

Subject Index

- absorbed state, 59, 61
- accuracy illusions, 235, 236, 310, 313
- accuracy rate, 11, 12, 23, 68, 119, 120, 163, 168, 169, 173, 235, 283, 285
- acyclic graph, 198
- adenoma, 291
- adenosis, 291
- Agrawal, Imielinski, and Swami (AIS) algorithm, 243
- altered RA1 algorithm (ARA1), 247–255
- American College of Radiology (ACR) Breast Imaging Lexicon, 298
- antecedent part, 242, 251, 292
- antichain, 197
- application areas, 4, 12, 20, 21, 31, 173, 234
- Apriori algorithm, 244, 249
- AprioriHybrid, 243
- AprioriTid, 243
- AQ system, 128
- artificial mammographic cases, 187
- associated findings (in breast cancer), 175, 186, 188
- association rules, 25, 241–244, 246, 247, 251, 252, 254, 255
- association rules (negative), 251
- attributes, 22
- back propagation algorithm, 285
- back propagation of errors, 177
- basic sciences (applications in), 6
- battle planning, 6
- Bayesian models, 174
- beam search, 46, 61
- benign case, 289
- “best” knowledge, 100
- BI-RADS (in breast cancer diagnosis), 298
- bias, 23, 112, 212, 224, 236, 285
- biceps brachii muscle, 279
- binarization, of data, 26
- binary attributes, 26, 27, 32, 36, 99, 127, 134, 145, 176, 185, 186, 189, 193, 200, 231, 292
- binomial test, 272
- biopsy (of breast cancer), 175, 185, 186, 188, 189
- bipolar sigmoid transfer function, 285, 286
- Boolean function (definition of), 29
- Boolean function inference, 24, 37, 51, 111, 120, 129, 131, 133, 134, 144, 147, 201, 203, 223
- border (between classes), 236
- border area, 235, 236
- border vectors, 199, 201–203, 207, 214, 215, 219, 221, 223–225
- border vectors (number of), 199
- borders, 180, 181, 236–239, 282, 309
- borders of monotone Boolean function, 200, 311
- branch-and-bound (B&B), 22, 36, 38, 42, 50, 57, 60, 64, 69, 73, 85, 128, 132, 163, 170
- breast cancer diagnosis, 5, 173, 174, 182–184, 188, 192, 197, 232, 297, 298, 308
- business (applications in), 6
- calcifications, 175, 179, 185, 188, 189, 196, 290, 293–295, 308
- calcifications density, 175, 185, 188, 196, 293–295
- calcifications irregularity, 175, 185, 188, 196, 293
- calcifications variation, 175, 185, 188, 196, 294
- candidate item set, 242, 249, 250
- candidate list, 76, 78–80, 82, 84, 86, 244, 245

- cardinality of a set, 39
- census data analysis, 243
- centroids (negative), 264
- centroids (positive), 264
- chain, 197
- chain partition, 197, 198, 223
- chain poset, 206, 224
- characteristic frequencies, 280, 281
- characteristics, 22
- circuit design, 23
- classes, 3
- classification, 4
- classification modeling, 243
- classification of examples, 74, 91, 99, 101, 103
- classification rules, 11, 15–18, 23, 25, 31, 37, 38, 268, 275, 285, 292
- classification scenarios, 103
- clause inference, 33, 39, 40, 72, 75, 93, 157, 159, 160
- clause satisfiability problem, 107, 111, 160
- clauses, 50
- clinical applications, 175
- clique, 153
- clique cover, 154–160, 168, 169
- clique-based decomposition, 160, 161, 164, 168, 169
- cluster analysis, 174
- cluster centroids, 263
- clustering, 4, 259, 262, 263
- coastal erosion, 6
- common logic approaches, 25
- compact system (Boolean function), 110
- comparable vectors, 193
- complement (of the *R*-graph), 155
- complement of example, 147
- computer-aided diagnosis (CAD), 174
- concept learning, 178
- concept learning system (CLS), 128
- confidence interval, 91, 108
- confidence level (of association rule), 242
- conjunctive normal form (CNF), 22, 30, 199
- connected component (of the *R*-graph), 156–159
- connected component-based decomposition, 156
- connectionist machine, 25
- consequent part, 242
- content descriptors, see *keywords*, 259
- continuous attributes, 26, 27
- convex polyhedral, 16, 50
- convexity property, 100
- corrupted data, 10
- cost (of classification), 100, 101, 108
- crime control, 7
- criteria, 22
- cyclic directed graph, 198
- cycling, 247
- cysts, 291
- data analysis, 4
- data collection, 4, 10
- data mining, 3, 4, 20, 50, 51, 72, 98–100, 123, 170, 173, 191, 229, 296, 297, 308–315
- data mining (definition of), 3
- data mining equation for the future (the), 315
- data mining of EMG signals, 279
- data mining process, 11, 12, 20
- data preprocessing, 10
- decision trees, 156, 170, 174, 178, 234
- declassification process (of documents), 257
- decomposition (of problem), 156
- decomposition structure, 24
- degree of confidence, 174, 307, 308
- degree of lobularity, 304–307
- degree of microlobularity, 304, 307
- dense data, 243, 244
- density of parenchyma, 290, 293–295
- depth of undulation, 306
- design of a new product, 7
- design of new drugs, 5

- design problems, 233
- diagnosis, 4
- diagnosis problem, 234
- diagnostic classes, 177, 179, 180, 184, 190, 235–239, 291
- diagnostic classes (in breast cancer), 179
- diagnostic problems, 231
- diagnostic rules, 289
- dichotomized, 292
- digital images, 313
- digital mammography, 182, 297
- directed graph, 198
- discriminant analysis, 174, 179, 180
- discriminant functions, 236
- disjunctive normal form (DNF), 22, 199
- distributed computing, 312
- DNF clause, 24, 26, 50, 57, 62, 170, 246
- document classification, 259, 260, 271
- document clustering process, 259
- document indexing, 260
- document representation, 260
- document surrogate, 127
- documents (by the Associated Press), 126, 265, 275
- documents (by the U.S. Department of Energy (DOE)), 126, 258, 265, 275
- documents (by the Wall Street Journal), 126, 265, 275
- documents (of text), 127
- documents (ZIPFF class), 269, 270
- domain expert, 11–13, 100, 309, 313
- dominated state, 41–43
- dual (of LP), 147
- dual problem, 106, 147
- duality relationship, 147
- ductal orientation, 175, 185, 188, 189, 290, 293
- dynamic programming approach, 205
- electrode orientation, 277, 280
- electrodes, 279, 280
- electromyography (EMG), 277
- EMG signals, 277, 279, 280
- engine of car (analysis of), 5
- engineering (applications in), 5
- error minimization problem, 205
- error minimizing functions, 209
- ESPRESSO-MV system, 24
- ethical issues, 315
- “eureka” moment, 12
- evaluative function, 75, 76, 79
- exact algorithms, 312
- exhaustive enumeration, 41
- explanations, 4
- explanatory capabilities, 259, 313
- extraobserver variability (in digital mammography), 299
- false-negative, 11, 12, 51, 99, 173, 235, 236
- false-positive, 11, 12, 51, 99, 173, 235, 236
- feasible solution, 45, 46, 50, 111, 161
- features, 22
- feedback mechanism, 9, 12
- feedforward neural network, 177, 204
- fibrocystic change, 291
- fibrosis, 291
- finance, 7
- FIND-BORDER algorithm, 203, 215, 216
- fine needle aspirates (FNAs), 120
- Fisher’s linear discriminant analysis, 281–283, 285
- Flickr, 313
- forecasting, 4
- Fourier transform, 281
- fractile frequencies, 280
- fraudulent transactions, 11
- frequent item set, 242
- full wave rectified integral (FWRI), 280
- fuzzy *c*-means, 281, 282, 287
- fuzzy *k*-nearest neighbor, 281, 287

- fuzzy logic, 185, 297–301, 303–305, 308
- fuzzy models, 282
- fuzzy set approaches (FSA), 259
- fuzzy sets, 25, 299, 300, 303

- GEM system, 128, 130
- general Boolean functions, 25, 225, 311
- generalizability power, 131
- genetic algorithms, 182
- globalization, 312
- GPS (Global Positioning System), 313
- gradient-based optimization procedure, 285
- graph theory, 170
- GRASP approaches, 79, 80
- greedy algorithm, 35–37
- greedy approach, 50, 157, 170, 209
- grid computing, 312
- guided learning, 19, 80, 101, 102, 104, 105, 109, 112, 113, 115, 122, 123, 125, 126, 129, 193, 258, 259, 264, 265, 267, 268, 272, 273, 275, 311

- Hansel chains, 201, 202
- Hansel's algorithm, see *Hansel's lemma*, 201, 202, 215, 216, 223
- Hansel's lemma, 187, 201
- Hansel's theorem, see *Hansel's lemma*, 201
- hard cases (diagnosis of), 235
- hash tree, 249
- hashing, 249
- heterogeneous data, 12
- heuristics, 15, 24, 72, 73, 75, 76, 84–86, 102, 128, 132, 312
- heuristics for clause inference, 75
- “hidden” logic, 50, 64, 65, 68, 70, 103–105, 108, 110–117, 119, 120, 122, 123, 161–163, 168, 169, 194
- hierarchical approach, 188, 189, 197
- hierarchical decomposition, 196, 197, 225
- hierarchical decomposition of variables, 196
- hierarchy, 13
- high-definition (HD) video, 313
- histogram, 250, 252–254
- homogeneity property, 100
- homogeneous data, 100
- horizontal end points, 209
- Horn clauses, 72
- Horvitz–Thompson estimator, 215, 217
- hybridization, 312
- hyperplasia, 291
- hypothesis space, 23, 110–113

- ID3 algorithm, 113
- IF-THEN rules, 12, 259, 292
- illusions, see *accuracy illusions*, 235, 236, 310, 313
- image analysis, 313
- incomplete data, inference with, 80, 91
- incremental algorithms, 130, 209
- incremental learning, 113, 125, 129, 130, 132, 134, 144, 145, 265
- incremental learning from examples (ILE), 125, 128
- incremental OCAT (IOCAT), 126, 135
- incremental updates, 208
- index of actual reliability, 176
- index of potential reliability, 176, 178, 179
- indexing terms, see *keywords*, 257, 259, 263, 266
- inductive inference problem, 103
- inference objectives, 206
- infiltrating ductal carcinoma, 291
- information retrieval (IR), 126, 134, 258, 262, 265
- integer programming (IP), 24, 33, 35, 47, 149
- intelligent systems, 72, 300, 313
- interobserver variability, 174

- interpretable properties, 239
- interpretation of results, 12, 311
- interviewing process, 105
- intraductal carcinoma, 291–293, 295
- intraductal comedo type, 291
- intraobserver variability (in digital mam-
mography), 174
- investment opportunities, 7
- iPhone*, 313
- Irvine Repository of Learning Data-
bases, 84
- isometric loading, 277
- isomorphic mapping, 199
- isomorphic posets, 198
- isotonic block class with stratification
algorithm (BCS), 206
- item domain, 242

- judgmental rules, 300

- k -CNF, 23, 113
- k -decision rules, 23
- k -DNF, 23, 113
- K -nearest neighbor models, 182
- Karnaugh maps, 24
- keywords, 127, 191, 259, 260, 264,
266
- knowledge, 4
- knowledge acquisition, 103
- knowledge discovery, see *data min-
ing*, 3, 4, 20, 50, 51, 72,
98–100, 123, 170, 173, 191,
229, 296, 297, 308–315
- knowledge validation, 13, 23
- knowledge-based learning, 25

- large problem, 68, 99, 160, 169, 225
- large-scale learning problems, 150, 170
- layer, 197
- layer partition, 197
- LCIS, 291
- Le Gal type, 290, 293–295

- learning algorithm, 23, 106, 110, 112,
125, 126, 130, 134–136, 145,
147, 150, 170
- learning from examples, 22, 23, 102,
105, 170
- learning theory, 178
- least generalizing clause (LGC), 131,
135, 138, 141, 143
- legal issues, 315
- likelihood function, 211
- likelihood ratio, 196, 204, 206, 208,
211–214, 220–223
- likelihood value, 204, 211, 212
- LINDO, 35
- linear discrimination analysis, see *Fisher's
linear discriminant analysis*,
179, 281, 283, 285
- linear programming, 147, 174
- lobular, 298–300, 302–304
- local optimal point, 76
- logic, see *Boolean function*, 12, 16,
25, 29
- logical discriminant functions, 189
- logistic regression, 206, 281, 282, 284,
286, 287
- lower bound, 64, 155–157, 159–161,
168, 170, 200, 201, 215
- lower limit, 62, 64, 68, 69, 160, 168,
169, 255

- machine learning, 120, 134, 178
- malignancy, 175–178, 181, 196, 232,
298
- malignant case, 84, 180, 184, 292
- mammographic image, 308
- mammography, see also *digital mam-
mography*, 173, 177, 179,
297, 299
- market basket analysis, 241, 243
- market basket data, 241
- marketing methods, 6
- marketing opportunities, 6
- marketing strategies, 241
- mathematical logic, 100, 156, 178, 258

- MathWorks, Inc., 280
- MATLAB software, 280
- maximum cardinality, 63
- maximum clique, 69, 155–157, 160, 161, 168, 169
- maximum closure problem, 205
- maximum flow problem, 205
- maximum likelihood, 195, 205, 206, 220, 222–224, 284
- maximum likelihood estimates, 284
- maximum likelihood problem, 205
- maximum likelihood ratio, 222–224
- maximum simplicity, *see Occam's razor*, 37, 50, 99, 100
- McCluskey algorithm, 24
- mechanical system, 231
- medical diagnosis, 5, 11, 174
- medical sciences (applications in), 5
- membership functions, 301–307
- metaplasia, 291
- microlobulation, 308
- military operations, 6
- min-max algorithm, 206
- MineSet software, 251–255
- MINI system, 24
- minimal CNF representation, 199
- minimal DNF representation, 199
- minimum cardinality, 41, 59
- minimum cardinality problem (MCP), 39
- minimum clique cover, 154, 155
- minimum cost SAT (MINSAT), 24
- minimum number of clauses, 24, 68, 156, 160, 161, 169
- minimum size Boolean function, 24
- mining explorations, 6
- misclassification probabilities, 195, 204–206, 219, 221
- missing values, inference with, 74, 75, 91
- modal value (of fuzzy numbers), 300
- model of learnability, 178
- moment of truth, 12
- monotone Boolean function (nested), *see under nested monotone Boolean functions*, 194, 195, 197, 201–203, 207, 210, 217, 223, 224, 231, 239, 311
- monotone Boolean function (single), 194, 197, 203, 210, 224
- monotone Boolean functions, 25, 187, 191–208, 210–217, 219, 223–226, 229–232, 239, 311
- monotone Boolean functions (applications of), 207, 223, 224, 229, 231
- monotone Boolean functions (number of), 201, 204, 205, 207, 208, 214, 217, 219
- monotone Boolean functions (pair of independent), 224
- monotonicity, 19, 25, 174, 184, 187–189, 191, 192, 207, 226, 227, 229, 234, 235, 281, 283, 285, 309, 311
- monotonicity constraints, 194, 225
- monotonicity property (identification of), 236
- monotonicity property (in data), 174, 175
- Moore's law, 314
- most generalizing clause (MGC), 131, 132, 135
- multicast, 24
- multicriteria decision making, 300
- multiple classes, 312
- muscle condition, 280
- musculoskeletal injuries, 279
- narrow vicinity (NV) hypothesis, 178, 179, 181, 184, 187, 226
- nearest neighbor methods, 174
- negative class, 238, 239
- negative examples, 29
- negative model, 102, 103
- negative rule, 129
- nested monotone Boolean functions, 194, 195, 197, 201–203, 207, 210, 217, 223, 224, 231, 239, 311

- neural networks, 25, 99, 156, 170, 174, 177, 178, 183, 192, 204, 234, 238, 259, 282, 286, 297, 298, 309, 310
- 9/11 events in the U.S., 6
- noise in data, 13
- nondecreasing monotone Boolean functions, 193
- nonincreasing monotone Boolean functions, 193
- nonincremental learning from examples (NILE), 125, 128
- number of candidate solutions, 110

- OCAT (one clause at a time) approach, 35–38, 44, 47, 48, 50, 57, 64, 68, 69, 75, 76, 81, 102, 104–106, 110–113, 119, 125, 128, 129, 134–136, 138, 139, 144, 145, 149, 150, 158, 160, 161, 170, 243, 244, 247, 255, 259, 261, 265, 275, 276, 281, 289, 296
- Occam's razor, 23, 33, 35, 37, 50, 99
- Okham's razor, *see Occam's Razor*, 14
- ontologies, 4
- optimal clause, 43, 62, 65
- optimal solution, 41, 43, 45, 46, 65, 157, 160, 209, 223
- optimal state, 43, 61–63
- optimality, 46–48, 62, 63, 68, 160, 204, 206, 209, 224
- optimistic assessment (in diagnosis), 307
- optimization, 36, 50, 205, 206, 225, 284, 285
- optimization problem, 36, 50, 205, 206, 225
- oracle, 18, 19, 22, 31, 74, 85, 101–105, 107, 108, 112, 114, 123, 125, 129, 133, 193–196, 204, 207, 208, 210, 218, 219, 224, 226, 231, 264, 265, 268, 273
- oracle (deterministic), 17, 193, 194
- oracle (stochastic), 193, 195
- oracle (ternary), 208, 224
- oracle (three-valued), 193, 195, 208, 210, 217, 219, 224
- oracle (unrestricted), 195, 210, 217, 224
- ordered list, 26
- outliers, 10, 11, 13, 312
- overfitting problem, 32, 35, 100, 296, 310
- overgeneralization problem, 32, 100, 310

- p -value, 138, 139, 141, 143, 144, 271
- PAC (probably approximately correct), 23
- PAC algorithm, 23
- pair of nested monotone Boolean functions, 194, 202, 225, 231
- papillomatosis, 291
- parallel algorithm, 157
- parallelism, 80
- parameters, 22
- parametric model, 174, 206
- parsers, 258
- partial knowledge, 73
- partially defined Boolean function, 24
- partially defined examples, 72
- partially ordered set, *see poset*, 198
- partition algorithm, 243
- pattern, 19
- pattern complexity, 15, 16
- pattern recognition, 120, 181, 189, 308
- performance illusions, *see accuracy illusions*, 239
- periodogram, 281
- permutation, 110
- pessimistic assessment (in diagnosis), 307
- Picasa, 313
- political and social sciences (applications in), 7

- political campaign, 7
- pooled adjacent violators algorithm (PAVA), 206
- population (of examples), 69, 102, 126, 136
- poset, 198, 199, 201, 206, 209, 210, 224–226, 312
- positive class, 238, 239
- positive examples, 22, 29, 31, 32, 35–37, 39, 41, 44, 46, 47, 58, 59, 61–64, 74, 76, 78, 81, 83, 84, 93, 102, 106, 111, 115, 122, 127–129, 131–133, 148, 149, 152, 168, 231, 244, 246, 255, 260, 262
- positive model, 102
- positive rule, 129, 262
- power spectrum, 280, 281
- prediction, 4, 6, 11, 12, 174, 208, 277, 281, 287
- predictive modeling, 243
- PRESTO system, 24
- principle of maximum possible simplicity, *see Occam's razor*, 23
- problem definition, 7
- problem preprocessing, 43, 45
- problem solving, 8
- proceeding vector, 39
- process diagnosis problem, 234
- processing elements (in NNs), 177, 285
- pruning, 41
- pseudo-classification, 263

- queries (minimum number of), 194
- queries (number of), 194, 196, 200–202, 204, 207–211, 214–217, 219, 220, 223, 224
- query complexity, 194, 203, 208, 209, 214, 218, 219, 223–225
- query costs, 226
- question-asking strategy, *see guided learning*, 192

- RA1 algorithm, 76–79, 86, 92–95, 244–248, 267, 268, 271–273, 275, 276
- randomized algorithm 1 (RA1), 76, 80
- randomized algorithms, 76, 80
- randomized heuristic 2 (RA2), 81–84, 86, 90–92, 98, 99
- receiver operator characteristic (ROC) analysis, 183
- record linkage, 192, 206
- redundant precedence relations, 198
- rejectability graph (*R*-graph), 64, 152, 158, 159, 161, 169, 170
- related vectors, 197
- reliability criteria, 175, 178
- reliability of data mining systems, 173
- repair of a Boolean function, 130, 133
- representation hypothesis, 179
- root mean square (RMS), 280
- Round-Robin test, 265
- rule induction, 25, 206

- sample complexity, 23, 80, 112, 113
- sample set, 176, 187, 257
- SAT approach, 24, 34, 35, 38, 49, 50, 64, 65, 68, 72, 86, 113, 148–150, 160
- satisfiability (definition of), 25
- satisfiability (SAT), 24, 33, 38, 50, 79, 107, 130, 160
- screening mammography, 173
- search stages, 41, 46
- search states, 41, 43, 46, 57–59, 61, 63, 65
- search tree, 41, 45, 46, 59–61
- semantic analysis (SA), 239, 259
- sensors, 10
- sequential design of experiments, 204
- sequential monotone rule induction, 206
- set covering problem, 15, 37, 39
- set of all monotone Boolean functions, 199

- set-oriented mining (SETM), 243
- sigmoid function, 282
- sign test, 134, 138, 141, 144, 267, 272
- signal analysis, 6
- Silicon Graphics, Inc., 251, 255
- similarity measures, 258, 263
- similarity relationships, 4
- size of population (of examples), 176
- size of state space, 176, 179
- “smart” questions, 192
- social issues, 315
- Sokolov’s algorithm, 202, 203
- space complexity, 110
- SQL system, 243
- state space, 48, 176, 177, 179, 181, 184, 186
- states (of nature), 3, 7, 21, 30
- statistical models, 13, 15, 234
- stochastic membership questions, 194
- stochastic oracle, 195
- stochasticity, 311
- succeeding vector, 193, 197
- supervised classification, 257
- support (of association rule), 242, 255
- support vector machines (SVM), 25, 156, 170
- symbolic machine, 25
- symmetric chain partition, 198
- symmetric system, 102, 129, 268
- synthetic databases, 247
- system, 3
- target identification, 6
- tautologies, 163
- telecommunication data analysis, 243
- terminal nodes, 41, 46, 61
- terminal state, 45, 46, 58, 59, 61–63
- ternary function, 195
- testing set, 282, 285
- text classification, 258
- text documents (mining of), 126, 127, 135, 144, 257, 259, 260
- three-valued oracle, *see ternary function*, 195, 208
- threshold functions, 226
- TIPSTER collection, 125, 126, 134, 136, 144, 265, 266, 273, 275, 276
- total misclassification cost, 99, 100
- training data, 12, 31, 35, 37, 51, 64, 69, 86, 99, 101, 102, 104, 120, 125, 144, 147, 173, 174, 176, 177, 179, 184, 235, 238, 267, 282–286, 289, 292, 310
- training rate, 285
- transactions, 241, 242, 246, 247, 251
- trapezoid fuzzy numbers, 300
- traveler screening, 6
- triangular fuzzy numbers, 300
- tubular carcinoma, 291
- two-class problems, 3, 21
- ultraoptimistic diagnostic system, 235, 236
- unclassifiable, *see undecidable cases*, 3, 38, 44, 99, 103, 262, 265
- undecidable cases, 12, 271, 281–284, 286
- undulations, 298, 300–307
- undulations (size of), 298, 302, 303
- unrestricted oracle, 195
- upper zero, 199
- validation (cross), 265, 267, 269–271, 275
- validation (leave-one-out), 265, 267, 269, 271, 275
- validation (of system), 120
- Vapnik–Chernovenkis dimension, 23, 112
- variables, 22
- variance–covariance matrix, 180, 283
- vector (example) selection criteria, 209, 212
- vector space model (VSM), 258, 260, 262, 263, 275
- vertical middle, 209
- visualization, 311

- visualization of decomposition of general functions, 229
- visualization of monotone Boolean functions, 200
- visualization of nested monotone Boolean functions, 202
- visualization of posets, 198
- VLSI applications, 23
- wearable computers, 315
- Web applications, 313
- Web mining, 257
- Wisconsin breast cancer database, 84, 85, 87–92, 121
- Woman’s Hospital (in Baton Rouge, LA) dataset, 176, 179–182, 235, 289–291, 296
- World Wide Web, 4, 276
- YouTube, 313
- ZIPFF collection, 269, 270