Import software libraries

In [1]:
```python
# Import required libraries.
import sys                          # Read system parameters.
import numpy as np                  # Work with multi-dimensional arrays.
import pandas as pd                 # Manipulate and analyze data.
import matplotlib                   # Create and format charts.
import matplotlib.pyplot as plt
import seaborn as sns               # Make charting easier.
import warnings                                          # Suppress warnings.
warnings.filterwarnings('ignore')

# Summarize software libraries used.
print('Libraries used in this project:')
print('- NumPy {}'.format(np.__version__))
print('- Python {}'.format(sys.version))
print('- pandas {}'.format(pd.__version__))
print('- Matplotlib {}'.format(matplotlib.__version__))
print('- Seaborn {}'.format(sns.__version__))
```

```
Libraries used in this project:
- NumPy 1.19.5
- Python 3.9.7 (default, Sep 16 2021, 16:59:28) [MSC v.1916 64 bit (AMD64)]
- pandas 1.3.4
- Matplotlib 3.4.3
- Seaborn 0.11.2
```

Read and examine the data

In [2]:
```python
# Read the data that was put through the ETL process in Course 2 of the CDSP Specialization.

df = pd.read_pickle("online_history_cleaned.pickle")

# Preview the first five rows of the data.

df.head()
```

Out[2]:

	Invoice	StockCode	Quantity	InvoiceDate	Price	CustomerID	Country	TotalAmount	Description
0	536365	85123A	6	2010-12-01 08:26:00	2.55	u1785	United Kingdom	15.30	CREAM HANGING HEART T-LIGHT HOLDER
1	536367	84879	32	2010-12-01 08:34:00	1.69	u13047	United Kingdom	54.08	ASSORTED COLOUR BIRD ORNAMENT
2	536373	85123A	6	2010-12-01 09:02:00	2.55	u1785	United Kingdom	15.30	CREAM HANGING HEART T-LIGHT HOLDER
3	536375	85123A	6	2010-12-01 09:32:00	2.55	u1785	United Kingdom	15.30	CREAM HANGING HEART T-LIGHT HOLDER
4	536378	20725	10	2010-12-01 09:37:00	1.65	u14688	United Kingdom	16.50	LUNCH BAG RED RETROSPOT

In [3]:
```python
# Get the shape of the data.

df.shape
```

Out[3]:
```
(15206, 9)
```

In [4]:
```python
# Get the data types for every column in the DataFrame.

df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 15206 entries, 0 to 17031
Data columns (total 9 columns):
 #   Column       Non-Null Count  Dtype
---  ------       --------------  -----
 0   Invoice      15206 non-null  object
 1   StockCode    15206 non-null  object
 2   Quantity     15206 non-null  int64
 3   InvoiceDate  15206 non-null  datetime64[ns]
 4   Price        15194 non-null  float64
 5   CustomerID   12435 non-null  object
 6   Country      15206 non-null  object
 7   TotalAmount  15194 non-null  float64
 8   Description  15206 non-null  object
dtypes: datetime64[ns](1), float64(2), int64(1), object(5)
memory usage: 1.2+ MB
```

Generate summary statistics for all of the data

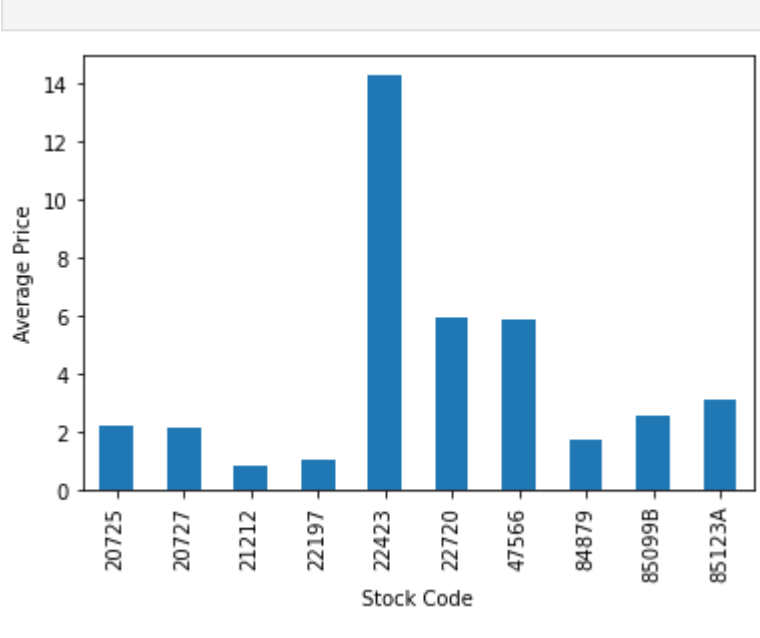
In [5]:
```python
# Get a DataFrame of summary statistics that describe the data, including mean, median, standard deviation, etc
# Be sure to include all variables, including categorical ones.

df.describe(include='all')
```

Out[5]:

	Invoice	StockCode	Quantity	InvoiceDate	Price	CustomerID	Country	TotalAmount	Description
count	15206	15206	15206.000000	15206	15194.000000	12435	15206	15194.000000	15206
unique	8315	10	NaN	8022	NaN	2473	1	NaN	10
top	536876	85123A	NaN	2011-05-10 15:07:00	NaN	u17841	United Kingdom	NaN	CREAM HANGING HEART T-LIGHT HOLDER
freq	10	2163	NaN	10	NaN	171	15206	NaN	2163
first	NaN	NaN	NaN	2010-12-01 08:26:00	NaN	NaN	NaN	NaN	NaN
last	NaN	NaN	NaN	2011-12-09 12:31:00	NaN	NaN	NaN	NaN	NaN
mean	NaN	NaN	16.775483	NaN	4.164267	NaN	NaN	40.705153	NaN
std	NaN	NaN	79.496270	NaN	4.377605	NaN	NaN	132.142503	NaN
min	NaN	NaN	1.000000	NaN	0.400000	NaN	NaN	0.550000	NaN
25%	NaN	NaN	2.000000	NaN	1.650000	NaN	NaN	8.850000	NaN
50%	NaN	NaN	6.000000	NaN	2.550000	NaN	NaN	16.500000	NaN
75%	NaN	NaN	12.000000	NaN	4.950000	NaN	NaN	30.360000	NaN
max	NaN	NaN	4300.000000	NaN	32.040000	NaN	NaN	4921.500000	NaN

Plot a bar chart for the average price per item

In [6]:
```python
# Plot the average price per item using a bar chart.
# Make sure the average price is on one axis, and each distinct item description is on the other axis.

df.groupby(["StockCode"])["Price"].mean().plot(kind='bar')
plt.xlabel("Stock Code")
plt.ylabel("Average Price")
plt.show()
```



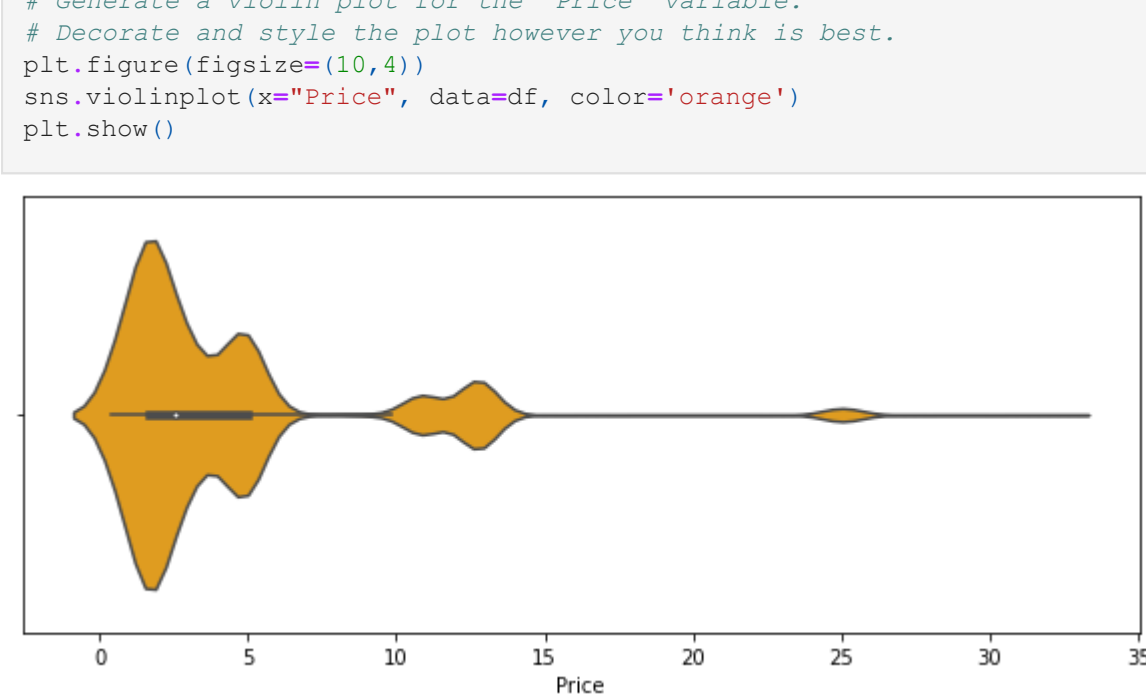
Explore the distribution of the numeric variable `Price`

In [7]:
```python
# Get a DataFrame of summary statistics for numeric variables only.

df.describe()
```

Out[7]:

	Quantity	Price	TotalAmount
count	15206.000000	15194.000000	15194.000000
mean	16.775483	4.164267	40.705153
std	79.496270	4.377605	132.142503
min	1.000000	0.400000	0.550000
25%	2.000000	1.650000	8.850000
50%	6.000000	2.550000	16.500000
75%	12.000000	4.950000	30.360000
max	4300.000000	32.040000	4921.500000

In [8]:
```python
# Generate a violin plot for the "Price" variable.
# Decorate and style the plot however you think is best.
plt.figure(figsize=(10,4))
sns.violinplot(x="Price", data=df, color='orange')
plt.show()
```



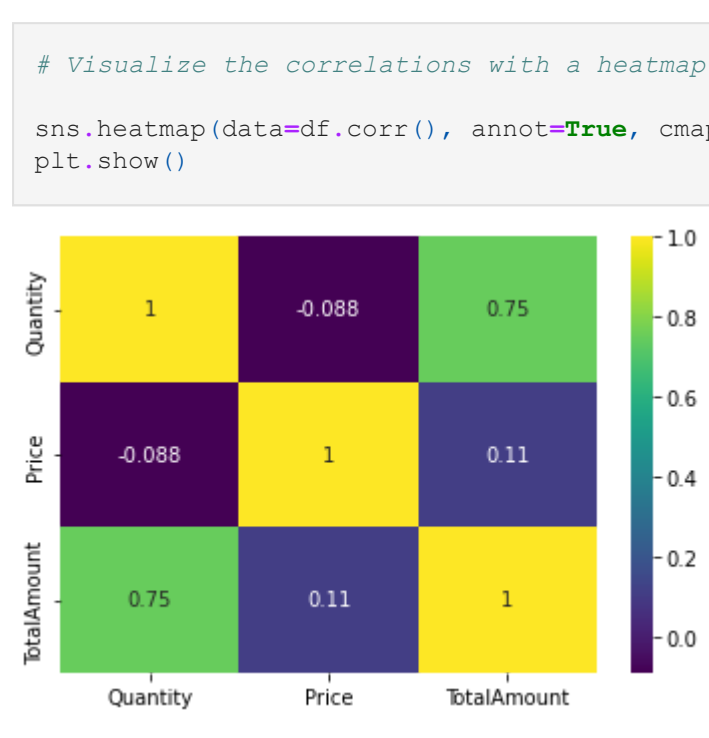
Visualize correlations between numeric variables

In [9]:
```python
# Generate a correlation matrix between all numeric variables.

df.corr()
```

Out[9]:

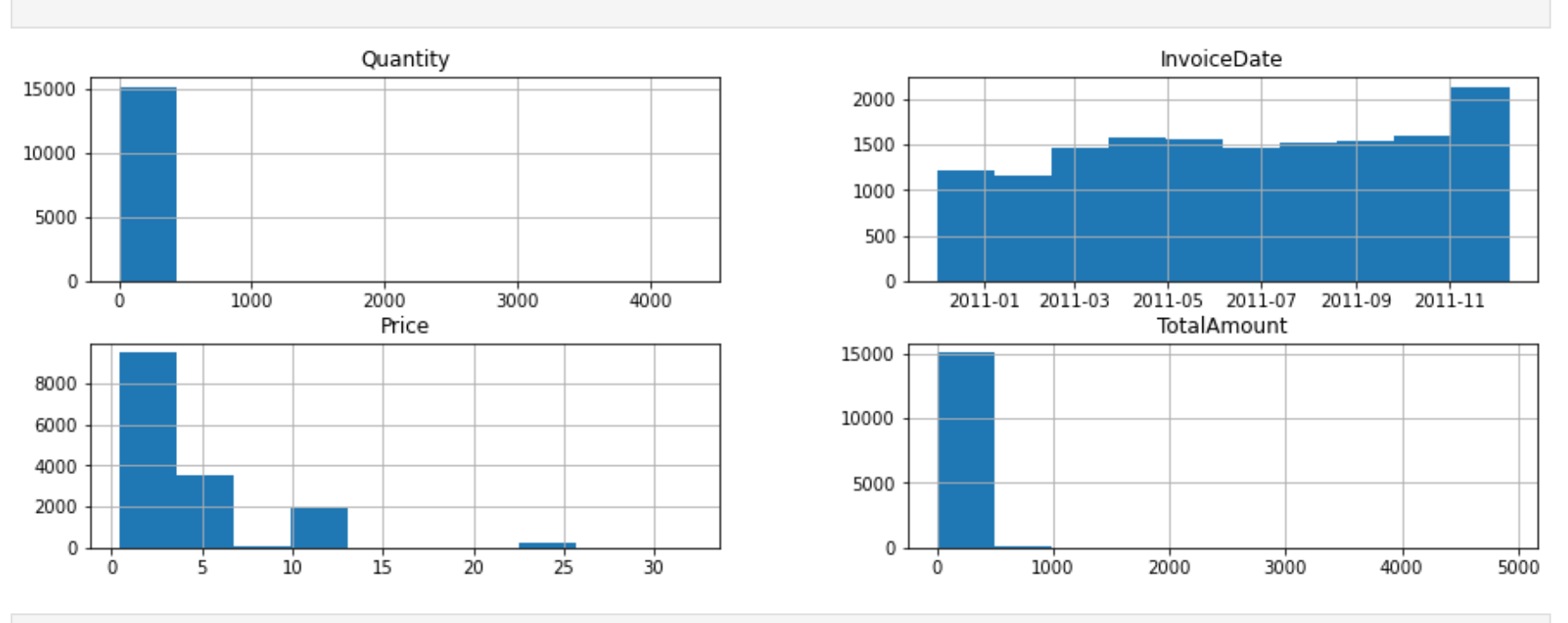
	Quantity	Price	TotalAmount
Quantity	1.000000	-0.088356	0.745641
Price	-0.088356	1.000000	0.109054
TotalAmount	0.745641	0.109054	1.000000

In [10]:
```python
# Visualize the correlations with a heatmap.

sns.heatmap(data=df.corr(), annot=True, cmap='viridis')
plt.show()
```

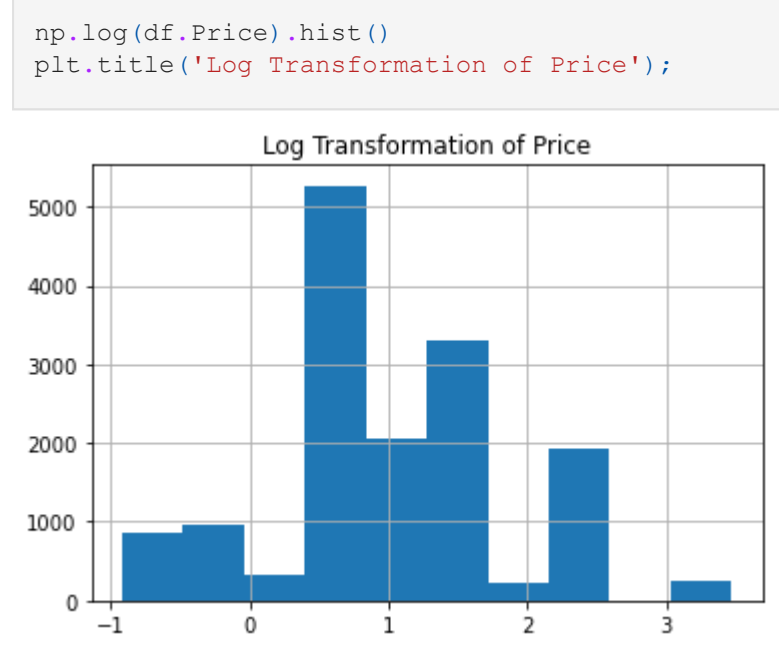


Transform skewed variables

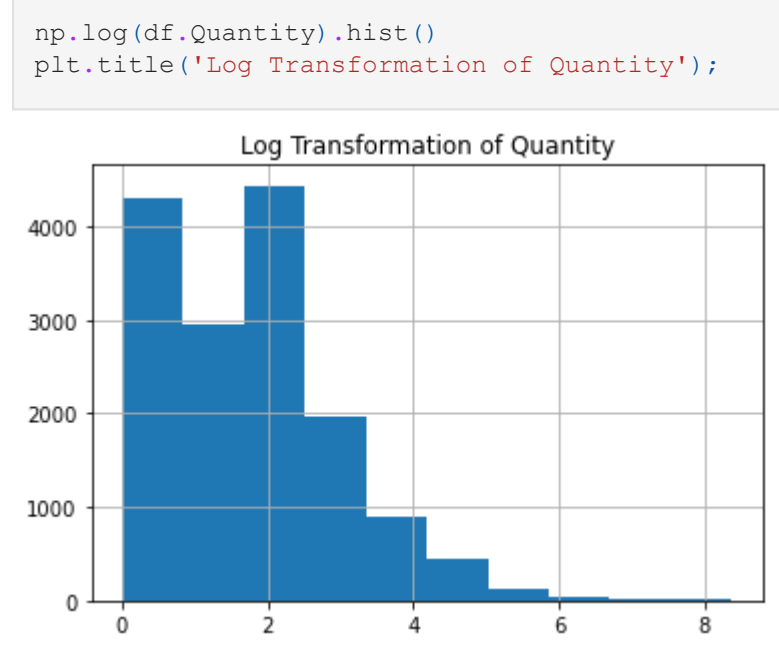
In [11]:
```python
# Plot histograms for the original distributions of all numeric variables.

df.hist(figsize=(15,5))
plt.show()
```



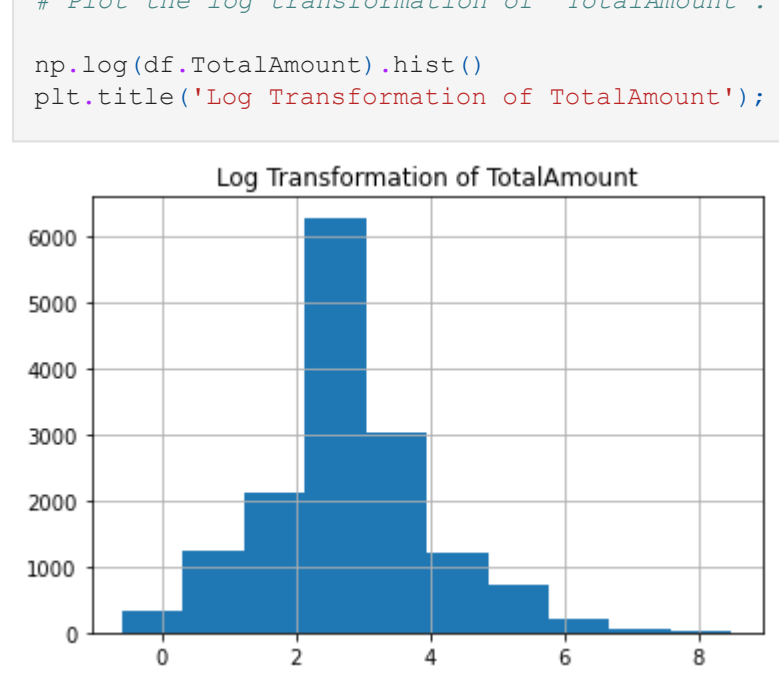
In [12]:
```python
# Plot the log transformation of "Price".

np.log(df.Price).hist()
plt.title('Log Transformation of Price');
```



In [13]:
```python
# Plot the log transformation of "Quantity".

np.log(df.Quantity).hist()
plt.title('Log Transformation of Quantity');
```



In [14]:
```python
# Plot the log transformation of "TotalAmount".

np.log(df.TotalAmount).hist()
plt.title('Log Transformation of TotalAmount');
```



Analyze time series data

In [15]:
```python
# Obtain the number of invoices by month.

df["Month"] = df["InvoiceDate"].dt.month

# Print the number of invoices by month.

df.head()
```

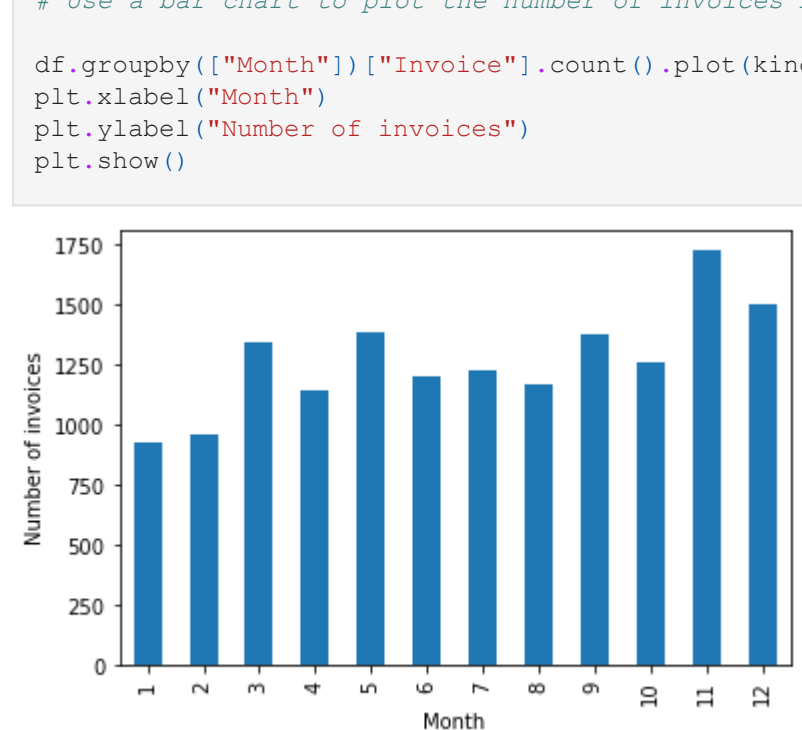
Out[15]:

	Invoice	StockCode	Quantity	InvoiceDate	Price	CustomerID	Country	TotalAmount	Description	Month
0	536365	85123A	6	2010-12-01 08:26:00	2.55	u1785	United Kingdom	15.30	CREAM HANGING HEART T-LIGHT HOLDER	12
1	536367	84879	32	2010-12-01 08:34:00	1.69	u13047	United Kingdom	54.08	ASSORTED COLOUR BIRD ORNAMENT	12
2	536373	85123A	6	2010-12-01 09:02:00	2.55	u1785	United Kingdom	15.30	CREAM HANGING HEART T-LIGHT HOLDER	12
3	536375	85123A	6	2010-12-01 09:32:00	2.55	u1785	United Kingdom	15.30	CREAM HANGING HEART T-LIGHT HOLDER	12
4	536378	20725	10	2010-12-01 09:37:00	1.65	u14688	United Kingdom	16.50	LUNCH BAG RED RETROSPOT	12

In [16]:
```python
df.groupby(["Month"])["Invoice"].count()
```

Out[16]:
```
Month
1      923
2      956
3     1345
4     1140
5     1384
6     1203
7     1227
8     1169
9     1378
10    1257
11    1726
12    1498
Name: Invoice, dtype: int64
```

In [17]:
```python
# Use a bar chart to plot the number of invoices by month.

df.groupby(["Month"])["Invoice"].count().plot(kind="bar")
plt.xlabel("Month")
plt.ylabel("Number of invoices")
plt.show()
```



Identify and handle missing data

In [18]:
```python
# Identify any missing data for all variables.

df.isnull().sum()
```

Out[18]:
```
Invoice           0
StockCode         0
Quantity          0
InvoiceDate       0
Price            12
CustomerID     2771
Country           0
TotalAmount      12
Description       0
Month             0
dtype: int64
```

In [19]:
```python
# Print the current shape of the data.

print(df.shape)

# Remove rows of data where "CustomerID" is unknown.



# Print the new shape of the data.
```

```
(15206, 10)
```

In [20]:
```python
df.dropna(subset=["CustomerID"], inplace=True)
```

In [21]:
```python
print(df.shape)
```

```
(12435, 10)
```

In [22]:
```python
# Fill in N/A values for "Price" and "TotalAmount" with 0.

df.fillna(value=0, inplace=True)


# Confirm there are no longer any missing values.
```

In [23]:
```python
df.isnull().sum()
```

Out[23]:
```
Invoice        0
StockCode      0
Quantity       0
InvoiceDate    0
Price          0
CustomerID     0
Country        0
TotalAmount    0
Description    0
Month          0
dtype: int64
```

One-hot encode the `Description` variable

In [24]:
```python
# One-hot encode the "Description" variable with dummy variables for each unique description.
# Prefix each dummy variable name with "Description".

df.Description.unique()

# Preview the first five rows of the DataFrame.
```

Out[24]:
```
array(['CREAM HANGING HEART T-LIGHT HOLDER',
       'ASSORTED COLOUR BIRD ORNAMENT', 'LUNCH BAG RED RETROSPOT',
       'PACK OF 72 RETROSPOT CAKE CASES', 'JUMBO BAG RED RETROSPOT',
       'POPCORN HOLDER', 'LUNCH BAG  BLACK SKULL.',
       'REGENCY CAKESTAND 3 TIER', 'PARTY BUNTING',
       'SET OF 3 CAKE TINS PANTRY DESIGN '], dtype=object)
```

In [25]:
```python
df.reset_index(inplace=True, drop=True)
```

In [26]:
```python
df
```

Out[26]:

	Invoice	StockCode	Quantity	InvoiceDate	Price	CustomerID	Country	TotalAmount	Description	Month
0	536365	85123A	6	2010-12-01 08:26:00	2.55	u1785	United Kingdom	15.30	CREAM HANGING HEART T-LIGHT HOLDER	12
1	536367	84879	32	2010-12-01 08:34:00	1.69	u13047	United Kingdom	54.08	ASSORTED COLOUR BIRD ORNAMENT	12
2	536373	85123A	6	2010-12-01 09:02:00	2.55	u1785	United Kingdom	15.30	CREAM HANGING HEART T-LIGHT HOLDER	12
3	536375	85123A	6	2010-12-01 09:32:00	2.55	u1785	United Kingdom	15.30	CREAM HANGING HEART T-LIGHT HOLDER	12
4	536378	20725	10	2010-12-01 09:37:00	1.65	u14688	United Kingdom	16.50	LUNCH BAG RED RETROSPOT	12
...	...	...	...	...	...	...	...	...	...	...
12430	581538	20727	1	2011-12-09 11:34:00	1.65	u14446	United Kingdom	1.65	LUNCH BAG BLACK SKULL.	12
12431	581538	20725	1	2011-12-09 11:34:00	1.65	u14446	United Kingdom	1.65	LUNCH BAG RED RETROSPOT	12
12432	581579	22197	24	2011-12-09 12:19:00	0.85	u17581	United Kingdom	20.40	POPCORN HOLDER	12
12433	581583	20725	40	2011-12-09 12:23:00	1.45	u13777	United Kingdom	58.00	LUNCH BAG RED RETROSPOT	12
12434	581585	84879	16	2011-12-09 12:31:00	1.69	u15804	United Kingdom	27.04	ASSORTED COLOUR BIRD ORNAMENT	12

12435 rows × 10 columns

In [27]:
```python
ohe = pd.get_dummies(data=df.Description, drop_first=True)
ohe
```

Out[27]:

	CREAM HANGING HEART T-LIGHT HOLDER	JUMBO BAG RED RETROSPOT	LUNCH BAG BLACK SKULL.	LUNCH BAG RED RETROSPOT	PACK OF 72 RETROSPOT CAKE CASES	PARTY BUNTING	POPCORN HOLDER	REGENCY CAKESTAND 3 TIER	SET OF 3 CAKE TINS PANTRY DESIGN
0	1	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0
2	1	0	0	0	0	0	0	0	0
3	1	0	0	0	0	0	0	0	0
4	0	0	0	1	0	0	0	0	0
...	...	...	...	...	...	...	...	...	...
12430	0	0	1	0	0	0	0	0	0
12431	0	0	0	1	0	0	0	0	0
12432	0	0	0	0	0	0	1	0	0
12433	0	0	0	1	0	0	0	0	0
12434	0	0	0	0	0	0	0	0	0

12435 rows × 9 columns

In [28]:
```python
# Concatenate the new encoded columns with the main DataFrame.

df2 = pd.concat([df, ohe], axis=1)

# Drop the original "Description" variable.

df2.head()
```

Out[28]:

	Invoice	StockCode	Quantity	InvoiceDate	Price	CustomerID	Country	TotalAmount	Description	Month	CREAM HANGING HEART T-LIGHT HOLDER	JUMBO BAG RED RETROSPOT
0	536365	85123A	6	2010-12-01 08:26:00	2.55	u1785	United Kingdom	15.30	CREAM HANGING HEART T-LIGHT HOLDER	12	1	0
1	536367	84879	32	2010-12-01 08:34:00	1.69	u13047	United Kingdom	54.08	ASSORTED COLOUR BIRD ORNAMENT	12	0	0
2	536373	85123A	6	2010-12-01 09:02:00	2.55	u1785	United Kingdom	15.30	CREAM HANGING HEART T-LIGHT HOLDER	12	1	0
3	536375	85123A	6	2010-12-01 09:32:00	2.55	u1785	United Kingdom	15.30	CREAM HANGING HEART T-LIGHT HOLDER	12	1	0
4	536378	20725	10	2010-12-01 09:37:00	1.65	u14688	United Kingdom	16.50	LUNCH BAG RED RETROSPOT	12	0	0

In [29]:
```python
df2.drop(["Description"], axis=1, inplace=True)
```

In [30]:
```python
# Preview the first five rows of the data.

df2.head()
```

Out[30]:

	Invoice	StockCode	Quantity	InvoiceDate	Price	CustomerID	Country	TotalAmount	Month	CREAM HANGING HEART T-LIGHT HOLDER	JUMBO BAG RED RETROSPOT	LUNCH BAG BLACK SKULL.
0	536365	85123A	6	2010-12-01 08:26:00	2.55	u1785	United Kingdom	15.30	12	1	0	0
1	536367	84879	32	2010-12-01 08:34:00	1.69	u13047	United Kingdom	54.08	12	0	0	0
2	536373	85123A	6	2010-12-01 09:02:00	2.55	u1785	United Kingdom	15.30	12	1	0	0
3	536375	85123A	6	2010-12-01 09:32:00	2.55	u1785	United Kingdom	15.30	12	1	0	0
4	536378	20725	10	2010-12-01 09:37:00	1.65	u14688	United Kingdom	16.50	12	0	0	0

Identify and remove columns with low variance

In [31]:
```python
# Obtain the standard deviation of each variable.

df2.std()
```

Out[31]:
```
Quantity                                            77.436253
InvoiceDate                         107 days 08:52:37.143634210
Price                                                3.506381
TotalAmount                                        132.092738
Month                                                3.379857
CREAM HANGING HEART T-LIGHT HOLDER                   0.362575
JUMBO BAG RED RETROSPOT                              0.322017
LUNCH BAG  BLACK SKULL.                              0.274661
LUNCH BAG RED RETROSPOT                              0.288011
PACK OF 72 RETROSPOT CAKE CASES                      0.254417
PARTY BUNTING                                        0.306081
POPCORN HOLDER                                       0.267557
REGENCY CAKESTAND 3 TIER                             0.317766
SET OF 3 CAKE TINS PANTRY DESIGN                     0.273557
dtype: object
```

In [32]:
```python
# Define a standard deviation threshold of 0.26.

threshold = 0.26

# Identify any columns that are lower than the threshold.



# Print the column(s) that will be dropped.
```

In [33]:
```python
df2.columns
```

Out[33]:
```
Index(['Invoice', 'StockCode', 'Quantity', 'InvoiceDate', 'Price',
       'CustomerID', 'Country', 'TotalAmount', 'Month',
       'CREAM HANGING HEART T-LIGHT HOLDER', 'JUMBO BAG RED RETROSPOT',
       'LUNCH BAG  BLACK SKULL.', 'LUNCH BAG RED RETROSPOT',
       'PACK OF 72 RETROSPOT CAKE CASES', 'PARTY BUNTING', 'POPCORN HOLDER',
       'REGENCY CAKESTAND 3 TIER', 'SET OF 3 CAKE TINS PANTRY DESIGN '],
      dtype='object')
```

In [34]:
```python
cols_to_drop = list(df2[['Quantity','Price','TotalAmount','Month']].std()[df2[['Quantity','Price','TotalAmount'
```

In [35]:
```python
print(cols_to_drop)
```

```
[]
```

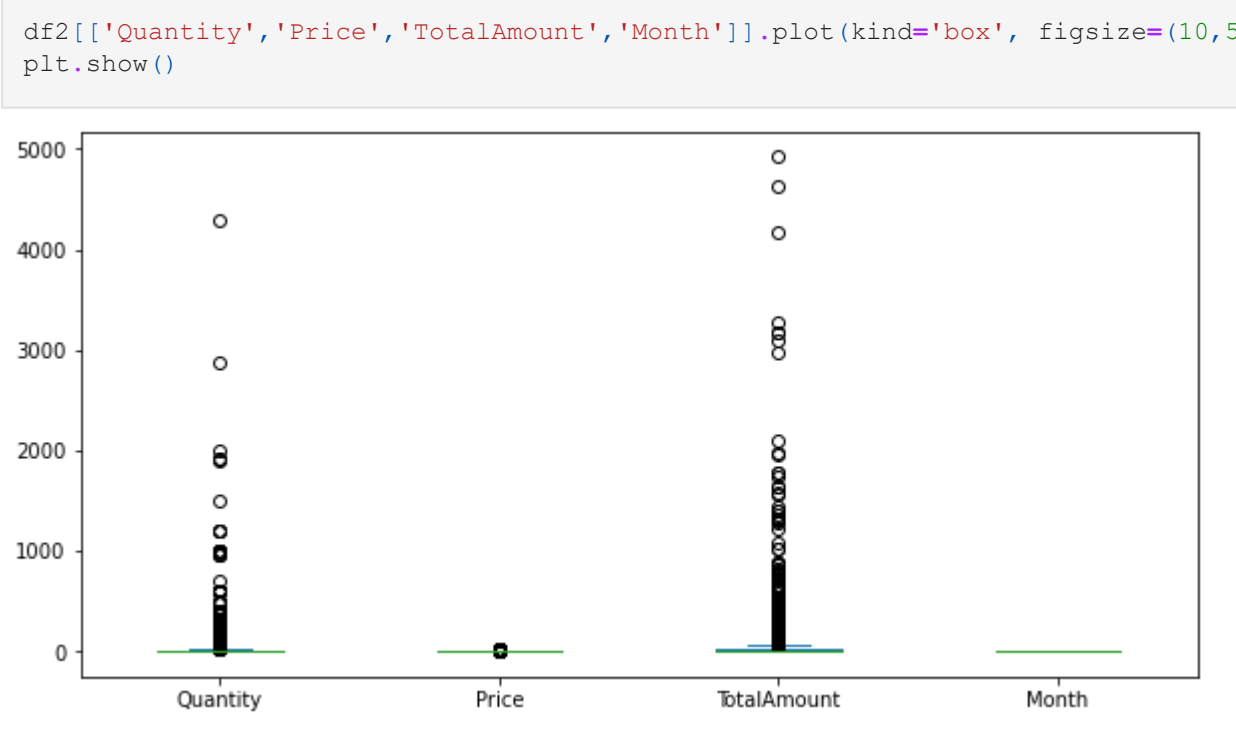
In [36]:
```python
# Drop the column(s) that have low standard deviation from the main dataset.



# Preview the first five rows of data.

df2.head()
```

Out[36]:

	Invoice	StockCode	Quantity	InvoiceDate	Price	CustomerID	Country	TotalAmount	Month	CREAM HANGING HEART T-LIGHT HOLDER	JUMBO BAG RED RETROSPOT	LUNCH BAG BLACK SKULL.
0	536365	85123A	6	2010-12-01 08:26:00	2.55	u1785	United Kingdom	15.30	12	1	0	0
1	536367	84879	32	2010-12-01 08:34:00	1.69	u13047	United Kingdom	54.08	12	0	0	0
2	536373	85123A	6	2010-12-01 09:02:00	2.55	u1785	United Kingdom	15.30	12	1	0	0
3	536375	85123A	6	2010-12-01 09:32:00	2.55	u1785	United Kingdom	15.30	12	1	0	0
4	536378	20725	10	2010-12-01 09:37:00	1.65	u14688	United Kingdom	16.50	12	0	0	0

Generate box plots for each numeric variable

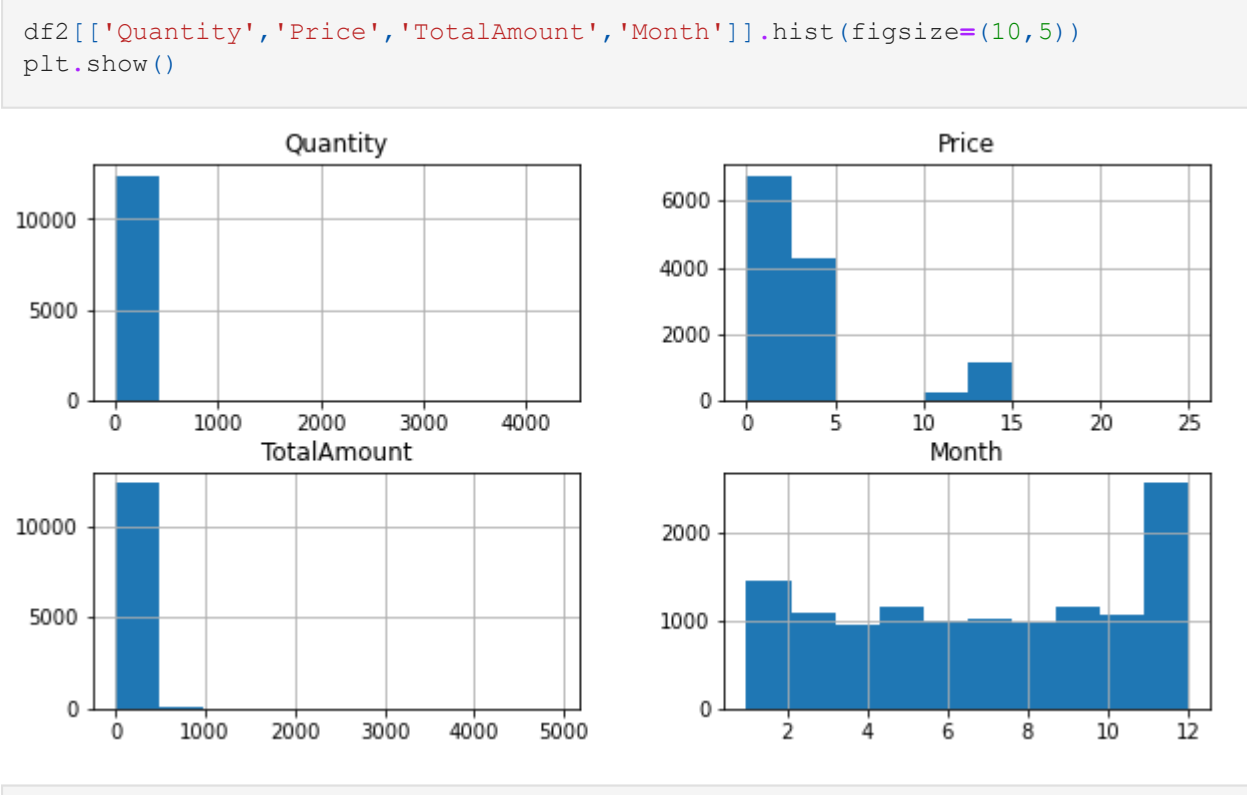
In [37]:
```python
# Draw box plots for each numeric variable.


df2[['Quantity','Price','TotalAmount','Month']].plot(kind='box', figsize=(10,5))
plt.show()
```



Identify and remove outliers

In [38]:
```python
# This function returns the lower and upper bounds of a numeric input variable.

def calc_outliers(var):
    q3 = np.percentile(var, 75)
    q1 = np.percentile(var, 25)

    iqr = 1.5 * (q3 - q1)

    lb = q1 - iqr
    ub = q3 + iqr

    print('Lower bound of outliers:', round(lb, 2), '\nUpper bound of outliers:', round(ub, 2))

    return lb, ub
```

In [39]:
```python
# Identify the shape of the data before removing outliers.

df2[['Quantity','Price','TotalAmount','Month']].hist(figsize=(10,5))
plt.show()
```



In [40]:
```python
# Call the calc_outliers() function iteratively for each numeric variable.
# For each variable:
#     Remove the outliers that are higher than the upper bounds.
#     Remove the variables that are lower than the lower bounds.
# As you iterate through each variable, print the shape of the data after the outliers for that variable are re


calc_outliers(df2.Quantity)
```

```
Lower bound of outliers: -15.0
Upper bound of outliers: 33.0
```

Out[40]:
```
(-15.0, 33.0)
```

In [41]:
```python
calc_outliers(df2.Price)
```

```
Lower bound of outliers: -3.3
Upper bound of outliers: 9.9
```

Out[41]:
```
(-3.3000000000000003, 9.9)
```

In [42]:
```python
calc_outliers(df2.TotalAmount)
```

```
Lower bound of outliers: -23.8
Upper bound of outliers: 66.07
```

Out[42]:
```
(-23.805, 66.07499999999999)
```

In [ ]:

Save the final dataset as a pickle file

In [43]:
```python
# Save the final dataset as a pickle file named online_history_cleaned_final.pickle.

df2.to_pickle("online_history_cleaned_final.pickle")
```

In [ ]: