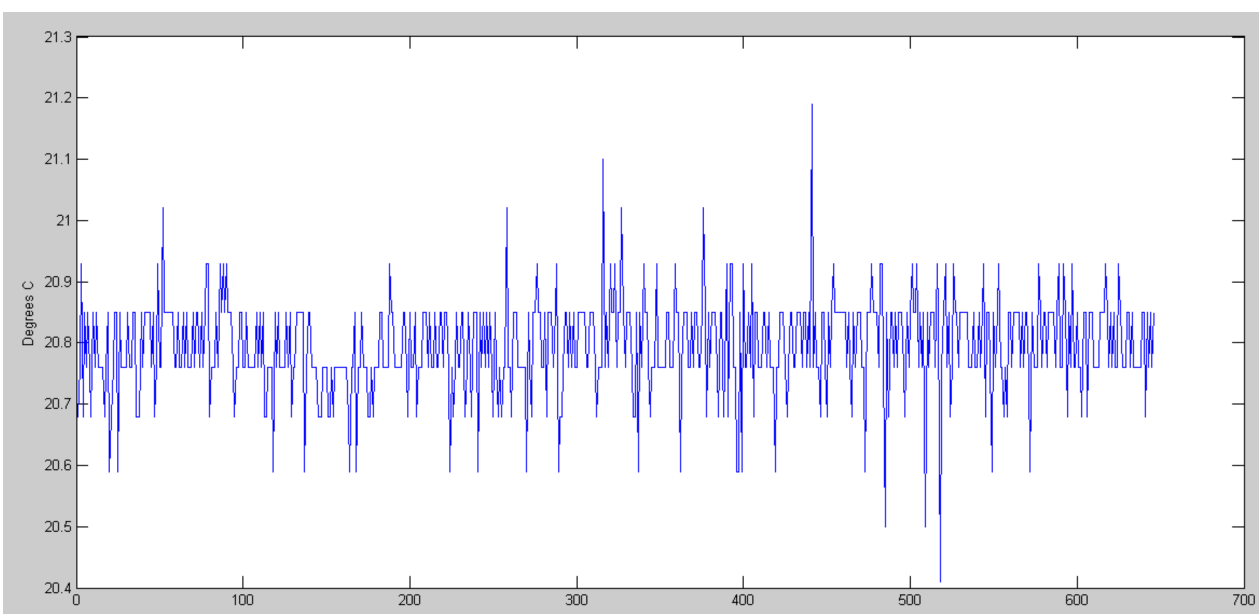
1) Using the temperature sensor from homework set #6, record the temperature of something at steady-state:

- Refrigerator, freezer, glass of luke-warm water, outside temperature, etc. Your pick.
- Collect 50+ data points

Plot the resulting data vs. time.



Temperature Sensor from Homework #6
Row 1: Raw A/D reading, Voltage
Row : Resistance (Ohms), Temperature (degees C)



Temperature of ECE 201 at 9:11am on 3/6/25

Code: Take the code from homework #6 and add two sections

- Initialize the serial port at 9600 baud
- Send the temerature data to the serial port

```
void main(void)
{
   int A2D, VOLT, OHM;
   float CELSIUS;
   unsigned int i, j;

   TRISA = TRISD = TRISC = TRISE = 0;
   TRISB = 0xFF;
   ADCON1 = 0x0F;

   LCD_Init();

   LCD_Move(0,0);  for (i=0; i<20; i++) LCD_Write(MSG0[i]);
   Wait_ms(500);

   LCD_Inst(0x01);

// Initialize the A/D port
   TRISA = 0xFF;
   TRISE = 0x0F;
   ADCON2 = 0x85;
   ADCON1 = 0x07;
   ADCON0 = 0x01;
   i = 0;


// Initialize Serial Port to 9600 baud
   TRISC = TRISC | 0xC0;
   TXIE = 0;
   RCIE = 0;
   BRGH = 0;
   BRG16 = 1;
   SYNC = 0;
   SPBRG = 255;
   TXSTA = 0x22;
   RCSTA = 0x90;

   while(1) {

      A2D = A2D_Read(1);
      VOLT = 0.488 * A2D;
      OHM = 1000.0 * (A2D / (1023.0 - A2D) );
      CELSIUS = 3930. / ( log( A2D / (1023. - A2D) ) + 13.1879 ) - 273;

      LCD_Move(0,0);  LCD_Out(A2D, 4, 0);
      LCD_Move(0,8);  LCD_Out(VOLT, 3, 2);
      LCD_Move(1,0);  LCD_Out(OHM, 4, 0);
      LCD_Move(1,8);  LCD_Out(CELSIUS*100, 4, 2);

      SCI_Out(CELSIUS*100, 4, 2);
      SCI_CRLF();

      Wait_ms(100);

      }
   }
```

2) From your data determine

- The mean,
- The standard deviation,
- The 90% confidence interval for the value of your next reading (individual)
- The 90% confidence interval for the actual temperature of whatever you're measuring (population)

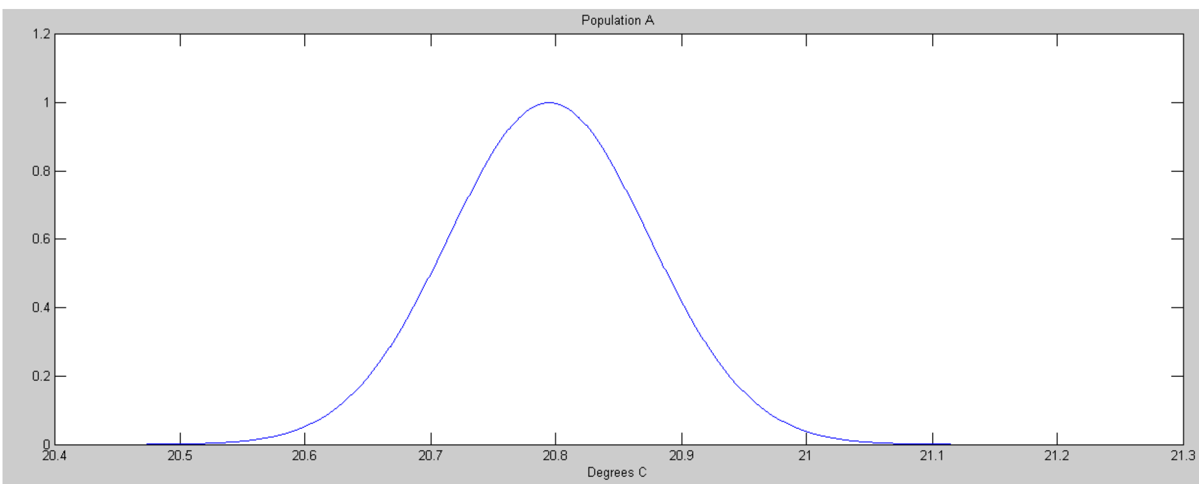
```
>> Xa = mean(A)
Xa =   20.7946

>> Sa = std(T)
Sa =     0.0801

>> Na = length(A)
Na = 646
```

Plotting the pdf:

```
>> s = [-4:0.01:4]';
>> p = exp(-s.^2 / 2);
>> plot(s*Sa+Xa, p)
>> ylim([0,1.2])
>> xlabel('Degrees C')
>> title('Population A')
```



pdf for population A

Individual

The 90% confidence interval for the next sample:

```
>> Xa + 1.647*Sa
ans =   20.9260

>> Xa - 1.647*Sa
ans =   20.6632
```

The 90% confidence interval for the next reading is (20.6632, 20.9260)

Population

```
>> Xa + 1.647*Sa/sqrt(Na)
ans =   20.7997

>> Xb - 1.647*Sa/sqrt(Na)
ans =   20.7894
```

The 90% confidence interval for the actual temperature is (20.7894, 20.7997)

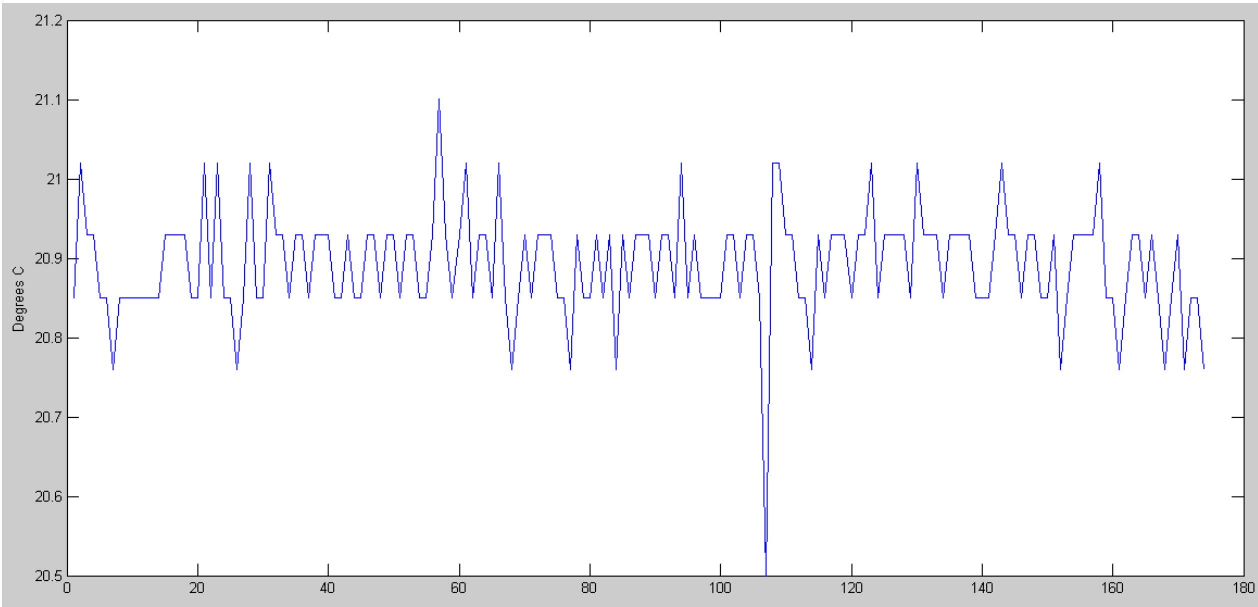
(wait 9 minutes - see if the sun shining in the window changes the temperature....)

Temperature in my office with the sun shining in the window is in the range of (20.7894 - 20.7997) degrees C with a probability of 0.9

Data Collection (population B)

3) Record another 50+ data points under the same conditions

Plot the resulting data vs. time



Temperature of ECE 201 at 9:20am on 3/6/25

4) From your data determine

- The mean,
- The standard deviation,
- The 90% confidence interval for the value of your next reading (individual)
- The 90% confidence interval for the actual temperature of whatever you're measuring (population)

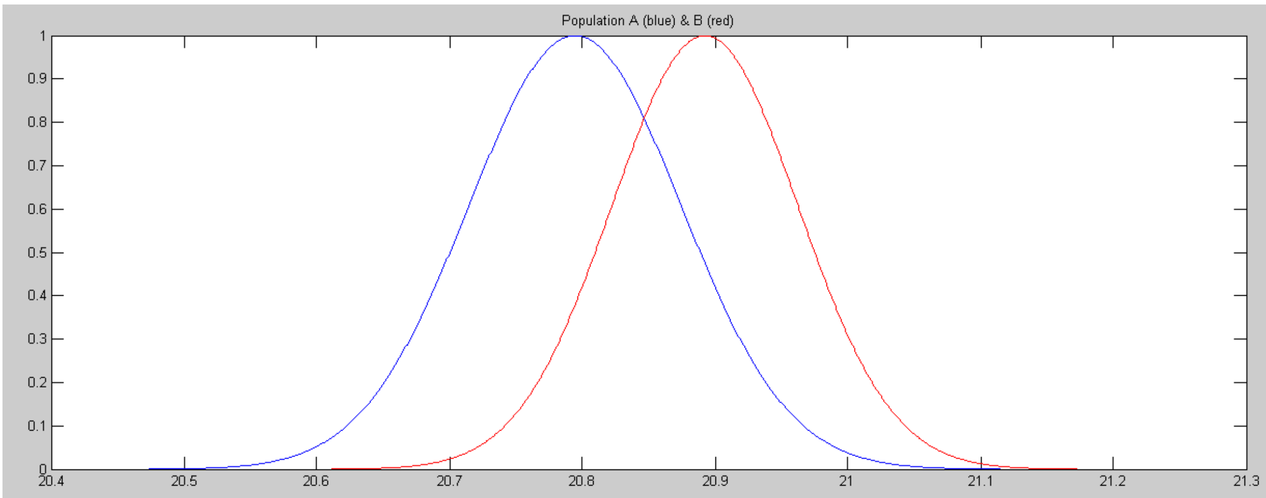
```
>> Xb = mean(B)
Xb =   20.8924

>> Sb = std(B)
Sb =    0.0702

>> Nb = length(B)
Nb =   174
```

Plotting the pdf:

```
>> s = [-4:0.01:4]';
>> p = exp(-s.^2 / 2);
>> plot(s*Sa+Xa, p, 'b', s*Sb+Xb, p, 'r')
>> title('Population A (blue) & B (red)')
```



pdf of population A (blue) and B (red)

90% confidence interval for the next reading

```
>> Xb + 1.654*Sb
ans =   21.0085

>> Xb - 1.654*Sb
ans =   20.7762
```

I'm 90% certain the next reading will be in the range of (20.7762, 21.0085)

90% confidence interval for population B's mean

```
>> Xb + 1.654*Sb/sqrt(Nb)
ans =   20.9012

>> Xb - 1.654*Sb/sqrt(Nb)
ans =   20.8836
```

I'm 90% certain that the actual temperature is in the range of (20.8836, 20.9012)

Comparison of Means Test (A vs. B)

5) Do a comparison of means test to determine the probability that

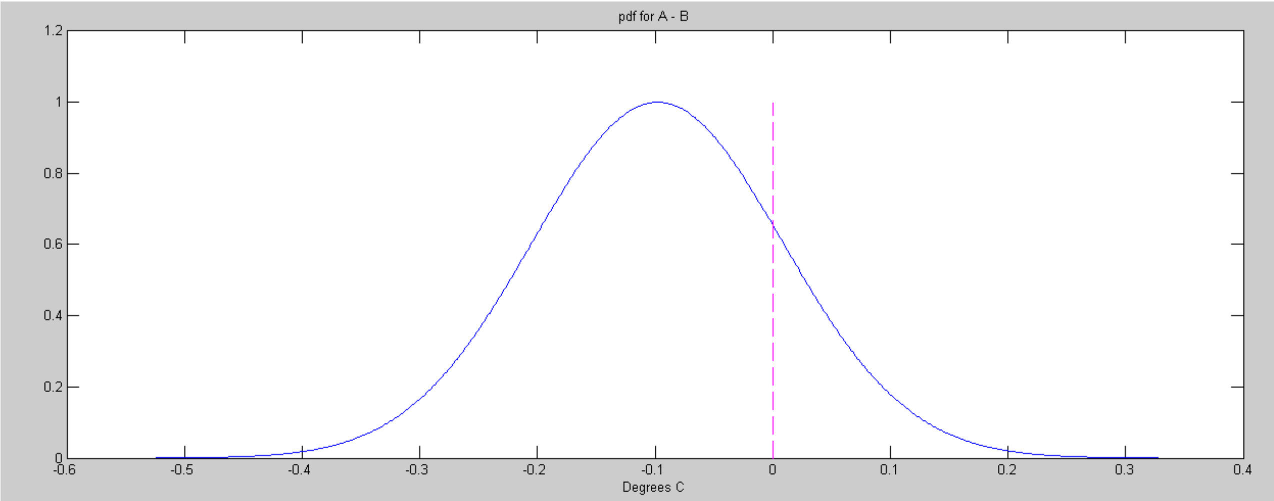
- The next measurement from A will have a higher value than the next meaurement from B
- Population A has a higher mean than population B

Create a new variable, W = A - B

```
>> Xw = Xa - Xb
Xw =   -0.0978

>> Sw = sqrt(Sa^2 + Sb^2)
Sw =    0.1065

>> plot(s*Sw+Xw, p)
>> xlabel('Degrees C')
>> title('pdf for A - B')
```



The probability that the next reading of A > next reading of B (individual)

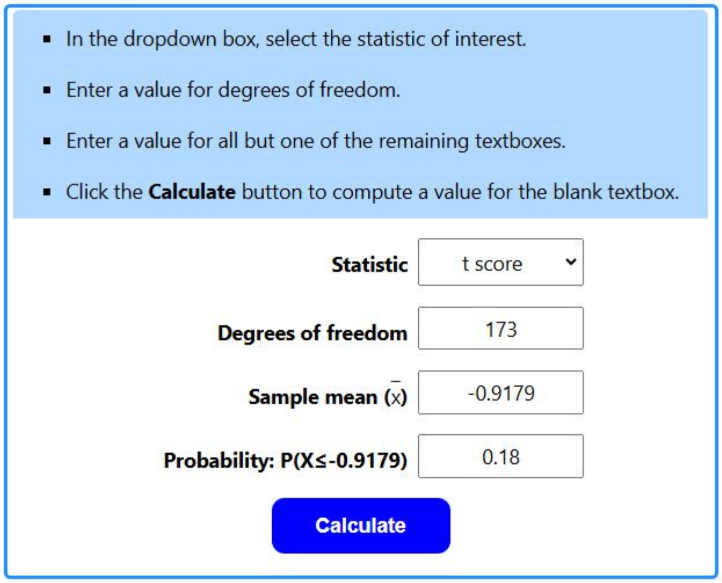
Find the area to the right of zero (A>B)

```
>> Tw = Xw / Sw
Tw =   -0.9179

>> Nw = min(Na, Nb)
Nw = 174
```

From StatTrek, a t-score of -0.9179 with 173 degrees of freedom (approximately correct) is 18%

There is an 18% chance that the next reading of A will be warmer than B



Population: For populations, sample size matters

```
>> Xw = Xa - Xb
Xw =   -0.0978

>> Sw = sqrt(Sa^2/Na + Sb^2/Nb)
Sw =    0.0062

>> Tw = Xw / Sw
Tw =  -15.7974
```

From StatTrek, there is a 0% (meaning less than 0.00005% chance) that A > B

(meaning my room is warming up with the sun coming in the window - measurable after only 9 minutes)