Simulation : Doctor’s Clinic

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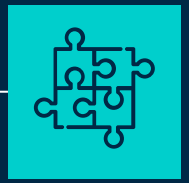
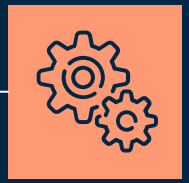


01

Problem Walkthrough



02

How the code works.

03

How did we do it?

Problem Walkthrough

01

What’s going on?

Key Points :

1. We need to simulate the work of a doctor's clinic in a given time. (What is a simulation?)
2. On average, 10 patients come at any given hour. (Average?)
3. Ages of the patients are between 20 and 60 years. All ages are equally likely to come.
4. The clinic deals with the patients by a first-come-first-served system. (FIFO)
5. The time taken by the patient with the doctor is equal to $\frac{Age}{5}$ minutes.

Key Points :

6. The output needed is the average waiting time of each patient and the number of untreated patients at the end of the given period.

7. What if the patient time decreased to $\frac{Age}{10}$?

How The Code Works

02

What’s happening under the hood.

Steps :

1. We need to simulate the behavior of a patient.

2. We need to simulate the behavior of a Doctor.

3. Then, We are ready to simulate the process.

4. Record the results.

How the code works.

1. We need to simulate the behavior of a patient.

Patient Class :

```
from pythonds.basic.queue import Queue # Inserting the implementation of the Queue into my code
import random # Inserting the library Random to be able to use "randrange"


class Patient:
    """
    A class to simulate patients in a clinic
    """
    def __init__(self, time):
        """
        The current patient is initialized with the arrival time given to the method and his age (which is a random number between 20 and 60)
        :param time: the time this patient got into the queue in seconds
        """
        self.arrivalTime = time
        self.age = random.randrange(20, 61)
```

How the code works.

```
def getAge(self):
    """
    Gets the Age of the patient
    :return: Integer between 20 and 60
    """
    return self.age

def getArrivalTime(self):
    """
    Gets the Arrival Time of the Patient
    :return: integer between 0 and the Max simulation time passed to the main function
    """
    return self.arrivalTime



def waitTime(self, currentSec):
    """
    Computes the amount time this patient waited in the queue before entering
    :param currentSec: the time this patient got out of the queue in seconds
    :return: integer more than or equal zero
    """
    return currentSec - self.arrivalTime
```

2. We need to simulate the behavior of a Doctor.

Doctor Class :

```
from Patient import * # Importing the file "Patient.py“

class Doctor:
    """
    A class to simulate a doctor treating patients in a clinic
    """

    def __init__(self, rate):

        """
        The doctor is initialized with the rate of treating patients, and NO current patients
        :param rate: the rate of treating patients
        """

        self.patientRate = rate
        self.timeRemaining = 0
        self.currentPatient = None
```

How the code works.

```
def enterNextPatient(self, patient):
    """
    This Method simulates the entering of the patients to the doctor
    :param patient: the next patient according to the queue (object of class Patient)
    :return: No return value
    """

    self.currentPatient = patient

    # Time taken to treat each patient = Age/5  or  Age/10  (* 60 to get it in seconds)
    self.timeRemaining = round(patient.getAge()/self.patientRate) * 60



def busy(self):
    """
    Method to check whether the doctor is free or not
    :return: boolean value (True if busy, False if not)
    """
    return self.currentPatient is not None
```

How the code works.

```
def tick(self):
    """
    This method simulates the clock in the clinic, one call for this method means that 1 second has passed
    :return: No return value
    """
    if self.currentPatient is not None:
        self.timeRemaining -= 1
        if self.timeRemaining == 0:
            self.currentPatient = None
```

3. Then, We are ready to simulate the process.

Main :

```
from Doctor import * # Import All from "Doctor.py"


def printResult(times, remaining):
    """
    Prints the result in the desired format
    """
    averageWaitTime = sum(times)/len(times)/60
    print("Average Waiting Time : ", "{:.2f}".format(averageWaitTime), " mins \t , Untreated Patients : ", remaining)
```

How the code works.

```
def newPatientArrived():
    """
    Function to check if a patient arrived in the current second or not
    :return: an integer from 1 to 360
    """
    return random.randrange(1, 361) == 150

##########################################################################
# According to the Problem we get an average of 10 patients per hour :
#
# 10 P/ hr = 10 P/ 60 min = 10 P / 3600 sec = 1 P / 360 sec
#
# so the probability of a new patient coming to the clinic in the next second is 1 to 360
#
# Which is applied by the Previous function
##########################################################################
```

How the code works.

```
def simulate(totalSimulationTime, rate):
    """
    Function to simulate the work of a clinic in a specific period of time
    :param totalSimulationTime: The amount of time you need to simulate the working of the clinic in hours
    :param rate: The rate of treating patients
    :return: No return value
    """

    # Convert to seconds
    totalSimulationTime *= 3600

    # Prepare
    clinicDoctor = Doctor(rate)
    patientQueue = Queue()
    waitingTimes = []
```

How the code works.

```
# Iterate over each second
for currentSec in range(totalSimulationTime):

    # Check if a patient arrived in this second
    if newPatientArrived():
            # YES? :
            # Add him to the queue
            newPatient = Patient(currentSec)
            patientQueue.enqueue(newPatient)

    # Check if the doctor is free and there are patients in the queue :
    if (not clinicDoctor.busy()) and (not patientQueue.isEmpty()):
            # YES? :
            # Enter the following patient to the doctor
            nextPatient = patientQueue.dequeue()
            clinicDoctor.enterNextPatient(nextPatient)

            # Save the amount of time this patient waited in the list "waitingTimes"
            waitingTimes.append(nextPatient.waitTime(currentSec))

    # 1 second passed in the clinic
    clinicDoctor.tick()
```

```
# Print the results
printResult(waitingTimes, patientQueue.size())
```

-------End of the function “Simulate”-------

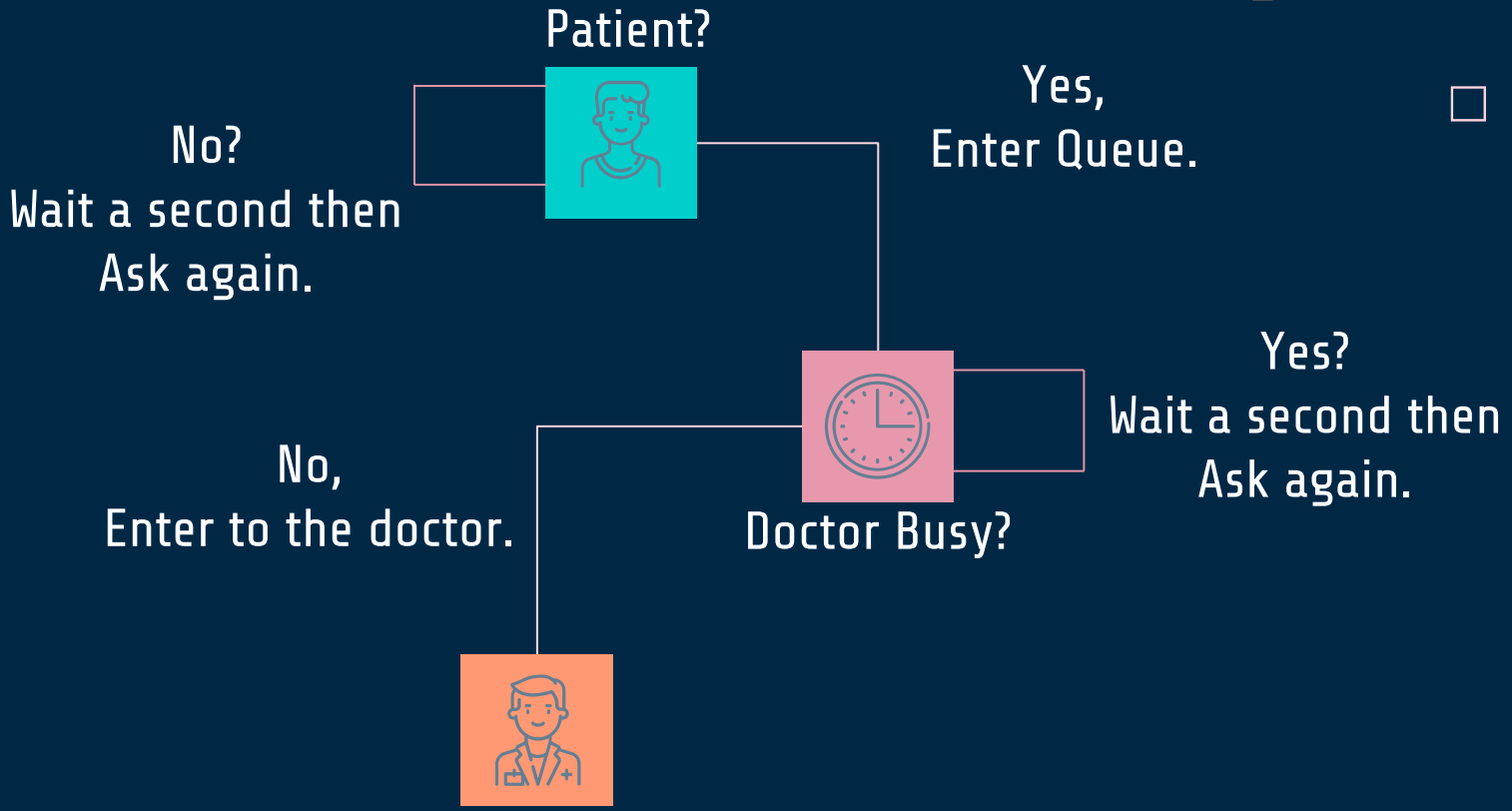
```
##########################
# We can then simulate with both rates (Age/5 and Age/10) and compare the results :

# Age / 5 :
print("Incase of (Age/5) : ")
for i in range(10):
    simulate(4, 5)

print("=" * 100)

# Age / 10 :
print("Incase of (Age/10) : ")
for i in range(10):
    simulate(4, 10)
```

Conclusion :


Patient?
No?
Wait a second then
Ask again.
Yes,
Enter Queue.
Doctor Busy?
Yes?
Wait a second then
Ask again.
No,
Enter to the doctor.

How did we do it?

03

Behind the scenes.

OUR PROCESS

Started studying the necessary parts for the project.

Start

Saturday 4/12

Sunday 5/12

1st Meeting

We illustrated the project main points.

And started writing the code on Monday .

2nd Meeting

Thursday 9/12

We revised our code before submitting it and discussed the possible questions that might come in the exam.

Saturday 11/12

Exam

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Thank You

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