

项目三实验报告

小组成员及信息

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问题概述

一个繁忙的小型飞机场，这个飞机场只有一个飞机跑道。在每个单位时间内，只有一架飞机可以着陆，活着只有一架飞机可以起飞，但不允许同时着陆和起飞。飞机的到达和起飞都是随机的，因此在任何给订的时刻，飞机跑道可能空闲，活着可能有一架飞机正在着陆或者起飞，并且可能有若干架飞机在等待着陆或者等待起飞。

抽象建模

Plane类：

他的对象表示单个飞机。他有飞机的一些起飞，着陆的一些基本行为。Plane需要维护特定的Plane对象的数据，这个数据必须包括航班号、到达机场系统的时间、到达或者离开的Plane的状态。

Random类：

他封装到达或离开跑道的飞机的随机特性。他有一个poisson方法，这个方法接受一个期望并返回一个整数，这个整数满足泊松分布。这个方法可以决定每个时间单元内有多少架飞机准备着陆或起飞，或者是飞机随机生成的油量。

Runway类：

飞机跑道需要维护两个飞机队列，我们成为landing和takeoff，用于保存正在等待的飞机。让飞机在地面上等待比让他在空中等待要好些，因此这个小的飞机厂仅当没有飞机等待着陆时才允许飞机起飞。因此，Runway的方法activity控制着对Runway的使用。

程序设计项目P1~P6

- P1. 将所有用于飞机场模拟的函数和方法组合成一个完整的程序。用飞机场模拟程序做若干次试运行实验,调整准备着陆和起飞的飞机数的期望值,并找出在飞机不会被拒绝服务的条件下这些数字的尽可能大的近似值。如果队列的长度增加或减少,那么这些值将会有何变化?
- P2. 修改模拟程序,使飞机场有两条飞机跑道,其中一条总是用于着陆,另一条总是用于起飞。比较双跑道机场能服务的总飞机数和单条飞机跑道的飞机场的相应数字,前者是否是后者的两倍?
- P3. 修改模拟程序,使飞机场有两条飞机跑道,其中一条总是用于着陆,另一条总是用于起飞。如果某个队列是空的,那么两条跑道都能用于其他的队列。如果着陆队列总是满的并且另一架飞机要到达着陆,那么将停止起飞,并将两条跑道都用于清理搁置的着陆飞机。
- P4. 修改模拟程序,使飞机场有3条飞机跑道,其中各保留一条总用于着陆和起飞,第三条用于着陆,但在着陆队列为空的情况下,第三条亦可用于起飞。
- P5. 修改最初的模拟程序(单条跑道),使得当每架飞机到达着陆时,它将有(作为它的数据成员的)一个(随机产生的)油位,以剩余的时间单元度量。如果飞机没有足够的油位在队列中等待,则允许它立即着陆。因此着陆队列里的飞机可能需要再等待附加的单元,因此可能用完自身的燃料。作为着陆函数的一部分检查这一点,并且查明在飞机由于燃料用尽而开始坠毁前机场有多忙。
- P6. 写一个占位程序来代替随机数函数,这个占位程序既能用于调试程序又允许用户正确地控制每一个时间单元内每个队列到达的飞机数。
-

问题分析 (结构、算法...)

P1:

这是最基础的一个飞机场的实现,只有一个跑道,按自上而下的分析方式来说,Runway用来模拟跑道,包括起飞降落,在Runway里面,每一个跑道都有一个等待队列和起飞的Plane对象对列,由Random类随机生成数量的飞机进入Runway的等待队列里,当队列为满的话,飞机直接离开转去其他飞机场。Runway中的activity方法先对着陆飞机进行出队,一次只有一架,activity返回跑道的状态。在activity执行进入等待队列和出队的行为时,调用Plane类里的函数,给使用用户该飞机的信息,包括飞机的航班号,等待时间,状态(起飞还是着陆)。

P2:

两条跑道，一个用于起飞一个用于着陆，跟P1相似，所做的修改仅仅在主函数上，实例化两个Runway类runway1和runway2，runway1仅用来着陆，runway2仅用来起飞。然后对分别对两个Runway调用activity()。

P3:

还是两条跑道，一个起飞一个着陆，但是当起飞跑道等待队列为空的时候，着陆飞机可以飞到起飞跑道进行着陆。当着起飞飞机等待队列为满的时候，起飞飞机可以到着陆跑道起飞。但是这时如果有飞机来着陆的话，起飞飞机全部待定，然后先让要着陆的飞机优先，等到着陆队列为空的话在此起飞。还是在主函数中进行修改，在代码中，判断当起飞队列为空或者当着陆队列为满的时候直接占用起飞队列，然后再对着陆飞机进行填充。当runway1的着陆队列为空的时候要起飞的飞机要用的着陆的跑道，我的算法是将要起飞的飞机平均分配到左右两个runway1中，这样比较符合生活中的逻辑。在Runway类的activity中pop一个飞机的时候，显示poplanding的队列，这样在Runway1中哪怕是之前有要起飞的飞机占了它的位置，当再来要着陆的飞机的时候，也是要让其优先着陆。

P4:

P2和P3的融合版，和上两种情况相似，不做过多阐述。

P5:

P5是在P1的情况下对飞机这个对象添加了随机油量，当要着陆的飞机没有油量的时候就优先降落，在Runway中进行修改，增添一个强制降落的状态，在activity中对飞机进行检查，如果飞机没有油量的就提前pop掉，pop的算法就是将指定位置之前的全都放到堆栈里，pop掉之后再把堆栈中的元素放回来。由于只有一个跑道，因此当有两个飞机处于紧急状态马上就要没油了的话，那么就一定有飞机要坠机。

P6:

写一个占位程序代替随机数，手动输入数据，请看运行时情况。

实验截图

P1

```

This program simulates an airport with only one runway.
One plane can land or depart in each unit of time.
Up to what number of planes can be waiting to land or take off at any time?
5
How many units of time will the simulation run?
5
Expected number of arrivals per unit time
1
Expected number of departures_per unit time?
1
Safety Warning: This airport will become saturated.
-----
Time: 0
Runway is idle.
Plane number:0 ready to land.
Time: 1
Plane number 0 landed after 0 time units in the takeoff queue.
Plane number:1 ready to take off.
Time: 2
Plane number 1 took off after 0 time units in the takeoff queue.
Plane number:2 ready to take off.
Plane number:3 ready to take off.
Time: 3
Plane number 2 took off after 0 time units in the takeoff queue.
Plane number:4 ready to take off.
Time: 4
Plane number 3 took off after 1 time unit in the takeoff queue.
-----
Simulation has concluded after 5 time units.
Total number of planes processed:                5
Total number of planes asking to land:            1
Total number of planes asking to take off:        4
Total number of planes accepted for landing:      1
Total number of planes accepted for takeoff:      4
Total number of planes refused for landing:       0
Total number of planes refused for takeoff:       0
Total number of planes that landed:              1
Total number of planes that took off:             3
Total number of Planes left in landing queue:     0
Total number of planes left in takeoff queue:     1
Percentage of time runway idle:                  20 %
Average wait in landing queue:                   0 time units
Average wait in takeoff queue:                   0.333333 time units
Average observed rate of planes wanting to land: 0.2 time unit
Average observed rate of planes wanting to take off: 0.8 time unit

```

P2

```

This program simulates an airport with two runways.
One runway is always for landing, the other is always for taking off.
Up to what number of planes can be waiting to land or take off at any time?
5
How many units of time will the simulation run?
5
Expected number of arrivals per unit time
2
Expected number of departures per unit time?
1
Safety Warning: This airport will become saturated.
-----
Plane number:0 ready to take off.
Time: 0
Runway 1 is idle.
Plane number:0 took off from runway 2 after 0 time units in the takeoff queue.
Plane number:1 ready to land.
Plane number:2 ready to land.
Plane number:3 ready to land.
Plane number:4 ready to take off.
Plane number:5 ready to take off.
Plane number:6 ready to take off.
Time: 1
Plane number:1 landed from runway 1 after 0 time units in the takeoff queue.
Plane number:4 took off from runway 2 after 0 time units in the takeoff queue.
Plane number:7 ready to land.
Time: 2
Plane number:2 landed from runway 1 after 1 time unit in the takeoff queue.
Plane number:5 took off from runway 2 after 1 time unit in the takeoff queue.
Plane number:8 ready to land.
Time: 3
Plane number:3 landed from runway 1 after 2 time units in the takeoff queue.
Plane number:6 took off from runway 2 after 2 time units in the takeoff queue.
Plane number:9 ready to land.
Plane number:10 ready to take off.
Time: 4
Plane number:7 landed from runway 1 after 2 time units in the takeoff queue.
Plane number:10 took off from runway 2 after 0 time units in the takeoff queue.
-----
Simulation has concluded after 5 time units.
Total number of planes processed:                11
Total number of planes asking to land:            6
Total number of planes asking to take off:        5
Total number of planes accepted for landing:      6
Total number of planes accepted for takeoff:      5
Total number of planes refused for landing:       0
Total number of planes refused for takeoff:       0
Total number of planes that landed:              4
Total number of planes that took off:             5
Total number of Planes left in landing queue:    0
Total number of planes left in takeoff queue:    0
Percentage of time runway idle:                  10 %
Average wait in landing queue:                    1.25 time units
Average wait in takeoff queue:                    0.6 time units
Average observed rate of planes wanting to land: 1.2 time unit
Average observed rate of planes wanting to take off: 1 time unit

```

P3

```

This program simulates an airport with two runways.
One runway is for landing, the other is for taking off.
If a runway is empty, it can have the other use.
One plane can land or depart in each unit of time.
Up to what number of planes can be waiting to land or take off at any time?
5
How many units of time will the simulation run?
5
Expected number of arrivals per unit time?
2
Expected number of departures_per unit time?
1
Safety Warning: This airport will become saturated.
Plane number:0 ready to land.
Time: 0
Plane number:0 landed from runway 1 after 0 time units in the takeoff queue.
Runway 2 is idle.
Plane number:1 ready to land.
Plane number:2 ready to land.
Plane number:3 ready to land.
Time: 1
Plane number:1 landed from runway 1 after 0 time units in the takeoff queue.
Runway 2 is idle.
Plane number:4 ready to land.
Plane number:5 ready to land.
Plane number:6 ready to land.
Plane number:7 ready to take off.
Plane number:8 ready to take off.
Time: 2
Plane number:2 landed from runway 1 after 1 time unit in the takeoff queue.
Plane number:7 took off from runway 2 after 0 time units in the takeoff queue.
Plane number:9 ready to land.
Plane number:10 ready to land.
Plane number:11 ready to land.
Plane number:12 ready to take off.
Time: 3
Plane number:3 landed from runway 1 after 2 time units in the takeoff queue.
Plane number:10 landed from runway 2 after 0 time units in the takeoff queue.
Plane number:13 ready to land.
Plane number:14 ready to land.
Plane number:15 ready to land.
Plane number:16 ready to land.
Time: 4
Plane number:4 landed from runway 1 after 2 time units in the takeoff queue.
Plane number:11 landed from runway 2 after 1 time unit in the takeoff queue.
-----
Simulation has concluded after 5 time units.
Total number of planes processed:                22
Total number of planes asking to land:            19
Total number of planes asking to take off:         3
Total number of planes accepted for landing:       14
Total number of planes accepted for takeoff:       3
Total number of planes refused for landing:        5
Total number of planes refused for takeoff:        0
Total number of planes that landed:               7
Total number of planes that took off:              1
Total number of Planes left in landing queue:      0
Total number of planes left in takeoff queue:      0
Percentage of time runway idle:                   20 %
Average wait in landing queue:                     0.857143 time units
Average wait in takeoff queue:                     0 time units
Average observed rate of planes wanting to land:   3.8 time unit
Average observed rate of planes wanting to take off: 0.6 time unit

```

P4

```

This program simulates an airport with three runways.
Runway 1 and 3 are for landing, runway 2 is for taking off.
If runway3 is empty, it can be used for taking off.
One plane can land or depart in each unit of time.
Up to what number of planes can be waiting to land or take off at any time?
5
How many units of time will the simulation run?
5
Expected number of arrivals per unit time?
2
Expected number of departures_per unit time?
1
Plane number:0 ready to land.
Plane number:1 ready to land.
Plane number:2 ready to land.
Plane number:3 ready to land.
Plane number:4 ready to take off.
Plane number:5 ready to take off.
Plane number:6 ready to take off.
Time: 0
Plane number:0 landed from runway 1 after 0 time units in the takeoff queue.
Plane number:4 took off from runway 2 after 0 time units in the takeoff queue.
Plane number:5 took off from runway 3 after 0 time units in the takeoff queue.
Plane number:7 ready to land.
Plane number:8 ready to land.
Plane number:9 ready to land.
Plane number:10 ready to take off.
Time: 1
Plane number:1 landed from runway 1 after 1 time unit in the takeoff queue.
Plane number:6 took off from runway 2 after 1 time unit in the takeoff queue.
Plane number:10 took off from runway 3 after 0 time units in the takeoff queue.
Plane number:11 ready to take off.
Time: 2
Plane number:2 landed from runway 1 after 2 time units in the takeoff queue.
Plane number:11 took off from runway 2 after 0 time units in the takeoff queue.
Runway 3 is idle.
Plane number:12 ready to land.
Plane number:13 ready to land.
Time: 3
Plane number:3 landed from runway 1 after 3 time units in the takeoff queue.
Runway 2 is idle.
Runway 3 is idle.
Plane number:14 ready to land.
Plane number:15 ready to land.
Plane number:16 ready to take off.
Time: 4
Plane number:7 landed from runway 1 after 3 time units in the takeoff queue.
Plane number:16 took off from runway 2 after 0 time units in the takeoff queue.
Runway 3 is idle.
-----
Simulation has conluded after 5 time units.
Total number of planes processed: 19
Total number of planes asking to land: 13
Total number of planes asking to take off: 6
Total number of planes accepted for landing: 11
Total number of planes accepted for takeoff: 6
Total number of planes refused for landing: 2
Total number of planes refused for takeoff: 0
Total number of planes that landed: 5
Total number of planes that took off: 6
Total number of Planes left in landing queue: 0
Total number of planes left in takeoff queue: 0
Percentage of time runway idle: 40 %
Average wait in landing queue: 1.8 time units
Average wait in takeoff queue: 0.166667 time units
Average observed rate of planes wanting to land: 2.6 time unit
Average observed rate of planes wanting to take off: 1.2 time unit

```

P5

```
This program simulates an airport with only one runway.
One plane can land or depart in each unit of time.
Up to what number of planes can be waiting to land or take off at any time?
5
How many units of time will the simulation run?
5
How many units of oil will planes get?
2
Expected number of arrivals per unit time?
3
Expected number of departures_per unit time?
1
Safety Warning: This airport will become saturated.
-----
Time:1
Plane number: 0 with 4 units is ready to land.
Plane number: 1 with 2 units is ready to land.
Plane number: 2 is ready to take off.
Plane number 0 landed after 0 time units in the takeoff queue.

Time:2
Plane number: 3 with 3 units is ready to land.
Plane number: 4 with 1 unit is ready to land.
Plane number: 5 with 3 units is ready to land.
Plane number: 6 with 1 unit is ready to land.
Plane number: 7 is ready to take off.
The airport blow up because of the plane crash!!!!

-----
Process exited after 4.87 seconds with return value 0
请按任意键继续. . .
```


P6

```

This program simulates an airport with three runways.
Runway 1 and 3 are for landing, runway 2 is for taking off.
If runway3 is empty, it can be used for taking off.
One plane can land or depart in each unit of time.
Up to what number of planes can be waiting to land or take off at any time?
5
How many units of time will the simulation run?
3
Expected number of arrivals per unit time?
1
Expected number of departures_per unit time?
1
-----
Do you want to control the number of planes this time? [1 for yes / 0 for no]
1
Please enter the number of arrival planes: 2
Do you want to control the number of planes this time? [1 for yes / 0 for no]
0
the number of departure planes will be set randomly
The random number is: 2
-----
Plane number:0 ready to land.
Plane number:1 ready to land.
Plane number:2 ready to take off.
Plane number:3 ready to take off.
Time: 0
Plane number:0 landed from runway 1 after 0 time units in the takeoff queue.
Plane number:2 took off from runway 2 after 0 time units in the takeoff queue.
Plane number:3 took off from runway 3 after 0 time units in the takeoff queue.
-----
Do you want to control the number of planes this time? [1 for yes / 0 for no]
0
the number of arrival planes will be set randomly
The random number is: 0
Do you want to control the number of planes this time? [1 for yes / 0 for no]
1
Please enter the number of departure planes: 2
-----
Plane number:4 ready to take off.
Plane number:5 ready to take off.
Time: 1
Plane number:1 landed from runway 1 after 1 time unit in the takeoff queue.
Plane number:4 took off from runway 2 after 0 time units in the takeoff queue.
Plane number:5 took off from runway 3 after 0 time units in the takeoff queue.
-----
Do you want to control the number of planes this time? [1 for yes / 0 for no]
0
the number of arrival planes will be set randomly
The random number is: 0
Do you want to control the number of planes this time? [1 for yes / 0 for no]
0
the number of departure planes will be set randomly
The random number is: 3
-----
Plane number:6 ready to take off.
Plane number:7 ready to take off.
Plane number:8 ready to take off.
Time: 2
Runway 1 is idle.
Plane number:6 took off from runway 2 after 0 time units in the takeoff queue.
Plane number:7 took off from runway 3 after 0 time units in the takeoff queue.
-----
Simulation has concluded after 3 time units.
Total number of planes processed:          9
Total number of planes asking to land:      2
Total number of planes asking to take off:  7
Total number of planes accepted for landing: 2
Total number of planes accepted for takeoff: 7
Total number of planes refused for landing:  0
Total number of planes refused for takeoff:  0
Total number of planes that landed:         2
Total number of planes that took off:        6
Total number of Planes left in landing queue: 0
Total number of planes left in takeoff queue: 0
Percentage of time runway idle:             16.6667 %
Average wait in landing queue:               0.5 time units
Average wait in takeoff queue:               0 time units
Average observed rate of planes wanting to land: 0.666667 time unit
Average observed rate of planes wanting to take off: 2.33333 time unit

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团队分工贡献

许延泽 (%40) :

完成P1、P2、P3、P5, 书写实验报告。

袁之浩 (%40) :

完成P4、P6, 寻找遗漏问题、算法错误。

于翔宇 (%20) :

团结小队成员, 起到团队“润滑油”作用。

管理项目信息, 对程序安全负责, 起到团队“安全员”作用。

在完成项目的同时, 给大家灌输习总书记在十九大期间所汇总的十九大报告的概要。

实验反思

这次的项目很特别, 与以往不同, 这次的pro有多个版本, 在完成的时候出现了将P1、P2、P3几乎同时完成的情况, 当检查到P1版本出现了错误的时候, 还要再多个版本进行修改, 下回应该提前确定好分工, 并且对第一个基础版本认真对待, 达到统一。这个程序的容错性和健壮性也一般。