```
pi@raspberrypi:~/Desktop $ gcc -g -o arm_lab arm_lab.s
arm_lab.s: Assembler messages:
arm_lab.s: Warning: end of file not at end of a line; newline inserted
pi@raspberrypi:~/Desktop $ ./arm_lab

18 17 16 15 14 13 12 11 10 0f 0e 0d 0c 0b 0a 09 08 07 06 05 04 03 02 01 00
18 16 14 12 10 0e 0c 0a 08 06 04 02 00
18 15 12 0f 0c 09 06 03 00
18 14 10 0c 08 04 00
18 13 0e 09 04
18 12 0c 06 00
18 11 0a 03
18 10 08 00
18 0f 06
18 0e 04
18 0d 02
18 0c 00
pi@raspberrypi:~/Desktop $
```

first.s ✖ | second.s ✖ | arm_lab.s ✖

```
@ James Voight CSCN342-001 11/21/20244
.global main
.extern printf

.data
format_specifier: .asciz "%02x "
newline_format: .asciz "\n"

.text
main:
        push {lr}
        mov r4, #1
outer_loop:
        ldr r0, =newline_format
        bl printf
        cmp r4, #12
        bgt end_program
        mov r5, #0x18
inner_loop:
        push {r4, r5}
        ldr r0, =format_specifier
        mov r1, r5
        bl printf
        pop {r4, r5}
        sub r5, r5, r4
        cmp r5, #0
        bge inner_loop
        add r4, r4, #1
        b outer_loop

end_program:
        mov r0, #0
        pop {pc}
```

Sent Items

Last week

O'Malley, Daniel M (Comput...
Approval for Struct D...   Thu 11/14
Forgot to give the sizes: * Author...

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Knowles, Emily Christine (Compu...
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Ah, sorry I didn't know that I had ...

Approval for Struct Design: CSCN 342

Voight, James Peter
To: O'Malley, Daniel M (Computational Sciences)
Wed 11/13/2024 6:18 PM

Dear Professor O'Malley,

I am an avid reader in my spare time (mainly fiction), so I decided to base my struct on elements related to a book's properties. I will be using the following fields:

1. **Author**: A string, representing the author's name.
2. **Title**: A string, for the book title.
3. **Completed**: A character, ('T' for true, 'F' for false) to indicate whether the book has been completed.
4. **Bookmarked**: An array of integers, each element represents a bookmarked page number. The array can hold up to 8 bookmarks.
5. **ReadTime**: A float, representing the estimated hours required to read the book.

I will implement a function called **modify_and_print_struct** that modifies and outputs each element in the struct. The function will in this case add a bookmarked page to the array and then output each struct field. An loop will also print out the **bookmarked** values. I will use printf with different format specifiers to display each field correctly. This will include a character format for **completed**, integer for **bookmarked**, and float for **readTime**.

Please let me know if my approach is within the assignment expectations or if there are any modifications that are needed. Thank you for your time.

Warm regards,
James Voight

Voight, James Peter
To: O'Malley, Daniel M (Computational Sciences)
Thu 11/14/2024 8:33 AM

Forgot to give the sizes:

- **Author**: max of 30 characters.
- **Title**: 50 characters.
- **Completed**: single character (either 'T' or 'F').
- **Read Time**: 8 bytes (double-precision float).
- **Bookmarked Pages**: 32 bytes – Array of eight 32-bit integers (4 bytes each), totaling 8 * 4 = 32 bytes.

...

O'Malley, Daniel M (Computational Sciences)
Approved. Thanks, Daniel O'Malley, Ph.D. Professor of IT/IS Department of Computer Science School of Business (434) 592-7341 Liberty University | Training Champion...
Thu 11/14/2024 5:46 PM

```
root@CSCN-342-Ubuntu-22: /home/vboxuser/Desktop/CSCN342 Code/Asgn04

root@CSCN-342-Ubuntu-22: /...    vboxuser@CSCN-342-Ubuntu-...    vboxuser@CSCN-342-Ubuntu-...

Bookmark 2: 68
Bookmark 3: 75
Bookmark 4: 84
Bookmark 5: 113
Bookmark 6: 212
root@CSCN-342-Ubuntu-22:/home/vboxuser/Desktop/CSCN342 Code/Asgn04# nasm -felf64 book_struct.asm
&& gcc -o book_struct book_struct.o -no-pie
root@CSCN-342-Ubuntu-22:/home/vboxuser/Desktop/CSCN342 Code/Asgn04# ./book_struct
Author: Seth Richter
Title: In Clawed Grasp
Completed: T
Read Time: 5.50 hours
Bookmark 1: 30
Bookmark 2: 68
Bookmark 3: 75
Bookmark 4: 84
Bookmark 5: 113

After modification:
Author: Seth Richter
Title: In Clawed Grasp
Completed: T
Read Time: 5.50 hours
Bookmark 1: 30
Bookmark 2: 68
Bookmark 3: 75
Bookmark 4: 84
Bookmark 5: 113
Bookmark 6: 212
root@CSCN-342-Ubuntu-22:/home/vboxuser/Desktop/CSCN342 Code/Asgn04#
```

x86 Assembly, ARM Assembly, and Structures

James Voight

School of Business, Liberty University

CSCN 342-001: Computer Architecture

Dr. Daniel O'Malley

November 22, 2024

x86 Assembly, ARM Assembly, and Structures

Data structs organize data within a mathematical model in a straightforward way. This allows data storage and retrieval to be an efficient manner. The data structure is processed using several operations such as inserting, deleting, traversing, and searching (Aggarwal & Kumar, 2021).

The created Book struct contains a 30 character author, 50 character title, 1 character completion flag (true of false), 8 byte read time, and a 32 bit integers representing an array of 8 bookmarks (32 bytes total, 8*4=32). A book's key information can be represented through this structure in an easy to access, organized manner.

The function modify_and_print interacts with the Book struct to perform 2 main tasks. First, it modifies the struct by adding another bookmark onto the array. Secondly, it calls the print_struct funtion to output the results. The example given in the figure shows a value of 212 being inserted into the sixth position fo the bookmarks array. The array stops printing when there are no more bookmarks or the max of 8 elements has been reached.

After the struct has been modifed, print_struct will display the new, updated content in the Book struct. Each field is outputted with appropriate formatiing while using the printf function to show the author, title, completion status, and read time. When it comes to the bookmarks, the function uses a loop to iterate through the array. Each non-zero bookmark value is then printed with 0 representing the non-utilized elements. The loop ends when it either encounters a zero value or until the array has reached size 8 (full).

References

Aggarwal, S., & Kumar, N. (2021). Data structures. In *Advances in Computers* (Vol. 121, pp. 43-81). Elsevier. https://www.sciencedirect.com/science/article/abs/pii/S0065245820300577