```
import numpy as np # linear algebra
import pandas as pd # data processing, CSV file I/O (e.g. pd.read_csv)

# Input data files are available in the read-only "../input/"
directory
# For example, running this (by clicking run or pressing Shift+Enter)
will list all files under the input directory

import os
for dirname, _, filenames in os.walk('/kaggle/input'):
    for filename in filenames:
        print(os.path.join(dirname, filename))

#load labraries
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns

#load the dataset
data = pd.read_csv(r"C:\Users\ADMIN\Desktop\Supply Chain Optimization\
US_Regional_Sales_Data.csv")

data.head()
```

```
   OrderNumber Sales Channel WarehouseCode ProcuredDate OrderDate
ShipDate  \
0  SO - 000101      In-Store  WARE-UHY1004     31/12/17   31/5/18
14/6/18
1  SO - 000102        Online  WARE-NMK1003     31/12/17   31/5/18
22/6/18
2  SO - 000103   Distributor  WARE-UHY1004     31/12/17   31/5/18
21/6/18
3  SO - 000104     Wholesale  WARE-NMK1003     31/12/17   31/5/18
2/6/2018
4  SO - 000105   Distributor  WARE-NMK1003     10/04/18   31/5/18
16/6/18

  DeliveryDate CurrencyCode  _SalesTeamID  _CustomerID  _StoreID
_ProductID  \
0      19/6/18          USD             6           15       259
12
1     2/7/2018          USD            14           20       196
27
2     1/7/2018          USD            21           16       213
16
3     7/6/2018          USD            28           48       107
23
4      26/6/18          USD            22           49       111
26
```

```
   Order Quantity  Discount Applied   Unit Cost  Unit Price
0               5              0.08  $1,001.18   $1,963.10
1               3              0.08  $3,348.66   $3,939.60
2               1              0.05    $781.22   $1,775.50
3               8              0.08  $1,464.69   $2,324.90
4               8              0.10  $1,476.14   $1,822.40
```

```
data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 7991 entries, 0 to 7990
Data columns (total 16 columns):
 #   Column            Non-Null Count  Dtype  
---  ------            --------------  -----  
 0   OrderNumber       7991 non-null   object 
 1   Sales Channel     7991 non-null   object 
 2   WarehouseCode     7991 non-null   object 
 3   ProcuredDate      7991 non-null   object 
 4   OrderDate         7991 non-null   object 
 5   ShipDate          7991 non-null   object 
 6   DeliveryDate      7991 non-null   object 
 7   CurrencyCode      7991 non-null   object 
 8   _SalesTeamID      7991 non-null   int64  
 9   _CustomerID       7991 non-null   int64  
 10  _StoreID          7991 non-null   int64  
 11  _ProductID        7991 non-null   int64  
 12  Order Quantity    7991 non-null   int64  
 13  Discount Applied  7991 non-null   float64
 14  Unit Cost         7991 non-null   object 
 15  Unit Price        7991 non-null   object 
dtypes: float64(1), int64(5), object(10)
memory usage: 999.0+ KB
```

```
#covert object to date
date_col = ['ProcuredDate','OrderDate','ShipDate','DeliveryDate']
def parse_date(date_str):
    formats = ['%d/%m/%y', '%d/%m/%Y']
    for fmt in formats:
        try:
            return pd.to_datetime(date_str, format=fmt)
        except ValueError:
            continue
    return pd.NaT  # Return NaT if none of the formats match
for col in date_col:
    data[col] = data[col].apply(parse_date)
```

```
data.head(10)
```

```
   OrderNumber Sales Channel WarehouseCode ProcuredDate  OrderDate 
ShipDate  \
0  SO - 000101      In-Store  WARE-UHY1004   2017-12-31 2018-05-31
2018-06-14
1  SO - 000102        Online  WARE-NMK1003   2017-12-31 2018-05-31
2018-06-22
2  SO - 000103   Distributor  WARE-UHY1004   2017-12-31 2018-05-31
2018-06-21
3  SO - 000104     Wholesale  WARE-NMK1003   2017-12-31 2018-05-31
2018-06-02
4  SO - 000105   Distributor  WARE-NMK1003   2018-04-10 2018-05-31
2018-06-16
5  SO - 000106        Online  WARE-PUJ1005   2017-12-31 2018-05-31
2018-06-08
6  SO - 000107      In-Store  WARE-XYS1001   2017-12-31 2018-05-31
2018-06-08
7  SO - 000108      In-Store  WARE-PUJ1005   2018-04-10 2018-05-31
2018-06-26
8  SO - 000109      In-Store  WARE-PUJ1005   2017-12-31 2018-06-01
2018-06-16
9  SO - 000110      In-Store  WARE-UHY1004   2017-12-31 2018-06-01
2018-06-29

  DeliveryDate CurrencyCode  _SalesTeamID  _CustomerID  _StoreID
_ProductID  \
0   2018-06-19          USD             6           15       259
12
1   2018-07-02          USD            14           20       196
27
2   2018-07-01          USD            21           16       213
16
3   2018-06-07          USD            28           48       107
23
4   2018-06-26          USD            22           49       111
26
5   2018-06-13          USD            12           21       285
1
6   2018-06-14          USD            10           14         6
5
7   2018-07-01          USD             6            9       280
46
8   2018-06-21          USD             4            9       299
47
9   2018-07-01          USD            10           33       261
13

   Order Quantity  Discount Applied   Unit Cost  Unit Price
0               5              0.08  $1,001.18   $1,963.10
1               3              0.08  $3,348.66   $3,939.60
2               1              0.05    $781.22   $1,775.50
3               8              0.08  $1,464.69   $2,324.90
```

```
4               8              0.10  $1,476.14   $1,822.40
5               5              0.05    $446.56   $1,038.50
6               4              0.15    $536.67   $1,192.60
7               5              0.05  $1,525.19   $1,815.70
8               4              0.30  $2,211.20   $3,879.30
9               8              0.05  $1,212.97   $1,956.40
```

```
data.isnull().sum().sum()
```

```
0
```

```
data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 7991 entries, 0 to 7990
Data columns (total 16 columns):
 #   Column            Non-Null Count  Dtype
---  ------            --------------  -----
 0   OrderNumber       7991 non-null   object
 1   Sales Channel     7991 non-null   object
 2   WarehouseCode     7991 non-null   object
 3   ProcuredDate      7991 non-null   datetime64[ns]
 4   OrderDate         7991 non-null   datetime64[ns]
 5   ShipDate          7991 non-null   datetime64[ns]
 6   DeliveryDate      7991 non-null   datetime64[ns]
 7   CurrencyCode      7991 non-null   object
 8   _SalesTeamID      7991 non-null   int64
 9   _CustomerID       7991 non-null   int64
 10  _StoreID          7991 non-null   int64
 11  _ProductID        7991 non-null   int64
 12  Order Quantity    7991 non-null   int64
 13  Discount Applied  7991 non-null   float64
 14  Unit Cost         7991 non-null   object
 15  Unit Price        7991 non-null   object
dtypes: datetime64[ns](4), float64(1), int64(5), object(6)
memory usage: 999.0+ KB
```

```
data["Delivery_time"] = (data["OrderDate"] -
data["DeliveryDate"]).dt.days
data["Unit Cost"] = pd.to_numeric(data["Unit Cost"].str.replace('$',
'').str.replace(',', ''))
data["Unit Price"] = pd.to_numeric(data["Unit Price"].str.replace('$',
'').str.replace(',', ''))
```

```
data.head()
```

```
   OrderNumber Sales Channel WarehouseCode ProcuredDate  OrderDate
ShipDate  \
0  SO - 000101      In-Store  WARE-UHY1004   2017-12-31 2018-05-31
2018-06-14
1  SO - 000102        Online  WARE-NMK1003   2017-12-31 2018-05-31
```

```
2018-06-22
2  SO - 000103   Distributor  WARE-UHY1004   2017-12-31 2018-05-31
2018-06-21
3  SO - 000104     Wholesale  WARE-NMK1003   2017-12-31 2018-05-31
2018-06-02
4  SO - 000105   Distributor  WARE-NMK1003   2018-04-10 2018-05-31
2018-06-16

  DeliveryDate CurrencyCode  _SalesTeamID  _CustomerID  _StoreID
_ProductID  \
0   2018-06-19          USD             6           15       259
12
1   2018-07-02          USD            14           20       196
27
2   2018-07-01          USD            21           16       213
16
3   2018-06-07          USD            28           48       107
23
4   2018-06-26          USD            22           49       111
26

   Order Quantity  Discount Applied  Unit Cost  Unit Price
Delivery_time
0               5              0.08    1001.18      1963.1
-19
1               3              0.08    3348.66      3939.6
-32
2               1              0.05     781.22      1775.5
-31
3               8              0.08    1464.69      2324.9
-7
4               8              0.10    1476.14      1822.4
-26
```

```
data.columns.values
```

```
array(['OrderNumber', 'Sales Channel', 'WarehouseCode',
'ProcuredDate',
       'OrderDate', 'ShipDate', 'DeliveryDate', 'CurrencyCode',
       '_SalesTeamID', '_CustomerID', '_StoreID', '_ProductID',
       'Order Quantity', 'Discount Applied', 'Unit Cost', 'Unit
Price',
       'Delivery_time'], dtype=object)
```

```
data.describe().T
```

```
                   count                            mean
min  \
ProcuredDate        7991  2019-05-29 05:11:01.794518784  2017-12-31
00:00:00
```

```
OrderDate           7991  2019-09-15 11:01:09.828557312  2018-05-31
00:00:00
ShipDate            7991  2019-09-30 15:04:26.249530624  2018-06-02
00:00:00
DeliveryDate        7991  2019-10-06 03:10:06.832686592  2018-06-07
00:00:00
_SalesTeamID      7991.0                      14.384307
1.0
_CustomerID       7991.0                      25.457014
1.0
_StoreID          7991.0                     183.850081
1.0
_ProductID        7991.0                      23.771743
1.0
Order Quantity    7991.0                       4.525341
1.0
Discount Applied  7991.0                       0.115649
0.05
Unit Cost         7991.0                    1431.911513
68.68
Unit Price        7991.0                    2284.536504
167.5
Delivery_time     7991.0                     -20.672882
-38.0

                                  25%                  50%  \
ProcuredDate      2018-10-27 00:00:00  2019-05-15 00:00:00
OrderDate         2019-01-16 12:00:00  2019-09-15 00:00:00
ShipDate          2019-01-31 00:00:00  2019-09-30 00:00:00
DeliveryDate      2019-02-06 00:00:00  2019-10-05 00:00:00
_SalesTeamID                      8.0                 14.0
_CustomerID                      13.0                 25.0
_StoreID                         91.0                183.0
_ProductID                       12.0                 24.0
Order Quantity                    3.0                  5.0
Discount Applied                 0.05                 0.08
Unit Cost                      606.12              1080.58
Unit Price                     1031.8               1849.2
Delivery_time                   -27.0                -21.0

                                  75%                  max
std
ProcuredDate      2020-03-10 00:00:00  2020-09-26 00:00:00
NaN
OrderDate         2020-05-12 00:00:00  2020-12-30 00:00:00
NaN
ShipDate          2020-05-28 00:00:00  2021-01-24 00:00:00
NaN
DeliveryDate      2020-06-01 00:00:00  2021-02-02 00:00:00
```

```
NaN
_SalesTeamID                     21.0                    28.0
7.986086
_CustomerID                      38.0                    50.0
14.414883
_StoreID                        276.0                   367.0
105.903946
_ProductID                       36.0                    47.0
13.526545
Order Quantity                    7.0                     8.0
2.312631
Discount Applied                 0.15                     0.4
0.085018
Unit Cost                     2040.25                 5498.56
1112.413063
Unit Price                     3611.3                  6566.0
1673.096364
Delivery_time                   -14.0                    -3.0
8.295398
```

```
data["Profit"] = round((data["Unit Price"] - data["Unit Cost"]) *
data["Order Quantity"] * (1 - data["Discount Applied"]), 2)
data.head()
```

```
   OrderNumber Sales Channel WarehouseCode ProcuredDate  OrderDate
ShipDate  \
0  SO - 000101      In-Store  WARE-UHY1004   2017-12-31 2018-05-31
2018-06-14
1  SO - 000102        Online  WARE-NMK1003   2017-12-31 2018-05-31
2018-06-22
2  SO - 000103   Distributor  WARE-UHY1004   2017-12-31 2018-05-31
2018-06-21
3  SO - 000104     Wholesale  WARE-NMK1003   2017-12-31 2018-05-31
2018-06-02
4  SO - 000105   Distributor  WARE-NMK1003   2018-04-10 2018-05-31
2018-06-16

  DeliveryDate CurrencyCode  _SalesTeamID  _CustomerID  _StoreID
_ProductID  \
0   2018-06-19          USD             6           15       259
12
1   2018-07-02          USD            14           20       196
27
2   2018-07-01          USD            21           16       213
16
3   2018-06-07          USD            28           48       107
23
4   2018-06-26          USD            22           49       111
26
```

```
   Order Quantity  Discount Applied  Unit Cost  Unit Price  
Delivery_time  \
0               5              0.08    1001.18      1963.1  
-19  
1               3              0.08    3348.66      3939.6  
-32  
2               1              0.05     781.22      1775.5  
-31  
3               8              0.08    1464.69      2324.9  
-7  
4               8              0.10    1476.14      1822.4  
-26  

    Profit  
0  4424.83  
1  1630.99  
2   944.57  
3  6331.15  
4  2493.07  
```

```
data.describe(include='int').T
```

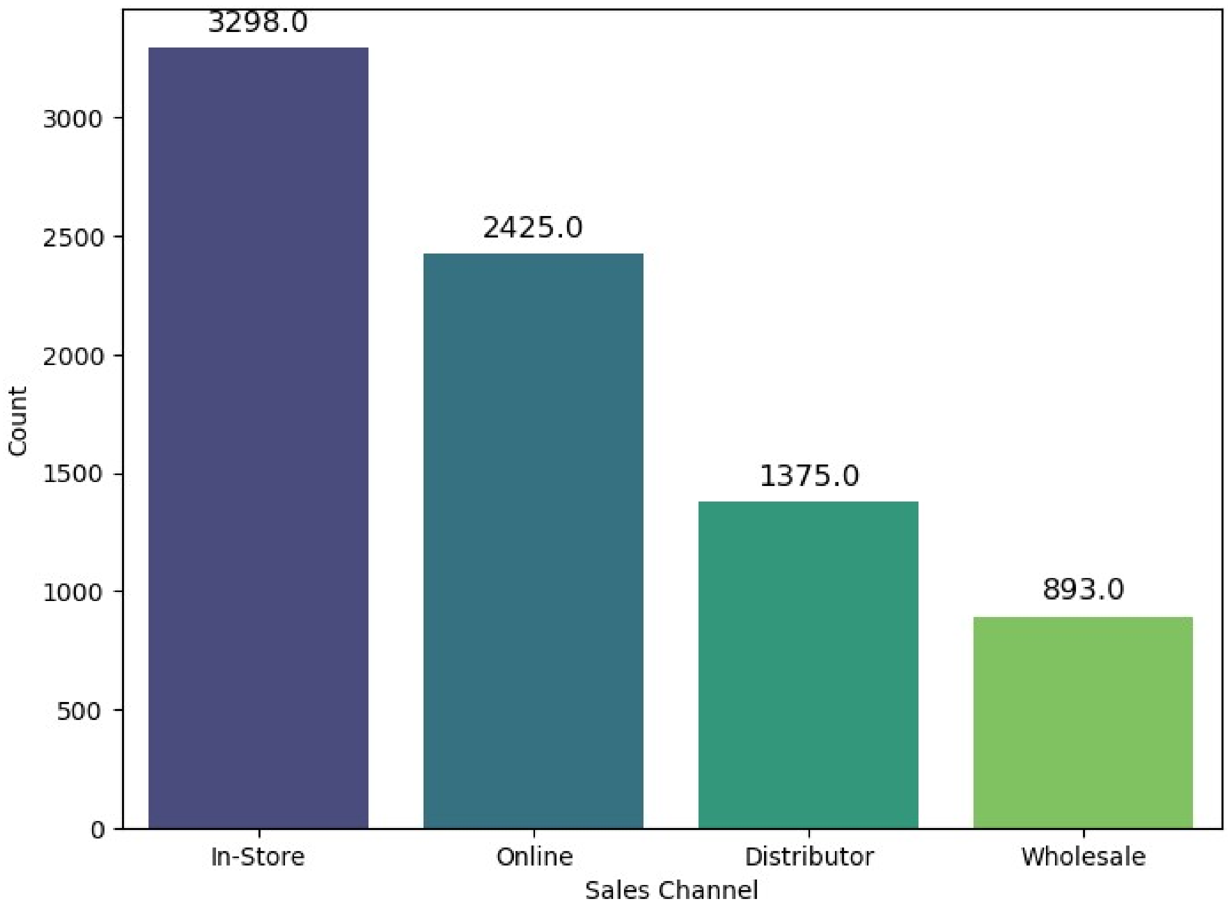
```
                 count        mean         std   min   25%    50%  
75%  \
_SalesTeamID    7991.0   14.384307    7.986086   1.0   8.0   14.0  
21.0   
_CustomerID     7991.0   25.457014   14.414883   1.0  13.0   25.0  
38.0   
_StoreID        7991.0  183.850081  105.903946   1.0  91.0  183.0  
276.0   
_ProductID      7991.0   23.771743   13.526545   1.0  12.0   24.0  
36.0   
Order Quantity  7991.0    4.525341    2.312631   1.0   3.0    5.0  
7.0   
Delivery_time   7991.0  -20.672882    8.295398 -38.0 -27.0  -21.0  -
14.0   

                  max  
_SalesTeamID     28.0  
_CustomerID      50.0  
_StoreID        367.0  
_ProductID       47.0  
Order Quantity    8.0  
Delivery_time    -3.0  
```

```
data.columns = [col.lower().replace('_', '') for col in data.columns]
data.rename(columns=lambda x: x.replace("(", "").replace(")", ""),
inplace=True)
```

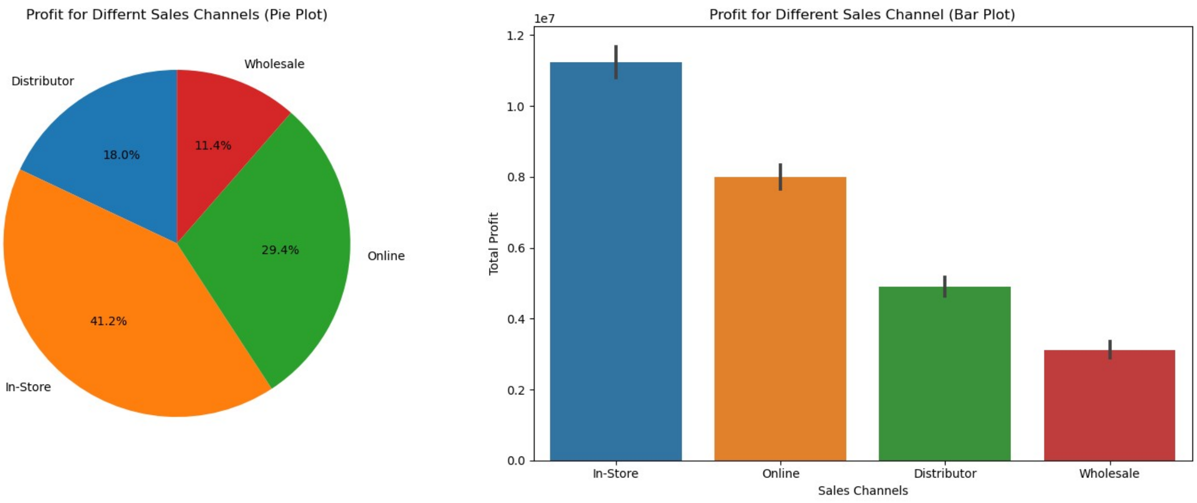
```
data.columns
```

```
Index(['ordernumber', 'sales channel', 'warehousecode',
'procureddate',
       'orderdate', 'shipdate', 'deliverydate', 'currencycode',
'salesteamid',
       'customerid', 'storeid', 'productid', 'order quantity',
       'discount applied', 'unit cost', 'unit price', 'deliverytime',
       'profit'],
      dtype='object')
```

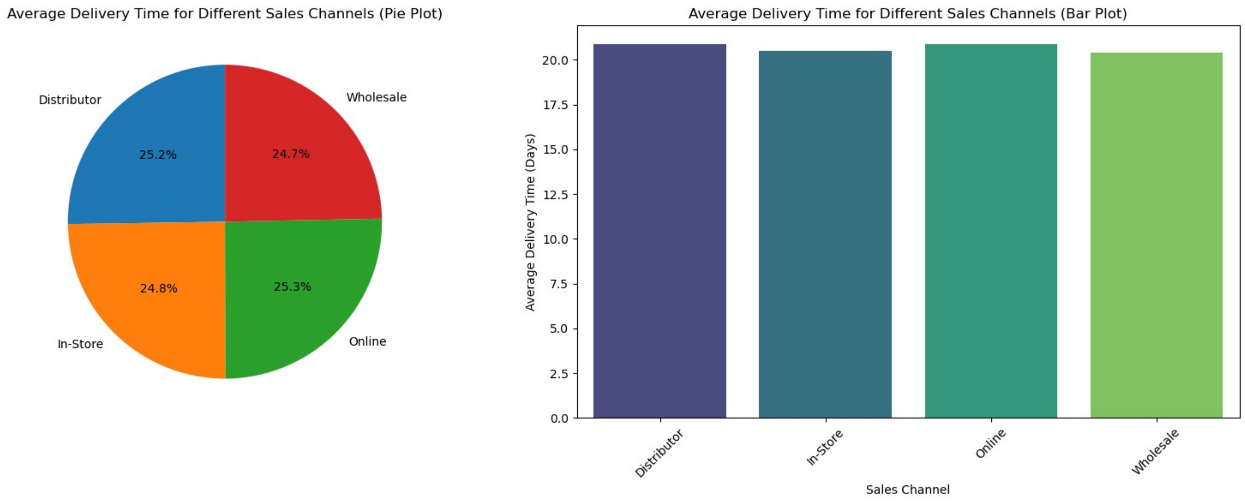
```
plt.figure(figsize=(8, 6))
ax = sns.countplot(x='sales channel', data=data, palette='viridis')
for p in ax.patches:
    ax.annotate(f'{p.get_height()}', (p.get_x() + p.get_width() / 2.,
p.get_height()),
                ha='center', va='center', fontsize=12, color='black',
xytext=(0, 10),
                textcoords='offset points')
plt.xlabel('Sales Channel')
plt.ylabel('Count')
plt.show()
```



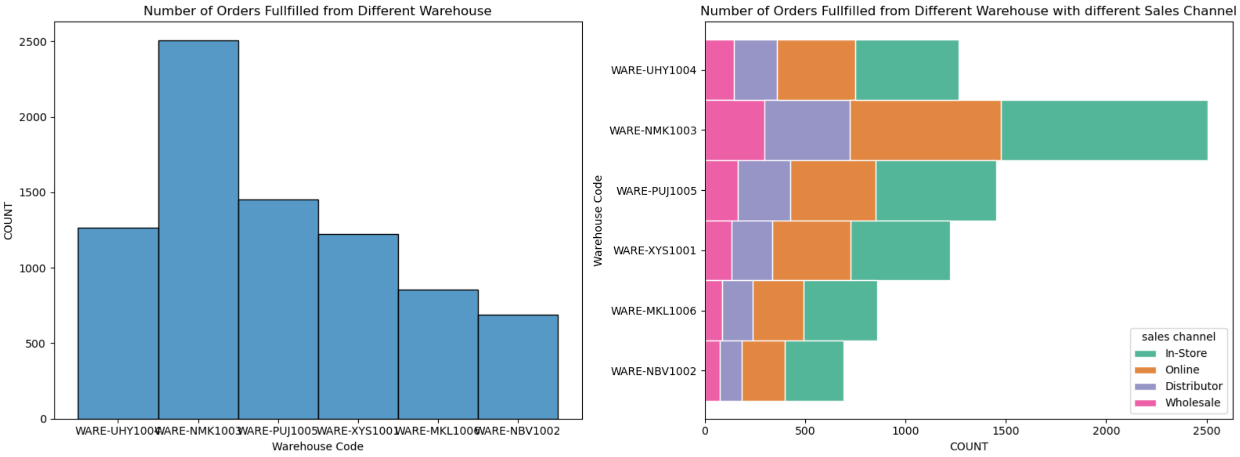
```
fig, axes = plt.subplots(nrows=1, ncols=2, figsize=(16, 6))

#plotting profit for Different sales Channels(Pie Plot)
data.groupby('sales channel')['profit'].sum().plot.pie(autopct='%1.1f%
%', startangle=90, ax=axes[0])
axes[0].set_title('Profit for Differnt Sales Channels (Pie Plot)')
axes[0].set_ylabel('')

#plotting profit for different sales channels(Bar Plot)
sns.barplot(x='sales channel', y='profit', data=data, estimator=sum,
ax=axes[1])
axes[1].set_title('Profit for Different Sales Channel (Bar Plot)')
axes[1].set_xlabel('Sales Channels')
axes[1].set_ylabel('Total Profit')

plt.tight_layout()
plt.show()
```



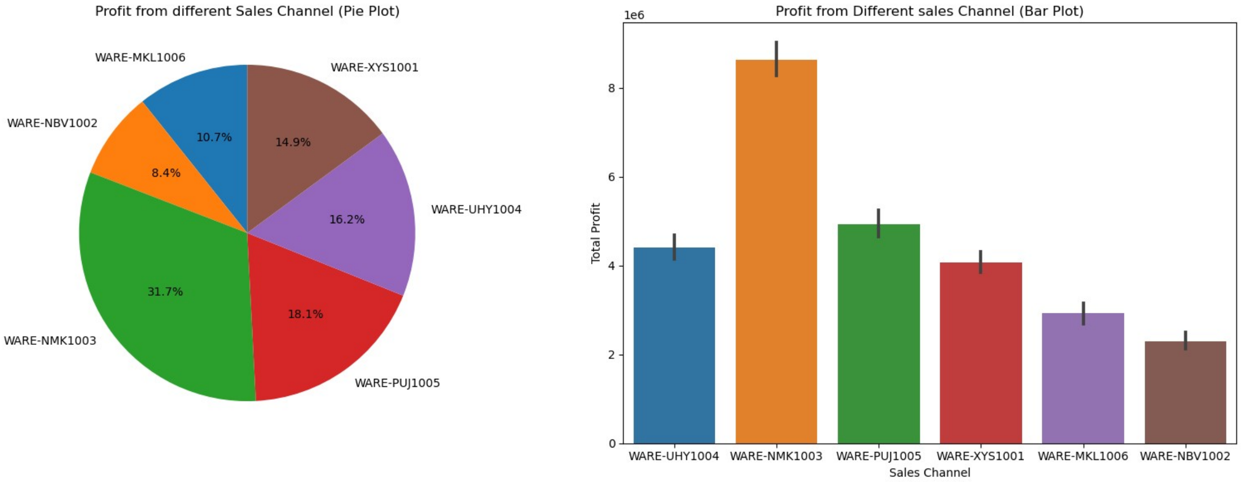
```
avg_delivery_time = data.groupby('sales channel')
['deliverytime'].mean()
avg_delivery_time = avg_delivery_time.abs()
fig, axes = plt.subplots(nrows=1, ncols=2, figsize=(16, 6))

# Plotting Average Delivery Time for Different Sales Channels (Pie
Plot)
avg_delivery_time.plot.pie(autopct='%1.1f%%', startangle=90,
ax=axes[0])
axes[0].set_title('Average Delivery Time for Different Sales Channels
(Pie Plot)')
axes[0].set_ylabel('')

# Plotting Average Delivery Time for Different Sales Channels (Bar
Plot)
sns.barplot(x=avg_delivery_time.index, y=avg_delivery_time.values,
palette='viridis', ax=axes[1])
axes[1].set_title('Average Delivery Time for Different Sales Channels
(Bar Plot)')
axes[1].set_xlabel('Sales Channel')
axes[1].set_ylabel('Average Delivery Time (Days)')
axes[1].tick_params(axis='x', rotation=45)

plt.tight_layout()
plt.show()
```



```
fig, axes = plt.subplots(nrows=1, ncols=2, figsize=(16, 6))

#Plotting Number of Orders Fullfilled from Different Warehoudse using
Seaborn
sns.histplot(data=data, x='warehousecode', ax=axes[0])
axes[0].set_title('Number of Orders Fullfilled from Different
Warehouse')
axes[0].set_xlabel('Warehouse Code')
axes[0].set_ylabel('COUNT')

#Plotting Number of Orders fullfilled  from Different Warehouse Using
Seaborn (Stacked Bar Plot)
sns.histplot(data=data, y='warehousecode', hue='sales channel',
multiple='stack', palette='Dark2', edgecolor='w', ax=axes[1])
axes[1].set_title('Number of Orders Fullfilled from Different
Warehouse with different Sales Channel')
axes[1].set_xlabel('COUNT')
axes[1].set_ylabel('Warehouse Code')

plt.tight_layout()
plt.show()
```

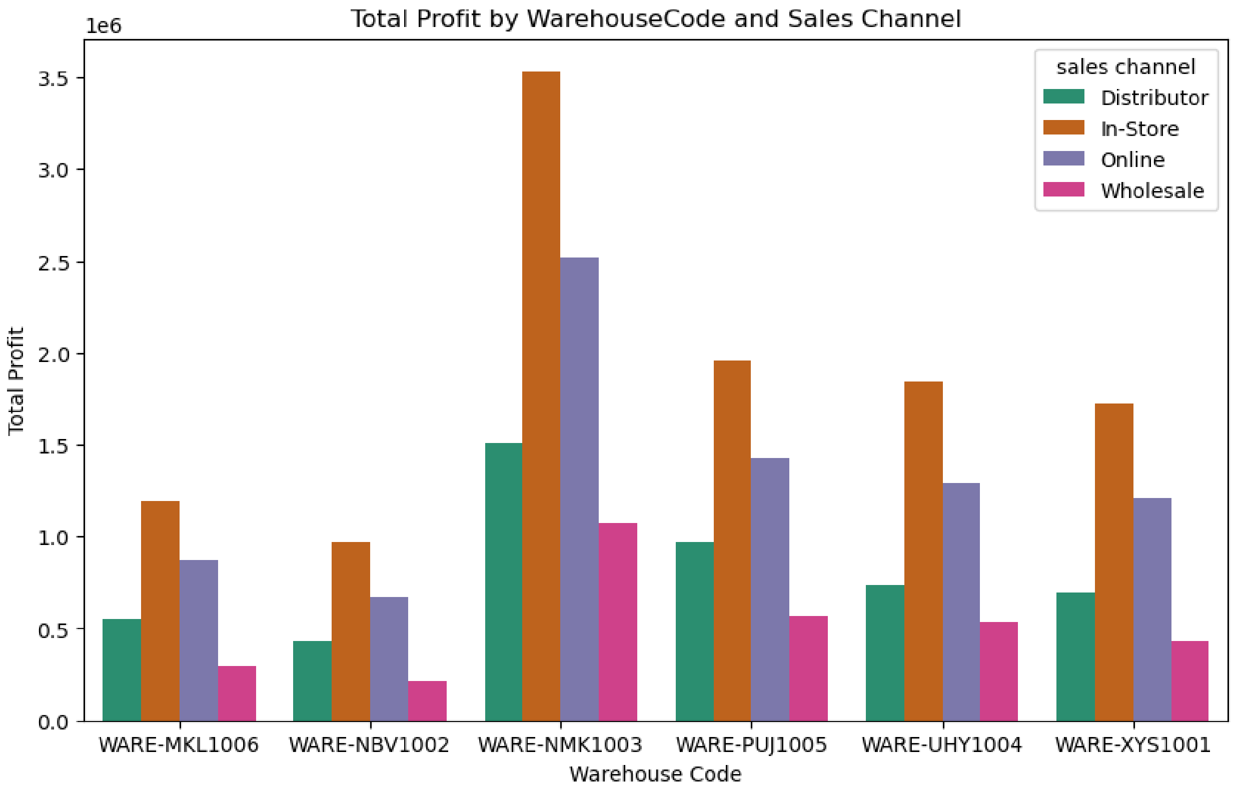


```
fig, axes = plt.subplots(nrows=1, ncols=2, figsize=(16, 6))

#Plotting Profit from different Sales Channel (Pie Plot)
data.groupby('warehousecode')['profit'].sum().plot.pie(autopct='%1.1f%%', startangle=90, ax=axes[0])
axes[0].set_title('Profit from different Sales Channel (Pie Plot)')
axes[0].set_ylabel('')

#Plotting Profit from different Sales Channel (Bar Plot)
sns.barplot(x='warehousecode', y='profit', data=data, estimator=sum, ax=axes[1])
axes[1].set_title('Profit from Different sales Channel (Bar Plot)')
axes[1].set_xlabel('Sales Channel')
axes[1].set_ylabel('Total Profit')

plt.tight_layout()
plt.show()
```

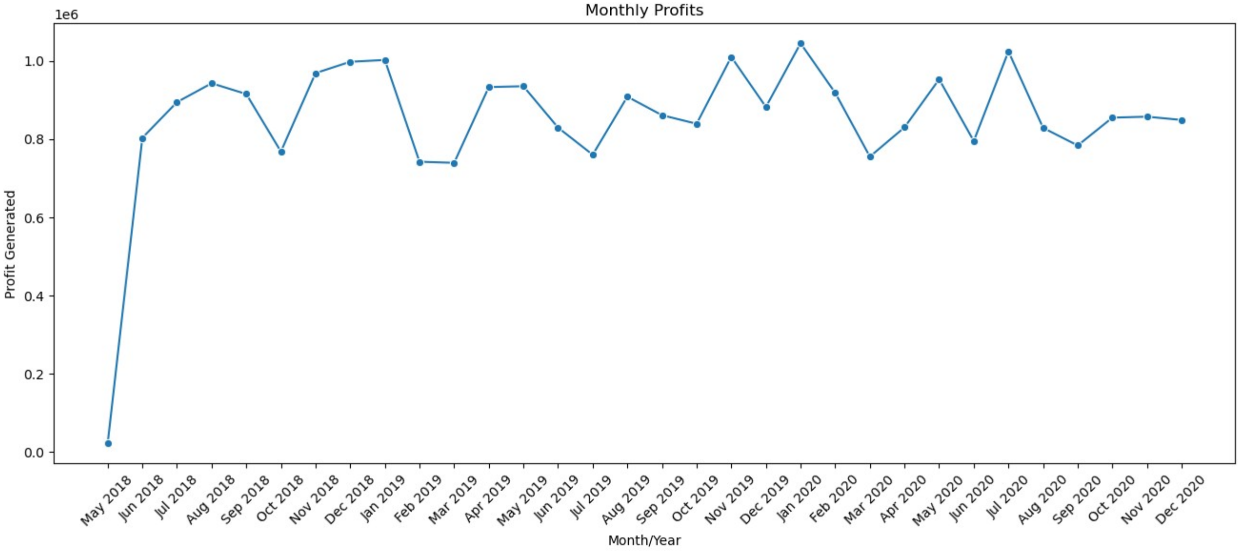


```
profit_by_category = data.groupby(['warehousecode', 'sales channel'])['profit'].sum().reset_index()
```

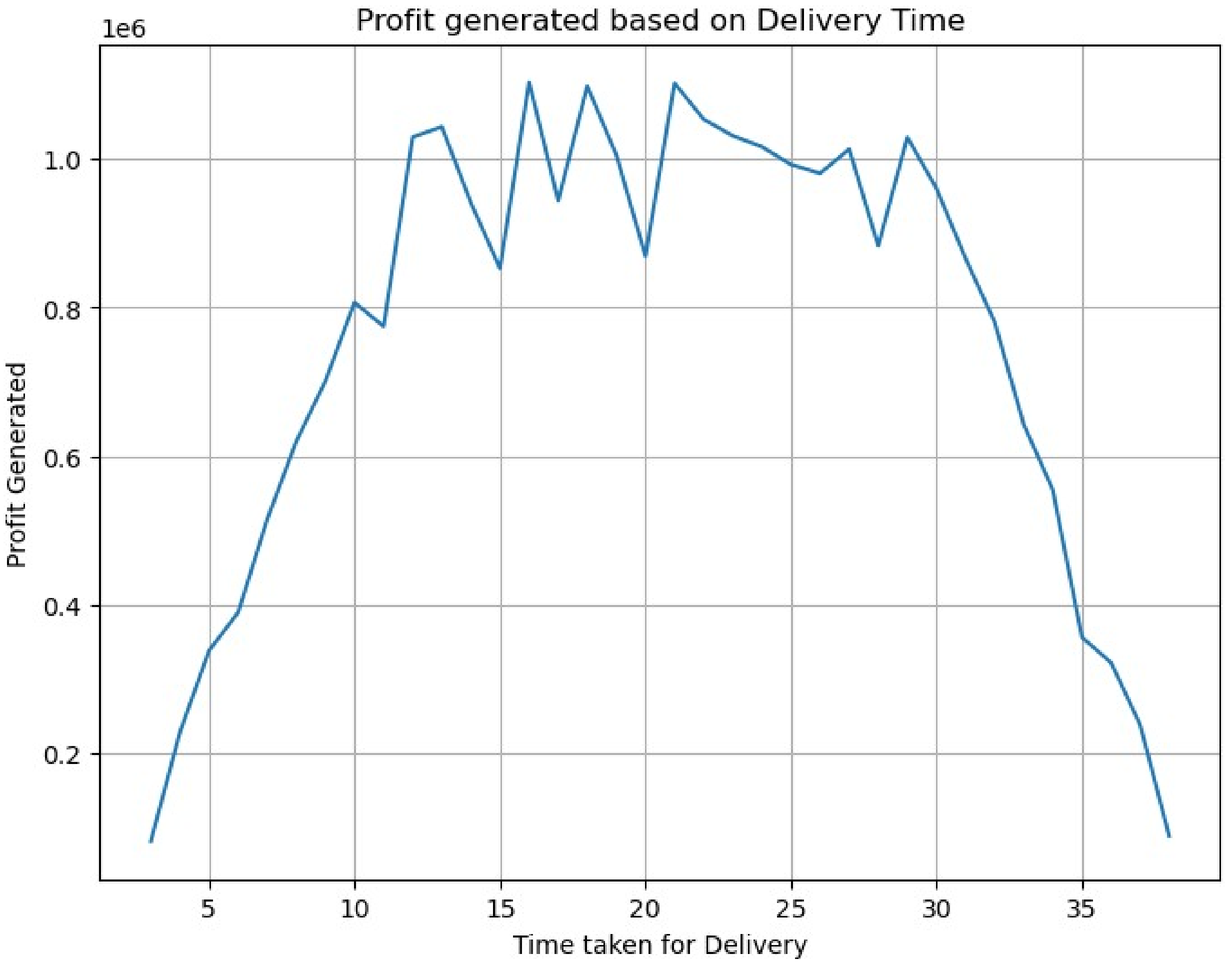
```
#Plotting total profit for each combiation using Seaborn (Bar Plot)
plt.figure(figsize=(10, 6))
sns.barplot(x='warehousecode', y='profit', hue='sales channel',
data=profit_by_category, palette='Dark2')
plt.title('Total Profit by WarehouseCode and Sales Channel')
plt.xlabel('Warehouse Code')
plt.ylabel('Total Profit')
plt.show()
```



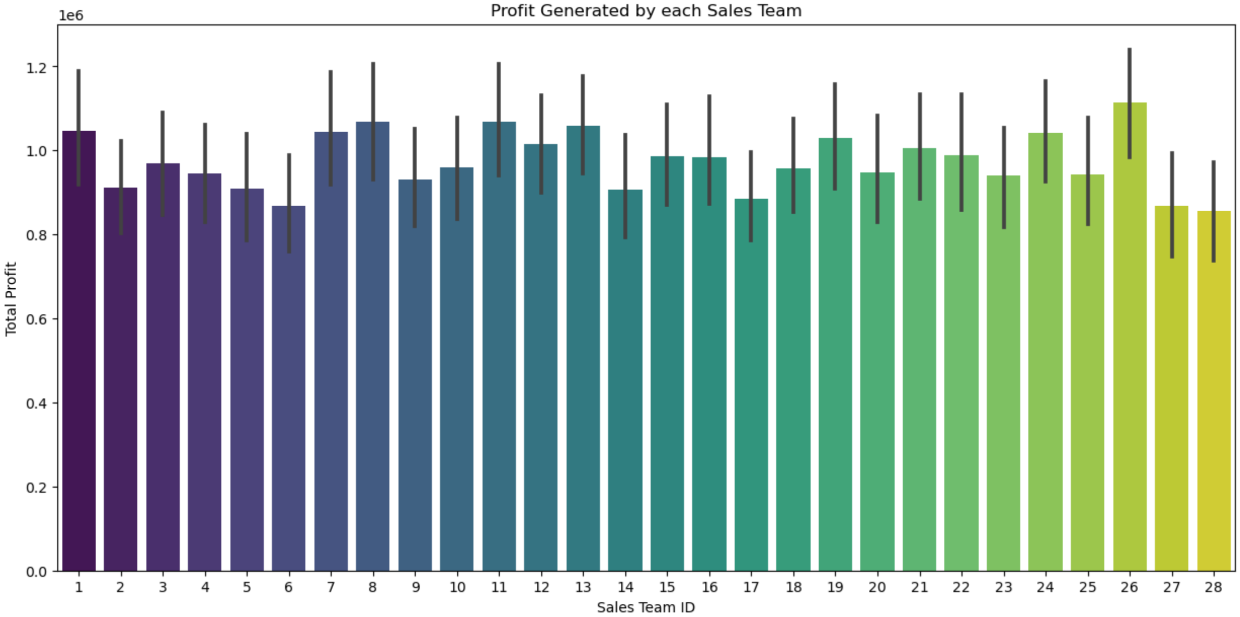
```
profit_by_month_year =
data.groupby([data['orderdate'].dt.to_period('M')])
['profit'].sum().reset_index()

#Plotting Profit generated per month for each month/year using Seaborn
(Line plot)
plt.figure(figsize=(16, 6))
sns.lineplot(x=profit_by_month_year.index, y='profit',
data=profit_by_month_year, marker='o')

#Format x-axis labels as "Jan 2018", "Feb 2018", etc.
plt.xticks(ticks=profit_by_month_year.index, labels=[date.strftime('%b
%Y') for date in profit_by_month_year['orderdate']], rotation=45)
plt.title('Monthly Profits')
plt.xlabel('Month/Year')
plt.ylabel('Profit Generated')
plt.show()
```



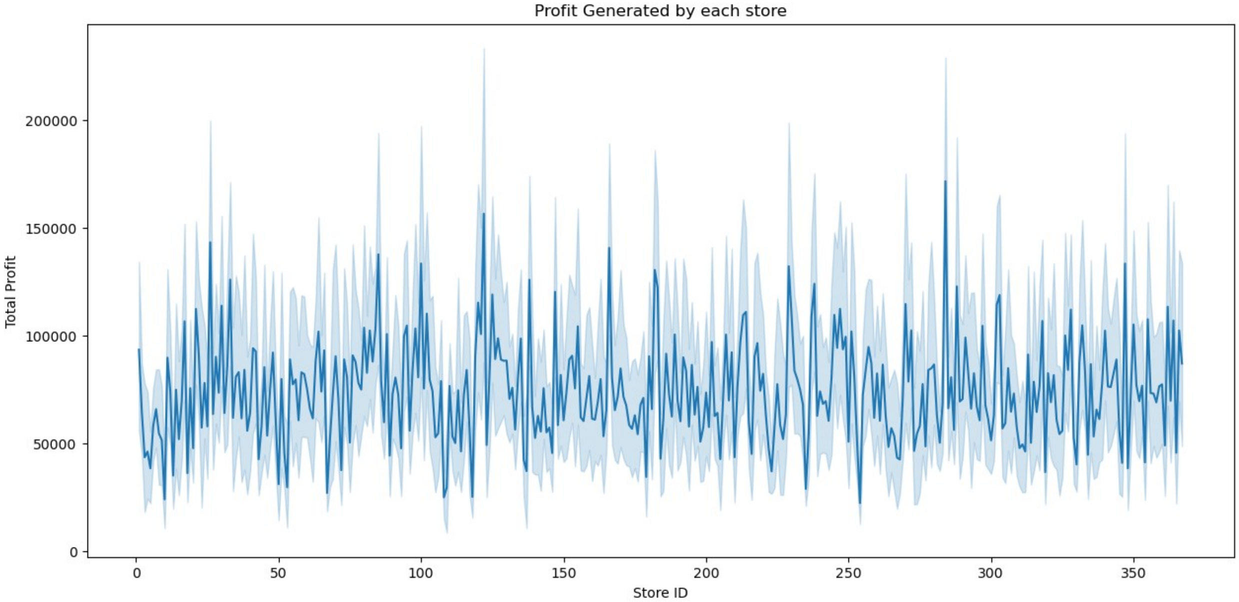
```
profit_delivery_time = data.groupby('deliverytime')
['profit'].sum().reset_index()
profit_delivery_time['deliverytime'] =
profit_delivery_time['deliverytime'].abs()

#Plotting Profit generated based on delivery time using Seaborn (Line
Plot)
plt.figure(figsize=(8, 6))
sns.lineplot(x='deliverytime', y='profit', data=profit_delivery_time)
plt.title('Profit generated based on Delivery Time')
plt.xlabel('Time taken for Delivery')
plt.ylabel('Profit Generated')
plt.grid(True)
plt.show()
```



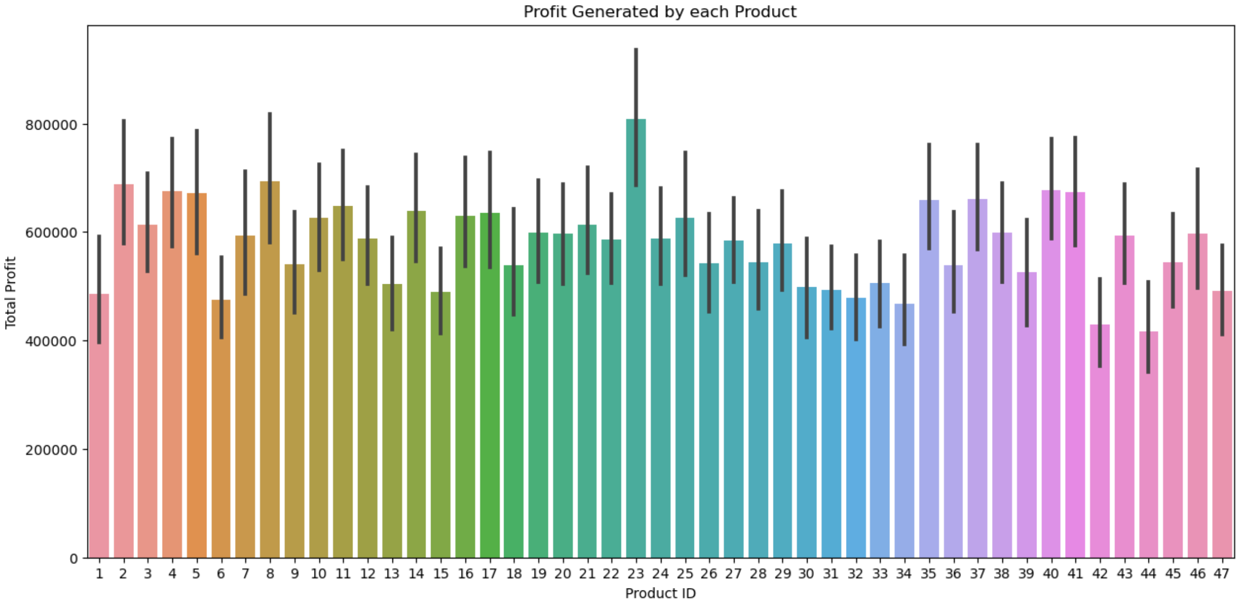
```
plt.figure(figsize=(15, 7))

ax = sns.barplot(x='salesteamid', y='profit', data=data,
estimator=sum, palette='viridis')
plt.title('Profit Generated by each Sales Team')
plt.xlabel('Sales Team ID')
plt.ylabel('Total Profit')
plt.show()
```



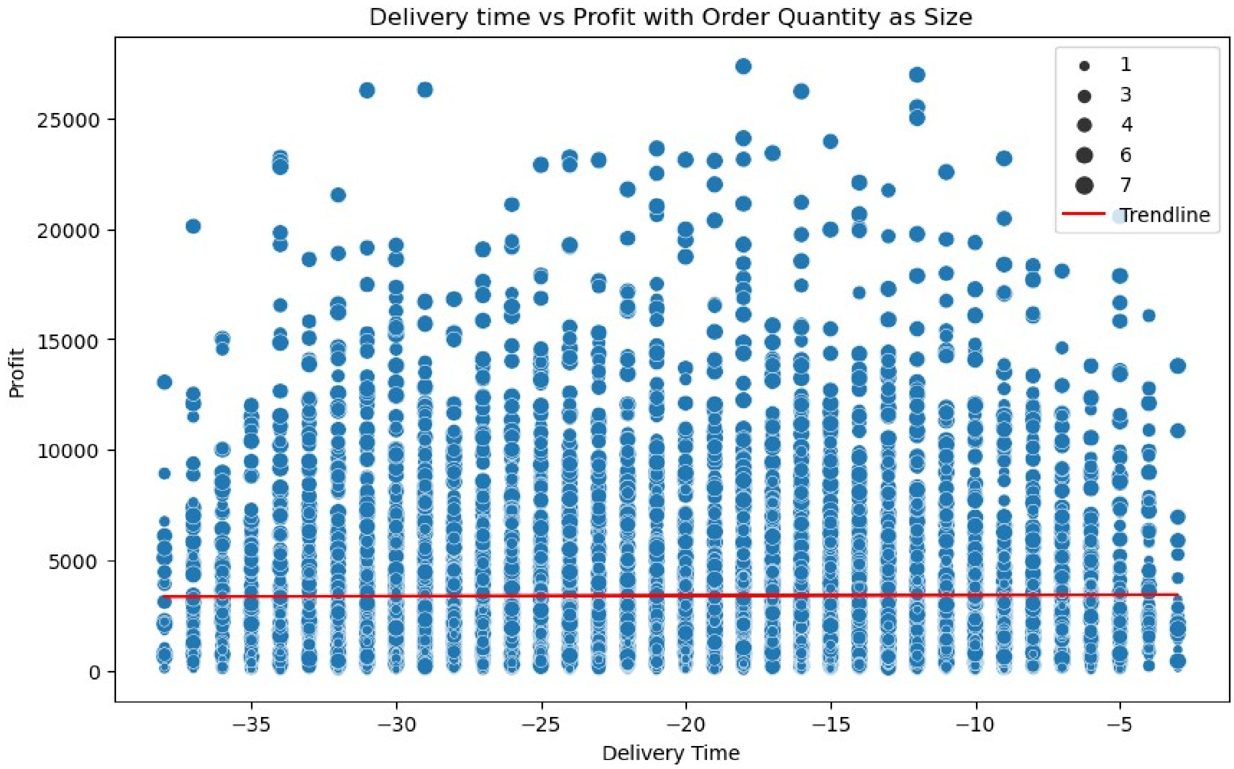
```
plt.figure(figsize=(15, 7))
ax=sns.lineplot(x='storeid', y='profit', data=data, estimator=sum)
plt.title('Profit Generated by each store')
plt.xlabel('Store ID')
plt.ylabel('Total Profit')
plt.show()
```



```
plt.figure(figsize=(15, 7))
ax = sns.barplot(x='productid', y='profit', data=data, estimator=sum)
plt.title('Profit Generated by each Product')
plt.xlabel('Product ID')
plt.ylabel('Total Profit')
plt.show()
```



```
coefficients = np.polyfit(data['deliverytime'], data['profit'], 1)
trendline = np.polyval(coefficients, data['deliverytime'])

#Plotting deliverytime vs profit with order quantity as size using
Seaborn (Scatter Plot)
plt.figure(figsize=(10, 6))
sns.scatterplot(x='deliverytime', y='profit', size='order quantity',
data=data)
plt.plot(data['deliverytime'], trendline, color='red',
label='Trendline')
plt.title('Delivery time vs Profit with Order Quantity as Size')
plt.xlabel('Delivery Time')
plt.ylabel('Profit')
plt.legend()
plt.show()
```



```
data = data.drop(['ordernumber', 'procureddate', 'orderdate',
'shipdate', 'deliverydate', 'currencycode'], axis=1)

data.head()

  sales channel warehousecode  salesteamid  customerid  storeid
productid  \
0      In-Store  WARE-UHY1004            6          15      259
12
1        Online  WARE-NMK1003           14          20      196
27
2   Distributor  WARE-UHY1004           21          16      213
16
3     Wholesale  WARE-NMK1003           28          48      107
23
4   Distributor  WARE-NMK1003           22          49      111
26

   order quantity  discount applied  unit cost  unit price
deliverytime  \
0               5              0.08    1001.18      1963.1           -
19
1               3              0.08    3348.66      3939.6           -
32
2               1              0.05     781.22      1775.5           -
31
```

```
3               8              0.08    1464.69      2324.9
-7
4               8              0.10    1476.14      1822.4                 -
26
```

```
    profit
0  4424.83
1  1630.99
2   944.57
3  6331.15
4  2493.07
```

```
data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 7991 entries, 0 to 7990
Data columns (total 12 columns):
 #   Column            Non-Null Count  Dtype
---  ------            --------------  -----
 0   sales channel     7991 non-null   object
 1   warehousecode     7991 non-null   object
 2   salesteamid       7991 non-null   int64
 3   customerid        7991 non-null   int64
 4   storeid           7991 non-null   int64
 5   productid         7991 non-null   int64
 6   order quantity    7991 non-null   int64
 7   discount applied  7991 non-null   float64
 8   unit cost         7991 non-null   float64
 9   unit price        7991 non-null   float64
 10  deliverytime      7991 non-null   int64
 11  profit            7991 non-null   float64
dtypes: float64(4), int64(6), object(2)
memory usage: 749.3+ KB
```

```
from sklearn import preprocessing
le = preprocessing.LabelEncoder()
data['sales channel'] = le.fit_transform(data['sales channel'])
data['warehousecode'] = le.fit_transform(data['warehousecode'])
```

```
from sklearn.preprocessing import StandardScaler
scaler = StandardScaler()
data[['profit']] = scaler.fit_transform(data[['profit']])
data[['unit cost']] = scaler.fit_transform(data[['unit cost']])
data[['unit price']] = scaler.fit_transform(data[['unit price']])
data.head()
```

```
   sales channel  warehousecode  salesteamid  customerid  storeid  
productid  \
0              1              4            6          15      259
12
```

```
1              2              2           14          20      196
27
2              0              4           21          16      213
16
3              3              2           28          48      107
23
4              0              2           22          49      111
26

   order quantity  discount applied  unit cost  unit price
deliverytime  \
0               5              0.08  -0.387229   -0.192133                    -
19
1               3              0.08   1.723162    0.989284                    -
32
2               1              0.05  -0.584974   -0.304267                    -
31
3               8              0.08   0.029468    0.024127
-7
4               8              0.10   0.039762   -0.276234                    -
26

     profit
0  0.272637
1 -0.478134
2 -0.662591
3  0.784909
4 -0.246473
```

```
from sklearn.model_selection import train_test_split

X = data.drop(['profit'], axis = 1)
y = data['profit']
X_train, X_test, y_train, y_test = train_test_split(X, y, train_size =
0.9, random_state = 42)

print("Shape of X_train:", X_train.shape)
print("Shape of X_test:", X_test.shape)
print("Shape of y_train:", y_train.shape)
print("Shape of y_test:", y_test.shape)
```

```
Shape of X_train: (7191, 11)
Shape of X_test: (800, 11)
Shape of y_train: (7191,)
Shape of y_test: (800,)
```

```
!pip install lightgbm
from sklearn.metrics import r2_score
from lightgbm import LGBMRegressor, Dataset
```

```
Collecting lightgbm
  Obtaining dependency information for lightgbm from
https://files.pythonhosted.org/packages/d9/28/3be76b591a2e14a031b681b8
283acf1dec2ad521f6f1701b7957df68c466/lightgbm-4.5.0-py3-none-
win_amd64.whl.metadata
  Downloading lightgbm-4.5.0-py3-none-win_amd64.whl.metadata (17 kB)
Requirement already satisfied: numpy>=1.17.0 in c:\users\admin\
anaconda3\lib\site-packages (from lightgbm) (1.24.3)
Requirement already satisfied: scipy in c:\users\admin\anaconda3\lib\
site-packages (from lightgbm) (1.11.1)
Downloading lightgbm-4.5.0-py3-none-win_amd64.whl (1.4 MB)
   ---------------------------------------- 0.0/1.4 MB ? eta -:--:--
   ---------------------------------------- 0.0/1.4 MB ? eta -:--:--
    --------------------------------------- 0.0/1.4 MB ? eta -:--:--
   - -------------------------------------- 0.0/1.4 MB 653.6 kB/s eta
0:00:03
   -- ------------------------------------- 0.1/1.4 MB 871.5 kB/s eta
0:00:02
   --- ------------------------------------ 0.1/1.4 MB 950.9 kB/s eta
0:00:02
   ------ --------------------------------- 0.2/1.4 MB 1.1 MB/s eta
0:00:02
   ------- -------------------------------- 0.3/1.4 MB 1.2 MB/s eta
0:00:01
   ---------- ----------------------------- 0.4/1.4 MB 1.3 MB/s eta
0:00:01
   ----------- ---------------------------- 0.4/1.4 MB 1.2 MB/s eta
0:00:01
   ------------- -------------------------- 0.5/1.4 MB 1.3 MB/s eta
0:00:01
   ---------------- ----------------------- 0.6/1.4 MB 1.4 MB/s eta
0:00:01
   ------------------- -------------------- 0.7/1.4 MB 1.5 MB/s eta
0:00:01
   ---------------------- ----------------- 0.8/1.4 MB 1.6 MB/s eta
0:00:01
   ------------------------- -------------- 0.9/1.4 MB 1.6 MB/s eta
0:00:01
   --------------------------- ------------ 1.0/1.4 MB 1.6 MB/s eta
0:00:01
   ----------------------------- ---------- 1.1/1.4 MB 1.6 MB/s eta
0:00:01
   -------------------------------- ------- 1.2/1.4 MB 1.7 MB/s eta
0:00:01
   ----------------------------------- ---- 1.3/1.4 MB 1.7 MB/s eta
0:00:01
   -------------------------------------- - 1.4/1.4 MB 1.7 MB/s eta
0:00:01
   ---------------------------------------  1.4/1.4 MB 1.8 MB/s eta
0:00:01
```

```
   ---------------------------------------- 1.4/1.4 MB 1.7 MB/s eta
0:00:00
Installing collected packages: lightgbm
Successfully installed lightgbm-4.5.0
```

```
lgb_params = {
    'n_jobs': -1,
    'random_state': 123
}

#Create and train the LGBMRegressor
lgb_model = LGBMRegressor(**lgb_params)

#Train the model
lgb_model.fit(X_train, y_train)
```

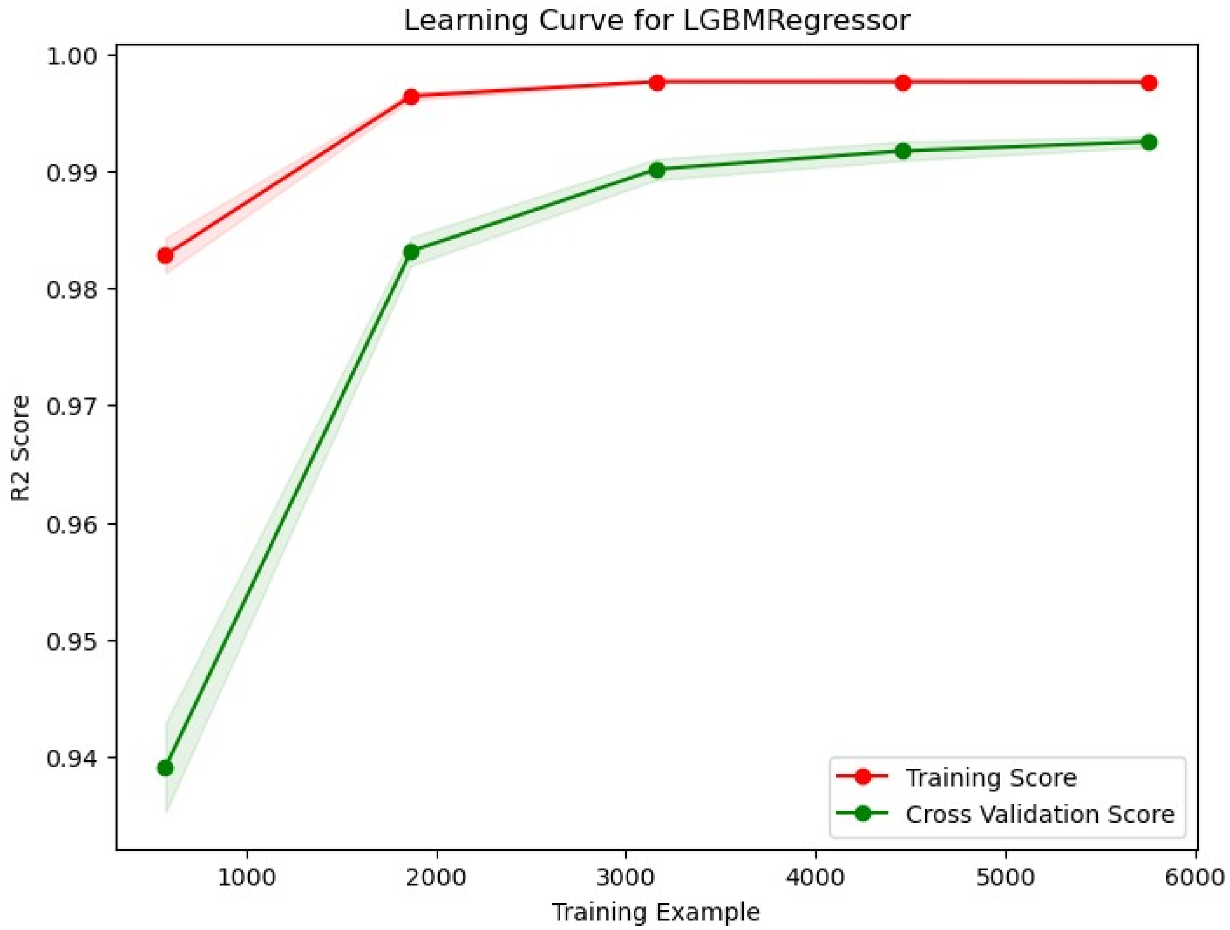
```
[LightGBM] [Warning] Found whitespace in feature_names, replace with
underlines
[LightGBM] [Info] Auto-choosing row-wise multi-threading, the overhead
of testing was 0.001146 seconds.
You can set `force_row_wise=true` to remove the overhead.
And if memory is not enough, you can set `force_col_wise=true`.
[LightGBM] [Info] Total Bins 942
[LightGBM] [Info] Number of data points in the train set: 7191, number
of used features: 11
[LightGBM] [Info] Start training from score 0.000265
```

```
LGBMRegressor(n_jobs=-1, random_state=123)
```

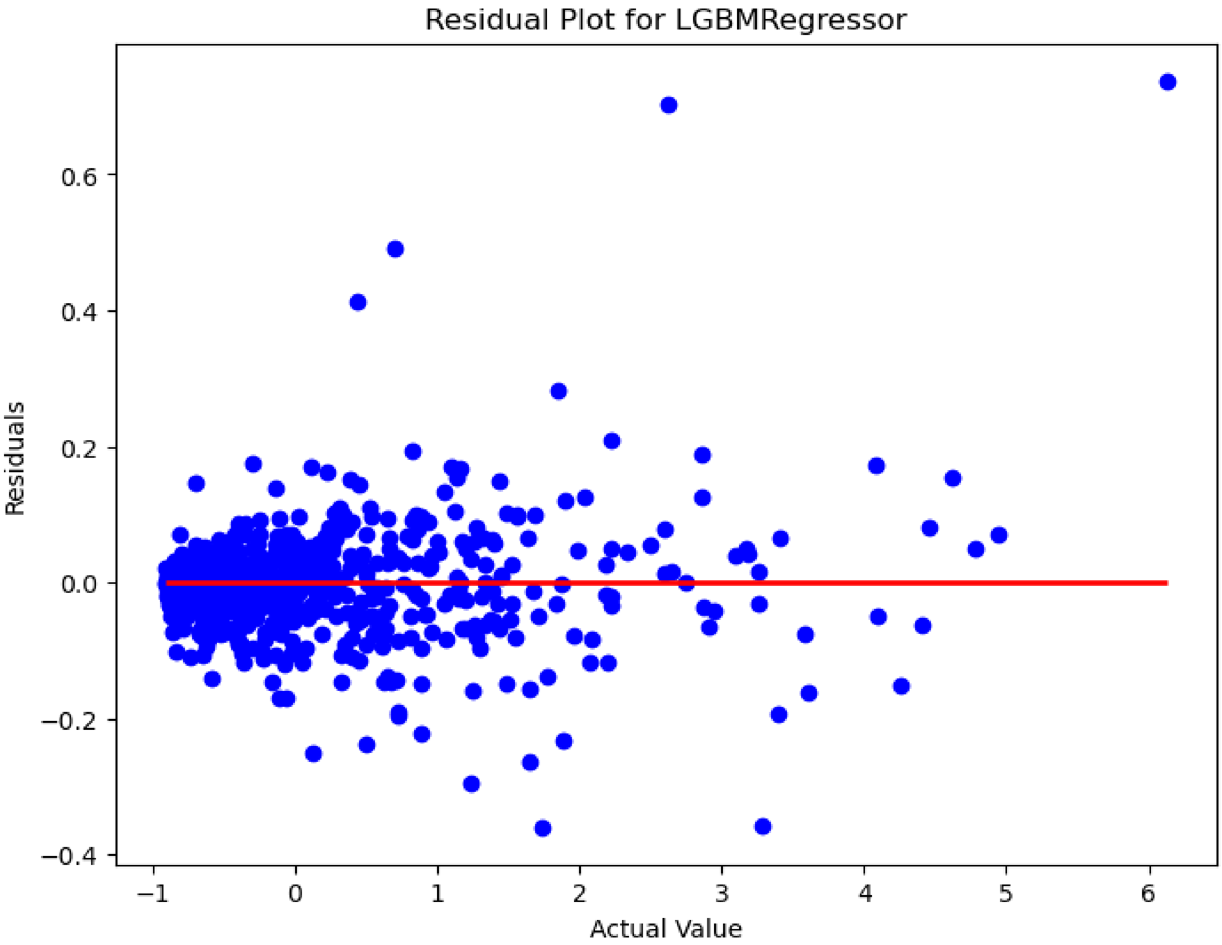
```
y_pred = lgb_model.predict(X_test)
r2 = r2_score(y_test, y_pred)

print(f"R2 score: {r2}")
```

```
R2 score: 0.9944052532120707
```

```
from sklearn.model_selection import learning_curve

train_sizes, train_scores, test_scores = learning_curve(
  lgb_model, X_train, y_train, cv=5, scoring='r2', n_jobs= -1)

train_scores_mean = np.mean(train_scores, axis=1)
train_scores_std = np.std(train_scores, axis=1)
test_scores_mean = np.mean(test_scores, axis=1)
test_scores_std = np.std(test_scores, axis=1)

plt.figure(figsize=(8, 6))
plt.fill_between(train_sizes, train_scores_mean - train_scores_std,
                 train_scores_mean + train_scores_std, alpha=0.1,
                 color="r")
plt.fill_between(train_sizes, test_scores_mean - test_scores_std,
                 test_scores_mean + test_scores_std, alpha=0.1,
color="g")
plt.plot(train_sizes, train_scores_mean, 'o-', color="r",
         label="Training Score")
plt.plot(train_sizes, test_scores_mean, 'o-', color="g",
         label="Cross Validation Score")
plt.xlabel("Training Example")
plt.ylabel("R2 Score")
plt.legend(loc="best")
plt.title("Learning Curve for LGBMRegressor")
plt.show()
```



```
residuals = y_test - y_pred

plt.figure(figsize=(8, 6))
plt.scatter(y_test, residuals, color='blue')
plt.hlines(y=0, xmin=min(y_test), xmax=max(y_test), color='red',
linewidth=2)
plt.xlabel('Actual Value')
plt.ylabel('Residuals')
plt.title('Residual Plot for LGBMRegressor')
plt.show()
```


Residual Plot for LGBMRegressor
Residuals
Actual Value