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: М8О-215Б-23

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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 используют одну из библиотек, используя информацию полученные 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 обоих 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: Рассчет интеграла функции sin(x) на отрезке [A, B] с шагом e (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 << "Translationed 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  Translationed 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  Library switched succesfully!  Input program code:  0 -> Library switch  1 -> Calculate integral  2 -> Translation  -1 -> Exit  2  Enter x: 6777  Translationing to binary  Result is: 1101001111001  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  Exit |

|  |
| --- |
| execve("./program1", ["./program1"], 0x7ffd99e57800 /\* 32 vars \*/) = 0  brk(NULL) = 0x5631996ec000  arch\_prctl(0x3001 /\* ARCH\_??? \*/, 0x7ffeeb757910) = -1 EINVAL (Invalid argument)  mmap(NULL, 8192, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_ANONYMOUS, -1, 0) = 0x7f2df9ca3000  access("/etc/ld.so.preload", R\_OK) = -1 ENOENT (No such file or directory)  openat(AT\_FDCWD, "./glibc-hwcaps/x86-64-v4/lib\_pr2\_1.so", O\_RDONLY|O\_CLOEXEC) = -1 ENOENT (No such file or directory)  openat(AT\_FDCWD, "./glibc-hwcaps/x86-64-v3/lib\_pr2\_1.so", O\_RDONLY|O\_CLOEXEC) = -1 ENOENT (No such file or directory)  openat(AT\_FDCWD, "./glibc-hwcaps/x86-64-v2/lib\_pr2\_1.so", O\_RDONLY|O\_CLOEXEC) = -1 ENOENT (No such file or directory)  openat(AT\_FDCWD, "./tls/x86\_64/x86\_64/lib\_pr2\_1.so", O\_RDONLY|O\_CLOEXEC) = -1 ENOENT (No such file or directory)  openat(AT\_FDCWD, "./tls/x86\_64/lib\_pr2\_1.so", O\_RDONLY|O\_CLOEXEC) = -1 ENOENT (No such file or directory)  openat(AT\_FDCWD, "./tls/x86\_64/lib\_pr2\_1.so", O\_RDONLY|O\_CLOEXEC) = -1 ENOENT (No such file or directory)  openat(AT\_FDCWD, "./tls/lib\_pr2\_1.so", O\_RDONLY|O\_CLOEXEC) = -1 ENOENT (No such file or directory)  openat(AT\_FDCWD, "./x86\_64/x86\_64/lib\_pr2\_1.so", O\_RDONLY|O\_CLOEXEC) = -1 ENOENT (No such file or directory)  openat(AT\_FDCWD, "./x86\_64/lib\_pr2\_1.so", O\_RDONLY|O\_CLOEXEC) = -1 ENOENT (No such file or directory)  openat(AT\_FDCWD, "./x86\_64/lib\_pr2\_1.so", O\_RDONLY|O\_CLOEXEC) = -1 ENOENT (No such file or directory)  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\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) = 0x7f2df9c9e000  mmap(0x7f2df9c9f000, 4096, PROT\_READ|PROT\_EXEC, openat(AT\_FDCWD, "/lib/x86\_64-linux-gnu/libstdc++.so.6", O\_RDONLY|O\_CLOEXEC) = 3MAP\_PRIVATE|MAP\_FIXED|MAP\_DENYWRITE, 3, 0x1000) = 0x7f2df9c9f000  mmap(0x7f2df9ca0000, 4096, PROT\_READ, MAP\_PRIVATE|MAP\_FIXED|MAP\_DENYWRITE, 3, 0x2000) = 0x7f2df9ca0000  mmap(0x7f2df9ca1000, 8192, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_FIXED|MAP\_DENYWRITE, 3, 0x2000) = 0x7f2df9ca1000  close(3) = 0  openat(AT\_FDCWD, "./glibc-hwcaps/x86-64-v4/libstdc++.so.6", O\_RDONLY|O\_CLOEXEC) = -1 ENOENT (No such file or directory)  openat(AT\_FDCWD, "./glibc-hwcaps/x86-64-v3/libstdc++.so.6", O\_RDONLY|O\_CLOEXEC) = -1 ENOENT (No such file or directory)  openat(AT\_FDCWD, "./glibc-hwcaps/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"..., 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-hwcaps/x86-64-v4/libc.so.6", O\_RDONLY|O\_CLOEXEC) = -1 ENOENT (No such file or directory)  openat(AT\_FDCWD, "./glibc-hwcaps/x86-64-v3/libc.so.6", O\_RDONLY|O\_CLOEXEC) = -1 ENOENT (No such file or directory)  openat(AT\_FDCWD, "./glibc-hwcaps/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, "./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\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\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) = 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\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\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  futex(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, "Translationed number: 1101001110"..., 117Translationed 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\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=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\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\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\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\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  futex(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\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", 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=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", 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=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