Lab 6: How colorful is Your Name

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Microcontrollers and Embedded Systems

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Introduction:

The Goal of this lab was to write a program in assembly implementing division and multiplication.

Procedure:

First write a loop that will loop four times to collect all data needed, the total number of coins of pennies, nickels, dimes and quarters. Store the total number of coins into variables p, n, d, q.

Calculate the total value in cents. Be sure to make a copy of the original total. Divide the total by 100. To do this multiple the number stored in a register by the constant 82 then right shift it 13 for the approximation. Once you have this number multiply it by 100 and subtract the original with the dollar number * 100 this gave the cents. Then print the dollar and cents.

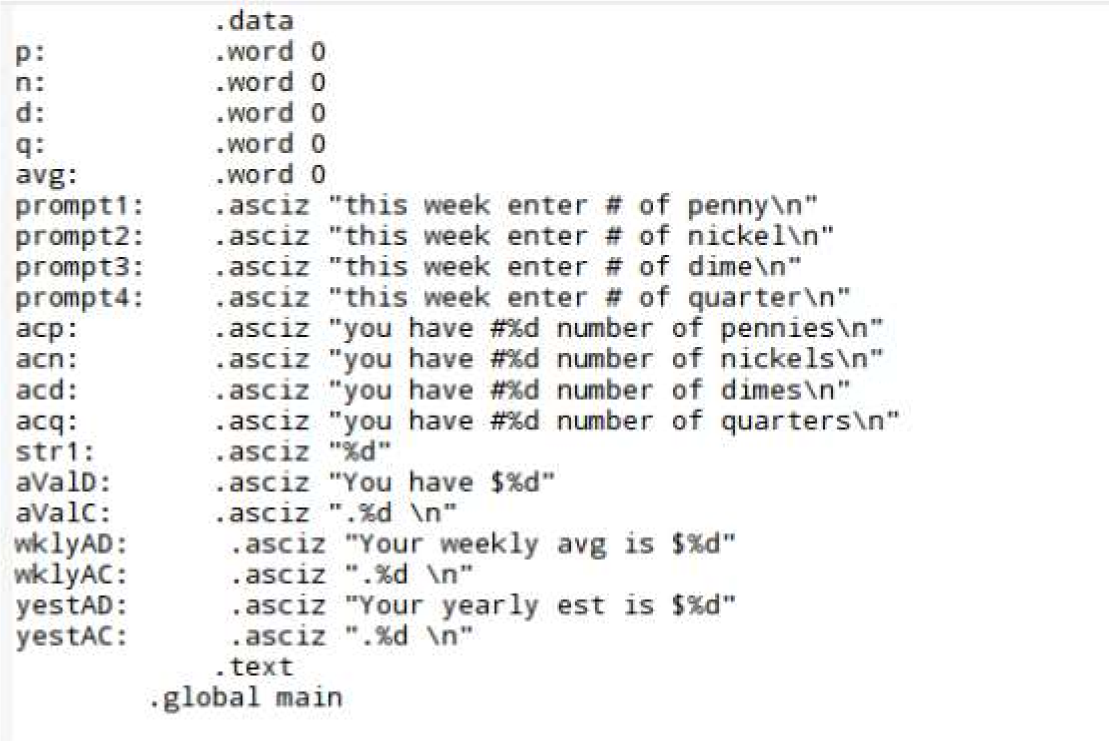
To get the weekly average divide the four week total by 4 by right shifting by 2.

Convert to dollar and cents using the same method with four week total.

To get the yearly total multiply weekly total by 52.

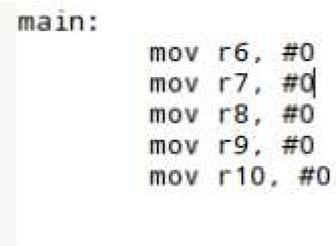
Convert to dollar and cents using the same method with four week total.

Code:



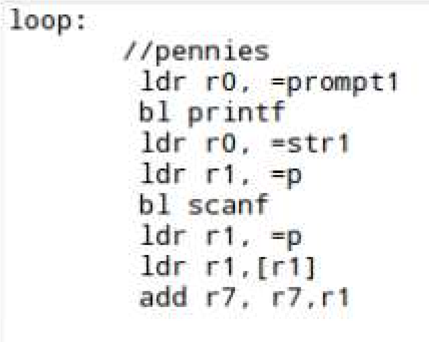
```
             .data
p:           .word 0
n:           .word 0
d:           .word 0
q:           .word 0
avg:         .word 0
prompt1:     .asciz "this week enter # of penny\n"
prompt2:     .asciz "this week enter # of nickel\n"
prompt3:     .asciz "this week enter # of dime\n"
prompt4:     .asciz "this week enter # of quarter\n"
acp:         .asciz "you have #%d number of pennies\n"
acn:         .asciz "you have #%d number of nickels\n"
acd:         .asciz "you have #%d number of dimes\n"
acq:         .asciz "you have #%d number of quarters\n"
str1:        .asciz "%d"
aValD:       .asciz "You have $%d"
aValC:       .asciz ".%d \n"
wklyAD:       .asciz "Your weekly avg is $%d"
wklyAC:       .asciz ".%d \n"
yestAD:       .asciz "Your yearly est is $%d"
yestAC:       .asciz ".%d \n"
             .text
        .global main
```

Set variables/prompts/messages

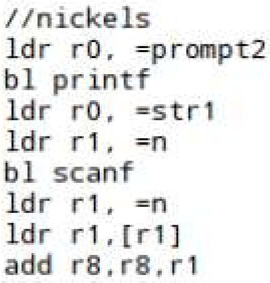


```
main:
        mov r6, #0
        mov r7, #0
        mov r8, #0
        mov r9, #0
        mov r10, #0
```

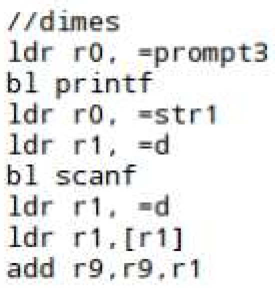
I set these registers to 0 to use in the loop



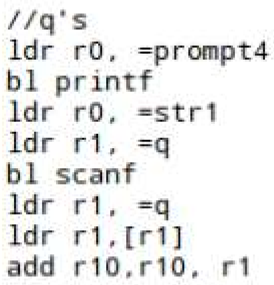
```
loop:
       //pennies
        ldr r0, =prompt1
        bl printf
        ldr r0, =str1
        ldr r1, =p
        bl scanf
        ldr r1, =p
        ldr r1,[r1]
        add r7, r7,r1
```



```
//nickels
ldr r0, =prompt2
bl printf
ldr r0, =str1
ldr r1, =n
bl scanf
ldr r1, =n
ldr r1,[r1]
add r8,r8,r1
```

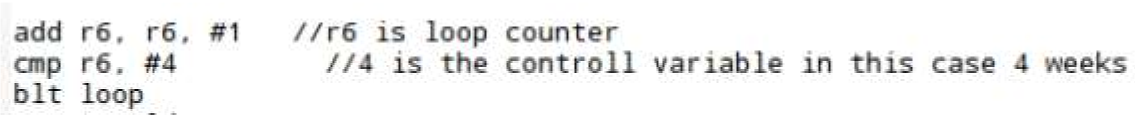


```
//dimes
ldr r0, =prompt3
bl printf
ldr r0, =str1
ldr r1, =d
bl scanf
ldr r1, =d
ldr r1,[r1]
add r9,r9,r1
```



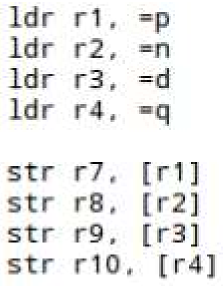
```
//q's
ldr r0, =prompt4
bl printf
ldr r0, =str1
ldr r1, =q
bl scanf
ldr r1, =q
ldr r1,[r1]
add r10,r10, r1
```

In each one of these a prompt for pennies, nickels, dimes and quarters are loaded to r0 and printed, scanf is used to read the value into variables p, n, d and q. The total number of each coin is stored in r7, r8, r9, r10.



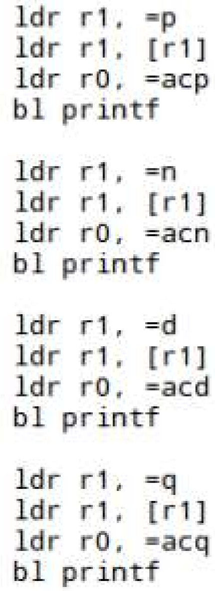
```
add r6, r6, #1   //r6 is loop counter
cmp r6, #4         //4 is the controll variable in this case 4 weeks
blt loop
```

Every time a loop is complete 1 is added to r6. R6 is compared to the constant 4 if r6 is less than 4 then it means 4 weeks have not been answered and the loop starts over again.



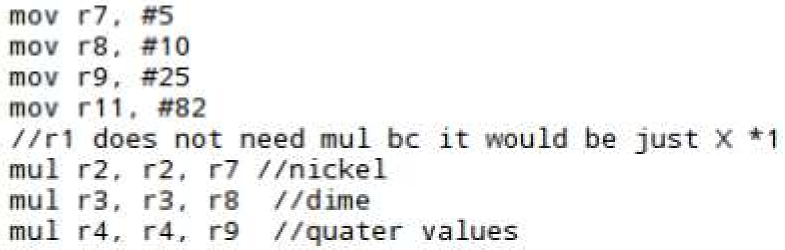
```
ldr r1, =p
ldr r2, =n
ldr r3, =d
ldr r4, =q

str r7, [r1]
str r8, [r2]
str r9, [r3]
str r10, [r4]
```

r7-10 holds the total number of coins r1-4 holds the variables. The value in r7-10 is stored into r1-4.



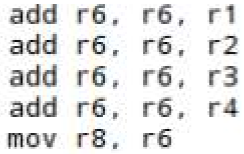
```
ldr r1, =p
ldr r1, [r1]
ldr r0, =acp
bl printf

ldr r1, =n
ldr r1, [r1]
ldr r0, =acn
bl printf

ldr r1, =d
ldr r1, [r1]
ldr r0, =acd
bl printf

ldr r1, =q
ldr r1, [r1]
ldr r0, =acq
bl printf
```

Now each variable is loaded into r1 and printf is called with the appropriate display messages.



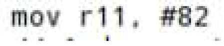
```
mov r7, #5
mov r8, #10
mov r9, #25
mov r11, #82
//r1 does not need mul bc it would be just X *1
mul r2, r2, r7 //nickel
mul r3, r3, r8  //dime
mul r4, r4, r9  //quater values
```

Calculating total value of pennies, nickels, dimes and quarters.



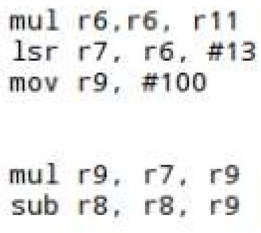
```
add r6, r6, r1
add r6, r6, r2
add r6, r6, r3
add r6, r6, r4
mov r8, r6
```

Adding the total value in cents and makes a copy in r8



```
mov r11, #82
```

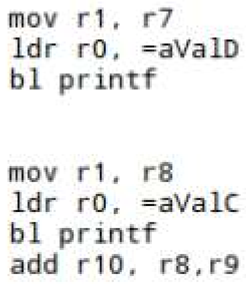
previously stored



```
mul r6,r6, r11
lsr r7, r6, #13
mov r9, #100


mul r9, r7, r9
sub r8, r8, r9
```

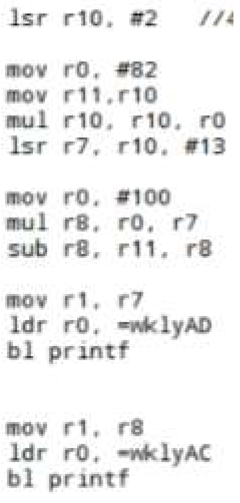
This segment multiplies by 82 then right shifts by 13 this is equal to dividing by 100.

Multiplying by 100 gives the dollar amount only subtracting the original dollar + cents with the dollar leaves the answer in cents only.



```
mov r1, r7
ldr r0, =aValD
bl printf


mov r1, r8
ldr r0, =aValC
bl printf
add r10, r8,r9
```

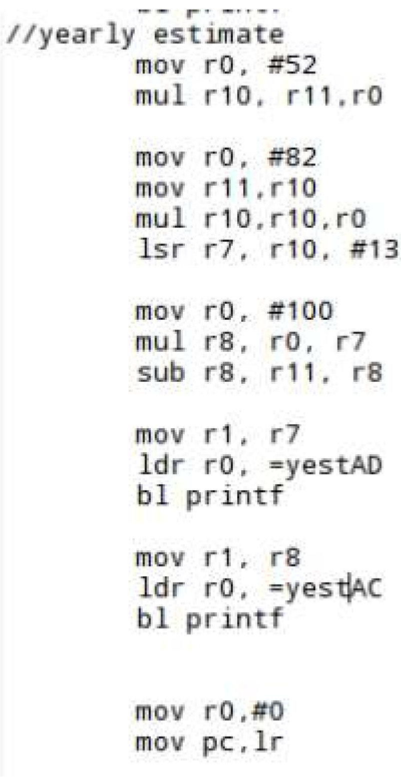
Prints the total value in dollars and cents and adds back r8, r9 and stored in r10 for the four week total sum in cents.



```
lsr r10, #2   //4

mov r0, #82
mov r11,r10
mul r10, r10, r0
lsr r7, r10, #13

mov r0, #100
mul r8, r0, r7
sub r8, r11, r8

mov r1, r7
ldr r0, =wklyAD
bl printf


mov r1, r8
ldr r0, =wklyAC
bl printf
```

Division by 4 and copied into r11.

Then converted into dollars and cents to be printed.

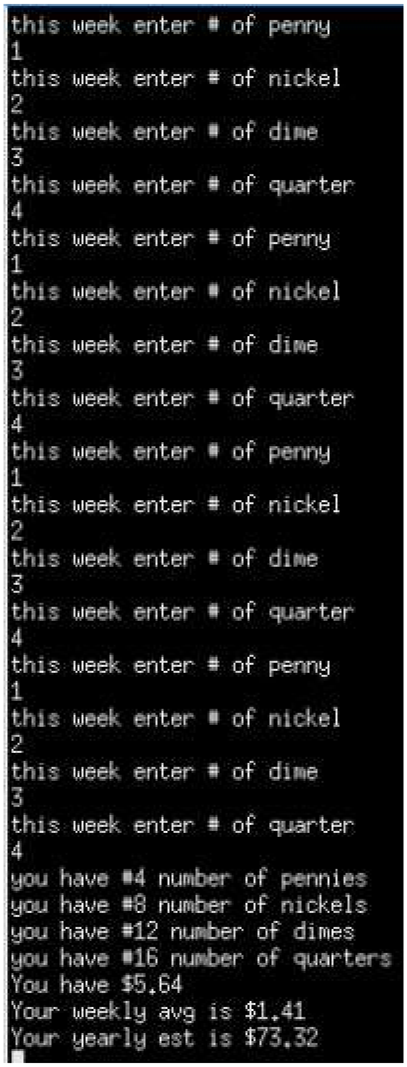


```
//yearly estimate
        mov r0, #52
        mul r10, r11,r0

        mov r0, #82
        mov r11,r10
        mul r10,r10,r0
        lsr r7, r10, #13

        mov r0, #100
        mul r8, r0, r7
        sub r8, r11, r8

        mov r1, r7
        ldr r0, =yestAD
        bl printf

        mov r1, r8
        ldr r0, =yestAC
        bl printf


        mov r0,#0
        mov pc,lr
```

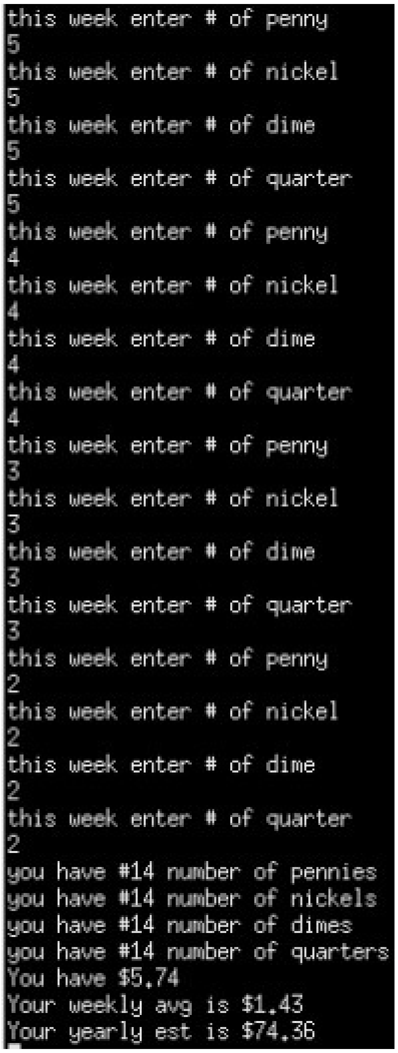
Yearly estimate is the weekly avg * 52(weeks).

I multiplied by 52 and converted into dollars and cents to be printed.

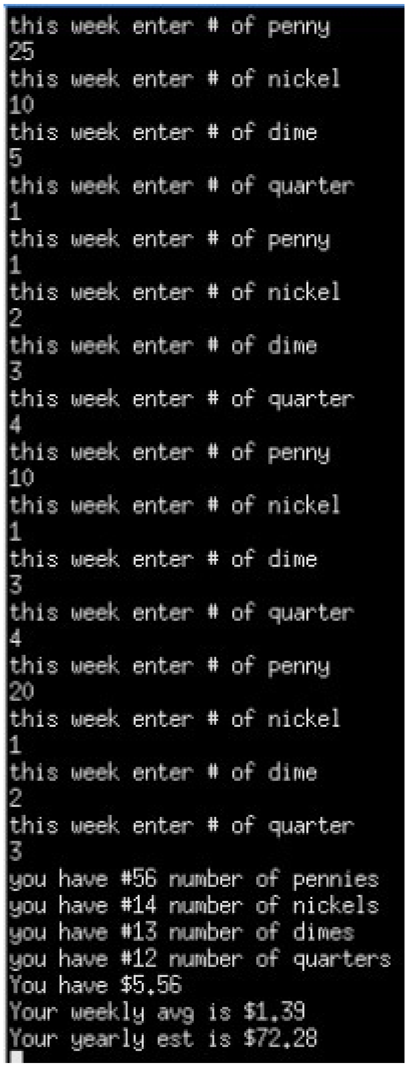
Results:



```
this week enter # of penny
1
this week enter # of nickel
2
this week enter # of dime
3
this week enter # of quarter
4
this week enter # of penny
1
this week enter # of nickel
2
this week enter # of dime
3
this week enter # of quarter
4
this week enter # of penny
1
this week enter # of nickel
2
this week enter # of dime
3
this week enter # of quarter
4
this week enter # of penny
1
this week enter # of nickel
2
this week enter # of dime
3
this week enter # of quarter
4
you have #4 number of pennies
you have #8 number of nickels
you have #12 number of dimes
you have #16 number of quarters
You have $5.64
Your weekly avg is $1.41
Your yearly est is $73.32
```



```
this week enter # of penny
5
this week enter # of nickel
5
this week enter # of dime
5
this week enter # of quarter
5
this week enter # of penny
4
this week enter # of nickel
4
this week enter # of dime
4
this week enter # of quarter
4
this week enter # of penny
3
this week enter # of nickel
3
this week enter # of dime
3
this week enter # of quarter
3
this week enter # of penny
2
this week enter # of nickel
2
this week enter # of dime
2
this week enter # of quarter
2
you have #14 number of pennies
you have #14 number of nickels
you have #14 number of dimes
you have #14 number of quarters
You have $5.74
Your weekly avg is $1.43
Your yearly est is $74.36
```



```
this week enter # of penny
25
this week enter # of nickel
10
this week enter # of dime
5
this week enter # of quarter
1
this week enter # of penny
1
this week enter # of nickel
2
this week enter # of dime
3
this week enter # of quarter
4
this week enter # of penny
10
this week enter # of nickel
1
this week enter # of dime
3
this week enter # of quarter
4
this week enter # of penny
20
this week enter # of nickel
1
this week enter # of dime
2
this week enter # of quarter
3
you have #56 number of pennies
you have #14 number of nickels
you have #13 number of dimes
you have #12 number of quarters
You have $5.56
Your weekly avg is $1.39
Your yearly est is $72.28
```

The program was successful.

Conclusion:

To divide by any constant you will need to divide a decently large number 2^11+ divide this by the constant then right shift the result by the power of 2 you first divided by. If your number was 2^13 then you right shift by 13 if it was 2^11 then you right shift by 11.