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EXPERIMENT 5

Aim: Apriori Algorithm and Association rule mining with WEKA

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

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% ?

Exp 5 (Aprori Algorithm)

Ex-1] (min_sup = 0.6, min_conf = 0.8)

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

Step 1

Item	Support count	Support
A	4	1
B	4	1
C	2	0.5
D	3	0.75
E	2	0.5
K	1	0.25

Frequent items = {A}, {B}, {D}

Step 2:

Itemset	Support
{A, B}	1
{A, D}	0.75
{B, D}	0.75

Frequent itemsets = {A, B}, {A, D}, {B, D}

Step 3:

Itemsets	Support
{A, B, D}	0.75

Frequent Itemset = {A, B, D}

Association rule	confidence
A → {B, D}	$\frac{3}{4}$ = 0.75

Frequent itemset calculated manually is {A,B,D} which means that support of {A,B,D} is more than threshold that is minimum support = 0.6

$B \rightarrow \{A, D\}$ 3/4 = 0.75

$D \rightarrow \{A, B\}$ 3/3 = 1

$\{A, B\} \rightarrow \{D\}$ 3/4 = 0.75

$\{A, D\} \rightarrow \{B\}$ 3/3 = 1

$\{B, D\} \rightarrow \{A\}$ 3/3 = 1

Hence association rules are

$\{D\} \rightarrow \{A, B\}$

$\{A, D\} \rightarrow \{B\}$

$\{B, D\} \rightarrow \{A\}$

Association rule generated manually are as shown above.These are considered because their confidence is more than threshold that is minimum confidence = 0.8

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.

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.

The file may be given to Weka in e.g. two different formats. They are called ARFF (attribute-relation file format) and CSV (comma separated values). Both are given below:

ARFF:

@relation exercise

@attribute exista {TRUE, FALSE}

… @data

TRUE,TRUE,FALSE,TRUE,FALSE,TRUE

…

… CSV:

exista,existb,existc,existd,existe,existk TRUE,TRUE,FALSE,TRUE,FALSE,TRUE

…

…

2. Once Data is loaded Click Associate Tab on top of the window.

3. Left click the field of Associator, choose Show Property from the drop down list. The property window of Apriori opens.

4. Weka runs an Apriori-type algorithm to find association rules, but this algorithm is not exact the same one as we discussed in class.

a. The min. support is not fixed. This algorithm starts with min. support as

upperBoundMinSupport (default 1.0 = 100%), iteratively decrease it by delta (default

0.05 = 5%). Note that upperBoundMinSupport is decreased by delta before the basic Apriori algorithm is run for the first time.

b. The algorithm stops when lowerBoundMinSupport (default 0.1 = 10%) is reached, or required number of rules – numRules (default value 10) have been generated.

c. c. Rules generated are ranked by metricType (default Confidence). Only rules with score higher than minMetric (default 0.9 for Confidence) are considered and delivered as the output.

d. If you choose to show the all frequent itemsets found, outputItemSets should be set as True.

5. Click Start button on the left of the window, the algorithm begins to run. The output is showing in the right window.

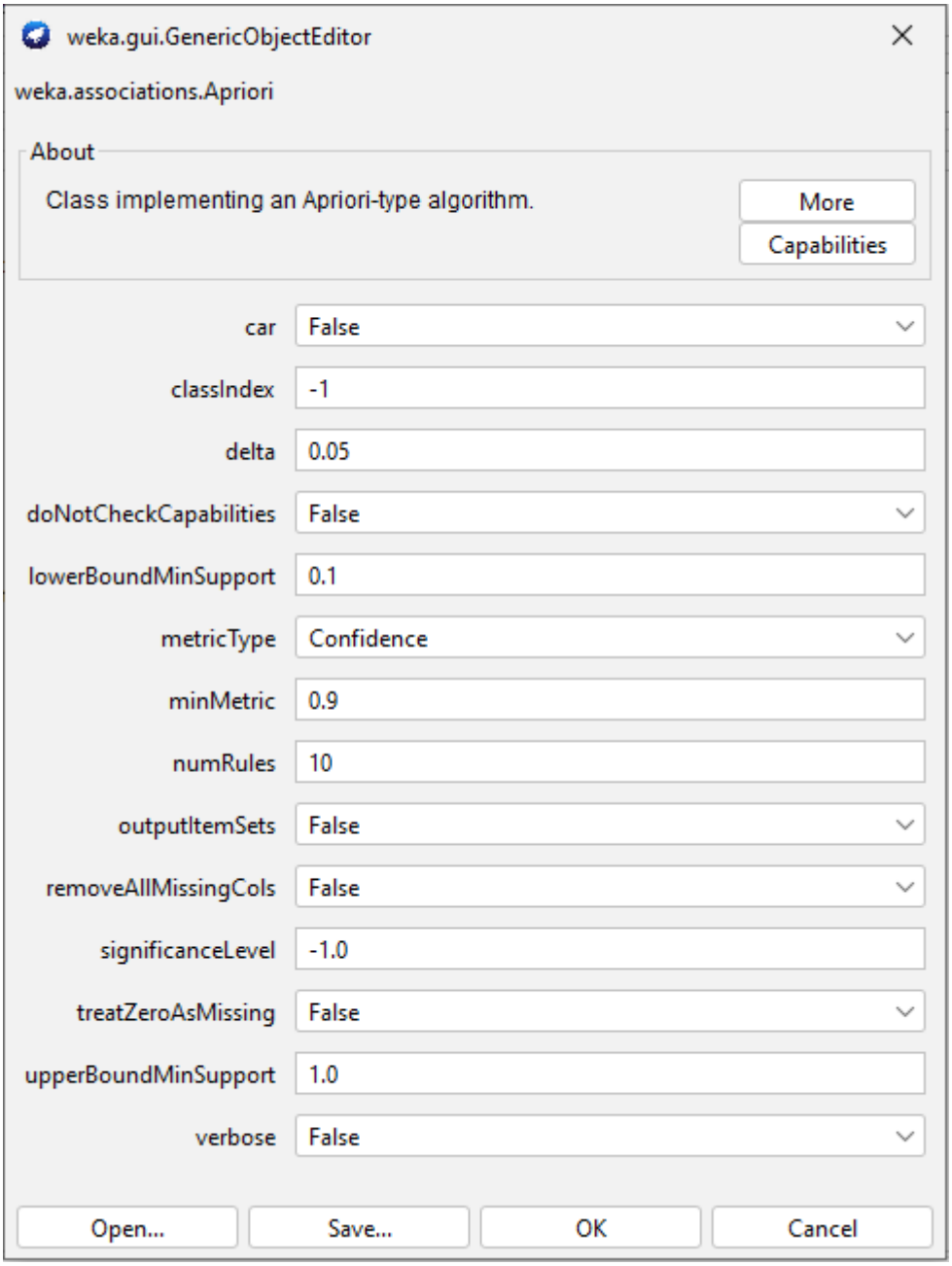
Did you succeed? Are the results the same as in your calculations? What kind of file did you use as input?

Associator output

```
=== Run information ===

Scheme:       weka.associations.Apriori -N 10 -T 0 -C 0.9 -D 0.05 -U 1.0 -M 0.1 -S -1.0 -c -1
Relation:     exercise
Instances:    4
Attributes:   6
              exista
              existb
              existc
              existd
              existe
              existk
=== Associator model (full training set) ===


Apriori
=======

Minimum support: 0.85 (3 instances)
Minimum metric <confidence>: 0.9
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:
```


Size of Large (Frequent) itemsets **containing 1 item** is 4 and it consists of {A},{B},{D},{K}.

```
=== Associator model (full training set) ===


Apriori
=======

Minimum support: 0.85 (3 instances)
Minimum metric <confidence>: 0.9
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)
```



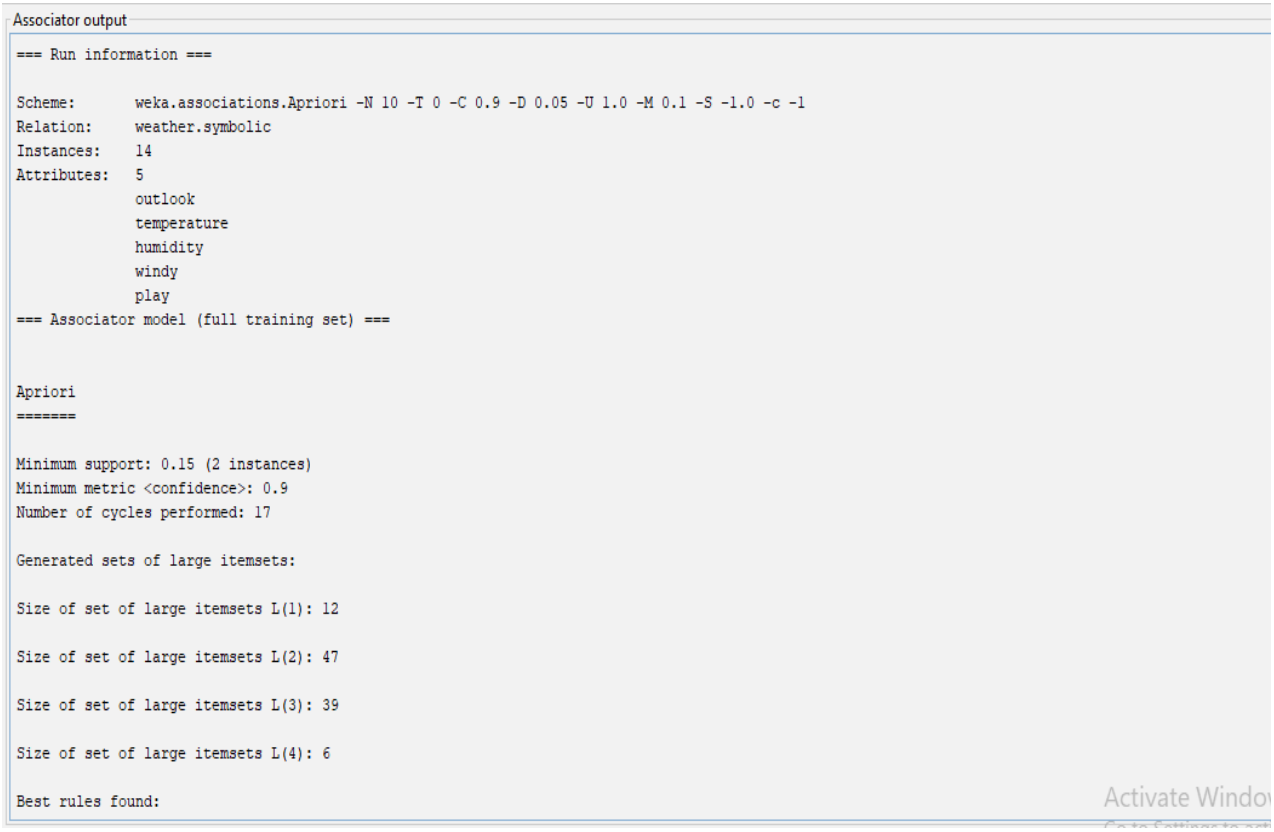
Exercise 3:

Mining Association Rule with WEKA Explorer – Weather dataset

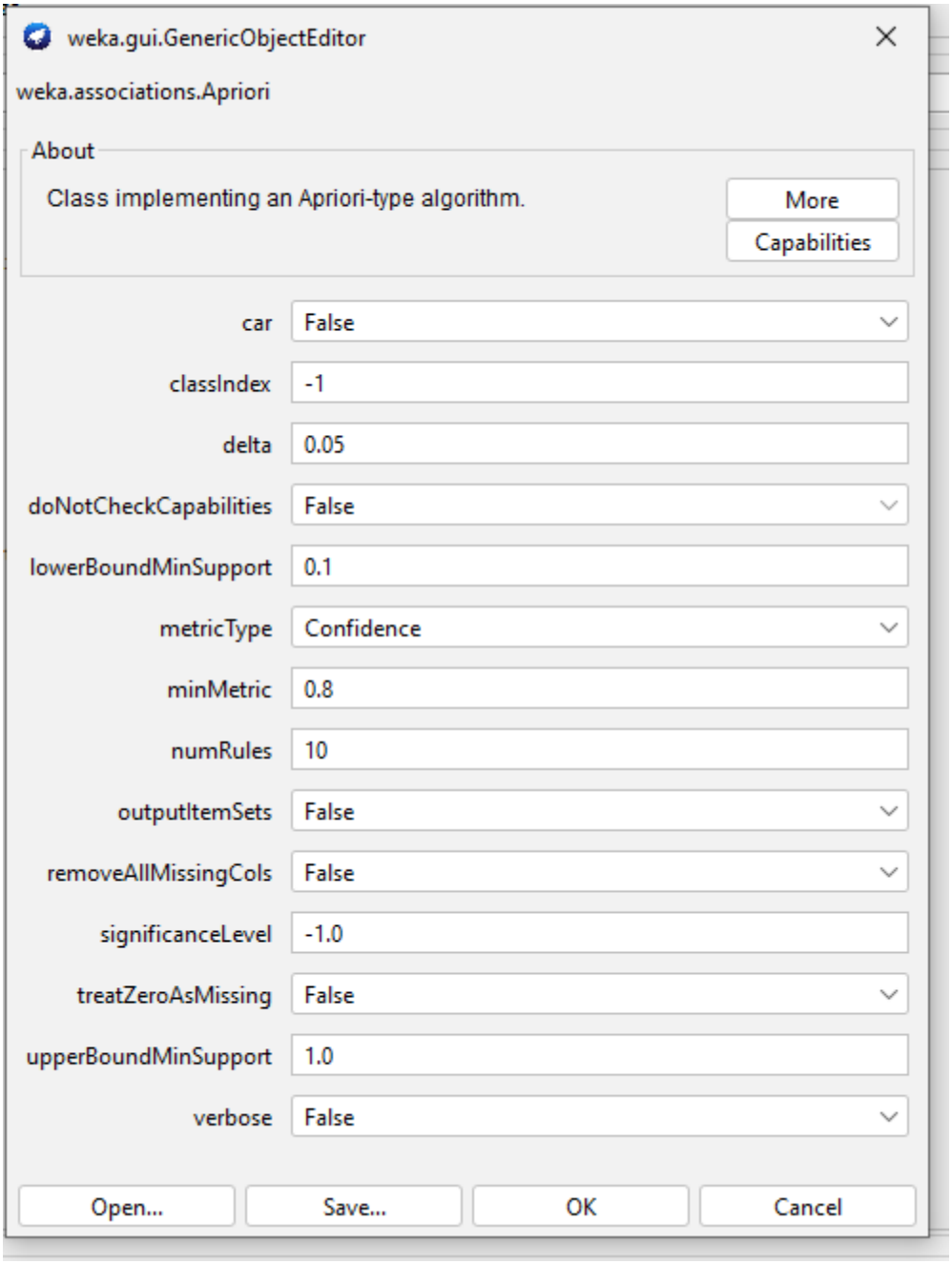
1. To get a feel for how to apply Apriori to prepared data set, start by mining association rules from the weather.nominal.arff data set of Lab One. Note that Apriori algorithm expects data that is purely nominal: If present, numeric attributes must be discretized first.

2. Like in the previous example choose Associate and Click Start button on the left of the window, the algorithm begins to run. The output is showing in the right window.

3. You could re-run Apriori algorithm by selecting different parameters, such as lowerBoundMinSupport, minMetric (min. confidence level), and different evaluation metric (confidence vs. lift), and so on.



```
Apriori
=======

Minimum support: 0.15 (2 instances)
Minimum metric <confidence>: 0.9
Number of cycles performed: 17

Generated sets of large itemsets:

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

Size of set of large itemsets L(2): 47

Size of set of large itemsets L(3): 39

Size of set of large itemsets L(4): 6

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. outlook=sunny temperature=hot 2 ==> humidity=high 2    <conf:(1)> lift:(2) lev:(0.07) [1] conv:(1)
10. temperature=hot play=no 2 ==> outlook=sunny 2    <conf:(1)> lift:(2.8) lev:(0.09) [1] conv:(1.29)
```


weka.gui.GenericObjectEditor
weka.associations.Apriori
About
Class implementing an Apriori-type algorithm.
More
Capabilities
car
False
classIndex
-1
delta
0.05
doNotCheckCapabilities
False
lowerBoundMinSupport
0.1
metricType
Confidence
minMetric
0.8
numRules
10
outputItemSets
False
removeAllMissingCols
False
significanceLevel
-1.0
treatZeroAsMissing
False
upperBoundMinSupport
1.0
verbose
False
Open...
Save...
OK
Cancel

```
=== Run information ===

Scheme:       weka.associations.Apriori -N 10 -T 0 -C 0.8 -D 0.05 -U 1.0 -M 0.1 -S -1.0 -c -1
Relation:     weather.symbolic
Instances:    14
Attributes:   5
              outlook
              temperature
              humidity
              windy
              play
=== Associator model (full training set) ===


Apriori
=======

Minimum support: 0.25 (3 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)
```



```
=== Associator model (full training set) ===


Apriori
=======

Minimum support: 0.25 (3 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)
```

Associator output

```
=== Run information ===

Scheme:       weka.associations.Apriori -N 10 -T 0 -C 0.8 -D 0.05 -U 1.0 -M 0.3 -S -1.0 -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>: 0.8
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)
```



```
              outlook
              temperature
              humidity
              windy
              play
=== Associator model (full training set) ===


Apriori
=======

Minimum support: 0.3 (4 instances)
Minimum metric <confidence>: 0.8
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)
```


Exercise 4:

Mining Association Rule with WEKA Explorer – Vote

Now consider a real-world dataset, vote.arff, which gives the votes of 435 U.S. congressmen on 16 key issues gathered in the mid-1980s, and also includes their party affiliation as a binary

attribute. Association-rule mining can also be applied to this data to seek interesting associations.

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 vote.arff file. To see the original dataset, click the Edit button, a viewer window opens with dataset loaded. This is a purely nominal dataset with some missing values (corresponding to abstentions).

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?

Associator output

```
=== Run information ===

Scheme:       weka.associations.Apriori -N 10 -T 0 -C 0.8 -D 0.05 -U 1.0 -M 0.3 -S -1.0 -c -1
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: 0.5 (217 instances)
Minimum metric <confidence>: 0.8
Number of cycles performed: 10
```

```
=== Associator model (full training set) ===


Apriori
=======

Minimum support: 0.5 (217 instances)
Minimum metric <confidence>: 0.8
Number of cycles performed: 10

Generated sets of large itemsets:

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

Size of set of large itemsets L(2): 4

Size of set of large itemsets L(3): 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. physician-fee-freeze=n 247 ==> Class=democrat 245    <conf:(0.99)> lift:(1.62) lev:(0.21) [93] conv:(31.8)
 3. adoption-of-the-budget-resolution=y Class=democrat 231 ==> physician-fee-freeze=n 219    <conf:(0.95)> lift:(1.67) lev:(0.2) [87] conv:(7.68)
 4. Class=democrat 267 ==> physician-fee-freeze=n 245    <conf:(0.92)> lift:(1.62) lev:(0.21) [93] conv:(5.02)
 5. adoption-of-the-budget-resolution=y 253 ==> Class=democrat 231    <conf:(0.91)> lift:(1.49) lev:(0.17) [75] conv:(4.25)
 6. aid-to-nicaraguan-contras=y 242 ==> Class=democrat 218    <conf:(0.9)> lift:(1.47) lev:(0.16) [69] conv:(3.74)
 7. physician-fee-freeze=n Class=democrat 245 ==> adoption-of-the-budget-resolution=y 219    <conf:(0.89)> lift:(1.54) lev:(0.18) [76] conv:(3.8)
 8. physician-fee-freeze=n 247 ==> adoption-of-the-budget-resolution=y 219    <conf:(0.89)> lift:(1.52) lev:(0.17) [75] conv:(3.56)
 9. physician-fee-freeze=n 247 ==> adoption-of-the-budget-resolution=y Class=democrat 219    <conf:(0.89)> lift:(1.67) lev:(0.2) [87] conv:(3.99)
10. adoption-of-the-budget-resolution=y 253 ==> physician-fee-freeze=n 219    <conf:(0.87)> lift:(1.52) lev:(0.17) [75] conv:(3.12)
```


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.

To do market basket analysis in Weka, each transaction is coded as an instance of which the attributes represent the items in the store. Each attribute has only one value: If a particular transaction does not contain it (i.e., the customer did not buy that item), this is coded as a missing value.

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.

Associator output

```
=== Run information ===

Scheme:       weka.associations.Apriori -N 10 -T 0 -C 0.8 -D 0.05 -U 1.0 -M 0.3 -S -1.0 -c -1
Relation:     supermarket
Instances:    4627
Attributes:   217
              [list of attributes omitted]
=== Associator model (full training set) ===


Apriori
=======

Minimum support: 0.3 (1388 instances)
Minimum metric <confidence>: 0.8
Number of cycles performed: 14

Generated sets of large itemsets:

Size of set of large itemsets L(1): 25

Size of set of large itemsets L(2): 69

Size of set of large itemsets L(3): 20

Best rules found:

 1. biscuits=t vegetables=t 1764 ==> bread and cake=t 1487    <conf:(0.84)> lift:(1.17) lev:(0.05) [217] conv:(1.78)
 2. total=high 1679 ==> bread and cake=t 1413    <conf:(0.84)> lift:(1.17) lev:(0.04) [204] conv:(1.76)
 3. biscuits=t milk-cream=t 1767 ==> bread and cake=t 1485    <conf:(0.84)> lift:(1.17) lev:(0.05) [213] conv:(1.75)
 4. biscuits=t fruit=t 1837 ==> bread and cake=t 1541    <conf:(0.84)> lift:(1.17) lev:(0.05) [218] conv:(1.73)
 5. biscuits=t frozen foods=t 1810 ==> bread and cake=t 1510    <conf:(0.83)> lift:(1.16) lev:(0.04) [207] conv:(1.69)
```


```
=== Associator model (full training set) ===


Apriori
=======

Minimum support: 0.3 (1388 instances)
Minimum metric <confidence>: 0.8
Number of cycles performed: 14

Generated sets of large itemsets:

Size of set of large itemsets L(1): 25

Size of set of large itemsets L(2): 69

Size of set of large itemsets L(3): 20

Best rules found:

 1. biscuits=t vegetables=t 1764 ==> bread and cake=t 1487    <conf:(0.84)> lift:(1.17) lev:(0.05) [217] conv:(1.78)
 2. total=high 1679 ==> bread and cake=t 1413    <conf:(0.84)> lift:(1.17) lev:(0.04) [204] conv:(1.76)
 3. biscuits=t milk-cream=t 1767 ==> bread and cake=t 1485    <conf:(0.84)> lift:(1.17) lev:(0.05) [213] conv:(1.75)
 4. biscuits=t fruit=t 1837 ==> bread and cake=t 1541    <conf:(0.84)> lift:(1.17) lev:(0.05) [218] conv:(1.73)
 5. biscuits=t frozen foods=t 1810 ==> bread and cake=t 1510    <conf:(0.83)> lift:(1.16) lev:(0.04) [207] conv:(1.69)
 6. frozen foods=t fruit=t 1861 ==> bread and cake=t 1548    <conf:(0.83)> lift:(1.16) lev:(0.05) [208] conv:(1.66)
 7. frozen foods=t milk-cream=t 1826 ==> bread and cake=t 1516    <conf:(0.83)> lift:(1.15) lev:(0.04) [201] conv:(1.65)
 8. baking needs=t milk-cream=t 1907 ==> bread and cake=t 1580    <conf:(0.83)> lift:(1.15) lev:(0.04) [207] conv:(1.63)
 9. milk-cream=t fruit=t 2038 ==> bread and cake=t 1684    <conf:(0.83)> lift:(1.15) lev:(0.05) [217] conv:(1.61)
10. baking needs=t biscuits=t 1764 ==> bread and cake=t 1456    <conf:(0.83)> lift:(1.15) lev:(0.04) [186] conv:(1.6)
```

Associator output

```
=== Run information ===

Scheme:       weka.associations.Apriori -N 10 -T 0 -C 0.8 -D 0.05 -U 1.0 -M 0.5 -S -1.0 -c -1
Relation:     supermarket
Instances:    4627
Attributes:   217
              [list of attributes omitted]
=== Associator model (full training set) ===


Apriori
=======

Minimum support: 0.5 (2314 instances)
Minimum metric <confidence>: 0.8
Number of cycles performed: 10

Generated sets of large itemsets:

Size of set of large itemsets L(1): 10

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

Best rules found:
```

Associator output

```
=== Run information ===

Scheme:       weka.associations.Apriori -N 10 -T 0 -C 0.8 -D 0.05 -U 1.0 -M 0.4 -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>: 0.8
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:
```

Associator output

```
=== Run information ===

Scheme:       weka.associations.Apriori -N 10 -T 0 -C 0.9 -D 0.05 -U 1.0 -M 0.3 -S -1.0 -c -1
Relation:     supermarket
Instances:    4627
Attributes:   217
              [list of attributes omitted]
=== Associator model (full training set) ===


Apriori
=======

Minimum support: 0.3 (1388 instances)
Minimum metric <confidence>: 0.9
Number of cycles performed: 14

Generated sets of large itemsets:

Size of set of large itemsets L(1): 25

Size of set of large itemsets L(2): 69

Size of set of large itemsets L(3): 20

Best rules found:
```

Conclusion:

Apriori algorithm uses a generate and test approach that is generates candidate itemsets and tests if they are frequent.It is breadth first search and terminates when no frequent or candidate set can be generated.We also observed that if an itemset is frequent then all of its subsets must also frequent.Here we performed Apriori algorithm on WEKA and observed that if we change parameters such as lower bound minimum support then large itemsets change.We also observed that sometimes no large itemsets is generated because lower bound minimum support was too high.