Московский Авиационный Институт

(Национальный Исследовательский Университет)

Институт №8 “Компьютерные науки и прикладная математика”

Кафедра №806 “Вычислительная математика и программирование”

Лабораторная работа №4 по курсу

«Операционные системы»

Группа: М80-206Б-22

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Оценка: _____

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Постановка задачи

Вариант 6.

1. Рассчет интеграла функции sin(x) на отрезке [A, B] с шагом e. Подсчет интеграла методом прямоугольников. Подсчет интеграла методом трапеций.
2. Подсчет площади плоской геометрической фигуры по двум сторонам. Фигура прямоугольник. Фигура прямоугольный треугольник.

Общий метод и алгоритм решения

Использованные системные вызовы:

- void *dlopen(const char *filename, int flag) - загружает динамическую библиотеку.
- int dlclose(void *handle) - уменьшает на единицу счетчик ссылок на указатель динамической библиотеки handle.
- void *dlsym(void *handle, char *symbol) - использует указатель на динамическую библиотеку, возвращаемую dlopen, и оканчивающееся нулем символьное имя, а затем возвращает адрес, указывающий, откуда загружается этот символ.

Код программы

lib_lab04.h

```c
#pragma once

float sin_integral(float a, float b, float e);
float square(float a, float b);
```

lib_lab04_impl1.c

```c
#include "lib_lab04.h"
#include <math.h>

float sin_integral(float a, float b, float e) {
    float res = 0;
    for (float i = a; i < b; i += e) {
        res += sinf(i);
    }
    res *= e;
    return res;
}

float square(float a, float b) {
    return a * b;
}
```

lib_lab04_impl2.c

```c
#include "lib_lab04.h"
#include <math.h>

float sin_integral(float a, float b, float e) {
    float res = (sinf(a) + sinf(b)) / 2;
    for (float i = a + e; i < b; i += e) {
        res += sinf(i);
    }
```

```
    res *= e;
    return res;
}

float square(float a, float b) {
    return a * b / 2;
}
```

main1.c

```
#include "lib_lab04.h"
#include <stdio.h>

void interface() {
    printf("Test program 1. \nFor help enter 'h' \n> ");
    while (1) {
        char cmd;
        cmd = getchar();
        if (cmd == 'h') {
            printf("h - display this page you are seeing now\n");
            printf("1 A B E - compute integral of sin(x) on the segment [A,
B] with step E\n");
            printf("2 A B - compute square of rectangle size of A x B\n");
            printf("q - quit\n");
        } else if (cmd == '1') {
            float a, b, e;
            scanf(" %f %f %f", &a, &b, &e);
            printf("Result of sin_integral is %f\n", sin_integral(a, b,
e));
        } else if (cmd == '2') {
            float a, b;
            scanf(" %f %f", &a, &b);
            printf("Result of square is %f\n", square(a, b));
        } else if (cmd == 'q'){
            break;
        } else {
            while (cmd != '\n') {
                getchar();
            }
            printf("Invalid command!\n");
        }
        printf("> ");
        cmd = getchar();
    }
}

int main() {
    interface();
    return 0;
}
```

main2.c

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

typedef struct {
    int impl;
    void* handles[2];
    void* funcs[2];
} lib;
```

```c
void change_implementation(lib* l, int impl) {
    l->funcs[0] = dlsym(l->handles[impl], "sin_integral");
    l->funcs[1] = dlsym(l->handles[impl], "square");
    l->impl = impl;
}

void interface(lib* l) {
    printf("Test program 1. \nFor help enter 'h' \n> ");
    while (1) {
        char cmd;
        cmd = getchar();
        if (cmd == 'h') {
            printf("h - display this page you are seeing now\n");
            printf("0 - change implementation (could be 0 or 1)");
            printf("1 A B E - compute integral of sin(x) on the segment [A,
B] with step E\n");
            printf("2 A B - compute square of rectangle size of A x B\n");
            printf("q - quit\n");
        } else if (cmd == '0') {
            change_implementation(l, (l->impl + 1) % 2);
            printf("Implementation changed. Current is %d\n", l->impl);
        } else if (cmd == '1') {
            float a, b, e;
            scanf(" %f %f %f", &a, &b, &e);
            printf("Result of sin_integral is %f\n", (((float (*)(float,
float, float)) l->funcs[0])(a, b, e)));
        } else if (cmd == '2') {
            float a, b;
            scanf(" %f %f", &a, &b);
            printf("Result of square is %f\n", ((float (*)(float, float))
l->funcs[1])(a, b));
        } else if (cmd == 'q'){
            break;
        } else {
            while (cmd != '\n') {
                getchar();
            }
            printf("Invalid command!\n");
        }
        printf("> ");
        cmd = getchar();
    }
}

int main() {
    lib l;
    l.handles[0] = dlopen("/home/cat_mood/programming/mai-os-
labs/lab04/build/liblib1.so", RTLD_LAZY | RTLD_LOCAL);
    if (l.handles[0] == NULL) {
        exit(1);
    }
    l.handles[1] = dlopen("/home/cat_mood/programming/mai-os-
labs/lab04/build/liblib2.so", RTLD_LAZY | RTLD_LOCAL);
    if (l.handles[1] == NULL) {
        exit(1);
    }
    change_implementation(&l, 0);

    interface(&l);

    dlclose(l.handles[0]);
    dlclose(l.handles[1]);
```

```
    return 0;
}
```

CMakeLists.txt

```
cmake_minimum_required(VERSION 3.10)

project(lab04)


set(C_STANDARD 99)

set(CMAKE_CXX_STANDARD_REQUIRED ON)


set(INCLUDE_DIR ${CMAKE_CURRENT_SOURCE_DIR}/include)

set(SOURCE_DIR ${CMAKE_CURRENT_SOURCE_DIR}/src)


include_directories(${INCLUDE_DIR})


# компилирую динамическую библиотеку первой реализации

add_library(lib1 SHARED ${SOURCE_DIR}/lib_lab04_impl1.c)

target_include_directories(lib1 PUBLIC ${INCLUDE_DIR})

# компилирую динамическую библиотеку первой реализации

add_library(lib2 SHARED ${SOURCE_DIR}/lib_lab04_impl2.c)

# указываю пути для include

target_include_directories(lib2 PUBLIC ${INCLUDE_DIR})

# прилинковываю математику (cmath)

target_link_libraries(lib1 PRIVATE m)

target_link_libraries(lib2 PRIVATE m)


# компилирую мэйны

add_executable(main1_impl1 ${CMAKE_CURRENT_SOURCE_DIR}/main1.c)

add_executable(main1_impl2 ${CMAKE_CURRENT_SOURCE_DIR}/main1.c)
```

```
# прилинковываю скомпилированные библиотеки

target_link_libraries(main1_impl1 PRIVATE lib1 PRIVATE m)

target_link_libraries(main1_impl2 PRIVATE lib2 PRIVATE m)



# компилирую мэйн для dynamic loading library (ничего не линкую к ней)

add_executable(main2 ${CMAKE_CURRENT_SOURCE_DIR}/main2.c)
```

Команда add_library() с флагом SHARED компилирует динамическую библиотеку. «Скрывает» под собой флаги -fPIC при компиляции объектных файлов и -shared при компиляции библиотеки.

target_link_libraries() прилинковывает библиотеки к указанной цели. «Скрывает» под собой флаг -lnamelib. Флаг PRIVATE служит для того, чтобы указать какие элементы (исходники, библиотеки, цели) необходимы для сборки этой цели. Т.е. эта цель зависима от этих элементов, но другие цели, которые будут использовать эту цель в качестве зависимости, не получат её зависимости транзитивно.

add_executable() компилирует в исполняемый файл

Протокол работы программы

Strace:

execve("./main1_impl1", ["./main1_impl1"], 0x7ffc10d8ab30 /* 36 vars */) = 0

brk(NULL) = 0x55d755744000

arch_prctl(0x3001 /* ARCH_??? */, 0x7ffcfc54f2e0) = -1 EINVAL (Invalid argument)

mmap(NULL, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) = 0x7f643c9b3000

access("/etc/ld.so.preload", R_OK) = -1 ENOENT (No such file or directory)

openat(AT_FDCWD, "/home/cat_mood/programming/mai-os-labs/lab04/build/glibc-hwcaps/x86-64-v3/liblib1.so", O_RDONLY|O_CLOEXEC) = -1 ENOENT (No such file or directory)

newfstatat(AT_FDCWD, "/home/cat_mood/programming/mai-os-labs/lab04/build/glibc-hwcaps/x86-64-v3", 0x7ffcfc54e500, 0) = -1 ENOENT (No such file or directory)

openat(AT_FDCWD, "/home/cat_mood/programming/mai-os-labs/lab04/build/glibc-hwcaps/x86-64-v2/liblib1.so", O_RDONLY|O_CLOEXEC) = -1 ENOENT (No such file or directory)

newfstatat(AT_FDCWD, "/home/cat_mood/programming/mai-os-labs/lab04/build/glibc-hwcaps/x86-64-v2", 0x7ffcfc54e500, 0) = -1 ENOENT (No such file or directory)

openat(AT_FDCWD, "/home/cat_mood/programming/mai-os-labs/lab04/build/tls/x86_64/x86_64/liblib1.so", O_RDONLY|O_CLOEXEC) = -1 ENOENT (No such file or directory)

newfstatat(AT_FDCWD, "/home/cat_mood/programming/mai-os-labs/lab04/build/tls/x86_64/x86_64", 0x7ffcfc54e500, 0) = -1 ENOENT (No such file or directory)

openat(AT_FDCWD, "/home/cat_mood/programming/mai-os-labs/lab04/build/tls/x86_64/liblib1.so", O_RDONLY|O_CLOEXEC) = -1 ENOENT (No such file or directory)

newfstatat(AT_FDCWD, "/home/cat_mood/programming/mai-os-labs/lab04/build/tls/x86_64", 0x7ffcfc54e500, 0) = -1 ENOENT (No such file or directory)

openat(AT_FDCWD, "/home/cat_mood/programming/mai-os-labs/lab04/build/tls/x86_64/liblib1.so", O_RDONLY|O_CLOEXEC) = -1 ENOENT (No such file or directory)

newfstatat(AT_FDCWD, "/home/cat_mood/programming/mai-os-labs/lab04/build/tls/x86_64", 0x7ffcfc54e500, 0) = -1 ENOENT (No such file or directory)

openat(AT_FDCWD, "/home/cat_mood/programming/mai-os-labs/lab04/build/tls/liblib1.so", O_RDONLY|O_CLOEXEC) = -1 ENOENT (No such file or directory)

newfstatat(AT_FDCWD, "/home/cat_mood/programming/mai-os-labs/lab04/build/tls", 0x7ffcfc54e500, 0) = -1 ENOENT (No such file or directory)

openat(AT_FDCWD, "/home/cat_mood/programming/mai-os-labs/lab04/build/x86_64/x86_64/liblib1.so", O_RDONLY|O_CLOEXEC) = -1 ENOENT (No such file or directory)

newfstatat(AT_FDCWD, "/home/cat_mood/programming/mai-os-labs/lab04/build/x86_64/x86_64", 0x7ffcfc54e500, 0) = -1 ENOENT (No such file or directory)

openat(AT_FDCWD, "/home/cat_mood/programming/mai-os-labs/lab04/build/x86_64/liblib1.so", O_RDONLY|O_CLOEXEC) = -1 ENOENT (No such file or directory)

newfstatat(AT_FDCWD, "/home/cat_mood/programming/mai-os-labs/lab04/build/x86_64", 0x7ffcfc54e500, 0) = -1 ENOENT (No such file or directory)

openat(AT_FDCWD, "/home/cat_mood/programming/mai-os-labs/lab04/build/x86_64/liblib1.so", O_RDONLY|O_CLOEXEC) = -1 ENOENT (No such file or directory)

newfstatat(AT_FDCWD, "/home/cat_mood/programming/mai-os-labs/lab04/build/x86_64", 0x7ffcfc54e500, 0) = -1 ENOENT (No such file or directory)

openat(AT_FDCWD, "/home/cat_mood/programming/mai-os-labs/lab04/build/liblib1.so", O_RDONLY|O_CLOEXEC) = 3

read(3, "\177ELF\2\1\1\0\0\0\0\0\0\0\0\0\3\0>\0\1\0\0\0\0\0\0\0\0\0\0\0"..., 832) = 832

newfstatat(3, "", {st_mode=S_IFREG|0755, st_size=15592, ...}, AT_EMPTY_PATH) = 0

mmap(NULL, 16432, PROT_READ, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) = 0x7f643c9ae000

mmap(0x7f643c9af000, 4096, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x1000) = 0x7f643c9af000

mmap(0x7f643c9b0000, 4096, PROT_READ, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x2000) = 0x7f643c9b0000

mmap(0x7f643c9b1000, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x2000) = 0x7f643c9b1000

```
close(3)                        = 0

openat(AT_FDCWD, "/home/cat_mood/programming/mai-os-labs/lab04/build/libc.so.6",
O_RDONLY|O_CLOEXEC) = -1 ENOENT (No such file or directory)

openat(AT_FDCWD, "/etc/ld.so.cache", O_RDONLY|O_CLOEXEC) = 3

newfstatat(3, "", {st_mode=S_IFREG|0644, st_size=25087, ...}, AT_EMPTY_PATH) = 0

mmap(NULL, 25087, PROT_READ, MAP_PRIVATE, 3, 0) = 0x7f643c9a7000

close(3)                        = 0

openat(AT_FDCWD, "/lib/x86_64-linux-gnu/libc.so.6", O_RDONLY|O_CLOEXEC) = 3

read(3, "\177ELF\2\1\1\3\0\0\0\0\0\0\0\0\3\0>\0\1\0\0\0P\237\2\0\0\0\0\0"..., 832) = 832

pread64(3, "\6\0\0\0\4\0\0\0@\0\0\0\0\0\0\0@\0\0\0\0\0\0\0@\0\0\0\0\0\0\0"..., 784, 64) = 784

pread64(3, "\4\0\0\0 \0\0\0\5\0\0\0GNU\0\2\0\0\300\4\0\0\0\3\0\0\0\0\0\0\0"..., 48, 848) = 48

pread64(3, "\4\0\0\0\24\0\0\0\3\0\0\0GNU\0 =\340\2563\265?\356\25x\261\27\313A#\350"..., 68,
896) = 68

newfstatat(3, "", {st_mode=S_IFREG|0755, st_size=2216304, ...}, AT_EMPTY_PATH) = 0

pread64(3, "\6\0\0\0\4\0\0\0@\0\0\0\0\0\0\0@\0\0\0\0\0\0\0@\0\0\0\0\0\0\0"..., 784, 64) = 784

mmap(NULL, 2260560, PROT_READ, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) =
0x7f643c77f000

mmap(0x7f643c7a7000, 1658880, PROT_READ|PROT_EXEC,
MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x28000) = 0x7f643c7a7000

mmap(0x7f643c93c000, 360448, PROT_READ,
MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x1bd000) = 0x7f643c93c000

mmap(0x7f643c994000, 24576, PROT_READ|PROT_WRITE,
MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x214000) = 0x7f643c994000

mmap(0x7f643c99a000, 52816, PROT_READ|PROT_WRITE,
MAP_PRIVATE|MAP_FIXED|MAP_ANONYMOUS, -1, 0) = 0x7f643c99a000

close(3)                        = 0

openat(AT_FDCWD, "/lib/x86_64-linux-gnu/libm.so.6", O_RDONLY|O_CLOEXEC) = 3

read(3, "\177ELF\2\1\1\3\0\0\0\0\0\0\0\0\3\0>\0\1\0\0\0\0\0\0\0\0\0\0\0"..., 832) = 832

newfstatat(3, "", {st_mode=S_IFREG|0644, st_size=940560, ...}, AT_EMPTY_PATH) = 0

mmap(NULL, 942344, PROT_READ, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) =
0x7f643c698000

mmap(0x7f643c6a6000, 507904, PROT_READ|PROT_EXEC,
MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0xe000) = 0x7f643c6a6000

mmap(0x7f643c722000, 372736, PROT_READ,
MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x8a000) = 0x7f643c722000

mmap(0x7f643c77d000, 8192, PROT_READ|PROT_WRITE,
MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0xe4000) = 0x7f643c77d000
```

close(3) = 0

mmap(NULL, 12288, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) = 0x7f643c695000

arch_prctl(ARCH_SET_FS, 0x7f643c695740) = 0

set_tid_address(0x7f643c695a10) = 16131

set_robust_list(0x7f643c695a20, 24) = 0

rseq(0x7f643c6960e0, 0x20, 0, 0x53053053) = 0

mprotect(0x7f643c994000, 16384, PROT_READ) = 0

mprotect(0x7f643c77d000, 4096, PROT_READ) = 0

mprotect(0x7f643c9b1000, 4096, PROT_READ) = 0

mprotect(0x55d7544a7000, 4096, PROT_READ) = 0

mprotect(0x7f643c9ed000, 8192, PROT_READ) = 0

prlimit64(0, RLIMIT_STACK, NULL, {rlim_cur=8192*1024, rlim_max=RLIM64_INFINITY}) = 0

munmap(0x7f643c9a7000, 25087) = 0

newfstatat(1, "", {st_mode=S_IFCHR|0620, st_rdev=makedev(0x88, 0x5), ...}, AT_EMPTY_PATH) = 0

getrandom("\x27\xd9\x17\xca\x4f\x48\xee\x55", 8, GRND_NONBLOCK) = 8

brk(NULL) = 0x55d755744000

brk(0x55d755765000) = 0x55d755765000

write(1, "Test program 1. \n", 17Test program 1.

) = 17

write(1, "For help enter 'h' \n", 20For help enter 'h'

) = 20

newfstatat(0, "", {st_mode=S_IFCHR|0620, st_rdev=makedev(0x88, 0x5), ...}, AT_EMPTY_PATH) = 0

write(1, "> ", 2>) = 2

read(0, q

"q\n", 1024) = 2

lseek(0, -1, SEEK_CUR) = -1 ESPIPE (Illegal seek)

exit_group(0) = ?

+++ exited with 0 +++

Вторая программа

execve("./main2", ["./main2"], 0x7fff828656a0 /* 36 vars */) = 0

```
brk(NULL)                               = 0x5607d3d01000
arch_prctl(0x3001 /* ARCH_??? */, 0x7ffe44d13960) = -1 EINVAL (Invalid argument)
mmap(NULL, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) = 0x7f981eebf000
access("/etc/ld.so.preload", R_OK)      = -1 ENOENT (No such file or directory)
openat(AT_FDCWD, "/etc/ld.so.cache", O_RDONLY|O_CLOEXEC) = 3
newfstatat(3, "", {st_mode=S_IFREG|0644, st_size=25023, ...}, AT_EMPTY_PATH) = 0
mmap(NULL, 25023, PROT_READ, MAP_PRIVATE, 3, 0) = 0x7f981eeb8000
close(3)                                = 0
openat(AT_FDCWD, "/lib/x86_64-linux-gnu/libc.so.6", O_RDONLY|O_CLOEXEC) = 3
read(3, "\177ELF\2\1\1\3\0\0\0\0\0\0\0\0\3\0>\0\1\0\0\0P\237\2\0\0\0\0"..., 832) = 832
pread64(3, "\6\0\0\0\4\0\0\0@\0\0\0\0\0\0\0@\0\0\0\0\0\0\0@\0\0\0\0\0\0\0"..., 784, 64) = 784
pread64(3, "\4\0\0\0 \0\0\0\5\0\0\0GNU\0\2\0\0\300\4\0\0\0\3\0\0\0\0\0\0"..., 48, 848) = 48
pread64(3, "\4\0\0\0\24\0\0\0\3\0\0\0GNU\0 =\340\2563\265?\356\25x\261\27\313A#\350"..., 68, 896) = 68
newfstatat(3, "", {st_mode=S_IFREG|0755, st_size=2216304, ...}, AT_EMPTY_PATH) = 0
pread64(3, "\6\0\0\0\4\0\0\0@\0\0\0\0\0\0\0@\0\0\0\0\0\0\0@\0\0\0\0\0\0\0"..., 784, 64) = 784
mmap(NULL, 2260560, PROT_READ, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) = 0x7f981ec90000
mmap(0x7f981ecb8000, 1658880, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x28000) = 0x7f981ecb8000
mmap(0x7f981ee4d000, 360448, PROT_READ, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x1bd000) = 0x7f981ee4d000
mmap(0x7f981eea5000, 24576, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x214000) = 0x7f981eea5000
mmap(0x7f981eeab000, 52816, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_ANONYMOUS, -1, 0) = 0x7f981eeab000
close(3)                                = 0
mmap(NULL, 12288, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) = 0x7f981ec8d000
arch_prctl(ARCH_SET_FS, 0x7f981ec8d740) = 0
set_tid_address(0x7f981ec8da10)         = 7005
set_robust_list(0x7f981ec8da20, 24)     = 0
rseq(0x7f981ec8e0e0, 0x20, 0, 0x53053053) = 0
mprotect(0x7f981eea5000, 16384, PROT_READ) = 0
mprotect(0x5607d1f4b000, 4096, PROT_READ) = 0
```

mprotect(0x7f981eef9000, 8192, PROT_READ) = 0

prlimit64(0, RLIMIT_STACK, NULL, {rlim_cur=8192*1024, rlim_max=RLIM64_INFINITY}) = 0

munmap(0x7f981eeb8000, 25023) = 0

getrandom("\x0f\x39\xd2\xf2\xcb\xdd\x9d\x6a", 8, GRND_NONBLOCK) = 8

brk(NULL) = 0x5607d3d01000

brk(0x5607d3d22000) = 0x5607d3d22000

openat(AT_FDCWD, "/home/cat_mood/programming/mai-os-labs/lab04/build/liblib1.so", O_RDONLY|O_CLOEXEC) = 3

read(3, "\177ELF\2\1\1\0\0\0\0\0\0\0\0\0\3\0>\0\1\0\0\0\0\0\0\0\0\0\0\0"..., 832) = 832

newfstatat(3, "", {st_mode=S_IFREG|0755, st_size=15536, ...}, AT_EMPTY_PATH) = 0

mmap(NULL, 16432, PROT_READ, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) = 0x7f981eeba000

mmap(0x7f981eebb000, 4096, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x1000) = 0x7f981eebb000

mmap(0x7f981eebc000, 4096, PROT_READ, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x2000) = 0x7f981eebc000

mmap(0x7f981eebd000, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x2000) = 0x7f981eebd000

close(3) = 0

openat(AT_FDCWD, "/etc/ld.so.cache", O_RDONLY|O_CLOEXEC) = 3

newfstatat(3, "", {st_mode=S_IFREG|0644, st_size=25023, ...}, AT_EMPTY_PATH) = 0

mmap(NULL, 25023, PROT_READ, MAP_PRIVATE, 3, 0) = 0x7f981ec86000

close(3) = 0

openat(AT_FDCWD, "/lib/x86_64-linux-gnu/libm.so.6", O_RDONLY|O_CLOEXEC) = 3

read(3, "\177ELF\2\1\1\3\0\0\0\0\0\0\0\0\3\0>\0\1\0\0\0\0\0\0\0\0\0\0\0"..., 832) = 832

newfstatat(3, "", {st_mode=S_IFREG|0644, st_size=940560, ...}, AT_EMPTY_PATH) = 0

mmap(NULL, 942344, PROT_READ, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) = 0x7f981eb9f000

mmap(0x7f981ebad000, 507904, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0xe000) = 0x7f981ebad000

mmap(0x7f981ec29000, 372736, PROT_READ, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x8a000) = 0x7f981ec29000

mmap(0x7f981ec84000, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0xe4000) = 0x7f981ec84000

close(3) = 0

```
mprotect(0x7f981ec84000, 4096, PROT_READ) = 0

mprotect(0x7f981eebd000, 4096, PROT_READ) = 0

munmap(0x7f981ec86000, 25023)           = 0

openat(AT_FDCWD, "/home/cat_mood/programming/mai-os-labs/lab04/build/liblib2.so",
O_RDONLY|O_CLOEXEC) = 3

read(3, "\177ELF\2\1\1\0\0\0\0\0\0\0\0\0\3\0>\0\1\0\0\0\0\0\0\0\0\0\0\0"..., 832) = 832

newfstatat(3, "", {st_mode=S_IFREG|0755, st_size=15608, ...}, AT_EMPTY_PATH) = 0

mmap(NULL, 16432, PROT_READ, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) =
0x7f981ec88000

mmap(0x7f981ec89000, 4096, PROT_READ|PROT_EXEC,
MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x1000) = 0x7f981ec89000

mmap(0x7f981ec8a000, 4096, PROT_READ,
MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x2000) = 0x7f981ec8a000

mmap(0x7f981ec8b000, 8192, PROT_READ|PROT_WRITE,
MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x2000) = 0x7f981ec8b000

close(3)                                = 0

mprotect(0x7f981ec8b000, 4096, PROT_READ) = 0

newfstatat(1, "", {st_mode=S_IFCHR|0620, st_rdev=makedev(0x88, 0x5), ...},
AT_EMPTY_PATH) = 0

write(1, "Test program 1. \n", 17Test program 1.

)      = 17

write(1, "For help enter 'h' \n", 20For help enter 'h'

)   = 20

newfstatat(0, "", {st_mode=S_IFCHR|0620, st_rdev=makedev(0x88, 0x5), ...},
AT_EMPTY_PATH) = 0

write(1, "> ", 2> )                     = 2

read(0, 0

"0\n", 1024)                  = 2

write(1, "Implementation changed. Current "..., 37Implementation changed. Current is 1

) = 37

write(1, "> ", 2> )                     = 2

read(0, q

"q\n", 1024)                  = 2

munmap(0x7f981eeba000, 16432)           = 0

munmap(0x7f981ec88000, 16432)           = 0
```

munmap(0x7f981eb9f000, 942344) = 0

lseek(0, -1, SEEK_CUR) = -1 ESPIPE (Illegal seek)

exit_group(0) = ?

+++ exited with 0 +++

Тестирование:

```
cat_mood@nuclear-box:~/programming/mai-os-labs/lab04/build$ ./main1_impl1
Test program 1.
For help enter 'h'
> h
h - display this page you are seeing now
1 A B E - compute integral of sin(x) on the segment [A, B] with step E
2 A B - compute square of rectangle size of A x B
q - quit
> 1 1 5 0.001
Result of sin_integral is 0.256649
> 2 2 5
Result of square is 10.000000
> q
cat_mood@nuclear-box:~/programming/mai-os-labs/lab04/build$ ./main1_impl2
Test program 1.
For help enter 'h'
> 1 1 5 0.001
Result of sin_integral is 0.255749
> 2 2 5
Result of square is 5.000000
> q
cat_mood@nuclear-box:~/programming/mai-os-labs/lab04/build$ ./main2
Test program 1.
For help enter 'h'
> 1 1 5 0.001
Result of sin_integral is 0.256649
> 2 2 5
Result of square is 10.000000
```

```
> 0

Implementation changed. Current is 1

> 1 1 5 0.001

Result of sin_integral is 0.255749

> 2 2 5

Result of square is 5.000000

> q
```

Вывод

В ходе лабораторной работы я получил опыт разработки динамической библиотеки, узнал о dynamic link и dynamic loading library, их различии; использовал такие системные вызовы, как dlopen, dlsym, dlclose; узнал, как компилируются динамические библиотеки.