

Отчёт по ИДЗ-4

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Выполнение критериев на 4-5 баллов

1. Описание сценария

В рамках разработанного приложения реализовано взаимодействие пользователей (читателей) с электронной системой библиотеки. Каждый читатель может выбрать несколько книг, прочитать их и вернуть в библиотеку. В случае если выбранная книга в данный момент недоступна, читатель будет ожидать её возвращения. Важно, что все процессы происходят параллельно, так как несколько читателей могут одновременно брать и возвращать книги. Модель включает следующие основные субъекты и объекты:

- Читатель — пользователь библиотеки, который выбирает книги, читает их и возвращает в библиотеку. Читатели действуют параллельно, что симулирует реальное поведение в многопользовательской среде.
- Библиотека — система, управляющая доступом к книгам. В библиотеке есть несколько книг, которые могут быть заняты или свободны. Когда читатель берет книгу, она становится занятой, и другой читатель должен ждать, пока книга не будет возвращена.
- Логгер — компонент системы, отвечающий за запись логов, позволяя отслеживать все события, происходящие в процессе работы программы.

2. Модель параллельных вычислений

Многозадачность в данной программе реализована с использованием многопоточности. Каждый читатель работает в отдельном потоке, взаимодействуя с библиотекой и выбирая книги. Для синхронизации доступа к общим ресурсам (то есть книгам) используются мьютексы и условные переменные.

- Мьютексы блокируют доступ к книгам, чтобы избежать гонки за ресурсами, когда несколько читателей пытаются получить одну и ту же

книгу одновременно.

- Условные переменные используются для ожидания, если книга еще не возвращена. Читатель может быть заблокирован до тех пор, пока книга не станет доступной.

3. Входные данные

Входные данные представляют собой:

- ID читателя — уникальный идентификатор каждого читателя.
- Список книг — библиотека содержит несколько книг. Читатель может выбрать книги из этого списка.
- Данные о доступности книг — для каждой книги поддерживается состояние (занята/свободна), которое изменяется по мере того, как читатели берут и возвращают книги.

Генерация случайных чисел:

- Количество книг: от 1 до 3 книг для каждого читателя в одном цикле.
- Идентификаторы книг: случайно генерируются числа от 0 до максимального количества книг в библиотеке.
- Время ожидания: случайная задержка между действиями, которая варьируется от 1 до 3 секунд.

4. Алгоритм программы

Алгоритм работы программы включает следующие этапы:

1. Инициализация библиотеки: библиотека содержит несколько книг, каждая из которых имеет статус (занята/свободна).
2. Выбор книг: читатель случайным образом выбирает несколько книг для чтения.
3. Попытка взять книги: читатель пытается получить книги из библиотеки. Если книги заняты, он будет ждать, пока они не станут свободными.
4. Чтение книг: после того как книги получены, читатель "читает" их с задержкой, которая имитирует реальное время, проведенное за чтением.
5. Возврат книг: после чтения книги возвращаются в библиотеку.

6. Повторение: процесс повторяется несколько раз (например, 3 посещения библиотеки).

Читатели действуют параллельно, и каждый читатель работает в своем потоке. Синхронизация обеспечивается с помощью мьютексов и условных переменных для предотвращения конфликтов доступа к книгам.

5. Ввод и вывод данных

В программе предусмотрены два варианта ввода данных:

1. Ввод данных с консоли во время выполнения программы:
 - Читатель выбирает количество книг, которые хочет взять, и система случайным образом генерирует ID книг.
 - Программа отображает на экране сообщения о каждом шаге, включая выбор книг, ожидание, чтение и возврат книг.
2. Ввод данных через командную строку (в будущем для более удобного использования):
 - При запуске программы можно передавать параметры через командную строку для конфигурации количества читателей, количества книг и других параметров.

Вывод программы:

- Программа выводит подробную информацию о каждом шаге работы читателя:
 - Какой читатель берет какие книги.
 - Что происходит, если книга недоступна (ожидание).
 - Когда книги возвращаются в библиотеку.
 - Логи действий каждого читателя записываются в файл для дальнейшего анализа.

6. Результаты работы программы

Пример работы программы (на экране и в логах):

The screenshot shows a C++ IDE with the following components:

- Source Code:** The file `ConsoleApp_ABC.cpp` is open, showing a `main` function that initializes a random number generator, sets locale to Russian, and processes command-line arguments. It uses `std::mt19937` for random numbers and `std::atoi` to parse integers. The program simulates a library system with books and readers.
- Run Output:** The output window shows the program's execution. It prompts for the number of books (5) and readers (4), and the output file name (`output.txt`). The output then shows the sequence of events: Reader (3) takes book 3, Reader (1) takes book 1, Reader (1) takes book 2, Reader (2) is busy with book 3, Reader (2) is waiting for book 3, Reader (4) is busy with book 3, Reader (4) takes book 4, Reader (1) reads books 1 and 2, Reader (3) reads book 3, Reader (4) reads book 4, Reader (1) gets back book 1, Reader (1) gets back book 2, Reader (4) gets back book 4, Reader (4) is waiting for book 3, Reader (3) gets back book 3, Reader (1) takes book 0, and Reader (2) takes book 3.

Reader (3) has taken the book with id: 3.
Reader (1) has taken the book with id: 1.
Reader (1) has taken the book with id: 2.
Reader (2) hasn't any opportunities to take book with id:3;
because it's busy right now.
Reader (2) is waiting missing books.
Reader (4) hasn't any opportunities to take book with id:3;
because it's busy right now.
Reader (4) has taken the book with id: 4.
Reader (1) is reading books: 1 2
Reader (3) is reading books: 3
Reader (4) is reading books: 4
Reader (1) got back book with id: 1.
Reader (1) got back book with id: 2.
Reader (4) got back book with id: 4.
Reader (4) is waiting missing books.
Reader (3) got back book with id: 3.
Reader (1) has taken the book with id: 0.
Reader (2) was notified about the availability of book 3 an
d successfully took it.

Reader (2) is reading books: 3
Reader (1) is reading books: 0
Reader (3) has taken the book with id: 2.
Reader (3) is reading books: 2
Reader (3) got back book with id: 2.
Reader (1) got back book with id: 0.
Reader (3) has taken the book with id: 2.
Reader (3) is reading books: 2
Reader (2) got back book with id: 3.
Reader (4) was notified about the availability of book 3 and successfully took it.
Reader (4) is reading books: 3
Reader (1) has taken the book with id: 0.
Reader (1) has taken the book with id: 4.
Reader (1) is reading books: 0 4
Reader (3) got back book with id: 2.
Reader (3) stopped his visits to the library.
Reader (2) hasn't any opportunities to take book with id:0; because it's busy right now.
Reader (2) is waiting missing books.
Reader (4) got back book with id: 3.
Reader (1) got back book with id: 0.
Reader (1) got back book with id: 4.
Reader (2) was notified about the availability of book 0 and successfully took it.
Reader (2) is reading books: 0
Reader (4) has taken the book with id: 2.
Reader (4) has taken the book with id: 3.
Reader (4) has taken the book with id: 4.
Reader (4) is reading books: 2 3 4
Reader (4) got back book with id: 2.
Reader (4) got back book with id: 3.
Reader (4) got back book with id: 4.
Reader (1) stopped his visits to the library.
Reader (2) got back book with id: 0.
Reader (4) has taken the book with id: 1.
Reader (4) has taken the book with id: 2.
Reader (4) has taken the book with id: 4.

```
Reader (4) is reading books: 1 2 4
Reader (2) has taken the book with id: 0.
Reader (2) has taken the book with id: 3.
Reader (2) is reading books: 0 3
Reader (4) got back book with id: 1.
Reader (4) got back book with id: 2.
Reader (4) got back book with id: 4.
Reader (2) got back book with id: 0.
Reader (2) got back book with id: 3.
Reader (4) stopped his visits to the library.
Reader (2) stopped his visits to the library.
```

Также вывод записывается в файл с именем, заданным в командной строке.

Выполнение критериев на 6-7 баллов

1. Описание обобщенного алгоритма

Алгоритм, реализованный в данной программе, состоит из нескольких этапов, который обеспечивают параллельное взаимодействие читателей с библиотекой. Этот алгоритм можно описать следующим образом:

1. Инициализация системы:

- Система создаёт несколько книг в библиотеке, которые могут быть заняты или свободны. С помощью случайных чисел определяется, какие книги доступны в момент старта.

2. Создание читателей:

- Для каждого читателя создается отдельный поток.
- Каждый читатель при старте программы получает уникальный идентификатор, а также доступ к библиотеке и логгеру для записи действий.

3. Выбор книг:

- Каждый читатель случайным образом выбирает от 1 до 3 книг из доступных. Генерация случайных чисел используется для того, чтобы книги были выбраны случайным образом.

4. Попытка взять книги:

- Читатель обращается к библиотеке и пытается взять выбранные книги. Если книги свободны, он забирает их, иначе ждет, пока они не будут возвращены другими читателями.
- Используется синхронизация с помощью мьютексов и условных переменных для ожидания.

5. Чтение книг:

- После получения книги читатель "читает" её, что симулируется задержкой от 1 до 3 секунд.

6. Возврат книг:

- После завершения чтения книги возвращаются обратно в библиотеку, и доступ к ним становится возможным для других читателей.

7. Повторение:

- Читатели могут несколько раз выбрать книги и прочитать их в течение симуляции. После каждого чтения происходит возврат книг, а затем возможен новый цикл выбора и чтения книг.

Алгоритм обрабатывает несколько читателей, работающих параллельно, с использованием многозадачности. Каждое действие читателя выполняется в отдельном потоке, что позволяет моделировать реальную библиотечную среду.

2. Генерация случайных данных

В программе используется генерация случайных данных для имитации выбора книг, времени ожидания и времени чтения. Генерация случайных чисел осуществляется с использованием `mt19937` и `random_device`:

- **Выбор книг:** Количество книг, которое читатель выбирает за один раз, генерируется случайным образом в диапазоне от 1 до 3.
- **Идентификаторы книг:** Каждая книга имеет уникальный идентификатор, который генерируется случайным образом в пределах общего количества книг в библиотеке. Это моделирует случайный выбор книг из множества.
- **Время ожидания и чтения:** Для моделирования времени ожидания книги и времени чтения используется генерация случайных задержек

от 1 до 3 секунд. Это помогает создавать более реалистичную модель поведения читателей в библиотеке.

Пример генерации случайных чисел:

```
std::random_device rd;
std::mt19937 gen(rd());
int numBooks = gen() % 3 + 1;
int bookId = gen() % library->count_of_books;
usleep((gen() % 3 + 1) * 1000);
```

3. Ввод данных через командную строку

Для удовлетворения требований на 6-7 баллов была добавлена возможность ввода исходных данных через командную строку.

```
// Process command line arguments
for (int index = 1; index < argc; ++index) {
    std::string currentArg = argv[index];

    if ((currentArg == "-n" || currentArg == "--books") && index + 1 < argc) {
        N = std::atoi(argv[++index]);
    }
    else if ((currentArg == "-m" || currentArg == "--readers") && index + 1 <
argc) {
        M = std::atoi(argv[++index]);
    }
    else if ((currentArg == "-o" || currentArg == "--output") && index + 1 < argc)
{
        outputFile = argv[++index];
        std::cout << "Output file specified: " << outputFile << std::endl;
    }
    else if ((currentArg == "-c" || currentArg == "--config") && index + 1 < argc) {
        configFile = argv[++index];
    }
    else if (currentArg == "-h" || currentArg == "--help") {
        std::cout << "Usage: " << argv[0]
            << " [-n num_books] [-m num_readers] [-o output_file] [-c
config_file]\\n";
    }
}
```



```
    return 0;  
}  
}
```



A terminal window titled "cmake-build-debug — -zsh — 80x24" is shown. The window has a light gray title bar with three colored window control buttons (red, yellow, green) on the left. The terminal content shows a user prompt "matveipasynkov@MacBook-Pro-Matvej" followed by a command: "cmake-build-debug % ./ConsoleApp_ABC --readers 5 --books 10 --output output.txt". The cursor is at the end of the command line.

```
matveipasynkov@MacBook-Pro-Matvej cmake-build-debug % ./ConsoleApp_ABC --readers  
5 --books 10 --output output.txt
```

```
cmake-build-debug — -zsh — 80x24

[matveipasynkov@MacBook-Pro-Matvej cmake-build-debug % ./ConsoleApp_ABC --readers]
5 --books 10 --output output.txt
Output file specified: output.txt
Output file already set to: output.txt
Reader (1) has taken the book with id: 0.
Reader (2) has taken the book with id: 3.
Reader (4) has taken the book with id: 1.
Reader (3) hasn't any opportunities to take book with id:0; because it's busy ri
ght now.
Reader (2) is reading books: 3
Reader (4) has taken the book with id: 4.
Reader (4) has taken the book with id: 9.
Reader (3) hasn't any opportunities to take book with id:3; because it's busy ri
ght now.
Reader (3) is waiting missing books.
Reader (4) is reading books: 1 4 9
Reader (5) hasn't any opportunities to take book with id:1; because it's busy ri
ght now.
Reader (5) has taken the book with id: 8.
Reader (1) hasn't any opportunities to take book with id:1; because it's busy ri
```

```
cmake-build-debug — -zsh — 80x24

Reader (1) has taken the book with id: 0.
Reader (1) hasn't any opportunities to take book with id:3; because it's busy ri
ght now.
Reader (1) is reading books: 0
Reader (5) got back book with id: 3.
Reader (1) got back book with id: 0.
Reader (1) is waiting missing books.
Reader (5) has taken the book with id: 5.
Reader (5) has taken the book with id: 7.
Reader (5) has taken the book with id: 8.
Reader (1) was notified about the availability of book 3 and successfully took i
t.
Reader (5) is reading books: 5 7 8
Reader (1) is reading books: 3
Reader (3) got back book with id: 9.
Reader (5) got back book with id: 5.
Reader (5) got back book with id: 7.
Reader (5) got back book with id: 8.
Reader (3) stopped his visits to the library.
Reader (1) got back book with id: 3.
Reader (5) stopped his visits to the library.
Reader (1) stopped his visits to the library.
Simulation is finished. Results saved in output.txt
matveipasynkov@MacBook-Pro-Matvej cmake-build-debug %
```

Выполнение критериев на 8 баллов

1. Вывод результатов на экран и в файл.

Экран

```
Please specify the number of books (N): 5
Specify the number of readers (M): 4
Provide the output file name: output.txt
Reader (1) has taken the book with id: 4.
Reader (3) has taken the book with id: 0.
Reader (1) is reading books: 4
Reader (2) hasn't any opportunities to take book with id:0; b
Reader (2) is waiting missing books.
Reader (3) is reading books: 0
Reader (4) hasn't any opportunities to take book with id:0; b
Reader (4) is waiting missing books.
Reader (3) got back book with id: 0.
Reader (1) got back book with id: 4.
Reader (4) was notified about the availability of book 0 and
Reader (4) is reading books: 0
Reader (1) has taken the book with id: 4.
Reader (1) is reading books: 4
Reader (3) has taken the book with id: 1.
Reader (3) hasn't any opportunities to take book with id:4; b
Reader (3) is reading books: 1
Reader (4) got back book with id: 0.
Reader (2) was notified about the availability of book 0 and
Reader (2) is reading books: 0
Reader (1) got back book with id: 4.
Reader (3) got back book with id: 1.
Reader (3) is waiting missing books.
Reader (4) has taken the book with id: 4.
Reader (4) is reading books: 4
Reader (1) hasn't any opportunities to take book with id:0; b
Reader (1) has taken the book with id: 1.
Reader (1) has taken the book with id: 2.
Reader (1) is reading books: 1 2
Reader (2) got back book with id: 0.
Reader (1) got back book with id: 1.
Reader (1) got back book with id: 2.
Reader (1) is waiting missing books.
```

Reader (4) got back book with id: 4.
Reader (3) was notified about the availability of book 4 and
Reader (3) is reading books: 4
Reader (1) was notified about the availability of book 0 and
Reader (3) got back book with id: 4.
Reader (1) is reading books: 0
Reader (2) hasn't any opportunities to take book with id:0; b
Reader (2) has taken the book with id: 1.
Reader (2) has taken the book with id: 4.
Reader (2) is reading books: 1 4
Reader (4) hasn't any opportunities to take book with id:1; b
Reader (4) has taken the book with id: 2.
Reader (4) has taken the book with id: 3.
Reader (4) is reading books: 2 3
Reader (3) hasn't any opportunities to take book with id:0; b
Reader (3) hasn't any opportunities to take book with id:4; b
Reader (3) is waiting missing books.
Reader (4) got back book with id: 2.
Reader (4) got back book with id: 3.
Reader (4) is waiting missing books.
Reader (2) got back book with id: 1.
Reader (2) got back book with id: 4.
Reader (2) is waiting missing books.
Reader (1) got back book with id: 0.
Reader (3) was notified about the availability of book 0 and
Reader (3) is reading books: 0
Reader (4) was notified about the availability of book 1 and
Reader (4) is reading books: 1
Reader (4) got back book with id: 1.
Reader (1) stopped his visits to the library.
Reader (3) got back book with id: 0.
Reader (3) was notified about the availability of book 4 and
Reader (3) is reading books: 4
Reader (2) was notified about the availability of book 0 and
Reader (2) is reading books: 0
Reader (2) got back book with id: 0.
Reader (4) stopped his visits to the library.
Reader (3) got back book with id: 4.

```
Reader (3) stopped his visits to the library.  
Reader (2) has taken the book with id: 1.  
Reader (2) is reading books: 1  
Reader (2) got back book with id: 1.  
Reader (2) stopped his visits to the library.  
Simulation is finished. Results saved in output.txt
```

Файл

```
Reader (1) has taken the book with id: 4.  
Reader (3) has taken the book with id: 0.  
Reader (1) is reading books: 4  
Reader (2) hasn't any opportunities to take book with id:0; b  
Reader (2) is waiting missing books.  
Reader (3) is reading books: 0  
Reader (4) hasn't any opportunities to take book with id:0; b  
Reader (4) is waiting missing books.  
Reader (3) got back book with id: 0.  
Reader (1) got back book with id: 4.  
Reader (4) was notified about the availability of book 0 and  
Reader (4) is reading books: 0  
Reader (1) has taken the book with id: 4.  
Reader (1) is reading books: 4  
Reader (3) has taken the book with id: 1.  
Reader (3) hasn't any opportunities to take book with id:4; b  
Reader (3) is reading books: 1  
Reader (4) got back book with id: 0.  
Reader (2) was notified about the availability of book 0 and  
Reader (2) is reading books: 0  
Reader (1) got back book with id: 4.  
Reader (3) got back book with id: 1.  
Reader (3) is waiting missing books.  
Reader (4) has taken the book with id: 4.  
Reader (4) is reading books: 4  
Reader (1) hasn't any opportunities to take book with id:0; b  
Reader (1) has taken the book with id: 1.  
Reader (1) has taken the book with id: 2.  
Reader (1) is reading books: 1 2
```

Reader (2) got back book with id: 0.
Reader (1) got back book with id: 1.
Reader (1) got back book with id: 2.
Reader (1) is waiting missing books.
Reader (4) got back book with id: 4.
Reader (3) was notified about the availability of book 4 and
Reader (3) is reading books: 4
Reader (1) was notified about the availability of book 0 and
Reader (3) got back book with id: 4.
Reader (1) is reading books: 0
Reader (2) hasn't any opportunities to take book with id:0; b
Reader (2) has taken the book with id: 1.
Reader (2) has taken the book with id: 4.
Reader (2) is reading books: 1 4
Reader (4) hasn't any opportunities to take book with id:1; b
Reader (4) has taken the book with id: 2.
Reader (4) has taken the book with id: 3.
Reader (4) is reading books: 2 3
Reader (3) hasn't any opportunities to take book with id:0; b
Reader (3) hasn't any opportunities to take book with id:4; b
Reader (3) is waiting missing books.
Reader (4) got back book with id: 2.
Reader (4) got back book with id: 3.
Reader (4) is waiting missing books.
Reader (2) got back book with id: 1.
Reader (2) got back book with id: 4.
Reader (2) is waiting missing books.
Reader (1) got back book with id: 0.
Reader (3) was notified about the availability of book 0 and
Reader (3) is reading books: 0
Reader (4) was notified about the availability of book 1 and
Reader (4) is reading books: 1
Reader (4) got back book with id: 1.
Reader (1) stopped his visits to the library.
Reader (3) got back book with id: 0.
Reader (3) was notified about the availability of book 4 and
Reader (3) is reading books: 4
Reader (2) was notified about the availability of book 0 and

```
Reader (2) is reading books: 0
Reader (2) got back book with id: 0.
Reader (4) stopped his visits to the library.
Reader (3) got back book with id: 4.
Reader (3) stopped his visits to the library.
Reader (2) has taken the book with id: 1.
Reader (2) is reading books: 1
Reader (2) got back book with id: 1.
Reader (2) stopped his visits to the library.
```

2. Вывод результатов в командной строке и в файл.

Терминал

```
matveipasynkov@MacBook-Pro-Matvej cmake-build-debug %
./ConsoleApp_ABC --readers 5 --books 10 --output output.txt
Output file specified: output.txt
Output file already set to: output.txt
Reader (1) has taken the book with id: 0.
Reader (2) has taken the book with id: 1.
Reader (2) has taken the book with id: 3.
Reader (4) has taken the book with id: 2.
Reader (5) has taken the book with id: 4.
Reader (5) has taken the book with id: 5.
Reader (5) has taken the book with id: 8.
Reader (3) has taken the book with id: 7.
Reader (1) hasn't any opportunities to take book with id:4; because it's busy
right now.
Reader (1) has taken the book with id: 9.
Reader (5) is reading books: 4 5 8
Reader (3) is reading books: 7
Reader (4) is reading books: 2
Reader (2) hasn't any opportunities to take book with id:7; because it's busy
right now.
Reader (1) is reading books: 0 9
Reader (2) is reading books: 1 3
Reader (4) got back book with id: 2.
Reader (3) got back book with id: 7.
Reader (5) got back book with id: 4.
```

Reader (5) got back book with id: 5.
Reader (5) got back book with id: 8.
Reader (1) got back book with id: 0.
Reader (1) got back book with id: 9.
Reader (1) is waiting missing books.
Reader (2) got back book with id: 1.
Reader (2) got back book with id: 3.
Reader (2) is waiting missing books.
Reader (3) has taken the book with id: 2.
Reader (3) has taken the book with id: 3.
Reader (1) was notified about the availability of book 4 and successfully took it.
Reader (2) was notified about the availability of book 7 and successfully took it.
Reader (1) is reading books: 4
Reader (5) hasn't any opportunities to take book with id:3; because it's busy right now.
Reader (3) is reading books: 2 3
Reader (4) hasn't any opportunities to take book with id:7; because it's busy right now.
Reader (2) is reading books: 7
Reader (4) is waiting missing books.
Reader (5) hasn't any opportunities to take book with id:7; because it's busy right now.
Reader (5) is waiting missing books.
Reader (1) got back book with id: 4.
Reader (3) got back book with id: 2.
Reader (3) got back book with id: 3.
Reader (5) was notified about the availability of book 3 and successfully took it.
Reader (5) is reading books: 3
Reader (1) hasn't any opportunities to take book with id:3; because it's busy right now.
Reader (1) is waiting missing books.
Reader (3) has taken the book with id: 9.
Reader (2) got back book with id: 7.
Reader (3) is reading books: 9
Reader (4) was notified about the availability of book 7 and successfully took it.
Reader (4) is reading books: 7
Reader (3) got back book with id: 9.
Reader (5) got back book with id: 3.

Reader (2) has taken the book with id: 0.
Reader (4) got back book with id: 7.
Reader (1) was notified about the availability of book 3 and successfully took it.
Reader (5) was notified about the availability of book 7 and successfully took it.
Reader (1) is reading books: 3
Reader (2) hasn't any opportunities to take book with id:3; because it's busy right now.
Reader (2) has taken the book with id: 5.
Reader (5) is reading books: 7
Reader (2) is reading books: 0 5
Reader (3) stopped his visits to the library.
Reader (2) got back book with id: 0.
Reader (2) got back book with id: 5.
Reader (2) is waiting missing books.
Reader (5) got back book with id: 7.
Reader (5) has taken the book with id: 0.
Reader (5) has taken the book with id: 8.
Reader (4) hasn't any opportunities to take book with id:0; because it's busy right now.
Reader (4) has taken the book with id: 7.
Reader (5) is reading books: 0 8
Reader (4) is reading books: 7
Reader (1) got back book with id: 3.
Reader (2) was notified about the availability of book 3 and successfully took it.
Reader (2) is reading books: 3
Reader (2) got back book with id: 3.
Reader (1) has taken the book with id: 3.
Reader (4) got back book with id: 7.
Reader (4) is waiting missing books.
Reader (5) got back book with id: 0.
Reader (5) got back book with id: 8.
Reader (1) is reading books: 3
Reader (4) was notified about the availability of book 0 and successfully took it.
Reader (4) is reading books: 0
Reader (5) stopped his visits to the library.
Reader (4) got back book with id: 0.
Reader (2) has taken the book with id: 6.
Reader (2) is reading books: 6

Reader (1) got back book with id: 3.
Reader (2) got back book with id: 6.
Reader (4) stopped his visits to the library.
Reader (1) stopped his visits to the library.
Reader (2) stopped his visits to the library.
Simulation is finished. Results saved in output.txt

Файл

```
Reader (1) has taken the book with id: 0.  
Reader (2) has taken the book with id: 1.  
Reader (2) has taken the book with id: 3.  
Reader (4) has taken the book with id: 2.  
Reader (5) has taken the book with id: 4.  
Reader (5) has taken the book with id: 5.  
Reader (5) has taken the book with id: 8.  
Reader (3) has taken the book with id: 7.  
Reader (1) hasn't any opportunities to take book with id:4; b  
Reader (1) has taken the book with id: 9.  
Reader (5) is reading books: 4 5 8  
Reader (3) is reading books: 7  
Reader (4) is reading books: 2  
Reader (2) hasn't any opportunities to take book with id:7; b  
Reader (1) is reading books: 0 9  
Reader (2) is reading books: 1 3  
Reader (4) got back book with id: 2.  
Reader (3) got back book with id: 7.  
Reader (5) got back book with id: 4.  
Reader (5) got back book with id: 5.  
Reader (5) got back book with id: 8.  
Reader (1) got back book with id: 0.  
Reader (1) got back book with id: 9.  
Reader (1) is waiting missing books.  
Reader (2) got back book with id: 1.  
Reader (2) got back book with id: 3.  
Reader (2) is waiting missing books.  
Reader (3) has taken the book with id: 2.  
Reader (3) has taken the book with id: 3.  
Reader (1) was notified about the availability of book 4 and
```

Reader (2) was notified about the availability of book 7 and
Reader (1) is reading books: 4
Reader (5) hasn't any opportunities to take book with id:3; b
Reader (3) is reading books: 2 3
Reader (4) hasn't any opportunities to take book with id:7; b
Reader (2) is reading books: 7
Reader (4) is waiting missing books.
Reader (5) hasn't any opportunities to take book with id:7; b
Reader (5) is waiting missing books.
Reader (1) got back book with id: 4.
Reader (3) got back book with id: 2.
Reader (3) got back book with id: 3.
Reader (5) was notified about the availability of book 3 and
Reader (5) is reading books: 3
Reader (1) hasn't any opportunities to take book with id:3; b
Reader (1) is waiting missing books.
Reader (3) has taken the book with id: 9.
Reader (2) got back book with id: 7.
Reader (3) is reading books: 9
Reader (4) was notified about the availability of book 7 and
Reader (4) is reading books: 7
Reader (3) got back book with id: 9.
Reader (5) got back book with id: 3.
Reader (2) has taken the book with id: 0.
Reader (4) got back book with id: 7.
Reader (1) was notified about the availability of book 3 and
Reader (5) was notified about the availability of book 7 and
Reader (1) is reading books: 3
Reader (2) hasn't any opportunities to take book with id:3; b
Reader (2) has taken the book with id: 5.
Reader (5) is reading books: 7
Reader (2) is reading books: 0 5
Reader (3) stopped his visits to the library.
Reader (2) got back book with id: 0.
Reader (2) got back book with id: 5.
Reader (2) is waiting missing books.
Reader (5) got back book with id: 7.
Reader (5) has taken the book with id: 0.

```
Reader (5) has taken the book with id: 8.
Reader (4) hasn't any opportunities to take book with id:0; b
Reader (4) has taken the book with id: 7.
Reader (5) is reading books: 0 8
Reader (4) is reading books: 7
Reader (1) got back book with id: 3.
Reader (2) was notified about the availability of book 3 and
Reader (2) is reading books: 3
Reader (2) got back book with id: 3.
Reader (1) has taken the book with id: 3.
Reader (4) got back book with id: 7.
Reader (4) is waiting missing books.
Reader (5) got back book with id: 0.
Reader (5) got back book with id: 8.
Reader (1) is reading books: 3
Reader (4) was notified about the availability of book 0 and
Reader (4) is reading books: 0
Reader (5) stopped his visits to the library.
Reader (4) got back book with id: 0.
Reader (2) has taken the book with id: 6.
Reader (2) is reading books: 6
Reader (1) got back book with id: 3.
Reader (2) got back book with id: 6.
Reader (4) stopped his visits to the library.
Reader (1) stopped his visits to the library.
Reader (2) stopped his visits to the library.
```

3. Реализация работы с конфигурационным файлом (три примера).

config1.txt

N=3

M=6

outputFile=output1.txt

output1.txt

Reader (2) has taken the book with id: 2.

Reader (1) has taken the book with id: 0.

Reader (3) has taken the book with id: 1.
Reader (2) is reading books: 2
Reader (4) hasn't any opportunities to take book with id:0; because it's busy right now.
Reader (1) hasn't any opportunities to take book with id:2; because it's busy right now.
Reader (5) hasn't any opportunities to take book with id:0; because it's busy right now.
Reader (3) is reading books: 1
Reader (1) is reading books: 0
Reader (4) hasn't any opportunities to take book with id:2; because it's busy right now.
Reader (4) is waiting missing books.
Reader (6) hasn't any opportunities to take book with id:0; because it's busy right now.
Reader (5) hasn't any opportunities to take book with id:1; because it's busy right now.
Reader (6) hasn't any opportunities to take book with id:1; because it's busy right now.
Reader (5) hasn't any opportunities to take book with id:2; because it's busy right now.
Reader (6) hasn't any opportunities to take book with id:2; because it's busy right now.
Reader (6) is waiting missing books.
Reader (5) is waiting missing books.
Reader (2) got back book with id: 2.
Reader (1) got back book with id: 0.
Reader (1) is waiting missing books.
Reader (5) was notified about the availability of book 0 and successfully took it.
Reader (5) is reading books: 0
Reader (2) hasn't any opportunities to take book with id:0; because it's busy right now.
Reader (2) hasn't any opportunities to take book with id:1; because it's busy right now.
Reader (2) has taken the book with id: 2.
Reader (2) is reading books: 2
Reader (3) got back book with id: 1.
Reader (5) got back book with id: 0.

Reader (5) was notified about the availability of book 1 and successfully took it.
Reader (4) was notified about the availability of book 0 and successfully took it.
Reader (5) is reading books: 1
Reader (4) is reading books: 0
Reader (5) got back book with id: 1.
Reader (4) got back book with id: 0.
Reader (6) was notified about the availability of book 0 and successfully took it.
Reader (6) is reading books: 0
Reader (2) got back book with id: 2.
Reader (2) is waiting missing books.
Reader (1) was notified about the availability of book 2 and successfully took it.
Reader (1) is reading books: 2
Reader (1) got back book with id: 2.
Reader (5) was notified about the availability of book 2 and successfully took it.
Reader (5) is reading books: 2
Reader (6) got back book with id: 0.
Reader (6) was notified about the availability of book 1 and successfully took it.
Reader (6) is reading books: 1
Reader (3) hasn't any opportunities to take book with id:2; because it's busy right now.
Reader (3) is waiting missing books.
Reader (1) hasn't any opportunities to take book with id:1; because it's busy right now.
Reader (1) is waiting missing books.
Reader (2) was notified about the availability of book 0 and successfully took it.
Reader (2) is reading books: 0
Reader (5) got back book with id: 2.
Reader (4) was notified about the availability of book 2 and successfully took it.
Reader (4) is reading books: 2
Reader (2) got back book with id: 0.
Reader (4) got back book with id: 2.
Reader (3) was notified about the availability of book 2 and successfully took it.
Reader (3) is reading books: 2
Reader (6) got back book with id: 1.
Reader (1) was notified about the availability of book 1 and successfully took it.
Reader (1) is reading books: 1
Reader (5) has taken the book with id: 0.
Reader (3) got back book with id: 2.

Reader (5) is reading books: 0
Reader (4) hasn't any opportunities to take book with id:0; because it's busy right now.
Reader (6) was notified about the availability of book 2 and successfully took it.
Reader (6) is reading books: 2
Reader (4) hasn't any opportunities to take book with id:2; because it's busy right now.
Reader (4) is waiting missing books.
Reader (5) got back book with id: 0.
Reader (6) got back book with id: 2.
Reader (4) was notified about the availability of book 0 and successfully took it.
Reader (4) is reading books: 0
Reader (1) got back book with id: 1.
Reader (3) hasn't any opportunities to take book with id:0; because it's busy right now.
Reader (3) is waiting missing books.
Reader (2) was notified about the availability of book 1 and successfully took it.
Reader (6) has taken the book with id: 2.
Reader (2) is reading books: 1
Reader (6) is reading books: 2
Reader (4) got back book with id: 0.
Reader (1) has taken the book with id: 0.
Reader (1) hasn't any opportunities to take book with id:1; because it's busy right now.
Reader (1) hasn't any opportunities to take book with id:2; because it's busy right now.
Reader (1) is reading books: 0
Reader (5) hasn't any opportunities to take book with id:2; because it's busy right now.
Reader (5) is waiting missing books.
Reader (1) got back book with id: 0.
Reader (1) is waiting missing books.
Reader (3) was notified about the availability of book 0 and successfully took it.
Reader (3) is reading books: 0
Reader (2) got back book with id: 1.
Reader (6) got back book with id: 2.
Reader (4) was notified about the availability of book 2 and successfully took it.
Reader (4) is reading books: 2

Reader (6) hasn't any opportunities to take book with id:0; because it's busy right now.
Reader (6) has taken the book with id: 1.
Reader (6) hasn't any opportunities to take book with id:2; because it's busy right now.
Reader (6) is reading books: 1
Reader (6) got back book with id: 1.
Reader (6) is waiting missing books.
Reader (2) hasn't any opportunities to take book with id:0; because it's busy right now.
Reader (1) was notified about the availability of book 1 and successfully took it.
Reader (3) got back book with id: 0.
Reader (1) is reading books: 1
Reader (2) hasn't any opportunities to take book with id:1; because it's busy right now.
Reader (2) is waiting missing books.
Reader (4) got back book with id: 2.
Reader (5) was notified about the availability of book 2 and successfully took it.
Reader (5) is reading books: 2
Reader (1) got back book with id: 1.
Reader (6) was notified about the availability of book 0 and successfully took it.
Reader (6) is reading books: 0
Reader (4) has taken the book with id: 1.
Reader (4) is reading books: 1
Reader (5) got back book with id: 2.
Reader (4) got back book with id: 1.
Reader (3) stopped his visits to the library.
Reader (1) was notified about the availability of book 2 and successfully took it.
Reader (1) is reading books: 2
Reader (6) got back book with id: 0.
Reader (2) was notified about the availability of book 0 and successfully took it.
Reader (2) is reading books: 0
Reader (4) stopped his visits to the library.
Reader (5) stopped his visits to the library.
Reader (2) got back book with id: 0.
Reader (2) was notified about the availability of book 1 and successfully took it.
Reader (2) is reading books: 1
Reader (1) got back book with id: 2.

Reader (6) was notified about the availability of book 2 and successfully took it.
Reader (6) is reading books: 2
Reader (2) got back book with id: 1.
Reader (1) stopped his visits to the library.
Reader (6) got back book with id: 2.
Reader (2) stopped his visits to the library.
Reader (6) stopped his visits to the library.

config2.txt

N=4
M=5
outputFile=output2.txt

output2.txt

Reader (1) has taken the book with id: 0.
Reader (3) has taken the book with id: 2.
Reader (2) hasn't any opportunities to take book with id:0; because it's busy right now.
Reader (3) is reading books: 2
Reader (1) hasn't any opportunities to take book with id:2; because it's busy right now.
Reader (1) has taken the book with id: 3.
Reader (2) is waiting missing books.
Reader (4) hasn't any opportunities to take book with id:0; because it's busy right now.
Reader (1) is reading books: 0 3
Reader (5) hasn't any opportunities to take book with id:0; because it's busy right now.
Reader (5) hasn't any opportunities to take book with id:2; because it's busy right now.
Reader (5) is waiting missing books.
Reader (4) has taken the book with id: 1.
Reader (4) hasn't any opportunities to take book with id:2; because it's busy right now.
Reader (4) is reading books: 1
Reader (3) got back book with id: 2.
Reader (1) got back book with id: 0.
Reader (1) got back book with id: 3.

Reader (1) is waiting missing books.
Reader (5) was notified about the availability of book 0 and successfully took it.
Reader (5) is reading books: 0
Reader (1) was notified about the availability of book 2 and successfully took it.
Reader (1) is reading books: 2
Reader (4) got back book with id: 1.
Reader (4) is waiting missing books.
Reader (3) hasn't any opportunities to take book with id:0; because it's busy right now.
Reader (3) has taken the book with id: 1.
Reader (3) has taken the book with id: 3.
Reader (3) is reading books: 1 3
Reader (3) got back book with id: 1.
Reader (3) got back book with id: 3.
Reader (3) is waiting missing books.
Reader (5) got back book with id: 0.
Reader (2) was notified about the availability of book 0 and successfully took it.
Reader (2) is reading books: 0
Reader (1) got back book with id: 2.
Reader (2) got back book with id: 0.
Reader (5) was notified about the availability of book 2 and successfully took it.
Reader (4) was notified about the availability of book 0 and successfully took it.
Reader (5) is reading books: 2
Reader (4) is reading books: 0
Reader (1) hasn't any opportunities to take book with id:0; because it's busy right now.
Reader (1) has taken the book with id: 1.
Reader (1) has taken the book with id: 3.
Reader (1) is reading books: 1 3
Reader (4) got back book with id: 0.
Reader (3) was notified about the availability of book 0 and successfully took it.
Reader (3) is reading books: 0
Reader (1) got back book with id: 1.
Reader (1) got back book with id: 3.
Reader (1) is waiting missing books.
Reader (2) hasn't any opportunities to take book with id:0; because it's busy right now.
Reader (2) hasn't any opportunities to take book with id:2; because it's busy

right now.
Reader (2) has taken the book with id: 3.
Reader (2) is reading books: 3
Reader (5) got back book with id: 2.
Reader (4) was notified about the availability of book 2 and successfully took it.
Reader (4) is reading books: 2
Reader (2) got back book with id: 3.
Reader (2) is waiting missing books.
Reader (5) hasn't any opportunities to take book with id:0; because it's busy right now.
Reader (5) hasn't any opportunities to take book with id:2; because it's busy right now.
Reader (5) has taken the book with id: 3.
Reader (5) is reading books: 3
Reader (4) got back book with id: 2.
Reader (5) got back book with id: 3.
Reader (5) is waiting missing books.
Reader (3) got back book with id: 0.
Reader (1) was notified about the availability of book 0 and successfully took it.
Reader (1) is reading books: 0
Reader (3) hasn't any opportunities to take book with id:0; because it's busy right now.
Reader (3) has taken the book with id: 2.
Reader (3) has taken the book with id: 3.
Reader (3) is reading books: 2 3
Reader (3) got back book with id: 2.
Reader (3) got back book with id: 3.
Reader (3) is waiting missing books.
Reader (1) got back book with id: 0.
Reader (4) has taken the book with id: 0.
Reader (4) is reading books: 0
Reader (4) got back book with id: 0.
Reader (5) was notified about the availability of book 0 and successfully took it.
Reader (5) is reading books: 0
Reader (1) has taken the book with id: 1.
Reader (1) is reading books: 1
Reader (1) got back book with id: 1.
Reader (4) hasn't any opportunities to take book with id:0; because it's busy

right now.

Reader (4) is waiting missing books.

Reader (5) got back book with id: 0.

Reader (1) stopped his visits to the library.

Reader (5) was notified about the availability of book 2 and successfully took it.

Reader (5) is reading books: 2

Reader (2) was notified about the availability of book 0 and successfully took it.

Reader (2) is reading books: 0

Reader (5) got back book with id: 2.

Reader (2) got back book with id: 0.

Reader (2) was notified about the availability of book 2 and successfully took it.

Reader (3) was notified about the availability of book 0 and successfully took it.

Reader (2) is reading books: 2

Reader (3) is reading books: 0

Reader (5) has taken the book with id: 1.

Reader (5) has taken the book with id: 3.

Reader (5) is reading books: 1 3

Reader (3) got back book with id: 0.

Reader (4) was notified about the availability of book 0 and successfully took it.

Reader (4) is reading books: 0

Reader (5) got back book with id: 1.

Reader (5) got back book with id: 3.

Reader (3) stopped his visits to the library.

Reader (2) got back book with id: 2.

Reader (4) got back book with id: 0.

Reader (2) has taken the book with id: 1.

Reader (2) has taken the book with id: 2.

Reader (2) has taken the book with id: 3.

Reader (2) is reading books: 1 2 3

Reader (5) stopped his visits to the library.

Reader (4) stopped his visits to the library.

Reader (2) got back book with id: 1.

Reader (2) got back book with id: 2.

Reader (2) got back book with id: 3.

Reader (2) stopped his visits to the library.

config3.txt

N=6

M=5

outputFile=output3.txt

output3.txt

Reader (1) has taken the book with id: 0.

Reader (2) has taken the book with id: 1.

Reader (3) has taken the book with id: 2.

Reader (5) has taken the book with id: 3.

Reader (4) hasn't any opportunities to take book with id:2; because it's busy right now.

Reader (4) hasn't any opportunities to take book with id:3; because it's busy right now.

Reader (4) is waiting missing books.

Reader (3) is reading books: 2

Reader (5) is reading books: 3

Reader (1) hasn't any opportunities to take book with id:2; because it's busy right now.

Reader (1) hasn't any opportunities to take book with id:3; because it's busy right now.

Reader (2) hasn't any opportunities to take book with id:2; because it's busy right now.

Reader (1) is reading books: 0

Reader (2) is reading books: 1

Reader (5) got back book with id: 3.

Reader (3) got back book with id: 2.

Reader (1) got back book with id: 0.

Reader (1) is waiting missing books.

Reader (2) got back book with id: 1.

Reader (2) is waiting missing books.

Reader (3) has taken the book with id: 0.

Reader (3) has taken the book with id: 3.

Reader (3) is reading books: 0 3

Reader (5) hasn't any opportunities to take book with id:2; because it's busy right now.

Reader (5) hasn't any opportunities to take book with id:3; because it's busy right now.

Reader (5) has taken the book with id: 5.

Reader (5) is reading books: 5
Reader (5) got back book with id: 5.
Reader (5) is waiting missing books.
Reader (3) got back book with id: 0.
Reader (3) got back book with id: 3.
Reader (3) has taken the book with id: 4.
Reader (3) is reading books: 4
Reader (3) got back book with id: 4.
Reader (3) stopped his visits to the library.
Reader (4) surpassed the wait time for book 2.
Reader (4) has taken the book with id: 3.
Reader (4) has taken the book with id: 4.
Reader (4) is reading books: 3 4
Reader (4) got back book with id: 3.
Reader (4) got back book with id: 4.
Reader (4) has taken the book with id: 0.
Reader (4) has taken the book with id: 4.
Reader (4) is reading books: 0 4
Reader (4) got back book with id: 0.
Reader (4) got back book with id: 4.
Reader (4) stopped his visits to the library.
Reader (1) surpassed the wait time for book 2.
Reader (5) surpassed the wait time for book 2.
Reader (2) surpassed the wait time for book 2.
Reader (5) has taken the book with id: 0.
Reader (5) is reading books: 0
Reader (1) hasn't any opportunities to take book with id:0; because it's busy right now.
Reader (1) has taken the book with id: 1.
Reader (1) has taken the book with id: 4.
Reader (1) is reading books: 1 4
Reader (2) hasn't any opportunities to take book with id:4; because it's busy right now.
Reader (2) is waiting missing books.
Reader (5) got back book with id: 0.
Reader (1) got back book with id: 1.
Reader (1) got back book with id: 4.
Reader (1) is waiting missing books.

Reader (2) was notified about the availability of book 4 and successfully took it.
Reader (2) is reading books: 4
Reader (1) was notified about the availability of book 0 and successfully took it.
Reader (1) is reading books: 0
Reader (5) stopped his visits to the library.
Reader (1) got back book with id: 0.
Reader (2) got back book with id: 4.
Reader (1) has taken the book with id: 0.
Reader (1) has taken the book with id: 3.
Reader (1) has taken the book with id: 4.
Reader (1) is reading books: 0 3 4
Reader (2) hasn't any opportunities to take book with id:2; because it's busy right now.
Reader (2) is waiting missing books.
Reader (1) got back book with id: 0.
Reader (1) got back book with id: 3.
Reader (1) got back book with id: 4.
Reader (1) stopped his visits to the library.
Reader (2) surpassed the wait time for book 2.
Reader (2) stopped his visits to the library.