

**ПРАВИТЕЛЬСТВО РОССИЙСКОЙ ФЕДЕРАЦИИ
НАЦИОНАЛЬНЫЙ ИССЛЕДОВАТЕЛЬСКИЙ УНИВЕРСИТЕТ
«ВЫСШАЯ ШКОЛА ЭКОНОМИКИ»**

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МИКРОПРОЕКТ 2. ЗАДАЧА ОБ ОБЕДАЮЩИХ ФИЛОСОФАХ.

Пояснительная записка

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1. ВВЕДЕНИЕ

1.1. Текст задания

Задача об обедающих философях. Пять философов сидят возле круглого стола. Они проводят жизнь, чередуя приемы пищи и размышления. В центре стола находится большое блюдо спагетти. Спагетти длинные и запутанные, философам тяжело управляться с ними, поэтому каждый из них, чтобы съесть порцию, должен пользоваться двумя вилками. К несчастью, философам дали только пять вилок. Между каждой парой философов лежит одна вилка, поэтому эти высококультурные и предельно вежливые люди договорились, что каждый будет пользоваться только теми вилками, которые лежат рядом с ним (слева и справа). Написать многопоточную программу, моделирующую поведение философов с помощью семафоров. Программа должна избегать фатальной ситуации, в которой все философы голодны, но ни один из них не может взять обе вилки (например, каждый из философов держит по одной вилки и не хочет отдавать ее). Решение должно быть симметричным, то есть все потоки-философы должны выполнять один и тот же код.

2. ТРЕБОВАНИЯ К ПРОГРАММЕ

2.1. Исходные данные

Программе подается на вход единственное число – максимальное количество итераций вывода программы. Диапазон значений – $[1, 2^{31}-1]$. При неверном вводе программа запрашивает ввод повторно.

2.2. Вывод программы

Программа на каждой итерации вывода, выполняющейся каждую секунду, выводит время с начала запуска программы, произошедшие события с прошлого вывода и текущее состояние стола (какие ложки лежат на столе, а какие – находятся в руках у философов).

2.3. Обеспечение стабильной работы программы

Для предотвращения ситуации, когда все философы голодны, но не один из них не может взять себе вилку, философам разрешается брать только две вилки одновременно, если эти вилки, конечно, свободны.

3. ПРИМЕНЯЕМЫЕ РАСЧЁТНЫЕ МЕТОДЫ

Для решения поставленной задачи программа в главном потоке создает 7 потоков. 5 – философы (philosophers), один – для вывода (printing_thread) и еще один – для синхронизации (sync – ограничение доступа к общим переменным для правильной работы программы и правильного и непротиворечивого вывода). Эти потоки запускаются в функциях eat и print_iteration.

Программа использует библиотеку thread C++ и реализует класс semaphore, основанный на mutex [1]. Каждая вилка реализована как объект semaphore.

3.1. Semaphore

Реализует стандартный интерфейс семафоров для C++ – wait(), post() и try_wait(). ^[2] ~~(Идея взята из [2])~~

Также реализует интерфейс для работы метода std::lock. [3]

3.2. Eat

Функция для работы потоков философов. Для симуляции ожидания вилок функция использует семафоры, которые моделируют вилки. Обе вилки предаются параметрами в функцию std::lock, которая вызывает для них методы wait() и ждет, пока каждый из методов завершится. Метод ждет какое-то случайное время ([300,700] мс) для симуляции «реакции» философов, а также какое-то время ([1,3] сек) пока текущий философ не доест порцию макарон. Для отправки данных о случившихся событиях (философ № X начал/закончил есть макароны) все события из метода eat() записываются в массив events и выводятся в методе print_iteration().

3.3. Print_iteration

Метод каждую секунду выводит время с начала запуска программы, произошедшие события с прошлого вывода (из массива events, который потом отчищается) и текущее состояние стола в формате

```
F--P1--F--P2
|         |
P5         .
|         |
F--P4---P3
```

(PX – философ номер X, . – пустое место для вилки, F – вилка (Fork)).

4. ТЕСТОВЫЕ ПРИМЕРЫ

TECT 1.

File - Semaphore

C:\CLionProjects\Semaphore\cmake-build-debug\Semaphore.exe
Enter maximum amount of iterations:10

```
time: 0s
F--P1--F--P2
|      |
P5      F
|      |
F--P4--F--P3

time: 1s
philosopher 1 started eating
philosopher 4 started eating
.--P1---P2
|      |
P5      F
|      |
.--P4---P3

time: 2s
philosopher 1 finished eating
philosopher 4 finished eating
F--P1--F--P2
|      |
P5      F
|      |
F--P4--F--P3

time: 3s
philosopher 5 started eating
philosopher 2 started eating
.--P1---P2
|      |
P5      .
|      |
.--P4--F--P3

time: 4s
philosopher 5 finished eating
philosopher 2 finished eating
philosopher 3 started eating
F--P1--F--P2
|      |
P5      .
|      |
F--P4---P3

time: 5s
philosopher 1 started eating
.--P1---P2
|      |
P5      .
|      |
F--P4---P3

time: 6s
philosopher 3 finished eating
philosopher 1 finished eating
F--P1--F--P2
|      |
P5      F
|      |
F--P4--F--P3

time: 7s
philosopher 3 started eating
philosopher 1 started eating
.--P1---P2
|      |
P5      .
|      |
F--P4---P3

time: 8s
philosopher 3 finished eating
.--P1---P2
|      |
P5      F
|      |
F--P4--F--P3

time: 9s
philosopher 4 started eating
.--P1---P2
|      |
P5      F
|      |
.--P4---P3
```

Process finished with exit code 0

TECT 2.

File - Semaphore

C:\CLionProjects\Semaphore\cmake-build-debug\Semaphore.exe
Enter maximum amount of iterations:15

time: 0s
F--P1--F--P2
| |
P5 F
| |
F--P4--F--P3

time: 1s
philosopher 4 started eating
philosopher 1 started eating
.--P1---.--P2
| |
P5 F
| |
.--P4---.--P3

time: 2s
philosopher 1 finished eating
philosopher 4 finished eating
F--P1--F--P2
| |
P5 F
| |
F--P4--F--P3

time: 3s
philosopher 2 started eating
philosopher 4 started eating
F--P1---.--P2
| |
P5 .
| |
.--P4---.--P3

time: 4s
philosopher 2 finished eating
philosopher 4 finished eating
F--P1--F--P2
| |
P5 F
| |
F--P4--F--P3

time: 5s
philosopher 2 started eating
philosopher 5 started eating
.--P1---.--P2
| |
P5 .
| |
.--P4--F--P3

time: 6s
philosopher 5 finished eating
philosopher 2 finished eating
F--P1--F--P2
| |
P5 F
| |
F--P4--F--P3

time: 7s
philosopher 5 started eating
philosopher 2 started eating
.--P1---.--P2
| |
P5 .
| |
.--P4--F--P3

time: 8s
philosopher 5 finished eating
F--P1---.--P2
| |
P5 .
| |
F--P4--F--P3

time: 9s
philosopher 5 started eating
.--P1---.--P2
| |
P5 .
| |
.--P4--F--P3

time: 10s
philosopher 2 finished eating
philosopher 3 started eating
.--P1--F--P2
| |
P5 .
| |
.--P4---.--P3

time: 11s
philosopher 3 finished eating
.--P1--F--P2
| |
P5 F
| |
.--P4--F--P3

File - Semaphore

```
time: 12s
philosopher 5 finished eating
philosopher 3 started eating
philosopher 5 started eating
.--P1--F--P2
|
P5      .
|
.--P4--.--P3
```

```
time: 13s
.--P1--F--P2
|
P5      .
|
.--P4--.--P3
```

```
time: 14s
philosopher 3 finished eating
philosopher 3 started eating
.--P1--F--P2
|
P5      .
|
.--P4--.--P3
```

Process finished with exit code 0

TECT 3.

File - Semaphore

C:\CLionProjects\Semaphore\cmake-build-debug\Semaphore.exe
Enter maximum amount of iterations:30

time: 0s
F--P1--F--P2
| |
P5 F
| |
F--P4--F--P3

time: 1s
philosopher 1 started eating
philosopher 4 started eating
.--P1---P2
| |
P5 F
| |
.--P4---P3

time: 2s
philosopher 1 finished eating
philosopher 4 finished eating
F--P1--F--P2
| |
P5 F
| |
F--P4--F--P3

time: 3s
philosopher 2 started eating
philosopher 5 started eating
.--P1---P2
| |
P5 .
| |
.--P4--F--P3

time: 4s
philosopher 2 finished eating
philosopher 5 finished eating
philosopher 3 started eating
F--P1--F--P2
| |
P5 .
| |
F--P4---P3

time: 5s
philosopher 5 started eating
.--P1--F--P2
| |
P5 .
| |
.--P4---P3

time: 6s
philosopher 3 finished eating
philosopher 5 finished eating
philosopher 2 started eating
F--P1---P2
| |
P5 .
| |
F--P4--F--P3

time: 7s
philosopher 5 started eating
.--P1---P2
| |
P5 .
| |
.--P4--F--P3

time: 8s
philosopher 2 finished eating
.--P1--F--P2
| |
P5 F
| |
.--P4--F--P3

time: 9s
philosopher 3 started eating
.--P1--F--P2
| |
P5 .
| |
.--P4---P3

time: 10s
philosopher 5 finished eating
philosopher 3 finished eating
philosopher 5 started eating
.--P1--F--P2
| |
P5 F
| |
.--P4--F--P3

time: 11s
philosopher 2 started eating
.--P1---P2
| |
P5 .
| |
.--P4--F--P3


```

time: 12s
philosopher 5 finished eating
F--P1--P2
|
P5
|
F--P4--F--P3

```

```

time: 13s
philosopher 4 started eating
philosopher 2 finished eating
F--P1--F--P2
|
P5
|
F--P4--F--P3

```

```

time: 14s
philosopher 2 started eating
F--P1--P2
|
P5
|
F--P4--F--P3

```

```

time: 15s
philosopher 4 finished eating
philosopher 5 started eating
F--P1--P2
|
P5
|
F--P4--F--P3

```

```

time: 16s
philosopher 2 finished eating
philosopher 5 finished eating
F--P1--F--P2
|
P5
|
F--P4--F--P3

```

```

time: 17s
philosopher 3 started eating
philosopher 1 started eating
F--P1--P2
|
P5
|
F--P4--F--P3

```

```

time: 18s
F--P1--P2
|
P5
|
F--P4--F--P3

```

```

time: 19s
philosopher 1 finished eating
philosopher 5 started eating
F--P1--F--P2
|
P5
|
F--P4--F--P3

```

```

time: 20s
philosopher 3 finished eating
philosopher 5 finished eating
philosopher 2 started eating
F--P1--P2
|
P5
|
F--P4--F--P3

```

```

time: 21s
philosopher 5 started eating
F--P1--P2
|
P5
|
F--P4--F--P3

```

```

time: 22s
philosopher 2 finished eating
philosopher 3 started eating
philosopher 5 finished eating
F--P1--F--P2
|
P5
|
F--P4--F--P3

```

```

time: 23s
philosopher 1 started eating
F--P1--P2
|
P5
|
F--P4--F--P3

```

```

time: 24s

```

File - Semaphore

```
.--P1--.--P2
|
P5      .
|
F--P4--.--P3
```

```
time: 25s
philosopher 3 finished eating
philosopher 4 started eating
.--P1--.--P2
|
P5      F
|
.--P4--.--P3
```

```
time: 26s
philosopher 1 finished eating
philosopher 2 started eating
F--P1--.--P2
|
P5      .
|
.--P4--.--P3
```

```
time: 27s
philosopher 2 finished eating
F--P1--F--P2
|
P5      F
|
.--P4--.--P3
```

```
time: 28s
philosopher 2 started eating
philosopher 4 finished eating
F--P1--.--P2
|
P5      .
|
F--P4--F--P3
```

```
time: 29s
philosopher 5 started eating
philosopher 2 finished eating
.--P1--F--P2
|
P5      F
|
.--P4--F--P3
```

Process finished with exit code 0

TECT 4.

File - Semaphore

C:\CLionProjects\Semaphore\cmake-build-debug\Semaphore.exe
Enter maximum amount of iterations:20

```
time: 0s
F--P1--F--P2
|      |
P5      F
|      |
F--P4--F--P3

time: 1s
philosopher 3 started eating
philosopher 1 started eating
.--P1---P2
|      |
P5      .
|      |
F--P4---P3

time: 2s
philosopher 3 finished eating
philosopher 1 finished eating
F--P1--F--P2
|      |
P5      F
|      |
F--P4--F--P3

time: 3s
philosopher 2 started eating
philosopher 4 started eating
F--P1---P2
|      |
P5      .
|      |
.--P4---P3

time: 4s
philosopher 2 finished eating
philosopher 4 finished eating
philosopher 5 started eating
.--P1--F--P2
|      |
P5      F
|      |
.--P4--F--P3

time: 5s
philosopher 2 started eating
.--P1---P2
|      |
P5      .
|      |
.--P4--F--P3

time: 6s
philosopher 5 finished eating
philosopher 2 finished eating
F--P1--F--P2
|      |
P5      F
|      |
F--P4--F--P3

time: 7s
philosopher 5 started eating
philosopher 3 started eating
.--P1--F--P2
|      |
P5      .
|      |
.--P4---P3

time: 8s
philosopher 5 finished eating
philosopher 3 finished eating
F--P1--F--P2
|      |
P5      F
|      |
F--P4--F--P3

time: 9s
philosopher 1 started eating
philosopher 4 started eating
.--P1---P2
|      |
P5      F
|      |
.--P4---P3

time: 10s
philosopher 1 finished eating
philosopher 4 finished eating
F--P1--F--P2
|      |
P5      F
|      |
F--P4--F--P3

time: 11s
philosopher 2 started eating
philosopher 5 started eating
.--P1---P2
|      |
P5      .
```

```

File - Semaphore
|
|--P4--F--P3

time: 12s
|--P1--.--P2
|
P5      .
|
|--P4--F--P3

time: 13s
|--P1--.--P2
|
P5      .
|
|--P4--F--P3

time: 14s
philosopher 2 finished eating
philosopher 5 finished eating
philosopher 3 started eating
F--P1--F--P2
|
P5      .
|
F--P4--.--P3

time: 15s
philosopher 1 started eating
.--P1--.--P2
|
P5      .
|
F--P4--.--P3

time: 16s
.--P1--.--P2
|
P5      .
|
F--P4--.--P3

time: 17s
philosopher 3 finished eating
philosopher 1 finished eating
F--P1--F--P2
|
P5      F
|
F--P4--F--P3

time: 18s
philosopher 4 started eating
philosopher 2 started eating
F--P1--.--P2
|
P5      .
|
.--P4--.--P3

time: 19s
F--P1--.--P2
|
P5      .
|
.--P4--.--P3

Process finished with exit code 0

```

TECT 5.

File - Semaphore

```
C:\CLionProjects\Semaphore\cmake-build-debug\Semaphore.exe
Enter maximum amount of iterations:-15
```

```
Wrong format. max_iter should be > 0.
Enter maximum amount of iterations:-10
```

```
Wrong format. max_iter should be > 0.
Enter maximum amount of iterations:-5
```

```
Wrong format. max_iter should be > 0.
Enter maximum amount of iterations:0
```

```
Wrong format. max_iter should be > 0.
Enter maximum amount of iterations:7
```

```
time: 0s
F--P1--F--P2
|      |
P5      F
|      |
F--P4--F--P3
```

```
time: 1s
philosopher 1 started eating
philosopher 3 started eating
.--P1--.--P2
|      |
P5      .
|      |
F--P4--.--P3
```

```
time: 2s
philosopher 1 finished eating
philosopher 3 finished eating
F--P1--F--P2
|      |
P5      F
|      |
F--P4--F--P3
```

```
time: 3s
philosopher 4 started eating
philosopher 1 started eating
.--P1--.--P2
|      |
P5      F
|      |
.--P4--.--P3
```

```
time: 4s
philosopher 4 finished eating
philosopher 1 finished eating
F--P1--F--P2
|      |
P5      F
|      |
F--P4--F--P3
```

```
time: 5s
philosopher 4 started eating
philosopher 2 started eating
F--P1--.--P2
|      |
P5      .
|      |
.--P4--.--P3
```

```
time: 6s
philosopher 2 finished eating
philosopher 4 finished eating
F--P1--F--P2
|      |
P5      F
|      |
F--P4--F--P3
```

Process finished with exit code 0

5. СПИСОК ИСТОЧНИКОВ

1. Интернет-ресурс, Свободный доступ, Язык: Английский, StackOverflow
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