



~~程序代写代做 CS 编程辅导~~

Lecture 11

Control Flow: if-else



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How to
Avoid
Spaghetti
Code?



Announcements

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Midterm 1 posted – due Wednesday February 22 before class



Task: Compute the mean deviation (MAD) of a given set of numbers

Submission: PDF file with screenshots of code & results

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Source code as txt – if your source code does not produce the

results you claim, not good!
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Quiz #3 – The Numbers

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The array `twice` contains the numbers 6, 28, 496, 8128, 33550336



One possibility for expressing the ~~numbers~~ numbers as $a_n = (2^{p_n} - 1)2^{p_n-1}$

where p_n is the n th prime number

When $2^{p_n} - 1$ is a prime number then a_n is a **perfect number**

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All proper divisors add up to the original number: $6 = 1 + 2 + 3$

$28 = 1 + 2 + 4 + 7 + 14$

$2^{p_n} - 1$ is prime for $p_n = 2, 3, 5, 7, 13, 17, 19, 31, 61, 89, \dots, 82589933, \dots ?$

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Any application?

None for perfect numbers.

Just for fun.

Lots for prime numbers.



Last time: Action

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Task in many parts:

1. Create an array in RAM with values {1, 1, 2, 3, 5, 8, 13, 21}
2. Write a loop to add all values together
3. Modify the loop so that it does not add if value == 13



Bonus: Can you loop through the array from last element to first element?

These make the best loops!

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4. Can you find the average of the given numbers?
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- Add all values
- Divide by the number of values Here divide by 8 How?

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rra.w

Always keep an eye for signed/unsigned range and overflow



Last time: Action

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Solving Part 2: Write a loop to add all numbers together



Counting Up

```
clr.w          ; index = 0, 2, ... , LENGTH-2
clr.w R5      ; accumulator R5 = 0
add_more:
add.w array(R4), R5
incd.w R4
cmp.w #LENGTH, R4
jlo add_more  ; break when R4 == LENGTH
```

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Counting Down

```
mov.w #LENGTH-1, R4 ; index = LENGTH-2, ..., 2, 0
clr.w R5             ; accumulator R5 = 0
add_more:
add.w array(R4), R5
decd.w R4
jhs add_more         ; break when R4 < 0
```

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Both are great !

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Solution

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```
.data
.array: .word 1, 1, 21
.SIZE: .set 8
.text
.array: .retain
.array: .retainrefs
; no memory allocation
; define symbolic constant SIZE = 8
; Assemble into program memory.
; Override ELF conditional linking
; And retain any sections that have

;-----[RESET]-----;
StopWDT    mov.w #__STACK_END, SP      ; Initialize stackpointer
            mov.w #WDTPW|WDTTHOLD|SWDTCTI ; Stop watchdog timer

;-----[Main loop here]-----;
; used indexed mode of addressing, index in R4
; indices are 0, 2, ..., 2*SIZE - 2
        clr.w R4      : init index to 0
        clr.w R5      : accumulate in R5

read_from_array:
        cmp.w #13, array(R4)
        jeq proceed_to_next ; if array(R4)==13 skip to next element
        add.w array(R4), R5 ; do not add, change index

proceed_to_next:
        incd.w R4      ; proceed index to next element in array
        cmp.w #2*SIZE, R4 ; check for end of array
        jlo read_from_array

main:     jmp main
        nop
```

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if-else

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if-else provides more control flow ...



```
if (condition)
{
    do something
}
else
{
    do something else
}
do more things
```

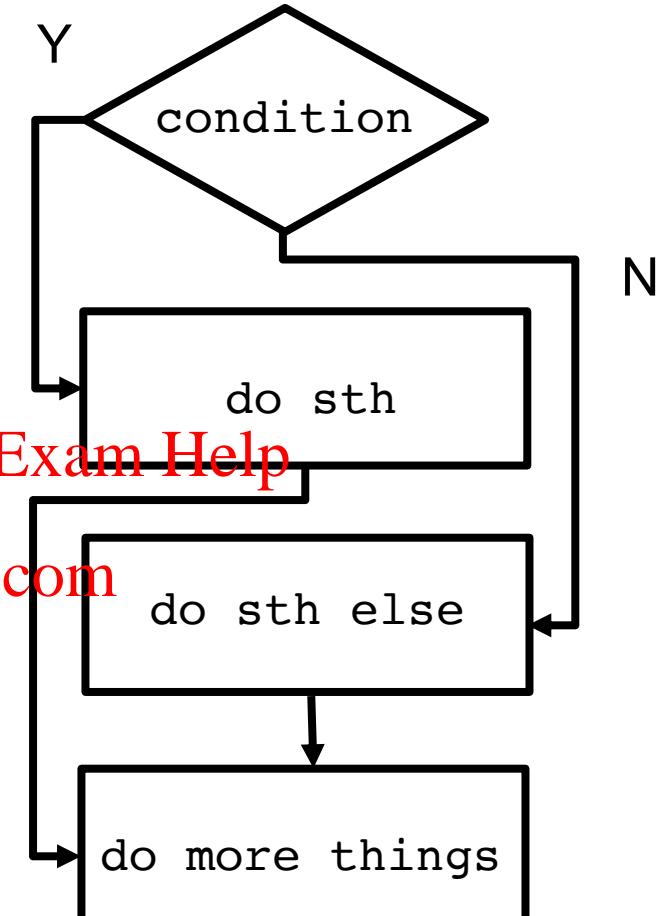
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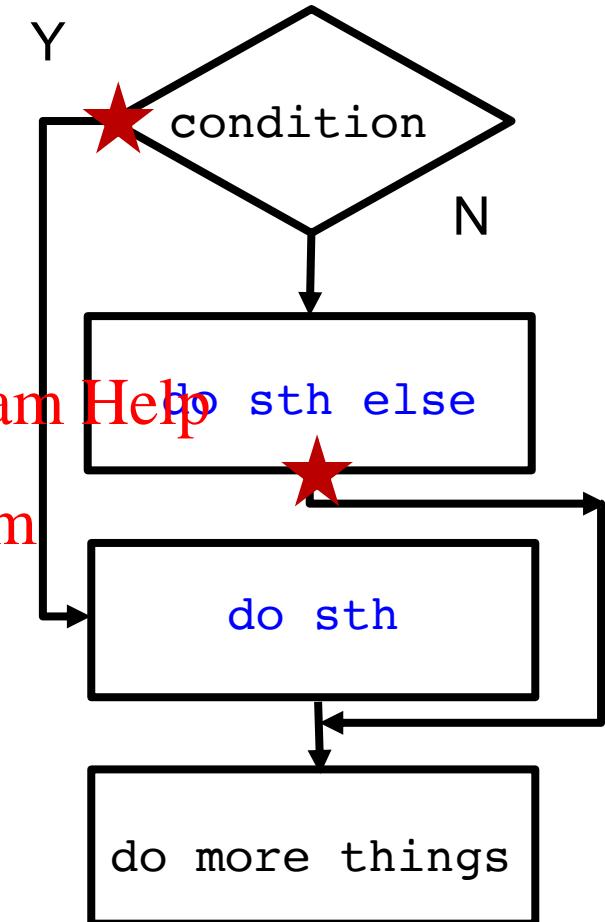
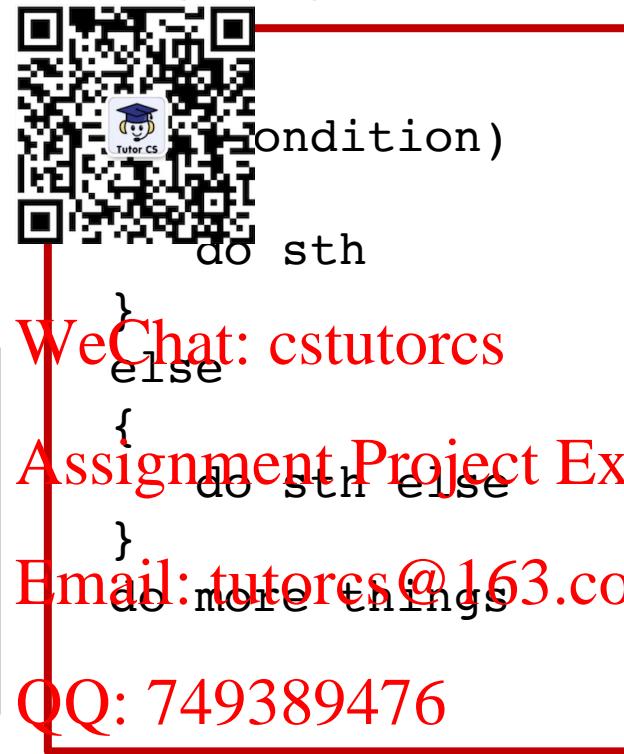
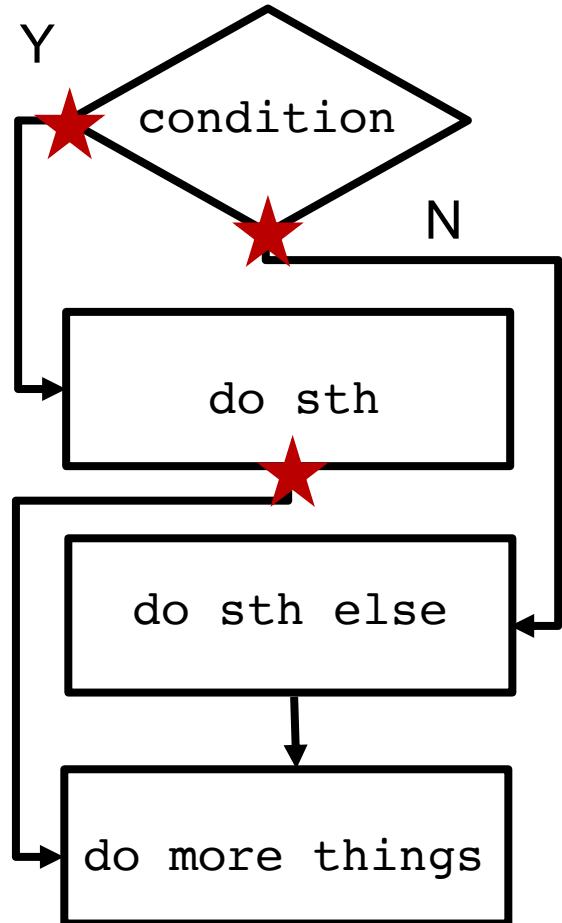
if-else results in more tangled spaghetti code

How to implement if-else – Opt. 1



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Simply change the order of doing things: do sth else block first

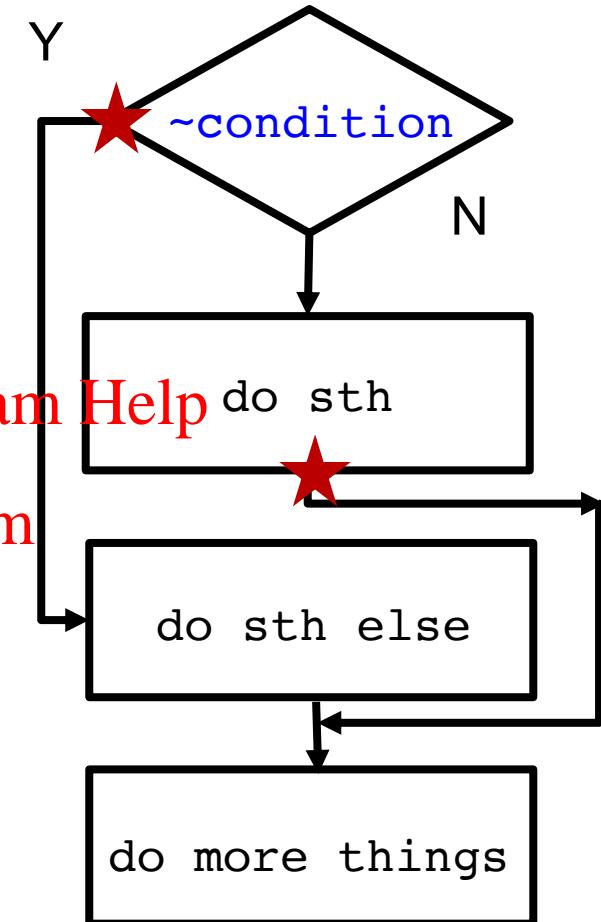
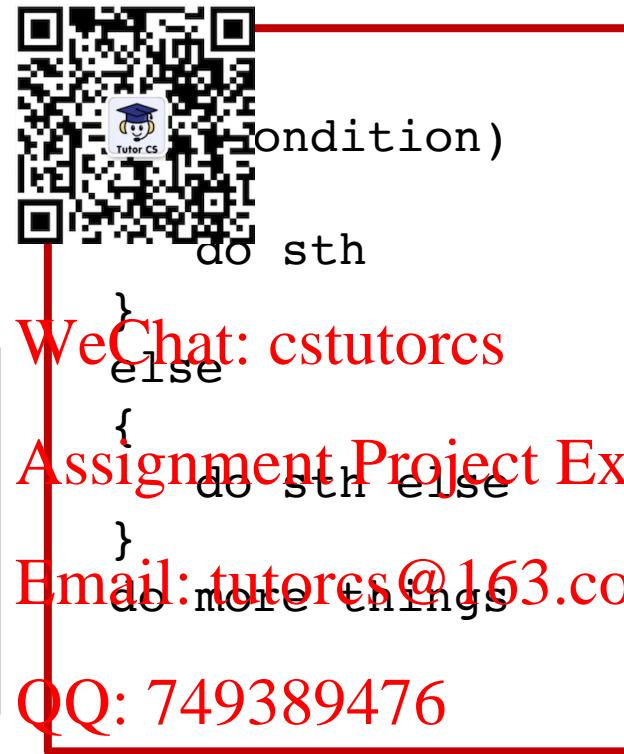
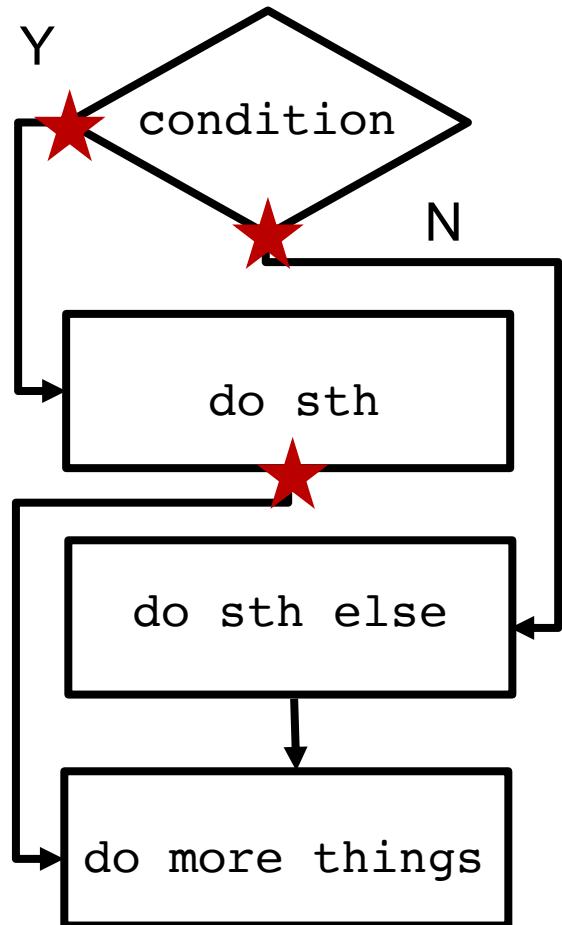


How to implement if-else – Opt. 2



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We can negate the condition:





Example if-else

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Task: Given an array of integers find the sum of even and odd numbers

```
if (x is even)
{
    even_sum += x;
}
else
{
    odd_sum += x;
}
...
...
```



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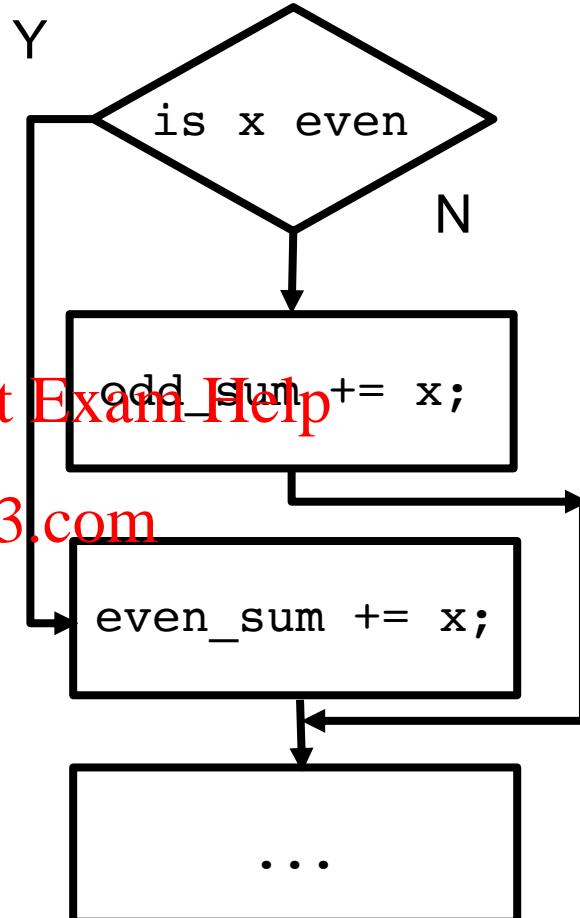
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At this point, the flowchart is easy
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How do we check if a number is even?

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Excuse to learn more instructions





bit.w

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decimal

When is a number even?

When the last digit



– i.e., 0, 2, 4, 6, 8

When is a **binary** number even?

When the last bit is even – i.e., 0

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How do we check this condition?

There is an instruction to ~~Check individual bits~~ – called **bitwise test**

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bit.w src, dst

bit.w is similar to compare, it does not change the value of src or dst

It only sets status bits (the C bit) according to (src & dst)

where & is bitwise and



bit.w

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e.g.

bit.b #00000001b



$$c = \begin{cases} 1 & \text{if last bit of } x \text{ is 1} \\ 0 & \text{if last bit of } x \text{ is 0} \end{cases}$$

We have two conditional jump instructions that check the carry bit explicitly

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jc

jnc

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Typing binary numbers is cumbersome and prone to error – esp. with 16 bits

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bit.w #0000000000000001b, x ; how many zeros??
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Use the MACROS that are already defined in header file "msp430.h"

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actually "msp430fr69891.h"



Bitmasks

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We will use **bitmasks** for setting, clearing or testing bits



defined in "msp430fr69891.h"

#define	(0x0001)
#define	(0x0002)
#define	(0x0004)
#define BIT3	(0x0008)
#define BIT4	(0x0010)
#define BIT5	(0x0020)
#define BIT6	(0x0040)
#define BIT7	(0x0080)
#define BIT8	(0x0100)
#define BIT9	(0x0200)
#define BITA	(0x0400)
#define BITB	(0x0800)
#define BITC	(0x1000)
#define BITD	(0x2000)
#define BITE	(0x4000)
#define BITF	(0x8000)

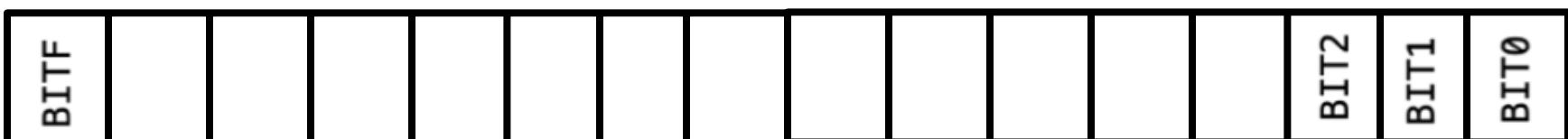
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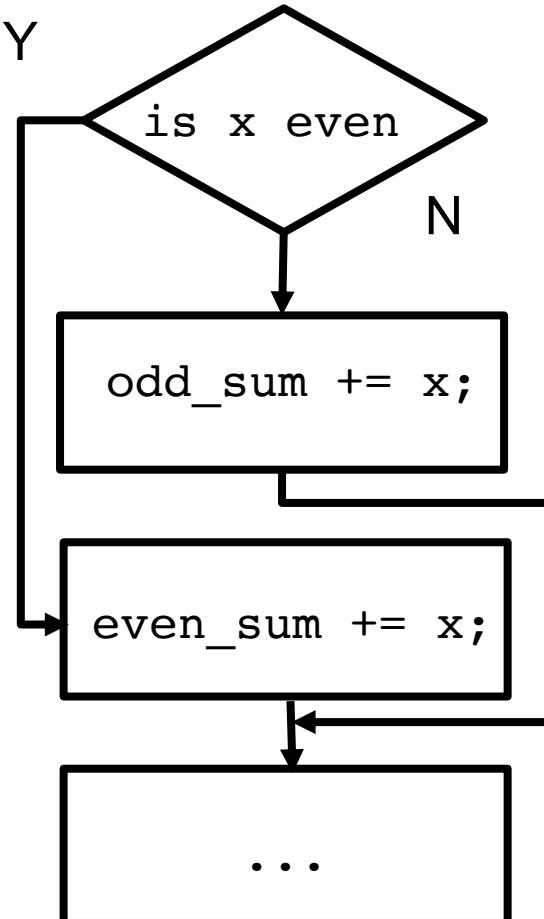




Back to our Example

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Consider following pseudocode – how do we implement it in assembly?



we check if a number is even?

```
bit.w #BIT0, x  
jc / jnc
```

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The rest we already know how to do
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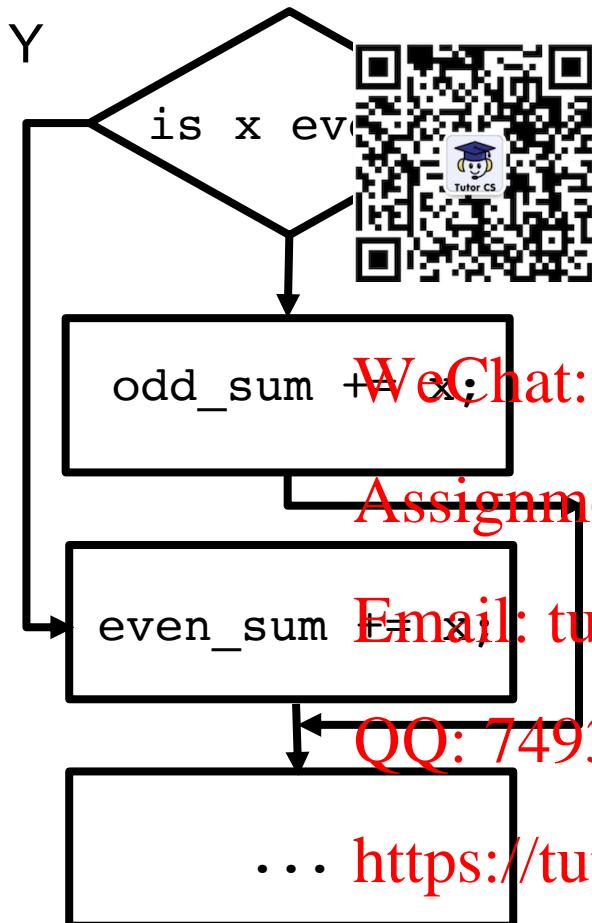
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Back to our Example

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```
bit.w #BIT0, x  
jnc if_even  
  
add.w x, odd_sum  
jmp if_end  
  
if_even: add.w x, even_sum  
if_end: ...
```

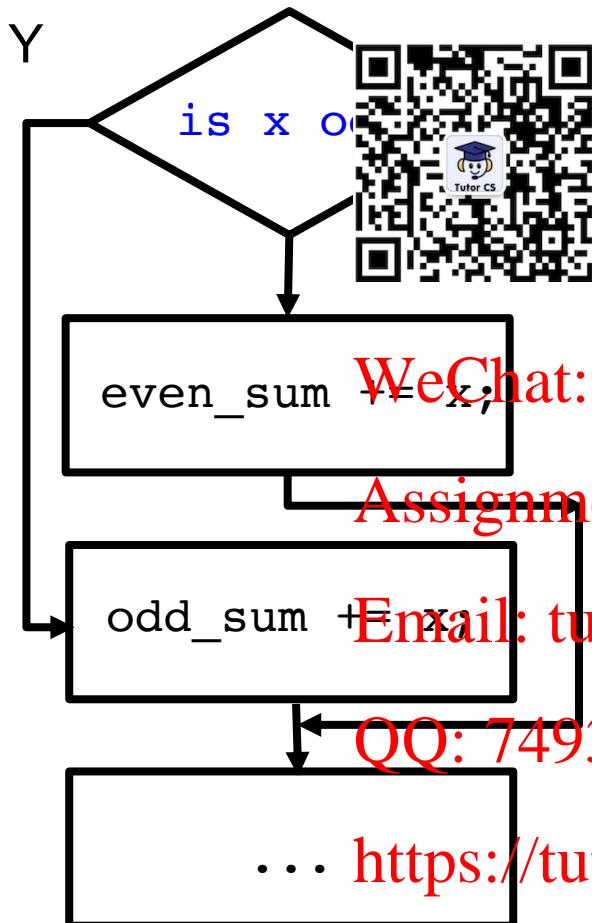
if_even: even_sum += x; **if_end:** ...

if_end: ... https://tutorcs.com



Alternate Implementation

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```
bit.w #BIT0, x  
jc if_odd  
  
add.w x, even_sum  
jmp if_end  
  
if_odd: add.w x, odd_sum  
if_end: ...
```

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if_odd: add.w x, odd_sum

if_odd: odd_sum += x
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if_end:

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More: Action

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Task in many parts:

1. Create an array in RAM with values {1, 1, 2, 3, 5, 8, 13, 21}
2. Write a loop to add all values together
3. Modify the loop so that it does not add if value == 13
4. Can you find the average of the given numbers?

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Today

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- Define two variables even_sum and odd_sum in RAM
- Loop through the array and find the sum of even and odd numbers

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Solution

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```
.data  
.retain  
.retainrefs  
  
even_sum: .word 0  
odd_sum: .word 0  
  
array: .word 1, 1, 2, 3, 5,  
LENGTH: .set 16
```



, LENGTH of array in bytes

```
.text  
;-----  
; Main loop here  
;  
;-----  
        clr.w  R4      ; R4 serves as index, start at 0  
; indices are 0, 1, ..., LENGTH - 2  
read:   mov.w  array(R4), R5 ; read array(R4)  
        bit.w  #BIT0, R5 ; check least significant bit  
        jne    odd       ; carry set if bit is 1, i.e., odd number  
even:   add.w  R5, even_sum ; we are here if array(R4) is even  
        jmp    proceed  ; proceed index to next element  
odd:    add.w  R5, odd_sum ; we are here if array(R4) is odd  
  
proceed: incd.w R4      ; index points to next element  
        cmp.w  #LENGTH, R4 ; check array boundary  
        jlo    read       ; break if LENGTH > index  
  
main:   jmp    main  
        nop
```

Code

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