## **Bibliography**

- [1] Naoki Abe and Hiroshi Mamitsuka. Query learning strategies using boosting and bagging. In *Machine Learning: Proceedings of the Fifteenth International Conference*, 1998.
- [2] Naoki Abe, Bianca Zadrozny, and John Langford. An iterative method for multi-class cost-sensitive learning. In *Proceedings of the Tenth ACM SIGKDD International Conference on Knowledge Discovery and Data Mining*, pages 3–11, 2004.
- [3] Shivani Agarwal, Thore Graepel, Ralf Herbrich, Sariel Har-Peled, and Dan Roth. Generalization bounds for the area under the ROC curve. *Journal of Machine Learning Research*, 6:393–425, 2005.
- [4] Shivani Agarwal and Dan Roth. Learnability of bipartite ranking functions. In *18th Annual Conference on Learning Theory*, 2005.
- [5] Shivani Agarwal and Shiladitya Sengupta. Ranking genes by relevance to a disease. In CSB2009: 8th Annual International Conference on Computational Systems Bioinformatics, 2009.
- [6] Erin L. Allwein, Robert E. Schapire, and Yoram Singer. Reducing multiclass to binary: A unifying approach for margin classifiers. *Journal of Machine Learning Research*, 1:113–141, 2000.
- [7] Ethem Alpaydin. *Introduction to Machine Learning*. MIT Press, 2004.
- [8] Martin Anthony and Peter L. Bartlett. *Neural Network Learning: Theoreti*cal Foundations. Cambridge University Press, 1999.
- [9] Javed A. Aslam and Scott E. Decatur. General bounds on statistical query learning and PAC learning with noise via hypothesis boosting. *Information and Computation*, 141(2):85–118, March 1998.

[10] Maria-Florina Balcan and Avrim Blum. A discriminative model for semi-supervised learning. *Journal of the ACM*, 57(3), March 2010.

- [11] Peter L. Bartlett. The sample complexity of pattern classification with neural networks: the size of the weights is more important than the size of the network. *IEEE Transactions on Information Theory*, 44(2):525–536, March 1998.
- [12] Peter L. Bartlett, Michael I. Jordan, and Jon D. McAuliffe. Convexity, classification, and risk bounds. *Journal of the American Statistical Association*, 101(473):138–156, March 2006.
- [13] Peter L. Bartlett and Shahar Mendelson. Rademacher and Gaussian complexities: Risk bounds and structural results. *Journal of Machine Learning Research*, 3:463–482, 2002.
- [14] Peter L. Bartlett and Mikhail Traskin. AdaBoost is consistent. *Journal of Machine Learning Research*, 8:2347–2368, 2007.
- [15] Eric Bauer and Ron Kohavi. An empirical comparison of voting classification algorithms: Bagging, boosting, and variants. *Machine Learning*, 36(1/2):105–139, 1999.
- [16] Eric B. Baum and David Haussler. What size net gives valid generalization? *Neural Computation*, 1(1):151–160, 1989.
- [17] Shai Ben-David, Philip M. Long, and Yishay Mansour. Agnostic boosting. In *Proceedings 14th Annual Conference on Computational Learning Theory and 5th European Conference on Computational Learning Theory*, pages 507–516, 2001.
- [18] Kristin P. Bennett, Ayhan Demiriz, and Richard Maclin. Exploiting unlabeled data in ensemble methods. In *Proceedings of SIGKDD International Conference on Knowledge Discovery and Data Mining*, 2002.
- [19] Alina Beygelzimer, John Langford, and Pradeep Ravikumar. Error-correcting tournaments. In *Algorithmic Learning Theory: 20th International Conference*, pages 247–262, 2009.
- [20] Peter J. Bickel, Ya'acov Ritov, and Alon Zakai. Some theory for generalized boosting algorithms. *Journal of Machine Learning Research*, 7:705–732, 2006.
- [21] Patrick Billingsley. *Probability and Measure*. Wiley, third edition, 1995.

[22] Christopher M. Bishop. *Pattern Recognition and Machine Learning*. Springer, 2006.

- [23] David Blackwell. An analog of the minimax theorem for vector payoffs. *Pacific Journal of Mathematics*, 6(1):1–8, Spring 1956.
- [24] David Blackwell. Controlled random walks. In *Proceedings of the International Congress of Mathematicians*, 1954, volume III, pages 336–338. North-Holland, 1956.
- [25] Avrim Blum. Empirical support for Winnow and Weighted Majority algorithms: Results on a calendar scheduling domain. *Machine Learning*, 26:5–23, 1997.
- [26] Avrim Blum. Random projection, margins, kernels, and feature-selection. In *Subspace, Latent Structure and Feature Selection*. Springer, 2005.
- [27] Anselm Blumer, Andrzej Ehrenfeucht, David Haussler, and Manfred K. Warmuth. Occam's razor. *Information Processing Letters*, 24(6):377–380, April 1987.
- [28] Anselm Blumer, Andrzej Ehrenfeucht, David Haussler, and Manfred K. Warmuth. Learnability and the Vapnik-Chervonenkis dimension. *Journal of the Association for Computing Machinery*, 36(4):929–965, October 1989.
- [29] Bernhard E. Boser, Isabelle M. Guyon, and Vladimir N. Vapnik. A training algorithm for optimal margin classifiers. In *Proceedings of the Fifth Annual ACM Workshop on Computational Learning Theory*, pages 144–152, 1992.
- [30] Stéphane Boucheron, Olivier Bousquet, and Gábor Lugosi. Theory of classification: A survey of some recent advances. *ESAIM: Probability and Statistics*, 9:323–375, 2005.
- [31] Stephen Boyd and Lieven Vandenberghe. *Convex Optimization*. Cambridge University Press, 2004.
- [32] L. M. Bregman. The relaxation method of finding the common point of convex sets and its application to the solution of problems in convex programming. *USSR Computational Mathematics and Mathematical Physics*, 7(3):200–217, 1967.
- [33] Leo Breiman. Probability. SIAM, 1992.
- [34] Leo Breiman. Bagging predictors. *Machine Learning*, 24(2):123–140, 1996.

[35] Leo Breiman. Arcing classifiers. Annals of Statistics, 26(3):801–849, 1998.

- [36] Leo Breiman. Prediction games and arcing classifiers. *Neural Computation*, 11(7):1493–1517, 1999.
- [37] Leo Breiman. Random forests. *Machine Learning*, 45(1):5–32, 2001.
- [38] Leo Breiman. Population theory for boosting ensembles. *Annals of Statistics*, 32(1):1–11, 2004.
- [39] Leo Breiman, Jerome H. Friedman, Richard A. Olshen, and Charles J. Stone. *Classification and Regression Trees*. Wadsworth & Brooks, 1984.
- [40] Peter Bühlmann and Torsten Hothorn. Boosting algorithms: regularization, prediction and model fitting. *Statistical Science*, 22(4):477–505, 2007.
- [41] Wray Buntine. Learning classification trees. *Statistics and Computing*, 2:63–73, 1992.
- [42] Rich Caruana and Alexandru Niculescu-Mizil. An empirical comparison of supervised learning algorithms. In *Proceedings of the 23rd International Conference on Machine Learning*, 2006.
- [43] N. N. Cencov. *Statistical Decision Rules and Optimal Inference*. American Mathematical Society, 1982.
- [44] Yair Censor and Stavros A. Zenios. *Parallel Optimization: Theory, Algorithms, and Applications*. Oxford University Press, 1997.
- [45] Nicolò Cesa-Bianchi, Yoav Freund, David Haussler, David P. Helmbold, Robert E. Schapire, and Manfred K. Warmuth. How to use expert advice. *Journal of the ACM*, 44(3):427–485, May 1997.
- [46] Nicolò Cesa-Bianchi, Yoav Freund, David P. Helmbold, and Manfred K. Warmuth. On-line prediction and conversion strategies. *Machine Learning*, 25:71–110, 1996.
- [47] Nicolò Cesa-Bianchi and Gábor Lugosi. *Prediction, Learning, and Games*. Cambridge University Press, 2006.
- [48] N. N. Chentsov. Nonsymmetrical distance between probability distributions, entropy and the theorem of Pythagoras. *Mathematical Notes*, pages 686–691, September 1968.

[49] William Cohen. Fast effective rule induction. In *Proceedings of the Twelfth International Conference on Machine Learning*, pages 115–123, 1995.

- [50] William W. Cohen and Yoram Singer. A simple, fast, and effective rule learner. In *Proceedings of the Sixteenth National Conference on Artificial Intelligence*, pages 335–342, 1999.
- [51] David Cohn, Les Atlas, and Richard Ladner. Improving generalization with active learning. *Machine Learning*, 15(2):201–221, 1994.
- [52] Michael Collins. Discriminative reranking for natural language parsing. In *Proceedings of the Seventeenth International Conference on Machine Learning*, 2000.
- [53] Michael Collins and Terry Koo. Discriminative reranking for natural language parsing. *Computational Linguistics*, 31(1):25–70, March 2005.
- [54] Michael Collins, Robert E. Schapire, and Yoram Singer. Logistic regression, AdaBoost and Bregman distances. *Machine Learning*, 48(1/2/3), 2002.
- [55] Corinna Cortes and Mehryar Mohri. AUC optimization vs. error rate minimization. In *Advances in Neural Information Processing Systems 16*, 2004.
- [56] Corinna Cortes and Vladimir Vapnik. Support-vector networks. *Machine Learning*, 20(3):273–297, September 1995.
- [57] Thomas M. Cover and Joy A. Thomas. *Elements of Information Theory*. Wiley, 1991.
- [58] Nello Cristianini and John Shawe-Taylor. An Introduction to Support Vector Machines and Other Kernel-based Learning Methods. Cambridge University Press, 2000.
- [59] I. Csiszár. I-divergence geometry of probability distributions and minimization problems. *Annals of Probability*, 3(1):146–158, 1975.
- [60] Imre Csiszár and Paul C. Shields. Information theory and statistics: A tutorial. Foundations and Trends in Communications and Information Theory, 1(4):417–528, 2004.
- [61] Sasha Cyganowski, Peter Kloeden, and Jerzy Ombach. From Elementary Probability to Stochastic Differential Equations with MAPLE. Springer, 2002.

[62] George B. Dantzig. A proof of the equivalence of the programming problem and the game problem. In *Activity Analysis of Production and Allocation: Proceedings of a Conference*, pages 330–335. John Wiley & Sons, 1951.

- [63] Stephen Della Pietra, Vincent Della Pietra, and John Lafferty. Inducing features of random fields. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 19(4):1–13, April 1997.
- [64] Stephen Della Pietra, Vincent Della Pietra, and John Lafferty. Duality and auxiliary functions for Bregman distances. Technical Report CMU-CS-01-109, School of Computer Science, Carnegie Mellon University, 2001.
- [65] Ayhan Demiriz, Kristin P. Bennett, and John Shawe-Taylor. Linear programming boosting via column generation. *Machine Learning*, 46(1/2/3):225–254, 2002.
- [66] Robert Detrano, Andras Janosi, Walter Steinbrunn, Matthias Pfisterer, Johann-Jakob Schmid, Sarbjit Sandhu, Kern H. Guppy, Stella Lee, and Victor Froelicher. International application of a new probability algorithm for the diagnosis of coronary artery disease. *American Journal of Cardiology*, 64(5):304–310, August 1989.
- [67] Luc Devroye, Lázló Györfi, and Gábor Lugosi. *A Probabilistic Theory of Pattern Recognition*. Springer, 1996.
- [68] Thomas G. Dietterich. An experimental comparison of three methods for constructing ensembles of decision trees: Bagging, boosting, and randomization. *Machine Learning*, 40(2):139–158, 2000.
- [69] Thomas G. Dietterich. Ensemble learning. In Michael A. Arbib, editor, *The Handbook of Brain Theory and Neural Networks*. MIT Press, second edition, 2002.
- [70] Thomas G. Dietterich and Ghulum Bakiri. Solving multiclass learning problems via error-correcting output codes. *Journal of Artificial Intelligence Research*, 2:263–286, January 1995.
- [71] Harris Drucker and Corinna Cortes. Boosting decision trees. In *Advances* in *Neural Information Processing Systems 8*, pages 479–485, 1996.
- [72] Harris Drucker, Robert Schapire, and Patrice Simard. Boosting performance in neural networks. *International Journal of Pattern Recognition and Artificial Intelligence*, 7(4):705–719, 1993.

[73] Richard O. Duda, Peter E. Hart, and David G. Stork. *Pattern Classification*. Wiley, second edition, 2001.

- [74] Miroslav Dudík. *Maximum Entropy Density Estimation and Modeling Geographic Distributions of Species*. PhD thesis, Princeton University, 2007.
- [75] Miroslav Dudík, Steven J. Phillips, and Robert E. Schapire. Performance guarantees for regularized maximum entropy density estimation. In *17th Annual Conference on Learning Theory*, 2004.
- [76] Miroslav Dudík, Steven J. Phillips, and Robert E. Schapire. Maximum entropy density estimation with generalized regularization and an application to species distribution modeling. *Journal of Machine Learning Research*, 8:1217–1260, 2007.
- [77] R. M. Dudley. Central limit theorems for empirical measures. *Annals of Probability*, 6(6):899–929, 1978.
- [78] Nigel Duffy and David Helmbold. Potential boosters? In *Advances in Neural Information Processing Systems 11*, 1999.
- [79] Nigel Duffy and David Helmbold. Boosting methods for regression. *Machine Learning*, 49(2/3), 2002.
- [80] Andrzej Ehrenfeucht, David Haussler, Michael Kearns, and Leslie Valiant. A general lower bound on the number of examples needed for learning. *Information and Computation*, 82(3):247–261, September 1989.
- [81] Günther Eibl and Karl-Peter Pfeiffer. Multiclass boosting for weak classifiers. *Journal of Machine Learning Research*, 6:189–210, 2005.
- [82] Jane Elith, Catherine H. Graham, Robert P. Anderson, Miroslav Dudík, Simon Ferrier, Antoine Guisan, Robert J. Hijmans, Falk Huettmann, John R. Leathwick, Anthony Lehmann, Jin Li, Lucia G. Lohmann, Bette A. Loiselle, Glenn Manion, Craig Moritz, Miguel Nakamura, Yoshinori Nakazawa, Jacob McC. M. Overton, A. Townsend Peterson, Steven J. Phillips, Karen Richardson, Ricardo Scachetti-Pereira, Robert E. Schapire, Jorge Soberón, Stephen Williams, Mary S. Wisz, and Niklaus E. Zimmermann. Novel methods improve prediction of species' distributions from occurrence data. *Ecography*, 29:129–151, 2006.
- [83] Sergio Escalera, Oriol Pujol, and Petia Radeva. On the decoding process in ternary error-correcting output codes. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 32(1):120–134, January 2010.

[84] William Feller. *An Introduction to Probability and Its Applications*, volume II. Wiley, second edition, 1971.

- [85] Sally Floyd and Manfred Warmuth. Sample compression, learnability, and the Vapnik-Chervonenkis dimension. *Machine Learning*, 21(3):269–304, 1995.
- [86] Dean P. Foster and Rakesh Vohra. Regret in the on-line decision problem. *Games and Economic Behavior*, 29:7–35, 1999.
- [87] Marcus Frean and Tom Downs. A simple cost function for boosting. Technical report, Department of Computer Science and Electrical Engineering, University of Queensland, 1998.
- [88] Yoav Freund. Boosting a weak learning algorithm by majority. *Information and Computation*, 121(2):256–285, 1995.
- [89] Yoav Freund. An adaptive version of the boost by majority algorithm. *Machine Learning*, 43(3):293–318, June 2001.
- [90] Yoav Freund, Raj Iyer, Robert E. Schapire, and Yoram Singer. An efficient boosting algorithm for combining preferences. *Journal of Machine Learning Research*, 4:933–969, 2003.
- [91] Yoav Freund and Llew Mason. The alternating decision tree learning algorithm. In *Proceedings of the Sixteenth International Conference on Machine Learning*, pages 124–133, 1999.
- [92] Yoav Freund and Manfred Opper. Drifting games and Brownian motion. *Journal of Computer and System Sciences*, 64:113–132, 2002.
- [93] Yoav Freund and Robert E. Schapire. Experiments with a new boosting algorithm. In *Machine Learning: Proceedings of the Thirteenth International Conference*, pages 148–156, 1996.
- [94] Yoav Freund and Robert E. Schapire. Game theory, on-line prediction and boosting. In *Proceedings of the Ninth Annual Conference on Computational Learning Theory*, pages 325–332, 1996.
- [95] Yoav Freund and Robert E. Schapire. A decision-theoretic generalization of on-line learning and an application to boosting. *Journal of Computer and System Sciences*, 55(1):119–139, August 1997.
- [96] Yoav Freund and Robert E. Schapire. Adaptive game playing using multiplicative weights. *Games and Economic Behavior*, 29:79–103, 1999.

[97] Peter W. Frey and David J. Slate. Letter recognition using Holland-style adaptive classifiers. *Machine Learning*, 6:161–182, 1991.

- [98] Jerome Friedman, Trevor Hastie, and Robert Tibshirani. Additive logistic regression: A statistical view of boosting. *Annals of Statistics*, 28(2):337–374, April 2000.
- [99] Jerome H. Friedman. Another approach to polychotomous classification. Technical report, Stanford University, 1996.
- [100] Jerome H. Friedman. Greedy function approximation: A gradient boosting machine. *Annals of Statistics*, 29(5), October 2001.
- [101] Drew Fudenberg and David K. Levine. Consistency and cautious fictitious play. *Journal of Economic Dynamics and Control*, 19:1065–1089, 1995.
- [102] Drew Fudenberg and David K. Levine. *The Theory of Learning in Games*. MIT Press, 1998.
- [103] Drew Fudenberg and Jean Tirole. Game Theory. MIT Press, 1991.
- [104] Johannes Fürnkranz and Gerhard Widmer. Incremental reduced error pruning. In *Machine Learning: Proceedings of the Eleventh International Conference*, pages 70–77, 1994.
- [105] Walter Gautschi. Error function and Fresnel integrals. In Milton Abramowitz and Irene A. Stegun, editors, *Handbook of Mathematical Func*tions With Formulas, Graphs, and Mathematical Tables. US Department of Commerce, 1972.
- [106] Dmitry Gavinsky. Optimally-smooth adaptive boosting and application to agnostic learning. *Journal of Machine Learning Research*, 4:101–117, 2003.
- [107] Claudio Gentile and David P. Helmbold. Improved lower bounds for learning from noisy examples: An information-theoretic approach. *Information and Computation*, 166(2):133–155, May 2001.
- [108] Mikael Goldmann, Johan Håstad, and Alexander Razborov. Majority gates vs. general weighted threshold gates. *Computational Complexity*, 2:277–300, 1992.
- [109] A. L. Gorin, B. A. Parker, R. M. Sachs, and J. G. Wilpon. How may I help you? In *Proceedings Interactive Voice Technology for Telecommunications Applications (IVTTA)*, pages 57–60, 1996.

[110] A. L. Gorin, G. Riccardi, and J. H. Wright. How may I help you? *Speech Communication*, 23(1-2):113–127, October 1997.

- [111] Adam J. Grove and Dale Schuurmans. Boosting in the limit: Maximizing the margin of learned ensembles. In *Proceedings of the Fifteenth National Conference on Artificial Intelligence*, 1998.
- [112] Peter D. Grünwald. *The Minimum Description Length Principle*. MIT Press, 2007.
- [113] L. G. Gubin, B. T. Polyak, and E. V. Raik. The method of projections for finding the common point of convex sets. *USSR Computational Mathematics and Mathematical Physics*, 7(6):1–24, 1967.
- [114] Venkatesan Guruswami and Amit Sahai. Multiclass learning, boosting, and error-correcting codes. In *Proceedings of the Twelfth Annual Conference on Computational Learning Theory*, pages 145–155, 1999.
- [115] D. W. Hagelbarger. SEER, A SEquence Extrapolating Robot. *IRE Transactions on Electronic Computers*, EC-5(1):1–7, March 1956.
- [116] I. Halperin. The product of projection operators. *Acta Scientiarum Mathematicarum*, 23:96–99, 1962.
- [117] James Hannan. Approximation to Bayes risk in repeated play. In M. Dresher, A. W. Tucker, and P. Wolfe, editors, *Contributions to the Theory of Games*, volume III, pages 97–139. Princeton University Press, 1957.
- [118] Sergiu Hart and Andreu Mas-Coell. A general class of adaptive strategies. *Journal of Economic Theory*, 98:26–54, 2001.
- [119] Trevor Hastie and Robert Tibshirani. Classification by pairwise coupling. *Annals of Statistics*, 26(2):451–471, 1998.
- [120] Trevor Hastie, Robert Tibshirani, and Jerome Friedman. *The Elements of Statistical Learning: Data Mining, Inference, and Prediction.* Springer Verlag, 2001.
- [121] David Haussler, Michael Kearns, Nick Littlestone, and Manfred K. Warmuth. Equivalence of models for polynomial learnability. *Information and Computation*, 95(2):129–161, December 1991.
- [122] David P. Helmbold and Robert E. Schapire. Predicting nearly as well as the best pruning of a decision tree. *Machine Learning*, 27(1):51–68, April 1997.

[123] Wassily Hoeffding. Probability inequalities for sums of bounded random variables. *Journal of the American Statistical Association*, 58(301):13–30, March 1963.

- [124] Klaus-U. Höffgen and Hans-U. Simon. Robust trainability of single neurons. In *Proceedings of the Fifth Annual ACM Workshop on Computational Learning Theory*, pages 428–439, July 1992.
- [125] Robert C. Holte. Very simple classification rules perform well on most commonly used datasets. *Machine Learning*, 11(1):63–91, 1993.
- [126] Jeffrey C. Jackson and Mark W. Craven. Learning sparse perceptrons. In *Advances in Neural Information Processing Systems 8*, pages 654–660, 1996.
- [127] E. T. Jaynes. Information theory and statistical mechanics. *Physical Review*, 106(4):620–630, May 15 1957.
- [128] Wenxin Jiang. Process consistency for AdaBoost. *Annals of Statistics*, 32(1):13–29, 2004.
- [129] Adam Tauman Kalai and Rocco A. Servedio. Boosting in the presence of noise. *Journal of Computer and System Sciences*, 71:266–290, 2005.
- [130] J. N. Kapur and H. K. Kesavan. *Entropy Optimization Principles with Applications*. Academic Press, 1992.
- [131] Ioannis Karatzas and Steven E. Shreve. *Brownian Motion and Stochastic Calculus*. Springer, second edition, 1991.
- [132] Michael Kearns and Yishay Mansour. On the boosting ability of top-down decision tree learning algorithms. In *Proceedings of the Twenty-Eighth Annual ACM Symposium on the Theory of Computing*, 1996.
- [133] Michael Kearns and Leslie G. Valiant. Cryptographic limitations on learning Boolean formulae and finite automata. *Journal of the Association for Computing Machinery*, 41(1):67–95, January 1994.
- [134] Michael J. Kearns and Umesh V. Vazirani. *An Introduction to Computational Learning Theory*. MIT Press, 1994.
- [135] Jyrki Kivinen and Manfred K. Warmuth. Boosting as entropy projection. In *Proceedings of the Twelfth Annual Conference on Computational Learning Theory*, pages 134–144, 1999.

[136] Aldebaro Klautau, Nikola Jevtić, and Alon Orlitsky. On nearest-neighbor error-correcting output codes with application to all-pairs multiclass support vector machines. *Journal of Machine Learning Research*, 4:1–15, 2003.

- [137] Ron Kohavi and Clayton Kunz. Option decision trees with majority votes. In *Machine Learning: Proceedings of the Fourteenth International Conference*, pages 161–169, 1997.
- [138] Ron Kohavi and David H. Wolpert. Bias plus variance decomposition for zero-one loss functions. In *Machine Learning: Proceedings of the Thirteenth International Conference*, pages 275–283, 1996.
- [139] V. Koltchinskii and D. Panchenko. Empirical margin distributions and bounding the generalization error of combined classifiers. *Annals of Statistics*, 30(1), February 2002.
- [140] Eun Bae Kong and Thomas G. Dietterich. Error-correcting output coding corrects bias and variance. In *Proceedings of the Twelfth International Conference on Machine Learning*, pages 313–321, 1995.
- [141] Nir Krause and Yoram Singer. Leveraging the margin more carefully. In *Proceedings of the Twenty-First International Conference on Machine Learning*, 2004.
- [142] C. Kremen, A. Cameron, A. Moilanen, S. J. Phillips, C. D. Thomas, H. Beentje, J. Dransfield, B. L. Fisher, F. Glaw, T. C. Good, G. J. Harper, R. J. Hijmans, D. C. Lees, Jr. E. Louis, R. A. Nussbaum, C. J. Raxworthy, A. Razafimpahanana, G. E. Schatz, M. Vences, D. R. Vieites, P. C. Wright, and M. L. Zjhra. Aligning conservation priorities across taxa in madagascar with high-resolution planning tools. *Science*, 320(5873):222–226, April 11 2008.
- [143] Abba Krieger, Chuan Long, and Abraham Wyner. Boosting noisy data. In *Proceedings of the Eighteenth International Conference on Machine Learning*, pages 274–281, 2001.
- [144] S. Kullback and R. A. Leibler. On information and sufficiency. *Annals of Mathematical Statistics*, 22(1):79–86, 1951.
- [145] Solomon Kullback. Information Theory and Statistics. Wiley, 1959.
- [146] Ludmila I. Kuncheva. Combining Pattern Classifiers: Methods and Algorithms. Wiley, 2004.

[147] John Lafferty. Additive models, boosting and inference for generalized divergences. In *Proceedings of the Twelfth Annual Conference on Computational Learning Theory*, pages 125–133, 1999.

- [148] John D. Lafferty, Stephen Della Pietra, and Vincent Della Pietra. Statistical learning algorithms based on Bregman distances. In *Proceedings of the Canadian Workshop on Information Theory*, 1997.
- [149] Guy Lebanon and John Lafferty. Boosting and maximum likelihood for exponential models. In *Advances in Neural Information Processing Systems* 14, 2002.
- [150] Michel Ledoux and Michel Talagrand. *Probability in Banach Spaces: Isoperimetry and Processes*. Springer-Verlag, 1991.
- [151] David D. Lewis and Jason Catlett. Heterogeneous uncertainty sampling for supervised learning. In *Machine Learning: Proceedings of the Eleventh International Conference*, 1994.
- [152] David D. Lewis and William A. Gale. A sequential algorithm for training text classifiers. In *Proceedings of the 17th Annual International ACM SIGIR Conference on Research and Development in Information Retrieval*, pages 3–12, 1994.
- [153] Nick Littlestone. Learning when irrelevant attributes abound: A new linear-threshold algorithm. *Machine Learning*, 2:285–318, 1988.
- [154] Nick Littlestone and Manfred Warmuth. Relating data compression and learnability. Unpublished manuscript, November 1987.
- [155] Nick Littlestone and Manfred K. Warmuth. The weighted majority algorithm. *Information and Computation*, 108:212–261, 1994.
- [156] Tie-Yan Liu. Learning to rank for information retrieval. *Foundations and Trends in Information Retrieval*, 3(3):225–331, 2009.
- [157] Philip M. Long and Rocco A. Servedio. Martingale boosting. In *18th Annual Conference on Learning Theory*, 2005.
- [158] Philip M. Long and Rocco A. Servedio. Adaptive martingale boosting. In *Advances in Neural Information Processing Systems 21*, 2009.
- [159] Philip M. Long and Rocco A. Servedio. Random classification noise defeats all convex potential boosters. *Machine Learning*, 78:287–304, 2010.

[160] David G. Luenberger and Yinyu Ye. *Linear and nonlinear programming*. Springer, third edition, 2008.

- [161] Gábor Lugosi and Nicolas Vayatis. On the Bayes-risk consistency of regularized boosting methods. *Annals of Statistics*, 32(1):30–55, 2004.
- [162] Richard Maclin and David Opitz. An empirical evaluation of bagging and boosting. In *Proceedings of the Fourteenth National Conference on Artificial Intelligence*, pages 546–551, 1997.
- [163] Stéphane G. Mallat and Zhifeng Zhang. Matching pursuits with time-frequency dictionaries. *IEEE Transactions on Signal Processing*, 41(12):3397–3415, December 1993.
- [164] Shie Mannor, Ron Meir, and Tong Zhang. Greedy algorithms for classification consistency, convergence rates, and adaptivity. *Journal of Machine Learning Research*, 4:713–742, 2003.
- [165] Yishay Mansour and David McAllester. Boosting using branching programs. *Journal of Computer and System Sciences*, 64(1):103–112, 2002.
- [166] Stephen Marsland. *Machine Learning: An Algorithmic Perspective*. Chapman & Hall/CRC, 2009.
- [167] Llew Mason, Peter Bartlett, and Jonathan Baxter. Direct optimization of margins improves generalization in combined classifiers. In *Advances in Neural Information Processing Systems* 12, 2000.
- [168] Llew Mason, Jonathan Baxter, Peter Bartlett, and Marcus Frean. Functional gradient techniques for combining hypotheses. In *Advances in Large Margin Classifiers*. MIT Press, 1999.
- [169] David Mease and Abraham Wyner. Evidence contrary to the statistical view of boosting. *Journal of Machine Learning Research*, 9:131–156, 2008.
- [170] Ron Meir and Gunnar Rätsch. An introduction to boosting and leveraging. In S. Mendelson and A. Smola, editors, *Advanced Lectures on Machine Learning (LNAI2600)*, pages 119–184. Springer, 2003.
- [171] Tom M. Mitchell. Machine Learning. McGraw Hill, 1997.
- [172] Indraneel Mukherjee and Robert E. Schapire. A theory of multiclass boosting. In *Advances in Neural Information Processing Systems* 23, 2011.

[173] Roger B. Myerson. *Game Theory: Analysis of Conflict*. Harvard University Press, 1997.

- [174] J. von Neumann. Zur theorie der gesellschaftsspiele. *Mathematische Annalen*, 100:295–320, 1928.
- [175] John von Neumann. Functional Operators, Volume II: The Geometry of Orthogonal Spaces. Princeton University Press, 1950.
- [176] Bernt Øksendal. Stochastic Differential Equations: An Introduction with Applications. Springer, sixth edition, 2003.
- [177] T. Onoda, G. Rätsch, and K.-R. Müller. An asymptotic analysis of AdaBoost in the binary classification case. In *Proceedings of the 8th International Conference on Artificial Neural Networks*, pages 195–200, 1998.
- [178] Martin J. Osborne and Ariel Rubinstein. *A Course in Game Theory*. MIT Press, 1994.
- [179] Guillermo Owen. Game Theory. Academic Press, third edition, 1995.
- [180] Nikunj C. Oza and Stuart Russell. Online bagging and boosting. In *Eighth International Workshop on Artificial Intelligence and Statistics*, pages 105–112, 2001.
- [181] Steven J. Phillips, Miroslav Dudík, and Robert E. Schapire. A maximum entropy approach to species distribution modeling. In *Proceedings of the Twenty-First International Conference on Machine Learning*, 2004.
- [182] J. R. Quinlan. Bagging, boosting, and C4.5. In *Proceedings of the Thirteenth National Conference on Artificial Intelligence*, pages 725–730, 1996.
- [183] J. Ross Quinlan. *C4.5: Programs for Machine Learning*. Morgan Kaufmann, 1993.
- [184] Shyamsundar Rajaram and Shivani Agarwal. Generalization bounds for k-partite ranking. In *Proceedings of the NIPS-2005 Workshop on Learning to Rank*, 2005.
- [185] G. Rätsch, T. Onoda, and K.-R. Müller. Soft margins for AdaBoost. *Machine Learning*, 42(3):287–320, 2001.
- [186] Gunnar Rätsch and Manfred K. Warmuth. Efficient margin maximizing with boosting. *Journal of Machine Learning Research*, 6:2131–2152, 2005.

[187] Lev Reyzin and Robert E. Schapire. How boosting the margin can also boost classifier complexity. In *Proceedings of the 23rd International Conference on Machine Learning*, 2006.

- [188] G. Riccardi, A. L. Gorin, A. Ljolje, and M. Riley. Spoken language understanding for automated call routing. In *Proceedings of the 1997 IEEE International Conference on Acoustics, Speech, and Signal Processing*, pages 1143–1146, 1997.
- [189] Greg Ridgeway, David Madigan, and Thomas Richardson. Boosting methodology for regression problems. In *Proceedings of the International Workshop on AI and Statistics*, pages 152–161, 1999.
- [190] R. Tyrrell Rockafellar. Convex Analysis. Princeton University Press, 1970.
- [191] Saharon Rosset, Ji Zhu, and Trevor Hastie. Boosting as a regularized path to a maximum margin classifier. *Journal of Machine Learning Research*, 5:941–973, 2004.
- [192] Cynthia Rudin, Corinna Cortes, Mehryar Mohri, and Robert E. Schapire. Margin-based ranking meets boosting in the middle. In 18th Annual Conference on Learning Theory, 2005.
- [193] Cynthia Rudin, Ingrid Daubechies, and Robert E. Schapire. The dynamics of AdaBoost: Cyclic behavior and convergence of margins. *Journal of Machine Learning Research*, 5:1557–1595, 2004.
- [194] Cynthia Rudin and Robert E. Schapire. Margin-based ranking and an equivalence between AdaBoost and RankBoost. *Journal of Machine Learning Research*, 10:2193–2232, 2009.
- [195] Cynthia Rudin, Robert E. Schapire, and Ingrid Daubechies. Analysis of boosting algorithms using the smooth margin function. *Annals of Statistics*, 35(6):2723–2768, 2007.
- [196] Walter Rudin. *Principles of Mathematical Analysis*. McGraw-Hill, third edition, 1976.
- [197] N. Sauer. On the density of families of sets. *Journal of Combinatorial Theory Series A*, 13:145–147, 1972.
- [198] Robert E. Schapire. The strength of weak learnability. *Machine Learning*, 5(2):197–227, 1990.

[199] Robert E. Schapire. Using output codes to boost multiclass learning problems. In *Machine Learning: Proceedings of the Fourteenth International Conference*, pages 313–321, 1997.

- [200] Robert E. Schapire. Drifting games. *Machine Learning*, 43(3):265–291, June 2001.
- [201] Robert E. Schapire, Yoav Freund, Peter Bartlett, and Wee Sun Lee. Boosting the margin: A new explanation for the effectiveness of voting methods. *Annals of Statistics*, 26(5):1651–1686, October 1998.
- [202] Robert E. Schapire, Marie Rochery, Mazin Rahim, and Narendra Gupta. Incorporating prior knowledge into boosting. In *Proceedings of the Nineteenth International Conference on Machine Learning*, 2002.
- [203] Robert E. Schapire, Marie Rochery, Mazin Rahim, and Narendra Gupta. Boosting with prior knowledge for call classification. *IEEE Transactions on Speech and Audio Processing*, 13(2):174–181, March 2005.
- [204] Robert E. Schapire and Yoram Singer. Improved boosting algorithms using confidence-rated predictions. *Machine Learning*, 37(3):297–336, December 1999.
- [205] Robert E. Schapire and Yoram Singer. BoosTexter: A boosting-based system for text categorization. *Machine Learning*, 39(2/3):135–168, May/June 2000.
- [206] Greg Schohn and David Cohn. Less is more: Active learning with support vector machines. In *Proceedings of the Seventeenth International Conference on Machine Learning*, 2000.
- [207] Bernhard Schölkopf and Alex Smola. *Learning with Kernels*. MIT Press, 2002.
- [208] Holger Schwenk and Yoshua Bengio. Training methods for adaptive boosting of neural networks. In *Advances in Neural Information Processing Systems* 10, pages 647–653, 1998.
- [209] Rocco A. Servedio. Smooth boosting and learning with malicious noise. *Journal of Machine Learning Research*, 4:633–648, 2003.
- [210] Shai Shalev-Shwartz and Yoram Singer. On the equivalence of weak learnability and linear separability: new relaxations and efficient boosting algorithms. *Machine Learning*, 80:141–163, 2010.

[211] C. E. Shannon. A mathematical theory of communication. *The Bell System Technical Journal*, 1948.

- [212] Claude E. Shannon. A mind-reading (?) machine. Technical report, Bell Laboratories, 1953.
- [213] Amanda J. C. Sharkey, editor. *Combining Artificial Neural Nets: Ensemble and Modular Multi-Net Systems*. Springer, 1999.
- [214] A. N. Shiryaev. *Probability*. Springer, second edition, 1996.
- [215] S. K. Srinivasan and R. Vasudevan. *Introduction to Random Differential Equations and their Applications*. Elsevier, 1971.
- [216] Robert Tibshirani. Bias, variance and prediction error for classification rules. Technical report, University of Toronto, November 1996.
- [217] Robert Tibshirani. Regression shrinkage and selection via the lasso. *Journal of the Royal Statistical Society, Series B (Methodological)*, 58(1):267–288, 1996.
- [218] Gokhan Tur, Dilek Hakkani-Tür, and Robert E. Schapire. Combining active and semi-supervised learning for spoken language understanding. *Speech Communication*, 45:171–186, 2005.
- [219] Gokhan Tur, Robert E. Schapire, and Dilek Hakkani-Tür. Active learning for spoken language understanding. In *IEEE International Conference on Acoustics, Speech, and Signal Processing*, 2003.
- [220] L. G. Valiant. A theory of the learnable. *Communications of the ACM*, 27(11):1134–1142, November 1984.
- [221] V. N. Vapnik and A. Ya. Chervonenkis. On the uniform convergence of relative frequencies of events to their probabilities. *Theory of Probability and its Applications*, XVI(2):264–280, 1971.
- [222] V. N. Vapnik and A. Ya. Chervonenkis. *Theory of Pattern Recognition*. Nauka, 1974. (In Russian).
- [223] Vladimir Vapnik. Estimation of Dependences Based on Empirical Data. Springer-Verlag, 1982.
- [224] Vladimir N. Vapnik. *The Nature of Statistical Learning Theory*. Springer, 1995.

[225] Vladimir N. Vapnik. Statistical Learning Theory. Wiley, 1998.

- [226] Paul Viola and Michael Jones. Rapid object detection using a boosted cascade of simple features. In *Proceedings of the 2001 IEEE Computer Society Conference on Computer Vision and Pattern Recognition*, volume I, pages 511–518, 2001.
- [227] Paul Viola and Michael Jones. Robust real-time object detection. In Second International Workshop on Statistical and Computational Theories of Vision Modeling, Learning, Computing, and Sampling, 2001.
- [228] Volodimir G. Vovk. Aggregating strategies. In *Proceedings of the Third Annual Workshop on Computational Learning Theory*, pages 371–383, 1990.
- [229] Liwei Wang, Masashi Sugiyama, Cheng Yang, Zhi-Hua Zhou, and Jufu Feng. On the margin explanation of boosting algorithms. In *21st Annual Conference on Learning Theory*, 2008.
- [230] Frans M. J. Willems, Yuri M. Shtarkov, and Tjalling J. Tjalkens. The context tree weighting method: basic properties. *IEEE Transactions on Information Theory*, 41(3):653–664, 1995.
- [231] Abraham J. Wyner. On boosting and the exponential loss. In *Proceedings* of the Ninth International Workshop on Artificial Intelligence and Statistics, 2003.
- [232] Yongxin Taylor Xi, Zhen James Xiang, Peter J. Ramadge, and Robert E. Schapire. Speed and sparsity of regularized boosting. In *Proceedings of the Twelfth International Conference on Artificial Intelligence and Statistics*, pages 615–622, 2009.
- [233] Jun Xu and Hang Li. AdaRank: A boosting algorithm for information retrieval. In *Proceedings of the 30th Annual International ACM SIGIR Conference on Research and Development in Information Retrieval*, pages 391–398, 2007.
- [234] Tong Zhang. Statistical behavior and consistency of classification methods based on convex risk minimization. *Annals of Statistics*, 32(1):56–134, 2004.
- [235] Tong Zhang and Bin Yu. Boosting with early stopping: Convergence and consistency. *Annals of Statistics*, 33(4):1538–1579, 2005.

[236] Peng Zhao and Bin Yu. Stagewise Lasso. *Journal of Machine Learning Research*, 8:2701–2726, 2007.

[237] Ji Zhu, Hui Zou, Saharon Rosset, and Trevor Hastie. Multi-class AdaBoost. *Statistics and Its Interface*, 2:349–360, 2009.