A4_1914078_GroceryStore

March 27, 2022

[1]:

```
import pandas as pd
import random
```

[2]:

```
servTimeProb = { "serviceTime": [1, 2, 3, 4, 5, 6], "pdf": [ 0.05, 0.1, 0.2, 0.3, 0.25, 0.1]}
interArrProb = {"interArrivalTime": [1, 2, 3, 4, 5, 6, 7, 8], "pdf": [ 0.125, 0.125, 0.125, 0.125, 0.125, 0.125, 0.125, 0.125]}
```

[3]:

```
def setRange(df, dataMeta):
    range_begins = [1]
    for i in range(1, len(df)):
      range_begins.append(int(round(df['cdf'][i-1], dataMeta) * (10 ** dataMeta)))
    range_ends = []
    for i in range(len(df)):
      range_ends.append(int(round(df['cdf'][i], dataMeta) * (10 ** dataMeta)))
    df["begin"] = range_begins
    df["end"] = range_ends
```

[4]:

```
def makeServiceTimeTable(servTimeProb):
    serviceTime = pd.DataFrame(servTimeProb)
    serviceTime['cdf'] = serviceTime['pdf'].cumsum()
    serviceMeta = len(str(serviceTime['pdf'].min()).split(".")[1])
    setRange(serviceTime, serviceMeta)
    return serviceTime
```

[5]:

```
def makeInterArrivalTimeTable(interArrProb):
    interArrTime = pd.DataFrame(interArrProb)
    interArrTime['cdf'] = interArrTime['pdf'].cumsum()
    interArrMeta = len(str(interArrTime['pdf'].min()).split(".")[1])
    setRange(interArrTime, interArrMeta)
    return interArrTime
```

[6]:

```
def lookUp(df, randDig):
    for i in range(len(df)):
        if randDig > df["begin"].iloc[i] and randDig <= df["end"].iloc[i]:
            randDig = df.iloc[:, 0][i]
    return randDig
```

[7]:

```
def makeTable(serviceTime, interArrTime):
    # random digits
    randDigServTime = random.sample(range(serviceTime["begin"].iloc[0],␣
↪serviceTime["end"].iloc[-1]), 20)
    randDigIntArrTime = [0] + random.sample(range(interArrTime["begin"].
↪iloc[0], interArrTime["end"].iloc[-1]), 19)

    # lookup function
    interArrTimeAssigned = [0] + [lookUp(interArrTime, x) for x in␣
↪randDigIntArrTime[1:]]
    servTimeAssigned = [lookUp(serviceTime, x) for x in randDigServTime]
    # starting table
    simGroceryStore = pd.DataFrame({"randDigInterArrTime": randDigIntArrTime,␣
↪"interArrTimeAssigned": interArrTimeAssigned})
    # arrival time
    simGroceryStore["arrivalTime"] = simGroceryStore["interArrTimeAssigned"].
↪cumsum()
    # service time columns added
    simGroceryStore["randDigServTime"] = randDigServTime
    simGroceryStore["servTimeAssigned"] = servTimeAssigned

    # rest of the columns' first element
    serviceBegins = [0]
    waitingTime = [0]
    serviceEnds = [simGroceryStore["servTimeAssigned"].iloc[0]]
    totalTimeSpentByCust = [simGroceryStore["servTimeAssigned"].iloc[0]]
    idleTime = [0]
    isCustomerWaiting = [0]

    # completing the table
    for i in range(1, 20):
        serviceBegan = simGroceryStore["arrivalTime"].iloc[i] if␣
↪simGroceryStore["arrivalTime"].iloc[i] > serviceEnds[i-1] else␣
↪serviceEnds[i-1]
        serviceBegins.append(serviceBegan)
        timeWaited = serviceBegan - simGroceryStore["arrivalTime"].iloc[i] if␣
↪serviceBegan > simGroceryStore["arrivalTime"].iloc[i] else 0
        waitingTime.append(timeWaited)
        serviceEnded = simGroceryStore["servTimeAssigned"].iloc[i] +␣
↪serviceBegan
        serviceEnds.append(serviceEnded)
        timeSpent = serviceEnded - simGroceryStore["arrivalTime"].iloc[i]
        totalTimeSpentByCust.append(timeSpent)
        timeSpentIdle = serviceBegan - serviceEnds[i-1]
        idleTime.append(timeSpentIdle)
        isCustomerWaiting.append(1 if timeWaited > 0 else 0)
    simGroceryStore["serviceBegins"] = serviceBegins
    simGroceryStore["waitingTime"] = waitingTime
    simGroceryStore["serviceEnds"] = serviceEnds
    simGroceryStore["totalTimeSpentByCust"] = totalTimeSpentByCust
    simGroceryStore["idleTime"] = idleTime
    simGroceryStore["isCustomerWaiting"] = isCustomerWaiting
    return simGroceryStore
```

[8]:

```
serviceTime = makeServiceTimeTable(servTimeProb)
interArrTime = makeInterArrivalTimeTable(interArrProb)
simGroceryStore = makeTable(serviceTime, interArrTime)
```

[25]:

```
serviceTime
```

[25]:

```
   serviceTime   pdf   cdf  begin  end
0            1  0.05  0.05      1    5
1            2  0.10  0.15      5   15
2            3  0.20  0.35     15   35
3            4  0.30  0.65     35   65
4            5  0.25  0.90     65   90
5            6  0.10  1.00     90  100
```

[26]:

```
interArrTime
```

[26]:

```
   interArrivalTime    pdf    cdf  begin   end
0                 1  0.125  0.125      1   125
1                 2  0.125  0.250    125   250
2                 3  0.125  0.375    250   375
3                 4  0.125  0.500    375   500
4                 5  0.125  0.625    500   625
5                 6  0.125  0.750    625   750
6                 7  0.125  0.875    750   875
7                 8  0.125  1.000    875  1000
```

[9]:

```
simGroceryStore
```

[9]:

```
    randDigInterArrTime  interArrTimeAssigned  arrivalTime  randDigServTime  \
0                     0                     0            0               52
1                   277                     3            3               34
2                   988                     8           11               90
3                   518                     5           16               79
4                   616                     5           21               59
5                   304                     3           24               58
6                   321                     3           27               88
7                   460                     4           31               17
```

```
8                    906                     8           39               14
9                    401                     4           43               45
10                   290                     3           46                8
11                   403                     4           50               71
12                   935                     8           58               33
13                   607                     5           63                9
14                   348                     3           66               43
15                   301                     3           69               75
16                   199                     2           71               54
17                   315                     3           74               84
18                     9                     1           75               29
19                   443                     4           79                7

    servTimeAssigned  serviceBegins  waitingTime  serviceEnds  \
0                  4              0            0            4
1                  3              4            1            7
2                  5             11            0           16
3                  5             16            0           21
4                  4             21            0           25
5                  4             25            1           29
6                  5             29            2           34
7                  3             34            3           37
8                  2             39            0           41
9                  4             43            0           47
10                 2             47            1           49
11                 5             50            0           55
12                 3             58            0           61
13                 2             63            0           65
14                 4             66            0           70
15                 5             70            1           75
16                 4             75            4           79
17                 5             79            5           84
18                 3             84            9           87
19                 2             87            8           89

    totalTimeSpentByCust  idleTime  isCustomerWaiting
0                      4         0                  0
1                      4         0                  1
2                      5         4                  0
3                      5         0                  0
4                      4         0                  0
5                      5         0                  1
6                      7         0                  1
7                      6         0                  1
8                      2         2                  0
9                      4         2                  0
10                     3         0                  1
```

```
11                       5          1                   0
12                       3          3                   0
13                       2          2                   0
14                       4          1                   0
15                       6          0                   1
16                       8          0                   1
17                      10          0                   1
18                      12          0                   1
19                      10          0                   1
```

[24]:

```
print("Average waiting time:", simGroceryStore["waitingTime"].mean(), "minutes")
print(f"Probability that customer waits: {simGroceryStore['isCustomerWaiting'].
 ↪value_counts()[1]/20}")
print(f"Probability that server is idle: {1- simGroceryStore['idleTime'].
 ↪value_counts()[0]/20}")
print(f"Average service time: {simGroceryStore['servTimeAssigned'].mean()}")
print(f"Average time between arrivals: {simGroceryStore['interArrTimeAssigned'].
 ↪mean()}")
print(f"Average waiting time for those who wait:␣
 ↪{simGroceryStore['waitingTime'].sum()/simGroceryStore['waitingTime'].
 ↪value_counts()[0]}")
print(f"Average time customer spends in the system:␣
 ↪{simGroceryStore['totalTimeSpentByCust'].mean()}")
```

```
Average waiting time: 1.75 minutes
Probability that customer waits: 0.5
Probability that server is idle: 0.35
Average service time: 3.7
Average time between arrivals: 3.95
Average waiting time for those who wait: 3.5
Average time customer spends in the system: 5.45
```

[ ]: