ФЕДЕРАЛЬНОЕ ГОСУДАРСТВЕННОЕ АВТОНОМНОЕ ОБРАЗОВАТЕЛЬНОЕ УЧРЕЖДЕНИЕ ВЫСШЕГО ОБРАЗОВАНИЯ  
«РОССИЙСКИЙ УНИВЕРСИТЕТ ТРАНСПОРТА»  
(РУТ (МИИТ))

Институт транспортной техники и систем управления

Кафедра «Управление и защита информации»

ОТЧЁТ  
О ПРАКТИЧЕСКОЙ РАБОТЕ №4.3

По дисциплине «Процедурное программирование»

Выполнил: ст. гр. ТКИ – 112

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**Цель работы**

Создать многомерный массив nˣm из *n* целых чисел. Реализовать возможность заполнения массива как случайными числами, так и с помощью клавиатуры по желанию пользователя. Пункты задания организовать в виде функций (методов). Вывести массив на экран.

Задачи:

* Заменить максимальный элемент каждой строки нулем.
* Вставить перед всеми строками, первый элемент, которых делится на 3, строку из нулей.

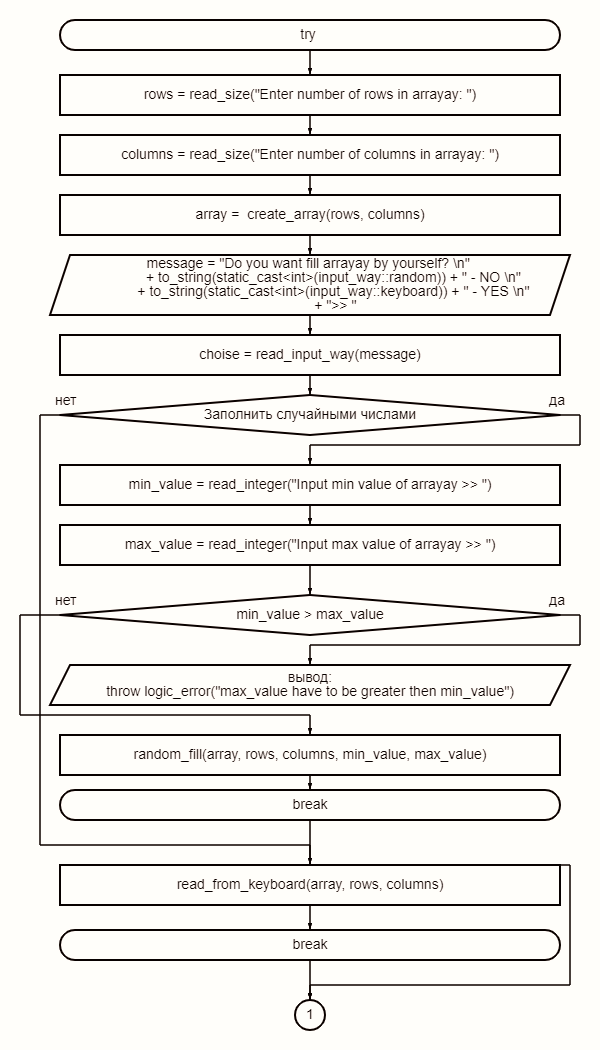
**Проектирование алгоритма**

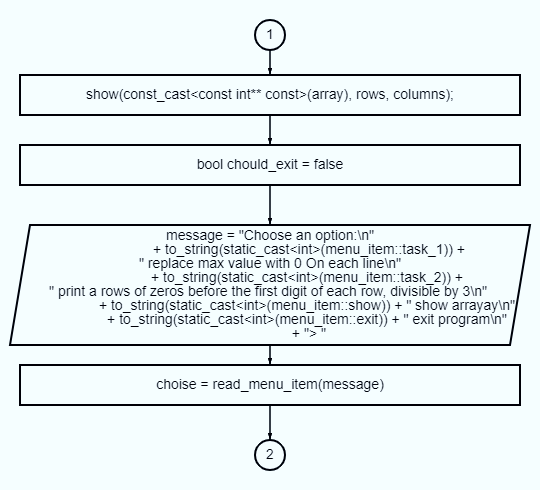
Так как пункты задания по условию требуется организовать в виде функций, следовательно, в виде функций необходимо организовать также и некоторые базовые операции, такие как ввод и вывод массива. Методы — это функции, которые могут выполнять действия над данными, реализуя возможность заполнения массива случайными числами и с помощью клавиатуры.

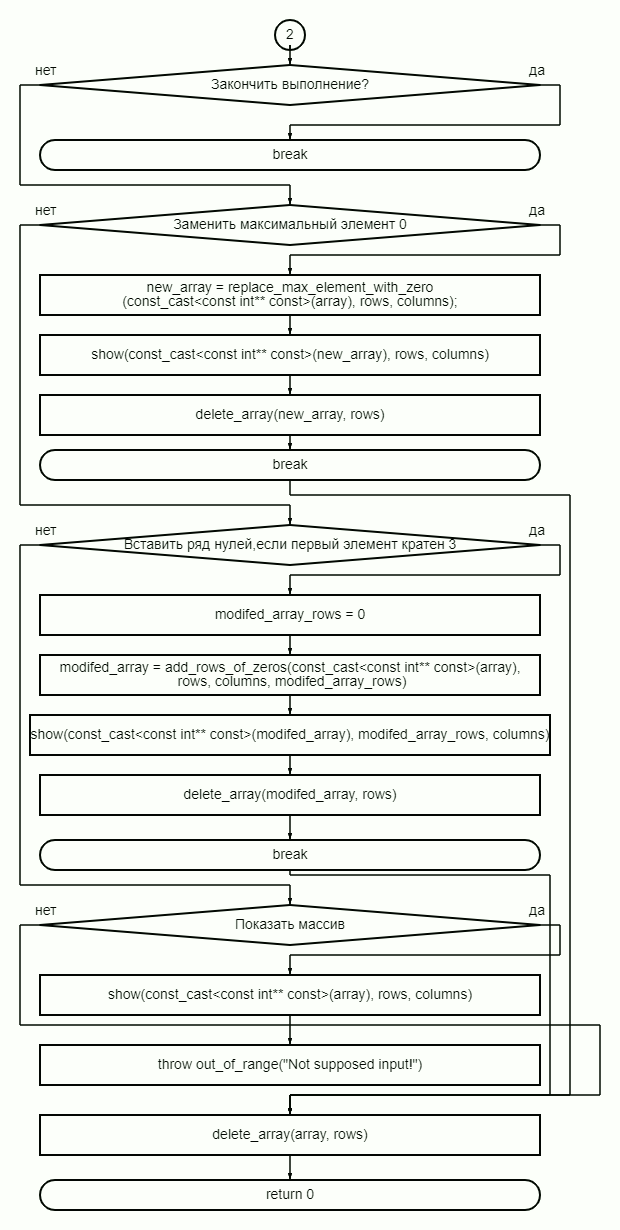
**Написание алгоритма**

|  |
| --- |
| **#include <iostream>**  **#include <random>**  **#include <string>**    **using namespace std;**  **/\*\***  **\* \brief Способ заполнения массива.**  **\*/**  **enum class input\_way**  **{**  **/\*\***  **\* \brief Заполнение массива при помощи ГПСЧ.**  **\*/**  **random,**    **/\*\***  **\* \brief Заполнение массива при помощи пользовательского ввода.**  **\*/**  **keyboard**  **};**    **/\*\***  **\* \brief Меню.**  **\*/**  **enum class menu\_item**  **{**  **/\*\***  **\* \brief Показывает массив.**  **\*/**  **show,**  **/\*\***  **\* \brief Заменить максимальный элемент массив на 0.**  **\*/**  **task\_1,**  **/\*\***  **\* \brief Добавить ряд нулей перед строкой, если первый элемент кратен 3.**  **\*/**  **task\_2,**  **/\*\***  **\* \brief Завершает программу.**  **\*/**  **exit**  **};**    **/\*\***  **\* \brief Функция позволяет ввести число предверяя его сообщением \a message.**  **\* \param message Передаваемое сообщение.**  **\* \return Введёное пользователем число.**  **\*/**  **int read\_integer(const string& message = "") noexcept;**    **/\*\***  **\* \brief Считывает способ запонения массива.**  **\* \param Мотивирующее сообщение.**  **\* \return Способ заполнения массива.**  **\*/**  **input\_way read\_input\_way(const string& message = "");**    **/\*\***  **\* \brief Считывает пункт меню.**  **\* \param Мотивирующее сообщение.**  **\* \return Пункт меню.**  **\*/**  **menu\_item read\_menu\_item(const string& message = "");**    **/\*\***  **\* \brief Считывает оазмер по одному из измерений массива.**  **\* \param Мотивирующее сообщение.**  **\* \return Способ заполнения массива.**  **\* \exception out\_of\_range В случае если введён размер меньше или раен нулю.**  **\*/**  **size\_t read\_size(const string& message = "");**    **/\*\***  **\* \brief Создаёт двумерный массив.**  **\* \param rows Количество строк.**  **\* \param columns Количество столбцов.**  **\* \return Созданный массив.**  **\*/**  **int\*\* create\_array(const size\_t rows, const size\_t columns);**    **/\*\***  **\* \brief Функция заполняет массив случайными числами в заданном промежутке. Возможны перебои при работе с большими массивами.**  **\* \param array Заполняемый массив.**  **\* \param rows Количество строк.**  **\* \param columns Количество столбцов.**  **\* \param min\_value Левая граница распределения.**  **\* \param max\_value Правая граница распределения.**  **\*/**  **void random\_fill(int\*\* array, const size\_t rows, const size\_t columns, const int min\_value, const int max\_value);**    **/\*\***  **\* \brief Функция позволяет пользователю вручную заполнить массив.**  **\* \param rows Количество строк.**  **\* \param columns Количество столбцов.**  **\*/**  **void read\_from\_keyboard(int\*\* array, const size\_t rows, const size\_t columns);**    **/\*\***  **\* \brief Функция выводит на экран данный ей массив.**  **\* \param array Отображаемый массив.**  **\* \param rows Количество строк.**  **\* \param columns Количество столбцов.**  **\*/**  **void show(const int\*\* const array, const size\_t rows, const size\_t columns);**    **/\*\***  **\* \brief Функция меняет наибольший(наибольшие) элементы на ноль.**  **\* \param array Исходный массив.**  **\* \param rows Количество строк.**  **\* \param columns Количество столбцов.**  **\* \return Изменённый массив**  **\*/**  **int\*\* replace\_max\_element\_with\_zero(const int\*\* const array, const size\_t rows, const size\_t columns);**    **/\*\***  **\* \brief Получает значение максимального элемента \a array.**  **\* \param Массив элементов.**  **\* \param Размер массива.**  **\* \return Максимальный элемент.**  **\*/**  **int get\_max\_value(const int\* const array, const size\_t size);**    **/\*\***  **\* \brief Функция добавляет ряд нулей перед строкой, если первый элемент кратен 3.**  **\* \param array Исходный массив.**  **\* \param rows Количество строк.**  **\* \param columns Количество столбцов.**  **\* \param new\_array\_rows out параметр, хранящий число строк изменённого массива.**  **\* \return Изменённый элемент.**  **\*/**  **int\*\* add\_rows\_of\_zeros(const int\*\* const array, const size\_t rows, const size\_t columns, size\_t& new\_array\_rows);**    **/\*\***  **\* \brief Функция освобождает динамическую память массива**  **\* \param array Массив для "зачистки"**  **\* \param rows Количество строк массива**  **\*/**  **void delete\_array(int\*\* array, const size\_t rows);**    **/\*\***  **Главная функция программы**  **0 в случае успеха**  **\*/**  **int main()**  **{**  **try**  **{**  **const auto rows = read\_size("Enter number of rows in arrayay: ");**  **const auto columns = read\_size("Enter number of columns in arrayay: ");**    **auto array = create\_array(rows, columns);**    **auto message = "Do you want fill arrayay by yourself? \n"**  **+ to\_string(static\_cast<int>(input\_way::random)) + " - NO \n"**  **+ to\_string(static\_cast<int>(input\_way::keyboard)) + " - YES \n"**  **+ ">> ";**    **const auto choise = read\_input\_way(message);**  **switch (choise)**  **{**  **case input\_way::random:**  **{**  **const auto min\_value = read\_integer("Input min value of arrayay >> ");**  **const auto max\_value = read\_integer("Input max value of arrayay >> ");**  **if (min\_value > max\_value)**  **{**  **throw logic\_error("max\_value have to be greater then min\_value");**  **}**    **random\_fill(array, rows, columns, min\_value, max\_value);**  **break;**  **}**  **case input\_way::keyboard:**  **{**  **read\_from\_keyboard(array, rows, columns);**  **break;**  **}**  **default :**  **{**  **throw out\_of\_range("You entered wrong choice!");**  **}**  **}**    **show(const\_cast<const int\*\* const>(array), rows, columns);**    **bool chould\_exit = false;**  **do**  **{**  **auto message = "Choose an option:\n"**  **+ to\_string(static\_cast<int>(menu\_item::task\_1)) + " replace max value with 0 On each line\n"**  **+ to\_string(static\_cast<int>(menu\_item::task\_2)) + " print a rows of zeros before the first digit of each row, divisible by 3\n"**  **+ to\_string(static\_cast<int>(menu\_item::show)) + " show arrayay\n"**  **+ to\_string(static\_cast<int>(menu\_item::exit)) + " exit program\n"**  **+ "> ";**    **const auto choise = read\_menu\_item(message);**  **switch (choise)**  **{**  **case menu\_item::exit:**  **{**  **chould\_exit = true;**  **break;**  **}**  **case menu\_item::task\_1:**  **{**  **const auto new\_array = replace\_max\_element\_with\_zero(const\_cast<const int\*\* const>(array), rows, columns);**  **show(const\_cast<const int\*\* const>(new\_array), rows, columns);**  **delete\_array(new\_array, rows);**  **break;**  **}**  **case menu\_item::task\_2:**  **{**  **size\_t modifed\_array\_rows = 0;**  **auto modifed\_array = add\_rows\_of\_zeros(const\_cast<const int\*\* const>(array), rows, columns, modifed\_array\_rows);**  **show(const\_cast<const int\*\* const>(modifed\_array), modifed\_array\_rows, columns);**  **delete\_array(modifed\_array, rows);**  **break;**  **}**  **case menu\_item::show:**  **{**  **show(const\_cast<const int\*\* const>(array), rows, columns);**  **break;**  **}**  **default:**  **{**  **throw out\_of\_range("Not supposed input!");**  **}**  **}**  **} while (!chould\_exit);**    **delete\_array(array, rows);**  **}**  **catch (out\_of\_range& error)**  **{**  **cerr << error.what() << endl;**  **return 1;**  **}**  **catch(logic\_error& logic\_error)**  **{**  **cerr << logic\_error.what() << endl;**  **return 2;**  **}**    **return 0;**  **}**    **int read\_integer(const string& message) noexcept**  **{**  **cout << message;**  **int x = 0;**  **cin >> x;**  **return x;**  **}**    **input\_way read\_input\_way(const string& message)**  **{**  **const auto choise = read\_integer(message);**  **return static\_cast<input\_way>(choise);**  **}**    **menu\_item read\_menu\_item(const string& message)**  **{**  **const auto choise = read\_integer(message);**  **return static\_cast<menu\_item>(choise);**  **}**    **size\_t read\_size(const string& message)**  **{**  **const auto size = read\_integer(message);**  **if (size < 0)**  **{**  **throw out\_of\_range("size have to be greater than zero");**  **}**  **return static\_cast<size\_t>(size);**  **}**    **int\*\* create\_array(const size\_t rows, const size\_t columns)**  **{**  **auto array = new int\*[rows];**  **for(size\_t i = 0; i < rows; i++)**  **{**  **array[i] = new int[columns];**  **}**    **return array;**  **}**    **void random\_fill(int\*\* array, const size\_t rows, const size\_t columns, const int min\_value, const int max\_value)**  **{**  **random\_device rd;**  **mt19937 gen(rd());**  **uniform\_int\_distribution<> uniformIntDistribution(min\_value, max\_value);**    **for(size\_t i = 0; i < rows; i++)**  **{**  **for (size\_t j = 0; j < columns; j++)**  **{**  **array[i][j] = uniformIntDistribution(gen);**  **}**  **}**  **}**    **void read\_from\_keyboard(int\*\* array, const size\_t rows, const size\_t columns)**  **{**  **for (size\_t i = 0; i < rows; i++)**  **{**  **for (size\_t j = 0; j < columns; j++)**  **{**  **cin >> array[i][j];**  **}**  **}**  **}**    **void show(const int\*\* const array, const size\_t rows, const size\_t columns)**  **{**  **for (size\_t i = 0; i < rows; i++)**  **{**  **cout << '[' << i << "] - ";**  **size\_t j = 0;**    **for (; j < columns; j++)**  **{**  **cout << '[' << array[i][j] << "], ";**  **}**  **cout << endl;**    **}**  **}**    **int\*\* replace\_max\_element\_with\_zero(const int\*\* const array, const size\_t rows, const size\_t columns)**  **{**  **int\*\* new\_array = create\_array(rows, columns);**    **for (size\_t i = 0; i < rows; i++)**  **{**  **const auto max\_value = get\_max\_value(array[i], columns);**  **for (size\_t j = 0; j < columns; j++)**  **{**  **new\_array[i][j] = array[i][j] == max\_value**  **? 0**  **: array[i][j];**  **}**  **}**    **return new\_array;**  **}**    **int get\_max\_value(const int\* const array, const size\_t size)**  **{**  **int max\_value = array[0];**  **for (size\_t i = 0; i < size; i++)**  **{**  **if (max\_value < array[i])**  **{**  **max\_value = array[i];**  **}**  **}**    **return max\_value;**  **}**    **int\*\* add\_rows\_of\_zeros(const int\*\* const array, const size\_t rows, const size\_t columns, size\_t& new\_array\_rows)**  **{**  **int added\_rows\_count = 0;**  **for (size\_t i = 0; i < rows; i++)**  **{**  **if (array[i][0] % 3 == 0)**  **{**  **added\_rows\_count++;**  **}**  **}**    **new\_array\_rows = rows + added\_rows\_count;**  **auto new\_array = create\_array(new\_array\_rows, columns);**    **size\_t k = 0;**  **for (size\_t i = 0; i < rows; i++)**  **{**  **if(array[i][0] % 3 == 0)**  **{**  **for (size\_t j = 0; j < columns; j++)**  **{**  **new\_array[k][j] = 0;**  **}**  **k++;**  **}**    **for (size\_t j = 0; j < columns; j++)**  **{**  **new\_array[k][j] = array[i][j];**  **}**  **k++;**  **}**    **return new\_array;**  **}**    **void delete\_array(int\*\* array, const size\_t rows)**  **{**  **if (array != nullptr)**  **{**  **for (size\_t i = 0; i < rows; i++)**  **{**  **if (array[i] != nullptr)**  **{**  **delete[] array[i];**  **array[i] = nullptr;**  **}**  **}**    **delete[] array;**  **array = nullptr;**  **}**  **}** |

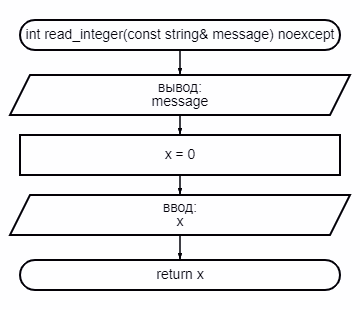
**Блок схема**

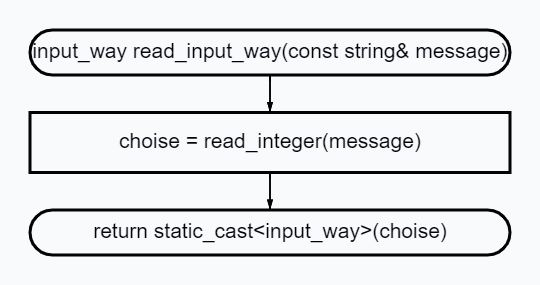


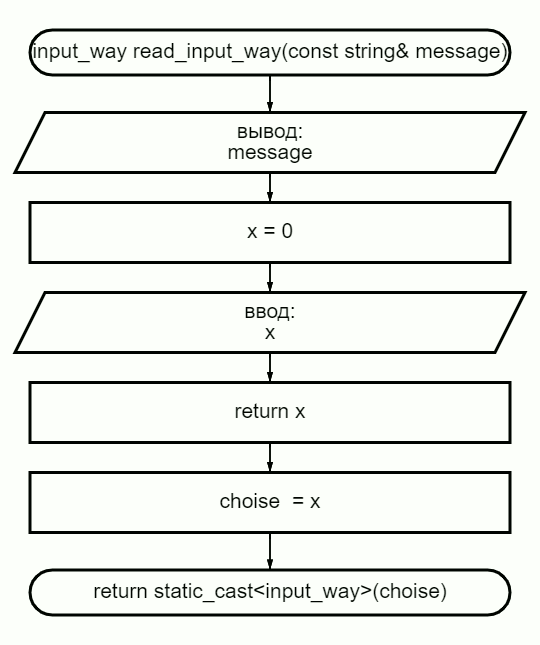


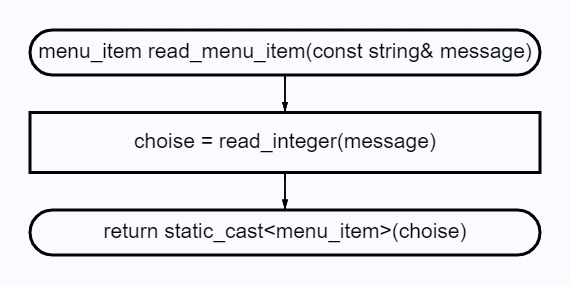


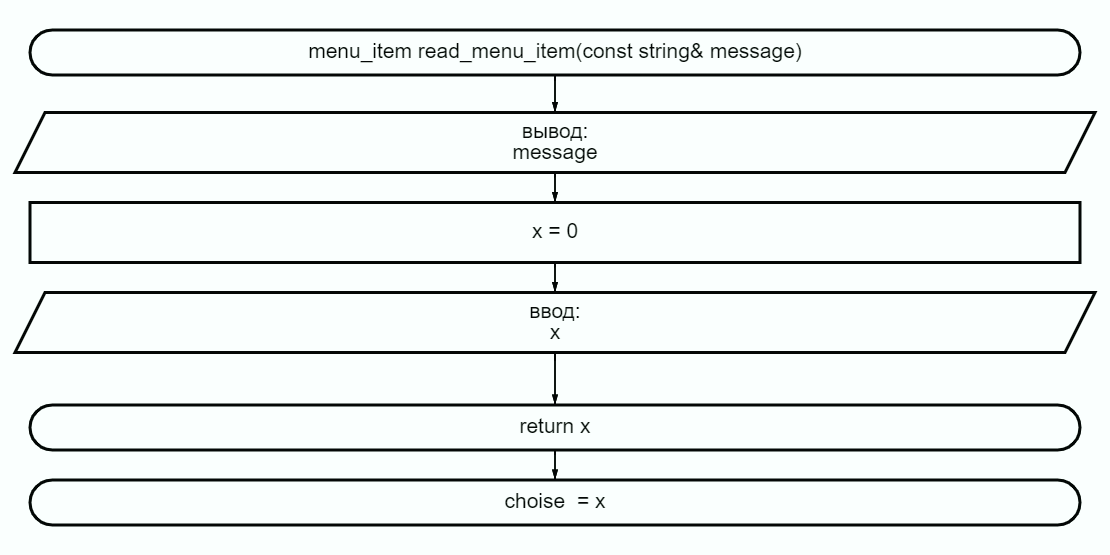
**Функции**

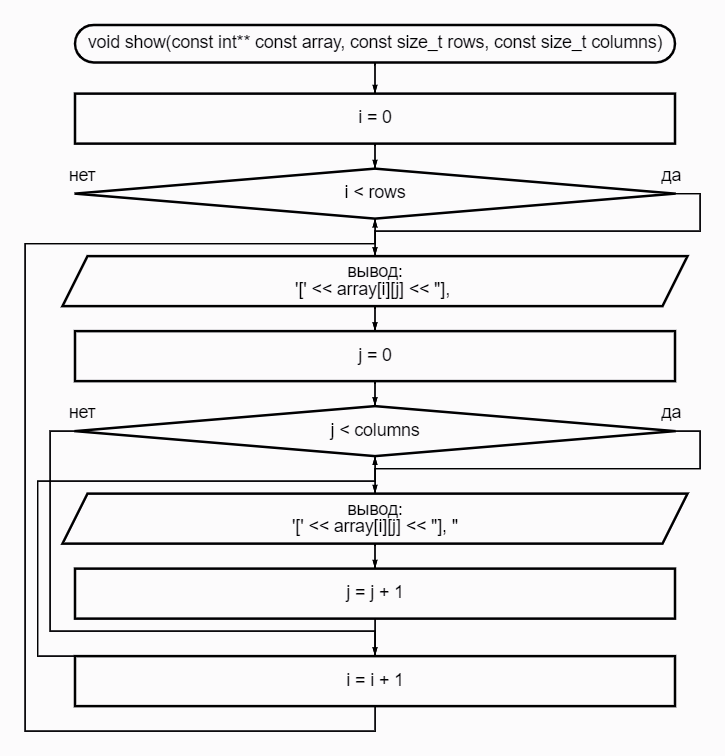


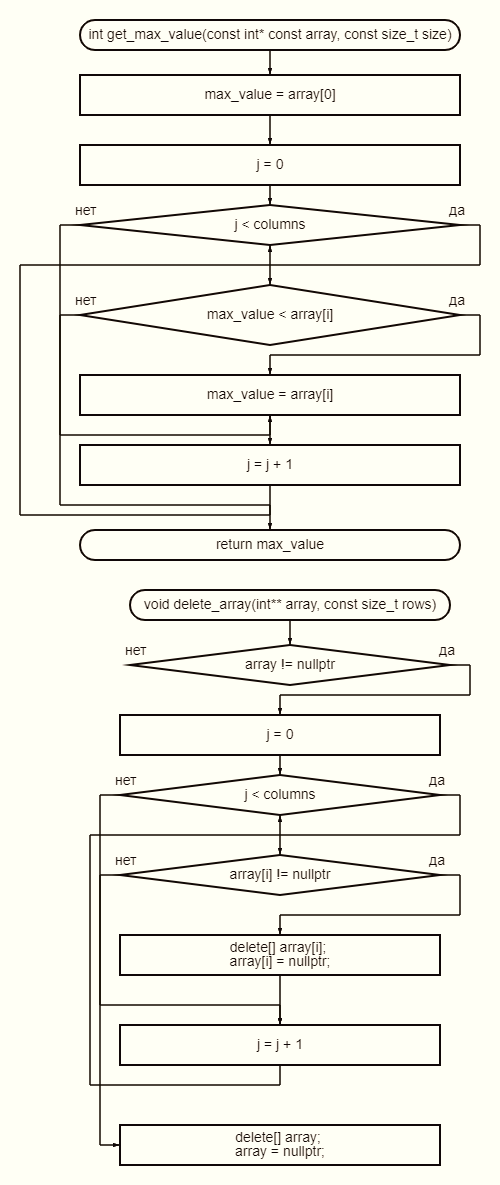


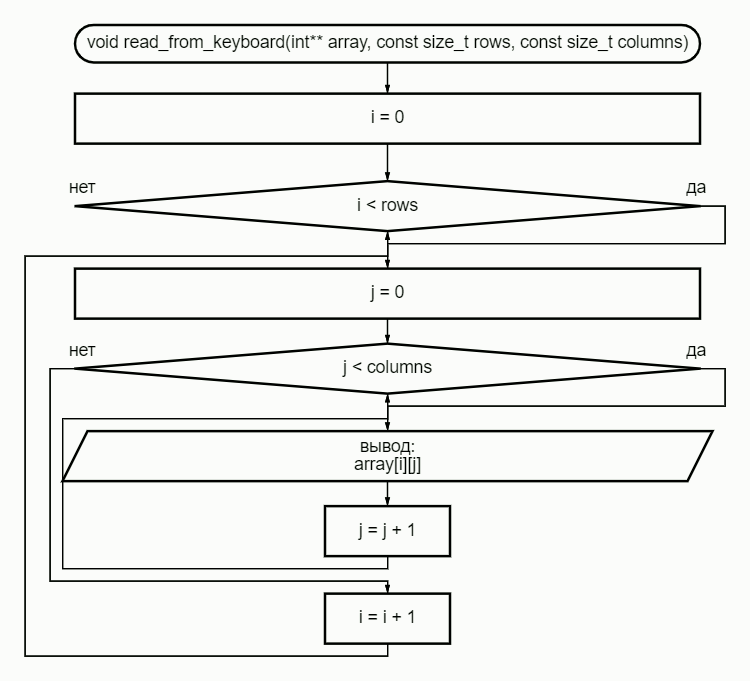


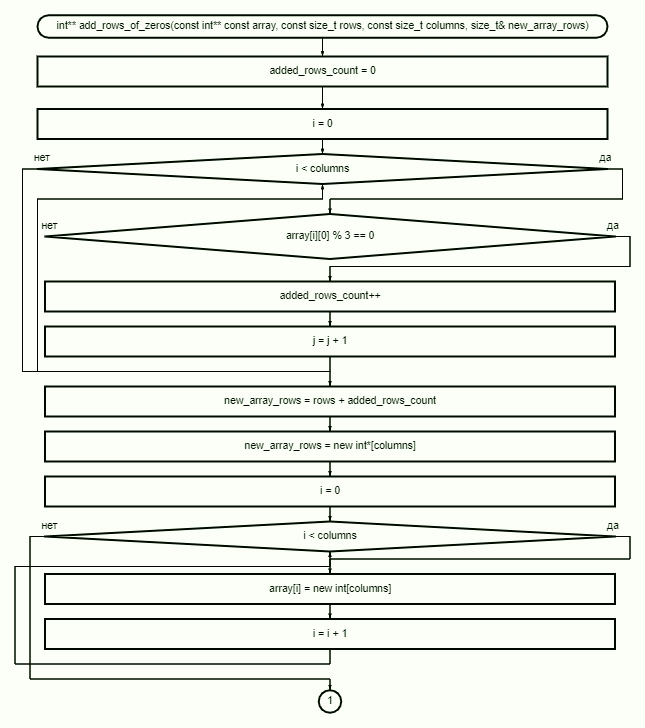


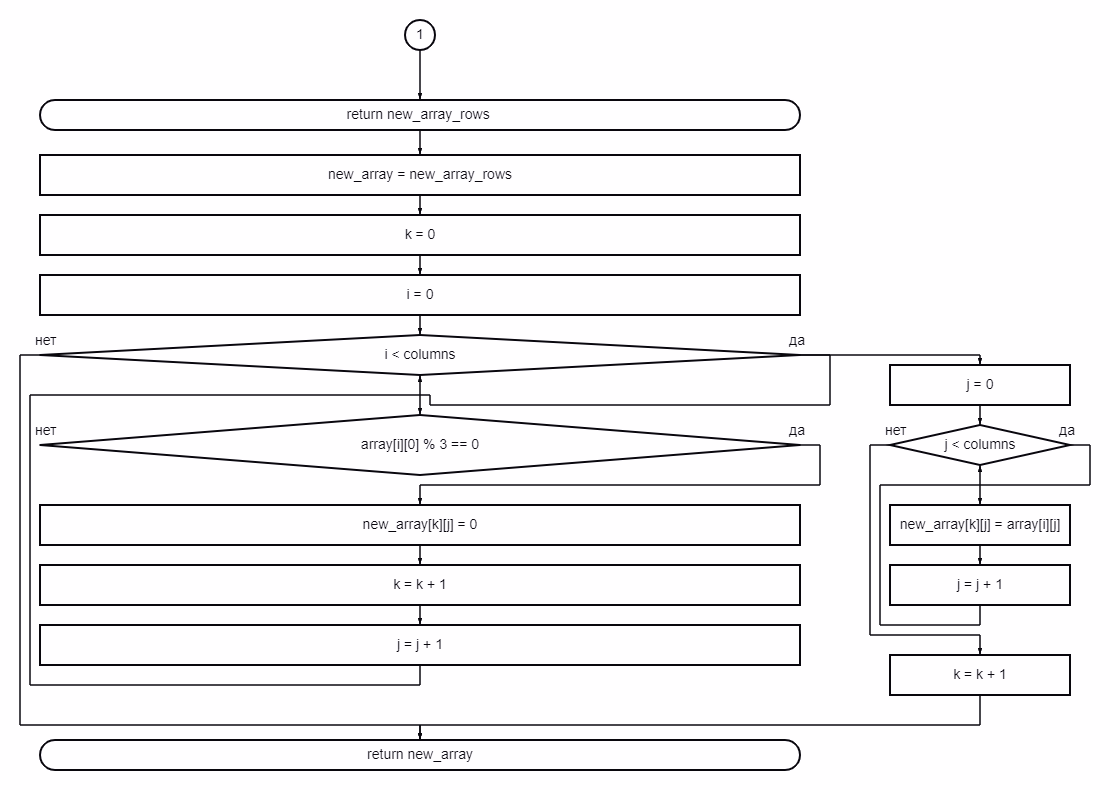


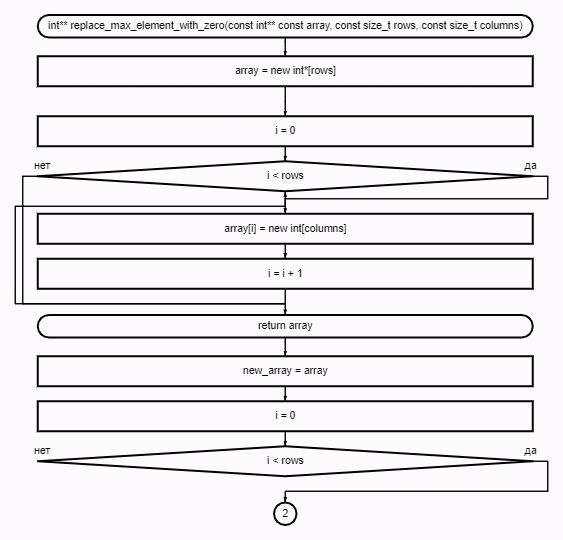


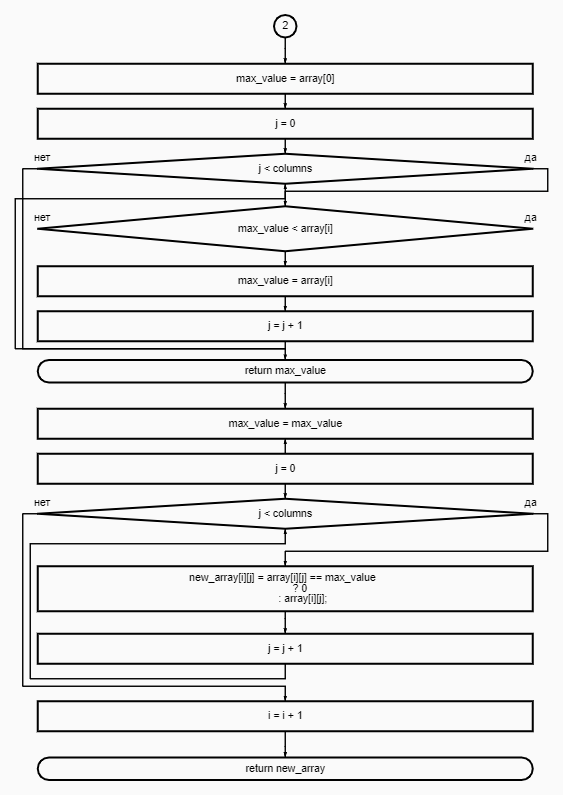


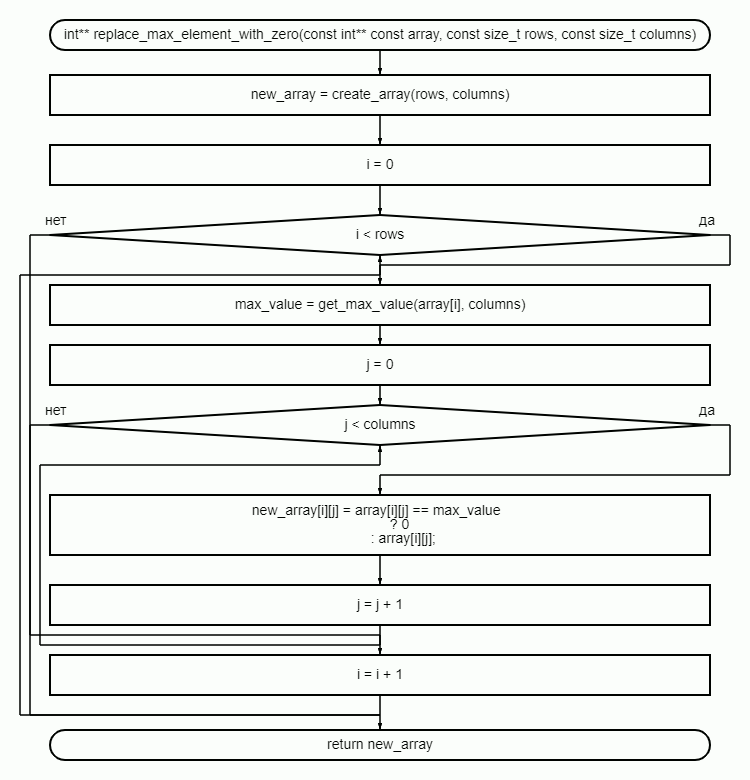




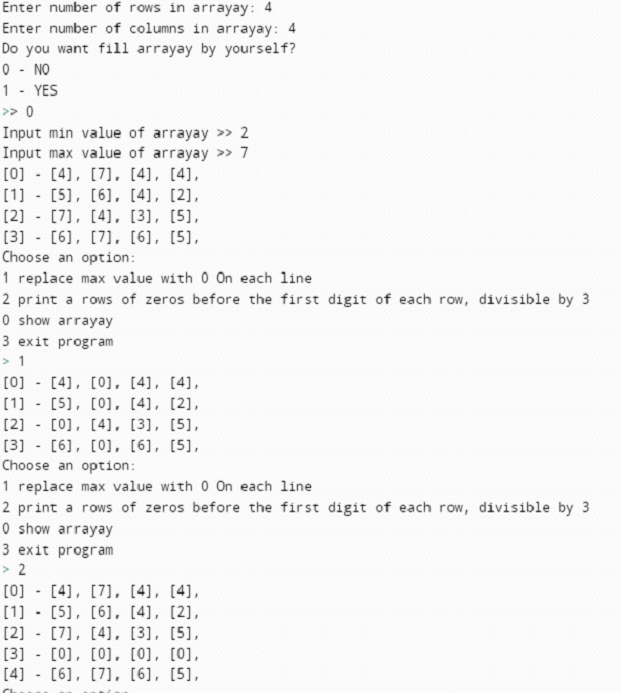


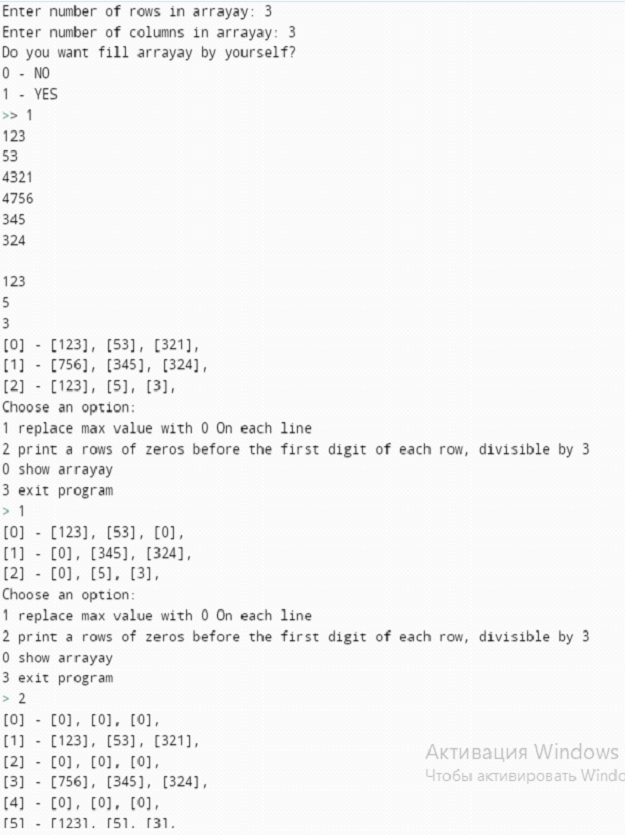






**Проверка**





**СПИСОК ИСПОЛЬЗОВАННЫХ ИСТОЧНИКОВ**

* Бьярне Страуструп - Программирование. Принципы и практика с использованием C++ (2016)   
  (URL:[Бьярне Страуструп - Программирование. Принципы и практика с использованием HYPERLINK 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