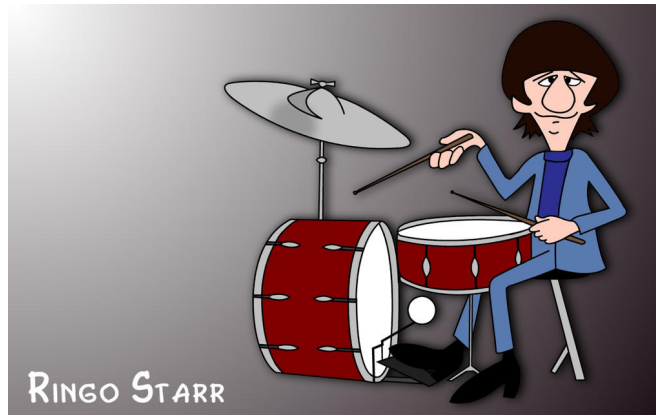


ECE 476/676 - Homework #7

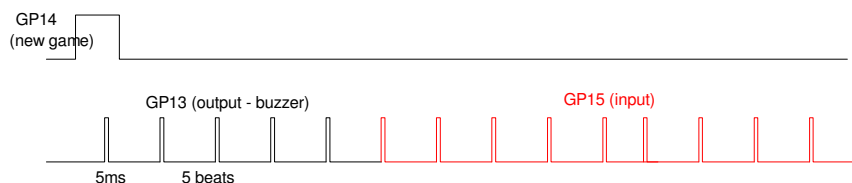
Edge Interrupts, Timer Interrupts

Drummer Trainer

One of the hallmarks of Ringo Starr was that he was very good at maintaining a beat throughout a song. Are you?



Write a python program that generates a random tempo from 40 to 80 beats-per-minute (bpm) and then has you maintain that tempo.



Drummer Trainer	
BPM	57
# Beats	6
Error	-13ms
Mean	4.3ms
St Dev	7.6ms

Specifically

- When the program starts, a random number in the range of 40 to 80 is generated.
- The Pico will then output five beats at that tempo
- The user is then to continue playing that tempo for another ten beats by pressing button GP15
- Each time you press GP15, the error in your tempo (in milliseconds) is displayed
- As you go along, the LCD displays
 - The target beats per minute
 - The beat number (increase by one each time you press GP15),
 - The error in your current beat in ms
 - The mean error since the start of this round
 - The standard deviation of your error in this round

- A new game is triggered by pressing GP14 (new random tempo, clear variables)

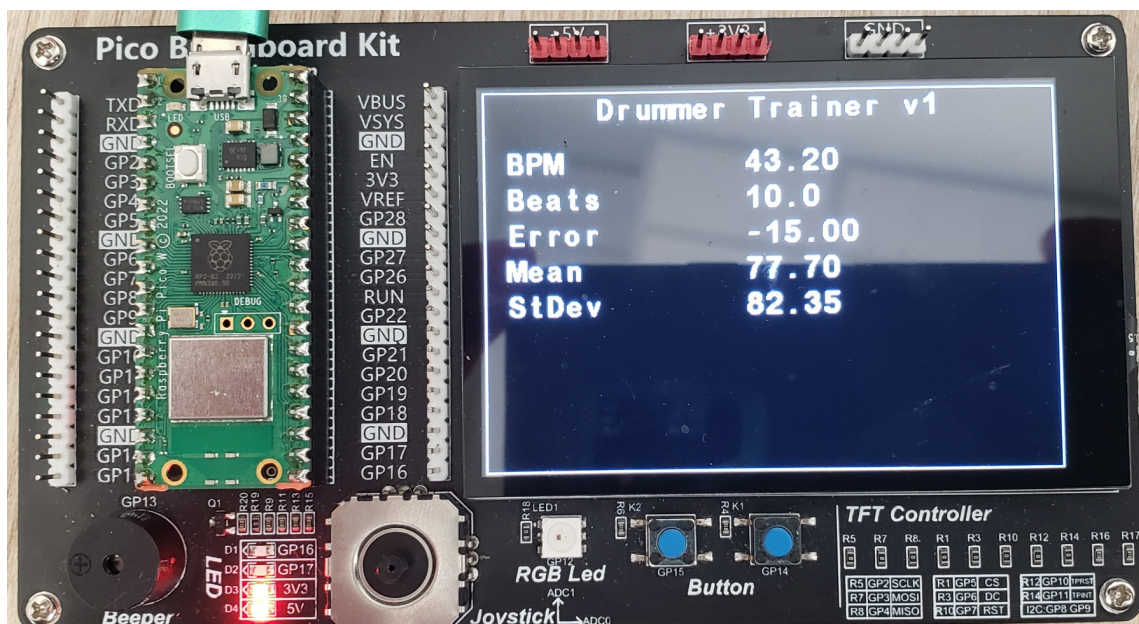
The goal is to make the mean and standard deviation of the error as small as possible,

Grading

- 10pt A random tempo is generated and displayed on the LCD in the range of 40 to 80 bmp
- 10pt Periodic timer interrupts play five beats at this tempo
- 10pt One-shot timer interrupts set the duration of the buzzer to 5ms (you can change this)
- 10pt After five beats, edge interrupts are triggered each time you press GP15
- 10pt The LCD displays the total number of beats you've done (GP15 presses)
- 10pt The LCD displays the error, mean error, and standard deviation of the error
- 10pt Edge interrupts start a new game on pressing GP14
- 10pt Demonstrate your Drummer Trainer

Result

```
New Game
-9 T_Beat = 1389 T_Thump = 1285 error (ms) = 104
-8 T_Beat = 1389 T_Thump = 1382 error (ms) = 7
-7 T_Beat = 1389 T_Thump = 1408 error (ms) = -19
-6 T_Beat = 1389 T_Thump = 1315 error (ms) = 74
-5 T_Beat = 1389 T_Thump = 1435 error (ms) = -46
-4 T_Beat = 1389 T_Thump = 1362 error (ms) = 27
-3 T_Beat = 1389 T_Thump = 1405 error (ms) = -16
-2 T_Beat = 1389 T_Thump = 1296 error (ms) = 93
-1 T_Beat = 1389 T_Thump = 1378 error (ms) = 11
0 T_Beat = 1389 T_Thump = 1442 error (ms) = -53
1 T_Beat = 1389 T_Thump = 1315 error (ms) = 74
2 T_Beat = 1389 T_Thump = 1410 error (ms) = -21
3 T_Beat = 1389 T_Thump = 1282 error (ms) = 107
4 T_Beat = 1389 T_Thump = 1330 error (ms) = 59
5 T_Beat = 1389 T_Thump = 1195 error (ms) = 194
6 T_Beat = 1389 T_Thump = 1328 error (ms) = 61
7 T_Beat = 1389 T_Thump = 1372 error (ms) = 17
8 T_Beat = 1389 T_Thump = 1211 error (ms) = 178
9 T_Beat = 1389 T_Thump = 1213 error (ms) = 176
10 T_Beat = 1389 T_Thump = 1404 error (ms) = -15
```



Coding:

Display:

```
# LCD initialization

LCD.Init()
Black = LCD.RGB(0,0,0)
White = LCD.RGB(250,250,250)
Grey  = LCD.RGB(50,50,50)
Red   = LCD.RGB(250,0,0)
Orange = LCD.RGB(250,100,0)
Yellow = LCD.RGB(250,250,0)
Green  = LCD.RGB(50,250,0)
Blue   = LCD.RGB(0, 50, 250)

def New_Game():
    LCD.Clear(Black)
    LCD.Box(1,1,479,319,White)
    LCD.Title('Drummer Trainer v1', White, Black)
    LCD.Text3('BPM      ', 20, 50, White, Black)
    LCD.Text3('Beats   ', 20, 80, White, Black)
    LCD.Text3('Error   ', 20, 110, White, Black)
    LCD.Text3('Mean    ', 20, 140, White, Black)
    LCD.Text3('StDev   ', 20, 170, White, Black)
    flag = 0

BPM = Beats = Error = Mean = StDev = flag = 0

def Display():
    global BPM, Beats, Error, Mean, StDev
    LCD.Text3('{:.2f}'.format(BPM) + ' ', 220, 50, White, Black)
    LCD.Text3('{:.1f}'.format(Beats) + ' ', 220, 80, White, Black)
    LCD.Text3('{:.2f}'.format(Error)+ ' ', 220, 110, White, Black)
    LCD.Text3('{:.2f}'.format(Mean) + ' ', 220, 140, White, Black)
    LCD.Text3('{:.2f}'.format(StDev) + ' ', 220, 170, White, Black)
    flag = 0
```

Edge Interrupts

```
# Edge Interrupts

Start = Pin(14, Pin.IN, Pin.PULL_UP)

def ISR_New_Game(Start):
    global T_Beat, N0, N1, m1, m2
    print('New Game')
    T_Beat = randint(500, 1500)
    N1 = m1 = m2 = 0
    N0 = 0
    N1 = -10
    Ton.init(period = T_Beat, mode=Ton.PERIODIC, callback=LED_On)

Start.irq(trigger=Pin.IRQ_FALLING, handler=ISR_New_Game)

T1 = T2 = T_Thump = T_Beat = N0 = N1 = m1 = m2 = 0
Error = 0
m1 = m2 = 0
```

```

Thump = Pin(15, Pin.IN, Pin.PULL_UP)
def ISR_Thump(Thump):
    global T2, T1, T_Thump, T_Beat, N1, m1, m2, flag, Error
    T2 = T1
    T1 = ticks_ms()
    T_Thump = T1 - T2
    e = T_Beat - T_Thump
    if( N1 < 10 ):
        if(abs(e) < 500):
            N1 += 1
            Error = e
            m1 += Error
            m2 += Error ** 2
            flag = 1
            print(N1, ' T_Beat = ', T_Beat, ' T_Thump = ', T_Thump, ' error (ms) = ', e)

Thump.irq(trigger=Pin.IRQ_FALLING, handler=ISR_Thump)

```

Timer Interrupts

```
# Timer Interrupts
LED = Pin(13, Pin.OUT)
Ton = Timer()
Toff = Timer()

def LED_On(timer):
    global N0, N1, T_Beat, m1, m2
    if(N1 < 0):
        LED.value(1)
        Toff.init(period=3, mode=Toff.ONE_SHOT, callback=LED_Off)
        m1 = 0
        m2 = 0

def LED_Off(timer):
    LED.value(0)

T_Beat = randint(500, 1500)
Ton.init(period = 5000, mode=Ton.PERIODIC, callback=LED_On)
```

Main Loop

```
# Main Routine
New_Game()

while(1):
    if(flag):
        flag = 0
        BPM = 60000 / T_Beat
        Beats = N1
        if(N1 > 1):
            Mean = m1 / N1
            Var = (m2 / N1 - (m1 / N1)**2)
            Var = max(0, Var)
            StDev = Var**0.5
        Display()
```

Results

```

7   T_Beat = 686   T_Thump = 654   error (ms) = 32
8   T_Beat = 686   T_Thump = 680   error (ms) = 6
9   T_Beat = 686   T_Thump = 682   error (ms) = 4
10  T_Beat = 686   T_Thump = 672   error (ms) = 14

```

New Game

-9	T_Beat = 1389	T_Thump = 1285	error (ms) = 104
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-7	T_Beat = 1389	T_Thump = 1408	error (ms) = -19
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