project.ipynb

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PROJECT Title- Simulation Model to Determine StaffingStrategy and Warehouse Capacity for aDistribution Center

SIMULATION MODEL

[1]

```
from scipy.stats import poisson
def simulation_model(max_stock,x):
 #defining the variables
 life_of_product=80
 available_stock=max_stock
 stocks =[0]*(life_of_product+1)
 stocks[-1] = max_stock
 stock_arrival=5
 required_exp_date=30
 demand = 0
 unfullfilled_days=0
 wastage_array=[]
 wastage=0
 for m in range(91):
  for i in range(stock_arrival):
   #calculating the wastage in the process and appending it into the array
   wastage += sum(stocks[:required_exp_date])
   wastage_array.append(wastage)
   # simulating the distribution of the demand
   day_demand = poisson.rvs(mu=150)
   demand+= day_demand
   available_stock -= wastage
   # when avaialable stock is less than daydemand
   if available_stock < day_demand:
    unfullfilled_days += 1
    available_stock = 0
   else:
    available_stock-=day_demand
   #discarding the stock have expiry date less than or equal to 30
   for j in range(len(stocks)-1,required_exp_date-1,-1):
    if stocks[j] >= day_demand:
     stocks[j] -= day_demand
     day_demand = 0
     break
    else:
     day_demand -= stocks[j]
     stocks[j] = 0
   for k in range(1, len(stocks)):
    stocks[k-1] = stocks[k]
   stocks[-1] = 0
  if available_stock == 0:
   stocks[-1] = max_stock
  #calculating the wastage
  else:
   stocks[-1] = demand + wastage
  wastage = 0
  for l in range(required_exp_date):
   stocks[l] = 0
  available_stock = max_stock
 #returning the metrics
 return  wastage_array,unfullfilled_days
```

SIMULATING THE MODEL OVER VARYING WAREHOUSE CAPACITY

```
max_stock = [400,450,500,550,600,650,700,750,800,850,900,950,1000,1100,1200,1300,1400]
stock_arrival = [5]
results=[]
temp = []
for i in range(len(max_stock)):
 for j in range(len(stock_arrival)):
  a,b = simulation_model(max_stock[i],stock_arrival[j])
  temp.append([sum(a),b])
 results.append(temp)
 temp=[]
```

GRAPHS

[3]

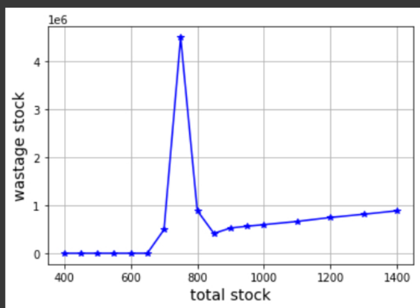
```
wastage_graph=[]
unfulfilled_graph=[]
for i in range(len(max_stock)):
 for j in range(len(stock_arrival)):
```

```
        wastage_graph.append(results[i][j][0])
        unfulfilled_graph.append(results[i][j][1])
```

WAREHOUSE CAPACITY VS WASTAGE STOCK

[4]

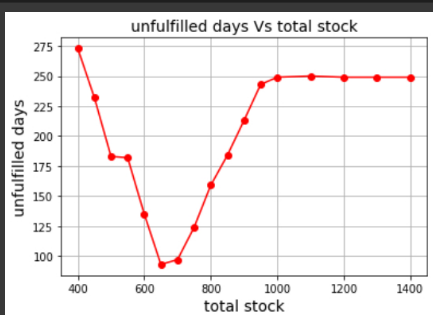
```
import matplotlib.pyplot as plt
plt.plot(max_stock, wastage_graph, '*-b')
plt.xlabel('total stock', fontsize=14)
plt.ylabel('wastage stock', fontsize=14)
plt.grid(True)
plt.show()
```



WAREHOUSE CAPACITY VS UNFULFILLED DAYS

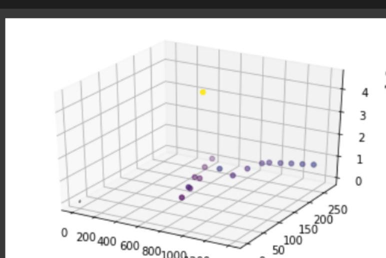
[5]

```
import matplotlib.pyplot as plt
plt.plot(max_stock, unfulfilled_graph, color='red', marker='o')
plt.title('unfulfilled days Vs total stock', fontsize=14)
plt.xlabel('total stock', fontsize=14)
plt.ylabel('unfulfilled days', fontsize=14)
plt.grid(True)
plt.show()
```



3D GRAPH

```
from mpl_toolkits import mplot3d
import numpy as np
import matplotlib.pyplot as plt
fig = plt.figure()
ax = plt.axes(projection='3d')
zline = np.linspace(0, 15, 1000)
xline = np.sin(zline)
yline = np.cos(zline)
ax.plot3D(xline, yline, zline, 'gray')
zdata = max_stock
xdata = wastage_graph
ydata = unfulfilled_graph
ax.scatter3D(zdata, ydata, xdata, c=xdata);
```



MODEL TO SIMULATE POINT ESTIMATES

```
from scipy.stats import poisson
def simulation_model_pe(max_stock,stock_arrival):
```

```python
    wastage_pe=[]
    unfullfilled_pe=[]
    life_of_product=80
    available_stock=max_stock
    stocks =[0]*(life_of_product+1)
    stocks[-1] = max_stock
    stock_arrival=5
    required_exp_date=30
    demand = 0
    unfullfilled_days=0
    wastage_array=[]
    wastage=0
    for z in range(100):
     for m in range(91):
      for i in range(stock_arrival):
       #calculating the wastage in the process and appending it into the array
       wastage += sum(stocks[:required_exp_date])
       wastage_array.append(wastage)
       # simulating the distribution of the demand
       day_demand = poisson.rvs(mu=150)
       demand+= day_demand
       available_stock -= wastage
       # when avaialable stock is less than daydemand
       if available_stock < day_demand:
        unfullfilled_days += 1
        available_stock = 0
       else:
        available_stock-=day_demand
       #discarding the stock have expiry date less than or equal to 30
       for j in range(len(stocks)-1,required_exp_date-1,-1):
        if stocks[j] >= day_demand:
         stocks[j] -= day_demand
         day_demand = 0
         break
        else:
         day_demand -= stocks[j]
         stocks[j] = 0
       for k in range(1, len(stocks)):
        stocks[k-1] = stocks[k]
       stocks[-1] = 0
      if available_stock == 0:
       stocks[-1] = max_stock
      #Calculating the wastage
      else:
       stocks[-1] = demand + wastage
      wastage = 0
      for l in range(required_exp_date):
       stocks[l] = 0
      available_stock = max_stock
     wastage_pe.append(sum(wastage_array))
     wastage_array=[]
     unfullfilled_pe.append(unfullfilled_days)
     unfulfilled_days=0
    return  wastage_pe,unfullfilled_pe
```

[8]
```python
wastage_pe,unfullfilled_pe= simulation_model(850,5)
```

[9]
```python
import scipy.stats as stats
import math
mean=np.mean(wastage_pe)
z = stats.norm.ppf(q=0.975)
x= z*(np.std(wastage_pe))/math.sqrt(100)
ci = (mean-x,mean+x)
print('the expected average wastage',mean)
print('95% confidence interval',ci)
```

```
the expected average wastage 1091.1868131868132
95% confidence interval (353.53769387003535, 1828.835932503591)
```

```python
import scipy.stats as stats
import math
mean=np.mean(unfullfilled_pe)
z = stats.norm.ppf(q=0.975)
x= z*(np.std(unfullfilled_pe))/math.sqrt(100)
ci = (mean-x,mean+x)
print('the expected average wastage',mean)
print('95% confidence interval',ci)
```

[ ]

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