American Journal of Engineering Research (AJER)
e-ISSN: 2320-0847 p-ISSN : 2320-0936
Volume-7, Issue-9, pp-238-244
www.ajer.org
Research Paper Open Access

Evaluation of Kernel Effects on SVM Classification in the Success of Wart Treatment Methods

Ali DEGIRMENCI[1] and Omer KARAL[1]
[1](*Electrical and Electronics Engineering, Ankara Yıldırım Beyazıt University, Turkey)*
Corresponding Author: Omer KARAL

ABSTRACT : Computer-aided systems have started to be used in the medical field as well as in many areas over the last few decades. These studies are generally focused on the detection of the disease using medical images. However, the determination of the treatment method to be applied is as important as the diagnosis of the disease. Because, choosing the appropriate treatment method affects the success of the treatment, duration of the healing period. There are several approaches to determining wart treatment methods. One of these is the support vector machine (SVM), which is widely used in classification problems. However, the accuracy of the SVM depends on the type and parameters of the kernel used. In this study, SVM based learning algorithm with different kernels and parameters was investigated in predicting the success of wart treatment methods. In order to obtain more robust and reliable results, the used kernels and their parameters have been analyzed by k-fold cross-validation method. It was observed from the experimental results that SVM with Gaussian kernel ($C=2^9$, $\sigma=2^4$) achieved 93,11% success in the "cryotherapy" data set and that SVM with linear kernel ($C=2^{-2}$) achieved 81,33% success in the "immunotherapy" data set. These rates are higher than previously reported. In conclusion, the success of the proposed SVM based learning model is highly dependent on the kernel and parameters used.
KEYWORDS Skin Disease, SVM, Machine Learning

Date of Submission: 06-09-2018 Date of acceptance: 22-09-2018

I. INTRODUCTION

Skin covers the body, and therefore it has many functions. It protects the body form bacteria, viruses, ultraviolet light and dehydration. Heat of the environment, hardness or softness of the material and pressure are sensed via skin. It regulates the heat of the body. Because the skin is mainly exposed to environmental and genetic factors, there are many skin diseases. Some of the skin diseases may lead the death if they are not treated adequately. For example, it is estimated that more than thirteen thousand people will die of skin cancer in 2018 in the United States according to the Cancer facts and figures 2017 [1]. Some of the skin diseases may be infectious and spread.

One of the infectious skin disease type is wart, which is caused by the human papillomavirus (HPV). In general, color of the wart is similar to the skin color, and texture of the wart is rough. It can be noticeable with the growths in the outer layer of the skin and can be seen in any part of the body. Since wart is an infectious disease, it can be infected by skin contact with a person who has a wart disease. Factors that increase the likelihood of wart disease include low immune system, use of common substances, and cracks or cuts in the skin.

There are several types of the warts. These are common wart, flat wart, genital wart, plantar wart and so on. Common warts are seen generally in the hands, fingers. Size of the common warts are varied, and surface of the common warp is rough. Flat warts are generally smaller in size compared to the other wart types, and top of the warts has flat shape. This kind of warts are more common in children and young people than in others. Genital warts are seen on the genital and anal area. Size and shape of this kind of warts are varies. Additionally, it may lead to cervical cancer in the women. Plantar warts seen on the sole of the foot and causes pain. In addition, it grows into the skin [2,3].

There exist different treatment methods to cure the warts, such as immunotherapy, cryotherapy, surgery and so on. In the intralesional immunotherapy treatment method, something is injected to the wart. After, body's natural defense is aroused a reaction in this method. In the cryotherapy treatment method, wart is frozen by using liquid nitrogen. This method is painful and healing time depends on the area and the wart type. It applied multiple times with in a 1-3 weeks period to heal the wart completely. In surgical treatment operation, wart can be burned, removed with a laser or cut out from the body by a doctor. However, surgical treatment method may leave a scar on the body [2-5]. Apart from the above-mentioned treatment methods, warts may disappear after period of time without any treatment. But, this make take months even years.

In recent years, computer based systems have been widely used to help physicians. Because the diagnosis of diseases is very important in the process of healing. The choice of the wrong procedure may lead to the patient not recovering. In the literature, many studies have been performed using machine learning-based methods to assist doctors [6,7]. Yuan et al. proposed a system for early melanoma detection from 22 pairs of clinical skin lesion images [8]. Firstly, texture features are extracted. Later, forth order polynomial kernel is used for the classification of the benign and malignant of the skin lesion. Test results showed that malignancy of the pixels is determined 70% accurately. Afirin et al. designed a system for prognosis and diagnosis of the six different skin diseases, which are acne, eczema, psoriasis, tinea corporis, scabies and vitiligo [9]. In their study, high quality skin images as well as medical history of the patients has been used. Initially, abnormalities on the skin is determined by using image processing and segmentation techniques. After that, feedforward backpropagation artificial neural Networks method has been used in the classification of the skin disease. Accuracy of this method to identify the diseased skin is 95.99 and disease classification accuracy is 94.016%. Elgamal et al. compared two supervised machine learning algorithms to detect skin cancer [10]. Features of the digital images are extracted by using discrete wavelet transformation. Principle component analysis is used to determine more prominent features. Later, determined features are used in the feed forward back-propagation artificial neural network and k-nearest neighbor. Performance score of these methods are 95% and 97.5% in the feed forward back-propagation artificial neural network, k-nearest neighbor methods, respectively. Maneker et al. improved a computerized system for detection of the wart, benign and malignant skin cancer by using multiclass support vector machine (SVM) [11]. Segmentation of the images are made by c-means and watershed algorithms separately. Comparing these methods, the c-means gave better results. Features are extracted from the skin images by using Grey Level Co-occurrence Matrix and Image Quality Assessment methods. Additionally, graphical user interface is designed for ease of use. The abovementioned algorithms/methods are used for diagnosis of the disease type using medical images. However, the determination of the treatment method to be applied is as important as the diagnosis of the disease.

Recently, new algorithms have been developed to determine the method of treatment of diseases. For example, Chen et al. performed a drug recommendation system to the diabetes patients [12]. Their system is suitable for patients with type 2 diabetes and has been described for treatment of glucose-lowering drugs. In system design, fuzzy logic with ontological reasoning is used and 80% accuracy is achieved. Razali et al. proposed a new treatment choice plan for acute upper respiratory tract infection [13]. The patient's age, complaint, gender and race information were collected. Using decision tree method, 94.73% performance was achieved. Deisenhofer et al. developed a treatment selection method for post-traumatic stress disorder [14]. In this method, personalized advantage index and genetic algorithm are used. Khozeimeh et al. suggested a machine learning algorithm for treatment selection of the wart disease [15]. Dataset used in this study, contains common and plantar wart diseases 180 patients. Half of them were treated with cryotherapy and the remaining half were treated with immunotherapy. These are generally used in wart treatment in dermatology clinics. The adaptive network-based fuzzy inference system is designed to determine which treatment method responds better to wart treatment. The responses to treatment were 83.33% for immunotherapy and 80.7% for cryotherapy. Uzun et al. used the Naive Bayes and k-nearest neighbor algorithms to measure which method is more successful in wart treatment [16]. In the Naive Bayes method, accuracy was obtained as 67.78% and in the k-nearest neighborhood method (k=7), accuracy was 80%.

In this study, the success of the immunotherapy and cryotherapy methods used in the treatment of common and plantar wart diseases was studied under the SVM framework using different kernels. As a result, a detailed analysis was conducted to determine the success of the treatment method by using different kernels and parameters in the SVM framework to assist medical specialists in predicting the success of the treatment method.

The rest of the paper is organized as follows. In section 2, detailed information about the dataset is given. In section 3, method used in this study is presented. In section 4, results of the method are demonstrated. In the last section, final conclusions and future work is provided.

II. DATASET

The dataset used in this study is obtained from the UCI (University of California at Irvine) machine learning repository [5, 15]. It is collected from the dermatology clinic of Ghaem Hospital in Mashhad between the period of January 2013 and February 2015. In this dataset, the success of immunotherapy and cryotherapy methods in treating plantar and common wart has been analyzed, noticing that these methods are generally used in wart treatment. 180 cases were analyzed in that study. Half of these cases were treated with cryotherapy and the remaining half were treated with immunotherapy method. Selection of the patients were determined randomly.

The first dataset consists of patients treated with cryotherapy and six features obtained from these cases. These features are gender, age, elapsed time before the treatment, number, type and the surface area of the warts. It consisted of 47 men and 43 women. 27 patients in males and 21 patients in females responded to this treatment method and the accuracy of the treatment was 53.33% in total. 30 percent of the cases has in both types of warts, 60 percent of which had only in common warts and 10 percent of had only plantar warts. Range of the age was between 15 and 67 years. The average time before the start of treatment is 7.66 months. Wart number average per person is equal to 5.51 and the maximum number of warts in a person was 12. The surface areas of the warts vary between 4 and 750 mm^2.

The second dataset consists of the cases that were treated with immunotherapy and intralesional injection of Candida antigen. In addition to the features of the first dataset, induration diameter of the initial test is calculated which is in the range between 5 and 70 mm. This dataset consists of 41 males and 49 females aged 15-56 years. 32 patients in males and 39 patients in females responded to this treatment method and the accuracy of the treatment was 78.89% in total. 82.05% of the males and 79.59% of the females responded to the immunotherapy treatment. Surface area of the warts changed between 6-900 mm^2. Elapsed time before the treatment is in the nearly same period (7.23 months). Maximum number of warts in the person is 19 and average initial test induration diameter value is 14.33 mm. More detailed information about the dataset, inclusion and the exclusion criteria of the patients can be found in [5,15].

III. METHOD

Support Vector Machine (SVM) is a widely used supervised learning technique for solving nonlinear classification, prediction and regression problems [17,18]. In classification problems, the SVM tries to discover the optimal separating hyperplane formation among classes by maximizing the margin between them (Figure 1a). This creates a classifier hyperplane at the center of the maximum margin [19]. The training samples over the hyperplane are classified as +1 while those below the hyperplane are classified as -1. The training samples that are closest to the optimal separating hyperplane are called support vectors (Fig. 1b).

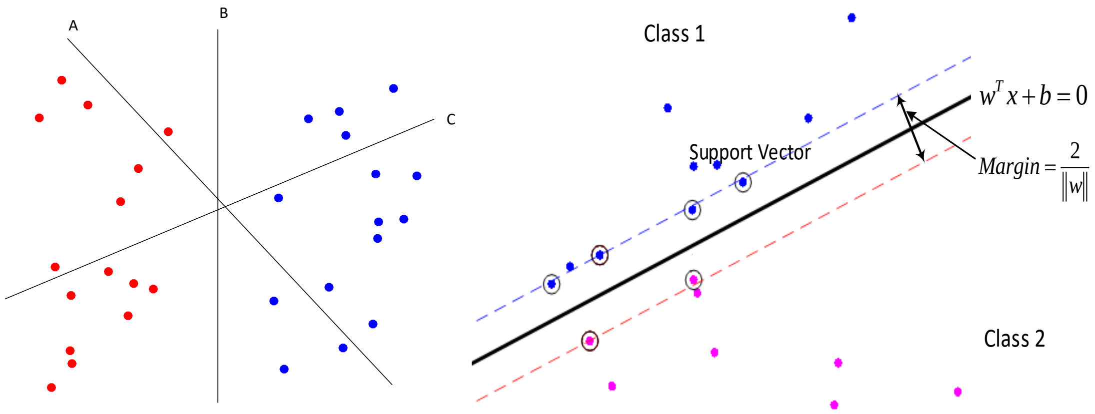

Fig. 1. Determination of the best hyperplane (a) multiple hyperplane, (b) optimum hyperplane

Consider a given training dataset of instance label pairs (x_i, y_i) with $x_i \in R^n$, $y_i \in \{1, -1\}$, and $i \in \{1,2,\ldots,N\}$. The goal of SVM is to find the optimal separating hyperplane, which can separate the two classes from the training dataset. For linear separable data, a separating hyperplane can be defined as:

$$y_i(\mathbf{w}.\mathbf{x}_i + b) \geq 1 - \xi_i \quad (1)$$

where b is the bias, **w** is the weight vector that defines the direction of the hyperplane in the future space, and is the nonnegative slack variables (errors) [17]. It has been shown [20] that the optimal separating hyperplane is achieved by minimizing the errors (ξ_i) and the Euclidean norm of the weight vector **w**.

$$min\ (J(\mathbf{w}, \xi)) = \frac{1}{2}\|\mathbf{w}\|^2 + C\sum_{i=1}^{N} \xi_i \quad (2)$$

$$subject\ to \begin{cases} y_i(\mathbf{w}.\mathbf{x}_i + b) \geq 1 - \xi_{i,} \\ i = 1, 2, ...N\ and\ \ \xi_{i,} \geq 0 \end{cases} \tag{3}$$

where C is the user-defined regularization parameter. The constrained second-order optimization problem described in (2) and (3) can be solved optimally in high-dimensional space by the Lagrange multipliers method [21].

$$min\ (J(\mathbf{w}, b, \alpha)) = \frac{1}{2}\|\mathbf{w}\|^2 + C\sum_{i=1}^{N}\xi_i - \sum_{i=1}^{N}\alpha_i\left[y_i(\mathbf{w}.\mathbf{x}_i + b) - 1\right] \tag{4}$$

where, $\alpha_i \geq 0$ with i∈{1,2,…,N} are the Lagrange multipliers. The solution of the Lagrangian function (4) is determined by saddle point. After performing the required calculations, the dual problem for linearly-separable patterns can be obtained as follows.

$$Q(\alpha) = \sum_{i=1}^{N}\alpha_i - \frac{1}{2}\sum_{i=1}^{N}\sum_{j=1}^{N}\alpha_i\alpha_j y_i y_j \mathbf{x}_i\mathbf{x}_j \tag{5}$$

$$subject\,to\ \ 0 \leq \alpha_i \leq C,\ \ i = 1, ..., N\ \ and \sum_{i=1}^{N}\alpha_i y_i = 0. \tag{6}$$

The newly constructed objective function includes only Lagrange multipliers (α_i) as unknown. After determining the optimal Lagrange multipliers, we can calculate the optimal weight vector as follows.

$$\mathbf{w}_o = \sum_{i=1}^{N} y_i\alpha_i\mathbf{x}_i \tag{7}$$

As can be seen from (7) optimal weight vector w_o is a linear combination of the training samples. The decision function to be used for classifying the new data can be written as:

$$g(\mathbf{x}) = sign\left(\sum_{i=1}^{N} y_i\alpha_i\mathbf{x}_i + b\right) \tag{8}$$

If the training data can not be separated by a linear hyperplane, the input data is moved by some non-linear kernel functions to a high dimensional feature space and linearly separated there. In this case, the decision function is written as follows:

$$g(\mathbf{x}) = sign\left(\sum_{i=1}^{N} y_i\alpha_i K(\mathbf{x}_i, \mathbf{x}_j) + b\right) \tag{9}$$

where $K(x_i, x_j)$ is the kernel function.

Accuracy of the SVM results is strongly influenced by the choice of kernel and its's parameters [22]. A large number of kernels have been proposed in the literature. Among these, the most preferred kernel types are Linear kernel, polynomial kernel, radial basis function kernel and sigmoid kernel. Each kernel needs different adjustable parameters as can be seen in Table 1.

Table I: Commonly used SVM kernels

Kernel Name	**Definition**	**Parameter**
Linear	$x_i^T x_j + c$	None
Polynomial	$\left(x_i^T x_j + 1\right)^d$	d
RadialBasisFunction	$e^{-\frac{1}{2\sigma^2}\|x_i - x_j\|^2}$	σ
Sigmoid	$\tanh(n\,x_i\,x_j + \theta)$	n, Θ

IV. EXPERIMENTAL RESULTS

This study is performed by using immunotherapy and cryotherapy datasets which are mentioned in Section 2. These treatment methods are widely used wart treatment methods. Immunotherapy gives better results compared to the cryotherapy method according to the results of the datasets. In this study, success of the immunotherapy and cryotherapy methods are evaluated. Accuracy of the methods are measured as:

$$Accuracy = \frac{TP + TN}{TP + TN + FP + FN} \qquad (10)$$

where TP = true positive, TN = True negative, FP = false positive and FN = false negative. As it is known, accuracy of the methods is dependent on selection of the training and testing data. For example, choosing the first part of the data as training data may produce a good model (data) for the algorithm and give the highest results, or vice versa. In the literature, the k-fold cross-validation method is a widely used method to test the success results of the algorithm [23-25]. In this method, dataset is partitioned into k equal sized subsamples, randomly. Later, one of the subsamples is allocated to test the method and the remaining k-1 subsamples are used in the training of the algorithm. After that, a model is constructed from the training data and accuracy of the constructed model is determined with the test data. Followingly, the algorithm is run k times and results are recorded. By calculating the average of the results, the performance of the algorithm is measured more precisely. The k-value is chosen as 5 to evaluate the success rate of both treatment methods. Additionally, each case is run 10 times to obtain more robust results. Treatment method selection accuracy for different types of kernels of the both cryotherapy and immunotherapy methods are given in the Table 1 and 2, respectively. In the cryotherapy method highest accuracy is obtained with the Gaussian kernel 93.11% with $\sigma = 2^4$, $C = 2^9$ and linear kernel gives the closer results (88.22%, $C = 2^{-2}$). In this case, increasing the order in the polynomial kernel (d=8) and increasing the n in the sigmoid kernel does not alter the results.

In the immunotherapy wart type, highest accuracy is obtained by linear kernel with $C = 2^{-2}$. As can be seen from Table 3, other kernels give the close results except for the lower degree polynomial and small n and high cost sigmoid kernel.

Table II: Experimental results of cryotherapy dataset under different kernels and parameters

a) RBF

	$C = 2^3$	$C = 2^4$	$C = 2^5$	$C = 2^6$	$C = 2^7$	$C = 2^8$	$C = 2^9$	$C = 2^{10}$	$C = 2^{11}$
$\sigma = 2^0$	60,444	61,111	59,778	60,444	60,222	61,111	61,111	61,333	61,333
$\sigma = 2^1$	75,222	76,333	76,111	77,333	76,000	76,556	76,444	75,889	75,444
$\sigma = 2^2$	87,222	88,667	88,111	88,222	88,333	88,889	88,778	88,667	87,778
$\sigma = 2^3$	91,444	91,556	91,778	92,111	91,111	91,778	91,111	91,889	91,444
$\sigma = 2^4$	89,333	92,556	92,222	92,667	91,333	92,111	**93,111**	92,000	91,889
$\sigma = 2^5$	86,667	89,667	89,778	89,556	91,444	92,111	91,778	91,333	91,111

b) Sigmoid

	$C = 2^{-4}$	$C = 2^{-3}$	$C = 2^{-2}$	$C = 2^{-1}$	$C = 2^0$	$C = 2^1$	$C = 2^2$	$C = 2^3$
$\sigma = 2^{-10}$	53,333	**56,444**	50,556	48,889	42,667	39,444	37,556	37,556
$\sigma = 2^{-9}$	53,333	47,222	50,000	46,000	43,667	41,444	38,444	37,333
$\sigma = 2^{-8}$	53,333	53,333	49,444	45,667	46,667	42,000	41,444	40,667
$\sigma = 2^{-7}$	53,333	53,333	53,333	53,333	53,222	47,667	47,222	46,111
$\sigma = 2^{-6}$	53,333	53,333	53,333	53,333	53,333	53,333	53,333	53,333
$\sigma = 2^{-5}$	53,333	53,333	53,333	53,333	53,333	53,333	53,333	53,333

c) Linear

$C = 2^{-4}$	$C = 2^{-3}$	$C = 2^{-2}$	$C = 2^{-1}$	$C = 2^0$	$C = 2^1$	$C = 2^2$	$C = 2^3$	$C = 2^4$	$C = 2^5$
86,778	86,111	**88,222**	86,556	86,556	85,889	85,889	85,556	86,667	86

d) Polynomial

	$C = 2^1$	$C = 2^2$	$C = 2^3$	$C = 2^4$	$C = 2^5$	$C = 2^6$	$C = 2^7$	$C = 2^8$	$C = 2^9$
2	62,556	62,333	61,667	62,889	**64,556**	62,889	62,000	63,000	61,444
3	54,222	56,222	56,111	54,222	55,667	54,889	54,667	56,222	54,111
4	48,556	46,000	45,778	47,778	46,333	46,889	46,111	47,000	47,111
6	55,333	54,000	55,778	54,222	54,556	56,111	56,778	56,000	56,444
8	53,333	53,333	53,333	53,333	53,333	53,333	53,333	53,333	53,333
10	53,333	53,333	53,333	53,333	53,333	53,333	53,333	53,333	53,333

Table III: Experimental results of immunotherapy dataset under different kernels and parameters

a) RBF

	$C = 2^1$	$C = 2^2$	$C = 2^3$	$C = 2^4$	$C = 2^5$	$C = 2^6$	$C = 2^7$	$C = 2^8$
$\sigma = 2^0$	78,889	78,889	78,889	78,889	78,889	78,889	78,889	78,889
$\sigma = 2^1$	78,889	78,889	78,889	78,889	78,889	78,889	78,889	78,889
$\sigma = 2^2$	78,111	77,889	77,778	78,222	78,111	77,889	78,111	77,778
$\sigma = 2^3$	77,222	77,000	76,444	76,000	76,778	76,222	76,000	76,222
$\sigma = 2^4$	73,667	69,222	68,444	69,111	66,333	67,222	66,444	67,556
$\sigma = 2^5$	74,667	72,889	72,556	71,889	70,778	70,556	67,556	66,333

b) Sigmoid

	$C = 2^{-4}$	$C = 2^{-3}$	$C = 2^{-2}$	$C = 2^{-1}$	$C = 2^{0}$	$C = 2^{1}$	$C = 2^{2}$	$C = 2^{3}$
$\sigma = 2^{-10}$	78,889	78,889	78,556	72,889	71,111	70,000	71,444	68,000
$\sigma = 2^{-9}$	78,889	78,889	77,111	74,000	72,667	71,444	70,667	70,556
$\sigma = 2^{-8}$	78,889	78,889	78,889	78,889	78,889	78,889	76,111	75,111
$\sigma = 2^{-7}$	78,889	78,889	78,889	78,889	78,889	78,889	78,889	78,889
$\sigma = 2^{-6}$	78,889	78,889	78,889	78,889	78,889	78,889	78,889	78,889

c) Linear

$C = 2^{-4}$	$C = 2^{-3}$	$C = 2^{-2}$	$C = 2^{-1}$	$C = 2^{0}$	$C = 2^{1}$	$C = 2^{2}$	$C = 2^{3}$	$C = 2^{4}$	$C = 2^{5}$
79,889	79,444	**81,333**	79,889	79,667	78,667	79,778	78,778	79,333	76,778

d) Polynomial

	$C = 2^{0}$	$C = 2^{1}$	$C = 2^{2}$	$C = 2^{3}$	$C = 2^{4}$	$C = 2^{5}$	$C = 2^{6}$	$C = 2^{7}$
2	58,333	55,667	51,333	52,333	54,333	52,333	52,778	53,333
3	48,444	51,333	47,222	50,111	49,444	54,000	42,667	42,444
4	43,111	39,556	40,667	40,222	37,111	40,000	41,000	41,222
6	78,889	78,889	78,889	78,889	78,889	78,889	78,889	78,889
8	78,889	78,889	78,889	78,889	78,889	78,889	78,889	78,889

V. CONCLUSION

This study investigates the selection of kernel and kernel specific parameters in the SVM-based algorithm to determine the success of commonly used wart treatment methods such as cryotherapy and immunotherapy. For this purpose, a series of experiments were carried out using four different kernels with different kernel parameters. Experimental results show that 93.11% in cryotherapy method with radial basis kernel function with parameters ($C=2^{6}$, $\sigma=2^{-9}$) and 81.33% accuracy is obtained with linear kernel with parameter ($C=2^{-2}$) in immunotherapy by using 90 samples in each case. Results from the Table 2 and 3 shows that kernel type and parameter selection for the SVM method is highly important. Because the performance of the algorithm is mostly depending on these parameters. As a future work, performance of the system can be increased by defining custom kernels. In addition, increasing the number of cases and adding more features to the dataset increases the robustness and objectiveness of the system.

REFERENCES

[1]. American Cancer Society. Cancer Facts & Figures 2018. Atlanta: American cancer Society;2018.
[2]. Du Vivier, A.: Atlas of clinical dermatology. Elsevier Health Sciences(2002).
[3]. Burns, T., Breathnach, S., Cox, N., Griffiths, C.: Textbook of dermatology. Blackwell, 49, 32-49(2004).
[4]. "Warts: Overview". U.S. National Library of Medicine.https://www.ncbi.nlm.nih.gov/pubmedhealth/PMH0072770/ (accessed 20 May 2018)
[5]. Khozeimeh, F., Jabbari Azad, F., MahboubiOskouei, Y., Jafari, M., Tehranian, S., Alizadehsani, R., Layegh, P.: Intralesional immunotherapy compared to cryotherapy in the treatment of warts. International journal of dermatology, 56(4), 474-478(2017).
[6]. Amin, M. N., Habib, M. A.: Comparison of different classification techniques using WEKA for hematological data. American Journal of Engineering Research, 4(3), 55-61(2015).
[7]. Rabbi, M. F., Uddin, M. P., Ali, M. A., Kibria, M. F., Afjal, M. I., Islam, M. S., &Nitu, A. M. Performance Evaluation of Data Mining Classification Techniques for Heart Disease Prediction, 7(2),278-283 (2018).
[8]. Yuan, X., Yang, Z., Zouridakis, G., Mullani, N.: SVM-based texture classification and application to early melanoma detection. In Engineering in Medicine and Biology Society, 2006. EMBS'06. 28th Annual International Conference of the IEEE, 4775-4778(2006).
[9]. Arifin, M. S., Kibria, M. G., Firoze, A., Amini, M. A., Yan, H.: Dermatological disease diagnosis using color-skin images. International Conference on Machine Learning and Cybernetics (ICMLC), 1675-1680(2012).
[10]. Elgamal, M.: Automatic skin cancer images classification. IJACSA) International Journal of Advanced Computer Science and Applications, 4(3), 287-294(2013).
[11]. Manerkar, M. S., Harsh, S., Saxena, J., Sarma, S. P., Snekhalatha, U., Anburajan, M. CLASSIFICATION OF SKIN DISEASE USING MULTI SVM CLASSIFIER. In 3rd International Conference on Electrical, Electronics, Engineering Trends, Communication, Optimization and Sciences-2016, 362-368.
[12]. Chen, R. C., Huang, C. Y., Bau, C. T., Chen, L. S.: A decision support system for diabetes medicine selection using patient centered treatment based on fuzzy logic and domain ontology. International Journal of Innovative Computing, Information and Control, 13(5), 1681-1692(2017).
[13]. Razali, A. M., Ali, S.: Generating treatment plan in medicine: A data mining approach. American Journal of Applied Sciences, 6(2), 345(2009).
[14]. Deisenhofer, A. K., Delgadillo, J., Rubel, J. A., Böhnke, J. R., Zimmermann, D., Schwartz, B., Lutz, W.: Individual treatment selection for patients with posttraumatic stress disorder. Depression and anxiety, 35(6), 541-550(2018).
[15]. Khozeimeh, F., Alizadehsani, R., Roshanzamir, M., Khosravi, A., Layegh, P., Nahavandi, S.: An expert system for selecting wart treatment method. Computers in biology and medicine, 81, 167-175(2017).
[16]. Uzun, R., İşler, Y., &Toksan, M.: Choose of wart treatment method using Naive Bayes and k-nearest neighbors classifiers. In 2018 26th Signal Processing and Communications Applications Conference (SIU), 1-4(2018).
[17]. Cortes, C., Vapnik, V.: Support-vector networks. Machine learning, 20(3), 273-297(1995).
[18]. Vapnik, V., & Mukherjee, S.: Support vector method for multivariate density estimation. In Advances in neural information processing systems, 659-665(2000).

[19]. Pradhan, B.: A comparative study on the predictive ability of the decision tree, support vector machine and neuro-fuzzy models in landslide susceptibility mapping using GIS. Computers & Geosciences, 51, 350-365(2013).
[20]. Haykin, S.: Neural networks: a comprehensive foundation. Prentice Hall PTR, (1994).
[21]. Fletcher, R.: Practical methods of optimization. John Wiley & Sons, (2013).
[22]. Damaševičius, R.: Optimization of SVM parameters for recognition of regulatory DNA sequences. Top, 18(2), 339-353(2010).
[23]. Kohavi, R.: A study of cross-validation and bootstrap for accuracy estimation and model selection. International Joint Conference on Artificial Intelligence (IJCAI),14(2), 1137-1145(1995).
[24]. Refaeilzadeh, P., Tang, L., Liu, H.: Cross-validation. In Encyclopedia of database systems (pp. 532-538). Springer, Boston, MA(2009).
[25]. Sindhu, M. E., Vijaya, M. S.: Predicting Churners in Telecommunication Using Variants of Support Vector Machine. American Journal of Engineering Research, 4(3), 11-18 (2015).

Omer KARAL "Evaluation of Kernel Effects on SVM Classification in the Success of Wart Treatment Methods "American Journal of Engineering Research (AJER), vol. 7, no. 09, 2018, pp. 238-244