

**ECU178 Computer Science:  
207SE Operating Systems, Security and Networks  
Portfolio**

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## Item 1 - Linux Command Line

### 1. Logfile containing evidence of activities

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## Item 2 - Assembly Code

### 1. Right-Angled triangle

Using x86 Assembly code, draw a Right-angled triangle

Listing 1: Right angled triangle

```
section .data

Prompt db 'Enter height of triangle: '
pLen equ $-Prompt
5 chr db '*'
nl:      db "  ", 0x0a ; variable to draw a new line
nl_len  equ $-nl ; length of new line variable

section .bss
10 num resb 2 ;reserve 2 bytes for the input variable

section .text
global _start
_start:
15
;Ask user for size of triangle
mov eax,4
mov ebx,1
mov ecx,Prompt
20 mov edx,pLen
int 80h

;store the variable
mov eax,3
25 mov ebx,0
mov ecx,num
mov edx,2
int 80h

30 mov ecx, [num] ;dereference input and store in ecx
sub ecx,'0' ;convert from ascii to decimal
xor ch,ch ; clear upper half of ecx

mov ebx,1
35
lo: ;outer loop, amount of lines in triangle
push ecx ; push outer loop count to stack
mov ecx,ebx ; place inner loop count in the loop counter
li: ; inner loop, amount of stars in line
40
push ecx
push ebx ;push ecx and ebx to stack so they can be used in drawing
mov eax,4
mov ebx,1
45 mov ecx,chr
mov edx,1
int 80h ;draw star
```

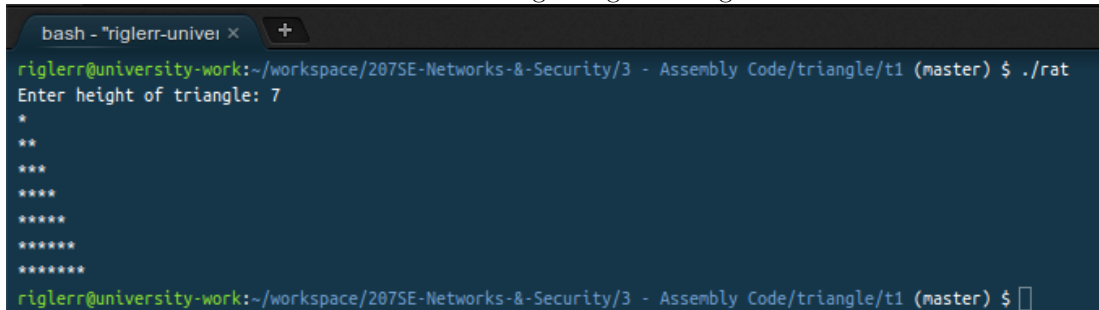
```
    pop ebx
    pop ecx ; pop ecx last, so it is has the correct loop counter value
50  loop li ; end of inner loop

    push ebx ; push ebx to stack, so to use ebx in starting a new line
    mov eax, 4
    mov ebx, 1
55  mov ecx, nl
    mov edx, nl_len
    int 0x80 ;draws a new line

    pop ebx ;pop inner loop count off stack
60  inc ebx ;increment inner loop count (to draw 1 more triangle next iteration)
    pop ecx ;pop outler loop count off stack to use as counter for lo
    loop lo ;end of outer loop
    int 80h;

65  mov eax,1
    mov ebx,0
    int 80h;exit
```

## Evidence of Right angled triangle



```
bash - "riglerr-univer x" +
riglerr@university-work:~/workspace/207SE-Networks-&-Security/3 - Assembly Code/triangle/t1 (master) $ ./rat
Enter height of triangle: 7
*
**
***
****
*****
*****
*****
riglerr@university-work:~/workspace/207SE-Networks-&-Security/3 - Assembly Code/triangle/t1 (master) $
```

## 2. Isosceles Triangle

Using x86 Assembly code, draw an Isosceles triangle

Listing 2: Isosceles Triangle

```

section .data

Prompt db 'Enter height of triangle: '
pLen equ $-Prompt
5 chr db '*'
nl:      db "  ", 0x0a ; variable to draw a new line
nl_len equ $-nl ; length of new line variable
ns: db " "; variable to draw a space
ns_l equ $-ns ; length of space variable

10 section .bss
num resb 2 ;reserve 2 bytes for the input variable
width resb 2

15 section .text
global _start
_start:

;Ask user for size of triangle
20 mov eax,4
mov ebx,1
mov ecx,Prompt
mov edx,pLen
int 80h

25 ;store the variable
mov eax,3
mov ebx,0
mov ecx,num
30 mov edx,2
int 80h

mov ecx, [num] ;dereference input and store in ecx
sub ecx,'0' ;convert from ascii to decimal
35 xor ch,ch ; clear upper half of ecx

mov ebx,1
mov eax,ecx

40 ;this block places w=2n-1 into eax
push ebx ;push inner loop to stack
mov ebx,2 ; move 2 into ebx
mul ebx ; multiply eax by 2
sub eax,1 ; subtract 1 from eax
45 pop ebx
mov [width],eax ; place width value into width variable

lo: ;outer loop, amount of lines in triangle

```

```
50    push ecx ; push outer loop count to stack

    ;This block works out the number of spaces to print before drawing
    ;noOfSpace = (width-noOfAsterisks)/2
    mov ecx,[width] ; make loop counter equal to the width of the triangle
55    sub ecx,ebx ;subtract number of asterisks
    shr ecx,1 ; shift right, divides ecx by 2^1 (2)
    jz 12 ; jump to the 12 label if the result of the division was 0

    13:
60    push ebx ; push ebx to stack, so to use ebx in starting a new line
    push ecx
    mov eax, 4
    mov ebx, 1
    mov ecx, ns
65    mov edx, ns_1
    int 0x80 ;draws a new line
    pop ecx ;pop inner loop count off stack
    pop ebx

70    loop 13

    12:

    mov ecx,ebx ; place inner loop count in the loop counter
75    li: ; inner loop, amount of stars in line

        push ecx
        push ebx ;push ecx and ebx to stack so they can be used in drawing
        mov eax,4
80        mov ebx,1
        mov ecx,chr
        mov edx,1
        int 80h ;draw star
        pop ebx
85        pop ecx ; pop ecx last, so it is has the correct loop counter value
    loop li ; end of inner loop

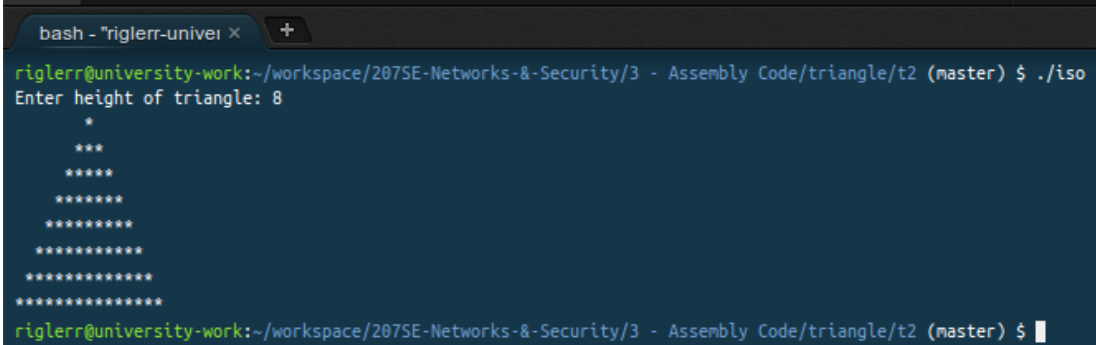
    push ebx ; push ebx to stack, so to use ebx in starting a new line
    mov eax, 4
90    mov ebx, 1
    mov ecx, nl
    mov edx, nl_len
    int 0x80 ;draws a new line

95    pop ebx ;pop inner loop count off stack
    ; add two to the inner loop counter,
    ;each line always has an odd number of asterisks
    add ebx,2

100    pop ecx ;pop outer loop count off stack to use as counter for lo
    loop lo ;end of outer loop
```

```
int 80h;  
105 mov eax,1  
mov ebx,0  
int 80h;exit
```

## Evidence of triangle



The screenshot shows a terminal window with the following content:

```
bash - "riglerr-univer × +  
riglerr@university-work:~/workspace/207SE-Networks-&-Security/3 - Assembly Code/triangle/t2 (master) $ ./iso  
Enter height of triangle: 8  
*  
***  
*****  
*****  
*****  
*****  
*****  
*****  
*****  
*****  
*****  
riglerr@university-work:~/workspace/207SE-Networks-&-Security/3 - Assembly Code/triangle/t2 (master) $
```



### Item 3 - Bootloader

1. Make a Bootloader that displays my name
2. Make a Bootloader that displays a triangle of dots

## Item 4 - Inside Proc

### 1. List the CPU Information using the Cat Command

```
rob@rob-HP-ProBook-6470b: /proc
rob@rob-HP-ProBook-6470b:/proc$ cat /proc/cpuinfo
processor       : 0
vendor_id      : GenuineIntel
cpu family     : 6
model          : 58
model name     : Intel(R) Core(TM) i5-3340M CPU @ 2.70GHz
stepping       : 9
microcode      : 0x16
cpu MHz        : 1200.000
cache size     : 3072 KB
physical id    : 0
siblings       : 4
core id        : 0
cpu cores      : 2
apicid         : 0
initial apicid : 0
fpu            : yes
fpu_exception  : yes
cpuid level    : 13
wp             : yes
flags           : fpu vme de pse tsc msr pae mce cx8 apic sep mtrr pge mca
cmov pat pse36 clflush dts acpi mmx fxsr sse sse2 ss ht tm pbe syscall nx r
dtscp ln constant_tsc arch_perfmon pebs bts rep_good nopl xtopology nonstop
_tsc aperfmperf eagerfpu pni pclmulqdq dtes64 monitor ds_cpl vmx smx est tm
2 ssse3 cx16 xtpr pdcm pcid sse4_1 sse4_2 x2apic popcnt tsc_deadline_timer
aes xsave avx f16c rdrand lahf_lm ida arat epb xsaveopt pln pts dtherm tpr_
shadow vnmi flexpriority ept vpid fsgsbase smep erms
bogomips       : 5387.64
clflush size   : 64
cache_alignmen : 64
address sizes   : 36 bits physical, 48 bits virtual
power managemen:

processor       : 1
vendor_id      : GenuineIntel
cpu family     : 6
model          : 58
model name     : Intel(R) Core(TM) i5-3340M CPU @ 2.70GHz
stepping       : 9
microcode      : 0x16
cpu MHz        : 1200.000
```

## 2. Show a table of the interrupts on the system

```
rob@rob-HP-ProBook-6470b: /proc
rob@rob-HP-ProBook-6470b:/proc$ cat /proc/interrupts
```

	CPU0	CPU1	CPU2	CPU3		
0:	17	0	0	0	IO-APIC-edge	timer
1:	127	965	84	114	IO-APIC-edge	i8042
5:	1	0	0	0	IO-APIC-edge	parpor
8:	0	0	0	1	IO-APIC-edge	rtc0
9:	161	666	69	45	IO-APIC-fasteoi	acpi
12:	17919	140293	11353	10149	IO-APIC-edge	i8042
16:	156	160	13	16	IO-APIC-fasteoi	ehci_h
18:	2	0	0	0	IO-APIC-fasteoi	firewl
23:	0	0	0	0	IO-APIC-edge	lis3lv
40:	0	0	0	0	PCI-MSI-edge	PCIe P
41:	0	0	0	0	PCI-MSI-edge	PCIe P
42:	0	0	0	0	PCI-MSI-edge	PCIe P
43:	0	0	0	0	PCI-MSI-edge	PCIe P
44:	0	0	0	0	PCI-MSI-edge	xhci_h
46:	13082	7835	8087	8869	PCI-MSI-edge	ahci
47:	11	0	1	3	PCI-MSI-edge	mei_me
48:	137	253	45647	54	PCI-MSI-edge	twlwl
49:	4755	31559	2541	2296	PCI-MSI-edge	i915
50:	1179	80	17	57	PCI-MSI-edge	snd_hd
NMI:	0	0	0	0	Non-maskable interrupts	
LOC:	45464	43595	48260	38011	Local timer interrupts	
SPU:	0	0	0	0	Spurious interrupts	
PMI:	0	0	0	0	Performance monitoring i	
IWI:	2279	1883	1820	1826	IRQ work interrupts	
RTR:	2	0	0	0	APIC ICR read retriles	
RES:	20170	18531	19566	18119	Rescheduling interrupts	
CAL:	494	594	574	529	Function call interrupts	

## 3. Show number of CPUs, the producer of the CPUs and the CPU Model.

```
rob@rob-HP-ProBook-6470b: /proc
rob@rob-HP-ProBook-6470b:/proc$ clear

rob@rob-HP-ProBook-6470b:/proc$ grep model /proc/cpuinfo
```

```
model          : 58
model name     : Intel(R) Core(TM) i5-3340M CPU @ 2.70GHz
model          : 58
model name     : Intel(R) Core(TM) i5-3340M CPU @ 2.70GHz
model          : 58
model name     : Intel(R) Core(TM) i5-3340M CPU @ 2.70GHz
model          : 58
model name     : Intel(R) Core(TM) i5-3340M CPU @ 2.70GHz
rob@rob-HP-ProBook-6470b:/proc$
```

4. How the parameters that are passed to the kernel when starting up linux.

```
rob@rob-HP-ProBook-6470b: /proc
rob@rob-HP-ProBook-6470b:/proc$ clear

rob@rob-HP-ProBook-6470b:/proc$ cat /proc/cmdline
BOOT_IMAGE=/boot/vmlinuz-3.13.0-39-generic root=UUID=cada5b07-62dd-4282-b91
b-46d583d8b2ab ro quiet splash vt.handoff=7
rob@rob-HP-ProBook-6470b:/proc$ █
```

5. Show the name of the output devices and the number of megabytes read per second during the second sampled interval.

```
rob@rob-HP-ProBook-6470b: /proc
rob@rob-HP-ProBook-6470b:/proc$ clear

rob@rob-HP-ProBook-6470b:/proc$ awk '{ print $3, $4}' /proc/diskstats | gre
p sda
sda 20786
sda1 166
sda2 2
sda3 162
sda4 164
sda5 14715
sda6 161
sda7 5229
rob@rob-HP-ProBook-6470b:/proc$ █
```

## 6. Menu based shell script.

Listing 3: Bash Script

```
#!/bin/bash

# DISPLAYS A MENU

5 while true;
do
echo "1. Display information about the CPU. "
echo "2. Display the interrupts system. "
echo "3. Display a process PID for a process on the system and its status. "
10 echo "4. exit. "

read input_variable
#STORES THE INPUT INTO A VARIABLE CALLED "input_variable"

15 echo "Your choice was $input_variable"

#CASE STATEMENT TO DIFFERENTIATE OUTPUT RESPECTIVE TO THE USER'S CHOICE.

case "$input_variable" in
20 1) #Display CPU info
    echo Displaying CPU information
    grep model /proc/cpuinfo
    ;;
25 2) #Display the interrupts info
    echo Displaying interrupts
    cat /proc/interrupts
    ;;
3) #Display the PID and its status.
30 echo Enter PID
    read input2
    ps -p "$input2"
    ;;
4) #stop the script
35 break
    ;;
#END CASE STATEMENT
esac
#END OF WHILE LOOP
40 done

echo "Exiting"
```

## Item 5 - Buffer tutorial

### 1. Commented version of the rovided code

Listing 4: Commented Buffer Code

```
#include <fcntl.h>
#include <stdlib.h>
#include <unistd.h> //Define header files
#include <stdio.h>

5
#define BUF_SIZE 500 //Define Buffer size as 500.
#define OUTPUT_MODE 0700 //Define file permission.

int main(int argc, char *argv[])
10 {
    int in_fd, out_fd;
    int rd_size = 1, wr_size;
    char buf[BUF_SIZE]; //Declare buffer.

15     if (argc != 3)
        exit(1);

    in_fd = open(argv[1], O_RDONLY); //Open input file.
    if (in_fd < 0)
20         exit(2);

    out_fd = creat(argv[2], OUTPUT_MODE); //Create output file.
    if (out_fd < 0)
        exit(3);

25     while (rd_size > 0) {

        rd_size = read(in_fd, buf, BUF_SIZE); // Continuously read from input file
                                                //into buffer.

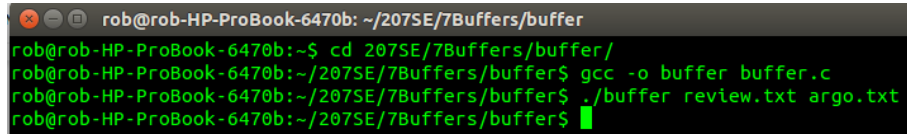
30         if (rd_size < 0)
            exit(4);

        wr_size = write(out_fd, buf, rd_size); // Continuously write from buffer into
                                                //the output file.

35         if (wr_size <= 0) {
            close(in_fd); //Close both of the files.
            close(out_fd);
            exit(5);
        }

40     }
}
```

## 2. Evidence of compiled code

A terminal window with a black background and green text. The window title is "rob@rob-HP-ProBook-6470b: ~/207SE/7Buffers/buffer". The terminal shows the following commands and output:

```
rob@rob-HP-ProBook-6470b:~$ cd 207SE/7Buffers/buffer/  
rob@rob-HP-ProBook-6470b:~/207SE/7Buffers/buffer$ gcc -o buffer buffer.c  
rob@rob-HP-ProBook-6470b:~/207SE/7Buffers/buffer$ ./buffer review.txt argo.txt  
rob@rob-HP-ProBook-6470b:~/207SE/7Buffers/buffer$
```

Argo.txt contains the exact same text that was in review.txt

### 3. Code adaptation to show how many cahracters were read in total and how many times the buffer was filled

Listing 5: Adpated Code

```
#include <fcntl.h>
#include <stdlib.h>
#include <unistd.h>
#include <stdio.h>
5 //Define header files

#define BUF_SIZE 500 //Define Buffer size as 500.
#define OUTPUT_MODE 0700 //Define file permission.

10 int main(int argc, char *argv[])
{
    int in_fd, out_fd;
    int buf_count=0,rd_count=0;
    int rd_size = 1, wr_size;
15    char buf[BUF_SIZE]; //Declare buffer.

    if (argc != 3)
        exit(1);

20    in_fd = open(argv[1], O_RDONLY); //Open input file.
    if (in_fd < 0)
        exit(2);

    out_fd = creat(argv[2], OUTPUT_MODE); //Create output file.
25    if (out_fd < 0)
        exit(3);

    while (rd_size > 0) {

30        rd_size = read(in_fd, buf, BUF_SIZE); //Continuously read from input file
                                                //into buffer.
        rd_count+= rd_size;
        if(rd_size > 0)
            buf_count +=1; //Counts the number of times the buffer
35                                //is filled (only if rd_size is > 0
        exit(4);

        wr_size = write(out_fd, buf, rd_size); //Continuously write from buffer into
                                                //output file.

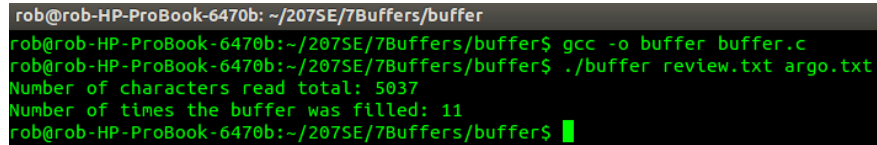
40        if (wr_size<=0){
            close(in_fd); //Close input file.
            close(out_fd); //Close output file

45        printf("Number of characters read total: %d\n",rd_count -1 );
            //Prints how many Characters were read.
        printf("Number of times the buffer was filled: %d\n",buf_count);
            //Prints how many times the buffer was filled
```



```
50 | exit(5);  
    | }  
    | }  
    | }
```

### 3a Evidence



```
rob@rob-HP-ProBook-6470b: ~/207SE/7Buffers/buffer  
rob@rob-HP-ProBook-6470b:~/207SE/7Buffers/buffer$ gcc -o buffer buffer.c  
rob@rob-HP-ProBook-6470b:~/207SE/7Buffers/buffer$ ./buffer review.txt argo.txt  
Number of characters read total: 5037  
Number of times the buffer was filled: 11  
rob@rob-HP-ProBook-6470b:~/207SE/7Buffers/buffer$ █
```

## 4. Altering the buffer size

- Doubling the buffer size to 1000, the program filled the buffer 6 times. This is half of the original value + 1.
- Doubling the buffer size again to 2000 , the program filled the buffer 3 times which is half of 6.
- Raising the the buffer size to 10000, the program filled the buffer 1 time, indicating that the entire text was placed into the buffer.

There is a direct linear correlation between the buffer size and the amount of times that the buffer was filled.

## 5. Adapt the code so that it is possible to compare if two files are the same.

Listing 6: Adapted code

```
#include <fcntl.h>
#include <stdlib.h>
#include <unistd.h>
#include <stdio.h>
5 //Define header files

#define BUF_SIZE 500 //Define Buffer size as 500.
#define OUTPUT_MODE 0700 //Define file permission.

10 int main(int argc, char *argv[])
{
    int in_fd, in0_fd; // Create integers to hold file handles.
    int rd_size = 1; // Create integer to hold the amount of bytes in the buffer.
    char buf[BUF_SIZE]; //Declare 1st buffer.
15 char buf0[BUF_SIZE]; //Declare 2nd buffer.

    if (argc != 3)
        exit(1);

20

    in_fd = open(argv[1], O_RDONLY); //Open 1st file.
    if (in_fd < 0)
        exit(2);

25

    in0_fd = open(argv[2], O_RDONLY); //Open 2nd file.
    if (in0_fd < 0)
        exit(3);

30 while (rd_size > 0) {

    int i;
    rd_size = read(in_fd, buf, BUF_SIZE); // Read From 1st file into 1st buffer

35

    if (rd_size < 0)
        exit(4);
    rd_size = read(in0_fd, buf0, rd_size); //Read from 2nd file into 2nd buffer

    for (i = 0; i < BUF_SIZE; i++){//Loop through the contents of each buffer.

40

        if (buf[i] == buf0[i])// If buffer contents are equal, go to next buffer element.
            continue;
        else { //If buffer contents are not the same,
            //close the files and display a message
            //and exit the program.

45

            close(in_fd); //Close input file.
            close(in0_fd); //Close output file
            printf("Files are not the same. \n");
50 exit(5);
        }
    }
}
```

```
        } //end else
    } //end for
} //end while

55 printf("Files are the same \n");// Display this message if the files are the same

} //end main
```

### 5a. Evidence of comparison between review.txt and argo.txt

```
rob@rob-HP-ProBook-6470b: ~/207SE/7Buffers/buffer
rob@rob-HP-ProBook-6470b:~/207SE/7Buffers/buffer$ ./bufcomp review.txt argo.txt
Files are the same
rob@rob-HP-ProBook-6470b:~/207SE/7Buffers/buffer$ █
```

### 5b. Evidence of comparison between argo.txt and reviewobserver.txt

```
rob@rob-HP-ProBook-6470b: ~/207SE/7Buffers/buffer
rob@rob-HP-ProBook-6470b:~/207SE/7Buffers/buffer$ ./bufcomp argo.txt review_observer.txt
Files are not the same.
rob@rob-HP-ProBook-6470b:~/207SE/7Buffers/buffer$ █
```

## Item 6 - Cache tutorial

### 1. Complete the `cr_read_byte` function

Please see the provided code in `cache_reader.c`

### 2. Prove the file is being buffered

To prove the code is being buffered. I included `printf("\n");` on line 58 in the `cache_reader.c` file . The program now starts a new line every time it reaches the end of the buffer ( in this example 20).

### 3. Provide some statistics

To count the number of bytes read, I created a variable called `byte_tot` in the `cr_file` structure (line12) in the `cache_reader.h` file. This variable is used in the `Refill()` method (line 15). Every time the `Refill()` method is called, it adds the value of `len` (which contains the number of bytes currently being read) to itself.

The amount of times the buffer was refilled, was calculated by dividing the number of bytes read from the text by the size of the buffer.

Listing 7: `cache_example.c`

```
#include "cache_reader.h"

//Simple file display to show how easy it is to use the cached reader functions

5 int main(){
    char c;
    int refill_count=0;
    int byte_count=0;
    //Open a file
10 cr_file* f = cr_open("text",20);

    //While there are useful bytes coming from it
    while((c=cr_read_byte(f))!=EOF){
        //Print them
15 printf("%c",c);

    }

20 //Then close the file
    printf("\nByte Count: %d",f->byte_tot);
    // Displaying the total number of bytes read.

    printf("\nRefill Count: %d\n",f->byte_tot/f->bufferlength);
25 //Displaying the total number of times the buffer was filled.
    //(No_of_bytes / buffersize).
    cr_close(f);

    //And finish
30 return 0;
}
```

Listing 8: cache\_reader.h

```
#include <stdio.h>
#include <stdlib.h>

//The internals of this struct aren't important
//from the user's point of view
5 typedef struct{
    FILE* file;           //File being read
    int bufferlength;     //Fixed buffer length
    int usedbuffer;       //Current point in the buffer
10    char* buffer;        //A pointer to a piece of memory
                        // same length as "bufferlength"
    int byte_tot;         //Integer to store the total amount of bytes that were read
                        //from the file.
15 } cr_file;

//Open a file with a given size of buffer to cache with
cr_file* cr_open(char* filename, int buffersize);

20

//Close an open file
void cr_close(cr_file* f);

//Read a byte. Will return EOF if empty.
25 char cr_read_byte(cr_file* f);

//-----

30

//Refill an empty buffer. Not intended for users
int refill(cr_file* buff);
```

Listing 9: cache\_reader.c

```
#include "cache_reader.h"

int refill(cr_file* buff){
    //Refills a buffer
    //Only works when completely used buffer
5    if(buff->usedbuffer!=buff->bufferlength)
        return 0;
    else{
        buff->usedbuffer=0;
10        int len=fread(buff->buffer, sizeof(char), buff->bufferlength, buff->file);
        //If we didn't fill the buffer, fill up with EOF
        if(len<buff->bufferlength)
            for(int i=len;i<buff->bufferlength;i++)
                buff->buffer[i]=EOF; //Accessing like an array!
15        buff->byte_tot +=len; //Adding len to the byte total.
        return len;
    }
}

20 void cr_close(cr_file* f){
    free(f->buffer);
    fclose(f->file);
}

25 cr_file* cr_open(char * filename, int buffersize){

    //Info on malloc
30    //http://www.space.unibe.ch/comp_doc/c_manual/C/FUNCTIONS/malloc.html
    FILE* f;
    if ((f = fopen(filename, "r")) == NULL){
        fprintf(stderr, "Cannot open %s\n", filename);
        return 0;
35    }

    cr_file* a=(cr_file*)malloc(sizeof(cr_file));
    a->file=f;
    a->bufferlength=buffersize;
40    a->usedbuffer=buffersize; //Start off with no characters,
        // so refill will work as expected
    a->buffer=(char*)malloc(sizeof(char)*buffersize);
    a->byte_tot =0;
    refill(a);
45    return a;
}

50
```

```
55 //-----
char cr_read_byte(cr_file* f){

    char btoRet; // byte to hold the character to return.
    if (f->usedbuffer >= f->bufferlength){ // if the buffer is all used, refill()
60     printf(" \n "); // starts a new line very time the buffer needs to be refilled.
        refill(f);

    }
    else{ // If buffer hasn't been fully used, return the chracter and increase
65     // the usedBuffer position by 1.

        btoRet = f->buffer[f->usedbuffer]; //Place next character in the
            //btoRet variable.
        f->usedbuffer +=1; //Move the buffer position up by 1.
70     return btoRet; //return the varibale.

    }

}
```

## Item 7 - Kernell