Module 2 Project - Northwind Analysis / SQL

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- Student pace: part time
- Scheduled project review date/time: 3/22/19 at 2:15pm PST
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Importing the libraries and databases

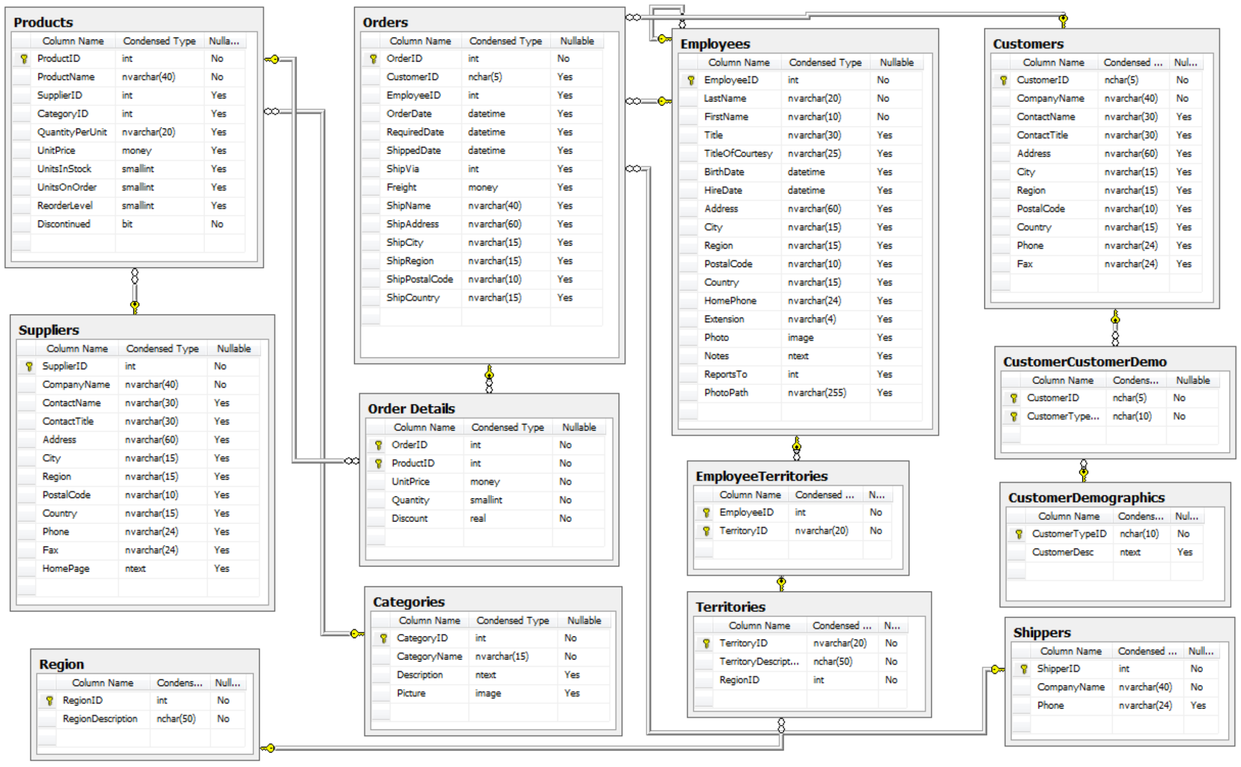
In [13]:
```
# Importing required libraries
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
%matplotlib inline
import sqlalchemy
from sqlalchemy import create_engine
from sqlalchemy.orm import Session, sessionmaker
from sqlalchemy import inspect
from scipy import stats
import statsmodels.api as sm
from statsmodels.formula.api import ols
from matplotlib.dates import DateFormatter
import matplotlib.dates as mdates
import warnings
warnings.filterwarnings('ignore') # hide matplotlib warnings
```

In [14]:
```
# Creating an engine and connecting to a database with SQLAlchemy
engine = create_engine("sqlite:///Northwind_small.sqlite", echo=False)
Session = sessionmaker(bind=engine)
session = Session()
con = engine.connect()
```

Comparing schema table vs. table names

In [15]:
```
inspector = inspect(engine)
print(inspector.get_table_names())
```

```
['Category', 'Customer', 'CustomerCustomerDemo', 'CustomerDemographic', 'Emplo
yee', 'EmployeeTerritory', 'Order', 'OrderDetail', 'Product', 'Region', 'Shipp
er', 'Supplier', 'Territory']
```



Products

Column Name	Condensed Type	Nulla...
ProductID	int	No
ProductName	nvarchar(40)	No
SupplierID	int	Yes
CategoryID	int	Yes
QuantityPerUnit	nvarchar(20)	Yes
UnitPrice	money	Yes
UnitsInStock	smallint	Yes
UnitsOnOrder	smallint	Yes
ReorderLevel	smallint	Yes
Discontinued	bit	No

Orders

Column Name	Condensed Type	Nullable
OrderID	int	No
CustomerID	nchar(5)	Yes
EmployeeID	int	Yes
OrderDate	datetime	Yes
RequiredDate	datetime	Yes
ShippedDate	datetime	Yes
ShipVia	int	Yes
Freight	money	Yes
ShipName	nvarchar(40)	Yes
ShipAddress	nvarchar(60)	Yes
ShipCity	nvarchar(15)	Yes
ShipRegion	nvarchar(15)	Yes
ShipPostalCode	nvarchar(10)	Yes
ShipCountry	nvarchar(15)	Yes

Employees

Column Name	Condensed Type	Nullable
EmployeeID	int	No
LastName	nvarchar(20)	No
FirstName	nvarchar(10)	No
Title	nvarchar(30)	Yes
TitleOfCourtesy	nvarchar(25)	Yes
BirthDate	datetime	Yes
HireDate	datetime	Yes
Address	nvarchar(60)	Yes
City	nvarchar(15)	Yes
Region	nvarchar(15)	Yes
PostalCode	nvarchar(10)	Yes
Country	nvarchar(15)	Yes
HomePhone	nvarchar(24)	Yes
Extension	nvarchar(4)	Yes
Photo	image	Yes
Notes	ntext	Yes
ReportsTo	int	Yes
PhotoPath	nvarchar(255)	Yes

Customers

Column Name	Condensed ...	Nul...
CustomerID	nchar(5)	No
CompanyName	nvarchar(40)	No
ContactName	nvarchar(30)	Yes
ContactTitle	nvarchar(30)	Yes
Address	nvarchar(60)	Yes
City	nvarchar(15)	Yes
Region	nvarchar(15)	Yes
PostalCode	nvarchar(10)	Yes
Country	nvarchar(15)	Yes
Phone	nvarchar(24)	Yes
Fax	nvarchar(24)	Yes

Suppliers

Column Name	Condensed Type	Nullable
SupplierID	int	No
CompanyName	nvarchar(40)	No
ContactName	nvarchar(30)	Yes
ContactTitle	nvarchar(30)	Yes
Address	nvarchar(60)	Yes
City	nvarchar(15)	Yes
Region	nvarchar(15)	Yes
PostalCode	nvarchar(10)	Yes
Country	nvarchar(15)	Yes
Phone	nvarchar(24)	Yes
Fax	nvarchar(24)	Yes
HomePage	ntext	Yes

Order Details

Column Name	Condensed Type	Nullable
OrderID	int	No
ProductID	int	No
UnitPrice	money	No
Quantity	smallint	No
Discount	real	No

CustomerCustomerDemo

Column Name	Condens...	Nullable
CustomerID	nchar(5)	No
CustomerType...	nchar(10)	No

EmployeeTerritories

Column Name	Condensed ...	N...
EmployeeID	int	No
TerritoryID	nvarchar(20)	No

CustomerDemographics

Column Name	Condens...	Nul...
CustomerTypeID	nchar(10)	No
CustomerDesc	ntext	Yes

Categories

Column Name	Condensed Type	Nullable
CategoryID	int	No
CategoryName	nvarchar(15)	No
Description	ntext	Yes
Picture	image	Yes

Territories

Column Name	Condensed ...	N...
TerritoryID	nvarchar(20)	No
TerritoryDescript...	nchar(50)	No
RegionID	int	No

Shippers

Column Name	Condensed ...	Null...
ShipperID	int	No
CompanyName	nvarchar(40)	No
Phone	nvarchar(24)	Yes

Region

Column Name	Condens...	Null...
RegionID	int	No
RegionDescription	nchar(50)	No

The number of schema names and table names show 13 tables total.

To analyze the SQL schema, I'll convert them into a Pandas dataframe

In [16]:
```
#convert sql tables into pandas dataframes
dfEmployee = pd.read_sql('SELECT * FROM [employee]', engine)
dfCategory = pd.read_sql('SELECT * FROM [category]', engine)
dfCustomer = pd.read_sql('SELECT * FROM [customer]', engine)
dfShipper = pd.read_sql('SELECT * FROM [shipper]', engine)
dfSupplier = pd.read_sql('SELECT * FROM [supplier]', engine)
dfOrder = pd.read_sql('SELECT * FROM [order]', engine)
dfProduct = pd.read_sql('SELECT * FROM [product]', engine)
dfOrderDetail = pd.read_sql('SELECT * FROM [orderdetail]', engine)
dfCustomerCustomerDemo = pd.read_sql('SELECT * FROM [customercustomerdemo]', engin
dfCustomerDemographic = pd.read_sql('SELECT * FROM [customerdemographic]', engine)
dfRegion = pd.read_sql('SELECT * FROM [region]', engine)
dfTerritory = pd.read_sql('SELECT * FROM [territory]', engine)
dfEmployeeTerritory = pd.read_sql('SELECT * FROM [employeeterritory]', engine)
```

Part 1: EDA - What is Northwind exactly?

In [17]:
```
# A look at what prodcuts Northwind sells
dfCategory.head()
```

Out[17]:

	Id	CategoryName	Description
0	1	Beverages	Soft drinks, coffees, teas, beers, and ales
1	2	Condiments	Sweet and savory sauces, relishes, spreads, an...
2	3	Confections	Desserts, candies, and sweet breads
3	4	Dairy Products	Cheeses
4	5	Grains/Cereals	Breads, crackers, pasta, and cereal

In [18]:
```
dfCategory.tail()
```

Out[18]:

	Id	CategoryName	Description
3	4	Dairy Products	Cheeses
4	5	Grains/Cereals	Breads, crackers, pasta, and cereal
5	6	Meat/Poultry	Prepared meats
6	7	Produce	Dried fruit and bean curd
7	8	Seafood	Seaweed and fish

Northwind appears to be a food distributor

In [19]:
```
# Checking out the regions Northwind covers
dfRegion.head()
```

Out[19]:

	Id	RegionDescription
0	1	Eastern
1	2	Western
2	3	Northern
3	4	Southern

In [20]:
```
dfTerritory.head()
```

Out[20]:

	Id	TerritoryDescription	RegionId
0	01581	Westboro	1
1	01730	Bedford	1
2	01833	Georgetow	1
3	02116	Boston	1
4	02139	Cambridge	1

In [21]:
```
# I'd like to check their revenue sales for their products
cat_rev = pd.read_sql_query('''SELECT ca.CategoryName,
                                  COUNT(DISTINCT p.ProductName) Products,
                                  SUM((od.UnitPrice * (1 - od.Discount) * od.Quantit
                                  FROM OrderDetail od
                                  JOIN Product p ON od.ProductId = p.Id
                                  JOIN Category ca ON p.CategoryId = ca.Id
                                  GROUP BY ca.CategoryName
                                  ORDER BY Revenue DESC
                              ''', engine)
cat_rev
```

Out[21]:

	CategoryName	Products	Revenue
0	Beverages	12	267868.1800
1	Dairy Products	10	234507.2850
2	Confections	13	167357.2250
3	Meat/Poultry	6	163022.3595
4	Seafood	12	131261.7375
5	Condiments	12	106047.0850
6	Produce	5	99984.5800
7	Grains/Cereals	7	95744.5875

In [22]:
```
print(cat_rev['Products'].sum(), 'products sold.')
```

```
77 products sold.
```

It seems Northwind sold 77 different types of products and Beverages and Dairy Products are the top sellers to their customer base.

In [23]:
```
# I wanted to see how many employees work at Northwind
dfEmployee.head()
```

Out[23]:

	Id	LastName	FirstName	Title	TitleOfCourtesy	BirthDate	HireDate	Address	Ci
0	1	Davolio	Nancy	Sales Representative	Ms.	1980-12-08	2024-05-01	507 - 20th Ave. E. Apt. 2A	Seatt
1	2	Fuller	Andrew	Vice President, Sales	Dr.	1984-02-19	2024-08-14	908 W. Capital Way	Tacon
2	3	Leverling	Janet	Sales Representative	Ms.	1995-08-30	2024-04-01	722 Moss Bay Blvd.	Kirklar
3	4	Peacock	Margaret	Sales Representative	Mrs.	1969-09-19	2025-05-03	4110 Old Redmond Rd.	Redmor
4	5	Buchanan	Steven	Sales Manager	Mr.	1987-03-04	2025-10-17	14 Garrett Hill	Londc

```
In [24]: dfEmployee.tail()
```

Out[24]:

	Id	LastName	FirstName	Title	TitleOfCourtesy	BirthDate	HireDate	Address	C
4	5	Buchanan	Steven	Sales Manager	Mr.	1987-03-04	2025-10-17	14 Garrett Hill	Lond
5	6	Suyama	Michael	Sales Representative	Mr.	1995-07-02	2025-10-17	Coventry House Miner Rd.	Lond
6	7	King	Robert	Sales Representative	Mr.	1992-05-29	2026-01-02	Edgeham Hollow Winchester Way	Lond
7	8	Callahan	Laura	Inside Sales Coordinator	Ms.	1990-01-09	2026-03-05	4726 - 11th Ave. N.E.	Seat
8	9	Dodsworth	Anne	Sales Representative	Ms.	1998-01-27	2026-11-15	7 Houndstooth Rd.	Lond

In [25]:
```
df = pd.read_sql_query('''SELECT e.Id, e.LastName, e.FirstName, e.Title, e.City Of
                            COUNT(DISTINCT od.OrderId) Orders_fulfilled,
                            SUM(od.Quantity) Unit_quantities_sold
                            FROM Employee e
                            JOIN [Order] o ON e.Id = o.EmployeeId
                            JOIN OrderDetail od ON o.Id = od.OrderId
                            JOIN EmployeeTerritory et ON et.EmployeeId = e.Id
                            JOIN Territory t on et.Territoryid = t.Id
                            JOIN Region r on t.RegionId = r.Id
                            GROUP BY e.Id
                            ORDER BY LastName
                        ''', engine)
df
```

Out[25]:

	Id	LastName	FirstName	Title	Office	Orders_fulfilled	Unit_quantities_sold
0	5	Buchanan	Steven	Sales Manager	London	42	21252
1	8	Callahan	Laura	Inside Sales Coordinator	Seattle	104	23652
2	1	Davolio	Nancy	Sales Representative	Seattle	123	15624
3	9	Dodsworth	Anne	Sales Representative	London	43	18690
4	2	Fuller	Andrew	Vice President, Sales	Tacoma	96	42385
5	7	King	Robert	Sales Representative	London	72	46540
6	3	Leverling	Janet	Sales Representative	Kirkland	127	31408
7	4	Peacock	Margaret	Sales Representative	Redmond	156	29394
8	6	Suyama	Michael	Sales Representative	London	67	17635

There's a total of 9 Northwind employees. Four employees are in London and the remaining are in the US.

In [26]:
```
# I now want to get a sense of the Northwind customers and which region they're lo
dfCustomer.head()
```

Out[26]:

	Id	CompanyName	ContactName	ContactTitle	Address	City	Region	PostalCoc
0	ALFKI	Alfreds Futterkiste	Maria Anders	Sales Representative	Obere Str. 57	Berlin	Western Europe	122(
1	ANATR	Ana Trujillo Emparedados y helados	Ana Trujillo	Owner	Avda. de la Constitución 2222	México D.F.	Central America	0502
2	ANTON	Antonio Moreno Taquería	Antonio Moreno	Owner	Mataderos 2312	México D.F.	Central America	0502
3	AROUT	Around the Horn	Thomas Hardy	Sales Representative	120 Hanover Sq.	London	British Isles	WA1 1D
4	BERGS	Berglunds snabbköp	Christina Berglund	Order Administrator	Berguvsvägen 8	Luleå	Northern Europe	S-958 2

In [27]:
```
dfCustomer.tail()
```

Out[27]:

	Id	CompanyName	ContactName	ContactTitle	Address	City	Region	Pc
86	WARTH	Wartian Herkku	Pirkko Koskitalo	Accounting Manager	Torikatu 38	Oulu	Scandinavia	
87	WELLI	Wellington Importadora	Paula Parente	Sales Manager	Rua do Mercado, 12	Resende	South America	(
88	WHITC	White Clover Markets	Karl Jablonski	Owner	305 - 14th Ave. S. Suite 3B	Seattle	North America	
89	WILMK	Wilman Kala	Matti Karttunen	Owner/Marketing Assistant	Keskuskatu 45	Helsinki	Scandinavia	
90	WOLZA	Wolski Zajazd	Zbyszek Piestrzeniewicz	Owner	ul. Filtrowa 68	Warszawa	Eastern Europe	

There are a total of 91 Northwind customers

In [28]:
```
customer_by_region = pd.read_sql_query('''SELECT c.Region
                                           FROM Customer c
                                       ''', engine)

customer_by_region['Region'].value_counts()
```

Out[28]:
```
Western Europe     28
South America      16
North America      16
Southern Europe    10
British Isles       8
Central America     5
Northern Europe     4
Scandinavia         3
Eastern Europe      1
Name: Region, dtype: int64
```

Overall, Northwind is a food distribution company with offices in London and the US. They are a relatively small company comprising of 9 employees. At quick glance, the London office appears to sell fewer products than the US. Northwind has 91 customers and the regions customers are located are in the table above. The top selling products are Beverages and Dairy Products.

Part 2: Hypothesis Testing

Questions:

1. Question 1: Does discount amount have a statistically significant effect on the quantity of a product in an order? If so, at what level(s) of discount?
2. Question 2: Is there a statistically significant difference in USA vs. London employee performance?
3. Question 3: Is there a statistical significance between discounts given by USA vs. London employees?
4. Question 4: Do USA or London employees have higher invoice totals?

> ### Hypothesis 1: Does discount amount have a statistically significant effect on the quantity of a product in an order? If so, at what level(s) of discount?

- H_0: The average number of products ordered is the same regardless of their being a discount

- H_α: The average number of products ordered with a discount is either higher or lower than orders without a discount

In [29]:
```
# Extracting the dataset for question 1 as a pandas dataframe
df1 = pd.read_sql_query('''SELECT Quantity, Discount FROM OrderDetail''', engine)
df1.head()
```

Out[29]:

	Quantity	Discount
0	12	0.0
1	10	0.0
2	5	0.0
3	9	0.0
4	40	0.0

In [30]:
```
df1.describe()
```

Out[30]:

	Quantity	Discount
count	2155.000000	2155.000000
mean	23.812993	0.056167
std	19.022047	0.083450
min	1.000000	0.000000
25%	10.000000	0.000000
50%	20.000000	0.000000
75%	30.000000	0.100000
max	130.000000	0.250000

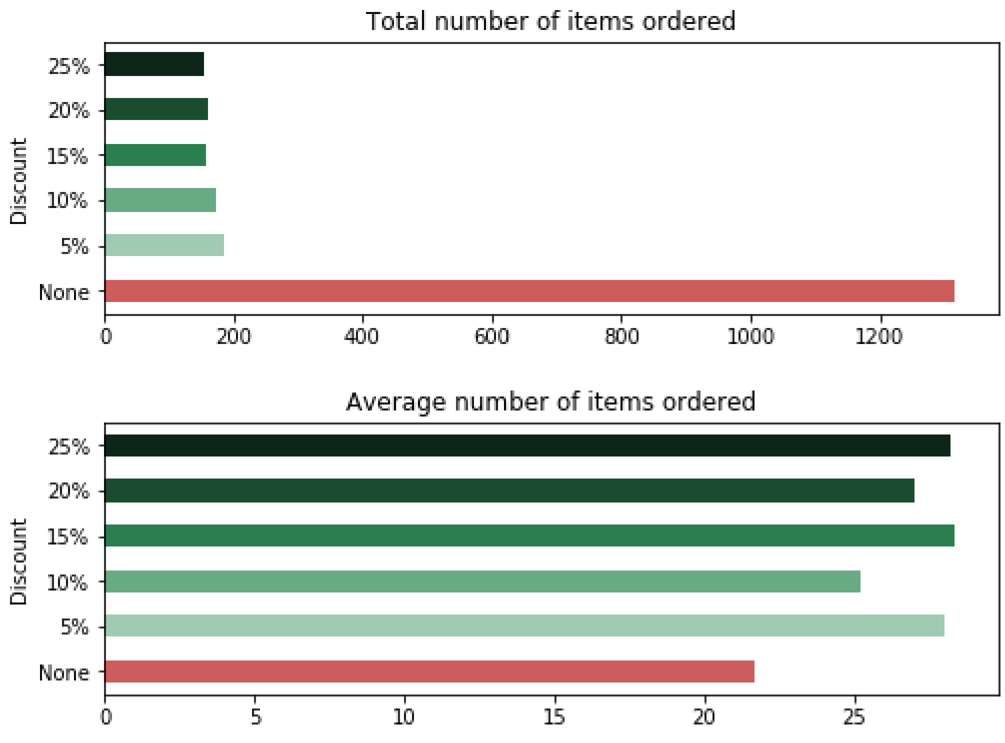
In [31]:
```
df1.Discount.value_counts()
```

Out[31]:
```
0.00    1317
0.05     185
0.10     173
0.20     161
0.15     157
0.25     154
0.03       3
0.02       2
0.01       1
0.04       1
0.06       1
Name: Discount, dtype: int64
```

In [32]:
```
# It might be best to drop discounts at 1%, 2%, 3%, 4% and 6% since they contribut
df1 = df1[df1.Discount.isin(['0.00', '0.05', '0.10', '0.15', '0.20', '0.25'])]
```

In [33]:
```
#dfOrderDetail.sort_values(by='Discount', ascending=False)
#create two data sets; one with the discount and one without
no_discount = dfOrderDetail[dfOrderDetail['Discount'] == 0.0]['Quantity'].values
discount = dfOrderDetail[dfOrderDetail['Discount'] != 0.0 ]['Quantity'].values
```

In [34]:
```
# Plotting the number of orders and average quantity of items ordered with differe
fig, (ax1, ax2) = plt.subplots(2, 1, figsize=(8,6))
df1.groupby(['Discount'])['Quantity'].count().plot(kind='barh', ax=ax1, colors=['i
df1.groupby(['Discount'])['Quantity'].mean().plot(kind='barh', ax=ax2, colors=['in
ax1.set_title('Total number of items ordered')
ax1.set_ylabel('Discount')
ax2.set_ylabel('Discount')
ax2.set_title('Average number of items ordered')
ax1.set_yticklabels(['None', '5%', '10%', '15%', '20%', '25%'])
ax2.set_yticklabels(['None', '5%', '10%', '15%', '20%', '25%'])
fig.subplots_adjust(hspace=0.4);
```



In [35]:
```
#find the mean and std for the two data sets
mu_no_discount = no_discount.mean()
mu_discount = discount.mean()
std_no_discount = no_discount.std()
std_discount = discount.std()
```

In [36]:
```
print('mu for no discount:', mu_no_discount)
print('mu for discount:', mu_discount)
print('\n')
print('std for no discount:', std_no_discount)
print('std for discount:', std_discount)
```

```
mu for no discount: 21.715261958997722
mu for discount: 27.10978520286396


std for no discount: 17.500845477669806
std for discount: 20.759042075141373
```

In [37]:
```
stats.ttest_ind(no_discount, discount)
```

Out[37]:
```
Ttest_indResult(statistic=-6.4785631962949015, pvalue=1.1440924523215966e-10)
```

RESULT: The null hypothesis is rejected since the p value is 1.14 e^{-10}. Having a discount or not does not affect price.

In [38]:
```
# Examing 5 discount datasets
discount5 = dfOrderDetail[dfOrderDetail['Discount'] == 0.05]['Quantity'].values
discount10 = dfOrderDetail[dfOrderDetail['Discount'] == 0.10]['Quantity'].values
discount15 = dfOrderDetail[dfOrderDetail['Discount'] == 0.15]['Quantity'].values
discount20 = dfOrderDetail[dfOrderDetail['Discount'] == 0.20]['Quantity'].values
```

In [39]:
```
print('mu for 5% discount: ', discount5.mean())
print('std for 5% discount: ', discount5.std())
print('mu for 10% discount: ', discount10.mean())
print('std for 10% discount: ', discount10.std())
print('mu for 15% discount: ', discount15.mean())
print('std for 15% discount: ', discount15.std())
print('mu for 20% discount: ', discount20.mean())
print('std for 20% discount: ', discount20.std())
```

```
mu for 5% discount:  28.01081081081081
std for 5% discount:  22.12763691763768
mu for 10% discount:  25.23699421965318
std for 10% discount:  21.125181975751996
mu for 15% discount:  28.38216560509554
std for 15% discount:  20.85635892029252
mu for 20% discount:  27.024844720496894
std for 20% discount:  18.774222551927533
```

In [40]:
```
print(stats.ttest_ind(no_discount, discount5))
print(stats.ttest_ind(no_discount, discount10))
print(stats.ttest_ind(no_discount, discount15))
print(stats.ttest_ind(no_discount, discount20))
```

```
Ttest_indResult(statistic=-4.418557901446638, pvalue=1.064949724167325e-05)
Ttest_indResult(statistic=-2.423258752228738, pvalue=0.015500606526440095)
Ttest_indResult(statistic=-4.411192556207304, pvalue=1.1027809944864872e-05)
Ttest_indResult(statistic=-3.6019486047561884, pvalue=0.00032631258591041463)
```

RESULT: Similarily, the p values for each category are less than the test statistic. So I will reject the null hypothesis.

Hypothesis 2: Is there a statistically significant difference in USA vs. London employee performance?

H_0: There is no difference in performance between USA and London employees

H_α: There is a difference in performance between USA and London employees

In [41]:
```
# Incorporating the database
employees_orders = pd.read_sql_query( '''

                                SELECT O.EmployeeId, E.Country, COUNT(O.Id) AS Tot
                                FROM [Order] AS O
                                JOIN Employee as E
                                ON O.EmployeeId = E.Id
                                GROUP BY O.EmployeeId

                                ''' ,engine)
employees_orders
```

Out[41]:

	EmployeeId	Country	Total_Orders
0	1	USA	123
1	2	USA	96
2	3	USA	127
3	4	USA	156
4	5	UK	42
5	6	UK	67
6	7	UK	72
7	8	USA	104
8	9	UK	43

In [42]:
```
#find the mean and std for the two data sets
usa = employees_orders[employees_orders.Country == 'USA']['Total_Orders']
london  = employees_orders[employees_orders.Country == 'UK']['Total_Orders']
```

In [43]:
```
mu_usa = usa.mean()
std_usa = usa.std()
mu_london = london.mean()
std_london = london.std()
```

In [44]:
```
print('mu for usa:', mu_usa)
print('std for usa:', std_usa)
print('\n')
print('mu for london:', mu_london)
print('std for london:', std_london)
```

```
mu for usa: 121.2
std for usa: 23.33880888134611


mu for london: 56.0
std for london: 15.726834816113932
```

In [45]:
```
stats.ttest_ind(usa, london)
```

Out[45]:
```
Ttest_indResult(statistic=4.758164460817313, pvalue=0.002063854331616113)
```

RESULT: The p value is 0.002 which shows that I must reject the null hypothesis Result of the test shows that there is a statistically significant difference in employee performance between the 2 office.

Hypothesis 3: Is there a statistical significance between discounts given by USA vs. London employees?

H_0: There is no difference in discounts given by from USA and London employees

H_α: There is a difference in discounts given by from USA and London employees

```
In [46]: # Incorporating the database
         us_london_discount = pd.read_sql_query('''

                             SELECT OD.Discount, E.Country FROM [Order] AS O
                             JOIN OrderDetail AS OD ON O.Id = OD.OrderId
                             JOIN Employee AS E ON O.EmployeeId = E.Id

                             ''', engine)
         us_london_discount
```

Out[46]:

	Discount	Country
0	0.00	UK
1	0.00	UK
2	0.00	UK
3	0.00	UK
4	0.00	UK
5	0.00	USA
6	0.15	USA
7	0.15	USA
8	0.05	USA
9	0.05	USA
10	0.00	USA
11	0.05	USA
12	0.05	USA
13	0.00	USA
14	0.00	USA
15	0.00	USA
16	0.00	USA
17	0.15	UK
18	0.15	UK
19	0.00	UK
20	0.00	UK
21	0.00	UK
22	0.00	UK
23	0.00	UK
24	0.00	USA
25	0.00	USA
26	0.00	USA
27	0.00	USA

	Discount	Country
28	0.00	USA
29	0.20	USA
...	...	...
2125	0.15	USA
2126	0.15	USA
2127	0.25	USA
2128	0.25	USA
2129	0.25	USA
2130	0.20	USA
2131	0.00	USA
2132	0.00	USA
2133	0.02	USA
2134	0.05	USA
2135	0.10	USA
2136	0.00	USA
2137	0.05	USA
2138	0.00	USA
2139	0.03	USA
2140	0.03	USA
2141	0.04	USA
2142	0.00	USA
2143	0.00	USA
2144	0.05	USA
2145	0.00	USA
2146	0.02	USA
2147	0.00	USA
2148	0.00	USA
2149	0.06	USA
2150	0.03	USA
2151	0.00	USA
2152	0.01	USA
2153	0.00	USA
2154	0.00	USA

2155 rows × 2 columns

In [47]:
```
#find the mean and std for the two data sets
usa = us_london_discount[us_london_discount.Country == 'USA']['Discount']
london  = us_london_discount[us_london_discount.Country == 'UK']['Discount']
```

In [48]:
```
mu_usa = usa.mean()
std_usa = usa.std()
mu_london = london.mean()
std_london = london.std()
```

In [49]:
```
print('mu for usa:', mu_usa)
print('std for usa:', std_usa)
print('\n')
print('mu for london:', mu_london)
print('std for london:', std_london)
```

```
mu for usa: 0.05282923755513548
std for usa: 0.0823848377442701


mu for london: 0.06549295774647888
std for london: 0.08574460634032187
```

In [50]:
```
stats.ttest_ind(usa, london)
```

Out[50]:
```
Ttest_indResult(statistic=-3.109889948576017, pvalue=0.0018960759380324476)
```

In [ ]:

RESULT: There is statistically significant difference in discount amount between employees from USA and London. This result shows we must reject null hypothesis.

Hypothesis 4: Do USA or London employees have higher invoice totals?

H_0: London invoice totals are higher than USA invoices totals

H_α: London invoice totals are lower than USA invoice totals

In [51]:
```
#A way of measuring "effect" relative to the parameters of the
#control and treatment groups.
# 0.2 may be considered a "small" effect; 0.5 "medium"; 0.8 "large"
def cohend(control, treatment):
    numer = control.mean() - treatment.mean()
    var = ((len(control) * control.var()) + (len(treatment) * treatment.var())) /
    denom = np.sqrt(var)
    return numer / denom
```

In [52]:
```
#Get invoice totals for employees in the USA offices
usa_invoices = pd.read_sql_query('''SELECT od.OrderId,
                            SUM((od.UnitPrice * (1 - od.Discount)) * od.Quantity)
                            FROM OrderDetail od
                            JOIN [Order] o ON od.OrderId = o.Id
                            JOIN Employee e ON o.EmployeeId = e.Id
                            WHERE e.City != "London"
                            GROUP BY od.OrderId
                            ORDER BY e.LastName
                    ''', engine)
```

In [53]:
```
#Get invoice totals for employees in the London office
london_invoices = pd.read_sql_query('''SELECT od.OrderId,
                            SUM((od.UnitPrice * (1 - od.Discount)) * od.Quantity)
                            FROM OrderDetail od
                            JOIN [Order] o ON od.OrderId = o.Id
                            JOIN Employee e ON o.EmployeeId = e.Id
                            WHERE e.City = "London"
                            GROUP BY od.OrderId
                            ORDER BY e.LastName
                    ''', engine)
```

In [54]:
```
usa_invoices.head()
```

Out[54]:

	OrderId	Invoice_total
0	10262	584.0
1	10268	1101.2
2	10276	420.0
3	10278	1488.8
4	10279	351.0

In [55]:
```
#Taking a look at the data
london_invoices.head()
```

Out[55]:

	OrderId	Invoice_total
0	10248	440.00
1	10254	556.62
2	10269	642.20
3	10297	1420.00
4	10320	516.00

In [56]:
```
#Value to compare to p-value
alpha = 0.05

#A control group from the London invoices
#A treatment group from the USA invoices
control2 = london_invoices['Invoice_total']
treatment2 = usa_invoices['Invoice_total']
```

In [57]:
```
print('USA invoice mu:', treatment2.mean())
print('Number of USA invoices:', len(treatment2))
print('\n')
print('London invoice mu:', control2.mean())
print('Number of London invoices:', len(control2))
```

```
USA invoice mu: 1520.150702970297
Number of USA invoices: 606


London invoice mu: 1538.3112209821427
Number of London invoices: 224
```

In [58]:
```
t2, p2 = stats.ttest_ind(control2,treatment2, equal_var = False)
print('T stat is', t2)
print('P-value is', p2)
if p2 > alpha:
    print('Cohen\'s D is', cohend(control2, treatment2))
```

```
T stat is 0.12383782386231988
P-value is 0.9015080381474158
Cohen's D is 0.005109731621820012
```

RESULT: The p value is 0.90, which is greater than 0.05, so we must fail to reject the null hypothesis.

Conclusions:

- Hypothesis 1: There is a significant increase in quantity of products ordered when a discount is applied or not
- Hypothesis 2: There is statistically significant difference in orders quantity between two groups of employees from USA and London
- Hypothesis 3: Results shows there is statistically significant difference in discount amount between employees from USA and London
- Hypothesis 4: Invoice totals from the London office are just about average (or higher) when compared to the USA offices.