

MACHINE LEARNING: WEKA

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Making Learning: Weka

1. Motivación
2. Minería de datos
3. Weka
4. Aplicación
5. Conclusiones

Motivación

- * Noticia: La consultora Multinacional Everis precisa contratar a jóvenes recién **titulados especialistas** en áreas tecnológicas como el **Big Data y Business Intelligence**
- * **Motivar** a nuestros alumnos en las técnicas estadísticas y/o econométricas
- * Utilización de herramientas/**programas** de **libre acceso**

Minería de datos

- * **Ingentes** cantidades de **datos**
- * Necesidad de extraer **información útil** para la toma de decisiones. Estrategia competitiva
- * Minería de datos es una **tarea** dentro del **proceso KDD** (Knowledge Discovery in Database)
- * La **estadística** es una herramienta **fundamental** en la Minería de datos

Minería de datos vs Estadística

- * No hay línea divisora entre estadística y minería. Es una línea continua.
- * Muchas técnicas son estadísticas y la mayor parte de los algoritmos utilizan test estadísticos para construir normas o validar/evaluar los resultados.
- * Diferencia fundamental con la estadística es el tamaño del conjunto de datos.
 - * Estadística: Cientos o miles de datos
 - * Minería de datos: millones o miles de millones de datos

Minería de datos

Etapas extracción información útil:

1. Identificar objetivo/selección de datos
2. Pre-procesamiento de datos: 60%-70% del tiempo total
3. Minería de datos
4. Análisis de resultados
5. Asimilación de conocimiento

Minería de datos

Cosas que permite la minería de datos:

1. Predicción de comportamientos.
Ejemplo: Marketing dirigido
2. Predicción de tendencias. Ejemplo:
Predicción ventas
3. Descubrimiento de comportamientos desconocidos. Ejemplo: relaciones entre variables

Minería de datos

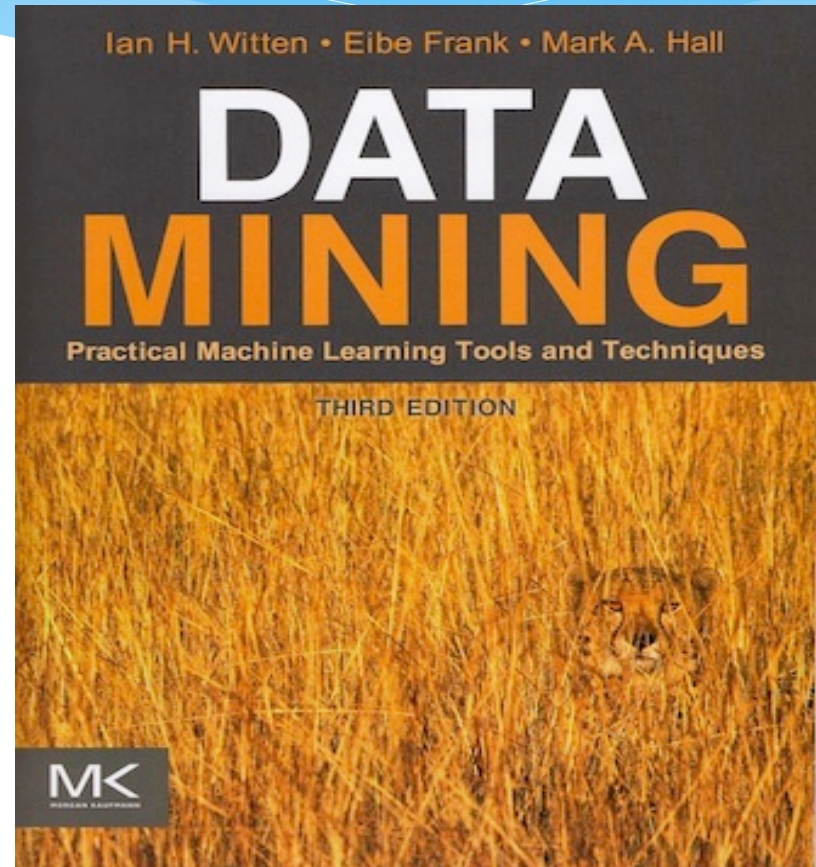
Técnicas de la minería de datos:

1. Redes neuronales
2. Árboles de decisión
3. Algoritmos
4. Regresión
5. Clustering

WEKA

- * Waikato Environment for Knowledge Analysis
- * Colección de algoritmos con licencia GNU-GPL
- * 1993, primera versión en C
- * 1997, versión en Java
- * <http://www.cs.waikato.ac.nz/ml/weka>
- * Windows, Mac y Linux
- * Ave endémica de Nueva Zelanda

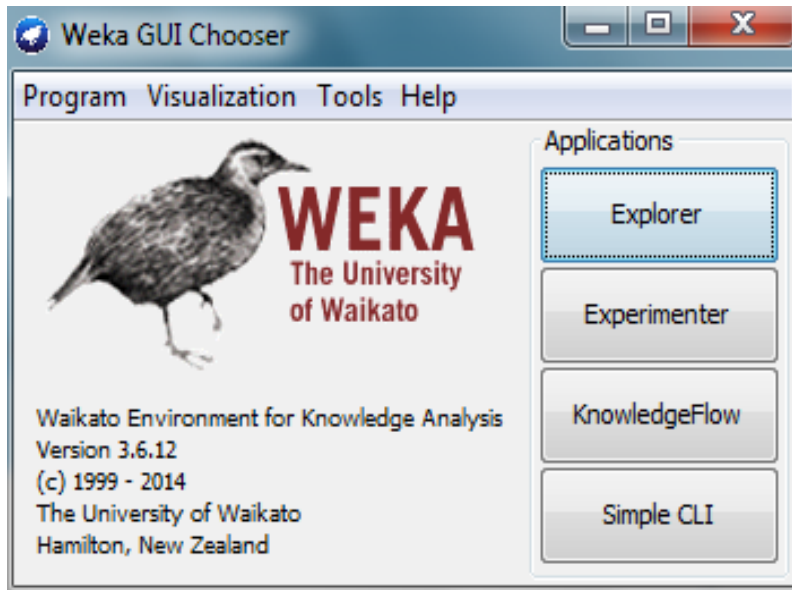
WEKA



WEKA

Cuatro entornos de trabajo:

1. **Explorer:** Uso de paquetes
2. **Experimenter:** Comparación de predicción
3. **KnowledgeFlow:** Aprendizaje incremental
4. **Simple CLI:** Comandos



Aplicación. Clasificación

PARADO	PRESTAM	RENTA	VIVPROP
0	0	6.943	1
0	0	17.889	1
1	0	1.138	1
1	0	8.093	0
1	0	4.116	1
1	0	6.785	1
1	0	7.278	1
1	0	2.749	1
1	0	6.433	1
1	0	8.359	1
1	0	7.174	0
1	0	5.004	0
0	0	5.558	1
1	0	4.511	1
1	0	6.286	1
1	0	5.965	1
1	0	7.729	1
1	0	4.882	0
1	0	9.261	0
0	1	14.219	1
0	0	14.996	1

- * Datos utilizados antigua licenciatura ADE
- * 1000 observaciones
- * ¿Reciben o no préstamo bancario?
- * Situación laboral
- * Renta
- * Propietario o no de vivienda

Aplicación. Clasificación

Dependent Variable: PRESTAM

Method: ML - **Binary Logit** (Quadratic hill climbing)

Sample: 1 1000

Included observations: 1000

Convergence achieved after 6 iterations

Covariance matrix computed using second derivatives

	Coefficient	Std. Error	z-Statistic	Prob.
C	-4.214824	0.516033	-8.167736	0.0000
RENTA	0.142950	0.018250	7.832665	0.0000
PARADO	-0.969263	0.270492	-3.583334	0.0003
VIVPROP	0.719559	0.488548	1.472853	0.1408
McFadden R-squared	0.215358	Mean dependent var	0.086000	
S.D. dependent var	0.280504	S.E. of regression	0.253246	
Akaike info criterion	0.468089	Sum squared resid	63.87690	
Schwarz criterion	0.487720	Log likelihood	-230.0446	
Hannan-Quinn criter.	0.475550	Restr. log likelihood	-293.1843	
LR statistic	126.2794	Avg. log likelihood	-0.230045	
Prob(LR statistic)	0.000000			
Obs with Dep=0	914	Total obs	1000	
Obs with Dep=1	86			

Resultados del modelo:

- * Renta incrementa probabilidad de recibir préstamo
- * Estar parado disminuye la probabilidad de recibir préstamo
- * Poseer vivienda propia no afecta

Aplicación. Clasificación

Dependent Variable: PRESTAM

Method: ML - Binary Logit (Quadratic hill climbing)

Sample: 1 1000. Included observations: 1000

Prediction Evaluation (success cutoff C = 0.5)

	Estimated Equation			Constant Probability		
	Dep=0	Dep=1	Total	Dep=0	Dep=1	Total
P(Dep=1)≤C	901	72	973	914	86	1000
P(Dep=1)>C	13	14	27	0	0	0
Total	914	86	1000	914	86	1000
Correct	901	14	915	914	0	914
% Correct	98.58	16.28	91.50	100.00	0.00	91.40
% Incorrect	1.42	83.72	8.50	0.00	100.00	8.60
Total Gain*	-1.42	16.28	0.10			
Percent Gain**	NA	16.28	1.16			

WEKA. Clasificación

Weka Explorer

Preprocess | Classify | Cluster | Associate | Select attributes | Visualize

Open file... Open URL... Open DB... Generate... Undo Edit... Save...

Filter: Choose **NominalToBinary** -R first-last Apply

Current relation
Relation: prestam-weka.filters.unsupervised.attribute.NumericToNom...
Instances: 1000 Attributes: 4

Attributes

All None Invert Pattern

No.	Name
1	<input type="checkbox"/> PARADO
2	<input checked="" type="checkbox"/> PRESTAM
3	<input type="checkbox"/> RENTA
4	<input type="checkbox"/> VIVPROP

Remove

Status: OK

Selected attribute
Name: PRESTAM
Missing: 0 (0%) Distinct: 2 Type: Numeric
Unique: 0 (0%)

Statistic	Value
Minimum	0
Maximum	1
Mean	0.086
StdDev	0.281

Class: VIVPROP (Num) Visualize All

Value	Count
0	914
1	86

Log x 0

WEKA. Clasificación

Weka Explorer

Preprocess | Classify | Cluster | Associate | Select attributes | Visualize

Open file... Open URL... Open DB... Generate... Undo Edit... Save...

Filter: Choose **NumericToNominal** -R first-last Apply

Current relation
Relation: prestam-weka.filters.unsupervised.attribute.NumericToNom...
Instances: 1000 Attributes: 4

Attributes

All None Invert Pattern

No.	Name
1	<input type="checkbox"/> PARADO
2	<input checked="" type="checkbox"/> PRESTAM
3	<input type="checkbox"/> RENTA
4	<input type="checkbox"/> VIVPROP

Remove

Selected attribute
Name: PRESTAM Type: Nominal
Missing: 0 (0%) Distinct: 2 Unique: 0 (0%)

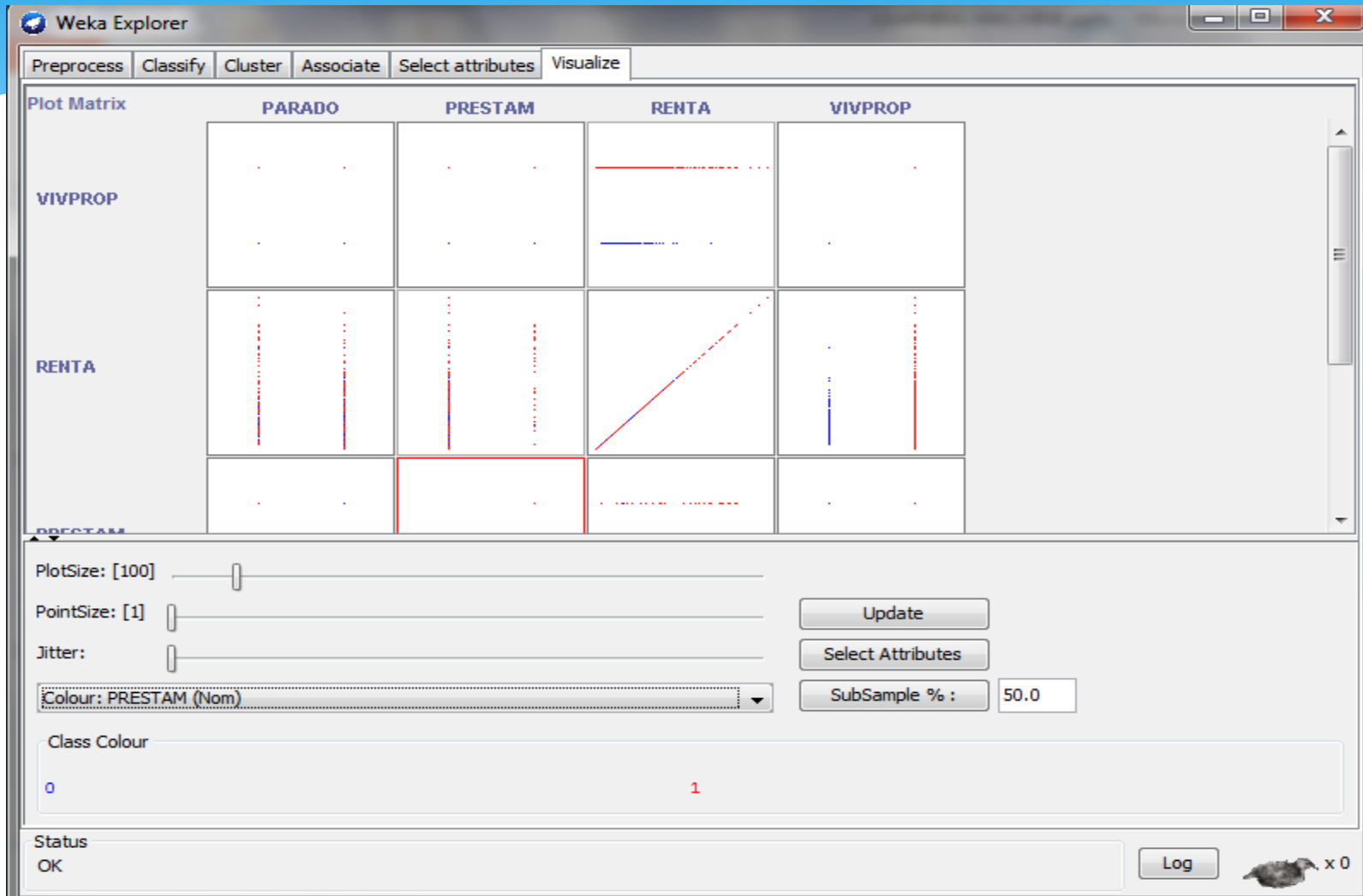
No.	Label	Count
1	0	914
2	1	86

Class: VIVPROP (Num) Visualize All

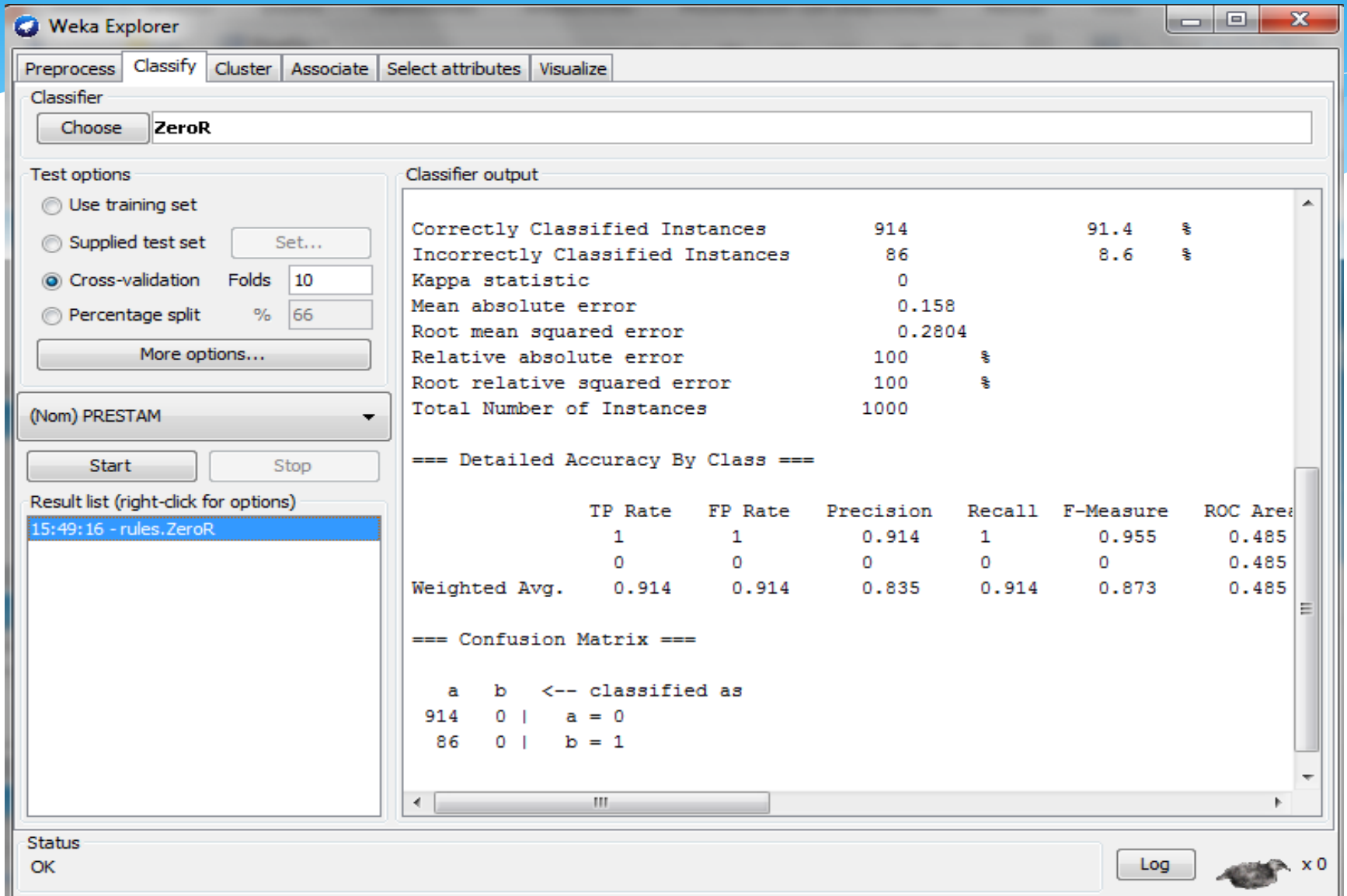
Label	Count
0	914
1	86

Status: OK Log x 0

WEKA. Clasificación



WEKA. Clasificación



The screenshot shows the Weka Explorer application window. The 'Classify' tab is active, and the 'ZeroR' classifier is selected. The 'Test options' section shows 'Cross-validation' with 10 folds. The 'Classifier output' pane displays the following results:

Correctly Classified Instances 914 91.4 %
Incorrectly Classified Instances 86 8.6 %
Kappa statistic 0
Mean absolute error 0.158
Root mean squared error 0.2804
Relative absolute error 100 %
Root relative squared error 100 %
Total Number of Instances 1000

=== Detailed Accuracy By Class ===

	TP Rate	FP Rate	Precision	Recall	F-Measure	ROC Area
1	1	1	0.914	1	0.955	0.485
0	0	0	0	0	0	0.485
Weighted Avg.	0.914	0.914	0.835	0.914	0.873	0.485

=== Confusion Matrix ===

a	b	<-- classified as
914	0	a = 0
86	0	b = 1

The 'Result list' shows a single entry: '15:49:16 - rules.ZeroR'. The status bar at the bottom indicates 'Status OK' and a 'Log' button.

WEKA. Clasificación

The screenshot shows the Weka Explorer application window. The 'Classify' tab is active. On the left, a tree view shows the 'weka' directory containing 'classifiers', 'functions', 'lazy', 'meta', 'mi', 'misc', 'rules', and 'trees'. Under 'rules', several classifiers are listed, with 'ZeroR' selected. The main area displays the following performance metrics:

```
Classified Instances      914      91.4 %
Classified Instances      86       8.6 %
Confusion matrix
Confusion error          0.158
Confusion squared error  0.2804
Confusion absolute error 100 %
Confusion squared error 100 %
Number of Instances      1000
```

Accuracy By Class ===

	TP Rate	FP Rate	Precision	Recall	F-Measure	ROC Area
0	1	1	0.914	1	0.955	0.485
1	0	0	0	0	0	0.485
Average	0.914	0.914	0.835	0.914	0.873	0.485

Confusion Matrix ===

```
-- classified as
a = 0
b = 1
```

The status bar at the bottom shows 'Status OK' and a 'Log' button.

WEKA. Clasificación

The screenshot shows the Weka Explorer window with the 'Classify' tab selected. The classifier chosen is 'Logistic -R 1.0E-8 -M -1'. The test options are set to 'Cross-validation' with 10 folds and a 66% split. The result list shows the 'Logistic' model is selected. The classifier output displays the following statistics:

Metric	Value	Percentage
Correctly Classified Instances	916	91.6 %
Incorrectly Classified Instances	84	8.4 %
Kappa statistic	0.2307	
Mean absolute error	0.129	
Root mean squared error	0.2536	
Relative absolute error	81.6533	%
Root relative squared error	90.4465	%
Total Number of Instances	1000	

Below the main statistics, a 'Detailed Accuracy By Class' table is shown:

	TP Rate	FP Rate	Precision	Recall	F-Measure	ROC Area
Class 0	0.986	0.826	0.927	0.986	0.955	0.808
Class 1	0.174	0.014	0.536	0.174	0.263	0.808
Weighted Avg.	0.916	0.756	0.893	0.916	0.896	0.808

Finally, a 'Confusion Matrix' is displayed:

```
=== Confusion Matrix ===
 a  b  <-- classified as
901 13 |  a = 0
 71 15 |  b = 1
```

The status bar at the bottom indicates 'OK' and a 'Log' button is visible.

WEKA. Clasificación

The screenshot shows the Weka Explorer application window. The 'Classify' tab is active, and the 'Classifier' dropdown is set to 'J48 -C 0.25 -M 2'. The 'Test options' section has 'Cross-validation' selected with 'Folds' set to 10. The 'Result list' on the left shows three entries, with '14:00:44 - trees.J48' selected. The 'Classifier output' pane displays the following performance metrics:

Metric	Value	Percentage	Symbol
Correctly Classified Instances	916	91.6	%
Incorrectly Classified Instances	84	8.4	%
Kappa statistic	0.2948		
Mean absolute error	0.1355		
Root mean squared error	0.2648		
Relative absolute error	85.7613		%
Root relative squared error	94.4311		%
Total Number of Instances	1000		

Below the main metrics, there is a section for 'Detailed Accuracy By Class' with the following table:

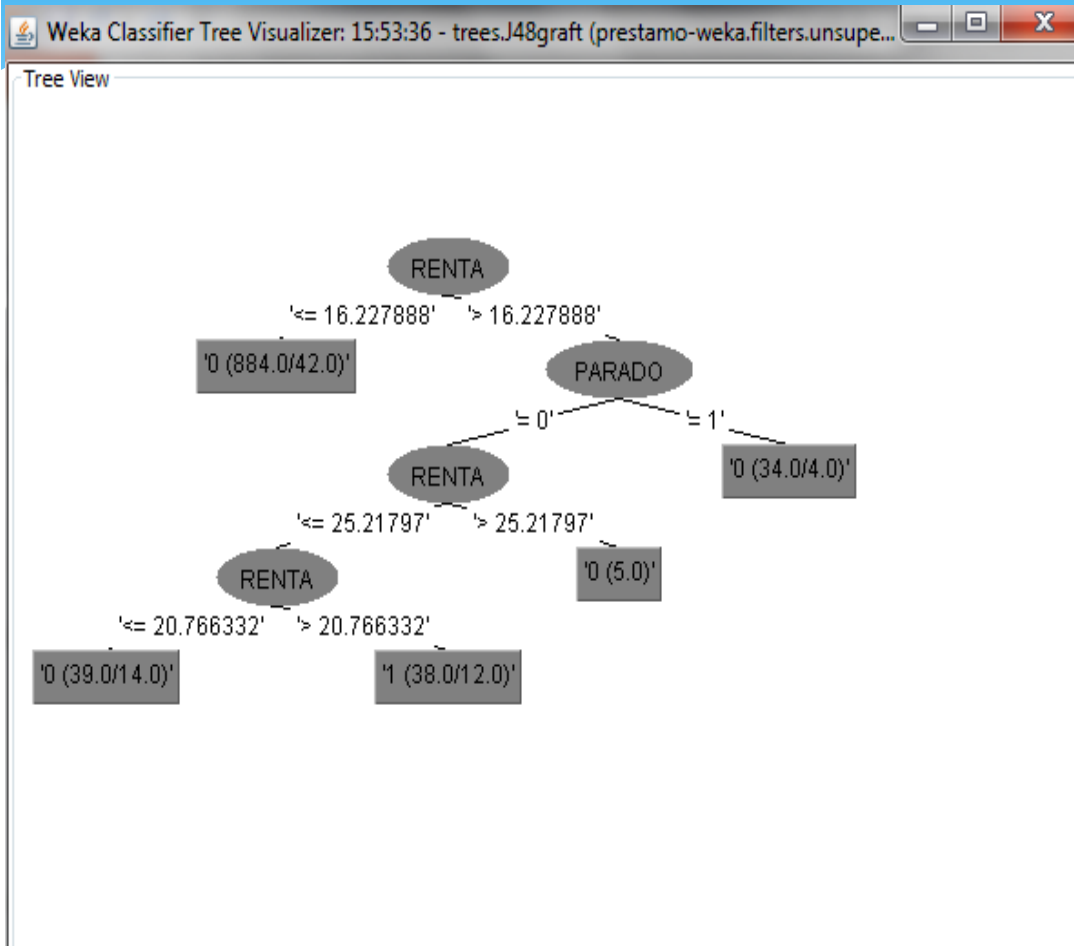
	TP Rate	FP Rate	Precision	Recall	F-Measure	ROC Area
Class 0	0.979	0.756	0.932	0.979	0.955	0.719
Class 1	0.244	0.021	0.525	0.244	0.333	0.719
Weighted Avg.	0.916	0.693	0.897	0.916	0.902	0.719

Finally, the 'Confusion Matrix' is shown as follows:

```
=== Confusion Matrix ===
 a  b  <-- classified as
895 19 |  a = 0
 65 21 |  b = 1
```

The status bar at the bottom indicates 'Status OK' and includes a 'Log' button and a small icon.

WEKA. Clasificación



Reciben préstamo bancario quienes tienen rentas superiores a 20,7 y no están en desempleo

WEKA. Clasificación

The screenshot shows the Weka Explorer interface with the 'Classify' tab selected. The classifier chosen is 'SimpleCart -S 1 -M 2.0 -N 5 -C 1.0'. The test options are set to 'Cross-validation' with 10 folds. The dataset '(Nom) PRESTAM' is loaded. The classifier output is displayed in a text area, showing overall performance metrics and a detailed accuracy table by class.

Classifier
Choose **SimpleCart -S 1 -M 2.0 -N 5 -C 1.0**

Test options
 Use training set
 Supplied test set (Set...)
 Cross-validation Folds: 10
 Percentage split %: 66
More options...

Classifier output

```
Correctly Classified Instances      924      92.4 %
Incorrectly Classified Instances    76       7.6 %
Kappa statistic                    0.3437
Mean absolute error                 0.1288
Root mean squared error             0.2591
Relative absolute error             81.5444 %
Root relative squared error         92.3972 %
Total Number of Instances          1000
```

=== Detailed Accuracy By Class ===

	TP Rate	FP Rate	Precision	Recall	F-Measure	ROC Area
0	0.986	0.733	0.935	0.986	0.96	0.683
1	0.267	0.014	0.639	0.267	0.377	0.683
Weighted Avg.	0.924	0.671	0.909	0.924	0.909	0.683

=== Confusion Matrix ===

```
 a  b  <-- classified as
901 13 |  a = 0
 63 23 |  b = 1
```

Status
OK

Log x 0

WEKA. Clasificación

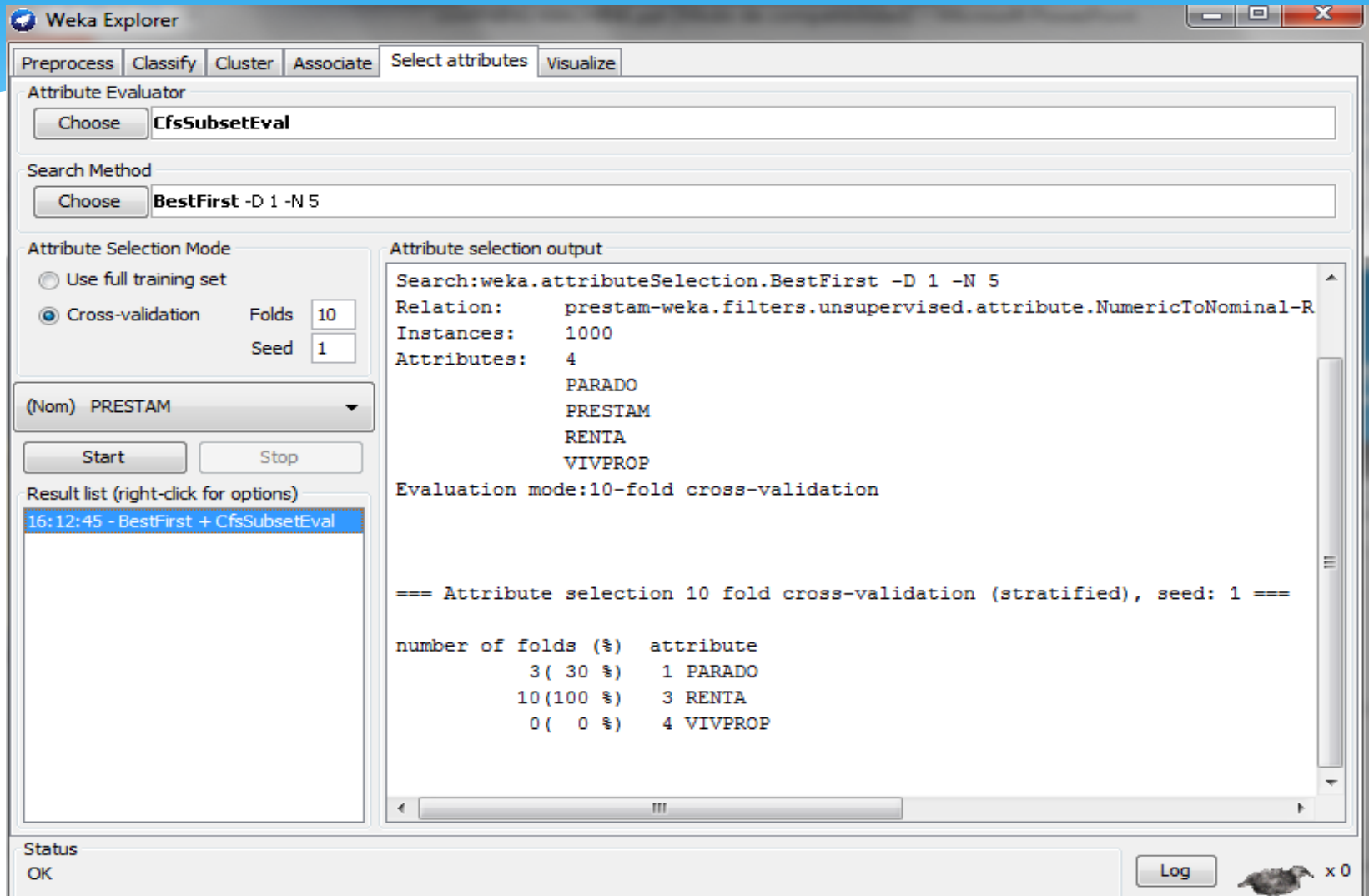
CART Decision Tree

```
RENTA < 16.421594499999998: 0(842.0/42.0)
RENTA >= 16.421594499999998
| PARADO=(0)
| | RENTA < 25.2920725
| | | RENTA < 21.075501
| | | | RENTA < 17.166837: 1(2.0/0.0)
| | | | RENTA >= 17.166837
| | | | | RENTA < 20.3251475
| | | | | RENTA < 19.2279765
| | | | | | RENTA < 17.666596: 0(2.0/0.0)
| | | | | | RENTA >= 17.666596
| | | | | | | RENTA < 18.845913
| | | | | | | | RENTA < 18.242503499999998: 0(8.0/4.0)
| | | | | | | | RENTA >= 18.242503499999998: 1(2.0/0.0)
| | | | | | | | RENTA >= 18.845913: 0(2.0/0.0)
| | | | | | | RENTA >= 19.2279765: 1(2.0/0.0)
| | | | | | RENTA >= 20.3251475: 0(13.0/4.0)
| | | | RENTA >= 21.075501: 1(26.0/12.0)
| | RENTA >= 25.2920725: 0(5.0/0.0)
| PARADO!=(0): 0(30.0/4.0)
```

Number of Leaf Nodes: 11

Size of the Tree: 21

WEKA. Clasificación



The screenshot shows the Weka Explorer application window. The 'Select attributes' tab is active. The 'Attribute Evaluator' is set to 'CfsSubsetEval' and the 'Search Method' is 'BestFirst -D 1 -N 5'. The 'Attribute Selection Mode' is set to 'Cross-validation' with 10 folds and a seed of 1. The dataset '(Nom) PRESTAM' is selected. The 'Attribute selection output' pane displays the following text:

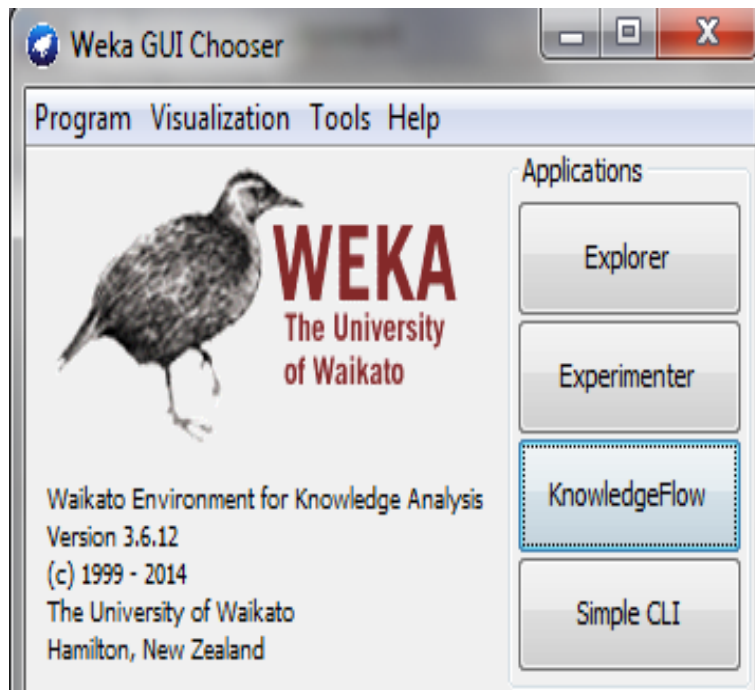
```
Search:weka.attributeSelection.BestFirst -D 1 -N 5
Relation:   prestam-weka.filters.unsupervised.attribute.NumericToNominal-R
Instances:  1000
Attributes: 4
            PARADO
            PRESTAM
            RENTA
            VIVPROP
Evaluation mode:10-fold cross-validation

=== Attribute selection 10 fold cross-validation (stratified), seed: 1 ===

number of folds (%)  attribute
                   3 ( 30 %)  1 PARADO
                   10(100 %)  3 RENTA
                   0 (  0 %)  4 VIVPROP
```

The 'Result list' shows a single entry: '16:12:45 - BestFirst + CfsSubsetEval'. The status bar at the bottom indicates 'Status OK' and 'Log'.

WEKA. Clasificación



EXPERIMENTER:

Comparar varios algoritmos de clasificación:

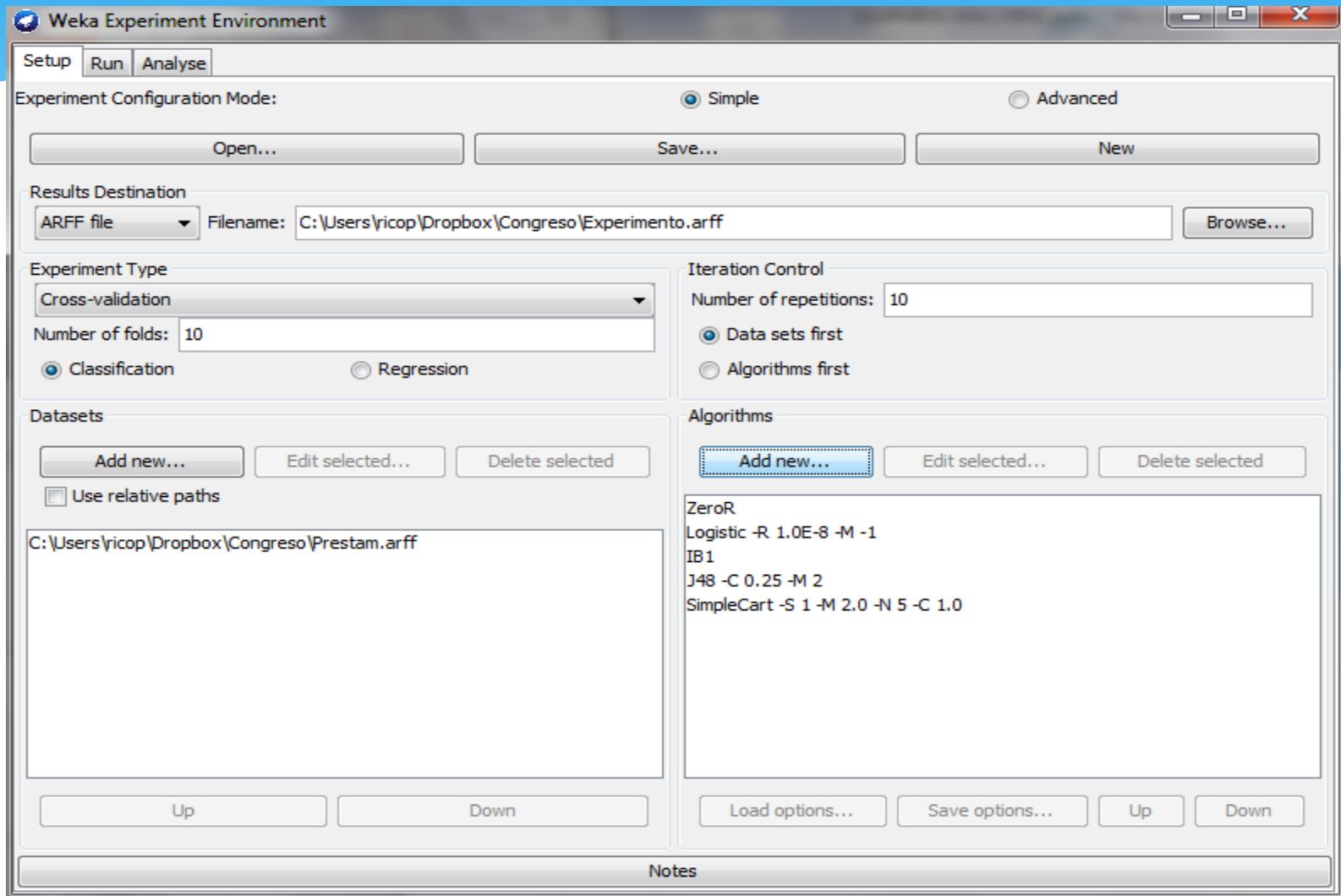
ZeroR

Logit

Tree

Lazy

WEKA. Clasificación



WEKA. Clasificación

The screenshot displays the Weka Experiment Environment window. The interface is divided into several sections:

- Source:** Shows "Got 500 results" and buttons for "File...", "Database...", and "Experiment".
- Configure test:** Contains various settings:
 - Testing with: Paired T-Tester (corrected)
 - Row: Select
 - Column: Select
 - Comparison field: Percent_correct
 - Significance: 0.05
 - Sorting (asc.) by: <default>
 - Test base: Select
 - Displayed Columns: Select
 - Show std. deviations:
 - Output Format: Select
- Test output:** Displays test results:
 - Tester: weka.experiment.PairedCorrectedTTester
 - Analysing: Percent_correct
 - Datasets: 1
 - Resultsets: 5
 - Confidence: 0.05 (two tailed)
 - Sorted by: -
 - Date: 12/05/15 14:26

Dataset (1) rules.ZeroR '' | (2) functions.L (3) ...

Dataset	(1) rules.ZeroR ''	(2) functions.L	(3) ...
prestam-weka.filters.unsu(100)	78.40(0.49)	78.40(0.49)	69

(v/ /*) | (0/1/0)

Key:
(1) rules.ZeroR '' 48055541465867954
(2) functions.Logistic '-R 1.0E-8 -M -1' 3932117032546553727
(3) lazy.IB1 '' -6152184127304895851
(4) trees.J48 '-C 0.25 -M 2' -217733168393644444
(5) trees.SimpleCart '-S 1 -M 2.0 -N 5 -C 1.0' 4154189200352566053
- Result list:** Shows a list of results with a scroll bar. The selected item is "14:26:59 - Percent_correct - rules.ZeroR " 4805554146".

WEKA. Clasificación

```
Dataset                (1) rules.ZeroR '' | (2) functions.L (3) lazy.IB1 '' (4) trees.J48 ' (5) trees.Simpl
-----
prestam-weka.filters.unsu(100)  78.40(0.49) | 78.40(0.49)  69.99(4.27) * 78.40(0.49)  78.37(0.56)
-----
                               (v/ /*) |      (0/1/0)      (0/0/1)      (0/1/0)      (0/1/0)
```

Key:

- (1) rules.ZeroR '' 48055541465867954
- (2) functions.Logistic '-R 1.0E-8 -M -1' 3932117032546553727
- (3) lazy.IB1 '' -6152184127304895851
- (4) trees.J48 '-C 0.25 -M 2' -217733168393644444
- (5) trees.SimpleCart '-S 1 -M 2.0 -N 5 -C 1.0' 4154189200352566053

Aplicación. Cluster

V1	V2	V3	V4	V5	V6
6	4	7	3	2	3
2	3	1	4	5	4
7	2	6	4	1	3
4	6	4	5	3	6
1	3	2	2	6	4
6	4	6	3	3	4
5	3	6	3	3	4
7	3	7	4	1	4
2	4	3	3	6	3
3	5	3	6	4	6
1	3	2	3	5	3
5	4	5	4	2	4
2	2	1	5	4	4
4	6	4	6	4	7
6	5	4	2	1	4
3	5	4	6	4	7
4	4	7	2	2	5
3	7	2	6	4	3
4	6	3	7	2	7
2	3	2	4	7	2

- * V1: Salir de compras es divertido
- * V2: Salir de compras afecta al presupuesto
- * V3: Combinar salir de compras con comida fuera
- * V4: Salir de compras para hacer las mejores compras
- * V5: No me importa salir de compras
- * V6: Se puede ahorrar dinero comparando precios

Aplicación. Clúster

Objetivo: Agrupar consumidores homogéneos frente a su actitud hacia las compras

Fuente: “Análisis de conglomerados” Santiago de la Fuente Fernández. UAM, 2011

WEKA CLUSTERING

Weka Explorer

Preprocess | Classify | Cluster | Associate | Select attributes | Visualize

Open file... Open URL... Open DB... Generate... Undo Edit... Save...

Filter: Choose **None** Apply

Current relation
Relation: IE-weka.filters.unsupervised.attribute.NumericToNominal-R...
Instances: 20 Attributes: 6

Attributes

All None Invert Pattern

No.	Name
1	<input checked="" type="checkbox"/> V1
2	<input type="checkbox"/> V2
3	<input type="checkbox"/> V3
4	<input type="checkbox"/> V4
5	<input type="checkbox"/> V5
6	<input type="checkbox"/> V6

Remove

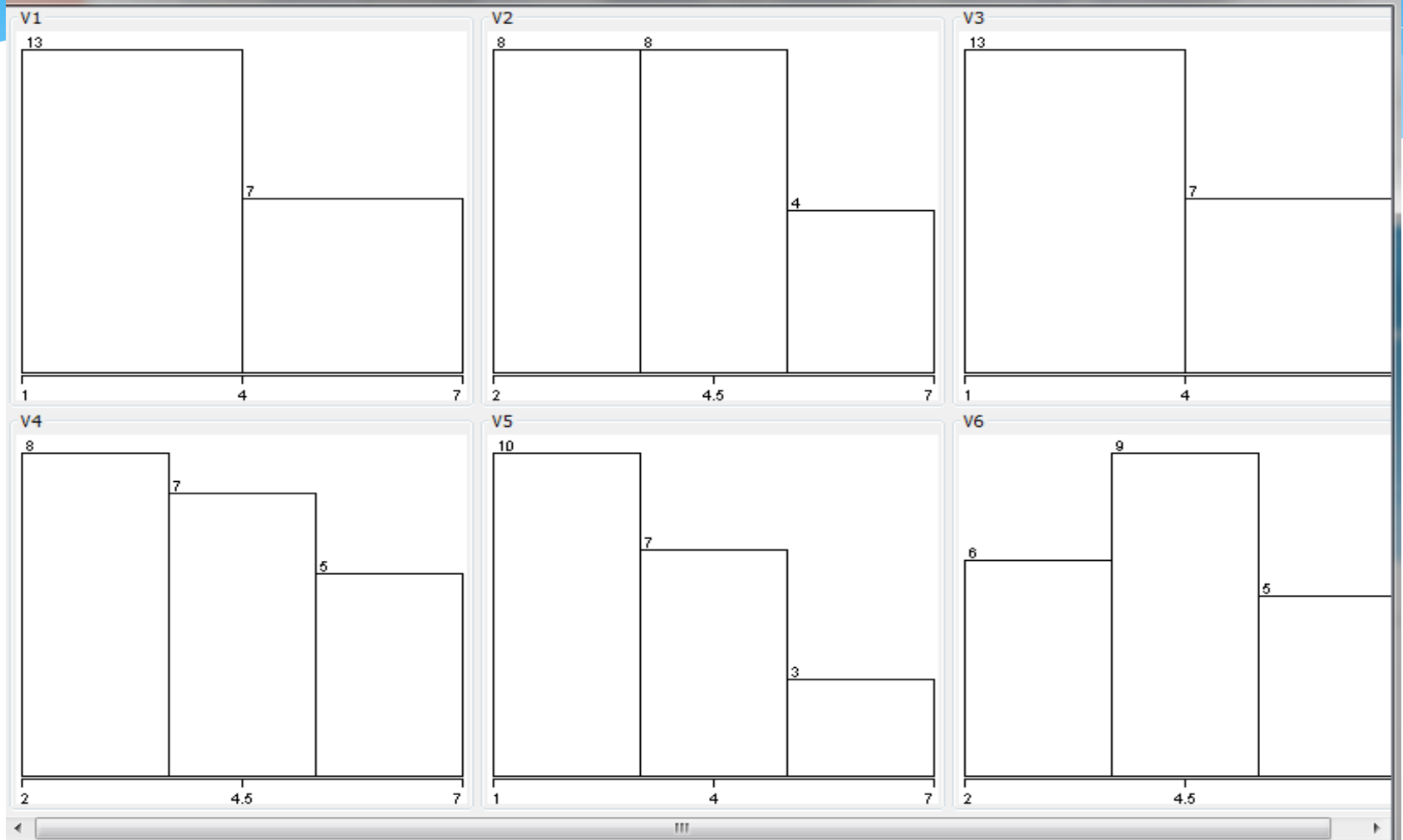
Selected attribute
Name: V1 Type: Numeric
Missing: 0 (0%) Distinct: 7 Unique: 0 (0%)

Statistic	Value
Minimum	1
Maximum	7
Mean	3.85
StdDev	1.899

Class: V6 (Num) Visualize All

Status: OK Log x 0

WEKA CLUSTERING



WEKA

The image shows the WEKA Explorer interface with the SimpleKMeans clusterer configuration dialog open. The main window has tabs for Preprocess, Classify, Cluster, Associate, Select attributes, and Visualize. The Clusterer tab is active, showing SimpleKMeans with parameters: -N 2 -A "weka.core.EuclideanDistance -R first-last" -I 500 -S 10. The Cluster mode section includes options for training set, test set, percentage split (66%), and visualization. The dialog box, titled 'weka.gui.GenericObjectEditor', shows the SimpleKMeans class and its configuration: displayStdDevs (False), distanceFunction (EuclideanDistance -R first-last), dontReplaceMissingValues (False), maxIterations (500), numClusters (2), preserveInstancesOrder (False), and seed (10). Buttons for Open..., Save..., OK, and Cancel are at the bottom of the dialog.

Weka Explorer

Preprocess Classify Cluster Associate Select attributes Visualize

Clusterer

Choose **SimpleKMeans** -N 2 -A "weka.core.EuclideanDistance -R first-last" -I 500 -S 10

Cluster mode

Use training set

Supplied test set Set...

Percentage split % 66

Classes to clusters evaluation

(Num) V6

Store clusters for visualization

Ignore attributes

Start Stop

Result list (right-click for options)

Clusterer output

weka.gui.GenericObjectEditor

weka.clusterers.SimpleKMeans

About

Cluster data using the k means algorithm. More Capabilities

displayStdDevs False

distanceFunction Choose **EuclideanDistance** -R first-last

dontReplaceMissingValues False

maxIterations 500

numClusters 2

preserveInstancesOrder False

seed 10

Open... Save... OK Cancel

Status OK Log x 0

WEKA

kMeans

=====

Number of iterations: 3

Within cluster **sum of squared errors: 6.09**

Missing values globally replaced with mean/mode

Cluster centroids:

Attribute	Full Data (20)	Cluster#	
		0 (12)	1 (8)
V1	3.85	2.58	5.75
V2	4.10	4.42	3.62
V3	3.95	2.58	6
V4	4.10	4.75	3.12
V5	3.45	4.50	1.87
V6	4.35	4.67	3.87

Time taken to build model (full training data) : 0.02 seconds

=== Model and evaluation on training set ===

Clustered Instances

0	12 (60%)
1	8 (40%)

WEKA

kMeans

=====

Number of iterations: 3

Within cluster **sum of squared errors: 2.72**

Missing values globally replaced with mean/mode

Cluster centroids:

Attribute	Full Data (20)	Cluster#		
		0 (6)	1 (8)	2 (6)
V1	3.85	3.50	5.75	1.67
V2	4.10	5.83	3.62	3
V3	3.95	3.33	6	1.83
V4	4.10	6	3.12	3.5
V5	3.45	3.5	1.87	5.5
V6	4.35	6	3.87	3.33

Time taken to build model (full training data) : 0 seconds

=== Model and evaluation on training set ===

Clustered Instances

0 6 (30%)
1 8 (40%)
2 6 (30%)

WEKA

- * Primer clúster corresponde a consumidores ahorrativos: V2, V4 y V6 elevados
- * Segundo clúster corresponde a consumidores que disfrutan con las compras: V1 y V3 elevados
- * Tercer clúster corresponde a consumidores apáticos: V1 y V3 bajos y V5 elevado

- * V1: Salir de compras es divertido
- * V2: Salir de compras afecta al presupuesto
- * V3: Combinar salir de compras con comida fuera
- * V4: Salir de compras para hacer las mejores compras
- * V5: No me importa salir de compras
- * V6: Se puede ahorrar dinero comparando precios

CONCLUSIONES

- * Alumnos: mejorar las competencias en estadística
- * Reflexionar sobre planes de estudios en ciencias económicas y empresariales
- * Fomentar el uso de software libre entre el alumnado



**MUCHAS GRACIAS
POR VUESTRA
ATENCIÓN**