# Отчёт по лабораторной работе №

по курсу «Языки и методы программирования».

Выполнил студент группы М8О-111Б-23: Воробьев Глеб Янович № по списку 5.

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Входной контроль знаний с оценкой: _____

Отчет сдан «29» февраля 2024 г.

Итоговая оценка: _____

Подпись преподавателя: _____

**1**. **Тема:**
Абстрактные типы данных, рекурсия, модульное программирование на ЯП Си. Автоматизация сборки программ модульной структуры с использованием утилиты make.

**2. Цель работы:**
Применение различных сортировок к различным типам данных и обучение по работе с утилитой make.

**3. Задание:**
АТД - дек, процедура - поиск и удаление максимального и минимального элемента, метод - сортировка линейным выбором

**4. Оборудование**:
Процессор AMD Ryzen 5 7640HS.
ОП 16 ГБ.
SSD 512 ГБ.
Монитор 2560x1600~165Hz.

**5. Программное обеспечение:**
*Операционная система семейства Unix.*
*Наименование Ubuntu версия 22.04.3.*
*Интерпретатор команд GNU bash версия 6.2.0.*
*Система программирования -.*
*Редактор текстов Visual Studio Code.*

**6. Идея, метод, алгоритм решения задачи:**
Код реализует поиск максимального и минимального элемента в деке, который представлен как кольцевой буфер. Реализация дека представлена в файлах udt.c и udt.h. Для нахождения макс и мин элементов используется сортировка выборам, которая представлена в файле main.c
содержание main.c:

1. swap(int *xp, int *yp): Функция обмена значениями двух целочисленных переменных. Принимает адреса двух переменных и меняет их значения местами.
2. selectionSort(deque *d): Алгоритм сортировки выбором для дека. Для каждого элемента в деке (кроме последнего) функция находит минимальный элемент в неотсортированной части дека и обменивает его с текущим элементом. Функция учитывает кольцевую структуру дека, вычисляя "реальные" индексы элементов, начиная с индекса head.
3. printDeque(deque *d): Функция печати элементов дека на экран. Выводит все элементы дека с начала до конца, учитывая кольцевую структуру дека и начальный индекс head.
4. main(): Главная функция, которая предоставляет пользователю меню для взаимодействия с деком. В меню есть опции для добавления элементов в голову или хвост дека, печати минимального и максимального элемента, удаления минимального и максимального элемента, проверки размера и пустоты дека, а также для печати всех элементов дека.

Для компиляции используется утилита make

**7. Сценарий выполнения работы:**
makefile

```
all:
   gcc main.c udt.c
```

udt.h

```
#ifndef _UDT_H_
#define _UDT_H_

#define POOL_SIZE 100

typedef struct {
   int head;
   int tail;
   int size;
   int data[POOL_SIZE];
} deque;

void PushHeadDeque(deque *d, int key);
void PushTailDeque(deque *d, int key);
void PopHeadDeque(deque *d);
void PopTailDeque(deque *d);
char TopHeadDeque(deque *d);
char TopTailDeque(deque *d);
void CreateDeque(deque *d);
void deleteDeque(deque *d);
int getSizeDeque(deque *d);
int isEmptyDeque(deque *d);

#endif
```

udt.c

```
#include <stdio.h>

#include "udt.h"

void CreateDeque(deque *d)
{
   d->head = 0;
   d->tail = 0;
   d->size = 0;
}

int isEmptyDeque(deque *d)
{
   return d->size == 0;
}

int getSizeDeque(deque *d)
{
   return d->size;
}
```

```
void PushHeadDeque(deque *d, int key)
{
    if (d->size == POOL_SIZE) // Проверяем, не заполнен ли дек.
        return; // Если дек полон, мы не можем добавить новый элемент.

    // Если дек пуст, добавляем элемент в начало, не меняем индекс head.
    if (d->size == 0) {
        d->data[d->head] = key; // Вставляем элемент в текущую позицию
head, которая равна 0.
    } else {
        // Уменьшаем head на 1 с учетом кольцевой структуры.
        d->head = (d->head - 1 + POOL_SIZE) % POOL_SIZE;
        d->data[d->head] = key; // Вставляем элемент в позицию перед
текущим head.
    }
    d->size++; // Увеличиваем размер дека.
}


void PushTailDeque(deque *d, int key)
{
    if (d->size == POOL_SIZE) // Проверяем, не заполнен ли дек.
        return; // Если дек полон, мы не можем добавить новый элемент.

    // Вычисляем индекс для вставки элемента в конец дека.
    int index = (d->head + d->size) % POOL_SIZE;
    d->data[index] = key; // Вставляем элемент.
    d->size++; // Увеличиваем размер дека.
    d->tail = index; // Обновляем индекс tail.
}


void PopHeadDeque(deque *d)
{
    if (!d->size)
        return;
    d->head++;
    d->head %= POOL_SIZE;
    d->size--;
}

void PopTailDeque(deque *d)
{
    if (!d->size)
        return;
    d->tail = (d->tail - 1 + POOL_SIZE) % POOL_SIZE;
    d->size--;
}
```

```
char TopHeadDeque(deque *d)
{
    if (d->size)
        return d->data[d->head];
    else
        return '\0';
}

char TopTailDeque(deque *d)
{
    if (d->size)
        return d->data[d->tail];
    else
        return '\0';
}

void deleteDeque(deque *d)
{
    d->head = 0;
    d->tail = 0;
    d->size = 0;
}
```

main.c

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

void swap(int *xp, int *yp)
{
    int tmp = *xp;
    *xp = *yp;
    *yp = tmp;
}

void selectionSort(deque *d)
{
    int i, j, min_idx, real_i, real_min_idx, real_j;

    for (i = 0; i < d->size - 1; i++) {
        real_i = (d->head + i) % POOL_SIZE;
        min_idx = real_i;

        for (j = i + 1; j < d->size;  j++) {
            real_j = (d->head + j) % POOL_SIZE;
            if (d->data[real_j] < d->data[min_idx])
                min_idx = real_j;
        }
```

```
        if (min_idx != real_i)
            swap(&(d->data[min_idx]), &(d->data[real_i]));
    }
}

void printDeque(deque *d)
{
    int i, index;
    for (i = 0; i < d->size; i++) {
        index = (d->head + i) % POOL_SIZE;
        printf("%d ", d->data[index]);
    }
    printf("\n");
}


int main()
{
    deque deck;

    CreateDeque(&deck);

    int state, key;

    do {
        printf("Choose the option: 1-push to head, 2-push to tail, 3-print
min, 4-print max, 5-delete min, 6-delete max, 7-size, 8-check if empty,
9-print deque\n");
        scanf("%d", &state);
        if (state == 1) {
            printf("Type value: ");
            scanf(" %d", &key);
            PushHeadDeque(&deck, key);
            printf("%d added to head\n", key);
        } else if (state == 2) {
            printf("Type value: ");
            scanf(" %d", &key);
            PushTailDeque(&deck, key);
            printf("%d added to tail\n", key);
        } else if (state == 3) {
            if (!isEmptyDeque(&deck)) {
                selectionSort(&deck);
                char head = TopHeadDeque(&deck);
                printf("Min is %d\n", head);
            } else {
                printf("Deque is empty\n");
            }
```

```
        } else if (state == 4) {
            if (!isEmptyDeque(&deck)) {
                selectionSort(&deck);
                char tail = TopTailDeque(&deck);
                printf("Max is %d\n", tail);
            } else {
                printf("Deque is empty\n");
            }
        } else if (state == 5) {
            if (!isEmptyDeque(&deck)) {
                selectionSort(&deck);
                PopHeadDeque(&deck);
                printf("Min is deleted\n");
            } else {
                printf("Deque is empty\n");
            }
        } else if (state == 6) {
            if (!isEmptyDeque(&deck)) {
                selectionSort(&deck);
                PopTailDeque(&deck);
                printf("Max is deleted\n");
            } else {
                printf("Deque is empty\n");
            }
        } else if (state == 7) {
            int size = getSizeDeque(&deck);
            printf("Size is %d\n", size);
        } else if (state == 8) {
            int empty = isEmptyDeque(&deck);
            printf("Deque is %s\n", empty ? "empty" : "not empty");
        } else if (state == 9) {
            printf("Deque:\n");
            printDeque(&deck);
        }
    } while(state);

    deleteDeque(&deck);

    return 0;
}
```

*Допущен к выполнению работы.* **Подпись преподавателя** _____

**8**. **Распечатка протокола:**
Choose the option: 1-push to head, 2-push to tail, 3-print min, 4-print max, 5-delete min, 6-delete max, 7-size, 8-check if empty, 9-print deque
10

```
Choose the option: 1-push to head, 2-push to tail, 3-print min, 4-print max, 5-delete min, 6-delete max, 7-size, 8-check if empty, 9-print deque
5
Deque is empty
Choose the option: 1-push to head, 2-push to tail, 3-print min, 4-print max, 5-delete min, 6-delete max, 7-size, 8-check if empty, 9-print deque
6
Deque is empty
Choose the option: 1-push to head, 2-push to tail, 3-print min, 4-print max, 5-delete min, 6-delete max, 7-size, 8-check if empty, 9-print deque
1
Type value: 5
5 added to head
Choose the option: 1-push to head, 2-push to tail, 3-print min, 4-print max, 5-delete min, 6-delete max, 7-size, 8-check if empty, 9-print deque
2
Type value: 4
4 added to tail
Choose the option: 1-push to head, 2-push to tail, 3-print min, 4-print max, 5-delete min, 6-delete max, 7-size, 8-check if empty, 9-print deque
10
Choose the option: 1-push to head, 2-push to tail, 3-print min, 4-print max, 5-delete min, 6-delete max, 7-size, 8-check if empty, 9-print deque
9
Deque:
5 4
Choose the option: 1-push to head, 2-push to tail, 3-print min, 4-print max, 5-delete min, 6-delete max, 7-size, 8-check if empty, 9-print deque
4
Max is 5
Choose the option: 1-push to head, 2-push to tail, 3-print min, 4-print max, 5-delete min, 6-delete max, 7-size, 8-check if empty, 9-print deque
3
Min is 4
Choose the option: 1-push to head, 2-push to tail, 3-print min, 4-print max, 5-delete min, 6-delete max, 7-size, 8-check if empty, 9-print deque
5
Min is deleted
Choose the option: 1-push to head, 2-push to tail, 3-print min, 4-print max, 5-delete min, 6-delete max, 7-size, 8-check if empty, 9-print deque
10
Choose the option: 1-push to head, 2-push to tail, 3-print min, 4-print max, 5-delete min, 6-delete max, 7-size, 8-check if empty, 9-print deque
9
Deque:
5
Choose the option: 1-push to head, 2-push to tail, 3-print min, 4-print max, 5-delete min, 6-delete max, 7-size, 8-check if empty, 9-print deque
6
Max is deleted
Choose the option: 1-push to head, 2-push to tail, 3-print min, 4-print max, 5-delete min, 6-delete max, 7-size, 8-check if empty, 9-print deque
9
Deque:

Choose the option: 1-push to head, 2-push to tail, 3-print min, 4-print max, 5-delete min, 6-delete max, 7-size, 8-check if empty, 9-print deque
1
Type value: 10
10 added to head
Choose the option: 1-push to head, 2-push to tail, 3-print min, 4-print max, 5-delete min, 6-delete max, 7-size, 8-check if empty, 9-print deque
2
Type value: 20
20 added to tail
Choose the option: 1-push to head, 2-push to tail, 3-print min, 4-print max, 5-delete min, 6-delete max, 7-size, 8-check if empty, 9-print deque
2
Type value: 30
30 added to tail
Choose the option: 1-push to head, 2-push to tail, 3-print min, 4-print max, 5-delete min, 6-delete max, 7-size, 8-check if empty, 9-print deque
9
Deque:
```

10 20 30
Choose the option: 1-push to head, 2-push to tail, 3-print min, 4-print max, 5-delete min, 6-delete max, 7-size, 8-check if empty, 9-print deque
3
Min is 10
Choose the option: 1-push to head, 2-push to tail, 3-print min, 4-print max, 5-delete min, 6-delete max, 7-size, 8-check if empty, 9-print deque
4
Max is 30
Choose the option: 1-push to head, 2-push to tail, 3-print min, 4-print max, 5-delete min, 6-delete max, 7-size, 8-check if empty, 9-print deque
6
Max is deleted
Choose the option: 1-push to head, 2-push to tail, 3-print min, 4-print max, 5-delete min, 6-delete max, 7-size, 8-check if empty, 9-print deque
9
Deque:
10 20
Choose the option: 1-push to head, 2-push to tail, 3-print min, 4-print max, 5-delete min, 6-delete max, 7-size, 8-check if empty, 9-print deque
5
Min is deleted
Choose the option: 1-push to head, 2-push to tail, 3-print min, 4-print max, 5-delete min, 6-delete max, 7-size, 8-check if empty, 9-print deque
9
Deque:
20
Choose the option: 1-push to head, 2-push to tail, 3-print min, 4-print max, 5-delete min, 6-delete max, 7-size, 8-check if empty, 9-print deque
6
Max is deleted
Choose the option: 1-push to head, 2-push to tail, 3-print min, 4-print max, 5-delete min, 6-delete max, 7-size, 8-check if empty, 9-print deque
9
Deque:

Choose the option: 1-push to head, 2-push to tail, 3-print min, 4-print max, 5-delete min, 6-delete max, 7-size, 8-check if empty, 9-print deque
7
Size is 0
Choose the option: 1-push to head, 2-push to tail, 3-print min, 4-print max, 5-delete min, 6-delete max, 7-size, 8-check if empty, 9-print deque
8
Deque is empty
Choose the option: 1-push to head, 2-push to tail, 3-print min, 4-print max, 5-delete min, 6-delete max, 7-size, 8-check if empty, 9-print deque
1
Type value: 10
10 added to head
Choose the option: 1-push to head, 2-push to tail, 3-print min, 4-print max, 5-delete min, 6-delete max, 7-size, 8-check if empty, 9-print deque
1
Type value: 20
20 added to head
Choose the option: 1-push to head, 2-push to tail, 3-print min, 4-print max, 5-delete min, 6-delete max, 7-size, 8-check if empty, 9-print deque
1
Type value: 20
20 added to head
Choose the option: 1-push to head, 2-push to tail, 3-print min, 4-print max, 5-delete min, 6-delete max, 7-size, 8-check if empty, 9-print deque
1
Type value: 10
10 added to head
Choose the option: 1-push to head, 2-push to tail, 3-print min, 4-print max, 5-delete min, 6-delete max, 7-size, 8-check if empty, 9-print deque
9
Deque:
10 20 20 10
Choose the option: 1-push to head, 2-push to tail, 3-print min, 4-print max, 5-delete min, 6-delete max, 7-size, 8-check if empty, 9-print deque
4
Max is 20

Choose the option: 1-push to head, 2-push to tail, 3-print min, 4-print max, 5-delete min, 6-delete max, 7-size, 8-check if empty, 9-print deque
3
Min is 10
Choose the option: 1-push to head, 2-push to tail, 3-print min, 4-print max, 5-delete min, 6-delete max, 7-size, 8-check if empty, 9-print deque
6
Max is deleted
Choose the option: 1-push to head, 2-push to tail, 3-print min, 4-print max, 5-delete min, 6-delete max, 7-size, 8-check if empty, 9-print deque
9
Deque:
10 10 20
Choose the option: 1-push to head, 2-push to tail, 3-print min, 4-print max, 5-delete min, 6-delete max, 7-size, 8-check if empty, 9-print deque
5
Min is deleted
Choose the option: 1-push to head, 2-push to tail, 3-print min, 4-print max, 5-delete min, 6-delete max, 7-size, 8-check if empty, 9-print deque
9
Deque:
10 20
Choose the option: 1-push to head, 2-push to tail, 3-print min, 4-print max, 5-delete min, 6-delete max, 7-size, 8-check if empty, 9-print deque
7
Size is 2
Choose the option: 1-push to head, 2-push to tail, 3-print min, 4-print max, 5-delete min, 6-delete max, 7-size, 8-check if empty, 9-print deque
8
Deque is not empty
Choose the option: 1-push to head, 2-push to tail, 3-print min, 4-print max, 5-delete min, 6-delete max, 7-size, 8-check if empty, 9-print deque
5
Min is deleted
Choose the option: 1-push to head, 2-push to tail, 3-print min, 4-print max, 5-delete min, 6-delete max, 7-size, 8-check if empty, 9-print deque
9
Deque:
20
Choose the option: 1-push to head, 2-push to tail, 3-print min, 4-print max, 5-delete min, 6-delete max, 7-size, 8-check if empty, 9-print deque
1
Type value: -10
-10 added to head
Choose the option: 1-push to head, 2-push to tail, 3-print min, 4-print max, 5-delete min, 6-delete max, 7-size, 8-check if empty, 9-print deque
2
Type value: -30
-30 added to tail
Choose the option: 1-push to head, 2-push to tail, 3-print min, 4-print max, 5-delete min, 6-delete max, 7-size, 8-check if empty, 9-print deque
2
Type value: 40
40 added to tail
Choose the option: 1-push to head, 2-push to tail, 3-print min, 4-print max, 5-delete min, 6-delete max, 7-size, 8-check if empty, 9-print deque
9
Deque:
-10 20 -30 40
Choose the option: 1-push to head, 2-push to tail, 3-print min, 4-print max, 5-delete min, 6-delete max, 7-size, 8-check if empty, 9-print deque
7
Size is 4
Choose the option: 1-push to head, 2-push to tail, 3-print min, 4-print max, 5-delete min, 6-delete max, 7-size, 8-check if empty, 9-print deque
3
Min is -30
Choose the option: 1-push to head, 2-push to tail, 3-print min, 4-print max, 5-delete min, 6-delete max, 7-size, 8-check if empty, 9-print deque
4
Max is 40
Choose the option: 1-push to head, 2-push to tail, 3-print min, 4-print max, 5-delete min, 6-delete max, 7-size, 8-check if empty, 9-print deque
6

Max is deleted
Choose the option: 1-push to head, 2-push to tail, 3-print min, 4-print max, 5-delete min, 6-delete max, 7-size, 8-check if empty, 9-print deque
9
Deque:
-30 -10 20
Choose the option: 1-push to head, 2-push to tail, 3-print min, 4-print max, 5-delete min, 6-delete max, 7-size, 8-check if empty, 9-print deque
5
Min is deleted
Choose the option: 1-push to head, 2-push to tail, 3-print min, 4-print max, 5-delete min, 6-delete max, 7-size, 8-check if empty, 9-print deque
9
Deque:
-10 20
Choose the option: 1-push to head, 2-push to tail, 3-print min, 4-print max, 5-delete min, 6-delete max, 7-size, 8-check if empty, 9-print deque
1
Type value: -3
-3 added to head
Choose the option: 1-push to head, 2-push to tail, 3-print min, 4-print max, 5-delete min, 6-delete max, 7-size, 8-check if empty, 9-print deque
6
Max is deleted
Choose the option: 1-push to head, 2-push to tail, 3-print min, 4-print max, 5-delete min, 6-delete max, 7-size, 8-check if empty, 9-print deque
9
Deque:
-10 -3
Choose the option: 1-push to head, 2-push to tail, 3-print min, 4-print max, 5-delete min, 6-delete max, 7-size, 8-check if empty, 9-print deque
3
Min is -10
Choose the option: 1-push to head, 2-push to tail, 3-print min, 4-print max, 5-delete min, 6-delete max, 7-size, 8-check if empty, 9-print deque
4
Max is -3
Choose the option: 1-push to head, 2-push to tail, 3-print min, 4-print max, 5-delete min, 6-delete max, 7-size, 8-check if empty, 9-print deque
8
Deque is not empty
Choose the option: 1-push to head, 2-push to tail, 3-print min, 4-print max, 5-delete min, 6-delete max, 7-size, 8-check if empty, 9-print deque
7
Size is 2
Choose the option: 1-push to head, 2-push to tail, 3-print min, 4-print max, 5-delete min, 6-delete max, 7-size, 8-check if empty, 9-print deque
4
Max is -3
Choose the option: 1-push to head, 2-push to tail, 3-print min, 4-print max, 5-delete min, 6-delete max, 7-size, 8-check if empty, 9-print deque
6
Max is deleted
Choose the option: 1-push to head, 2-push to tail, 3-print min, 4-print max, 5-delete min, 6-delete max, 7-size, 8-check if empty, 9-print deque
5
Min is deleted
Choose the option: 1-push to head, 2-push to tail, 3-print min, 4-print max, 5-delete min, 6-delete max, 7-size, 8-check if empty, 9-print deque
9
Deque:

Choose the option: 1-push to head, 2-push to tail, 3-print min, 4-print max, 5-delete min, 6-delete max, 7-size, 8-check if empty, 9-print deque
7
Size is 0
Choose the option: 1-push to head, 2-push to tail, 3-print min, 4-print max, 5-delete min, 6-delete max, 7-size, 8-check if empty, 9-print deque
0

**9. Дневник отладки**

| № | Лаб. или дом. | Дата | Время | Событие | Действие по исправлению | Примечание |
|---|---|---|---|---|---|---|

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | | |

**10. Замечания автора:**
По существу работы: замечания отсутствуют.

**11. Выводы:**

Подпись студента _____