Московский Авиационный Институт

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Институт №8 “Компьютерные науки и прикладная математика”

Кафедра №806 “Вычислительная математика и программирование”

Лабораторная работа №4 по курсу

«Операционные системы»

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Постановка задачи

Вариант 8.

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

- Во время компиляции (на этапе «линковки»/linking)
- 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 (static_main.c), которая используют одну из библиотек, используя знания полученные на этапе компиляции;
- Тестовая программа (dynamic_main.c), которая загружает библиотеки, используя только их местоположение и контракты.

Функции для варианта:

- Сортировка:
  - пузырковая
  - Хоара
- Подсчет интеграла для функции sin(x) на отрезке [A, B] с шагом e методом:
  - прямоугольников
  - трапеций

Общий метод и алгоритм решения

Использованные системные вызовы:

- void *dlopen(const char * __path, int __mode) - подгружает динамическую библиотеку;
- void *dlsym(void *__handle, const char *__symbol) - находит адресс в подгруженной библиотеке (по ее __handle), с которого начинается __symbol;
- int dlclose(void *__handle) - уменьшает на единицу счетчик ссылок на указатель __handle, и если нет других загруженных библиотек, использующих ее символы и счетчик ссылок принимает нулевое значение, то динамическая библиотека выгружается.

Опишем работу dynamic main. Заводим переменную, обозначающую номер набора действующих конртактов. подгружаем первый набор как начальный. Если

пользователь ввел команду 0, происходит смена контрактов; если 1, происходит вызов первой функции действующего набора; если 2, происходит вызов второй функции деуствующего набора.

Описание CMakeLists.txt:

```
cmake_minimum_required(VERSION 3.22)
project(lab4)

set(CMAKE_C_STANDARD 99)

add_library(lib1_s STATIC first.c lib.h)
add_library(lib2_s STATIC second.c lib.h)
add_executable(prog1_s static_main.c)
add_executable(prog2_s static_main.c)
target_link_libraries(prog1_s lib1_s)
target_link_libraries(prog2_s lib2_s)

add_library(lib1_d SHARED first.c lib.h)
add_library(lib2_d SHARED second.c lib.h)
add_executable(prog_d dynamic_main.c)
target_link_libraries(lib1_d)
target_link_libraries(lib2_d)
target_link_libraries(prog_d ${CMAKE_DL_LIBS})

// Создание библиотек
// Линковка исполняемых файлов
```

Из всего этого самым интересным является переменная для cmake, а именно CMAKE_DL_LIBS, которая потом, при линковке dynamic_main, добавит флаг ‘-ldl’ (для использования библиотеки ‘dlfcn.h’). Еще параметры STATIC и SHARED нужны, чтобы указать на назначение создаваемых библиотек (Static - статические, образуется ассемблеровский файл статической библиотеки с расширением .a; Shared - образуется динамическая библиотека с возможностью подгрузки к исполняемому в период runtime (у меня с расширением .dylib)).

Код программы

lib.h

```
#pragma once

#include <stdio.h>
#include <stdlib.h>
#include <math.h>

float SinIntegral(float A, float B, float e);
void Sort(int* arr, int n);
```

first.c

```
#include "lib.h"
```

```
// Подсчет интеграла методом прямоугольников.
float SinIntegral(float A, float B, float e){
float S = 0;
int n = (B - A) / e;
for(int i = 0; i < n; i++){
float x = A + i * e;
S = S + e * sinf(x);
}
return S;
}
// Пузырьковая сортировка.
void swap(int *arr, int i, int j){
int tmp = arr[i];
arr[i]=arr[j];
arr[j]=tmp;
}
void Sort(int* arr, int n){
for(int i = 0; i < n; ++i){
int changed = 0;
for(int j = 0; j < n - 1; ++j){
if(arr[j] > arr[j+1]){
swap(arr, j, j+1);
changed = 1;
}
}
if(!changed) break;
}
}
```

second.c

```
#include "lib.h"
//Подсчет интеграла методом трапеций.
float SinIntegral(float A, float B, float e){
int n = (B - A) / e;
float S = 0;
for(int i = 0; i < n; i++){
float x1 = A + i * e;
float x2 = A + (i + 1) * e;
S += 0.5 * (x2 - x1) * (sinf(x1) + sinf(x2));
}
return S;
}
// Сортировка Хоара.
void swap(int *arr, int i, int j){
int tmp = arr[i];
arr[i]=arr[j];
arr[j]=tmp;
}
int hoar_partition(int *arr, int n, int b){
int i = 0, j = n-1;
while (i < j){
while (arr[i] < b) i++;
```

```
while (arr[j] > b) j--;
if (i < j){
swap(arr, i, j);
i++;
j--;
}
}
return i;
}
void Sort(int *arr, int n) {
while (n >= 2) {
double b = floor((arr[0]+arr[n-1])/2);
int i = hoar_partition(arr, n, b);
Sort(arr, i);
arr = &arr[i];
n = n - i;
}
}
```

static_main.c

```
#include "lib.h"
int main(){
int c;
printf("Select the number of command:\n1) Call 'float SinIntegral(float A, float B, float e)'\n2) Call 'void
Sort(int* arr, int n)'\n");
do{
c = getchar();
if(c =='1'){
float A, B, e;
printf("Type values of A, B and e (with space between): ");
if(scanf("%f %f %f", &A, &B, &e)){
// printf("\nA = %f, B = %f, e = %f\n", A, B, e);
printf("\nResult is %lf\n", SinIntegral(A, B, e));
}
else printf("\nSomething went wrong, try again\n");
}
else if(c == '2'){
int n = 0;
printf("Type array size: ");
if(scanf("%d", &n)){
int arr[n];
int correct = 1;
printf("\nType your array: ");
for(int i = 0; i < n; i++){
int tmp;
if(scanf("%d", &tmp)){
arr[i] = tmp;
}else{
correct = 0;
break;
}
}
```

```
if(correct){
Sort(arr, n);
printf("\nHere is your sorted array: ");
for(int i = 0; i < n; ++i){
printf("%d ", arr[i]);
}
printf("\n");
}
else printf("\nSomething went wrong, try again\n");
}else{
printf("\nWrong, try again\n");
}
}
else if(!(c == ' ' || c == '\n' || c == EOF)){
printf("Wrong command\nTry again\n");
}
}while(c != EOF);
return 0;
}
```

dynamic_main.c

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

int contr = 1;

const char* first_name = "liblib1_d.dylib";
const char* second_name = "liblib2_d.dylib";


void (*Sort)(int* arr, int n) = NULL;
float (*SinIntegral)(float A, float B, float e) = NULL;

void* lib_handle = NULL;

void load_lib() {
const char* name;

if(contr == 1){
name = first_name;
}
else if(contr == 2){
name = second_name;
}
lib_handle = dlopen(name, RTLD_LAZY);

if (lib_handle == NULL) {
perror("cannot find library");
exit(EXIT_FAILURE);
}
}
```

```
void load_contract() {
load_lib();
Sort = dlsym(lib_handle, "Sort");
SinIntegral = dlsym(lib_handle, "SinIntegral");
}

void change_contract() {
dlclose(lib_handle);

if(contr == 1){
contr = 2;
}
else if (contr == 2){
contr = 1;
}
load_contract();
}

int main() {
load_contract();
int command = 0;

printf("Select the number of command:\n0) Change contract\n1) Call 'float SinIntegral(float A, float B, float
e)'\n2) Call 'void Sort(int* arr, int n)'\n");
do{
command = getchar();
if(command == '0'){
change_contract();
printf("Contract has been changed\n");
if(contr == 1) {
printf("Contract is first\n");
}

else if(contr == 2){
printf("Contract is second\n");
}
}
else if(command == '1'){
float A, B, e;
printf("Type values of A, B and e (with space between): ");
if(scanf("%f %f %f", &A, &B, &e)){
// printf("\nA = %f, B = %f, e = %f\n", A, B, e);
printf("\nResult is %lf\n", SinIntegral(A, B, e));
}
else printf("\nSomething went wrong, try again\n");
}
else if (command == '2'){
int n = 0;
printf("Type array size: ");
if(scanf("%d", &n)){
int arr[n];
```

```
int correct = 1;
printf("\nType your array: ");
for(int i = 0; i < n; i++){
int tmp;
if(scanf("%d", &tmp)){
arr[i] = tmp;
}else{
correct = 0;
break;
}
}
if(correct){
Sort(arr, n);
printf("\nHere is your sorted array: ");
for(int i = 0; i < n; ++i){
printf("%d ", arr[i]);
}
printf("\n");
}
else printf("\nSomething went wrong, try again\n");

}else{
printf("\nWrong, try again\n");
}
}else if(!(command == ' ' || command == '\n' || command == EOF)) printf("Wrong command\nTry again\n");
}while (command != EOF);
return 0;
}
```

Протокол работы программы

Тестирование:

статическая реализация:

```
mishazhadnov@McB-airmi build % ./prog1_s
Select the number of command:
1) Call 'float SinIntegral(float A, float B, float e)'
2) Call 'void Sort(int* arr, int n)'
2
Type array size: 5
Type your array: 0 0 1 1 1
Here is your sorted array: 0 0 1 1 1
2
Type array size: 5
Type your array: 1 1 1 0 0
Here is your sorted array: 0 0 1 1 1
```

динамическая реализация:

```
mishazhadnov@McB-airmi build % ./prog_d
Select the number of command:
0) Change contract
1) Call 'float SinIntegral(float A, float B, float e)'
2) Call 'void Sort(int* arr, int n)'
2
Type array size: 3
Type your array: 0 13 0
Here is your sorted array: 0 0 13
1
Type values of A, B and e (with space between): 0 2 0.1
Result is 1.369502
0
Contract has been changed
Contract is second
1
Type values of A, B and e (with space between): 0 2 0.1
Result is 1.414966
```

Dtrace (аналог strace):

```
mishazhadnov@McB-airmi build % sudo dtruss ./prog_d

dtrace: system integrity protection is on, some features will not be available


SYSCALL(args)          = return
```

munmap(0x1118BC000, 0xA0000) = 0 0

munmap(0x11195C000, 0x8000) = 0 0

munmap(0x111964000, 0x4000) = 0 0

munmap(0x111968000, 0x4000) = 0 0

munmap(0x11196C000, 0x58000) = 0 0

open(".\0", 0x100000, 0x0) = 3 0

fcntl(0x3, 0x32, 0x7FF7B253B290) = 0 0

close(0x3) = 0 0

fsgetpath(0x7FF7B253B2A0, 0x400, 0x7FF7B253B288) = 64 0

fsgetpath(0x7FF7B253B2A0, 0x400, 0x7FF7B253B288) = 14 0

csrctl(0x0, 0x7FF7B253B6AC, 0x4) = -1 1

Select the number of command:

0) Change contract

1) Call 'float SinIntegral(float A, float B, float e)'

2) Call 'void Sort(int* arr, int n)'

__mac_syscall(0x7FF815B08E3B, 0x2, 0x7FF7B253B510) = 0 0

csrctl(0x0, 0x7FF7B253B6BC, 0x4) = -1 1

__mac_syscall(0x7FF815B05DC6, 0x5A, 0x7FF7B253B650) = 0 0

dtrace: error on enabled probe ID 1741 (ID 573: syscall::sysctl:return): invalid kernel access in action #10 at DIF offset 28

dtrace: error on enabled probe ID 1741 (ID 573: syscall::sysctl:return): invalid kernel access in action #10 at DIF offset 28

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dtrace: error on enabled probe ID 1741 (ID 573: syscall::sysctl:return): invalid kernel access in action #10 at DIF offset 28

open("/\0", 0x20100000, 0x0) = 3 0

openat(0x3, "System/Cryptexes/OS\0", 0x100000, 0x0) = 4 0

dup(0x4, 0x0, 0x0) = 5 0

fstatat64(0x4, 0x7FF7B253A3F1, 0x7FF7B253A7F0) = 0 0

openat(0x4, "System/Library/dyld/\0", 0x100000, 0x0) = 6 0

fcntl(0x6, 0x32, 0x7FF7B253A480) = 0 0

dup(0x6, 0x0, 0x0) = 7 0

dup(0x5, 0x0, 0x0) = 8 0

close(0x3) = 0 0

close(0x5) = 0 0

close(0x4) = 0 0

close(0x6) = 0 0

shared_region_check_np(0x7FF7B253AD68, 0x0, 0x0) = 0 0

fsgetpath(0x7FF7B253B2D0, 0x400, 0x7FF7B253B208) = 83 0

fcntl(0x8, 0x32, 0x7FF7B253B2D0) = 0 0

close(0x8) = 0 0

close(0x7) = 0 0

getfsstat64(0x0, 0x0, 0x2) = 7 0

getfsstat64(0x10DF02AA0, 0x3B48, 0x2) = 7 0

getattrlist("/\0", 0x7FF7B253B210, 0x7FF7B253B180) = 0 0

stat64("/System/Volumes/Preboot/Cryptexes/OS/System/Library/dyld/dyld_shared_cache_x86_64h\0", 0x7FF7B253B548, 0x0) = 0 0

dtrace: error on enabled probe ID 1690 (ID 845: syscall::stat64:return): invalid address (0x0) in action #11 at DIF offset 12

stat64("/Users/mishazhadnov/Desktop/wD/OS_labs_3t/lab4/src/build/prog_d\0", 0x7FF7B253A9E0, 0x0) = 0 0

open("/Users/mishazhadnov/Desktop/wD/OS_labs_3t/lab4/src/build/prog_d\0", 0x0, 0x0) = 3 0

mmap(0x0, 0xC4A8, 0x1, 0x40002, 0x3, 0x0) = 0x10D9D4000 0

fcntl(0x3, 0x32, 0x7FF7B253AAF0) = 0 0

close(0x3) = 0 0

munmap(0x10D9D4000, 0xC4A8) = 0 0

stat64("/Users/mishazhadnov/Desktop/wD/OS_labs_3t/lab4/src/build/prog_d\0", 0x7FF7B253AF40, 0x0) = 0 0

stat64("/usr/lib/libSystem.B.dylib\0", 0x7FF7B2539F50, 0x0) = -1 2

stat64("/System/Volumes/Preboot/Cryptexes/OS/usr/lib/libSystem.B.dylib\0", 0x7FF7B2539F00, 0x0) = -1 2

stat64("/usr/lib/libSystem.B.dylib\0", 0x7FF7B2539F50, 0x0) = -1 2

stat64("/usr/lib/libobjc.A.dylib\0", 0x7FF7B2537BA0, 0x0) = -1 2

stat64("/System/Volumes/Preboot/Cryptexes/OS/usr/lib/libobjc.A.dylib\0", 0x7FF7B2537B50, 0x0) = -1 2

stat64("/usr/lib/libobjc.A.dylib\0", 0x7FF7B2537BA0, 0x0) = -1 2

stat64("/usr/lib/system/libsystem_blocks.dylib\0", 0x7FF7B2537BA0, 0x0) = -1 2

stat64("/System/Volumes/Preboot/Cryptexes/OS/usr/lib/system/libsystem_blocks.dylib\0", 0x7FF7B2537B40, 0x0) = -1 2

stat64("/usr/lib/system/libsystem_blocks.dylib\0", 0x7FF7B2537BA0, 0x0) = -1 2

stat64("/usr/lib/system/libxpc.dylib\0", 0x7FF7B2537BA0, 0x0) = -1 2

stat64("/System/Volumes/Preboot/Cryptexes/OS/usr/lib/system/libxpc.dylib\0", 0x7FF7B2537B50, 0x0) = -1 2

stat64("/usr/lib/system/libxpc.dylib\0", 0x7FF7B2537BA0, 0x0) = -1 2

stat64("/usr/lib/system/libsystem_trace.dylib\0", 0x7FF7B2537BA0, 0x0) = -1 2

stat64("/System/Volumes/Preboot/Cryptexes/OS/usr/lib/system/libsystem_trace.dylib\0", 0x7FF7B2537B40, 0x0) = -1 2

stat64("/usr/lib/system/libsystem_trace.dylib\0", 0x7FF7B2537BA0, 0x0) = -1 2

stat64("/usr/lib/system/libcorecrypto.dylib\0", 0x7FF7B2537BA0, 0x0) = -1 2

stat64("/System/Volumes/Preboot/Cryptexes/OS/usr/lib/system/libcorecrypto.dylib\0", 0x7FF7B2537B50, 0x0) = -1 2

stat64("/usr/lib/system/libcorecrypto.dylib\0", 0x7FF7B2537BA0, 0x0) = -1 2

stat64("/usr/lib/system/libsystem_malloc.dylib\0", 0x7FF7B2537BA0, 0x0) = -1 2

stat64("/System/Volumes/Preboot/Cryptexes/OS/usr/lib/system/libsystem_malloc.dylib\0", 0x7FF7B2537B40, 0x0) = -1 2

stat64("/usr/lib/system/libsystem_malloc.dylib\0", 0x7FF7B2537BA0, 0x0) = -1 2

stat64("/usr/lib/system/libdispatch.dylib\0", 0x7FF7B2537BA0, 0x0) = -1 2

stat64("/System/Volumes/Preboot/Cryptexes/OS/usr/lib/system/libdispatch.dylib\0", 0x7FF7B2537B50, 0x0) = -1 2

stat64("/usr/lib/system/libdispatch.dylib\0", 0x7FF7B2537BA0, 0x0) = -1 2

stat64("/usr/lib/system/libsystem_featureflags.dylib\0", 0x7FF7B2537BA0, 0x0) = -1 2

stat64("/System/Volumes/Preboot/Cryptexes/OS/usr/lib/system/libsystem_featureflags.dylib\0", 0x7FF7B2537B40, 0x0) = -1 2

stat64("/usr/lib/system/libsystem_featureflags.dylib\0", 0x7FF7B2537BA0, 0x0) = -1 2

stat64("/usr/lib/system/libsystem_c.dylib\0", 0x7FF7B2537BA0, 0x0) = -1 2

stat64("/System/Volumes/Preboot/Cryptexes/OS/usr/lib/system/libsystem_c.dylib\0", 0x7FF7B2537B50, 0x0) = -1 2

stat64("/usr/lib/system/libsystem_c.dylib\0", 0x7FF7B2537BA0, 0x0) = -1 2

stat64("/usr/lib/libc++.1.dylib\0", 0x7FF7B2537BA0, 0x0) = -1 2

stat64("/System/Volumes/Preboot/Cryptexes/OS/usr/lib/libc++.1.dylib\0", 0x7FF7B2537B50, 0x0) = -1 2

stat64("/usr/lib/libc++.1.dylib\0", 0x7FF7B2537BA0, 0x0) = -1 2

stat64("/usr/lib/libc++abi.dylib\0", 0x7FF7B2537BA0, 0x0) = -1 2

stat64("/System/Volumes/Preboot/Cryptexes/OS/usr/lib/libc++abi.dylib\0", 0x7FF7B2537B50, 0x0) = -1 2

stat64("/usr/lib/libc++abi.dylib\0", 0x7FF7B2537BA0, 0x0) = -1 2

stat64("/usr/lib/system/libdyld.dylib\0", 0x7FF7B2537BA0, 0x0) = -1 2

stat64("/System/Volumes/Preboot/Cryptexes/OS/usr/lib/system/libdyld.dylib\0", 0x7FF7B2537B50, 0x0) = -1 2

stat64("/usr/lib/system/libdyld.dylib\0", 0x7FF7B2537BA0, 0x0) = -1 2

stat64("/usr/lib/system/libsystem_info.dylib\0", 0x7FF7B2537BA0, 0x0) = -1 2

stat64("/System/Volumes/Preboot/Cryptexes/OS/usr/lib/system/libsystem_info.dylib\0", 0x7FF7B2537B50, 0x0) = -1 2

stat64("/usr/lib/system/libsystem_info.dylib\0", 0x7FF7B2537BA0, 0x0) = -1 2

stat64("/usr/lib/system/libsystem_darwin.dylib\0", 0x7FF7B2537BA0, 0x0) = -1 2

stat64("/System/Volumes/Preboot/Cryptexes/OS/usr/lib/system/libsystem_darwin.dylib\0", 0x7FF7B2537B40, 0x0) = -1 2

stat64("/usr/lib/system/libsystem_darwin.dylib\0", 0x7FF7B2537BA0, 0x0) = -1 2

stat64("/usr/lib/system/libsystem_notify.dylib\0", 0x7FF7B2537BA0, 0x0) = -1 2

stat64("/System/Volumes/Preboot/Cryptexes/OS/usr/lib/system/libsystem_notify.dylib\0", 0x7FF7B2537B40, 0x0) = -1 2

stat64("/usr/lib/system/libsystem_notify.dylib\0", 0x7FF7B2537BA0, 0x0) = -1 2

stat64("/usr/lib/system/libsystem_networkextension.dylib\0", 0x7FF7B2537BA0, 0x0) = -1 2

stat64("/System/Volumes/Preboot/Cryptexes/OS/usr/lib/system/libsystem_networkextension.dylib\0", 0x7FF7B2537B40, 0x0) = -1 2

stat64("/usr/lib/system/libsystem_networkextension.dylib\0", 0x7FF7B2537BA0, 0x0) = -1 2

stat64("/usr/lib/system/libsystem_asl.dylib\0", 0x7FF7B2537BA0, 0x0) = -1 2

stat64("/System/Volumes/Preboot/Cryptexes/OS/usr/lib/system/libsystem_asl.dylib\0", 0x7FF7B2537B50, 0x0) = -1 2

stat64("/usr/lib/system/libsystem_asl.dylib\0", 0x7FF7B2537BA0, 0x0) = -1 2

stat64("/usr/lib/system/libsystem_symptoms.dylib\0", 0x7FF7B2537BA0, 0x0) = -1 2

stat64("/System/Volumes/Preboot/Cryptexes/OS/usr/lib/system/libsystem_symptoms.dylib\0", 0x7FF7B2537B40, 0x0) = -1 2

stat64("/usr/lib/system/libsystem_symptoms.dylib\0", 0x7FF7B2537BA0, 0x0) = -1 2

stat64("/usr/lib/system/libsystem_containermanager.dylib\0", 0x7FF7B2537BA0, 0x0) = -1 2

stat64("/System/Volumes/Preboot/Cryptexes/OS/usr/lib/system/libsystem_containermanager.dylib\0", 0x7FF7B2537B40, 0x0) = -1 2

stat64("/usr/lib/system/libsystem_containermanager.dylib\0", 0x7FF7B2537BA0, 0x0) = -1 2

stat64("/usr/lib/system/libsystem_configuration.dylib\0", 0x7FF7B2537BA0, 0x0) = -1 2

stat64("/System/Volumes/Preboot/Cryptexes/OS/usr/lib/system/libsystem_configuration.dylib\0", 0x7FF7B2537B40, 0x0) = -1 2

stat64("/usr/lib/system/libsystem_configuration.dylib\0", 0x7FF7B2537BA0, 0x0) = -1 2

stat64("/usr/lib/system/libsystem_sandbox.dylib\0", 0x7FF7B2537BA0, 0x0) = -1 2

stat64("/System/Volumes/Preboot/Cryptexes/OS/usr/lib/system/libsystem_sandbox.dylib\0", 0x7FF7B2537B40, 0x0) = -1 2

stat64("/usr/lib/system/libsystem_sandbox.dylib\0", 0x7FF7B2537BA0, 0x0) = -1 2

stat64("/usr/lib/system/libquarantine.dylib\0", 0x7FF7B2537BA0, 0x0) = -1 2

stat64("/System/Volumes/Preboot/Cryptexes/OS/usr/lib/system/libquarantine.dylib\0", 0x7FF7B2537B50, 0x0) = -1 2

stat64("/usr/lib/system/libquarantine.dylib\0", 0x7FF7B2537BA0, 0x0) = -1 2

stat64("/usr/lib/system/libsystem_coreservices.dylib\0", 0x7FF7B2537BA0, 0x0) = -1 2

stat64("/System/Volumes/Preboot/Cryptexes/OS/usr/lib/system/libsystem_coreservices.dylib\0", 0x7FF7B2537B40, 0x0) = -1 2

stat64("/usr/lib/system/libsystem_coreservices.dylib\0", 0x7FF7B2537BA0, 0x0) = -1 2

stat64("/usr/lib/system/libsystem_m.dylib\0", 0x7FF7B2537BA0, 0x0) = -1 2

stat64("/System/Volumes/Preboot/Cryptexes/OS/usr/lib/system/libsystem_m.dylib\0", 0x7FF7B2537B50, 0x0) = -1 2

stat64("/usr/lib/system/libsystem_m.dylib\0", 0x7FF7B2537BA0, 0x0) = -1 2

stat64("/usr/lib/system/libmacho.dylib\0", 0x7FF7B2537BA0, 0x0) = -1 2

stat64("/System/Volumes/Preboot/Cryptexes/OS/usr/lib/system/libmacho.dylib\0", 0x7FF7B2537B50, 0x0) = -1 2

stat64("/usr/lib/system/libmacho.dylib\0", 0x7FF7B2537BA0, 0x0) = -1 2

stat64("/usr/lib/system/libcommonCrypto.dylib\0", 0x7FF7B2537BA0, 0x0) = -1 2

stat64("/System/Volumes/Preboot/Cryptexes/OS/usr/lib/system/libcommonCrypto.dylib\0", 0x7FF7B2537B40, 0x0) = -1 2

stat64("/usr/lib/system/libcommonCrypto.dylib\0", 0x7FF7B2537BA0, 0x0) = -1 2

stat64("/usr/lib/system/libunwind.dylib\0", 0x7FF7B2537BA0, 0x0) = -1 2

stat64("/System/Volumes/Preboot/Cryptexes/OS/usr/lib/system/libunwind.dylib\0", 0x7FF7B2537B50, 0x0) = -1 2

stat64("/usr/lib/system/libunwind.dylib\0", 0x7FF7B2537BA0, 0x0) = -1 2

stat64("/usr/lib/liboah.dylib\0", 0x7FF7B2537BA0, 0x0) = -1 2

stat64("/System/Volumes/Preboot/Cryptexes/OS/usr/lib/liboah.dylib\0", 0x7FF7B2537B50, 0x0) = -1 2

stat64("/usr/lib/liboah.dylib\0", 0x7FF7B2537BA0, 0x0) = -1 2

stat64("/usr/lib/system/libcopyfile.dylib\0", 0x7FF7B2537BA0, 0x0) = -1 2

stat64("/System/Volumes/Preboot/Cryptexes/OS/usr/lib/system/libcopyfile.dylib\0", 0x7FF7B2537B50, 0x0) = -1 2

stat64("/usr/lib/system/libcopyfile.dylib\0", 0x7FF7B2537BA0, 0x0) = -1 2

stat64("/usr/lib/system/libcompiler_rt.dylib\0", 0x7FF7B2537BA0, 0x0) = -1 2

stat64("/System/Volumes/Preboot/Cryptexes/OS/usr/lib/system/libcompiler_rt.dylib\0", 0x7FF7B2537B50, 0x0) = -1 2

stat64("/usr/lib/system/libcompiler_rt.dylib\0", 0x7FF7B2537BA0, 0x0) = -1 2

stat64("/usr/lib/system/libsystem_collections.dylib\0", 0x7FF7B2537BA0, 0x0) = -1 2

stat64("/System/Volumes/Preboot/Cryptexes/OS/usr/lib/system/libsystem_collections.dylib\0", 0x7FF7B2537B40, 0x0) = -1 2

stat64("/usr/lib/system/libsystem_collections.dylib\0", 0x7FF7B2537BA0, 0x0) = -1 2

stat64("/usr/lib/system/libsystem_secinit.dylib\0", 0x7FF7B2537BA0, 0x0) = -1 2

stat64("/System/Volumes/Preboot/Cryptexes/OS/usr/lib/system/libsystem_secinit.dylib\0", 0x7FF7B2537B40, 0x0) = -1 2

stat64("/usr/lib/system/libsystem_secinit.dylib\0", 0x7FF7B2537BA0, 0x0) = -1 2

stat64("/usr/lib/system/libremovefile.dylib\0", 0x7FF7B2537BA0, 0x0) = -1 2

stat64("/System/Volumes/Preboot/Cryptexes/OS/usr/lib/system/libremovefile.dylib\0", 0x7FF7B2537B50, 0x0) = -1 2

stat64("/usr/lib/system/libremovefile.dylib\0", 0x7FF7B2537BA0, 0x0) = -1 2

stat64("/usr/lib/system/libkeymgr.dylib\0", 0x7FF7B2537BA0, 0x0) = -1 2

stat64("/System/Volumes/Preboot/Cryptexes/OS/usr/lib/system/libkeymgr.dylib\0", 0x7FF7B2537B50, 0x0) = -1 2

stat64("/usr/lib/system/libkeymgr.dylib\0", 0x7FF7B2537BA0, 0x0) = -1 2

stat64("/usr/lib/system/libsystem_dnssd.dylib\0", 0x7FF7B2537BA0, 0x0) = -1 2

stat64("/System/Volumes/Preboot/Cryptexes/OS/usr/lib/system/libsystem_dnssd.dylib\0", 0x7FF7B2537B40, 0x0) = -1 2

stat64("/usr/lib/system/libsystem_dnssd.dylib\0", 0x7FF7B2537BA0, 0x0) = -1 2

stat64("/usr/lib/system/libcache.dylib\0", 0x7FF7B2537BA0, 0x0) = -1 2

stat64("/System/Volumes/Preboot/Cryptexes/OS/usr/lib/system/libcache.dylib\0", 0x7FF7B2537B50, 0x0) = -1 2

stat64("/usr/lib/system/libcache.dylib\0", 0x7FF7B2537BA0, 0x0) = -1 2

stat64("/usr/lib/libSystem.B.dylib\0", 0x7FF7B2537BA0, 0x0) = -1 2

stat64("/System/Volumes/Preboot/Cryptexes/OS/usr/lib/libSystem.B.dylib\0", 0x7FF7B2537B50, 0x0) = -1 2

stat64("/usr/lib/libSystem.B.dylib\0", 0x7FF7B2537BA0, 0x0) = -1 2

stat64("/usr/lib/system/libsystem_darwindirectory.dylib\0", 0x7FF7B2537BA0, 0x0) = -1 2

stat64("/System/Volumes/Preboot/Cryptexes/OS/usr/lib/system/libsystem_darwindirectory.dylib\0", 0x7FF7B2537B40, 0x0) = -1 2

stat64("/usr/lib/system/libsystem_darwindirectory.dylib\0", 0x7FF7B2537BA0, 0x0) = -1 2

open("/dev/dtracehelper\0", 0x2, 0x0) = 3 0

ioctl(0x3, 0x80086804, 0x7FF7B2539B38) = 0 0

close(0x3) = 0 0

open("/Users/mishazhadnov/Desktop/wD/OS_labs_3t/lab4/src/build/prog_d\0", 0x0, 0x0) = 3 0

__mac_syscall(0x7FF815B08E3B, 0x2, 0x7FF7B25390F0) = 0 0

map_with_linking_np(0x7FF7B2539090, 0x1, 0x7FF7B25390C0) = -1 22

close(0x3) = 0 0

mprotect(0x10D9C8000, 0x4000, 0x1) = 0 0

shared_region_check_np(0xFFFFFFFFFFFFFFFF, 0x0, 0x0) = 0 0

mprotect(0x10DF00000, 0x40000, 0x1) = 0 0

access("/AppleInternal/XBS/.isChrooted\0", 0x0, 0x0) = -1 2

bsdthread_register(0x7FF815DFBB9C, 0x7FF815DFBB88, 0x2000) = 1073742303 0

getpid(0x0, 0x0, 0x0) = 53765 0

shm_open(0x7FF815C9EF42, 0x0, 0x15C9D388) = 3 0

fstat64(0x3, 0x7FF7B253A060, 0x0) = 0 0

mmap(0x0, 0x4000, 0x1, 0x40001, 0x3, 0x0) = 0x10D9D6000 0

close(0x3) = 0 0

ioctl(0x2, 0x4004667A, 0x7FF7B253A124) = 0 0

mprotect(0x10D9DF000, 0x1000, 0x0) = 0 0

mprotect(0x10D9E6000, 0x1000, 0x0) = 0 0

mprotect(0x10D9E7000, 0x1000, 0x0) = 0 0

mprotect(0x10D9EE000, 0x1000, 0x0) = 0 0

mprotect(0x10D9DA000, 0x98, 0x1) = 0 0

mprotect(0x10D9DA000, 0x98, 0x3) = 0 0

mprotect(0x10D9DA000, 0x98, 0x1) = 0 0

mprotect(0x10D9EF000, 0x1000, 0x1) = 0 0

mprotect(0x10D9F0000, 0x98, 0x1) = 0 0

mprotect(0x10D9F0000, 0x98, 0x3) = 0 0

mprotect(0x10D9F0000, 0x98, 0x1) = 0 0

mprotect(0x10D9DA000, 0x98, 0x3) = 0 0

mprotect(0x10D9DA000, 0x98, 0x1) = 0 0

mprotect(0x10D9EF000, 0x1000, 0x3) = 0 0

mprotect(0x10D9EF000, 0x1000, 0x1) = 0 0

mprotect(0x10DF00000, 0x40000, 0x3) = 0 0

mprotect(0x10DF00000, 0x40000, 0x1) = 0 0

issetugid(0x0, 0x0, 0x0) = 0 0

mprotect(0x10DF00000, 0x40000, 0x3) = 0 0

getentropy(0x7FF7B2539950, 0x20, 0x0) = 0 0

mprotect(0x10DF00000, 0x40000, 0x1) = 0 0

mprotect(0x10DF00000, 0x40000, 0x3) = 0 0

mprotect(0x10DF00000, 0x40000, 0x1) = 0 0

getattrlist("/Users/mishazhadnov/Desktop/wD/OS_labs_3t/lab4/src/build/prog_d\0", 0x7FF7B253A000, 0x7FF7B253A018) = 0 0

access("/Users/mishazhadnov/Desktop/wD/OS_labs_3t/lab4/src/build\0", 0x4, 0x0) = 0 0

open("/Users/mishazhadnov/Desktop/wD/OS_labs_3t/lab4/src/build\0", 0x0, 0x0) = 3 0

fstat64(0x3, 0x7FA0E6F04530, 0x0) = 0 0

csrctl(0x0, 0x7FF7B253A25C, 0x4) = -1 1

fgetattrlist(0x3, 0x7FF7B253A270, 0x7FF7B253A290) = 0 0

__mac_syscall(0x7FF8211BC6A4, 0x2, 0x7FF7B253A290) = 0 0

fcntl(0x3, 0x32, 0x7FF7B2539F10) = 0 0

close(0x3) = 0 0

open("/Users/mishazhadnov/Desktop/wD/OS_labs_3t/lab4/src/build/Info.plist\0", 0x0, 0x0) = -1 2

proc_info(0x2, 0xD205, 0xD) = 64 0

csops_audittoken(0xD205, 0x10, 0x7FF7B253A260) = -1 22

dtrace: error on enabled probe ID 1741 (ID 573: syscall::sysctl:return): invalid kernel access in action #10 at DIF offset 28

dtrace: error on enabled probe ID 1741 (ID 573: syscall::sysctl:return): invalid kernel access in action #10 at DIF offset 28

csops(0xD205, 0x0, 0x7FF7B253A6C4) = 0 0

mprotect(0x10DF00000, 0x40000, 0x3) = 0 0

open("liblib1_d.dylib\0", 0x0, 0x0) = 3 0

fcntl(0x3, 0x32, 0x7FF7B253A870) = 0 0

close(0x3) = 0 0

stat64("liblib1_d.dylib\0", 0x7FF7B253A430, 0x0) = 0 0

stat64("liblib1_d.dylib\0", 0x7FF7B2539E90, 0x0) = 0 0

open("liblib1_d.dylib\0", 0x0, 0x0) = 3 0

mmap(0x0, 0x8108, 0x1, 0x40002, 0x3, 0x0) = 0x10D9F8000 0

fcntl(0x3, 0x32, 0x7FF7B2539FA0) = 0 0

close(0x3) = 0 0

open("/Users/mishazhadnov/Desktop/wD/OS_labs_3t/lab4/src/build/liblib1_d.dylib\0", 0x0, 0x0) = 3 0

fcntl(0x3, 0x62, 0x7FF7B2539C78) = 0 0

mmap(0x10DA01000, 0x4000, 0x5, 0x40012, 0x3, 0x0) = 0x10DA01000 0

mmap(0x10DA05000, 0x4000, 0x3, 0x40012, 0x3, 0x4000) = 0x10DA05000 0

mmap(0x10DA09000, 0x4000, 0x1, 0x40012, 0x3, 0x8000) = 0x10DA09000 0

close(0x3) = 0 0

munmap(0x10D9F8000, 0x8108) = 0 0

open("/Users/mishazhadnov/Desktop/wD/OS_labs_3t/lab4/src/build/liblib1_d.dylib\0", 0x0, 0x0) = 3 0

close(0x3) = 0 0

mprotect(0x10DA05000, 0x4000, 0x1) = 0 0

getrlimit(0x1008, 0x7FF7B253B3F0, 0x0) = 0 0

fstat64(0x1, 0x7FF7B253B3D8, 0x0) = 0 0

ioctl(0x1, 0x4004667A, 0x7FF7B253B424) = 0 0

dtrace: error on enabled probe ID 1712 (ID 963: syscall::write_nocancel:return): invalid kernel access in action #12 at DIF offset 68

dtrace: error on enabled probe ID 1712 (ID 963: syscall::write_nocancel:return): invalid kernel access in action #12 at DIF offset 68

dtrace: error on enabled probe ID 1712 (ID 963: syscall::write_nocancel:return): invalid kernel access in action #12 at DIF offset 68

dtrace: error on enabled probe ID 1712 (ID 963: syscall::write_nocancel:return): invalid kernel access in action #12 at DIF offset 68

fstat64(0x0, 0x7FF7B253B578, 0x0) = 0 0

ioctl(0x0, 0x4004667A, 0x7FF7B253B5C4) = 0 0

0

Contract has been changed

Contract is second

dtrace: error on enabled probe ID 1714 (ID 961: syscall::read_nocancel:return): invalid kernel access in action #12 at DIF offset 68

munmap(0x10DA01000, 0xC000) = 0 0

open("liblib2_d.dylib\0", 0x0, 0x0) = 3 0

fcntl(0x3, 0x32, 0x7FF7B253A860) = 0 0

close(0x3) = 0 0

stat64("liblib2_d.dylib\0", 0x7FF7B253A420, 0x0) = 0 0

stat64("liblib2_d.dylib\0", 0x7FF7B2539E80, 0x0) = 0 0

open("liblib2_d.dylib\0", 0x0, 0x0) = 3 0

mmap(0x0, 0x8140, 0x1, 0x40002, 0x3, 0x0) = 0x10D9F8000 0

fcntl(0x3, 0x32, 0x7FF7B2539F90) = 0 0

close(0x3) = 0 0

open("/Users/mishazhadnov/Desktop/wD/OS_labs_3t/lab4/src/build/liblib2_d.dylib\0", 0x0, 0x0) = 3 0

fcntl(0x3, 0x62, 0x7FF7B2539C68) = 0 S_labs_3t/lab4/src/build/prog_d0

mmap(0x10DA01000, 0x4000, 0x5, 0x40012, 0x3, 0x0) = 0x10DA01000 0

mmap(0x10DA05000, 0x4000, 0x3, 0x40012, 0x3, 0x4000) = 0x10DA05000 0

mmap(0x10DA09000, 0x4000, 0x1, 0x40012, 0x3, 0x8000) = 0x10DA09000 0

close(0x3) = 0 0

munmap(0x10D9F8000, 0x8140) = 0 0

open("/Users/mishazhadnov/Desktop/wD/OS_labs_3t/lab4/src/build/liblib2_d.dylib\0", 0x0, 0x0) = 3 PS0

close(0x3) = 0 0

mprotect(0x10DA05000, 0x4000, 0x1) = 0 0

dtrace: error on enabled probe ID 1712 (ID 963: syscall::write_nocancel:return): invalid kernel access in action #12 at DIF offset 68

dtrace: error on enabled probe ID 1712 (ID 963: syscall::write_nocancel:return): invalid kernel access in action #12 at DIF offset 68

1

Type values of A, B and e (with space between): dtrace: error on enabled probe ID 1714 (ID 961: syscall::read_nocancel:return): invalid kernel access in action #12 at DIF offset 68

dtrace: error on enabled probe ID 1712 (ID 963: syscall::write_nocancel:return): invalid kernel access in action #12 at DIF offset 68

0 2 0.1

Result is 1.414966

dtrace: error on enabled probe ID 1714 (ID 961: syscall::read_nocancel:return): invalid kernel access in action #12 at DIF offset 68

dtrace: error on enabled probe ID 1712 (ID 963: syscall::write_nocancel:return): invalid kernel access in action #12 at DIF offset 68

dtrace: error on enabled probe ID 1712 (ID 963: syscall::write_nocancel:return): invalid kernel access in action #12 at DIF offset 68

0

Contract has been changed

Contract is first

dtrace: error on enabled probe ID 1714 (ID 961: syscall::read_nocancel:return): invalid kernel access in action #12 at DIF offset 68

munmap(0x10DA01000, 0xC000) = 0 0

open("liblib1_d.dylib\0", 0x0, 0x0) = 3 ��0

fcntl(0x3, 0x32, 0x7FF7B253A860) = 0 0

close(0x3) = 0 0

stat64("liblib1_d.dylib\0", 0x7FF7B253A420, 0x0) = 0 0

stat64("liblib1_d.dylib\0", 0x7FF7B2539E80, 0x0) = 0 stat640

open("liblib1_d.dylib\0", 0x0, 0x0) = 3 stat640

mmap(0x0, 0x8108, 0x1, 0x40002, 0x3, 0x0) = 0x10D9F8000 0

fcntl(0x3, 0x32, 0x7FF7B2539F90) = 0 0

close(0x3) = 0 0

open("/Users/mishazhadnov/Desktop/wD/OS_labs_3t/lab4/src/build/liblib1_d.dylib\0", 0x0, 0x0) = 3 0

fcntl(0x3, 0x62, 0x7FF7B2539C68) = 0 0

mmap(0x10DA01000, 0x4000, 0x5, 0x40012, 0x3, 0x0) = 0x10DA01000 0

mmap(0x10DA05000, 0x4000, 0x3, 0x40012, 0x3, 0x4000) = 0x10DA05000 0

mmap(0x10DA09000, 0x4000, 0x1, 0x40012, 0x3, 0x8000) = 0x10DA09000 0

close(0x3) = 0 ����0

munmap(0x10D9F8000, 0x8108) = 0 Preboot/Cryptexes/OS/usr/lib/system/libsystem_blocks.dylib0

open("/Users/mishazhadnov/Desktop/wD/OS_labs_3t/lab4/src/build/liblib1_d.dylib\0", 0x0, 0x0) = 3 0

close(0x3) = 0 0

mprotect(0x10DA05000, 0x4000, 0x1) = 0 0

dtrace: error on enabled probe ID 1712 (ID 963: syscall::write_nocancel:return): invalid kernel access in action #12 at DIF offset 68

dtrace: error on enabled probe ID 1712 (ID 963: syscall::write_nocancel:return): invalid kernel access in action #12 at DIF offset 68

1

Type values of A, B and e (with space between): dtrace: error on enabled probe ID 1714 (ID 961: syscall::read_nocancel:return): invalid kernel access in action #12 at DIF offset 68

dtrace: error on enabled probe ID 1712 (ID 963: syscall::write_nocancel:return): invalid kernel access in action #12 at DIF offset 68

0 2 0.1

```
Result is 1.369502

dtrace: error on enabled probe ID 1714 (ID 961: syscall::read_nocancel:return): invalid kernel access in action #12 at DIF offset 68

dtrace: error on enabled probe ID 1712 (ID 963: syscall::write_nocancel:return): invalid kernel access in action #12 at DIF offset 68

dtrace: error on enabled probe ID 1712 (ID 963: syscall::write_nocancel:return): invalid kernel access in action #12 at DIF offset 68

dtrace: error on enabled probe ID 1714 (ID 961: syscall::read_nocancel:return): invalid kernel access in action #12 at DIF offset 68
```

Вывод

В результате данной лабораторной работы я научился работать с динамическими библиотеками. Динамические библиотеки можно загружать в ходе выполнения программы. Их загрузка во время выполнения программы упрощает компиляцию программы, а также уменьшает размер исполняемых файлов.