parameter that help in heart disease prediction and reducing the weight of those which do not. (2) Our proposed system can reduce the decision-making time by eliminating the irrelevant samples as well as the material required. (3) SVM can perfectly classify the heart disease data by finding the optimal hyper-plane that separates the first class from those of second class. This makes it very adequate for heart disease prediction system which contains data of patient records with binary target.

Table 5. Comparison of state-of-the-art methods

Authors	Method	Accuracy (%)
Shouman et al. [15]	Decision tree	81.4
Peter et al. [16]	Multilayer perceptron	82.22
Nahar et al. [17]	Naive Bayes	69.11
Ismaeel et al. [18]	Extreme learning machine	80
Amin et al. [3]	Logistic regression	78.03
Our work	NCA-SVM	**85.43**

5. CONCLUSION

In this work, the combination of NCA and SVM is used to predict heart disease from real datasets provided by the UCI machine learning repository. The NCA feature selection can effectively select the most relevant parameters to make a good decision. Thus, the parameter selection in such a clinical application can seriously reduce the number of medical equipment as well as the labor and the time required to get the final decision while increasing the prediction performance. However, SVM was used for predicting the selected parameters in order to identify the presence/absence of heart disease. The obtained results showed that the NCA-SVM improve considerably the prediction system performance. Applying this model can have a direct impact and economic savings on the design and development of heart disease prediction systems in healthcare.

REFERENCES

[1] World health organization report on cardiovascular diseases. https://www.who.int/health-topics/cardiovascular-diseases/#tab=tab_1, accessed on Sep. 02, 2019.

[2] Raza, K. (2019). Improving the prediction accuracy of heart disease with ensemble learning and majority voting rule. U-Healthcare Monitoring Systems, 1: 179-196. https://doi.org/10.1016/B978-0-12-815370-3.00008-6

[3] Amin, M.S., Chiam, Y.K., Varathan, K.D. (2019). Identification of significant features and data mining techniques in predicting heart disease. Telematics and Informatics, 36: 82-93. https://doi.org/10.1016/j.tele.2018.11.007

[4] Deng, M., Wang, C., Tang, M., Zheng, T. (2018). Extracting cardiac dynamics within ECG signal for human identification and cardiovascular diseases classification. Neural Networks, 100: 70-83. https://doi.org/10.1016/j.neunet.2018.01.009

[5] Abushariah, M.A., Alqudah, A.A., Adwan, O.Y., Yousef, R.M. (2014). Automatic heart disease diagnosis system based on artificial neural network (ANN) and adaptive neuro-fuzzy inference systems (ANFIS) approaches. Journal of Software Engineering and Applications, 7(12): 1055. https://doi.org/10.4236/jsea.2014.712093.

[6] Bouali, H., Akaichi, J. (2014). Comparative study of different classification techniques: Heart disease use case. In: 2014 13th International Conference on Machine Learning and Applications, Detroit, MI, USA, pp. 482-486. https://doi.org/10.1109/ICMLA.2014.84

[7] Otoom, A.F., Abdallah, E.E., Kilani, Y., Kefaye, A., Ashour, M. (2015). Effective diagnosis and monitoring of heart disease. International Journal of Software Engineering and Its Applications, 9(1): 143-156. https://doi.org/10.14257/ijseia.2015.9.1.12

[8] Heart disease dataset of University of California at Irvine (UCI). https://archive.ics.uci.edu/ml/datasets/Heart+Disease. accessed on Sept. 02, 2019.

[9] Goldberger, J., Hinton, G.E., Roweis, S.T., Salakhutdinov, R.R. (2005). Neighbourhood components analysis. Advances in Neural Information Processing Systems, pp. 513-520.

[10] Singh-Miller, N., Collins, M., Hazen, T.J. (2007). Dimensionality reduction for speech recognition using neighborhood components analysis. In: 8th International Conference of Inter Speech, pp. 1158-1161.

[11] Yang, W., Wang, K., Zuo, W. (2012). Neighborhood component feature selection for high-dimensional data. Journal of Computers, 7(1): 161-168. https://doi:10.4304/jcp.7.1.161-168

[12] Vapnik, V. (1995). The Nature of Statistical Learning Theory. Springer Verlag, Berlin.

[13] Scholkopf, B., Smola, A.J. (2001). Learning with Kernels: Support Vector Machines, Regularization, Optimization, and Beyond. MIT Press.

[14] Radhika, Y., Shashi, M. (2009). Atmospheric temperature prediction using support vector machines. International Journal of Computer Theory and Engineering, 1(1): 55. https://doi.org/10.7763/IJCTE.2009.V1.9

[15] Shouman, M., Turner, T., Stocker, R. (2011). Using decision tree for diagnosing heart disease patients. In: 9th Australasian Data Mining Conference, pp. 23-30.

[16] Peter, T.J., Somasundaram, K. (2012). An empirical study on prediction of heart disease using classification data mining techniques. In: International Conference on Advances in Engineering, Science and Management (ICAESM-2012), pp. 514-518.

[17] Nahar, J., Imam, T., Tickle, K.S., Chen, Y.P.P. (2013). Computational intelligence for heart disease diagnosis: A medical knowledge driven approach. Expert Systems with Applications, 40(1): 96-104. https://doi.org/10.1016/j.eswa.2012.07.032

[18] Ismaeel, S., Miri, A., Chourishi, D. (2015). Using the extreme learning machine technique for heart disease diagnosis. In: International Humanitarian Technology Conference (IHTC2015), Ottawa, ON, Canada, pp. 1-3. https://doi.org/10.1109/IHTC.2015.7238043