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Институт №8 “Компьютерные науки и прикладная математика”
Кафедра №806 “Вычислительная математика и программирование”

Лабораторная работа №4 по курсу
«Операционные системы»

Группа: М8О-215Б-23

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Оценка: _____

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Постановка задачи

Вариант 19.

Требуется создать динамические библиотеки, которые реализуют заданный вариантом функционал. Далее использовать данные библиотеки 2-мя способами:

1. Во время компиляции (на этапе «линковки»/linking)
2. Во время исполнения программы. Библиотеки загружаются в память с помощью интерфейса ОС для работы с динамическими библиотеками

В конечном итоге, в лабораторной работе необходимо получить следующие части:

- Динамические библиотеки, реализующие контракты, которые заданы вариантом;
- Тестовая программа (программа №1), которая использует одну из библиотек, используя информацию, полученную на этапе компиляции;
- Тестовая программа (программа №2), которая загружает библиотеки, используя только их относительные пути и контракты.

Провести анализ двух типов использования библиотек.

Пользовательский ввод для обеих программ должен быть организован следующим образом:

1. Если пользователь вводит команду «0», то программа переключает одну реализацию контрактов на другую (необходимо только для программы №2). Можно реализовать лабораторную работу без данной функции, но максимальная оценка в этом случае будет «хорошо»;
2. «1 arg1 arg2 ... argN», где после «1» идут аргументы для первой функции, предусмотренной контрактами. После ввода команды происходит вызов первой функции, и на экране появляется результат её выполнения;
3. «2 arg1 arg2 ... argM», где после «2» идут аргументы для второй функции, предусмотренной контрактами. После ввода команды происходит вызов второй функции, и на экране появляется результат её выполнения.

Функция 1: Расчет интеграла функции $\sin(x)$ на отрезке $[A, B]$ с шагом ϵ (метод прямоугольника и метод трапеции)

Функция 2: Перевод числа x из десятичной системы счисления в другую (двоичную и троичную)

Общий метод и алгоритм решения

- `void* dlopen(const char* filename, int flag);` - загружает динамическую библиотеку в память
- `int dlclose(void* handle);` - выгружает динамическую библиотеку из памяти
- `void* dlsym(void* handle, const char* symbol);` - получает адрес символа из библиотеки
- `char* dlerror(void);` - возвращает строку с описанием последней ошибки

Алгоритм решения:

1. Создаем файлы с реализацией функций (по одному на каждую, в итоге 4)
2. Создаем первую программу, которой будем передавать данные библиотеки на этапе компиляции
3. Создаем вторую программу, в которой дополнительно прописываем логику для загрузки и выгрузки динамических библиотек

Код программы

int_rect.cpp

```
#include <cmath>

extern "C" float SinIntegral(float A, float B, float e) {
    float result = 0.0f;

    int steps = static_cast<int>((B - A) / e);

    for (int i = 0; i < steps; i++) {
        float x = A + i * e + e / 2.0f;
        result += sin(x) * e;
    }

    return result;
}
```

Int_trap.cpp

```
#include <cmath>

extern "C" float SinIntegral(float A, float B, float e) {
    int n = (int)((B - A) / e);
    float result = sin(A) / 2.0f;

    for(int i = 1; i < n; i++) {
        float x = A + i * e;
        result += sin(x);
    }

    result += sin(B) / 2.0f;
    result *= e;

    return result;
}
```

tr_bin.cpp

```
extern "C" char* Translation(long x) {
    if (x == 0) {
        char* result = new char[2];
        result[0] = '0';
        result[1] = '\0';
        return result;
    }

    const int BITS = 64;
    char temp[BITS];

    bool isNegative = (x < 0);
    if (isNegative) {
        x = -(x + 1);
    }

    int pos = 0;
    for (int i = BITS - 1; i >= 0; i--) {
        if (isNegative) {
            temp[i] = ((x & 1) ^ 1) + '0';
        } else {
            temp[i] = (x & 1) + '0';
        }
        x >>= 1;
    }
}
```

```

int firstDigit = 0;
while (firstDigit < BITS && temp[firstDigit] == '0') {
    firstDigit++;
}
if (firstDigit == BITS) firstDigit--;

int resultSize = BITS - firstDigit + (isNegative ? 2 : 1);
char* result = new char[resultSize];

int j = 0;
if (isNegative) {
    result[j++] = '-';
}

for (int i = firstDigit; i < BITS; i++) {
    result[j++] = temp[i];
}
result[j] = '\0';

return result;
}

```

tr_tri.cpp

```

extern "C" char* Translation(long x) {
    if (x == 0) {
        char* result = new char[2];
        result[0] = '0';
        result[1] = '\0';
        return result;
    }

    bool isNegative = (x < 0);
    if (isNegative) {
        x = -x;
    }

    // Calculate maximum digits needed for base 3
    // log3(2^64) ≈ 40.3, so 42 digits is enough for any long
    const int MAX_DIGITS = 42;
    char* temp = new char[MAX_DIGITS];
    int pos = 0;

    while (x > 0) {
        temp[pos++] = (x % 3) + '0';
        x /= 3;
    }

    int resultSize = pos + (isNegative ? 2 : 1);
    char* result = new char[resultSize];

    int j = 0;
    if (isNegative) {
        result[j++] = '-';
    }

    for (int i = pos - 1; i >= 0; i--) {
        result[j++] = temp[i];
    }
    result[j] = '\0';

    delete[] temp;
    return result;
}

```

program1.cpp

```
#include <iostream>

extern "C" float SinIntegral(float A, float B, float e);
extern "C" char* Translation(long x);

int main()
{
    int prog;
    while (true)
    {
        std::cout << "Input program code:\n 1 -> Calculate integral\n 2 -> Translation\n-1 -> Exit\n";
        std::cin >> prog;
        switch (prog)
        {
            case 1:
                std::cout << "Enter A, B and e: ";
                float A, B, e;
                std::cin >> A >> B >> e;

                std::cout << "Calculated integral: " << SinIntegral(A, B, e) << "\n\n";
                break;
            case 2:
                long x;
                std::cout << "Enter x: ";
                std::cin >> x;

                std::cout << "Translated number: " << Translation(x) << "\n\n";
                break;
            default:
                std::cout << "Exit\n";
                return 0;
        }
    }
}
```

program2.cpp

```
#include <iostream>
#include <dlfcn.h>

int main()
{
    int prog = 1;
    int real = 1;
    void *lib = nullptr;

    typedef float (*IntFunc)(float, float, float);
    typedef char* (*TranslationFunc)(long);

    IntFunc SinIntegral;
    TranslationFunc Translation;

    // Initial library load
    lib = dlopen("./lib_pr2_1.so", RTLD_LAZY);
    if (!lib)
    {
        std::cerr << "Error loading initial library: " << dlerror() << std::endl;
        return 1;
    }
    std::cout << "Library is loaded\n";

    SinIntegral = (IntFunc)dlsym(lib, "SinIntegral");
    Translation = (TranslationFunc)dlsym(lib, "Translation");
}
```

```

if (!SinIntegral || !Translation)
{
    std::cerr << "Failed to load symbols: " << dlerror() << std::endl;
    dlclose(lib);
    return 1;
}

while (true)
{
    std::cout << "Input program code:\n 0 -> Library switch\n 1 -> Calculate integral\n 2
-> Translation\n-1 -> Exit\n";
    std::cin >> prog;
    switch (prog)
    {
    case 0:
        dlclose(lib); // Close the current library
        if (real == 1)
        {
            lib = dlopen("./lib_pr2_2.so", RTLD_LAZY);
            real = 2;
        }
        else
        {
            lib = dlopen("./lib_pr2_1.so", RTLD_LAZY);
            real = 1;
        }

        if (!lib)
        { // Check for dlopen errors
            std::cerr << "Error loading library: " << dlerror() << std::endl;
            return 1;
        }
        system("clear");
        std::cout << "Library switched succesfully!\n";

        // Reload symbols
        SinIntegral = (IntFunc)dlsym(lib, "SinIntegral");
        Translation = (TranslationFunc)dlsym(lib, "Translation");
        if (!SinIntegral || !Translation)
        {
            std::cerr << "Failed to load symbols: " << dlerror() << std::endl;
            dlclose(lib);
            return 1;
        }
        break;
    case 1:
        system("clear");
        float A, B, e;
        std::cout << "Enter A, B and e: ";
        std::cin >> A >> B >> e;

        if (real == 1)
            std::cout << "Counting integral with rectangles\n";
        else
            std::cout << "Counting integral with trapeze\n";
        std::cout << "Integral: " << SinIntegral(A, B, e) << "\n\n";
        break;
    case 2:
        system("clear");
        long x;
        std::cout << "Enter x: ";
        std::cin >> x;

        if (real == 1)
            std::cout << "Translationing to binary\n";
    }
}

```

```

        else
            std::cout << "Translationing to trinity\n";
            std::cout << "Result is: " << Translation(x) << "\n\n";
            break;
        default:
            std::cout << "Exit\n";
            dlclose(lib);
            return 0;
    }
}
}

```

Makefile

```

all: program1 program2 lib_pr2_1.so lib_pr2_2.so clean

# Program 1
program1: program1.o lib_pr2_1.so
    g++ -o program1 program1.o -L. -l_pr2_1 -Wl,-rpath,.

program1.o: program1.cpp
    g++ -c program1.cpp

int_rect.o: int_rect.cpp
    g++ -c int_rect.cpp

tr_bin.o: tr_bin.cpp
    g++ -c tr_bin.cpp

# Program 2
program2: program2.o
    g++ -o program2 program2.o -ldl

program2.o: program2.cpp
    g++ -c program2.cpp

lib_pr2_1.so: int_rect.o tr_bin.o
    g++ -shared -o lib_pr2_1.so int_rect.o tr_bin.o

lib_pr2_2.so: int_trap.o tr_tri.o
    g++ -shared -o lib_pr2_2.so int_trap.o tr_tri.o

int_trap.o:
    g++ -c int_trap.cpp

tr_tri.o:
    g++ -c tr_tri.cpp

# Clean
clean:
    rm -f *.o

```

Протокол работы программы

Program1

```

den4ik2975@den4ikpc:~/CLionProjects/MAI_OS_Labs/Labs/Lab4/src$ ./program1
Input program code:
 1 -> Calculate integral
 2 -> Translation
-1 -> Exit
1
Enter A, B and e: 5 6 0.000000008

```

```
Calculated integral: -0.125

Input program code:
 1 -> Calculate integral
 2 -> Translation
-1 -> Exit
2
Enter x: 563434
Translated number: 10001001100011101010

Input program code:
 1 -> Calculate integral
 2 -> TranslationCCC
-1 -> Exit
-1
Exit
```

program2

```
den4ik2975@den4ikpc:~/CLionProjects/MAI_OS_Labs/Labs/Lab4/src$ ./program2
Library is loaded
Input program code:
 0 -> Library switch
 1 -> Calculate integral
 2 -> Translation
-1 -> Exit
1
Enter A, B and e: 1 2.5 0.0000005
Counting integral with rectangles
Integral: 1.34082

Input program code:
 0 -> Library switch
 1 -> Calculate integral
 2 -> Translation
-1 -> Exit
0
Library switched succesfully!
Input program code:
 0 -> Library switch
 1 -> Calculate integral
 2 -> Translation
-1 -> Exit
1
Enter A, B and e: 1 2.5 0.0000005
Counting integral with trapeze
Integral: 1.341

Input program code:
 0 -> Library switch
 1 -> Calculate integral
 2 -> Translation
-1 -> Exit
2
Enter x: 6777
Translationing to trinity
Result is: 100022000

Input program code:
 0 -> Library switch
 1 -> Calculate integral
 2 -> Translation
-1 -> Exit
0
```



```

openat(AT_FDCWD, "/glibc-hwcap/x86-64-v4/libstdc++.so.6", O_RDONLY|O_CLOEXEC) = -1 ENOENT
(No such file or directory)
openat(AT_FDCWD, "/glibc-hwcap/x86-64-v3/libstdc++.so.6", O_RDONLY|O_CLOEXEC) = -1 ENOENT
(No such file or directory)
openat(AT_FDCWD, "/glibc-hwcap/x86-64-v2/libstdc++.so.6", O_RDONLY|O_CLOEXEC) = -1 ENOENT
(No such file or directory)
openat(AT_FDCWD, "/tls/x86_64/x86_64/libstdc++.so.6", O_RDONLY|O_CLOEXEC) = -1 ENOENT (No
such file or directory)
openat(AT_FDCWD, "/tls/x86_64/libstdc++.so.6", O_RDONLY|O_CLOEXEC) = -1 ENOENT (No such file
or directory)
openat(AT_FDCWD, "/tls/x86_64/libstdc++.so.6", O_RDONLY|O_CLOEXEC) = -1 ENOENT (No such file
or directory)
openat(AT_FDCWD, "/tls/libstdc++.so.6", O_RDONLY|O_CLOEXEC) = -1 ENOENT (No such file or
directory)
openat(AT_FDCWD, "/x86_64/x86_64/libstdc++.so.6", O_RDONLY|O_CLOEXEC) = -1 ENOENT (No such
file or directory)
openat(AT_FDCWD, "/x86_64/libstdc++.so.6", O_RDONLY|O_CLOEXEC) = -1 ENOENT (No such file or
directory)
openat(AT_FDCWD, "/x86_64/libstdc++.so.6", O_RDONLY|O_CLOEXEC) = -1 ENOENT (No such file or
directory)
openat(AT_FDCWD, "/libstdc++.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=20627, ...}, AT_EMPTY_PATH) = 0
mmap(NULL, 20627, PROT_READ, MAP_PRIVATE, 3, 0) = 0x7f2df9c98000
close(3) = 0
openat(AT_FDCWD, "/lib/x86_64-linux-gnu/libstdc++.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\0\0\0\0"..., 832) = 832
newfstatat(3, "", {st_mode=S_IFREG|0644, st_size=2522584, ...}, AT_EMPTY_PATH) = 0
mmap(NULL, 2539968, PROT_READ, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) = 0x7f2df9a2b000
mprotect(0x7f2df9ac7000, 1830912, PROT_NONE) = 0
mmap(0x7f2df9ac7000, 1249280, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3,
0x9c000) = 0x7f2df9ac7000
mmap(0x7f2df9bf8000, 577536, PROT_READ, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x1cd000) =
0x7f2df9bf8000
mmap(0x7f2df9c86000, 57344, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3,
0x25a000) = 0x7f2df9c86000
mmap(0x7f2df9c94000, 12736, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_ANONYMOUS, -1, 0)
= 0x7f2df9c94000
close(3) = 0
openat(AT_FDCWD, "/glibc-hwcap/x86-64-v4/libc.so.6", O_RDONLY|O_CLOEXEC) = -1 ENOENT (No
such file or directory)
openat(AT_FDCWD, "/glibc-hwcap/x86-64-v3/libc.so.6", O_RDONLY|O_CLOEXEC) = -1 ENOENT (No
such file or directory)
openat(AT_FDCWD, "/glibc-hwcap/x86-64-v2/libc.so.6", O_RDONLY|O_CLOEXEC) = -1 ENOENT (No
such file or directory)
openat(AT_FDCWD, "/tls/x86_64/x86_64/libc.so.6", O_RDONLY|O_CLOEXEC) = -1 ENOENT (No such
file or directory)
openat(AT_FDCWD, "/tls/x86_64/libc.so.6", O_RDONLY|O_CLOEXEC) = -1 ENOENT (No such file or
directory)
openat(AT_FDCWD, "/tls/x86_64/libc.so.6", O_RDONLY|O_CLOEXEC) = -1 ENOENT (No such file or
directory)
openat(AT_FDCWD, "/tls/libc.so.6", O_RDONLY|O_CLOEXEC) = -1 ENOENT (No such file or
directory)
openat(AT_FDCWD, "/x86_64/x86_64/libc.so.6", O_RDONLY|O_CLOEXEC) = -1 ENOENT (No such file
or directory)
openat(AT_FDCWD, "/x86_64/libc.so.6", O_RDONLY|O_CLOEXEC) = -1 ENOENT (No such file or
directory)
openat(AT_FDCWD, "/x86_64/libc.so.6", O_RDONLY|O_CLOEXEC) = -1 ENOENT (No such file or
directory)
openat(AT_FDCWD, "/x86_64/libc.so.6", O_RDONLY|O_CLOEXEC) = -1 ENOENT (No such file or
directory)
openat(AT_FDCWD, "/libc.so.6", O_RDONLY|O_CLOEXEC) = -1 ENOENT (No such file or directory)
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\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\\0I\\17\\357\\204\\3$\\f\\221\\2039x\\324\\224\\323\\236S"... ,
68, 896) = 68
newfstatat(3, "", {st_mode=S_IFREG|0755, st_size=2220400, ...}, 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"..., 784, 64) = 784
mmap(NULL, 2264656, PROT_READ, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) = 0x7f2df9802000
mprotect(0x7f2df982a000, 2023424, PROT_NONE) = 0
mmap(0x7f2df982a000, 1658880, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3,
0x28000) = 0x7f2df982a000
mmap(0x7f2df99bf000, 360448, PROT_READ, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x1bd000) =
0x7f2df99bf000
mmap(0x7f2df9a18000, 24576, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3,
0x215000) = 0x7f2df9a18000
mmap(0x7f2df9a1e000, 52816, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_ANONYMOUS, -1, 0)
= 0x7f2df9a1e000
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"..., 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) = 0x7f2df971b000
mmap(0x7f2df9729000, 507904, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3,
0xe000) = 0x7f2df9729000
mmap(0x7f2df97a5000, 372736, PROT_READ, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x8a000) =
0x7f2df97a5000
mmap(0x7f2df9800000, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3,
0xe4000) = 0x7f2df9800000
close(3) = 0
openat(AT_FDCWD, "/lib/x86_64-linux-gnu/libgcc_s.so.1", 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"..., 832) = 832
newfstatat(3, "", {st_mode=S_IFREG|0644, st_size=141896, ...}, AT_EMPTY_PATH) = 0
mmap(NULL, 144232, PROT_READ, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) = 0x7f2df96f7000
mmap(0x7f2df96fa000, 110592, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3,
0x3000) = 0x7f2df96fa000
mmap(0x7f2df9715000, 16384, PROT_READ, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x1e000) =
0x7f2df9715000
mmap(0x7f2df9719000, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3,
0x21000) = 0x7f2df9719000
close(3) = 0
mmap(NULL, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) = 0x7f2df96f5000
mmap(NULL, 12288, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) = 0x7f2df96f2000
arch_prctl(ARCH_SET_FS, 0x7f2df96f2740) = 0
set_tid_address(0x7f2df96f2a10) = 14173
set_robust_list(0x7f2df96f2a20, 24) = 0
rseq(0x7f2df96f30e0, 0x20, 0, 0x53053053) = 0
mprotect(0x7f2df9a18000, 16384, PROT_READ) = 0
mprotect(0x7f2df9719000, 4096, PROT_READ) = 0
mprotect(0x7f2df9800000, 4096, PROT_READ) = 0
mprotect(0x7f2df9c86000, 45056, PROT_READ) = 0
mprotect(0x7f2df9ca1000, 4096, PROT_READ) = 0
mprotect(0x5631704f9000, 4096, PROT_READ) = 0
mprotect(0x7f2df9cdd000, 8192, PROT_READ) = 0
prlimit64(0, RLIMIT_STACK, NULL, {rlim_cur=8192*1024, rlim_max=RLIM64_INFINITY}) = 0
munmap(0x7f2df9c98000, 20627) = 0
futexp(0x7f2df9c947fc, FUTEX_WAKE_PRIVATE, 2147483647) = 0
getrandom("\\xe6\\x23\\x61\\xfb\\x38\\x3b\\x93\\x8d", 8, GRND_NONBLOCK) = 8
brk(NULL) = 0x5631996ec000
brk(0x56319970d000) = 0x56319970d000
newfstatat(1, "", {st_mode=S_IFREG|0644, st_size=9469, ...}, AT_EMPTY_PATH) = 0
write(1, "Input program code:\\n 1 -> Calcul"... , 74Input program code:
 1 -> Calculate integral
 2 -> Translation
-1 -> Exit
) = 74
newfstatat(0, "", {st_mode=S_IFCHR|0620, st_rdev=makedev(0x88, 0x2), ...}, AT_EMPTY_PATH) = 0
read(0, "1\\n", 1024) = 2
write(1, "Enter A, B and e: ", 18Enter A, B and e: ) = 18

```

```

read(0, "1 6 0.000009\n", 1024)          = 13
write(1, "Calculated integral: -0.419868\n\n...", 106Calculated integral: -0.419868

Input program code:
1 -> Calculate integral
2 -> Translation
-1 -> Exit
) = 106
read(0, "2\n", 1024)                      = 2
write(1, "Enter x: ", 9Enter x: )          = 9
read(0, "433434\n", 1024)                = 7
write(1, "Translated number: 1101001110"...117Translated number: 1101001110100011010

Input program code:
1 -> Calculate integral
2 -> Translation
-1 -> Exit
) = 117
read(0, "0\n", 1024)                      = 2
write(1, "Exit\n", 5Exit
) = 5
lseek(0, -1, SEEK_CUR)                    = -1 ESPIPE (Illegal seek)
exit_group(0)                             = ?
+++ exited with 0 +++

```

Strace

```

execve("./program2", [ "./program2" ], 0x7fff9c3e1ac0 /* 32 vars */) = 0
brk(NULL)                               = 0x56424ff7a000
arch_prctl(0x3001 /* ARCH_??? */, 0x7ffc3333bc50) = -1 EINVAL (Invalid argument)
mmap(NULL, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) = 0x7f2c22c1f000
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=20627, ...}, AT_EMPTY_PATH) = 0
mmap(NULL, 20627, PROT_READ, MAP_PRIVATE, 3, 0) = 0x7f2c22c19000
close(3)                                = 0
openat(AT_FDCWD, "/lib/x86_64-linux-gnu/libstdc++.so.6", O_RDONLY|O_CLOEXEC) = 3
read(3, "\177ELF\2\1\1\3\0\0\0\0\0\0\0\0\0\0\3\0>\0\1\0\0\0\0\0\0\0\0\0\0\0\0"..., 832) = 832
newfstatat(3, "", {st_mode=S_IFREG|0644, st_size=2522584, ...}, AT_EMPTY_PATH) = 0
mmap(NULL, 2539968, PROT_READ, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) = 0x7f2c229ac000
mprotect(0x7f2c22a48000, 1830912, PROT_NONE) = 0
mmap(0x7f2c22a48000, 1249280, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x9c000) = 0x7f2c22a48000
mmap(0x7f2c22b79000, 577536, PROT_READ, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x1cd000) = 0x7f2c22b79000
mmap(0x7f2c22c07000, 57344, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x25a000) = 0x7f2c22c07000
mmap(0x7f2c22c15000, 12736, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_ANONYMOUS, -1, 0) = 0x7f2c22c15000
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\0\0\3\0>\0\1\0\0\0\0\0\0\0\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"..., 48, 848) = 48
pread64(3, "\4\0\0\0\24\0\0\0\3\0\0\0GNU\0I\17\357\204\3$\f\221\2039x\324\224\323\236S"..., 68, 896) = 68
newfstatat(3, "", {st_mode=S_IFREG|0755, st_size=2220400, ...}, 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, 2264656, PROT_READ, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) = 0x7f2c22783000
mprotect(0x7f2c227ab000, 2023424, PROT_NONE) = 0
mmap(0x7f2c227ab000, 1658880, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x28000) = 0x7f2c227ab000
mmap(0x7f2c22940000, 360448, PROT_READ, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x1bd000) = 0x7f2c22940000
mmap(0x7f2c22999000, 24576, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3,

```

```

0x215000) = 0x7f2c22999000
mmap(0x7f2c2299f000, 52816, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_ANONYMOUS, -1, 0)
= 0x7f2c2299f000
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"..., 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) = 0x7f2c2269c000
mmap(0x7f2c226aa000, 507904, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3,
0xe000) = 0x7f2c226aa000
mmap(0x7f2c22726000, 372736, PROT_READ, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x8a000) =
0x7f2c22726000
mmap(0x7f2c22781000, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3,
0xe4000) = 0x7f2c22781000
close(3) = 0
openat(AT_FDCWD, "/lib/x86_64-linux-gnu/libgcc_s.so.1", 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"..., 832) = 832
newfstatat(3, "", {st_mode=S_IFREG|0644, st_size=141896, ...}, AT_EMPTY_PATH) = 0
mmap(NULL, 144232, PROT_READ, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) = 0x7f2c22678000
mmap(0x7f2c2267b000, 110592, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3,
0x3000) = 0x7f2c2267b000
mmap(0x7f2c22696000, 16384, PROT_READ, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x1e000) =
0x7f2c22696000
mmap(0x7f2c2269a000, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3,
0x21000) = 0x7f2c2269a000
close(3) = 0
mmap(NULL, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) = 0x7f2c22676000
arch_prctl(ARCH_SET_FS, 0x7f2c22677400) = 0
set_tid_address(0x7f2c226776d0) = 15656
set_robust_list(0x7f2c226776e0, 24) = 0
rseq(0x7f2c22677da0, 0x20, 0, 0x53053053) = 0
mprotect(0x7f2c22999000, 16384, PROT_READ) = 0
mprotect(0x7f2c2269a000, 4096, PROT_READ) = 0
mprotect(0x7f2c22781000, 4096, PROT_READ) = 0
mmap(NULL, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) = 0x7f2c22674000
mprotect(0x7f2c22c07000, 45056, PROT_READ) = 0
mprotect(0x564242cea000, 4096, PROT_READ) = 0
mprotect(0x7f2c22c59000, 8192, PROT_READ) = 0
prlimit64(0, RLIMIT_STACK, NULL, {rlim_cur=8192*1024, rlim_max=RLIM64_INFINITY}) = 0
munmap(0x7f2c22c19000, 20627) = 0
futexp(0x7f2c22c157fc, FUTEX_WAKE_PRIVATE, 2147483647) = 0
getrandom("\x93\x27\xa9\xb2\xf4\xcb\x6c\xe2", 8, GRND_NONBLOCK) = 8
brk(NULL) = 0x56424ff7a000
brk(0x56424ff9b000) = 0x56424ff9b000
openat(AT_FDCWD, "../lib_pr2_1.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"..., 832) = 832
newfstatat(3, "", {st_mode=S_IFREG|0755, st_size=15760, ...}, AT_EMPTY_PATH) = 0
getcwd("/home/den4ik2975/CLionProjects/MAI_OS_Labs/Labs/Lab4/src", 128) = 57
mmap(NULL, 16448, PROT_READ, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) = 0x7f2c22c1a000
mmap(0x7f2c22c1b000, 4096, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3,
0x1000) = 0x7f2c22c1b000
mmap(0x7f2c22c1c000, 4096, PROT_READ, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x2000) =
0x7f2c22c1c000
mmap(0x7f2c22c1d000, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3,
0x2000) = 0x7f2c22c1d000
close(3) = 0
mprotect(0x7f2c22c1d000, 4096, PROT_READ) = 0
newfstatat(1, "", {st_mode=S_IFREG|0644, st_size=6016, ...}, AT_EMPTY_PATH) = 0
write(1, "Library is loaded\nInput program "..., 113Library is loaded
Input program code:
0 -> Library switch
1 -> Calculate integral
2 -> Translation
-1 -> Exit
) = 113

```



```

newfstatat(0, "", {st_mode=S_IFCHR|0620, st_rdev=makedev(0x88, 0x2), ...}, AT_EMPTY_PATH) = 0
read(0, "2\n", 1024) = 2
write(1, "Enter x: ", 9Enter x: ) = 9
read(0, "577\n", 1024) = 4
write(1, "Translationing to binary\nResult "..., 143Translationing to binary
Result is: 1001000001

```

Input program code:

```

0 -> Library switch
1 -> Calculate integral
2 -> Translation
-1 -> Exit

```

```
) = 143
```

```
read(0, "0\n", 1024) = 2
```

```
munmap(0x7f2c22c1a000, 16448) = 0
```

```
openat(AT_FDCWD, "./lib_pr2_2.so", 0 RDONLY|O_CLOEXEC) = 3
```

```
read(3, "\177ELF\2\1\1\0\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=15736, ...}, AT_EMPTY_PATH) = 0
```

```
getcwd("/home/den4ik2975/CLionProjects/MAI_OS_Labs/Labs/Lab4/src", 128) = 57
```

```
mmap(NULL, 16448, PROT_READ, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) = 0x7f2c22c1a000
```

```
mmap(0x7f2c22c1b000, 4096, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x1000) = 0x7f2c22c1b000
```

```
mmap(0x7f2c22c1c000, 4096, PROT_READ, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x2000) = 0x7f2c22c1c000
```

```
mmap(0x7f2c22c1d000, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x2000) = 0x7f2c22c1d000
```

```
close(3) = 0
```

```
mprotect(0x7f2c22c1d000, 4096, PROT_READ) = 0
```

```
write(1, "Library switched succesfully!\nIn"... , 125Library switched succesfully!
```

Input program code:

```

0 -> Library switch
1 -> Calculate integral
2 -> Translation

```

```
-1 -> Exit
```

```
) = 125
```

```
read(0, "2\n", 1024) = 2
```

```
write(1, "Enter x: ", 9Enter x: ) = 9
```

```
read(0, "577\n", 1024) = 4
```

```
write(1, "Translationing to trinity\nResult"... , 140Translationing to trinity
```

```
Result is: 210101
```

Input program code:

```

0 -> Library switch
1 -> Calculate integral
2 -> Translation

```

```
-1 -> Exit
```

```
) = 140
```

```
read(0, "0\n", 1024) = 2
```

```
munmap(0x7f2c22c1a000, 16448) = 0
```

```
openat(AT_FDCWD, "./lib_pr2_1.so", 0 RDONLY|O_CLOEXEC) = 3
```

```
read(3, "\177ELF\2\1\1\0\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=15760, ...}, AT_EMPTY_PATH) = 0
```

```
getcwd("/home/den4ik2975/CLionProjects/MAI_OS_Labs/Labs/Lab4/src", 128) = 57
```

```
mmap(NULL, 16448, PROT_READ, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) = 0x7f2c22c1a000
```

```
mmap(0x7f2c22c1b000, 4096, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x1000) = 0x7f2c22c1b000
```

```
mmap(0x7f2c22c1c000, 4096, PROT_READ, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x2000) = 0x7f2c22c1c000
```

```
mmap(0x7f2c22c1d000, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x2000) = 0x7f2c22c1d000
```

```
close(3) = 0
```

```
mprotect(0x7f2c22c1d000, 4096, PROT_READ) = 0
```

```
write(1, "Library switched succesfully!\nIn"... , 125Library switched succesfully!
```

Input program code:

```
0 -> Library switch
```

```
1 -> Calculate integral
2 -> Translation
-1 -> Exit
) = 125
read(0, "-1\n", 1024)           = 3
munmap(0x7f2c22c1a000, 16448)   = 0
write(1, "Exit\n", 5Exit
)                               = 5
lseek(0, -1, SEEK_CUR)          = -1 ESPIPE (Illegal seek)
exit_group(0)                   = ?
+++ exited with 0 +++
```

Вывод

Сделаны