Proyecto 1 Final

November 23, 2024

1 Proyecto 1 Final

Cargamos los datos

[83]:
```python
import pandas as pd
ds_path = "data/retail_sales_dataset4.csv"
df = pd.read_csv(ds_path)
```

[84]:
```python
df.head()
```

[84]:
```
   Transaction ID        Date Customer ID  Gender  Age Product Category  \
0             522  2023-01-01     CUST522    Male   46           Beauty
1             180  2023-01-01     CUST180    Male   41         Clothing
2             559  2023-01-01     CUST559  Female   40         Clothing
3             303  2023-01-02     CUST303    Male   19      Electronics
4             979  2023-01-02     CUST979  Female   19           Beauty

   Quantity  Price per Unit  Total Amount  Calculated Total Amount  \
0         3             500          1500                     1500
1         3             300           900                      900
2         4             300          1200                     1200
3         3              30            90                       90
4         1              25            25                       25

  Sale_Category Age Classification  Total Amount Stdev Difference
0          Alta             Adulto                     940.002368
1         Media             Adulto                     340.002368
2         Media             Adulto                     640.002368
3          Baja       Adulto Joven                     469.997632
4          Baja       Adulto Joven                     534.997632
```

Exploramos los datos

[85]:
```python
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1000 entries, 0 to 999
Data columns (total 13 columns):
 #   Column                         Non-Null Count  Dtype
```

```
---  ------                         --------------  -----
 0   Transaction ID                 1000 non-null   int64
 1   Date                           1000 non-null   object
 2   Customer ID                    1000 non-null   object
 3   Gender                         1000 non-null   object
 4   Age                            1000 non-null   int64
 5   Product Category               1000 non-null   object
 6   Quantity                       1000 non-null   int64
 7   Price per Unit                 1000 non-null   int64
 8   Total Amount                   1000 non-null   int64
 9   Calculated Total Amount        1000 non-null   int64
 10  Sale_Category                  1000 non-null   object
 11  Age Classification             1000 non-null   object
 12  Total Amount Stdev Difference  1000 non-null   float64
dtypes: float64(1), int64(6), object(6)
memory usage: 101.7+ KB
```

Se observan tipos de datos que pueden ser ajustados

Observamos los valores unicos de las variables categóricas

[86]:
```python
from utils import convert_bolean_columns
convert_bolean_columns(df)
df["Customer ID"] = df["Customer ID"].astype("category")
df['Gender'] = df['Gender'].astype("category")
df["Product Category"] = df["Product Category"].astype("category")
df['Sale_Category'] = df['Sale_Category'].astype("category")
df['Age Classification'] = df['Age Classification'].astype("category")
df["Date"] = pd.to_datetime(df["Date"], format="%Y-%m-%d")
from utils import get_categoric_columns
categoric_columns = get_categoric_columns(df)
for i in categoric_columns:
    print(i)
    print(df[i].unique())
```

```
Customer ID
['CUST522', 'CUST180', 'CUST559', 'CUST303', 'CUST979', …, 'CUST233',
'CUST805', 'CUST857', 'CUST211', 'CUST650']
Length: 1000
Categories (1000, object): ['CUST001', 'CUST002', 'CUST003', 'CUST004', …,
'CUST996', 'CUST997', 'CUST998', 'CUST999']
Gender
['Male', 'Female']
Categories (2, object): ['Female', 'Male']
Product Category
['Beauty', 'Clothing', 'Electronics']
Categories (3, object): ['Beauty', 'Clothing', 'Electronics']
Sale_Category
['Alta', 'Media', 'Baja']
```

```
Categories (3, object): ['Alta', 'Baja', 'Media']
Age Classification
['Adulto', 'Adulto Joven', 'Adulto mayor']
Categories (3, object): ['Adulto', 'Adulto Joven', 'Adulto mayor']
```

[87]:
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1000 entries, 0 to 999
Data columns (total 13 columns):
 #   Column                        Non-Null Count  Dtype
---  ------                        --------------  -----
 0   Transaction ID                1000 non-null   int64
 1   Date                          1000 non-null   datetime64[ns]
 2   Customer ID                   1000 non-null   category
 3   Gender                        1000 non-null   category
 4   Age                           1000 non-null   int64
 5   Product Category              1000 non-null   category
 6   Quantity                      1000 non-null   int64
 7   Price per Unit                1000 non-null   int64
 8   Total Amount                  1000 non-null   int64
 9   Calculated Total Amount       1000 non-null   int64
 10  Sale_Category                 1000 non-null   category
 11  Age Classification            1000 non-null   category
 12  Total Amount Stdev Difference 1000 non-null   float64
dtypes: category(5), datetime64[ns](1), float64(1), int64(6)
memory usage: 109.1 KB
```

Continuamos con la exploración de los datos

Visualizamos la cabecera, luego las últimas entradas

[88]:
```
df.tail(10)
```

[88]:
```
     Transaction ID       Date Customer ID  Gender  Age Product Category  \
990             989 2023-12-28     CUST989  Female   44      Electronics
991             664 2023-12-28     CUST664  Female   44         Clothing
992             429 2023-12-28     CUST429    Male   64      Electronics
993             908 2023-12-29     CUST908    Male   46           Beauty
994             520 2023-12-29     CUST520  Female   49      Electronics
995             233 2023-12-29     CUST233  Female   51           Beauty
996             805 2023-12-29     CUST805  Female   30           Beauty
997             857 2023-12-31     CUST857    Male   60      Electronics
998             211 2024-01-01     CUST211    Male   42           Beauty
999             650 2024-01-01     CUST650    Male   55      Electronics

     Quantity  Price per Unit  Total Amount  Calculated Total Amount  \
990         1              25            25                       25
991         4             500          2000                     2000
```

```
992         2              25          50                        50
993         4             300        1200                      1200
994         4              25         100                       100
995         2             300         600                       600
996         3             500        1500                      1500
997         2              25          50                        50
998         3             500        1500                      1500
999         1              30          30                        30

    Sale_Category Age Classification  Total Amount Stdev Difference
990          Baja             Adulto                     534.997632
991          Alta             Adulto                    1440.002368
992          Baja       Adulto mayor                     509.997632
993         Media             Adulto                     640.002368
994          Baja             Adulto                     459.997632
995          Baja             Adulto                      40.002368
996          Alta             Adulto                     940.002368
997          Baja       Adulto mayor                     509.997632
998          Alta             Adulto                     940.002368
999          Baja             Adulto                     529.997632
```

Verificamos los valores descriptivos

[89]:
```
df.describe().T
```

[89]:
```
                               count                           mean  \
Transaction ID                1000.0                          500.5
Date                            1000  2023-07-03 00:25:55.200000256
Age                           1000.0                         41.392
Quantity                      1000.0                          2.514
Price per Unit                1000.0                         179.89
Total Amount                  1000.0                          456.0
Calculated Total Amount       1000.0                          456.0
Total Amount Stdev Difference 1000.0                     496.319048

                                              min                  25%  \
Transaction ID                                1.0               250.75
Date                          2023-01-01 00:00:00  2023-04-08 00:00:00
Age                                          18.0                 29.0
Quantity                                      1.0                  1.0
Price per Unit                               25.0                 30.0
Total Amount                                 25.0                 60.0
Calculated Total Amount                      25.0                 60.0
Total Amount Stdev Difference           40.002368           359.997632

                                              50%                  75%  \
Transaction ID                              500.5               750.25
Date                          2023-06-29 12:00:00  2023-10-04 00:00:00
```

```
Age                                     42.0                53.0
Quantity                                 3.0                 4.0
Price per Unit                          50.0               300.0
Total Amount                           135.0               900.0
Calculated Total Amount                135.0               900.0
Total Amount Stdev Difference     469.997632          529.997632

                                         max         std
Transaction ID                        1000.0  288.819436
Date                     2024-01-01 00:00:00         NaN
Age                                     64.0    13.68143
Quantity                                 4.0    1.132734
Price per Unit                         500.0  189.681356
Total Amount                          2000.0  559.997632
Calculated Total Amount               2000.0  559.997632
Total Amount Stdev Difference    1440.002368  279.006281
```

[90]:
```python
df.describe(include='category').T
```

[90]:

	count	unique	top	freq
Customer ID	1000	1000	CUST999	1
Gender	1000	2	Female	510
Product Category	1000	3	Clothing	351
Sale_Category	1000	3	Baja	736
Age Classification	1000	3	Adulto	751

1.1 Identificación de valores nulos y outliers

Buscamos duplicados

[91]:
```python
duplicated = df.duplicated().sum()
print(f"Registros duplicados en df: {duplicated}")
```

```
Registros duplicados en df: 0
```

No existen valores duplicados

Ahora valores nulos

[92]:
```python
from utils import get_nulll_data_info
get_nulll_data_info(df)
```

[92]:

	datos sin NAs en q	Na en q	Na en %
Transaction ID	1000	0	0.0
Date	1000	0	0.0
Customer ID	1000	0	0.0
Gender	1000	0	0.0
Age	1000	0	0.0
Product Category	1000	0	0.0

```
Quantity                                    1000          0       0.0
Price per Unit                              1000          0       0.0
Total Amount                                1000          0       0.0
Calculated Total Amount                     1000          0       0.0
Sale_Category                               1000          0       0.0
Age Classification                          1000          0       0.0
Total Amount Stdev Difference               1000          0       0.0
```

No existen valores nulos

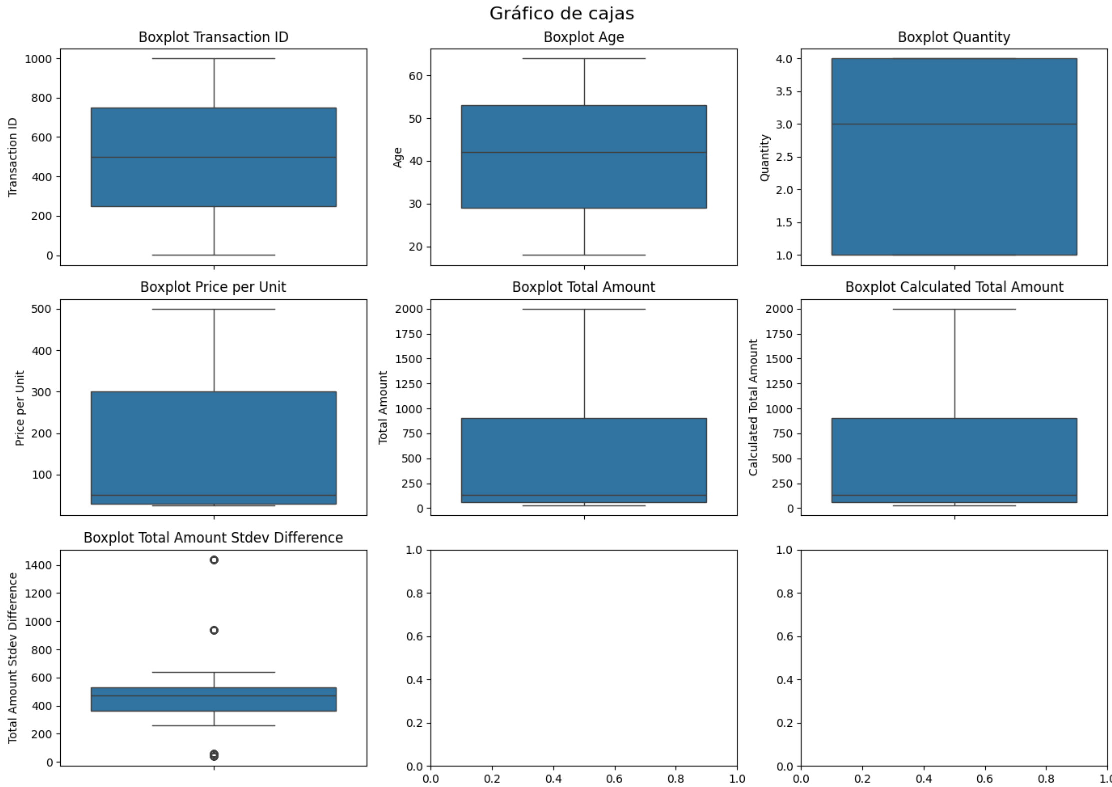
Ahora verificamos los outliers

[93]:
```python
from utils import get_outliers_data
get_outliers_data(df)
```

[93]:
```
             Transaction ID   Age  Quantity  Price per Unit  Total Amount  \
N° Outliers             0.0   0.0       0.0             0.0           0.0
% Outliers              0.0   0.0       0.0             0.0           0.0
Lim. mix             -498.5  -7.0      -3.5          -375.0       -1200.0
Lim. max             1499.5  89.0       8.5           705.0        2160.0

             Calculated Total Amount  Total Amount Stdev Difference
N° Outliers                      0.0                     185.000000
% Outliers                       0.0                      18.500000
Lim. mix                     -1200.0                     104.997632
Lim. max                      2160.0                     784.997632
```

Visualizamos las gráficas de cajas de nuestras columnas

[94]:
```python
from utils import graph_boxplot, get_numeric_columns
graph_boxplot(df, columns=get_numeric_columns(df))
```



Ahora veremos las caracteristicas descriptivas de las variables númericas

[95]:
```
df.describe()
```

[95]:
```
       Transaction ID                           Date          Age     Quantity  \
count     1000.000000                           1000   1000.00000  1000.000000
mean       500.500000  2023-07-03 00:25:55.200000256     41.39200     2.514000
min          1.000000            2023-01-01 00:00:00     18.00000     1.000000
25%        250.750000            2023-04-08 00:00:00     29.00000     1.000000
50%        500.500000            2023-06-29 12:00:00     42.00000     3.000000
75%        750.250000            2023-10-04 00:00:00     53.00000     4.000000
max       1000.000000            2024-01-01 00:00:00     64.00000     4.000000
std        288.819436                            NaN     13.68143     1.132734

       Price per Unit  Total Amount  Calculated Total Amount  \
count     1000.000000   1000.000000              1000.000000
mean       179.890000    456.000000               456.000000
min         25.000000     25.000000                25.000000
25%         30.000000     60.000000                60.000000
50%         50.000000    135.000000               135.000000
75%        300.000000    900.000000               900.000000
max        500.000000   2000.000000              2000.000000
```

```
std        189.681356    559.997632              559.997632

       Total Amount Stdev Difference
count                    1000.000000
mean                      496.319048
min                        40.002368
25%                       359.997632
50%                       469.997632
75%                       529.997632
max                      1440.002368
std                       279.006281
```

[96]:
```python
from utils import get_descriptive_statistics
get_descriptive_statistics(df)
```

[96]:
```
                       Transaction ID        Age  Quantity  Price per Unit  \
min                          1.000000  18.000000  1.000000       25.000000
max                       1000.000000  64.000000  4.000000      500.000000
mean                       500.500000  41.392000  2.514000      179.890000
std                        288.819436  13.681430  1.132734      189.681356
median                     500.500000  42.000000  3.000000       50.000000
variation_coefficient        0.577062   0.330533  0.450571        1.054430

                       Total Amount  Calculated Total Amount  \
min                       25.000000                25.000000
max                     2000.000000              2000.000000
mean                     456.000000               456.000000
std                      559.997632               559.997632
median                   135.000000               135.000000
variation_coefficient      1.228065                 1.228065

                       Total Amount Stdev Difference
min                                        40.002368
max                                      1440.002368
mean                                      496.319048
std                                       279.006281
median                                    469.997632
variation_coefficient                       0.562151
```

No utilizaremos la columna Load ID ya que es solo un identificador

[97]:
```python
df.drop("Transaction ID", axis=1, inplace=True)
df.drop("Customer ID", axis=1, inplace=True)
```

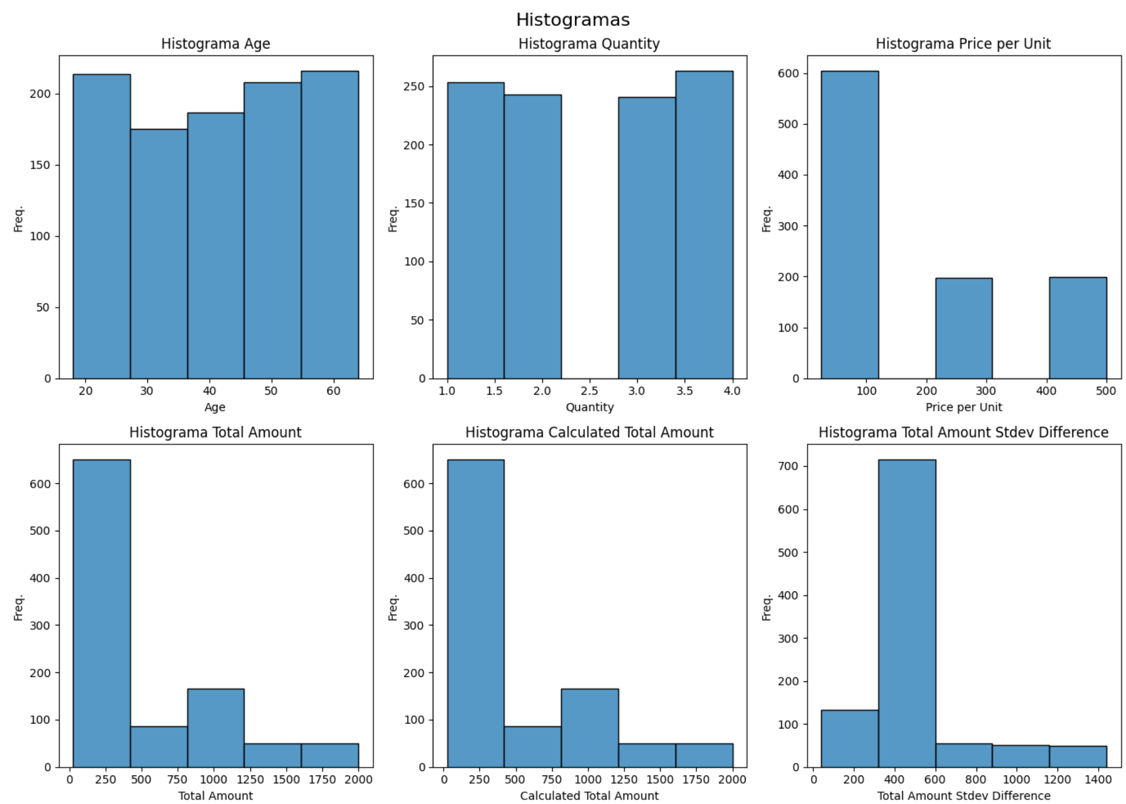
[98]:
```python
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1000 entries, 0 to 999
```

```
Data columns (total 11 columns):
 #   Column                         Non-Null Count  Dtype
---  ------                         --------------  -----
 0   Date                           1000 non-null   datetime64[ns]
 1   Gender                         1000 non-null   category
 2   Age                            1000 non-null   int64
 3   Product Category               1000 non-null   category
 4   Quantity                       1000 non-null   int64
 5   Price per Unit                 1000 non-null   int64
 6   Total Amount                   1000 non-null   int64
 7   Calculated Total Amount        1000 non-null   int64
 8   Sale_Category                  1000 non-null   category
 9   Age Classification             1000 non-null   category
 10  Total Amount Stdev Difference  1000 non-null   float64
dtypes: category(4), datetime64[ns](1), float64(1), int64(5)
memory usage: 59.2 KB
```

Ahora visualizaremos los histogramas de las diferentes columnas numéricas para entender mejor la distribución

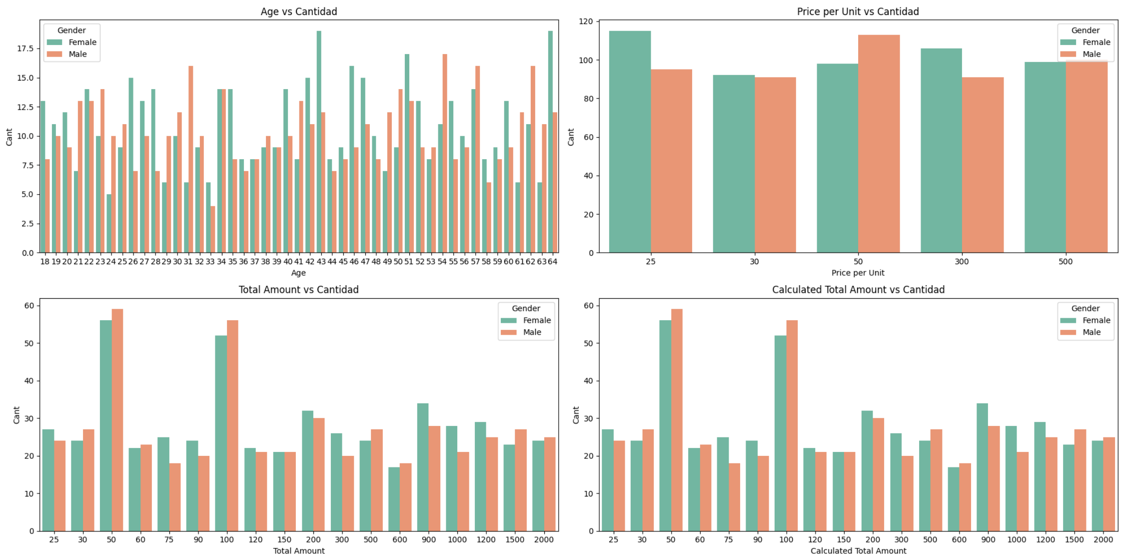
[99]:
```python
from utils import graph_histogram
graph_histogram(df, get_numeric_columns(df))
```



No se observa nada fuera de lo normal en las distribuciones

Se aprecia que la columna max.heart.rate posee una distribución normal, así como la columna edad, oldpeak, colesterol y ST.slope

[100]:
```python
from utils import graph_barplot
graph_barplot(df, ["Age", "Price per Unit", "Total Amount", "Calculated Total␣
↪Amount"],'Gender', num_columns=2, figsize=(20,10), title="Cantidad")
```



Observamos que tenemos datos desbalanceados para las columnas

Veremos las correlaciones entre las caracteristicas

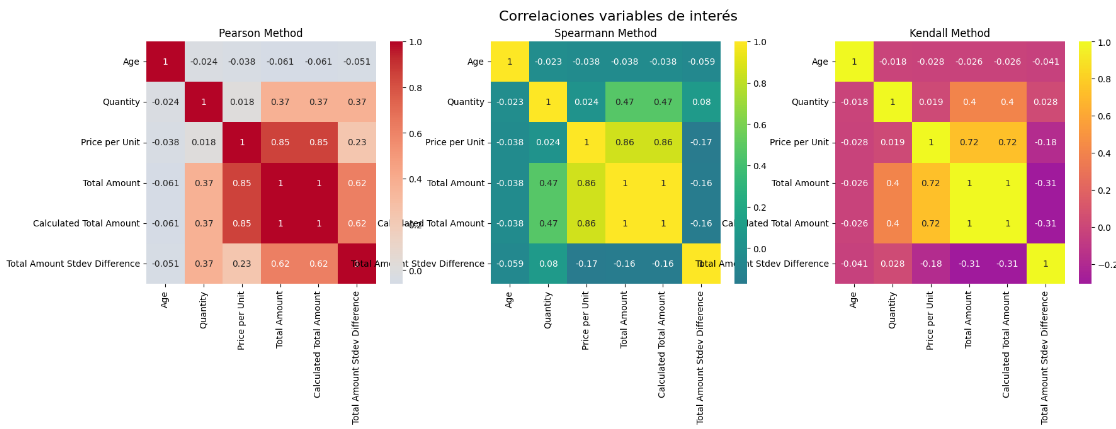
[101]:
```python
from utils import get_numeric_columns
numeric_columns = get_numeric_columns(df)
corr_matrix = df[numeric_columns].corr(method="pearson")
spearmann = df[numeric_columns].corr(method="spearman")
kendall = df[numeric_columns].corr(method="kendall")
corr_matrix
```

[101]:
```
                                   Age  Quantity  Price per Unit  \
Age                           1.000000 -0.023737       -0.038423
Quantity                     -0.023737  1.000000        0.017501
Price per Unit               -0.038423  0.017501        1.000000
Total Amount                 -0.060568  0.373707        0.851925
Calculated Total Amount      -0.060568  0.373707        0.851925
Total Amount Stdev Difference -0.051358  0.374290        0.233934

                              Total Amount  Calculated Total Amount  \
Age                              -0.060568                -0.060568
```

```
Quantity                            0.373707             0.373707
Price per Unit                      0.851925             0.851925
Total Amount                        1.000000             1.000000
Calculated Total Amount             1.000000             1.000000
Total Amount Stdev Difference       0.619832             0.619832

                               Total Amount Stdev Difference
Age                                                -0.051358
Quantity                                            0.374290
Price per Unit                                      0.233934
Total Amount                                        0.619832
Calculated Total Amount                             0.619832
Total Amount Stdev Difference                       1.000000
```

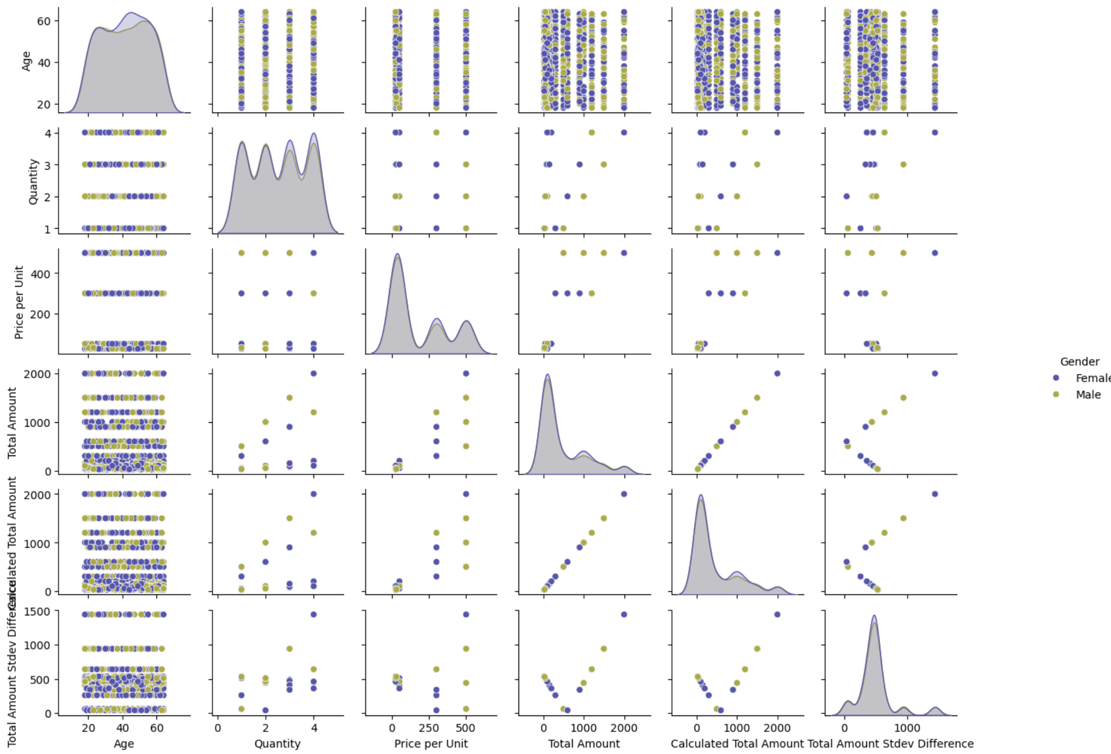
Ahora graficamos el mapa de calor de las correlaciones

[102]:
```python
from utils import graph_correlations
graph_correlations(corr_matrix, spearmann, kendall, "Correlaciones variables de␣
↪interés", figsize= (20,5))
```



Ahora observaremos la dispersión entre las variables

[103]:
```python
import matplotlib.pyplot as plt
import seaborn as sns
numeric_columns = get_numeric_columns(df)
palette = sns.color_palette("gist_stern", n_colors=2)
g = sns.pairplot(df[[*numeric_columns] + ["Gender"]], hue='Gender', height=1.2,␣
↪diag_kind = 'kde', palette=palette)
g.figure.set_size_inches(15, 10)
plt.show()
```



Iniciamos la preparación de datos

[104]:
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1000 entries, 0 to 999
Data columns (total 11 columns):
 #   Column                         Non-Null Count  Dtype
---  ------                         --------------  -----
 0   Date                           1000 non-null   datetime64[ns]
 1   Gender                         1000 non-null   category
 2   Age                            1000 non-null   int64
 3   Product Category               1000 non-null   category
 4   Quantity                       1000 non-null   int64
 5   Price per Unit                 1000 non-null   int64
 6   Total Amount                   1000 non-null   int64
 7   Calculated Total Amount        1000 non-null   int64
 8   Sale_Category                  1000 non-null   category
 9   Age Classification             1000 non-null   category
 10  Total Amount Stdev Difference  1000 non-null   float64
dtypes: category(4), datetime64[ns](1), float64(1), int64(5)
memory usage: 59.2 KB
```

[105]:
```
from utils import get_numeric_columns, get_categoric_columns
numeric_columns = get_numeric_columns(df)
categoric_columns = get_categoric_columns(df)

print(numeric_columns)
print(categoric_columns)
predict_numeric = [
    'Price per Unit',
]

predict_categoric = [
    "Gender",
    "Age Classification",
    "Product Category",
]

output = "Total Amount"


X = df[[*predict_numeric] + [*predict_categoric]]
y = df[output]
```

```
['Age', 'Quantity', 'Price per Unit', 'Total Amount', 'Calculated Total Amount',
'Total Amount Stdev Difference']
['Gender', 'Product Category', 'Sale_Category', 'Age Classification']
```

Preparamos el set de entrenamiento

[106]:
```
from sklearn.model_selection import train_test_split


X_train, X_test, y_train, y_test = train_test_split(
    X,
    y,
    test_size=0.3,
    random_state=0,
)
```

Dividimos el dataset en 70% para entrenamiento, 30% para pruebas

Preparamos el preprocesador y asignamos el Encoder OneHOT

[107]:
```
from sklearn.compose import ColumnTransformer
from sklearn.preprocessing import OneHotEncoder, StandardScaler

categorical_transformer = OneHotEncoder(handle_unknown='ignore')
scaler = StandardScaler()

preprocessor = ColumnTransformer(
```

```
    transformers=[
        ("num", scaler, predict_numeric),
        ("cat", categorical_transformer, predict_categoric),
    ]
)
```

[108]:
```
from sklearn.pipeline import Pipeline


pipeline = Pipeline(steps=[('preprocessor', preprocessor)])
```

1.1.1 Random Forest

Generamos el modelo KNN

[109]:
```
from sklearn.ensemble import RandomForestRegressor
from sklearn.model_selection import GridSearchCV


pipeline_rf = Pipeline(
    steps=[
        ('preprocessor', preprocessor),
        ('model', GridSearchCV(
            RandomForestRegressor(random_state=42),
            param_grid={
                'n_estimators': [1, 51],
                'max_depth': [1, 10],
            },
            cv=5,
            refit=True,
            verbose=2,
        )),
    ]
)

pipeline_rf.fit(X_train, y_train)
```

```
Fitting 5 folds for each of 4 candidates, totalling 20 fits
[CV] END …max_depth=1, n_estimators=1; total time=   0.0s
[CV] END …max_depth=1, n_estimators=1; total time=   0.0s
[CV] END …max_depth=1, n_estimators=1; total time=   0.0s
[CV] END …max_depth=1, n_estimators=1; total time=   0.0s
[CV] END …max_depth=1, n_estimators=1; total time=   0.0s
[CV] END …max_depth=1, n_estimators=51; total time=   0.2s
[CV] END …max_depth=1, n_estimators=51; total time=   0.1s
[CV] END …max_depth=1, n_estimators=51; total time=   0.1s
[CV] END …max_depth=1, n_estimators=51; total time=   0.1s
[CV] END …max_depth=1, n_estimators=51; total time=   0.1s
```

```
[CV] END …max_depth=10, n_estimators=1; total time=   0.0s
[CV] END …max_depth=10, n_estimators=1; total time=   0.0s
[CV] END …max_depth=10, n_estimators=1; total time=   0.0s
[CV] END …max_depth=10, n_estimators=1; total time=   0.0s
[CV] END …max_depth=10, n_estimators=1; total time=   0.0s
[CV] END …max_depth=10, n_estimators=51; total time=   0.1s
[CV] END …max_depth=10, n_estimators=51; total time=   0.1s
[CV] END …max_depth=10, n_estimators=51; total time=   0.1s
[CV] END …max_depth=10, n_estimators=51; total time=   0.1s
[CV] END …max_depth=10, n_estimators=51; total time=   0.1s
```

[109]:
```
Pipeline(steps=[('preprocessor',
                 ColumnTransformer(transformers=[('num', StandardScaler(),
                                                  ['Price per Unit']),
                                                 ('cat',
OneHotEncoder(handle_unknown='ignore'),
                                                  ['Gender',
                                                   'Age Classification',
                                                   'Product Category'])])),
                ('model',
                 GridSearchCV(cv=5,
                              estimator=RandomForestRegressor(random_state=42),
                              param_grid={'max_depth': [1, 10],
                                          'n_estimators': [1, 51]},
                              verbose=2))])
```

[110]:
```python
params_rf = pipeline_rf.steps[-1][1].best_params_

params_rf
```

[110]:
```
{'max_depth': 10, 'n_estimators': 51}
```

1.1.2 KNN

Creamos el modelo KNN

[111]:
```python
from sklearn.neighbors import KNeighborsRegressor
from sklearn.model_selection import GridSearchCV



pipeline_knn = Pipeline(
    steps=[
        ('preprocessor', preprocessor),
        ('model', GridSearchCV(
            KNeighborsRegressor(),
            param_grid={
                "n_neighbors": list(range(1, 100)),
```

```python
            },
            cv=5,
            refit=True,
            verbose=2,
        )),
    ]
)

pipeline_knn.fit(X_train, y_train)
```

```
Fitting 5 folds for each of 99 candidates, totalling 495 fits
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[CV] END …n_neighbors=70; total time=   0.0s
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[CV] END …n_neighbors=72; total time=   0.0s
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[CV] END …n_neighbors=73; total time=   0.0s
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[CV] END …n_neighbors=75; total time=   0.0s
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[CV] END …n_neighbors=75; total time=   0.0s
```

```
[CV] END …n_neighbors=75; total time=   0.0s
[CV] END …n_neighbors=75; total time=   0.0s
[CV] END …n_neighbors=76; total time=   0.0s
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[CV] END …n_neighbors=78; total time=   0.0s
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[CV] END …n_neighbors=78; total time=   0.0s
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[CV] END …n_neighbors=79; total time=   0.0s
[CV] END …n_neighbors=80; total time=   0.0s
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[CV] END …n_neighbors=82; total time=   0.0s
[CV] END …n_neighbors=82; total time=   0.0s
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[CV] END …n_neighbors=82; total time=   0.0s
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[CV] END …n_neighbors=83; total time=   0.0s
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[CV] END …n_neighbors=84; total time=   0.0s
[CV] END …n_neighbors=85; total time=   0.0s
```

```
[CV] END …n_neighbors=85; total time=   0.0s
[CV] END …n_neighbors=85; total time=   0.0s
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[CV] END …n_neighbors=89; total time=   0.0s
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[CV] END …n_neighbors=94; total time=   0.0s
[CV] END …n_neighbors=95; total time=   0.0s
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[CV] END …n_neighbors=99; total time=   0.0s
[CV] END …n_neighbors=99; total time=   0.0s
```

[111]:
```
Pipeline(steps=[('preprocessor',
                 ColumnTransformer(transformers=[('num', StandardScaler(),
                                                  ['Price per Unit']),
                                                 ('cat',
OneHotEncoder(handle_unknown='ignore'),
                                                  ['Gender',
                                                   'Age Classification',
                                                   'Product Category'])])),
                ('model',
                 GridSearchCV(cv=5, estimator=KNeighborsRegressor(),
                              param_grid={'n_neighbors': [1, 2, 3, 4, 5, 6, 7,
                                                          8, 9, 10, 11, 12, 13,
                                                          14, 15, 16, 17, 18,
                                                          19, 20, 21, 22, 23,
                                                          24, 25, 26, 27, 28,
                                                          29, 30, …]},
                              verbose=2))])
```

[112]:
```
params_knn = pipeline_knn.steps[-1][1].best_params_
```

```
params_knn
```

[112]:
```
{'n_neighbors': 15}
```

1.1.3 Linear Regression

Generamos el modelo de regresion lineal

[113]:
```
from sklearn.linear_model import LinearRegression


pipeline_lr = Pipeline(
    steps=[
        ('preprocessor', preprocessor),
        ('model', LinearRegression()),
    ]
)

pipeline_lr.fit(X_train, y_train)
```

[113]:
```
Pipeline(steps=[('preprocessor',
                 ColumnTransformer(transformers=[('num', StandardScaler(),
                                                  ['Price per Unit']),
                                                 ('cat',
OneHotEncoder(handle_unknown='ignore'),
                                                  ['Gender',
                                                   'Age Classification',
                                                   'Product Category'])])),
                ('model', LinearRegression())])
```

1.1.4 LGBM

Generamos el modelo LGBM

[114]:
```
import lightgbm as lgb


# No se necesitan transformaciones de columnas categoricas ya que el modelo␣
↪LGBM los maneja por defecto
preprocessor_lgb = ColumnTransformer(
    transformers=[
        ("num", scaler, predict_numeric),
    ]
)

pipeline_lgbm = Pipeline(
    steps=[
        ('preprocessor', preprocessor_lgb),
```

```python
        ('model', lgb.LGBMRegressor(random_state=0)),
    ]
)

pipeline_lgbm.fit(X_train, y_train)
```

```
[LightGBM] [Info] Auto-choosing col-wise multi-threading, the overhead of
testing was 0.000031 seconds.
You can set `force_col_wise=true` to remove the overhead.
[LightGBM] [Info] Total Bins 6
[LightGBM] [Info] Number of data points in the train set: 700, number of used
features: 1
[LightGBM] [Info] Start training from score 465.578571
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf
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[LightGBM] [Warning] No further splits with positive gain, best gain: -inf
```

```
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf
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[LightGBM] [Warning] No further splits with positive gain, best gain: -inf
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[LightGBM] [Warning] No further splits with positive gain, best gain: -inf
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf
```

```
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf
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[LightGBM] [Warning] No further splits with positive gain, best gain: -inf
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[LightGBM] [Warning] No further splits with positive gain, best gain: -inf
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf
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[LightGBM] [Warning] No further splits with positive gain, best gain: -inf
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf
```

[114]:
```
Pipeline(steps=[('preprocessor',
                 ColumnTransformer(transformers=[('num', StandardScaler(),
                                                  ['Price per Unit'])])),
                ('model', LGBMRegressor(random_state=0))])
```

1.2 EValuamos los modelos

1.2.1 Random Forest

Evaluamos el modelo Random Forest

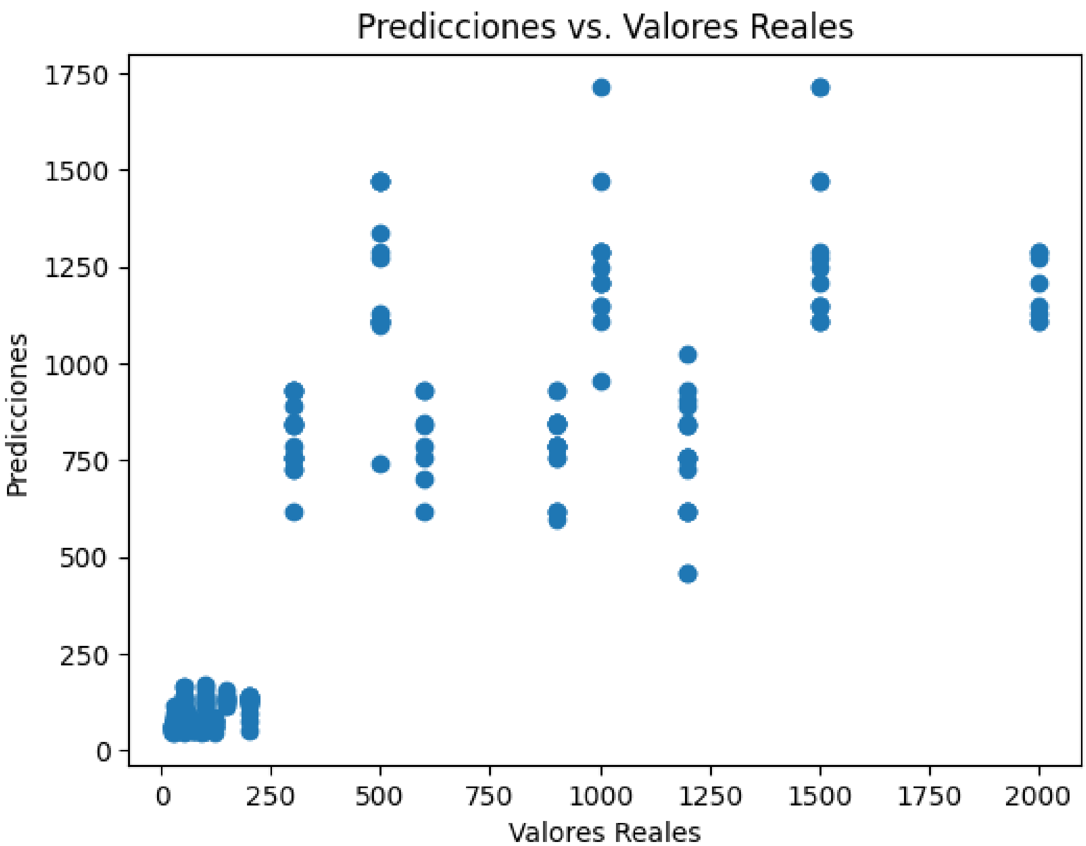
[115]:
```python
from sklearn.metrics import root_mean_squared_error, r2_score,␣
 ↪mean_absolute_error
import matplotlib.pyplot as plt
y_pred_rf = pipeline_rf.predict(X_test)
rmse_rf = root_mean_squared_error(y_test, y_pred_rf)
mse_rf = rmse_rf ** 2
r2_rf = r2_score(y_test, y_pred_rf)
mae_rf = mean_absolute_error(y_test, y_pred_rf)

print(f'Error Cuadrático Medio: {mse_rf}')
print(f'Error Cuadrático Medio Raíz: {rmse_rf}')
print(f'R-cuadrado: {r2_rf}')
print(f'Error Absoluto Medio: {mae_rf}')
```

```
Error Cuadrático Medio: 91085.3846151297
Error Cuadrático Medio Raíz: 301.80355301939323
R-cuadrado: 0.6543772874221129
Error Absoluto Medio: 184.07396535426
```

[116]:

```
plt.scatter(y_test, y_pred_rf)
plt.xlabel('Valores Reales')
plt.ylabel('Predicciones')
plt.title('Predicciones vs. Valores Reales')
plt.show()
```



1.2.2 KNN

Evaluamos el modelo KNN

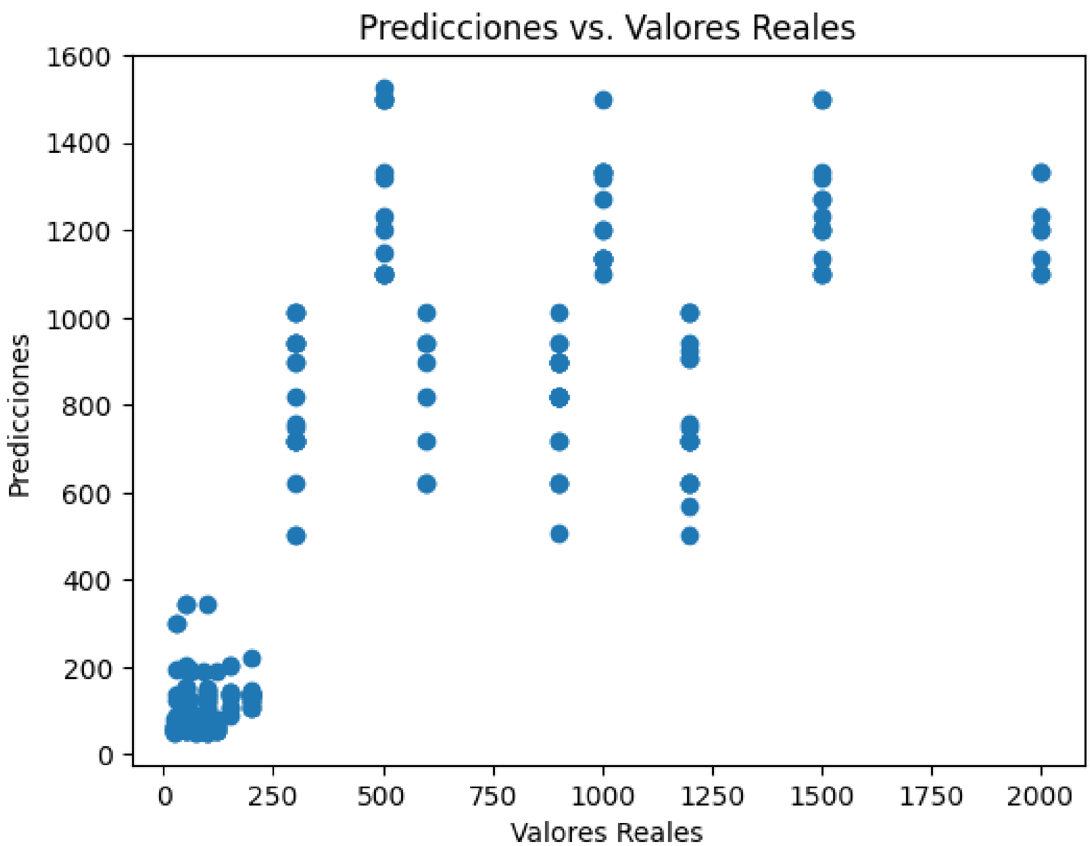
[117]:

```
y_pred_knn = pipeline_knn.predict(X_test)
rmse_knn = root_mean_squared_error(y_test, y_pred_knn)
mse_knn = rmse_knn ** 2
r2_knn = r2_score(y_test, y_pred_knn)
mae_knn = mean_absolute_error(y_test, y_pred_knn)

print(f'Error Cuadrático Medio: {mse_knn}')
print(f'Error Cuadrático Medio Raíz: {rmse_knn}')
print(f'R-cuadrado: {r2_knn}')
print(f'Error Absoluto Medio: {mae_knn}')
```

```
Error Cuadrático Medio: 95841.62
Error Cuadrático Medio Raíz: 309.5829775682119
R-cuadrado: 0.6363297929494953
Error Absoluto Medio: 190.0
```

[118]:
```
plt.scatter(y_test, y_pred_knn)
plt.xlabel('Valores Reales')
plt.ylabel('Predicciones')
plt.title('Predicciones vs. Valores Reales')
plt.show()
```



1.2.3 Linear Regression

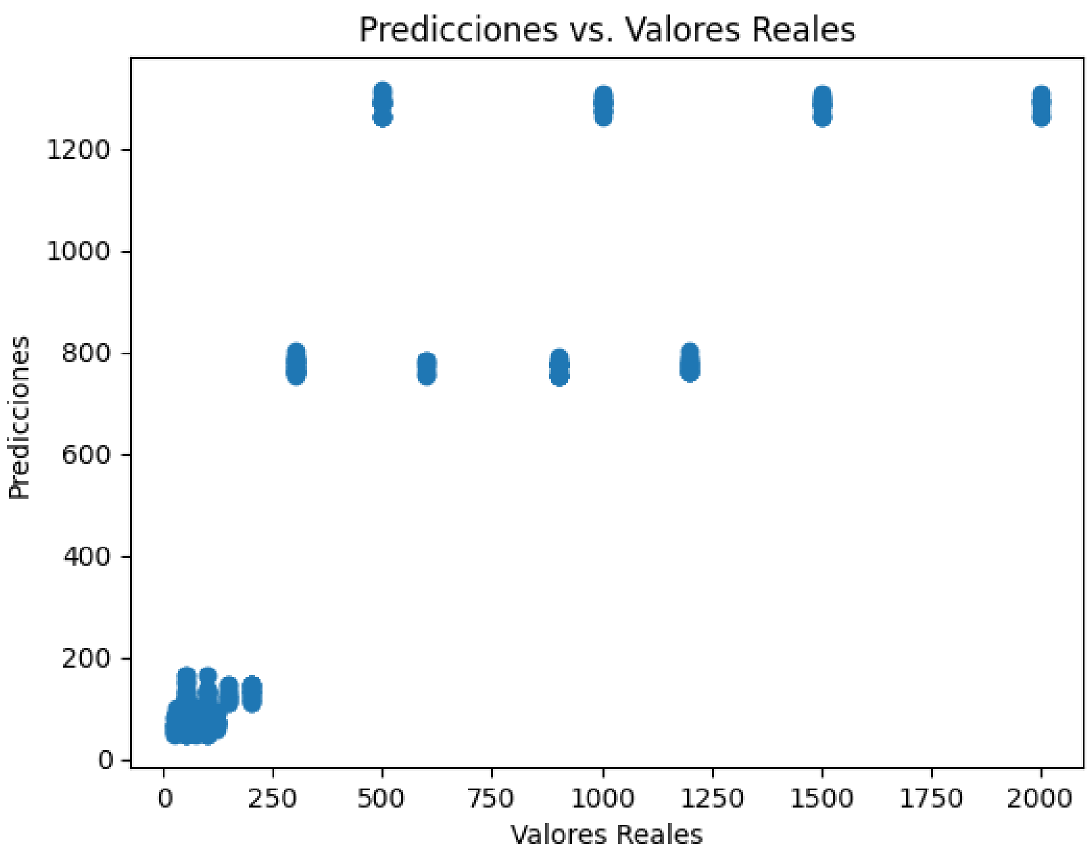
Evaluamos el modelo de Regresion Lineal

[119]:
```
y_pred_lr = pipeline_lr.predict(X_test)
rmse_lr = root_mean_squared_error(y_test, y_pred_lr)
mse_lr = rmse_lr ** 2
r2_lr = r2_score(y_test, y_pred_lr)
mae_lr = mean_absolute_error(y_test, y_pred_lr)
```

```
print(f'Error Cuadrático Medio: {mse_lr}')
print(f'Error Cuadrático Medio Raíz: {rmse_lr}')
print(f'R-cuadrado: {r2_lr}')
print(f'Error Absoluto Medio: {mae_lr}')
```

```
Error Cuadrático Medio: 81139.77
Error Cuadrático Medio Raíz: 284.85043443884723
R-cuadrado: 0.6921158369826144
Error Absoluto Medio: 179.64333333333335
```

[120]:
```
plt.scatter(y_test, y_pred_lr)
plt.xlabel('Valores Reales')
plt.ylabel('Predicciones')
plt.title('Predicciones vs. Valores Reales')
plt.show()
```



1.2.4 LGBM

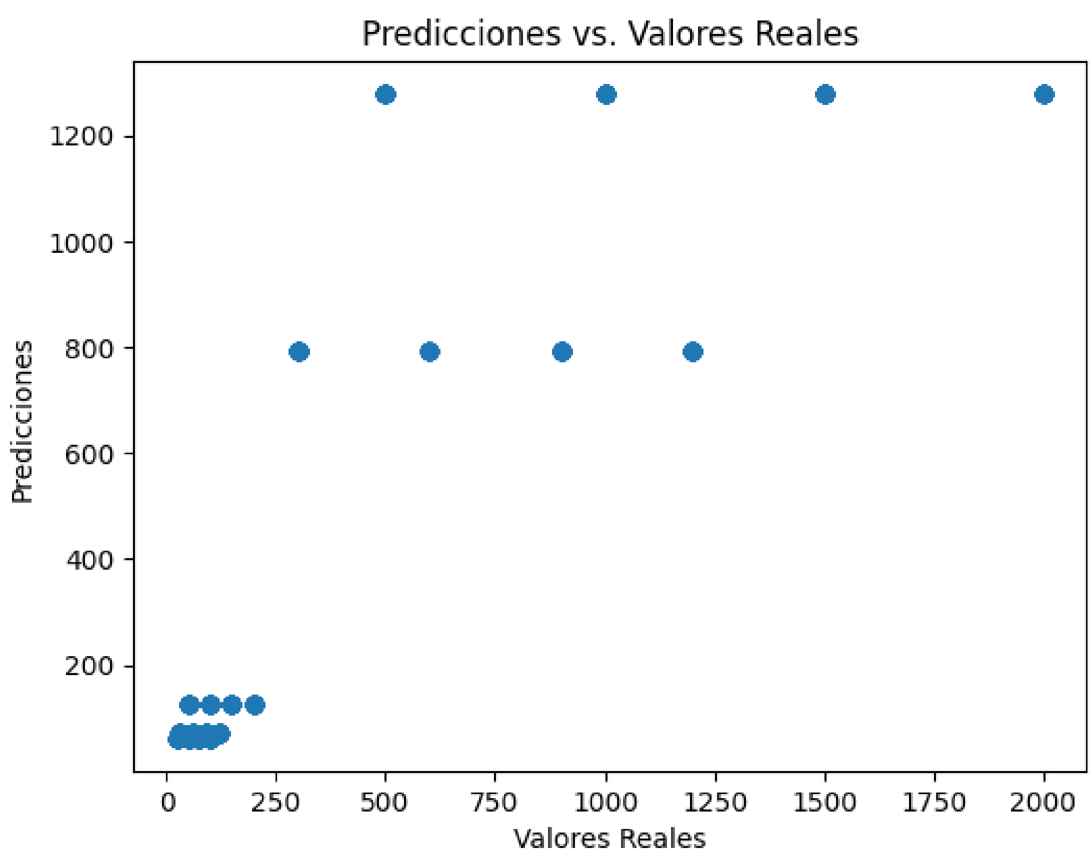
Evaluamos el modelo LGBM

[121]:
```
y_pred_lgbm = pipeline_lgbm.predict(X_test)
rmse_lgbm = root_mean_squared_error(y_test, y_pred_lgbm)
mse_lgbm = rmse_lgbm ** 2
r2_lgbm = r2_score(y_test, y_pred_lgbm)
mae_lgbm = mean_absolute_error(y_test, y_pred_lgbm)

print(f'Error Cuadrático Medio: {mse_lgbm}')
print(f'Error Cuadrático Medio Raíz: {rmse_lgbm}')
print(f'R-cuadrado: {r2_lgbm}')
print(f'Error Absoluto Medio: {mae_lgbm}')
```

```
Error Cuadrático Medio: 80544.78034227462
Error Cuadrático Medio Raíz: 283.80412319463335
R-cuadrado: 0.6943735201480064
Error Absoluto Medio: 177.04317822026593
```

[122]:
```
plt.scatter(y_test, y_pred_lgbm)
plt.xlabel('Valores Reales')
plt.ylabel('Predicciones')
plt.title('Predicciones vs. Valores Reales')
plt.show()
```



1.3 Analisis de Metricas

Generamos una tabla para visualizar mejor

[123]:
```
results = [
    ("Regresión Lineal", r2_lr, rmse_lr, mse_lr, mae_lr),
    ("KNN", r2_knn, rmse_knn, mse_knn, mae_knn),
    ("Random Forests", r2_knn, rmse_knn, mse_knn, mae_knn),
    ("LGBM", r2_lgbm, rmse_lgbm, mse_lgbm, mae_lgbm),
]

header = ["Método", "R2", "RMSE", "MSE", "MAE"]

df_results = pd.DataFrame(results, columns=header)

df_results
```

[123]:

	Método	R2	RMSE	MSE	MAE
0	Regresión Lineal	0.692116	284.850434	81139.770000	179.643333
1	KNN	0.636330	309.582978	95841.620000	190.000000
2	Random Forests	0.636330	309.582978	95841.620000	190.000000
3	LGBM	0.694374	283.804123	80544.780342	177.043178

LGBM tiene el mejor valor de R^2 (0.6944), lo que significa que es el modelo que mejor explica la variabilidad de los datos. También tiene el RMSE, MSE y MAE más bajos, lo que indica que tiene el menor error en comparación con los otros modelos. Por lo tanto, LGBM parece ser el mejor modelo en este caso.

[124]:
```
params_knn_str = ""

for clave, valor in params_knn.items():
    params_knn_str += f"{clave}={valor},"

params_knn_str = params_knn_str.rstrip(",")

params_rf_str = ""

for clave, valor in params_rf.items():
    params_rf_str += f"{clave}={valor},"

params_rf_str = params_rf_str.rstrip(",")
```

[ ]:
```
plt.figure(figsize=(20, 6))
plt.scatter(y_test, y_pred_knn, label=f"KNN ({params_knn_str})")
plt.scatter(y_test, y_pred_rf, label=f"Random Forests ({params_rf_str})")
plt.scatter(y_test, y_pred_lr, label="Regresión Lineal")
```

```python
plt.scatter(y_test, y_pred_lgbm, label="LGBM")
plt.legend(loc='lower right')
plt.xlabel('Valores Reales')
plt.ylabel('Predicciones')
plt.title('Predicciones vs. Valores Reales Total Amount')
plt.show()
```