Index

A

Absolute deviation. 187 Account data, 40 Account management database, information storage, 40 Accuracy ratio (AR), 179 AUC, linear relation, 181 calculation, example, 181f Acquisition costs, 334t Activation functions, 146 Actual fraud, predicted fraud (contrast), 185f Adaptive boosting (Adaboost) procedure, 165-166 Adjacency list, 221f, 222 Adjacency matrix, 221, 242, 250 mathematical representation, 221f Administrative activities (fire incident claims), 12 Administrators, experts (collusion, 14 Affiliation networks, 267 Age default risk, contrast. 60f regression model 63-64 split, entropy (calculation), 139f Agglomerative hierarchical clustering divisive hierarchical clustering, contrast, 94f methods, usage, 95–96 Aggregate loss distribution, 329–331 description, 328-329 indicators, 331f Monte Carlo simulation, 333 Alert Type, 292 Analysis of variance (ANOVA) test, 143 Analytical fraud models backtesting, 302-311 calibration, backtesting, 308 design/documentation, 311-312 life cycle, 280-281

performance metric, monitoring, 306t stability, backtesting, 305-307 Analytical model life cycle, 280f Analytics, strategic contribution, 337-338 Anomaly detection, 343 Anticipating effect, 274 Anti-fraud steering group, 345 Anti-money laundering setting, cash transfers (clustering), 90 Approval activities (fire incident claims), 12 Approval cycle, absence, 14 AR. See Accuracy ratio Area under the ROC curve (AUC), 192. See also Multiclass area under the ROC curve calculation (performance metric), 178 Assignment decision. See Decision trees Association rule analysis, 88–89 Association rules consideration, 89 examples, 88 Attrition, problem, 338 AUC. See Area under the ROC curve Autoregressive integrated moving average (ARIMA), 127 Average claim value, distribution, 297f Average path length, 212 network, 240, 242

B

Backward looking time horizon, 190 Backward variable selection, 152f procedure, usage, 151 Bagging, 164–165 Bankruptcy contrast, 124f filing, 271 Base class, 168–169 Bayesian methods, 148 Behavioral characteristics, example, 41 - 42Behavioral information, 41-42 Benford's law, 48-51 deviation, 50-51 example, 50f Best matching unit (BMU) location, 110 weight vector, 109 Between-community edges, 259-260 quantification, 260 weight, sum, 260 Betweenness, 227, 239t, 244-246 centrality, 246t illustration, 245f recalculation, 262 Binary classification, 198–199 Binary fraud target (modeling), linear regression (usage), 127 Binary link statistics, 253 usage, 268-269 Binary logistic regression, 169 Binary red-flag indicators, 93 Binary weight, 216 Binomial distribution, usage, 196 Binomial test, usage, 309-310 Bipartite graph, 267 connectivity matrix, 2681 example, 267f node types, 268–269 usage, 276-277 Bipartite networks, 267, 273 Bipartite representation, 266-269 Birds, clustering (example), 96f dendrogram, 96f BMU. See Best matching unit Boosting, 165-166. See also Adaptive boosting Bootstrapping, 175, 175f procedure adoption, 307 usage, 307 Bootstraps, 164-165 Bottom-up approaches, 263-264 Bottom-up clustering, 263–264 Bounding function. See Logistic regression

Break-point analysis, 343 intra-account fraud detection method, 84 example, 85f Brier score (BS), measurement, 182 Browser-based digital dashboard, usage, 291–292 Business policy, 15 customer relationship management, example, 14 Business rules, set (usage), 290–291

С

C4.5 (decision tree), 137 CAIRO matrix, 319 Call detail records, example, 20t Cannot-link constraints See Semi-supervised clustering CAP. See Cumulative accuracy profile Capital, sufficient level, 326-327 CART (decision tree), 137 Cascade correlation, 148 Case management, 290-295 environment, 292 Categorical data, 47 Categorization, 60–63 Chi-squared analysis, usage, 61 Centrality. See Closeness metrics, 227, 238-246 components, 239t CHAID (decision tree), 137 Chief analytics officer (CAO), addition, 346 Chi-squared analysis, usage, 61 Chi-squared distance, calculation, 63 Chi-squared distribution, 134 test statistic, relationship, 310 Chi-squared test statistic, 333 Claim amounts, distribution, 297f geographical distribution, 298f enlargement, 299f score, 292 value, distribution. See Average claim value. ClaimID, 292 Classification, 122. See also Binary classification accuracy, 176, 189 data set, example, 127t error, 176

measures, dependence, 177 model, 342 calibration, monitoring, 308t SVMs, procedure, 162 techniques. See Multiclass classification techniques. Classifier. See Probabilistic relational neighbor cost sensitivity, 199 relational neighbor classifier, 233-234 Click fraud. 6t Closed-form solutions, 329 Closed-loop fraud-management strategy, adoption, 345 Closeness, 227, 239t, 243-244 centrality, 243-244 summary, 245t Cluster centroids random selection, 105f recalculation, 107f, 108f stability, 104 ClusterID, 116 Clustering, 90-116. See also Spectral clustering claims, 90 constraints, usage, 111-114 countries, SOMs (usage), 11 dendrogram, 262f distance metrics, 91-94 example. See Birds. interpretation, decision trees (usage), 116f screen plot, 97f semi-supervised clustering, must-link/cannot-link constraints, 113f solutions, evaluation/interpretation, 114-116 steps, indication, 96f techniques, contrast, 92f, 95f transactions, 90 Cluster profiling, histograms (usage), 115f Clusters analysis, usage. See Fraud detection. distances, calculation, 95f CNA. See Complex network analysis Coefficient of determination (R^2) , performance metric, 186

Collective inference algorithms, 227-228, 238, 246-254 Column-normalized adjacency matrix, 248-249 Common Neighbor approach, 217 Communities. See Complete communities; Partial communities connection, 244, 246 detection. See Credit card fraud. fraudulent influence, 265 mining, 254-265 split (evaluation), modularity Q (usage), 262-263 Company overview, detection model basis (example), 276t Complete communities, 264 example, 264f Complex network analysis (CNA) benefit, 222 usage, 214 Component plane, usage, 110. See also Literacy; Political rights Confidence colculation, 89 onfidence level function, 330 indication, 331f selection, decision, 330-331 CONFIDENTIAL role, 325 Confusion matrix. See Multiclass confusion matrix calculation, 176 example, 176t Connectance, 226 Connectivity matrix, 221. See also Bipartite graph mathematical representation, 221f Constraints. See Minimum separation constraint; Must-link constraint Constraints, usage, 111-114 Contextual information, 42 Contingency table, 67t Continuous data, 46-47 Continuous targets, CAP curve (usage), 187f Contracted DT, 283, 285t Contractual data, 40 Convergence, 249-250 Convolution, 329 Corporate fraud governance, 343–345

Corrective measures, complement (preventive actions), 315 Corruption, 5t Corruption Perception Index (CPI), 110 Cosine measure, basis, 93 Cost efficiency, 18 Cost-sensitive classifier, 199-200 Cost-sensitive cut-off, adoption, 199 Cost-sensitive learning, 198-200 function, 199-200 Counterfeit, 5t Count link statistics. 253 Court of Justice (European Union), 326 Cramer's V, filter measure (Chi-squared analysis basis), 67 Credit card context, time series, 86 holder, store (link), 268-269 setting, clustering transactions, 90 transfer, blocking, 291 Credit card fraud, 5t AUC level. 200 behavior patterns, 25-26 community detection, 259f detection pivot table, example, 82f setting, 284 supervised/unsupervised learning example, 24-26 historical cases, 331 losses. 9 red flags, 58 time series data set, 332f toy example, 220 Credit card transaction data example, 219t fields, 24t fraud, network (bipartite graph), 276 - 277processing, 279 Cressey, Donald R., 8 Criminal, wrongful category, 3 Critical fraud rate, 309 Cross-border privacy, regulation, 326 Cross-labeled edges, 225 Cross-validation. See Performance procedure, 174-175 Cumulative accuracy profile (CAP), 179

curves, usage, 186–187. *See also* Continuous targets. example, 180f Cumulative logistic regression, estimation, 169–170 Cumulative notch difference graph, 184f Customer relationship management (CRM) database, information storage, 40 Cut-off, 177 adoption. *See* Cost-sensitive cut-off. usage, 176f Cyber espionage, 343

D

Data. See Fraud data coentists account data, 40 analysis, pie charts. See Exploratory data analysis. breach, 343 categorical data, 47 continuous data, 46-47 contractual data, 40 correctness, 314 data-driven fraud detection, 17-19 data item level, outlier detection, 25f data set level, outlier detection, 25f elements, types, 46-47 embedding. See Unstructured data. external data, access, 325-326 features. 271-272 importance, 38 information, 331-333 internal data, access, 319-324 missing values, 52-53 owners, 316 poolers, importance, 41 privacy, 317-326 protection, 326 qualitative, expert-based data, 42-43 security issues, 337 sources. See Publicly available data. merging, 43-44 types, 38-43 stability, backtesting, 302-304 two-step approach, 303 standardization, 59 stewards, 316-317 subscription data, 40 surveys, 41

table, aggregation. See Normalized data tables. textual data, handling (approaches), 340 transactional data, 39-40 unstructured source, 339-340 Data-driven fraud detection system adoption, 286-287 implementation, 2 Data quality, 314-317 indicators design/evaluation, 315-316 listings, 316 issues, 314-315 causes, 315 programs/management, 315-317 results, action, 316-317 root causes, investigation, 316 Data set. See Hierarchical clustering; Linear regression example, 69. See also Classification, Impurity; Performance. factual data sets, 272 historical data sets, 272 observed variance, 70 outliers, absence/presence, 84 predictive models, development. See Skewed data sets. principal component analysis, illustration. See Two-dimensional data set. splitting, 172-175 transactional data sets, 272–273 values, 195f-197K Decimal scaling, 59 Decision boundaries, modeling, 141-142 Decision tables (DTs), 283-284 anomalies, observation, 286 contracted DT, 283, 285t expansion, 284t minimization, 285t quadrants, 283 tabular representation, usage, 283 usage. See Rule verification. Decision trees, 75, 136-144 assignment decision, 137 boundaries, 142f building, ClusterID (usage), 116 concepts, 136-137 error, difference, 168

example, 137f forest, creation, 166 growth (cessation), validation set (usage), 140f multiclass decision trees, 170 power, 144 properties, 141-142 splitting decision, 137 stopping decision, 137 usage, 116f Decompositional approach, 153f, 163 Default risk, age (contrast), 60f Degree, 228, 239t distribution, 230, 230f illustration, 230f fraudulent degree, 228 in-degree, 229 legitimate degree, 229 out-degree, 229 types, 229t 🗸 Degrees of separation, 242 theorem. See Six degrees of separation theorem. Delete, missing value scheme, 52 Der a-constraints. See Semi-supervised clustering Dendrogram example, 97f impact, 262 Denial of service (DoS) attacks, 343 Density, 228t, 232 summary, 233t Descriptive analytics, 78 Descriptive statistics, 51 Detection model, basis (example), 276t Device hacking, 343 Dicing (OLAP operation), 81 Dick, Philip K., 23 Dijkstra's algorithm, 241 illustration, 241f Directed network, 229–230 Direct network features, 271–272 Dispersion, influence, 258 Distance metrics, 91–94 Divergence metric, 182 Divisive hierarchical clustering agglomerative hierarchical clustering, contrast, 94f initiation, 95-96 DoS. See Denial of service Drill-down (OLAP operation), 81

DTs. *See* Decision tables Dyadicity, 226 Dyadic network, 226–227 Dynamic characteristics, examples, 41–42 Dynamic interface/dashboard, usage, 288

E

Economic cycle, impact, 340 Edge. See Cross-labeled edges; Hyper-edge; Multi-edge; Self-edge betweenness, calculation, 262 expected probability, 223-225 ratio. See Within-community edges. removal, 262 representation, example, 216 weight, representation, 217, 222 EFL. See Expected fraud loss Ego-centered network (egonet) nodes, 218f representation, 218 usage. See Social security fraud. Eigenvalues, usage, 70 Eigenvectors, usage, 70 EL. See Expected loss Empirical probability distribution adoption, 328 Employee numbers, behavioral dynamic characteristic 41 - 42Encryption techniques, 337 Ensemble method: 164–168, 188 bagging, 164-165 boosting, 165-166 evaluation, 167-168 random forests, 166-167 Entropy, 138-139 calculation. See Age. equation, 170 Gini, contrast, 139f nodes, 138 weighted decrease, 139 Epochs, 147 Epsilon-constraint (ε -constraint), 113-114. See also Semisupervised clustering Error estimate, calculation, 177 type I error, impact, 310

Error variables necessity, 159 usage, 117–118 E-sales, rise, 326 Euclidean distance example, 92 Manhattan distance, contrast, 92f metrics, 94-95, 104, 109 Eulerian path, 210 European Union (Court of Justice), 326 Evaluation-related activities (fire incident claims), 12 Evidence coding, weights, 63–64 Expected fraud amount, 336 usage, 290t Expected fraud loss (EFL), 122 calculation, 194 Expected loss (EL), 327-329, 333 indication, 33 Expected misclassification cost, minimization, 199 Expert-based approach, 10–11 Expert-based fraud detection approaches, 2 E. pert-based limits, business knowledge basis, 56 Exploratory data analysis, pie charts, 49f Exploratory statistical analysis, 47-48 Exposure score, 273 External data, access, 325-326 External experts, in-depth assessment (fire incident claims), 12 External information, 43 Extracted rules/trees, benchmark, 154

F

Factual data sets, 272 Farness, inverse, 244 Feature space mapping, example, 160f Featurization example, 237f overview, 254 process, 254 unstructured network, mapping, 255t–257t FICO score, 41 Financial loss, avoidance, 14 Financial shocks, absorption, 316 Financial statement fraud, AUC level, 200 Fire incident claims, handling, 12 process, example, 13f Firewalls, 337 First digit (frequency distribution description), Benford's law (usage), 50f Follower-followee relationships, 215 usage. See Twitter network. Forced claim acceptance, 14 Forecasting, 338-339 Forgiving effect, 274 Forward looking time horizon, 190 4-regular graph, 231f Fourier transformations, usage, 329 FP. See Fraud percentage Fraud alert. 290-295 audit trail, 291–292 tracking, 291-292 amount, 125, 333 histogram, 332f usage. See Expected fraud amount. analysts, performance metric (usage), 307 analytics, economic perspective, 333-336 average monthly loss, impact, 33 awareness training, 344 behavior, volatility, 23 call detail records, example, 20t case management, 290-295 categories/types, 5t-7t commitment, 258 concealment, 3-4 confirmation, 22 contrast, scatter plot, 185f corrective measures, 15-16 cost, 9 efficiency, 18 crime, organization, 4 cycle, 22-23 flowchart, 23f data time series, analysis, 328 defining, 2-3 detection, 10 financial impact, 9 forecasting, usage, 338-339 forms, 4-5 investigators, efficiency (evaluation), 301f

management, 344 mechanism, 10-11 comprehension, 11 existence, 16-17 models. See Analytical fraud models. motivational basis, 8-9 networks, analysis, 217 nonfraud, contrast, 234 operational efficiency, 18 opportunity, 7f, 8 path, existence, 16-17 performance benchmarks, 200-201 pressure, 7f, 8 prevention, 10-12, 22 preventive measures, 16 probability, 290. See also Probability of fraud. calibration, 309 propagation, 250 questions, 342-344 rate. See Critical fraud rate. rationalization, 7f, 8 revenues, loss, 9 scientific perspective, 32–34 conclusions, 34 scientific publications, statistics, 33f score, assumption, 132 setting, association rules, 88-89 size, estimation, 9 social phenomenon, 9, 222-227 treats, examples, 342 triangle, 7f uncommonness, 3 vulnerability reviews, 344 Fraud analytics decision trees, usage, 143-144 process model, 26-30 connections, 26f Fraud analytics model characteristics, 28t economical cost, 28t interpretability, 28t operational efficiency, 28t regulatory compliance, 28t representation, 281-286 statistical accuracy, 28t traffic light indicator approach, 282-286 Fraud data scientists, 30-32 business comprehension, 32 communication/visualization skills. 31 - 32

Fraud data scientists (Continued) creativity, 32 profile, 33f programming expertise, 31 quantitative skills, 30-31 Fraud detection, 10-12, 22. See also Data-driven fraud detection big data, 15-17 capability, 275-276 cluster analysis, 91f domain, benefits, 209 expert-based approach, 10-11 improvement, 343 mission critical application, 314 model basis, example, 276t retraining/updating frequency, 23 OLAP cube, 81f PageRank algorithm, impact, 251 performance benchmarks, 201t potential, 296 power, 23 precision, 17-18 process, efficiency (measurement), 300f rule, example, 11 sample, investigation, 286-290 scorecard, example, 133f system, 94 data-driven fraud detection system, adoption, 286-287 operation/maintenance, 335-336 usage, 287 techniques, 12-22, 271-272 Fraud-Fraud label, 226 Fraud investigation, 22 activities, 14 fire incident claims, 12 Fraud-Legitimate label, 226 Fraud loss capital calculation, 326–333 Monte Carlo simulation, usage, 331-333 evolution/variation, explanation, 339 observation, 333-334 Pareto distributed fraud loss, 333f Fraud percentage (FP) prediction, 142 regression tree, usage, 142f

Fraudsters absence, data set values, 195t, 196f contact list, 213-214 exploratory data analysis, 49f groups, discovery, 254-265 oversampling, 191f presence, data set values, 197t representation, 226 techniques/tricks, evolution, 4 Fraudulent bankruptcy, regular bankruptcy (contrast), 124f Fraudulent degree, summary, 229t Fraudulent network, example, 218f Fraudulent node, 217 geodesic paths, 243t non-zero values, 250-251 Fraudulent triangles, 232t Frequency component, description, 328-329 domain, 329 Friend group 264 impac. 258 F-statistic calculation, 143 intra-cluster similarity, comparison, 306 Fully connected network (nodes), 235 Fully expanded decision table, 284t Funneling effect, 212

G

Gadget fraud, 343 Garbage in, garbage out (GIGO) principle, 315 Generalized autoregressive conditional heteroskedasticity (GARCH), 127 Genetic algorithms, 148 Geodesic paths, 227, 239-243. See also Fraudulent node calculations, computation expense, 239 Geodesics, number, 238 Gibbs sampling, 246, 251–252 GIGO. See Garbage in, garbage out Gini coefficient, 181 entropy, contrast, 139f equation, 170 Girvan-Newman algorithm, 261–262 clustering, dendrogram, 262f

community split, 263 result, dendrogram (impact), 262 Global minima, local minima (contrast), 148 Graph, 215 example. See (Un)directed graph. extension, bipartite representation, 266-269 4-regular graph, 231f partitioning, 259-260 algorithms, 264-265 methods, 262-263 splitting. See Whole graph. theoretic center, 239t, 240 Graphical outlier detection procedures, 80-83 Graph theoretic center, 227 Guilt-by-association, 209, 212, 233

H

Healthcare fraud, 6t Heterogeneity, 143 Heterophilicity, 226 Heterophobic network, 227 Hexagonal SOM grid, rectangular SOM grid (contrast), 110f Hidden layer, 146 Hidden neurons number selection, 148 variation, 148 squares, 150 tuning, 148 Hidden unit activation values, 163–164 categorization, clustering (usage), 152 Hierarchical clustering, 94-97 data, scattering plot (usage), 99f data set, 97t initiation. See Divisive hierarchical clustering. methods, usage. See Agglomerative hierarchical clustering methods. procedures example, 97-104 output, 98f-103f techniques, nonhierarchical clustering techniques (contrast), 92f Hinton diagram example, 151f

inspection, 150 usage, 150 Histograms, usage, 115f Historical data sets, 272 Hit rate, improvement, 287 Homogeneity, 143 Homophilic network, 223, 225f real-life example, 224f Homophily, 222-227 concept, 222 Hosmer-Lemeshow test, 310 Hyper-edge, 216 Hyperplane. See Multiple separating hyperplanes defining, 117 perpendicular distance_157-158

I

ICT architecture, 280 ICT services, 336-537 Identity theft, 7t frequent contact list, 213f social traud. 213–214 If-then classification rules, extraction, 152-153 11-then rules, 163–164 usage, example, 284 Impurity (calculation), data sets (example), 138f In-degree, 229-230 Independent test set, performance (measurement), 148 Indirect network features, 272 Informal economy, average size, 9 Information. See Behavioral information contextual information. 42 diffusion, 240 exchange, 211-212 external information, 43 network information. 42 storage, 40 value filter measure, calculation, 66t Information value (IV) filter, weight of evidence basis, 66 Innocent communities, 264-265 Insourcing, outsourcing (contrast), 336-338 Insurance claim filing, 343 fraud detection rule, example, 11

Insurance claim (Continued) handling process, internal fraud detection (expert-based approach example), 12–15 Insurance fraud, 5t AUC level, 200 cost. 9 detection, transactions database, 88t example, 125 setting, rule set, 285-286 Insurance setting, clustering claims, Intellectual property (IP) rights, 337 Intercept term (β_0), 145 Inter-cluster similarity, 306 Internal anti-fraud controls, 344 Internal data, access, 319-324 Internal experts, in-depth assessment (fire incident claims), 12 Internet of Things (IoT), 342-344 impact, 314 Interpretability, 136 Intra-account detection method, 85 Intra-cluster similarity, F-statistic (comparison), 306 Intrinsic behavior, description, 237f Intrinsic (local) data feature, 261 Intrinsic features, relational features (combination), 275f Intrinsic variables, 236 Invalid observations, outlier type, 53 IP. See Intellectual property Iterative algorithm, usage, 147 Iterative bisection, 200 example, 261 Iterative classification algorithm, 246, 253

J Jaccard index, usage, 93 Jaccard weight, 217

K

Keep, missing value scheme, 52 *k*-means clustering, 75, 104–108 cluster centroids, recalculation, 107f exercise, output, 116t iteration, 105f cluster centroids, recalculation, 108f iteration observations

assignation, 106f reassignation, 108f, 107f original data start, 105f setup, 114 *k*-nearest neighbors, selection, 193 Kolmogorov-Smirnov distance, 181 example, 181f Kolmogorov-Smirnov statistic, range, 182 Köningsberg bridges, 210, 210f schematic representation, 211f L Label-based access control (LBAC), 324-325 protection, 325 Lagrange multipliers, 118 Lagrangian multipliers, usage, 160 Lagrangian optimization, usage, 118, 158, 162 Laplacian eigenvectors/eigenvalues, 260 Lasso regression, 127 LPAC. See Label-based access control Leading digit, occurrence (mathematical formula), 50 Leave node, 143 observations. 142 Legitimate degree, summary, 229t Legitimate-Legitimate fraud, 226 Legitimate node, 217 Legitimate triangles, 232t Leniency-related activities (fire

incident claims), 12

Likelihood approach, 194–197

Linear decision boundary, 130f

Linear programming, 155–156

variable selection, 133-136

Linear separable case, 156-159

Literacy, component plane (usage), 112

Link statistics, types, 253

Linear regression, 125–127

LGF. See Loss given fraud

Lift curve, 178-179

example, 179f

Linear kernel, 161

problem, 156

data set. 125t

usage, 127

test statistic, 134

Local classifier, posterior probabilities, 251-252 Local minima, 155-156 global minima, contrast, 148f Logistic regression, 129–133. See also Multiclass logistic regression bounding function, 128f concepts, 127-129 formulation, 128 linear decision boundary, 130f model, 128 estimation, 236, 238 neural network representation, 145f properties, 129-131 reformulation, 129 scorecard, building, 131-133 variable selection, 133-136 Log-log axes, 230 Log odds (logit), 129 Loopy belief propagation, 246, 253 Lorenz curve, 179 Loss peaks, 327 random observations, 330 Loss distribution closed-form solution. 329 derivation, approaches, 329-330 frequency/severity components 328-329 open-form solution, 329-Loss given fraud (LGF), 194

Μ

MAD. See Mean absolute deviation Mahalanobis distance defining, 83 performance measure, 182 Manhattan (city block) distance, 92 Euclidean distance, contrast, 92f metrics, 94-95 Margin, maximization, 158 Marital status, good/bad customer (contingency table), 67t Market basket analysis, 88 MARS. See Multivariate adaptive regression splines Maximum likelihood, usage, 129 Mean absolute deviation (MAD), 306, 307 definition, 186 Mean-corrected values, 61

Mean squared error (MSE), 168, 306, 307 calculation, 142 cost function, optimization, 147 measure, 186 MetaCost, introduction, 200 Milgram, Stanley, 211 MinCut, 260 Minima, contrast, 148f Minimized decision table, 285t Minimum separation (δ) constraint, usage, 112–114 Minkowski distance, 91 MinMaxCut, 261-265 metric. 261 Min/Max standardization, 59 Minority Report (Dick), 23 Misclassifications costs, 198t error variables, usage, 159 expected cost, minimization, 199 Missing values, 52–53 schemes, 52 usage, example, 53t MLP. See Multilayer perceptron Modeling, extensions, 338-341 Mode link statistics, 253 Modularity Q, 262 calculation. 263 maximization, 262f usage, 262-263 Monetary value, 277 Money laundering, 6t Monte Carlo simulation impact, 333 usage, 329–333 MSE. See Mean squared error Multiclass area under the ROC curve, 186 Multiclass classification techniques, 168 - 172Multiclass confusion matrix, 183t Multiclass decision trees, 170 Multiclass logistic regression, 168–170 Multiclass neural networks, 170 Multiclass problems one-versus-all coding, example, 172f one-versus-one coding, example, 171f Multiclass support vector machines, 171 - 172

Multiclass targets, performance measures, 182 Multicollinearity, 69-70 Multidimensional data analysis, 296 Multi-edge, 216 Multilayer perceptron (MLP) neural network, 145 example, 145f hidden layer, 146 output layer, 146 Multipartite graphs, 269, 269f Multiple separating hyperplanes, 157f Multivariate adaptive regression splines (MARS), 127 Multivariate outliers, 54f Multiway splits, 141 Must-link constraint, 112-114. See also Semi-supervised clustering

N

Negative background information, provision, 114 Negative utility, 289 Neighborhood, 233 behavior, description, 237f impact, metrics, 227–254 Neighborhood metrics, 227, 228 degree, 228-230 overview, 228t Networks, 209-222 affiliate networks, 267 analysis, case study, 270–277 average path lei gib, 212, 240, 242 bipartite networks, 267 central node, 240 characteristics/applications, 209-222 components, 209, 214-218 degree distribution, 230 directed network, 229-230 dyadicity, 226-227 form, 209–222 fraudulent network, example, 218f graphical representation, 220 heterophobic network, 227 homophilic character, 226 homophily, 223 information, 42 mathematical representation, 221f nodes betweenness centrality, 246t

closeness/closeness centrality, 245t groups, 258 initialization, 277 processing, 210 relational neighbor probabilities, 234 representation, 214f, 219-222. See also Ego-centered network (egonet), representation. sample, 229f, 254f, 270f social networks. 211-214 Neural networks, 144-155, 188. See also Multiclass neural networks black box, opening, 150-155 building, 151 concepts, 144–146 overfitting, prevention, 149 reestimation, 51 representation, 163f. See also Logistic regression. rule extraction decompositional approach, 153f pedagogical approach, 154f shortcomings, 155–156 training, 148, 152 stopping, validation set (usage), 149f usage, 149 Nodes communities, betweenness, 245f connecting paths, number, 242f degree, 228 edges, 216 fully connected network, 235 influence, 266 initialization, 277 links, 292 relationship, 215 types, 217 integration, 269 value, 244 Nonfraudsters exploratory data analysis, 49f model, 177 undersampling, 191f Nonhierarchical clustering techniques, hierarchical clustering techniques (contrast), 92f Nonlinear regression function, 162 Nonlinear SVM classifier, 160–161

Non-normalized data table, example, 44f *n*-order neighborhood, 227 Normality, deviations, 57–58 Normalized data tables, aggregation, 44f Normalized weight, 217 Null hypothesis, 311 Numerical components, usage, 341 Numeric weight, 217

0

Observations, 165 assignation, 106f classification, necessity, 282-283 posterior probability, 199 reassignation, 107f, 108f Occupational fraud, committing, 8 OLS. See Ordinary least squares On-diagonal elements, 182-183 One-class SVMs, 117-118 example, 117f One-hop neighborhood, 228 One-versus-all coding estimates, 171 example. See Multiclass problems. meta schemes, 172 One-versus-one coding, 184 estimates, 171 example, 171f meta schemes, 172 Online analytical process (QLAP), 26, 296 cube. See Fraud detection. dicing, 81 drill-down, 81 functionality, impact, 291-292 OLAP-based multidimensional data analysis, 48 operations, 79, 81 outsourcing, 337-338 roll-up, 79, 81 slicing, 81 Online social network sites, usage, 208 Online transaction processing (OLTP), 39 Open-form solutions, 329-330 Operational efficiency, 18, 189 variable selection criterion, 136 Operational risk, 327 impact, 328

Operation costs, 334t Opportunity. See Fraud Optimization problem, 158 procedure, 147 Ordinary least squares (OLS) regression, 126 Ordinary least squares (OLS), usage, 127 Organization structure, analytical teams (embedding), 344 Other People's Money (Cressey), 8 Outcome utilities, 335 values, 289 Out-degree, 229-230 Outlier detection, 25f, 53-57 box plots, 55f histogram, 54f procedures graphical outlier detection procedures, 80-83 statistical outlier detection procedures, 83–89 techniques, 24 3D scatter plot, 80f z-scores, usage, 55t Outliers definition, 78 multivariate outliers, 54f treatment, 53-57 red flags, 57-59 t-score, 86-87 types, 53 Out-of-the-loop (O), 319 Output layer, 146 Outsourcing analytics, benefits, 336-337 insourcing, contrast, 336-338 Overfitting, 140 cause, 149 prevention, 149 risk, 159 Overlapping communities, 264–265 example, 265f Overlapping distributions, SVM classifier (usage), 159f Oversampling, 190–192. See Fraudsters percentage, level, 193 undersampling, combination, 192 understanding, 197 Ownership costs, 334t

P

PageRank, 246 algorithm, 247-251 example, 247f, 251t expression, 248 extension, 250 iterative process, illustration, 249f scores, 250-251 Parametric Student's t-test, usage, 311 Pareto distributed fraud loss, 333f Pareto distribution, 333 Pareto severity distribution, 333-334 Partial communities, 264 example, 264f Partially negative rule, 50 Pearson correlation basis, 93 calculation, 65 coefficient, calculation, 185 Pedagogical approach, 154f Peer-group analysis, 85-87 advantage, 87-88 example, 87f transaction data set, 86t Peer pressure, effect, 258 People-to-people network, 250 representation, 266 Perfectly linearly separable case, SVM classifier (usage), 157f Performance benchmarks. See Fraud detection. calculation, data set (example), 176t estimation, training/test sample setup (contrast), 173f measurement, 128-189 cross-validation, 174f data set, splitting, 172, 174 Performance metric (PM), 178, 305-306 distributions, 307 monitoring, 306t statistic test, 307 PF. See Probability of fraud Plagiarism, 7t PM. See Performance metric Poisson distribution adoption, 328-329 fitting, 331-332 monthly fraud frequency, 333f usage, 332 Poisson frequency distribution, 332-333

Political rights, component plane, 113 Polynomial kernel, 161 Population shift/instability, SSI implication, 304 Positive utility, 289 Posterior probabilities, adjustment, 197-198 example, 198f Post ownership costs, 334t Power curve, 179 Power law, 230 Predicted fraud, actual fraud (contrast), 185f Predictions (calculation), cut-off (usage), 176f Predictive analytics, 122 classification, 122 🗸 models, performance measures, 188-189 regression, 122 types, 122, 338 Predictive learning, techniques, 338 Predictive models, evaluation, 172–188 Pressure. See Fraud Pridits, 72 analysis, 73-74 score, 73-74 Principal components analysis, 68-71 illustration, 68f Principal components, calculation, 70 Privacy, 317-326 cross-border privacy, regulation, 326 Probabilistic relational neighbor, 228t classifier, 234-235 social network, 235f Probability distribution, adoption. See Empirical probability distribution. estimates, representation, 252 Probability of fraud (PF), 194 Product type variable, coarse classification, 61t, 62t empirical frequencies, options, 62t independence frequencies, options, 63t pivot table, 61t Product warranty fraud, 6t Propagation algorithm, 273 example, 273f Pseudo-realistic observations, 332–333 Publicly available data, sources, 43

p-values, 134, 136, 143 availability, 150 calculation, student's *t*-distribution (usage), 135f computation/representation, 311

Q

Quadratic programming (QP) problem, 118 solution, Lagrangian optimization (usage), 158 Qualitative, expert-based data, 42–43 Quality of Service (QoS) levels, achievement, 276

R

RACI. See Responsible Accountable Consulted Informed Radial basis function (RBF) kernel, 161 Random forests, 166-167 alternative, 167 Random surfer model, 248 RASCI. See Responsible Approve Support Consult Inform RatioCut, 260 metric, 261 Rationalization. See Fraud Ratios, overlap, 69 RBF. See Radial basis function REC. See Regression error characteristic Receiver operating characteristic (ROC) analysis introduction, 183-184 table, 177t curve, 177, 173f example, 275f graph, usage, 181 Recency frequency and monetary (RFM) variables, 39, 90 depiction, 82 framework, usage, 277 population distribution, 115-116 Rectangular SOM grid, hexagonal SOM grid (contrast), 109f Recursive-partitioning algorithms (RPAs), 136-137 Red flags, 57-59 indicators, 93, 94 Regression, 122 classifier. See Relational logistic regression classifier.

nonlinear regression function, 162 SVMs, usage, 161-162, 162f time series regression, 339 trees, 142-143, 164 usage, 142f Regression error characteristic (REC) curve, 187 area, 306, 307 data. 188t example, 188f Regression models, 306, 342 calibration backtesting, 310-311 monitoring, 310t performance measures, 185-188 Regular bankruptcy, fraudulent bankruptcy (contrast), 124f Rejected claims, processing, 14 Relational features 238t intrinsic features, combination, 275f Relational logistic regression classifier, 236-233 social network features, 236f Relational neighbor, 228t, 235 Cassifier, 233–234 social network, example, 233f probabilities, 234t Relaxation labeling, 246, 253 Replace (impute), missing value scheme, 52 Resources, exposure score, 273f Responsible Accountable Consulted Informed (RACI) matrix, 318-319 example, 318f Responsible Approve Support Consult Inform (RASCI) matrix, 319 Return on investment (ROI), 335-336 formula, calculation, 336 RFM. See Recency frequency and monetary Ridge regression, 127 Ridits, 72-73 example, 72-73 scores, 73-74 Right-tailed test, usage, 309 Risk defining, 327 operational risk, 327 RMSE. See Root mean squared error ROC. See Receiver operating characteristic

ROI. See Return on investment
Roll-up (OLAP operation), 79, 81
Root mean squared error (RMSE), 186
RPAs. See Recursive-partitioning algorithms *R*-squared, 307
Rule extraction, 150 approaches, 163
Rule set. See Insurance fraud
Rule verification, decision table (usage), 286t

S

Same-labeled edges, 226 Sample window, variation, 190 Sampling, 45-46 SAS Social Network Analysis claim detail investigation, 294f dashboard, 292, 293f link detection. 295f SAS Visual Analytics, 296 Scaling, introduction, 132 Scatter plot, usage, 99f Screen plot, usage (example), 97f Section Centrality metrics, 261-262 Security labels, 324-325 components, 324 Security policies, 324-325 Segmentation, 74–75 Seidel's algorithm, 242 Self-edge, 216 Self-organizing maps (SOMs) 109-116 grids, contrast, 105f usage. See Clustering. visualization methods, 110 Semi-fraudulent triangles, 232t Semi-labeled graph, 251–252 Semi-labeled network, 246 Semi-supervised clustering delta-constraints (δ -constraints), 114f epsilon-constraints (ε -constraints), 114f must-link/cannot-link constraints, 113f Shared events, count, 266 Shortest path, 239 Sigmoid transformation, 56 Simple matching coefficient (SMC), usage, 92-94

Simulated monthly observations, 332-333 Singular value decomposition (SVD), components, 341 Sink node, 210-211 Six degrees of separation theorem, 212 Skewed data sets oversampling, 190-192 predictive models, development, 189-200 sample window, variation, 190 time window, variation, 190f undersampling, 190-192 Slicing (OLAP operation), 81 Small World experiment (Milgram), 211-212 SMC. See Simple matching coefficient SMOTE. See Synthetic minority oversamplingtechnique SMS, usage, 291° Social networking sites, 208 Social networks, 211-214 example. See Relational neighbor. features. See Relational logistic regression classifier. members, connection, 221-222 probabilistic relational neighbor classifier, 235f Social security fraud, 212-213 AUC level, 200 egonet, usage, 277f real-life data set, basis, 273f real-life network, degree distribution, 230f Sociodemographic information, subscription data source, 40-41 Soft labeling, 253 Solvency, behavioral/dynamic characteristic, 41-42 SOMs. See Self-organizing maps Source node, 210–211 Sparse matrix, 221 Spectral clustering, 260 Spider constructions, 271. See also Tax evasion fraud Splitting decision, 137-140. See also Decision trees Squared error, 187 Squashing functions, 146 SSEs. See Sum of squared errors SSI. See System stability index

Standardization procedures, adoption, 59 State, term (usage), 283 Statistical outlier detection procedures, 83-89 Stepwise logistic regression, usage, 236 Stopping decision, 140-141. See also Decision trees execution, 170 Structured data variables, 255t-257t Student's t-distribution, 136 usage, 135f Student's t-test, 85, 305 usage. See Parametric Student's t-test. Suboptimal task allocation, 14 Subscription data, 40 Sum of squared errors (SSEs), computation, 115 Supervised model, 343 Support vector machines (SVMs), 56, 155-164, 188. See also Multiclass support vector machines; One-class SVMs: v-SVMs black box, opening, 163-164 classification SVMs, origins, 156 classifier, 159. See also Nonlinear SVM classifier. building, 161 usage, 159f. See also Perfectly linearly separable case. classifier, neural neuvork representation, 163f formulation, 162 linear programming, 155-156 problem formulation, 160 usage, 161-162, 162f Surveys, 41 Suspicious activity, call detail records (example), 20t Synthetic minority oversampling technique (SMOTE), 192-193 example, 193f understanding, 197 System stability index (SSI) calculation, 303. See also Variables. example, 303t level, elevation (implication), 304 monitoring, 304t

Т Target definition, 123-125 Tax evasion. 7t Tax evasion fraud example, 122 red flags, 58 spider construction, 124f Tax-inspection setting, tax statements (clustering), 90 TCO. See Total cost of ownership Telecommunications fraud, 6t AUC level, 200 Telecommunications-related fraud, red-flag activities, 58 Telematics, 343 Temporal weighing, 273 Text analytics, 339–341 Text data, transformation, 341 Text mapping, 340 Textual data ambiguity/complexity, presence, 341 handling, approaches, 343 Time series regression, 338 Timestamp, usage, 275 Time window, variation, 190f Total cost of fraud handling, 336 Total cost of ownership (TCO), 333-335 analysis, goal, 334-335 calculation, costs (example), 334t Total degree, summary, 229t Trace value, 263 Traffic light coding procedure, implementation, 306-307 Traffic light indicator approach, 282-283 representation, 282f Training set, 158 Transactional data, 39–40 sets, 272-273 Transaction data example. See Credit card. set. See Peer-group analysis. Transactions database, 88t number. 277 Transformations, 130 example, 131f Transversal standards, development, 345-346 Traveling Salesman Problem (TSP), 211 Tree map, display, 296, 302

Triangles, 228t, 231 types, 232t Truncation, z-scores (usage), 57f Trusted violators, 8 t-score, calculation, 86-87 TSP. See Traveling Salesman Problem t-statistic, value, 85 t-test, impact, 311 Turnover, behavioral/dynamic characteristic, 41-42 Twitter network, follower-followee relationships, 215f Two-dimensional data set, principal component analysis (illustration), 68 Two-hop path, 243 Two-stage models, 150 example, 155f Type I error, impact, 310

U

UL. See Unexpected loss Uncertainty, description, 327-328 Uncommon fraud, 3 Undersampling, 190-192. See also Nonfraudsters oversampling, combination, 192 understanding, 197 (Un)directed graph, example, 215f Unexpected loss (UL), 327-329, 333 absorption, 326-327 calculation, operational risk (impact), 328/ indication, 3315 Unified distance (U)-matrix, 111 Unipartite graphs, 266 example, 266f United Kingdom, fraud (impact), 9 Unstructured data embedding, 42 sources/types, 339-340 Unstructured information, 42 Unstructured network information, translation, 209 mapping, 255t-257t Unsupervised learning, 78 usefulness. 79 v-SVMs, 118 Utility assignation, 289

components, sum (equivalence), 288–289 negative utility, 289 positive utility, 289 values. *See* Outcome utilities.

V

Validation set, usage, 140f, 149f Valid observations, outlier type, 53 Value at Risk (VAR), 127, 330 indication, 331f Variables. See Intrinsic variables linear dependency, 65 significance, reference values, 135t SSI calculation, 305t subsets, 135f values, permutation, 167 Variables selection, 65–68, 150 criteria, 135–156 filters, 65t performing, 133–134 procedure, 150-151 Visual analytics, 296–302 Visual data exploration, 47–48

W

WACC. See Weighted average cost of capital Ward's distance, 95 Ward's method, 104 Web configurable devices, access (force), 342 Web of frauds, 223 Web page links, 248 rank, 247 Weight. See Binary weight; Jaccard weight; Normalized weight; Numeric weight list. 221f. 222 matrix edge weight expression, 222 mathematical representation, 221f Weighted average cost of capital (WACC), 334-335 Weight learning, 147-149 Weight of evidence (WOE) calculations, 64t coding, 63-64 usage, 131-132

Weight parameter vector (β), closed-form formula, 126 Weight regularization, 149 White-box analytical technique, 153 White-box model, 144 Whole graph, splitting, 259 WITH CHECK option, 324 Within-community edges, 263 between-community edges, ratio, 259–260 World Wide Web technology stack, 342 Wrongful, human category, 3

 \mathbb{Z}

Z-scores calculation, 55, 84 standardization, 59 usage. *See* Outlier detection; Truncation.

http://www.bookshop.com

http://www.bbookshop.com