## Index

0 – 1 loss function, 160	antecedent, of rule, 67, 69
0.632 bootstrap, 155	AODE. See averaged one-dependence estimator
1R (1-rule), 86–90	AODE algorithm, 446t–450t, 451
discretization, 315	AODEsr algorithm, 446t–450t, 451
example use, 87t	applications, 375–399
learning procedure, 89–90	automation, 28
missing values and numeric data, 87–89	challenge of, 375
overfitting for, 88	data stream learning, 380–383
pseudocode, 86f	diagnosis, 25–26
11-point average recall, 175	fielded, 21–28
11 point average recan, 175	incorporating domain knowledge, 384–386
A	massive datasets, 378–380
accuracy, of association rules, 72, 73, 116	message classifier, 531–538
minimum, 72, 119, 122–123	text mining, 386–389
accuracy, of classification rules, 110, 205	Apriori algorithm, 216
activation function, 241–242	Apriori rule learner, 485–486, 486t
acuity parameter, 281	default options, 582
AD trees. See all-dimensions trees	output for association rules, 430f
AdaBoost, 358–361	parameters, 584
AdaBoostM1 algorithm, 358–359, 475t, 476–477	area under the curve (AUC), 177, 580
Add filter, 433t–435t, 436	area under the precision-recall curve (AUPRC), 177
AddClassification filter, 444t, 445	ARFF files, 52–56
AddCluster filter, 433t–435t, 436–437	attribute specifications in, 54
AddExpression filter, 433t–435t, 437	attribute types in, 54
AddID filter, 433t–435t, 436	converting files to, 417–419
additive logistic regression, 364–365	defined, 52–56
additive logistic regression, 362–365	illustrated, 53f
AdditiveRegression algorithm, 475t, 476	in Weka, 407
AddNoise filter, 433t–435t, 441, 568	arithmetic underflow, 266–267
AddValues filter, 433t–435t, 441, 368	assignment of key phrases, 387–388
ADTree algorithm, 446t–450t, 457	association learning, 40
adversarial data mining, 393–395	association rule mining, 582–584
agglomerative clustering, 273, 275–276	association rules, 11, 72–73. See also rules
Akaike Information Criterion (AIC), 267, 456	accuracy (confidence), 72–73, 116
algorithms. See specific Weka algorithms	characteristics, 72
all-dimensions (AD) trees, 270–271	computation requirement, 123–124
generation, 271–272	converting item sets to, 119
illustrated examples, 271f	coverage (support), 72, 116
alternating decision trees, 366–367	double-consequent, 123
example, 367, 367f	examples, 11
prediction nodes, 366–367	finding, 116
*	•
splitter nodes, 366–367	finding large item sets, 219–222
Analyze panel, 505–509, 512–515	frequent-pattern tree, 216–219
ancestor-of relation, 46	mining, 116–124
AND, 233	predicting multiple consequences, 72
anomalies, detecting, 334–335	relationships between, 73

*Note:* Page numbers followed by "f" indicates a figure, "t" indicates a table, and "b" indicates entry is inside boxed text.

association rules (continued)	ordinal, 50–51
single-consequent, 123	ratio, 50
in Weka, 429–430	relations between, 77
association-rule learners, 485-487	relation-valued, 54-55
attribute evaluation methods, 487-494	relevant, 308
attribute subset evaluators, 488	removing, 436–438
list of, 489t	semantic relation between, 384
single-attribute evaluators, 490-492	string, 54, 579–580
attribute filters, 432	string, conversion, 439–440
supervised, 443–445	types of, 39, 56–58
unsupervised, 432–441	values of, 49
attribute selection, 306, 307–314. See also data	values of, changing, 438
transformation	weighting, 246–247
backward elimination, 311–312	AttributeSelectedClassifier algorithm, 475t, 478,
beam search, 312	582
best-first search, 312	AttributeSelection filter, 444, 444t
filter method, 308-309	AttributeSummarizer, 498, 499t
forward selection, 311–312	AUC. See area under the curve
instance-based learning methods, 310	AUPRC. See area under the precision-recall
nearest-neighbor learning, 567–568	curve
race search, 313	authorship ascription, 387–388
recursive feature elimination, 309-310	AutoClass, 273, 291, 293
schemata search, 313	automatic attribute selection, 562, 575-576
scheme-independent, 308-310	automatic parameter tuning, 577–578
scheme-specific, 312–314	automation applications, 28
searching the attribute space and, 311–312	averaged one-dependence estimator (AODE),
selective Naïve Bayes, 314	269, 451
symmetric uncertainty, 310b	average-linkage method, 275-276
in Weka, 430	
Weka evaluation methods for, 487-494	В
Weka Explorer exercise, 575–577	background knowledge, 380
Weka search methods for, 490t	backpropagation, 235–241
wrapper method, 308-309	stochastic, 238b–239b
attribute subset evaluators, 488	backward elimination, 311-312
attribute-efficient learners, 131	backward pruning, 195
attributes, 9-10, 39, 49	bagging, 352–356
adding, 436–438	algorithm for, 355f
ARFF format, 54	bias-variance decomposition, 353–355
Boolean, 51	with costs, 355–356
causal relations, 384	idealized procedure versus, 354
combination of, 116	instability neutralization, 354
conversions, 438–439	for numeric prediction, 354–355
date, 54	as parallel, 379
difference, 132	randomization versus, 357
discrete, 51	in Weka, 474–479
evaluating, 87t	Bagging algorithm, 474, 475t
highly branching, 105–107	bags, 141–142
identification code, 88	class labels, 142–143
interval, 50	instances, joining, 300
irrelevant, 308	positive, 301–302
nominal, 49, 289	positive probability, 302
normalized, 57	balanced iterative reducing and clustering using
numeric, 49, 193–194	hierarchies (BIRCH), 293

D. I. 1377 121	1 16 262
Balanced Winnow, 131	classifiers, 362
ball trees, 135	in computational learning theory, 361
in finding nearest neighbors, 136	decision stumps, 362
illustrated, 136f	forward stagewise additive modeling, 362
nodes, 135–136	power of, 361–362
splitting method, 136–137	in Weka, 476–477
two cluster centers, 141f	bootstrap, 155–156
batch learning, 238b–239b	bootstrap aggregating. See bagging
Bayes Information Criterion, 293	Boundary Visualizer, 571, 574
Bayesian clustering, 290–292	buildClassifier() method, 537–538, 540, 555
AutoClass, 291	
DensiTree, 292, 292f	C
hierarchical, 292	C4.5, 108, 198b, 201–202, 307–308
Bayesian multinet, 270	functioning of, 201
Bayesian networks, 143, 261-273	MDL-based adjustment, 201-202
algorithms, 268-270	C5.0, 254–255
AD tree, 270–272, 271f	calibration, class probability, 343-346
conditional independence, 264-266	discretization-based, 345
data structures for fast learning, 270–272	logistic regression, 346
example illustrations, 263f, 265f	PAV-based, 345-346
K2 algorithm, 273	Capabilities class, 540, 556-557
learning, 266–268	CAPPS. See Computer-Assisted Passenger
making predictions, 262–266	Prescreening System
Markov blanket, 269	CART system, 192, 261, 456
prior distribution over network structures,	cost-complexity pruning, 202
268	categorical attributes. See nominal
structure learning by conditional	attributes
independence tests, 270	category utility, 273, 284–285
TAN, 269	calculation, 284b–285b
visualization example, 454f	incremental clustering, 279, 281
BayesianLogisticRegression algorithm, 446t–450t,	causal relations, 384
453	CBA technique, 223
BayesNet algorithm, 446t–450t, 453	Center filter, 433t–435t, 437
beam search, 312	CfsSubsetEval method, 488, 489t
Bernoulli process, 150	chain rule, 342–343
BestFirst method, 490t, 492	ChangeDateFormat filter, 433t–435t, 440
best-first search, 312	ChiSquaredAttributeEval, 489t, 491
BFTree algorithm, 446t–450t, 456	circular ordering, 51
bias, 31–33	CitationKNN algorithm, 446t–450t, 473
language, 31–32	class boundaries
multilayer perceptron, 233	non-axis parallel, 250
overfitting-avoidance, 32–33	
search, 32	rectangular, 248, 249f class labels
bias-variance decomposition, 353–355	bags, 142–143
binary classification problems, 63	reliability, 377–378
BIRCH. See balanced iterative reducing and	class noise, 568
clustering using hierarchies	class probability estimation, 337
bits, 100–101	dataset with two classes, 344, 344f
Boolean attributes, 51	difficulty, 343–344
Boolean classes, 71–72	overoptimistic, 344
boosting, 358–362	ClassAssigner component, 495, 499–500,
AdaBoost, 358–361	499t
algorithm for, 359–360, 359f	ClassAssigner filter, 433t–435t, 438

classes, 40	output interpretation, 563-564
Boolean, 71–72	setting test method, 565
membership functions for, 125	classifyInstance() method, 549–550
rectangular, 248, 249f	classifyMessage() method, 537–538
in Weka, 520	ClassOrder filter, 444, 444t
classification, 40	ClassValuePicker, 499-500, 499t
clustering for, 294–296	CLI. See command-line interface
cost-sensitive, 166–167, 356	CLOPE algorithm, 480t, 483
document, 387–388	closed-world assumptions, 43, 71–72
k-nearest-neighbor, 78	CLOSET+ algorithm, 223
Naïve Bayes for, 97–98	ClustererPerformanceEvaluator, 499–500, 499t
nearest-neighbor, 78	clustering, 40, 89
one-class, 335	agglomerative, 273, 275–276
pairwise, 339	algorithms, 81, 89
classification boundaries, 571–574	Bayesian, 290–292
1R visualization, 571–572	category utility, 273
decision tree visualization, 573	for classification, 294–296
Naïve Bayes visualization, 573	document, 387
nearest-neighbor visualization, 572	EM algorithm, 287
rule sets visualization, 573	evaluation, 186
classification learning, 40	group-average, 276
classification rules, 11, 62. See also rules	in grouping items, 41
accuracy, 205	hierarchical, 274–279
antecedent of, 69	incremental, 279–284
criteria for choosing tests, 203–204	iterative distance-based, 139
disjunctive normal form, 71–72	k-means, 139–140
with exceptions, 73, 194	MDL principle application to, 186–187
exclusive-or, 70, 70f	number of clusters, 274
global optimization, 208	probability-based, 285–286
good rule generation, 205–208	representation, 82f
missing values, 204–205	stage following, 81
multiple, 71	statistical, 314–315
numeric attributes, 205	in Weka, 429
from partial decision trees, 208–212	Weka algorithms, 480–485
producing with covering algorithms, 205	ClusterMembership filter, 433t–435t, 436–437
pruning, 206	Cobweb algorithm, 429, 480, 480t, 483
replicated subtree, 69, 71f	co-EM, 297
RIPPER rule learner, 208, 209f, 215	column separation, 340–341
	*
ClassificationViaClustering algorithm, 475t, 479 ClassificationViaRegression algorithm, 475t,	combining classifiers, in Weka, 477 command-line interface (CLI), 519–530. See also
479	Weka
Classifier class, 539, 549, 553–555	generic options, 526–529
ClassifierPerformanceEvaluator, 495–496,	options, 526–529
499–502, 499t	packages, 519
classifiers package, 519–520	scheme-specific options, 528t, 529
classifiers (Weka), 526	starting up, 519
capabilities, 555–557	weka.associations package, 525
implementation conventions, 555–557	weka.attributeSelection package, 525
ClassifierSubsetEval method, 488, 489t, 493	weka.classifiers package, 523–525
Classify panel, 422–424, 562–565	weka.clusseyiers package, 525–525 weka.clusterers package, 525
with C4.5 algorithm, 562–563	weka.core package, 520–523
classification error visualization, 565	weka.datagenerators package, 525
emonification entry risualization, 505	c. c

weka.estimators package, 525	recall-precision curves, 174–175
weka.filters package, 525	ROC curves, 172–174
comma-separated value (CSV)	cost-benefit analyzer, 170
data files, 408	CostBenefitAnalysis, 498, 499t
example data, 409f	cost-complexity pruning, 202
format, 407	cost-sensitive classification, 166–167, 356
ComplementNaiveBayes algorithm,	in Weka, 477
446t–450t	cost-sensitive learning, 167–168
complete-linkage method, 275	two-class, 167–168
computational learning theory, 361	in Weka, 477
computeInfoGain() method, 549	CostSensitiveAttributeEval method, 488, 489t,
Computer-Assisted Passenger Prescreening	491–492
System (CAPPS), 394	CostSensitiveClassifier algorithm, 475t,
concept descriptions, 39-40	477–478
concepts, 40-42. See also input	CostSensitiveSubsetEval method, 489t
defined, 39	co-training, 296
conditional independence, 264–266	EM and, 297
confidence	counting the cost, 163-180
of association rules, 72, 116	covariance matrix, 289
intervals, 150	coverage, of association rules, 72, 116
upper/lower bounds, 246	dividing, 122–123
confidence limits	minimum, 122–123
in error rate estimation, 197-198	specifying, 123-124
for normal distribution, 152t	covering algorithms, 108–116
on success probability, 246	example, 110–115
for Student's distribution, 159t	illustrated, 109f
confusion matrix, 164	instance space during operation of,
ConjunctiveRule algorithm, 446t-450t,	110f
459	operation, 110
consequent, of rule, 67	in producing rules, 205
ConsistencySubsetEval method, 488, 489t	in two-dimensional space, 108
constrained quadratic optimization, 225	CPU performance, 15
constructors, 523-524	dataset, 16t
contact lens problem, 12-13	in Weka, 423f
covering algorithm, 110-115	cross-validation, 89, 152-154
rules, 12f	estimates, 157-159
structural description, 13, 13f	folds, 153
continuous attributes. See numeric	leave-one-out, 154
attributes	repeated, 159
convex hulls, 224–225	for ROC curve generation, 173
Copy filter, 433t-435t, 436-437	stratified threefold, 153
corrected resampled t-test, 159	tenfold, 153-154, 306
cost curves, 177–180	threefold, 153
cost in, 179	CrossValidationFoldMaker, 495-496,
cost matrixes, 166-167, 166t, 172	499–502, 499t
cost of errors, 163-180	CSV. See comma-separated value
cost curves, 177–180	CSVLoader, 417–418
cost-sensitive classification, 166-167	cumulative margin distribution, 528-529
cost-sensitive learning, 167–168	customer support/service applications, 28
examples, 163–164	cutoff parameter, 283
lift charts, 168–172	CVParameterSelection algorithm, 475t, 478,
problem misidentification, 163-164	578

D	multiple classes to binary ones, 307,
Dagging algorithm, 474–476, 475t	338–343
data, 35	sampling, 307, 330-331
linearly separable, 127–128	data warehousing, 52
noise, 6–7	dataSet connections, 501
overlay, 52	DataVisualizer, 498, 499t
scarcity of, 397	date attributes, 54
sparse, 56	DBScan algorithm, 480t, 483-485, 484f
with string attributes, 579–580	decision boundaries, 63
data cleansing, 60, 307, 331–337. See also data	decision lists, 10
transformation	rules versus, 115-116
anomaly detection, 334-335	decision stumps, 362
decision tree improvement, 332	decision tree induction, 29, 332
methods, 307	complexity, 199-200
one-class learning, 335–337	top-down, 202-203
robust regression, 333–334	decision trees, 5, 64, 103f
data mining, 4–5, 8–9	alternating, 366-368, 367f
adversarial, 393–395	C4.5 algorithm and, 201-202
applying, 375–378	constructing, 99–108
as data analysis, 4–5	cost-complexity pruning, 202
ethics and, 33–36	for disjunction, 69f
learning machine and, 3–9	error rate estimation, 197–198
scheme comparison, 156–157	examples, 13f, 18f
ubiquitous, 395–397	highly branching attributes, 105-107
data preparation. See also input	improving, 332
ARFF files, 52–56	information calculation, 103–104
attribute types, 56–58	interactive construction, 569–571
data gathering in, 51-52	missing values, 64, 194–195
data knowledge and, 60	multivariate, 203
inaccurate values in, 59-60	nodes, 64
missing values in, 58-59	numeric attributes, 193–194
sparse data, 56	partial, obtaining rules from, 208–212
data projections, 306-307, 322-330	pruning, 195–197
partial least-squares regression, 326-328	with replicated subtree, 71f
principal components analysis, 324-326	rules, 200–201
random, 326	top-down induction of, 107–108
text to attribute vectors, 328–329	univariate, 203
time series, 330	visualizing, 573
data stream learning, 380–383	in Weka, 410–414 Weka Explorer exercise, 566–571
algorithm adaptation for, 381–382	*
Hoeffding bound, 382	DecisionStump algorithm, 446t–450t, 455 DecisionTable algorithm, 446t–450t, 457
memory usage, 383	Decorate algorithm, 475t, 476
Naïve Bayes for, 381	dedicated multi-instance methods, 301–302
tie-breaking strategy, 383	Delta, 330
data transformations, 305–349	dendrograms, 81, 274–275
attribute selection, 306–314	denormalization, 44
data cleansing, 307, 331–337	problems with, 46
data projection, 306–307, 322–330	DensiTree, 292, 292f
discretization of numeric attributes, 306,	diagnosis applications, 25–26
314–322	faults, 25–26
input types and, 323	machine language in, 25
methods for, 306	performance tests, 26

difference attributes, 132	boosting, 358–362
direct marketing, 27	interpretable ensembles, 365–369
directed acyclic graphs, 262	multiple models, 351–352
discrete attributes, 51	randomization, 356–358
converting to numeric attributes, 322	stacking, 369–371
discretization, 306, 314-322. See also data	entity extraction, in text mining, 388
transformation	entropy, 104
1R (1-rule), 315	entropy-based discretization, 316–319
decision tree learners, 315	error-based discretization versus, 320–322
entropy-based, 316–319	illustrated, 318f
error-based, 320–322	with MDL stopping criterion, 320
global, 315	results, 318f
partitioning, 87	stopping criteria, 315, 318–319
proportional k-interval, 316	enumerated, 51
supervised, 316, 574	enumerating concept space, 30–31
unsupervised, 316, 574	equal-frequency binning, 316
Weka Explorer exercise, 574–575	equal-interval binning, 316
Weka metalearner for, 443f	error log, 415–416
discretization-based calibration, 345	error rate, 148
Discretize filter, 416, 433t-435t, 438, 444t	decision tree, 197–198
disjunctive normal form, 71–72	repeated holdout, 152-153
distance functions, 131–132	success rate and, 197–198
difference attributes, 132	training set, 148
generalized, 249–250	error-based discretization, 320–322
for generalized exemplars, 248–249	errors
missing values, 132	classification, visualizing, 565
distribution, in Weka, 515–517	estimation, 156
diverse-density method, 302	inaccurate values and, 59–60
divide-and-conquer, 99–108, 308	mean-absolute, 181
DMNBText algorithm, 446t–450t, 453	mean-squared, 181
document classification, 387. See also classification	propagation, 238b–239b
actual documents, 580–581	relative-absolute, 181
in assignment of key phrases, 387–388	relative-squared, 181
in authorship ascription, 387–388	resubstitution, 148–149
data with string attributes, 579–580	squared, 161
in language identification, 387–388	training set, 197
as supervised learning, 387	estimation error, 156
Weka Explorer exercise, 578–582	ethics, 33–36
document clustering, 387	issues, 35–36
domain knowledge, 19	personal information and, 34–35
double-consequent rules, 123	reidentification and, 33–34
<i>DTNB</i> algorithm, 446t–450t, 457	Euclidean distance, 131
Dividual distribution is a second of the sec	function, 246
E	between instances, 276
early stopping, 238b–239b	evaluation
eigenvalues, 324	clustering, 186
eigenvectors, 324	as data mining key, 147
EM algorithm, 480–483, 480t, 482f	numeric prediction, 180–182
embedded machine learning, 531–538	performance, 148
END algorithm, 475t	examples, 42–49. See also instances; specific
ensemble learning, 351–373	examples  examples
additive regression, 362–365	class of, 40
bagging, 352–356	relations, 43–46
04661116, 332 330	1011110110, 75 70

examples (continued)	introduction to, 559–565
structured, 46–49	J4.8, 410–414
types of, 43–49	learning algorithms, 445-474
exceptions, rules with, 73–75, 212–215	loading and filtering files, 416–422
exclusive-or problem, 70f	loading data into, 408-410
exclusive-OR (XOR), 233	loading datasets, 559–560
exemplars, 245	market basket analysis, 584-585
generalizing, 247–249	metalearners, 427
noisy, pruning, 245–246	metalearning algorithms, 474-479
reducing number of, 245	models, 414–415
exhaustive error-correcting codes, 341	nearest-neighbor learning, 566–571
ExhaustiveSearch method, 490t, 493	neural networks, 469–472
expectation, 289	Preprocess panel, 411, 416, 419, 561
expectation maximization (EM) algorithm,	preprocessing, 574–578
287	real-world dataset mining, 584
maximization step, 295–296	search methods, 492–494
with Naïve Bayes, 295	Select Attributes panel, 430, 478
Experimenter, 405, 505–517. See also Weka	training/testing learning schemes,
advanced setup, 511–512	422–424
Analyze panel, 505–509, 512–515	Tree Visualizer, 427
distributed processing, 515–517	tutorial exercises for, 559–585
experiment illustration, 506f-508f	User Classifier, 424–427
results analysis, 509–510	Viewer, 560, 560f
Run panel, 505–506	Visualize panel, 430–432, 562
running experiments, 505	eXtensible Markup Language (XML),
Setup panel, 505, 510	52–56
simple setup, 510–511	E
starting up, 505–510	F
starting up, 505–510 expert models, 352	false negatives (FN), 164, 176t, 580
starting up, 505–510 expert models, 352 Explorer, 404, 407–494. <i>See also</i> Weka	false negatives (FN), 164, 176t, 580 false positive rate, 164
starting up, 505–510 expert models, 352 Explorer, 404, 407–494. <i>See also</i> Weka applying filters, 561	false negatives (FN), 164, 176t, 580 false positive rate, 164 false positives (FP), 164, 176t, 580
starting up, 505–510 expert models, 352 Explorer, 404, 407–494. See also Weka applying filters, 561 ARFF format, 417–419	false negatives (FN), 164, 176t, 580 false positive rate, 164 false positives (FP), 164, 176t, 580 Familiar system, 396–397
starting up, 505–510 expert models, 352 Explorer, 404, 407–494. See also Weka applying filters, 561 ARFF format, 417–419 Associate panel, 429–430	false negatives (FN), 164, 176t, 580 false positive rate, 164 false positives (FP), 164, 176t, 580 Familiar system, 396–397 FarthestFirst algorithm, 480t, 483
starting up, 505–510 expert models, 352 Explorer, 404, 407–494. See also Weka applying filters, 561 ARFF format, 417–419 Associate panel, 429–430 association-rule learning, 485–487	false negatives (FN), 164, 176t, 580 false positive rate, 164 false positives (FP), 164, 176t, 580 Familiar system, 396–397 FarthestFirst algorithm, 480t, 483 FastVector, 536
starting up, 505–510 expert models, 352 Explorer, 404, 407–494. See also Weka applying filters, 561 ARFF format, 417–419 Associate panel, 429–430 association-rule learning, 485–487 attribute selection, 487–494	false negatives (FN), 164, 176t, 580 false positive rate, 164 false positives (FP), 164, 176t, 580 Familiar system, 396–397 FarthestFirst algorithm, 480t, 483 FastVector, 536 feature selection, 346
starting up, 505–510 expert models, 352 Explorer, 404, 407–494. See also Weka applying filters, 561 ARFF format, 417–419 Associate panel, 429–430 association-rule learning, 485–487 attribute selection, 487–494 automatic attribute selection, 562,	false negatives (FN), 164, 176t, 580 false positive rate, 164 false positives (FP), 164, 176t, 580 Familiar system, 396–397 FarthestFirst algorithm, 480t, 483 FastVector, 536 feature selection, 346 feed-forward networks, 238b–239b
starting up, 505–510 expert models, 352 Explorer, 404, 407–494. See also Weka applying filters, 561 ARFF format, 417–419 Associate panel, 429–430 association-rule learning, 485–487 attribute selection, 487–494 automatic attribute selection, 562, 575–576	false negatives (FN), 164, 176t, 580 false positive rate, 164 false positives (FP), 164, 176t, 580 Familiar system, 396–397 FarthestFirst algorithm, 480t, 483 FastVector, 536 feature selection, 346 feed-forward networks, 238b–239b fielded applications, 21–28
starting up, 505–510 expert models, 352 Explorer, 404, 407–494. See also Weka applying filters, 561 ARFF format, 417–419 Associate panel, 429–430 association-rule learning, 485–487 attribute selection, 487–494 automatic attribute selection, 562, 575–576 automatic parameter tuning, 577–578	false negatives (FN), 164, 176t, 580 false positive rate, 164 false positives (FP), 164, 176t, 580 Familiar system, 396–397 FarthestFirst algorithm, 480t, 483 FastVector, 536 feature selection, 346 feed-forward networks, 238b–239b fielded applications, 21–28 automation, 28
starting up, 505–510 expert models, 352 Explorer, 404, 407–494. See also Weka applying filters, 561 ARFF format, 417–419 Associate panel, 429–430 association-rule learning, 485–487 attribute selection, 487–494 automatic attribute selection, 562, 575–576 automatic parameter tuning, 577–578 classification boundaries, 571–574	false negatives (FN), 164, 176t, 580 false positive rate, 164 false positives (FP), 164, 176t, 580 Familiar system, 396–397 FarthestFirst algorithm, 480t, 483 FastVector, 536 feature selection, 346 feed-forward networks, 238b–239b fielded applications, 21–28 automation, 28 customer service/support, 28
starting up, 505–510 expert models, 352 Explorer, 404, 407–494. See also Weka applying filters, 561 ARFF format, 417–419 Associate panel, 429–430 association-rule learning, 485–487 attribute selection, 487–494 automatic attribute selection, 562, 575–576 automatic parameter tuning, 577–578 classification boundaries, 571–574 Classify panel, 422–424, 562–565	false negatives (FN), 164, 176t, 580 false positive rate, 164 false positives (FP), 164, 176t, 580 Familiar system, 396–397 FarthestFirst algorithm, 480t, 483 FastVector, 536 feature selection, 346 feed-forward networks, 238b–239b fielded applications, 21–28 automation, 28 customer service/support, 28 decisions involving judgments, 22–23
starting up, 505–510 expert models, 352 Explorer, 404, 407–494. See also Weka applying filters, 561 ARFF format, 417–419 Associate panel, 429–430 association-rule learning, 485–487 attribute selection, 487–494 automatic attribute selection, 562, 575–576 automatic parameter tuning, 577–578 classification boundaries, 571–574 Classify panel, 422–424, 562–565 Cluster panel, 429	false negatives (FN), 164, 176t, 580 false positive rate, 164 false positives (FP), 164, 176t, 580 Familiar system, 396–397 FarthestFirst algorithm, 480t, 483 FastVector, 536 feature selection, 346 feed-forward networks, 238b–239b fielded applications, 21–28 automation, 28 customer service/support, 28 decisions involving judgments, 22–23 diagnosis, 25–26
starting up, 505–510 expert models, 352 Explorer, 404, 407–494. See also Weka applying filters, 561 ARFF format, 417–419 Associate panel, 429–430 association-rule learning, 485–487 attribute selection, 487–494 automatic attribute selection, 562, 575–576 automatic parameter tuning, 577–578 classification boundaries, 571–574 Classify panel, 422–424, 562–565 Cluster panel, 429 clustering algorithms, 480–485	false negatives (FN), 164, 176t, 580 false positive rate, 164 false positives (FP), 164, 176t, 580 Familiar system, 396–397 FarthestFirst algorithm, 480t, 483 FastVector, 536 feature selection, 346 feed-forward networks, 238b–239b fielded applications, 21–28 automation, 28 customer service/support, 28 decisions involving judgments, 22–23 diagnosis, 25–26 image screening, 23–24
starting up, 505–510 expert models, 352 Explorer, 404, 407–494. See also Weka applying filters, 561 ARFF format, 417–419 Associate panel, 429–430 association-rule learning, 485–487 attribute selection, 487–494 automatic attribute selection, 562, 575–576 automatic parameter tuning, 577–578 classification boundaries, 571–574 Classify panel, 422–424, 562–565 Cluster panel, 429 clustering algorithms, 480–485 CSV data files, 408	false negatives (FN), 164, 176t, 580 false positive rate, 164 false positives (FP), 164, 176t, 580 Familiar system, 396–397 FarthestFirst algorithm, 480t, 483 FastVector, 536 feature selection, 346 feed-forward networks, 238b–239b fielded applications, 21–28 automation, 28 customer service/support, 28 decisions involving judgments, 22–23 diagnosis, 25–26 image screening, 23–24 load forecasting, 24–25
starting up, 505–510 expert models, 352 Explorer, 404, 407–494. See also Weka applying filters, 561 ARFF format, 417–419 Associate panel, 429–430 association-rule learning, 485–487 attribute selection, 487–494 automatic attribute selection, 562, 575–576 automatic parameter tuning, 577–578 classification boundaries, 571–574 Classify panel, 422–424, 562–565 Cluster panel, 429 clustering algorithms, 480–485 CSV data files, 408 CSVLoader, 417–418	false negatives (FN), 164, 176t, 580 false positive rate, 164 false positives (FP), 164, 176t, 580 Familiar system, 396–397 FarthestFirst algorithm, 480t, 483 FastVector, 536 feature selection, 346 feed-forward networks, 238b–239b fielded applications, 21–28 automation, 28 customer service/support, 28 decisions involving judgments, 22–23 diagnosis, 25–26 image screening, 23–24 load forecasting, 24–25 manufacturing processes, 27
starting up, 505–510 expert models, 352 Explorer, 404, 407–494. See also Weka applying filters, 561 ARFF format, 417–419 Associate panel, 429–430 association-rule learning, 485–487 attribute selection, 487–494 automatic attribute selection, 562, 575–576 automatic parameter tuning, 577–578 classification boundaries, 571–574 Classify panel, 422–424, 562–565 Cluster panel, 429 clustering algorithms, 480–485 CSV data files, 408 CSVLoader, 417–418 Data Visualizer, 427	false negatives (FN), 164, 176t, 580 false positive rate, 164 false positives (FP), 164, 176t, 580 Familiar system, 396–397 FarthestFirst algorithm, 480t, 483 FastVector, 536 feature selection, 346 feed-forward networks, 238b–239b fielded applications, 21–28 automation, 28 customer service/support, 28 decisions involving judgments, 22–23 diagnosis, 25–26 image screening, 23–24 load forecasting, 24–25 manufacturing processes, 27 marketing and sales, 26–27
starting up, 505–510 expert models, 352 Explorer, 404, 407–494. See also Weka applying filters, 561 ARFF format, 417–419 Associate panel, 429–430 association-rule learning, 485–487 attribute selection, 487–494 automatic attribute selection, 562, 575–576 automatic parameter tuning, 577–578 classification boundaries, 571–574 Classify panel, 422–424, 562–565 Cluster panel, 429 clustering algorithms, 480–485 CSV data files, 408 CSVLoader, 417–418 Data Visualizer, 427 decision tree building, 410–414, 566–571	false negatives (FN), 164, 176t, 580 false positive rate, 164 false positives (FP), 164, 176t, 580 Familiar system, 396–397 FarthestFirst algorithm, 480t, 483 FastVector, 536 feature selection, 346 feed-forward networks, 238b–239b fielded applications, 21–28 automation, 28 customer service/support, 28 decisions involving judgments, 22–23 diagnosis, 25–26 image screening, 23–24 load forecasting, 24–25 manufacturing processes, 27 marketing and sales, 26–27 scientific, 28
starting up, 505–510 expert models, 352 Explorer, 404, 407–494. See also Weka applying filters, 561 ARFF format, 417–419 Associate panel, 429–430 association-rule learning, 485–487 attribute selection, 487–494 automatic attribute selection, 562, 575–576 automatic parameter tuning, 577–578 classification boundaries, 571–574 Classify panel, 422–424, 562–565 Cluster panel, 429 clustering algorithms, 480–485 CSV data files, 408 CSVLoader, 417–418 Data Visualizer, 427 decision tree building, 410–414, 566–571 discretization, 574–575	false negatives (FN), 164, 176t, 580 false positive rate, 164 false positives (FP), 164, 176t, 580 Familiar system, 396–397 FarthestFirst algorithm, 480t, 483 FastVector, 536 feature selection, 346 feed-forward networks, 238b–239b fielded applications, 21–28 automation, 28 customer service/support, 28 decisions involving judgments, 22–23 diagnosis, 25–26 image screening, 23–24 load forecasting, 24–25 manufacturing processes, 27 marketing and sales, 26–27 scientific, 28 web mining, 5
starting up, 505–510 expert models, 352 Explorer, 404, 407–494. See also Weka applying filters, 561 ARFF format, 417–419 Associate panel, 429–430 association-rule learning, 485–487 attribute selection, 487–494 automatic attribute selection, 562, 575–576 automatic parameter tuning, 577–578 classification boundaries, 571–574 Classify panel, 422–424, 562–565 Cluster panel, 429 clustering algorithms, 480–485 CSV data files, 408 CSVLoader, 417–418 Data Visualizer, 427 decision tree building, 410–414, 566–571 discretization, 574–575 document classification, 578–582	false negatives (FN), 164, 176t, 580 false positive rate, 164 false positives (FP), 164, 176t, 580 Familiar system, 396–397 FarthestFirst algorithm, 480t, 483 FastVector, 536 feature selection, 346 feed-forward networks, 238b–239b fielded applications, 21–28 automation, 28 customer service/support, 28 decisions involving judgments, 22–23 diagnosis, 25–26 image screening, 23–24 load forecasting, 24–25 manufacturing processes, 27 marketing and sales, 26–27 scientific, 28 web mining, 5 fields, 525
starting up, 505–510 expert models, 352 Explorer, 404, 407–494. See also Weka applying filters, 561 ARFF format, 417–419 Associate panel, 429–430 association-rule learning, 485–487 attribute selection, 487–494 automatic attribute selection, 562, 575–576 automatic parameter tuning, 577–578 classification boundaries, 571–574 Classify panel, 422–424, 562–565 Cluster panel, 429 clustering algorithms, 480–485 CSV data files, 408 CSVLoader, 417–418 Data Visualizer, 427 decision tree building, 410–414, 566–571 discretization, 574–575 document classification, 578–582 error log, 415–416	false negatives (FN), 164, 176t, 580 false positive rate, 164 false positives (FP), 164, 176t, 580 Familiar system, 396–397 FarthestFirst algorithm, 480t, 483 FastVector, 536 feature selection, 346 feed-forward networks, 238b–239b fielded applications, 21–28 automation, 28 customer service/support, 28 decisions involving judgments, 22–23 diagnosis, 25–26 image screening, 23–24 load forecasting, 24–25 manufacturing processes, 27 marketing and sales, 26–27 scientific, 28 web mining, 5 fields, 525 file mining, 48–49
starting up, 505–510 expert models, 352 Explorer, 404, 407–494. See also Weka applying filters, 561 ARFF format, 417–419 Associate panel, 429–430 association-rule learning, 485–487 attribute selection, 487–494 automatic attribute selection, 562, 575–576 automatic parameter tuning, 577–578 classification boundaries, 571–574 Classify panel, 422–424, 562–565 Cluster panel, 429 clustering algorithms, 480–485 CSV data files, 408 CSVLoader, 417–418 Data Visualizer, 427 decision tree building, 410–414, 566–571 discretization, 574–575 document classification, 578–582 error log, 415–416 filtering algorithms, 432–445	false negatives (FN), 164, 176t, 580 false positive rate, 164 false positives (FP), 164, 176t, 580 Familiar system, 396–397 FarthestFirst algorithm, 480t, 483 FastVector, 536 feature selection, 346 feed-forward networks, 238b–239b fielded applications, 21–28     automation, 28     customer service/support, 28     decisions involving judgments, 22–23     diagnosis, 25–26     image screening, 23–24     load forecasting, 24–25     manufacturing processes, 27     marketing and sales, 26–27     scientific, 28     web mining, 5 fields, 525 file mining, 48–49 files
starting up, 505–510 expert models, 352 Explorer, 404, 407–494. See also Weka applying filters, 561 ARFF format, 417–419 Associate panel, 429–430 association-rule learning, 485–487 attribute selection, 487–494 automatic attribute selection, 562, 575–576 automatic parameter tuning, 577–578 classification boundaries, 571–574 Classify panel, 422–424, 562–565 Cluster panel, 429 clustering algorithms, 480–485 CSV data files, 408 CSVLoader, 417–418 Data Visualizer, 427 decision tree building, 410–414, 566–571 discretization, 574–575 document classification, 578–582 error log, 415–416	false negatives (FN), 164, 176t, 580 false positive rate, 164 false positives (FP), 164, 176t, 580 Familiar system, 396–397 FarthestFirst algorithm, 480t, 483 FastVector, 536 feature selection, 346 feed-forward networks, 238b–239b fielded applications, 21–28 automation, 28 customer service/support, 28 decisions involving judgments, 22–23 diagnosis, 25–26 image screening, 23–24 load forecasting, 24–25 manufacturing processes, 27 marketing and sales, 26–27 scientific, 28 web mining, 5 fields, 525 file mining, 48–49

loading, 416–422	0
opening, 416	<b>G</b>
filter method, 308–309	gain ratio, 105–107
FilteredAssociator rule learner, 486t, 487	GainRatioAttributeEval method, 489t, 491
FilteredAttributeEval method, 489t,	Gaussian process regression, 243
491–492	GaussianProcesses algorithm, 446t-450t, 464
	generalization
FilteredClassifier algorithm, 475t, 569	exemplar, 247–249, 251
FilteredClassifier metalearning scheme,	instance-based learning and, 251
443–444, 538	stacked, 369-371
FilteredCluster algorithm, 480t, 483	generalization as search, 29
FilteredSubsetEval method, 488, 489t	bias, 31–33
filtering algorithms (Weka), 432–445	enumerating the concept space, 30-31
filtering approaches, 334–335	generalized distance functions, 249-250
filters, 404	Generalized Sequential Patterns (GSP), 223
applying, 421	GeneralizedSequentialPatterns rule learner, 486t,
applying (Weka Explorer), 561	487
attribute, 432–441, 443–445	generalizing exemplars, 247–248
choosing, 420f	distance functions for, 248–249
information on, 421	nested, 248
instance, 432, 441–442, 445	generic options (CLI), 526–529
supervised, 432, 443–445	list of, 527t
unsupervised, 432–442	GeneticSearch method, 490t, 493
in Weka, 411	getCapabilities() method, 539
finite mixtures, 286	getTechnicalInformation() method, 539
FirstOrder filter, 433t-435t, 439	glass dataset, 566–567
fixed set, 492	global optimization, classification rules for, 208
fixed width, 492	globalInfo() method, 539
flat files, 42	gradient ascent, 302
F-measure, 175, 479	gradient descent, 238b–239b
forward pruning, 195	illustrated, 237f
forward selection, 311–312	stochastic, 242–243
forward stagewise additive modeling, 362	subgradients, 242
implementation, 363	Grading algorithm, 475t, 477
numeric prediction, 362–363	GraphViewer, 498, 499t
overfitting and, 363	greedy method, for rule pruning, 253–254
residuals, 368–369	GreedyStepwise method, 490t, 492–493
FP-growth algorithm, 216, 223	GridSearch algorithm, 475t, 478
FPGrowth rule learner, 486-487, 486t	group-average clustering, 276
frequent-pattern trees, 216	growing sets, 205–206
building, 216–219	GSP. See Generalized Sequential Patterns
compact structure, 216-217	obit see constanted sequential randing
data preparation example, 217t-218t	Н
header tables, 219-222	Hamming distance, 339–340
implementation, 222-223	Hausdorff distance, 301, 303
speed, 222	hidden layer, multilayer perceptrons, 233,
structure illustration, 220f-221f	238b–239b, 239f
support threshold, 222-223	hierarchical clustering, 274–276. See also clustering
FT algorithm, 446t-450t, 456-457	agglomerative, 275–276
functional dependencies, 385	average-linkage method, 275–276
functional trees, 65	centroid-linkage method, 275
functions, Weka algorithms, 446t-450t,	dendrograms, 274–275
459–469	displays, 277f–278f
	3.5pm, 5, 2111 2101

hierarchical clustering (continued)	input, 23
example, 276–279	problems, 24
example illustration, 282f–283f	implementations (real machine learning
group-average, 276	schemes), 191–304
single-linkage algorithm, 275, 279	association rules, 216–223
HierarchicalClusterer algorithm, 480t, 483	Bayesian networks, 261–273
highly branching attributes, 105–107	classification rules, 203–216
hinge loss, 242–243, 242f	clustering, 273–293
histogram equalization, 316	decision trees, 192–203
HNB algorithm, 446t-450t, 451	instance-based learning, 244-251
Hoeffding bound, 382	linear model extension, 223–244
Hoeffding trees, 382–383	multi-instance learning, 298–303
HTML. See HyperText Markup Language	numeric prediction with local linear models
hyperpipes, 143	251–261
HyperPipes algorithm, 446t-450t, 474	semisupervised learning, 294-298
hyperplanes, 127	inaccurate values, 59-60
maximum-margin, 224–225	incremental clustering, 279-284
separating classes, 225b	acuity parameter, 281
hyperrectangles, 247	category utility, 279, 281
boundaries, 247	cutoff parameter, 283
exception, 248	example illustrations, 280f, 282f-283f
measuring distance to, 249	merging, 281
in multi-instance learning, 303	splitting, 281
overlapping, 248	incremental learning, 502-503
hyperspheres, 135	incremental reduced-error pruning, 206, 207f
HyperText Markup Language (HTML)	IncrementalClassifierEvaluator, 498-500,
delimiters, 390	499t
formatting commands, 389-390	inductive logic programming, 77
	InfoGainAttributeEval method, 489t, 491,
I	582
IB1 algorithm, 446t-450t, 472	information, 35, 100-101
IB3. See Instance-Based Learner version 3	calculating, 103-104
IBk algorithm, 446t-450t, 472	extraction, 388-389
Id3 algorithm, 446t-450t	gain calculation, 203-204
ID3 decision tree learner, 107-108, 539-555	measure, 103-104
buildClassifier() method, 540	value, 104
classifyInstance() method, 549-550	informational loss function, 161-163
computeInfoGain() method, 549	information-based heuristics, 204
gain ratio, 107-108	input, 39-60
getCapabilities() method, 539	aggregating, 142
getTechnicalInformation() method, 539	ARFF format, 52-56
globalInfo() method, 539	attribute types, 56–58
improvements, 108	attributes, 39
main() method, 553–555	concepts, 40-42
makeTree() method, 540-549	data assembly, 51–52
Sourcable interface, 539, 550	data transformations and, 323
source code, 541f-548f	examples, 42-49
TechnicalInformationHandler interface, 539	flat files, 42–43
toSource() method, 550-553	forms, 39
identification code attributes, 88	inaccurate values, 59-60
example, 106t	instances, 42–49
image screening, 23–24	missing values, 58–59
hazard detection system, 23	preparing, 51–60

sparse data, 56	incremental clustering, 279-284
tabular format, 124	Logistic output, 468f
input layer, multilayer perceptrons, 233	OPTICS visualization, 485f
instance connections, 193	rules, 14
instance filters, 432	rules with exceptions, 73-75, 74f, 213-215,
supervised, 445	213f
unsupervised, 441–442	SMO output, 463f-464f
instance space	SMO output with nonlinear kernel, 465f–467f
in covering algorithm operation, 110f	visualization, 431f
partitioning methods, 80f	isotonic regression, 345
rectangular generalizations in, 79	IsotonicRegression algorithm, 446t-450t, 462
Instance-Based Learner version 3 (IB3), 246	item sets, 116
instance-based learning, 78, 131–138	checking, of two consecutive sizes, 123
in attribute selection, 310	converting to rules, 119
characteristics, 78	in efficient rule generation, 122–123
distance functions, 131–132	example, 117t–118t
distance functions for generalized exemplars,	large, finding with association rules, 219–222
200	minimum coverage, 122
explicit knowledge representation and,	subsets of, 122–123
250–251	items, 116
generalization and, 251	iterative distance-based clustering, 139
generalizing exemplars, 247–248	nerative distance based clastering, 137
nearest-neighbor, 132–137	J
performance, 246	J48 algorithm, 410–411, 446t–450t, 498, 502–503,
pruning noise exemplars, 245–246	505, 519
reducing number of exemplars, 245	changing parameters for, 455f
visualizing, 81	cross-validation with, 498–500
weighting attributes, 246–247	discretization and, 575
instance-based representation, 78–81	evaluation method, 413
instances, 9–10, 39, 42	output, 412f
centroid, 139	parentheses following rule, 459
misclassified, 128–130	result visualization, 415f
	using, 411f
with missing values, 194	_
multilabeled, 40	J48graft algorithm, 446t–450t, 455
order, 55	Java database connectivity (JDBC)
sparse, 442	databases, 515
subset sort order, 194	drivers, 419, 510–511, 515
training, 184	Java virtual machine, 519
in Weka, 520	Javadoc indexes, 525–526
InstanceStreamToBatchMaker, 499–500, 499t	JRip algorithm, 446t–450t, 459
interactive decision tree construction, 569–571	judgment decisions, 22–23
interpretable ensembles, 365–369	
logistic model trees, 368–369	K
option trees, 365–368	K2 algorithm, 273
InterquartileRange filter, 433t–435t, 436	Kappa statistic, 166, 413
interval quantities, 50	kD-trees, 132
iris example, 13–15	building, 133
boundary decision, 63, 63f	in finding nearest-neighbor, 133–134,
data as clustering problem, 41t	134f
dataset, 14t	for training instances, 133f
DBScan clusters, 484f	updating, 135
decision tree, 65, 66f	kernel logistic regression, 231–232
hierarchical clusterings, 282f–283f	Kerner 10515010 10510551011, 231-232

kernel perceptron, 231–232	LADTree algorithm, 446t-450t, 457
kernel ridge regression, 229-231	language bias, 31–32
computational expense, 230b	language identification, 387-388
computational simplicity, 230b	Laplace estimator, 93, 291
drawback, 230b	large item sets, finding with association rules
kernel trick, 229-230	219–222
KernelFilter filter, 433t-435t, 439	LatentSemanticAnalysis method, 489t, 491
k-means clustering, 139	LaTeX typesetting system, 514-515
iterations, 139-140	law of diminishing returns, 379
k-means++, 139	lazy classifiers, in Weka, 446t-450t, 472
seeds, 139	LBR algorithm, 446t-450t, 472
k-nearest-neighbor method, 78	learning
knowledge, 35	association, 40
background, 380	batch, 238b-239b
metadata, 385	classification, 40
prior domain, 385	concept, 8
Knowledge Flow interface, 404–405, 495–503.	cost-sensitive, 167–168
See also Weka	data stream, 380-383
Associations panel, 498	ensemble, 351–373
Classifiers panel, 498	incremental, 502-503
Clusters panel, 498	instance-based, 78, 131-138, 244-251
components, 498-500	locally weighted, 259-261
components configuration and connection,	machine, 7–8
500–502	multi-instance, 48, 141-143, 298-303
dataSet connections, 501	one-class, 307, 335-337
evaluation components, 498-500, 499t	in performance situations, 21
Evaluation panel, 495-496, 499-500	rote, 78
Filters panel, 498	semisupervised, 294-298
illustrated, 496f	statistics versus, 28–29
incremental learning, 502-503	testing, 7
instance connections, 193	training/testing schemes, 422-424
operations, 500f	learning algorithms, 445-474
starting up, 495–498	Bayes, 446t-450t, 451-453
visualization components, 498–500,	functions, 446t-450t, 459-469
499t	lazy, 410-411, 446t-450t
knowledge representation, 85-145	MI, 446t-450t, 472-474
clusters, 81	miscellaneous, 446t-450t, 474
instance-based, 78-81	neural networks, 469-472
linear models, 62–63	rules, 446t-450t, 457-459
rules, 67–77	trees, 446t-450t, 454-457
tables, 61-62	learning Bayesian networks, 266-268
trees, 64–67	learning paradigms, 380
KStar algorithm, 446t-450t, 472	learning rate, 238b–239b
Kullback-Leibler distance, 473	learning scheme creation, in Weka, 539–557
L	least-squares linear regression, 63, 125–126
labor negotiations example, 15-19	LeastMedSq algorithm, 446t–450t, 462
dataset, 17t	leave-one-out cross-validation, 154
decision trees, 18f	level-0 models, 370–371
OneR output, 458f	level-1 model, 369-371
PART output, 460f–461f	LibLINEAR algorithm, 446t-450t, 469
training dataset 18–19	LibSVM algorithm, 446t–450t, 469

lift charts, 168-172	illustrated, 127f
data for, 169t	two-class, 126
illustrated, 170f	LogitBoost, 364-365, 457, 467
points on, 179	LogitBoost algorithm, 475t, 476-477
lift factor, 168	log-normal distribution, 290
linear classification	log-odds distribution, 290
logistic regression, 125-127	loss functions
using the perceptron, 127-129	0 – 1, 160
using Winnow, 129-131	informational, 161-163
linear machines, 144	quadratic, 160-163
linear models, 62-63, 124-131	LWL algorithm, 446t-450t, 472
in binary classification problems, 63	
boundary decision, 63	M
extending, 223–244	M5' program
generating, 224	CPU performance data with, 423f
illustrated, 62f–63f	error visualization, 426f
kernel ridge regression, 229-231	output for numeric prediction, 425f
linear classification, 125-131	M5P algorithm, 446t-450t, 456
linear regression, 124–125	M5Rules algorithm, 446t-450t, 459
local, numeric prediction with, 251-261	machine learning, 7–8
logistic regression, 125-127	applications, 8–9
maximum-margin hyperplane, 224-225	in diagnosis applications, 25
in model tree, 258t	embedded, 531–538
multilayer perceptrons, 232-241	expert models, 352
nonlinear class boundaries, 226-227	statistics and, 28-29
numeric prediction, 124-125	machine learning schemes, 191-304
perceptron, 127-129	association rules, 216-223
stochastic gradient descent, 242-243	Bayesian networks, 261–273
support vector machine use, 223	classification rules, 203-216
support vector regression, 227-229	clustering, 273–293
in two dimensions, 62	decision trees, 192–203
linear regression, 124–125	instance-based learning, 244-251
least-squares, 63, 125–126	linear model extensions, 223–244
locally weighted, 259–261	multi-instance learning, 298–303
multiple, 363	numeric prediction with local linear models,
multiresponse, 125–126	251–261
linear threshold unit, 144	semisupervised learning, 294–298
LinearForwardSelection method, 490t, 492–493	main() method, 553–555
LinearRegression algorithm, 446t-450t, 459-462	MakeDensityBasedCluster algorithm, 480t, 483
<i>LMT</i> algorithm, 446t–450t, 456	MakeIndicator filter, 433t–435t, 438
load forecasting, 24–25	makeTree() method, 540–549
loading files, 416–422	manufacturing process applications, 27
locally weighted linear regression, 259–261	market basket analysis, 26–27, 584–585
distance-based weighting schemes, 259-260	marketing and sales, 26–27
in nonlinear function approximation, 260	churn, 26
logic programs, 77	direct marketing, 27
Logistic algorithm, 446t-450t, 467, 468f	historical analysis, 27
logistic model trees, 368–369	market basket analysis, 26–27
logistic regression, 125–127	Markov blanket, 269
additive, 364–365	massive datasets, 378–380
calibration, 346	Massive Online Analysis (MOA), 383
generalizing, 126	MathExpression filter, 433t–435t, 437, 478

	1 '6 ' 1 204 205
maximization, 289	classification rules, 204–205
maximum-margin hyperplane, 224–225	decision trees, 64, 194–195
illustrated, 225f	distance function, 132
support vectors, 225	instances with, 194
MDD algorithm, 446t–450t, 472–473	machine learning schemes and, 58
MDL. See minimum description length	mixture models, 290
principle	Naïve Bayes, 94–97
mean-absolute errors, 181	partial decision trees, 212
mean-squared errors, 181	reasons for, 58
memory usage, 383	MISVM algorithm, 446t-450t, 473
MergeTwoValues filter, 433t-435t, 438	MIWrapper algorithm, 446t-450t, 473-474
message classifier application, 531-538	mixed-attribute problems, 10-11
classifyMessage() method, 537-538	mixture models, 286
main() method, 531–536, 532f–535f	extending, 289-290
MessageClassifier() constructor, 536	finite mixtures, 286
source code, 531, 532f–535f	missing values, 290
updateData() method, 536-537	nominal attributes, 289
MetaCost algorithm, 356, 475t, 477–478	two-class, 286f
metadata, 51, 384	MOA. See Massive Online Analysis
application examples, 384	model trees, 67, 251, 252
extraction, 388	building, 253
knowledge, 385	illustrated, 68f
relations among attributes, 384	
_	induction pseudocode, 255–257, 256f
metalearners, 427	linear models in, 258t
configuring for boosting decision stumps,	logistic, 368–369
429f	with nominal attributes, 257f
using, 427	pruning, 253–254
metalearning algorithms, in Weka, 474–479	rules from, 259
bagging, 474–476	smoothing calculation, 252
boosting, 476–477	ModelPerformanceChart, 498, 499t
combining classifiers, 477	MultiBoostAB algorithm, 475t, 476
cost-sensitive learning, 477–478	multiclass prediction, 164
list of, 475t	MultiClassClassifier algorithm, 475t, 479
performance optimization, 478–479	multi-instance data
randomization, 474–476	classifiers, in Weka, 446t-450t, 472-474
retargeting classifiers, 479	filters for, 440
methods (Weka), 520	multi-instance learning, 48, 141-143
metric trees, 137–138	aggregating the input, 142
MIBoost algorithm, 446t-450t, 473-474	aggregating the output, 142
MIDD algorithm, 446t-450t, 472-473	bags, 141–142, 300
MIEMDD algorithm, 446t-450t, 472-473	converting to single-instance learning,
MILR algorithm, 446t-450t, 473	298–300
minimum description length (MDL) principle,	dedicated methods, 301-302
163, 183–186	hyperrectangles for, 303
applying to clustering, 186–187	nearest-neighbor learning adaptation to,
metric, 267	301
probability theory and, 184–185	supervised, 141–142
training instances, 184	upgrading learning algorithms, 300–301
MINND algorithm, 446t–450t	multi-instance problems, 48
MIOptimalBall algorithm, 446t–450t, 473	÷
	ARFF file, 55f
MISMO algorithm, 446t–450t, 473	converting to single-instance problem, 142
missing values, 58–59	MultiInstanceToPropositional filter, 433t–435t,
1R, 87–89	440

1/11 1 1 1 · · · · · · · · · · · · · · ·	NAME 222
multilabeled instances, 40	NAND, 233
multilayer perceptrons, 232–241	NBTree algorithm, 446t–450t, 456
backpropagation, 235-241, 238b-239b	nearest-neighbor classification, 78
bias, 233	speed, 137–138
datasets corresponding to, 234f	nearest-neighbor learning
disadvantages, 238b-239b	attribute selection, 567–568
as feed-forward networks, 238b–239b	class noise and, 568
hidden layer, 233, 238b-239b, 239f	finding nearest neighbors, 88
input layer, 233	Hausdorff distance variants and, 303
units, 233	instance-based, 132-137
MultilayerPerceptron algorithm, 446t-450t,	multi-instance data adaptation, 301
469–472	training data, varying, 569
GUI, 469, 470f	Weka Explorer exercise, 566-571
NominalToBinaryFilter filter and, 471-472	nested dichotomies, 341-343
parameters, 471	code matrix, 342t
multinominal Naïve Bayes, 97-98	defined, 342
multiple classes to binary transformation, 307,	ensemble of, 343
338–343, 340t. See also data	neural networks, 469-472
transformation	n-fold cross-validation, 154
error-correcting output codes, 339-341	<i>n</i> -grams, 387–388
nested dichotomies, 341–343	Nnge algorithm, 446t-450t, 459
one-vsrest method, 338	noise, 6–7
pairwise classification, 339	class, 568
pairwise coupling, 339	nominal attributes, 49
simple methods, 338–339	mixture model, 289
multiple linear regression, 363	numeric prediction, 254
multiresponse linear regression, 125	symbols, 49
drawbacks, 125–126	NominalToBinary filter, 433t–435t, 439, 444,
membership function, 125	444t, 471–472
MultiScheme algorithm, 475t, 477	NominalToString filter, 433t-435t, 439
multistage decision property, 103–104	nonlinear class boundaries, 226–227
multivariate decision trees, 203	NonSparseToSparse filter, 441t, 442
	normal distribution
N	assumption, 97, 99
Naïve Bayes, 93, 308	confidence limits, 152t
for data streams, 381	normalization, 462
for document classification, 97–98	Normalize filter, 433t-435t, 437, 441t, 442
with EM, 295	NOT, 233
independent attributes assumption, 289–290	nuclear family, 44–46
locally weighted, 260	null hypothesis, 158
missing values, 94–97	numeric attributes, 49, 314–322
multinominal, 97–98	1R, 87–89
numeric attributes, 94–97	classification rules, 205
selective, 314	converting discrete attributes to, 322
semantics, 99	decision tree, 193–194
visualizing, 573	discretization of, 306
Weka algorithms, 446t–450t, 451–453	Naïve Bayes, 94–97
NaiveBayes algorithm, 446t–450t, 451, 452f	normal-distribution assumption for, 99
NaiveBayesMultinomial algorithm, 446t–450t	numeric prediction, 15, 40
NaiveBayesMultinomial-Updateable algorithm,	additive regression, 362–363
446t–450t, 451	bagging for, 354–355
NaiveBayesSimple algorithm, 446t–450t, 451	evaluating, 180–182
NaiveBayesUpdateable algorithm, 446t–450t, 451	linear models, 124–125
The stay of the st	1110 1110 1110 1110 1110 1110 1110 111

numeric prediction (continued)	orthogonal coordinate systems, 324
outcome as numeric value, 42	outliers, 335
performance measures, 180t, 182t	detection of, 335-336
support vector machine algorithms for,	output
227–228	aggregating, 142
numeric prediction (local linear models),	clusters, 81
251–261	instance-based representation, 78-81
building trees, 253	knowledge representation, 85-145
locally weighted linear regression,	linear models, 62–63
259–261	rules, 67–77
model tree induction, 255-257	tables, 61–62
model trees, 252	trees, 64–67
nominal attributes, 254	overfitting, 88
pruning trees, 253–254	for 1R, 88
rules from model trees, 259	backpropagation and, 238b-239b
numeric thresholds, 193	forward stagewise additive regression and,
numeric-attribute problems, 10–11	363
NumericCleaner filter, 433t–435t, 438	support vectors and, 226
NumericToBinary filter, 433t–435t, 439	overfitting-avoidance bias, 32–33
NumericToNominal filter, 433t–435t, 439	overlay data, 52
NumericTransform filter, 433t–435t	overally data, 52
rumerierransjorm meet, 1330-1330	P
0	PaceRegression algorithm, 446t–450t, 462
<i>Obfuscate</i> filter, 433t–435t, 441	packages, 519–520. See also Weka
object editors, 404	weka.associations, 525
generic, 417f	weka.attributeSelection, 525
objects (Weka), 520	weka.classifiers, 523–525
Occam's Razor, 183, 185, 361	weka.clusterers, 525
one-class learning, 307, 335–337	weka.core, 520–523
multiclass classifiers, 336	weka.core, 525–525 weka.datagenerators, 525
outlier detection, 335–336	weka.estimators, 525
one-dependence estimator, 269	weka.filters, 525
*	*
OneR algorithm, 446t–450t, 505	PageRank, 21, 375–376, 390
output, 458f	recomputation, 391
visualizing, 571–572	sink, 392
OneRAttributeEval method, 489t, 491	in Web mining, 391–392
one-tailed probability, 151	pair-adjacent violators (PAV) algorithm, 345–346
one-vsrest method, 338	paired t-test, 157
OPTICS algorithm, 480t, 484–485, 485f	pairwise classification, 339
option trees, 365–368	pairwise coupling, 339
as alternating decision trees, 366–368, 367f	parabolas, 248–249
decision trees versus, 365–366	parallelization, 379
example, 366f	<i>PART</i> algorithm, 411–413, 446t–450t, 460f–461f
generation, 366	partial decision trees
OR, 233	best leaf, 212
order-independent rules, 115	building example, 211f
orderings, 50	expansion algorithm, 210f
circular, 51	missing values, 212
partial, 51	obtaining rules from, 208–212
ordinal attributes, 50	partial least-squares regression, 326-328
coding of, 51	partial ordering, 51
OrdinalClassClassifier algorithm, 475t, 479	PartitionedMultiFilter filter, 433t–435t, 437–438

partitioning	prior knowledge, 385
for 1R, 88	prior probability, 92–94
discretization, 87	Prism algorithm, 446t-450t
instance space, 80f	PRISM method, 114-115, 215
training set, 195	probabilities
PAV. See pair-adjacent violators algorithm	class, calibrating, 343-346
perceptron learning rule, 128	maximizing, 185
illustrated, 129f	one-tailed, 151
updating of weights, 130	predicting, 159–163
perceptrons, 129	probability density function relationship,
instance presentation to, 129	96
kernel, 231–232	with rules, 12–13
linear classification using, 127-129	probability density functions, 96
multilayer, 232–241	probability estimates, 262
voted, 231–232	probability-based clustering, 285–286
performance	programming by demonstration, 396
classifier, predicting, 149	projection. See data projection
comparison, 147	proportional k-interval discretization, 316
error rate and, 148	PropositionalToMultiInstance filter, 433t-435t,
evaluation, 148	440
instance-based learning, 246	pruning
for numeric prediction, 180t, 182t	cost-complexity, 202
optimization in Weka, 478–479	decision trees, 195–197
predicting, 150	example illustration, 199f
text mining, 386–387	incremental reduced-error, 206, 207f
personal information use, 34–35	model trees, 253-254
PKIDiscretize filter, 433t–435t, 438	noisy exemplars, 245–246
PLSClassifier algorithm, 446t-450t, 462	postpruning, 195
PLSFilter filter, 444t, 445, 462	prepruning, 195
Poisson distribution, 290	reduced-error, 197, 206
postpruning, 195	rules, 200–201
subtree raising, 196–197	subtree lifting, 199–200
subtree replacement, 195–196	subtree raising, 196–197
prediction	subtree replacement, 195–196
with Bayesian networks, 262–266	pruning sets, 205–206
multiclass, 164	
nodes, 366–367	Q
outcomes, 164, 164t-165t	quadratic loss function, 160-163
three-class, 165t	1
two-class, 164t	R
PredictionAppender, 499-500, 499t	RacedIncrementalLogitBoost algorithm, 475t,
PredictiveApriori rule learner, 486t, 487	476–477
preprocessing techniques, 574–578	race search, 313
prepruning, 195	RaceSearch method, 490t, 493
principal component analysis, 324–326	radial basis function (RBF), 241-242
of dataset, 325f	kernels, 227
principal components, 325	networks, 227
recursive, 326	output layer, 241–242
principal components regression, 326	random projections, 326
PrincipalComponents filter, 433t–435t, 439	random subspaces, 357
PrincipalComponents method, 489t, 491	RandomCommittee algorithm, 475t, 476
principle of multiple explanations, 186	RandomForest algorithm, 446t-450t

randomization, 356–358	relation-valued attributes, 54–55
bagging versus, 357	instances, 56–57
results, 356–357	specification, 55
rotation forests, 357–358	relative-absolute errors, 181
in Weka, 474–476	relative-squared errors, 181
Randomize filter, 441t, 442	RELIEF (Recursive Elimination of Features), 346
randomizing	ReliefFAttributeEval method, 489t, 490-491
unsupervised attribute filters, 441	reloading datasets, 418–419
unsupervised instance filters, 442	Remove filter, 433t-435t, 436
RandomProjection filter, 433t-435t, 441	RemoveFolds filter, 441t, 442
RandomSearch method, 490t, 493	RemoveFrequentValues filter, 441t, 442
RandomSubset filter, 433t-435t, 437, 476	RemoveMisclassified filter, 441t, 442
RandomSubSpace algorithm, 475t	RemovePercentage filter, 441t, 442
RandomTree algorithm, 446t-450t, 455	RemoveRange filter, 441t, 442
Ranker method, 490-491, 490t, 494	RemoveType filter, 433t-435t, 436
RankSearch method, 490t, 493-494	RemoveUseless filter, 433t-435t, 436
ratio quantities, 50	RemoveWithValues filter, 441t, 442
RBF. See radial basis function	Reorder filter, 433t–435t, 437–438
RBFNetwork algorithm, 446t-450t, 467-469	repeated holdout, 152-153
recall-precision curves, 174–175	ReplaceMissingValues filter, 433t-435t, 438
AUPRC, 177	replicated subtree problem, 69
points on, 179	decision tree illustration, 71f
rectangular generalizations, 79	REPTree algorithm, 446t-450t, 456
recurrent neural networks, 238b-239b	Resample filter, 441t, 442, 444t, 445
recursive feature elimination, 309–310	reservoir sampling, 330–331
reduced-error pruning, 206, 238	ReservoirSample filter, 441t, 442
incremental, 206, 207f	residuals, 327, 368–369
reference density, 337	resubstitution errors, 148–149
reference distribution, 337	retargeting classifiers, in Weka, 479
regression, 15, 62	Ridor algorithm, 446t-450t, 459
additive, 362–365	RIPPER algorithm, 208, 209f, 215
isotonic, 345	ripple-down rules, 216
kernel ridge, 229–231	robo-soccer, 394
linear, 124–125	robust regression, 333–334
locally weighted, 259–261	ROC curves, 172–174, 581
logistic, 125–127	AUC, 177
partial least-squares, 326–328	from different learning schemes, 173–174
principal components, 326	generating with cross-validation, 173
robust, 333–334	jagged, 172–173
support vector, 227–229	points on, 179
regression equations, 15	sample, 173f
regression tables, 61–62	for two learning schemes, 174f
regression trees, 67, 251	rotation forests, 357–358
illustrated, 68f	RotationForest algorithm, 475t, 476
RegressionByDiscretization algorithm, 475t, 479	rote learning, 78
regularization, 244	row separation, 340
reidentification, 33–34	rule sets
RELAGGS filter, 433t–435t, 440	model trees for generating, 259
RELAGGS system, 302–303	for noisy data, 203
relations, 43–46	visualizing, 573
ancestor-of, 46	rules, 10, 67–77
sister-of, 43f, 45t	antecedent of, 67
superrelations, 44–46	association, 11, 72–73, 216–223

classification, 11, 69–72	seeds, 139
computer-generated, 19–21	selective Naïve Bayes, 314
consequent of, 67	semantic relationship, 384
constructing, 108–116	semisupervised learning, 294–298
decision lists versus, 115–116	clustering for classification, 294–296
decision tree, 200–201	co-EM, 297
efficient generation of, 122–123	co-training, 296
	C.
with exceptions, 73–75, 212–215	separate-and-conquer algorithms, 115–116, 308
expert-derived, 19–21	SerializedClassifier algorithm, 474
expressive, 75–77	SerializedModelSaver, 499–500, 499t
inferring, 86–90	set kernel, 301
from model trees, 259	shapes problem, 75
order-independent, 115	illustrated, 76f
perceptron learning, 128	training data, 76t
popularity, 70–71 PRISM method for constructing,	sIB algorithm, 480t, 485
114–115	sigmoid function, 236f sigmoid kernel, 227
probabilities, 12–13	SimpleCart algorithm, 446t–450t, 456
=	SimpleKMeans algorithm, 4401–430t, 430t SimpleKMeans algorithm, 480–481, 480t, 481f
pruning, 200–201	
ripple-down, 216 trees versus, 109–110	SimpleLinearRegression algorithm, 446t–450t, 459, 461f
Weka algorithms, 446t–450t, 457–459	SimpleLogistic algorithm, 446t–450t, 467
weka aigoritiinis, 440t–430t, 437–439	SimpleMI algorithm, 446t–450t, 473–474
S	single-attribute evaluators, 490–492
sampling, 307, 330–331. See also data	single-consequent rules, 123
transformation	single-linkage clustering algorithm, 275, 279
with replacement, 330–331	skewed datasets, 135
reservoir, 330–331	SMO algorithm, 446t–450t, 462, 463f–467f
without replacement, 330	smoothing calculation, 252
ScatterPlotMatrix, 498, 499t	SMOreg algorithm, 446t–450t, 462
ScatterSearchV1 method, 490t, 494	SMOTE filter, 444t, 445
schemata search, 313	soybean classification example, 5
scheme-independent attribute selection, 308–310	dataset, 20t
filter method, 308–309	examples rules, 19
instance-based learning methods, 310	sparse data, 56
recursive feature elimination, 309–310	sparse instances, 442
symmetric uncertainty, 310b	SparseToNonSparse filter, 441t, 442
wrapper method, 308–309	SPegasos algorithm, 446t–450t, 464
scheme-specific attribute selection, 312–314	splitter nodes, 366–367
accelerating, 313	splitting, 281
paired $t$ -test, 313	clusters, 274
race search, 313	criterion, 253
results, 312–313	model tree nodes, 255
schemata search, 313	SpreadSubsample filter, 444t, 445
selective Naïve Bayes, 314	SQLViewer, 419
scheme-specific options, 528t, 529	squared error, 161
scientific applications, 28	stacking, 334, 369–371
screening images, 23–24	defined, 144, 369
SDR. See standard deviation reduction	level-0 model, 370-371
search, generalization as, 29	level-1 model, 369-371
search bias, 32	model input, 369
search engines, in web mining, 21–22	output combination, 369
search methods (Weka), 421, 490t	as parallel, 379

Stacking algorithm, 475t, 477	instance, 445
Stacking C algorithm, 475t, 477	using, 432
standard deviation from the mean, 151	supervised learning, 40
standard deviation reduction (SDR), 253,	support, of association rules, 72, 116
254	support vector machines (SVMs), 191–192
Standardize filter, 433t–435t, 437	co-EM with, 297
standardizing statistical variables, 57	hinge loss, 242–243
statistical clustering, 314–315	linear model usage, 223
statistical modeling, 90–99	term usage, 223
statistics, machine learning and, 28–29	training, 225
step function, 236f	weight update, 243
stochastic backpropagation, 238b–239b	support vector regression, 227–229
stochastic gradient descent, 242–243	flatness maximization, 229
stopwords, 329, 387	illustrated, 228f
stratification, 152	for linear case, 229
variation reduction, 153–154	linear regression differences, 228
stratified holdout, 152	for nonlinear case, 229
stratified threefold cross-validation, 153	support vectors, 191–192, 225
StratifiedRemoveFolds filter, 444t, 445	finding, 225
StreamableFilter keyword, 526	overfitting and, 226
string attributes, 54	SVMAttributeEval method, 489t, 491
in document classification, 579–580	SwapValues filter, 433t–435t, 438
specification, 54	symmetric uncertainty, 310b
values, 54	SymmetricalUncertAttributeEval method,
StringToNominal filter, 433t–435t, 439	489t, 491
StringToWordVector filter, 419, 433t–435t,	
439–440, 538	Т
default, 581	•
options, 581	tables
StripChart, 498, 499t	as knowledge representation, 61–62
structural descriptions, 5–7	regression, 61–62
decision trees, 5	tabular input format, 124
learning techniques, 8–9	TAN. See tree-augmented Naïve Bayes
structure learning by conditional	teleportation, 392
independence tests, 270	tenfold cross-validation, 153–154, 306
Student's distribution with k-1 degrees of	Tertius rule learner, 486t, 487
freedom, 157	testing, 148–150
Student's t-test, 157	test data, 149
subgradients, 242	test sets, 149
subsampling, 442	in Weka, 422–424
SubsetByExpression filter, 441t, 442	TestSetMaker, 499–502, 499t
SubsetSizeForwardSelection method, 490t,	text mining, 386–389 data mining versus, 386–387
492–493	data mining versus, 360–387 document classification, 387–388
subtree lifting, 199–200	
subtree raising, 196–197 subtree replacement, 195–196	entity extraction, 388 information extraction, 388–389
success rate, error rate and, 197–198	
	metadata extraction, 388 performance, 386–387
superparent one-dependence estimator, 269 superrelations, 44–46	stopwords, 387
supervised discretization, 316, 574	text summarization, 387
supervised discretization, 316, 374 supervised filters, 432, 443–445	text summarization, 387 text to attribute vectors, 328–329
attribute, 443–445	Text to attribute vectors, 528–529 TextViewer, 499t
amiouc, ++3-++3	IUNI FIC WEI, TIII

theory, 183	<i>t</i> -test, 157
exceptions to, 183	corrected resampled, 159
MDL principle and, 183-184	paired, 157
threefold cross-validation, 153	two-class mixture model, 286f
three-point average recall, 175	two-class problem, 75
ThresholdSelector algorithm, 475t, 479	typographic errors, 59
time series, 330	
Delta, 330	U
filters for, 440	ubiquitous computing, 395-396
timestamp attribute, 330	ubiquitous data mining, 395–397
TimeSeriesDelta filter, 433t-435t, 440	univariate decision trees, 203
TimeSeriesTranslate filter, 433t-435t, 440	unmasking, 394–395
timestamp attribute, 330	unsupervised attribute filters, 432–441.
tokenization, 328–329, 440	See also filtering algorithms;
top-down induction, of decision trees,	filters
107–108	adding/removing attributes, 436-438
toSource() method, 550–553	changing values, 438
training, 148–150	conversions, 438–439
data, 149	list of, 433t–435t
data verification, 569	multi-instance data, 440
documents, 579t	randomizing, 441
instances, 184	string conversion, 439–440
learning schemes (Weka), 422–424	time series, 440
support vector machines, 225	unsupervised discretization, 316, 574
training sets, 147	unsupervised instance filters, 441–442
error, 197	list of, 441t
error rate, 148	randomizing, 442
partitioning, 195	sparse instances, 442
size effects, 569t	subsampling, 442
TrainingSetMaker, 499–502, 499t	UpdateableClassifier keyword, 526
TrainTestSplitMaker, 499–500, 499t	updateData() method, 536–537
tree diagrams. See dendrograms	User Classifier (Weka), 65, 424–427
tree-augmented Naïve Bayes (TAN), 269 trees, 64–67. See also decision trees	segmentation data with, 428f
	UserClassifier algorithm, 446t–450t, 570
AD, 270–272, 271f	V
ball, 135–137	validation data, 149
frequent-pattern, 216–219 functional, 65	validation sets, 379
Hoeffding, 382–383	variables, standardizing, 57
kD, 132–133, 133f–134f	variance, 354
logistic model, 368–369	Venn diagrams, in cluster representation,
metric, 137–138	81
model, 67, 68f, 251–252	VFI algorithm, 417, 446t–450t
option, 365–368	visualization
regression, 67, 68f, 251	Bayesian network, 454f
rules versus, 109–110	classification errors, 565
Weka algorithms, 416, 446t–450t	decision trees, 573
trees package, 519–520	Naïve Bayes, 573
true negatives (TN), 164, 580	nearest-neighbor learning, 572
true positive rate, 164	OneR, 571–572
true positives (TP), 164, 580	rule sets, 573
<i>t</i> -statistic, 158–159	in Weka, 430–432

Visualize panel, 430–432, 562	association rules, 429–430
Vote algorithm, 475t, 477	association-rule learners, 485–487
voted perceptron, 197	attribute selection, 430, 487–494
VotedPerceptron algorithm, 446t–450t, 464	clustering, 429
voting feature intervals, defined, 138	clustering algorithms, 480–485
W	command-line interface, 519–530
==	components configuration and connection,
WAODE algorithm, 446t–450t, 451	500–502
Wavelet filter, 433t–435t, 439	CPU performance data, 423f
weather problem example, 9–12	data preparation, 407
alternating decision tree, 367f	development of, 403
ARFF file for, 53f, 409f	evaluation components, 498–500, 499t
association rules, 11, 120t–121t	experiment distribution, 515–517
attribute space, 311f	Experimenter, 405, 505–517
attributes, 9–10	Explorer, 404, 407–494
attributes evaluation, 87t	filtering algorithms, 432–445
Bayesian network visualization, 454f	Generic Object Editor, 417f
Bayesian networks, 263f, 265f	GUI Chooser panel, 408 how to use, 404–405
clustering, 280f counts and probabilities, 91t	
CSV format for, 409f	incremental learning, 502–503 interfaces, 404–405
data with numeric class, 42t	ISO-8601 date/time format, 54
dataset, 10t	Knowledge Flow, 404–405, 495–503
decision tree, 103f	learning algorithms, 445–474
EM output, 482f	learning algorithms, 443–474 learning scheme creation, 539–557
expanded tree stumps, 102f	market basket analysis, 584–585
FP-tree insertion, 217t–218t	message classifier application, 531–538
identification codes, 106t	metalearning algorithms, 474–479
item sets, 117t–118t	neural networks, 469–472
multi-instance ARFF file, 55f	packages, 519–525
NaiveBayes output, 452f	search methods, 492–494
numeric data with summary statistics,	simple setup, 510–511
95t	structure of, 519–526
option tree, 366f	User Classifier facility, 65, 424–427
SimpleKMeans output, 481f	visualization, 430–432
tree stumps, 100f	visualization components, 498-500, 499t
web mining, 5, 389–392	weka.associations package, 525
PageRank algorithm, 390-392	weka.attributeSelection package, 525
search engines, 21–22	weka.classifiers package, 523-525
teleportation, 392	DecisionStump class, 523, 524f
wrapper induction, 390	implementations, 523
weight decay, 238b-239b	weka.classifiers.trees.Id3, 539-555
weighting attributes	buildClassifier() method, 540
instance-based learning, 246-247	classifyInstance() method, 549-550
test, 247	computeInfoGain() method, 549
updating, 247	getCapabilities() method, 539
weights	getTechnicalInformation() method, 539
determination process, 15	globalInfo() method, 539
with rules, 12–13	main() method, 553-555
Weka, 403–406	makeTree() method, 540-549
advanced setup, 511-512	Sourcable interface, 539, 550
ARFF format, 407	source code, 541f–548f
association rule mining, 582-584	source code for weather example, 551f-553f

TechnicalInformationHandler interface, 539 toSource() method, 550-553 weka.clusterers package, 525 weka.core package, 520-523 classes, 523 web page illustration, 521f-522f weka.datagenerators package, 525 weka.estimators package, 525 weka.filters package, 525 weka.log, 415-416 weka package, 520 Weka workbench, 376, 403 filters, 404 J4.8 algorithm, 410-414 Winnow, 129-130 Balanced, 131

linear classification with, 88

updating of weights, 130
versions illustration, 130f
Winnow algorithm, 446t–450t
wisdom, 35
wrapper induction, 390
wrapper method, 308–309
wrappers, 389–390
WrapperSubsetEval method, 488, 489t

## Χ

XMeans algorithm, 480t, 483 XML (eXtensible Markup Language), 52–56 XOR (exclusive-OR), 233 XRFF format, 419

## Z

zero-frequency problem, 162 *ZeroR* algorithm, 413, 446t–450t, 459, 505