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### Assignment No. 3

#### Title

Apply a-priori algorithm to find frequently occurring items from given data and generate strong association rules using support and confidence thresholds.

#### Objective:

1. Model associations between products by determining sets of items frequently purchased together and building association rules to derive recommendations.
2. Learn Market Basket Analysis using A-priori & FP growth Algorithm using Rapidminer

#### Problem Statement:

Demonstrate Market Basket Analysis using a-priori algorithm to find frequently occurring items from given data and generate strong association rules using support and confidence thresholds..

#### Outcomes:

1. Students will be able to demonstrate Market Basket Analysis using Rapidminer
2. Students will be able to demonstrate A-priori & FP Growth Algorithm to find Frequent item set.
3. Students will be able to generate strong association rules using support and confidence thresholds.

**Hardware Requirement:** Any CPU with Pentium Processor or similar, 256 MB RAM or more, 1 GB Hard Disk or more

**Software Requirements:** 32/64 bit Linux/Windows Operating System, latest Rapidminer Tool

#### Theory:

##### Association rule for mining:

- Proposed by R Agrawal and R Srikant in 1994.
- It is an important data mining model studied extensively by the database and data mining community.
- Assume all data are categorical.
- Initially used for Market Basket Analysis to find how items purchased by customers are related.

**The Apriori algorithm:**

- The best known algorithm
- Two steps:
  - Find all item sets that have minimum support (frequent item sets, also called large item sets).
  - It Create Association rule with support and Confidence.
  - E.g. if we buy tooth brush : it suggest Colgate and tongue cleaner
    - MILK > BREAD
    - MILK > EGGS
    - MILK > BREAD > EGGS

**Support :**

$$\text{Market Basket Optimisation: } \text{support}(I) = \frac{\# \text{ transactions containing } I}{\# \text{ transactions}}$$

$$\text{Movie Recommendation: } \text{support}(M) = \frac{\# \text{ user watchlists containing } M}{\# \text{ user watchlists}}$$

- **How many people have seen X-Machina**
  - A: 10 / 100
  - **Support = 10%**

**Confidence:**

$$\text{Market Basket Optimisation: } \text{confidence}(I_1 \rightarrow I_2) = \frac{\# \text{ transactions containing } I_1 \text{ and } I_2}{\# \text{ transactions containing } I_1}$$

$$\text{Movie Recommendation: } \text{confidence}(M_1 \rightarrow M_2) = \frac{\# \text{ user watchlists containing } M_1 \text{ and } M_2}{\# \text{ user watchlists containing } M_1}$$

- People who have Watched Interstellar, are likely to like Ex-Machina as well
  - A: 40 watched Interstellar
  - out of 40, only 7 watched Ex-Machina
  - **Confidence = 7 / 40 = 17.5%**

**Lift :**

Market Basket Optimisation: 
$$\text{lift}(\mathbf{I_1} \rightarrow \mathbf{I_2}) = \frac{\text{confidence}(\mathbf{I_1} \rightarrow \mathbf{I_2})}{\text{support}(\mathbf{I_2})}$$

Movie Recommendation: 
$$\text{lift}(\mathbf{M_1} \rightarrow \mathbf{M_2}) = \frac{\text{confidence}(\mathbf{M_1} \rightarrow \mathbf{M_2})}{\text{support}(\mathbf{M_2})}$$

- People who watched
  - Interstellar 40 / 100
  - Ex-Machina 07 / 40
  - What is the Likely hood if we recommend Ex-machina to person who has watched Interstellar?
- **LIFT = Confidence / Support**  
 = 17.5% / 10%  
 = 1.75

**Algorithm:**

1. Set a min support & confidence
2. Take all the Subsets in transactions
3. Take all the rules these subsets having higher confidence than minimum confidence
4. Sort the rules by decreasing lift

**Data Set**

T-Id	Item Set
T-1000	M,O,N,K,E,Y
T-1001	D,O,N,K,E,Y
T-1002	M,A,K,E
T-1003	M,U,C,K,Y
<b>T-1004</b>	<b>C,O,O,K,E</b>

**Table 1: Data Set**

**Given:** Minimum **Support** = 60%  
 Minimum **Confidence** = 80%

**Candidate Table C1:** Now find support count of each item set

Item Set	Support Count
M	3
O	4
N	2
E	4
Y	3
D	1
A	1
U	1
C	2
K	5

**Table 2 : Candidate Table C1**

- Now find out minimum Support
- $\text{Support} = 60/100 * 5$   
=3
- Where 5 is Number of entry
- Compare Min Support with each item set

**L1 Support Count**

Item Set	Support Count
M	3
O	4
K	5
E	4
Y	3

**Table 3: L1 Support Count****Candidate Table C2:**

Item Set	Support Count
MO	1
MK	3
ME	2
MY	2
OK	3

OE	3
OY	2
KE	4
KY	3
EY	2

**Table 4: Candidate Table C2**

- Now again Compare C2 with Min Support 3

**L2 Support Count**

Item Set	Support Count
MK	3
OK	3
OE	3
KE	4
KY	3

**Table 5: L2 Support Count**

- After satisfied minimum support criteria
- Make Pair to generate C3

### Candidate Table C3

Item Set	Support count
M,K,O	1
M,K,E	2
M,K,Y	2
O,K,E	3
O,K,Y	2

**Table 6: Candidate Table C3**

### Support Count

Now again compare the item set with min support 3

Item Set	Support Count
O,K,E	3

**Table 7: L3 Support Count**

**Now create** association rule with support and Confidence for {O,K,E}

- Confidence = Support/No. of time it Occurs

Association Rule	Support	Confidence	Confidence (%)
$O \wedge K \Rightarrow E$	3	$3/3 = 1$	$1*100=100$
$O \wedge E \Rightarrow K$	3	$3/3 = 1$	$1*100=100$
$K \wedge E \Rightarrow O$	3	$3/4 = 0.75$	$0.75*100=75$
$E \Rightarrow O \wedge K$	3	$3/4 = 0.75$	$0.75*100=75$
$K \Rightarrow O \wedge E$	3	$3/5 = 0.6$	$0.6*100=60$
$O \Rightarrow K \wedge E$	3	$3/4 = 0.75$	$0.75*100=75$

**Table 8: Association Rule**

- Compare this with Minimum Confidence=80%

Rule	Support	Confidence
$O \wedge K \Rightarrow E$	3	100
$O \wedge E \Rightarrow K$	3	100

**Table 9: Support and Confidence**

Hence final Association rule are

$\{O \wedge K \Rightarrow E\}$

$\{O \wedge E \Rightarrow K\}$

- From first observation we predict that if the customer buy item O and item K then defiantly he will by item E
- From Second observation we predict that the customer buy item O and item E then defiantly he will by item K

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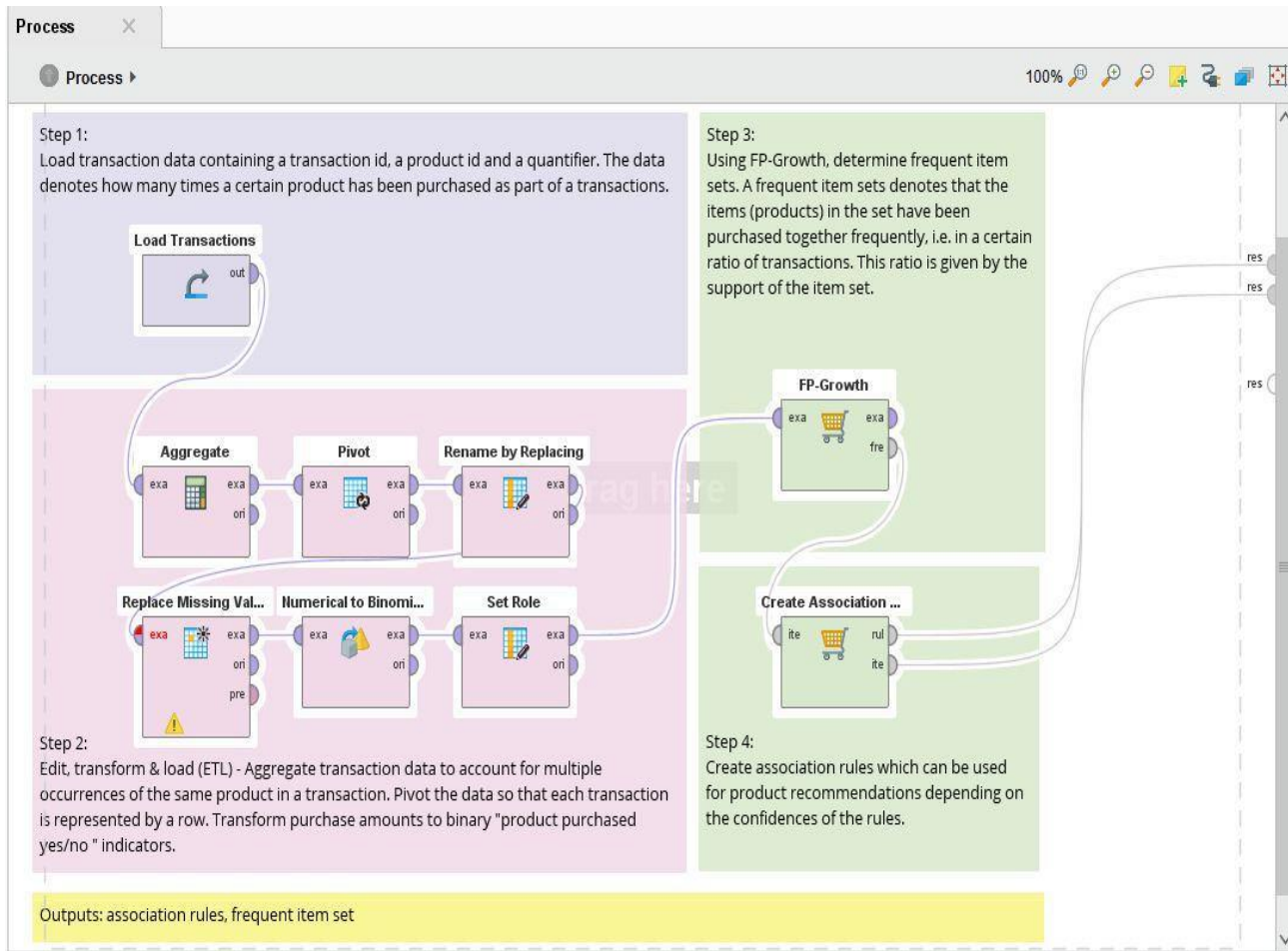
### Market Basket Analysis using Rapid Miner

Rapid Miner is a data science software platform developed by the company of the same name that provides an integrated environment for data preparation, machine learning, deep learning, text mining, and predictive analytics. It is used for business and commercial applications as well as for research, education, training, rapid prototyping, and application development and supports all steps of the machine learning process including data preparation, results visualization, model validation and optimization Rapid Miner is developed on an open core model. The Rapid Miner Studio Free Edition, which is limited to 1 logical processor and 10,000 data rows, is available under the AGPL license.

Commercial pricing starts at \$2,500 and is available from the developer.

### MARKET BASKET ANALYSIS

Model associations between products by determining sets of items frequently purchased together and building association rules to derive recommendations.



**Figure 1: MARKET BASKET ANALYSIS**

No. of Sets: 47	<b>Size</b>	<b>Support</b>	<b>Item 1</b>	<b>Item 2</b>	<b>Item 3 ↓</b>
Total Max. Size: 3	3	0.006	Product 12	Product 20	Product 27
Min. Size: 1	3	0.006	Product 11	Product 12	Product 20
Max. Size: 3	3	0.006	Product 11	Product 20	Product 19
Contains Item:	1	0.138	Product 11		
	1	0.136	Product 12		
	1	0.103	Product 20		
	1	0.079	Product 10		
	1	0.079	Product 18		
	1	0.079	Product 23		
	1	0.073	Product 15		
	1	0.071	Product 26		
	1	0.067	Product 13		
	1	0.059	Product 21		

**Figure 2: Frequent Item Sets (FP Growth)**

**Conclusion:** Thus we learn that to find frequently occurring items from given data and generate strong association rules using support and confidence thresholds using a-priori algorithm

### Assignment Questions?

1. Explain Association Rule?
2. Explain the term Support, Confidence, Lift?
3. What is the Application of A-Priori algorithm?
4. What is Market Basket Analysis? Explain with suitable example?



5. What is the difference between A-priori & FP growth Algorithm?

**References:-**

<https://docs.rapidminer.com/downloads/RapidMiner-v6-user-manual.pdf>  
<https://mitu.co.in>