Assignment A P2 Lab 4 do-while loop

Lab 4: do -While loop

```
int num[3] = {-1, -2, -3};
int total = 0;
int i = 0;
int N = 3
do{
    total += num[i]
    i += 1
} while ( i != N);
```

$t0	num[]
$t1	total
$t2	N
$t3	i
$t4	
$t5	offset or num[i]

show your result register and memory value after program execution (Screenshot)

Submit Items:

GitHub Link to your file directly. (Please make it a link, not a text)

https://github.com/AVC-CS/p2-mtvonbargen/blob/6eba2246bc44ef53a30596bf7d477e71d8b4259a/P2A4.asm

Elaborate on your program

```
################ Data segment ####################
.data
    num:        .word -1, -2, -3    # Array of integers to be summed
    total:      .word 0             # Variable to store the sum of the array

################ Code segment ####################
.text
    main:
        # do
        # total += num[i]   total is equal to the sum of total and num[i]
        # i += 1            increment i (array index) by 1.
        # while ( i != N)   check if i is not equal to N (number of indexes)

        la $t0, num             # Load the address of the array num into $t0
        lw $t1, total           # Load total into $t1(0)
        li $t2, 3               # N = 3
        li $t3, 0               # i = 0
        li $t5, 0               # initialize offset at 0

    loop:
        sll $t5, $t3, 2         # multiply $t3(i(0)) by 2^2(4) to calculate byte offset $t5(0)
        add $t4, $t5, $t0       # add offset ($t5(0)) with num address ($t0(10010000)) in order to compute memory address. $t4(10010000)
        lw $t4, 0($t4)          # overwrite $t4 with the value located at $t4's current calculated index.
        add $t1, $t1, $t4       # total += num[i], adds ($t1(0)) and ($t4(-1))
        addi $t3, $t3, 1        # i += 1 (i = 1)
        bne $t3, $t2, loop      # branch off to loop, if $t3(1) does not equal $t2(3)
        j exit

    exit:
    li $v0, 10
    syscall
```

IT WORKS IT WORKKSS AHH

Program Results

10010000 = ffffffff = -1
10010004 = fffffffe = -2
10010008 = fffffffd = -3

```
R8 (t0)  = 10010000
R9 (t1)  = 00000000
R10 (t2) = 00000003
R11 (t3) = 00000000
R12 (t4) = 10010000
R13 (t5) = 00000000
```

BEFORE Overwrite. We can see that from t0 to t3 has been initialized. T4 before overwrite, contains the first memory address of num[]. T5 is 0 because we are still at the first index.

```
R8 (t0)  = 10010000
R9 (t1)  = 00000000
R10 (t2) = 00000003
R11 (t3) = 00000000
R12 (t4) = ffffffff
R13 (t5) = 00000000
```

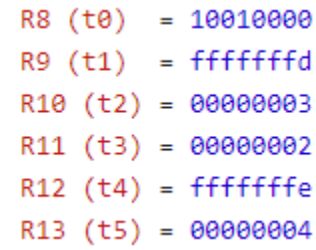
AFTER Overwrite. We have now accessed what's inside 1001000, it is -1, from num[]. Now we can proceed and calculate the rest. iteration.

1st Iteration

```
R8 (t0)  = 10010000
R9 (t1)  = ffffffff
R10 (t2) = 00000003
R11 (t3) = 00000001
R12 (t4) = ffffffff
R13 (t5) = 00000000
```

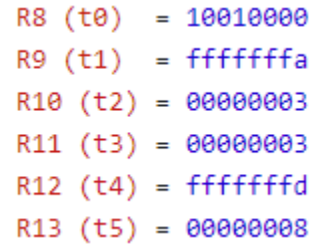
The first iteration, we calculated total as -1, because total was 0 and the first value in the array is -1. So 0 + -1 = -1. Represented as ffffffff.

2nd Iteration



Total is now -3, because we calculated total, which was -1, with the 2nd value in the array, which was -2. So -1 + -2 = -3. Represented as fffffffd. Also notice how t3 successfully incremented by 1, and t5 is incremented by 4 which is the offset.

3rd Iteration (Final Iteration)



Total is now -6. Total previously was -3, and now we use the 3rd value in the array, -3, to add total with. So -3 + -3 = -6. Represented as fffffffa. Because t2 now matches with t3, which is 3, we move on and execute the exit branch to exit the program.

Register Value. What is the purpose of this register? How is it updated throughout your program?

$t0 - holds the entire num array
$t1 - holds total
$t2 - holds N (number of indexes)
$t3 - hold i (current index)
$t4 - holds memory address of current index, then allows us to access value in that memory address's index
$t5 - holds calculated offset value

The interaction between register and memory space

The la (load address) instruction loads the address of the num array into register $t0. Then, using the index i stored in $t3, the program calculates the correct byte offset by shifting i left by two bits (sll $t5, $t3, 2), which effectively multiplies i by 4 to account for the size of each integer in the array. This offset is added to the base address ($t0) of the array to compute the memory address of the current element (add $t4, $t5, $t0). The lw (load word) instruction retrieves the value at that address into $t4. The sum of these values is then added to the total variable, which is stored in $t1. After each iteration, $t3 is incremented to move to the next index, and the program continues until the loop condition is met which is i != N.

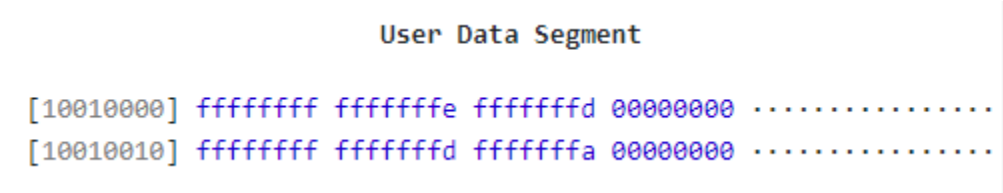
Program logic

This program implements a loop that calculates the sum of an array of integers. It initializes the array num with values -1, -2, and -3 and the total variable to 0. Using a do-while loop structure, the program continuously adds the value at num[i] to total, where i starts at 0 and increments by

1 in each iteration. The loop terminates when i equals the total number of elements in the array (N = 3). Each iteration calculates the correct memory address for the current element using the index i, and the program adds the element's value to the cumulative sum stored in total. The program ends with a system call to exit.

EXTRA

I realized I didn't save total's value anywhere for convenience of seeing what the previous sums were. Maybe it was required maybe it's not. But I implemented an additional array called "save" which does exactly this. So now the Data Segment showcases the previous total calculations.



Here's how the code looks now with this additional change.

```
################ Data segment ####################
.data
    num:        .word -1, -2, -3    # Array of integers to be summed
    total:      .word 0             # Variable to store the sum of the array
    save:       .space 12           # Allocated space to showcase previous total calculations
################ Code segment ####################
.text
    main:
        # do
        # total += num[i]   total is equal to the sum of total and num[i]
        # i += 1            increment i (array index) by 1.
        # while ( i != N)   check if i is not equal to N (number of indexes)

        la $t0, num             # Load the address of the array num into $t0
        lw $t1, total           # Load total into $t1(0)
        li $t2, 3               # N = 3
        li $t3, 0               # i = 0
        li $t5, 0               # initialize offset at 0
        la $t6, save            # loads address of empty save array

    loop:
        sll $t5, $t3, 2         # multiply $t3(i(0)) by 2^2(4) to calculate byte offset $t5(0)
        add $t4, $t5, $t0       # add offset ($t5(0)) with num address ($t0(10010000)) in order to compute memory address. $t4(10010000)
        lw $t4, 0($t4)          # overwrite $t4 with the value located at $t4's current calculated index.
        add $t1, $t1, $t4       # total += num[i], adds ($t1(0)) and ($t4(-1))
        sw $t1, 0($t6)          # save total into first save array
        addi $t3, $t3, 1        # i += 1 (i = 1)
        addi $t6, $t6, 4        # increment memory address of save (t6).
        bne $t3, $t2, loop      # branch off to loop, if $t3(1) does not equal $t2(3)
        j exit
```