

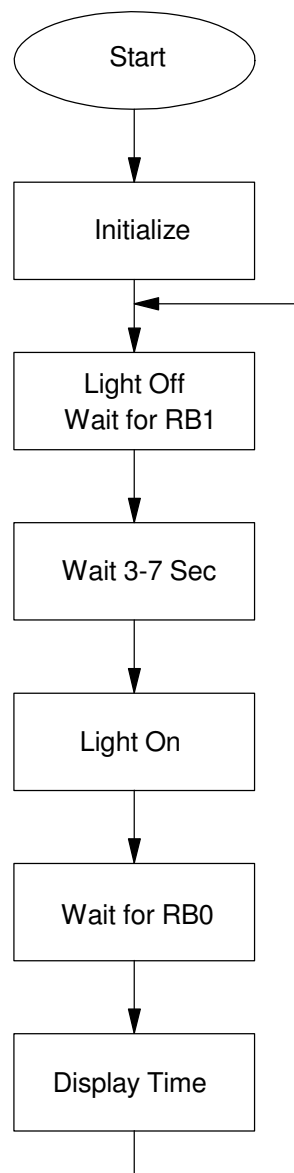
ECE 376 - Homework #7

Student t-Tests.

Reflex Time

- The game starts when you press RB0
- Once pressed, the PIC waits 3.0 to 7.0 seconds (random)
- After waiting, the lights on PORTA turn on
- The PIC then starts looping, one loop every 1ms, to keep track of time
- Once the lights turn on, press RB0 again
- The time delay from when the lights turn on and you press RB0 is your reflex time,.

1) Give a flow chart for this program



2) Give the corresponding C code

```
// Global Variables
const unsigned char MSG0[21] = "Reflex.C";

// Subroutine Declarations
#include <pic18.h>

// Subroutines
#include "lcd_portd.c"

// Main Routine

void main(void)
{
    unsigned int DELAY;
    unsigned int TIME;
    unsigned int i, j;

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

    LCD_Init(); // initialize the LCD

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

    // 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) {
        :
        :
        C Code
        :
        :
    }
}
```

Compilation Result:

Memory Summary:

Program space	used	C40h (3136) of 10000h bytes	(4.8%)
Data space	used	29h (41) of F80h bytes	(1.0%)
EEPROM space	used	0h (0) of 400h bytes	(0.0%)
ID Location space	used	0h (0) of 8h nibbles	(0.0%)
Configuration bits	used	0h (0) of 7h words	(0.0%)

3) Verify your code works (collect data)

Reflex Times

```
00.241
00.230
00.199
00.182
00.224

DATA = [ 00.241
00.230
00.199
00.182
00.224];

>> x = mean(DATA)

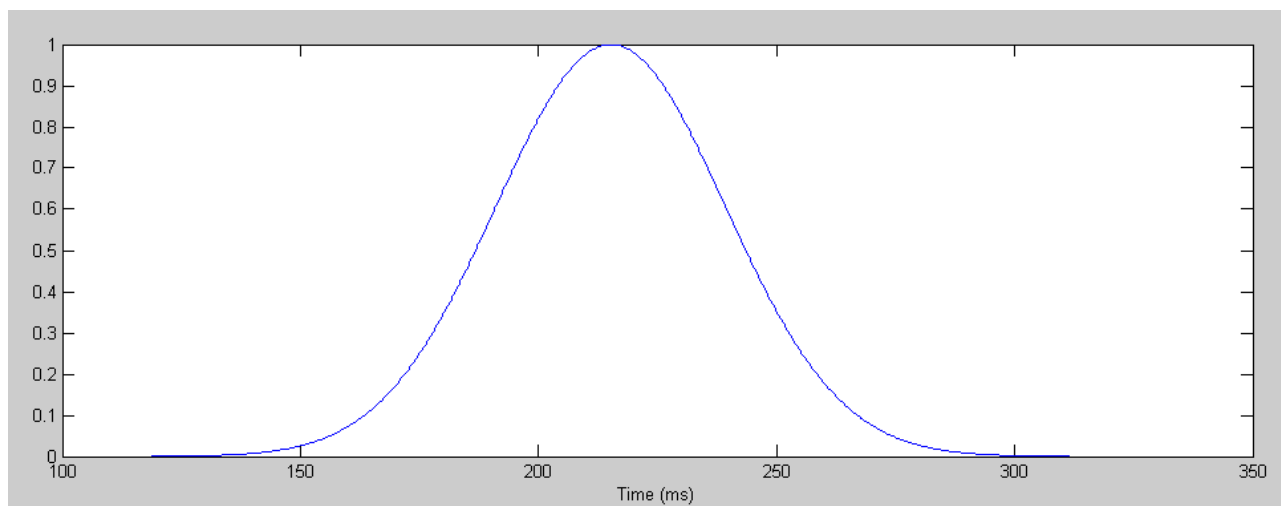
x =    0.2152

>> s = std(DATA)

s =    0.0241

>> s1 = [-4:0.01:4]';
>> p = exp(-s1.^2 / 2);
>> plot((s1*s+x)*1000, p)
>> xlabel('Time (ms)')

>> xlabel('Time (ms)')
>> plot((s1*s+x)*1000, p, 163.8*[1,1],[0,0.5], 'r--', 266.6*[1,1],[0,0.5], 'r--')
```



pdf for reflex times

t-Test with One Population

4) Record your reflex time with 2+ readings (Population A)

- Give the raw data

Reflex Times

```
A = [ 0.241, 0.230, 0.199, 0.182, 0.224 ];
```

5) Use a student t-test to determine

a) The 90% confidence interval for your reflex time (individual)

With 5 data points (4 degrees of freedom), the t-score for 5% tails is 2.13281

The 90% confidence interval is then

```
>> Xa = mean(A)
Xa = 0.2152
>> Sa = std(A)
Sa = 0.0241
>> Xa + 2.13281*Sa
ans = 0.2666
>> Xa - 2.13281*Sa
ans = 0.1638
```

My reflex time is in the range of (0.1638, 0.2666) with a probability of 0.9.

b) The 90% confidence interval for your average reaction time (population)

The variance drops with the sample size for populations

```
>> Xa - 2.13281*Sa/sqrt(5)
ans = 0.1922
>> Xa + 2.13281*Sa/sqrt(5)
ans = 0.2382
```

My average reflex time is in the range of (0.1922, 0.2382) with a probability of 0.9.

t-Test with Two Populations

6) Record a different set of reflex times (Population B)

- Yourself a little while later
- Someone else's reflex times

Experiment: Are my reflex times to sound less than my reflex times to sight?

- Tie a speaker to RA1
- Press RB0 when I hear the speaker pop (light turns on)

```
B = [0.175, 0.177, 0.141, 0.136, 0.166, 0.136]
```

7) Use a student t-test to determine

- The probability that $A > B$ (a random sample from population A is larger than a random sample from population B)
- The probability that A's average reaction time is more than B's average reaction time.

```
>> A = [ 0.241, 0.230, 0.199, 0.182, 0.224];
>> B = [ 0.175, 0.177, 0.141, 0.136, 0.166, 0.136];

>> Xw = mean(A) - mean(B)

Xw =      0.0600

>> Vw = var(A) + var(B);
>> Sw = sqrt(std(A)^2 + std(B)^2)

Sw =      0.0311

>> Sw = sqrt(var(A) + var(B))

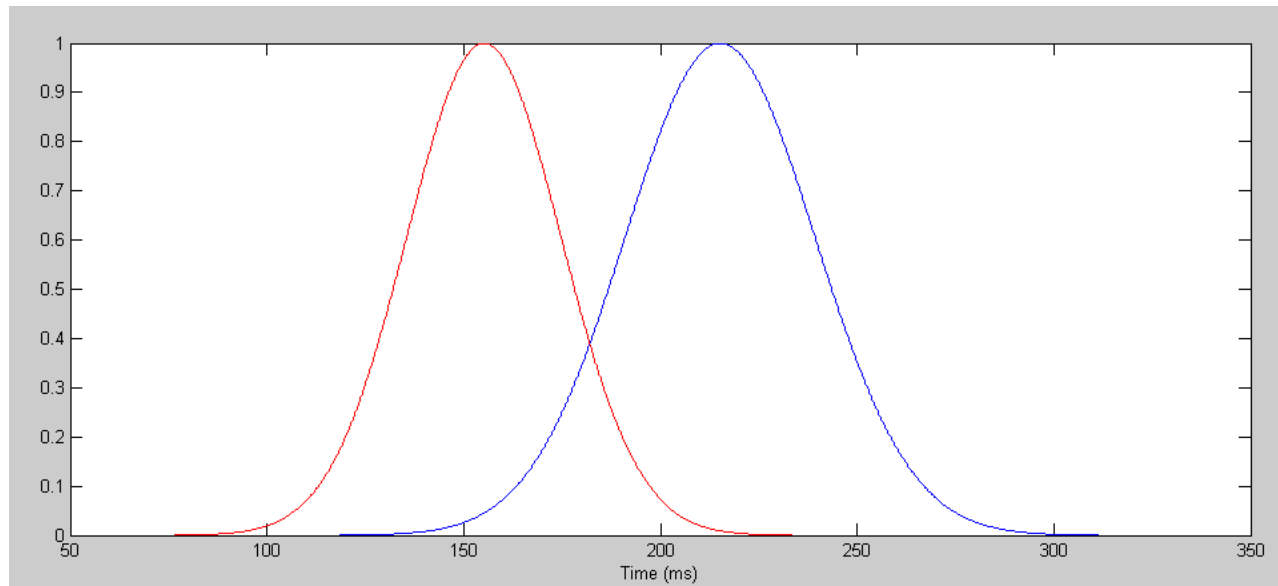
Sw =      0.0311

>> t = Xw / Sw

t =      1.9313
```

From StatTrek, a t-score with 4 degrees of freedom (smaller of A and B) gives a probability of 0.06281

In my next experiment, sight has a 6.28% chance of beating sound



pdf for reflex time with respect to light (red) and sound (blue)

b) The probability that your average reflex time is less than the other person's average reflex time.

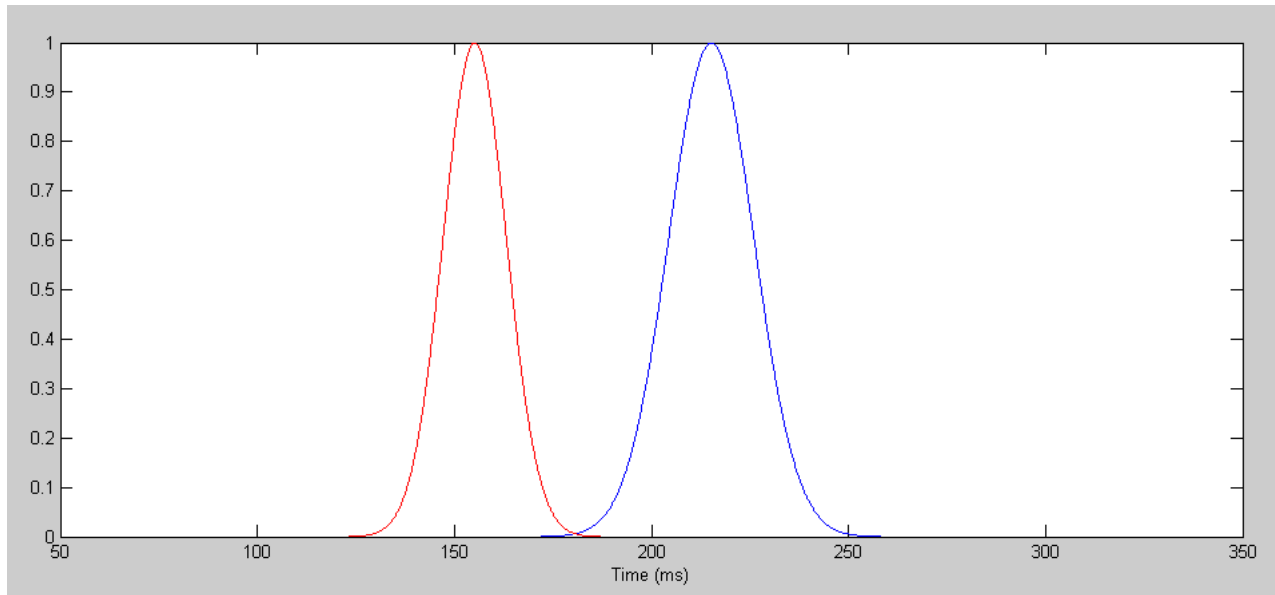
This is a population question (population mean), so the variance decreases with the sample size

```
>> Sw = sqrt(var(A)/length(A) + var(B)/length(B))
Sw =      0.0134
>> t = Xw / Sw
t =      4.4692
```

From StatTrek, a t-score of 4.4692 with 4 degrees of freedom corresponds to a probability of 0.00554

There is a 0.554% chance that my reflex time to sight is better than my reflex time to sound

```
>> plot(s1*(std(A)/sqrt(Na))+mean(A),p,'b',s1*(std(B)/sqrt(Nb))+mean(B),p,'r');
>> xlim([50,350])
>> xlabel('Time (ms)')
```



pdf for my average reaction time to light (red) and sound (blue)