











One should also assess the selection of the metaparameters more thoroughly. This could be based on grid-search and cross-validation (CV) [7], although we encountered challenges with both LOO-CV and fold-based CV techniques with the random basis in [8, 9].

An interesting future direction would certainly be to derive a weighted distance measure based on the sampled accuracy of the features. Furthermore, sampling could be replaced or directed using analytical methods, because the simple form of the distance-based basis allows straightforward computation of the feature saliency similarly to [7].

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## References

1. L. Breiman. Random forests. *Machine learning*, 45(1):5–32, 2001.
2. W. Cao, X. Wang, Z. Ming, and J. Gao. A review on neural networks with random weights. *Neurocomputing*, 275:278–287, 2018.
3. A. H. de Souza Junior, F. Corona, G. A. Barreto, Y. Miche, and A. Lendasse. Minimal Learning Machine: A novel supervised distance-based approach for regression and classification. *Neurocomputing*, 164:34–44, 2015.
4. I. Guyon, J. Li, T. Mader, P. A. Pletscher, G. Schneider, and M. Uhr. Competitive baseline methods set new standards for the nips 2003 feature selection benchmark. *Pattern Recognition Letters*, 28(12):1438–1444, 2007.
5. G.-B. Huang, Q.-Y. Zhu, and C.-K. Siew. Extreme learning machine: theory and applications. *Neurocomputing*, 70(1):489–501, 2006.
6. T. Kärkkäinen. On cross-validation for MLP model evaluation. In *Structural, Syntactic, and Statistical Pattern Recognition*, Lecture Notes in Computer Science (8621), pages 291–300. Springer-Verlag, 2014.
7. T. Kärkkäinen. Assessment of feature saliency of MLP using analytic sensitivity. In *Proceedings of the European Symposium on Artificial Neural Networks, Computational Intelligence and Machine Learning - ESANN 2015*, pages 273–278, 2015.
8. T. Kärkkäinen. Extreme Minimal Learning Machine. In *26th European Symposium on Artificial Neural Networks, Computational Intelligence and Machine Learning - ESANN 2018*, pages 237–242, 2018.
9. T. Kärkkäinen. Extreme Minimal Learning Machine: Ridge regression with distance-based basis. *Neurocomputing*, 2018. to appear, 21 pages.
10. T. Kärkkäinen and R. Glowinski. A Douglas-Rachford method for sparse Extreme Learning Machine. *Methods and Applications of Analysis*, pages 1–17, 2018. (in review).
11. T. Kärkkäinen and E. Heikkola. Robust formulations for training multilayer perceptrons. *Neural Computation*, 16(4):837–862, 2004.
12. R. Kohavi. A study of cross-validation and bootstrap for accuracy estimation and model selection. In *Proceedings of the 14th International Joint Conference on Artificial Intelligence (IJCAI'95)*, volume 2, pages 1137–1145, 1995.
13. P. S. Levy and S. Lemeshow. *Sampling of populations: methods and applications*. John Wiley & Sons, 2013.
14. H. Liu and H. Motoda. *Feature selection for knowledge discovery and data mining*, volume 454. Springer Science & Business Media, 2012.