AUP Assignment 1

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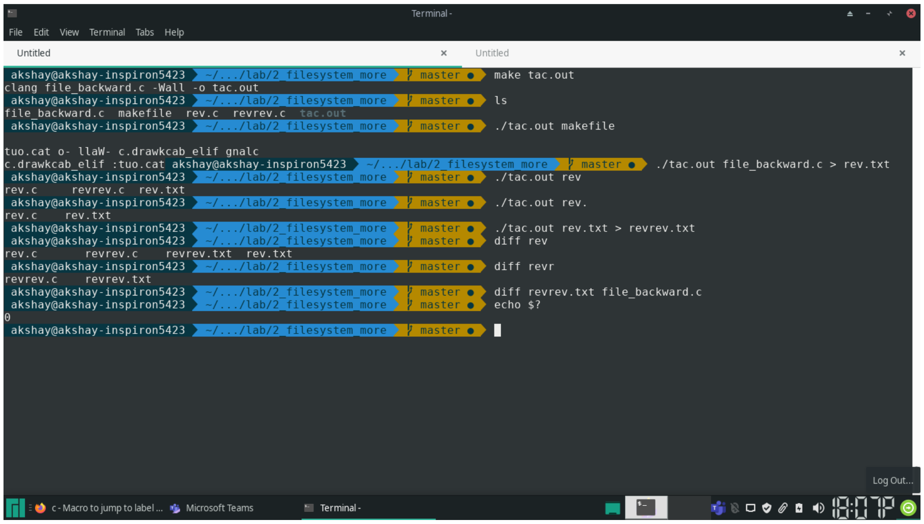
Q1

Take a file name as command line argument and print the file in backwards.

```
#include <sys/types.h>
#include <sys/stat.h>
#include <fcntl.h>
#include <unistd.h>
#include <errno.h>
#include <stdio.h>
#include <string.h>

void str_reverse(char *buf, int len) {
        int left, right;
        left = 0;
        right = len - 1;
        char temp;
        while (left < right) {
                temp = buf[left];
                buf[left] = buf[right];
                buf[right] = temp;
                ++left;
                --right;
        }
}

#define BUFSIZE 4096

int main(int argc, char *argv[]) {
        if (argc != 2) {
                printf("usage: ./tac.out <filename>\n");
                return EINVAL;
        }
```

```
int fp, bytes, bytes_prev, bytes_read;
char buf[BUFSIZE];


/* try to open file */
if ((fp = open(argv[1], O_RDONLY)) == -1) {
        perror(argv[1]);
        return errno;
}

/* assert: file exist and fd has a descriptor
 * which points to file */

/* go to end of file */
if ((bytes = lseek(fp, 0, SEEK_END)) == -1) {
        perror("cannot lseek to end of file");
        goto graceful_exit;
}
/* printf("Size of file = %d\n", bytes); */

bytes_prev = bytes;
/* printf("bytes read = %d\n", bytes_prev); */
while ((bytes = lseek(fp, -BUFSIZE, SEEK_CUR)) != -1) {
        /* while we *can* move BUFSIZE bytes backward */
        bytes_prev = bytes;

        if ((bytes_read = read(fp, buf, BUFSIZE)) != BUFSIZE) {
                perror("read");
                goto graceful_exit;
        }
        /* assert: read BUFSIZE bytes into buffer */

        str_reverse(buf, BUFSIZE);
        /* reverse the buffer */

        if (write(1, buf, BUFSIZE) != BUFSIZE) {
                perror("unable to write chunk to stdout");
                goto graceful_exit;
        }
        /* wrote the reverse of the buffer to stdout */

        if (lseek(fp, -BUFSIZE, SEEK_CUR) != bytes_prev) {
                perror("unable to seek to previous position");
                goto graceful_exit;
        }
```

```
                /* assert: at the end of the next block to be read */
        }

        /* assert: cannot lseek BUFSIZE bytes backward, this means that there
         * are less than BUFSIZE bytes left OR we have read the last chunk */

        /* assert: bytes_prev contains the offset of the last chunk that was
         * *read* */

        if (errno != EINVAL) {
                /* assert: error is not due to going before 0 */
                perror("wrong error when lseeking to negative offset");
                goto graceful_exit;
        }

        if (lseek(fp, 0, SEEK_SET) != 0) {
                perror("cannot seek to beginning of file");
                goto graceful_exit;
        }

        /* assert: we are at the beginning of file */

        if (read(fp, buf, bytes_prev) != bytes_prev) {
                /* printf("bytes_read = %d\n", bytes_prev); */
                perror("unable to read last chunk");
                goto graceful_exit;
        }

        str_reverse(buf, bytes_prev);
        if (write(1, buf, bytes_prev) != bytes_prev) {
                perror("unable to write last chunk");
                goto graceful_exit;
        }

        close(fp);
        return 0;

graceful_exit:
        close(fp);
        return errno;
}
```


Terminal -
File Edit View Terminal Tabs Help
Untitled
Untitled
c - Macro to jump to label ...
Microsoft Teams
Terminal -
Log Out...

```
 akshay@akshay-inspiron5423  ~/.../lab/2_filesystem_more  master ●  make tac.out
clang file_backward.c -Wall -o tac.out
 akshay@akshay-inspiron5423  ~/.../lab/2_filesystem_more  master ●  ls
file_backward.c  makefile  rev.c  revrev.c  tac.out
 akshay@akshay-inspiron5423  ~/.../lab/2_filesystem_more  master ●  ./tac.out makefile

tuo.cat o- llaW- c.drawkcab_elif gnalc
c.drawkcab_elif :tuo.cat akshay@akshay-inspiron5423  ~/.../lab/2_filesystem_more  master ●  ./tac.out file_backward.c > rev.txt
 akshay@akshay-inspiron5423  ~/.../lab/2_filesystem_more  master ●  ./tac.out rev
rev.c     revrev.c  rev.txt
 akshay@akshay-inspiron5423  ~/.../lab/2_filesystem_more  master ●  ./tac.out rev.
rev.c    rev.txt
 akshay@akshay-inspiron5423  ~/.../lab/2_filesystem_more  master ●  ./tac.out rev.txt > revrev.txt
 akshay@akshay-inspiron5423  ~/.../lab/2_filesystem_more  master ●  diff rev
rev.c       revrev.c    revrev.txt  rev.txt
 akshay@akshay-inspiron5423  ~/.../lab/2_filesystem_more  master ●  diff revr
revrev.c    revrev.txt
 akshay@akshay-inspiron5423  ~/.../lab/2_filesystem_more  master ●  diff revrev.txt file_backward.c
 akshay@akshay-inspiron5423  ~/.../lab/2_filesystem_more  master ●  echo $?
0
 akshay@akshay-inspiron5423  ~/.../lab/2_filesystem_more  master ●
```

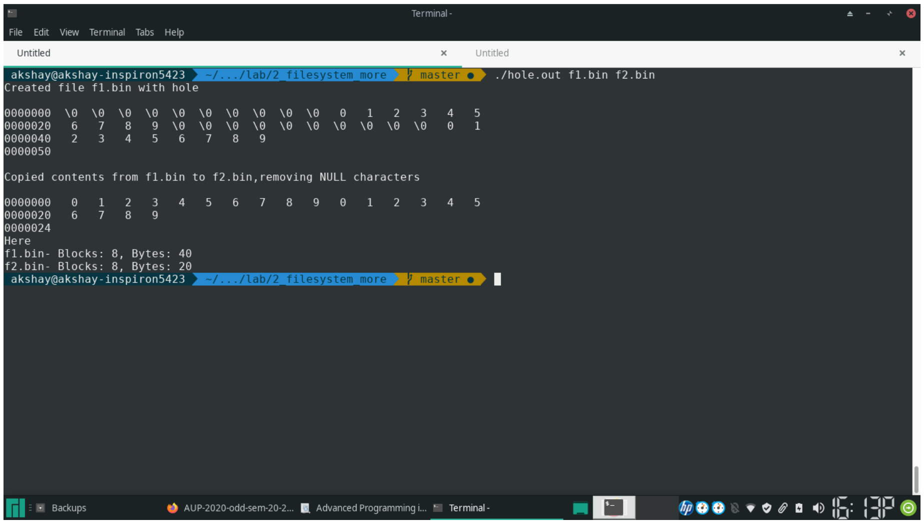
Q2

Write a program to create a file with a hole: write any 10 bytes at an offset of 10 and another 10 bytes at an offset of 30. Using "system" function, invoke "od" command and view the contents. Later copy the contents of the file to another file without writing the bytes of 0. Once again verify the contents by invoking "system" with "od". What is the size of the file with hole and the new file found using lstat?

```
#include <sys/types.h>
#include <sys/stat.h>
#include <fcntl.h>
#include <unistd.h>
#include <errno.h>
#include <stdio.h>
#include <stdlib.h>

#define TEXT "0123456789"

        int filter(char *dest, char *src, int n) {
                int l1, l2;
                l1 = l2 = 0;
                while (l1 < n) {
                        if (src[l1]) {
                                dest[l2++] = src[l1];
                        }
                        l1++;
                }
                return l2;
        }



int main(int argc, char *argv[]) {
        int fi, fo;
        char buf[256];
        char buf2[256];
        int bytes;

        if (argc != 3) {
                fprintf(stderr, "usage: ./hole.out <file1> <file2>\n");
                return EINVAL;
        }

        if ((fo = open(argv[1],
                                        O_WRONLY | O_CREAT | O_TRUNC,
                                        S_IRUSR | S_IWUSR)) == -1) {

                perror(argv[1]);
                return errno;
        }

        if (lseek(fo, 10, SEEK_SET) == -1) {
                perror("lseek 10");
                close(fo);
                return errno;
        }

        if (write(fo, TEXT, 10) != 10) {
                perror("write [10, 20)");
                close(fo);
                return errno;
        }

        if (lseek(fo, 30, SEEK_SET) == -1) {
                perror("lseek 30");
                close(fo);
                return errno;
        }

        if (write(fo, TEXT, 10) == -1) {
                perror("write [30, 40)");
                close(fo);
                return errno;
        }

        printf("Created file %s with hole\n\n", argv[1]);

        close(fo);

        sprintf(buf, "od -c %s", argv[1]);

        if (system(buf) == -1) {
                perror(buf);
                return errno;
        }

        if ((fi = open(argv[1], O_RDONLY)) == -1) {
                perror(argv[1]);
                return errno;
        }

        if ((fo = open(argv[2],
                                        O_WRONLY | O_CREAT | O_TRUNC,
                                        S_IRUSR | S_IWUSR)) == -1) {
                perror(argv[2]);
                close(fi);
                return errno;
        }

        printf("\nCopied contents from %s to %s,"
                        "removing NULL characters\n\n",
                        argv[1], argv[2]);

        int len;
        while((bytes = read(fi, buf, 256)) == 256) {
                len = filter(buf2, buf, 256);
                if (write(fo, buf2, len) != len) {
                        perror("write failed");
                        close(fi);
                        close(fo);
                        return errno;
                }
                return 0;
        }

        len = filter(buf2, buf, bytes);
        if (write(fo, buf2, len) != len) {
```

```
                perror("write failed");
                close(fi);
                close(fo);
                return errno;
        }

        close(fi);
        close(fo);

        sprintf(buf, "od -c %s", argv[2]);

        if (system(buf) == -1) {
                perror(buf);
                return errno;
        }

        struct stat f1, f2;

        printf("Here\n");

        if (lstat(argv[1], &f1) == -1) {
                sprintf(buf, "lstat %s", argv[1]);
                perror(buf);
                return errno;
        }

        if (lstat(argv[2], &f2) == -1) {
                sprintf(buf, "lstat %s", argv[2]);
                perror(buf);
                return errno;
        }

        printf("%s- Blocks: %ld, Bytes: %ld\n", argv[1], f1.st_blocks, f1.st_size);

        printf("%s- Blocks: %ld, Bytes: %ld\n", argv[2], f2.st_blocks, f2.st_size);

        return 0;
}
```

Ouput



```
akshay@akshay-inspiron5423 ~/.../lab/2_filesystem_more  master ● ./hole.out f1.bin f2.bin
Created file f1.bin with hole

0000000  \0  \0  \0  \0  \0  \0  \0  \0  \0  \0   0   1   2   3   4   5
0000020   6   7   8   9  \0  \0  \0  \0  \0  \0  \0  \0  \0  \0   0   1
0000040   2   3   4   5   6   7   8   9
0000050

Copied contents from f1.bin to f2.bin,removing NULL characters

0000000   0   1   2   3   4   5   6   7   8   9   0   1   2   3   4   5
0000020   6   7   8   9
0000024
Here
f1.bin- Blocks: 8, Bytes: 40
f2.bin- Blocks: 8, Bytes: 20
akshay@akshay-inspiron5423 ~/.../lab/2_filesystem_more  master ●
```

Explanation

- The bytes in the hole, when read, show NULL.
- The size of the file with the hole is 40 bytes, while when non-null characters are copied to another file, the size of the new file is 20 bytes
- Because there is no way to differentiate between NULL bytes in the hole and NULL bytes which might be present in the file as data, data bytes might be skipped when copying only the non-nulls to the new file

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Q3

Which are time values gets modified by the successful execution of the function? Assume two cases: open(“file1”, O_WRONLY|O_CREAT, 777) ;

1. File already existing
2. New file is created

The following program was used for carrying out the procedure

```
#include <sys/types.h>
#include <fcntl.h>
#include <unistd.h>
#include <errno.h>
#include <stdio.h>
```

```c
int main(int argc, char *argv[]) {
        int fp;

        if (argc != 2) {
                fprintf(stderr, "usage: ./tryopen.out <filename>");
                return EINVAL;
        }

        if ((fp = open(argv[1], O_WRONLY | O_CREAT, 777)) == -1) {
                perror(argv[1]);
                return errno;
        }

        close(fp);

        return 0;
}
```

Existing file

1. Existing file times were examined using “stat” command
2. The program was run with the name of the existing file as argument
3. The file times were examined again using the stat command
4. The file times in (1) and (3) were found to be the same

New file

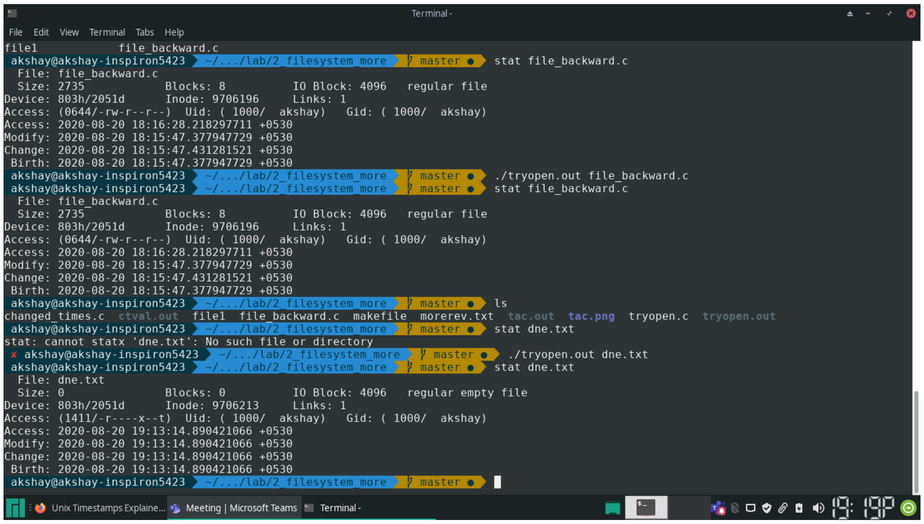
1. Running stat with name of non existing file gave error
2. Program was run with new file name, creating an empty file
3. The file times were examined using the stat command
4. All the three times had the same value

Explanation

1. When the file already exists, **none of the time values get affected**. This has been verified by calling the function and viewing the modified values before and after stat.

- This is because *the file is not modified* (no write happens) - The file is not *accessed as it has been opened in write mode.* - The file is not changed, because data in the inode has not been changed.

2. When the new file is created, **all the time values are affected**. All three fields are set to the same time.



```
file1            file_backward.c
 akshay@akshay-inspiron5423  ~/.../lab/2_filesystem_more   master ●  stat file_backward.c
  File: file_backward.c
  Size: 2735            Blocks: 8          IO Block: 4096   regular file
Device: 803h/2051d      Inode: 9706196     Links: 1
Access: (0644/-rw-r--r--)  Uid: ( 1000/  akshay)   Gid: ( 1000/  akshay)
Access: 2020-08-20 18:16:28.218297711 +0530
Modify: 2020-08-20 18:15:47.377947729 +0530
Change: 2020-08-20 18:15:47.431281521 +0530
 Birth: 2020-08-20 18:15:47.377947729 +0530
 akshay@akshay-inspiron5423  ~/.../lab/2_filesystem_more   master ●  ./tryopen.out file_backward.c
 akshay@akshay-inspiron5423  ~/.../lab/2_filesystem_more   master ●  stat file_backward.c
  File: file_backward.c
  Size: 2735            Blocks: 8          IO Block: 4096   regular file
Device: 803h/2051d      Inode: 9706196     Links: 1
Access: (0644/-rw-r--r--)  Uid: ( 1000/  akshay)   Gid: ( 1000/  akshay)
Access: 2020-08-20 18:16:28.218297711 +0530
Modify: 2020-08-20 18:15:47.377947729 +0530
Change: 2020-08-20 18:15:47.431281521 +0530
 Birth: 2020-08-20 18:15:47.377947729 +0530
 akshay@akshay-inspiron5423  ~/.../lab/2_filesystem_more   master ●  ls
changed_times.c  ctval.out  file1  file_backward.c  makefile  morerev.txt  tac.out  tac.png  tryopen.c  tryopen.out
 akshay@akshay-inspiron5423  ~/.../lab/2_filesystem_more   master ●  stat dne.txt
stat: cannot statx 'dne.txt': No such file or directory
 ✘ akshay@akshay-inspiron5423  ~/.../lab/2_filesystem_more   master ●  ./tryopen.out dne.txt
 akshay@akshay-inspiron5423  ~/.../lab/2_filesystem_more   master ●  stat dne.txt
  File: dne.txt
  Size: 0               Blocks: 0          IO Block: 4096   regular empty file
Device: 803h/2051d      Inode: 9706213     Links: 1
Access: (1411/-r----x--t)  Uid: ( 1000/  akshay)   Gid: ( 1000/  akshay)
Access: 2020-08-20 19:13:14.890421066 +0530
Modify: 2020-08-20 19:13:14.890421066 +0530
Change: 2020-08-20 19:13:14.890421066 +0530
 Birth: 2020-08-20 19:13:14.890421066 +0530
 akshay@akshay-inspiron5423  ~/.../lab/2_filesystem_more   master ● 
```