OS lab Assignment – 2

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Implement command interpreter, read a line of command, integrate IO redirection and Piping.

```c
#include <errno.h>
#include <fcntl.h>
#include <linux/limits.h>
#include <stdbool.h>
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <sys/stat.h>
#include <unistd.h>
#define max(a, b) \
    ({ __typeof__ (a) _a = (a); \
       __typeof__ (b) _b = (b); \
     _a > _b ? _a : _b; })
void printWelcome() {
    printf("WELCOME TO THE COMMAND INTERPRETER\n\n\n");
}
void splitInputIntoWords(char *input, int len, char ***allWords, int *argument
sLength, char *delimiter) {
    char *word;
    char *savePointer1 = NULL;
    char *savedInput1 = (char *)calloc(len + 1, sizeof(char));
    char *savedInput2 = (char *)calloc(len + 1, sizeof(char));
    strcpy(savedInput1, input);
    strcpy(savedInput2, savedInput1);
    savedInput1[len] = savedInput2[len] = '\0';
    char *deLimit = delimiter;
    word = strtok_r(savedInput1, deLimit, &savePointer1);
    int countNoOfWords = 0;
    int maxLenWord = 0;
    while (word != NULL) {
        int len = strlen(word);
        maxLenWord = max(len, maxLenWord);
        word = strtok_r(NULL, deLimit, &savePointer1);
        countNoOfWords++;
    }
    for (int i = 0; i < (*argumentsLength); i++) {
        free((*allWords)[i]);
    }
    if ((*allWords)) free(*allWords);
    (*allWords) = NULL;
    (*argumentsLength) = 0;
    (*allWords) = (char **)calloc(countNoOfWords + 1, sizeof(char *));
    for (int i = 0; i < countNoOfWords; i++) {
        (*allWords)[i] = (char *)calloc(maxLenWord + 1, sizeof(char));
    }
    (*allWords)[countNoOfWords] = NULL;
    char *savePointer2 = NULL;
    word = strtok_r(savedInput2, deLimit, &savePointer2);
```

```
    int index = 0;
    while (word != NULL) {
        int currLen = strlen(word);
        for (int i = 0; i < currLen; i++) {
            (*allWords)[index][i] = word[i];
        }
        (*allWords)[index][currLen] = '\0';
        word = strtok_r(NULL, deLimit, &savePointer2);
        index++;
    }
    (*argumentsLength) = countNoOfWords;
    return;
}
bool checkIfFile(char *path) {
    struct stat buffer;
    int exists = stat(path, &buffer);
    if (exists == 0 && (S_IFREG & buffer.st_mode)) {
        return 1;
    }
    return 0;
}
void checkInCurrDir(char *commandName, char **filePath) {
    if (checkIfFile(commandName)) {
        char *temp = NULL;
        filePath = realpath(commandName, (temp));
    }
    return;
}
void checkInPATH(char *commandName, char **filePath) {
    char *tempPath = getenv("PATH");
    char *fullPath = (char *)calloc(strlen(tempPath), sizeof(char));
    strcpy(fullPath, tempPath);
    char *token = strtok(fullPath, ":");
    struct stat buffer;
    while (token != NULL) {
        char *currItem = (char *)calloc(strlen(commandName) + strlen(token), s
izeof(char));
        sprintf(currItem, "%s/%s", token, commandName);
        if (checkIfFile(currItem)) {
            char *temp = NULL;
            (*filePath) = realpath(currItem, (temp));

            return;
        }
        token = strtok(NULL, ":");
    }
    return;
}
void getActualPath(char *commandName, char **filePath) {
    checkInCurrDir(commandName, filePath);
    if ((*filePath) != NULL) return;
    checkInPATH(commandName, filePath);

    return;
}
```

```
void removeWhiteSpaces(char *str) {
    int i = 0, j = 0;
    while (str[i] != '\0') {
        if (str[i] != ' ' && str[i] != '\n')
            str[j++] = str[i];
        i++;
    }
    str[j] = '\0';
    return;
}
void segregateFiles(char *command, int noOfFiles[], char **allFiles[]) {
    char *savedInput1 = (char *)calloc(strlen(command), sizeof(char));
    char *savedInput2 = (char *)calloc(strlen(command), sizeof(char));
    strcpy(savedInput1, command);
    strcpy(savedInput2, command);
    int index = 0;
    int maxLen = 0;
    int lenOfString = strlen(command);
    for (; index < lenOfString; index++) {
        if (savedInput1[index] == ' ' || savedInput1[index] == '\t' || savedIn
put1[index] == '\n') continue;
        int j = index;
        int count = 0;
        for (j = index; j < lenOfString; j++) {
            if (savedInput1[j] != '>') {
                if (savedInput1[j] == '<') j++;
                break;
            }
            count = count + 1;
        }
        if (count > 3) {
            printf("There is some error here %s\n", command);
            exit(0);
        }
        while (++j && j < lenOfString) {
            if (savedInput1[j] == ' ' || savedInput1[j] == '\t' || savedInput1
[j] == '\n')
                continue;
            else
                break;
        }
        index = j;
        noOfFiles[count]++;
        while (j + 1 < lenOfString && savedInput1[j + 1] != ' ' && savedInput1
[j + 1] != '>' && savedInput1[j + 1] != '<') j++;
        maxLen = max(maxLen, j - index + 1);
        index = j;
    }
    for (int i = 0; i < 3; i++) {
        allFiles[i] = (char **)calloc(noOfFiles[i], sizeof(char *));
        for (int j = 0; j < noOfFiles[i]; j++) {
            allFiles[i][j] = (char *)calloc(maxLen + 1, sizeof(char));
        }
    }
    index = 0;
```

```
    int temp[3] = {0};
    for (; index < lenOfString; index++) {
        if (savedInput1[index] == ' ' || savedInput1[index] == '\t' || savedIn
put1[index] == '\n') continue;
        int count = 0;
        int j = index;
        for (j = index; j < lenOfString; j++) {
            if (savedInput1[j] != '>') {
                if (savedInput1[j] == '<') j++;
                break;
            }
            count = count + 1;
        }
        if (count > 3) {
            printf("There is some error here %s\n", command);
            exit(0);
        }
        while (++j && j < lenOfString) {
            if (savedInput1[j] == ' ' || savedInput1[j] == '\t' || savedInput1
[j] == '\n')
                continue;
            else {
                j--;
                break;
            }
        }
        index = j;
        int currIndex = temp[count];
        while (j + 1 < lenOfString && savedInput1[j + 1] != ' ' && savedInput1
[j + 1] != '>' && savedInput1[j + 1] != '<') {
            j++;
        }
        for (int k = index; k <= j; k++) {
            allFiles[count][currIndex][k - index] = savedInput1[k];
        }
        allFiles[count][currIndex][j + 1 - index] = '\0';
        removeWhiteSpaces(allFiles[count][currIndex]);
        temp[count]++;
        maxLen = max(maxLen, j - index + 1);
        index = j;
    }
}
int getCommand(char *input, int len) {
    for (int i = 0; i < len; i++) {
        if (input[i] == '>' || input[i] == '<') return i;
    }
    return len;
}
void getFDs(char **allFiles[], int noOfFiles[], int *fileDescpt[]) {
    fileDescpt[0] = (int *)calloc(noOfFiles[0] + 1, sizeof(int));
    fileDescpt[1] = (int *)calloc(noOfFiles[1] + 1, sizeof(int));
    fileDescpt[2] = (int *)calloc(noOfFiles[2], sizeof(int));
    for (int i = 0; i < noOfFiles[0]; i++) {
        int fd = open(allFiles[0][i], O_RDONLY);
        if (fd == -1) {
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```
            printf("cannot open the file %s\n", allFiles[0][i]);
        }
        fileDescpt[0][i] = fd;
    }
    for (int i = 0; i < noOfFiles[1]; i++) {
        {
            FILE *f;
            f = fopen(allFiles[1][i], "w");
            fclose(f);
        }
        int fd = open(allFiles[1][i], O_WRONLY | O_APPEND);
        if (fd == -1) {
            printf("cannot open the file %s\n", allFiles[1][i]);
        }
        fileDescpt[1][i] = fd;
    }
    for (int i = 0; i < noOfFiles[2]; i++) {
        {
            FILE *f;
            f = fopen(allFiles[2][i], "a");
            fclose(f);
        }
        int fd = open(allFiles[2][i], O_WRONLY | O_APPEND);
        if (fd == -1) {
            printf("cannot open the file %s\n", allFiles[2][i]);
        }
        fileDescpt[2][i] = fd;
    }
}
void getAllFileDescriptors(char *command, char **actualCommand, char **allFile
s[], int noOfFiles[], int *fileDescpt[]) {
    int index = getCommand(command, strlen(command));
    char *fileString = command + index;
    (*actualCommand) = (char *)calloc(index + 1, sizeof(char));
    for (int i = 0; i < index; i++) {
        (*actualCommand)[i] = command[i];
    }
    (*actualCommand)[index] = '\0';
    segregateFiles(fileString, noOfFiles, allFiles);
    getFDs(allFiles, noOfFiles, fileDescpt);
}
void completeCommandExecutionWithRedirection(char *actualCommand, int *fileDes
cpt[], int noOfFiles[], char **allFiles[], char *arguments[], int index, int n
) {
    char tempFileOut[] = "/tmp/tempFile-XXXXXX";
    int tempFileOutFD = mkstemp(tempFileOut);
    char tempFileIn[] = "/tmp/tempFile-XXXXXX";
    int tempFileInFD = mkstemp(tempFileIn);
    unlink(tempFileIn);
    unlink(tempFileOut);
    int child = fork();
    if (child != 0) {
        wait();
        for (int i = 1; i <= 2; i++) {
            lseek(tempFileOutFD, 0, SEEK_SET);
```

```
            char c;
            int count = 1;
            for (int j = 0; j < noOfFiles[i]; j++) {
                lseek(tempFileOutFD, 0, SEEK_SET);
                while ((count = read(tempFileOutFD, &c, 1)) > 0)
                    write(fileDescpt[i][j], &c, 1);
            }
            if (i == 1) {
                int j = noOfFiles[i];
                lseek(tempFileOutFD, 0, SEEK_SET);
                count = 1;
                if (index + 1 == n && noOfFiles[1] + noOfFiles[2] == 0) {
                    while ((count = read(tempFileOutFD, &c, 1)) > 0)
                        write(STDOUT_FILENO, &c, 1);
                    continue;
                }
                while ((count = read(tempFileOutFD, &c, 1)) > 0)
                    write(fileDescpt[i][j], &c, 1);
                c = EOF;
                write(fileDescpt[i][j], &c, 1);
            }
        }
    } else {
        int count = 1;
        for (int i = 0; i < 1; i++) {
            char c;
            for (int j = 0; j < noOfFiles[i]; j++) {
                if (fileDescpt[i][j] < 0) continue;
                while ((count = read(fileDescpt[i][j], &c, 1)) > 0)
                    write(tempFileInFD, &c, 1);
            }
        }
        if (index == 0) {
            if (noOfFiles[0] == 0)
                tempFileInFD = STDIN_FILENO;
        } else {
            char c;
            while ((count = read(fileDescpt[0][noOfFiles[0]], &c, 1)) == 1 &&
c != -1) {
                write(tempFileInFD, &c, 1);
            }
        }
        lseek(tempFileInFD, 0, SEEK_SET);
        dup2(tempFileOutFD, STDOUT_FILENO);
        if (!(index == 0 && noOfFiles[0] == 0))
            dup2(tempFileInFD, STDIN_FILENO);
        execvp(actualCommand, arguments);
        printf("Some error occured while executing %s\n", actualCommand);
        exit(0);
    }
    exit(0);
}
void startCommandExecution(char *input, int len, bool bgExec) {
    char **allWords = NULL;
    char **allPipes = NULL;
```

```
    int pipesLength = 0;
    char *delimiterForCommand = " \t\n";
    char *delimiterForPipe = "|";
    splitInputIntoWords(input, len, &allPipes, &pipesLength, delimiterForPipe)
;
    int p[pipesLength + 1][2];
    for (int i = 0; i < pipesLength + 1; i++) {
        pipe(p[i]);
    }
    for (int pipeIndex = 0; pipeIndex < pipesLength; pipeIndex++) {
        close(p[pipeIndex][1]);
        int argumentLength = 0;
        char *command = (char *)calloc(strlen(allPipes[pipeIndex]), sizeof(cha
r));
        strcpy(command, allPipes[pipeIndex]);
        char **allFiles[3];
        int noOfFiles[3] = {0};
        int *fileDescpt[3] = {0};
        char *actualCommand = "";
        getAllFileDescriptors(command, &actualCommand, allFiles, noOfFiles, fi
leDescpt);
        char **allArguments = NULL;
        splitInputIntoWords(actualCommand, strlen(actualCommand), &allArgument
s, &argumentLength, delimiterForCommand);
        fileDescpt[0][noOfFiles[0]] = p[pipeIndex][0];
        fileDescpt[1][noOfFiles[1]] = p[pipeIndex + 1][1];
        int child = fork();
        if (child == 0) {
            completeCommandExecutionWithRedirection(allArguments[0], fileDescp
t, noOfFiles, allFiles, allArguments, pipeIndex, pipesLength);
            exit(0);
        } else {
            wait();
        }
    }
    if (bgExec == true)
        printf("done execution %s pid=%d \n", input, getpid(), getppid());
    exit(0);
}
int main() {
    printWelcome();
    size_t MAX_LEN = 0;
    char *input = NULL;
    char **allWords = NULL;
    char **allPipes = NULL;
    int pipesLength = 0;
    int argumentLength = 0;
    char *pwd = (char *)calloc(PATH_MAX, sizeof(char));
    char *absolutePath = (char *)calloc(PATH_MAX, sizeof(char));
    char *delimiterForCommand = " \t\n";
    char *delimiterForPipe = "|";
    while (1) {
        printf("cmd >", pwd);
        if (input)
            free(input);
```

```
        MAX_LEN = 0;
        int len = getline(&input, &MAX_LEN, stdin);
        if (strcmp(input, "exit\n") == 0) {
            break;
        }
        if (strcmp(input, "\n") == 0) {
            continue;
        }
        bool bgExec = false;
        for (int i = len - 1; i >= 0; i--) {
            if (input[i] == ' ' || input[i] == '\t' || input[i] == '\n')
                continue;
            else {
                if (input[i] == '&') {
                    input[i] = '\0';
                    bgExec = true;
                }
                break;
            }
        }
        int startChild = fork();
        if (startChild == 0) {
            if (bgExec)
                printf("Started background execution pid=%d\n", getpid());
            startCommandExecution(input, len, bgExec);
            exit(0);
        } else {
            if (!bgExec) {
                wait();
            }
        }
    }
}
```

Command execution:

```
┌──(kali㉿kali)-[~/Documents/os-lab/197118_Santosh_2]
└─$ ./"command_interpreter"
WELCOME TO THE COMMAND INTERPRETER

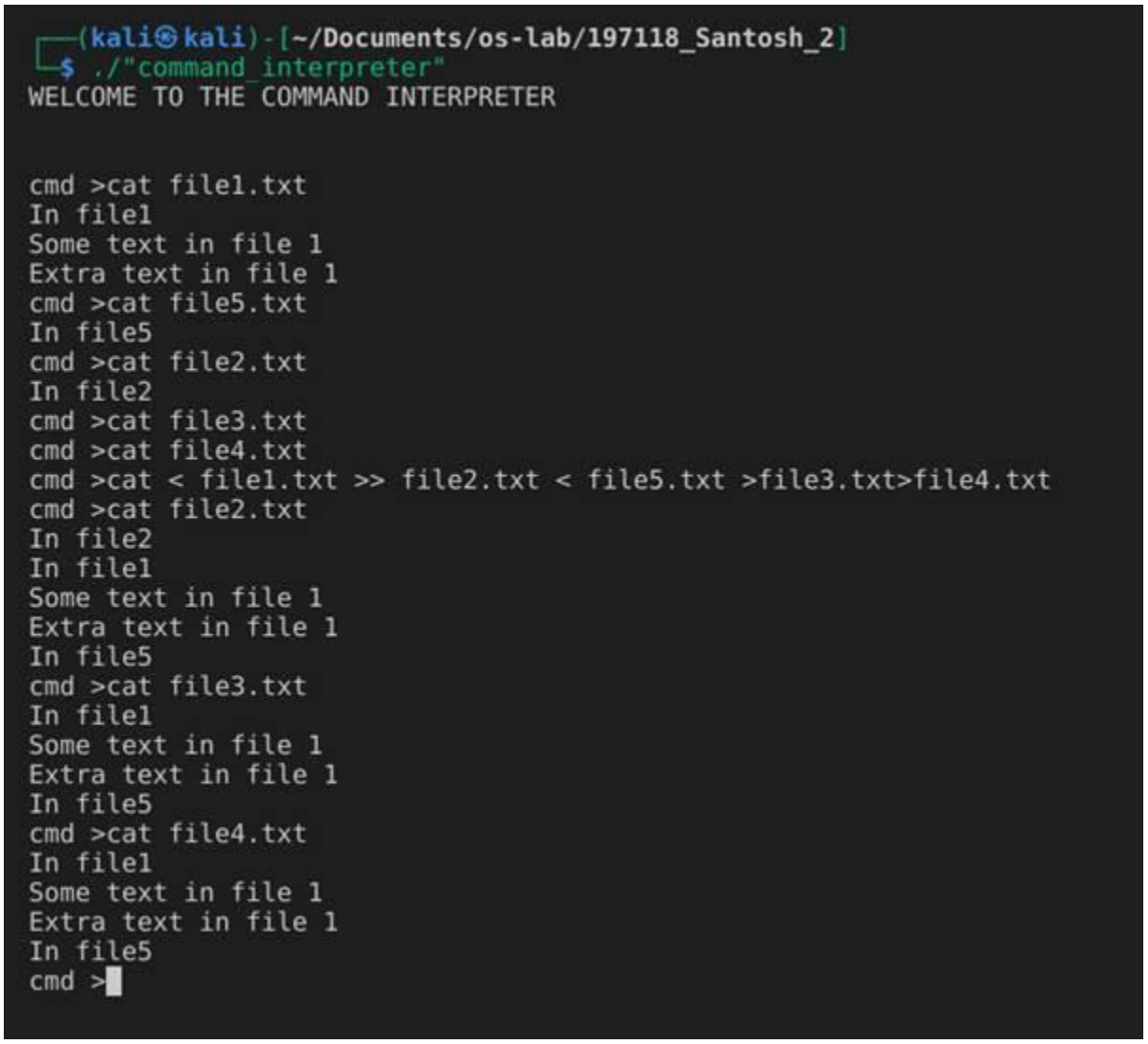

cmd >cat file1.txt
In file1
Some text in file 1
Extra text in file 1
cmd >
```

Input Redirection:

```
┌──(kali㉿kali)-[~/Documents/os-lab/197118_Santosh_2]
└─$ ./"command_interpreter"
WELCOME TO THE COMMAND INTERPRETER


cmd >cat file1.txt
In file1
Some text in file 1
Extra text in file 1
cmd >cat file2.txt
cmd >cat file1.txt > file2.txt
cmd >cat file2.txt
In file1
Some text in file 1
Extra text in file 1
cmd >
```

Multiple IO redirections:



Piping example:

```
┌──(kali㉿kali)-[~/Documents/os-lab/197118_Santosh_2]
└─$ ./command_interpreter
WELCOME TO THE COMMAND INTERPRETER


cmd >cat file1.txt
In file1
Some text in file 1
Extra text in file 1
There is this line with file1
cmd >cat file1.txt | grep file1
In file1
There is this line with file1
cmd >
```

Multiple IO redirections with Piping:

```
┌──(kali㉿kali)-[~/Documents/os-lab/197118_Santosh_2]
└─$ ./command_interpreter
WELCOME TO THE COMMAND INTERPRETER


cmd >cat file1.txt
In file1
Some text in file 1
Extra text in file 1
There is this line with file1
cmd >cat file2.txt
This is file2
cmd >cat file3.txt
cmd >cat file1.txt > file3.txt >>file2.txt | grep file1
In file1
There is this line with file1
cmd >cat file2.txt
This is file2
In file1
Some text in file 1
Extra text in file 1
There is this line with file1
cmd >cat file3.txt
In file1
Some text in file 1
Extra text in file 1
There is this line with file1
cmd >exit

┌──(kali㉿kali)-[~/Documents/os-lab/197118_Santosh_2]
└─$
```

With background executio:

```
┌──(kali㉿kali)-[~/Documents/os-lab/197118_Santosh_2]
└─$ ./command_interpreter
WELCOME TO THE COMMAND INTERPRETER


cmd >cat file1.txt | grep file1 &
cmd >Started background execution pid=37475
In file1
There is this line with file1
done execution cat file1.txt | grep file1  pid=37475

cmd >exit

┌──(kali㉿kali)-[~/Documents/os-lab/197118_Santosh_2]
└─$
```

```
┌──(kali㉿kali)-[~/Documents/os-lab/197118_Santosh_2]
└─$ ./command_interpreter
WELCOME TO THE COMMAND INTERPRETER


cmd >ls -l
total 148
-rwxr-xr-x 1 kali kali 22808 Sep 14 12:32 command_interpreter
-rw-r--r-- 1 kali kali 13892 Sep 14 12:36 command_interpreter.c
-rwxr-xr-x 1 kali kali 21880 Sep 14 03:44 division
-rw-r--r-- 1 kali kali 11277 Sep 14 09:03 division.c
-rw-r--r-- 1 kali kali    80 Sep 14 12:17 file1.txt
-rw-r--r-- 1 kali kali    89 Sep 14 12:38 file2.txt
-rw-r--r-- 1 kali kali   169 Sep 14 12:38 file3.txt
-rw-r--r-- 1 kali kali   148 Sep 14 12:38 file4.txt
-rw-r--r-- 1 kali kali     9 Sep 14 12:09 file5.txt
-rw-r--r-- 1 kali kali   175 Sep 14 10:22 file6.txt
-rwxr-xr-x 1 kali kali 17368 Sep  1 09:45 shell
-rw-r--r-- 1 kali kali    75 Sep 13 23:55 temp.txt
-rwxr-xr-x 1 kali kali 17560 Sep 12 09:32 test
-rw-r--r-- 1 kali kali  3864 Sep 12 09:33 test.c
cmd >ls -l | grep file.*
-rw-r--r-- 1 kali kali    80 Sep 14 12:17 file1.txt
-rw-r--r-- 1 kali kali    89 Sep 14 12:38 file2.txt
-rw-r--r-- 1 kali kali   169 Sep 14 12:38 file3.txt
-rw-r--r-- 1 kali kali   148 Sep 14 12:38 file4.txt
-rw-r--r-- 1 kali kali     9 Sep 14 12:09 file5.txt
-rw-r--r-- 1 kali kali   175 Sep 14 10:22 file6.txt
cmd >exit

┌──(kali㉿kali)-[~/Documents/os-lab/197118_Santosh_2]
└─$
```