生产者消费者上机实验

一、实验内容

采用信号量机制实现消费者与生产者的线程同步，具体内容为

- 1个生产者，1个消费者
- 1个生产者，多个消费者
- 多个生产者，1个消费者
- 多个生产者，多个消费者

二、实验环境

使用visual studio 2019开发，采用.net framework 4.7.2框架，界面采用winform框架。

三、实验思路

    首先分别编写生产者、消费者线程代码，在其中实现线程间的同步问题，之后通过所输入的生产者、消费者数目等等信息创建对应进程，最后将输出结果输出到显示器。

    需要三个信号量对该模型进行线程同步，其一是需要一个互斥量mutex，其作用是控制写同步；其余两个是两个Semaphore类型的produce和consume信号量分别控制生产者和消费者的线程同步问题，初始条件下缓冲区内没有货物，produce信号量的值为缓冲区大小（意味着生产者能生产货物），consume信号量的值为0（意味着消费者并不能消费货物）。

3.1 生产者线程

    首先对于produce信号量申请资源，即WaitOne()函数，若申请失败，则输出错误信息，若申请成功，则进入下一流程；之后通过mutex进行加写锁，生产货物，输出信息，完成之后释放写锁，即ReleaseMutex()函数；之后cosume信号量释放资源，即Release()函数（意味着消费者可以消费生产者所生产的这一货物）；之后根据速率大小设置生产者线程的挂起时间；最后判断生产的总货物数目是否大于输入时所设置的数目，若是，则退出线程。

3.2 消费者线程

    大致流程同理如上，不同之处在于消费者线程首先对consume信号量申请资源，之后对produce信号量释放资源。

3.3 创建并开启线程

使用线程数组生成生产者以及消费者线程，来控制线程名称规范。

```
Thread[] producers = new Thread[producerCnt];
        for (int i = 0; i < producerCnt; i++)
        {
            string name = "producer" + i;
            producers[i] = new Thread(() => { produceItem(name, productRate);
});
            producers[i].IsBackground = true;
            producers[i].Start();
        }
```

如上是生产者线程的创建及开启。

四、实验结果

4.1 winform UI设计

4.2 1个生产者，1个消费者

4.3 1个生产者，多个消费者

Form1

生产者数目： 1
消费者数目： 2
产品最大数目：5

生产速率(s)：1
消费速率(s)：1

Result:

Start

```
begin of producer consumer problem
producer0 produces an item, totally 1, now there are 1 items in the buffer
consumer0 consumes an item, now there are 0 items in the buffer
producer0 produces an item, totally 2, now there are 1 items in the buffer
consumer0 consumes an item, now there are 0 items in the buffer
producer0 produces an item, totally 3, now there are 1 items in the buffer
consumer1 consumes an item, now there are 0 items in the buffer
producer0 produces an item, totally 4, now there are 1 items in the buffer
consumer0 consumes an item, now there are 0 items in the buffer
producer0 produces an item, totally 5, now there are 1 items in the buffer
consumer0 consumes an item, now there are 0 items in the buffer
```

4.4 多个生产者，一个消费者

Form1

生产者数目： 2

消费者数目： 1

产品最大数目： 5

生产速率(s)： 1

消费速率(s)： 1

Start

Result:

```
begin of producer consumer problem
producer0 produces an item, totally 1, now there are 1 items in the buffer
producer1 produces an item, totally 2, now there are 2 items in the buffer
consumer0 consumes an item, now there are 1 items in the buffer
producer1 produces an item, totally 3, now there are 2 items in the buffer
producer0 produces an item, totally 4, now there are 3 items in the buffer
consumer0 consumes an item, now there are 2 items in the buffer
producer1 produces an item, totally 5, now there are 3 items in the buffer
```

4.5 多个生产者，多个消费者

Form1

生产者数目： 3

消费者数目： 2

产品最大数目： 10

生产速率(s): 1

消费速率(s): 1

Start

Result:

```
begin of producer consumer problem
producer2 produces an item, totally 1, now there are 1 items in the buffer
producer0 produces an item, totally 2, now there are 2 items in the buffer
producer1 produces an item, totally 3, now there are 3 items in the buffer
consumer0 consumes an item, now there are 2 items in the buffer
consumer1 consumes an item, now there are 1 items in the buffer
producer2 produces an item, totally 4, now there are 2 items in the buffer
consumer0 consumes an item, now there are 1 items in the buffer
producer0 produces an item, totally 5, now there are 2 items in the buffer
consumer1 consumes an item, now there are 1 items in the buffer
producer1 produces an item, totally 6, now there are 2 items in the buffer
producer2 produces an item, totally 7, now there are 3 items in the buffer
consumer0 consumes an item, now there are 2 items in the buffer
producer0 produces an item, totally 8, now there are 3 items in the buffer
consumer1 consumes an item, now there are 2 items in the buffer
producer1 produces an item, totally 9, now there are 3 items in the buffer
producer2 produces an item, totally 10, now there are 4 items in the buffer
```

Form1 — □ ×

生产者数目： 3 生产速率(s)： 3

消费者数目： 2 消费速率(s)： 2

产品最大数目： 10

Result: Start

```
begin of producer consumer problem
producer0 produces an item, totally 1, now there are 1 items in the buffer
producer2 produces an item, totally 2, now there are 2 items in the buffer
producer1 produces an item, totally 3, now there are 3 items in the buffer
consumer0 consumes an item, now there are 2 items in the buffer
consumer1 consumes an item, now there are 1 items in the buffer
consumer1 consumes an item, now there are 0 items in the buffer
producer1 produces an item, totally 4, now there are 1 items in the buffer
producer2 produces an item, totally 5, now there are 2 items in the buffer
producer0 produces an item, totally 6, now there are 3 items in the buffer
consumer0 consumes an item, now there are 2 items in the buffer
consumer1 consumes an item, now there are 1 items in the buffer
consumer0 consumes an item, now there are 0 items in the buffer
producer2 produces an item, totally 7, now there are 1 items in the buffer
producer0 produces an item, totally 8, now there are 2 items in the buffer
producer1 produces an item, totally 9, now there are 3 items in the buffer
consumer1 consumes an item, now there are 2 items in the buffer
consumer0 consumes an item, now there are 1 items in the buffer
consumer1 consumes an item, now there are 0 items in the buffer
producer1 produces an item, totally 10, now there are 1 items in the buffer
producer0 produces an item, totally 11, now there are 2 items in the buffer
producer2 produces an item, totally 12, now there are 3 items in the buffer
consumer0 consumes an item, now there are 2 items in the buffer
```