

CSE 344 System Programming Homework #1

Project Report

a. Project Summary

In this project, I have developed a Student Grade Management System that utilizes low-level system calls, such as `open()`, `read()`, `write()`, and process management through the `fork()` function. This system is designed to efficiently manage student grades stored in files, offering a range of functionalities to add, search, sort, and display student grades. The project emphasizes the use of fundamental system programming concepts to manipulate file data and manage processes in a Unix/Linux environment.

b. Process Management

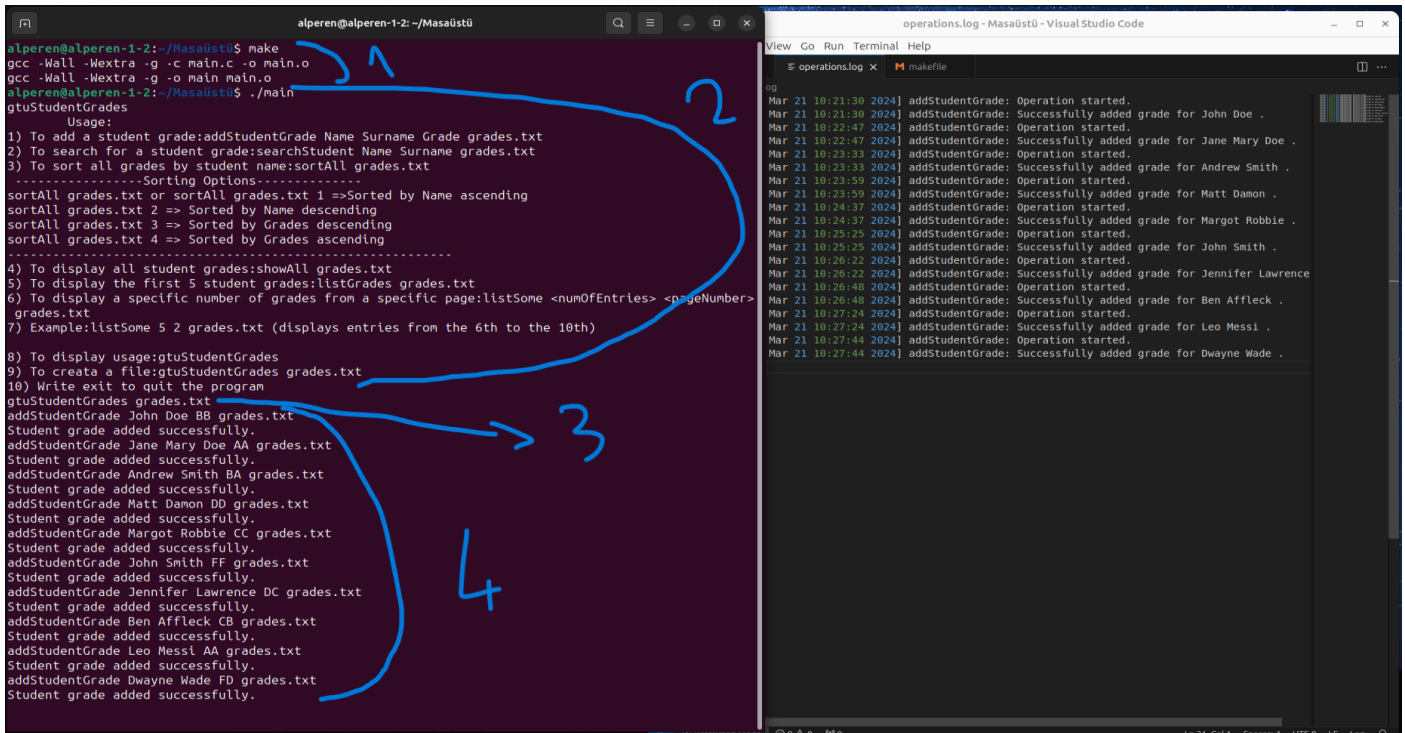
Process Management to ensure robustness and isolation, file operations are performed in separate child processes created using the `fork()` system call. This design choice isolates each operation, ensuring that any failure in a file operation does not compromise the integrity of the main application. The parent process waits for the completion of each child process, handling any errors and ensuring clean termination of child processes.

c. Process Termination and Error Handling

Process termination and error handling were key to maintaining system stability and ensuring resource management. Child processes, created for tasks like file operations, were terminated with `exit()`, signaling successful completion or error conditions back to the parent process. The parent used `wait()` or `waitpid()` to prevent zombie processes and manage resource cleanup. Errors within child processes prompted logging via `logMessage` before exiting with `EXIT_FAILURE`. The parent monitored these exit statuses to log errors and, if necessary, inform the user or initiate corrective measures, ensuring a robust and error-resilient system.

d. Test Cases

The “make” command must be typed to compile the program. (1)



The screenshot shows a terminal window on the left and a Visual Studio Code window on the right. The terminal window displays the output of the 'make' command, which compiles the program. It then shows the usage of the program, followed by a series of commands and their outputs. The Visual Studio Code window shows the 'operations.log' file, which contains a log of the program's operations.

```
alperen@alperen-1-2: ~/Masaüstü
gcc -Wall -Wextra -g -c main.c -o main.o
gcc -Wall -Wextra -g -o main main.o
alperen@alperen-1-2: ~/Masaüstü$ ./main
gtuStudentGrades
Usage:
1) To add a student grade:addStudentGrade Name Surname Grade grades.txt
2) To search for a student grade:searchStudent Name Surname grades.txt
3) To sort all grades by student name:sortAll grades.txt
-----Sorting Options-----
sortAll grades.txt or sortAll grades.txt 1 =>Sorted by Name ascending
sortAll grades.txt 2 => Sorted by Name descending
sortAll grades.txt 3 => Sorted by Grades descending
sortAll grades.txt 4 => Sorted by Grades ascending
-----
4) To display all student grades:showAll grades.txt
5) To display the first 5 student grades:listGrades grades.txt
6) To display a specific number of grades from a specific page:listSome <numOfEntries> <pageNumber>
grades.txt
7) Example:listSome 5 2 grades.txt (displays entries from the 6th to the 10th)
8) To display usage:gtuStudentGrades
9) To create a file:gtuStudentGrades grades.txt
10) Write exit to quit the program
gtuStudentGrades grades.txt
addStudentGrade John Doe BB grades.txt
Student grade added successfully.
addStudentGrade Jane Mary Doe AA grades.txt
Student grade added successfully.
addStudentGrade Andrew Smith BA grades.txt
Student grade added successfully.
addStudentGrade Matt Damon DD grades.txt
Student grade added successfully.
addStudentGrade Margot Robbie CC grades.txt
Student grade added successfully.
addStudentGrade John Smith FF grades.txt
Student grade added successfully.
addStudentGrade Jennifer Lawrence DC grades.txt
Student grade added successfully.
addStudentGrade Ben Affleck CB grades.txt
Student grade added successfully.
addStudentGrade Leo Messi AA grades.txt
Student grade added successfully.
addStudentGrade Dwayne Wade FD grades.txt
Student grade added successfully.
```

The Visual Studio Code window shows the 'operations.log' file, which contains a log of the program's operations. The log shows the following operations:

- Mar 21 10:21:30 2024] addStudentGrade: Operation started.
- Mar 21 10:21:30 2024] addStudentGrade: Successfully added grade for John Doe .
- Mar 21 10:22:47 2024] addStudentGrade: Operation started.
- Mar 21 10:22:47 2024] addStudentGrade: Successfully added grade for Jane Mary Doe .
- Mar 21 10:23:33 2024] addStudentGrade: Operation started.
- Mar 21 10:23:33 2024] addStudentGrade: Successfully added grade for Andrew Smith .
- Mar 21 10:23:59 2024] addStudentGrade: Operation started.
- Mar 21 10:23:59 2024] addStudentGrade: Successfully added grade for Matt Damon .
- Mar 21 10:24:37 2024] addStudentGrade: Operation started.
- Mar 21 10:24:37 2024] addStudentGrade: Successfully added grade for Margot Robbie .
- Mar 21 10:25:25 2024] addStudentGrade: Operation started.
- Mar 21 10:25:25 2024] addStudentGrade: Successfully added grade for John Smith .
- Mar 21 10:26:22 2024] addStudentGrade: Operation started.
- Mar 21 10:26:22 2024] addStudentGrade: Successfully added grade for Jennifer Lawrence .
- Mar 21 10:26:48 2024] addStudentGrade: Operation started.
- Mar 21 10:26:48 2024] addStudentGrade: Successfully added grade for Ben Affleck .
- Mar 21 10:27:24 2024] addStudentGrade: Operation started.
- Mar 21 10:27:24 2024] addStudentGrade: Successfully added grade for Leo Messi .
- Mar 21 10:27:44 2024] addStudentGrade: Operation started.
- Mar 21 10:27:44 2024] addStudentGrade: Successfully added grade for Dwayne Wade .

The “gtuStudentGrades” without an argument command prints usage of the program.(2)

The “gtuStudentGrades grades.txt” command creates a file named “grades.txt”. (3)

On the above screenshot I added 10 students to system using “addStudentGrade” command. The “addStudentGrade Name Surname Grade filename” commands add student to system and it writes the .log file operation to trace the program. (4)

```
addStudentGrade Dwayne Wade FD grades.txt
Student grade added successfully.
searchStudent Matt Damon grades.txt
Matt Damon , DD
searchStudent Jane Mary Doe grades.txt
Jane Mary Doe , AA
searchStudent Johnny Doe grades.txt
Student 'Johnny Doe' not found.
searchStudent John Doe grades.txt
John Doe , BB
searchStudent Jennifer Lawrence grades.txt
Jennifer Lawrence , DC
searchStudent Andrew grades.txt
Invalid command!
Usage:
1) To add a student grade:addStudentGrade Name Surname Grade grades.txt
2) To search for a student grade:searchStudent Name Surname grades.txt
3) To sort all grades by student name:sortAll grades.txt
-----Sorting Options-----
sortAll grades.txt or sortAll grades.txt 1 =>Sorted by Name ascending
sortAll grades.txt 2 => Sorted by Name descending
sortAll grades.txt 3 => Sorted by Grades descending
sortAll grades.txt 4 => Sorted by Grades ascending
-----
4) To display all student grades:showAll grades.txt
5) To display the first 5 student grades:listGrades grades.txt
6) To display a specific number of grades from a specific page:listSome <numOfEntries> <pageNumber> grades.txt
7) Example:listSome 5 2 grades.txt (displays entries from the 6th to the 10th)
8) To display usage:gtuStudentGrades
9) To create a file:gtuStudentGrades grades.txt
10) Write exit to quit the program
searchStudent Andrew Smith grades.txt
Andrew Smith , BA
showAll grades.txt
John Doe , BB
Jane Mary Doe , AA
Andrew Smith , BA
Matt Damon , DD
Margot Robbie , CC
John Smith , FF
Jennifer Lawrence , DC
Ben Affleck , CB
Leo Messi , AA
Dwayne Wade , FD
listGrades grades.txt
```

```
Go Run Terminal Help
operations.log X F grades.txt M makefile
addStudentGrade: Operation started.
addStudentGrade: Successfully added grade for John Doe .
addStudentGrade: Operation started.
addStudentGrade: Successfully added grade for Jane Mary Doe .
addStudentGrade: Operation started.
addStudentGrade: Successfully added grade for Andrew Smith .
addStudentGrade: Operation started.
addStudentGrade: Successfully added grade for Matt Damon .
addStudentGrade: Operation started.
addStudentGrade: Successfully added grade for Margot Robbie .
addStudentGrade: Operation started.
addStudentGrade: Successfully added grade for John Smith .
addStudentGrade: Operation started.
addStudentGrade: Successfully added grade for Jennifer Lawrence .
addStudentGrade: Operation started.
addStudentGrade: Successfully added grade for Ben Affleck .
addStudentGrade: Operation started.
addStudentGrade: Successfully added grade for Leo Messi .
addStudentGrade: Operation started.
addStudentGrade: Successfully added grade for Dwayne Wade .
searchStudent: Operation started.
searchStudent: Student found: Matt Damon.
searchStudent: Operation started.
searchStudent: Student found: Jane Mary Doe.
searchStudent: Operation started.
searchStudent: Student not found: Johnny Doe.
searchStudent: Operation started.
searchStudent: Student found: John Doe.
searchStudent: Operation started.
searchStudent: Student found: Jennifer Lawrence.
searchStudent: Operation started.
searchStudent: Student found: Andrew Smith.
showAll: Operation started.
showAll: Displayed all student grades successfully.
listGrades: Operation started.
listGrades: Listing grades completed successfully.
listSome: Operation started.
listSome: Listing completed successfully.
```

The usage “searchStudent” and “showAll” command can be seen in this screenshot.

The “searchStudent Name Surname filename” prints student and grade. (1)

If command entered without missing argument the program prints the usage of the program. (2)

The “showAll filename” prints all student in the file. (3)

```
alperen@alperen-1-2: ~/Masaüstü
Dwayne Wade , FD
listGrades grades.txt
John Doe , BB
Jane Mary Doe , AA
Andrew Smith , BA
Matt Damon , DD
Margot Robbie , CC
listSome 5 2 grades.txt
John Smith , FF
Jennifer Lawrence , DC
Ben Affleck , CB
Leo Messi , AA
Dwayne Wade , FD
listSome 4 3 grades.txt
Leo Messi , AA
Dwayne Wade , FD
listSome 4 1 grades.txt
John Doe , BB
Jane Mary Doe , AA
Andrew Smith , BA
Matt Damon , DD
sortAll grades.txt
Andrew Smith , BA
Ben Affleck , CB
Dwayne Wade , FD
Jane Mary Doe , AA
Jennifer Lawrence , DC
John Doe , BB
John Smith , FF
Leo Messi , AA
Margot Robbie , CC
Matt Damon , DD
sortAll grades.txt 1
Students sorted ascending ordered by name.
Andrew Smith , BA
Ben Affleck , CB
Dwayne Wade , FD
Jane Mary Doe , AA
Jennifer Lawrence , DC
John Doe , BB
John Smith , FF
Leo Messi , AA
Margot Robbie , CC
Matt Damon , DD
sortAll grades.txt 2
Students sorted descending ordered by name.
Matt Damon , DD
```

1

2

3

4

5

```
operations.log - Masaüstü - Visual Studio Code
Go Run Terminal Help
operations.log x grades.txt makefile
addStudentGrade: Operation started.
addStudentGrade: Successfully added grade for John Smith .
addStudentGrade: Operation started.
addStudentGrade: Successfully added grade for Jennifer Lawrence .
addStudentGrade: Operation started.
addStudentGrade: Successfully added grade for Ben Affleck .
addStudentGrade: Operation started.
addStudentGrade: Successfully added grade for Leo Messi .
addStudentGrade: Operation started.
addStudentGrade: Successfully added grade for Dwayne Wade .
searchStudent: Operation started.
searchStudent: Student found: Matt Damon.
searchStudent: Operation started.
searchStudent: Student found: Jane Mary Doe.
searchStudent: Operation started.
searchStudent: Student not found: Johnny Doe.
searchStudent: Operation started.
searchStudent: Student found: John Doe.
searchStudent: Operation started.
searchStudent: Student found: Jennifer Lawrence.
searchStudent: Operation started.
searchStudent: Student found: Andrew Smith.
showAll: Operation started.
showAll: Displayed all student grades successfully.
listGrades: Operation started.
listGrades: Listing grades completed successfully.
listSome: Operation started.
listSome: Listing completed successfully.
listSome: Operation started.
listSome: Listing completed successfully.
listSome: Operation started.
listSome: Listing completed successfully.
listSome: Operation started.
listSome: Listing completed successfully.
sortAll: Operation started.
sortAll: Displayed students sorted ascending ordered by name.
sortAll: Operation started.
sortAll: Displayed students sorted ascending ordered by name.
sortAll: Operation started.
sortAll: Displayed students sorted descending ordered by name.
sortAll: Operation started.
sortAll: Displayed students sorted descending ordered by grade.
sortAll: Operation started.
sortAll: Displayed students sorted ascending ordered by grade.
```

```
grades.txt
1 John Doe , BB
2 Jane Mary Doe , AA
3 Andrew Smith , BA
4 Matt Damon , DD
5 Margot Robbie , CC
6 John Smith , FF
7 Jennifer Lawrence , DC
8 Ben Affleck , CB
9 Leo Messi , AA
10 Dwayne Wade , FD
11
```

```
alperen@alperen-1-2: ~/Masaüstü
Andrew Smith , BA
Ben Affleck , CB
Dwayne Wade , FD
Jane Mary Doe , AA
Jennifer Lawrence , DC
John Doe , BB
John Smith , FF
Leo Messi , AA
Margot Robbie , CC
Matt Damon , DD
sortAll grades.txt 2
Students sorted descending ordered by name.
Matt Damon , DD
Margot Robbie , CC
Leo Messi , AA
John Smith , FF
John Doe , BB
Jennifer Lawrence , DC
Jane Mary Doe , AA
Dwayne Wade , FD
Ben Affleck , CB
Andrew Smith , BA
sortAll grades.txt 3
Students sorted descending ordered by grades.
Jane Mary Doe , AA
Leo Messi , AA
Andrew Smith , BA
John Doe , BB
Ben Affleck , CB
Margot Robbie , CC
Jennifer Lawrence , DC
Matt Damon , DD
Dwayne Wade , FD
John Smith , FF
sortAll grades.txt 4
Students sorted ascending ordered by grades.
John Smith , FF
Dwayne Wade , FD
Matt Damon , DD
Jennifer Lawrence , DC
Margot Robbie , CC
Ben Affleck , CB
John Doe , BB
Andrew Smith , BA
Jane Mary Doe , AA
Leo Messi , AA
```

6

7

8

```
operations.log - Masaüstü - Visual Studio Code
Go Run Terminal Help
operations.log x grades.txt makefile
addStudentGrade: Operation started.
addStudentGrade: Successfully added grade for John Smith .
addStudentGrade: Operation started.
addStudentGrade: Successfully added grade for Jennifer Lawrence .
addStudentGrade: Operation started.
addStudentGrade: Successfully added grade for Ben Affleck .
addStudentGrade: Operation started.
addStudentGrade: Successfully added grade for Leo Messi .
addStudentGrade: Operation started.
addStudentGrade: Successfully added grade for Dwayne Wade .
searchStudent: Operation started.
searchStudent: Student found: Matt Damon.
searchStudent: Operation started.
searchStudent: Student found: Jane Mary Doe.
searchStudent: Operation started.
searchStudent: Student not found: Johnny Doe.
searchStudent: Operation started.
searchStudent: Student found: John Doe.
searchStudent: Operation started.
searchStudent: Student found: Jennifer Lawrence.
searchStudent: Operation started.
searchStudent: Student found: Andrew Smith.
showAll: Operation started.
showAll: Displayed all student grades successfully.
listGrades: Operation started.
listGrades: Listing grades completed successfully.
listSome: Operation started.
listSome: Listing completed successfully.
listSome: Operation started.
listSome: Listing completed successfully.
listSome: Operation started.
listSome: Listing completed successfully.
listSome: Operation started.
listSome: Listing completed successfully.
sortAll: Operation started.
sortAll: Displayed students sorted ascending ordered by name.
sortAll: Operation started.
sortAll: Displayed students sorted ascending ordered by name.
sortAll: Operation started.
sortAll: Displayed students sorted descending ordered by name.
sortAll: Operation started.
sortAll: Displayed students sorted descending ordered by grade.
sortAll: Operation started.
sortAll: Displayed students sorted ascending ordered by grade.
```

```
grades.txt
1 John Doe , BB
2 Jane Mary Doe , AA
3 Andrew Smith , BA
4 Matt Damon , DD
5 Margot Robbie , CC
6 John Smith , FF
7 Jennifer Lawrence , DC
8 Ben Affleck , CB
9 Leo Messi , AA
10 Dwayne Wade , FD
11
```

The usage of “listGrades” , “listSome” and “sortAll” commands can be seen in this screenshot.

The “listGrades grades.txt” command prints first five entries of the file. (1)

The “listSome 5 2 grades.txt” commands prints entries between 6th and 10th . (2)

The “listSome 4 3 grades.txt” commands prints entries between 9th and 10th . (3)

The “listSome 4 1 grades.txt” commands prints entries between 1st and 4th. (4)

The “sortAll grades.txt” or “sortAll grades.txt 1” command prints student ascending ordered by name. (5)

The “sortAll grades.txt 2” command prints student descending ordered by name. (6)

The “sortAll grades.txt 3 ” command prints student descending ordered by grade. (7)

The “sortAll grades.txt 4 ” command prints student descending ordered by grade. (8)

sortAll grades.txt 1 => Sorts names by ascending order.

sortAll grades.txt 2=> Sorts names by descending order.

sortAll grades.txt 3=> Sorts grades by descending order.

sortAll grades.txt 4=> Sorts grades by ascending order.

****Note:** The sortAll function just sorts students and does not change content of the file.

```
alperen@alperen-1-2: ~/Masaüstü
Leo Messi , AA
addStudent asda grades.txt
Invalid command!
Usage:
1) To add a student grade:addStudentGrade Name Surname Grade grades.txt
2) To search for a student grade:searchStudent Name Surname grades.txt
3) To sort all grades by student name:sortAll grades.txt
-----Sorting Options-----
sortAll grades.txt or sortAll grades.txt 1 =>Sorted by Name ascending
sortAll grades.txt 2 => Sorted by Name descending
sortAll grades.txt 3 => Sorted by Grades descending
sortAll grades.txt 4 => Sorted by Grades ascending
-----
4) To display all student grades:showAll grades.txt
5) To display the first 5 student grades:listGrades grades.txt
6) To display a specific number of grades from a specific page:listSome <numOfEntries> <pageNumber> grades.txt
7) Example:listSome 5 2 grades.txt (displays entries from the 6th to the 10th)

8) To display usage:gtuStudentGrades
9) To create a file:gtuStudentGrades grades.txt
10) Write exit to quit the program
listGra grades.txt
Invalid command!
Usage:
1) To add a student grade:addStudentGrade Name Surname Grade grades.txt
2) To search for a student grade:searchStudent Name Surname grades.txt
3) To sort all grades by student name:sortAll grades.txt
-----Sorting Options-----
sortAll grades.txt or sortAll grades.txt 1 =>Sorted by Name ascending
sortAll grades.txt 2 => Sorted by Name descending
sortAll grades.txt 3 => Sorted by Grades descending
sortAll grades.txt 4 => Sorted by Grades ascending
-----
4) To display all student grades:showAll grades.txt
5) To display the first 5 student grades:listGrades grades.txt
6) To display a specific number of grades from a specific page:listSome <numOfEntries> <pageNumber> grades.txt
7) Example:listSome 5 2 grades.txt (displays entries from the 6th to the 10th)

8) To display usage:gtuStudentGrades
9) To create a file:gtuStudentGrades grades.txt
10) Write exit to quit the program
exit
Exiting program...
alperen@alperen-1-2:~/Masaüstü$ make clean
rm -f main main.o
```

Some wrong entered commands and usage can be seen in the screenshot. (1)

To quit the program “exit” command must be entered. (2)

The “make clean” removes compiled objects and executables. (3)

Alperen Duran

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