

Heatmaps

MARKET BASKET ANALYSIS IN PYTHON



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MovieLens dataset

```
import pandas as pd

# Load ratings data.
ratings = pd.read_csv('datasets/movie_ratings.csv')
print(ratings.head())
```

```
   userId  movieId  title
0    3149    54286  Bourne Ultimatum, The (2007)
1    3149     1220  Blues Brothers, The (1980)
2    3149     4007  Wall Street (1987)
3    3149     7156  Fog of War: Eleven...
4    3149    97304  Argo (2012)
```

Creating "transactions" from ratings

```
# Recover unique user IDs.  
user_id = movies['userId'].unique()  
  
# Create library of highly rated movies for each user.  
libraries = [list(ratings[ratings['userId'] == u].title) for u in user_id]  
  
# Print example library.  
print(library[0])
```

```
['Battlestar Galactica (2003)',  
 'Gorgon, The (1964)',  
 'Under the Skin (2013)',  
 'Upstream Color (2013)',  
 'Destry Rides Again (1939)',  
 'Dr. Phibes Rises Again (1972)']
```

One-hot encoding transactions

```
from mlxtend.preprocessing import TransactionEncoder

# Instantiate transaction encoder.
encoder = TransactionEncoder()

# One-hot encode libraries.
onehot = encoder.fit(libraries).transform(libraries)

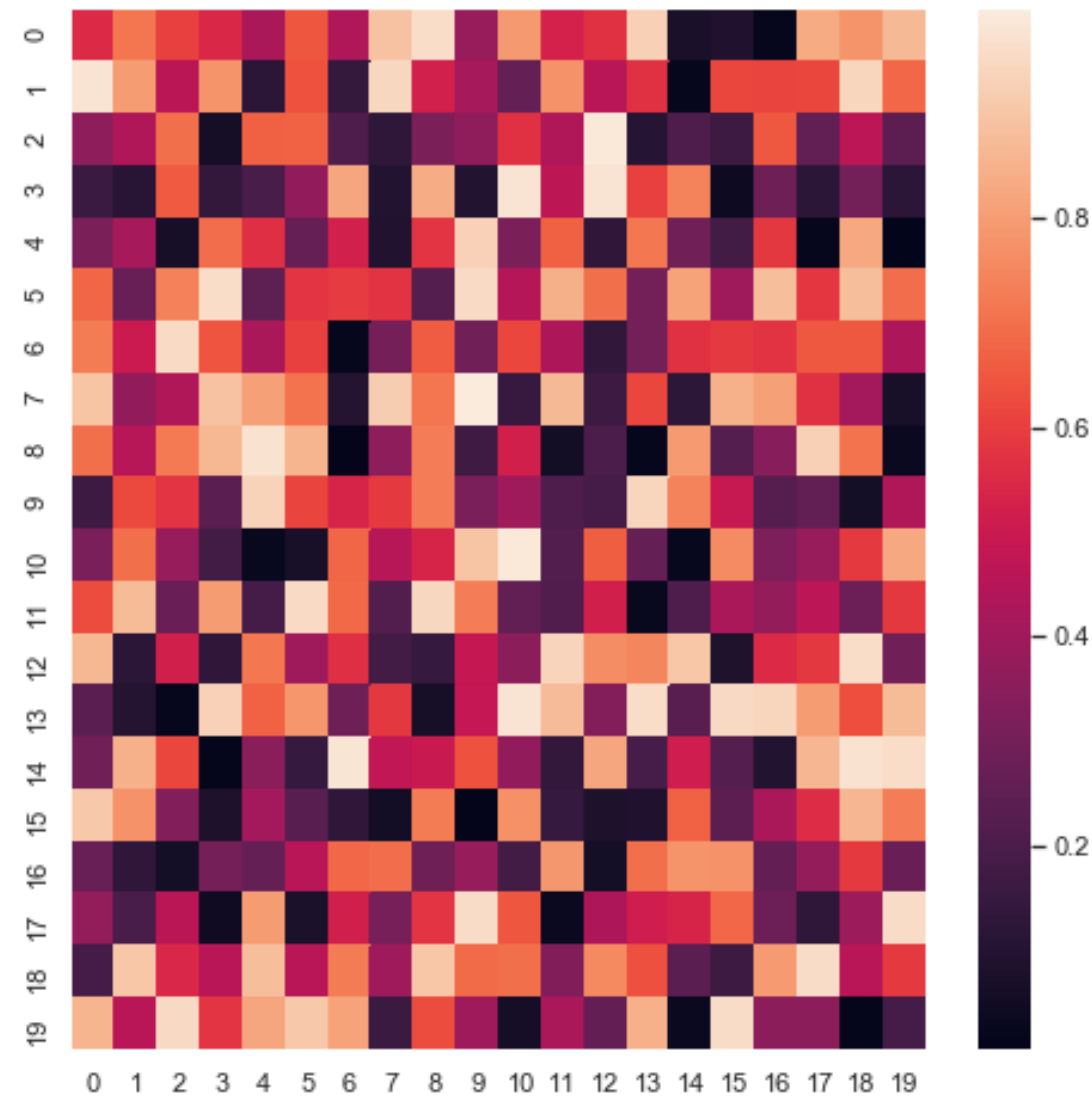
# Use movie titles as column headers.
onehot = pd.DataFrame(onehot, columns = encoder.columns_)

# Print onehot header.
print(onehot.head())
```

One-hot encoding transactions

```
(500) Days of Summer (2009) .45 (2006) 10 Things I Hate About You (1999)
0                                False      False
1                                False      False
2                                False      False
3                                False      False
4                                False      False
```

What is a heatmap?



Preparing the data

1. **Generate the rules.**
 - Use Apriori algorithm and association rules.
2. **Convert antecedents and consequents into strings.**
 - Stored as frozen sets by default in mlxtend.
3. **Convert rules into matrix format.**
 - Suitable for use in heatmaps.

Preparing the data

```
from mlxtend.frequent_patterns import association_rules, apriori
import seaborn as sns
```

```
# Apply the apriori algorithm
frequent_itemsets = apriori(onehot, min_support=0.10,
                           use_colnames=True, max_len=2)

# Recover the association rules
rules = association_rules(frequent_itemsets)
```


Generating a heatmap

```
# Convert antecedents and consequents into strings
rules['antecedents'] = rules['antecedents'].apply(lambda a: ','.join(list(a)))
rules['consequents'] = rules['consequents'].apply(lambda a: ','.join(list(a)))
```

```
# Print example.
print(rules[['antecedents', 'consequents']])
```

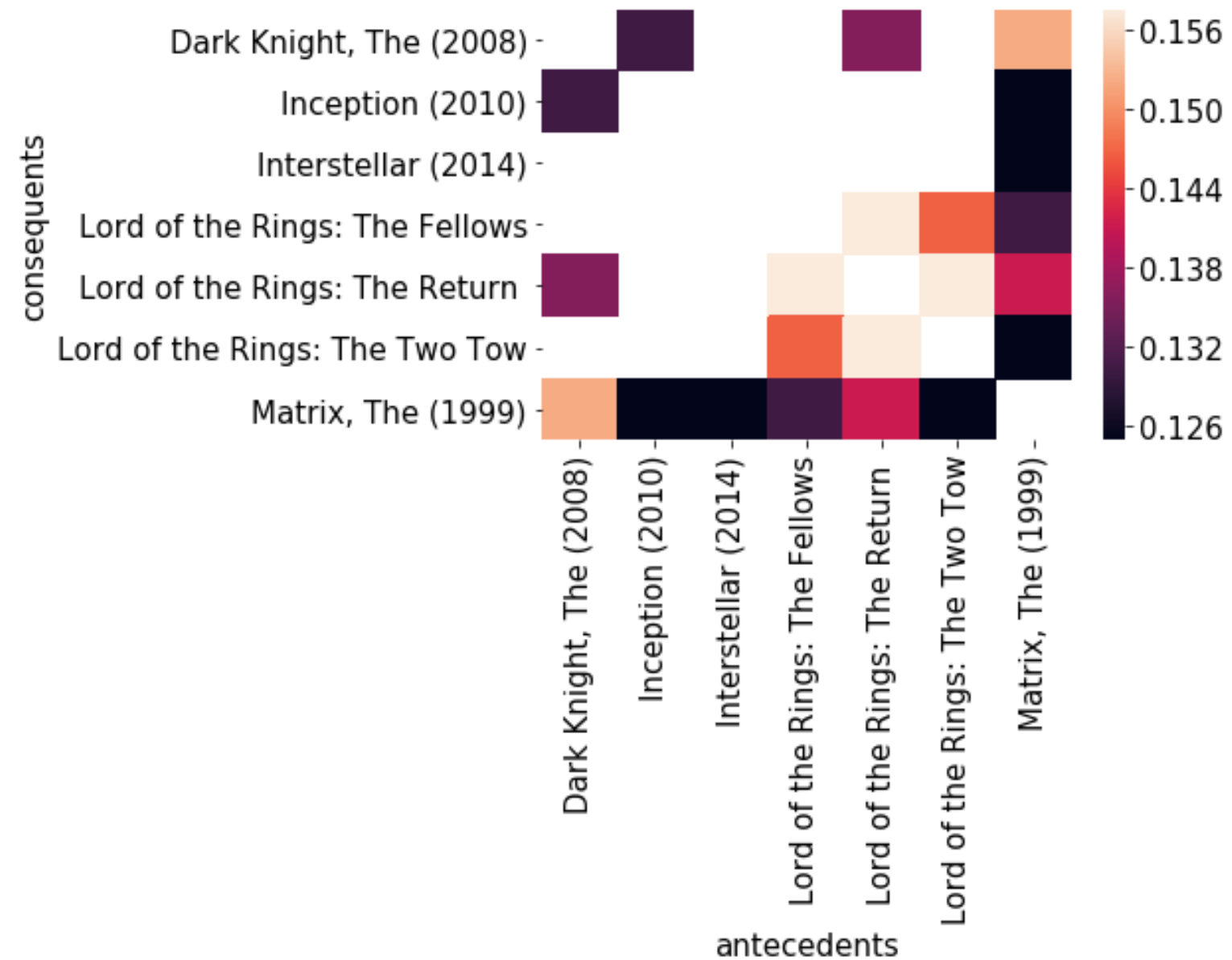
	antecedents	consequents
0	Batman Begins (2005)	Dark Knight Rises, The (2012)

Generating a heatmap

```
# Transform antecedent, consequent, and support columns into matrix
support_table = rules.pivot(index='consequents', columns='antecedents',
                             values='support')
```

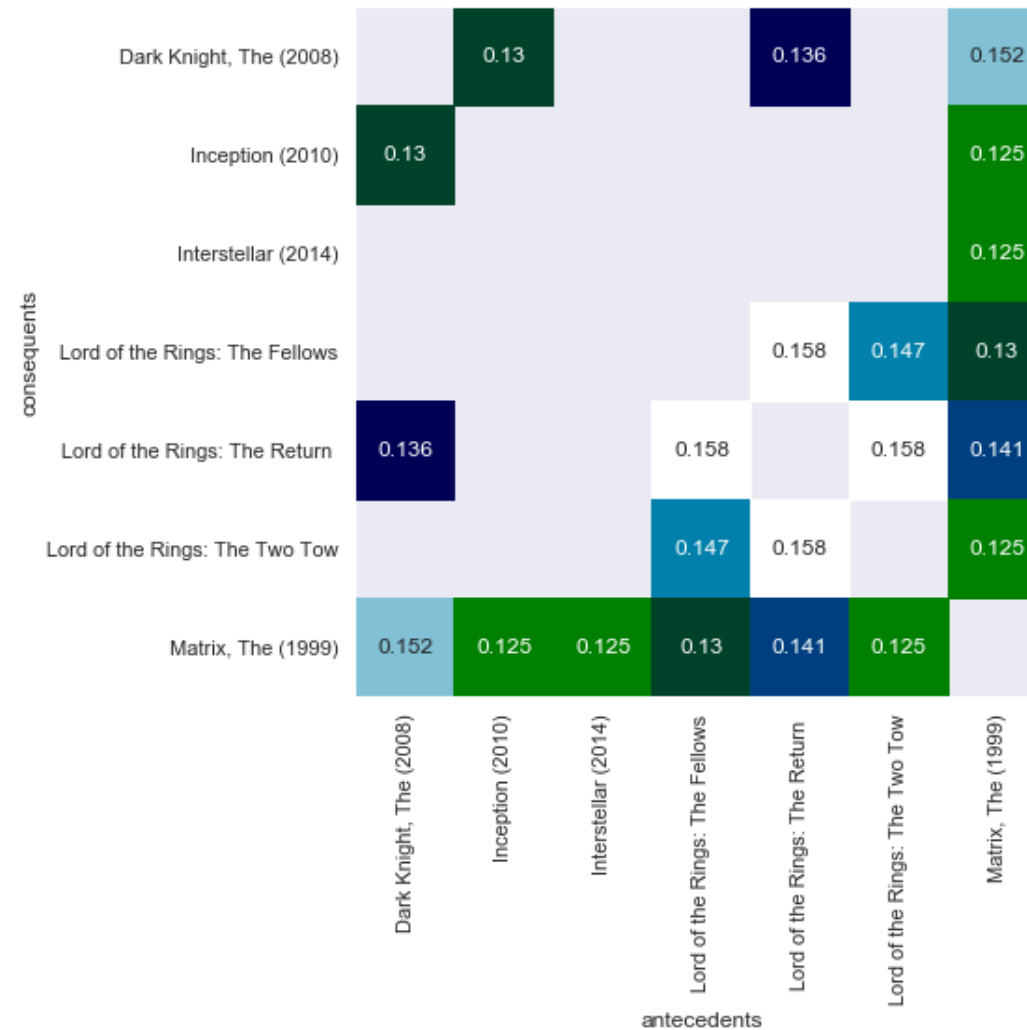
```
# Generate heatmap
sns.heatmap(support_table)
```

Generating a heatmap



Customizing heatmaps

```
sns.heatmap(pivot, annot=True, cbar=False, cmap='ocean')
```

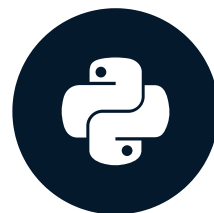


Let's practice!

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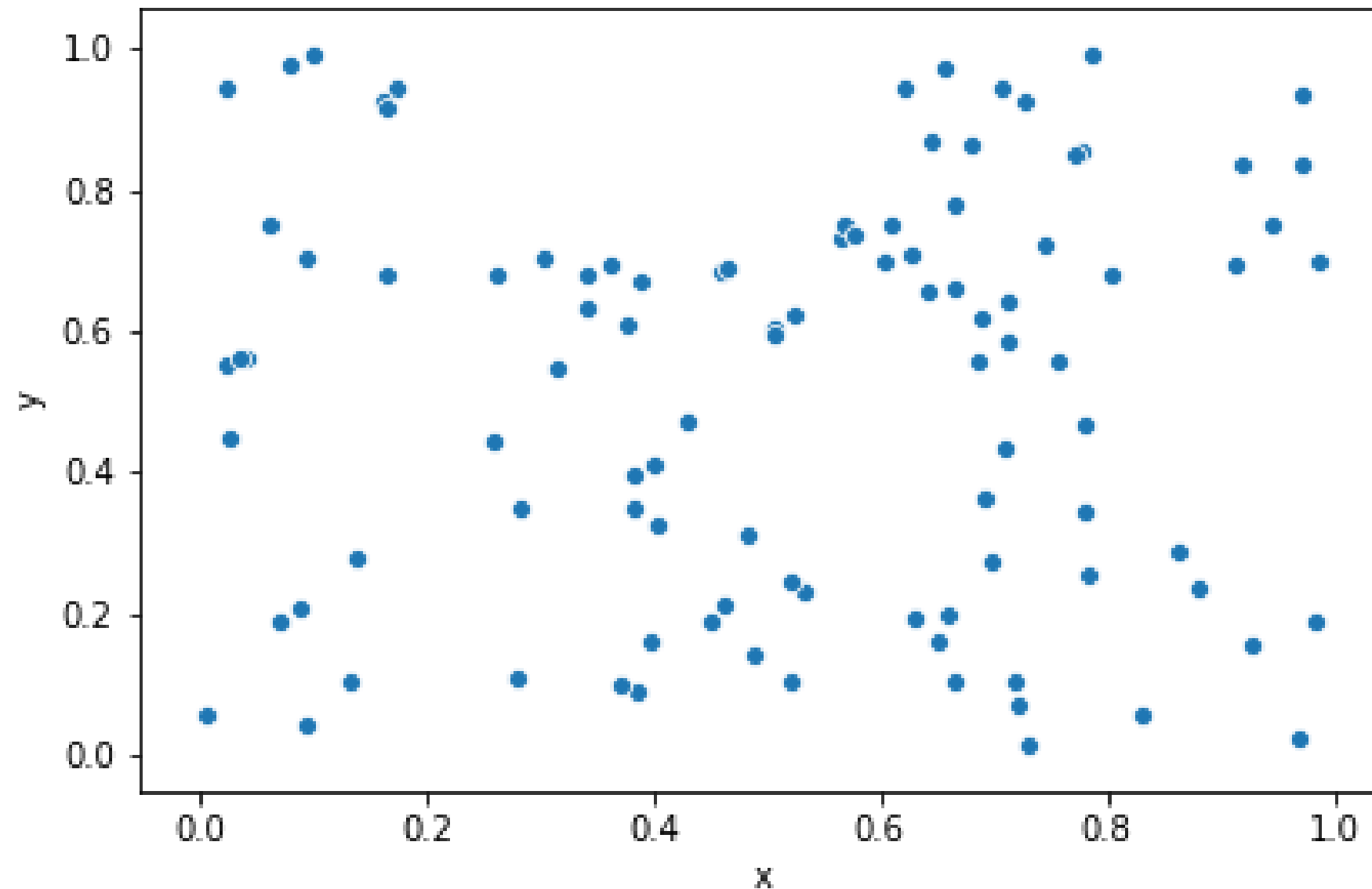
Scatterplots

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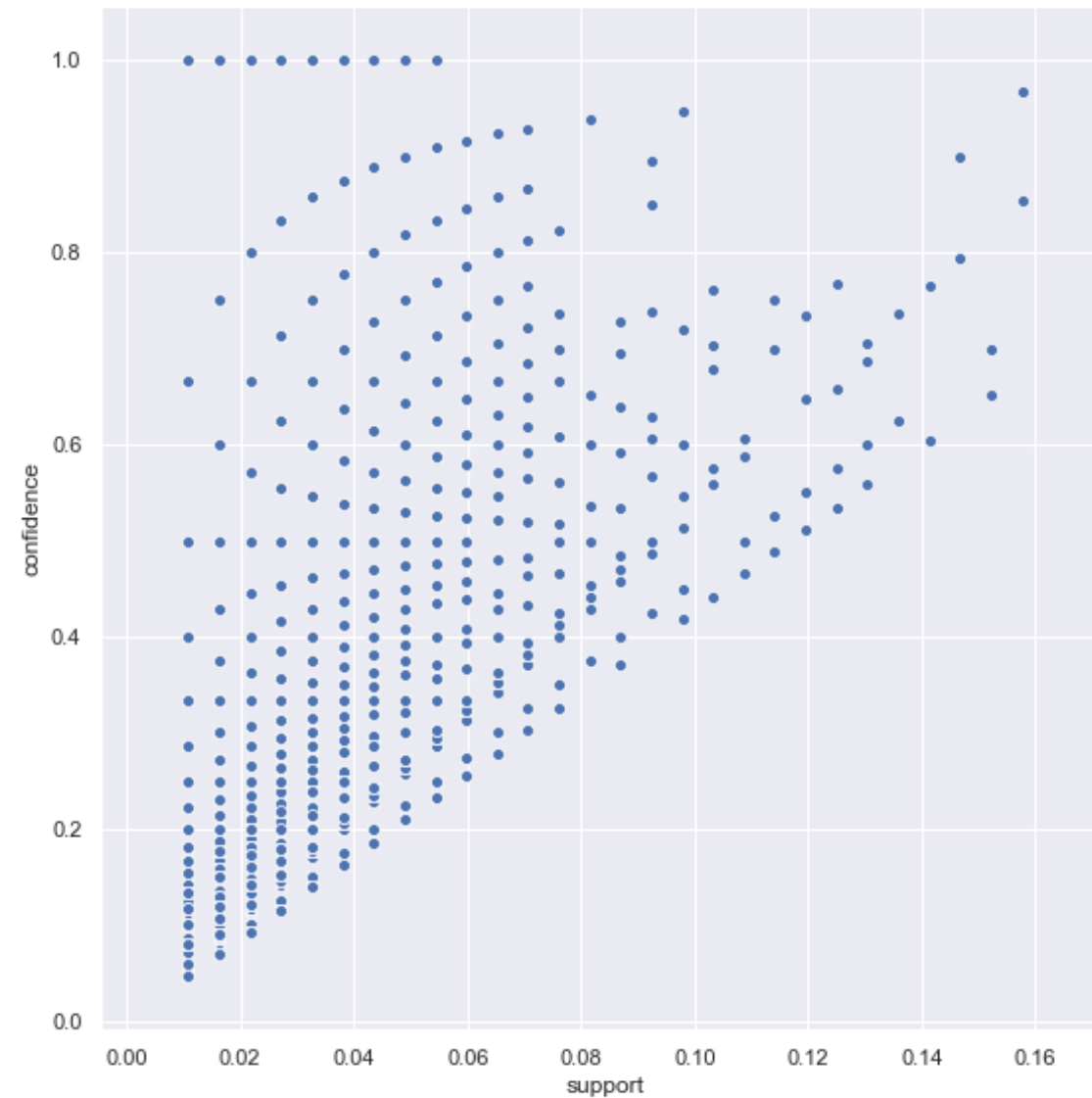
Introduction to scatterplots



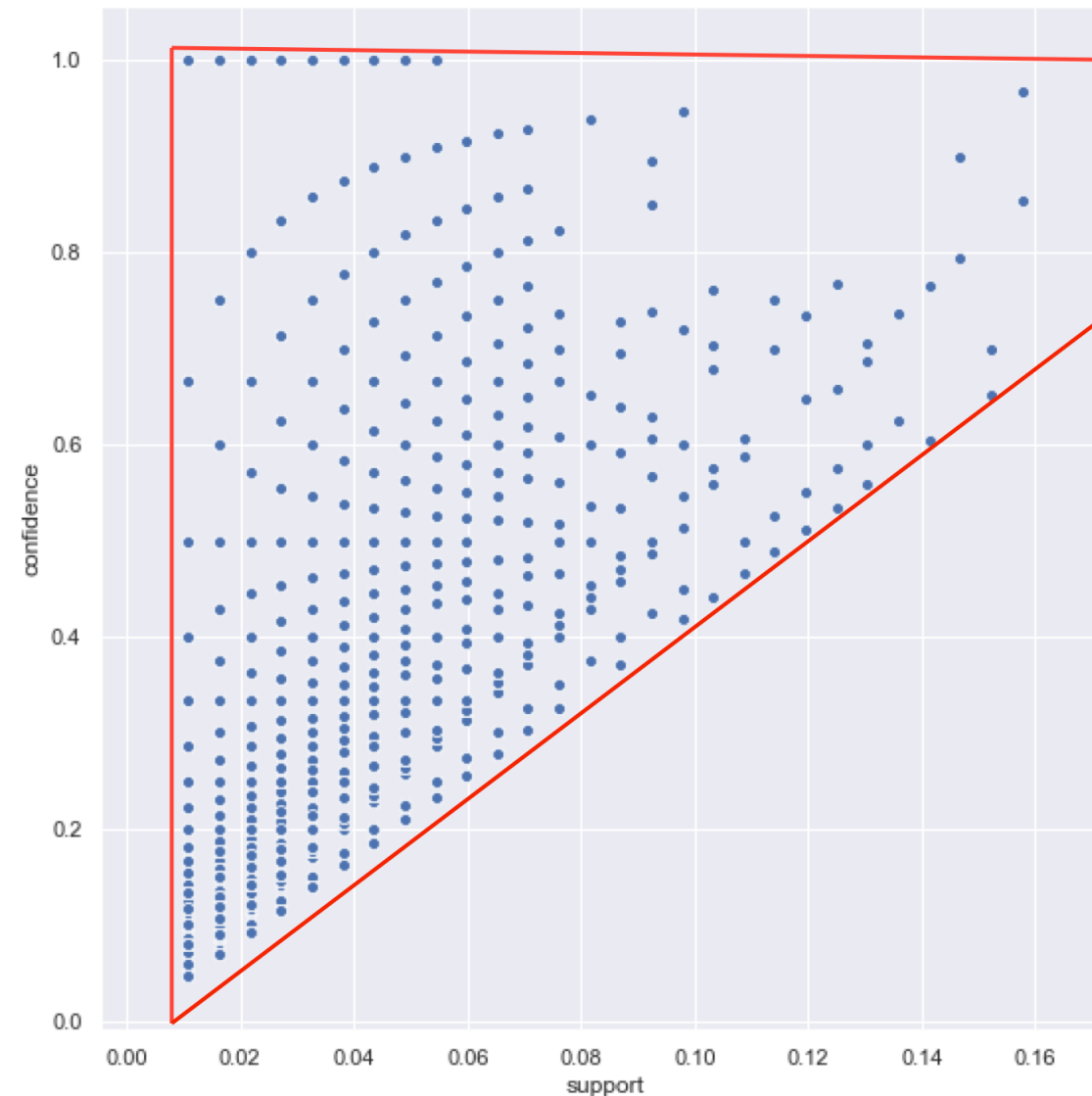
Introduction to scatterplots

- **A scatterplot displays pairs of values.**
 - Antecedent and consequent support.
 - Confidence and lift.
- **No model is assumed.**
 - No trend line or curve needed.
- **Can provide starting point for pruning.**
 - Identify patterns in data and rules.

Support versus confidence



Support versus confidence



¹ Bayardo Jr., R.J. and Agrawal, R. (1999). Mining the Most Interesting Rules. In Proceedings of the Fifth ACM SIGKDD International Conference on Knowledge Discovery and Data Mining (pp. 145-154).

Generating a scatterplot

```
import pandas as pd
import seaborn as sns
from mlxtend.frequent_patterns import association_rules, apriori

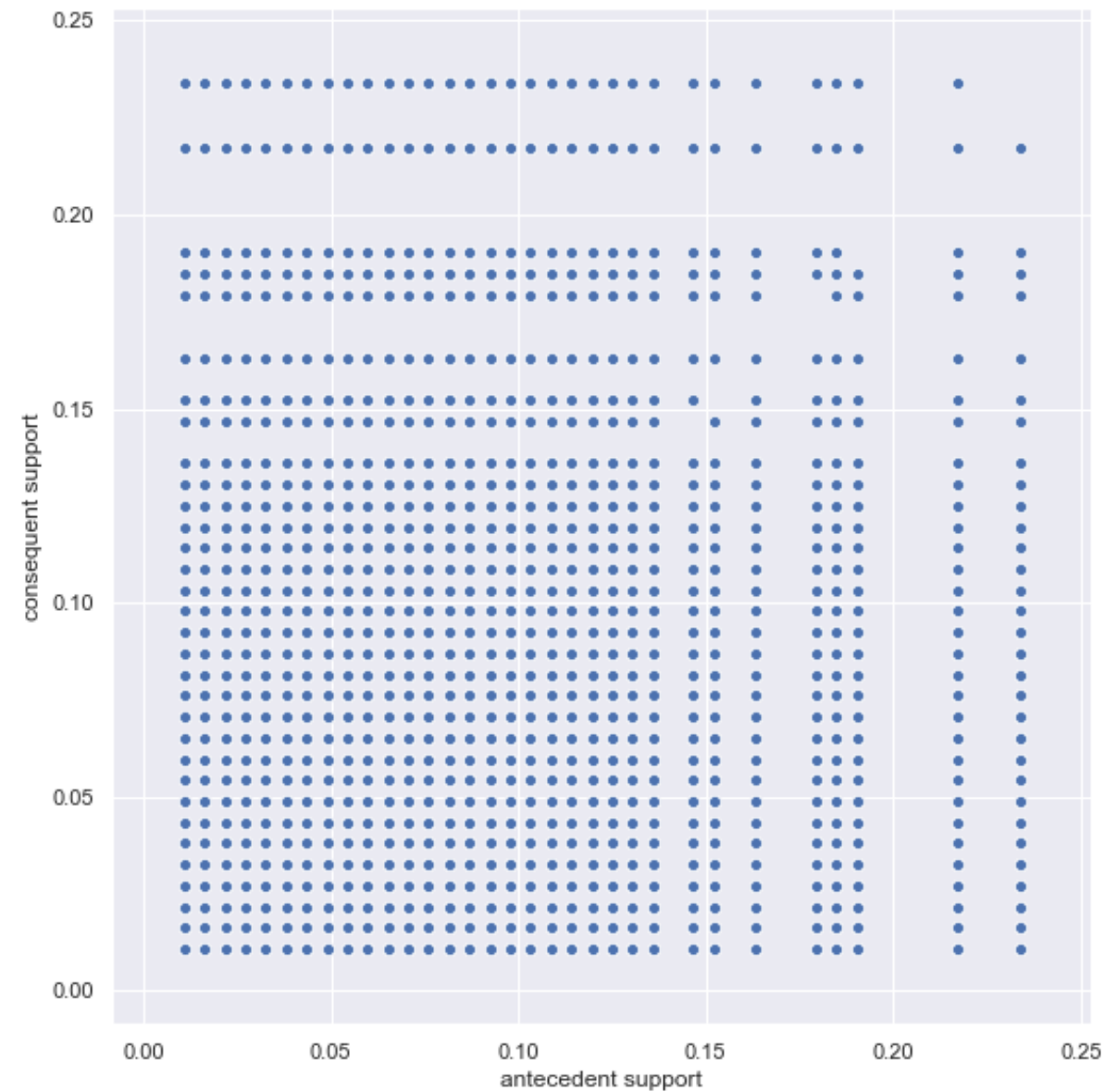
# Load one-hot encoded MovieLens data
onehot = pd.read_csv('datasets/movies_onehot.csv')

# Generate frequent itemsets using Apriori
frequent_itemsets = apriori(onehot, min_support=0.01, use_colnames=True, max_len=2)

# Generate association rules
rules = association_rules(frequent_itemsets, metric='support', min_threshold=0.0)

sns.scatterplot(x="antecedent support", y="consequent support", data=rules)
```

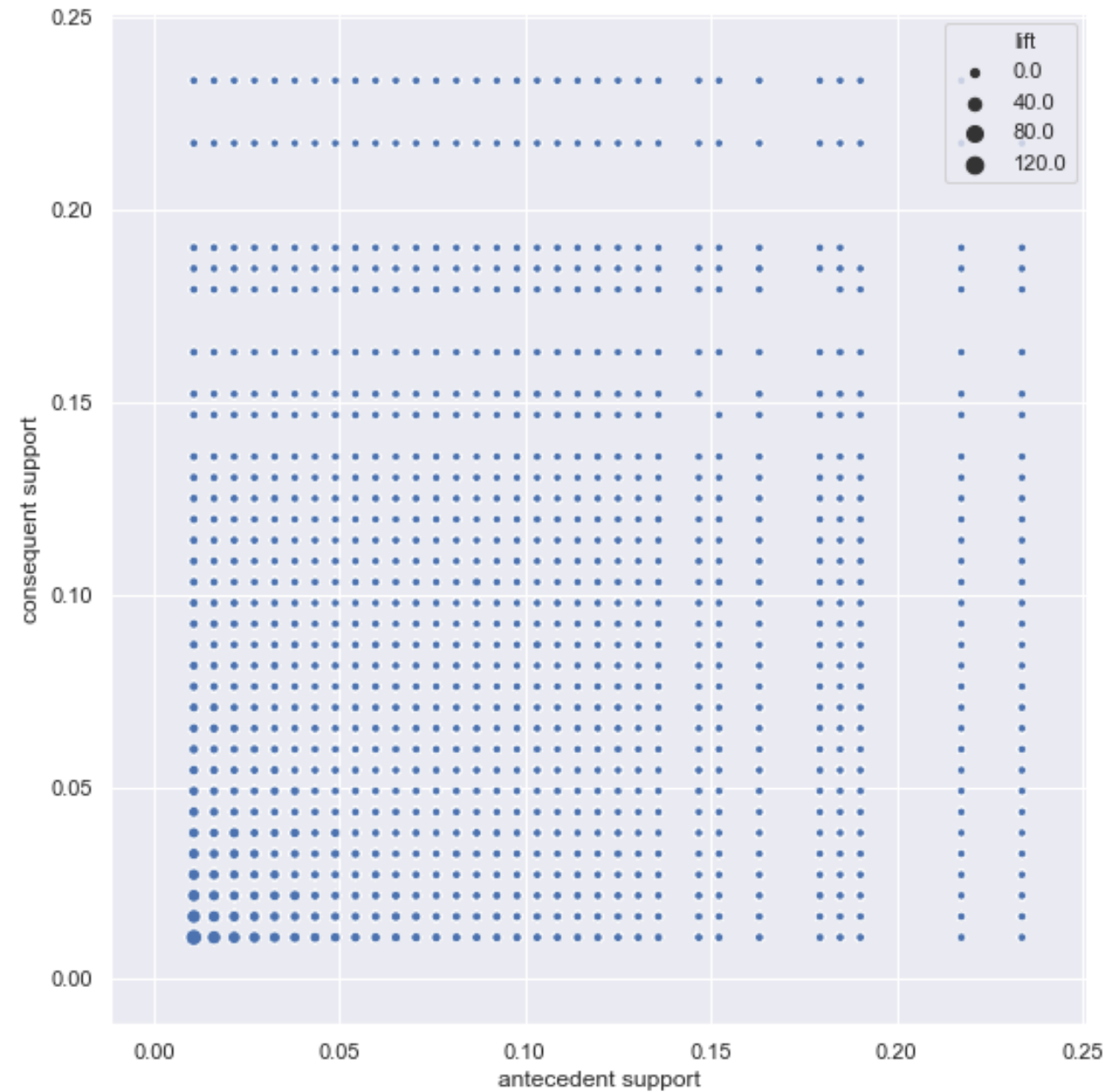
Generating a scatterplot



Adding a third metric

```
sns.scatterplot(x="antecedent support",  
                y="consequent support",  
                size="lift",  
                data=rules)
```

Adding a third metric



What can we learn from scatterplots?

- **Identify natural thresholds in data.**
 - Not possible with heatmaps or other visualizations.
- **Visualize entire dataset.**
 - Not limited to small number of rules.
- **Use findings to prune.**
 - Use natural thresholds and patterns to prune.

Let's practice!

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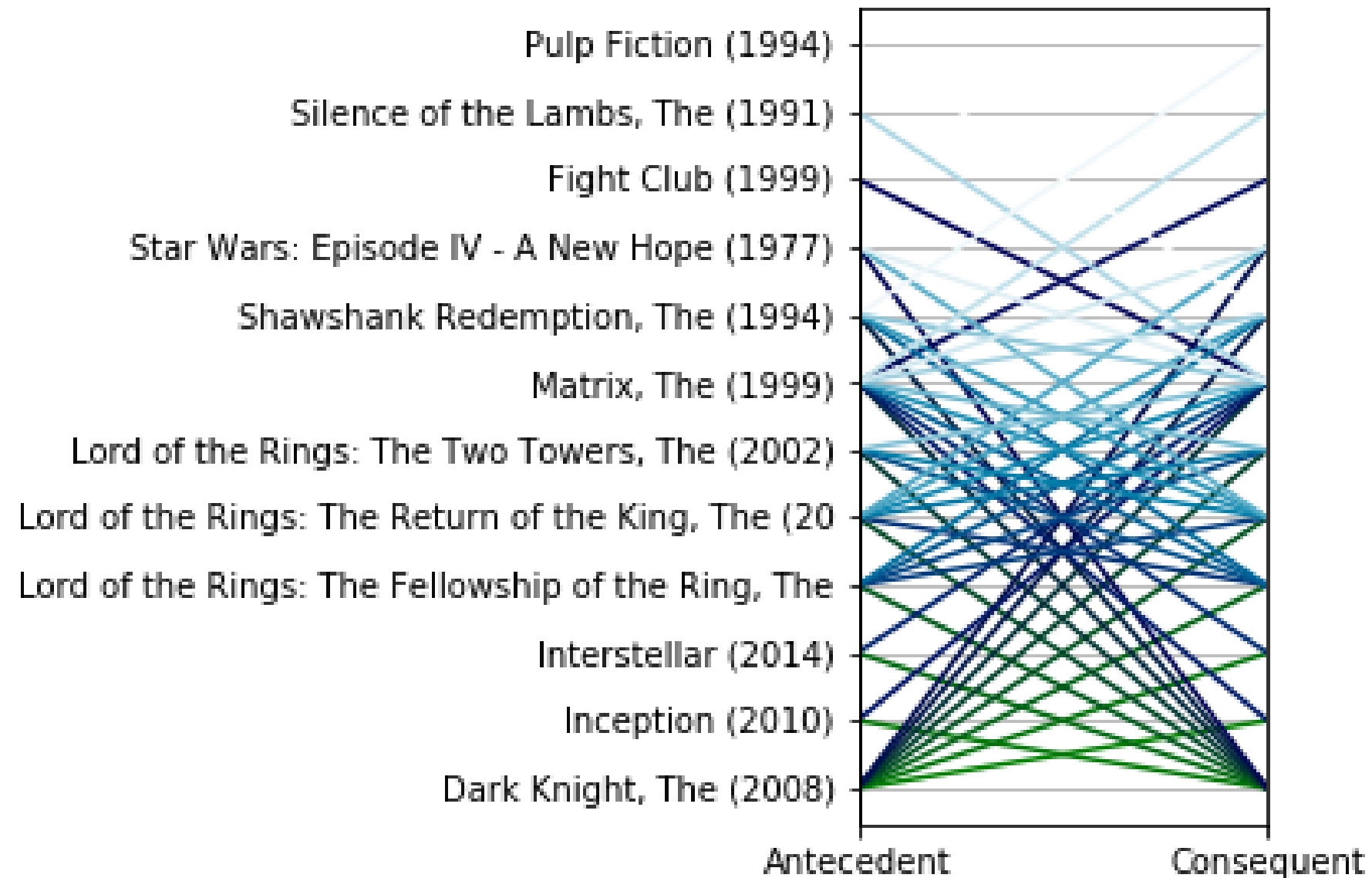
Parallel coordinates plot

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What is a parallel coordinates plot?



When to use parallel coordinate plots

- **Parallel coordinates vs. heatmap.**
 - Don't need intensity information.
 - Only want to know whether rule exists.
 - Want to reduce visual clutter.
- **Parallel coordinates vs. scatterplot.**
 - Want individual rule information.
 - Not interested in multiple metrics.
 - Only want to examine final rules.

Preparing the data

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

```
# Load the one-hot encoded data
```

```
onehot = pd.read_csv('datasets/movies_onehot.csv')
```

```
# Generate frequent itemsets
```

```
frequent_itemsets = apriori(onehot, min_support = 0.10, use_colnames = True, max_len = 2)
```

```
# Generate association rules
```

```
rules = association_rules(frequent_itemsets, metric = 'support', min_threshold = 0.00)
```

Converting rules to coordinates

```
# Convert rules to coordinates.
rules['antecedent'] = rules['antecedents'].apply(lambda antecedent: list(antecedent)[0])
rules['consequent'] = rules['consequents'].apply(lambda consequent: list(consequent)[0])
rules['rule'] = rules.index
```

```
# Define coordinates and label
coords = rules[['antecedent', 'consequent', 'rule']]

# Print example
print(coords.head(1))
```

	antecedent	consequent	rule
0	Dark Knight, The (2008)	Inception (2010)	0

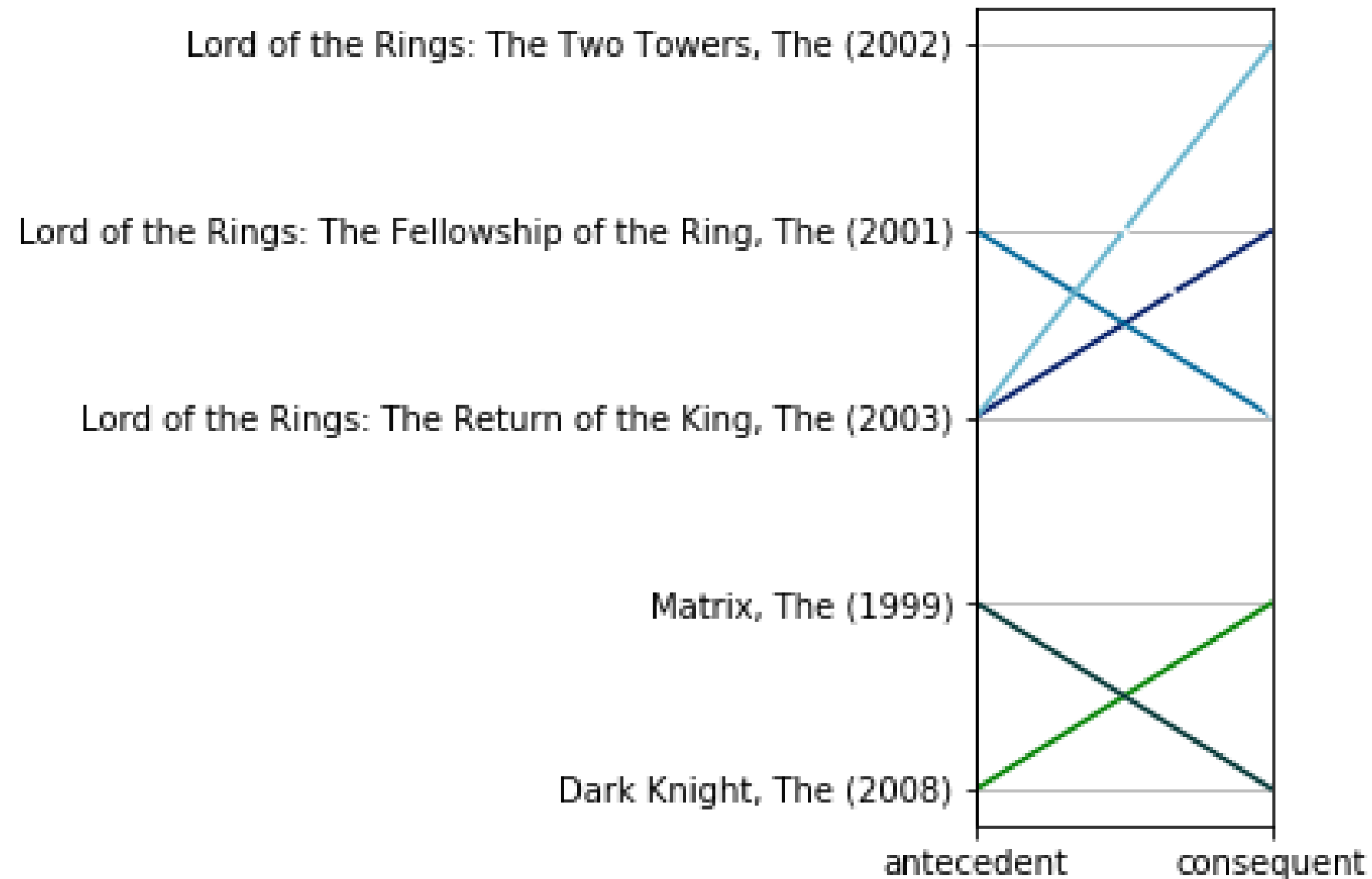
Generating a parallel coordinates plot

```
from pandas.plotting import parallel_coordinates
```

```
# Generate parallel coordinates plot
```

```
parallel_coordinates(coords, 'rule', colormap = 'ocean')
```

Generating a parallel coordinates plot



Refining a parallel coordinates plot

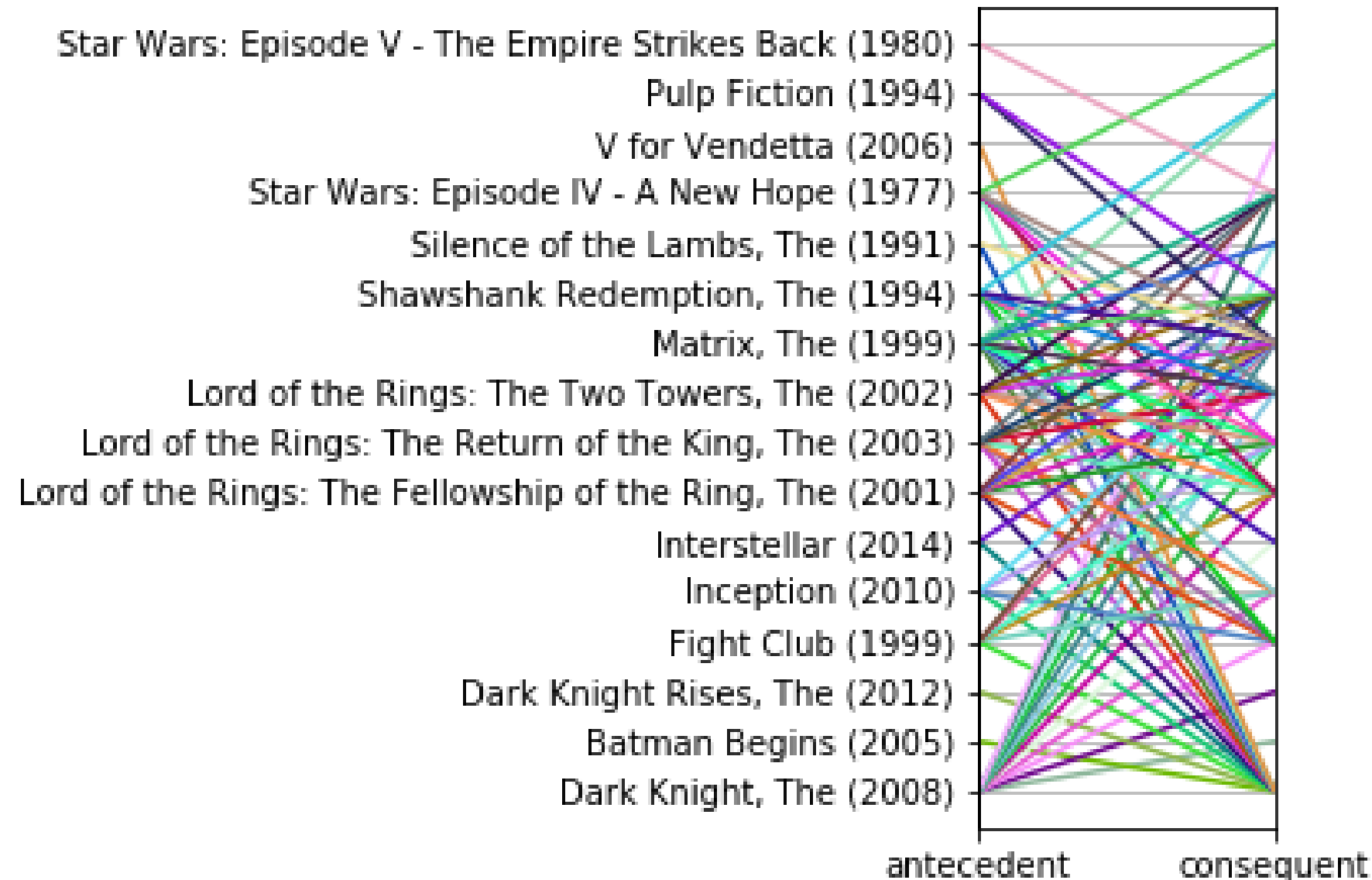
```
# Generate frequent itemsets
frequent_itemsets = apriori(onehot, min_support = 0.01, use_colnames = True, max_len = 2)

# Generate association rules
rules = association_rules(frequent_itemsets, metric = 'lift', min_threshold = 1.00)

# Generate coordinates and print example
coords = rules_to_coordinates(rules)

# Generate parallel coordinates plot
parallel_coordinates(coords, 'rule')
```


Refining a parallel coordinates plot

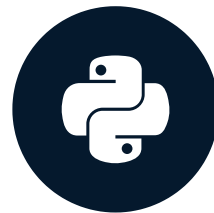


Let's practice!

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Congratulations!

MARKET BASKET ANALYSIS IN PYTHON



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Instructor

Transactions and itemsets

- Transactions

TID	Transaction
1	MILK, BREAD, BISCUIT
...	...
20	TEA, MILK, COFFEE, CEREAL

- Itemsets

- {MILK, BREAD}
- {MILK, COFFEE, CEREAL}

Association rules and metrics

- **Association Rules**

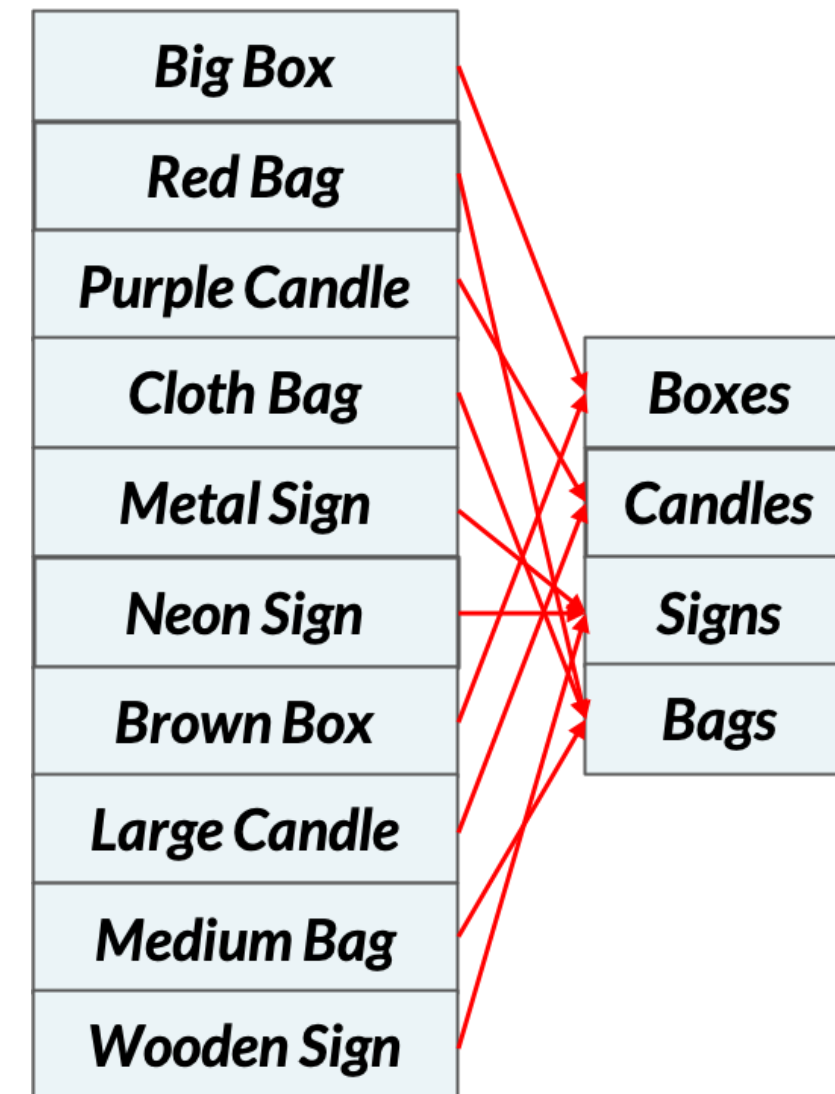
- Use if-then structure.
 - If A then B.
- Have antecedent(s) and consequent(s).
- Many association rules.

- **Metrics**

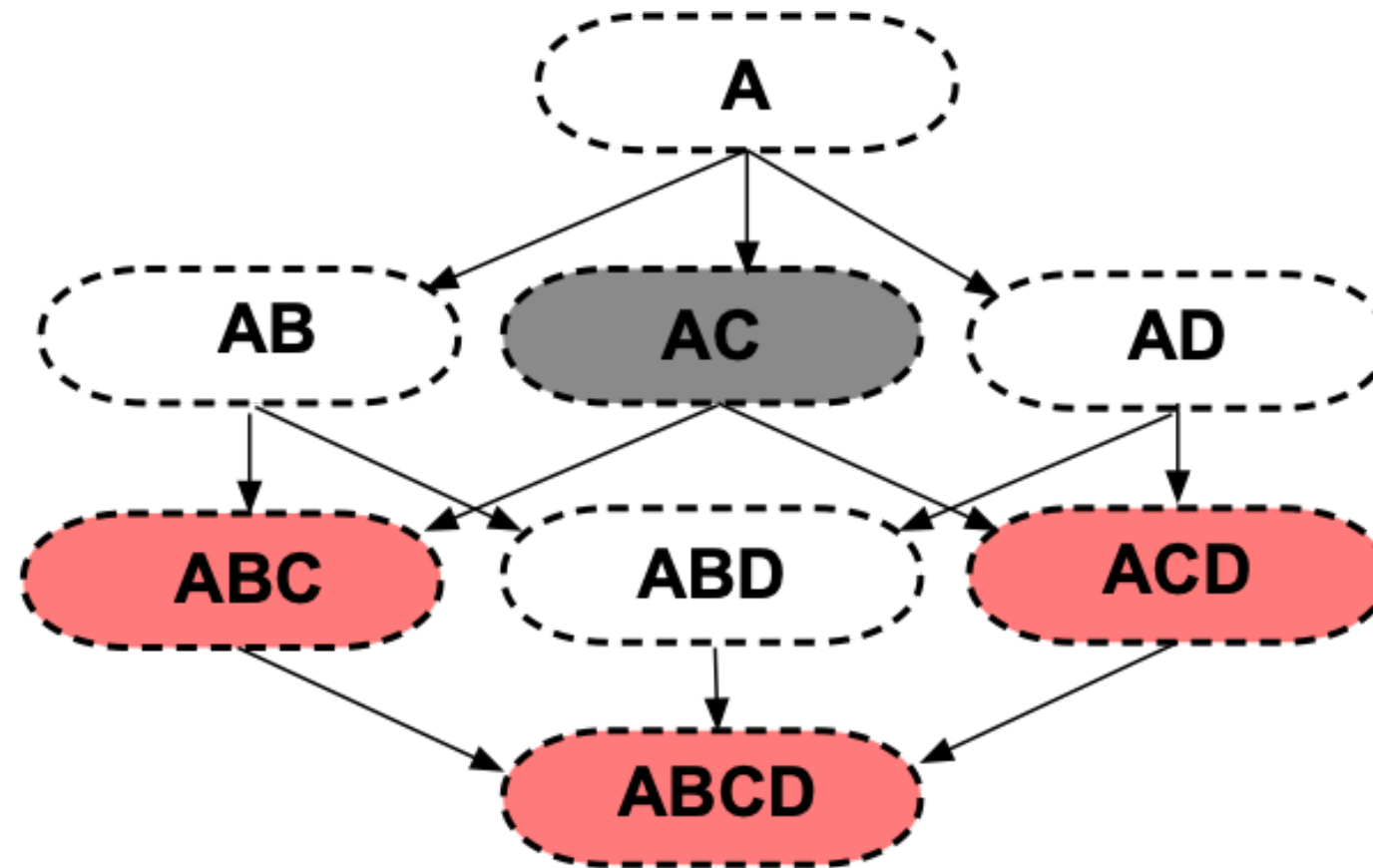
- Measure strength of association.
 - Support, lift, confidence, conviction
- Used to prune itemsets and rules.

Pruning and aggregation

Big Box
Red Bag
Purple Candle
Cloth Bag
Metal Sign
Neon Sign
Brown Box
Large Candle
Medium Bag
Wooden Sign

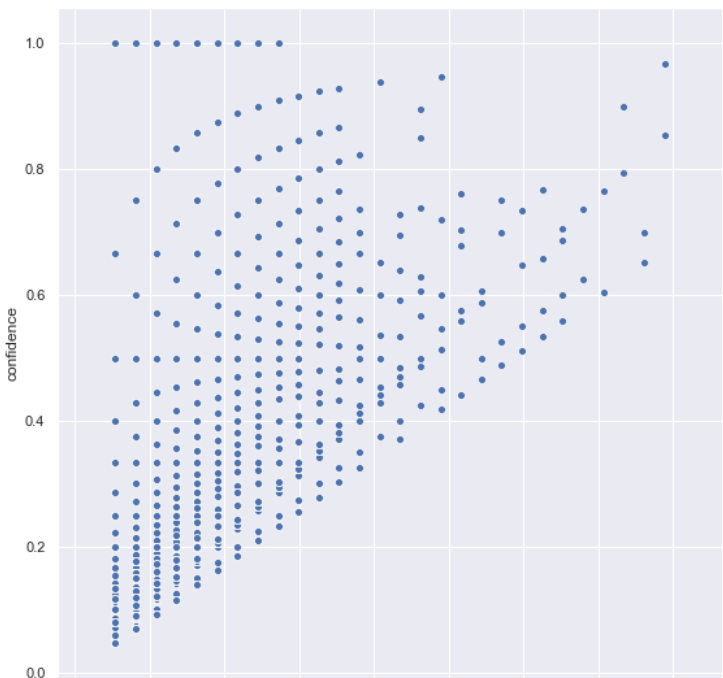
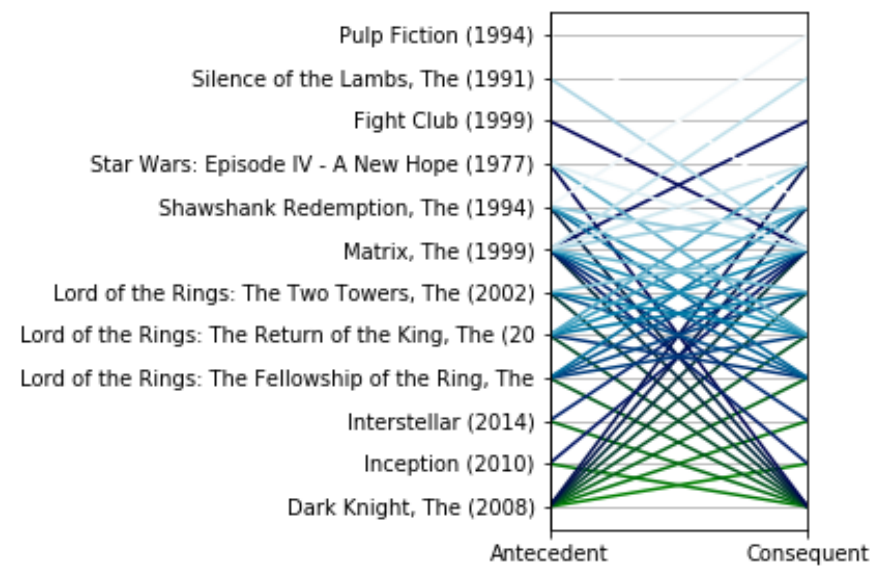
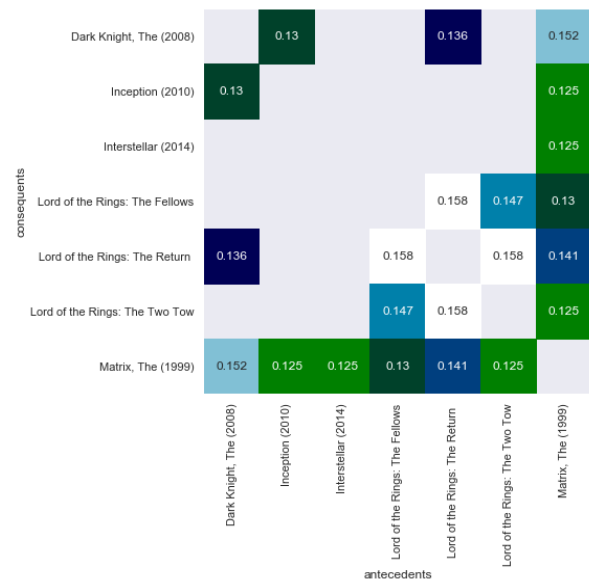


The Apriori algorithm



■ = not in frequent two-item sets
■ = eliminated by Apriori Principle

Visualizing rules



Congratulations!

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