In [1]:

```
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
%matplotlib inline

from mlxtend.frequent_patterns import apriori
from mlxtend.frequent_patterns import association_rules
```

In [2]:

```
df = pd.read_excel('Online Retail.xlsx')
```

In [3]:

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 541909 entries, 0 to 541908
Data columns (total 8 columns):
 #   Column       Non-Null Count   Dtype
---  ------       --------------   -----
 0   InvoiceNo    541909 non-null  object
 1   StockCode    541909 non-null  object
 2   Description  540455 non-null  object
 3   Quantity     541909 non-null  int64
 4   InvoiceDate  541909 non-null  datetime64[ns]
 5   UnitPrice    541909 non-null  float64
 6   CustomerID   406829 non-null  float64
 7   Country      541909 non-null  object
dtypes: datetime64[ns](1), float64(2), int64(1), object(4)
memory usage: 33.1+ MB
```

In [4]:

```
df.head(10)
```

Out[4]:

	InvoiceNo	StockCode	Description	Quantity	InvoiceDate	UnitPrice	CustomerID	Cou
0	536365	85123A	WHITE HANGING HEART T-LIGHT HOLDER	6	2010-12-01 08:26:00	2.55	17850.0	Un Kingc
1	536365	71053	WHITE METAL LANTERN	6	2010-12-01 08:26:00	3.39	17850.0	Un Kingc
2	536365	84406B	CREAM CUPID HEARTS COAT HANGER	8	2010-12-01 08:26:00	2.75	17850.0	Un Kingc
3	536365	84029G	KNITTED UNION FLAG HOT WATER BOTTLE	6	2010-12-01 08:26:00	3.39	17850.0	Un Kingc
4	536365	84029E	RED WOOLLY HOTTIE WHITE HEART.	6	2010-12-01 08:26:00	3.39	17850.0	Un Kingc
5	536365	22752	SET 7 BABUSHKA NESTING BOXES	2	2010-12-01 08:26:00	7.65	17850.0	Un Kingc
6	536365	21730	GLASS STAR FROSTED T-LIGHT HOLDER	6	2010-12-01 08:26:00	4.25	17850.0	Un Kingc
7	536366	22633	HAND WARMER UNION JACK	6	2010-12-01 08:28:00	1.85	17850.0	Un Kingc
8	536366	22632	HAND WARMER RED POLKA DOT	6	2010-12-01 08:28:00	1.85	17850.0	Un Kingc
9	536367	84879	ASSORTED COLOUR BIRD ORNAMENT	32	2010-12-01 08:34:00	1.69	13047.0	Un Kingc

In [5]:

```
df['Description']=df['Description'].str.strip()
```

```
df.dropna(axis=0,subset=['InvoiceNo'],inplace=True)
df['InvoiceNo']=df['InvoiceNo'].astype('str')
```

In [6]:

```
df.head(10)
```

Out[6]:

	InvoiceNo	StockCode	Description	Quantity	InvoiceDate	UnitPrice	CustomerID	Cou
0	536365	85123A	WHITE HANGING HEART T-LIGHT HOLDER	6	2010-12-01 08:26:00	2.55	17850.0	Un Kingc
1	536365	71053	WHITE METAL LANTERN	6	2010-12-01 08:26:00	3.39	17850.0	Un Kingc
2	536365	84406B	CREAM CUPID HEARTS COAT HANGER	8	2010-12-01 08:26:00	2.75	17850.0	Un Kingc
3	536365	84029G	KNITTED UNION FLAG HOT WATER BOTTLE	6	2010-12-01 08:26:00	3.39	17850.0	Un Kingc
4	536365	84029E	RED WOOLLY HOTTIE WHITE HEART.	6	2010-12-01 08:26:00	3.39	17850.0	Un Kingc
5	536365	22752	SET 7 BABUSHKA NESTING BOXES	2	2010-12-01 08:26:00	7.65	17850.0	Un Kingc
6	536365	21730	GLASS STAR FROSTED T-LIGHT HOLDER	6	2010-12-01 08:26:00	4.25	17850.0	Un Kingc
7	536366	22633	HAND WARMER UNION JACK	6	2010-12-01 08:28:00	1.85	17850.0	Un Kingc
8	536366	22632	HAND WARMER RED POLKA DOT	6	2010-12-01 08:28:00	1.85	17850.0	Un Kingc
9	536367	84879	ASSORTED COLOUR BIRD ORNAMENT	32	2010-12-01 08:34:00	1.69	13047.0	Un Kingc

In [7]:

```python
df[df.InvoiceNo.str.contains('C', na=False)].head()
```

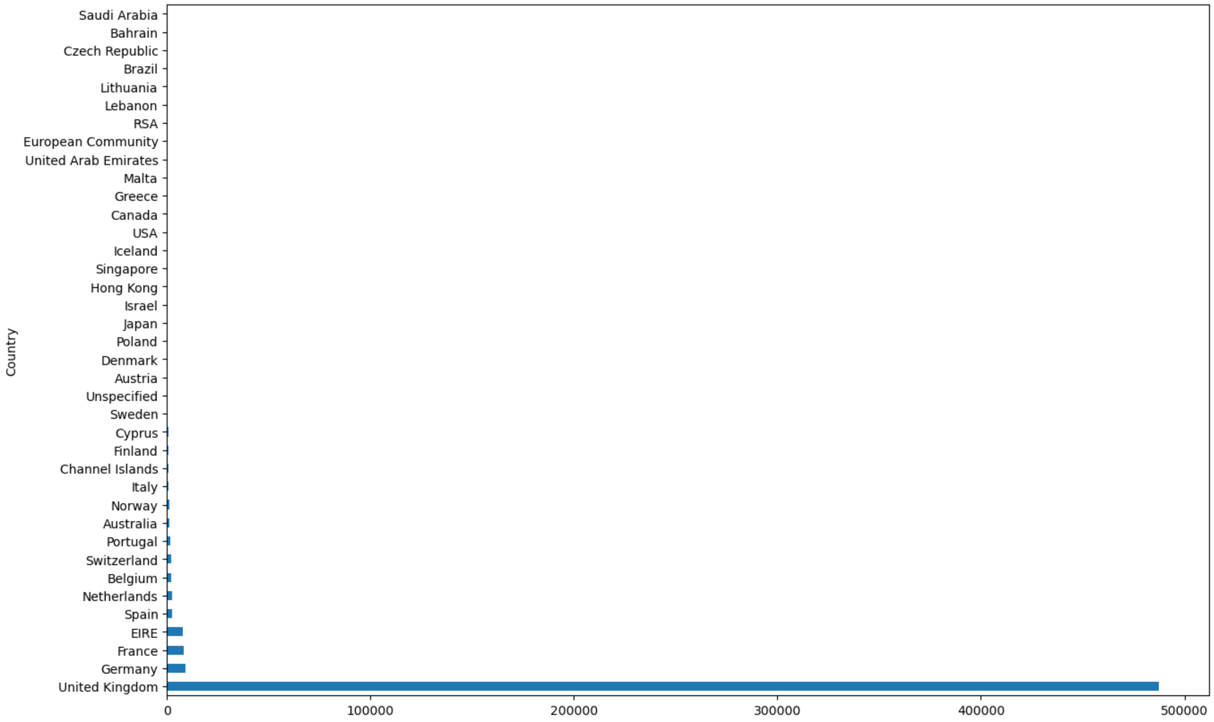
Out[7]:

	InvoiceNo	StockCode	Description	Quantity	InvoiceDate	UnitPrice	CustomerID	Co
141	C536379	D	Discount	-1	2010-12-01 09:41:00	27.50	14527.0	Kir
154	C536383	35004C	SET OF 3 COLOURED FLYING DUCKS	-1	2010-12-01 09:49:00	4.65	15311.0	Kir
235	C536391	22556	PLASTERS IN TIN CIRCUS PARADE	-12	2010-12-01 10:24:00	1.65	17548.0	Kir
236	C536391	21984	PACK OF 12 PINK PAISLEY TISSUES	-24	2010-12-01 10:24:00	0.29	17548.0	Kir
237	C536391	21983	PACK OF 12 BLUE PAISLEY TISSUES	-24	2010-12-01 10:24:00	0.29	17548.0	Kir

In [8]:
```
df=df[~df['InvoiceNo'].str.contains('C')]
```

In [9]:
```
df['Country'].value_counts().plot(kind='barh', figsize=(15,10))
```

Out[9]:
```
<Axes: ylabel='Country'>
```



In [10]:
```
basket = df[df['Country']=="Germany"].groupby(['InvoiceNo','Description'])['Quantit
```

```
In [11]: basket = basket.sum().unstack().reset_index().fillna(0).set_index('InvoiceNo')
```

```
In [12]: basket.head(10)
```

Out[12]:

Description	10 COLOUR SPACEBOY PEN	12 COLOURED PARTY BALLOONS	12 IVORY ROSE PEG PLACE SETTINGS	12 MESSAGE CARDS WITH ENVELOPES	12 PENCIL SMALL TUBE WOODLAND	12 PENCILS SMALL TUBE RED RETROSPOT	PE S
InvoiceNo							
536527	0.0	0.0	0.0	0.0	0.0	0.0	
536840	0.0	0.0	0.0	0.0	0.0	0.0	
536861	0.0	0.0	0.0	0.0	0.0	0.0	
536967	0.0	0.0	0.0	0.0	0.0	0.0	
536983	0.0	0.0	0.0	0.0	0.0	0.0	
537197	0.0	0.0	0.0	0.0	0.0	0.0	
537198	0.0	0.0	0.0	0.0	0.0	0.0	
537201	0.0	0.0	0.0	0.0	0.0	0.0	
537212	0.0	0.0	0.0	0.0	0.0	0.0	
537250	0.0	0.0	0.0	0.0	0.0	0.0	

10 rows × 1695 columns

```
In [13]: def encode_data(datapoint):
             if datapoint <= 0:
                 return 0
             if datapoint >= 1:
                 return 1
```

```
In [14]: basket = basket.applymap(encode_data)
```

```
C:\Users\GIA KIET\AppData\Local\Temp\ipykernel_18308\1901855995.py:1: FutureWarning:
DataFrame.applymap has been deprecated. Use DataFrame.map instead.
  basket = basket.applymap(encode_data)
```

```
In [15]: basket.drop('POSTAGE', inplace=True, axis=1)
```

```
In [16]: itemsets = apriori(basket.astype('bool'),min_support=0.05,use_colnames=True)
```

```
In [17]: itemsets.head(10)
```

Out[17]:

	support	itemsets
0	0.102845	(6 RIBBONS RUSTIC CHARM)
1	0.070022	(ALARM CLOCK BAKELIKE PINK)
2	0.065646	(CHARLOTTE BAG APPLES DESIGN)
3	0.050328	(CHILDRENS CUTLERY DOLLY GIRL)
4	0.061269	(COFFEE MUG APPLES DESIGN)
5	0.063457	(FAWN BLUE HOT WATER BOTTLE)
6	0.072210	(GUMBALL COAT RACK)
7	0.056893	(IVORY KITCHEN SCALES)
8	0.063457	(JAM JAR WITH PINK LID)
9	0.091904	(JAM MAKING SET PRINTED)

In [18]:
```
rules = association_rules(itemsets, metric="confidence", min_threshold=0.5)
```

In [19]:
```
rules.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 8 entries, 0 to 7
Data columns (total 10 columns):
 #   Column              Non-Null Count  Dtype  
---  ------              --------------  -----  
 0   antecedents         8 non-null      object 
 1   consequents         8 non-null      object 
 2   antecedent support  8 non-null      float64
 3   consequent support  8 non-null      float64
 4   support             8 non-null      float64
 5   confidence          8 non-null      float64
 6   lift                8 non-null      float64
 7   leverage            8 non-null      float64
 8   conviction          8 non-null      float64
 9   zhangs_metric       8 non-null      float64
dtypes: float64(8), object(2)
memory usage: 772.0+ bytes
```

In [20]:
```
rules["antecedents"]=rules["antecedents"].apply(lambda x:list(x)[0]).astype("unicod
rules["consequents"]=rules["consequents"].apply(lambda x:list(x)[0]).astype("unicod
```

In [21]:
```
for i in range(len(rules)):
    print(rules.loc[i, 'antecedents'], ' ==> ', rules.loc[i, 'consequents'],
          ' [', rules.loc[i, 'support'], ', ', rules.loc[i, 'confidence'], ']')
```

```
PLASTERS IN TIN CIRCUS PARADE  ==>  PLASTERS IN TIN WOODLAND ANIMALS  [ 0.0678336980
3063458 ,  0.5849056603773585 ]
PLASTERS IN TIN SPACEBOY  ==>  PLASTERS IN TIN WOODLAND ANIMALS  [ 0.061269146608315
096 ,  0.5714285714285714 ]
PLASTERS IN TIN WOODLAND ANIMALS  ==>  ROUND SNACK BOXES SET OF4 WOODLAND  [ 0.07439
824945295405 ,  0.5396825396825397 ]
RED RETROSPOT CHARLOTTE BAG  ==>  WOODLAND CHARLOTTE BAG  [ 0.05908096280087528 ,  0
.8437500000000001 ]
ROUND SNACK BOXES SET OF 4 FRUITS  ==>  ROUND SNACK BOXES SET OF4 WOODLAND  [ 0.1312
9102844638948 ,  0.8333333333333333 ]
ROUND SNACK BOXES SET OF4 WOODLAND  ==>  ROUND SNACK BOXES SET OF 4 FRUITS  [ 0.1312
9102844638948 ,  0.5357142857142857 ]
SPACEBOY LUNCH BOX  ==>  ROUND SNACK BOXES SET OF4 WOODLAND  [ 0.0700218818380744 ,
0.6808510638297872 ]
WOODLAND CHARLOTTE BAG  ==>  ROUND SNACK BOXES SET OF4 WOODLAND  [ 0.063457330415754
92 ,  0.5 ]
```

In [22]:

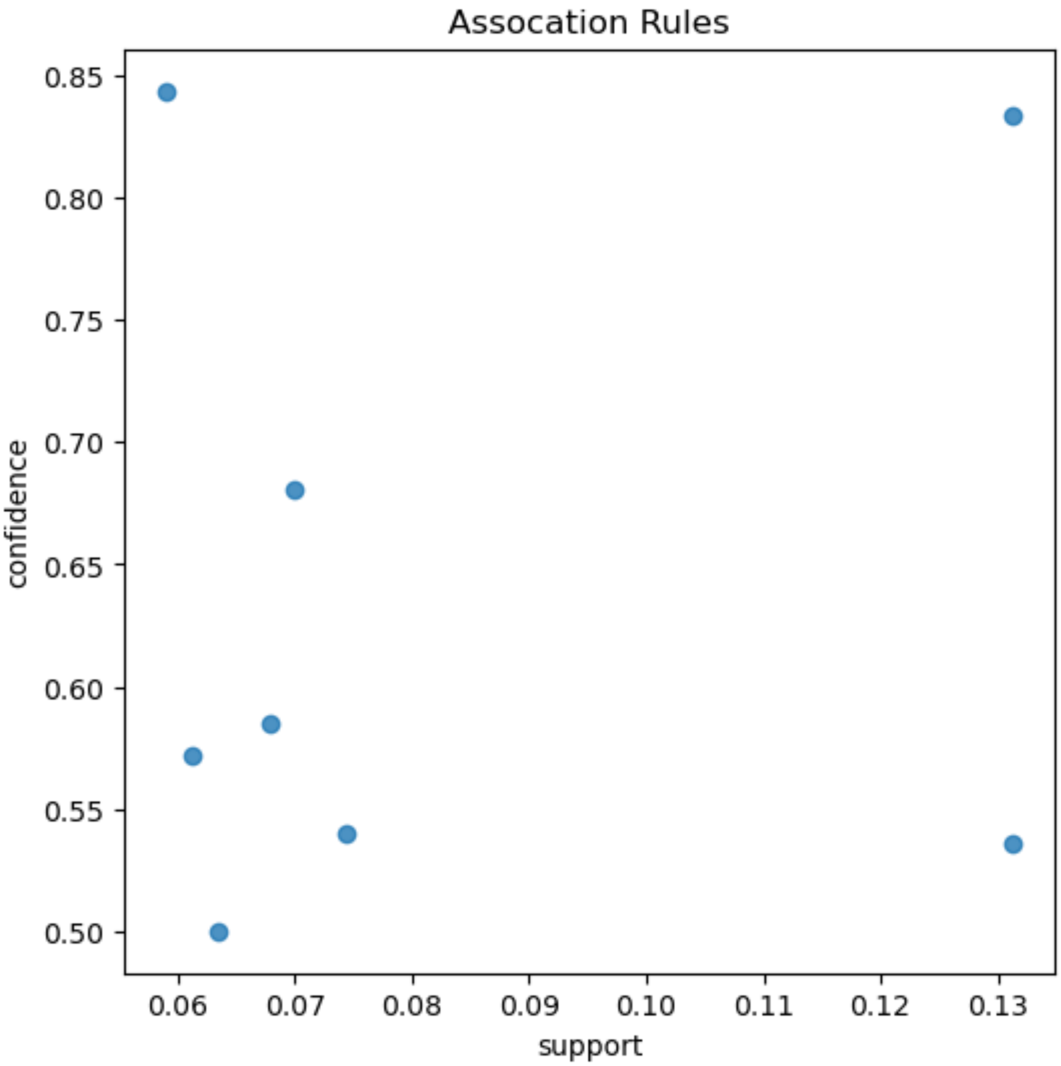
```
support = rules['support'].values
confidence = rules['confidence'].values
```

In [23]:

```
plt.figure(figsize=(6,6))
plt.title('Assocation Rules')
plt.xlabel('support')
plt.ylabel('confidence')
sns.regplot(x=support,y=confidence, fit_reg=False)
```

Out[23]:

```
<Axes: title={'center': 'Assocation Rules'}, xlabel='support', ylabel='confidenc
e'>
```



In [24]:
```
from mlxtend.frequent_patterns import fpgrowth
itemsets = fpgrowth(basket.astype('bool'), min_support=0.05, use_colnames=True)
```

In [25]:
```
rules = association_rules(itemsets, metric="confidence", min_threshold=0.5)
```

In [26]:
```
rules.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 8 entries, 0 to 7
Data columns (total 10 columns):
 #   Column              Non-Null Count  Dtype  
---  ------              --------------  -----  
 0   antecedents         8 non-null      object 
 1   consequents         8 non-null      object 
 2   antecedent support  8 non-null      float64
 3   consequent support  8 non-null      float64
 4   support             8 non-null      float64
 5   confidence          8 non-null      float64
 6   lift                8 non-null      float64
 7   leverage            8 non-null      float64
 8   conviction          8 non-null      float64
 9   zhangs_metric       8 non-null      float64
dtypes: float64(8), object(2)
memory usage: 772.0+ bytes
```

In [27]:

```
rules["antecedents"]=rules["antecedents"].apply(lambda x:list(x)[0]).astype("unicod
rules["consequents"]=rules["consequents"].apply(lambda x:list(x)[0]).astype("unicod
```

In [28]:

```
for i in range(len(rules)):
    print(rules.loc[i, 'antecedents'], ' ==> ', rules.loc[i, 'consequents'],
          ' [', rules.loc[i, 'support'], ', ', rules.loc[i, 'confidence'], ']')
```

```
ROUND SNACK BOXES SET OF 4 FRUITS  ==>  ROUND SNACK BOXES SET OF4 WOODLAND  [ 0.1312
9102844638948 ,  0.8333333333333333 ]
ROUND SNACK BOXES SET OF4 WOODLAND  ==>  ROUND SNACK BOXES SET OF 4 FRUITS  [ 0.1312
9102844638948 ,  0.5357142857142857 ]
WOODLAND CHARLOTTE BAG  ==>  ROUND SNACK BOXES SET OF4 WOODLAND  [ 0.063457330415754
92 ,  0.5 ]
PLASTERS IN TIN CIRCUS PARADE  ==>  PLASTERS IN TIN WOODLAND ANIMALS  [ 0.0678336980
3063458 ,  0.5849056603773585 ]
SPACEBOY LUNCH BOX  ==>  ROUND SNACK BOXES SET OF4 WOODLAND  [ 0.0700218818380744 ,
0.6808510638297872 ]
RED RETROSPOT CHARLOTTE BAG  ==>  WOODLAND CHARLOTTE BAG  [ 0.05908096280087528 ,  0
.8437500000000001 ]
PLASTERS IN TIN WOODLAND ANIMALS  ==>  ROUND SNACK BOXES SET OF4 WOODLAND  [ 0.07439
824945295405 ,  0.5396825396825397 ]
PLASTERS IN TIN SPACEBOY  ==>  PLASTERS IN TIN WOODLAND ANIMALS  [ 0.061269146608315
096 ,  0.5714285714285714 ]
```

In [29]:

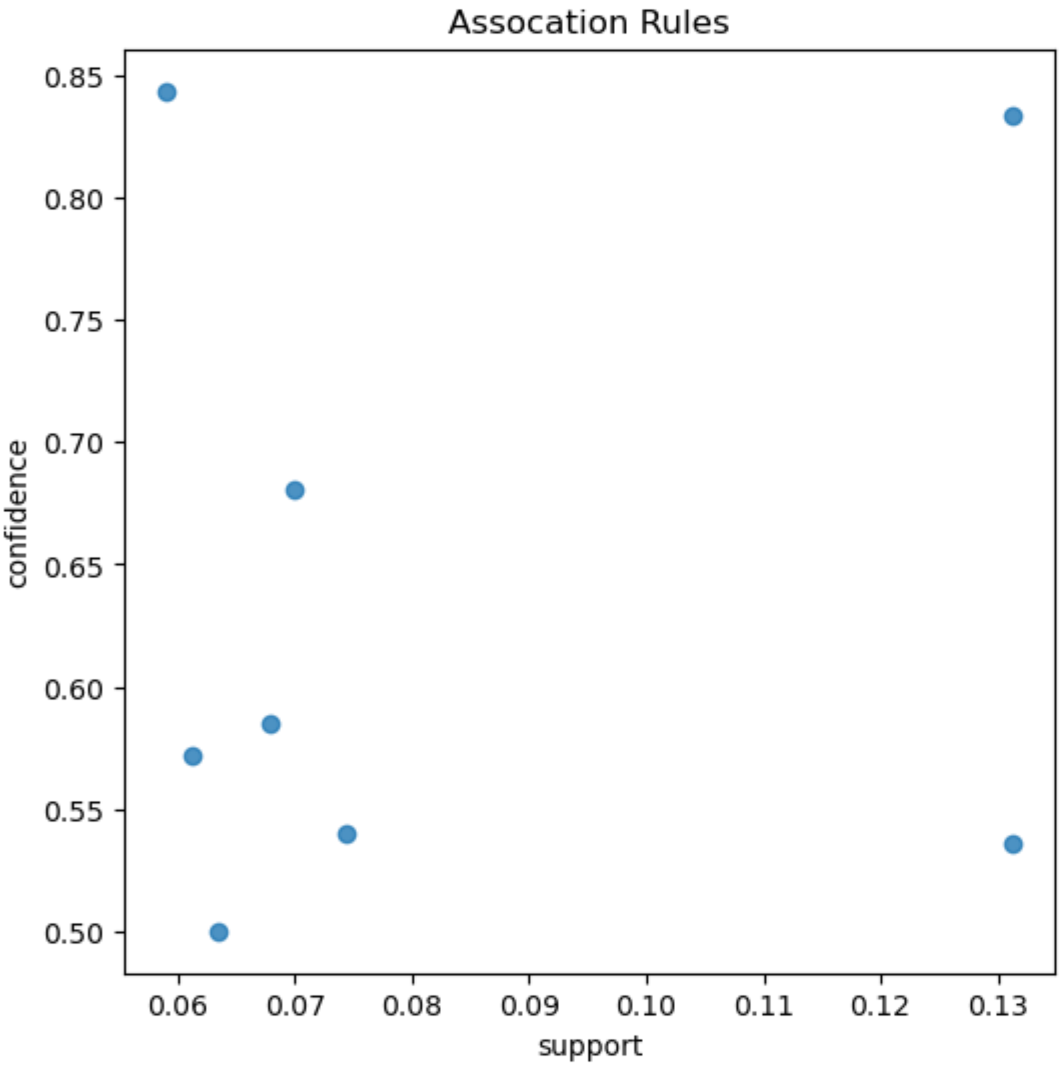
```
support = rules['support'].values
confidence = rules['confidence'].values
```

In [30]:

```
plt.figure(figsize=(6,6))
plt.title('Assocation Rules')
plt.xlabel('support')
plt.ylabel('confidence')
sns.regplot(x=support,y=confidence, fit_reg=False)
```

Out[30]:

```
<Axes: title={'center': 'Assocation Rules'}, xlabel='support', ylabel='confidenc
e'>
```



```
In [31]: #Kết luận: Hai thuật toán cho ra kết quả giống nhau.
```