Задание 2

Реализовать Класс MyConcurrentQueue

Отчёт

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1. Постановка задачи

Реализовать класс/структуру MyConcurrentQueue, которая поддерживает работу с многопоточными операциями. Основные требования к реализации:

Атрибут *MyConcurrentQueue::queue* — очередь, которая поддерживает произвольные POD-данные. Емкость очереди ограничена.

Метод *MyConcurrentQueue::put()* — добавляет элемент в очередь. Если очередь заполнена, поток ждет освобождения места.

Метод *MyConcurrentQueue::get()* — извлекает элемент из очереди. Если очередь пуста, поток ждет появления элемента.

Методы *put()* и *get()* могут вызываться одновременно различным числом потоков (произвольным).

Поток, вызвавший *put()* или *get()*, может завершить свою операцию позже других потоков, несмотря на то, что начал раньше.

Реализовать корректную работу очереди при любом состоянии:

Если очередь пуста, потоки, пытающиеся взять элемент, ожидают.

Если очередь заполнена, потоки, пытающиеся добавить элемент, ожидают.

2. Формат командной строки

g++ -std=c++11 -pthread -o concurrent_queue concurrent_queue.cpp

./concurrent_queue

3. Спецификация системы

Pe- Operation System：Ubuntu 20.04.5 LTS

- Architecture: x86_64

- Model name：Intel(R) Core(TM) i7-10750H CPU @ 2.60GHz

- CPU(s):1

- Memory:8 GB

- g++ (Ubuntu 9.4.0-1ubuntu1~20.04.2) 9.4

4. зультаты выполнения

4.1 Увеличение требований：

- Производитель добавляет в очередь 15 товаров за один вызов метода put().

- Каждый производитель выполняет случайное количество операций (от 1 до 5), добавляя товары.

- Если количество товаров в очереди падает ниже 2, производитель активируется и начинает производство.

- Каждый потребитель берет из очереди один товар за вызов get(). Если товаров нет, поток ждет.

4.2 Реализация：

4.2.1 Атрибуты:

capacity — максимальная вместимость очереди.

item_count — текущее количество товаров в очереди.

done — флаг, сигнализирующий об окончании работы всех производителей.

Мьютекс (mutex) и условные переменные (*cond_full, cond_empty*) для синхронизации потоков.

4.2.2 Методы:

put() — добавляет товары в очередь. Производитель блокируется, если очередь заполнена.

get() — извлекает товары из очереди. Потребитель блокируется, если очередь пуста.

set_done() — уведомляет, что производители завершили работу.

4.2.3 Логика работы:

Производители и потребители работают параллельно. Если товаров не хватает, потребители ждут, а если очередь заполнена, производители ждут.

Когда производители завершают работу, они устанавливают флаг done, чтобы потребители могли завершить свою работу.

4.3 Тестирование

4.3.1   Test1

В тесте 1 у нас есть один производитель и три потребителя. Программа выполняется в общей сложности 4,50894 секунды.

Test 1: {1 producer, N consumers}
Producer 1 will produce 3 TIMES.
Producer 1 produced 15 items, total items: 15
Consumer 1 consumed 1 item, remaining items: 14
Consumer 2 consumed 1 item, remaining items: 13
Consumer 3 consumed 1 item, remaining items: 12
Consumer 1 consumed 1 item, remaining items: 11
Consumer 2 consumed 1 item, remaining items: 10
Consumer 3 consumed 1 item, remaining items: 9
Consumer 2 consumed 1 item, remaining items: 8
Consumer 3 consumed 1 item, remaining items: 7
Consumer 1 consumed 1 item, remaining items: 6
Consumer 3 consumed 1 item, remaining items: 5

Consumer 1 consumed 1 item, remaining items: 4
Consumer 2 consumed 1 item, remaining items: 3
Consumer 3 consumed 1 item, remaining items: 2
Consumer 1 consumed 1 item, remaining items: 1
Consumer 2 consumed 1 item, remaining items: 0
Producer 1 produced 15 items, total items: 15
Consumer 1 consumed 1 item, remaining items: 14
Consumer 3 consumed 1 item, remaining items: 13
Consumer 2 consumed 1 item, remaining items: 12
Consumer 2 consumed 1 item, remaining items: 11
Consumer 3 consumed 1 item, remaining items: 10
Consumer 1 consumed 1 item, remaining items: 9
Consumer 3 consumed 1 item, remaining items: 8
Consumer 1 consumed 1 item, remaining items: 7
Consumer 2 consumed 1 item, remaining items: 6
Consumer 1 consumed 1 item, remaining items: 5
Consumer 2 consumed 1 item, remaining items: 4
Consumer 3 consumed 1 item, remaining items: 3
Consumer 2 consumed 1 item, remaining items: 2
Consumer 1 consumed 1 item, remaining items: 1
Consumer 3 consumed 1 item, remaining items: 0
Producer 1 produced 15 items, total items: 15
Consumer 2 consumed 1 item, remaining items: 14
Consumer 1 consumed 1 item, remaining items: 13
Consumer 3 consumed 1 item, remaining items: 12
Producer 1 finished producing.
Consumer 3 consumed 1 item, remaining items: 11
Consumer 1 consumed 1 item, remaining items: 10
Consumer 2 consumed 1 item, remaining items: 9
Consumer 1 consumed 1 item, remaining items: 8
Consumer 3 consumed 1 item, remaining items: 7
Consumer 2 consumed 1 item, remaining items: 6
Consumer 1 consumed 1 item, remaining items: 5
Consumer 3 consumed 1 item, remaining items: 4
Consumer 2 consumed 1 item, remaining items: 3
Consumer 3 consumed 1 item, remaining items: 2
Consumer 2 consumed 1 item, remaining items: 1
Consumer 1 consumed 1 item, remaining items: 0
Consumer3finished consuming.
Consumer2finished consuming.
Consumer1finished consuming.
Elapsed time: 4.50894 seconds

4.3.2 Test2

В тесте 2 у нас есть три производителя и один потребитель.

Продолжительность программы составляет в общей сложности 31,5407

секунды.

Test 2: {N producers, 1 consumer}
Producer 2 will produce 1 TIMES.
Producer 2 produced 15 items, total items: 15
Producer 3 will produce 3 TIMES.
Consumer 1 consumed 1 item, remaining items: 14
Producer 1 will produce 3 TIMES.
Consumer 1 consumed 1 item, remaining items: 13
Producer 2 finished producing.
Consumer 1 consumed 1 item, remaining items: 12
Consumer 1 consumed 1 item, remaining items: 11
Consumer 1 consumed 1 item, remaining items: 10
Consumer 1 consumed 1 item, remaining items: 9
Consumer 1 consumed 1 item, remaining items: 8
Consumer 1 consumed 1 item, remaining items: 7
Consumer 1 consumed 1 item, remaining items: 6
Consumer 1 consumed 1 item, remaining items: 5
Consumer 1 consumed 1 item, remaining items: 4
Consumer 1 consumed 1 item, remaining items: 3
Consumer 1 consumed 1 item, remaining items: 2
Consumer 1 consumed 1 item, remaining items: 1
Producer 3 produced 15 items, total items: 16
Consumer 1 consumed 1 item, remaining items: 15
Consumer 1 consumed 1 item, remaining items: 14
Consumer 1 consumed 1 item, remaining items: 13
Consumer 1 consumed 1 item, remaining items: 12
Consumer 1 consumed 1 item, remaining items: 11
Consumer 1 consumed 1 item, remaining items: 10
Consumer 1 consumed 1 item, remaining items: 9
Consumer 1 consumed 1 item, remaining items: 8
Consumer 1 consumed 1 item, remaining items: 7
Consumer 1 consumed 1 item, remaining items: 6
Consumer 1 consumed 1 item, remaining items: 5
Consumer 1 consumed 1 item, remaining items: 4
Consumer 1 consumed 1 item, remaining items: 3
Consumer 1 consumed 1 item, remaining items: 2
Consumer 1 consumed 1 item, remaining items: 1
Producer 3 produced 15 items, total items: 16
Consumer 1 consumed 1 item, remaining items: 15
Consumer 1 consumed 1 item, remaining items: 14

Consumer 1 consumed 1 item, remaining items: 13
Consumer 1 consumed 1 item, remaining items: 12
Consumer 1 consumed 1 item, remaining items: 11
Consumer 1 consumed 1 item, remaining items: 10
Consumer 1 consumed 1 item, remaining items: 9
Consumer 1 consumed 1 item, remaining items: 8
Consumer 1 consumed 1 item, remaining items: 7
Consumer 1 consumed 1 item, remaining items: 6
Consumer 1 consumed 1 item, remaining items: 5
Consumer 1 consumed 1 item, remaining items: 4
Consumer 1 consumed 1 item, remaining items: 3
Consumer 1 consumed 1 item, remaining items: 2
Consumer 1 consumed 1 item, remaining items: 1
Producer 1 produced 15 items, total items: 16
Consumer 1 consumed 1 item, remaining items: 15
Consumer 1 consumed 1 item, remaining items: 14
Consumer 1 consumed 1 item, remaining items: 13
Consumer 1 consumed 1 item, remaining items: 12
Consumer 1 consumed 1 item, remaining items: 11
Consumer 1 consumed 1 item, remaining items: 10
Consumer 1 consumed 1 item, remaining items: 9
Consumer 1 consumed 1 item, remaining items: 8
Consumer 1 consumed 1 item, remaining items: 7
Consumer 1 consumed 1 item, remaining items: 6
Consumer 1 consumed 1 item, remaining items: 5
Consumer 1 consumed 1 item, remaining items: 4
Consumer 1 consumed 1 item, remaining items: 3
Consumer 1 consumed 1 item, remaining items: 2
Consumer 1 consumed 1 item, remaining items: 1
Producer 3 produced 15 items, total items: 16
Consumer 1 consumed 1 item, remaining items: 15
Producer 3 finished producing.
Consumer 1 consumed 1 item, remaining items: 14
Consumer 1 consumed 1 item, remaining items: 13
Consumer 1 consumed 1 item, remaining items: 12
Consumer 1 consumed 1 item, remaining items: 11
Consumer 1 consumed 1 item, remaining items: 10
Consumer 1 consumed 1 item, remaining items: 9
Consumer 1 consumed 1 item, remaining items: 8
Consumer 1 consumed 1 item, remaining items: 7
Consumer 1 consumed 1 item, remaining items: 6
Consumer 1 consumed 1 item, remaining items: 5
Consumer 1 consumed 1 item, remaining items: 4
Consumer 1 consumed 1 item, remaining items: 3

Consumer 1 consumed 1 item, remaining items: 2
Consumer 1 consumed 1 item, remaining items: 1
Producer 1 produced 15 items, total items: 16
Consumer 1 consumed 1 item, remaining items: 15
Consumer 1 consumed 1 item, remaining items: 14
Consumer 1 consumed 1 item, remaining items: 13
Consumer 1 consumed 1 item, remaining items: 12
Consumer 1 consumed 1 item, remaining items: 11
Consumer 1 consumed 1 item, remaining items: 10
Consumer 1 consumed 1 item, remaining items: 9
Consumer 1 consumed 1 item, remaining items: 8
Consumer 1 consumed 1 item, remaining items: 7
Consumer 1 consumed 1 item, remaining items: 6
Consumer 1 consumed 1 item, remaining items: 5
Consumer 1 consumed 1 item, remaining items: 4
Consumer 1 consumed 1 item, remaining items: 3
Consumer 1 consumed 1 item, remaining items: 2
Consumer 1 consumed 1 item, remaining items: 1
Producer 1 produced 15 items, total items: 16
Consumer 1 consumed 1 item, remaining items: 15
Producer 1 finished producing.
Consumer 1 consumed 1 item, remaining items: 14
Consumer 1 consumed 1 item, remaining items: 13
Consumer 1 consumed 1 item, remaining items: 12
Consumer 1 consumed 1 item, remaining items: 11
Consumer 1 consumed 1 item, remaining items: 10
Consumer 1 consumed 1 item, remaining items: 9
Consumer 1 consumed 1 item, remaining items: 8
Consumer 1 consumed 1 item, remaining items: 7
Consumer 1 consumed 1 item, remaining items: 6
Consumer 1 consumed 1 item, remaining items: 5
Consumer 1 consumed 1 item, remaining items: 4
Consumer 1 consumed 1 item, remaining items: 3
Consumer 1 consumed 1 item, remaining items: 2
Consumer 1 consumed 1 item, remaining items: 1
Consumer 1 consumed 1 item, remaining items: 0
Consumer1finished consuming.
Elapsed time: 31.5407 seconds

4.3.3 Test3

В тесте 3 у нас есть два производителя и пять потребителей. Программа

выполняется в общей сложности 5,41331 секунды.

Test 3: {M producers, N consumers}

Producer 1 will produce 4 TIMES.
Producer 1 produced 15 items, total items: 15
Producer 2 will produce 2 TIMES.
Consumer 1 consumed 1 item, remaining items: 14
Consumer 2 consumed 1 item, remaining items: 13
Consumer 3 consumed 1 item, remaining items: 12
Consumer 4 consumed 1 item, remaining items: 11
Consumer 5 consumed 1 item, remaining items: 10
Consumer 2 consumed 1 item, remaining items: 9
Consumer 5 consumed 1 item, remaining items: 8
Consumer 1 consumed 1 item, remaining items: 7
Consumer 3 consumed 1 item, remaining items: 6
Consumer 4 consumed 1 item, remaining items: 5
Consumer 4 consumed 1 item, remaining items: 4
Consumer 1 consumed 1 item, remaining items: 3
Consumer 5 consumed 1 item, remaining items: 2
Consumer 3 consumed 1 item, remaining items: 1
Producer 2 produced 15 items, total items: 16
Consumer 2 consumed 1 item, remaining items: 15
Consumer 5 consumed 1 item, remaining items: 14
Consumer 1 consumed 1 item, remaining items: 13
Consumer 3 consumed 1 item, remaining items: 12
Consumer 4 consumed 1 item, remaining items: 11
Consumer 2 consumed 1 item, remaining items: 10
Consumer 1 consumed 1 item, remaining items: 9
Consumer 3 consumed 1 item, remaining items: 8
Consumer 5 consumed 1 item, remaining items: 7
Consumer 4 consumed 1 item, remaining items: 6
Consumer 2 consumed 1 item, remaining items: 5
Consumer 3 consumed 1 item, remaining items: 4
Consumer 1 consumed 1 item, remaining items: 3
Consumer 5 consumed 1 item, remaining items: 2
Consumer 4 consumed 1 item, remaining items: 1
Producer 1 produced 15 items, total items: 16
Consumer 2 consumed 1 item, remaining items: 15
Consumer 1 consumed 1 item, remaining items: 14
Consumer 5 consumed 1 item, remaining items: 13
Consumer 4 consumed 1 item, remaining items: 12
Consumer 2 consumed 1 item, remaining items: 11
Consumer 3 consumed 1 item, remaining items: 10
Consumer 5 consumed 1 item, remaining items: 9
Consumer 4 consumed 1 item, remaining items: 8
Consumer 2 consumed 1 item, remaining items: 7
Consumer 1 consumed 1 item, remaining items: 6

Consumer 3 consumed 1 item, remaining items: 5
Consumer 4 consumed 1 item, remaining items: 4
Consumer 2 consumed 1 item, remaining items: 3
Consumer 5 consumed 1 item, remaining items: 2
Consumer 3 consumed 1 item, remaining items: 1
Producer 2 produced 15 items, total items: 16
Consumer 1 consumed 1 item, remaining items: 15
Consumer 2 consumed 1 item, remaining items: 14
Consumer 4 consumed 1 item, remaining items: 13
Consumer 5 consumed 1 item, remaining items: 12
Consumer 1 consumed 1 item, remaining items: 11
Consumer 3 consumed 1 item, remaining items: 10
Producer 2 finished producing.
Consumer 2 consumed 1 item, remaining items: 9
Consumer 4 consumed 1 item, remaining items: 8
Consumer 5 consumed 1 item, remaining items: 7
Consumer 1 consumed 1 item, remaining items: 6
Consumer 3 consumed 1 item, remaining items: 5
Consumer 4 consumed 1 item, remaining items: 4
Consumer 5 consumed 1 item, remaining items: 3
Consumer 2 consumed 1 item, remaining items: 2
Consumer 1 consumed 1 item, remaining items: 1
Producer 1 produced 15 items, total items: 16
Consumer 3 consumed 1 item, remaining items: 15
Consumer 5 consumed 1 item, remaining items: 14
Consumer 4 consumed 1 item, remaining items: 13
Consumer 2 consumed 1 item, remaining items: 12
Consumer 3 consumed 1 item, remaining items: 11
Consumer 1 consumed 1 item, remaining items: 10
Consumer 4 consumed 1 item, remaining items: 9
Consumer 2 consumed 1 item, remaining items: 8
Consumer 3 consumed 1 item, remaining items: 7
Consumer 1 consumed 1 item, remaining items: 6
Consumer 5 consumed 1 item, remaining items: 5
Consumer 2 consumed 1 item, remaining items: 4
Consumer 1 consumed 1 item, remaining items: 3
Consumer 3 consumed 1 item, remaining items: 2
Consumer 5 consumed 1 item, remaining items: 1
Producer 1 produced 15 items, total items: 16
Consumer 4 consumed 1 item, remaining items: 15
Consumer 3 consumed 1 item, remaining items: 14
Consumer 1 consumed 1 item, remaining items: 13
Consumer 5 consumed 1 item, remaining items: 12
Consumer 4 consumed 1 item, remaining items: 11

Consumer 2 consumed 1 item, remaining items: 10
Producer 1 finished producing.
Consumer 3 consumed 1 item, remaining items: 9
Consumer 5 consumed 1 item, remaining items: 8
Consumer 1 consumed 1 item, remaining items: 7
Consumer 4 consumed 1 item, remaining items: 6
Consumer 2 consumed 1 item, remaining items: 5
Consumer 5 consumed 1 item, remaining items: 4
Consumer 1 consumed 1 item, remaining items: 3
Consumer 4 consumed 1 item, remaining items: 2
Consumer 3 consumed 1 item, remaining items: 1
Consumer 2 consumed 1 item, remaining items: 0
Consumer1finished consuming.
Consumer5finished consuming.
Consumer4finished consuming.
Consumer3finished consuming.
Consumer2finished consuming.
Elapsed time: 5.41331 seconds

4.3.4 Test4

В Test4 у нас есть производитель и потребитель. Продолжительность

программы составляет в общей сложности 9,01489 секунды.

Test 4: {1 producer, 1 consumer}
Producer 1 will produce 2 TIMES.
Producer 1 produced 15 items, total items: 15
Consumer 1 consumed 1 item, remaining items: 14
Consumer 1 consumed 1 item, remaining items: 13
Consumer 1 consumed 1 item, remaining items: 12
Consumer 1 consumed 1 item, remaining items: 11
Consumer 1 consumed 1 item, remaining items: 10
Consumer 1 consumed 1 item, remaining items: 9
Consumer 1 consumed 1 item, remaining items: 8
Consumer 1 consumed 1 item, remaining items: 7
Consumer 1 consumed 1 item, remaining items: 6
Consumer 1 consumed 1 item, remaining items: 5
Consumer 1 consumed 1 item, remaining items: 4
Consumer 1 consumed 1 item, remaining items: 3
Consumer 1 consumed 1 item, remaining items: 2
Consumer 1 consumed 1 item, remaining items: 1
Producer 1 produced 15 items, total items: 16
Consumer 1 consumed 1 item, remaining items: 15
Producer 1 finished producing.
Consumer 1 consumed 1 item, remaining items: 14

Consumer 1 consumed 1 item, remaining items: 13
Consumer 1 consumed 1 item, remaining items: 12
Consumer 1 consumed 1 item, remaining items: 11
Consumer 1 consumed 1 item, remaining items: 10
Consumer 1 consumed 1 item, remaining items: 9
Consumer 1 consumed 1 item, remaining items: 8
Consumer 1 consumed 1 item, remaining items: 7
Consumer 1 consumed 1 item, remaining items: 6
Consumer 1 consumed 1 item, remaining items: 5
Consumer 1 consumed 1 item, remaining items: 4
Consumer 1 consumed 1 item, remaining items: 3
Consumer 1 consumed 1 item, remaining items: 2
Consumer 1 consumed 1 item, remaining items: 1
Consumer 1 consumed 1 item, remaining items: 0
Consumer1finished consuming.
Elapsed time: 9.01489 seconds