Bharatiya Vidya Bhavan's
Sardar Patel Institute of Technology
Bhavan's Campus, Munshi Nagar, Andheri (West), Mumbai-400058-India
(Autonomous College Affiliated to University of Mumbai)
Academic SEM: VII **Year: 2022-23**

Experiment: Apriori Algorithm and Association rule mining with WEKA

Name:	Anushka Anil Pilena
UID:	2018110036
Class:	BE ETRX
Batch:	A
Subject:	Data Analytics Lab

Objective: Apply Apriori Algorithm to given dataset : Association Rule Mining with WEKA

System Requirements: Weka version 3.8.6

DataSet:
Groceries.csv

	A	B	C	D	E	F	G
1	Trans_id	exista	existb	existc	existd	existe	existk
2	T1	TRUE	TRUE	FALSE	TRUE	FALSE	TRUE
3	T2	TRUE	TRUE	TRUE	TRUE	TRUE	FALSE
4	T3	TRUE	TRUE	TRUE	FALSE	TRUE	FALSE
5	T4	TRUE	TRUE	FALSE	TRUE	FALSE	FALSE

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Results:

Exercise 1: The 'database' below has four transactions. What association rules can be found in this set, if the minimum support (i.e coverage) is 60% and the minimum confidence (i.e. accuracy) is 80% ?

Trans_id Itemlist
T1 {K, A, D, B}
T2 {D, A C, E, B}
T3 {C, A, B, E}
T4 {B, A, D}

Hint: Make a tabular and binary representation of the data in order to better see the relationship between Items. First generate all item sets with minimum support of 60%. Then form rules and calculate their confidence base on the conditional probability P(B|A) = |B∩A| / |A|. Remember to only take the item sets from the previous phase whose support is 60% or more.

→

Tabular Representation :

Trans id	A	B	C	D	E	K
T1	1	1	0	1	0	1
T2	1	1	1	1	1	0
T3	1	1	1	0	1	0
T4	1	1	0	1	0	0

Min Support = 0.6

Item	Frequency	Support
A	4	4/4 = 1
B	4	4/4 = 1
C	2	2/4 = 0.5
D	3	3/4 = 0.75
E	2	2/4 = 0.5
K	1	1/4 = 0.25

Considering item sets with Support ≥ 60%

A = 1 , B = 1 & D = 0.75

Considering 2 items at a time

Pair	Frequency	Support
AB	4	4/4 = 1
AD	3	3/4 = 0.75
BD	3	3/4 = 0.75

Considering 3 items at a time

ABD Freq:3 Support = 3/4 = 0.75

Forming rules & finding confidence

A → B	P(B/A) = 4/4 = 1
B → A	P(A/B) = 4/4 = 1
A → D	P(D/A) = 3/4 = 0.75
D → A	P(A/D) = 3/3 = 1
B → D	P(D/B) = 3/4 = 0.75
D → B	P(B/D) = 3/3 = 1.0
AB → D	P(D/AB) = 3/4 = 0.75
D → AB	P(AB/D) = 3/3 = 1
AD → B	P(B/AD) = 3/3 = 1
B → AD	P(AD/B) = 3/4 = 0.75
BD → A	P(A/BD) = 3/3 = 1
A → BD	P(BD/A) = 3/4 = 0.75

Considering Rules with Confidence ≥ 80%

A → B	100%
B → A	100%
D → A	100%
D → B	100%
D → AB	100%
AD → B	100%
DB → A	100%

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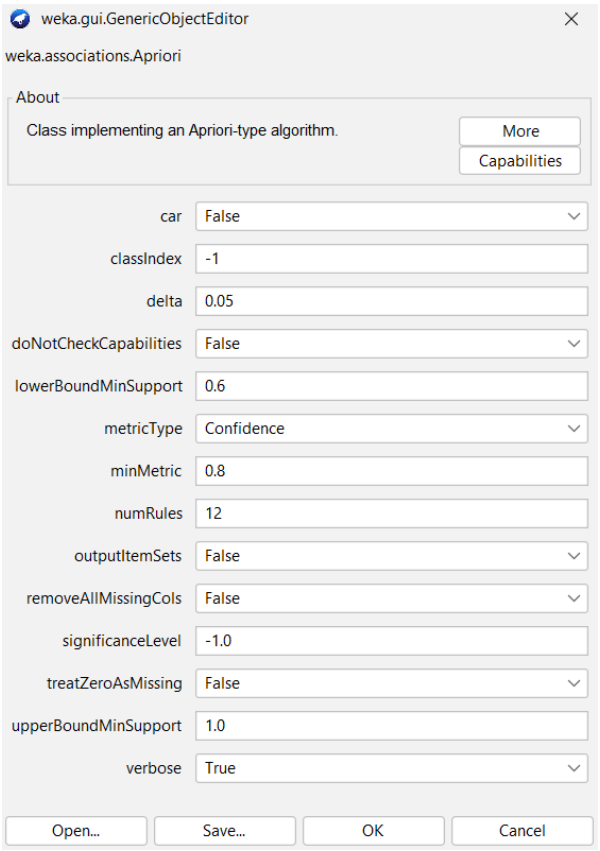
Exercise:2 Input file generation and Initial experiments with Weka's association rule discovery. 1. Launch Weka and try to do the calculations you performed manually in the previous exercise. Use the apriori algorithm for generating the association rules.

Did you succeed? Are the results the same as in your calculations?
→ Yes

What kind of file did you use as input?
→ CSV



Associator output

```
=== Run information ===

Scheme:       weka.associations.Apriori -N 12 -T 0 -C 0.8 -D 0.05 -U 1.0 -M 0.6 -S -1.0 -V -c -1
Relation:     data
Instances:    4
Attributes:   7
              Trans_id
              exista
              existb
              existc
              existd
              existe
              existk
=== Associator model (full training set) ===


Apriori
=======

Minimum support: 0.85 (3 instances)
Minimum metric <confidence>: 0.8
Number of cycles performed: 3

Generated sets of large itemsets:

Size of set of large itemsets L(1): 4

Size of set of large itemsets L(2): 5

Size of set of large itemsets L(3): 2

Best rules found:

 1. existb=TRUE 4 ==> exista=TRUE 4    <conf:(1)> lift:(1) lev:(0) [0] conv:(0)
 2. exista=TRUE 4 ==> existb=TRUE 4    <conf:(1)> lift:(1) lev:(0) [0] conv:(0)
 3. existd=TRUE 3 ==> exista=TRUE 3    <conf:(1)> lift:(1) lev:(0) [0] conv:(0)
 4. existk=FALSE 3 ==> exista=TRUE 3    <conf:(1)> lift:(1) lev:(0) [0] conv:(0)
 5. existd=TRUE 3 ==> existb=TRUE 3    <conf:(1)> lift:(1) lev:(0) [0] conv:(0)
 6. existk=FALSE 3 ==> existb=TRUE 3    <conf:(1)> lift:(1) lev:(0) [0] conv:(0)
 7. existb=TRUE existd=TRUE 3 ==> exista=TRUE 3    <conf:(1)> lift:(1) lev:(0) [0] conv:(0)
 8. exista=TRUE existd=TRUE 3 ==> existb=TRUE 3    <conf:(1)> lift:(1) lev:(0) [0] conv:(0)
 9. existd=TRUE 3 ==> exista=TRUE existb=TRUE 3    <conf:(1)> lift:(1) lev:(0) [0] conv:(0)
10. existb=TRUE existk=FALSE 3 ==> exista=TRUE 3    <conf:(1)> lift:(1) lev:(0) [0] conv:(0)
11. exista=TRUE existk=FALSE 3 ==> existb=TRUE 3    <conf:(1)> lift:(1) lev:(0) [0] conv:(0)
12. existk=FALSE 3 ==> exista=TRUE existb=TRUE 3    <conf:(1)> lift:(1) lev:(0) [0] conv:(0)
```

Exercise 3: Mining Association Rule with WEKA Explorer – Weather dataset

Task 1. Run Apriori on this data with default settings. Comment on the rules that are generated. Several of them are quite similar. How are their support and confidence values related?

Task 2. It is interesting to see that none of the rules in the default output involve Class = republican. Why do you think that is?

```
=== Run information ===

Scheme:       weka.associations.Apriori -N 10 -T 0 -C 0.8 -D 0.05 -U 1.0 -M 0.2 -S -1.0 -V -c -1
Relation:     weather.symbolic
Instances:    14
Attributes:   5
              outlook
              temperature
              humidity
              windy
              play
=== Associator model (full training set) ===


Apriori
=======

Minimum support: 0.25 (4 instances)
Minimum metric <confidence>: 0.8
Number of cycles performed: 15

Generated sets of large itemsets:

Size of set of large itemsets L(1): 12

Size of set of large itemsets L(2): 26

Size of set of large itemsets L(3): 4

Best rules found:

 1. outlook=overcast 4 ==> play=yes 4    <conf:(1)> lift:(1.56) lev:(0.1) [1] conv:(1.43)
 2. temperature=cool 4 ==> humidity=normal 4    <conf:(1)> lift:(2) lev:(0.14) [2] conv:(2)
 3. humidity=normal windy=FALSE 4 ==> play=yes 4    <conf:(1)> lift:(1.56) lev:(0.1) [1] conv:(1.43)
 4. outlook=sunny play=no 3 ==> humidity=high 3    <conf:(1)> lift:(2) lev:(0.11) [1] conv:(1.5)
 5. outlook=sunny humidity=high 3 ==> play=no 3    <conf:(1)> lift:(2.8) lev:(0.14) [1] conv:(1.93)
 6. outlook=rainy play=yes 3 ==> windy=FALSE 3    <conf:(1)> lift:(1.75) lev:(0.09) [1] conv:(1.29)
 7. outlook=rainy windy=FALSE 3 ==> play=yes 3    <conf:(1)> lift:(1.56) lev:(0.08) [1] conv:(1.07)
 8. temperature=cool play=yes 3 ==> humidity=normal 3    <conf:(1)> lift:(2) lev:(0.11) [1] conv:(1.5)
 9. humidity=normal 7 ==> play=yes 6    <conf:(0.86)> lift:(1.33) lev:(0.11) [1] conv:(1.25)
10. play=no 5 ==> humidity=high 4    <conf:(0.8)> lift:(1.6) lev:(0.11) [1] conv:(1.25)
```

```
=== Run information ===

Scheme:       weka.associations.Apriori -N 10 -T 0 -C 0.5 -D 0.05 -U 1.0 -M 0.2 -S -1.0 -V -c -1
Relation:     weather.symbolic
Instances:    14
Attributes:   5
              outlook
              temperature
              humidity
              windy
              play
=== Associator model (full training set) ===


Apriori
=======

Minimum support: 0.3 (4 instances)
Minimum metric <confidence>: 0.5
Number of cycles performed: 14

Generated sets of large itemsets:

Size of set of large itemsets L(1): 12

Size of set of large itemsets L(2): 9

Size of set of large itemsets L(3): 1

Best rules found:

 1. outlook=overcast 4 ==> play=yes 4    <conf:(1)> lift:(1.56) lev:(0.1) [1] conv:(1.43)
 2. temperature=cool 4 ==> humidity=normal 4    <conf:(1)> lift:(2) lev:(0.14) [2] conv:(2)
 3. humidity=normal windy=FALSE 4 ==> play=yes 4    <conf:(1)> lift:(1.56) lev:(0.1) [1] conv:(1.43)
 4. humidity=normal 7 ==> play=yes 6    <conf:(0.86)> lift:(1.33) lev:(0.11) [1] conv:(1.25)
 5. play=no 5 ==> humidity=high 4    <conf:(0.8)> lift:(1.6) lev:(0.11) [1] conv:(1.25)
 6. windy=FALSE 8 ==> play=yes 6    <conf:(0.75)> lift:(1.17) lev:(0.06) [0] conv:(0.95)
 7. play=yes 9 ==> humidity=normal 6    <conf:(0.67)> lift:(1.33) lev:(0.11) [1] conv:(1.13)
 8. play=yes 9 ==> windy=FALSE 6    <conf:(0.67)> lift:(1.17) lev:(0.06) [0] conv:(0.96)
 9. temperature=mild 6 ==> humidity=high 4    <conf:(0.67)> lift:(1.33) lev:(0.07) [1] conv:(1)
10. temperature=mild 6 ==> play=yes 4    <conf:(0.67)> lift:(1.04) lev:(0.01) [0] conv:(0.71)
```

Exercise 4: Mining Association Rule with WEKA Explorer – Vote

```
=== Run information ===

Scheme:       weka.associations.Apriori -N 10 -T 0 -C 0.9 -D 0.05 -U 1.0 -M 0.2 -S -1.0 -V -c -
Relation:     vote
Instances:    435
Attributes:   17
              handicapped-infants
              water-project-cost-sharing
              adoption-of-the-budget-resolution
              physician-fee-freeze
              el-salvador-aid
              religious-groups-in-schools
              anti-satellite-test-ban
              aid-to-nicaraguan-contras
              mx-missile
              immigration
              synfuels-corporation-cutback
              education-spending
              superfund-right-to-sue
              crime
              duty-free-exports
              export-administration-act-south-africa
              Class
=== Associator model (full training set) ===

Apriori
=======

Minimum support: 0.45 (196 instances)
Minimum metric <confidence>: 0.9
Number of cycles performed: 11

Generated sets of large itemsets:

Size of set of large itemsets L(1): 20

Size of set of large itemsets L(2): 17

Size of set of large itemsets L(3): 6

Size of set of large itemsets L(4): 1

Best rules found:

 1. adoption-of-the-budget-resolution=y physician-fee-freeze=n 219 ==> Class=democrat 219    <conf:(1)> lift:(1.63) lev:(0.19) [84] conv:(84.58)
 2. adoption-of-the-budget-resolution=y physician-fee-freeze=n aid-to-nicaraguan-contras=y 198 ==> Class=democrat 198    <conf:(1)> lift:(1.63) lev:(0.18) [76] conv:(76.47)
 3. physician-fee-freeze=n aid-to-nicaraguan-contras=y 211 ==> Class=democrat 210    <conf:(1)> lift:(1.62) lev:(0.19) [80] conv:(40.74)
 4. physician-fee-freeze=n education-spending=n 202 ==> Class=democrat 201    <conf:(1)> lift:(1.62) lev:(0.18) [77] conv:(39.01)
 5. physician-fee-freeze=n 247 ==> Class=democrat 245    <conf:(0.99)> lift:(1.62) lev:(0.21) [93] conv:(31.8)
 6. el-salvador-aid=n Class=democrat 200 ==> aid-to-nicaraguan-contras=y 197    <conf:(0.98)> lift:(1.77) lev:(0.2) [85] conv:(22.18)
 7. el-salvador-aid=n 208 ==> aid-to-nicaraguan-contras=y 204    <conf:(0.98)> lift:(1.76) lev:(0.2) [88] conv:(18.46)
 8. adoption-of-the-budget-resolution=y aid-to-nicaraguan-contras=y Class=democrat 203 ==> physician-fee-freeze=n 198    <conf:(0.98)> lift:(1.72) lev:(0.19) [82] conv:(14.62)
 9. el-salvador-aid=n aid-to-nicaraguan-contras=y 204 ==> Class=democrat 197    <conf:(0.97)> lift:(1.57) lev:(0.17) [71] conv:(9.85)
10. aid-to-nicaraguan-contras=y Class=democrat 218 ==> physician-fee-freeze=n 210    <conf:(0.96)> lift:(1.7) lev:(0.2) [86] conv:(10.47)
```

Task 1. Run Apriori on this data with default settings. Comment on the rules that are generated. Several of them are quite similar. How are their support and confidence values related?

→ According to the rules, it can be said that a person is a democrat with a confidence level of at least 90%. The person is a democrat most of the time. The class is Democratic when the budget resolution is adopted, doctor fees are frozen, and no education funding is done. When aid is provided to the Nicaraguan contras but not to El Salvador, the class is a democrat's. Given the following circumstances, the data indicates that the class will be a Democrat with a minimum 98% confidence.

Task 2. It is interesting to see that none of the rules in the default output involve Class = republican. Why do you think that is?

→ Apriori algorithm bases its rule-making on the frequency of each incident. 267 cases in the provided dataset belong to Democrats, whereas 168 instances belong to Republicans. The class is more likely to be predicted as a Democrat than a Republican due to the bias in the data and the higher frequency of Democrats.

Exercise 5: Let's run Apriori on another real-world dataset.
Load data at Preprocess tab. Click the Open file button to bring up a standard dialog through which you can select a file. Choose the supermarket.arff file. To see the original dataset, click the Edit button, a viewer window opens with dataset loaded.

```
=== Run information ===

Scheme:       weka.associations.Apriori -N 10 -T 0 -C 0.7 -D 0.05 -U 1.0 -M 0.2 -S -1.0 -c -1
Relation:     supermarket
Instances:    4627
Attributes:   217
              [list of attributes omitted]
=== Associator model (full training set) ===


Apriori
=======

Minimum support: 0.4 (1851 instances)
Minimum metric <confidence>: 0.7
Number of cycles performed: 12

Generated sets of large itemsets:

Size of set of large itemsets L(1): 18

Size of set of large itemsets L(2): 16

Best rules found:

 1. biscuits=t 2605 ==> bread and cake=t 2083    <conf:(0.8)> lift:(1.11) lev:(0.04) [208] conv:(1.4)
 2. milk-cream=t 2939 ==> bread and cake=t 2337    <conf:(0.8)> lift:(1.1) lev:(0.05) [221] conv:(1.37)
 3. fruit=t 2962 ==> bread and cake=t 2325    <conf:(0.78)> lift:(1.09) lev:(0.04) [193] conv:(1.3)
 4. baking needs=t 2795 ==> bread and cake=t 2191    <conf:(0.78)> lift:(1.09) lev:(0.04) [179] conv:(1.29)
 5. frozen foods=t 2717 ==> bread and cake=t 2129    <conf:(0.78)> lift:(1.09) lev:(0.04) [173] conv:(1.29)
 6. vegetables=t 2961 ==> bread and cake=t 2298    <conf:(0.78)> lift:(1.08) lev:(0.04) [167] conv:(1.25)
 7. juice-sat-cord-ms=t 2463 ==> bread and cake=t 1869    <conf:(0.76)> lift:(1.05) lev:(0.02) [96] conv:(1.16)
 8. vegetables=t 2961 ==> fruit=t 2207    <conf:(0.75)> lift:(1.16) lev:(0.07) [311] conv:(1.41)
 9. fruit=t 2962 ==> vegetables=t 2207    <conf:(0.75)> lift:(1.16) lev:(0.07) [311] conv:(1.41)
10. bread and cake=t 3330 ==> milk-cream=t 2337    <conf:(0.7)> lift:(1.1) lev:(0.05) [221] conv:(1.22)
```

Task 1. Experiment with Apriori and investigate the effect of the various parameters described before. Prepare a brief oral presentation on the main findings of your investigation.
→ The above analysis gives us the association how are things purchased in group and what are the likelihood that they appear in group

- We can say with 80% confidence that a person who bought biscuit will buy bread and cake
- We can say with 80% confidence that a person who bought milkcrean will buy bread and cake
  The reverse also happens but the confidence is 75%
- We can say with 78% confidence that a person who bought fruit will buy bread and cake
- We can say with 78% confidence that a person who bought bakingneeds will buy bread and cake
- We can say with 78% confidence that a person who bought frozenfoods will buy bread and cake
- We can say with 78% confidence that a person who bought vegetable will buy bread and cake
- We can say with 75% confidence that a person who bought fruit will buy vegetable

The above analysis gives us idea how likely a group is formed and those items can be grouped together in the mall

Conclusion:

- Weka is an effective tool for studying the apriori algorithm in practical contexts and using it to the user's advantage.
- Apriori algorithm considers an element's frequency and likelihood that it will occur while anticipating the rules.
- Each rule has a confidence level that indicates how confidently it can be expressed.
- Depending on the kind of data that needs to be forecasted, the values of confidence and minimum support vary.
- The frequency of the class value affects how a rule behaves.
- If the data are unbalanced, the algorithm may produce findings that are skewed or incorrect.