Operating Systems – 234123

**Homework Exercise 4 – Dry**

Teaching Assistant in charge:

**Or Keret**

Assignment Subjects & Relevant Course material

**Virtual Memory & Memory Management**

**Recitations 10-12, Lectures 8-9**

# Submission Format

1. Only **typed** submissions in **PDF** format will be accepted. Scanned handwritten submissions will not be graded.
2. The dry part submission must contain a single PDF file named with your student IDs –

**DHW4\_123456789\_300200100.pdf**

1. The submission should contain the following:
   1. The first page should contain the details about the submitters - **Name, ID number and email address**.
   2. Your answers to the dry part questions.
2. Submission is done electronically via the course website, in the **HW4 – Dry** submission box.

# Grading

1. **All** question answers must be supplied with a **full explanation**. Most of your grade is determined by your **explanation** and **evident effort**, and not on the absolute correctness of your answer.
2. Remember! your goal is to communicate the knowledge that you have acquired. Full credit will be given only to correct solutions which are **clearly** described. Convoluted and obtuse descriptions will receive low grades.

# Questions & Answers

* The Q&A for the exercise will take place at a public forum Piazza **only**. Please **DO NOT** send questions to the private email addresses of the TAs.
* Critical updates about the HW will be published in **pinned** notes in the piazza forum. These notes are **mandatory** and it is your responsibility to be updated.

A number of guidelines to use the forum:

* **Read previous Q&A carefully before asking the question**; repeated questions will probably go without answers
* Be polite, remember that course staff does this as a service for the students
* You’re not allowed to post any kind of solution and/or source code in the forum as a hint for other students; In case you feel that you have to discuss such a matter, please come to the reception hour
* When posting questions regarding **hw**4, put them in the **hw**4 folder

# Late Days

* Please **DO NOT** send postponement requests to the TA responsible for this assignment. Only the **TA in charge** can authorize postponements. In case you need a postponement, please fill out the attached form: <https://forms.office.com/r/5mwQE7EGzm>

**שאלה 1 – ניהול זיכרון:**

נתון שהמחשב זה עתה עלה (מיד אחרי reboot), שהארכיטקטורה של המחשב היא x86/64bit, שמשתמשת יחידה בשם אליס משתמשת בו כרגע, שכל מה שאליס עשתה עד עתה זה להריץ shell על המחשב (כחלק מתהליך ה-login), שקיים קובץ בשם my\_file.txt בתיקיית העבודה הנוכחית של אליס בגודל 32KB, ושהתהליך הראשון שאליס מריצה ב-shell מבצע את קטע הקוד הבא:

|  |  |
| --- | --- |
| #define PAGE\_SIZE (4\*1024) | 1 |
| int main()  { | 2 |
| int fd = open("./my\_file.txt", O\_RDWR); | 3 |
| char\* buffer = malloc(2 \* PAGE\_SIZE); | 4 |
| read(fd, buffer, 2 \* PAGE\_SIZE); | 5 |
| char\* array = (char\*) mmap(NULL, 4 \* PAGE\_SIZE, PROT\_READ | PROT\_WRITE, MAP\_SHARED, fd, 0); | 6 |
| char x = array[12]; | 7 |
| char z = array[12 + 2 \* PAGE\_SIZE]; | 8 |
| array[12 + 2 \* PAGE\_SIZE] = x; | 9 |
| return 0; | 10 |
| } | 11 |

1. מה המספר **המינימלי** של מסגרות פיזיות חדשות שמוקצות (בעבור data בלבד, מבלי להתחשב ב-page table) בכל אחת מהשורות הבאות?

|  |  |  |
| --- | --- | --- |
| שורה | מספר מסגרות | הסבר קצר |
| 3 |  |  |
| 4 |  |  |
| 5 |  |  |
| 6 |  |  |
| 7 |  |  |
| 8 |  |  |
| 9 |  |  |

2. כיצד תשתנה תשובתכן לסעיף 1 אם בשורה 6 היה רשום MAP\_PRIVATE במקום MAP\_SHARED? ציינו באיזה שורות תשובתכן הייתה **משתנה** והסבירו:

**תשובה:**

3. כיצד תשתנה תשובתכן לסעיף 1 אם מיד כאשר התהליך הנ"ל מסתיים הוא מורץ שוב? נמקו (השאלה מתייחסת להרצה השנייה.)

**תשובה:**

4. כאשר מורץ הקוד לראשונה, מה הוא המספר **המקסימלי** של מסגרות פיזיות חדשות שמוקצות בעבור **טבלת הדפים** של התהליך? **יש לשרטט את המסגרות של טבלאות הדפים בשביל נימוק התשובה**.

הנחות: (1) התעלמו ממסגרות המוקצות עבור המחסנית (stack).

(2) הניחו שהכתובת של buffer (שורה 4) היא:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 11 0 | 20 12 | 29 21 | 38 30 | 47 39 |
| 000000000000 | 111111111 | 111111111 | 000000**1**00 | 000000000 |

(3) הניחו שהכתובת של array (שורה 6) היא: (שימו לב להבדל בכתובות)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 11 0 | 20 12 | 29 21 | 38 30 | 47 39 |
| 000000000000 | 111111111 | 111111111 | 000000**0**00 | 000000000 |

**תשובה:**

1. הגדירו major page fault.

**תשובה:**

1. מה מספרי השורות בהן מתרחש major page fault? נמקו

**תשובה:**

1. כיצד תשתנה תשובתכן לסעיף **6** אם בשורה 6 היה רשום MAP\_PRIVATE במקום MAP\_SHARED? נמקו

**תשובה:**

**שאלה 2 – ניהול זיכרון:**

שאלה זו כתובה באנגלית מאחר ושהיא מכילה לא מעט מושגים ושמות אשר קל יותר לבטאם באנגלית. נא לפתור אותה באיזה שפה שתרצנה\ו.

In the wet part of this homework, you implemented an interface that manages dynamic memory in for a process.

In this part of the homework, you will analyze the existing malloc() (from <cstdlib>) while learning about some new Linux tools.

**NOTE:** Do NOT submit code you write in this homework with your wet submission. Simply copy your code to your dry submission file, wherever requested.

## Section 1:

1. Look up the “strace” utility online, read a little bit, and try to use it yourself by running `strace ls` in your OS terminal. Finally, explain here in a few words what the it does.

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1. Write a simple program in C that receives a number “x” from the command line and allocates (using malloc()) a block of memory that is “x” bytes long. You can assume there’s always one input it will always be a positive integer. Run strace with your compiled program.  
   Finally, attach the code of the program and a screenshot of the output of running strace with your compiled program below

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## The output you received from running strace on your program was probably very messy. There’s no way to tell which system call was used during the execution of malloc. Suggest a simple addition to your C code, such that you will be able to spot the system call used during the execution of malloc anyway. You’re not allowed to add flags to strace. Your change must be made in the C code.

## \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

## Section 2:

In the wet part of this homework, you wrote/will write a malloc() alternative that uses both sbrk() and mmap(). Your job in this section is to determine which memory functions the malloc() function that is included in your stdlib uses.

Hint: Use the program and the tools from the last section to help you out!

1. Which **two** system calls does the stdlib standard malloc() use in its implementation? Attach screenshots that prove your answer.

1) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ 2) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Find the **threshold** that malloc uses to transition from using one function to the other. In other words, what is the number of bytes, after which calling malloc with that number, would result in using one system call instead of the other? Attach screenshots that prove your answer.

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