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ARTIFICIAL NEURAL NETWORKS VS SUPPORT VECTOR MACHINES FOR MEMBRANE DISEASES DETECTION

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Abstract - ***Artificial Neural Networks (ANNs) as well*** *as Support Vector Machines (SVM) are very powerful tools which can be utilized for pattern recognition. They* ***are being used in a large array of different areas including medicine. This thesis exemplifies the*** *applicability of computer science in medicine, particularly dermatological tools and software which uses ANN or SVM. Basic information about ANN, including description of Back-Propagation Learning Algorithm, has also been introduced as well as information about SVM. Finally the system recognition of skin diseases, called Skin checker, is described. Skin checker has been developed in two versions: using ANN and SVM. Both versions have been tested and their results of recognition of skin diseases from pictures of the skin fragments are compared and presented here.*

Key Words: Medical image segmentation, ANN and SVM, Skin Diseases, Pattern Recognition.

I. INTRODUCTION

Classical learning systems like neural networks suffer from their theoretical weakness, e.g. back-propagation usually converges only to locally optimal solutions. Here SVMs can provide a significant improvement. SVMs have been developed in the reverse order to the development of Neural Networks (NNs).

Skin diseases are now very common all over the world. For example the number of people with skin cancer has doubled in the past 15 years. "Currently, between 2 and 3 million non-melanoma skin cancers and 132,000 melanoma skin cancers occur globally each year. One in every three cancers diagnosed is a skin cancer and, according to Skin Cancer Foundation Statistics, one in every five Americans will develop skin cancer in their lifetime". Different kinds of allergies are also becoming more common. Many of these diseases are very dangerous, particularly when not treated at an early stage. Dermatologists have at their disposal large catalogues with pictures of skin segments, which they use as a reference for diagnosis of their patients cases' skin ailments. However it may be difficult even for experienced doctors, to make correct diagnosis because many symptoms look very similar to each other, even though they are caused by different diseases. All details such as color, size or density of the skin changes are important. Modern medicine is looking for solutions, which could help doctors with any aspect of their work using the new technology. Such tools already exist, to our knowledge they concentrate on analysis of the color of skin changes and UV photography.

Although these tools are commercially available, there seems to a lot of room for further improvement. The goal of this thesis is to make a system to recognize skin diseases using Artificial Neural Networks (ANNs) and Support Vector Machines (SVM). After testing both methods results will be compared. System should learn from the set of skin segments images taken by digital camera. After that it should return the probability of existence of any recognized disease, based on the same type of image made by user. Images should have the same size and should be taken from the same distance. Some practical study may display need of using other information (not only pictures) to train the network, for example part of the body where the symptoms were found or if the patient feels pain or tickle.

II. Related work

Automatic differentiation the mechanical transformation of numeric computer programs to calculate derivatives efficiently and accurately dates to the origin of the computer age. Reverse mode automatic differentiation both antedates and generalizes the method of backwards propagation of errors used in machine learning. Despite this, practitioners in a variety of fields, including machine learning, have been little influenced by automatic differentiation, and make scant use of available tools[1].Many methods in machine learning require the evaluation of derivatives. This is particularly evident when

one considers that most traditional learning algorithms rely on the computation of gradients and Hessians of an objective function, with examples in Artificial Neural Networks (ANNs), natural language processing, and computer vision Derivatives in computational models are handled by four main methods: (a) working out derivatives manually and coding results into computer (b) numerical differentiation(c) symbolic differentiation using computer algebra and (d) automatic differentiation.

Parkinson's disease (PD) is the next mainly common neurodegenerative disease only exceeds by Alzheimer's disease (AD). Parkinson's disease is a general disease of central nervous system along with the aged person and its difficult symptoms introduce some complexities for the clinical diagnosis. Moreover, it is estimated to enlarge in the subsequently decade with accelerated treatment costs as an outcome. Medical results produces undesirable biases, faults and extreme clinical costs which influence the value of services offered to patients. Precise detection is extremely important for cure planning which can decreases the incurable results. Precise outcome can be achieved through Artificial Neural Network. In addition to being accurate, these methods must meet speedily in order to relate them for real time applications. Artificial Neural Network (ANN)-based diagnosis of medical diseases has been taken into great consideration in recent years. In this methods three types of classifiers based on MLP, ANN, and SVM are used to support the experts in the diagnosis of PD.

2.1Neural Network

Artificial Neural Network (ANN) takes their name from the network of nerve cells in the brain. Recently, ANN has been found to be an important technique for classification and optimization problem. Artificial Neural Networks (ANN) has emerged as a powerful learning technique to perform complex tasks in highly nonlinear dynamic environments. Some of the prime advantages of using ANN models are their ability to learn based on optimization of an appropriate error function and their excellent performance for approximation of nonlinear function. The ANN is capable of performing nonlinear mapping between the input and output space due to its large parallel interconnection between different layers and the nonlinear processing characteristics. An artificial neuron basically consists of a computing element that performs the weighted sum of the input signal and the connecting weight.

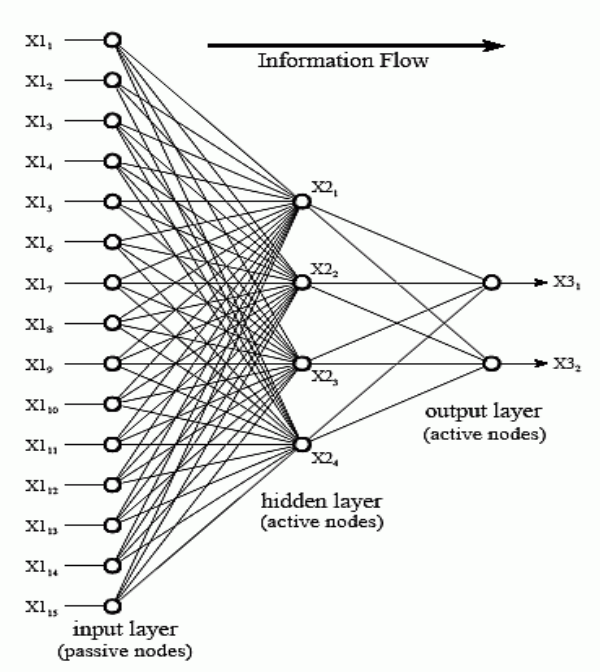

Fig1.1: Neural Network Architecture

2.2. Machine Learning Using Support Vector Machines

Artificial Neural Networks (ANN) has been the most widely used machine learning methodology. They draw much of their inspiration from neurosciences. Structurally attempting to mimic the architecture of the human brain during learning, ANN aims to incorporate 'human-like intelligence' within computer systems. Recently, a new learning methodology called Support Vector Machine (SVM) has been introduced. SVM is said to perform better than ANN in many cases. Furthermore, SVM can be mathematically derived and simpler to analyze theoretically compared to NN. It also provides a clear intuition of what learning is about. SVM work by mapping training data for learning tasks into a higher dimensional feature space using kernel functions and then find a maximal margin hyper plane, which separates the data. Learning the solution hyper plane involves using Quadratic Programming (QP) which is computationally intensive.

III. PREVIOUS IMPLEMENTATIONS

In a preferred embodiment of the invention, a system for early diagnosis of DNA changes in Non-Melanoma Skin Cancer (NMSC) and melanoma skin cancer, and their precursor lesions indicative of solid tumor development is provided. The particular changes, such as the common deletion, the 3895 bp deletion identified in associated mutations and the incidence of as yet

uncharacterized deletions in Mt-DNA (Mitochondrial DNA) serve as reliable bio-markers of sun exposure, and associated skin cancer. Non-melanoma skin cancer in particular is associated with chronic lifelong sun exposure. Melanoma skin cancer seems to be more related to acute burning episodes. The mutation fingerprint of the entire Mt-DNA genome in human NMSC and its precursor lesions is determined.

Thus Mt-DNA changes are established as an early bio-marker of human skin cancer and its precursor lesions. Denaturing HPLC can then be used to assess low levels of heteroplasmy at the sequences of interest this approach can also provide an insight into the development of early changes in other human tumors.

3.1 Data Set Collections Samples

Biological samples can be collected by any known means, whether for the purpose of constructing an Mt-DNA sequence database, or performing a diagnostic test on an individual. Samples destined for database generation include, but are not limited to: tumors banks, maternal lineage studies involving affected and unaffected individuals from the same maternal lineage, as well as maternal lineage studies from groups or populations with high frequencies of specific disease such as, but not limited to skin and prostate

Blood	distant benign	adjacent benign	malignant	Unknown
100.00%	0.00%	0.00%	0.00%	0.00%
16.13%	35.48%	9.68%	29.03%	16.13%
12.9%	12.90%	45.16%	3.22%	25.81%
3.22%	0.00%	0.00%	96.78%	0.00%

Table 1.1: ID Chi Square Test

IV. SYSTEM IMPLEMETNATION

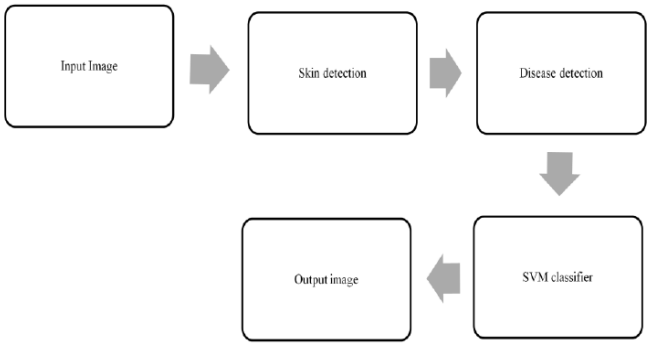

Fig 1.2: System Architecture

Skin diseases are now very common all over the world. For example, the number of people with skin cancer has doubled in the past 15 years. "Currently, between 2 and 3 million no melanoma skin cancers and 132,000 melanoma skin cancers occurs globally each year. SVM also applied to some medical tools. One of them, proposed in, identifies patients with breast cancer for whom chemotherapy could prolong survival time. In the experiment, SVM was used for classifying patients into one of three possible prognostic groups: Good, Poor or Intermediate. After classification of 253 patients, 82.7% test set correctness was achieved. Another application of SVM in medicine is described in. A system for cancer diagnosis used the DNA micro-array data as a classification data set.

Diagnosis error obtained by above mentioned system was smaller than in systems which uses other known methods. Reduction of the error achieved 36%. SVM is relatively new method of classification and it expands very quickly. That will certainly cause wider use of SVM in different areas, also in medicine.

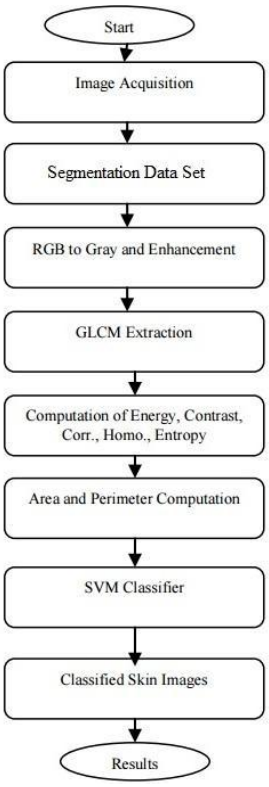

Fig 1.3: SVM Model

4.1 Skin Mole Localization Using Dog Filters and a Support Vector Machine

Mole pattern changes are important clues in detecting early signs of melanoma, a deadly skin cancer. Early detection is especially important for melanoma because,

while advanced cases are not curable, the disease can be cured if detected early. However, a principled system to register mole pattern changes is currently lacking. In fact, a major burden on the dermatological workforce is in manual surveillance of pigmented lesions, which is both time consuming and prone to human error. In this section, Dog scale-space filters and the designed Support Vector Machine (SVM) classifier will be introduced. Since the size of moles can vary, moles should be searched in a multistage fashion. The Dog filter is applied to RGB color channels separately, and the set unions of the output maxima over scale in each channel are considered possible mole candidates. When combining the Dog maxima, any mole candidates occurring within a radius of another mole candidate is eliminated. Once mole candidates are localized, regions around mole candidates are cropped from the hair-removed image.

4.2 Skin Pigmentation:

Several methods based on absorbance spectrum in visible and near infra-red have already been presented in the literature for quantifying the melanin in the skin. The main idea of these methods is to select specific spectral bands in the data in order to extract information on skin pigmentation. One of the most famous algorithms has been proposed by Stamatas in. This algorithm is based on the analysis of the skin chromospheres absorbance spectrum. An affine model of the melanin absorbance is proposed in the

4.3 Classification SVM

For this type of SVM, training involves the minimization of the error function:

$$\frac{1}{2} w^T w + C \sum_{i=1}^{N} \xi_i$$

Subject to the constraints:

$$y_i \left(w^T \phi(x_i) + b \right) \geq 1 - \xi_i \text{ and } \xi_i \geq 0, i = 1, \ldots, N$$

Where C is the capacity constant, w is the vector of coefficients, b is a constant, and ξ_i represents parameters for handling non separable data (inputs). The index i labels the N training cases. Note that $y \in \pm 1$ represents the class labels and xi represents the independent variables. The kernel is used to transform data from the input (independent) to the feature space. It should be noted that the larger the C, the more the error is penalized. Thus, C should be chosen with care to avoid over fitting.

SVM TYPE 2

In contrast to Classification SVM Type 1, the Classification SVM Type 2 model minimizes the error function:

$$\frac{1}{2} w^T w - \nu\rho + \frac{1}{N} \sum_{i=1}^{N} \xi_i$$

Subject to the constraints:

$$y_i \left(w^T \phi(x_i) + b \right) \geq \rho - \xi_i, \xi_i \geq 0, i = 1, \ldots, N \text{ and } \rho \geq 0$$

N a regression SVM, you have to estimate the functional dependence of the dependent variable y on a set of independent variables x. It assumes, like other regression problems, that the relationship between the independent and dependent variables is given by a deterministic function f plus the addition of some additive noise:

4.4 Recognition of Skin Diseases

Dermatology is considered to be heavily dependent on visual estimations. Even very experienced doctors have to continually verify their knowledge. The changes of the skin are visible but they are hard to identify because of the large number of different skin diseases, which have similar or identical symptoms. "Dermatology is different from other specialties because the diseases can easily be seen. Keen eyes, aided sometimes by a magnifying glass, are all that are needed for a complete examination of the skin. Often it is best to examine the patient briefly before obtaining a full history.

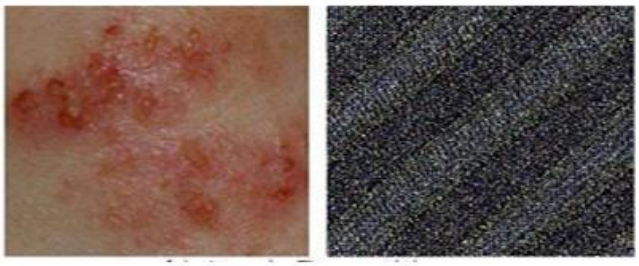

Fig: 1.4 Atopic Dermatitis

Melanoma Maligns Melanoma Maligns is a type of skin cancer that originates in the melanocytes, the skin cells containing pigment or color scattered throughout the body. In the United States alone, 32000 people are affected per year. Melanoma is one of the fastest growing cancers, increasing at 4.3% per year. One person dies from melanoma per hour. The melanoma may proliferate locally, spread by satellite lesions, or extend via the lymphatics or blood stream, from which it may invade any organ of the body, especially the lungs, liver, brain, skin, and bones.

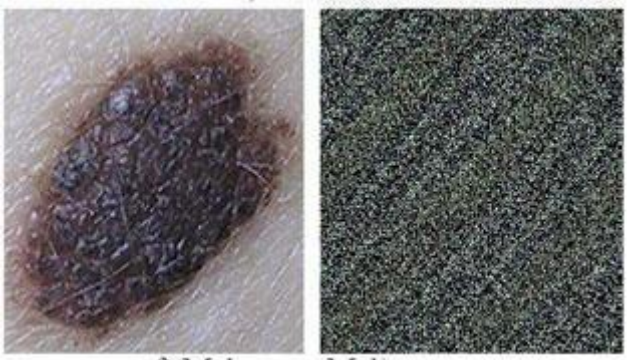

Fig : Melanoma Malignas

EVALUATION RESULT:

While training the network, we have set the desired total network error to 0,001. We have set also the maximum number of epochs to 3000. Unfortunately it was impossible for quick prop algorithm to achieve that error; however obtained values are near those desired. They vary between 0,003 and 0,005 according to the momentum value. The presents how the learning proceeded. It shows the total network error in consecutive epochs. We can see that the best error flow was for = 0, 5, it is near the perfect desired flow

Disease	NoP	$\alpha = 0,2$	$\alpha = 0,4$	$\alpha = 0,5$	$\alpha = 0,6$	$\alpha = 0,7$
Acne Vulgaris	29	93,6%	96,0%	94,4%	95,2%	96,0%
Atopic Dermatitis	29	95,3%	94,0%	95,3%	96,0%	93,6%
Granuloma Annulare	19	94,4%	94,3%	93,4%	95,2%	93,9%
Keloid	29	95,2%	94,5%	95,0%	94,7%	94,1%
Melanocytic Nevus	75	96,7%	97,5%	97,0%	96,4%	96,0%
Melanoma Maligna	13	95,4%	94,3%	92,0%	93,0%	93,6%
Nevus Pilosus	21	95,1%	94,9%	95,5%	95,9%	94,1%
Total	215	95,1%	95,1%	94,7%	95,2%	94,5%

Table : Results of Testing the ANN with Back Prop Algorithm for Different Moment Values. Nop - Number of Pictures Used for Training the ANN.

SVM Technical

We have used SVC for classification of pictures, the results of testing the SVM for different value are presented in the. Results for Melanoma Maligna are much worse comparing to other diseases: partially because it‟s the smallest training set but also because those pictures are quite similar to Melanocytic Nevus, which is the biggest set This is also a common problem in dermatology to differentiate between Melanocytic Nevus which is not very dangerous and Melanoma Maligna which can be lethal.

Disease	NoP	$\nu = 0,05$	$\nu = 0,1$	$\nu = 0,15$	$\nu = 0,2$	$\nu = 0,25$
Acne Vulgaris	29	89,3%	89,9%	89,4%	89,6%	89,5%
Atopic Dermatitis	29	84,2%	85,0%	84,8%	84,9%	84,8%
Granuloma Annulare	19	91,3%	90,8%	90,7%	90,9%	90,8%
Keloid	29	92,5%	92,9%	93,0%	93,0%	92,7%
Melanocytic Nevus	75	89,1%	89,4%	89,6%	87,2%	82,3%
Melanoma Maligna	13	57,3%	58,1%	60,4%	43,2%	18,9%
Nevus Pilosus	21	88,9%	90,1%	90,0%	90,1%	91,7%
Total	215	84,7%	85,2%	85,4%	82,7%	78,7%

Table: Result for SVM

EXPERIMENTS AND RESULTS

We have used SVC for classification of pictures, the results of testing the SVM for different value are presented in the. Results for Melanoma Maligna are much worse comparing to other diseases: partially because it‟s the smallest training set but also because those pictures are quite similar to Melanocytic Nevus, which is the biggest set. This is also a common problem in dermatology to differentiate between Melanocytic Nevus which is not very dangerous and Melanoma Maligna which can be lethal.

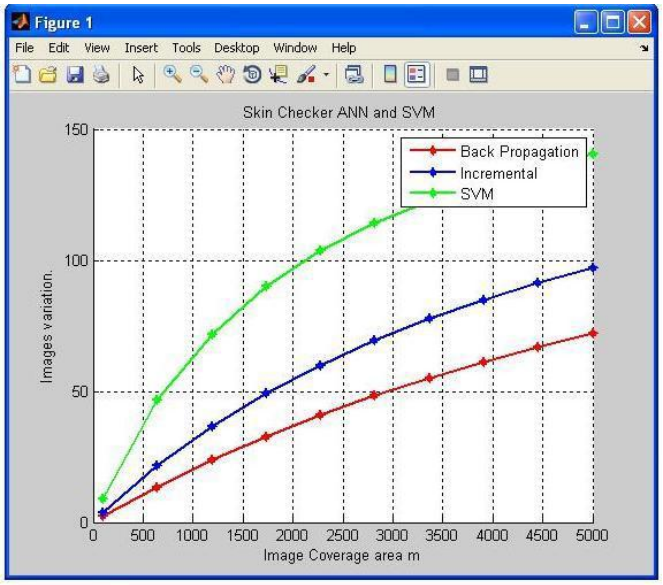

Fig 1.5: Result for SVM

The presents a comparison of the best results achieved by each method. It appears that much better results in classification were obtained using ANN than SVM. It seems also that ANNs are more resistant to insufficient data amount, because even for small set of Melanoma Maligns pictures results were satisfactory. That cannot be said about SVM, which had a problem with classification of above mentioned disease and mislead it with Melanocytic Nevus. Comparing both used ANN‟s algorithms we can observe that better

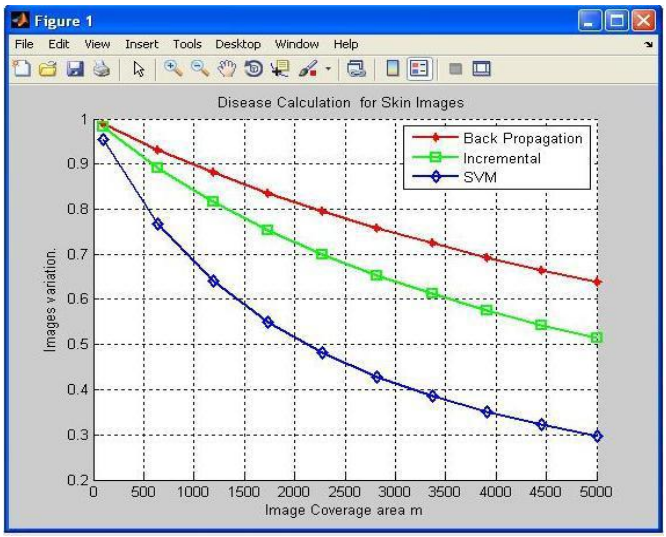

Fig: Cross Validation Result

CONCLUSION

ANNs are very efficient tools for pattern recognition and they can be successfully used in dermatological applications. They can increase the detestability of dangerous diseases and lower the mortality rate of patients. Skin checker can recognize diseases but the doctor has to decide if there is a need to analyze some part of the skin. After using the program, the doctor has to decide what to do with the results. The data obtained from the program can be helpful. Although computers cannot replace the dermatologist, they can make his work easier and more effective. Proposed system might be also very useful for general practitioners, who do not have wide knowledge about dermatology. ANN and SVM are participated in the skin disease for each image characteristic of the pattern recognition. The MATLAB Simulation results are based on the images recognition of the Medical Image Data Set. ANN based on used to the back Propagation Algorithm to similar compare to SVM technical using DNA Data set. Least error rate finds out the minimum value of SVM.

Future Enhancement

Although Skin checker has classified diseases correctly, there are still a lot of improvements which can be done to increase its accuracy. Some additional information can be added to the training set, for example age of the patient, color of the skin, etc. Bigger datasets with more different diseases should be used to make the use of Skin checker reasonable, however it is hard to obtain enough pictures currently. Also a tool, which will help the doctor to prepare the picture for classification would be desirable, as well as some hardware to obtain proper images of the skin. Set of instructions about how to take usable pictures, including information about light, distance from a patient, etc. should improve the usability of Skin checker.

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