22 November 2021

INFO 4117 : Data Mining ou Fouille de données

Somaire I. Introduction Générale

Introduction Générale

Définition de Data Mining

Le **Data Mining** est le processus d'analyse massif de données et du big data sous différents angles afin d'identifier des relations entre les données et de les transformer en informations exploitable.

Méthodes de Data Mining

Ceci étant dit nous nous démandrons forcement quelles sont ses méthodes qui permettent d'identifier des relations. Nous verons dans la suite les méthodes suivantes:

- **Règles d'associations**
- **Classification supervisée**
- **Classification non-supervisée**
- **Regression Lineaire.**

Données manipulées par le Data Mining

Aussi nous avons parlé de données, quelles sortes de données pouvons nous manipuler:

- *Base de données relationnelle*
- *Base de données unifiées (Data warehouse)*
- *Données structurées (spatiales, graphes, text, web, . . .)*
- *Base de données Objet-relationnel*
- *Base de données temporelle, sequentielles, Transactionnelles, . . .*
- *multimedia*

Sorties du Data Mining

Nous parlons de Data Mining, mais quelles sont les sorties attendu de celui?

descriptive Data Mining ou fouille descriptive: qui est une technique de fouille de données qui permet de regrouper les données en entrées sous la forme (X) tel que ses sous groupes possèdent des attributs identiques en terme de valeur.

- Résumé de données, cas extrême, évolution des donnés
- Motifs fréquents, associations et corrélations
- Partition des données

predictive Data Mining ou fouille prédictive: qui est une technique de fouille de données qui permet de partir de données existantes afin de construire un modèle sous la forme (X,Y) pour permettre la représentation des classes.

- Classification : caractérisation ou discrimination
- Régression : valeur prédite continue.

Data Mining Versus Statistique Descriptive

- Je pense qu'il est temps de faire un tout petit éclaircisement, de plus en plus, il y'a confusion entre statistique descriptive et data mining. La différence de base est:

- ☒ **la statistique descriptive** fait de l'analyse dite confirmatoire, c'est-à-dire qui réalise des analyses pas très complexe. Supposons le problème de profiles clientèle dans le markeing ciblé, l'analyse descriptive face à ce problème cherchera à le transformer en problème à valeurs d'opposition type "jeunes/sénior","citadins/ruraux", ... Ce qui n'est pas une solution optimale au problème.
- ☒ **le data mining** fait à son tour une analyse dite exploratoire donc la complexité est plus élévée difficile à resoudre au hazard.

Data Mining - Etapes de mise en place

$$\textbf{DataMining}(\textbf{Probleme}) = \begin{bmatrix} BusinessUnderstanding \\ \vdots \\ DataUnderstanding \\ \vdots \\ Pretreatment \\ \vdots \\ Modeling \\ \vdots \\ Evaluation \\ \vdots \\ Deployment \end{bmatrix}$$

Schéma Décrivant les étapes de la fouille de données en entreprise

$$\textbf{DataMining}(\textbf{Probleme}) = \begin{bmatrix} Fouille - Proprement - dite(Application - des - algorithmes - de - fouille) \\ \vdots \\ Evaluation(Mésure - de - l'intérêt - des - connaissances - extraites) \\ \vdots \\ Représentation - des - connaissances(visualisation - et - représentation) \end{bmatrix}$$

- **Business understanding (comprehension du domaine)**: c'est une phase pendant laquelle l'expert du domaine sera explorer le domaine pour déceller tous les secret.
- **Data understanding**: c'est également une phase pendant laquelle l'expert du domaine devra recenser les données du système et leur importance.
- **Pretreatment**: c'est la phase du DM(Data Mining) où démarre le travail de l'informaticien. Après avoir l'echangé avec l'expert du domaine, le groupe de data mining va devoir appliquer certains traitement sur le jeu de données porté à projet. Par prétraitement, nous entendons ***transformation de données(discrétisation de certains attributs), nettoyage de données(suppression de bruits, données inconsistantes), intégration de données(combinaision de plusieur sources),selection de données(pertinentes)***
- **Modéling**: il s'ajout d'un prétraitement qui a pour but de rendre le jeu données compatible à l'algorithme à utiliser.
- **Evalutaion**: il s'agit ici de déterminer à partir de la sortie de(s) algorithme(s) de utilisé si la connaissance extraite est pertinente.
- **Deployment**: Il s'agit ici, de présenter le resultat de travail de fouille de données au près du client sous une forme visuelle et exploitable par lui.

Nous allons ainsi donc nous appésentir sur les opérations de prétraitement qui sont d'une importance majeur dans tout le processus.

Pourquoi le prétraitement de données???

- Les données réelles tendent à être incomplètes, bruitées ou inconsistantes. Le prétraitement propose des méthodes pour résoudre ses erreurs.
- Opérations:
  - Nettoyage de données
  - Intégration de données
  - Sélection de données
  - transformation de données

Nettoyage de données???

- Le **But** du nettoyage de données est de traiter les données manquantes et supprimer les bruits.
- Une **Donnée manquante** est l'absence de valeur (donnée) pour un attribut décrivant l'objet.
- **Bruit** erreur aléatoire introduite dans la mesure d'une donnée.

```
# arules packages loading
library('arules')
```

```
## Loading required package: Matrix
```

```
##
## Attaching package: 'arules'
```

```
## The following objects are masked from 'package:base':
##
##     abbreviate, write
```

```
# load iris data
data('iris')

# create our own iris data
iris_vn <- iris
## resume
summary(iris_vn)
```

```
##   Sepal.Length    Sepal.Width     Petal.Length    Petal.Width
##  Min.   :4.300   Min.   :2.000   Min.   :1.000   Min.   :0.100
##  1st Qu.:5.100   1st Qu.:2.800   1st Qu.:1.600   1st Qu.:0.300
##  Median :5.800   Median :3.000   Median :4.350   Median :1.300
##  Mean   :5.843   Mean   :3.057   Mean   :3.758   Mean   :1.199
##  3rd Qu.:6.400   3rd Qu.:3.300   3rd Qu.:5.100   3rd Qu.:1.800
##  Max.   :7.900   Max.   :4.400   Max.   :6.900   Max.   :2.500
##        Species
##  setosa    :50
##  versicolor:50
##  virginica :50
##
##
##
```

```
# create a transaction
## from matrix
#a_matrix <- Matrix(c(1,1,1,0,0,1,1,0,0,0,1,1,0,1,0,0,0,1,0,1,1,1,0,1,1), ncol=5)
#trans1a <- as(a_matrix, "transaction")

#trans1 <- transactions(a_list)


## from data frame
```

```r
a_df <- data.frame(
  age=as.factor(c(6,8,7,6,9,5)),
  grade=as.factor(c(1,3,1,1,4,1))
)
```

Discretisation

C'est le fait de quitter d'une variable à valeurs réelles (infini) vers des variables à valeurs entiers (fini). _Comme exemple de discrétisation nous avons :

la Binarisation : qui est une méthode communement utilisée en datamining pendant le pré-traitement de données.

```r
# discretize iris_vn
iris_vn1 <- iris_vn
iris_vn1[,4] <- discretize(iris_vn1[,4], breaks=3, quantile=FALSE, labels=c("short","medium","long"))
iris_vn1[,3] <- discretize(iris_vn1[,3], breaks=3, quantile=FALSE, labels=c("short","medium","long"))
iris_vn1[,2] <- discretize(iris_vn1[,2], breaks=3, quantile=FALSE, labels=c("short","medium","long"))
iris_vn1[,1] <- discretize(iris_vn1[,1], breaks=3, quantile=FALSE, labels=c("short","medium","long"))
trans <- transactions(iris_vn1)
```

Règles d'association

```r
# rules in iris_vn trans
rules <- apriori(trans,parameter = list(supp = 0.1, conf = 0.7, target = "rules"))
```

```
## Apriori
##
## Parameter specification:
##  confidence minval smax arem  aval originalSupport maxtime support minlen
##         0.7    0.1    1 none FALSE            TRUE       5     0.1      1
##  maxlen target  ext
##      10  rules TRUE
##
## Algorithmic control:
##  filter tree heap memopt load sort verbose
##     0.1 TRUE TRUE  FALSE TRUE    2    TRUE
##
## Absolute minimum support count: 15
##
## set item appearances ...[0 item(s)] done [0.00s].
## set transactions ...[15 item(s), 150 transaction(s)] done [0.00s].
## sorting and recoding items ... [15 item(s)] done [0.00s].
## creating transaction tree ... done [0.00s].
## checking subsets of size 1 2 3 4 5 done [0.00s].
## writing ... [177 rule(s)] done [0.00s].
## creating S4 object  ... done [0.00s].
```

```r
inspect(rules)
```

```
##       lhs                       rhs                       support confidence  coverage     lift count
## [1]   {Sepal.Length=short}  => {Petal.Length=short}  0.2666667  0.8695652 0.3066667 2.608696    40
```

```
## [2]   {Petal.Length=short}  => {Sepal.Length=short}  0.2666667  0.8000000 0.3333333 2.608696    40
## [3]   {Sepal.Length=short}  => {Petal.Width=short}   0.2666667  0.8695652 0.3066667 2.608696    40
## [4]   {Petal.Width=short}   => {Sepal.Length=short}  0.2666667  0.8000000 0.3333333 2.608696    40
## [5]   {Sepal.Length=short}  => {Species=setosa}      0.2666667  0.8695652 0.3066667 2.608696    40
## [6]   {Species=setosa}      => {Sepal.Length=short}  0.2666667  0.8000000 0.3333333 2.608696    40
## [7]   {Petal.Width=medium}  => {Petal.Length=medium} 0.2866667  0.8958333 0.3200000 2.742347    43
## [8]   {Petal.Length=medium} => {Petal.Width=medium}  0.2866667  0.8775510 0.3266667 2.742347    43
## [9]   {Petal.Width=medium}  => {Species=versicolor}  0.3000000  0.9375000 0.3200000 2.812500    45
## [10]  {Species=versicolor}  => {Petal.Width=medium}  0.3000000  0.9000000 0.3333333 2.812500    45
## [11]  {Petal.Length=medium} => {Species=versicolor}  0.3066667  0.9387755 0.3266667 2.816327    46
## [12]  {Species=versicolor}  => {Petal.Length=medium} 0.3066667  0.9200000 0.3333333 2.816327    46
## [13]  {Petal.Length=short}  => {Petal.Width=short}   0.3333333  1.0000000 0.3333333 3.000000    50
## [14]  {Petal.Width=short}   => {Petal.Length=short}  0.3333333  1.0000000 0.3333333 3.000000    50
## [15]  {Petal.Length=short}  => {Species=setosa}      0.3333333  1.0000000 0.3333333 3.000000    50
## [16]  {Species=setosa}      => {Petal.Length=short}  0.3333333  1.0000000 0.3333333 3.000000    50
## [17]  {Petal.Length=short}  => {Sepal.Width=long}    0.2533333  0.7600000 0.3333333 2.035714    38
## [18]  {Petal.Width=short}   => {Species=setosa}      0.3333333  1.0000000 0.3333333 3.000000    50
## [19]  {Species=setosa}      => {Petal.Width=short}   0.3333333  1.0000000 0.3333333 3.000000    50
## [20]  {Petal.Width=short}   => {Sepal.Width=long}    0.2533333  0.7600000 0.3333333 2.035714    38
## [21]  {Species=setosa}      => {Sepal.Width=long}    0.2533333  0.7600000 0.3333333 2.035714    38
## [22]  {Species=virginica}   => {Sepal.Length=long}   0.2466667  0.7400000 0.3333333 2.176471    37
## [23]  {Sepal.Length=long}   => {Species=virginica}   0.2466667  0.7254902 0.3400000 2.176471    37
## [24]  {Species=virginica}   => {Petal.Length=long}   0.3133333  0.9400000 0.3333333 2.764706    47
## [25]  {Petal.Length=long}   => {Species=virginica}   0.3133333  0.9215686 0.3400000 2.764706    47
## [26]  {Species=virginica}   => {Petal.Width=long}    0.3133333  0.9400000 0.3333333 2.711538    47
## [27]  {Petal.Width=long}    => {Species=virginica}   0.3133333  0.9038462 0.3466667 2.711538    47
## [28]  {Sepal.Length=long}   => {Petal.Length=long}   0.2666667  0.7843137 0.3400000 2.306805    40
## [29]  {Petal.Length=long}   => {Sepal.Length=long}   0.2666667  0.7843137 0.3400000 2.306805    40
## [30]  {Sepal.Length=long}   => {Petal.Width=long}    0.2533333  0.7450980 0.3400000 2.149321    38
## [31]  {Petal.Width=long}    => {Sepal.Length=long}   0.2533333  0.7307692 0.3466667 2.149321    38
## [32]  {Petal.Length=long}   => {Petal.Width=long}    0.3066667  0.9019608 0.3400000 2.601810    46
## [33]  {Petal.Width=long}    => {Petal.Length=long}   0.3066667  0.8846154 0.3466667 2.601810    46
## [34]  {Sepal.Length=short,
##        Petal.Length=short}  => {Petal.Width=short}   0.2666667  1.0000000 0.2666667 3.000000    40
## [35]  {Sepal.Length=short,
##        Petal.Width=short}   => {Petal.Length=short}  0.2666667  1.0000000 0.2666667 3.000000    40
## [36]  {Petal.Length=short,
##        Petal.Width=short}   => {Sepal.Length=short}  0.2666667  0.8000000 0.3333333 2.608696    40
## [37]  {Sepal.Length=short,
##        Petal.Length=short}  => {Species=setosa}      0.2666667  1.0000000 0.2666667 3.000000    40
## [38]  {Sepal.Length=short,
##        Species=setosa}      => {Petal.Length=short}  0.2666667  1.0000000 0.2666667 3.000000    40
## [39]  {Petal.Length=short,
##        Species=setosa}      => {Sepal.Length=short}  0.2666667  0.8000000 0.3333333 2.608696    40
## [40]  {Sepal.Length=short,
##        Petal.Length=short}  => {Sepal.Width=long}    0.1866667  0.7000000 0.2666667 1.875000    28
## [41]  {Sepal.Length=short,
##        Sepal.Width=long}    => {Petal.Length=short}  0.1866667  1.0000000 0.1866667 3.000000    28
## [42]  {Sepal.Width=long,
##        Petal.Length=short}  => {Sepal.Length=short}  0.1866667  0.7368421 0.2533333 2.402746    28
## [43]  {Sepal.Length=short,
##        Petal.Width=short}   => {Species=setosa}      0.2666667  1.0000000 0.2666667 3.000000    40
## [44]  {Sepal.Length=short,
##        Species=setosa}      => {Petal.Width=short}   0.2666667  1.0000000 0.2666667 3.000000    40
```

```
## [45]  {Petal.Width=short,
##        Species=setosa}      => {Sepal.Length=short}  0.2666667  0.8000000 0.3333333 2.608696    40
## [46]  {Sepal.Length=short,
##        Petal.Width=short}   => {Sepal.Width=long}    0.1866667  0.7000000 0.2666667 1.875000    28
## [47]  {Sepal.Length=short,
##        Sepal.Width=long}    => {Petal.Width=short}   0.1866667  1.0000000 0.1866667 3.000000    28
## [48]  {Sepal.Width=long,
##        Petal.Width=short}   => {Sepal.Length=short}  0.1866667  0.7368421 0.2533333 2.402746    28
## [49]  {Sepal.Length=short,
##        Species=setosa}      => {Sepal.Width=long}    0.1866667  0.7000000 0.2666667 1.875000    28
## [50]  {Sepal.Length=short,
##        Sepal.Width=long}    => {Species=setosa}      0.1866667  1.0000000 0.1866667 3.000000    28
## [51]  {Sepal.Width=long,
##        Species=setosa}      => {Sepal.Length=short}  0.1866667  0.7368421 0.2533333 2.402746    28
## [52]  {Sepal.Width=medium,
##        Petal.Width=medium}  => {Petal.Length=medium} 0.1066667  0.9411765 0.1133333 2.881152    16
## [53]  {Sepal.Width=medium,
##        Petal.Length=medium} => {Petal.Width=medium}  0.1066667  0.9411765 0.1133333 2.941176    16
## [54]  {Sepal.Width=medium,
##        Petal.Width=medium}  => {Species=versicolor}  0.1133333  1.0000000 0.1133333 3.000000    17
## [55]  {Sepal.Width=medium,
##        Species=versicolor}  => {Petal.Width=medium}  0.1133333  0.9444444 0.1200000 2.951389    17
## [56]  {Sepal.Width=medium,
##        Petal.Length=medium} => {Species=versicolor}  0.1066667  0.9411765 0.1133333 2.823529    16
## [57]  {Sepal.Width=medium,
##        Species=versicolor}  => {Petal.Length=medium} 0.1066667  0.8888889 0.1200000 2.721088    16
## [58]  {Sepal.Width=medium,
##        Species=virginica}   => {Sepal.Length=long}   0.1000000  0.8333333 0.1200000 2.450980    15
## [59]  {Sepal.Width=medium,
##        Species=virginica}   => {Petal.Length=long}   0.1133333  0.9444444 0.1200000 2.777778    17
## [60]  {Sepal.Width=medium,
##        Petal.Length=long}   => {Species=virginica}   0.1133333  0.8947368 0.1266667 2.684211    17
## [61]  {Sepal.Width=medium,
##        Species=virginica}   => {Petal.Width=long}    0.1200000  1.0000000 0.1200000 2.884615    18
## [62]  {Sepal.Width=medium,
##        Petal.Width=long}    => {Species=virginica}   0.1200000  0.9473684 0.1266667 2.842105    18
## [63]  {Sepal.Length=long,
##        Sepal.Width=medium}  => {Petal.Length=long}   0.1133333  0.7727273 0.1466667 2.272727    17
## [64]  {Sepal.Width=medium,
##        Petal.Length=long}   => {Sepal.Length=long}   0.1133333  0.8947368 0.1266667 2.631579    17
## [65]  {Sepal.Length=long,
##        Sepal.Width=medium}  => {Petal.Width=long}    0.1066667  0.7272727 0.1466667 2.097902    16
## [66]  {Sepal.Width=medium,
##        Petal.Width=long}    => {Sepal.Length=long}   0.1066667  0.8421053 0.1266667 2.476780    16
## [67]  {Sepal.Width=medium,
##        Petal.Length=long}   => {Petal.Width=long}    0.1200000  0.9473684 0.1266667 2.732794    18
## [68]  {Sepal.Width=medium,
##        Petal.Width=long}    => {Petal.Length=long}   0.1200000  0.9473684 0.1266667 2.786378    18
## [69]  {Sepal.Width=short,
##        Petal.Width=medium}  => {Petal.Length=medium} 0.1666667  0.8620690 0.1933333 2.638987    25
## [70]  {Sepal.Width=short,
##        Petal.Length=medium} => {Petal.Width=medium}  0.1666667  0.9259259 0.1800000 2.893519    25
## [71]  {Sepal.Width=short,
##        Petal.Width=medium}  => {Species=versicolor}  0.1733333  0.8965517 0.1933333 2.689655    26
```

```
## [72]  {Sepal.Width=short,
##        Species=versicolor}  => {Petal.Width=medium}  0.1733333  0.9629630 0.1800000 3.009259    26
## [73]  {Sepal.Length=medium,
##        Sepal.Width=short}   => {Petal.Width=medium}  0.1266667  0.7307692 0.1733333 2.283654    19
## [74]  {Sepal.Width=short,
##        Petal.Length=medium} => {Species=versicolor}  0.1666667  0.9259259 0.1800000 2.777778    25
## [75]  {Sepal.Width=short,
##        Species=versicolor}  => {Petal.Length=medium} 0.1666667  0.9259259 0.1800000 2.834467    25
## [76]  {Sepal.Width=short,
##        Species=virginica}   => {Petal.Length=long}   0.1133333  0.8947368 0.1266667 2.631579    17
## [77]  {Sepal.Width=short,
##        Petal.Length=long}   => {Species=virginica}   0.1133333  0.8947368 0.1266667 2.684211    17
## [78]  {Sepal.Width=short,
##        Species=virginica}   => {Petal.Width=long}    0.1066667  0.8421053 0.1266667 2.429150    16
## [79]  {Sepal.Width=short,
##        Petal.Width=long}    => {Species=virginica}   0.1066667  0.9411765 0.1133333 2.823529    16
## [80]  {Sepal.Width=short,
##        Petal.Length=long}   => {Petal.Width=long}    0.1000000  0.7894737 0.1266667 2.277328    15
## [81]  {Sepal.Width=short,
##        Petal.Width=long}    => {Petal.Length=long}   0.1000000  0.8823529 0.1133333 2.595156    15
## [82]  {Petal.Length=medium,
##        Petal.Width=medium}  => {Species=versicolor}  0.2866667  1.0000000 0.2866667 3.000000    43
## [83]  {Petal.Width=medium,
##        Species=versicolor}  => {Petal.Length=medium} 0.2866667  0.9555556 0.3000000 2.925170    43
## [84]  {Petal.Length=medium,
##        Species=versicolor}  => {Petal.Width=medium}  0.2866667  0.9347826 0.3066667 2.921196    43
## [85]  {Sepal.Length=medium,
##        Petal.Width=medium}  => {Petal.Length=medium} 0.1866667  0.9333333 0.2000000 2.857143    28
## [86]  {Sepal.Length=medium,
##        Petal.Length=medium} => {Petal.Width=medium}  0.1866667  0.8750000 0.2133333 2.734375    28
## [87]  {Sepal.Length=medium,
##        Petal.Width=medium}  => {Species=versicolor}  0.1866667  0.9333333 0.2000000 2.800000    28
## [88]  {Sepal.Length=medium,
##        Species=versicolor}  => {Petal.Width=medium}  0.1866667  0.9032258 0.2066667 2.822581    28
## [89]  {Sepal.Length=medium,
##        Petal.Length=medium} => {Species=versicolor}  0.2000000  0.9375000 0.2133333 2.812500    30
## [90]  {Sepal.Length=medium,
##        Species=versicolor}  => {Petal.Length=medium} 0.2000000  0.9677419 0.2066667 2.962475    30
## [91]  {Petal.Length=short,
##        Petal.Width=short}   => {Species=setosa}      0.3333333  1.0000000 0.3333333 3.000000    50
## [92]  {Petal.Length=short,
##        Species=setosa}      => {Petal.Width=short}   0.3333333  1.0000000 0.3333333 3.000000    50
## [93]  {Petal.Width=short,
##        Species=setosa}      => {Petal.Length=short}  0.3333333  1.0000000 0.3333333 3.000000    50
## [94]  {Petal.Length=short,
##        Petal.Width=short}   => {Sepal.Width=long}    0.2533333  0.7600000 0.3333333 2.035714    38
## [95]  {Sepal.Width=long,
##        Petal.Length=short}  => {Petal.Width=short}   0.2533333  1.0000000 0.2533333 3.000000    38
## [96]  {Sepal.Width=long,
##        Petal.Width=short}   => {Petal.Length=short}  0.2533333  1.0000000 0.2533333 3.000000    38
## [97]  {Petal.Length=short,
##        Species=setosa}      => {Sepal.Width=long}    0.2533333  0.7600000 0.3333333 2.035714    38
## [98]  {Sepal.Width=long,
##        Petal.Length=short}  => {Species=setosa}      0.2533333  1.0000000 0.2533333 3.000000    38
```

```
## [99]  {Sepal.Width=long,
##        Species=setosa}      => {Petal.Length=short}  0.2533333  1.0000000 0.2533333 3.000000    38
## [100] {Petal.Width=short,
##        Species=setosa}      => {Sepal.Width=long}    0.2533333  0.7600000 0.3333333 2.035714    38
## [101] {Sepal.Width=long,
##        Petal.Width=short}   => {Species=setosa}      0.2533333  1.0000000 0.2533333 3.000000    38
## [102] {Sepal.Width=long,
##        Species=setosa}      => {Petal.Width=short}   0.2533333  1.0000000 0.2533333 3.000000    38
## [103] {Sepal.Length=long,
##        Species=virginica}   => {Petal.Length=long}   0.2466667  1.0000000 0.2466667 2.941176    37
## [104] {Petal.Length=long,
##        Species=virginica}   => {Sepal.Length=long}   0.2466667  0.7872340 0.3133333 2.315394    37
## [105] {Sepal.Length=long,
##        Petal.Length=long}   => {Species=virginica}   0.2466667  0.9250000 0.2666667 2.775000    37
## [106] {Sepal.Length=long,
##        Species=virginica}   => {Petal.Width=long}    0.2400000  0.9729730 0.2466667 2.806653    36
## [107] {Petal.Width=long,
##        Species=virginica}   => {Sepal.Length=long}   0.2400000  0.7659574 0.3133333 2.252816    36
## [108] {Sepal.Length=long,
##        Petal.Width=long}    => {Species=virginica}   0.2400000  0.9473684 0.2533333 2.842105    36
## [109] {Petal.Length=long,
##        Species=virginica}   => {Petal.Width=long}    0.2933333  0.9361702 0.3133333 2.700491    44
## [110] {Petal.Width=long,
##        Species=virginica}   => {Petal.Length=long}   0.2933333  0.9361702 0.3133333 2.753442    44
## [111] {Petal.Length=long,
##        Petal.Width=long}    => {Species=virginica}   0.2933333  0.9565217 0.3066667 2.869565    44
## [112] {Sepal.Length=long,
##        Petal.Length=long}   => {Petal.Width=long}    0.2466667  0.9250000 0.2666667 2.668269    37
## [113] {Sepal.Length=long,
##        Petal.Width=long}    => {Petal.Length=long}   0.2466667  0.9736842 0.2533333 2.863777    37
## [114] {Petal.Length=long,
##        Petal.Width=long}    => {Sepal.Length=long}   0.2466667  0.8043478 0.3066667 2.365729    37
## [115] {Sepal.Length=short,
##        Petal.Length=short,
##        Petal.Width=short}   => {Species=setosa}      0.2666667  1.0000000 0.2666667 3.000000    40
## [116] {Sepal.Length=short,
##        Petal.Length=short,
##        Species=setosa}      => {Petal.Width=short}   0.2666667  1.0000000 0.2666667 3.000000    40
## [117] {Sepal.Length=short,
##        Petal.Width=short,
##        Species=setosa}      => {Petal.Length=short}  0.2666667  1.0000000 0.2666667 3.000000    40
## [118] {Petal.Length=short,
##        Petal.Width=short,
##        Species=setosa}      => {Sepal.Length=short}  0.2666667  0.8000000 0.3333333 2.608696    40
## [119] {Sepal.Length=short,
##        Petal.Length=short,
##        Petal.Width=short}   => {Sepal.Width=long}    0.1866667  0.7000000 0.2666667 1.875000    28
## [120] {Sepal.Length=short,
##        Sepal.Width=long,
##        Petal.Length=short}  => {Petal.Width=short}   0.1866667  1.0000000 0.1866667 3.000000    28
## [121] {Sepal.Length=short,
##        Sepal.Width=long,
##        Petal.Width=short}   => {Petal.Length=short}  0.1866667  1.0000000 0.1866667 3.000000    28
## [122] {Sepal.Width=long,
```

```
##        Petal.Length=short,
##        Petal.Width=short}   => {Sepal.Length=short}  0.1866667  0.7368421 0.2533333 2.402746    28
## [123] {Sepal.Length=short,
##        Petal.Length=short,
##        Species=setosa}      => {Sepal.Width=long}    0.1866667  0.7000000 0.2666667 1.875000    28
## [124] {Sepal.Length=short,
##        Sepal.Width=long,
##        Petal.Length=short}  => {Species=setosa}      0.1866667  1.0000000 0.1866667 3.000000    28
## [125] {Sepal.Length=short,
##        Sepal.Width=long,
##        Species=setosa}      => {Petal.Length=short}  0.1866667  1.0000000 0.1866667 3.000000    28
## [126] {Sepal.Width=long,
##        Petal.Length=short,
##        Species=setosa}      => {Sepal.Length=short}  0.1866667  0.7368421 0.2533333 2.402746    28
## [127] {Sepal.Length=short,
##        Petal.Width=short,
##        Species=setosa}      => {Sepal.Width=long}    0.1866667  0.7000000 0.2666667 1.875000    28
## [128] {Sepal.Length=short,
##        Sepal.Width=long,
##        Petal.Width=short}   => {Species=setosa}      0.1866667  1.0000000 0.1866667 3.000000    28
## [129] {Sepal.Length=short,
##        Sepal.Width=long,
##        Species=setosa}      => {Petal.Width=short}   0.1866667  1.0000000 0.1866667 3.000000    28
## [130] {Sepal.Width=long,
##        Petal.Width=short,
##        Species=setosa}      => {Sepal.Length=short}  0.1866667  0.7368421 0.2533333 2.402746    28
## [131] {Sepal.Width=medium,
##        Petal.Length=medium,
##        Petal.Width=medium}  => {Species=versicolor}  0.1066667  1.0000000 0.1066667 3.000000    16
## [132] {Sepal.Width=medium,
##        Petal.Width=medium,
##        Species=versicolor}  => {Petal.Length=medium} 0.1066667  0.9411765 0.1133333 2.881152    16
## [133] {Sepal.Width=medium,
##        Petal.Length=medium,
##        Species=versicolor}  => {Petal.Width=medium}  0.1066667  1.0000000 0.1066667 3.125000    16
## [134] {Sepal.Length=long,
##        Sepal.Width=medium,
##        Species=virginica}   => {Petal.Length=long}   0.1000000  1.0000000 0.1000000 2.941176    15
## [135] {Sepal.Width=medium,
##        Petal.Length=long,
##        Species=virginica}   => {Sepal.Length=long}   0.1000000  0.8823529 0.1133333 2.595156    15
## [136] {Sepal.Length=long,
##        Sepal.Width=medium,
##        Petal.Length=long}   => {Species=virginica}   0.1000000  0.8823529 0.1133333 2.647059    15
## [137] {Sepal.Length=long,
##        Sepal.Width=medium,
##        Species=virginica}   => {Petal.Width=long}    0.1000000  1.0000000 0.1000000 2.884615    15
## [138] {Sepal.Width=medium,
##        Petal.Width=long,
##        Species=virginica}   => {Sepal.Length=long}   0.1000000  0.8333333 0.1200000 2.450980    15
## [139] {Sepal.Length=long,
##        Sepal.Width=medium,
##        Petal.Width=long}    => {Species=virginica}   0.1000000  0.9375000 0.1066667 2.812500    15
## [140] {Sepal.Width=medium,
```

```
##         Petal.Length=long,
##         Species=virginica}   => {Petal.Width=long}    0.1133333  1.0000000 0.1133333 2.884615    17
## [141] {Sepal.Width=medium,
##         Petal.Width=long,
##         Species=virginica}   => {Petal.Length=long}   0.1133333  0.9444444 0.1200000 2.777778    17
## [142] {Sepal.Width=medium,
##         Petal.Length=long,
##         Petal.Width=long}    => {Species=virginica}   0.1133333  0.9444444 0.1200000 2.833333    17
## [143] {Sepal.Length=long,
##         Sepal.Width=medium,
##         Petal.Length=long}   => {Petal.Width=long}    0.1066667  0.9411765 0.1133333 2.714932    16
## [144] {Sepal.Length=long,
##         Sepal.Width=medium,
##         Petal.Width=long}    => {Petal.Length=long}   0.1066667  1.0000000 0.1066667 2.941176    16
## [145] {Sepal.Width=medium,
##         Petal.Length=long,
##         Petal.Width=long}    => {Sepal.Length=long}   0.1066667  0.8888889 0.1200000 2.614379    16
## [146] {Sepal.Width=short,
##         Petal.Length=medium,
##         Petal.Width=medium}  => {Species=versicolor}  0.1666667  1.0000000 0.1666667 3.000000    25
## [147] {Sepal.Width=short,
##         Petal.Width=medium,
##         Species=versicolor}  => {Petal.Length=medium} 0.1666667  0.9615385 0.1733333 2.943485    25
## [148] {Sepal.Width=short,
##         Petal.Length=medium,
##         Species=versicolor}  => {Petal.Width=medium}  0.1666667  1.0000000 0.1666667 3.125000    25
## [149] {Sepal.Length=medium,
##         Sepal.Width=short,
##         Petal.Width=medium}  => {Petal.Length=medium} 0.1133333  0.8947368 0.1266667 2.738990    17
## [150] {Sepal.Length=medium,
##         Sepal.Width=short,
##         Petal.Length=medium} => {Petal.Width=medium}  0.1133333  0.9444444 0.1200000 2.951389    17
## [151] {Sepal.Length=medium,
##         Sepal.Width=short,
##         Petal.Width=medium}  => {Species=versicolor}  0.1133333  0.8947368 0.1266667 2.684211    17
## [152] {Sepal.Length=medium,
##         Sepal.Width=short,
##         Species=versicolor}  => {Petal.Width=medium}  0.1133333  0.9444444 0.1200000 2.951389    17
## [153] {Sepal.Length=medium,
##         Sepal.Width=short,
##         Petal.Length=medium} => {Species=versicolor}  0.1133333  0.9444444 0.1200000 2.833333    17
## [154] {Sepal.Length=medium,
##         Sepal.Width=short,
##         Species=versicolor}  => {Petal.Length=medium} 0.1133333  0.9444444 0.1200000 2.891156    17
## [155] {Sepal.Length=medium,
##         Petal.Length=medium,
##         Petal.Width=medium}  => {Species=versicolor}  0.1866667  1.0000000 0.1866667 3.000000    28
## [156] {Sepal.Length=medium,
##         Petal.Width=medium,
##         Species=versicolor}  => {Petal.Length=medium} 0.1866667  1.0000000 0.1866667 3.061224    28
## [157] {Sepal.Length=medium,
##         Petal.Length=medium,
##         Species=versicolor}  => {Petal.Width=medium}  0.1866667  0.9333333 0.2000000 2.916667    28
## [158] {Petal.Length=short,
```

```
##        Petal.Width=short,
##        Species=setosa}      => {Sepal.Width=long}    0.2533333  0.7600000 0.3333333 2.035714    38
## [159] {Sepal.Width=long,
##        Petal.Length=short,
##        Petal.Width=short}   => {Species=setosa}      0.2533333  1.0000000 0.2533333 3.000000    38
## [160] {Sepal.Width=long,
##        Petal.Length=short,
##        Species=setosa}      => {Petal.Width=short}   0.2533333  1.0000000 0.2533333 3.000000    38
## [161] {Sepal.Width=long,
##        Petal.Width=short,
##        Species=setosa}      => {Petal.Length=short}  0.2533333  1.0000000 0.2533333 3.000000    38
## [162] {Sepal.Length=long,
##        Petal.Length=long,
##        Species=virginica}   => {Petal.Width=long}    0.2400000  0.9729730 0.2466667 2.806653    36
## [163] {Sepal.Length=long,
##        Petal.Width=long,
##        Species=virginica}   => {Petal.Length=long}   0.2400000  1.0000000 0.2400000 2.941176    36
## [164] {Petal.Length=long,
##        Petal.Width=long,
##        Species=virginica}   => {Sepal.Length=long}   0.2400000  0.8181818 0.2933333 2.406417    36
## [165] {Sepal.Length=long,
##        Petal.Length=long,
##        Petal.Width=long}    => {Species=virginica}   0.2400000  0.9729730 0.2466667 2.918919    36
## [166] {Sepal.Length=short,
##        Petal.Length=short,
##        Petal.Width=short,
##        Species=setosa}      => {Sepal.Width=long}    0.1866667  0.7000000 0.2666667 1.875000    28
## [167] {Sepal.Length=short,
##        Sepal.Width=long,
##        Petal.Length=short,
##        Petal.Width=short}   => {Species=setosa}      0.1866667  1.0000000 0.1866667 3.000000    28
## [168] {Sepal.Length=short,
##        Sepal.Width=long,
##        Petal.Length=short,
##        Species=setosa}      => {Petal.Width=short}   0.1866667  1.0000000 0.1866667 3.000000    28
## [169] {Sepal.Length=short,
##        Sepal.Width=long,
##        Petal.Width=short,
##        Species=setosa}      => {Petal.Length=short}  0.1866667  1.0000000 0.1866667 3.000000    28
## [170] {Sepal.Width=long,
##        Petal.Length=short,
##        Petal.Width=short,
##        Species=setosa}      => {Sepal.Length=short}  0.1866667  0.7368421 0.2533333 2.402746    28
## [171] {Sepal.Length=long,
##        Sepal.Width=medium,
##        Petal.Length=long,
##        Species=virginica}   => {Petal.Width=long}    0.1000000  1.0000000 0.1000000 2.884615    15
## [172] {Sepal.Length=long,
##        Sepal.Width=medium,
##        Petal.Width=long,
##        Species=virginica}   => {Petal.Length=long}   0.1000000  1.0000000 0.1000000 2.941176    15
## [173] {Sepal.Width=medium,
##        Petal.Length=long,
##        Petal.Width=long,
```

```
##        Species=virginica}   => {Sepal.Length=long}   0.1000000  0.8823529 0.1133333 2.595156    15
## [174] {Sepal.Length=long,
##        Sepal.Width=medium,
##        Petal.Length=long,
##        Petal.Width=long}    => {Species=virginica}   0.1000000  0.9375000 0.1066667 2.812500    15
## [175] {Sepal.Length=medium,
##        Sepal.Width=short,
##        Petal.Length=medium,
##        Petal.Width=medium}  => {Species=versicolor}  0.1133333  1.0000000 0.1133333 3.000000    17
## [176] {Sepal.Length=medium,
##        Sepal.Width=short,
##        Petal.Width=medium,
##        Species=versicolor}  => {Petal.Length=medium} 0.1133333  1.0000000 0.1133333 3.061224    17
## [177] {Sepal.Length=medium,
##        Sepal.Width=short,
##        Petal.Length=medium,
##        Species=versicolor}  => {Petal.Width=medium}  0.1133333  1.0000000 0.1133333 3.125000    17
```

```
frequent_itemsets <- apriori(trans,parameter = list(supp = 0.1, conf = 0.7, target = "frequent itemsets
```

```
## Apriori
##
## Parameter specification:
##  confidence minval smax arem  aval originalSupport maxtime support minlen
##          NA    0.1    1 none FALSE            TRUE       5     0.1      1
##  maxlen            target  ext
##      10 frequent itemsets TRUE
##
## Algorithmic control:
##  filter tree heap memopt load sort verbose
##     0.1 TRUE TRUE  FALSE TRUE    2    TRUE
##
## Absolute minimum support count: 15
##
## set item appearances ...[0 item(s)] done [0.00s].
## set transactions ...[15 item(s), 150 transaction(s)] done [0.00s].
## sorting and recoding items ... [15 item(s)] done [0.00s].
## creating transaction tree ... done [0.00s].
## checking subsets of size 1 2 3 4 5 done [0.00s].
## sorting transactions ... done [0.00s].
## writing ... [108 set(s)] done [0.00s].
## creating S4 object  ... done [0.00s].
```

```
inspect(frequent_itemsets)
```

```
##       items                    support transIdenticalToItemsets count
## [1]   {Sepal.Length=short}   0.3066667                0.0000000    46
## [2]   {Sepal.Width=medium}   0.3133333                0.0000000    47
## [3]   {Sepal.Width=short}    0.3133333                0.0000000    47
## [4]   {Petal.Width=medium}   0.3200000                0.0000000    48
## [5]   {Petal.Length=medium} 0.3266667                0.0000000    49
## [6]   {Petal.Length=short}   0.3333333                0.0000000    50
## [7]   {Petal.Width=short}    0.3333333                0.0000000    50
## [8]   {Species=setosa}       0.3333333                0.0000000    50
## [9]   {Species=versicolor}   0.3333333                0.0000000    50
```

```
##  [10]  {Species=virginica}   0.3333333              0.0000000    50
##  [11]  {Sepal.Length=long}   0.3400000              0.0000000    51
##  [12]  {Petal.Length=long}   0.3400000              0.0000000    51
##  [13]  {Petal.Width=long}    0.3466667              0.0000000    52
##  [14]  {Sepal.Length=medium} 0.3533333              0.0000000    53
##  [15]  {Sepal.Width=long}    0.3733333              0.0000000    56
##  [16]  {Sepal.Length=short,
##         Petal.Length=short}  0.2666667              0.0000000    40
##  [17]  {Sepal.Length=short,
##         Petal.Width=short}   0.2666667              0.0000000    40
##  [18]  {Sepal.Length=short,
##         Species=setosa}      0.2666667              0.0000000    40
##  [19]  {Sepal.Length=short,
##         Sepal.Width=long}    0.1866667              0.0000000    28
##  [20]  {Sepal.Width=medium,
##         Petal.Width=medium}  0.1133333              0.0000000    17
##  [21]  {Sepal.Width=medium,
##         Petal.Length=medium} 0.1133333              0.0000000    17
##  [22]  {Sepal.Width=medium,
##         Species=versicolor}  0.1200000              0.0000000    18
##  [23]  {Sepal.Width=medium,
##         Species=virginica}   0.1200000              0.0000000    18
##  [24]  {Sepal.Length=long,
##         Sepal.Width=medium}  0.1466667              0.0000000    22
##  [25]  {Sepal.Width=medium,
##         Petal.Length=long}   0.1266667              0.0000000    19
##  [26]  {Sepal.Width=medium,
##         Petal.Width=long}    0.1266667              0.0000000    19
##  [27]  {Sepal.Width=short,
##         Petal.Width=medium}  0.1933333              0.0000000    29
##  [28]  {Sepal.Width=short,
##         Petal.Length=medium} 0.1800000              0.0000000    27
##  [29]  {Sepal.Width=short,
##         Species=versicolor}  0.1800000              0.0000000    27
##  [30]  {Sepal.Width=short,
##         Species=virginica}   0.1266667              0.0000000    19
##  [31]  {Sepal.Width=short,
##         Petal.Length=long}   0.1266667              0.0000000    19
##  [32]  {Sepal.Width=short,
##         Petal.Width=long}    0.1133333              0.0000000    17
##  [33]  {Sepal.Length=medium,
##         Sepal.Width=short}   0.1733333              0.0000000    26
##  [34]  {Petal.Length=medium,
##         Petal.Width=medium}  0.2866667              0.0000000    43
##  [35]  {Petal.Width=medium,
##         Species=versicolor}  0.3000000              0.0000000    45
##  [36]  {Sepal.Length=medium,
##         Petal.Width=medium}  0.2000000              0.0000000    30
##  [37]  {Petal.Length=medium,
##         Species=versicolor}  0.3066667              0.0000000    46
##  [38]  {Sepal.Length=medium,
##         Petal.Length=medium} 0.2133333              0.0000000    32
##  [39]  {Petal.Length=short,
##         Petal.Width=short}   0.3333333              0.0000000    50
```

```
## [40]  {Petal.Length=short,
##         Species=setosa}      0.3333333               0.0000000    50
## [41]  {Sepal.Width=long,
##         Petal.Length=short}  0.2533333               0.0000000    38
## [42]  {Petal.Width=short,
##         Species=setosa}      0.3333333               0.0000000    50
## [43]  {Sepal.Width=long,
##         Petal.Width=short}   0.2533333               0.0000000    38
## [44]  {Sepal.Width=long,
##         Species=setosa}      0.2533333               0.0000000    38
## [45]  {Sepal.Length=medium,
##         Species=versicolor}  0.2066667               0.0000000    31
## [46]  {Sepal.Length=long,
##         Species=virginica}   0.2466667               0.0000000    37
## [47]  {Petal.Length=long,
##         Species=virginica}   0.3133333               0.0000000    47
## [48]  {Petal.Width=long,
##         Species=virginica}   0.3133333               0.0000000    47
## [49]  {Sepal.Length=long,
##         Petal.Length=long}   0.2666667               0.0000000    40
## [50]  {Sepal.Length=long,
##         Petal.Width=long}    0.2533333               0.0000000    38
## [51]  {Sepal.Length=long,
##         Sepal.Width=long}    0.1000000               0.0000000    15
## [52]  {Petal.Length=long,
##         Petal.Width=long}    0.3066667               0.0000000    46
## [53]  {Sepal.Width=long,
##         Petal.Width=long}    0.1066667               0.0000000    16
## [54]  {Sepal.Length=short,
##         Petal.Length=short,
##         Petal.Width=short}   0.2666667               0.0000000    40
## [55]  {Sepal.Length=short,
##         Petal.Length=short,
##         Species=setosa}      0.2666667               0.0000000    40
## [56]  {Sepal.Length=short,
##         Sepal.Width=long,
##         Petal.Length=short}  0.1866667               0.0000000    28
## [57]  {Sepal.Length=short,
##         Petal.Width=short,
##         Species=setosa}      0.2666667               0.0000000    40
## [58]  {Sepal.Length=short,
##         Sepal.Width=long,
##         Petal.Width=short}   0.1866667               0.0000000    28
## [59]  {Sepal.Length=short,
##         Sepal.Width=long,
##         Species=setosa}      0.1866667               0.0000000    28
## [60]  {Sepal.Width=medium,
##         Petal.Length=medium,
##         Petal.Width=medium}  0.1066667               0.0000000    16
## [61]  {Sepal.Width=medium,
##         Petal.Width=medium,
##         Species=versicolor}  0.1133333               0.0000000    17
## [62]  {Sepal.Width=medium,
##         Petal.Length=medium,
```

```
##        Species=versicolor}  0.1066667               0.0000000    16
## [63]  {Sepal.Length=long,
##        Sepal.Width=medium,
##        Species=virginica}   0.1000000               0.0000000    15
## [64]  {Sepal.Width=medium,
##        Petal.Length=long,
##        Species=virginica}   0.1133333               0.0000000    17
## [65]  {Sepal.Width=medium,
##        Petal.Width=long,
##        Species=virginica}   0.1200000               0.0000000    18
## [66]  {Sepal.Length=long,
##        Sepal.Width=medium,
##        Petal.Length=long}   0.1133333               0.0000000    17
## [67]  {Sepal.Length=long,
##        Sepal.Width=medium,
##        Petal.Width=long}    0.1066667               0.0000000    16
## [68]  {Sepal.Width=medium,
##        Petal.Length=long,
##        Petal.Width=long}    0.1200000               0.0000000    18
## [69]  {Sepal.Width=short,
##        Petal.Length=medium,
##        Petal.Width=medium}  0.1666667               0.0000000    25
## [70]  {Sepal.Width=short,
##        Petal.Width=medium,
##        Species=versicolor}  0.1733333               0.0000000    26
## [71]  {Sepal.Length=medium,
##        Sepal.Width=short,
##        Petal.Width=medium}  0.1266667               0.0000000    19
## [72]  {Sepal.Width=short,
##        Petal.Length=medium,
##        Species=versicolor}  0.1666667               0.0000000    25
## [73]  {Sepal.Length=medium,
##        Sepal.Width=short,
##        Petal.Length=medium} 0.1200000               0.0000000    18
## [74]  {Sepal.Length=medium,
##        Sepal.Width=short,
##        Species=versicolor}  0.1200000               0.0000000    18
## [75]  {Sepal.Width=short,
##        Petal.Length=long,
##        Species=virginica}   0.1133333               0.0000000    17
## [76]  {Sepal.Width=short,
##        Petal.Width=long,
##        Species=virginica}   0.1066667               0.0000000    16
## [77]  {Sepal.Width=short,
##        Petal.Length=long,
##        Petal.Width=long}    0.1000000               0.0000000    15
## [78]  {Petal.Length=medium,
##        Petal.Width=medium,
##        Species=versicolor}  0.2866667               0.0000000    43
## [79]  {Sepal.Length=medium,
##        Petal.Length=medium,
##        Petal.Width=medium}  0.1866667               0.0000000    28
## [80]  {Sepal.Length=medium,
##        Petal.Width=medium,
```

```
##        Species=versicolor}  0.1866667              0.0000000    28
## [81]  {Sepal.Length=medium,
##        Petal.Length=medium,
##        Species=versicolor}  0.2000000              0.0000000    30
## [82]  {Petal.Length=short,
##        Petal.Width=short,
##        Species=setosa}      0.3333333              0.0000000    50
## [83]  {Sepal.Width=long,
##        Petal.Length=short,
##        Petal.Width=short}   0.2533333              0.0000000    38
## [84]  {Sepal.Width=long,
##        Petal.Length=short,
##        Species=setosa}      0.2533333              0.0000000    38
## [85]  {Sepal.Width=long,
##        Petal.Width=short,
##        Species=setosa}      0.2533333              0.0000000    38
## [86]  {Sepal.Length=long,
##        Petal.Length=long,
##        Species=virginica}   0.2466667              0.0000000    37
## [87]  {Sepal.Length=long,
##        Petal.Width=long,
##        Species=virginica}   0.2400000              0.0000000    36
## [88]  {Petal.Length=long,
##        Petal.Width=long,
##        Species=virginica}   0.2933333              0.0000000    44
## [89]  {Sepal.Length=long,
##        Petal.Length=long,
##        Petal.Width=long}    0.2466667              0.0000000    37
## [90]  {Sepal.Length=short,
##        Petal.Length=short,
##        Petal.Width=short,
##        Species=setosa}      0.2666667              0.0000000    40
## [91]  {Sepal.Length=short,
##        Sepal.Width=long,
##        Petal.Length=short,
##        Petal.Width=short}   0.1866667              0.0000000    28
## [92]  {Sepal.Length=short,
##        Sepal.Width=long,
##        Petal.Length=short,
##        Species=setosa}      0.1866667              0.0000000    28
## [93]  {Sepal.Length=short,
##        Sepal.Width=long,
##        Petal.Width=short,
##        Species=setosa}      0.1866667              0.0000000    28
## [94]  {Sepal.Width=medium,
##        Petal.Length=medium,
##        Petal.Width=medium,
##        Species=versicolor}  0.1066667              0.0000000    16
## [95]  {Sepal.Length=long,
##        Sepal.Width=medium,
##        Petal.Length=long,
##        Species=virginica}   0.1000000              0.0000000    15
## [96]  {Sepal.Length=long,
##        Sepal.Width=medium,
```

```
##        Petal.Width=long,
##        Species=virginica}   0.1000000               0.0000000    15
## [97]  {Sepal.Width=medium,
##        Petal.Length=long,
##        Petal.Width=long,
##        Species=virginica}   0.1133333               0.0000000    17
## [98]  {Sepal.Length=long,
##        Sepal.Width=medium,
##        Petal.Length=long,
##        Petal.Width=long}    0.1066667               0.0000000    16
## [99]  {Sepal.Width=short,
##        Petal.Length=medium,
##        Petal.Width=medium,
##        Species=versicolor}  0.1666667               0.0000000    25
## [100] {Sepal.Length=medium,
##        Sepal.Width=short,
##        Petal.Length=medium,
##        Petal.Width=medium}  0.1133333               0.0000000    17
## [101] {Sepal.Length=medium,
##        Sepal.Width=short,
##        Petal.Width=medium,
##        Species=versicolor}  0.1133333               0.0000000    17
## [102] {Sepal.Length=medium,
##        Sepal.Width=short,
##        Petal.Length=medium,
##        Species=versicolor}  0.1133333               0.0000000    17
## [103] {Sepal.Length=medium,
##        Petal.Length=medium,
##        Petal.Width=medium,
##        Species=versicolor}  0.1866667               0.0000000    28
## [104] {Sepal.Width=long,
##        Petal.Length=short,
##        Petal.Width=short,
##        Species=setosa}      0.2533333               0.0000000    38
## [105] {Sepal.Length=long,
##        Petal.Length=long,
##        Petal.Width=long,
##        Species=virginica}   0.2400000               0.0000000    36
## [106] {Sepal.Length=short,
##        Sepal.Width=long,
##        Petal.Length=short,
##        Petal.Width=short,
##        Species=setosa}      0.1866667               0.1866667    28
## [107] {Sepal.Length=long,
##        Sepal.Width=medium,
##        Petal.Length=long,
##        Petal.Width=long,
##        Species=virginica}   0.1000000               0.1000000    15
## [108] {Sepal.Length=medium,
##        Sepal.Width=short,
##        Petal.Length=medium,
##        Petal.Width=medium,
##        Species=versicolor}  0.1133333               0.1133333    17
```

```
closed_frequent_itemsets <- apriori(trans,parameter = list(supp = 0.1, conf = 0.7, target = "closed freq
```

```
## Apriori
##
## Parameter specification:
##  confidence minval smax arem  aval originalSupport maxtime support minlen
##          NA    0.1    1 none FALSE            TRUE       5     0.1      1
##  maxlen                  target  ext
##      10 closed frequent itemsets TRUE
##
## Algorithmic control:
##  filter tree heap memopt load sort verbose
##     0.1 TRUE TRUE  FALSE TRUE    2    TRUE
##
## Absolute minimum support count: 15
##
## set item appearances ...[0 item(s)] done [0.00s].
## set transactions ...[15 item(s), 150 transaction(s)] done [0.00s].
## sorting and recoding items ... [15 item(s)] done [0.00s].
## creating transaction tree ... done [0.00s].
## checking subsets of size 1 2 3 4 5 done [0.00s].
## filtering closed item sets ... done [0.00s].
## sorting transactions ... done [0.00s].
## writing ... [64 set(s)] done [0.00s].
## creating S4 object  ... done [0.00s].
```

```
inspect(closed_frequent_itemsets)
```

```
##      items                    support transIdenticalToItemsets count
## [1]  {Sepal.Length=short}  0.3066667               0.0000000    46
## [2]  {Sepal.Width=medium}  0.3133333               0.0000000    47
## [3]  {Sepal.Width=short}   0.3133333               0.0000000    47
## [4]  {Petal.Width=medium}  0.3200000               0.0000000    48
## [5]  {Petal.Length=medium} 0.3266667               0.0000000    49
## [6]  {Species=versicolor}  0.3333333               0.0000000    50
## [7]  {Species=virginica}   0.3333333               0.0000000    50
## [8]  {Sepal.Length=long}   0.3400000               0.0000000    51
## [9]  {Petal.Length=long}   0.3400000               0.0000000    51
## [10] {Petal.Width=long}    0.3466667               0.0000000    52
## [11] {Sepal.Length=medium} 0.3533333               0.0000000    53
## [12] {Sepal.Width=long}    0.3733333               0.0000000    56
## [13] {Sepal.Width=medium,
##       Petal.Length=medium} 0.1133333               0.0000000    17
## [14] {Sepal.Width=medium,
##       Species=versicolor}  0.1200000               0.0000000    18
## [15] {Sepal.Length=long,
##       Sepal.Width=medium}  0.1466667               0.0000000    22
## [16] {Sepal.Width=medium,
##       Petal.Length=long}   0.1266667               0.0000000    19
## [17] {Sepal.Width=medium,
##       Petal.Width=long}    0.1266667               0.0000000    19
## [18] {Sepal.Width=short,
##       Petal.Width=medium}  0.1933333               0.0000000    29
## [19] {Sepal.Width=short,
```

```
##       Petal.Length=medium} 0.1800000               0.0000000    27
## [20] {Sepal.Width=short,
##       Species=versicolor}  0.1800000               0.0000000    27
## [21] {Sepal.Width=short,
##       Species=virginica}   0.1266667               0.0000000    19
## [22] {Sepal.Width=short,
##       Petal.Length=long}   0.1266667               0.0000000    19
## [23] {Sepal.Width=short,
##       Petal.Width=long}    0.1133333               0.0000000    17
## [24] {Sepal.Length=medium,
##       Sepal.Width=short}   0.1733333               0.0000000    26
## [25] {Petal.Width=medium,
##       Species=versicolor}  0.3000000               0.0000000    45
## [26] {Sepal.Length=medium,
##       Petal.Width=medium}  0.2000000               0.0000000    30
## [27] {Petal.Length=medium,
##       Species=versicolor}  0.3066667               0.0000000    46
## [28] {Sepal.Length=medium,
##       Petal.Length=medium} 0.2133333               0.0000000    32
## [29] {Sepal.Length=medium,
##       Species=versicolor}  0.2066667               0.0000000    31
## [30] {Petal.Length=long,
##       Species=virginica}   0.3133333               0.0000000    47
## [31] {Petal.Width=long,
##       Species=virginica}   0.3133333               0.0000000    47
## [32] {Sepal.Length=long,
##       Petal.Length=long}   0.2666667               0.0000000    40
## [33] {Sepal.Length=long,
##       Petal.Width=long}    0.2533333               0.0000000    38
## [34] {Sepal.Length=long,
##       Sepal.Width=long}    0.1000000               0.0000000    15
## [35] {Petal.Length=long,
##       Petal.Width=long}    0.3066667               0.0000000    46
## [36] {Sepal.Width=long,
##       Petal.Width=long}    0.1066667               0.0000000    16
## [37] {Sepal.Width=medium,
##       Petal.Width=medium,
##       Species=versicolor}  0.1133333               0.0000000    17
## [38] {Sepal.Width=medium,
##       Petal.Width=long,
##       Species=virginica}   0.1200000               0.0000000    18
## [39] {Sepal.Length=long,
##       Sepal.Width=medium,
##       Petal.Length=long}   0.1133333               0.0000000    17
## [40] {Sepal.Width=medium,
##       Petal.Length=long,
##       Petal.Width=long}    0.1200000               0.0000000    18
## [41] {Sepal.Width=short,
##       Petal.Width=medium,
##       Species=versicolor}  0.1733333               0.0000000    26
## [42] {Sepal.Length=medium,
##       Sepal.Width=short,
##       Petal.Width=medium}  0.1266667               0.0000000    19
## [43] {Sepal.Length=medium,
```

```
##       Sepal.Width=short,
##       Petal.Length=medium} 0.1200000               0.0000000    18
## [44] {Sepal.Length=medium,
##       Sepal.Width=short,
##       Species=versicolor}  0.1200000               0.0000000    18
## [45] {Sepal.Width=short,
##       Petal.Length=long,
##       Species=virginica}   0.1133333               0.0000000    17
## [46] {Sepal.Width=short,
##       Petal.Width=long,
##       Species=virginica}   0.1066667               0.0000000    16
## [47] {Sepal.Width=short,
##       Petal.Length=long,
##       Petal.Width=long}    0.1000000               0.0000000    15
## [48] {Petal.Length=medium,
##       Petal.Width=medium,
##       Species=versicolor}  0.2866667               0.0000000    43
## [49] {Sepal.Length=medium,
##       Petal.Length=medium,
##       Species=versicolor}  0.2000000               0.0000000    30
## [50] {Petal.Length=short,
##       Petal.Width=short,
##       Species=setosa}      0.3333333               0.0000000    50
## [51] {Sepal.Length=long,
##       Petal.Length=long,
##       Species=virginica}   0.2466667               0.0000000    37
## [52] {Petal.Length=long,
##       Petal.Width=long,
##       Species=virginica}   0.2933333               0.0000000    44
## [53] {Sepal.Length=long,
##       Petal.Length=long,
##       Petal.Width=long}    0.2466667               0.0000000    37
## [54] {Sepal.Length=short,
##       Petal.Length=short,
##       Petal.Width=short,
##       Species=setosa}      0.2666667               0.0000000    40
## [55] {Sepal.Width=medium,
##       Petal.Length=medium,
##       Petal.Width=medium,
##       Species=versicolor}  0.1066667               0.0000000    16
## [56] {Sepal.Width=medium,
##       Petal.Length=long,
##       Petal.Width=long,
##       Species=virginica}   0.1133333               0.0000000    17
## [57] {Sepal.Length=long,
##       Sepal.Width=medium,
##       Petal.Length=long,
##       Petal.Width=long}    0.1066667               0.0000000    16
## [58] {Sepal.Width=short,
##       Petal.Length=medium,
##       Petal.Width=medium,
##       Species=versicolor}  0.1666667               0.0000000    25
## [59] {Sepal.Length=medium,
##       Petal.Length=medium,
```

```
##       Petal.Width=medium,
##       Species=versicolor}  0.1866667               0.0000000    28
## [60] {Sepal.Width=long,
##       Petal.Length=short,
##       Petal.Width=short,
##       Species=setosa}      0.2533333               0.0000000    38
## [61] {Sepal.Length=long,
##       Petal.Length=long,
##       Petal.Width=long,
##       Species=virginica}   0.2400000               0.0000000    36
## [62] {Sepal.Length=short,
##       Sepal.Width=long,
##       Petal.Length=short,
##       Petal.Width=short,
##       Species=setosa}      0.1866667               0.1866667    28
## [63] {Sepal.Length=long,
##       Sepal.Width=medium,
##       Petal.Length=long,
##       Petal.Width=long,
##       Species=virginica}   0.1000000               0.1000000    15
## [64] {Sepal.Length=medium,
##       Sepal.Width=short,
##       Petal.Length=medium,
##       Petal.Width=medium,
##       Species=versicolor}  0.1133333               0.1133333    17
```

```
maximally_frequent_itemsets <- apriori(trans,parameter = list(supp = 0.1, conf = 0.7, target = "maximal
```

```
## Apriori
##
## Parameter specification:
##  confidence minval smax arem  aval originalSupport maxtime support minlen
##          NA    0.1    1 none FALSE            TRUE       5     0.1      1
##  maxlen                     target  ext
##      10 maximally frequent itemsets TRUE
##
## Algorithmic control:
##  filter tree heap memopt load sort verbose
##     0.1 TRUE TRUE  FALSE TRUE    2    TRUE
##
## Absolute minimum support count: 15
##
## set item appearances ...[0 item(s)] done [0.00s].
## set transactions ...[15 item(s), 150 transaction(s)] done [0.00s].
## sorting and recoding items ... [15 item(s)] done [0.00s].
## creating transaction tree ... done [0.00s].
## checking subsets of size 1 2 3 4 5 done [0.00s].
## filtering maximal item sets ... done [0.00s].
## sorting transactions ... done [0.00s].
## writing ... [9 set(s)] done [0.00s].
## creating S4 object  ... done [0.00s].
```

```
inspect(maximally_frequent_itemsets)
```

```
##     items                   support transIdenticalToItemsets count
```

```
## [1] {Sepal.Length=long,
##      Sepal.Width=long}    0.1000000               0.0000000    15
## [2] {Sepal.Width=long,
##      Petal.Width=long}    0.1066667               0.0000000    16
## [3] {Sepal.Width=short,
##      Petal.Length=long,
##      Species=virginica}   0.1133333               0.0000000    17
## [4] {Sepal.Width=short,
##      Petal.Width=long,
##      Species=virginica}   0.1066667               0.0000000    16
## [5] {Sepal.Width=short,
##      Petal.Length=long,
##      Petal.Width=long}    0.1000000               0.0000000    15
## [6] {Sepal.Width=medium,
##      Petal.Length=medium,
##      Petal.Width=medium,
##      Species=versicolor}  0.1066667               0.0000000    16
## [7] {Sepal.Length=short,
##      Sepal.Width=long,
##      Petal.Length=short,
##      Petal.Width=short,
##      Species=setosa}      0.1866667               0.1866667    28
## [8] {Sepal.Length=long,
##      Sepal.Width=medium,
##      Petal.Length=long,
##      Petal.Width=long,
##      Species=virginica}   0.1000000               0.1000000    15
## [9] {Sepal.Length=medium,
##      Sepal.Width=short,
##      Petal.Length=medium,
##      Petal.Width=medium,
##      Species=versicolor}  0.1133333               0.1133333    17
```

```
rules_itemset_appearance <- apriori(trans,parameter = list(supp = 0.1, conf = 0.7, target = "rules"), ap
```

```
## Apriori
##
## Parameter specification:
##  confidence minval smax arem  aval originalSupport maxtime support minlen
##         0.7    0.1    1 none FALSE            TRUE       5     0.1      1
##  maxlen target  ext
##      10  rules TRUE
##
## Algorithmic control:
##  filter tree heap memopt load sort verbose
##     0.1 TRUE TRUE  FALSE TRUE    2    TRUE
##
## Absolute minimum support count: 15
##
## set item appearances ...[1 item(s)] done [0.00s].
## set transactions ...[15 item(s), 150 transaction(s)] done [0.00s].
## sorting and recoding items ... [15 item(s)] done [0.00s].
## creating transaction tree ... done [0.00s].
## checking subsets of size 1 2 3 4 5 done [0.00s].
## writing ... [14 rule(s)] done [0.00s].
```

```
## creating S4 object  ... done [0.00s].
```

```
inspect(rules_itemset_appearance)
```

```
##      lhs                     rhs                 support confidence  coverage     lift count
## [1]  {Sepal.Length=short} => {Species=setosa} 0.2666667  0.8695652 0.3066667 2.608696    40
## [2]  {Petal.Length=short} => {Species=setosa} 0.3333333  1.0000000 0.3333333 3.000000    50
## [3]  {Petal.Width=short}  => {Species=setosa} 0.3333333  1.0000000 0.3333333 3.000000    50
## [4]  {Sepal.Length=short,
##       Petal.Length=short} => {Species=setosa} 0.2666667  1.0000000 0.2666667 3.000000    40
## [5]  {Sepal.Length=short,
##       Petal.Width=short}  => {Species=setosa} 0.2666667  1.0000000 0.2666667 3.000000    40
## [6]  {Sepal.Length=short,
##       Sepal.Width=long}   => {Species=setosa} 0.1866667  1.0000000 0.1866667 3.000000    28
## [7]  {Petal.Length=short,
##       Petal.Width=short}  => {Species=setosa} 0.3333333  1.0000000 0.3333333 3.000000    50
## [8]  {Sepal.Width=long,
##       Petal.Length=short} => {Species=setosa} 0.2533333  1.0000000 0.2533333 3.000000    38
## [9]  {Sepal.Width=long,
##       Petal.Width=short}  => {Species=setosa} 0.2533333  1.0000000 0.2533333 3.000000    38
## [10] {Sepal.Length=short,
##       Petal.Length=short,
##       Petal.Width=short}  => {Species=setosa} 0.2666667  1.0000000 0.2666667 3.000000    40
## [11] {Sepal.Length=short,
##       Sepal.Width=long,
##       Petal.Length=short} => {Species=setosa} 0.1866667  1.0000000 0.1866667 3.000000    28
## [12] {Sepal.Length=short,
##       Sepal.Width=long,
##       Petal.Width=short}  => {Species=setosa} 0.1866667  1.0000000 0.1866667 3.000000    28
## [13] {Sepal.Width=long,
##       Petal.Length=short,
##       Petal.Width=short}  => {Species=setosa} 0.2533333  1.0000000 0.2533333 3.000000    38
## [14] {Sepal.Length=short,
##       Sepal.Width=long,
##       Petal.Length=short,
##       Petal.Width=short}  => {Species=setosa} 0.1866667  1.0000000 0.1866667 3.000000    28
```

```
### discretize all numeric columns differently
irisDisc <- discretizeDF(iris_vn, default = list(method = "interval", breaks = 2, labels = c("small", "l
head(irisDisc)
```

```
##   Sepal.Length Sepal.Width Petal.Length Petal.Width Species
## 1        small       large        small       small  setosa
## 2        small       small        small       small  setosa
## 3        small       large        small       small  setosa
## 4        small       small        small       small  setosa
## 5        small       large        small       small  setosa
## 6        small       large        small       small  setosa
```

```
trans1 <- transactions(irisDisc)
frequent_itemsets <- apriori(trans1,parameter = list(supp = 0.1, conf = 0.7, target = "rules"), appearar
```

```
## Apriori
##
## Parameter specification:
##  confidence minval smax arem  aval originalSupport maxtime support minlen
```

```
##         0.7    0.1    1 none FALSE            TRUE       5     0.1      1
##  maxlen target  ext
##      10  rules TRUE
##
## Algorithmic control:
##  filter tree heap memopt load sort verbose
##     0.1 TRUE TRUE  FALSE TRUE    2    TRUE
##
## Absolute minimum support count: 15
##
## set item appearances ...[1 item(s)] done [0.00s].
## set transactions ...[11 item(s), 150 transaction(s)] done [0.00s].
## sorting and recoding items ... [11 item(s)] done [0.00s].
## creating transaction tree ... done [0.00s].
## checking subsets of size 1 2 3 4 5 done [0.00s].
## writing ... [13 rule(s)] done [0.00s].
## creating S4 object  ... done [0.00s].
```

```
inspect(frequent_itemsets)
```

```
##      lhs                     rhs                 support confidence  coverage     lift count
## [1]  {Petal.Length=small} => {Species=setosa} 0.3333333  0.8196721 0.4066667 2.459016    50
## [2]  {Petal.Width=small}  => {Species=setosa} 0.3333333  0.7692308 0.4333333 2.307692    50
## [3]  {Sepal.Width=large,
##       Petal.Length=small} => {Species=setosa} 0.2533333  1.0000000 0.2533333 3.000000    38
## [4]  {Sepal.Width=large,
##       Petal.Width=small}  => {Species=setosa} 0.2533333  1.0000000 0.2533333 3.000000    38
## [5]  {Sepal.Length=small,
##       Sepal.Width=large}  => {Species=setosa} 0.2533333  0.9500000 0.2666667 2.850000    38
## [6]  {Petal.Length=small,
##       Petal.Width=small}  => {Species=setosa} 0.3333333  0.8474576 0.3933333 2.542373    50
## [7]  {Sepal.Length=small,
##       Petal.Length=small} => {Species=setosa} 0.3333333  0.8196721 0.4066667 2.459016    50
## [8]  {Sepal.Length=small,
##       Petal.Width=small}  => {Species=setosa} 0.3333333  0.7812500 0.4266667 2.343750    50
## [9]  {Sepal.Width=large,
##       Petal.Length=small,
##       Petal.Width=small}  => {Species=setosa} 0.2533333  1.0000000 0.2533333 3.000000    38
## [10] {Sepal.Length=small,
##       Sepal.Width=large,
##       Petal.Length=small} => {Species=setosa} 0.2533333  1.0000000 0.2533333 3.000000    38
## [11] {Sepal.Length=small,
##       Sepal.Width=large,
##       Petal.Width=small}  => {Species=setosa} 0.2533333  1.0000000 0.2533333 3.000000    38
## [12] {Sepal.Length=small,
##       Petal.Length=small,
##       Petal.Width=small}  => {Species=setosa} 0.3333333  0.8474576 0.3933333 2.542373    50
## [13] {Sepal.Length=small,
##       Sepal.Width=large,
##       Petal.Length=small,
##       Petal.Width=small}  => {Species=setosa} 0.2533333  1.0000000 0.2533333 3.000000    38
```

APPRENTISAGE SUPERVISÉ

Definition des critères de choix d'un bon projet.

terme	définition
précision d'une variable	c'est l'élément de la diagonale de la colonne divisé par la somme des element de la colonne
précision d'un jeu de données	c'est la moyenne des précisions des différentes variables du jeu de donnée
rappel d'une variable	c'est l'élément de la diagonale de la ligne divisé par la somme des elements de la ligne
rappel d'un jeu de données	c'est la moyenne des rappels des différentes variables du jeu de données
f messure	c'est le rapport de deux fois le rappel fois la precision par rapport à la somme rappel, précision
accurancy	c'est la somme des éléments de la diagonal divisé par la sommes de tous les éléments du dataset

```
# get caracteristics

caracterize_vn <- function(M){
  dataset_precision <- 0
  dataset_rapel <- 0
  diag_sum <- 0
  data_sum <- 0

  classe <- dim(M)[1]
  for(i in 1:classe){
    dataset_precision <- M[i,i]/sum(M[,i]) + dataset_precision
    dataset_rapel <- M[i,i]/sum(M[i,]) + dataset_rapel
    diag_sum <- M[i,i] + diag_sum
    data_sum <- sum(M[i,]) + data_sum
  }

  dataset_precision <- dataset_precision / classe
  dataset_rapel <- dataset_rapel / classe
  fmesure <- (2*dataset_rapel*dataset_precision)/(dataset_precision+dataset_rapel)
  accurance <- diag_sum / data_sum

  return (list(precision=dataset_precision, rappel=dataset_rapel, fmesure=fmesure, accurancy = accuranc
}
```

reseau de neurones

```
#install.packages('arulesViz')
library('nnet')
library('neuralnet')
```

```
data('iris')
iris1 = iris
```

```r
# binarisation de la classe Species
iris1 <- cbind(iris1, iris1$Species == 'setosa')
iris1 <- cbind(iris1, iris1$Species == 'versicolor')
iris1 <- cbind(iris1, iris1$Species == 'virginica')
names(iris1)[6] = 'setosa'
names(iris1)[7] = 'versicolor'
names(iris1)[8] = 'virginica'

# diviser en une partie d'apprentissage et une partie de test
V = sample(nrow(iris1), 2*nrow(iris1)/3)
iris1train = iris1[V,]
iris1test = iris1[-V,]
```

```r
# construction du model et affichage
nn <- neuralnet(setosa+versicolor+virginica ~ Sepal.Length+Sepal.Width+Petal.Length+Petal.Width, data=ir
plot(nn)
#model <- nnet(species ~ ., iris_vn1, size=10)
```

WTA : Le neuronne ayant la plus grande fonction d'activation est à 1

c(1) : dans la function apply permet de dire d'appliquer la function passé en paramètre suivant les lignes

c(2) : dans la function apply permet de dire d'appliquer la function passé en paramètre suivant les colonnes

```r
# prediction
mypredict <- compute(nn, iris1[c(1:4)])$net.result
maxidx <- function(arr){return(which(arr == max(arr)))}
idx <- apply(mypredict, c(1), maxidx)

prediction <- c('setosa','versicolor','virginica')[idx]
table(prediction,iris$Species)
```

```
##
## prediction   setosa versicolor virginica
##   setosa         50          0         0
##   versicolor      0         45         0
##   virginica       0          5        50
```