Московский Авиационный Институт

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Институт №8 "Компьютерные науки и прикладная математика"

Кафедра №806 "Вычислительная математика и программирование"

Лабораторная работа №2 по курсу

«Операционные системы»

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Постановка задачи

Вариант 2.

Отсортировать массив целых чисел при помощи параллельного алгоритма быстрой сортировки.

Составить программу на языке Си, обрабатывающую данные в многопоточном режиме. При обработки использовать стандартные средства создания потоков операционной системы (Windows/Unix).

Ограничение максимального количества потоков, работающих в один момент времени, должно быть задано ключом запуска вашей программы. Так же необходимо уметь продемонстрировать количество потоков, используемое вашей программой с помощью стандартных средств операционной системы.

Общий метод и алгоритм решения

Использованные системные вызовы:

- l int pthread_create(pthread_t *thread, const pthread_attr_t *attr, void *(*start_routine) (void *), void *arg); – создаёт новый поток;
- l int pthread_join(pthread_t thread, void **retval); – ожидает завершения потока.

Программа разбивает заданный массив на N частей (N = количество потоков). Далее создаётся N потоков и для каждого куска массива вызывается быстрая сортировка (условно делим части напополам, меняем местами по индексу "большие" элементы с "маленькими"). По окончании куски массива сливаются в один.

Код программы

main.cpp

```cpp
#include "sort.hpp"

#include "threads.hpp"

#include <iostream>

#include <chrono>


using namespace std::chrono;

using namespace std;


int main(int argc, char* argv[]) {

    if (argc != 2) {

        perror("Using: ./lab2_exe number_of_threads");

        exit(-1);

    }

    int n;

    cout << "Enter the quantity of elements: ";

    cin >> n;

    int mas[n];

    cout << "Fill array: ";

    for (int i = 0; i < n; ++i) {

        std::cin >> mas[i];

    }

    int threads(atoi(argv[1]));

    auto start = std::chrono::high_resolution_clock::now();

    sort(mas, n, threads);

    auto end = std::chrono::high_resolution_clock::now();


    duration<double> sec = end - start;
```

```cpp
    cout << "Result: ";

    cout << sec.count() << " s" << std::endl;


    return 0;

}
```

threads.hpp

```cpp
#pragma once

#include <pthread.h>


class ThreadsCount {

public:

    ThreadsCount();

    ThreadsCount(int count);

    ~ThreadsCount();

    int get_count();

    void set_count(int count);

    ThreadsCount& operator--();

private:

    int _count;

    pthread_mutex_t _mutex;

};
```

threads.cpp

```cpp
#include "threads.hpp"


ThreadsCount::ThreadsCount() : _count{0} {

    pthread_mutex_init(&_mutex, NULL);

}
```

```cpp
ThreadsCount::ThreadsCount(int count) : _count{count} {

    pthread_mutex_init(&_mutex, NULL);

}


ThreadsCount::~ThreadsCount() {

    _count = 0;

    pthread_mutex_destroy(&_mutex);

}


int ThreadsCount::get_count() {

    int res;

    pthread_mutex_lock(&_mutex);

    res = _count;

    pthread_mutex_unlock(&_mutex);

    return res;

}


void ThreadsCount::set_count(int count) {

    pthread_mutex_lock(&_mutex);

    _count = count;

    pthread_mutex_unlock(&_mutex);

}


ThreadsCount& ThreadsCount::operator--() {

    pthread_mutex_lock(&_mutex);

    --_count;

    pthread_mutex_unlock(&_mutex);

    return *this;

}
```

sort.hpp

```cpp
#pragma once


struct Piece{

    int* mas;

    int start;

    int end;

};



void sort(int* array, int n, int threads);
```

sort.cpp

```cpp
#include "sort.hpp"

#include <pthread.h>

#include <iostream>

#include <algorithm>



void create_thread(pthread_t* thread, const pthread_attr_t* attr, void
*(*start)(void *), void* arg) {

    if (pthread_create(thread, attr, start, arg) != 0) {

        perror("create_thread error!");

        exit(-1);

    }

}



void* thread_sort(void* arg) {

    Piece* p = (Piece*) arg;

    int i = p->start;

    int j = p->end;

    int mid = p->mas[(i + j) / 2];
```

```cpp
        int swaps = 0;

    do {

        while (p->mas[i] < mid) {

            ++i;

        }

        while (p->mas[j] > mid) {

            --j;

        }

        if (i <= j) {

            std::swap(p->mas[i], p->mas[j]);

            ++swaps;

            ++i;

            --j;

        }

    } while (i <= j);

    if (p->start < j) {

        Piece less = {p->mas, p->start, j};

        thread_sort(&less);

    }

    if (i < p->end) {

        Piece more = {p->mas, i, p->end};

        thread_sort(&more);

    }


    return 0;

}


int* merge(int* a, size_t size_a, int* b, size_t size_b) {

    size_t size_res = size_a + size_b;
```

```cpp
    int* res = new int[size_res];

    int i = 0, j = 0, k = 0;

    while (i < size_a || j < size_b) {

        if (i >= size_a) {

            res[k] = b[j];

            ++j;

        } else if (j >= size_b) {

            res[k] = a[i];

            ++i;

        } else {

            if (a[i] < b[j]) {

                res[k] = a[i];

                ++i;

            } else {

                res[k] = b[j];

                ++j;

            }

        }

        ++k;

    }

    return res;

}


void sort(int* array, int n, int threads) {

    Piece p[threads];

    pthread_t tid[threads];

    for (int i = 0; i < threads; ++i) {

        int* array_piece = new int[n / threads];

        int counter = 0;
```

```cpp
        for (int j = i * (n / threads); j < (i + 1) * (n / threads); ++j) {

            array_piece[counter] = array[j];

            ++counter;

        }

        p[i] = Piece{array_piece, 0, n / threads - 1};

        create_thread(&tid[i], NULL, thread_sort, &p[i]);

    }

    for (int i = 0; i < threads; ++i) {

        pthread_join(tid[i], NULL);

    }

    for (int i = 0; i < threads; ++i) {

        int counter = 0;

        for (int j = i * (n / threads); j < (i + 1) * (n / threads); ++j) {

            array[j] = p[i].mas[counter];

            ++counter;

        }

    }

    int* res = new int[0];

    size_t res_size = 0;

    for (int i = 0; i < threads; ++i) {

        res = merge(res, res_size, p[i].mas, n / threads);

        res_size += n / threads;

    }

    for (int i = 0; i < n; ++i) {

        array[i] = res[i];

    }

}
```

Протокол работы программы

Тестирование:

./lab02_exe 1

Enter the quantity of elements: 8

Fill array: 1 9 2 8 3 7 4 6

Result: 0.000450334 s

./lab02_exe 2

Enter the quantity of elements: 8

Fill array: 1 9 2 8 3 7 4 6

Result: 0.000210875 s

./lab02_exe 3

Enter the quantity of elements: 8

Fill array: 1 9 2 8 3 7 4 6

Result: 0.000771623 s

./lab02_exe 4

Enter the quantity of elements: 8

Fill array: 1 9 2 8 3 7 4 6

Result: 0.000947049 s

./lab02_exe 5

Enter the quantity of elements: 8

Fill array: 1 9 2 8 3 7 4 6

Result: 0.00142257 s

./lab02_exe 6

Enter the quantity of elements: 8

Fill array: 1 9 2 8 3 7 4 6

Result: 0.00165539 s

Количество потоков	Время, с	Ускорение	Эффективность
1	0.000450334	1	1
2	0.000210875	2,135549496	1,067774748
3	0.000771623	0,583619203	0,194539734
4	0.000947049	0,475512883	0,118878221
5	0.00142257	0,316563684	0,063312737
6	0.00165539	0,27204103	0,045340172

 При распараллеливании более, чем на 2 потока, превышается предел количества ядер, из-за чего сильно падает эффективность.

Strace:

strace -f ./lab02_exe 1

execve("./lab02_exe", ["./lab02_exe", "1"], 0x7ffc76a7a0d0 /* 74 vars */) = 0

brk(NULL)   = 0x564bcd567000

arch_prctl(0x3001 /* ARCH_??? */, 0x7fff371d36f0) = -1 EINVAL (Недопустимый аргумент)

mmap(NULL, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) = 0x7fae2d183000

access("/etc/ld.so.preload", R_OK)   = -1 ENOENT (Нет такого файла или каталога)

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

newfstatat(3, "", {st_mode=S_IFREG|0644, st_size=68035, ...}, AT_EMPTY_PATH) = 0

mmap(NULL, 68035, PROT_READ, MAP_PRIVATE, 3, 0) = 0x7fae2d172000

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=2260296, ...}, AT_EMPTY_PATH) = 0

mmap(NULL, 2275520, PROT_READ, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) = 0x7fae2ce00000

mprotect(0x7fae2ce9a000, 1576960, PROT_NONE) = 0

mmap(0x7fae2ce9a000, 1118208, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x9a000) = 0x7fae2ce9a000

mmap(0x7fae2cfab000, 454656, PROT_READ, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x1ab000) = 0x7fae2cfab000

mmap(0x7fae2d01b000, 57344, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x21a000) = 0x7fae2d01b000

mmap(0x7fae2d029000, 10432, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_ANONYMOUS, -1, 0) = 0x7fae2d029000

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\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\244;\374\204(\337f#\315I\214\234\f\256\271\32"..., 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) = 0x7fae2ca00000

```
    mmap(0x7fae2ca28000, 1658880, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE,
3, 0x28000) = 0x7fae2ca28000

    mmap(0x7fae2cbbd000, 360448, PROT_READ, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3,
0x1bd000) = 0x7fae2cbbd000

    mmap(0x7fae2cc15000, 24576, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE,
3, 0x214000) = 0x7fae2cc15000

    mmap(0x7fae2cc1b000, 52816, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_ANONYMOUS,
-1, 0) = 0x7fae2cc1b000

    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) = 0x7fae2d08b000

    mmap(0x7fae2d099000, 507904, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE,
3, 0xe000) = 0x7fae2d099000

    mmap(0x7fae2d115000, 372736, PROT_READ, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3,
0x8a000) = 0x7fae2d115000

    mmap(0x7fae2d170000, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE,
3, 0xe4000) = 0x7fae2d170000

    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=125488, ...}, AT_EMPTY_PATH) = 0

    mmap(NULL, 127720, PROT_READ, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) = 0x7fae2d06b000

    mmap(0x7fae2d06e000, 94208, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE,
3, 0x3000) = 0x7fae2d06e000

    mmap(0x7fae2d085000, 16384, PROT_READ, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x1a000)
= 0x7fae2d085000

    mmap(0x7fae2d089000, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE,
3, 0x1d000) = 0x7fae2d089000

    close(3)                              = 0

    mmap(NULL, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) =
0x7fae2d069000

    arch_prctl(ARCH_SET_FS, 0x7fae2d06a3c0) = 0

    set_tid_address(0x7fae2d06a690)       = 11822

    set_robust_list(0x7fae2d06a6a0, 24)   = 0

    rseq(0x7fae2d06ad60, 0x20, 0, 0x53053053) = 0

    mprotect(0x7fae2cc15000, 16384, PROT_READ) = 0

    mprotect(0x7fae2d089000, 4096, PROT_READ) = 0

    mprotect(0x7fae2d170000, 4096, PROT_READ) = 0
```

```
    mmap(NULL, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) =
0x7fae2d067000

    mprotect(0x7fae2d01b000, 45056, PROT_READ) = 0

    mprotect(0x564bcd2e8000, 4096, PROT_READ) = 0

    mprotect(0x7fae2d1bd000, 8192, PROT_READ) = 0

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

    munmap(0x7fae2d172000, 68035)        = 0

    getrandom("\xf2\x63\x25\x07\x0e\x34\x06\xa9", 8, GRND_NONBLOCK) = 8

    brk(NULL)                            = 0x564bcd567000

    brk(0x564bcd588000)                  = 0x564bcd588000

    futex(0x7fae2d02977c, FUTEX_WAKE_PRIVATE, 2147483647) = 0

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

    write(1, "Enter the quantity of elements: ", 32Enter the quantity of elements: ) = 32

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

    read(0, 8

    "8\n", 1024)                         = 2

    write(1, "Fill array: ", 12Fill array: )          = 12

    read(0, 1 9 2 8 3 7 4 6

    "1 9 2 8 3 7 4 6\n", 1024)           = 16

    rt_sigaction(SIGRT_1, {sa_handler=0x7fae2ca91870, sa_mask=[],
sa_flags=SA_RESTORER|SA_ONSTACK|SA_RESTART|SA_SIGINFO, sa_restorer=0x7fae2ca42520}, NULL, 8)
= 0

    rt_sigprocmask(SIG_UNBLOCK, [RTMIN RT_1], NULL, 8) = 0

    mmap(NULL, 8392704, PROT_NONE, MAP_PRIVATE|MAP_ANONYMOUS|MAP_STACK, -1, 0) =
0x7fae2c1ff000

    mprotect(0x7fae2c200000, 8388608, PROT_READ|PROT_WRITE) = 0

    rt_sigprocmask(SIG_BLOCK, ~[], [], 8)   = 0

    clone3({flags=CLONE_VM|CLONE_FS|CLONE_FILES|CLONE_SIGHAND|CLONE_THREAD|CLONE_SYSVSEM|CL
ONE_SETTLS|CLONE_PARENT_SETTID|CLONE_CHILD_CLEARTID, child_tid=0x7fae2c9ff910,
parent_tid=0x7fae2c9ff910, exit_signal=0, stack=0x7fae2c1ff000, stack_size=0x7fff00,
tls=0x7fae2c9ff640} => {parent_tid=[11859]}, 88) = 11859

    rt_sigprocmask(SIG_SETMASK, [], NULL, 8) = 0

    futex(0x7fae2c9ff910, FUTEX_WAIT_BITSET|FUTEX_CLOCK_REALTIME, 11859, NULL,
FUTEX_BITSET_MATCH_ANYstrace: Process 11859 attached

     <unfinished ...>

    [pid 11859] rseq(0x7fae2c9fffe0, 0x20, 0, 0x53053053) = 0

    [pid 11859] set_robust_list(0x7fae2c9ff920, 24) = 0

    [pid 11859] rt_sigprocmask(SIG_SETMASK, [], NULL, 8) = 0
```

```
[pid 11859] rt_sigprocmask(SIG_BLOCK, ~[RT_1], NULL, 8) = 0

[pid 11859] madvise(0x7fae2c1ff000, 8368128, MADV_DONTNEED) = 0

[pid 11859] exit(0)                     = ?

[pid 11822] <... futex resumed>)        = 0

[pid 11822] write(1, "Result: 0.00369566 s\n", 21Result: 0.00369566 s
) = 21

[pid 11859] +++ exited with 0 +++

lseek(0, -1, SEEK_CUR)                   = -1 ESPIPE (Недопустимая операция смещения)

exit_group(0)                           = ?

+++ exited with 0 +++
```
strace -f ./lab02_exe 2
```
execve("./lab02_exe", ["./lab02_exe", "2"], 0x7fff028d05d0 /* 74 vars */) = 0

brk(NULL)                               = 0x55e1c039a000

arch_prctl(0x3001 /* ARCH_??? */, 0x7fffe76461d0) = -1 EINVAL (Недопустимый аргумент)

mmap(NULL, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) =
0x7f76c0ea2000

access("/etc/ld.so.preload", R_OK)      = -1 ENOENT (Нет такого файла или каталога)

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

newfstatat(3, "", {st_mode=S_IFREG|0644, st_size=68035, ...}, AT_EMPTY_PATH) = 0

mmap(NULL, 68035, PROT_READ, MAP_PRIVATE, 3, 0) = 0x7f76c0e91000

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"..., 832) = 832

newfstatat(3, "", {st_mode=S_IFREG|0644, st_size=2260296, ...}, AT_EMPTY_PATH) = 0

mmap(NULL, 2275520, PROT_READ, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) = 0x7f76c0c00000

mprotect(0x7f76c0c9a000, 1576960, PROT_NONE) = 0

mmap(0x7f76c0c9a000, 1118208, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE,
3, 0x9a000) = 0x7f76c0c9a000

mmap(0x7f76c0dab000, 454656, PROT_READ, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3,
0x1ab000) = 0x7f76c0dab000

mmap(0x7f76c0e1b000, 57344, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE,
3, 0x21a000) = 0x7f76c0e1b000

mmap(0x7f76c0e29000, 10432, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_ANONYMOUS,
-1, 0) = 0x7f76c0e29000

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\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\244;\374\204(\337f#\315I\214\234\f\256\271\32"..., 68, 896)
= 68

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

    pread64(3, "\6\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) = 0x7f76c0800000

    mmap(0x7f76c0828000, 1658880, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE,
3, 0x28000) = 0x7f76c0828000

    mmap(0x7f76c09bd000, 360448, PROT_READ, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3,
0x1bd000) = 0x7f76c09bd000

    mmap(0x7f76c0a15000, 24576, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE,
3, 0x214000) = 0x7f76c0a15000

    mmap(0x7f76c0a1b000, 52816, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_ANONYMOUS,
-1, 0) = 0x7f76c0a1b000

    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) = 0x7f76c0b19000

    mmap(0x7f76c0b27000, 507904, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE,
3, 0xe000) = 0x7f76c0b27000

    mmap(0x7f76c0ba3000, 372736, PROT_READ, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3,
0x8a000) = 0x7f76c0ba3000

    mmap(0x7f76c0bfe000, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE,
3, 0xe4000) = 0x7f76c0bfe000

    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=125488, ...}, AT_EMPTY_PATH) = 0

    mmap(NULL, 127720, PROT_READ, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) = 0x7f76c0e71000

    mmap(0x7f76c0e74000, 94208, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE,
3, 0x3000) = 0x7f76c0e74000

    mmap(0x7f76c0e8b000, 16384, PROT_READ, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x1a000)
= 0x7f76c0e8b000

    mmap(0x7f76c0e8f000, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE,
3, 0x1d000) = 0x7f76c0e8f000

    close(3)                              = 0
```

```
    mmap(NULL, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) =
0x7f76c0e6f000

    arch_prctl(ARCH_SET_FS, 0x7f76c0e703c0) = 0

    set_tid_address(0x7f76c0e70690)         = 11985

    set_robust_list(0x7f76c0e706a0, 24)     = 0

    rseq(0x7f76c0e70d60, 0x20, 0, 0x53053053) = 0

    mprotect(0x7f76c0a15000, 16384, PROT_READ) = 0

    mprotect(0x7f76c0e8f000, 4096, PROT_READ) = 0

    mprotect(0x7f76c0bfe000, 4096, PROT_READ) = 0

    mmap(NULL, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) =
0x7f76c0e6d000

    mprotect(0x7f76c0e1b000, 45056, PROT_READ) = 0

    mprotect(0x55e1be759000, 4096, PROT_READ) = 0

    mprotect(0x7f76c0edc000, 8192, PROT_READ) = 0

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

    munmap(0x7f76c0e91000, 68035)           = 0

    getrandom("\x35\x1e\x23\x7e\xb9\xb7\xdb\xa1", 8, GRND_NONBLOCK) = 8

    brk(NULL)                               = 0x55e1c039a000

    brk(0x55e1c03bb000)                     = 0x55e1c03bb000

    futex(0x7f76c0e2977c, FUTEX_WAKE_PRIVATE, 2147483647) = 0

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

    write(1, "Enter the quantity of elements: ", 32Enter the quantity of elements: ) = 32

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

    read(0, 8

    "8\n", 1024)                    = 2

    write(1, "Fill array: ", 12Fill array: )            = 12

    read(0, 1 9 2 8 3 7 4 6

    "1 9 2 8 3 7 4 6\n", 1024)      = 16

    rt_sigaction(SIGRT_1, {sa_handler=0x7f76c0891870, sa_mask=[],
sa_flags=SA_RESTORER|SA_ONSTACK|SA_RESTART|SA_SIGINFO, sa_restorer=0x7f76c0842520}, NULL, 8)
= 0

    rt_sigprocmask(SIG_UNBLOCK, [RTMIN RT_1], NULL, 8) = 0

    mmap(NULL, 8392704, PROT_NONE, MAP_PRIVATE|MAP_ANONYMOUS|MAP_STACK, -1, 0) =
0x7f76bffff000

    mprotect(0x7f76c0000000, 8388608, PROT_READ|PROT_WRITE) = 0

    rt_sigprocmask(SIG_BLOCK, ~[], [], 8)   = 0
```

```
        clone3({flags=CLONE_VM|CLONE_FS|CLONE_FILES|CLONE_SIGHAND|CLONE_THREAD|CLONE_SYSVSEM|CL
ONE_SETTLS|CLONE_PARENT_SETTID|CLONE_CHILD_CLEARTID, child_tid=0x7f76c07ff910,
parent_tid=0x7f76c07ff910, exit_signal=0, stack=0x7f76bffff000, stack_size=0x7fff00,
tls=0x7f76c07ff640} => {parent_tid=[12024]}, 88) = 12024

        rt_sigprocmask(SIG_SETMASK, [], NULL, 8) = 0

        mmap(NULL, 8392704, PROT_NONE, MAP_PRIVATE|MAP_ANONYMOUS|MAP_STACK, -1, 0) =
0x7f76bf7fe000

        mprotect(0x7f76bf7ff000, 8388608, PROT_READ|PROT_WRITE) = 0

        rt_sigprocmask(SIG_BLOCK, ~[], [], 8)   = 0

        strace: Process 12024 attached

        [pid 11985]
clone3({flags=CLONE_VM|CLONE_FS|CLONE_FILES|CLONE_SIGHAND|CLONE_THREAD|CLONE_SYSVSEM|CLONE_S
ETTLS|CLONE_PARENT_SETTID|CLONE_CHILD_CLEARTID, child_tid=0x7f76bfffe910,
parent_tid=0x7f76bfffe910, exit_signal=0, stack=0x7f76bf7fe000, stack_size=0x7fff00,
tls=0x7f76bfffe640} <unfinished ...>

        [pid 12024] rseq(0x7f76c07fffe0, 0x20, 0, 0x53053053strace: Process 12025 attached

         <unfinished ...>

        [pid 11985] <... clone3 resumed> => {parent_tid=[12025]}, 88) = 12025

        [pid 12025] rseq(0x7f76bfffefe0, 0x20, 0, 0x53053053 <unfinished ...>

        [pid 11985] rt_sigprocmask(SIG_SETMASK, [],  <unfinished ...>

        [pid 12025] <... rseq resumed>)          = 0

        [pid 11985] <... rt_sigprocmask resumed>NULL, 8) = 0

        [pid 12025] set_robust_list(0x7f76bfffe920, 24 <unfinished ...>

        [pid 11985] futex(0x7f76c07ff910, FUTEX_WAIT_BITSET|FUTEX_CLOCK_REALTIME, 12024, NULL,
FUTEX_BITSET_MATCH_ANY <unfinished ...>

        [pid 12025] <... set_robust_list resumed>) = 0

        [pid 12025] rt_sigprocmask(SIG_SETMASK, [],  <unfinished ...>

        [pid 12024] <... rseq resumed>)          = 0

        [pid 12025] <... rt_sigprocmask resumed>NULL, 8) = 0

        [pid 12024] set_robust_list(0x7f76c07ff920, 24) = 0

        [pid 12025] rt_sigprocmask(SIG_BLOCK, ~[RT_1], NULL, 8) = 0

        [pid 12024] rt_sigprocmask(SIG_SETMASK, [],  <unfinished ...>

        [pid 12025] madvise(0x7f76bf7fe000, 8368128, MADV_DONTNEED <unfinished ...>

        [pid 12024] <... rt_sigprocmask resumed>NULL, 8) = 0

        [pid 12024] rt_sigprocmask(SIG_BLOCK, ~[RT_1],  <unfinished ...>

        [pid 12025] <... madvise resumed>)      = 0

        [pid 12025] exit(0 <unfinished ...>

        [pid 12024] <... rt_sigprocmask resumed>NULL, 8) = 0

        [pid 12025] <... exit resumed>)          = ?

        [pid 12024] madvise(0x7f76bffff000, 8368128, MADV_DONTNEED <unfinished ...>
```

```
[pid 12025] +++ exited with 0 +++
[pid 12024] <... madvise resumed>)       = 0
[pid 12024] exit(0)                      = ?
[pid 11985] <... futex resumed>)         = 0
[pid 12024] +++ exited with 0 +++
write(1, "Result: 0.00464304 s\n", 21Result: 0.00464304 s
)  = 21
lseek(0, -1, SEEK_CUR)                    = -1 ESPIPE (Недопустимая операция смещения)
exit_group(0)                            = ?
+++ exited with 0 +++
```

strace -f ./lab02_exe 3

```
execve("./lab02_exe", ["./lab02_exe", "3"], 0x7fffe9b53620 /* 74 vars */) = 0
brk(NULL)                                = 0x55c9e2538000
arch_prctl(0x3001 /* ARCH_??? */, 0x7ffef6650380) = -1 EINVAL (Недопустимый аргумент)
mmap(NULL, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) =
0x7fdd56a3e000
access("/etc/ld.so.preload", R_OK)       = -1 ENOENT (Нет такого файла или каталога)
openat(AT_FDCWD, "/etc/ld.so.cache", O_RDONLY|O_CLOEXEC) = 3
newfstatat(3, "", {st_mode=S_IFREG|0644, st_size=68035, ...}, AT_EMPTY_PATH) = 0
mmap(NULL, 68035, PROT_READ, MAP_PRIVATE, 3, 0) = 0x7fdd56a2d000
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"..., 832) = 832
newfstatat(3, "", {st_mode=S_IFREG|0644, st_size=2260296, ...}, AT_EMPTY_PATH) = 0
mmap(NULL, 2275520, PROT_READ, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) = 0x7fdd56800000
mprotect(0x7fdd5689a000, 1576960, PROT_NONE) = 0
mmap(0x7fdd5689a000, 1118208, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE,
3, 0x9a000) = 0x7fdd5689a000
mmap(0x7fdd569ab000, 454656, PROT_READ, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3,
0x1ab000) = 0x7fdd569ab000
mmap(0x7fdd56a1b000, 57344, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE,
3, 0x21a000) = 0x7fdd56a1b000
mmap(0x7fdd56a29000, 10432, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_ANONYMOUS,
-1, 0) = 0x7fdd56a29000
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\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\244;\374\204(\337f#\315I\214\234\f\256\271\32"..., 68, 896)
= 68

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

    pread64(3, "\6\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) = 0x7fdd56400000

    mmap(0x7fdd56428000, 1658880, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE,
3, 0x28000) = 0x7fdd56428000

    mmap(0x7fdd565bd000, 360448, PROT_READ, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3,
0x1bd000) = 0x7fdd565bd000

    mmap(0x7fdd56615000, 24576, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE,
3, 0x214000) = 0x7fdd56615000

    mmap(0x7fdd5661b000, 52816, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_ANONYMOUS,
-1, 0) = 0x7fdd5661b000

    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) = 0x7fdd56719000

    mmap(0x7fdd56727000, 507904, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE,
3, 0xe000) = 0x7fdd56727000

    mmap(0x7fdd567a3000, 372736, PROT_READ, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3,
0x8a000) = 0x7fdd567a3000

    mmap(0x7fdd567fe000, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE,
3, 0xe4000) = 0x7fdd567fe000

    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=125488, ...}, AT_EMPTY_PATH) = 0

    mmap(NULL, 127720, PROT_READ, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) = 0x7fdd566f9000

    mmap(0x7fdd566fc000, 94208, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE,
3, 0x3000) = 0x7fdd566fc000

    mmap(0x7fdd56713000, 16384, PROT_READ, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x1a000)
= 0x7fdd56713000

    mmap(0x7fdd56717000, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE,
3, 0x1d000) = 0x7fdd56717000

    close(3)                            = 0
```

```
    mmap(NULL, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) =
0x7fdd566f7000

    arch_prctl(ARCH_SET_FS, 0x7fdd566f83c0) = 0

    set_tid_address(0x7fdd566f8690)         = 12088

    set_robust_list(0x7fdd566f86a0, 24)     = 0

    rseq(0x7fdd566f8d60, 0x20, 0, 0x53053053) = 0

    mprotect(0x7fdd56615000, 16384, PROT_READ) = 0

    mprotect(0x7fdd56717000, 4096, PROT_READ) = 0

    mprotect(0x7fdd567fe000, 4096, PROT_READ) = 0

    mmap(NULL, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) =
0x7fdd566f5000

    mprotect(0x7fdd56a1b000, 45056, PROT_READ) = 0

    mprotect(0x55c9e05a5000, 4096, PROT_READ) = 0

    mprotect(0x7fdd56a78000, 8192, PROT_READ) = 0

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

    munmap(0x7fdd56a2d000, 68035)           = 0

    getrandom("\xd2\x05\x31\x1e\xb8\x9e\x0b\x1a", 8, GRND_NONBLOCK) = 8

    brk(NULL)                               = 0x55c9e2538000

    brk(0x55c9e2559000)                     = 0x55c9e2559000

    futex(0x7fdd56a2977c, FUTEX_WAKE_PRIVATE, 2147483647) = 0

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

    write(1, "Enter the quantity of elements: ", 32Enter the quantity of elements: ) = 32

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

    read(0, 8

    "8\n", 1024)                    = 2

    write(1, "Fill array: ", 12Fill array: )            = 12

    read(0, 1 9 2 8 3 7 4 6

    "1 9 2 8 3 7 4 6\n", 1024)      = 16

    rt_sigaction(SIGRT_1, {sa_handler=0x7fdd56491870, sa_mask=[],
sa_flags=SA_RESTORER|SA_ONSTACK|SA_RESTART|SA_SIGINFO, sa_restorer=0x7fdd56442520}, NULL, 8)
= 0

    rt_sigprocmask(SIG_UNBLOCK, [RTMIN RT_1], NULL, 8) = 0

    mmap(NULL, 8392704, PROT_NONE, MAP_PRIVATE|MAP_ANONYMOUS|MAP_STACK, -1, 0) =
0x7fdd55bff000

    mprotect(0x7fdd55c00000, 8388608, PROT_READ|PROT_WRITE) = 0

    rt_sigprocmask(SIG_BLOCK, ~[], [], 8)   = 0
```

```
    clone3({flags=CLONE_VM|CLONE_FS|CLONE_FILES|CLONE_SIGHAND|CLONE_THREAD|CLONE_SYSVSEM|CL
ONE_SETTLS|CLONE_PARENT_SETTID|CLONE_CHILD_CLEARTID, child_tid=0x7fdd563ff910,
parent_tid=0x7fdd563ff910, exit_signal=0, stack=0x7fdd55bff000, stack_size=0x7fff00,
tls=0x7fdd563ff640}strace: Process 12145 attached

     => {parent_tid=[12145]}, 88) = 12145

    [pid 12088] rt_sigprocmask(SIG_SETMASK, [],  <unfinished ...>

    [pid 12145] rseq(0x7fdd563fffe0, 0x20, 0, 0x53053053 <unfinished ...>

    [pid 12088] <... rt_sigprocmask resumed>NULL, 8) = 0

    [pid 12088] mmap(NULL, 8392704, PROT_NONE, MAP_PRIVATE|MAP_ANONYMOUS|MAP_STACK, -1, 0
<unfinished ...>

    [pid 12145] <... rseq resumed>)         = 0

    [pid 12088] <... mmap resumed>)         = 0x7fdd553fe000

    [pid 12088] mprotect(0x7fdd553ff000, 8388608, PROT_READ|PROT_WRITE <unfinished ...>

    [pid 12145] set_robust_list(0x7fdd563ff920, 24 <unfinished ...>

    [pid 12088] <... mprotect resumed>)     = 0

    [pid 12088] rt_sigprocmask(SIG_BLOCK, ~[],  <unfinished ...>

    [pid 12145] <... set_robust_list resumed>) = 0

    [pid 12088] <... rt_sigprocmask resumed>[], 8) = 0

    [pid 12088]
clone3({flags=CLONE_VM|CLONE_FS|CLONE_FILES|CLONE_SIGHAND|CLONE_THREAD|CLONE_SYSVSEM|CLONE_S
ETTLS|CLONE_PARENT_SETTID|CLONE_CHILD_CLEARTID, child_tid=0x7fdd55bfe910,
parent_tid=0x7fdd55bfe910, exit_signal=0, stack=0x7fdd553fe000, stack_size=0x7fff00,
tls=0x7fdd55bfe640} <unfinished ...>

    [pid 12145] rt_sigprocmask(SIG_SETMASK, [],  <unfinished ...>

    [pid 12088] <... clone3 resumed> => {parent_tid=[12146]}, 88) = 12146

    [pid 12088] rt_sigprocmask(SIG_SETMASK, [], NULL, 8) = 0

    strace: Process 12146 attached

    [pid 12088] mmap(NULL, 8392704, PROT_NONE, MAP_PRIVATE|MAP_ANONYMOUS|MAP_STACK, -1, 0
<unfinished ...>

    [pid 12145] <... rt_sigprocmask resumed>NULL, 8) = 0

    [pid 12088] <... mmap resumed>)         = 0x7fdd54bfd000

    [pid 12088] mprotect(0x7fdd54bfe000, 8388608, PROT_READ|PROT_WRITE <unfinished ...>

    [pid 12146] rseq(0x7fdd55bfefe0, 0x20, 0, 0x53053053 <unfinished ...>

    [pid 12088] <... mprotect resumed>)     = 0

    [pid 12145] rt_sigprocmask(SIG_BLOCK, ~[RT_1],  <unfinished ...>

    [pid 12088] rt_sigprocmask(SIG_BLOCK, ~[],  <unfinished ...>

    [pid 12146] <... rseq resumed>)         = 0

    [pid 12088] <... rt_sigprocmask resumed>[], 8) = 0

    [pid 12145] <... rt_sigprocmask resumed>NULL, 8) = 0
```

```
    [pid 12088]
clone3({flags=CLONE_VM|CLONE_FS|CLONE_FILES|CLONE_SIGHAND|CLONE_THREAD|CLONE_SYSVSEM|CLONE_S
ETTLS|CLONE_PARENT_SETTID|CLONE_CHILD_CLEARTID, child_tid=0x7fdd553fd910,
parent_tid=0x7fdd553fd910, exit_signal=0, stack=0x7fdd54bfd000, stack_size=0x7fff00,
tls=0x7fdd553fd640}strace: Process 12147 attached

 <unfinished ...>

    [pid 12145] madvise(0x7fdd55bff000, 8368128, MADV_DONTNEED <unfinished ...>

    [pid 12088] <... clone3 resumed> => {parent_tid=[12147]}, 88) = 12147

    [pid 12147] rseq(0x7fdd553fdfe0, 0x20, 0, 0x53053053 <unfinished ...>

    [pid 12088] rt_sigprocmask(SIG_SETMASK, [],  <unfinished ...>

    [pid 12147] <... rseq resumed>)         = 0

    [pid 12145] <... madvise resumed>)      = 0

    [pid 12088] <... rt_sigprocmask resumed>NULL, 8) = 0

    [pid 12147] set_robust_list(0x7fdd553fd920, 24 <unfinished ...>

    [pid 12145] exit(0 <unfinished ...>

    [pid 12088] futex(0x7fdd563ff910, FUTEX_WAIT_BITSET|FUTEX_CLOCK_REALTIME, 12145, NULL,
FUTEX_BITSET_MATCH_ANY <unfinished ...>

    [pid 12147] <... set_robust_list resumed>) = 0

    [pid 12146] set_robust_list(0x7fdd55bfe920, 24 <unfinished ...>

    [pid 12145] <... exit resumed>)         = ?

    [pid 12147] rt_sigprocmask(SIG_SETMASK, [],  <unfinished ...>

    [pid 12088] <... futex resumed>)        = 0

    [pid 12147] <... rt_sigprocmask resumed>NULL, 8) = 0

    [pid 12145] +++ exited with 0 +++

    [pid 12088] futex(0x7fdd55bfe910, FUTEX_WAIT_BITSET|FUTEX_CLOCK_REALTIME, 12146, NULL,
FUTEX_BITSET_MATCH_ANY <unfinished ...>

    [pid 12147] rt_sigprocmask(SIG_BLOCK, ~[RT_1], NULL, 8) = 0

    [pid 12146] <... set_robust_list resumed>) = 0

    [pid 12146] rt_sigprocmask(SIG_SETMASK, [], NULL, 8) = 0

    [pid 12147] madvise(0x7fdd54bfd000, 8368128, MADV_DONTNEED <unfinished ...>

    [pid 12146] rt_sigprocmask(SIG_BLOCK, ~[RT_1], NULL, 8) = 0

    [pid 12146] madvise(0x7fdd553fe000, 8368128, MADV_DONTNEED <unfinished ...>

    [pid 12147] <... madvise resumed>)      = 0

    [pid 12146] <... madvise resumed>)      = 0

    [pid 12147] exit(0 <unfinished ...>

    [pid 12146] exit(0 <unfinished ...>

    [pid 12147] <... exit resumed>)         = ?

    [pid 12146] <... exit resumed>)         = ?
```

```
[pid 12088] <... futex resumed>)        = 0

[pid 12146] +++ exited with 0 +++

[pid 12147] +++ exited with 0 +++

write(1, "Result: 0.00369793 s\n", 21Result: 0.00369793 s

)  = 21

lseek(0, -1, SEEK_CUR)                  = -1 ESPIPE (Недопустимая операция смещения)

exit_group(0)                           = ?

+++ exited with 0 +++
```

trace -f ./lab02_exe 6

```
execve("./lab02_exe", ["./lab02_exe", "6"], 0x7ffdbf806e70 /* 74 vars */) = 0

brk(NULL)                               = 0x5564cbdaf000

arch_prctl(0x3001 /* ARCH_??? */, 0x7fff7ec01040) = -1 EINVAL (Недопустимый аргумент)

mmap(NULL, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) =
0x7f13bd486000

access("/etc/ld.so.preload", R_OK)      = -1 ENOENT (Нет такого файла или каталога)

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

newfstatat(3, "", {st_mode=S_IFREG|0644, st_size=68035, ...}, AT_EMPTY_PATH) = 0

mmap(NULL, 68035, PROT_READ, MAP_PRIVATE, 3, 0) = 0x7f13bd475000

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=2260296, ...}, AT_EMPTY_PATH) = 0

mmap(NULL, 2275520, PROT_READ, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) = 0x7f13bd200000

mprotect(0x7f13bd29a000, 1576960, PROT_NONE) = 0

mmap(0x7f13bd29a000, 1118208, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE,
3, 0x9a000) = 0x7f13bd29a000

mmap(0x7f13bd3ab000, 454656, PROT_READ, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3,
0x1ab000) = 0x7f13bd3ab000

mmap(0x7f13bd41b000, 57344, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE,
3, 0x21a000) = 0x7f13bd41b000

mmap(0x7f13bd429000, 10432, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_ANONYMOUS,
-1, 0) = 0x7f13bd429000

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\244;\374\204(\337f#\315I\214\234\f\256\271\32"..., 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) = 0x7f13bce00000

    mmap(0x7f13bce28000, 1658880, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE,
3, 0x28000) = 0x7f13bce28000

    mmap(0x7f13bcfbd000, 360448, PROT_READ, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3,
0x1bd000) = 0x7f13bcfbd000

    mmap(0x7f13bd015000, 24576, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE,
3, 0x214000) = 0x7f13bd015000

    mmap(0x7f13bd01b000, 52816, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_ANONYMOUS,
-1, 0) = 0x7f13bd01b000

    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) = 0x7f13bd119000

    mmap(0x7f13bd127000, 507904, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE,
3, 0xe000) = 0x7f13bd127000

    mmap(0x7f13bd1a3000, 372736, PROT_READ, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3,
0x8a000) = 0x7f13bd1a3000

    mmap(0x7f13bd1fe000, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE,
3, 0xe4000) = 0x7f13bd1fe000

    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=125488, ...}, AT_EMPTY_PATH) = 0

    mmap(NULL, 127720, PROT_READ, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) = 0x7f13bd455000

    mmap(0x7f13bd458000, 94208, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE,
3, 0x3000) = 0x7f13bd458000

    mmap(0x7f13bd46f000, 16384, PROT_READ, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x1a000)
= 0x7f13bd46f000

    mmap(0x7f13bd473000, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE,
3, 0x1d000) = 0x7f13bd473000

    close(3)                            = 0

    mmap(NULL, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) =
0x7f13bd453000
```

```
arch_prctl(ARCH_SET_FS, 0x7f13bd4543c0) = 0

set_tid_address(0x7f13bd454690)          = 12192

set_robust_list(0x7f13bd4546a0, 24)     = 0

rseq(0x7f13bd454d60, 0x20, 0, 0x53053053) = 0

mprotect(0x7f13bd015000, 16384, PROT_READ) = 0

mprotect(0x7f13bd473000, 4096, PROT_READ) = 0

mprotect(0x7f13bd1fe000, 4096, PROT_READ) = 0

mmap(NULL, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) =
0x7f13bd451000

mprotect(0x7f13bd41b000, 45056, PROT_READ) = 0

mprotect(0x5564cbd77000, 4096, PROT_READ) = 0

mprotect(0x7f13bd4c0000, 8192, PROT_READ) = 0

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

munmap(0x7f13bd475000, 68035)           = 0

getrandom("\xd3\x9f\xea\x8d\x49\x2d\x07\xea", 8, GRND_NONBLOCK) = 8

brk(NULL)                               = 0x5564cbdaf000

brk(0x5564cbdd0000)                     = 0x5564cbdd0000

futex(0x7f13bd42977c, FUTEX_WAKE_PRIVATE, 2147483647) = 0

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

write(1, "Enter the quantity of elements: ", 32Enter the quantity of elements: ) = 32

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

read(0, 8

"8\n", 1024)                           = 2

write(1, "Fill array: ", 12Fill array: )               = 12

read(0, 1 9 2 8 3 7 4 6

"1 9 2 8 3 7 4 6\n", 1024)             = 16

rt_sigaction(SIGRT_1, {sa_handler=0x7f13bce91870, sa_mask=[],
sa_flags=SA_RESTORER|SA_ONSTACK|SA_RESTART|SA_SIGINFO, sa_restorer=0x7f13bce42520}, NULL, 8)
= 0

rt_sigprocmask(SIG_UNBLOCK, [RTMIN RT_1], NULL, 8) = 0

mmap(NULL, 8392704, PROT_NONE, MAP_PRIVATE|MAP_ANONYMOUS|MAP_STACK, -1, 0) =
0x7f13bc5ff000

mprotect(0x7f13bc600000, 8388608, PROT_READ|PROT_WRITE) = 0

rt_sigprocmask(SIG_BLOCK, ~[], [], 8)   = 0

clone3({flags=CLONE_VM|CLONE_FS|CLONE_FILES|CLONE_SIGHAND|CLONE_THREAD|CLONE_SYSVSEM|CL
ONE_SETTLS|CLONE_PARENT_SETTID|CLONE_CHILD_CLEARTID, child_tid=0x7f13bcdff910,
parent_tid=0x7f13bcdff910, exit_signal=0, stack=0x7f13bc5ff000, stack_size=0x7fff00,
tls=0x7f13bcdff640} => {parent_tid=[12254]}, 88) = 12254
```

```
      rt_sigprocmask(SIG_SETMASK, [], NULL, 8) = 0

      mmap(NULL, 8392704, PROT_NONE, MAP_PRIVATE|MAP_ANONYMOUS|MAP_STACK, -1, 0) =
0x7f13bbdfe000

      mprotect(0x7f13bbdff000, 8388608, PROT_READ|PROT_WRITE) = 0

      strace: Process 12254 attached

      [pid 12192] rt_sigprocmask(SIG_BLOCK, ~[], [], 8) = 0

      [pid 12254] rseq(0x7f13bcdfffe0, 0x20, 0, 0x53053053 <unfinished ...>

      [pid 12192]
clone3({flags=CLONE_VM|CLONE_FS|CLONE_FILES|CLONE_SIGHAND|CLONE_THREAD|CLONE_SYSVSEM|CLONE_S
ETTLS|CLONE_PARENT_SETTID|CLONE_CHILD_CLEARTID, child_tid=0x7f13bc5fe910,
parent_tid=0x7f13bc5fe910, exit_signal=0, stack=0x7f13bbdfe000, stack_size=0x7fff00,
tls=0x7f13bc5fe640} <unfinished ...>

      [pid 12254] <... rseq resumed>)         = 0

      [pid 12254] set_robust_list(0x7f13bcdff920, 24) = 0

      strace: Process 12255 attached

      [pid 12192] <... clone3 resumed> => {parent_tid=[12255]}, 88) = 12255

      [pid 12254] rt_sigprocmask(SIG_SETMASK, [],  <unfinished ...>

      [pid 12192] rt_sigprocmask(SIG_SETMASK, [],  <unfinished ...>

      [pid 12255] rseq(0x7f13bc5fefe0, 0x20, 0, 0x53053053 <unfinished ...>

      [pid 12192] <... rt_sigprocmask resumed>NULL, 8) = 0

      [pid 12254] <... rt_sigprocmask resumed>NULL, 8) = 0

      [pid 12192] mmap(NULL, 8392704, PROT_NONE, MAP_PRIVATE|MAP_ANONYMOUS|MAP_STACK, -1, 0)
= 0x7f13bb5fd000

      [pid 12255] <... rseq resumed>)          = 0

      [pid 12254] rt_sigprocmask(SIG_BLOCK, ~[RT_1],  <unfinished ...>

      [pid 12192] mprotect(0x7f13bb5fe000, 8388608, PROT_READ|PROT_WRITE <unfinished ...>

      [pid 12255] set_robust_list(0x7f13bc5fe920, 24 <unfinished ...>

      [pid 12254] <... rt_sigprocmask resumed>NULL, 8) = 0

      [pid 12192] <... mprotect resumed>)     = 0

      [pid 12255] <... set_robust_list resumed>) = 0

      [pid 12254] madvise(0x7f13bc5ff000, 8368128, MADV_DONTNEED <unfinished ...>

      [pid 12192] rt_sigprocmask(SIG_BLOCK, ~[],  <unfinished ...>

      [pid 12255] rt_sigprocmask(SIG_SETMASK, [],  <unfinished ...>

      [pid 12192] <... rt_sigprocmask resumed>[], 8) = 0

      [pid 12254] <... madvise resumed>)      = 0

      [pid 12192]
clone3({flags=CLONE_VM|CLONE_FS|CLONE_FILES|CLONE_SIGHAND|CLONE_THREAD|CLONE_SYSVSEM|CLONE_S
ETTLS|CLONE_PARENT_SETTID|CLONE_CHILD_CLEARTID, child_tid=0x7f13bbdfd910,
parent_tid=0x7f13bbdfd910, exit_signal=0, stack=0x7f13bb5fd000, stack_size=0x7fff00,
tls=0x7f13bbdfd640} <unfinished ...>
```

```
[pid 12255] <... rt_sigprocmask resumed>NULL, 8) = 0

strace: Process 12256 attached

[pid 12255] rt_sigprocmask(SIG_BLOCK, ~[RT_1],  <unfinished ...>

[pid 12254] exit(0 <unfinished ...>

[pid 12192] <... clone3 resumed> => {parent_tid=[12256]}, 88) = 12256

[pid 12256] rseq(0x7f13bbdfdfe0, 0x20, 0, 0x53053053 <unfinished ...>

[pid 12255] <... rt_sigprocmask resumed>NULL, 8) = 0

[pid 12254] <... exit resumed>)         = ?

[pid 12192] rt_sigprocmask(SIG_SETMASK, [],  <unfinished ...>

[pid 12256] <... rseq resumed>)         = 0

[pid 12255] madvise(0x7f13bbdfe000, 8368128, MADV_DONTNEED <unfinished ...>

[pid 12192] <... rt_sigprocmask resumed>NULL, 8) = 0

[pid 12256] set_robust_list(0x7f13bbdfd920, 24 <unfinished ...>

[pid 12254] +++ exited with 0 +++

[pid 12255] <... madvise resumed>)      = 0

[pid 12192] mmap(NULL, 8392704, PROT_NONE, MAP_PRIVATE|MAP_ANONYMOUS|MAP_STACK, -1, 0
<unfinished ...>

[pid 12256] <... set_robust_list resumed>) = 0

[pid 12192] <... mmap resumed>)         = 0x7f13badfc000

[pid 12255] exit(0 <unfinished ...>

[pid 12192] mprotect(0x7f13badfd000, 8388608, PROT_READ|PROT_WRITE <unfinished ...>

[pid 12256] rt_sigprocmask(SIG_SETMASK, [],  <unfinished ...>

[pid 12192] <... mprotect resumed>)     = 0

[pid 12255] <... exit resumed>)         = ?

[pid 12256] <... rt_sigprocmask resumed>NULL, 8) = 0

[pid 12192] rt_sigprocmask(SIG_BLOCK, ~[],  <unfinished ...>

[pid 12255] +++ exited with 0 +++

[pid 12256] rt_sigprocmask(SIG_BLOCK, ~[RT_1],  <unfinished ...>

[pid 12192] <... rt_sigprocmask resumed>[], 8) = 0

[pid 12256] <... rt_sigprocmask resumed>NULL, 8) = 0

[pid 12192]
clone3({flags=CLONE_VM|CLONE_FS|CLONE_FILES|CLONE_SIGHAND|CLONE_THREAD|CLONE_SYSVSEM|CLONE_S
ETTLS|CLONE_PARENT_SETTID|CLONE_CHILD_CLEARTID, child_tid=0x7f13bb5fc910,
parent_tid=0x7f13bb5fc910, exit_signal=0, stack=0x7f13badfc000, stack_size=0x7fff00,
tls=0x7f13bb5fc640} <unfinished ...>

[pid 12256] madvise(0x7f13bb5fd000, 8368128, MADV_DONTNEEDstrace: Process 12257
attached

 <unfinished ...>
```

```
[pid 12192] <... clone3 resumed> => {parent_tid=[12257]}, 88) = 12257

[pid 12256] <... madvise resumed>)        = 0

[pid 12192] rt_sigprocmask(SIG_SETMASK, [],  <unfinished ...>

[pid 12257] rseq(0x7f13bb5fcfe0, 0x20, 0, 0x53053053 <unfinished ...>

[pid 12192] <... rt_sigprocmask resumed>NULL, 8) = 0

[pid 12257] <... rseq resumed>)           = 0

[pid 12192] mmap(NULL, 8392704, PROT_NONE, MAP_PRIVATE|MAP_ANONYMOUS|MAP_STACK, -1, 0
<unfinished ...>

[pid 12257] set_robust_list(0x7f13bb5fc920, 24 <unfinished ...>

[pid 12192] <... mmap resumed>)           = 0x7f13ba5fb000

[pid 12257] <... set_robust_list resumed>) = 0

[pid 12192] mprotect(0x7f13ba5fc000, 8388608, PROT_READ|PROT_WRITE <unfinished ...>

[pid 12257] rt_sigprocmask(SIG_SETMASK, [],  <unfinished ...>

[pid 12192] <... mprotect resumed>)      = 0

[pid 12256] exit(0 <unfinished ...>

[pid 12257] <... rt_sigprocmask resumed>NULL, 8) = 0

[pid 12192] rt_sigprocmask(SIG_BLOCK, ~[],  <unfinished ...>

[pid 12256] <... exit resumed>)          = ?

[pid 12192] <... rt_sigprocmask resumed>[], 8) = 0

[pid 12257] rt_sigprocmask(SIG_BLOCK, ~[RT_1],  <unfinished ...>

[pid 12192]
clone3({flags=CLONE_VM|CLONE_FS|CLONE_FILES|CLONE_SIGHAND|CLONE_THREAD|CLONE_SYSVSEM|CLONE_S
ETTLS|CLONE_PARENT_SETTID|CLONE_CHILD_CLEARTID, child_tid=0x7f13badfb910,
parent_tid=0x7f13badfb910, exit_signal=0, stack=0x7f13ba5fb000, stack_size=0x7fff00,
tls=0x7f13badfb640} <unfinished ...>

[pid 12256] +++ exited with 0 +++

[pid 12257] <... rt_sigprocmask resumed>NULL, 8) = 0

[pid 12257] madvise(0x7f13badfc000, 8368128, MADV_DONTNEEDstrace: Process 12258
attached

 <unfinished ...>

[pid 12192] <... clone3 resumed> => {parent_tid=[12258]}, 88) = 12258

[pid 12257] <... madvise resumed>)       = 0

[pid 12192] rt_sigprocmask(SIG_SETMASK, [],  <unfinished ...>

[pid 12258] rseq(0x7f13badfbfe0, 0x20, 0, 0x53053053 <unfinished ...>

[pid 12257] exit(0 <unfinished ...>

[pid 12192] <... rt_sigprocmask resumed>NULL, 8) = 0

[pid 12258] <... rseq resumed>)          = 0

[pid 12192] mmap(NULL, 8392704, PROT_NONE, MAP_PRIVATE|MAP_ANONYMOUS|MAP_STACK, -1, 0
<unfinished ...>
```

```
[pid 12257] <... exit resumed>)           = ?

[pid 12192] <... mmap resumed>)           = 0x7f13b9dfa000

[pid 12258] set_robust_list(0x7f13badfb920, 24 <unfinished ...>

[pid 12257] +++ exited with 0 +++

[pid 12192] mprotect(0x7f13b9dfb000, 8388608, PROT_READ|PROT_WRITE <unfinished ...>

[pid 12258] <... set_robust_list resumed>) = 0

[pid 12192] <... mprotect resumed>)     = 0

[pid 12258] rt_sigprocmask(SIG_SETMASK, [],  <unfinished ...>

[pid 12192] rt_sigprocmask(SIG_BLOCK, ~[],  <unfinished ...>

[pid 12258] <... rt_sigprocmask resumed>NULL, 8) = 0

[pid 12192] <... rt_sigprocmask resumed>[], 8) = 0

[pid 12258] rt_sigprocmask(SIG_BLOCK, ~[RT_1],  <unfinished ...>

      [pid 12192]
clone3({flags=CLONE_VM|CLONE_FS|CLONE_FILES|CLONE_SIGHAND|CLONE_THREAD|CLONE_SYSVSEM|CLONE_S
ETTLS|CLONE_PARENT_SETTID|CLONE_CHILD_CLEARTID, child_tid=0x7f13ba5fa910,
parent_tid=0x7f13ba5fa910, exit_signal=0, stack=0x7f13b9dfa000, stack_size=0x7fff00,
tls=0x7f13ba5fa640} <unfinished ...>

[pid 12258] <... rt_sigprocmask resumed>NULL, 8) = 0

strace: Process 12259 attached

[pid 12258] madvise(0x7f13ba5fb000, 8368128, MADV_DONTNEED <unfinished ...>

[pid 12192] <... clone3 resumed> => {parent_tid=[12259]}, 88) = 12259

[pid 12259] rseq(0x7f13ba5fafe0, 0x20, 0, 0x53053053 <unfinished ...>

[pid 12192] rt_sigprocmask(SIG_SETMASK, [],  <unfinished ...>

[pid 12258] <... madvise resumed>)      = 0

[pid 12192] <... rt_sigprocmask resumed>NULL, 8) = 0

[pid 12259] <... rseq resumed>)         = 0

      [pid 12192] futex(0x7f13badfb910, FUTEX_WAIT_BITSET|FUTEX_CLOCK_REALTIME, 12258, NULL,
FUTEX_BITSET_MATCH_ANY <unfinished ...>

[pid 12258] exit(0 <unfinished ...>

[pid 12259] set_robust_list(0x7f13ba5fa920, 24 <unfinished ...>

[pid 12258] <... exit resumed>)          = ?

[pid 12259] <... set_robust_list resumed>) = 0

[pid 12192] <... futex resumed>)         = 0

[pid 12258] +++ exited with 0 +++

[pid 12259] rt_sigprocmask(SIG_SETMASK, [],  <unfinished ...>

[pid 12192] munmap(0x7f13bc5ff000, 8392704 <unfinished ...>

[pid 12259] <... rt_sigprocmask resumed>NULL, 8) = 0

[pid 12192] <... munmap resumed>)        = 0
```

```
[pid 12259] rt_sigprocmask(SIG_BLOCK, ~[RT_1],  <unfinished ...>

[pid 12192] futex(0x7f13ba5fa910, FUTEX_WAIT_BITSET|FUTEX_CLOCK_REALTIME, 12259, NULL,
FUTEX_BITSET_MATCH_ANY <unfinished ...>

[pid 12259] <... rt_sigprocmask resumed>NULL, 8) = 0

[pid 12259] madvise(0x7f13b9dfa000, 8368128, MADV_DONTNEED) = 0

[pid 12259] exit(0)                     = ?

[pid 12192] <... futex resumed>)        = 0

[pid 12259] +++ exited with 0 +++

munmap(0x7f13bbdfe000, 8392704)         = 0

write(1, "Result: 0.00343606 s\n", 21Result: 0.00343606 s

)   = 21

lseek(0, -1, SEEK_CUR)                  = -1 ESPIPE (Недопустимая операция смещения)

exit_group(0)                           = ?

+++ exited with 0 +++
```

Вывод

В ходе лабораторной работы я научилась создавать потоки в пределах одного процесса. Для реализации конкретного задания была использована условно видимая функция sort, которая на самом деле не содержала сортировок, только соединяла уже отсортированные по потокам части массива, что облегчило внешнюю работу с данной функцией, хотя в качестве аргументов ей передавались только количество потоков и массив данных. Более того, в ходе работы я столкнулась с Race Condition, когда потоки могли перехватывать данные, и, как результат, вылезала ошибка. Для решения этой проблемы я использовала mutex.