

## REFERENCES

- [1] AzatiSoftware, *AzatiSoftware Automated Data Labeling with Machine Learning*, 2019. <https://azati.ai/automated-data-labeling-with-machine-learning>.
- [2] R. Board and L. Pitt, "Semi-supervised learning," *Machine Learning*, vol. 4, no. 1, pp. 41–65, 1989.
- [3] B. Settles, "Active learning, volume 6 of synthesis lectures on artificial intelligence and machine learning," *Morgan & Claypool*, 2012.
- [4] K. Petersen, R. Feldt, S. Mujtaba, and M. Mattsson, "Systematic mapping studies in software engineering," in *12th International Conference on Evaluation and Assessment in Software Engineering (EASE) 12*, pp. 1–10, 2008.
- [5] S. Sukhbaatar and R. Fergus, "Learning from noisy labels with deep neural networks," *arXiv preprint arXiv:1406.2080*, vol. 2, no. 3, p. 4, 2014.
- [6] H. He and E. A. Garcia, "Learning from imbalanced data," *IEEE Transactions on knowledge and data engineering*, vol. 21, no. 9, pp. 1263–1284, 2009.
- [7] G. Van Horn and P. Perona, "The devil is in the tails: Fine-grained classification in the wild," *arXiv preprint arXiv:1709.01450*, 2017.
- [8] M. Buda, A. Maki, and M. A. Mazurowski, "A systematic study of the class imbalance problem in convolutional neural networks," *Neural Networks*, vol. 106, pp. 249–259, 2018.
- [9] L. G. Valiant, "A theory of the learnable," *Communications of the ACM*, vol. 27, no. 11, pp. 1134–1142, 1984.
- [10] Z.-H. Zhou and M. Li, "Semi-supervised regression with co-training," in *IJCAI*, vol. 5, pp. 908–913, 2005.
- [11] V. J. Prakash and D. L. Nithya, "A survey on semi-supervised learning techniques," *arXiv preprint arXiv:1402.4645*, 2014.
- [12] J. E. Van Engelen and H. H. Hoos, "A survey on semi-supervised learning," *Machine Learning*, vol. 109, no. 2, pp. 373–440, 2020.
- [13] Y. Fu, X. Zhu, and B. Li, "A survey on instance selection for active learning," *Knowledge and information systems*, vol. 35, no. 2, pp. 249–283, 2013.
- [14] A. Krishnakumar, "Active learning literature survey," *Tech. rep., Technical reports, University of California, Santa Cruz.*, vol. 42, 2007.
- [15] T. M. Mitchell, "The role of unlabeled data in supervised learning," in *Language, Knowledge, and Representation*, pp. 103–111, Springer, 2004.
- [16] A. Blum and T. Mitchell, "Combining labeled and unlabeled data with co-training," in *Proceedings of the eleventh annual conference on Computational learning theory*, pp. 92–100, 1998.
- [17] S. Dasgupta, M. L. Littman, and D. McAllester, "Pac generalization bounds for co-training," *Advances in neural information processing systems*, vol. 1, pp. 375–382, 2002.
- [18] V. R. de Sa, "Learning classification with unlabeled data," in *Advances in neural information processing systems*, pp. 112–119, Citeseer, 1994.
- [19] A. P. Dempster, N. M. Laird, and D. B. Rubin, "Maximum likelihood from incomplete data via the em algorithm," *Journal of the Royal Statistical Society: Series B (Methodological)*, vol. 39, no. 1, pp. 1–22, 1977.
- [20] V. Castelli and T. M. Cover, "On the exponential value of labeled samples," *Pattern Recognition Letters*, vol. 16, no. 1, pp. 105–111, 1995.
- [21] J. Ratsaby and S. S. Venkatesh, "Learning from a mixture of labeled and unlabeled examples with parametric side information," in *Proceedings of the eighth annual conference on Computational learning theory*, pp. 412–417, 1995.
- [22] F. G. Cozman, I. Cohen, M. C. Cirelo, et al., "Semi-supervised learning of mixture models," in *ICML*, vol. 4, p. 24, 2003.
- [23] V. Vapnik and V. Vapnik, "Statistical learning theory 156–160," 1998.
- [24] T. Jebara, J. Wang, and S.-F. Chang, "Graph construction and b-matching for semi-supervised learning," in *Proceedings of the 26th annual international conference on machine learning*, pp. 441–448, 2009.
- [25] S. I. Daitch, J. A. Kelner, and D. A. Spielman, "Fitting a graph to vector data," in *Proceedings of the 26th Annual International Conference on Machine Learning*, pp. 201–208, 2009.
- [26] P. S. Dhillon, P. P. Talukdar, and K. Crammer, "Inference-driven metric learning for graph construction," in *4th North East Student Colloquium on Artificial Intelligence*, 2010.
- [27] X. Zhu, J. S. Kandola, J. Lafferty, and Z. Ghahramani, "Graph kernels by spectral transforms," 2006.
- [28] A. Blum, J. Lafferty, M. R. Rwebangira, and R. Reddy, "Semi-supervised learning using randomized mincuts," in *Proceedings of the twenty-first international conference on Machine learning*, p. 13, 2004.
- [29] X. Zhu, Z. Ghahramani, and J. D. Lafferty, "Semi-supervised learning using gaussian fields and harmonic functions," in *Proceedings of the 20th International conference on Machine learning (ICML-03)*, pp. 912–919, 2003.
- [30] D. Zhou, O. Bousquet, T. N. Lal, J. Weston, and B. Schölkopf, "Learning with local and global consistency," *Advances in neural information processing systems*, vol. 16, no. 16, pp. 321–328, 2004.
- [31] S. Baluja, R. Seth, D. Sivakumar, Y. Jing, J. Yagnik, S. Kumar, D. Ravichandran, and M. Aly, "Video suggestion and discovery for youtube: taking random walks through the view graph," in *Proceedings of the 17th international conference on World Wide Web*, pp. 895–904, 2008.
- [32] P. P. Talukdar and K. Crammer, "New regularized algorithms for transductive learning," in *Joint European Conference on Machine Learning and Knowledge Discovery in Databases*, pp. 442–457, Springer, 2009.
- [33] Y. Bengio, O. Delalleau, and N. Le Roux, *Label Propagation and Quadratic Criterion*, pp. 193–216. MIT Press, semi-supervised learning ed., January 2006.
- [34] M. Orbach and K. Crammer, "Graph-based transduction with confidence," in *Joint European Conference on Machine Learning and Knowledge Discovery in Databases*, pp. 323–338, Springer, 2012.
- [35] M. S. T. Jaakkola and M. Szummer, "Partially labeled classification with markov random walks," *Advances in neural information processing systems (NIPS)*, vol. 14, pp. 945–952, 2002.
- [36] A. A. D. Corduneanu, *The Information Regularization Framework for Semi-Supervised Learning*. PhD thesis, Massachusetts Institute of Technology, 2006.
- [37] A. Corduneanu and T. S. Jaakkola, "On information regularization," *arXiv preprint arXiv:1212.2466*, 2012.
- [38] A. Subramanya and J. Bilmes, "Semi-supervised learning with measure propagation," *Journal of Machine Learning Research*, vol. 12, no. 11, 2011.
- [39] M. Belkin, P. Niyogi, and V. Sindhwani, "On manifold regularization," in *AISTATS*, vol. 1, 2005.
- [40] D. D. Lewis and W. A. Gale, "A sequential algorithm for training text classifiers," in *SIGIR'94*, pp. 3–12, Springer, 1994.
- [41] C. E. Shannon, "A mathematical theory of communication," *The Bell system technical journal*, vol. 27, no. 3, pp. 379–423, 1948.
- [42] D. D. Lewis and J. Catlett, "Heterogeneous uncertainty sampling for supervised learning," in *Machine learning proceedings 1994*, pp. 148–156, Elsevier, 1994.
- [43] B. Settles and M. Craven, "An analysis of active learning strategies for sequence labeling tasks," in *Proceedings of the 2008 Conference on Empirical Methods in Natural Language Processing*, pp. 1070–1079, 2008.
- [44] R. Hwa, "Sample selection for statistical parsing," *Computational linguistics*, vol. 30, no. 3, pp. 253–276, 2004.
- [45] J. Lafferty, A. McCallum, and F. C. Pereira, "Conditional random fields: Probabilistic models for segmenting and labeling sequence data," 2001.
- [46] A. Culotta and A. McCallum, "Reducing labeling effort for structured prediction tasks," in *AAAI*, vol. 5, pp. 746–751, 2005.
- [47] A. Fujii, K. Inui, T. Tokunaga, and H. Tanaka, "Selective sampling for example-based word sense disambiguation," *arXiv preprint cs/9910020*, 1999.
- [48] M. Lindenbaum, S. Markovitch, and D. Rusakov, "Selective sampling for nearest neighbor classifiers," *Machine learning*, vol. 54, no. 2, pp. 125–152, 2004.
- [49] C. Cortes and V. Vapnik, "Support-vector networks," *Machine learning*, vol. 20, no. 3, pp. 273–297, 1995.
- [50] S. Tong and E. Chang, "Support vector machine active learning for image retrieval," in *Proceedings of the ninth ACM international conference on Multimedia*, pp. 107–118, 2001.
- [51] A. K. McCallum and K. Nigam, "Employing em and pool-based active learning for text classification," in *Proc. International Conference on Machine Learning (ICML)*, pp. 359–367, Citeseer, 1998.
- [52] H. T. Nguyen and A. Smeulders, "Active learning using pre-clustering," in *Proceedings of the twenty-first international conference on Machine learning*, p. 79, 2004.

- [53] Z. Xu, R. Akella, and Y. Zhang, "Incorporating diversity and density in active learning for relevance feedback," in *European Conference on Information Retrieval*, pp. 246–257, Springer, 2007.
- [54] H. S. Seung, M. Oppel, and H. Sompolinsky, "Query by committee," in *Proceedings of the fifth annual workshop on Computational learning theory*, pp. 287–294, 1992.
- [55] I. Dagan and S. P. Engelson, "Committee-based sampling for training probabilistic classifiers," in *Machine Learning Proceedings 1995*, pp. 150–157, Elsevier, 1995.
- [56] N. Abe, "Query learning strategies using boosting and bagging," *Proc. of 15<sup>th</sup> Int. Conf. on Machine Learning (ICML98)*, pp. 1–9, 1998.
- [57] S. Keele *et al.*, "Guidelines for performing systematic literature reviews in software engineering," tech. rep., Technical report, Ver. 2.3 EBSE Technical Report. EBSE, 2007.
- [58] C. Wohlin, "Guidelines for snowballing in systematic literature studies and a replication in software engineering," in *Proceedings of the 18th international conference on evaluation and assessment in software engineering*, pp. 1–10, 2014.
- [59] W. D. G. de Oliveira, O. A. Penatti, and L. Berton, "A comparison of graph-based semi-supervised learning for data augmentation," in *2020 33rd SIBGRAPI Conference on Graphics, Patterns and Images (SIBGRAPI)*, pp. 264–271, IEEE, 2020.
- [60] C. Zhang and W.-S. Zheng, "Semi-supervised multi-view discrete hashing for fast image search," *IEEE Transactions on Image Processing*, vol. 26, no. 6, pp. 2604–2617, 2017.
- [61] J. Calder, B. Cook, M. Thorpe, and D. Slepcev, "Poisson learning: Graph based semi-supervised learning at very low label rates," in *International Conference on Machine Learning*, pp. 1306–1316, PMLR, 2020.
- [62] J. Tang, H. Li, G.-J. Qi, and T.-S. Chua, "Image annotation by graph-based inference with integrated multiple/single instance representations," *IEEE Transactions on Multimedia*, vol. 12, no. 2, pp. 131–141, 2009.
- [63] J. Tang, H. Li, G.-J. Qi, and T.-S. Chua, "Integrated graph-based semi-supervised multiple/single instance learning framework for image annotation," in *Proceedings of the 16th ACM international conference on Multimedia*, pp. 631–634, 2008.
- [64] H. Pei, Q. Lin, L. Yang, and P. Zhong, "A novel semi-supervised support vector machine with asymmetric squared loss," *Advances in Data Analysis and Classification*, pp. 1–33, 2020.
- [65] S. Wang, X. Guo, Y. Tie, I. Lee, L. Qi, and L. Guan, "Graph-based safe support vector machine for multiple classes," *IEEE Access*, vol. 6, pp. 28097–28107, 2018.
- [66] M. Zhao, T. W. Chow, Z. Zhang, and B. Li, "Automatic image annotation via compact graph based semi-supervised learning," *Knowledge-Based Systems*, vol. 76, pp. 148–165, 2015.
- [67] N. Kumar and S. P. Awate, "Semi-supervised robust mixture models in rkhs for abnormality detection in medical images," *IEEE Transactions on Image Processing*, vol. 29, pp. 4772–4787, 2020.
- [68] J. Tang, R. Hong, S. Yan, T.-S. Chua, G.-J. Qi, and R. Jain, "Image annotation by knn-sparse graph-based label propagation over noisily tagged web images," *ACM Transactions on Intelligent Systems and Technology (TIST)*, vol. 2, no. 2, pp. 1–15, 2011.
- [69] Y. Xia, F. Liu, D. Yang, J. Cai, L. Yu, Z. Zhu, D. Xu, A. Yuille, and H. Roth, "3d semi-supervised learning with uncertainty-aware multi-view co-training," in *Proceedings of the IEEE/CVF Winter Conference on Applications of Computer Vision*, pp. 3646–3655, 2020.
- [70] W. Lin, Z. Gao, and B. Li, "Shoestring: Graph-based semi-supervised classification with severely limited labeled data," in *Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition*, pp. 4174–4182, 2020.
- [71] R. Yan and M. Naphade, "Semi-supervised cross feature learning for semantic concept detection in videos," in *2005 IEEE Computer Society Conference on Computer Vision and Pattern Recognition (CVPR'05)*, vol. 1, pp. 657–663, IEEE, 2005.
- [72] Z. Yang and Y. Xu, "A safe screening rule for laplacian support vector machine," *Engineering Applications of Artificial Intelligence*, vol. 67, pp. 309–316, 2018.
- [73] F. Wu, X.-Y. Jing, J. Zhou, Y. Ji, C. Lan, Q. Huang, and R. Wang, "Semi-supervised multi-view individual and sharable feature learning for webpage classification," in *The World Wide Web Conference*, pp. 3349–3355, 2019.
- [74] J. Zhu, H. Wang, T. Yao, and B. K. Tsou, "Active learning with sampling by uncertainty and density for word sense disambiguation and text classification," in *Proceedings of the 22nd International Conference on Computational Linguistics (Coling 2008)*, pp. 1137–1144, 2008.
- [75] R. Liere and P. Tadepalli, "Active learning with committees for text categorization," in *AAAI/IAAI*, pp. 591–596, 1997.
- [76] L. Shi, R. Mihalcea, and M. Tian, "Cross language text classification by model translation and semi-supervised learning," in *Proceedings of the 2010 Conference on Empirical Methods in Natural Language Processing*, pp. 1057–1067, Association for Computational Linguistics, 2010.
- [77] X. Zeng, D. F. Wong, L. S. Chao, and I. Trancoso, "Graph-based semi-supervised model for joint chinese word segmentation and part-of-speech tagging," in *Proceedings of the 51st Annual Meeting of the Association for Computational Linguistics (Volume 1: Long Papers)*, pp. 770–779, 2013.
- [78] E. Ringger, P. McClanahan, R. Haertel, G. Busby, M. Carmen, J. Carroll, K. Seppi, and D. Lonsdale, "Active learning for part-of-speech tagging: Accelerating corpus annotation," in *Proceedings of the Linguistic Annotation Workshop*, pp. 101–108, 2007.
- [79] K. Lim, J. Y. Lee, J. Carbonell, and T. Poibeau, "Semi-supervised learning on meta structure: Multi-task tagging and parsing in low-resource scenarios," in *Proceedings of the AAAI Conference on Artificial Intelligence*, vol. 34, pp. 8344–8351, 2020.
- [80] Y. Liu and K. Kirchhoff, "Graph-based semi-supervised learning for phone and segment classification," in *INTERSPEECH*, pp. 1840–1843, 2013.
- [81] J.-T. Huang and M. Hasegawa-Johnson, "On semi-supervised learning of gaussian mixture models for phonetic classification," in *Proceedings of the NAACL HLT 2009 Workshop on Semi-Supervised Learning for Natural Language Processing*, pp. 75–83, Association for Computational Linguistics, 2009.
- [82] R. Rastogi and S. Sharma, "Fast laplacian twin support vector machine with active learning for pattern classification," *Applied Soft Computing*, vol. 74, pp. 424–439, 2019.
- [83] T. Zhang and Z.-H. Zhou, "Semi-supervised optimal margin distribution machines," in *IJCAI*, pp. 3104–3110, 2018.
- [84] F. K. Nakano, R. Cerri, and C. Vens, "Active learning for hierarchical multi-label classification," *Data Mining and Knowledge Discovery*, vol. 34, no. 5, pp. 1496–1530, 2020.
- [85] Y. Sheng, Y. Wu, J. Yang, W. Lu, P. Villars, and W. Zhang, "Active learning for the power factor prediction in diamond-like thermoelectric materials," *npj Computational Materials*, vol. 6, no. 1, pp. 1–7, 2020.
- [86] C. Chen, Y. Li, H. Qian, Z. Zheng, and Y. Hu, "Multi-view semi-supervised learning for classification on dynamic networks," *Knowledge-Based Systems*, vol. 195, p. 105698, 2020.
- [87] C. Chen, Y. Gong, and Y. Tian, "Semi-supervised learning methods for network intrusion detection," in *2008 IEEE international conference on systems, man and cybernetics*, pp. 2603–2608, IEEE, 2008.
- [88] D. Guan, W. Yuan, Y.-K. Lee, A. Gavrilov, and S. Lee, "Activity recognition based on semi-supervised learning," in *13th IEEE International Conference on Embedded and Real-Time Computing Systems and Applications (RTCSA 2007)*, pp. 469–475, IEEE, 2007.
- [89] Z. Yu, L. Su, L. Li, Q. Zhao, C. Mao, and J. Guo, "Question classification based on co-training style semi-supervised learning," *Pattern Recognition Letters*, vol. 31, no. 13, pp. 1975–1980, 2010.
- [90] X. Cui, J. Huang, and J.-T. Chien, "Multi-view and multi-objective semi-supervised learning for hmm-based automatic speech recognition," *IEEE Transactions on Audio, Speech, and Language Processing*, vol. 20, no. 7, pp. 1923–1935, 2012.
- [91] R. G. Colares, P. Machado, M. de Faria, A. Detoni, V. Tavano, *et al.*, "Microalgae classification using semi-supervised and active learning based on gaussian mixture models," *Journal of the Brazilian Computer Society*, vol. 19, no. 4, pp. 411–422, 2013.
- [92] L. Bull, K. Worden, and N. Dervilis, "Towards semi-supervised and probabilistic classification in structural health monitoring," *Mechanical Systems and Signal Processing*, vol. 140, p. 106653, 2020.
- [93] R. Lang, R. Lu, C. Zhao, H. Qin, and G. Liu, "Graph-based semi-supervised one class support vector machine for detecting abnormal lung sounds," *Applied Mathematics and Computation*, vol. 364, p. 124487, 2020.
- [94] K. Zhang, C. Li, Y. Wang, X. Zhu, and H. Wang, "Collaborative support vector machine for malware detection," *Procedia Computer Science*, vol. 108, pp. 1682–1691, 2017.

- [95] M. P. Kumar and M. K. Rajagopal, "Detecting facial emotions using normalized minimal feature vectors and semi-supervised twin support vector machines classifier," *Applied Intelligence*, vol. 49, no. 12, pp. 4150–4174, 2019.
- [96] B. Yoon, Y. Jeong, and S. Kim, "Detecting a risk signal in stock investment through opinion mining and graph-based semi-supervised learning," *IEEE Access*, vol. 8, pp. 161943–161957, 2020.
- [97] S. M. K. Zaman, X. Liang, and H. Zhang, "Graph-based semi-supervised learning for induction motors single-and multi-fault diagnosis using stator current signal," in *2020 IEEE/IAS 56th Industrial and Commercial Power Systems Technical Conference (I&CPS)*, pp. 1–10, IEEE, 2020.
- [98] S. Li, Y. Xue, Z. Wang, and G. Zhou, "Active learning for cross-domain sentiment classification," in *Twenty-Third International Joint Conference on Artificial Intelligence*, 2013.
- [99] S. Bommaraveni, T. X. Vu, S. Chatzinotas, and B. Ottersten, "Active content popularity learning and caching optimization with hit ratio guarantees," *IEEE Access*, vol. 8, pp. 151350–151359, 2020.
- [100] R. C. Prati, G. E. Batista, and M. C. Monard, "Data mining with imbalanced class distributions: concepts and methods," in *IICAI*, pp. 359–376, 2009.
- [101] R. C. Gonzalez and R. E. Woods, "Digital image processing, hoboken," 2018.
- [102] X. Zhu and A. B. Goldberg, "Introduction to semi-supervised learning," *Synthesis lectures on artificial intelligence and machine learning*, vol. 3, no. 1, pp. 1–130, 2009.