## Index

Note: Page numbers followed by "b", "f" and "t" indicate boxes, figures and tables respectively

AdaBoost model, 158–159, 159f ANNs. See Artificial neural networks (ANNs) Anomaly detection causes click fraud detection, 331b credit card transaction fraud monitoring, 331 data errors, 330 distributional assumption, 330 distribution classes, 330 normal data variance, 330 characteristics, 332–333 classification technique, 334 clustering, 334 computer network traffic, 329 density based outlier, 333, 339, 339f–341f distance based outlier, 333, 337f Detect Outlier (Distances) operator, 337 distance score, 334–335 Euclidean distance, 334 Iris data set, 335, 336f k-NN classification technique, 334–335 Outlier detection output, 338, 338f two-dimensional scatterplot, 334, 335f unsupervised outlier detection operator, 336 distribution based outlier, 333–334 distribution model, 332 generalized classification model, 344	high-volume transaction networks, 344  LOF technique minimal points, 342 output, 342–344, 343f RapidMiner process, 342, 343f relative density, 341–342 outlier, 329 sorting function, 332 statistical methods Mahalanobis distance, 332 standard normal distribution, 332, 333f stratified sampling method, 344–345 supervised and unsupervised techniques, 414 Anscombe's quartet, 45–46, 46f Apriori algorithm, 202–206, 202f–203f clickstream data set, 204, 204t frequent item set support calculation, 204, 205t rule generation, 206 support, 204, 205f Area under the curve (AUC), 263, 270, 272f Artificial intelligence, 4–5 Artificial neural networks (ANNs), 13, 18, 126f activation function, 126–127 advantages, 134 aggregation function, 124–125 AutoMLP, 130–131 back propagation, 127 biological neurons, 125f, 125b data preparation, 131 error calculation, 128–129, 128f evaluation, 130f, 132 hidden layers, 126	linear mathematical model, 124 missing values, 133 modeling operator and parameters, 131–132 model topology, 124, 124f optical character recognition, 127b perceptron, 124–125 performance vector, 132, 133f simple aggregation activation function, 128 transfer function, 124–125 universal approximator, 126–127 weight adjustment, 129–130, 129f Association analysis antecedent and consequent, 196 Apriori algorithm, 202–206, 202f–203f clickstream data set, 204, 204t frequent item set support calculation, 204, 205t rule generation, 206 support, 204, 205f association rules, 197 confidence, 198–199 conviction, 198, 200 cross selling, 196b FP-Growth algorithm, 208 conditional FP-tree, 210, 210f data preparation, 211–215, 211f frequent paths, 207 modeling operator and parameters, 212–213, 212f rules creation, 213 transactions 1, 2, and 3, 207, 208f transactions list, 207, 207t trimmed FP-tree, 209–210, 209f
---	--	---

Association analysis (Continued)	K-nearest neighbors. See K-nearest	bubble chart, 55, 55f
lift, 198–200	neighbors (k-NN)	class-stratified histogram, 48, 49
market basket analysis, 195–196	naïve bayesian. See Naïve bayesian	class-stratified quartile plot, 49,
rule generation process, 200-202,	rule induction. See Rule induction	50f
201f	SVMs. See Support vector machines	cognitive thinking, 47
support, 198–199	(SVMs)	density charts, 55, 56f
Automatic Multilayer Perceptron	Clustering, 286, 288f-289f	deviation chart, 57, 58f
(AutoMLP), 130–131	DBSCAN clustering, 240f.	distribution chart, 47–49, 48f
D	See Density-Based Spatial	histogram, 48, 48f
В	Clustering of Applications	parallel chart, 56–57, 57f
Bagging model, 156–157, 157f	with Noise (DBSCAN)	quartile plot, 49, 50f
Bayesian Information Criterion	clustering	scatter matrix plot, 53–55, 54f
(BIC), 232–234	dimensionality reduction, 218	scatter multiple plot, 53, 53f
Bayesian probabilistic theories, 4-5	document clustering, 218	scatterplot, 52–53, 52f
Big Data, 7	k-means clustering, 230f. See also	descriptive statistics, 37
Blog gender classification, 284	k-means clustering.	multivariate exploration. See
key features identification,	object reduction, 219 SOM, 242–243, 242f. <i>See also</i>	Multivariate exploration
296–297, 297f	Self-organizing map (SOM)	univariate exploration. See
LibSVM(linear) operators,		Univariate exploration Data mining process, 19f
297–299	types customer records segmentation,	anomaly detection
preprocessing text data, 293, 295f	222t, 222b	algorithm, 15
process documents, 293, 295f	DBSCAN, 221	application
Read Excel operator, 293, 294f	density clustering, 221	assimilation, 34
test data preparation, 299, 300f	Euclidean distance	production readiness, 32–33
training and testing predictive	measurement, 219	remodeling, 34
models, 297–299, 298f	exclusive/strict partitioning	response time, 33
unstructured data, 290t–292t, 288–293	clusters, 219	technical integration, 33
W-Logistic operators, 297–299	fuzzy/probabilistic clusters, 220	artificial neural network, 18
X-Validation operator, 297–299,	hierarchical clustering, 219, 221	automated clustering, 18
298f, 299t	model-based clustering, 221	classification model, 4–5, 10, 13
Bootstrap aggregating/bagging,	overlapping clusters, 219	CRISP-DM, 17–18, 18f
154–155	prototype-based clustering,	data preparation
Boston Housing data set, 170,	220–221	EDA, 23
171t–172t	SOM, 221	feature selection, 26
1711 1721	Confusion matrix, 189-190, 189f	missing values, 24
C	Cross Industry Standard Process for	outliers, 25–26
Categorical data types, 40	Data Mining (CRISP-DM),	pivot/transpose functions, 22-23
Chi-square-based filtering	17-18, 18f	quality, 24
attribute weighting, 362, 363f	_	sampling, 26-27
contingency table, 361–362, 362t	D	transformation, 25
expected frequency table, 361–362,	Data discovery techniques, 5	types and conversion, 25
362t	Data exploration	descriptive/explanatory modeling,
observed vs. expected frequencies,	data, definition, 37	18-19
362	data preparation, 38	DMAIC, 17-18
Classification	data sets	modeling, 28f
ANNs. See Artificial neural	categorical/nominal, 40-41	abstract data representation, 27
networks (ANNs)	numeric/continuous, 40	classification, 27
categorical target variable	types, 40-41	decision tree techniques, 28
prediction, 408–410	visual exploration, 39-40	ensemble modeling, 31–32
classes, 63	data understanding, 38	model evaluation, 31, 31t
decision trees. See Decision trees	data visualization, 37	regression model, 30, 30f
ensemble learners. See Ensemble	Andrews curves, 57-59, 59f	simple linear regression
learners	box whisker plot, 48-49	technique, 28

test data set, 28, 29f, 29t	credit scoring, 72	Density-clustering algorithm, 221,
training data set, 28, 29f, 29t	data preparation	234
predictive modeling, 18-19	attribute value replacement,	Descriptive statistics, 5, 37
prior knowledge, 19	76–77, 78f	characteristics, 41
attribute, 22	data transformation, 77-79,	multivariate exploration. See
causation vs. correlation, 22, 22t	80f	Multivariate exploration
data point/record/data object, 21	German credit data, 74-75, 75t	univariate exploration. See
data set, 21, 21t	disadvantages, 88	Univariate exploration
identifiers, 22	entropy, 65, 65f	Dimensional slicing, 5
label, 22	uncertainity reduction, 65b	Dimensions, 7
objective, 20	gain ratio, 82-83	
subject area, 20-21	Gini index, 83	E
quantitative analysis, 35	definition, 66	Ensemble learners, 14
RapidMiner software, 12. See also	Golf data set, 66, 67t, 69-70, 70f	AdaBoost model, 158–159,
RapidMiner	information gain, 68, 69t	159f
SEMMA, 17–18	split data, 66	aggregate hypothesis/model,
SOM, 14–15	subsets/branches, 69, 69f	148
types	information gain, 82, 88	Bagging meta model, 156–157,
anomaly/outlier detection, 9.	Meta Cost, 85	157f
See also Anomaly detection.	minimal gain value, 83	
classification, 9. See also	minimal leaf size, 85	Bagging operator, 155–156, 156f boosting, 157–158
Classification	overfitting, 70	
	post-pruning, 70–71	bootstrap aggregating/bagging,
clustering, 9. See also		154–155
Clustering	pre-pruning, 70–71	conditions, 151–152
market basket analysis, 9. See	prospect filtering, 72–73	drought prediction, 150b
also Association analysis	prospect scoring data, 83–84, 84f	error rate, 151
regression techniques, 9. See also	pruning, 70–71	generalization error, 162
Regression methods	regression trees, 64	meta learning, 148–149
supervised/unsupervised	scale normalization, 87	probability mass function, 150
learning models, 8, 10	Shannon entropy, 71	Random Forest operator, 160–161,
time series forecasting, 9. See	splitting data, 73	161f
also Time series forecasting	supervised learning algorithm, 74	voting, 153–154, 153f–155f
wrapper-type methods, 15–16	target variable, 64	Ensemble modeling, 31–32
Data storage, 6	Dendrogam, 221	Euclidean distance, 102–105
Data transformation tools	Density-Based Spatial Clustering	Exclusive/strict partitioning clusters
Append operator, 391–392	of Applications with Noise	219
data type conversion operators,	(DBSCAN) clustering	Exploratory data analysis (EDA), 23
387	border points, 236, 236f	See also Data exploration
De-pivot operator, 388	center-based density, 234, 235f	_
dichotomization, 386	centroid methods, 242	F
discretization output, 387-388,	core points, 236, 236f	Feature selection, 26
390f	data preparation, 238	attributes selection, 415-416
discretize operator, 387-388, 389f	density-clustering algorithm, 234	chi-square-based filtering
Join operator, 391-392	epsilon and MinPoints, 236	attribute weighting, 362, 363f
pivot tables, 388, 390f-391f	evaluation (optimal), 239	contingency table, 361-362,
Davies-Bouldin index, 229	high-density and low-density	362t
Decision trees, 13, 28	space, 235	expected frequency table,
accuracy, 83	k-distribution chart, 237, 238f	361-362, 362t
advantages, 87-88	noise points, 236, 236f	observed vs. expected
aggregate measures, 86	operator and parameters, 239	frequencies, 362
baseline model performance	prototype-based clustering,	rank attributes, 362, 363f
measures, 85, 85f	220–221	dimension reduction, 347, 370
credit default identification	varying densities, 237, 238f	filter type, 347
process, 85-86, 86f	visual output, 239-241, 241f	information theory

Feature selection ( <i>Continued</i> ) information exchange, 358 numeric Golf data set, 358–359, 360f motivation, 348b	K Keyword clustering Crawl Web operator, 285 document-clustering problem, 284 Get Pages operator, 285	distance, 102–105, 104f Jaccard similarity, 106–107 SMC, 106 unseen test record, 102
multicollinearity, 348	k-medoids operator, 286, 288f	L
multiple regression, 348	medoid clustering, 284–285	Linear regression
naïve Bayesian classifiers, 348	process, 286, 289f	average error, 169
PCA, 349, 357f. See also Principal	unstructured data, 285-286, 285f	data separation, 172, 173f
component analysis (PCA)	k-means clustering	dependent and independent
remove independent variables, 348	BIC, 232–234	variable, 167–168
types, 347	centroid prototype approach, 234	feature selection option, 173, 174f
wrapper type feature selection, 347	centroids output, 231, 232f	gradient descent, 169
aggressive feature selection, 369, 369f	cluster centroid/mean data object,	"greedy" feature selection,
Backward Elimination operator,	223	174–175, 176f
364–365, 367f	Cluster Distance Performance	linear regression operator, 173,
computational resource	operator, 231	174f
consumption, 364	cluster label, 229–230	median price, 169
forward selection, 364	Davies-Bouldin index, 229	model validity, 180
maximal relative decrease, 368	empty clusters, 228–229	null hypothesis, 177–178 p-values, ranking variables,
permissive feature selection,	Euclidean distance, 224	177–178, 177f
369, 369f	evaluation parameter, 229 initiation, 228	RapidMiner, 170, 171t–172t
preset stopping criterion,	labeled example set, 232	simple regression model, 167–168,
369-370	limitations, 232–234	168f
regression model, 364, 364t	local optimum, 227–228	split validation operator, 172–173,
Split Validation operator, 368	new centroids	173f
squared correlation, 368	location, 226, 226f–227f	squared correlation, 177, 177f
Frequent Pattern (FP)-Growth	operator and parameters, 231	unseen test data, 178-179, 179f
algorithm, 208	outliers, 229	"wrapper" functions, 176
conditional FP-tree, 210, 210f	performance criterion, 227–228	Linear regression model, 7
frequent paths, 207	performance vector, 232, 233f	Local outlier factor (LOF) technique
modeling operator and parameters, 212-213, 212f	postprocessing, 229	Binominal operator, 342-344
results interpretation, 213–215,	prototype-based clustering and	data preparation, 342
213f-214f	boundaries, 224, 225f	Detect Outlier operator, 342
rules creation, 213	prototype data point, 223	minimal points, 342
transactions list, 207, 207t	sum of squared errors, 226	output, 342-344, 343f
trimmed FP-tree, 209–210, 209f	termination, 227	RapidMiner process, 342, 343f
Fuzzy/probabilistic clusters, 220	visual output, 232, 233f	relative density, 341–342
7/1	Voronoi partitions, 223, 223f	Logistic regression, 1–2
G	K-nearest neighbors (k-NN), 334–335	binomial response variable, 191 confusion matrix, 189–190, 189f
Gain curves, 264, 268f	eager learners, 99	credit scoring exercise, 188
	forest type prediction, 100b lazy learners, 99, 108	data preparation, 188
Н	eager learners, 111	likelihood function, 185
Hamming distance, 102–105	execution and interpretation,	linear model, 182, 183f
Hierarchical clustering, 219, 221	109f–110f, 110	logit function, 180–181, 181f, 184
Hypothesis-driven techniques, 7–8	modeling operator and	MetaCost operator, 190–191, 190f
Hypothesis testing, 5–6	parameters, 108–109	modeling operator and parameters,
,.	nonparametric method, 99	188, 189f
	proximity measure	nonlinear curve, 182, 183f
Integer data type, 40	correlation similarity, 106	nonlinear optimization
Iterative algorithms, 4–5	cosine similarity, 107	techniques, 185

odds ratio analysis, 186b	Multivariate exploration	optimization tools
parameters, 184	central data point, 44	attributes upper bound and
"sigmoid" curve, 182	correlation	attributes lower bound
S-shaped curve, 182	Anscombe's quartet, 45, 46f	parameters, 399
SVM, 191, 191f	Cartesian coordinate, 45	configuration, 397, 399f
Titanic wreck, 186b, 187f	Pearson correlation coefficient,	disadvantage, 402
, ,	44-45, 45f	Generate Data operator, 397
M	quadratic functions, 45	genetic search optimization,
Machine learning, 4-5	•	402, 404f
Mahalanobis distance, 332	Q	grid search optimizer, 399–400,
Manhattan distance, 102-105	Queries, 6	400f-401f
Meaningful patterns extraction, 3		inner process, 397, 398f
MetaCost operator, 190-191, 190f	R	mutation and cross-over, 402
Minkowski distance, 102-105	Random Forest operator, 160–161,	"nested" operator, 396
Mixture of Gaussians, 221	161f	Optimize operator, 396
Model-based clustering, 221	RapidMiner	Optimize parameters, 397
Model evaluation	attributes, 375–376, 376f	polynomial function, 396–397,
AUC, 263, 270, 272f, 273	data importing and exporting	397f
classification performance metrics,	tools	quadratic greedy search
264–267, 269f	CSV file, 377–379, 380f	optimization, 402, 403f
confusion matrix/truth table, 257,	data import wizard, 379,	process, 377, 378f
259t	381f-382f	RapidMiner Studio GUI, 371
accuracy, 259	Import Configuration Wizard,	repository, 375, 375f
binary/binomial classification,	377–379	sampling and missing value tools
258	data scaling and transformation	balanced accuracy, 394
definition, 258	tools, 371	balancing data sets, 392
evaluation measures,	data set, 375–376	bootstrapping, 395
260, 260t	data transformation tools	imbalanced data set, 392, 393f
precision, 259	Append operator, 391–392	rebalance subprocess, 394, 395f
recall, 259	data type conversion operators,	replace missing values, 395-396
relevance, 259	387	unbalanced data, 392-394,
sensitivity, 258-259	De-pivot operator, 388	394f
specificity, 259	dichotomization, 386	YALE, 371
data partitioning, 267	discretize operator, 387–388,	Ratio data type, 40
Direct marketing (DM),	389f	Read Excel operator, 75, 76f
257b-258b	Join operator, 391–392	Receiver operator characteristic
evaluation, 267	label variable, 386–387	(ROC) curves, 257, 260,
Generate Direct Mailing Data	logistic regression, 386–387	262–263, 262f, 266f, 270,
operator, 264–267	machine learning algorithms, 386	272f, 273
Lift Chart operator creation, 267	pivot tables, 388, 390f–391f	Regression methods, 4-5, 30, 30f
lift charts, 257, 270, 271f	data types, 375–376	feature selection methods,
by RapidMiner, 270, 272f	data visualization tools, 383	165–166
lift curves, 263-264, 266f, 268f	bivariate plots, 383–386	function fitting, 165–166
modeling operator and parameters,	multivariate plots, 386	linear regression, 165, 174, 175f.
267	results, 382–383, 384f	See Linear regression
performance operator, 267	Statistics, 383, 385f	logistic regression, 165. See also
ROC curves, 257, 260, 262–263,	univariate plots, 383	Logistic regression
262f, 266f, 270, 272f, 273	decision tree, 376, 377f	RapidMiner, 165–166
Split Data operator, 267	example set, 375–376	Rename operator, 77-79
Split Validation operator, 267	graphical user interface	Repeated Incremental Pruning to
Moore's Law, 1–2	RapidMiner 6.0, 372, 373f	Produce Error Reduction
Multiple linear regression	views, 372, 374f	(RIPPER), 91
(MLR), 170	operator, 376	Replace (Dictionary), 76–77, 78f
	· r	

Representative models, 3-4, 4f	complex nonlinear dataset, 134	tokenization, 279-280
Rule induction, 13	disadvantage, 147	trained models, 299-302,
antecedent/condition, 89	hyperplane, 135, 135f	300f-301f
class selection, 91	Kernel functions, 138	unstructured data, 288-293,
conjunct, 89	linearly separable, 136, 137f	290t-292t
data preparation, 94-95	margin, 136, 136f	X-Validation operator, 297-299,
Decision Tree operator, 97, 98f	penalty, 136, 136f	298f, 299t
disjunct/classification rule, 89	prediction accuracy, 144, 145f	Time series forecasting, 308f
exhaustive rule set, 90	quadratic polynomial, 138	autocorrelation, 306
Golf data set, 88, 90f	Scatter 3D Color plot, 145, 146f	cross-sectional data, 305, 306f
learn-one-rule, 93	support vectors, 135	data-driven forecasting methods,
modeling operator and	two-ring nonlinear problem,	305-306
parameters, 95, 96f	145-147, 147f	decomposition, 306-307
mutually exclusive set, 89-90,		descriptive modeling, 306-307
98-99	T	forecasting demand, 307f, 307b
results interpretation, 95-97, 96f	Term frequency-inverse document	Holt's two-parameter exponential
RIPPER, 91	frequency (TF-IDF), 277–279	smoothing, 311-312
rule generation, 89f, 90-93, 92f	Text mining	Holt-winters' three-parameter
rule set, 89	clusters, 284	exponential smoothing,
sequential covering approach, 91	customer relationship	312-313
split conditions, 88	management software, 276	model-driven forecasting methods,
Tree to Rules operator, 97, 97f	data warehousing and business	306, 314f
	intelligence, 276	autoregression models and
S	IBM's Watson program, 276b	ARIMA, 316t, 317-318
Sample, Explore, Modify, Model, and	key features identification,	independent variables, 321
Assess (SEMMA), 17–18	296–297, 297f	Inner level process, 323-324,
Self-organizing map (SOM), 14–15	keyword clustering	325f
centroid update, 244–246,	Crawl Web operator, 285	label variable, 320, 322f
245f-246f	data preparation, 286, 287f	limit time box, 323-324
country data set, 248f, 249	document-clustering problem,	linear regression, 313-317, 315f,
data preparation, 249	284	316t
data transformation, 247, 247f	Get Pages operator, 285	polynomial regression, 313–314,
execution and interpretation, 251	k-medoids operator, 286, 288f	315f
grid space, 243	medoid clustering, 284-285	prediction horizon controls,
initialization, 244	unstructured data, 285-286,	318-319
location coordinates, 252, 254f	285f	regression equation, 321-322
modeling operator and parameters,	website keyword clustering	set iteration macro, 323-324
250-251, 250f	process, 286, 289f	Set Role operator, 319–320
neural network, 243-244	Lexical substitution, 280-282	step size, 320
termination, 246	meaningful n-grams, 283, 283f	Windowing operators, 318-320,
topology specification, 244	preprocessing operator, 293, 295f	320f
visual model, 251-252, 252f-253f	preprocessing steps, 283, 283t	windowing transformation,
Shannon entropy, 71	preprocessing text data, 293, 295f	317f-319f, 318, 320, 321f
Simple matching coefficient (SMC),	Read Excel operator, 293, 294f	Window size, 320
106	similarity mapping, 279	multiple linear regression model,
Simple regression model, 167–168,	stemming, 282-283	305
168f	stopword filtering, 280, 282f	naïve forecast. See Naïve forecast
Stochastic model, 7–8	stopwords, 280	neural network model, 305
Subject matter expertise, 4	term filtering, 280-282	notation system, 308
Support vector machines (SVMs), 14,	term frequencies, 281t	predictive modeling, 306–307
191, 191f	test data preparation, 299, 300f	predictor variables, 305
advantages, 148	TF-IDF, 277-279	supervised model, 305
boundary, 136, 136f	token, 279	Trend,-seasonality, 311, 312f

## U

Univariate exploration, 41, 42t descriptive statistics, 43, 43f deviation, 43 mean, 42 median, 42 mode, 42 range, 43 standard deviation, 43 variance, 43
Unsupervised process, 413

## V

Vote meta modeling operator, 153–154, 154f

## W

Wrapper type feature selection, 15–16, 347 aggressive feature selection, 369, 369f Backward Elimination operator, 364–365, 367f forward selection, 364
maximal relative decrease, 368
multiple regression model, 365
permissive feature selection, 369,
369f
preset stopping criterion, 369–370
Split Validation operator, 368



Yet Another Learning Environment (YALE), 371